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TECHNOLOGIES
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StellarMate OS

User Manual

Version 2.8
Released 2024.04.08

StellarMate X
StellarMate PRO

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StellarMate X

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Warnings

> ⚠ **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.**

Introduction

Description:

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. StellarMate X is simple:

1. Connect your equipment (Mount, Camera, DSLR, Focuser, Filter Wheel..etc) to StellarMate X via USB or WiFi.stellarmate x tablet
2. Connect to StellarMate X from either your Mobile, Tablet, or Laptop/Desktop Computer.
3. 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.

Quick Startup

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.

Ports

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

Service	Port	WAN/Internet Control
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

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 is no authentication/authorization portal provided by StellarMate, so only open portals at your own risk or by providing an additional layer of security.

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.

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 tp 4TB
- 4x USB 3.0 Ports

- 2x HDMI 2.0 port, support 4K@60Hz
- 1x 3.5mm Audio jack
- 1x Gigabit LAN Port
- 1x Gigabit LAN Port
- 1x Kensington Lock Slot
- 1x USB Type-C (Only for power supply)

StellarMate Pro

Following are the main sections for Stellarmate Pro:

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Warnings

⚠ **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.

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.
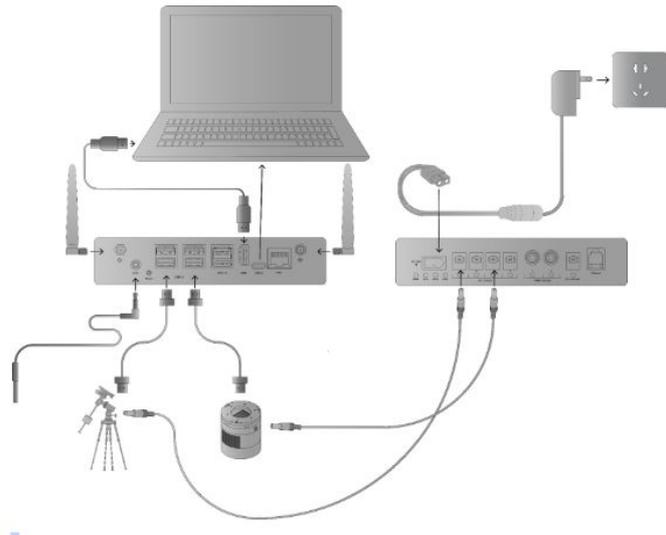
Specifications

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 (For Pictures transfer only to host PC, not as power supply)
Power Output	• 4x 12V DC • 2x 12V Dew Heaters • 1x 3-9V Variable Voltage
Auxiliary	• 1x Stepper Controller

	• 1x External Sensor Port

Package Contents

Astrophotography Controller

XT-60 Power Adapter

50cm & 100 cm DC Cable 5.5x2.1mm

Quick Start Guide

GPS & WiFi Antennas

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.

Assembling the unit
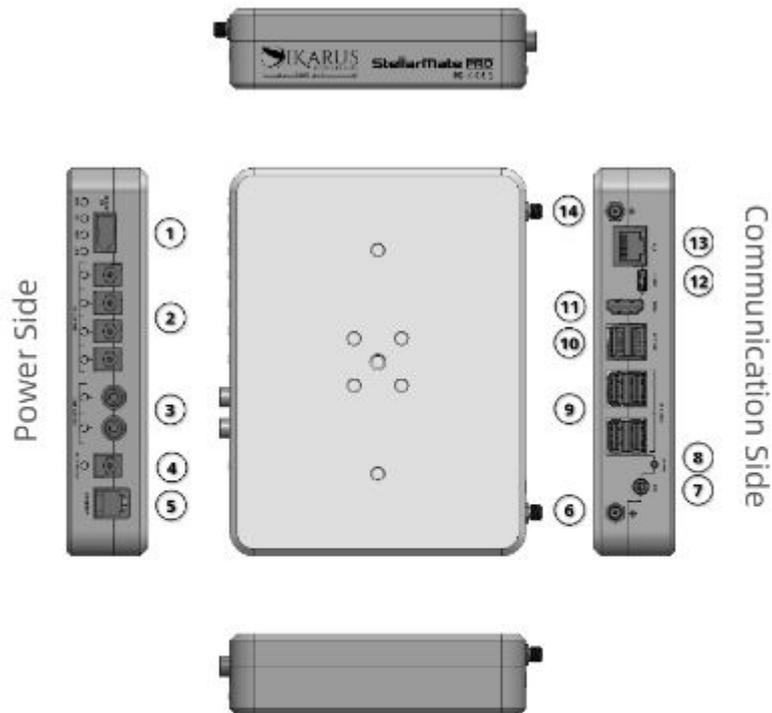
① 12V DC Power Input	⑥ GPS Antenna	⑪ HDMI Output
② 4x 12V DC Output	⑦ I2C/1-Wire Auxiliary Port	⑫ USB-C Data Output
③ 2x 12V PWM Output	⑧ Factory Reset	⑬ Gigabit Ethernet
④ 3-9V Variable DC Output	⑨ 4x USB 3.0	⑭ WiFi Antenna
⑤ Stepper Output	⑩ 2x USB 2.0	

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

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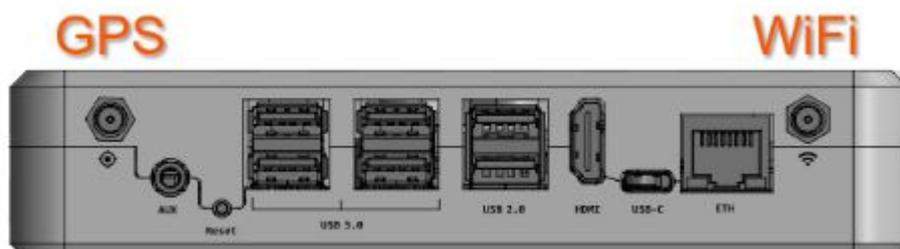
DO NOT SWAP THE ANTENNAS AND DO NOT REMOVE WHILE THE UNIT IS POWERED AS THIS MAY LEAD TO COMMUNICATION LOSS.

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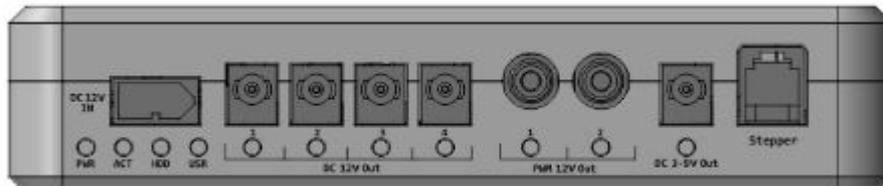
Alternatively, you may connect Ikarus Technologies certified 12V@10A Universal Power Supply (Sold Separately) directly to the unit.

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.
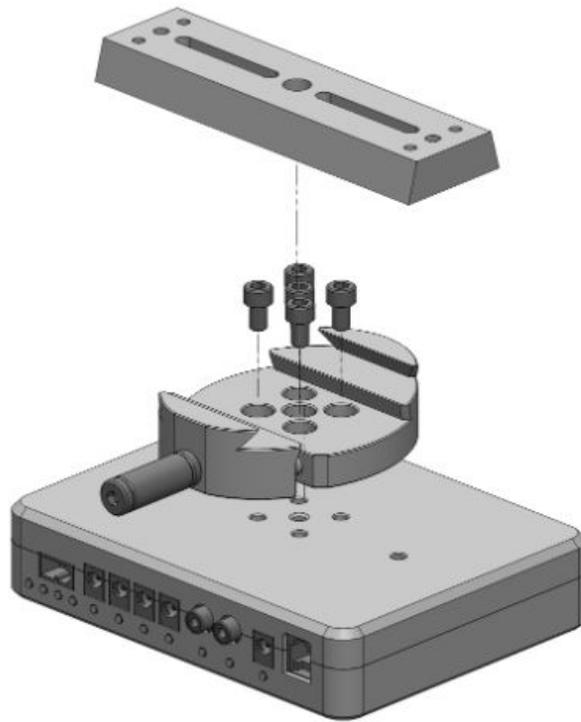
The case can be mounted onto a standard tripod head via the central ¼"-20 UNC thread. All the other threads are standard M6x1.0. The M6 screws length should not exceed 10mm.
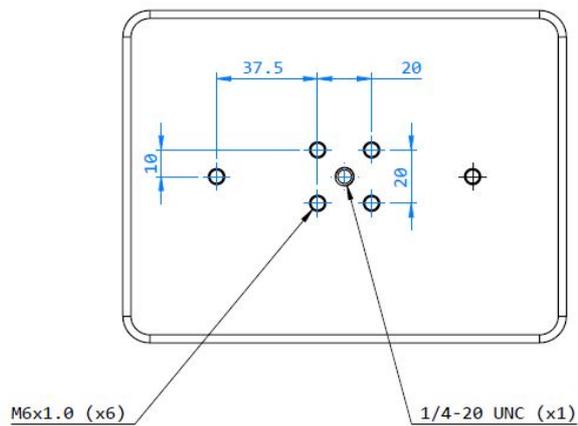
Power Connections

	Parameter	Unit	Min	Max	Nominal
1	Voltage Input DC	V	10	16	12
2	12V DC Output (1 - 4) Load	A	–	3	–
3	12V PWM Output (1 - 2) Load	A	–	3	–
4	Variable Output Voltage	V	3	9	–
5	Variable Output Load	A	–	3	–
6	USB2 Current Capability	A	–	0.5	–
7	USB3 Current Capability	A	–	1.5	–
8	Total Output Load (12V DC + PWM Outputs)	A	–	10	–
9	Total Output Load (USB2)	A	–	1.0	–
10	Total Output Load (USB3)	A	–	5.0	–

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.

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.

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.

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.

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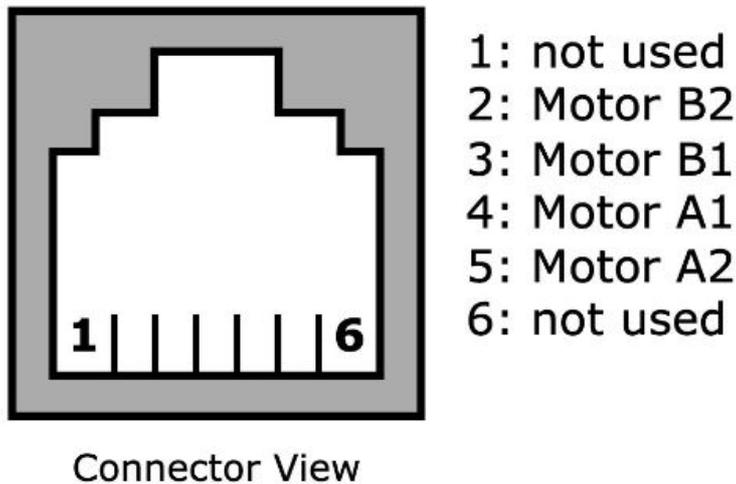
An male RJ12 6P4C (or 6P6C) plug needs to be wired to the motor as illustrated above.

Compatible Motors

Compatible motors

- NEMA-17

Maintainence

Following main sections for maintaining SM Pro:

1. Care Instructions
2. Factory reset
3. Fuses

Care Instructions

1. Use voltage-regulated power supply with a surge protector.
2. Keep StellarMate Pro's firmware updated for optimal performance and compatibility.

3. Store in a cool, dry place away from direct sunlight or extreme temperatures.

4. Avoid exposing StellarMate Pro to moisture or liquids to prevent damage.

5. Handle the device with care to prevent physical damage or impact.

6. Backup your data and configurations regularly to prevent data loss.

7. Do not operate a unit below zero Degrees Celsius or higher than 35 degrees Celsius ambient temperature.

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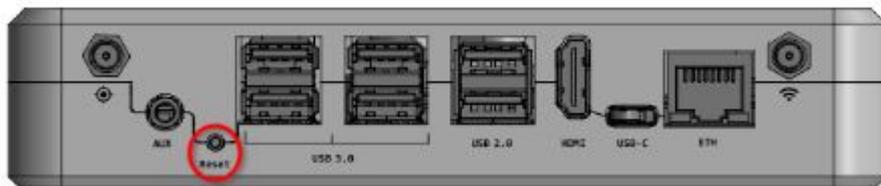
The following are the steps required to perform a factory reset:

1. Use a pin to press the reset button while the unit is off.

2. Power on the unit.

3. Wait until you start hearing a repeating slow beep.

4. Release the pin

5. Select the Factory Reset mode:

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

   b. **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.

6. 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.

Fuses

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

1. 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.

2. 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:
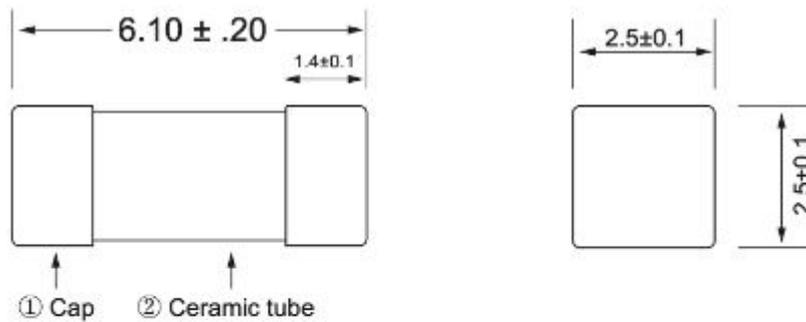
This fuse is protecting the internal circuits and USB connector, if the fuse is burned please contact us before replacing.

Troubleshooting

#	Issue	Possible Causes
1	Unit does not power up	1. Bad Power Supply 2. Bad Power Adapter Cable 3. Bottom fuse burned 4. ????
	Unit does not boot up: • HDD + ACT LEDs not blinking or dark • No Beep • 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.
2	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.
3	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.
4	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.
5	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.
6	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 an external display using an HDMI cable, then high resolution is known to cause interference with WiFi. Try to lower the HDMI resolution to improve the situation.
7	Stepper motor not moving	1. Check for burned fuse messages in StellarMate App. 2. Stepper motor is mechanically locked or blocked. Check if the focuser can move freely while power is off. 3. Check for cable damage. 4. Check if the motor is supported by SM Pro.
8	No Sensor data	1. Check if the supported sensor is used. 2. Check cable is fully plugged to the AUX port. 3. Faulty sensor.

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 if provides. Here are some useful resources to get you started:

- First Time Setup tutorial.
- StellarMate Video tutorials.
- Ekos Video Tutorials.

StellarMate App

You can connect to StellarMate X Controller in several ways, including:

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.

StellarMate on the Google Play   StellarMate on the App Store


⚠ 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!

Registration

When using StellarMate App for the first time, you need to register your device, or sign in using your existing stellarmate.com credentials:

1. StellarMate X: If you purchased an SM X or SM Pro device, you need to register the device first before proceeding. Click 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 sign in using your stellarmate.com username and password. 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.

Registration
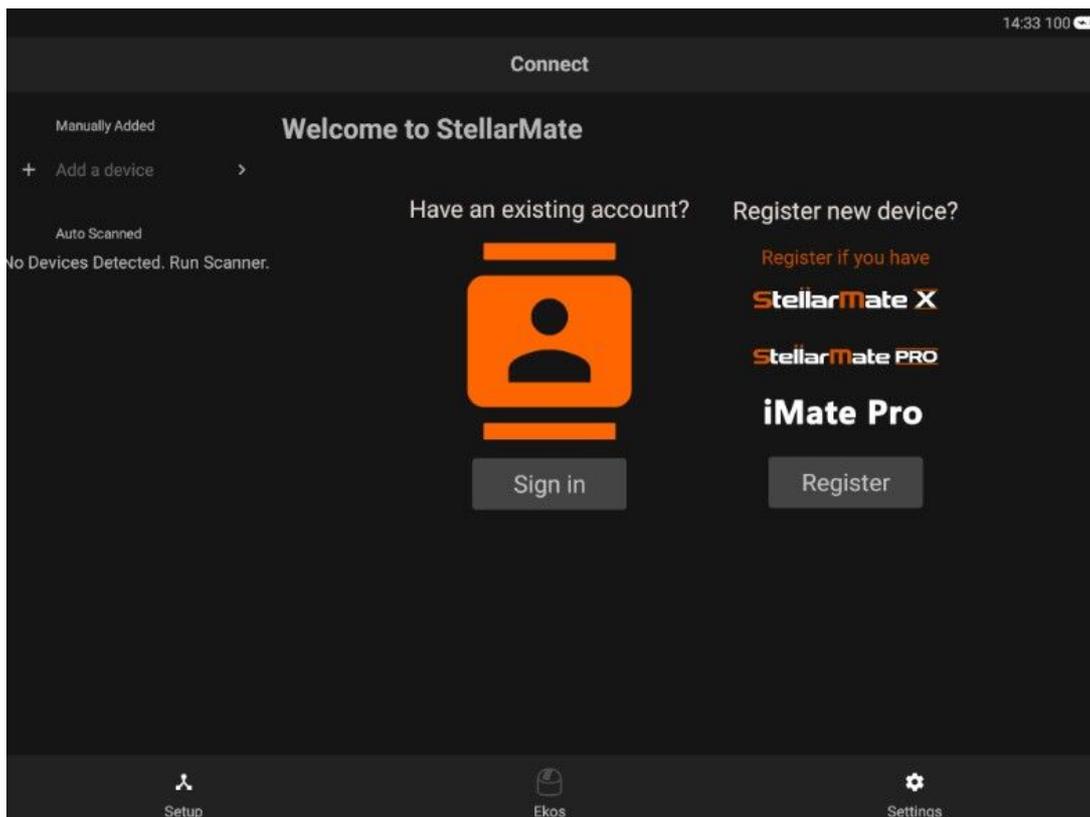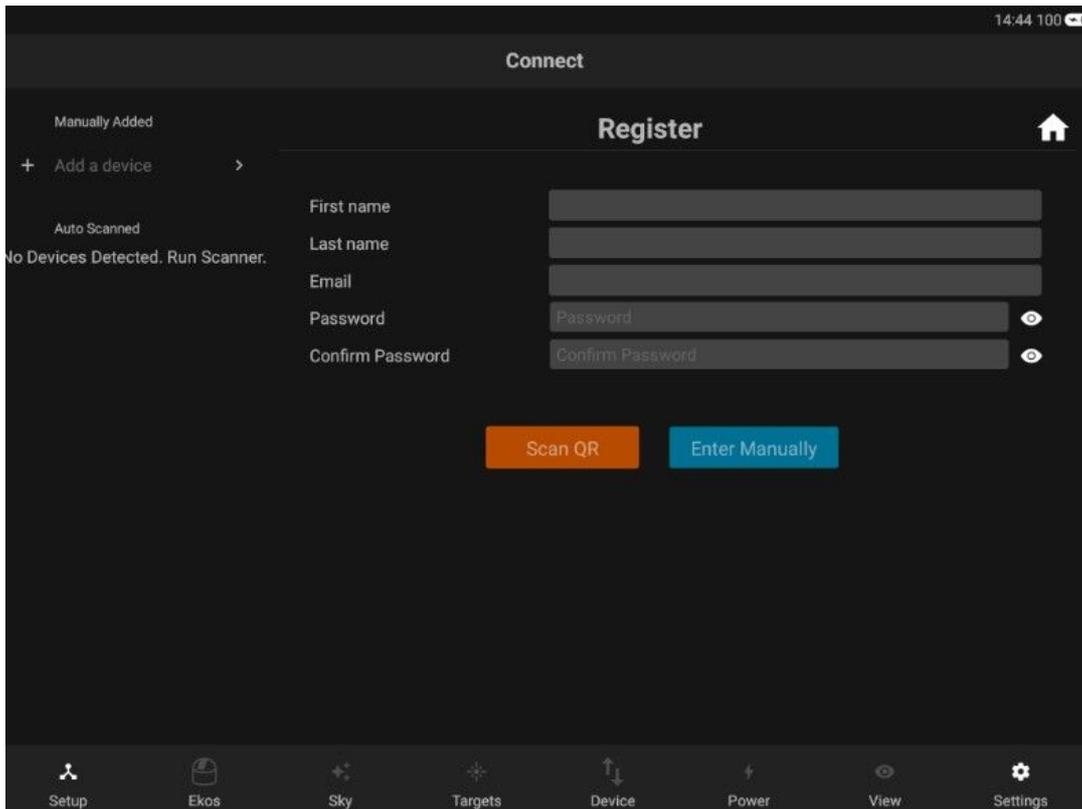
Once required fields are verified, the buttons will get enabled
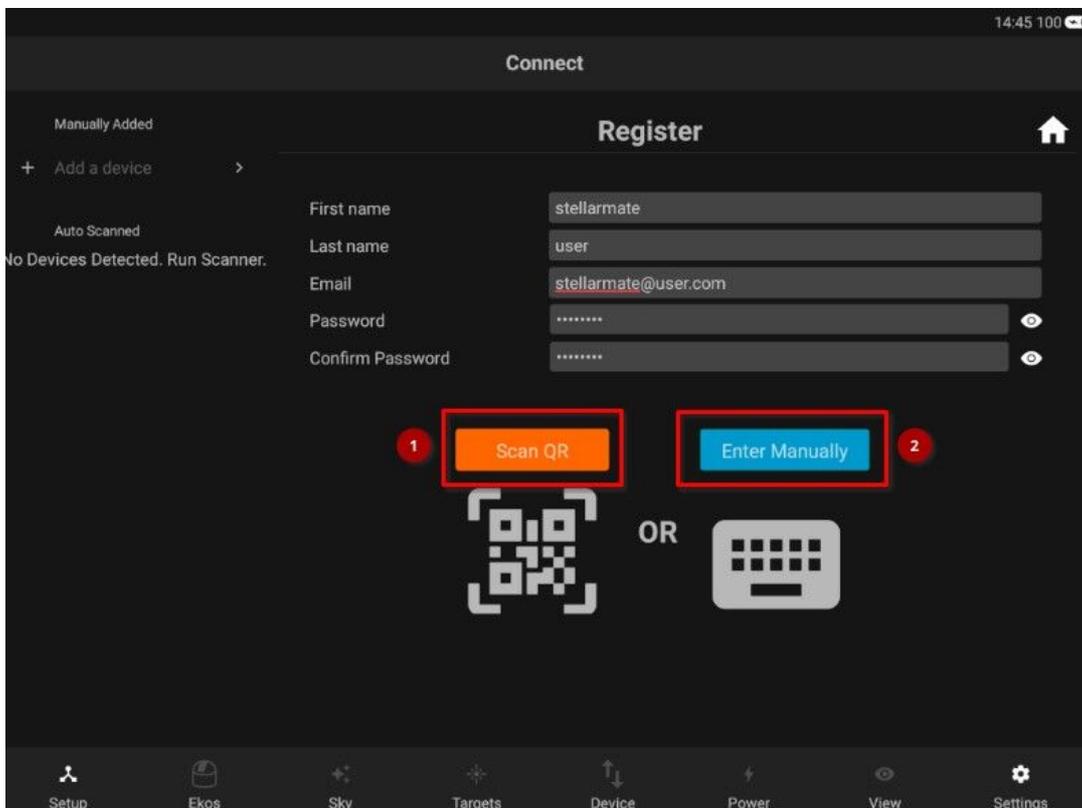
Register via:

- o [Scan QR code](#)
- o Enter Manually

ℹ️ **IMPORTANT**

The StellarMate Mobile App requires a QR Code (on the back of StellarMate Controller) in order to operate the StellarMate Controller. NO registration is required to use the StellarMate Controller if you intend to use it directly via Web or via Ekos client on Mac/PC/Linux. This step is only required if you want to use the StellarMate Mobile App. You can continue to use StellarMate as is, including accessing the Web Manager and VNC:

Web Manager URL: http://stellarmate.local:8624

Web VNC URL: http://stellarmate.local:6080

ℹ️ **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).
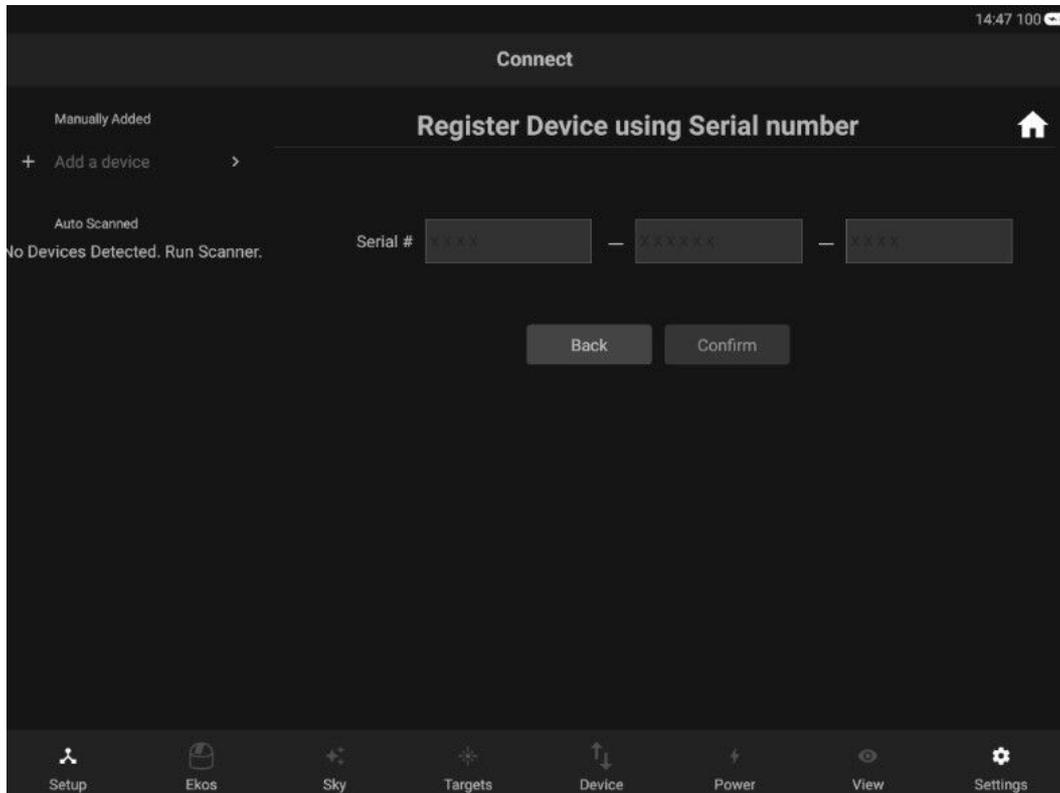

QR Code

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.

Manually

Enter serial written behind StellarMate device. Once you enter the correct Serial #, Buttons are enabled and You will be automatically logged in to SM App. Make sure you are connected to the Internet.

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. Tap on the Register button.
3. Enter registration information to sign up in StellarMate website and then click Next.
4. Scan the QR Code found at the back of the unit.

After registration is successful, you will be logged in automatically. Check your email for your license and login information.
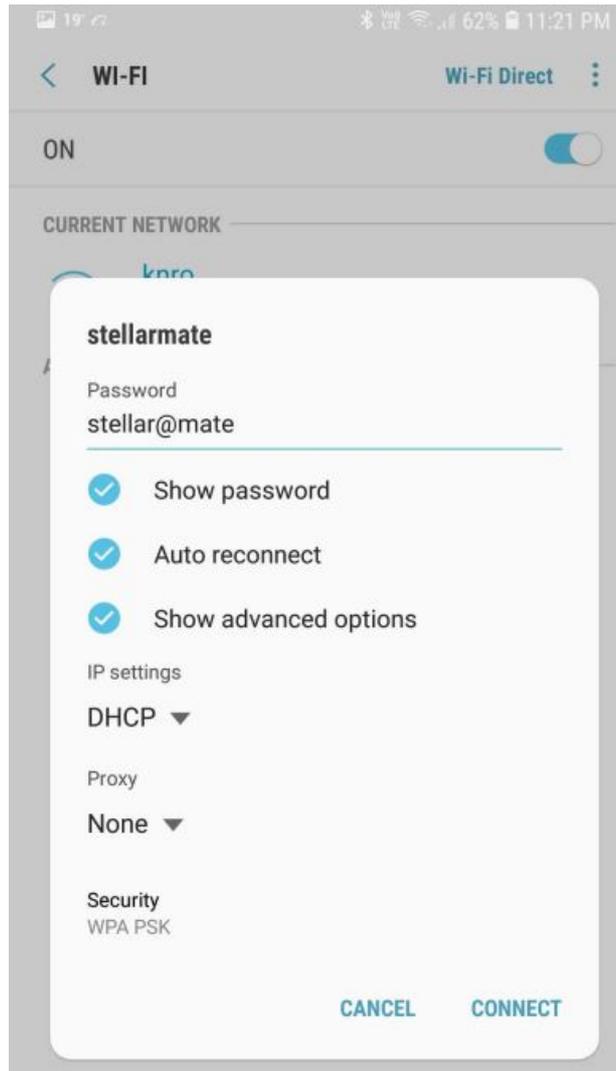
Setup

Go to your mobile OS WiFi settings and connect to the StellarMate hotspot.

Hotspot: `stellarmate`
Password: `stellar@mate`

ℹ️ **IMPORTANT**

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.
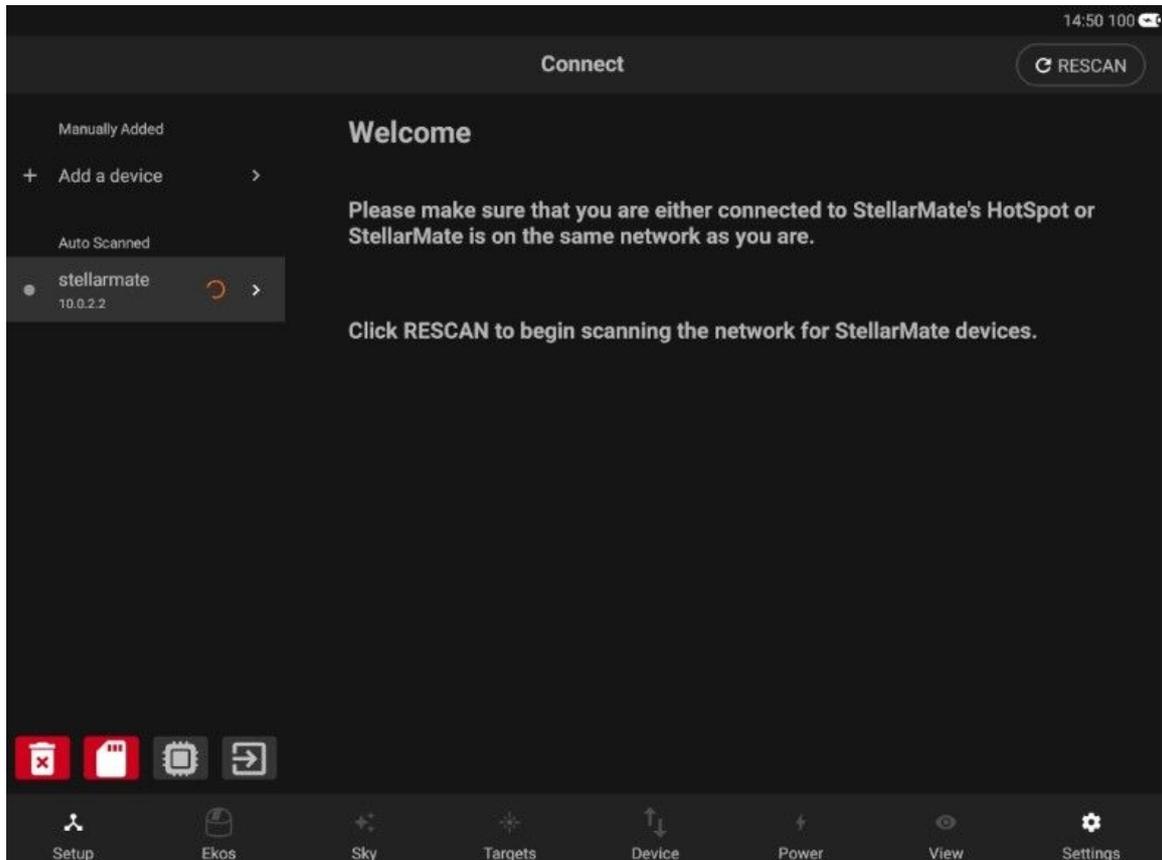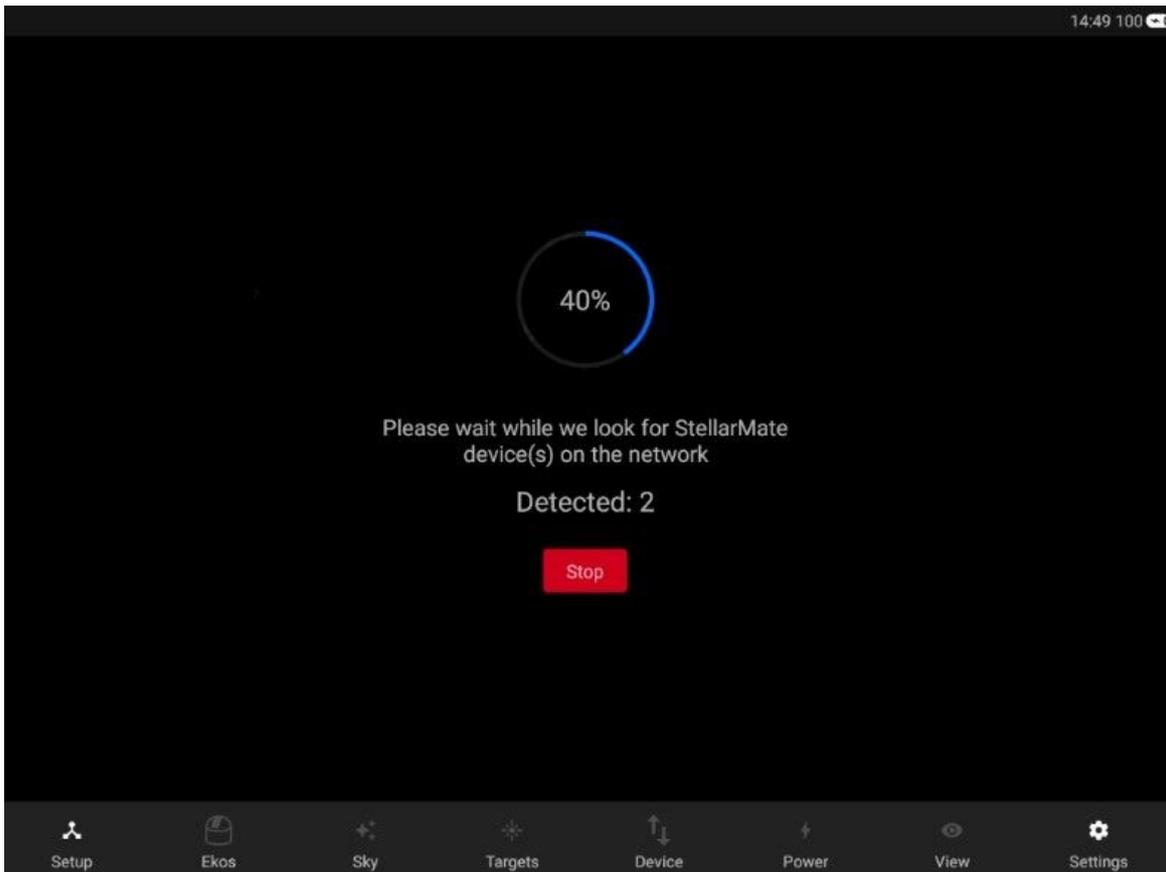
- After StellarMate is detected, tap on it to establish connection. Wait for a few seconds and the LED would turn green indicating a stable successful connection.
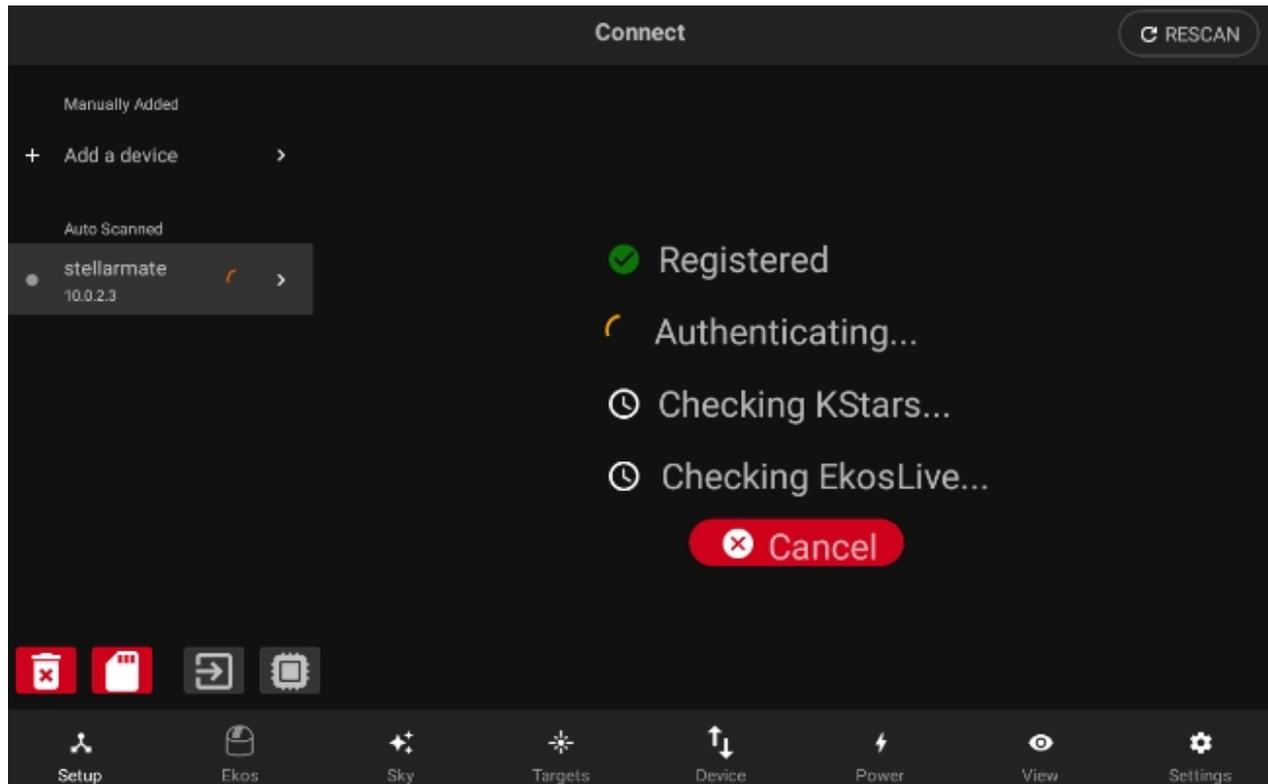
The right side pane should now display the Equipment Profile page. Now you are ready to connect to your astronomical equipment.

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.
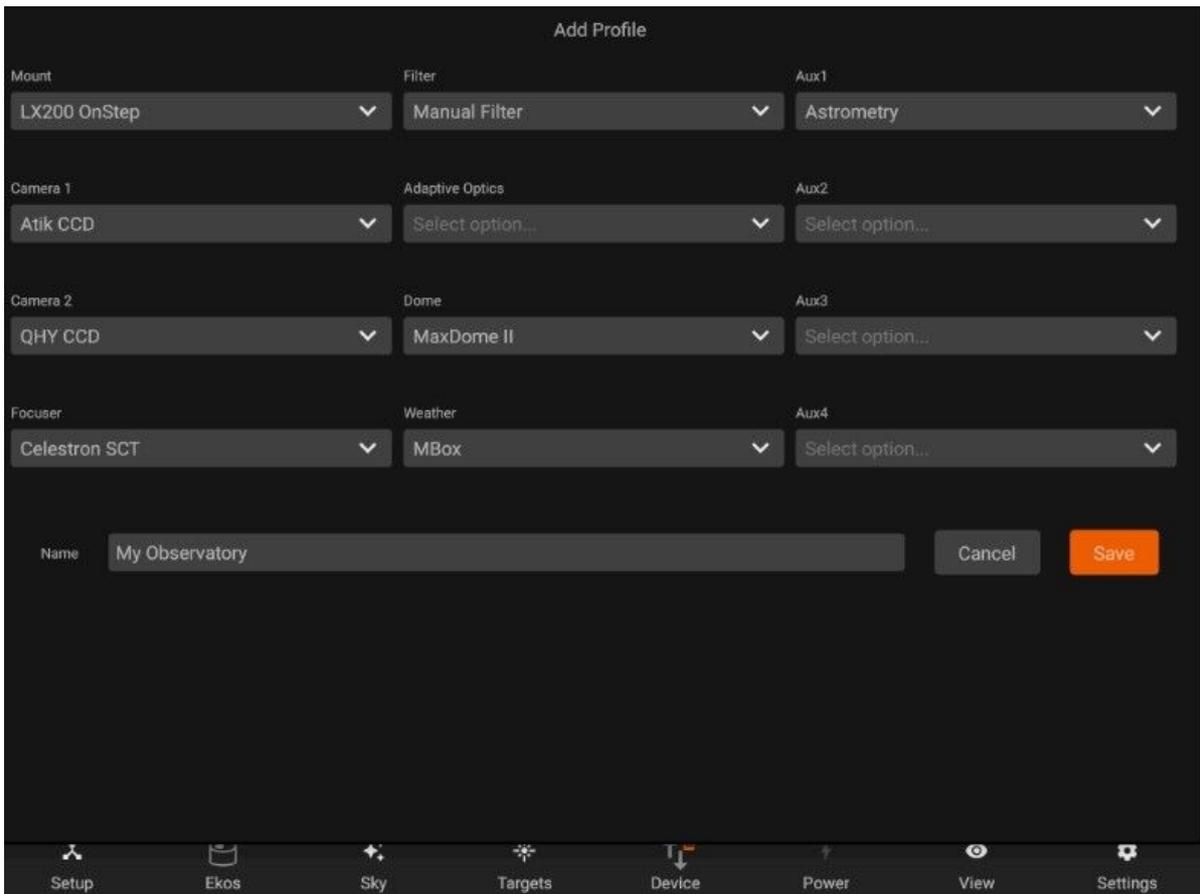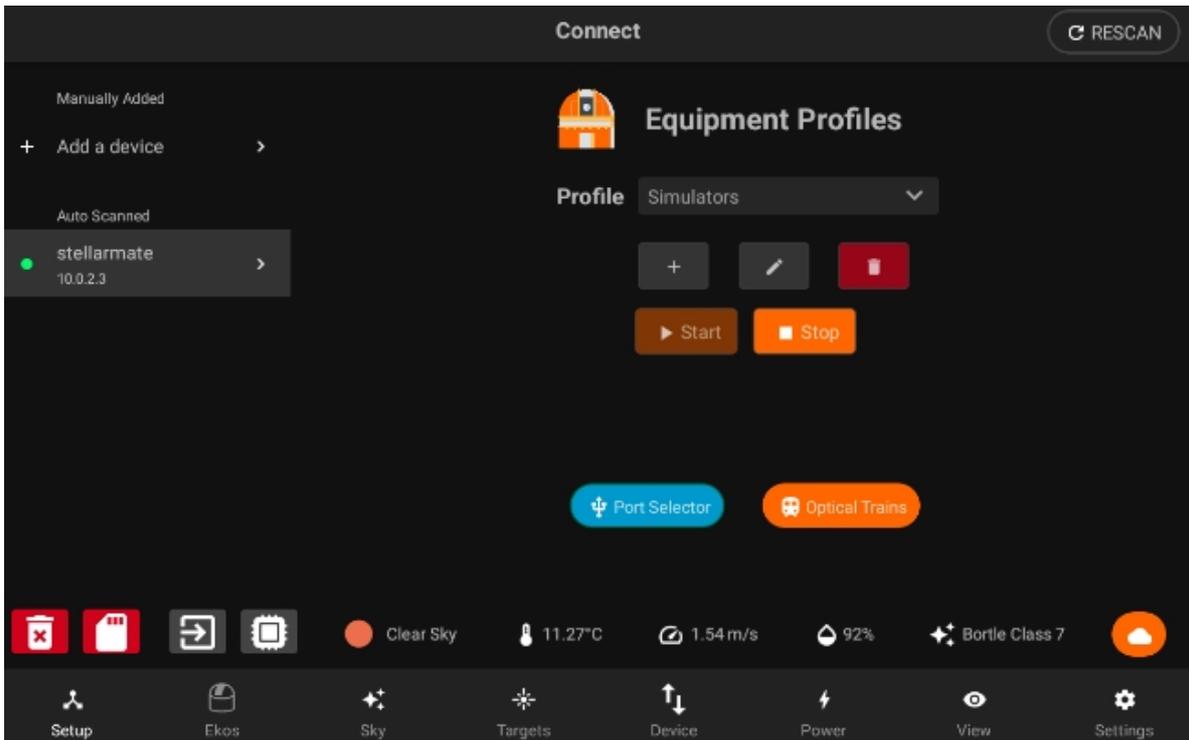
After all drivers are selected, enter the desired profile name and tap Save.

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.

⚠ 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 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 buton.
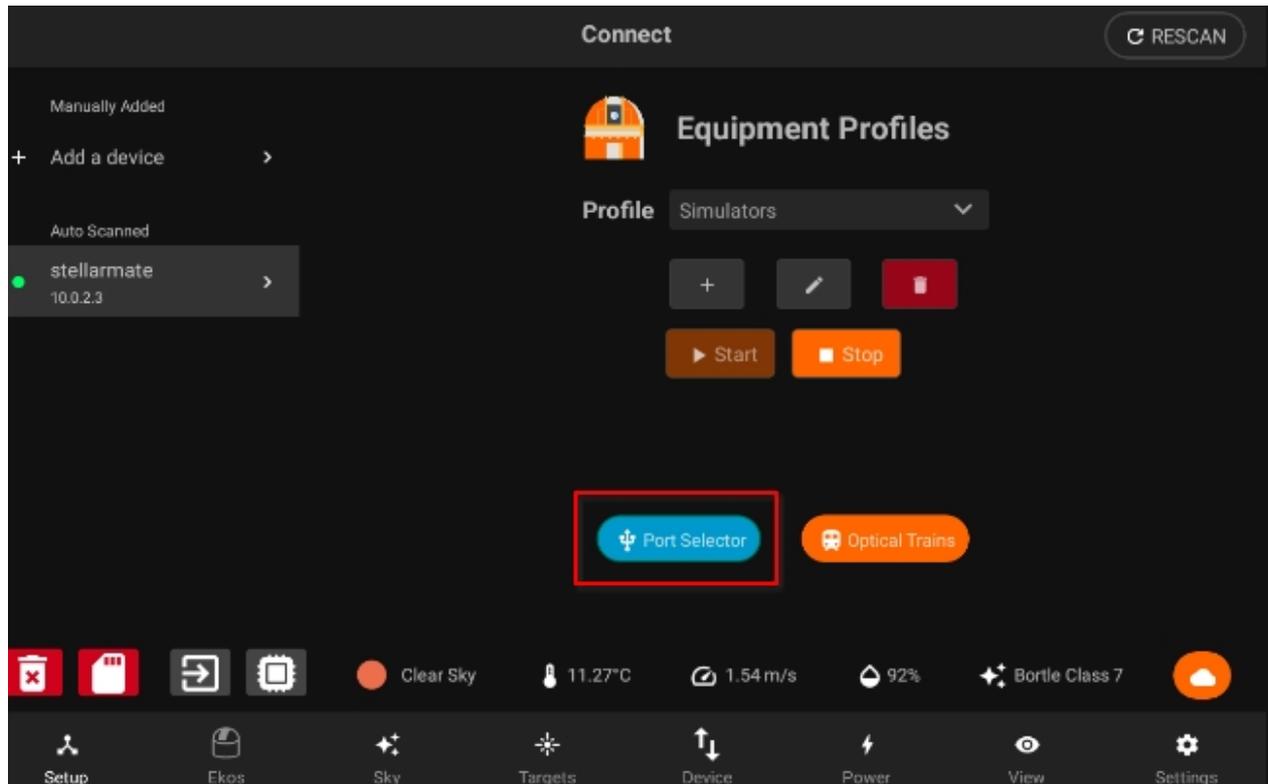
You can specify the ports for serial and network devices using the Port Selector.
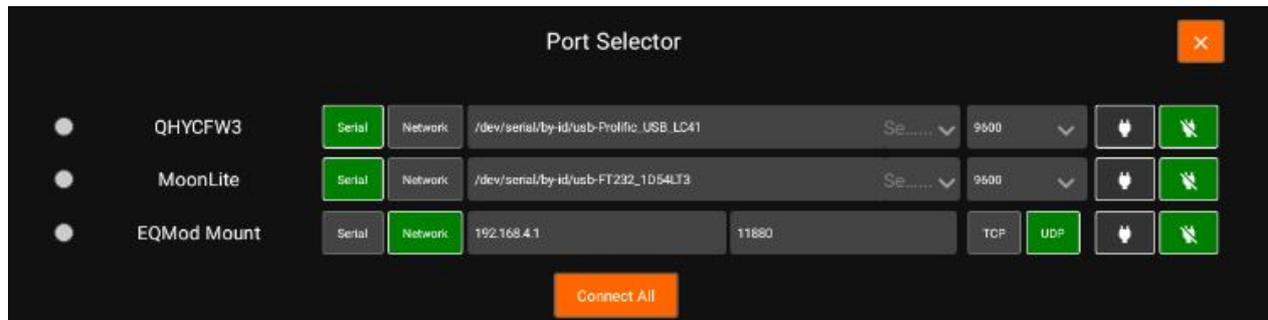
The serial ports can be selected from the drop-down. The addresses are unique to each connected device (similar to COM1, COM2..etc on Windows OS) but the automatically generated port names usually do not tell you which device they are connected to. When you have multiple serial devices, it can be tricky 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
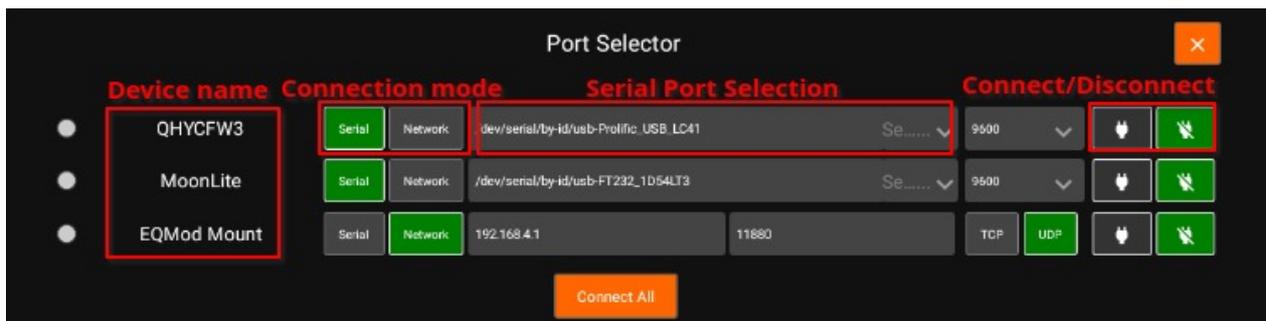
When connecting a serial device, you can specify the port by selecting from the drop-down or typing it in the text field

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).

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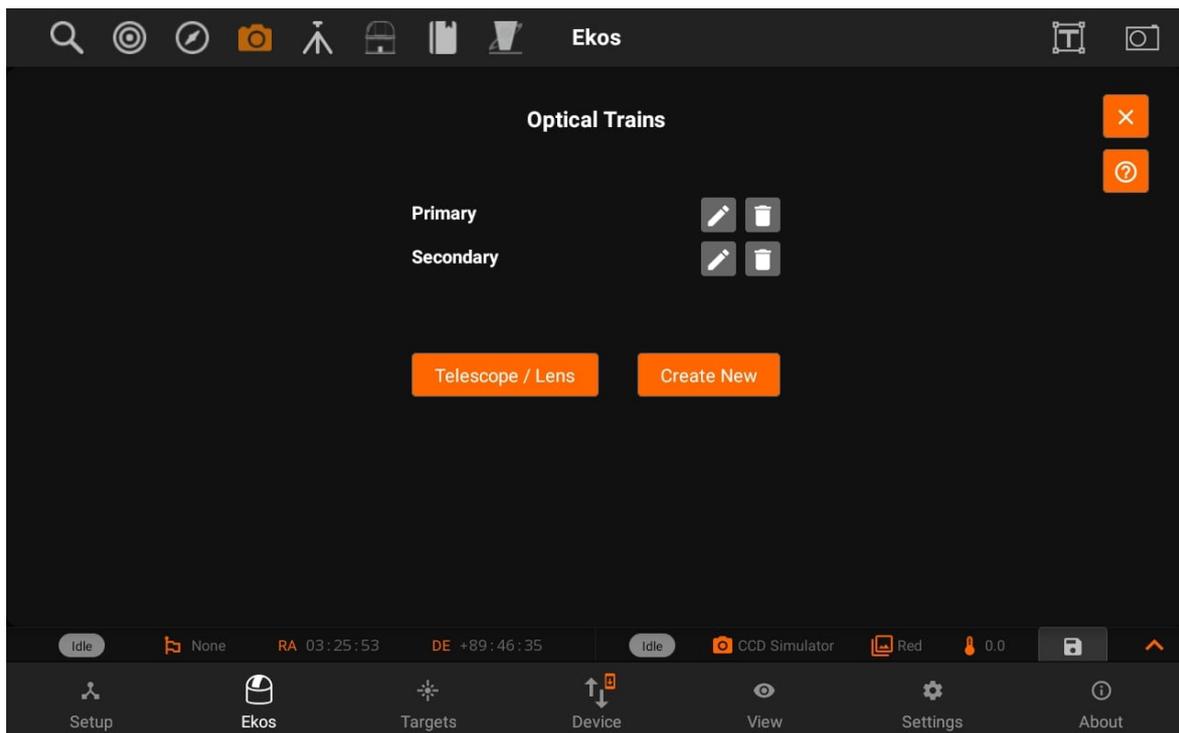
Optical Trains organize your equipment into separate unique optical paths. Each camera must have its own optical train. The following elements are specified in each train:

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.

   a. **Reducer**: By default it is specified at 1.0 which means that has no effect. Range is 0.1x to 0.9x.

    b. **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:

    a. **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.

    b. **ST4**: If using an ST4 cable between the guide camera and mount, then you should select the Guide Camera as the Guider.

    c. **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.
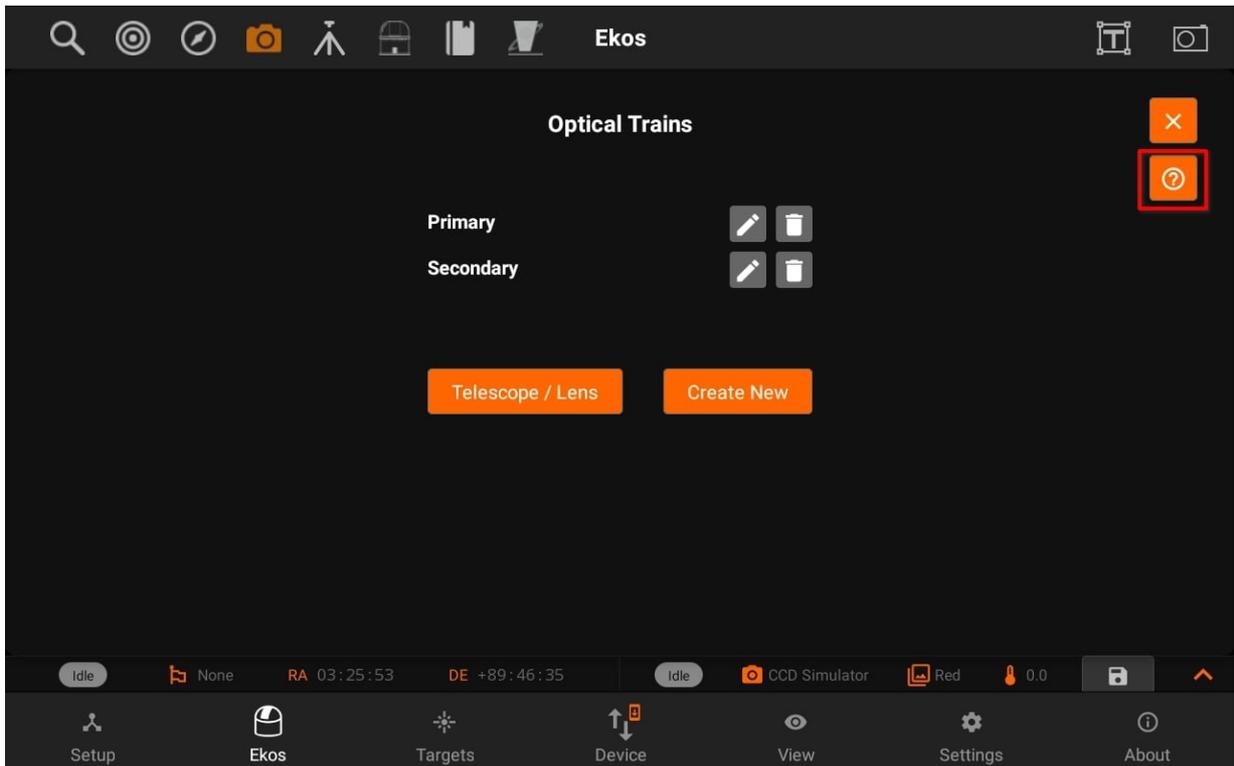
Tap the edit button and it will open the Optical train modal with the specific settings of a train.
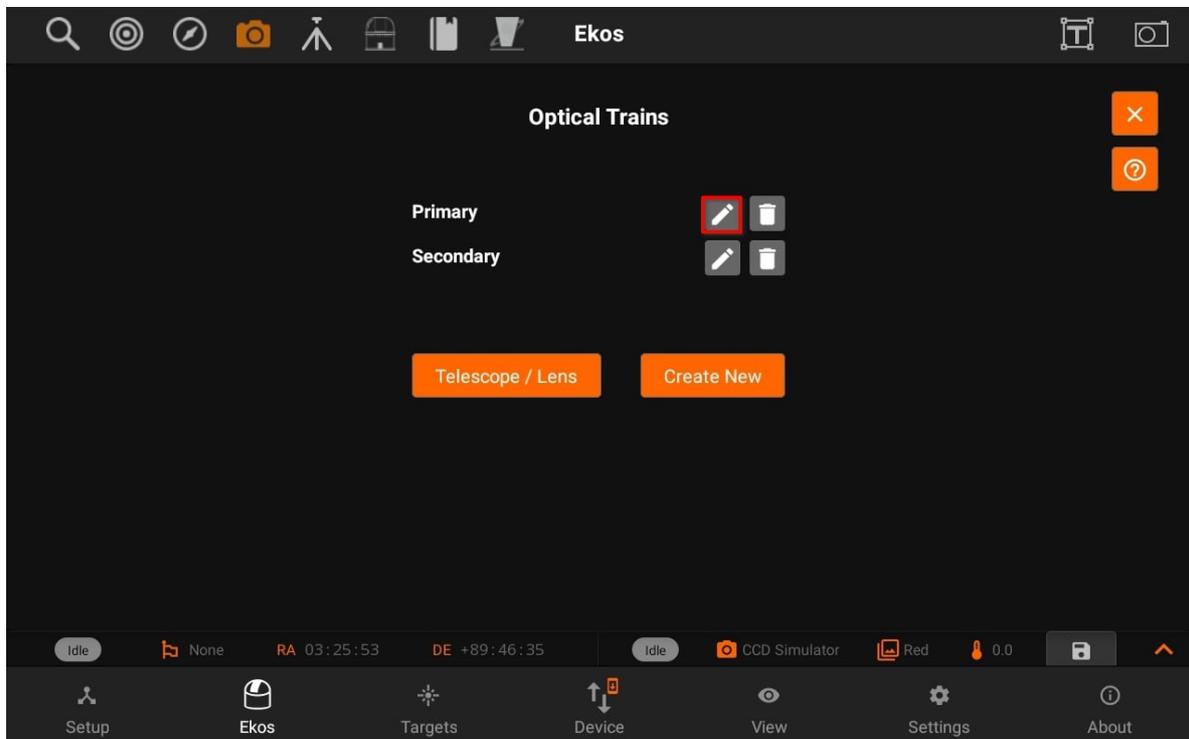
You can also reset the train configuration by pressing Red "Delete Icon" beside the name
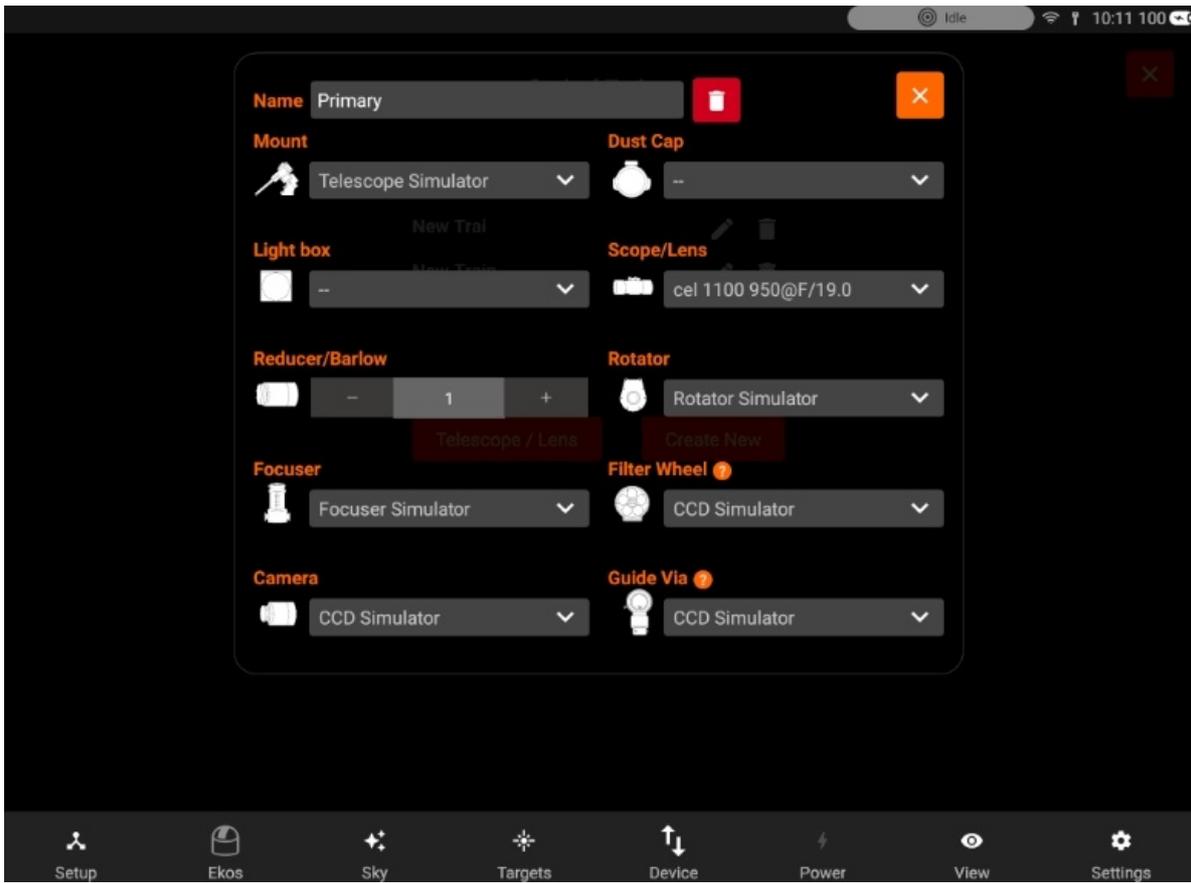
You can now view tool-tip for the description of some devices as shown in the images below:
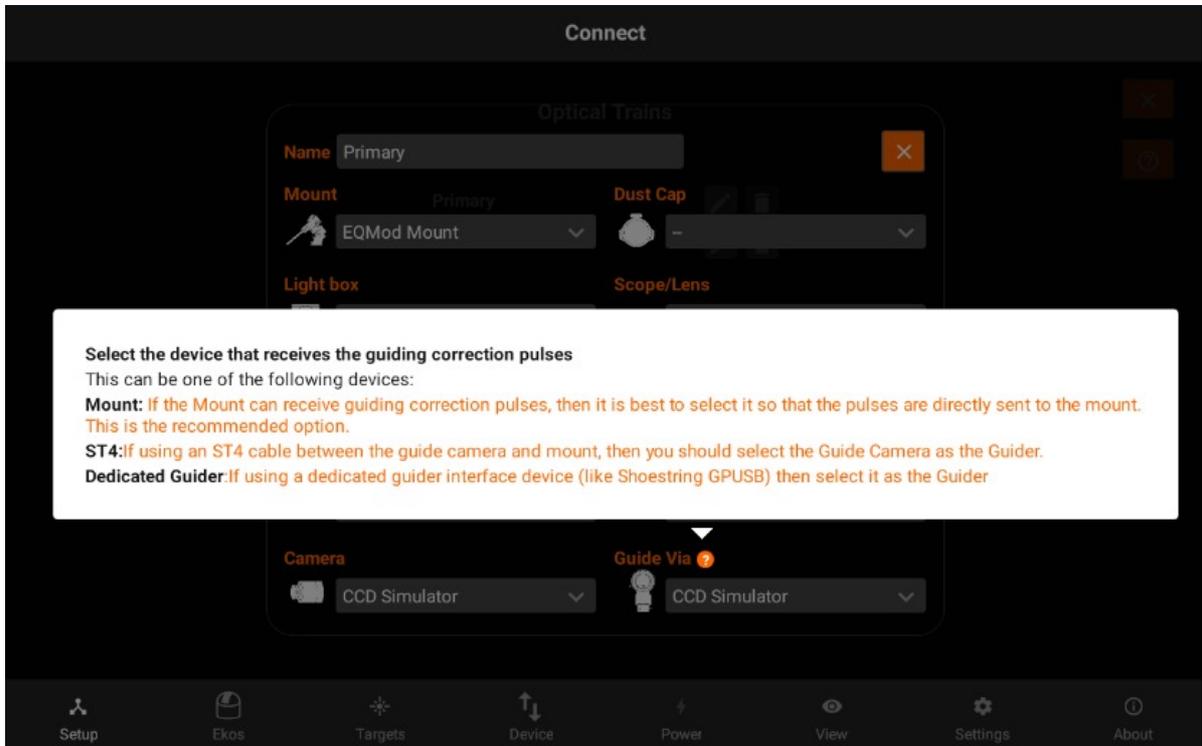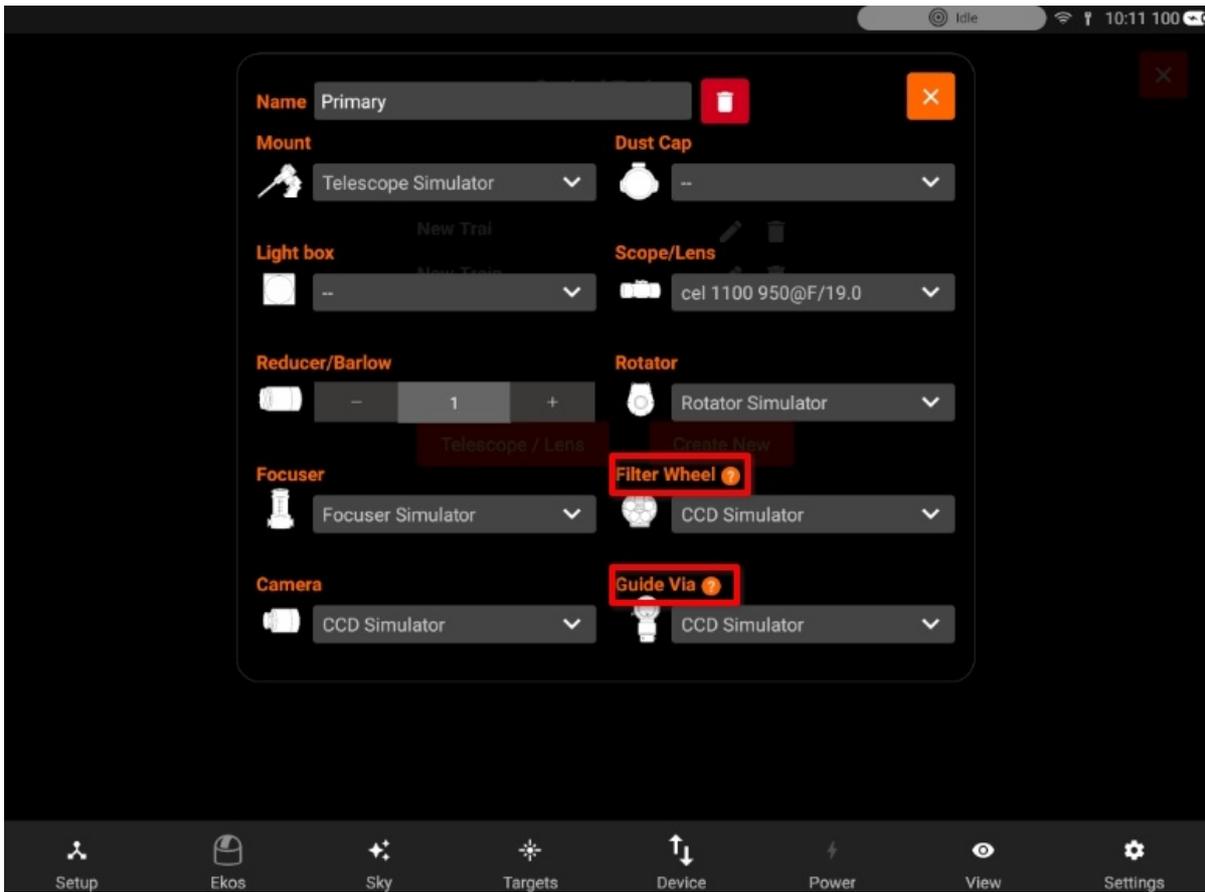
Tapping on Create new to creates a new train with a "New Train" name of previous /
default settings.
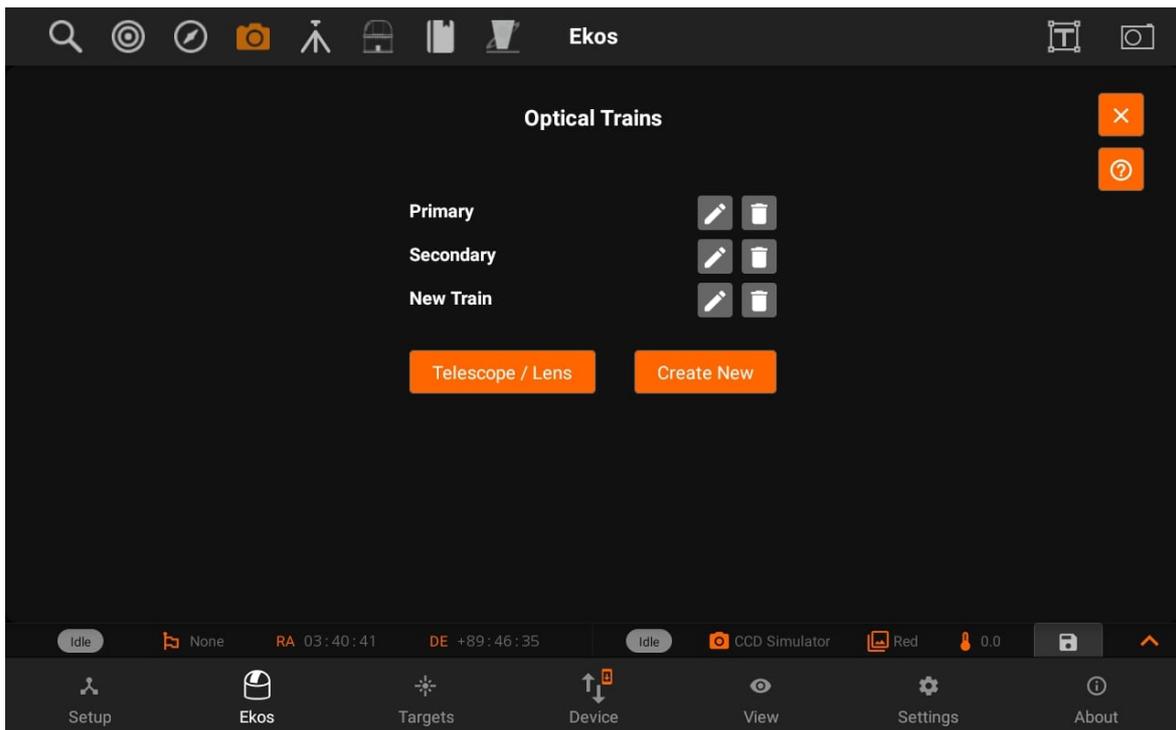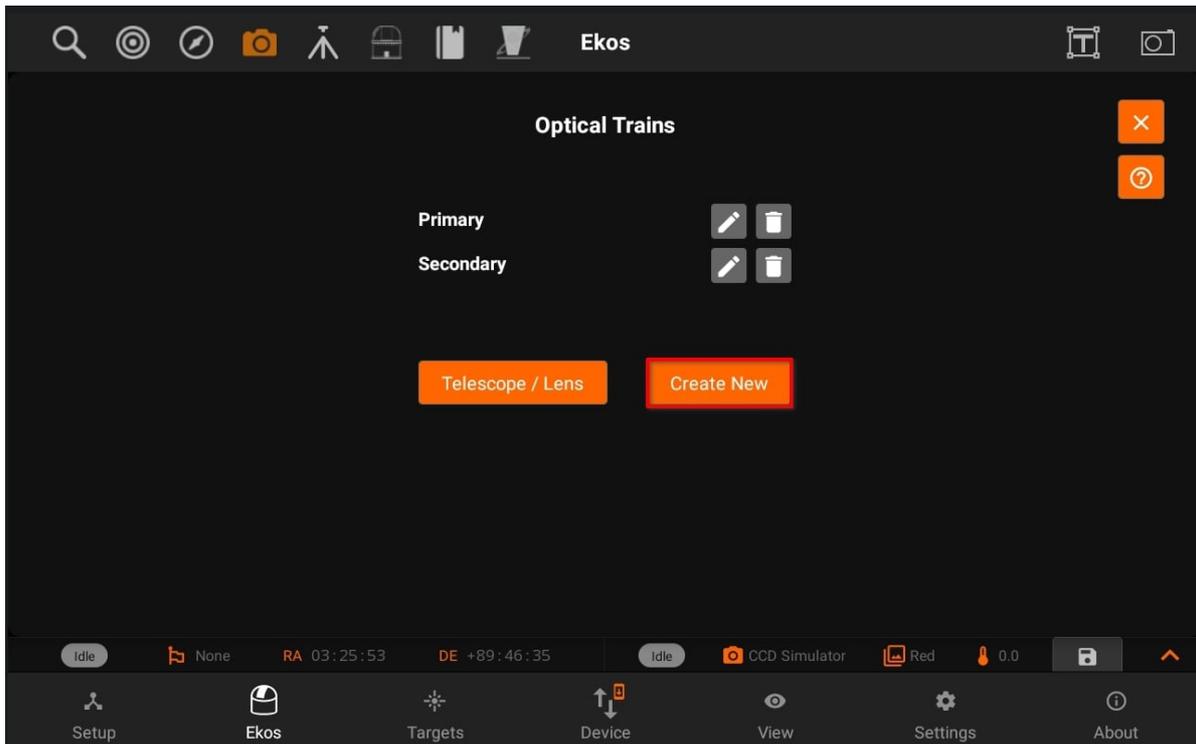
Telescope & Lens:
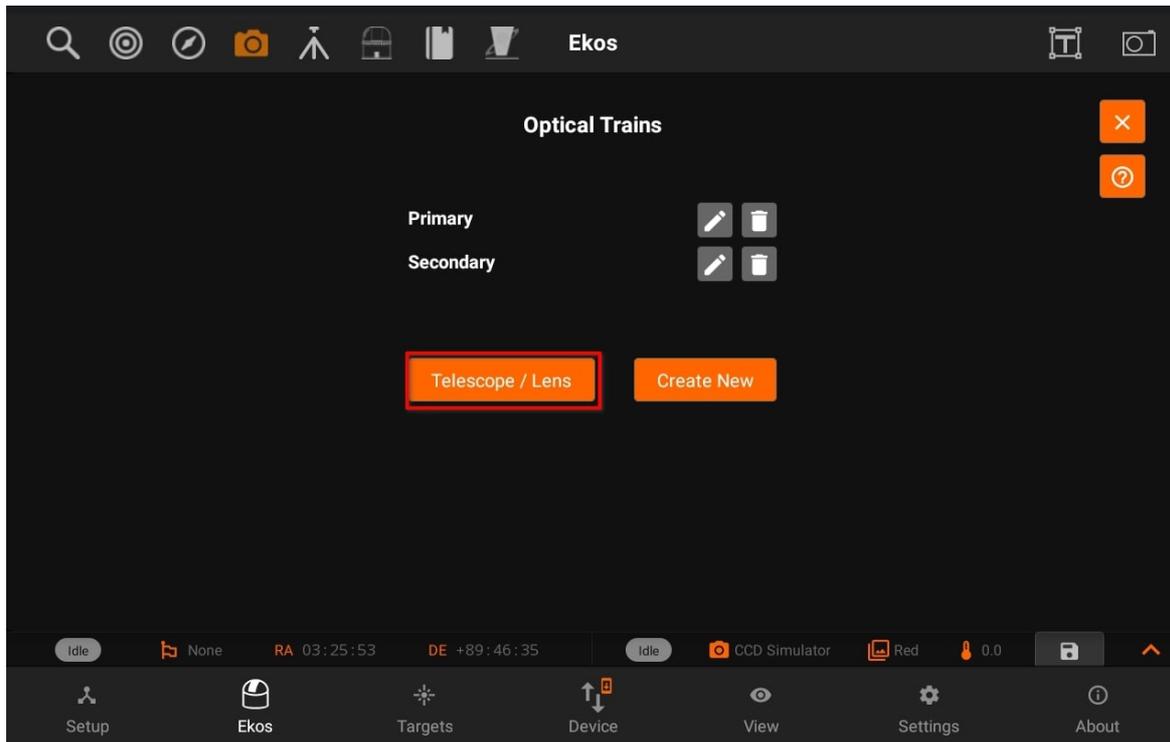
Displays Telescope / Lens View. So, you can Add / Update telescope and lens and then use those in different trains.
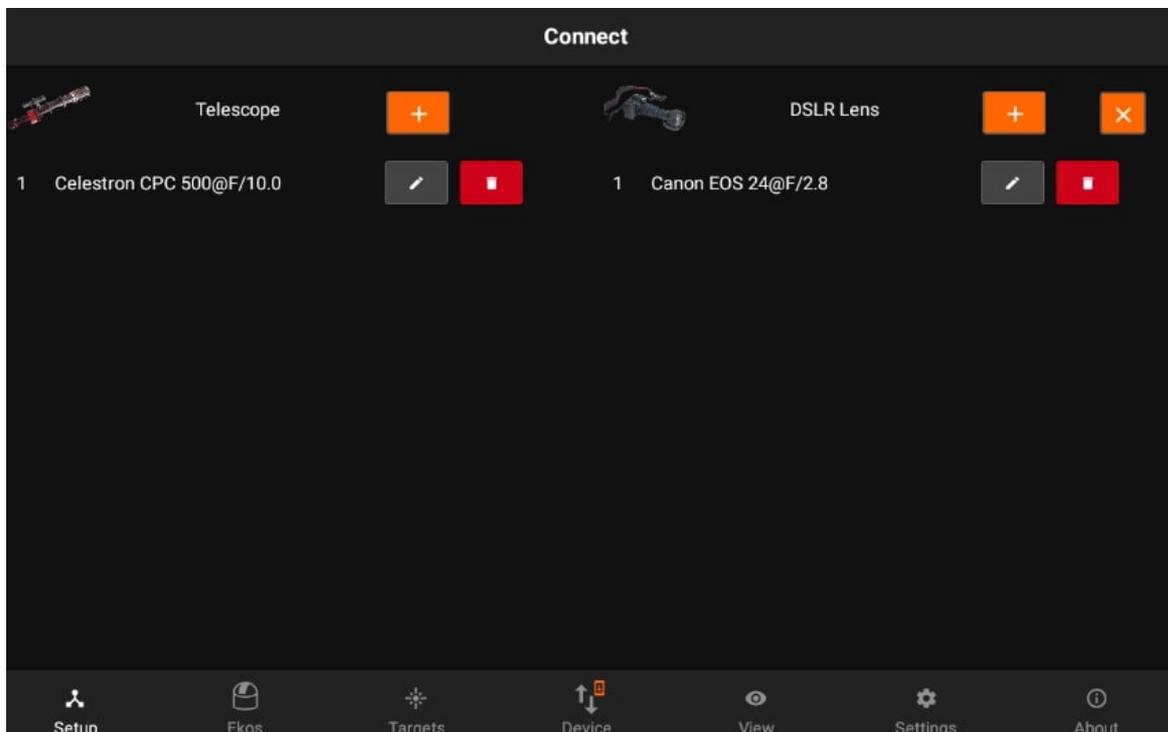
Tap on the Add/Edit button next to the telescope to edit the details of the telescope. All units are in millimeters.You can specify a Telescope and DSLR lens for your trains.
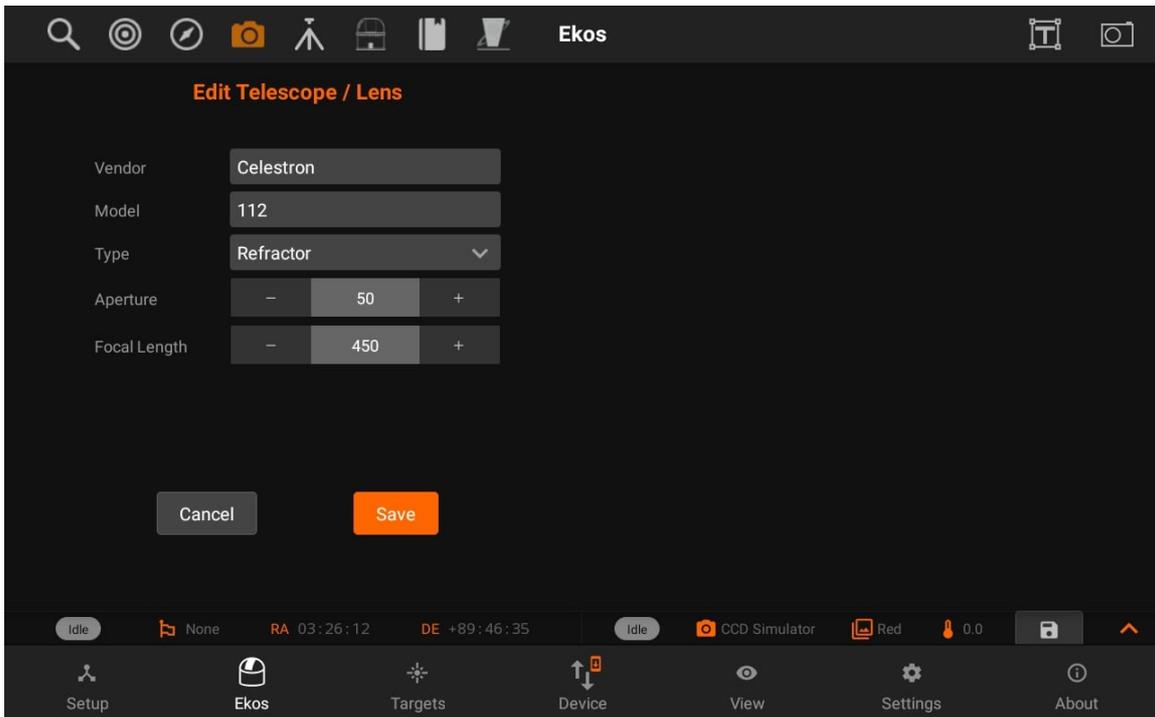
Similarly, you can add/edit DSLR lens and then use Scope/Lens in different Optical trains.
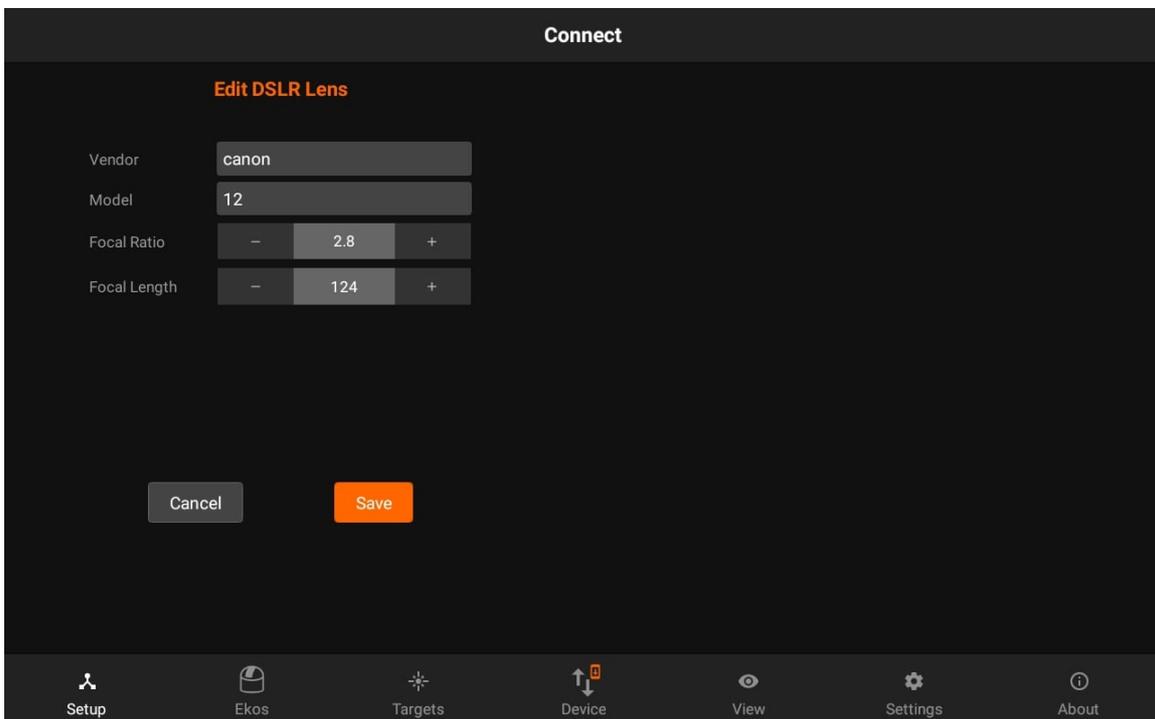
You can also access Optical train from the Setup Tab and Camera quick controls.

Weather Inforrmation

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.
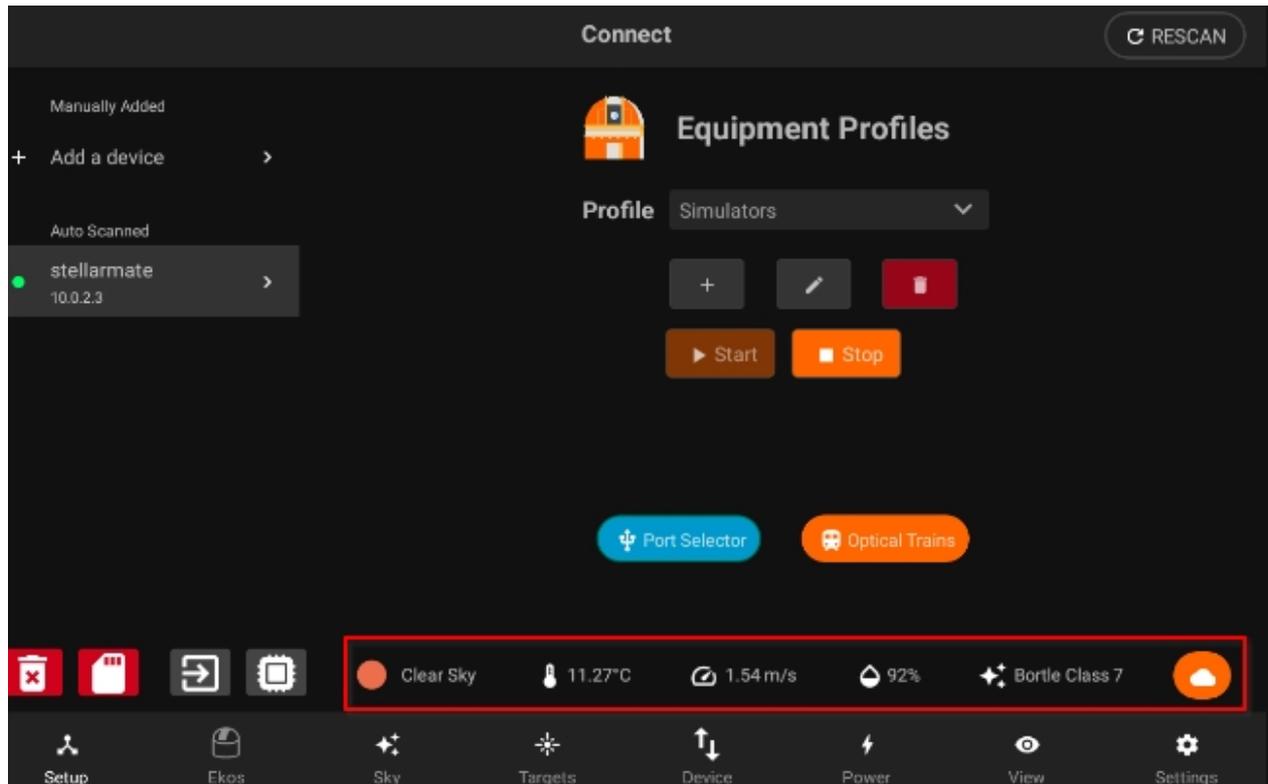
The cloud button displays the 3-hour cloud map based on your current location.
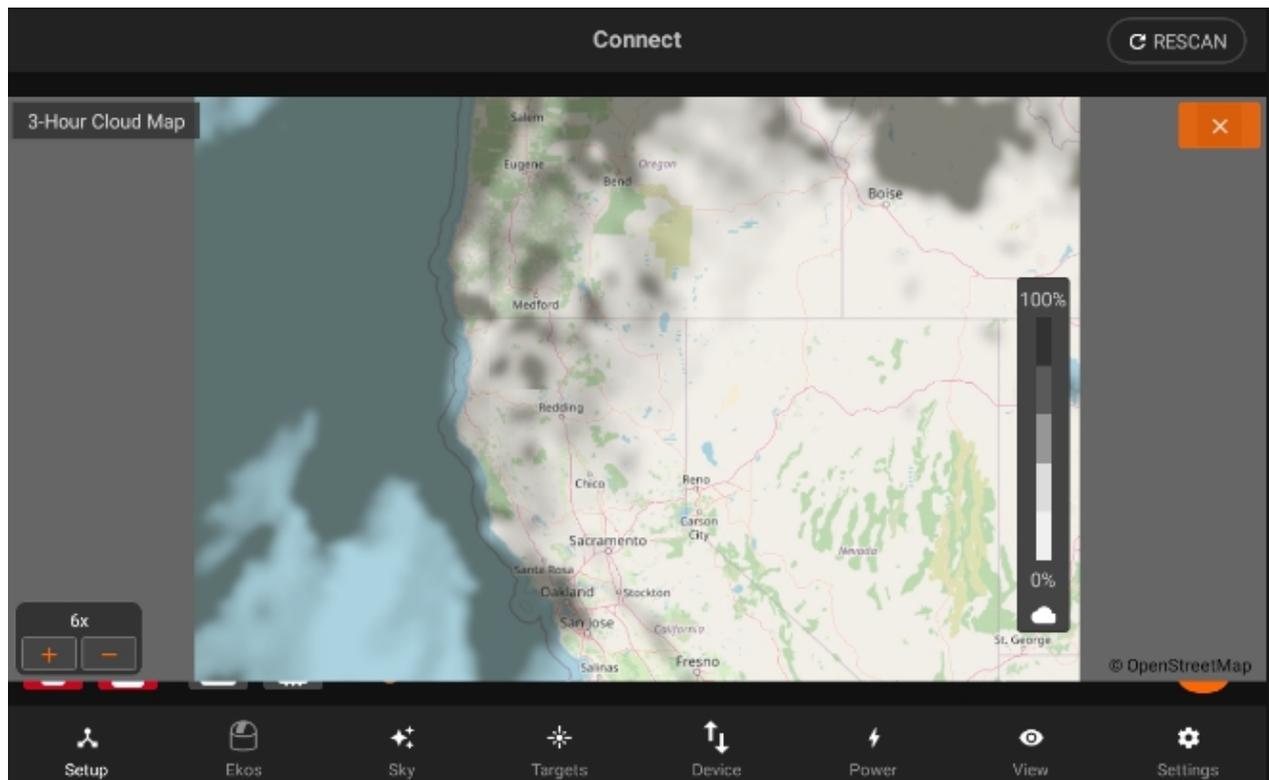
The visibility bar displays the percentage of cloud coverage over the map.

Tour Guide

If you would like to take a tour guide, you will see a pop up whether to continue Tour Guide or later.
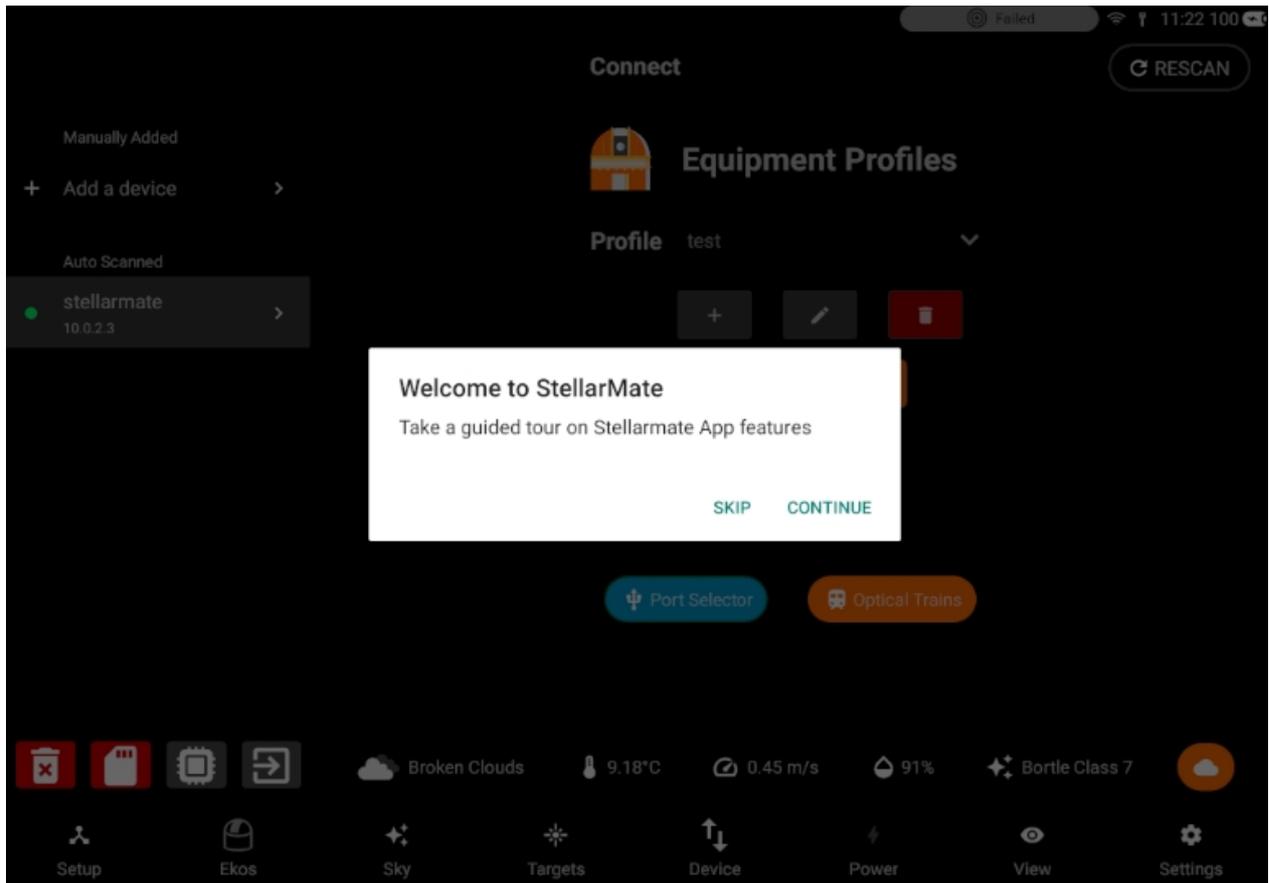
Currently Tour guide is available for few important features i.e Setup, Ekos & Targets.

Tour Guide can be seen in the few images below:

For Setup, you can tap "Next" to proceed to the next tour zones.
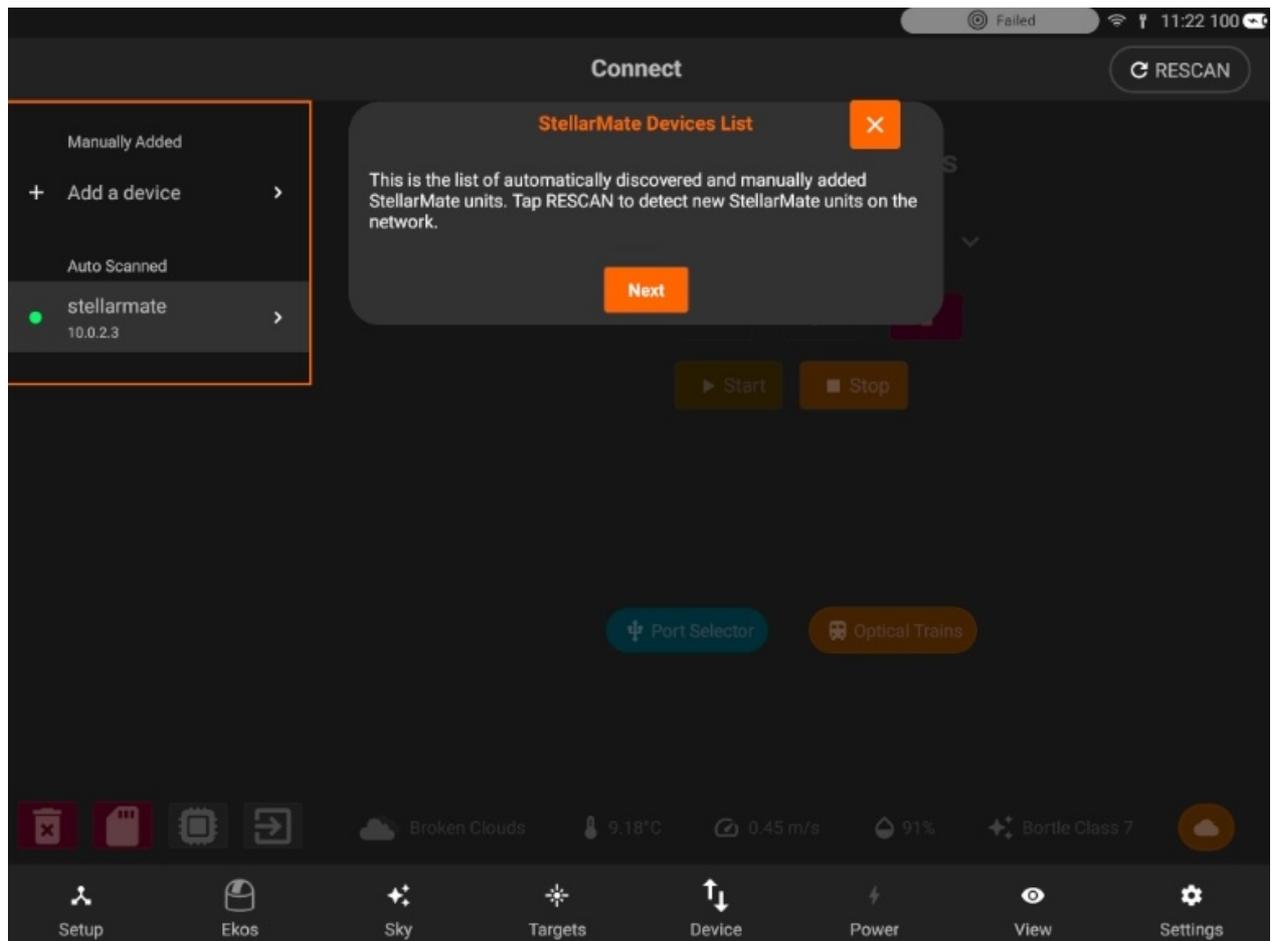
On tap "Finish", the tour guide for specific tap will be considered as completed. You can also tap "X" during Tour guide to close it. That will also be considered as completed.

ON tap "Previous" button, to view the previous tour guide zone.
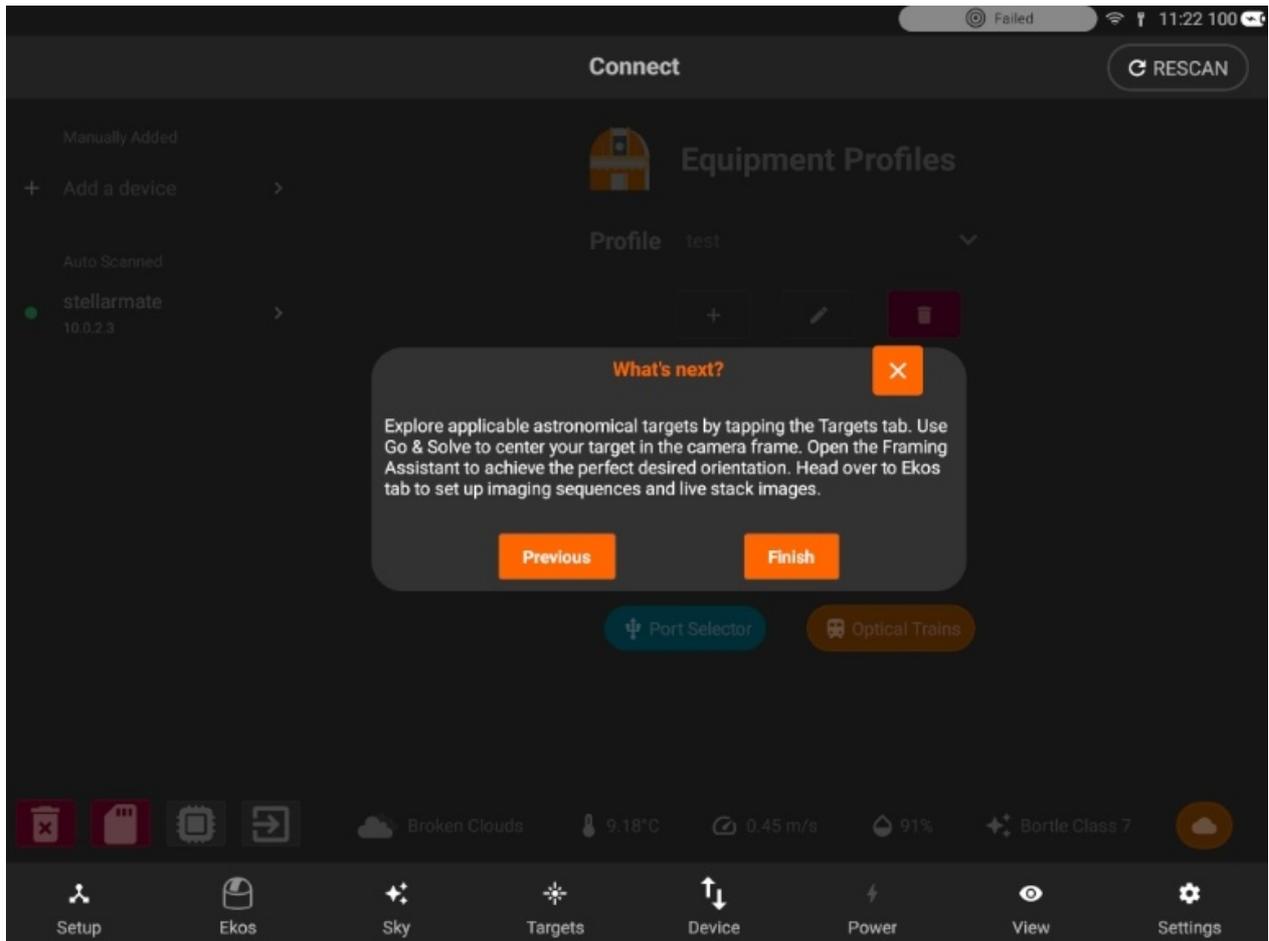
In Ekos, one line description of modules and Quick controls is explained.
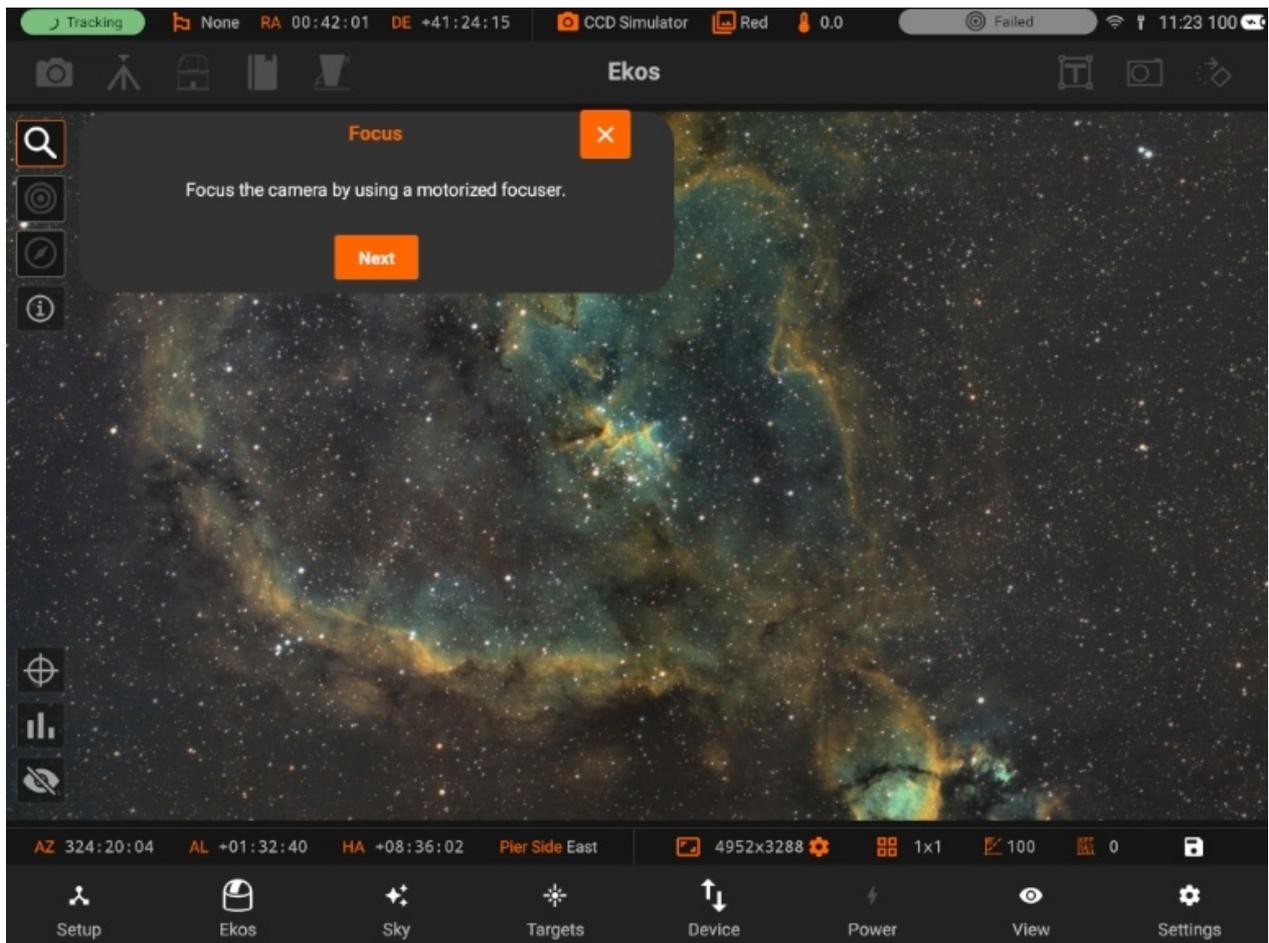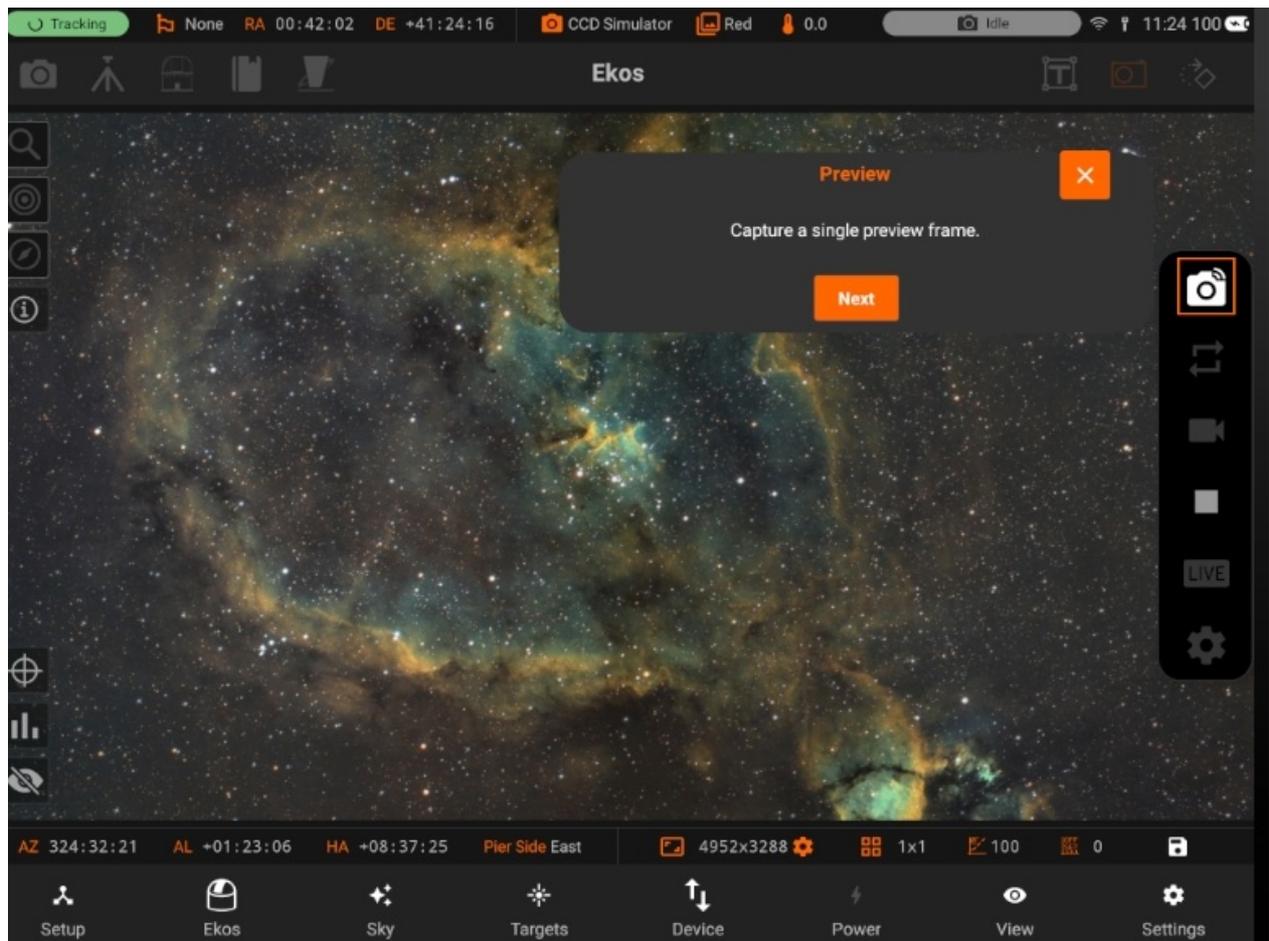
In Targets, the main features are explained as shown in the few images below.
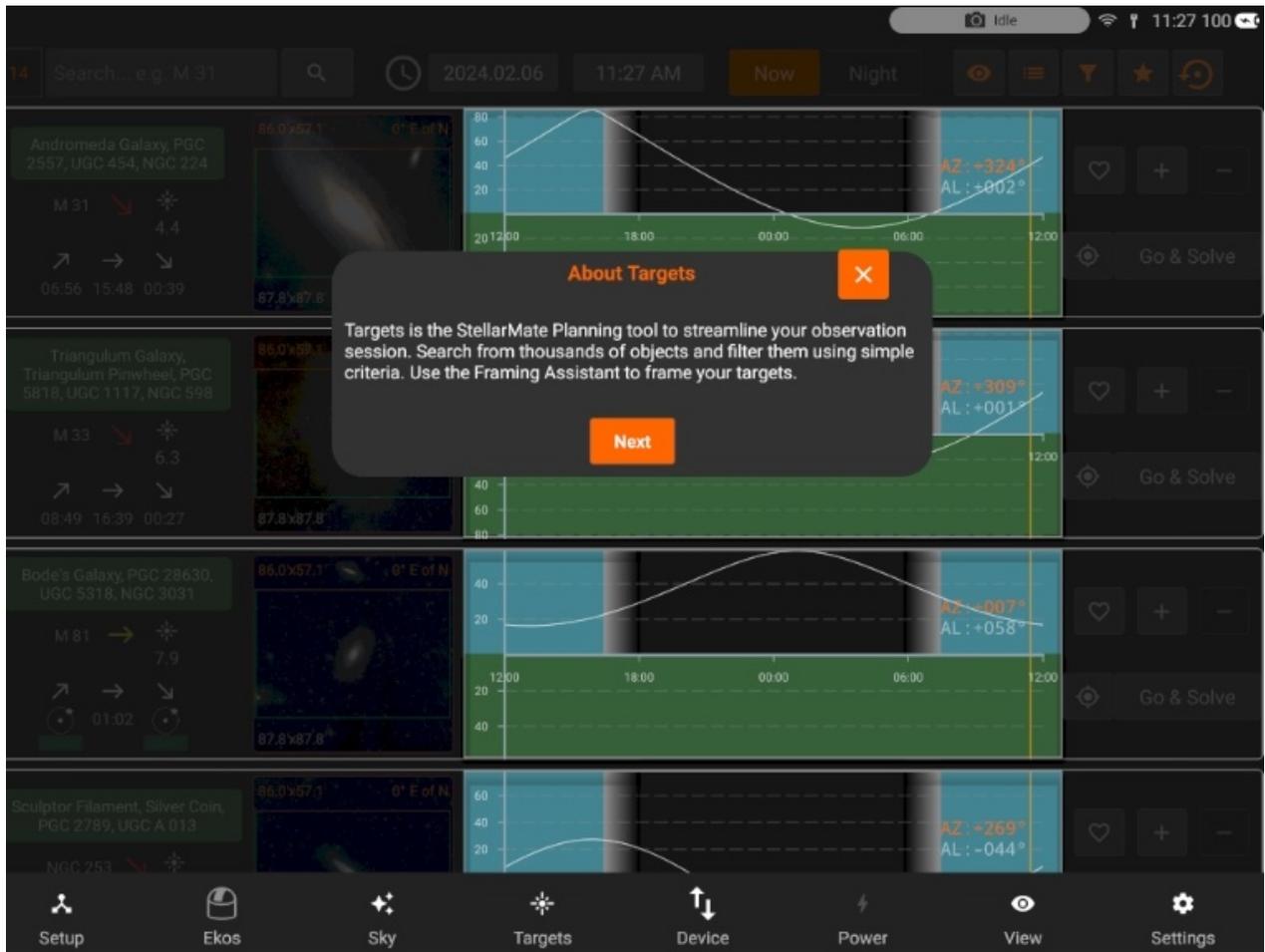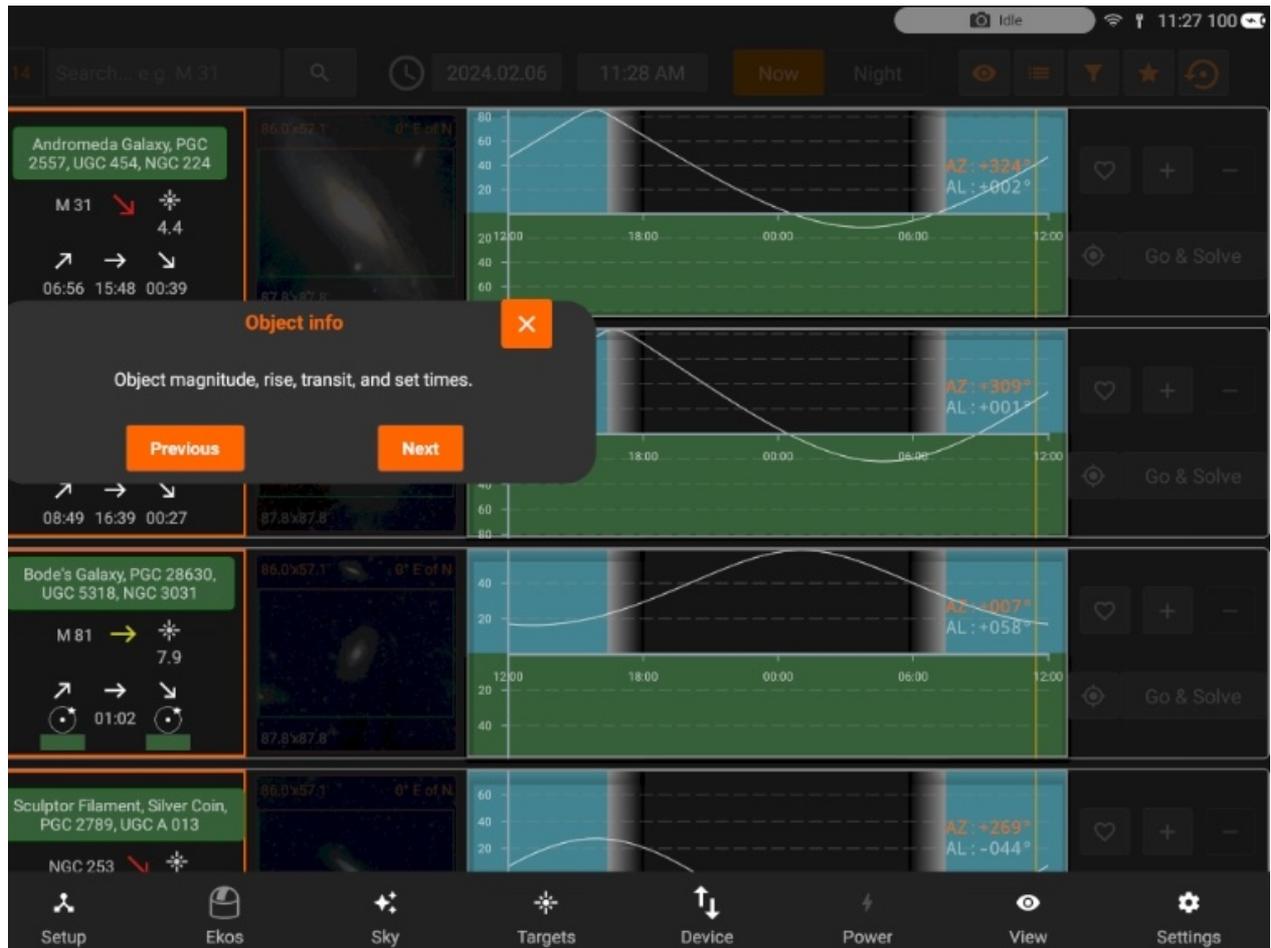
DSLR Setup

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.
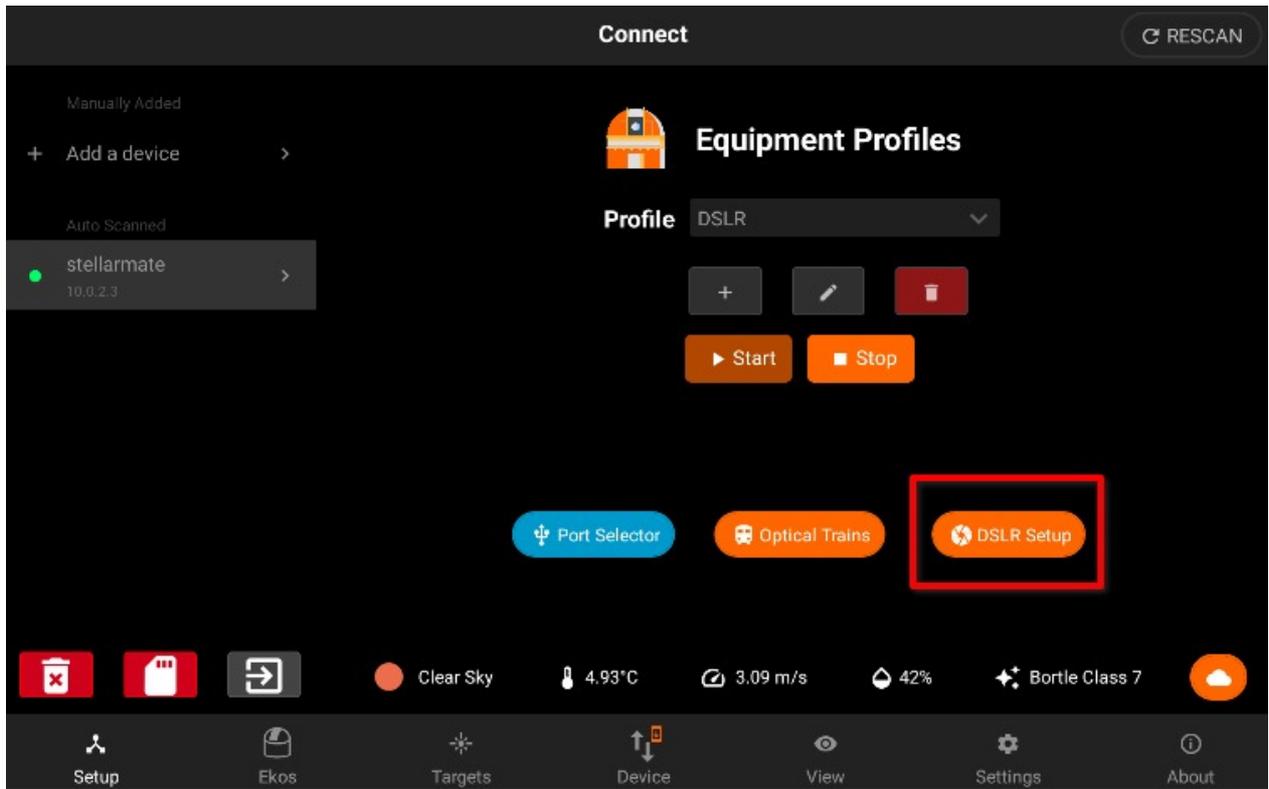
After configuring it, you can tap the save button.
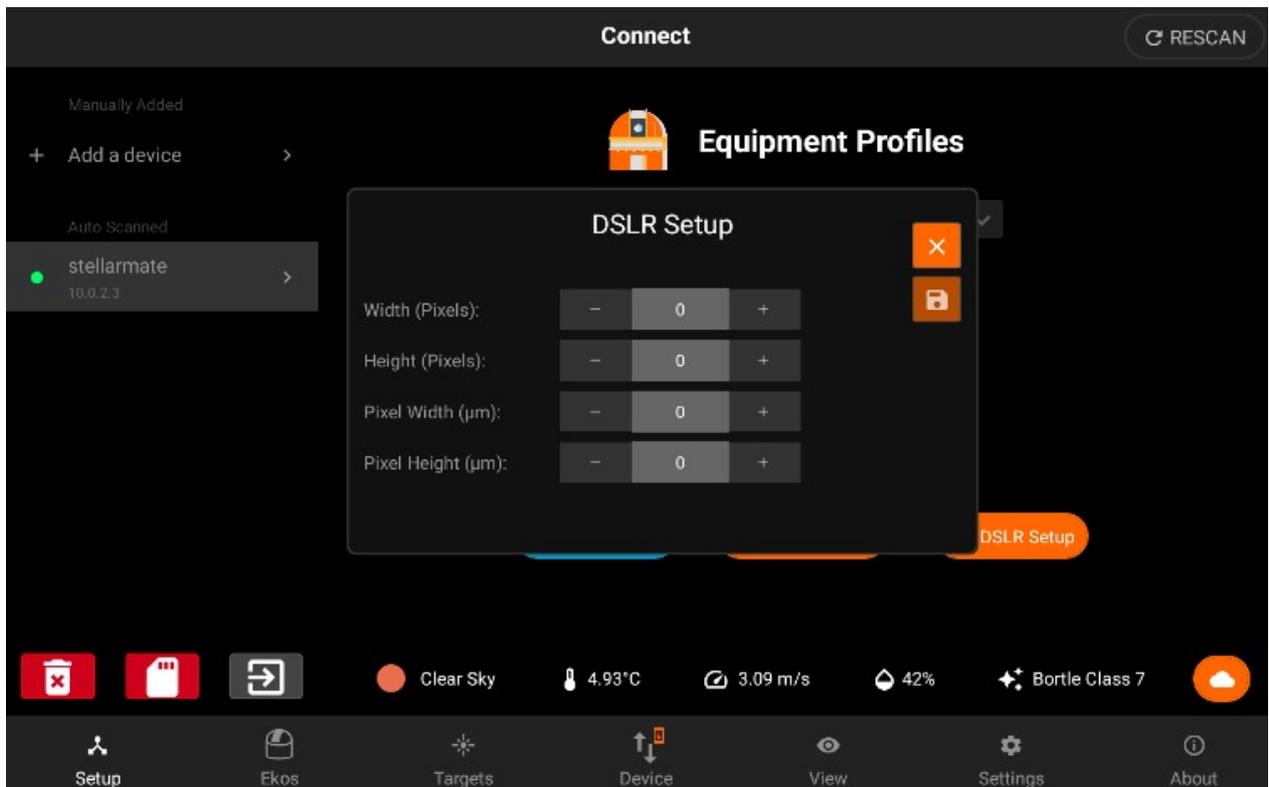
USB Devices

Now you are able to view the connected devices and it's details from StellarMate App.
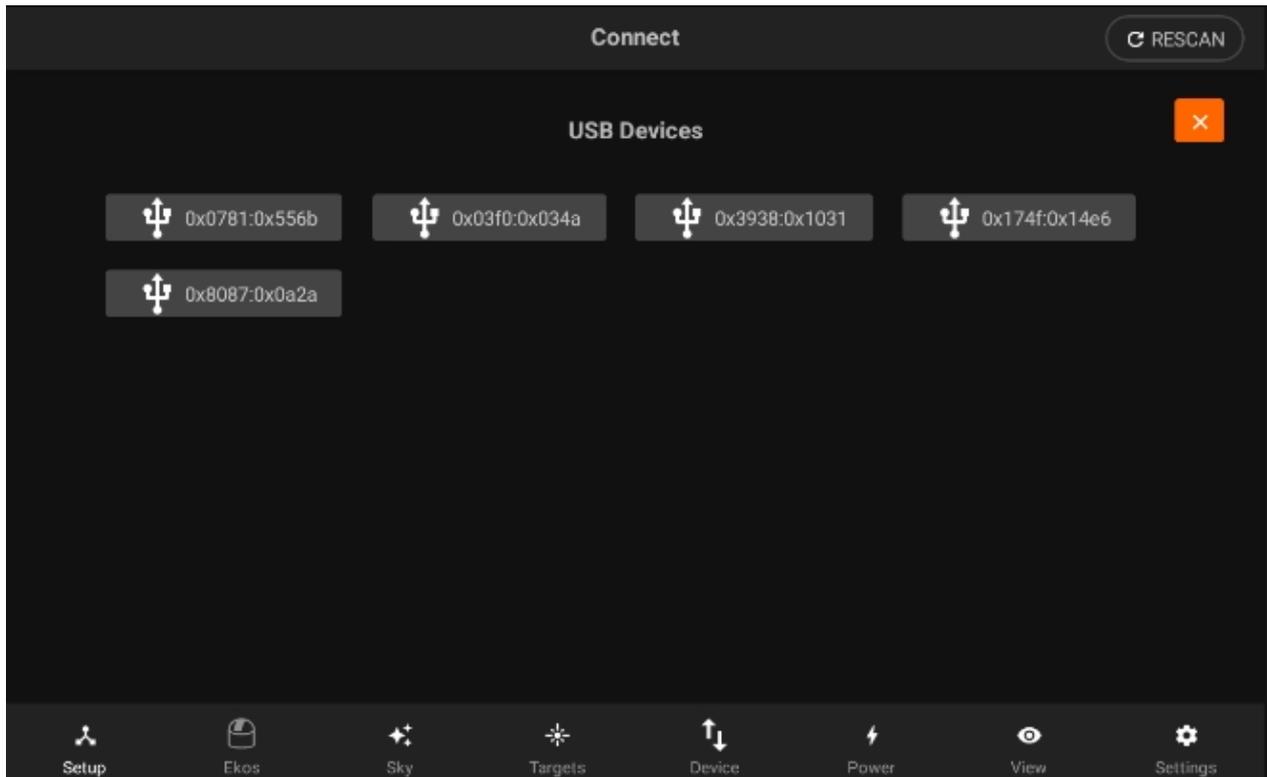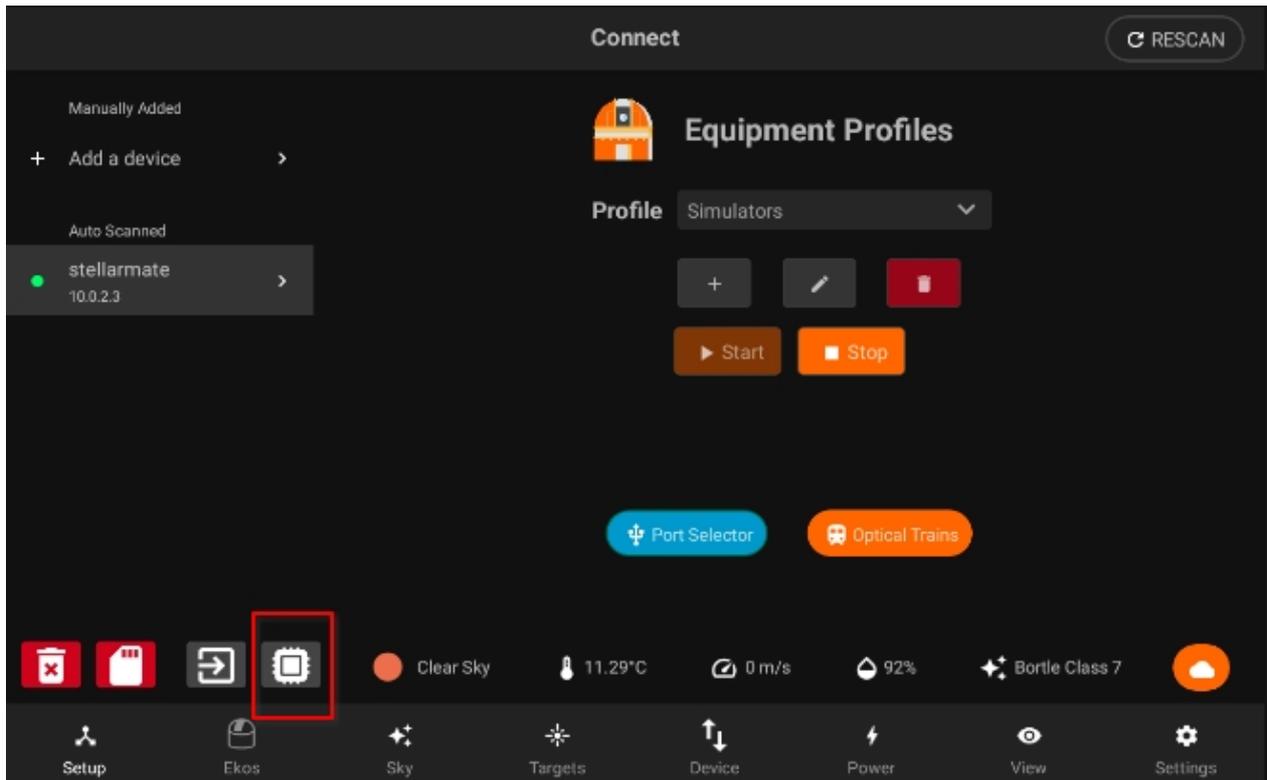
Pressing on each Device list, you will be able to the it's information.
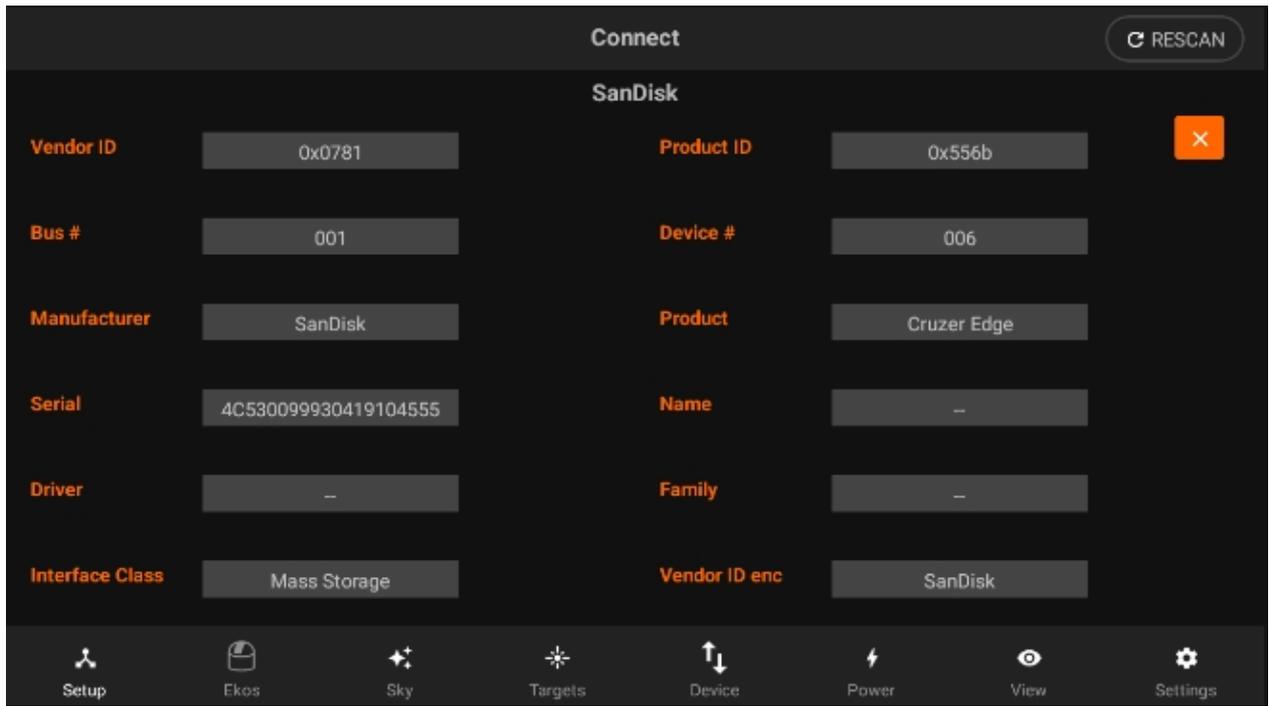
Ekos

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.
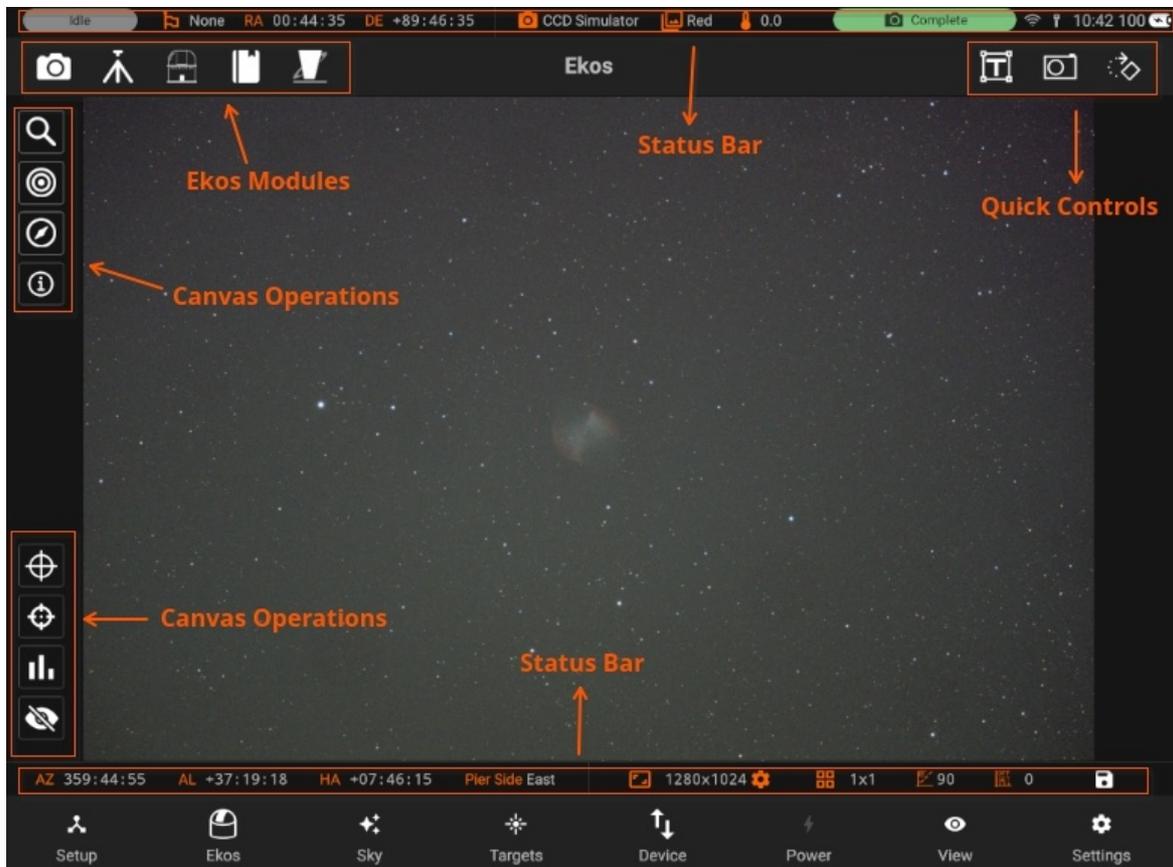
- Main Canvas: Displays the captured images.

- 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.
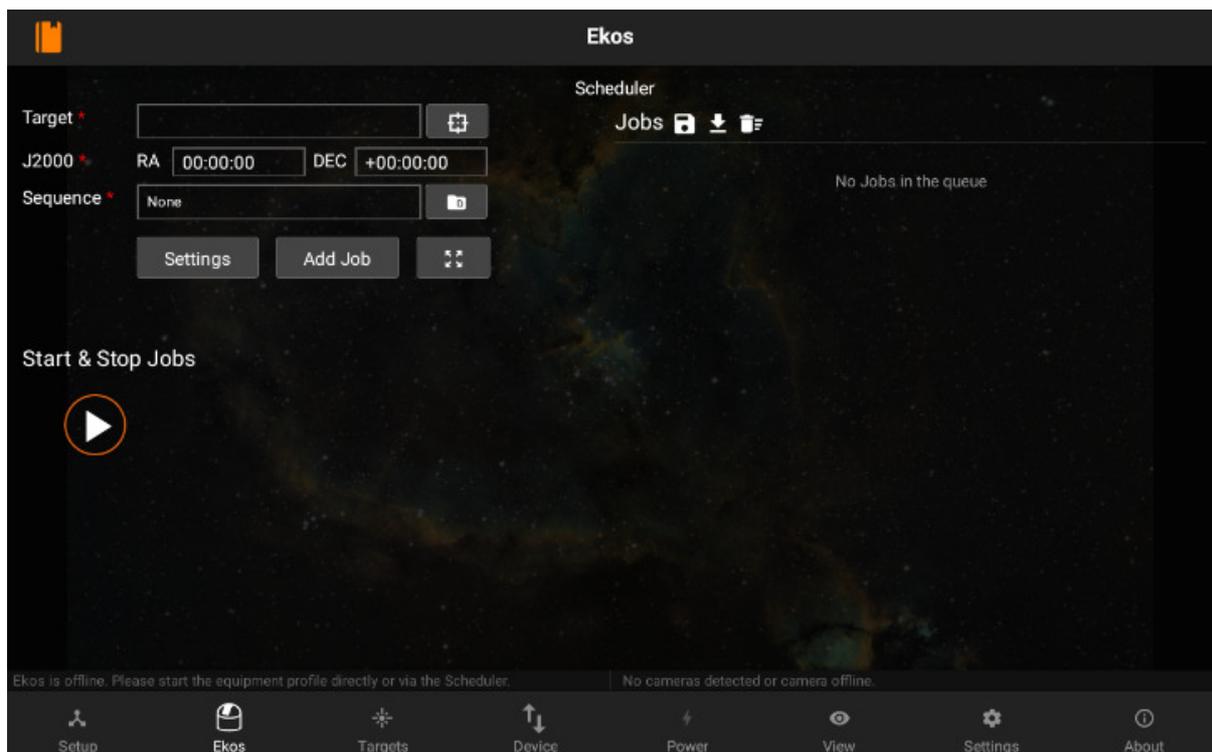
When an equipment profile is started, the Ekos modules are activated:
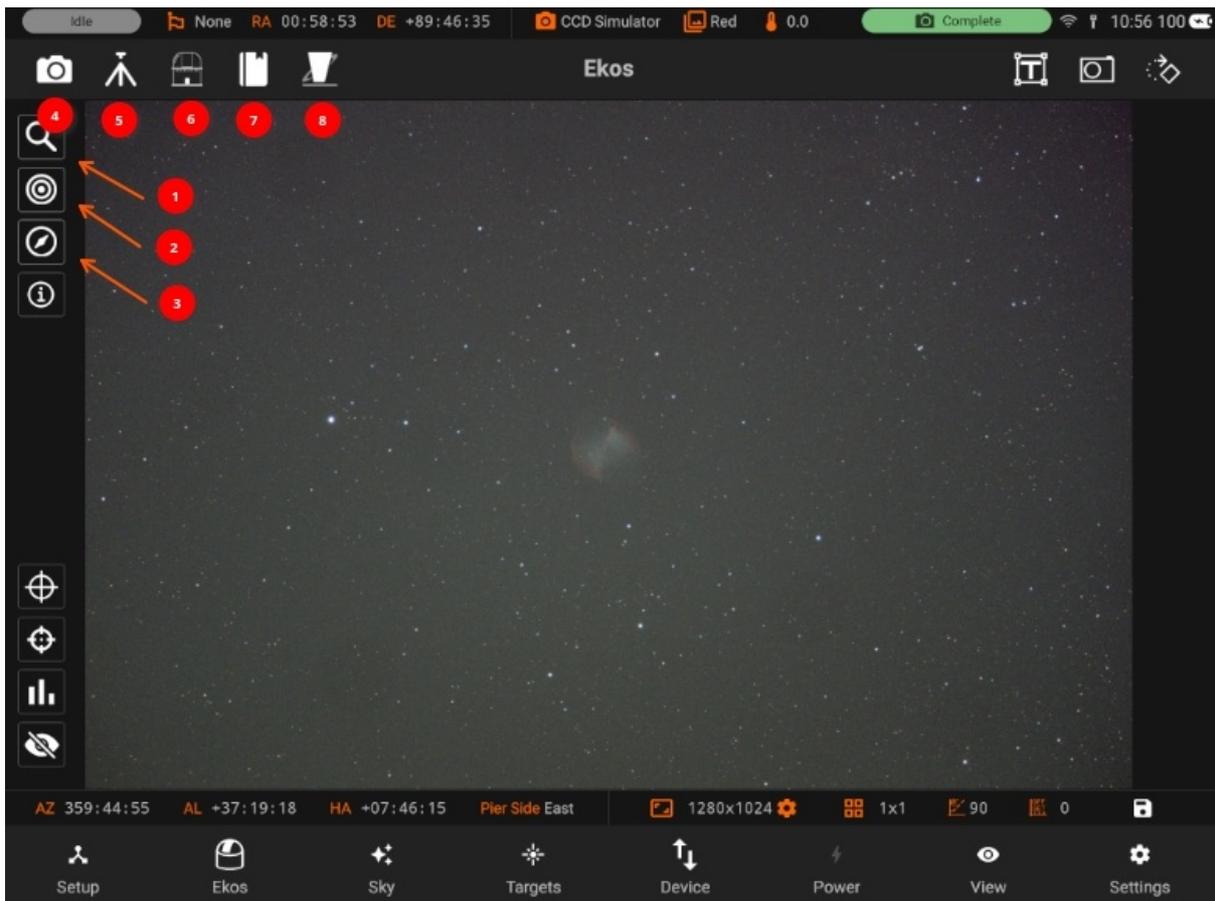
1. Focus: Focus your camera either automatically via an electronic focuser, or manually by adjusting the focus while framing, or by using Bahtinov Mask Assistant. Create presets for different configurations and set advanced settings to control the star detection and focusing algorithms.

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 overlayed 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.

Save Images:

You can also save the captured image to your Phone/Tablet by pressing the "Save" icon at bottom right.
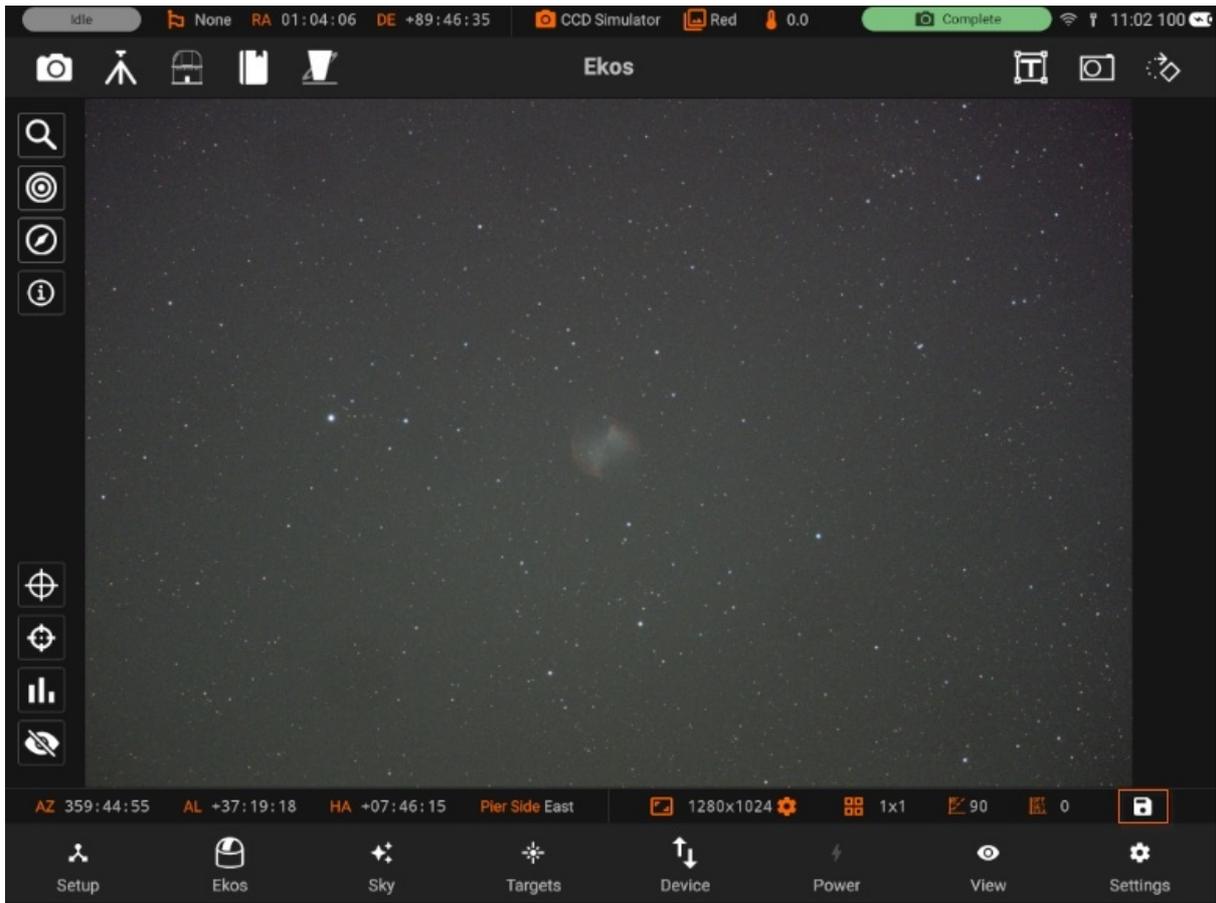
Quick Controls

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.
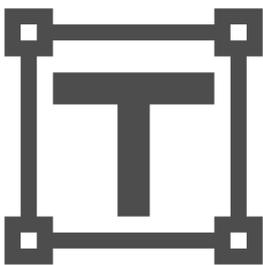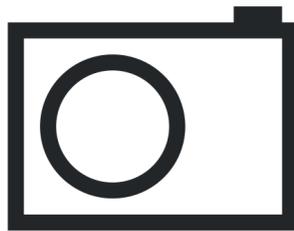
[Mount Quick Controls](#)   [Camera Quick Controls](#)   [Rotator Quick Controls](#)
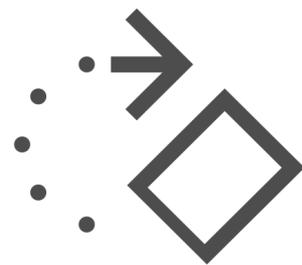
Mount
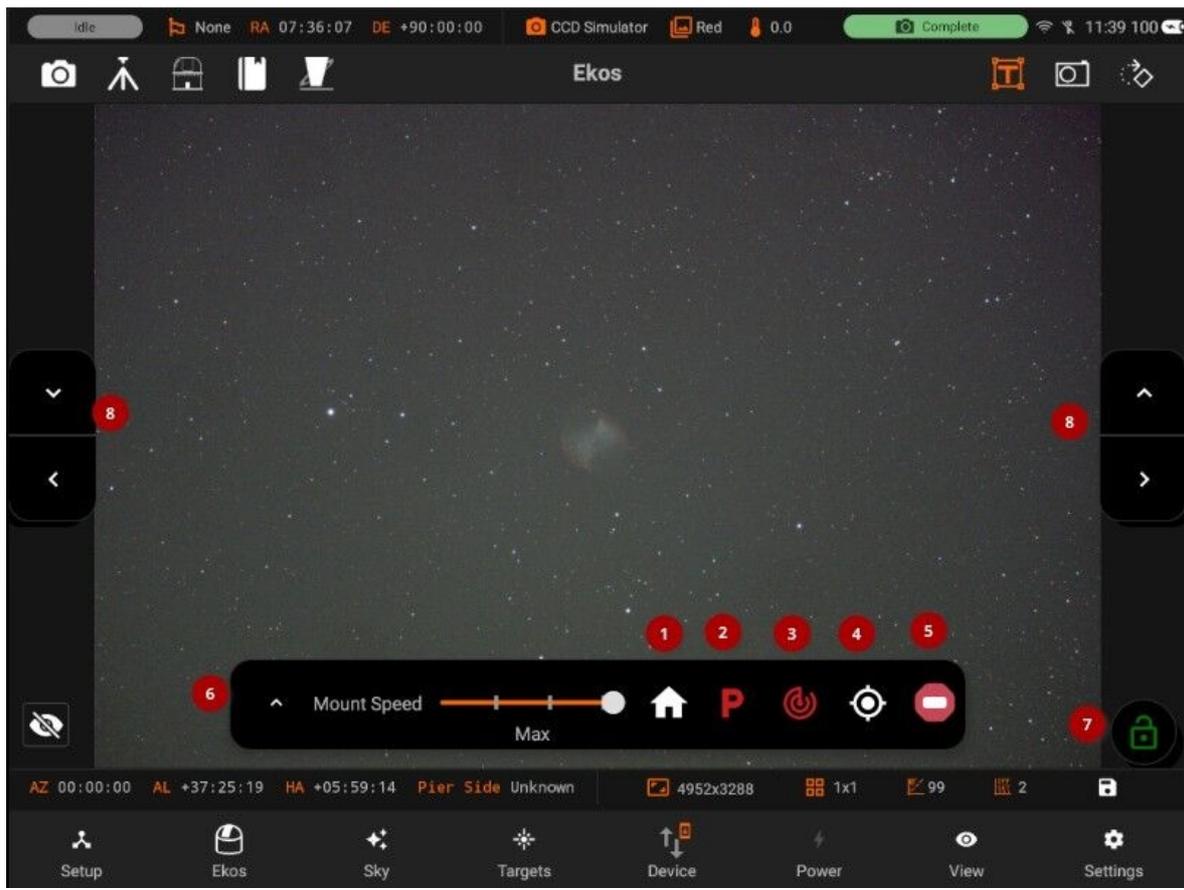
Mount quick controls allows you to control your mount quickly and easily, it has the following features:

1. **Home Support**: Toggle Home Support options
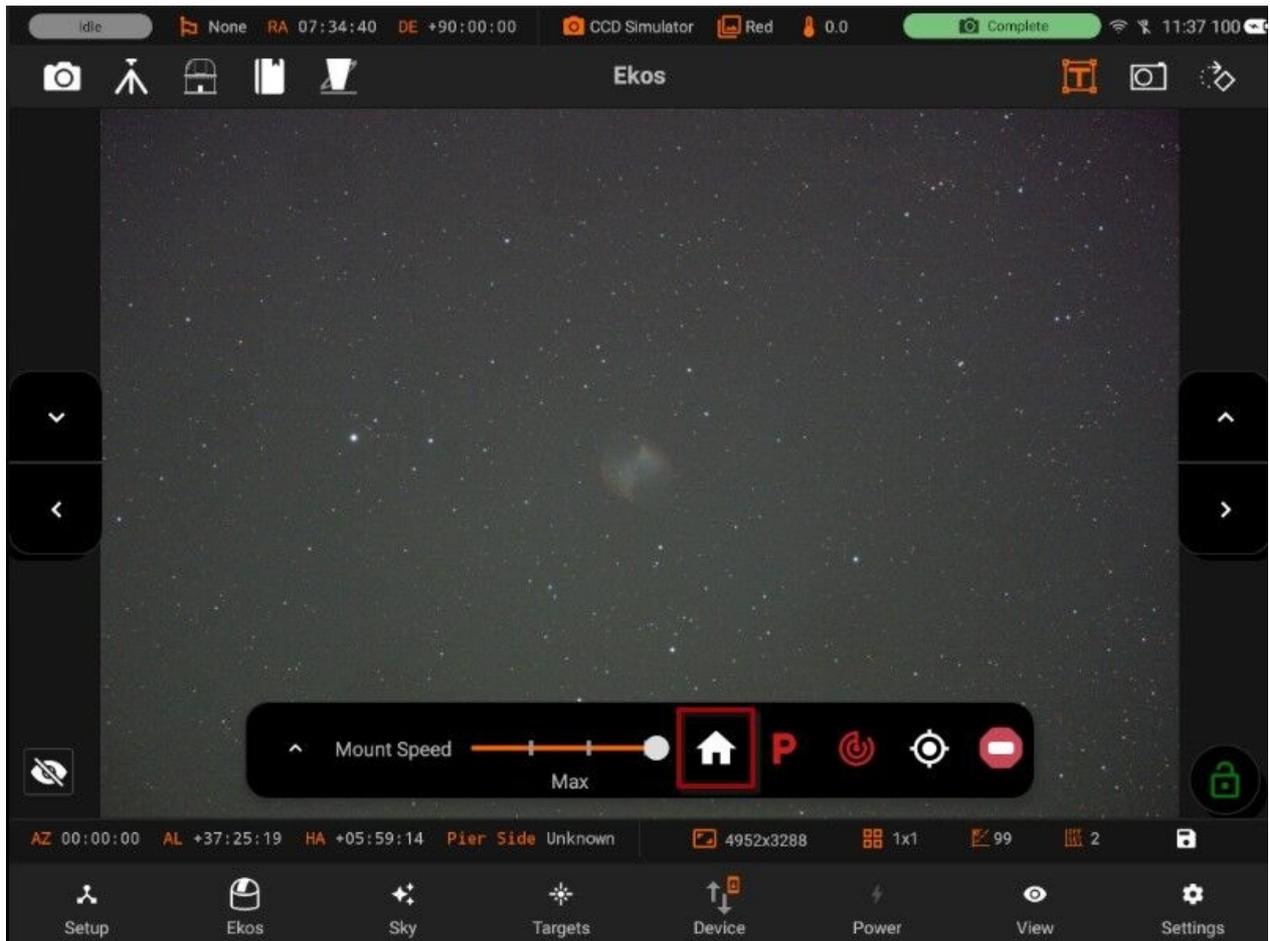
2. **Park/Unpark:** Park or Unpark mount.

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. **Controls:** Buttons from which you can move your Mount

   o **Left/Right/Up/Down:** Move your Mount towards specific directions.

8. **Lock Mount Controls:** Disable the Mount Controls

Unparking Your Mount

To unpark your mount, tap on the green **P** 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.
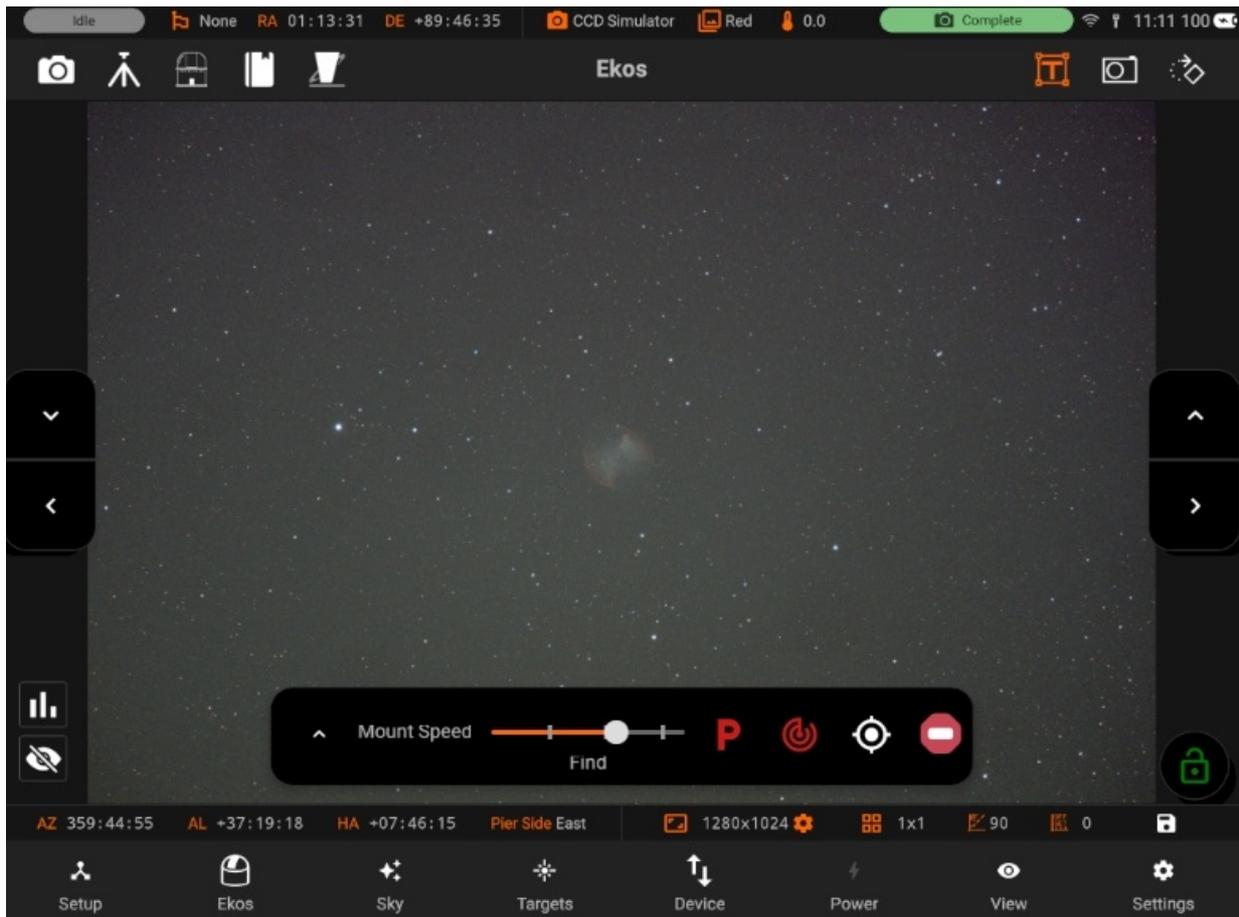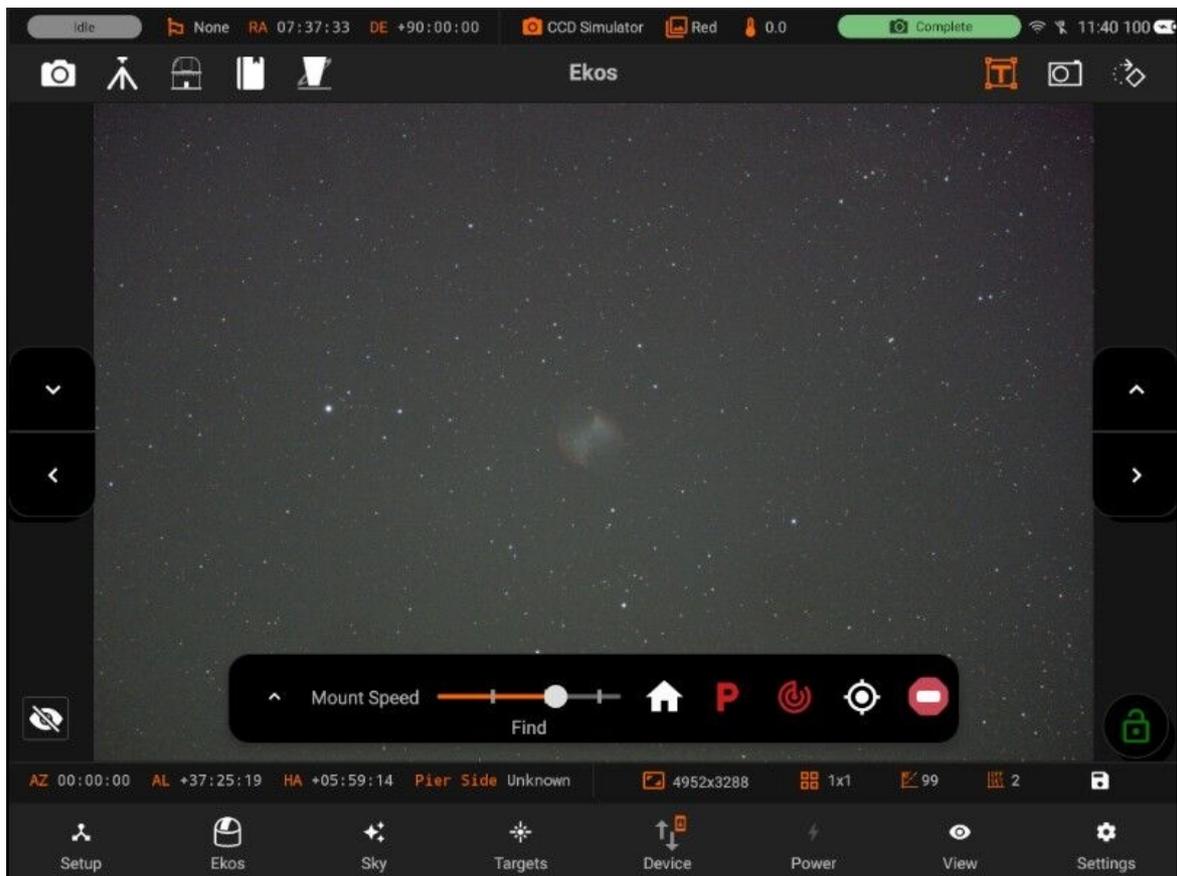
Goto or Sync

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 and category and choose a new target.
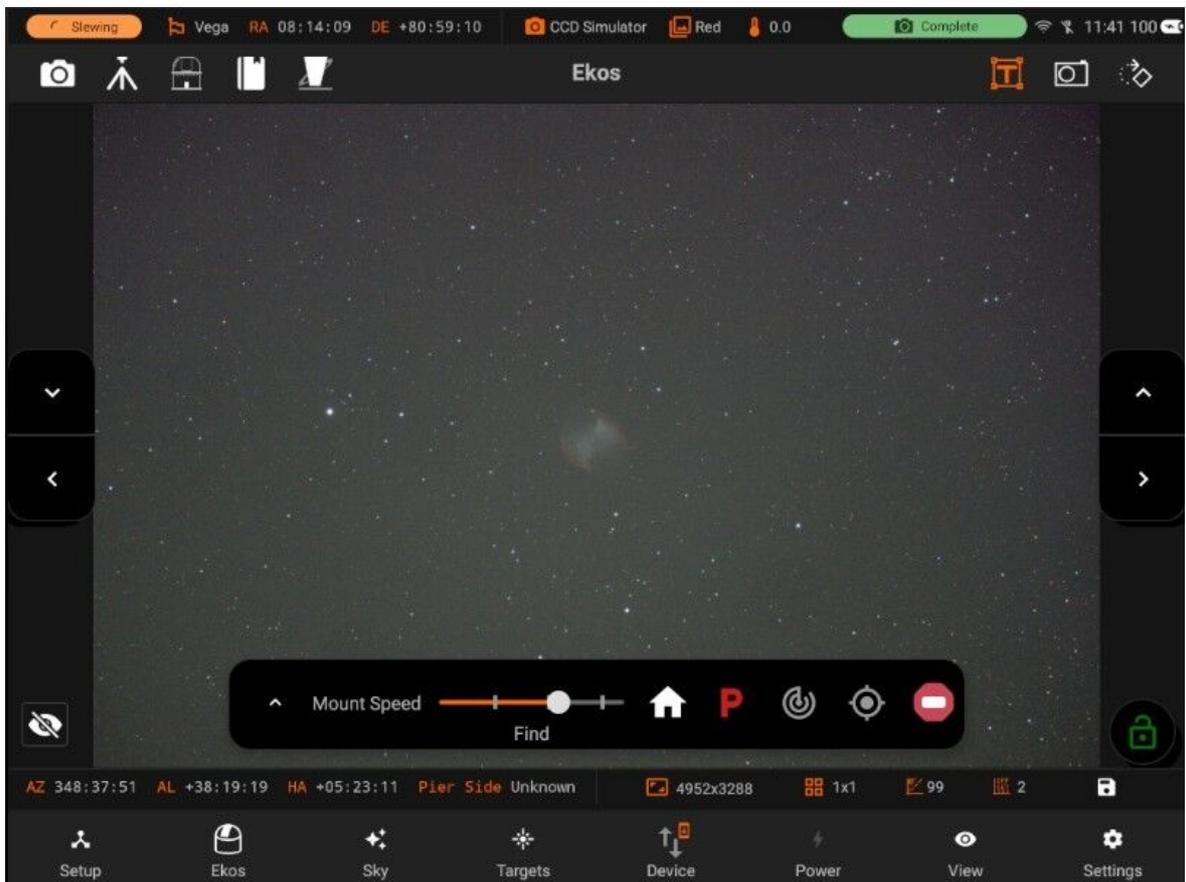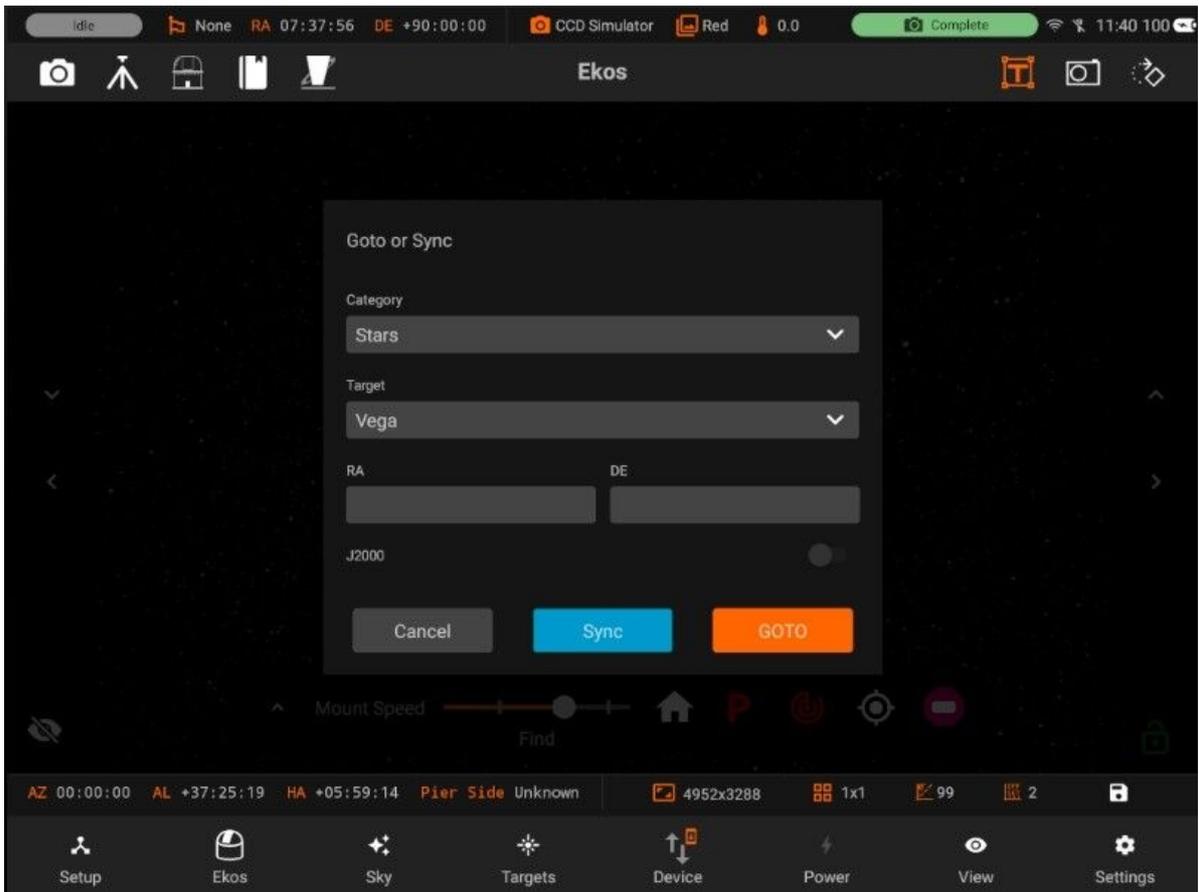
Moving to a specific direction manually

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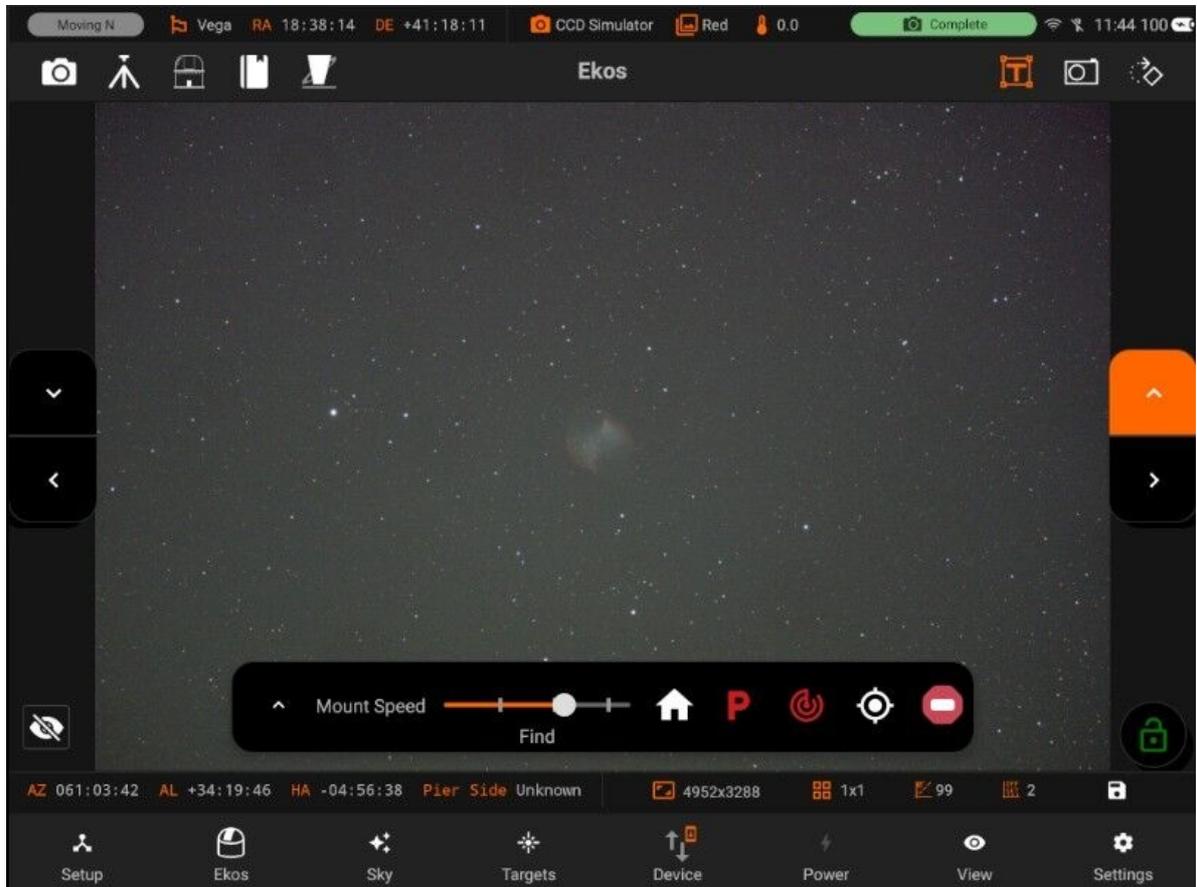
Locking Mount Controls

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.
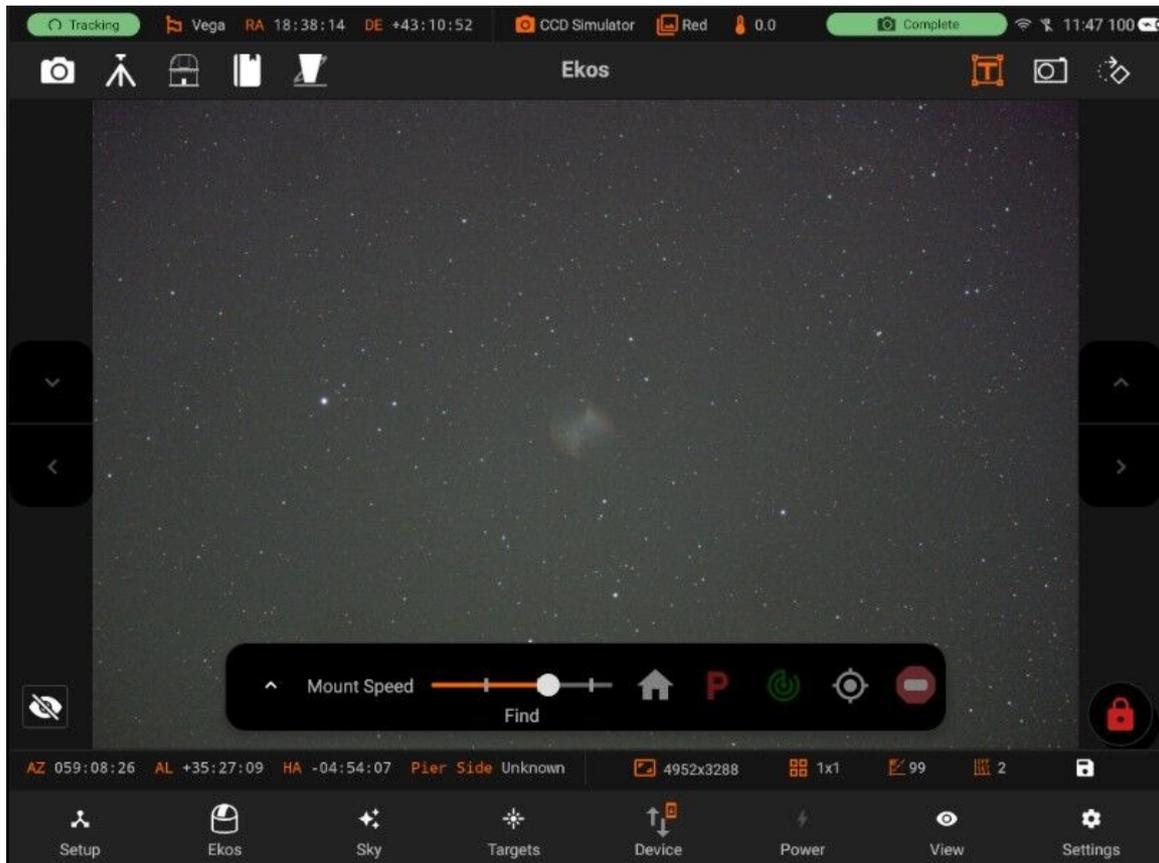
Parking Your Mount

You can park your mount by clicking on the red **P** 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.
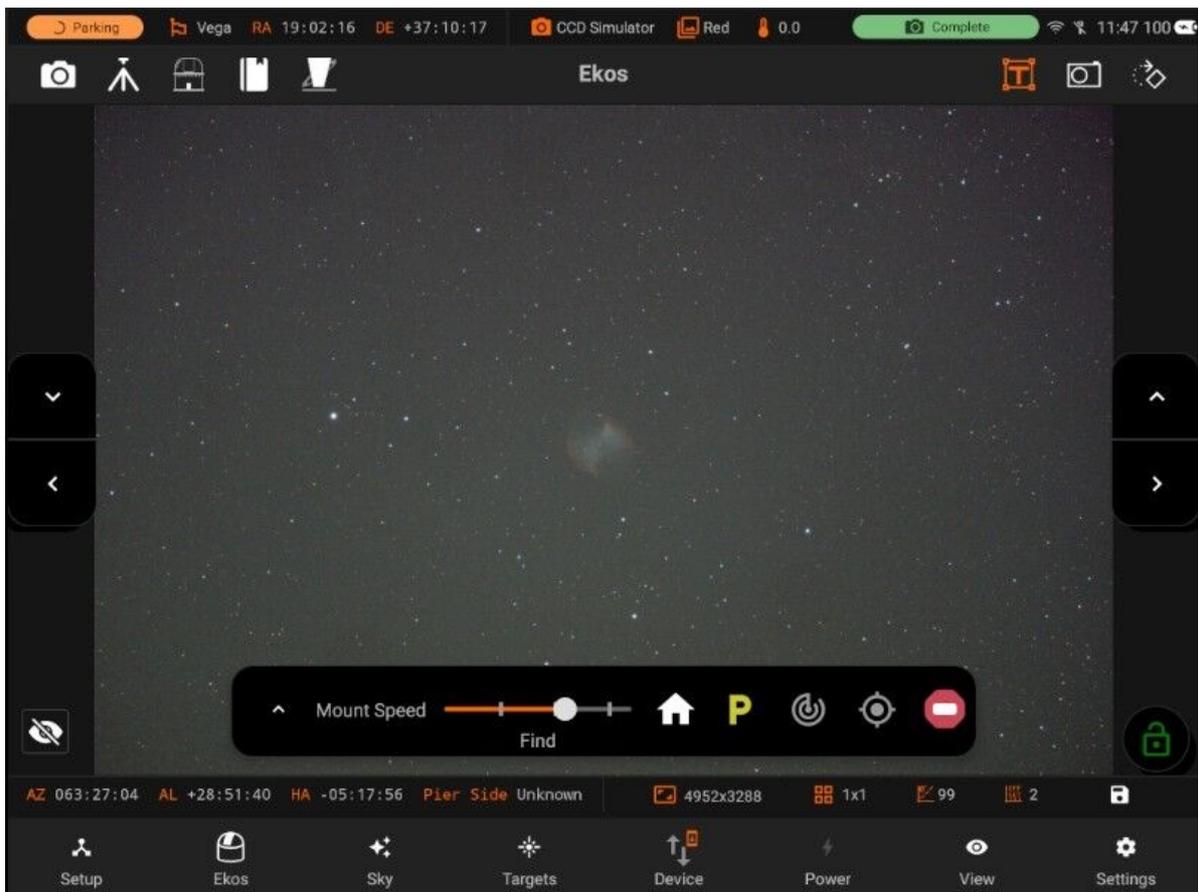
Reverse Directions:

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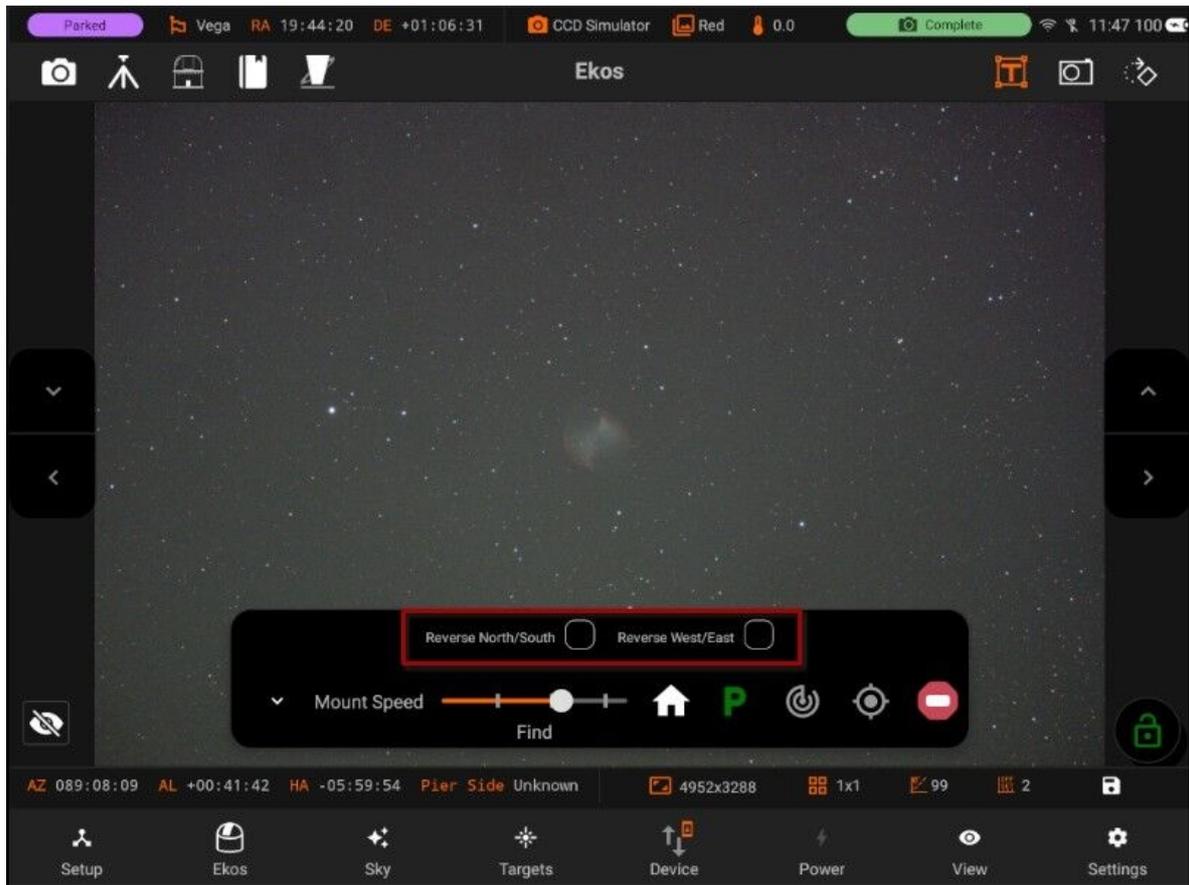
Home Support
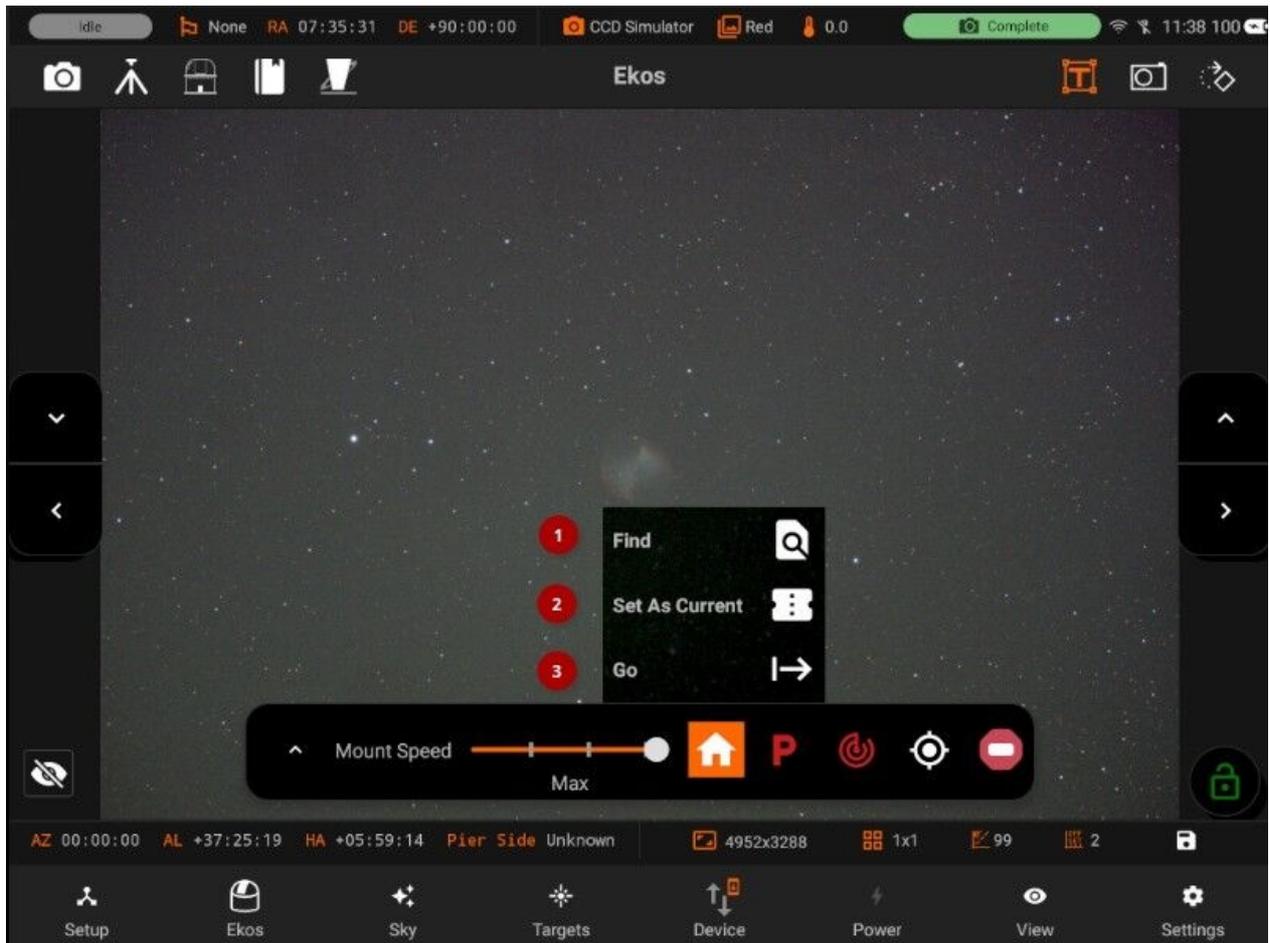
Some mounts offer support to slew to a predefined or custom Home position. It is important to clarify the differences between the mount's Park and Home positions:

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.

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

Preview & Framing
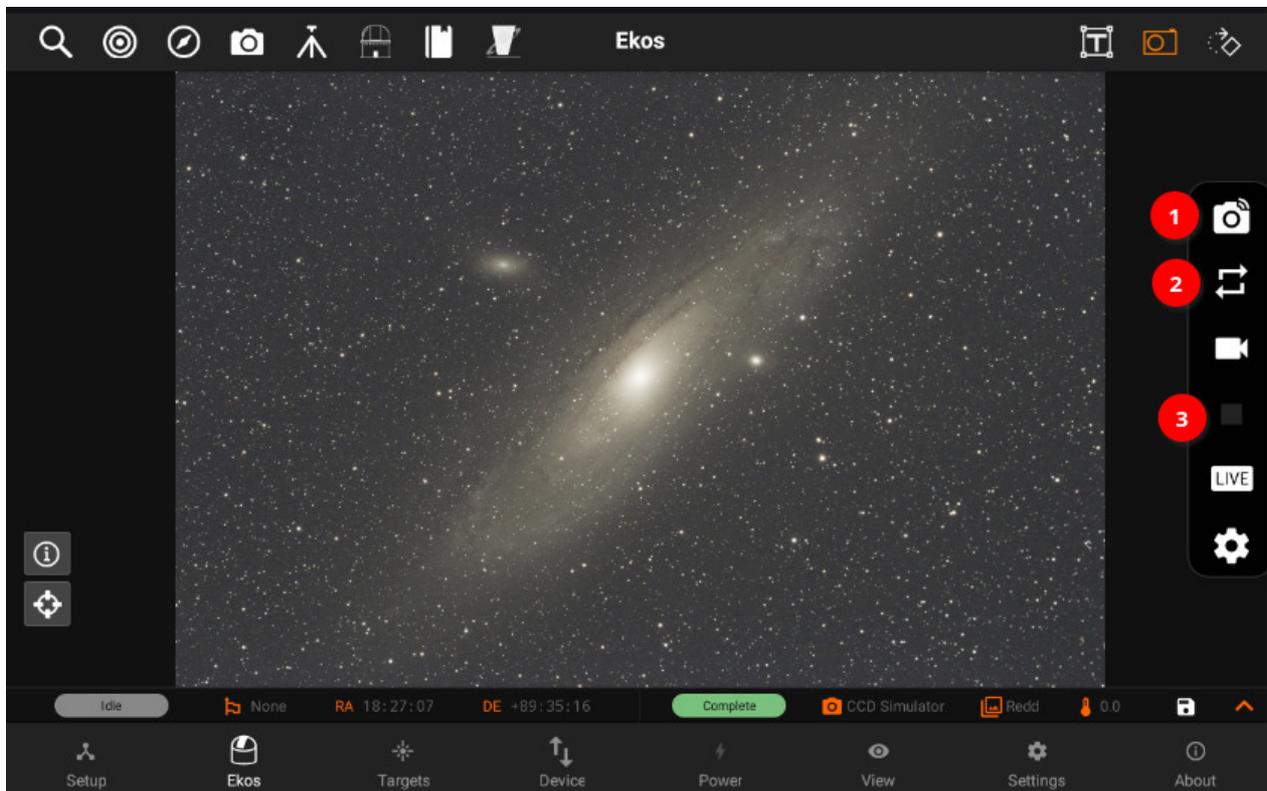
1. You can capture a preview image by tapping on the 📷 Camera button.
   - An animated circular progress icon will show the progress of the current capture and will show you when the image is being downloaded to the app by showing a green ☁ cloud download icon.
2. Looping can be done as well by tapping on the ⇄ Loop button (repeat icon).

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

Video Recording
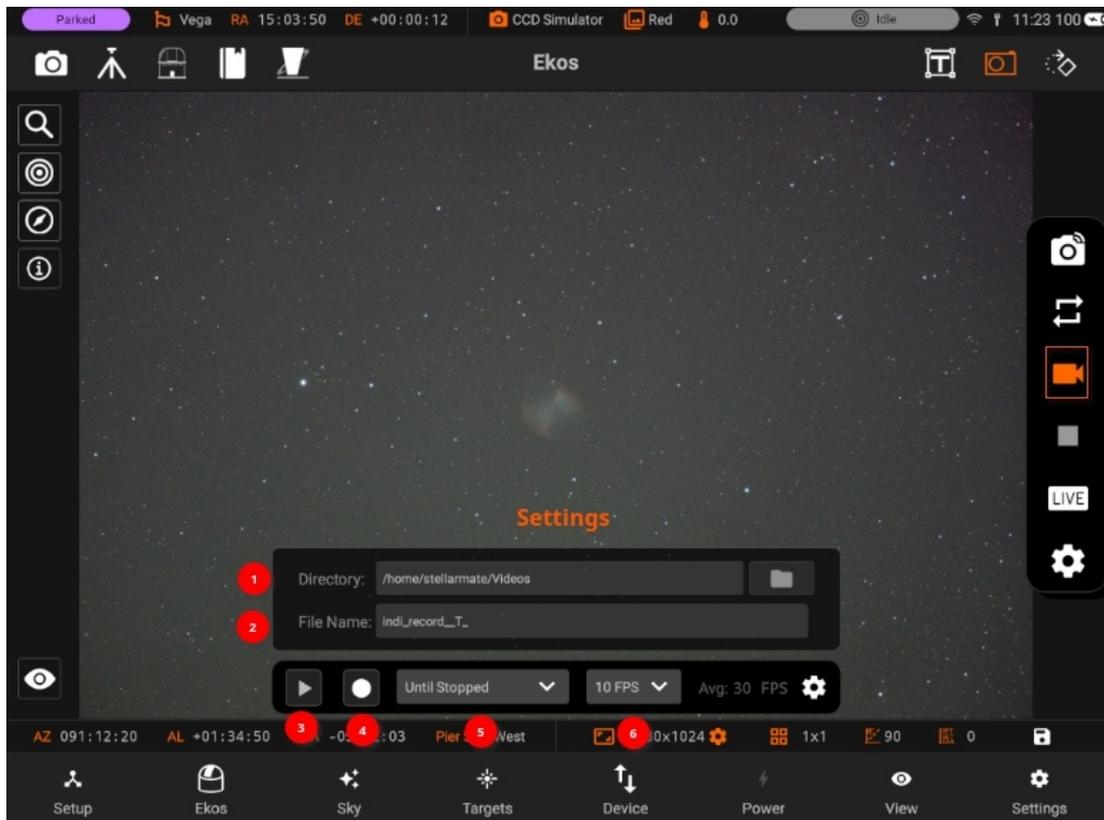
These are the following options in Video Recording:

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.
3. Play: Enables the video streaming if supported by the camera.
4. Record / Stop: Starts the recording, if the recording is started. Icon will be changed to stop icon. So, you can stop the recording.
5. Until stopped: Select one from the predefined video duration or select Until Stopped to to make the recording continues until explicitly stopped.

6. **FPS:** Record stream until these many frames are captured

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.

Live Stacking

StellarMate App includes support for Live Stacking. Live stacking works by combining data from multiple images to increase the *Signal to Noise* ratio. This would reduce the overall noise in the image and increase the contrast of the objects in the frame. Faint objects like galaxies and nebulae should pop up only after a few images are combined. As you continue to live-stack, the graininess of the image would be substantially reduced resulting in a crisp and smooth image.

The live stacked images are only as good as the data. Therefore, for Live-stacking to operate successfully, the following conditions must be met:

1. The image must be well-focused.
2. The image must contain sufficient stars for the algorithm to work. The livestacking algorithm inspects stars in each captured frame and performs the necessary star-alignment to compensate for any offsets or rotations among the captured images.
3. For exposures above 30 seconds, **you must have guiding activated**. Star trails tend to form with most consumer-grade mounts after usually 30 seconds. The maximum unguided exposures should be less than 30 seconds, or as appropriate given the tracking performance of the mount. Good Polar alignment significantly helps the livestacking performance.

Livestacking can be toggled directly or during the execution of a sequence job in the Capture module. When no sequence queue is running, the livestacker would trigger a capture loop using the primary camera in the Quick Controls Settings. For example, if the exposure duration was set to 5 seconds, then a 5-second capture loop is automatically started by the livestacker. The capture loop would run indefinitely until stopped by the user.

Alternatively, if a sequence queue is already running, then toggling the livestacker would make it wait for the next frame to arrive before processing it.

In either case, the first frame is used to extract the reference stars information, and the actual stacking begins starting with the second frame.

To toggle live stacking options, tap the **LIVE** button in the Camera Quick Controls. Tap the **Play** button to start the process. Livestacker utilizes a median stacking algorithm and automatic background extraction followed by contrast adjustments to bring out the details.
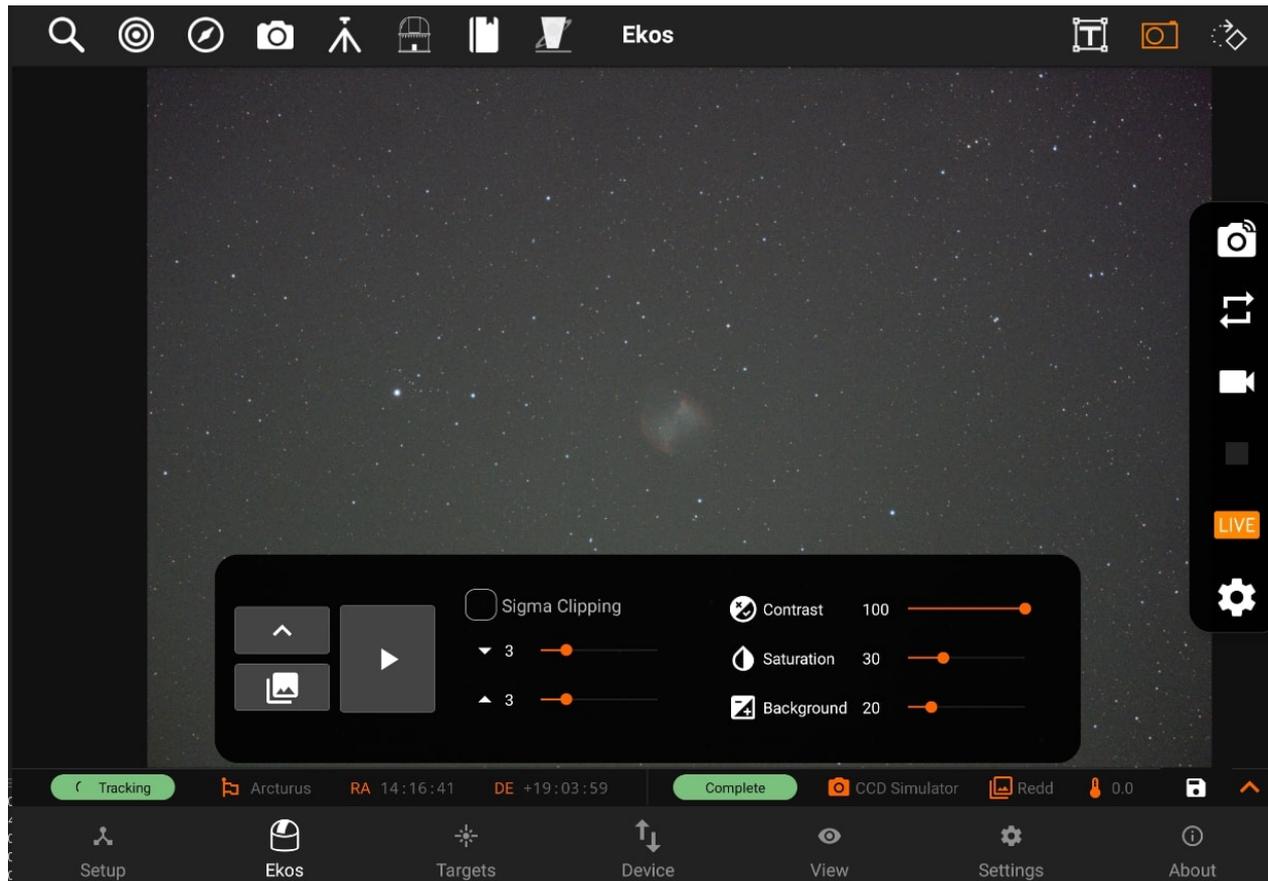
Sigma clipping helps with noise reduction during the stacking process. The mean and standard deviation are calculated from the first three captures. Subsequent captures are then sigma-clipped to remove any outliers outside the envelope of acceptable ranges around the mean.

The diagram below shows how values outside the envelope are masked and not included in the stacking process. You can control the upper and lower limits of this envelope by adjusting the s_{lower} and s_{upper} (default is set to 3) parameters in the app.

The *contrast* and *saturation* controls do not affect the stacking process itself, but apply some cosmetic adjustments to the final image to improve its quality. Some non-nebulae objects might benefit from the automatic background subtraction controlled by the Background parameter. Increasing this value would attempt to compensate for sky glow in the background, but might also result in loss of detail.

https://pixinsight.com/doc/tools/ImageIntegration/ImageIntegration.html
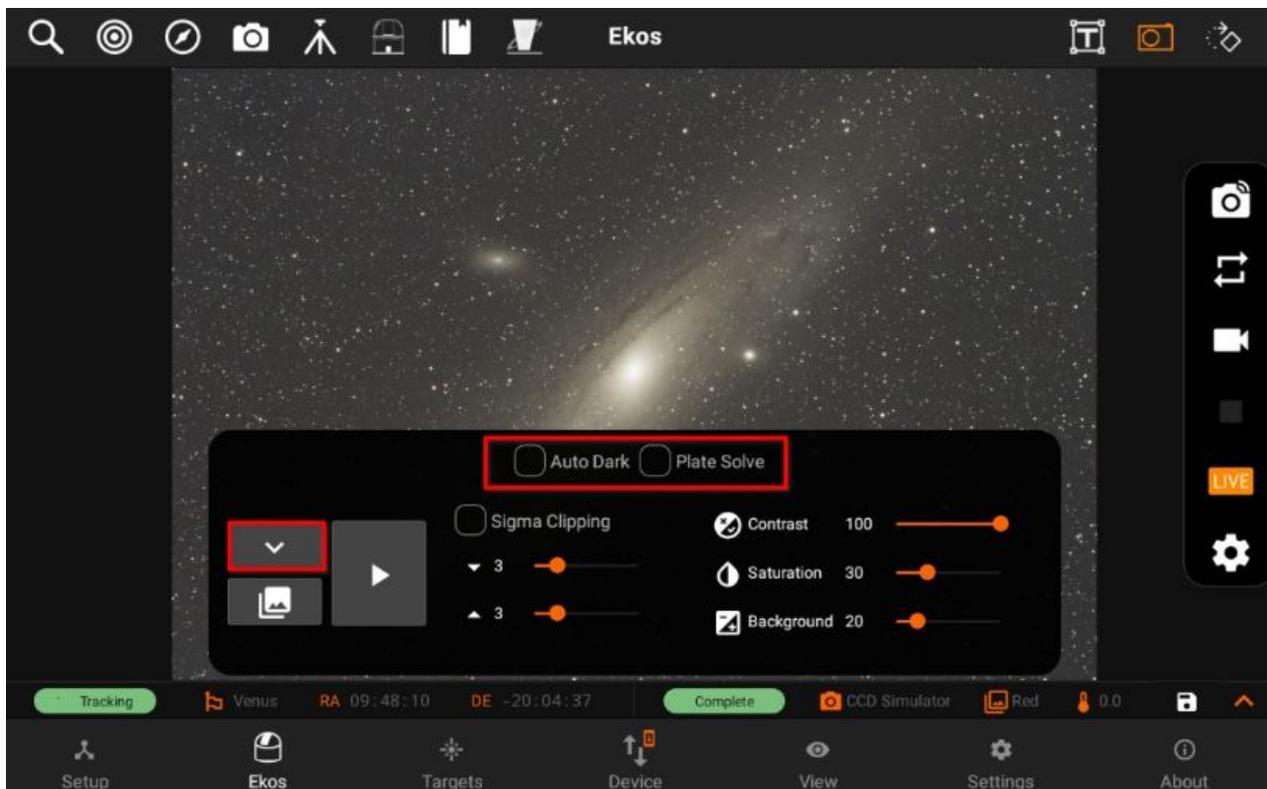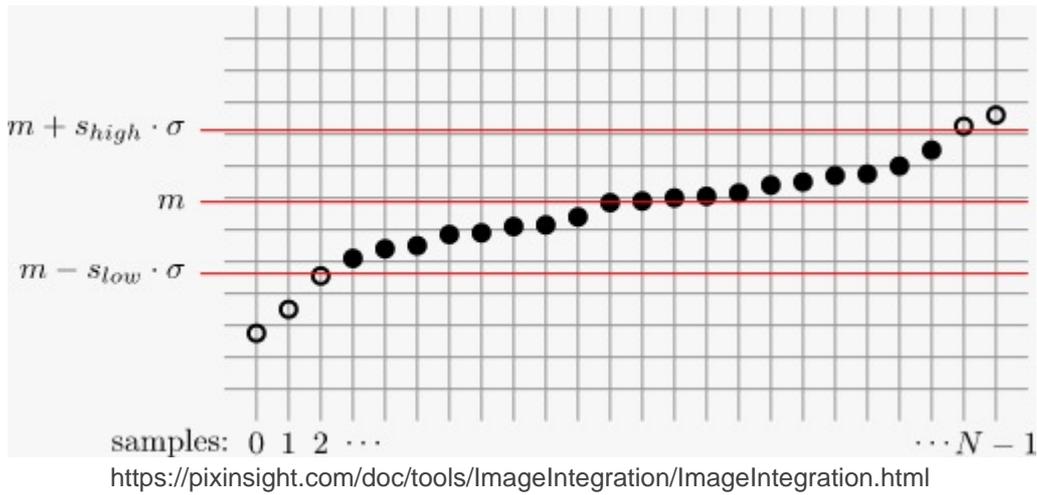
Auto Dark: Subtract dark frames when applicable.

Plate Solve: Solve each frame and align frames accordingly (beta).

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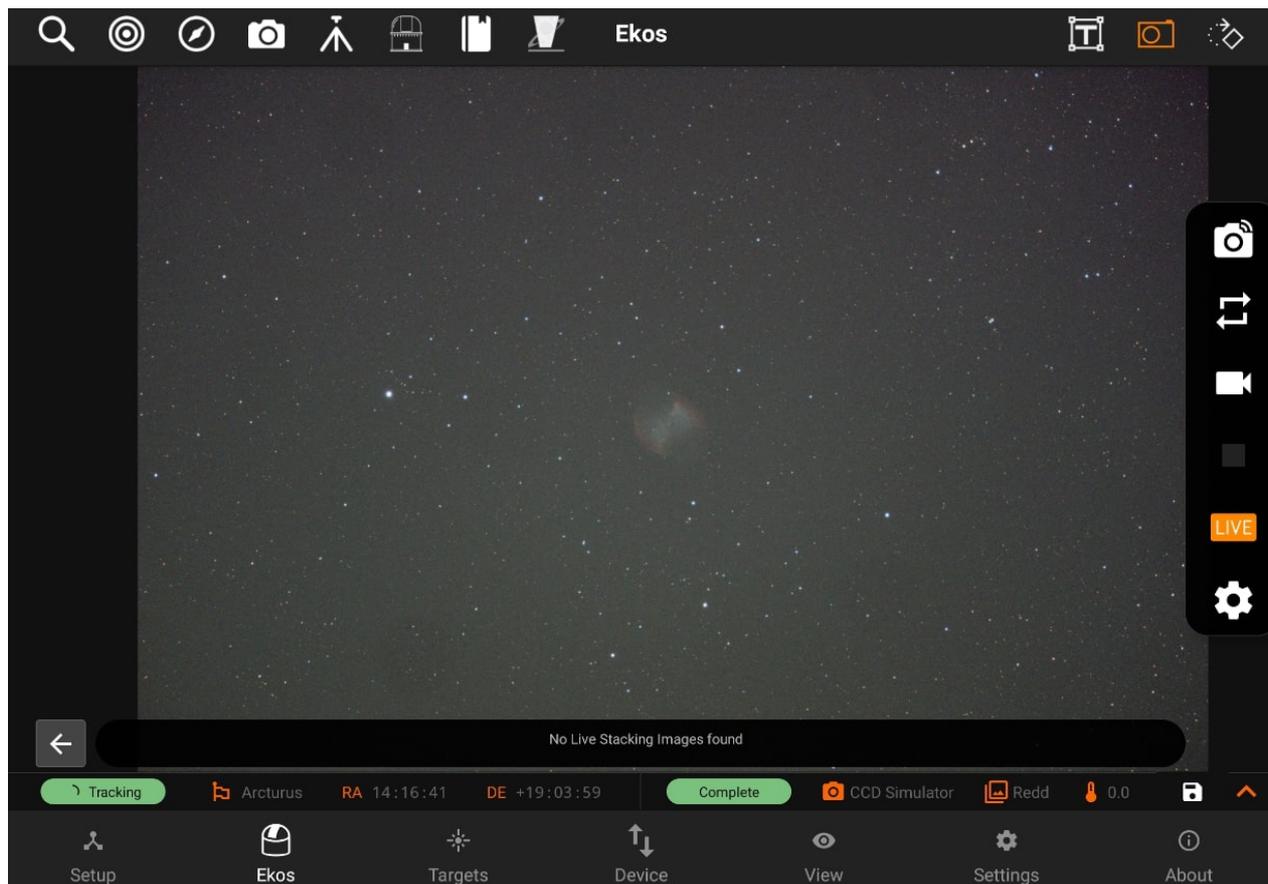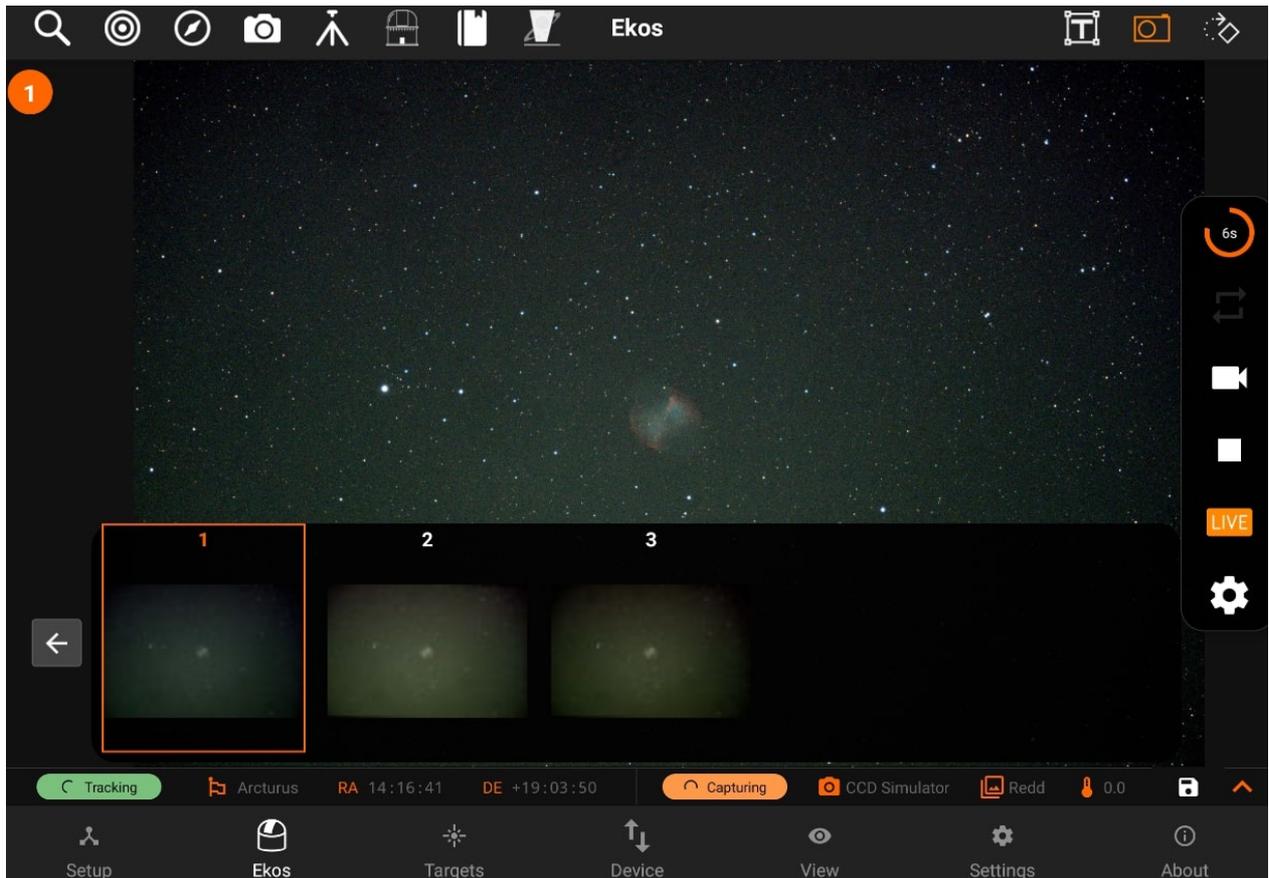
All live stacked images are saved as JPG in StellarMate Pictures directory, where they can be accessed later via the Gallery, StellarMate network share, or FTP.

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

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.
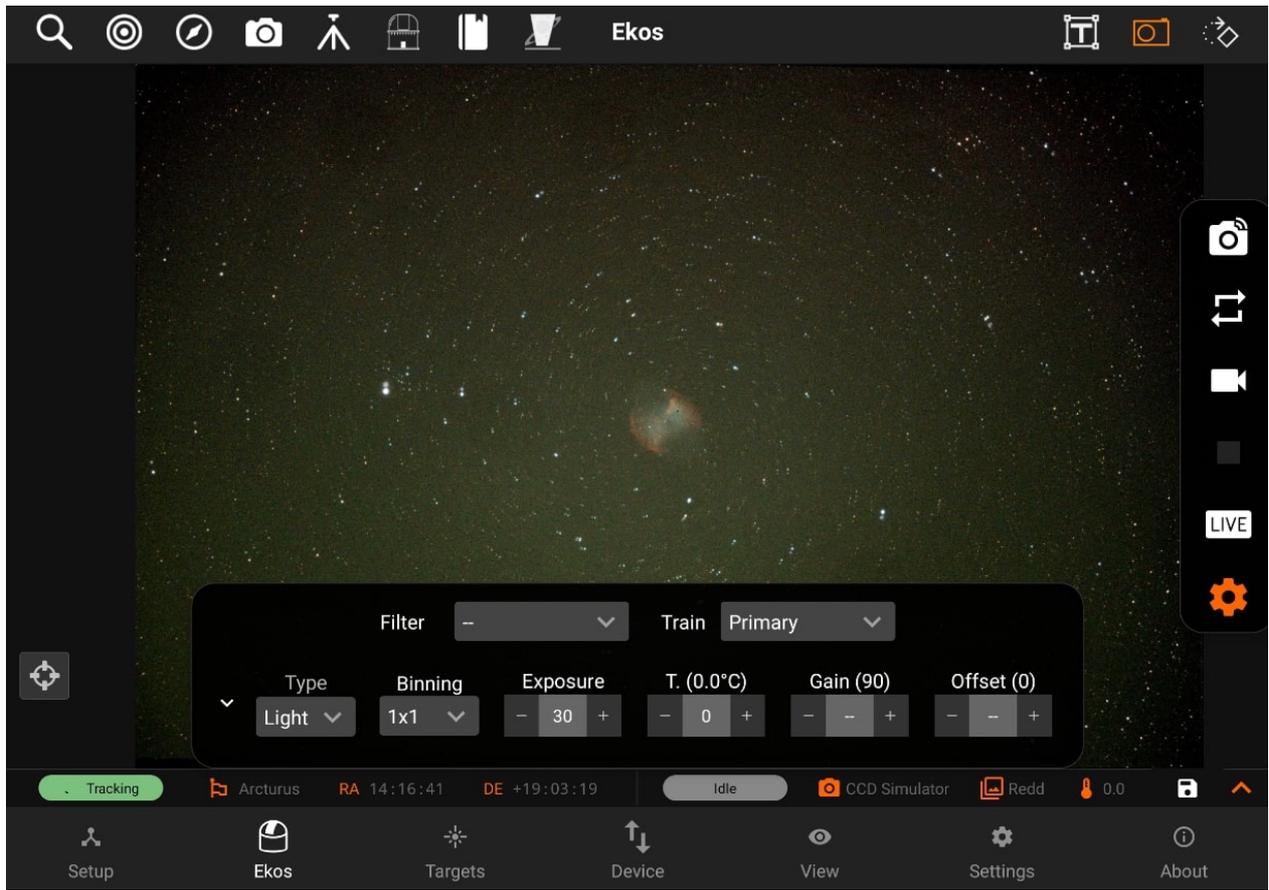
You can also toggle Optical trains from the Quick Camera Settings
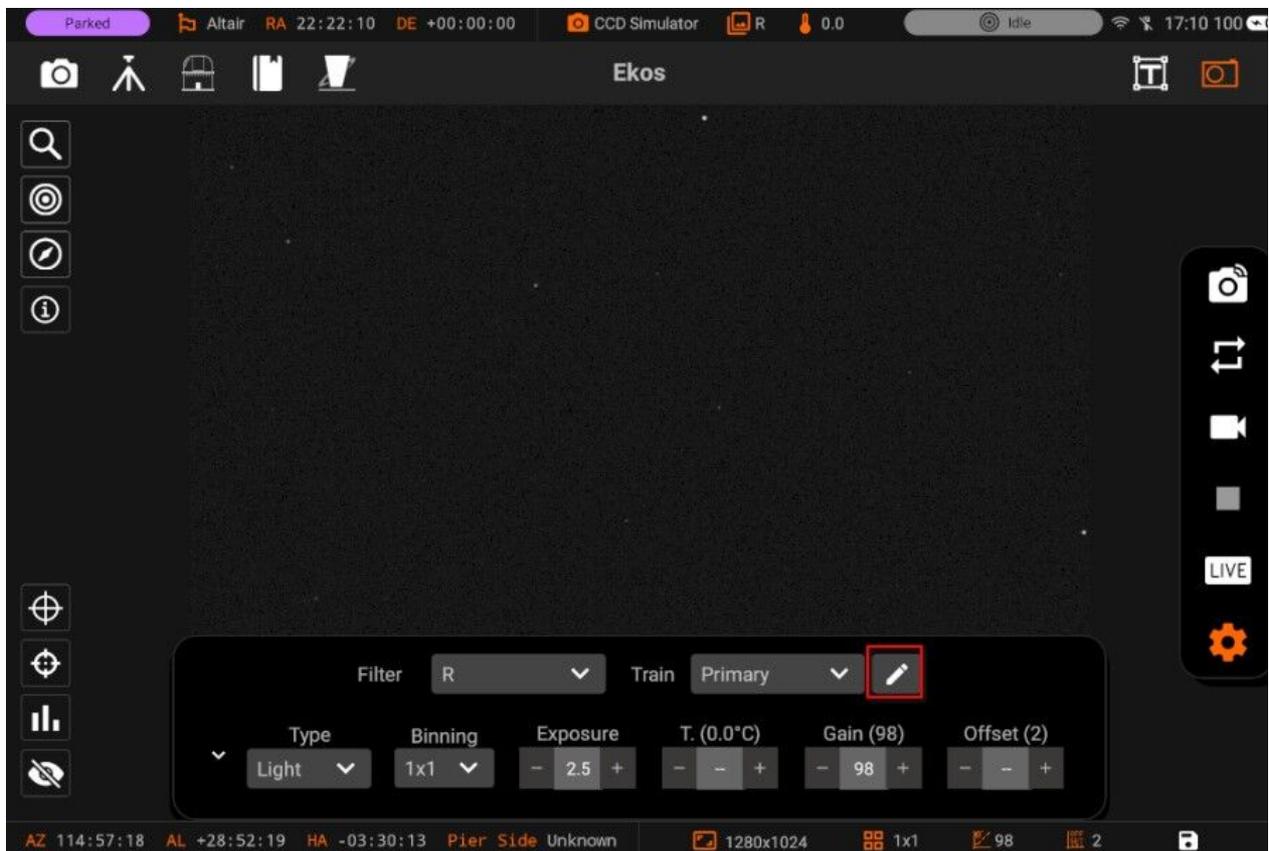
Rotator

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.
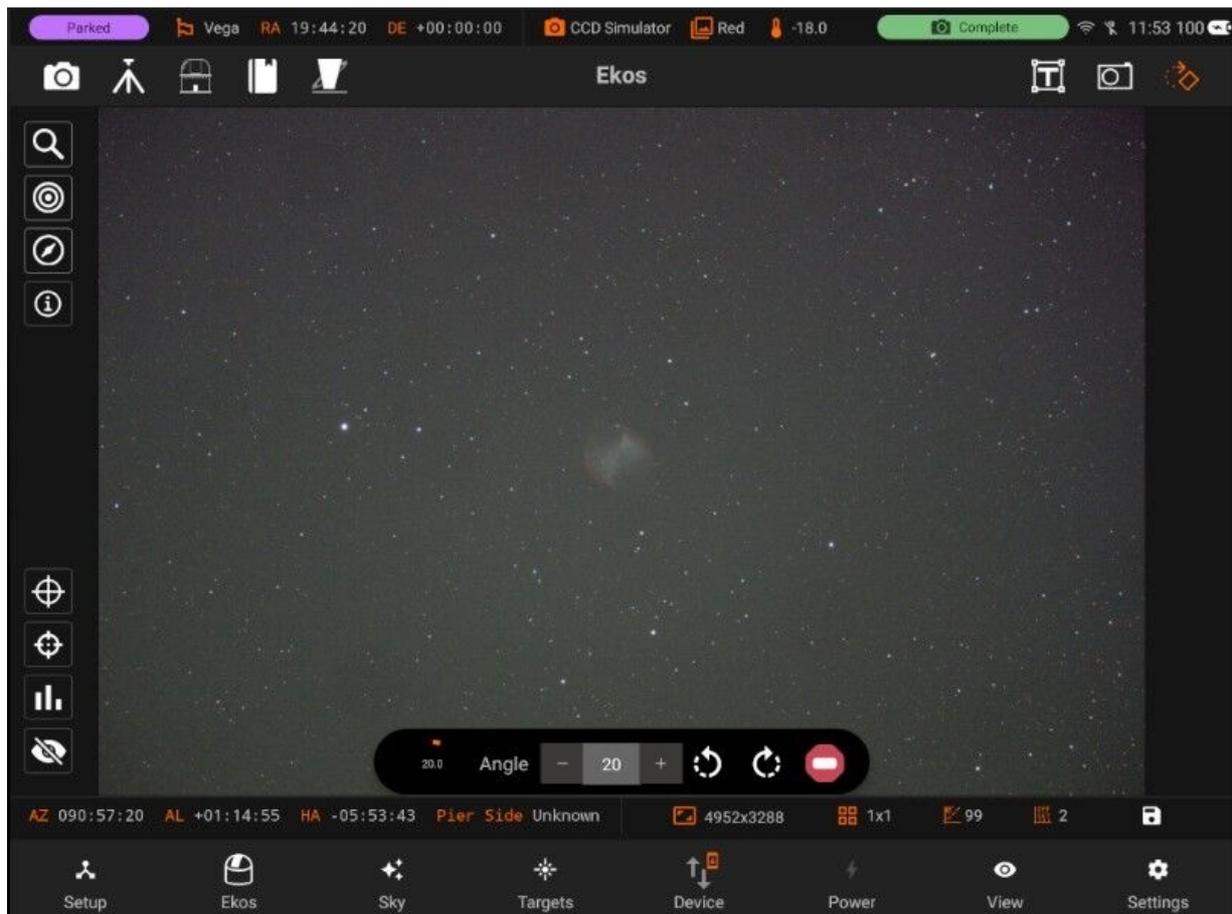
Going to an angle position by steps

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.
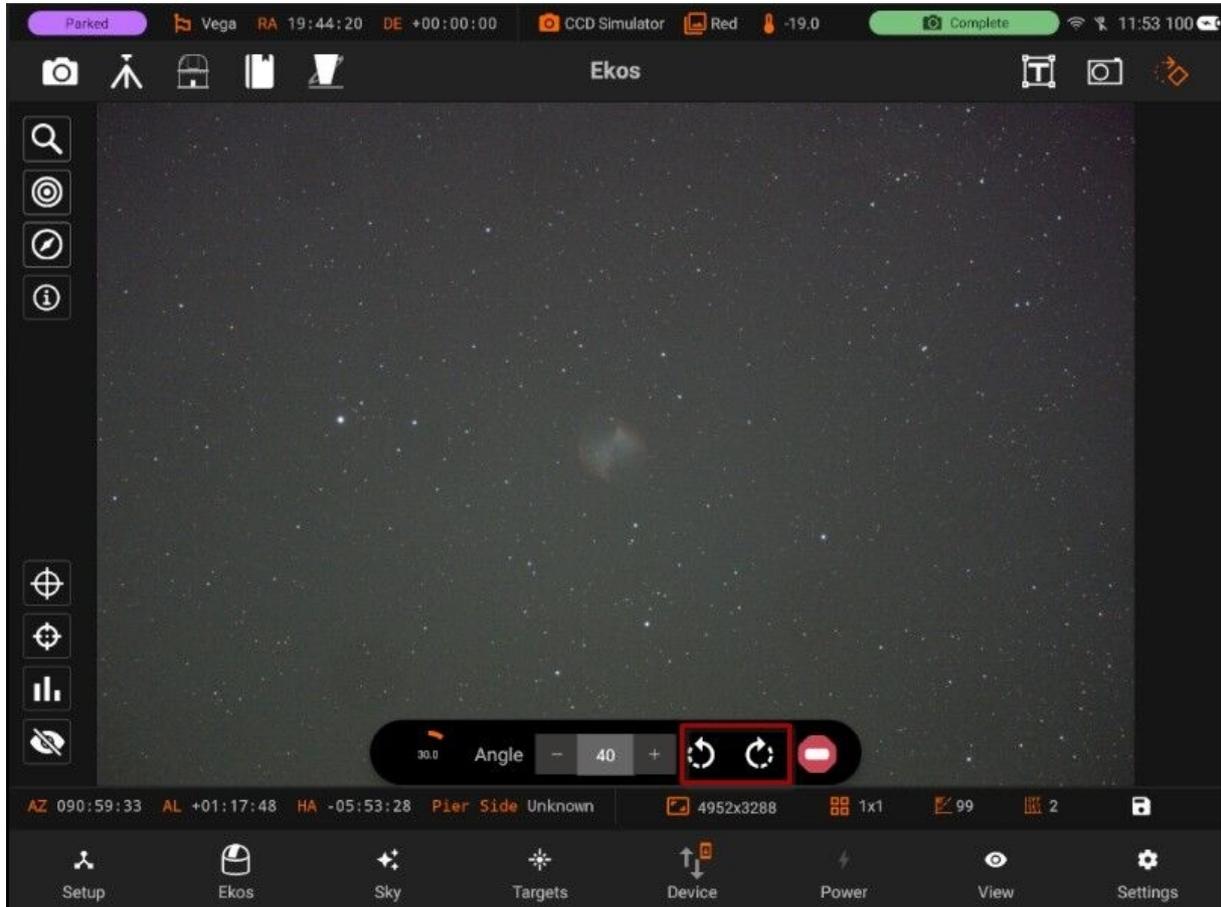
Modules

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.

Focus

Align

Guide

Capture

Mount

Observatory

[Scheduler](#)

Focus

In order to focus an image, Ekos 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 Ekos 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, so 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.

The Focus module allows you to do focusing using your focuser, it has the following features:

- Manage / Select [Optical trains](#).
- Goto absolute motor step
- Preview
- Loop
- Advanced options (settings, process, mechanics)
- Image viewer
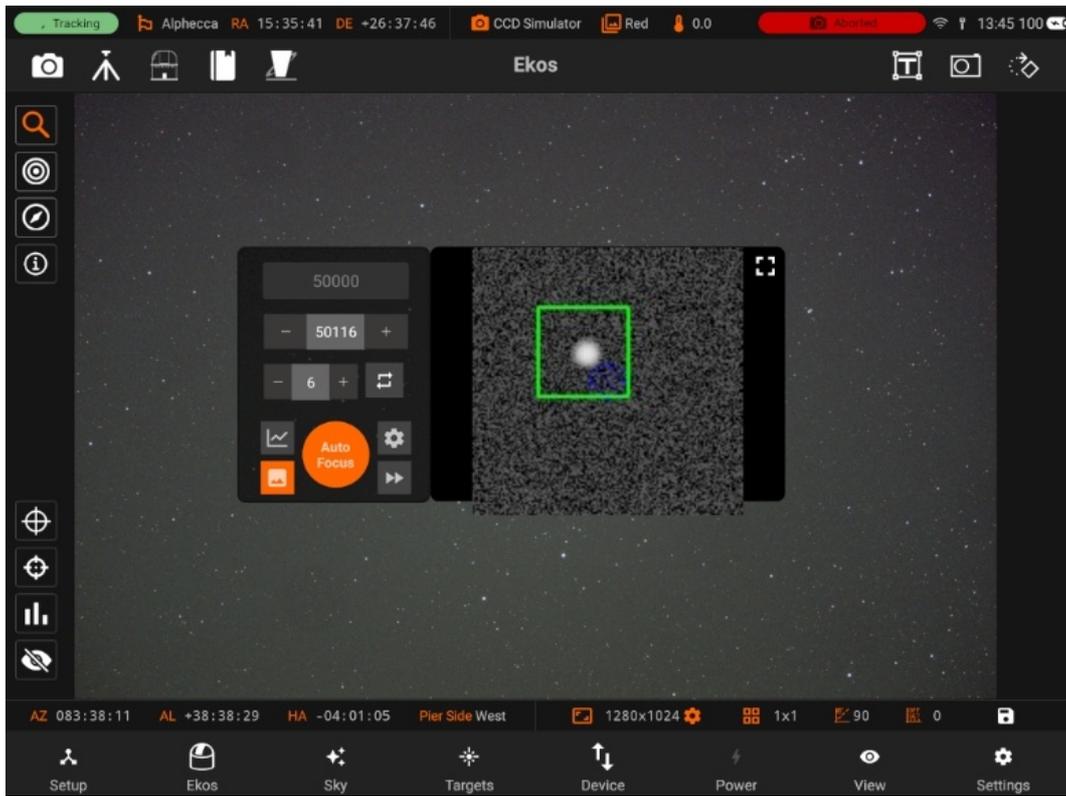
- HFR Plot

Now you can drag the Focus module to any part of the screen using gestures
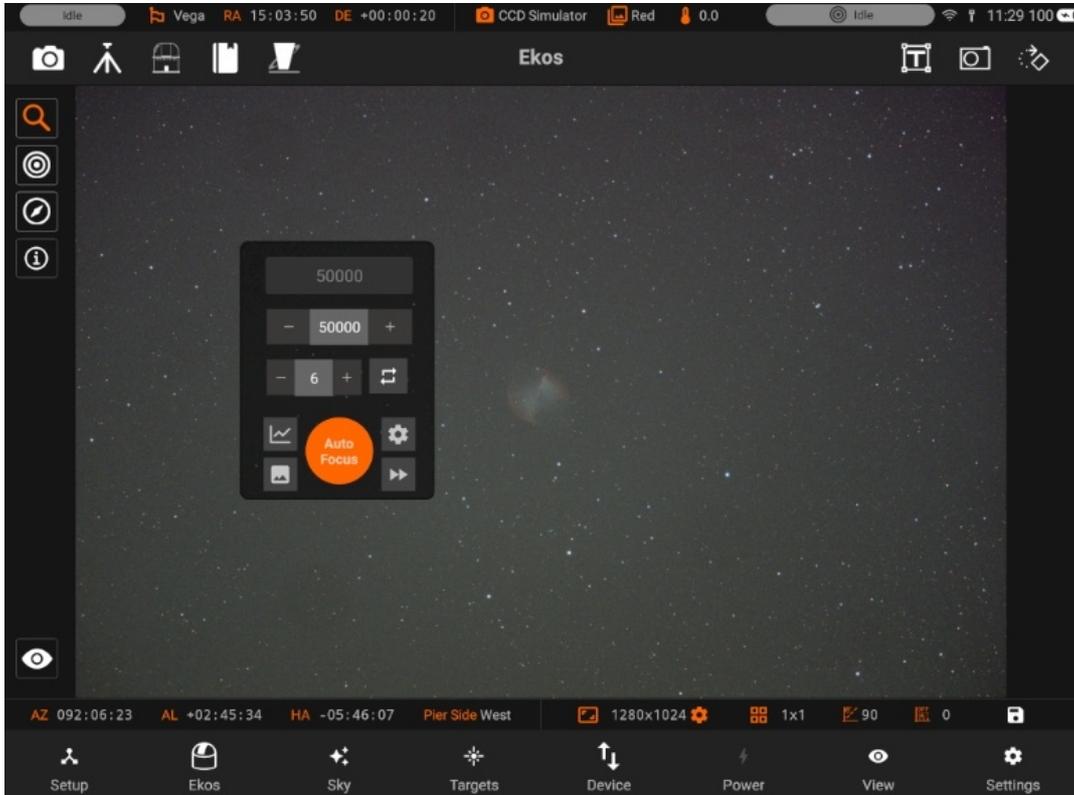
Quick Settings
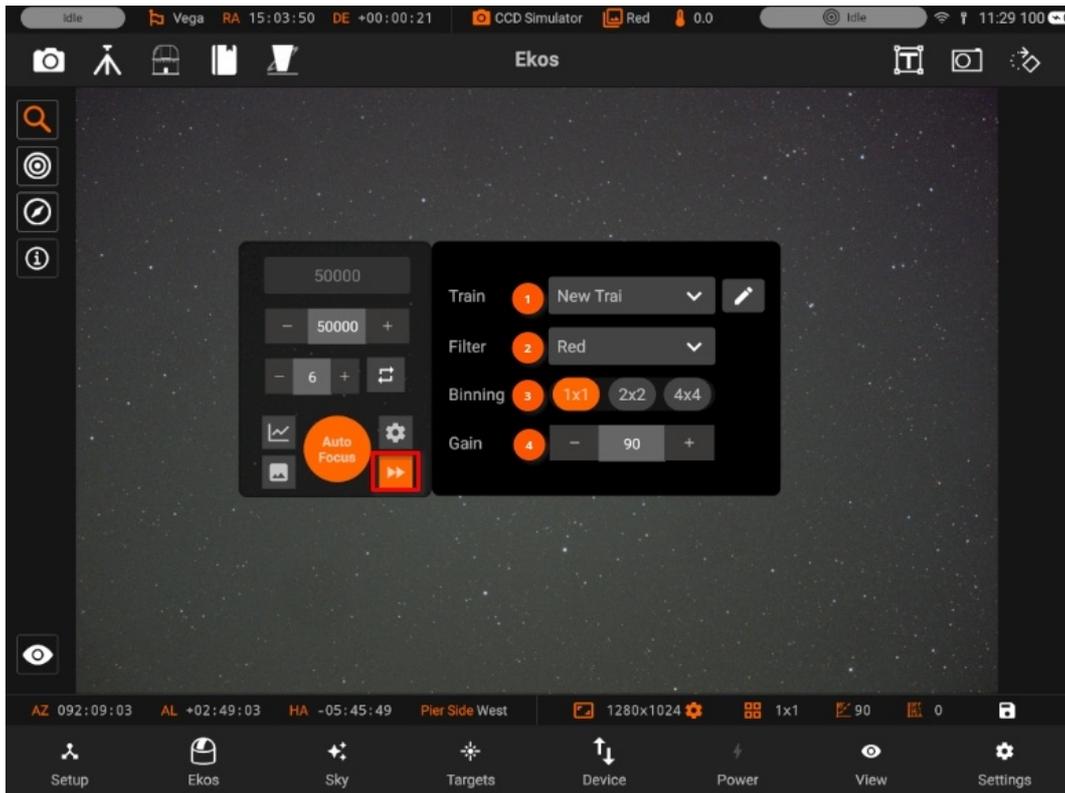
- Train

    You can Select / Edit a train specifically for Focus module. Each module has it's own train. Visit Optical trains topic for more.

- Filter
- Binning
- Gain

There are 3 ways to Autofocus in Ekos. Here, I've setup an example that covers each:

1. Use Autofocus on the designated filter. In the example, Lum is configured like this. Whenever the Lum filter is selected in a sequence, Autofocus will be run on Lum.

2. Use Autofocus on a "lock" filter. In the example, Sii, Ha and Oiii are configured like this. Whenever Sii, Ha or Oiii are selected in a sequence, Autofocus will be run on Lum. When Autofocus completes (for example at 37273), Focus will apply the offset to go from Lum to, for example, Ha (in this case (–23 – 0) = –23 ticks. The focuser moves to 37273 – 23 = 37250 and Ha will again be selected in the filter wheel.

3. Don't use Autofocus but apply offsets on filter change. Red, Green and Blue have been setup like this. For example, when swapping from Red to Green, no Autofocus will be run and the focuser will from its current position (e.g. 37118) by the offset different between Red and Green. In this case, 4 – (–21) = 25 ticks. So the focuser moves to 37118 + 25 = 37143 and Green will be selected in the filter wheel.

2. So how do I setup Filter Offsets?

You can do it manually by running Autofocus several times and getting an average focus position for each filter. Then do the maths yourself to work out the offsets and enter these numbers into the Offsets column in the Filter Settings popup.

3.6.5 Introduced the Build Filter Offsets utility, launched from the Filter Settings popup by pressing the Build Offsets button. This helps to automate the process. See the Build Offsets section in the Focus section of the Kstars Handbook

Auto focusing

You can do auto focusing by either keeping the preset setting as default or choosing an existing preset and then tapping on Auto Focus. The image viewer will show you the current image being captured by your camera, with a square around the detected star. An HFR Plot is also available on the right side of the screen to inform you about the current motor step and the HFR (Half-Flux-Radius). The blue points are the previous focus points, and the green point is the latest focus point. The HFR value is displayed under the HFR Plot.
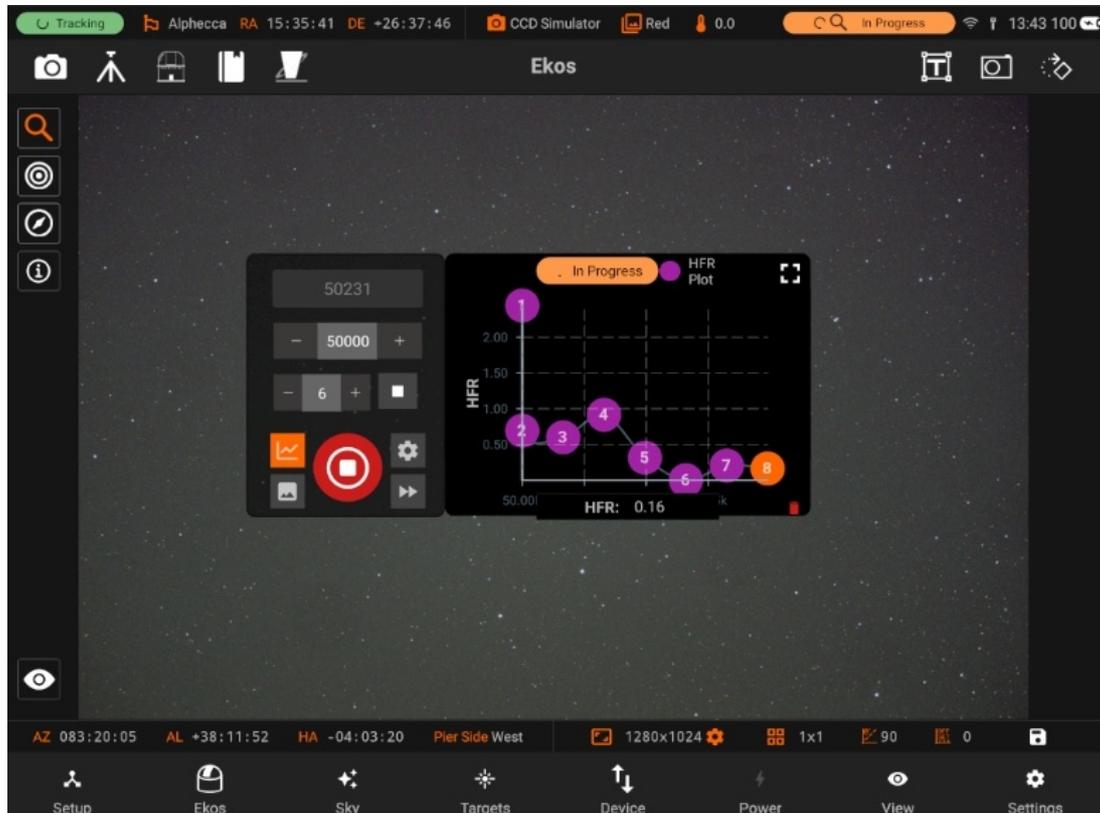
When the Auto Focusing is done, the status badge above the HFR Plot will turn to green and say "Complete".
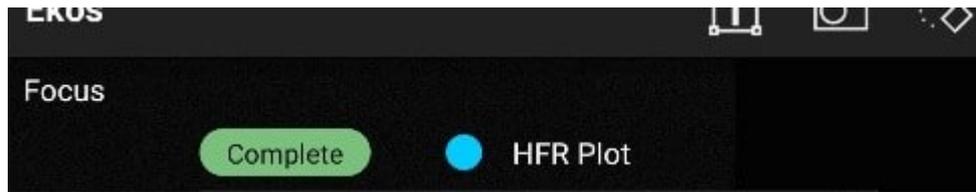
Settings

You will be able to see the Settings by pressing the Icon
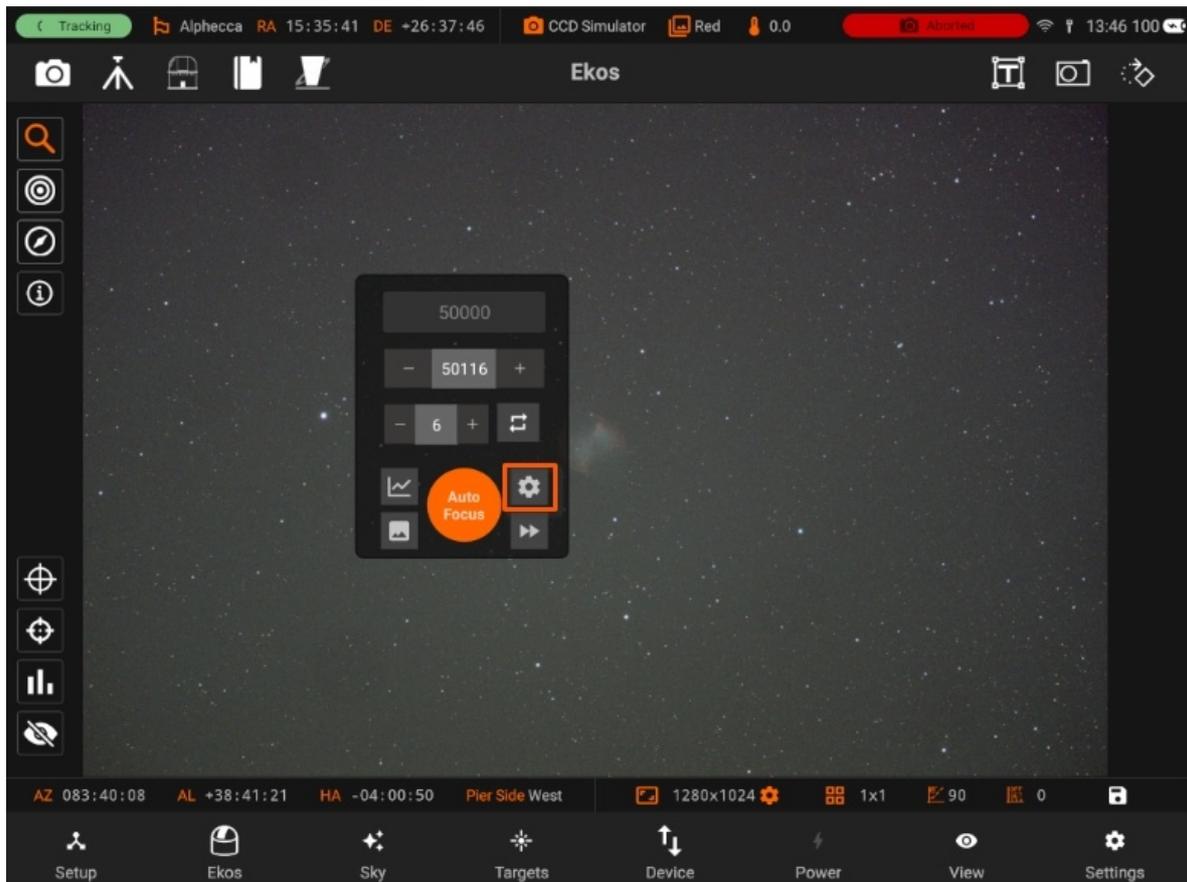
Following are the settings from [Focus module.](#)

- [Advanced settings](#)
- [Process settings](#)
- [Mechanics settings](#)

Advanced

Advanced setting
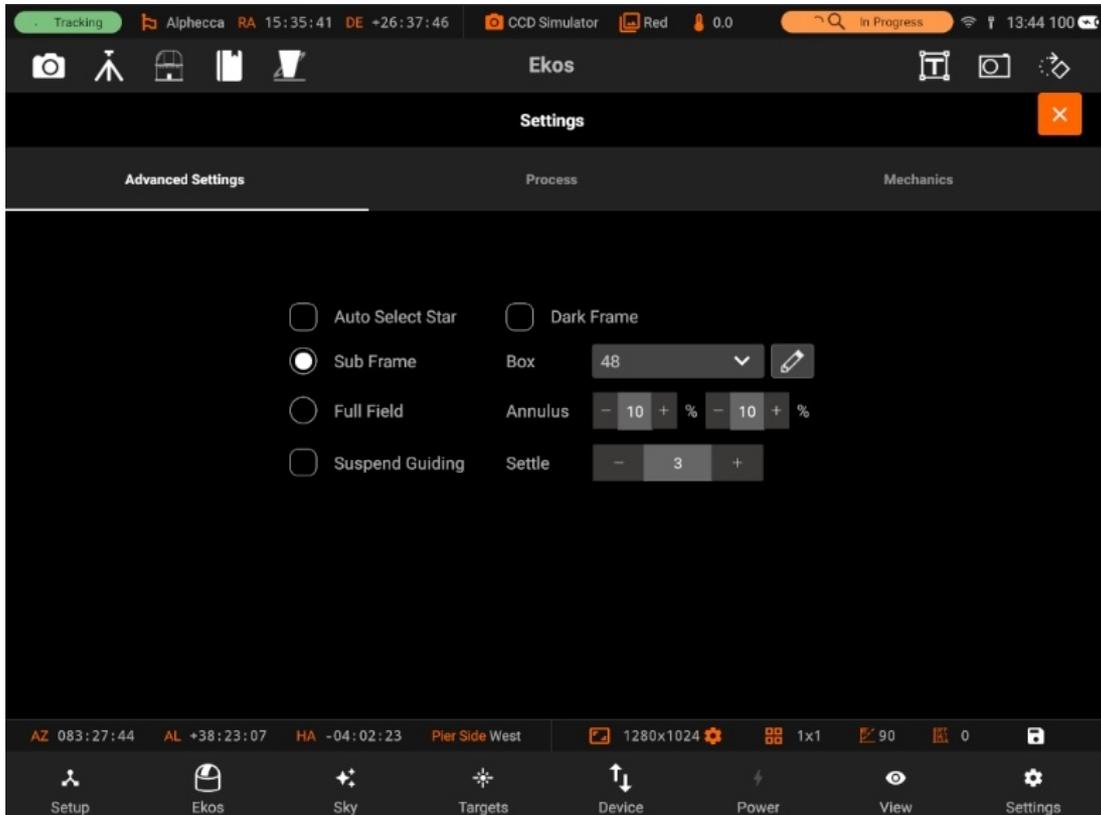
The Settings page has the following options:

- Auto Select Star: Automatically detect and select best star for guiding in the image.
- Subframe: Subframe around the focus star during the autofocus procedure. Enabling subframing can significantly speed up the focus process.
- 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.
- 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.
- 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.
- Box: Sets the box size used to enclose the focus star. Increase if you have very large stars.

- **Annulus**: During full field focusing, stars which are inside this percentage of the frame are filtered out of HFR calculation (default 0%). Detection algorithms may also have an inherent filter.
- **Settle**: Sets the amount of seconds to wait before resuming guiding.

Process
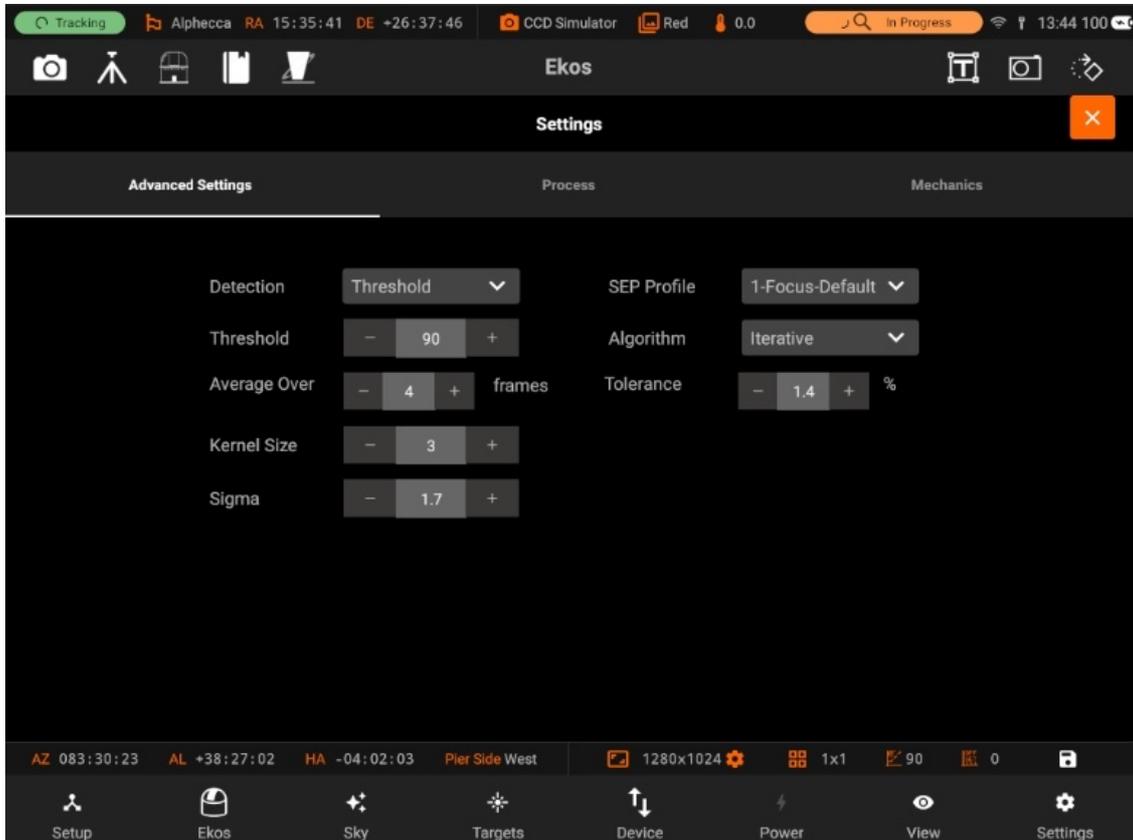
The Process page has the following options:

- 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.

- o 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.
- Threshold: Threshold percentage value is used for star detection using the Threshold detection algorithm. Increase to restrict the centroid to bright cores. Decrease to enclose fuzzy stars.
- Effect: Apply filter to image after capture to enhance it for preview purposes. It is highly advisable to turn off any effects during the focusing process as it may interfere with HFR calculations.
- Kernel size: This is the gaussian blur kernel size. Used for blurring the image before for instance the Bahtinov edge detection.
- Sigma: This is the gaussian blur sigma value. Used for blurring the image before for instance the Bahtinov edge detection.
- Algorithm: Select the auto focus process algorithm:
  - o 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.
  - o 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.
  - o 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%.
- 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.

⚠ Caution

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

- Average over: Sets the number of frames to capture in order to average the HFR value at the current focuser position.
- Num. of rows: The number of rows set in this field will be combined in the Bahtinov max average calculation. Changing this value might help to match the Bahtinov lines on the star pattern more accurately.

Mechanics
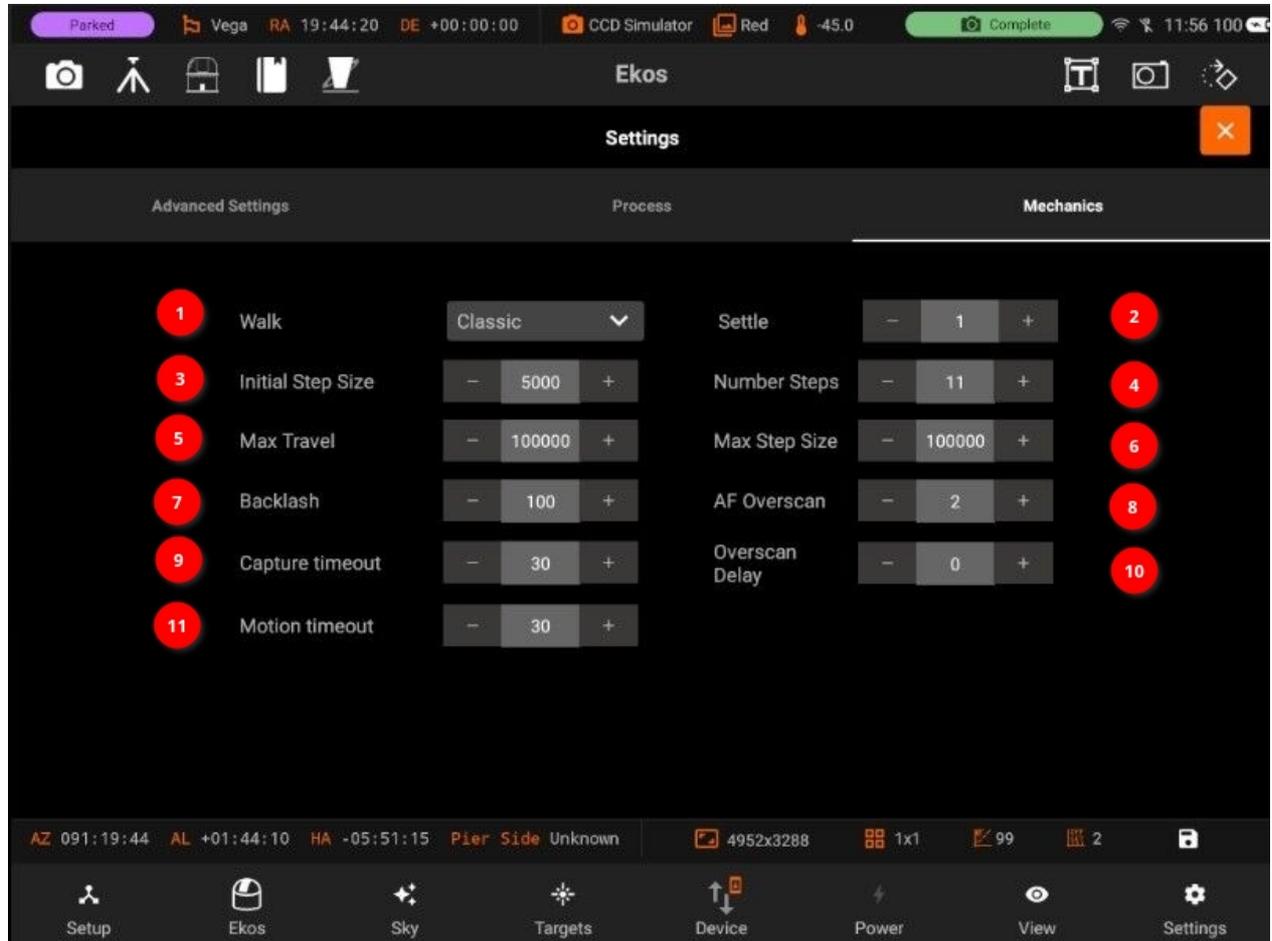
The Mechanics page has the following options:

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: 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.

4. 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.

5. Max Travel: Maximum travel in ticks before the auto-focus process aborts.

6. 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.

7. 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.

8. 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.

9. Capture timeout: Maximum time in seconds to wait for a captured image to be received before declaring a timeout.

10. Overscan Delay: Delay between completing the outward motion of an Overscan and starting the inward motion. For most focusers 0s is fine.

11. Motion timeout: Maximum time in seconds to wait for the focuser to move to the desired position before declaring a timeout.

Align
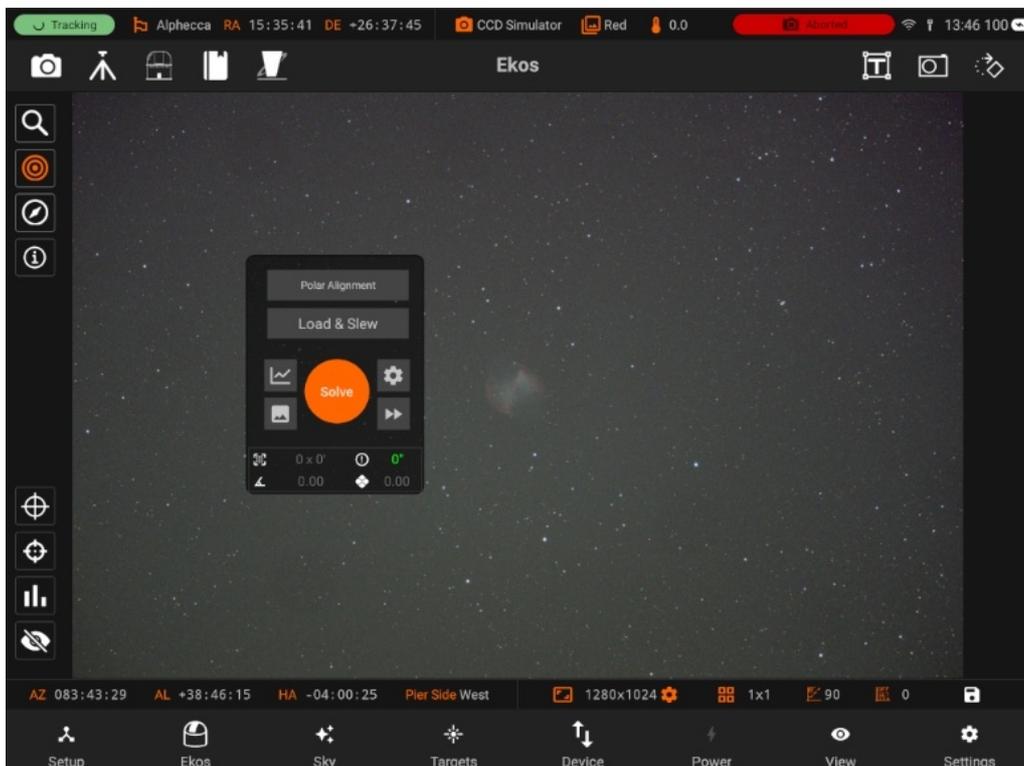
The Align module enables highly accurate GOTOs and dead-center target images by utilizing plate-solving. The process starts with capturing an image and plate-solving it to get the exact sky coordinates. Once the coordinates are obtained, the mount is synchronized and then commanded to slew to the correct target position. This cycle repeats until the mount is within a few arcsecs from the target.
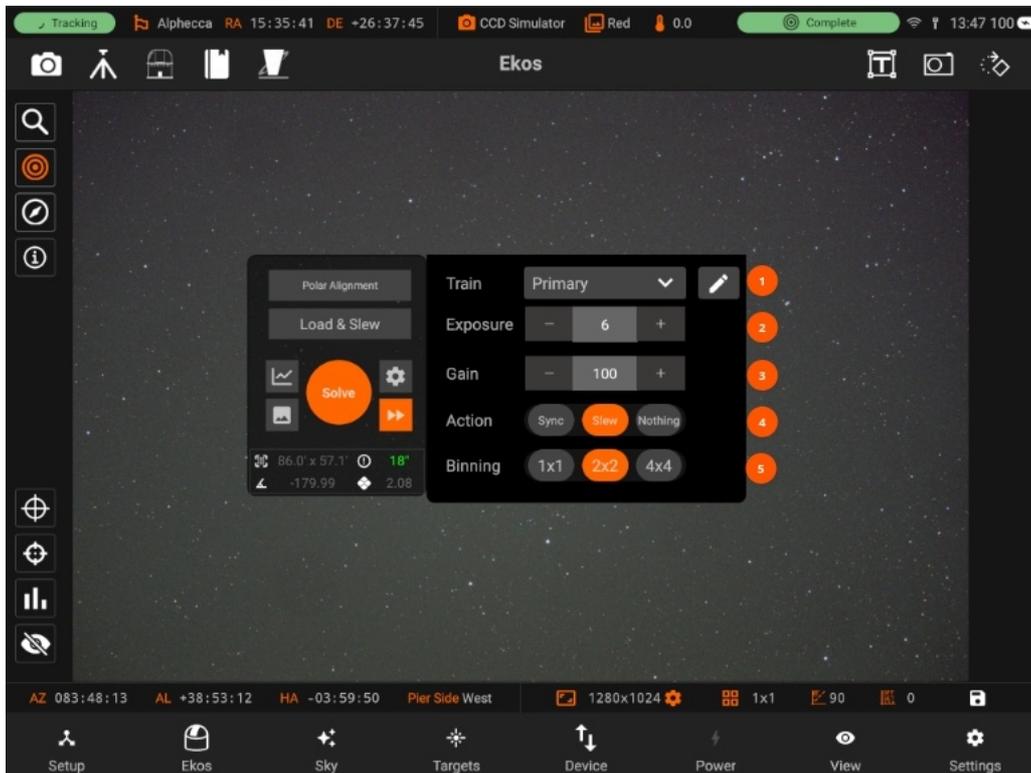
It has the following features:

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

- Polar Alignment Assistance
- Capture & Solve
- Load and Slew
- Image Viewer
- Alignment Plot

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. The points on the alignment plot have 3 different colors: Red, Yellow and Green. If a point is red, that means that the error is 1.5 times or more above the accuracy value, if it's yellow, that means that the error is between 1 times to 1.5 times above the accuracy value, and finally, if it's green, that means that the error is within the accuracy value. The accuracy value can be changed in the preset settings.
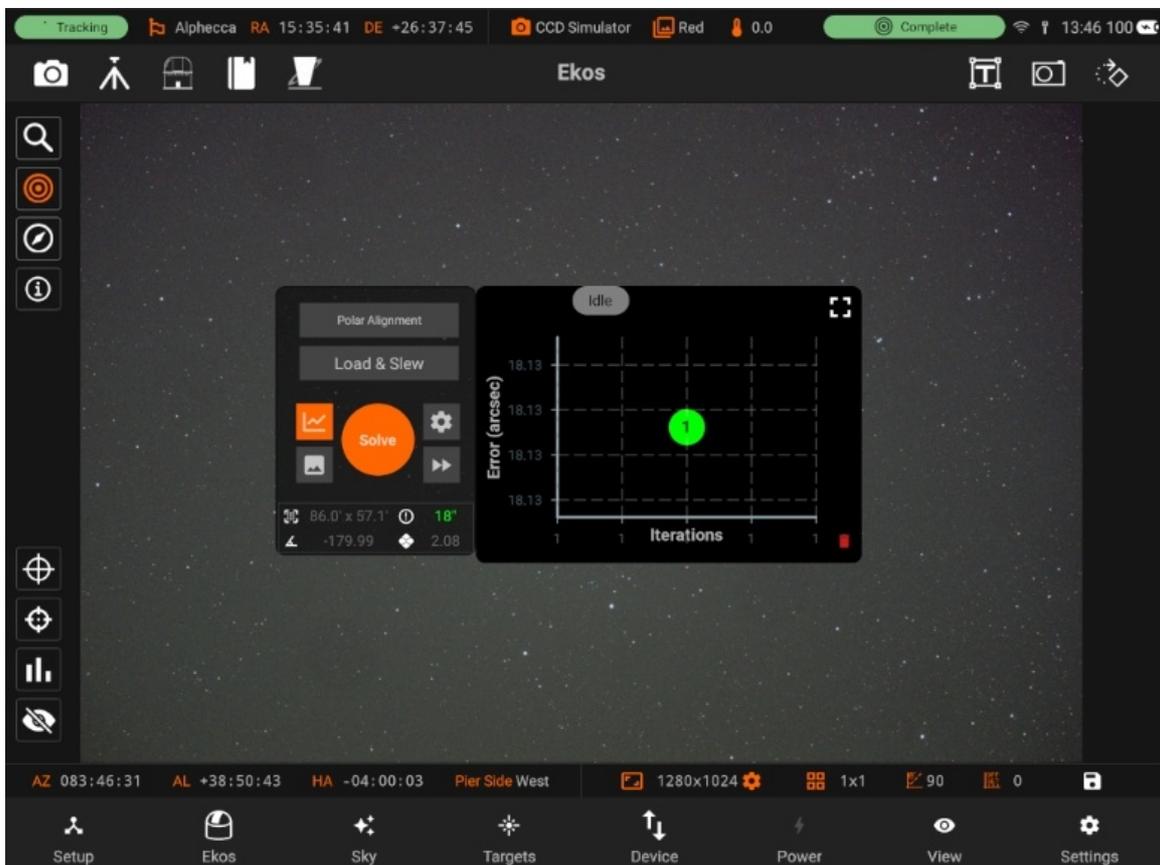
Load and Slew
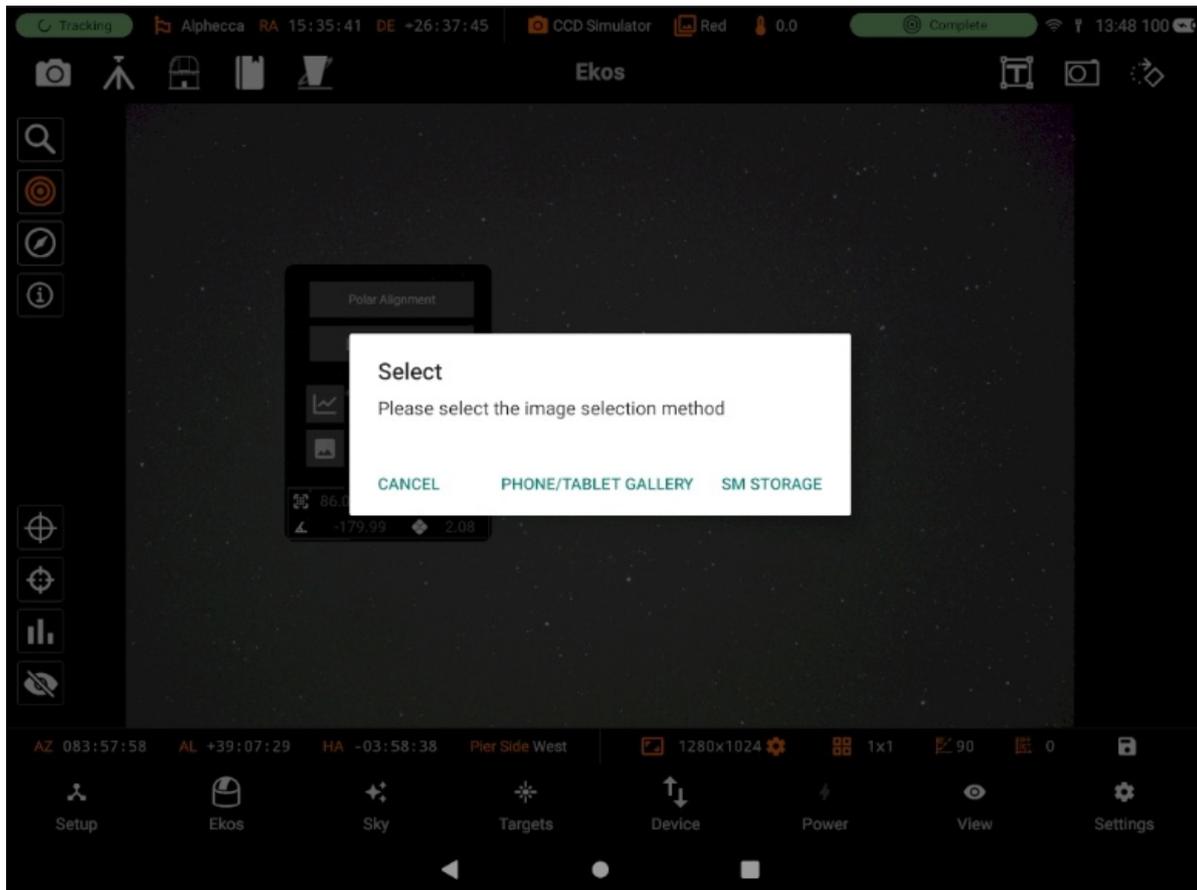
You can load Fits file from the tablet or using [Directory browser](#) to access SM device files. To start a load and slew action by tapping "Phone/Tablet Gallery" and selecting an image to slew to. Stellar-solver is very accurate at this and will be able to slew to object in the image.

PAA

Polar Alignment Assistance (PAA)

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

To start the polar alignment process, open the polar alignment assistance by clicking on PAA button.
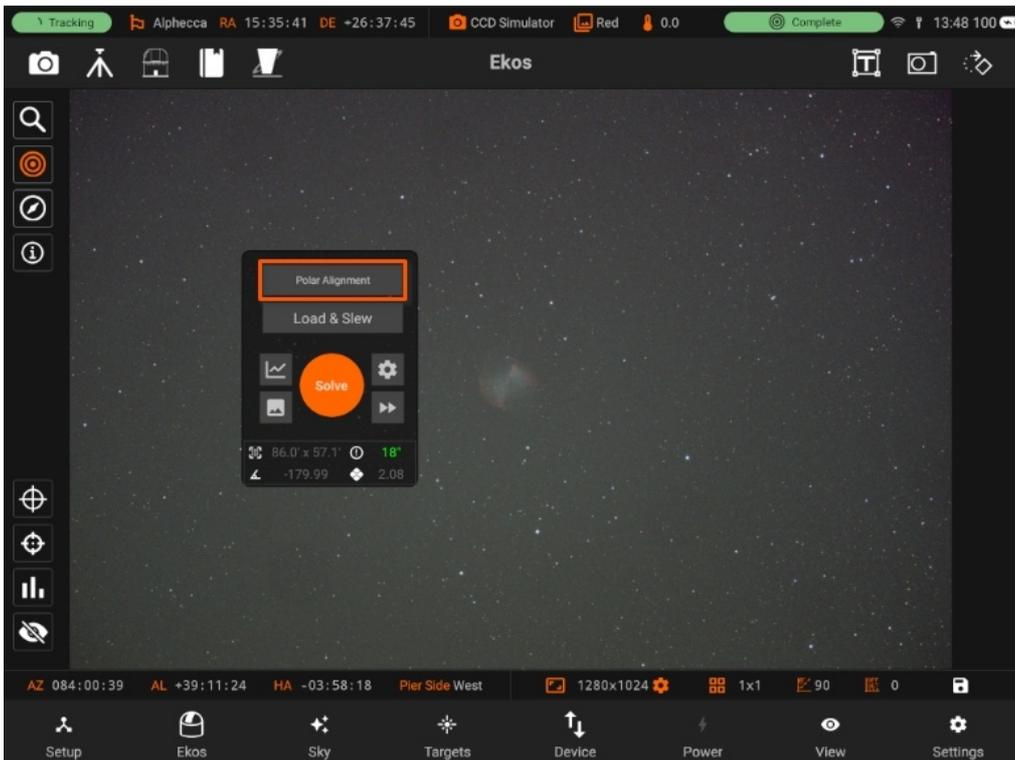
Use the Polar Alignment Settings to modify the settings.
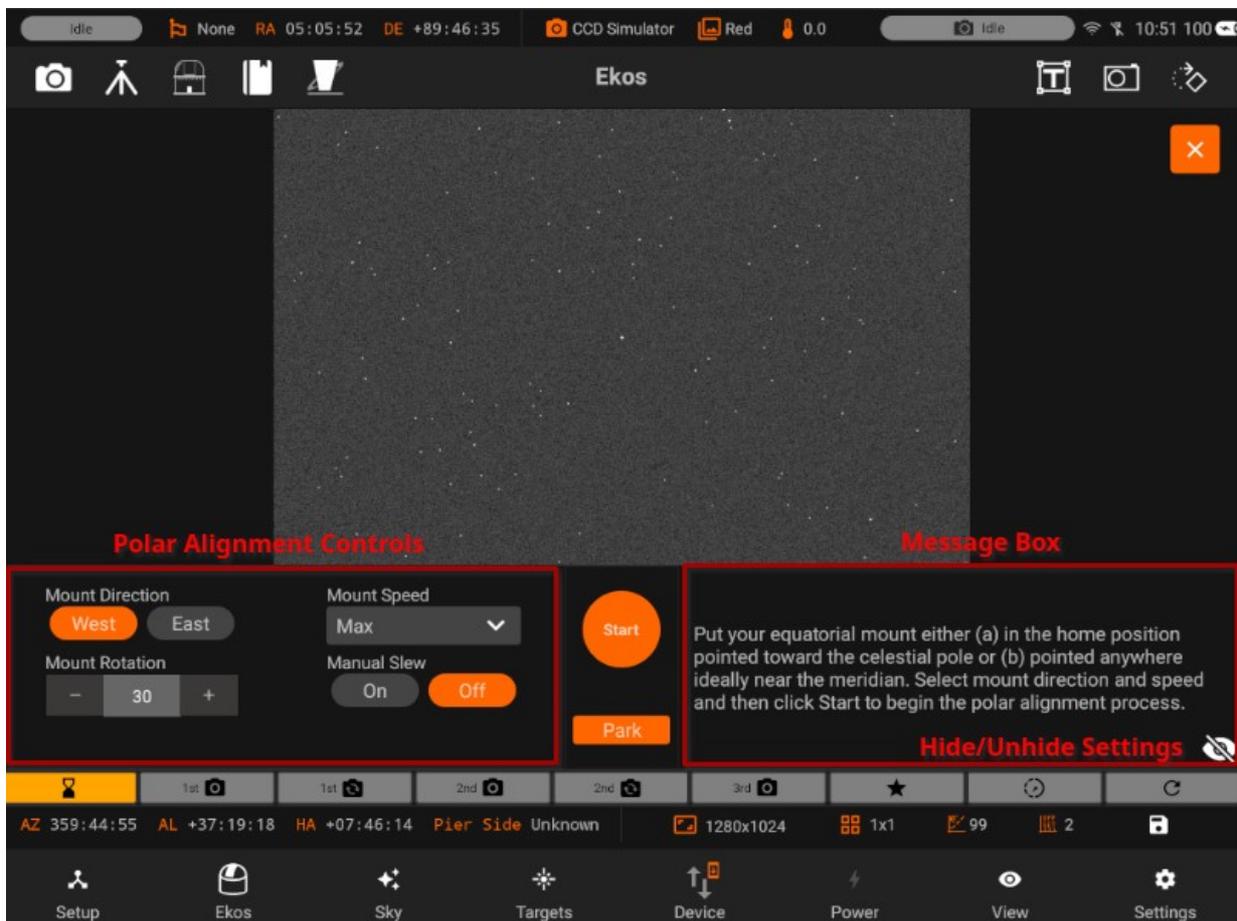
You can adjust the mount direction (1) by selecting **West** or **East** rotation. Adjusting the Mount Speed (2) by opening the speed menu and selecting the preferred rotation speed. Mount Rotation (3) allows the user to modify the amount of rotation the mount rotates after every capture. Manual Slew (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
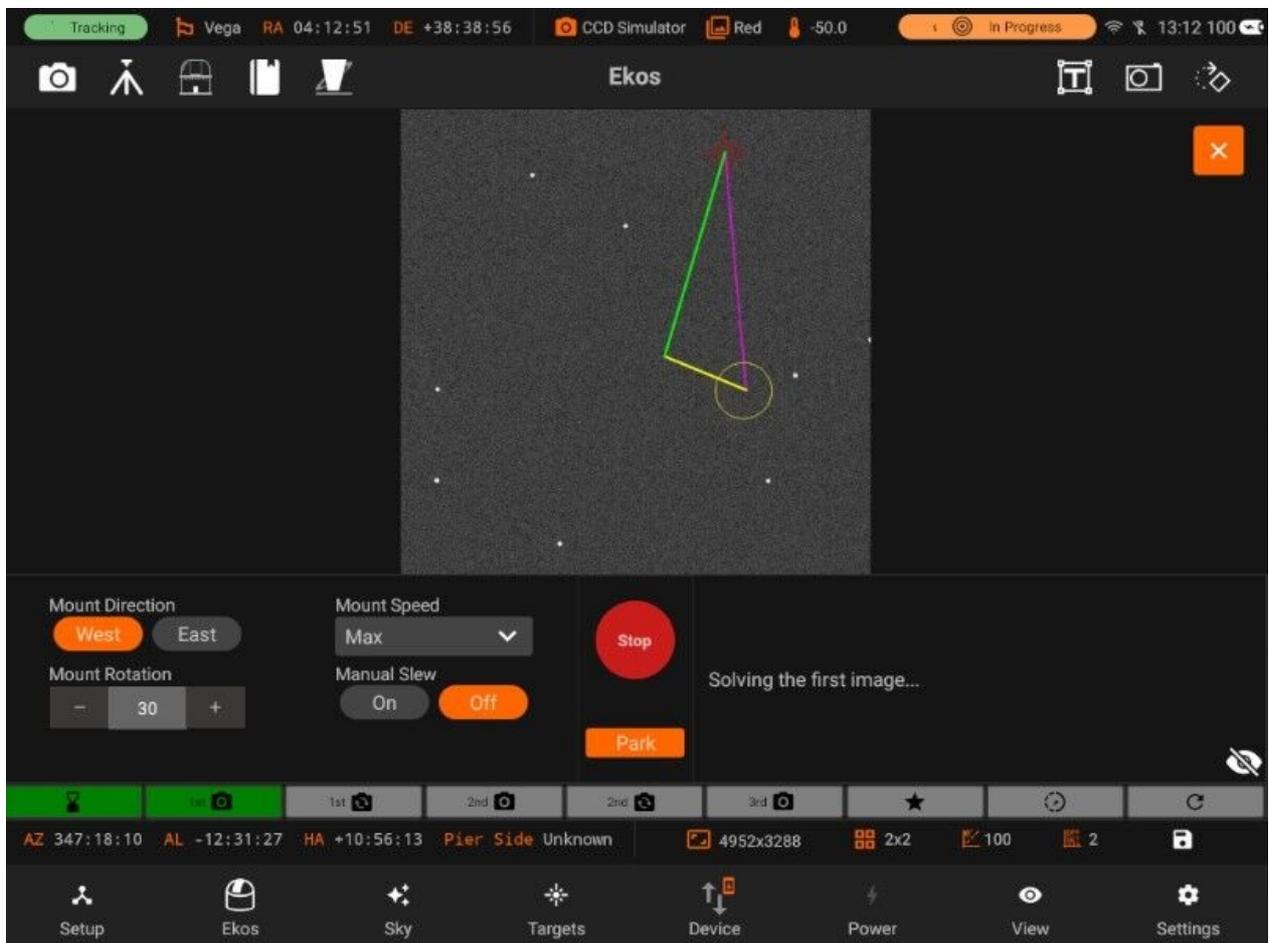
⟳ Second Capture
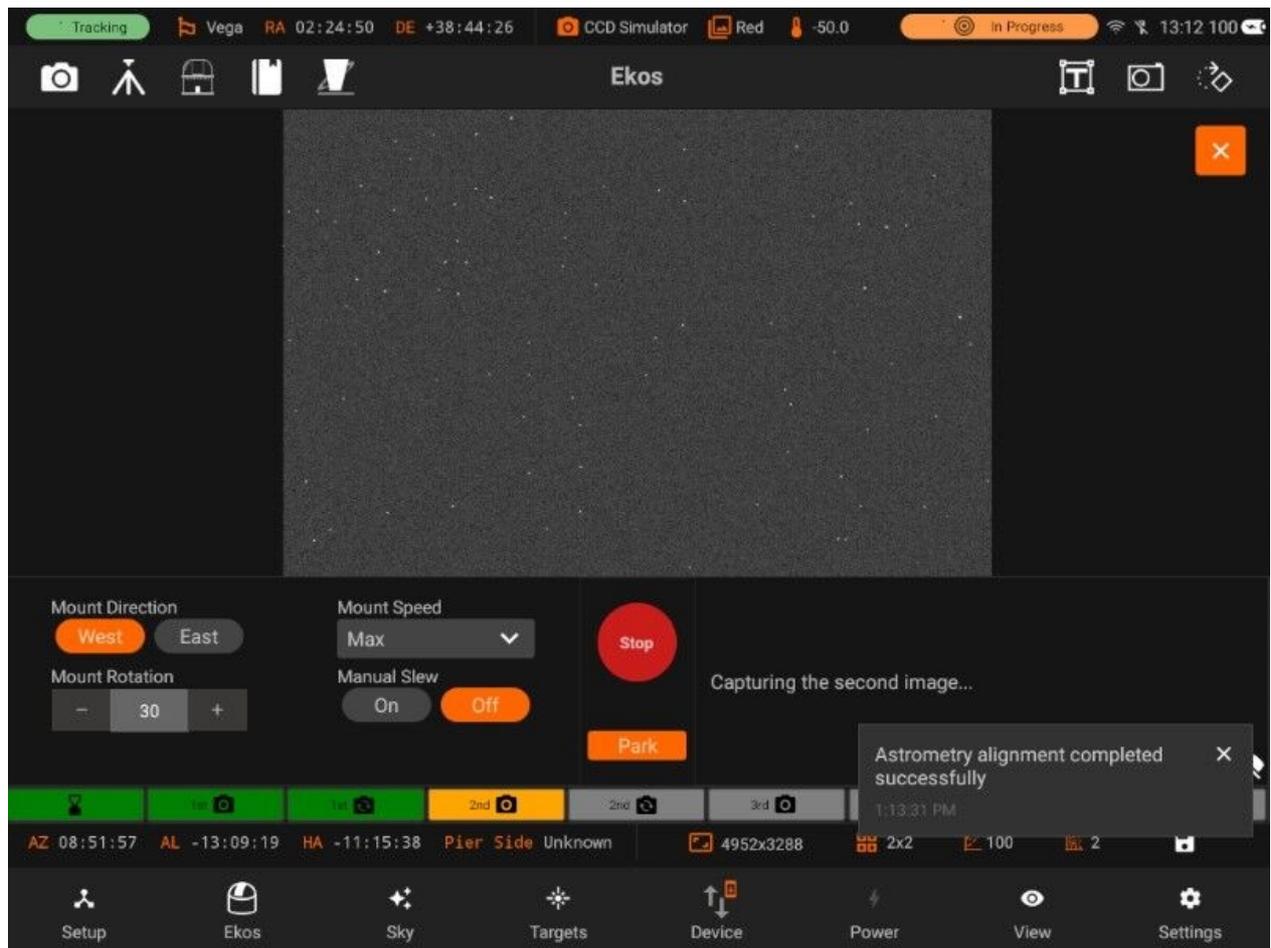
C Third Capture
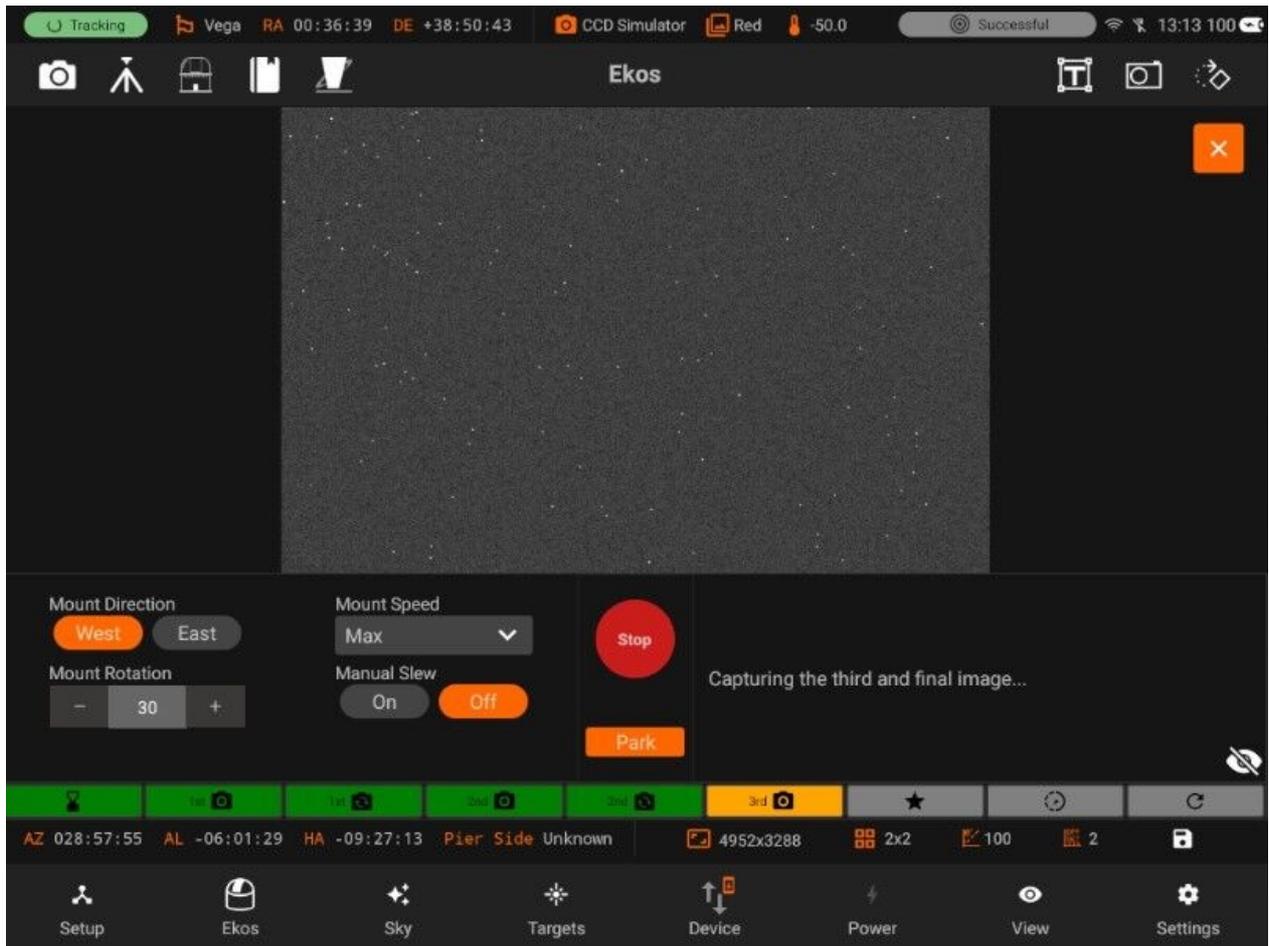
★ Select Star

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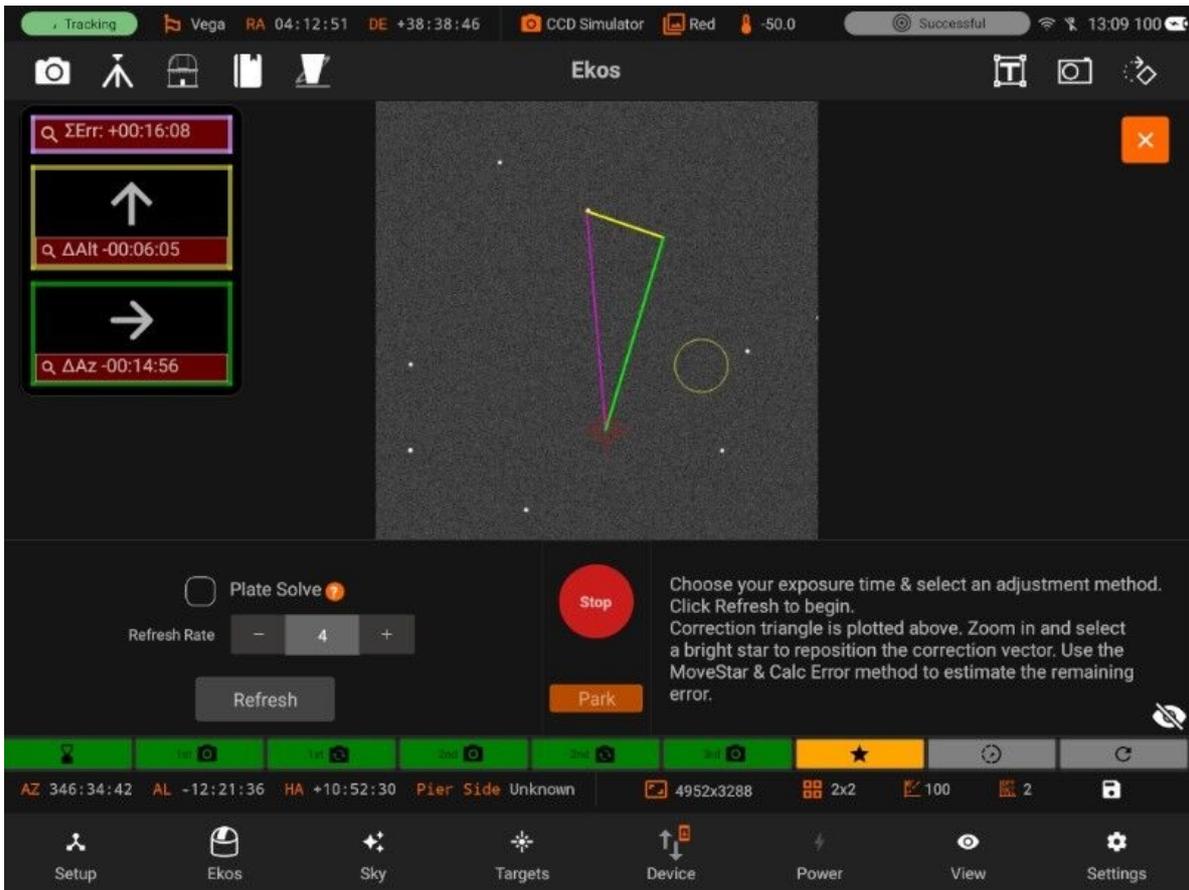
The correction vectors and screen will move to the selected position. At this stage you can use the pinch or spread gesture to use zoom in or out as shown. The zooming and tap features also works while the image is minimized.
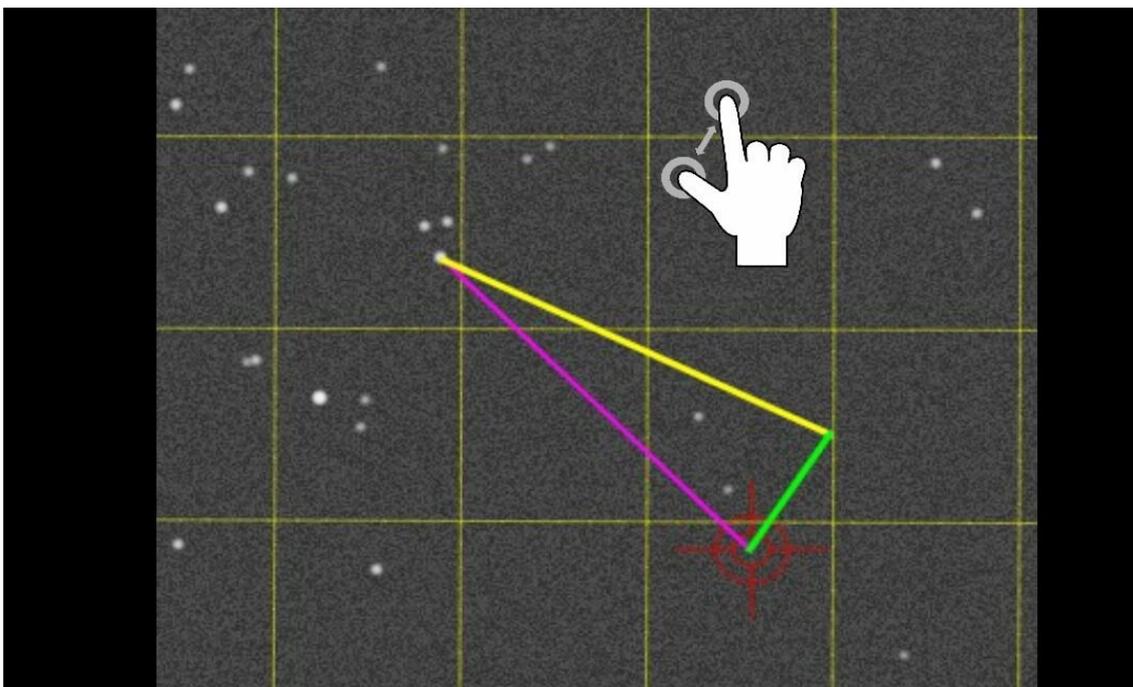
⟳ Select Refresh & Algorithm

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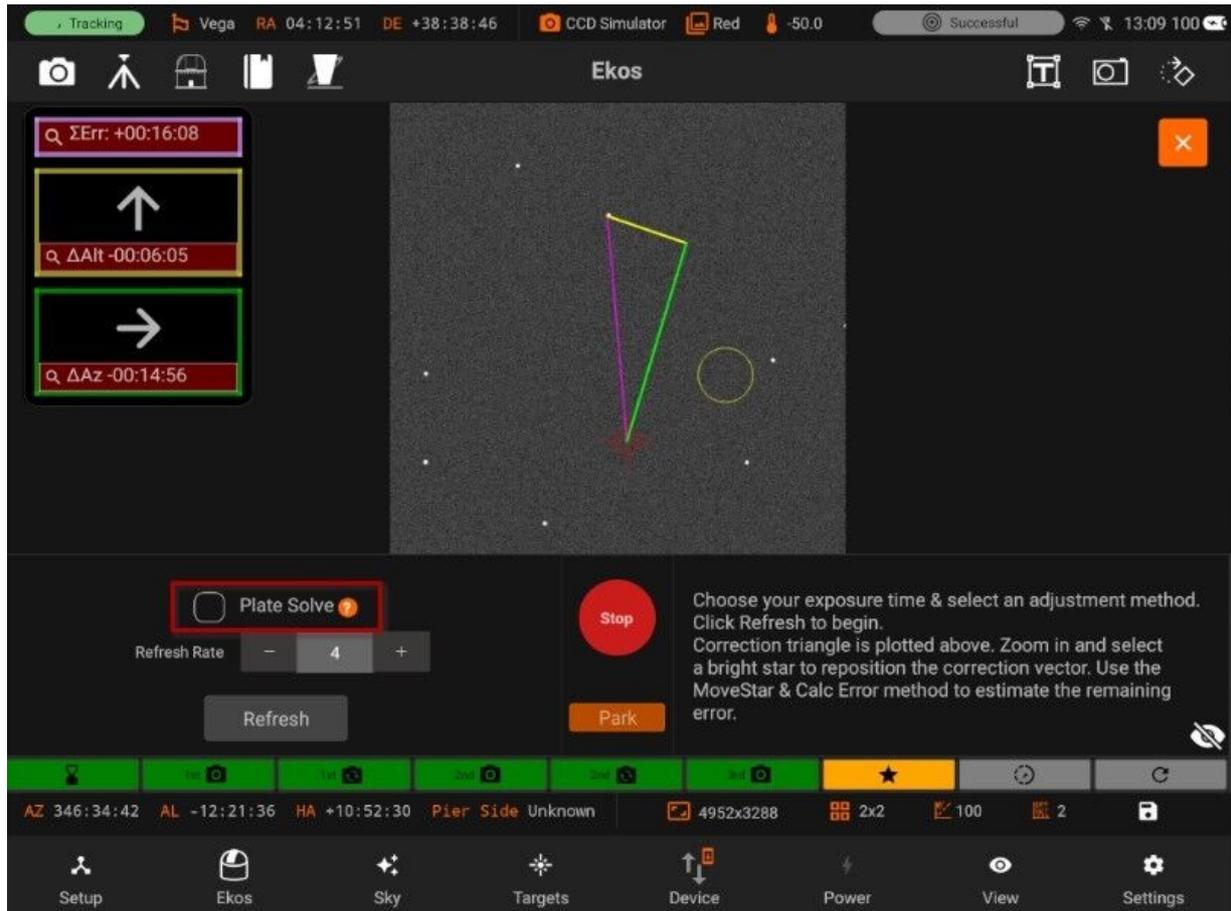
1. **Plate Solving:** Uses plate solving to track what the corrected alignment error is during the refresh process . User should try reduce the error in the Updated error line below and minimize the size of arrows. This is the only scheme that can fully correct an error larger than the image field-of-view,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

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

2. **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.
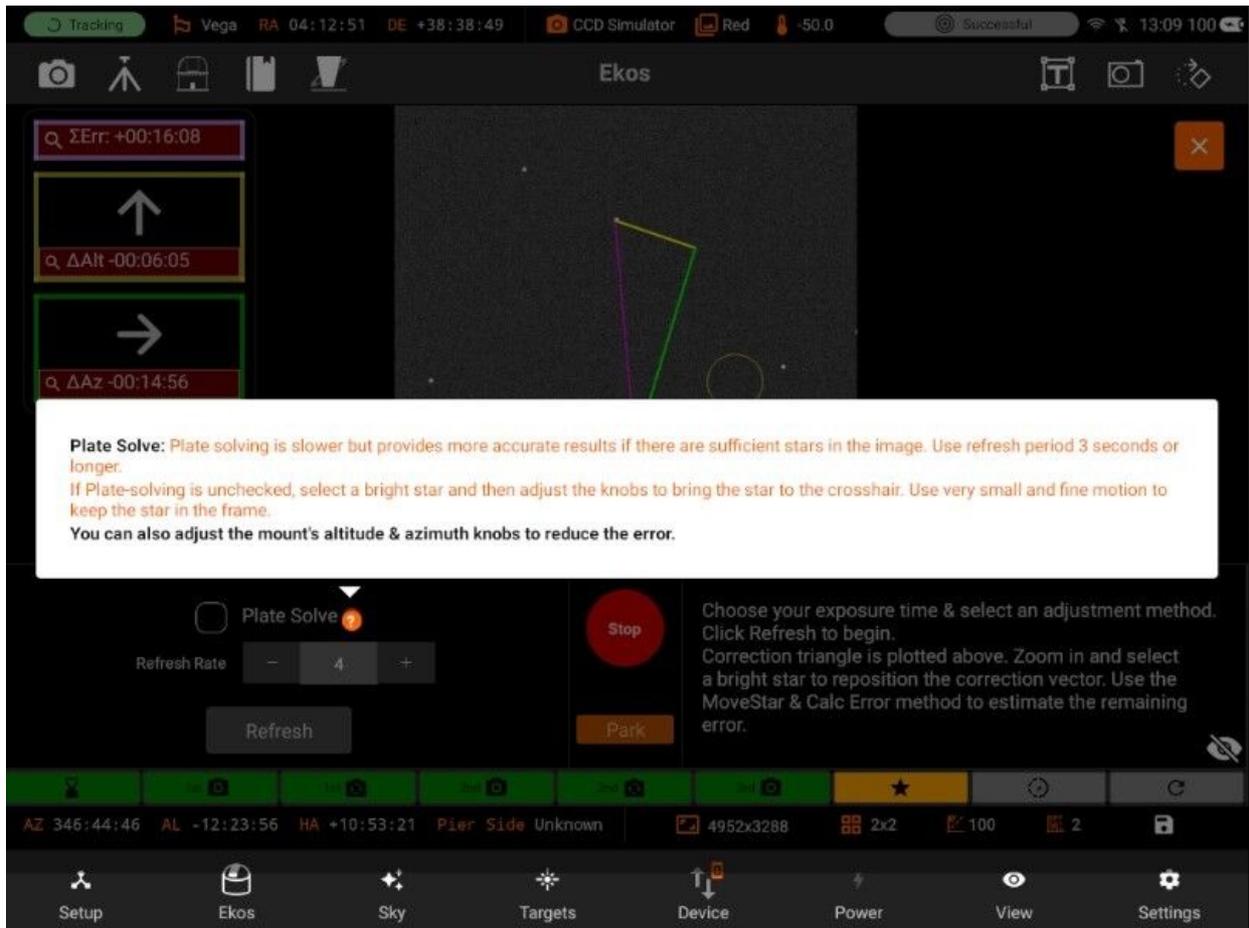
⟳ Refreshing

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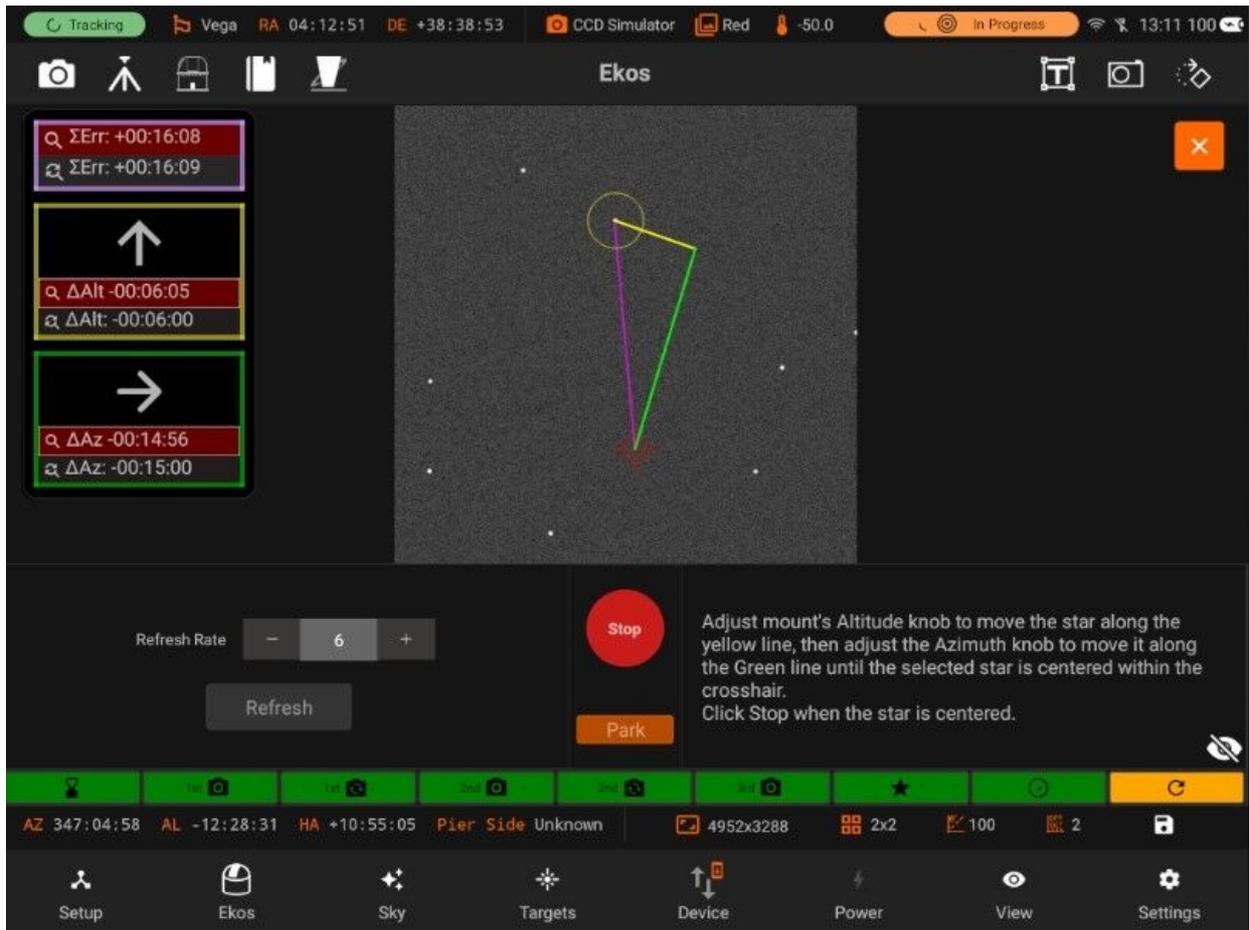
Settings

Following settings are from [Align module](#):
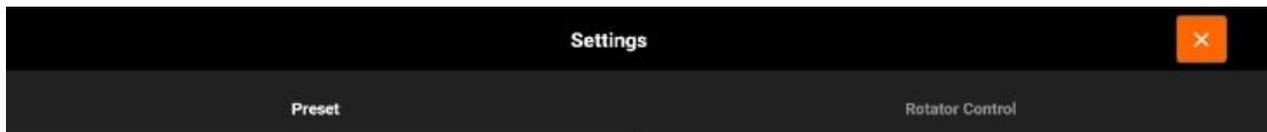
- [Preset settings](#)
- [Rotator control](#)

Presets

Preset Settings
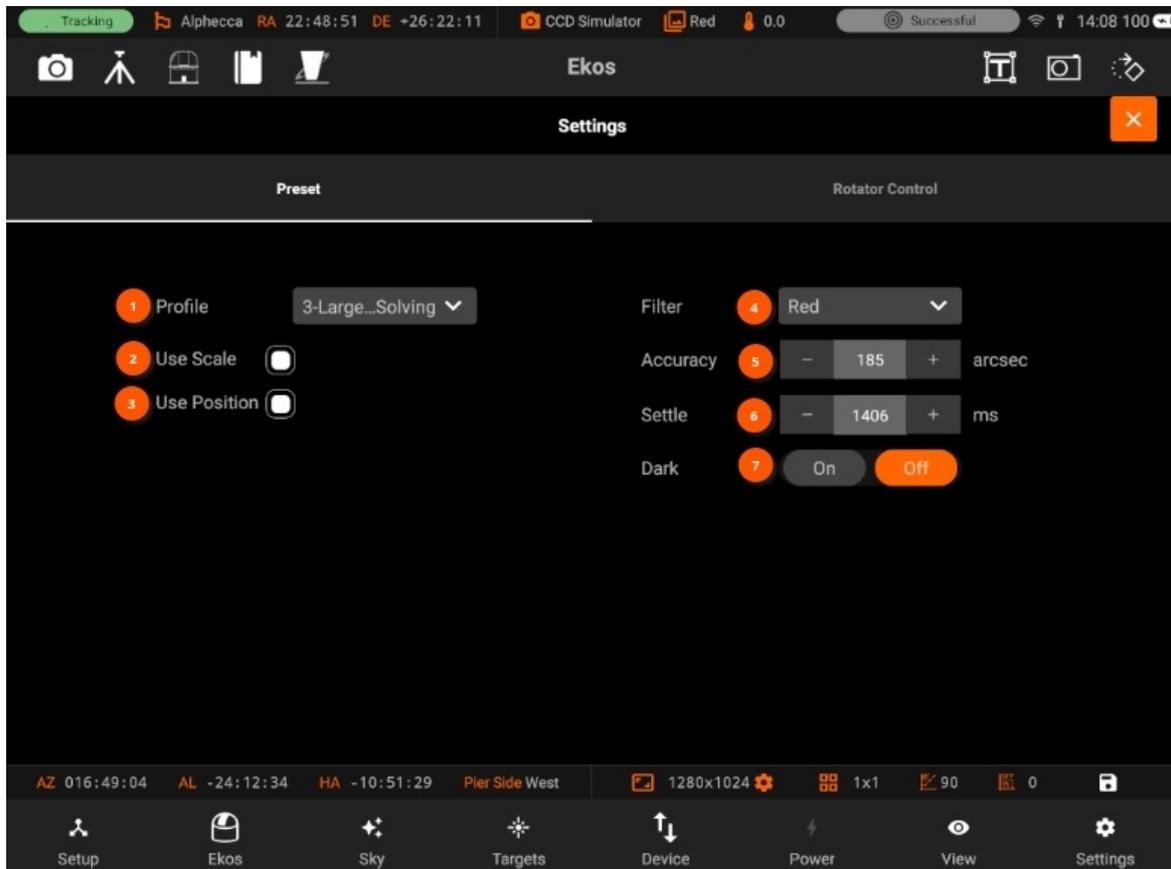
Preset settings has the following structure:

1. Exposure
2. Binning
3. Filter
4. Gain/ISO
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
8. **Use Scale:** Use image scale to speed up astrometry solver. This speeds up the solver greatly as it limits the number of images scales it needs to sift through.
9. **Use Position:** Limit the astrometry solver to only search for solutions near the mount coordinates. This can significantly speed up the solving process..

Rotator control

Rotator control
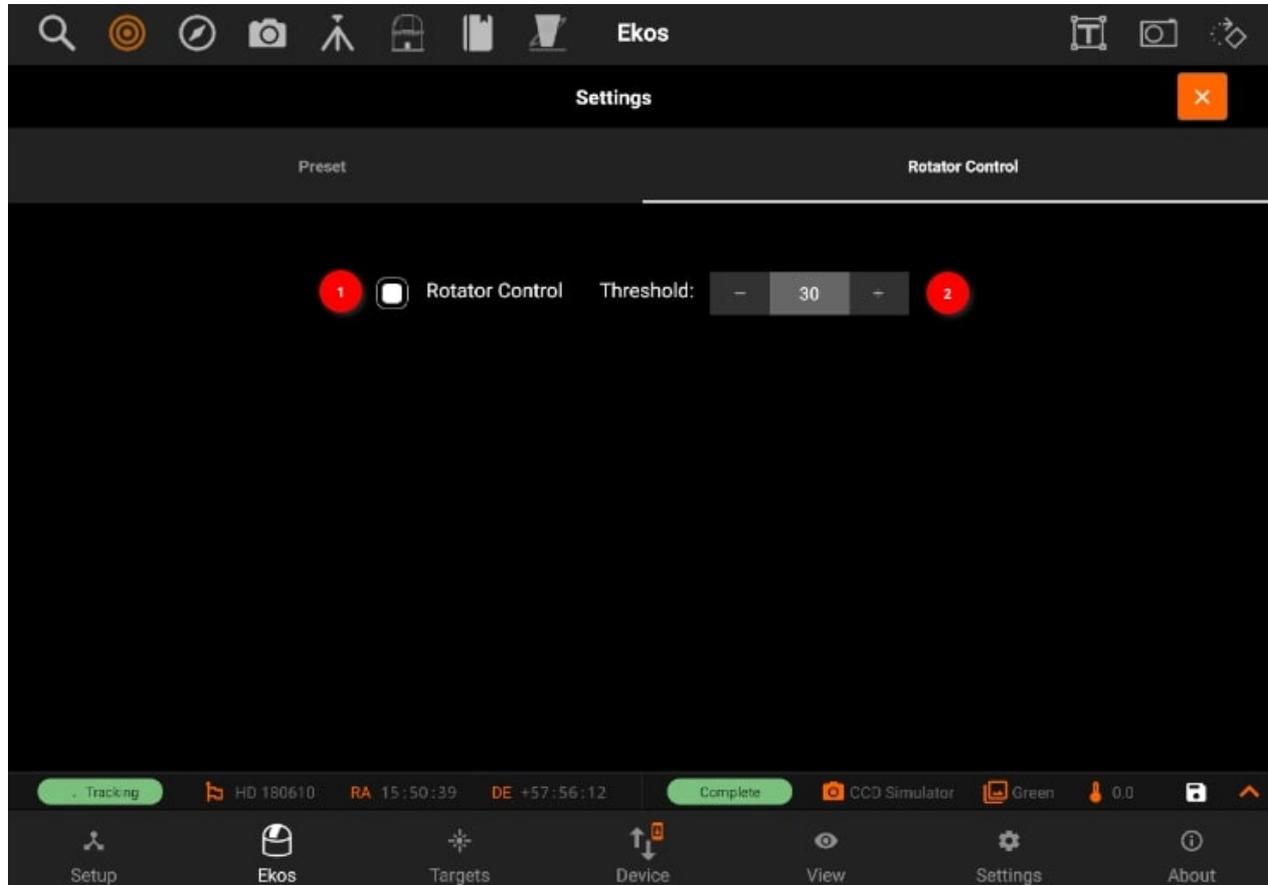
1. **Rotator Control:** Use automatic or manual rotation control when using Load & Slew. For automatic control, the mechanized rotator is commanded to rotate to match the desired position angle. For manual control, the user is asked to manually rotate the camera until the desired position angle is reached.

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.

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:

- Manage / Select Optical trains.
- Start guiding
- Preview
- Advanced Settings

- Image viewer
- Guide Plot
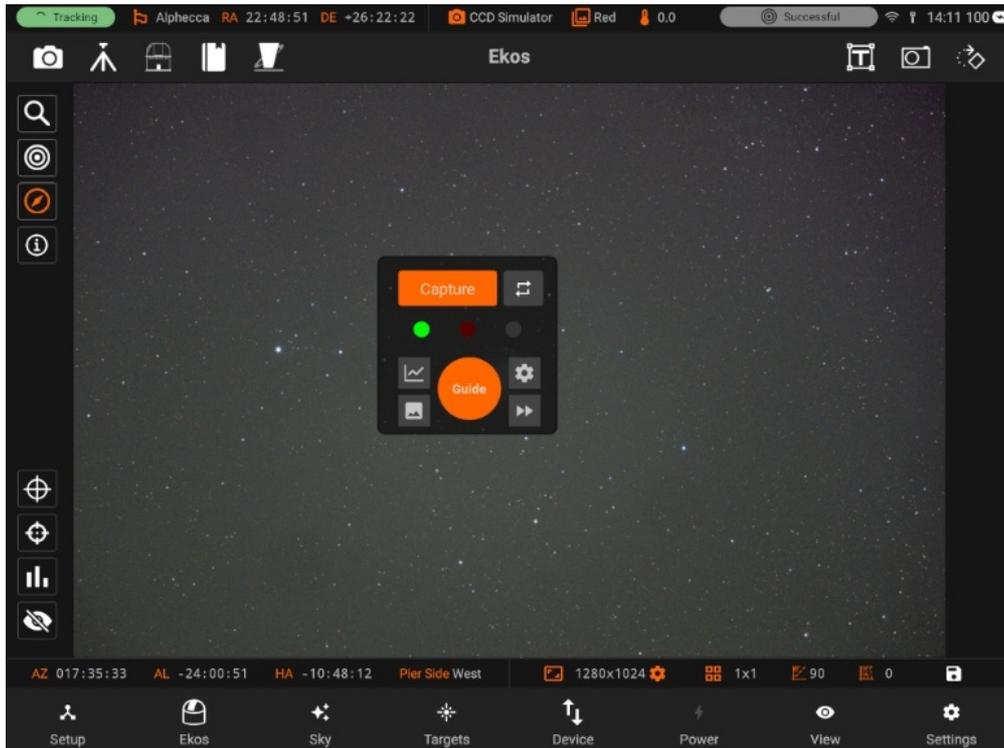
Guide Quick Settings:
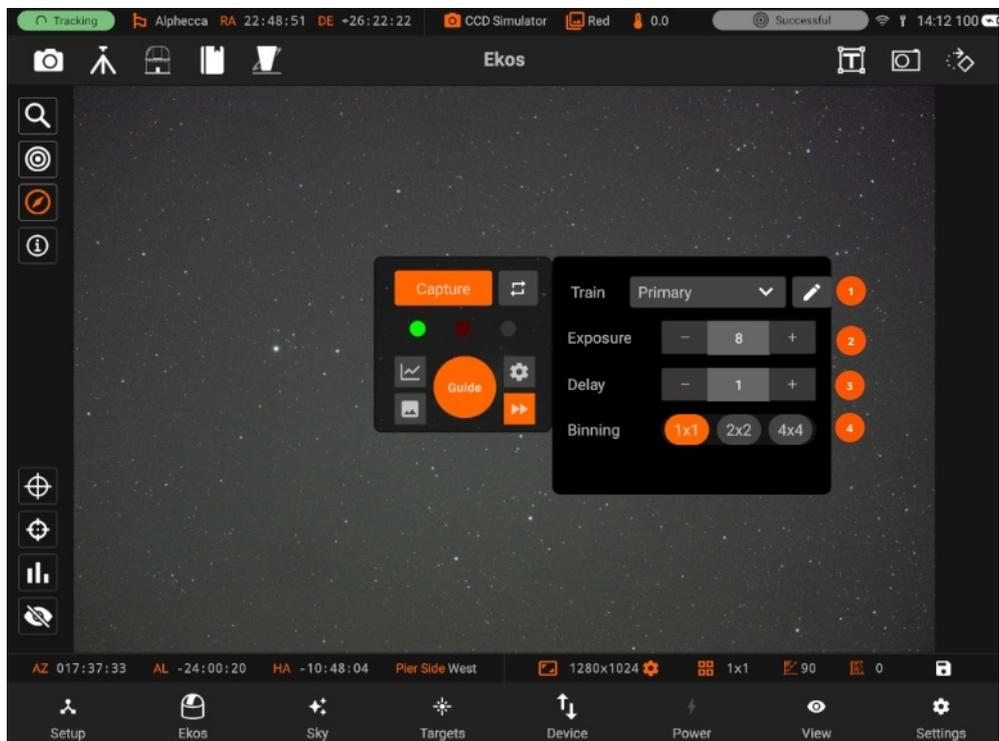
1. Train: You can Select / Edit a train specifically for Align module. Each module has it's own train. Visit Optical trains topic for more.

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.
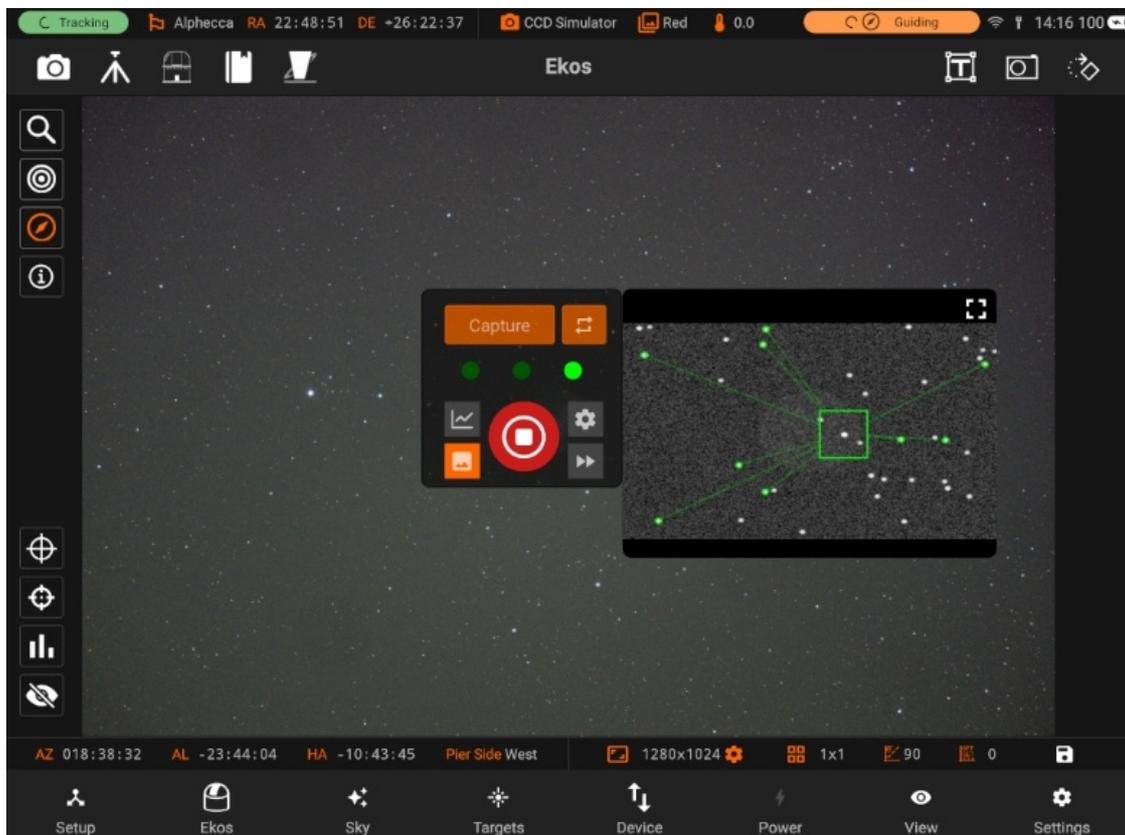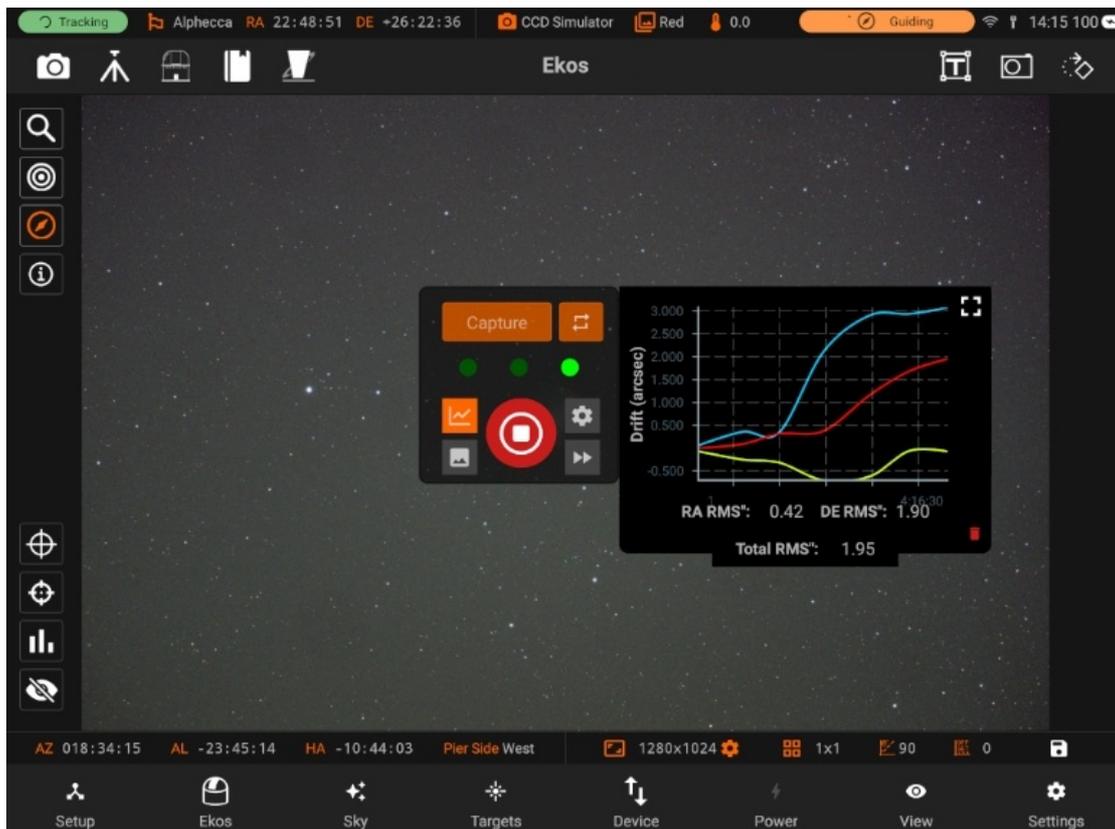
Settings

Following are the settings from [Guide module:](#)
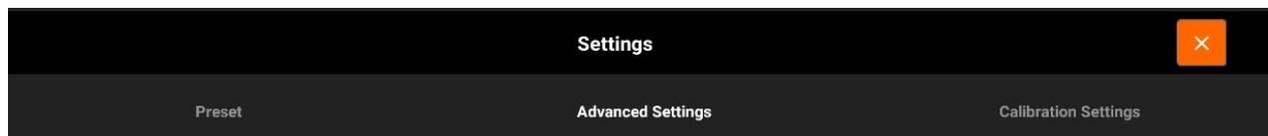
- [Preset settings](#)
- [Advanced settings](#)
- [Calibration settings](#)

Presets
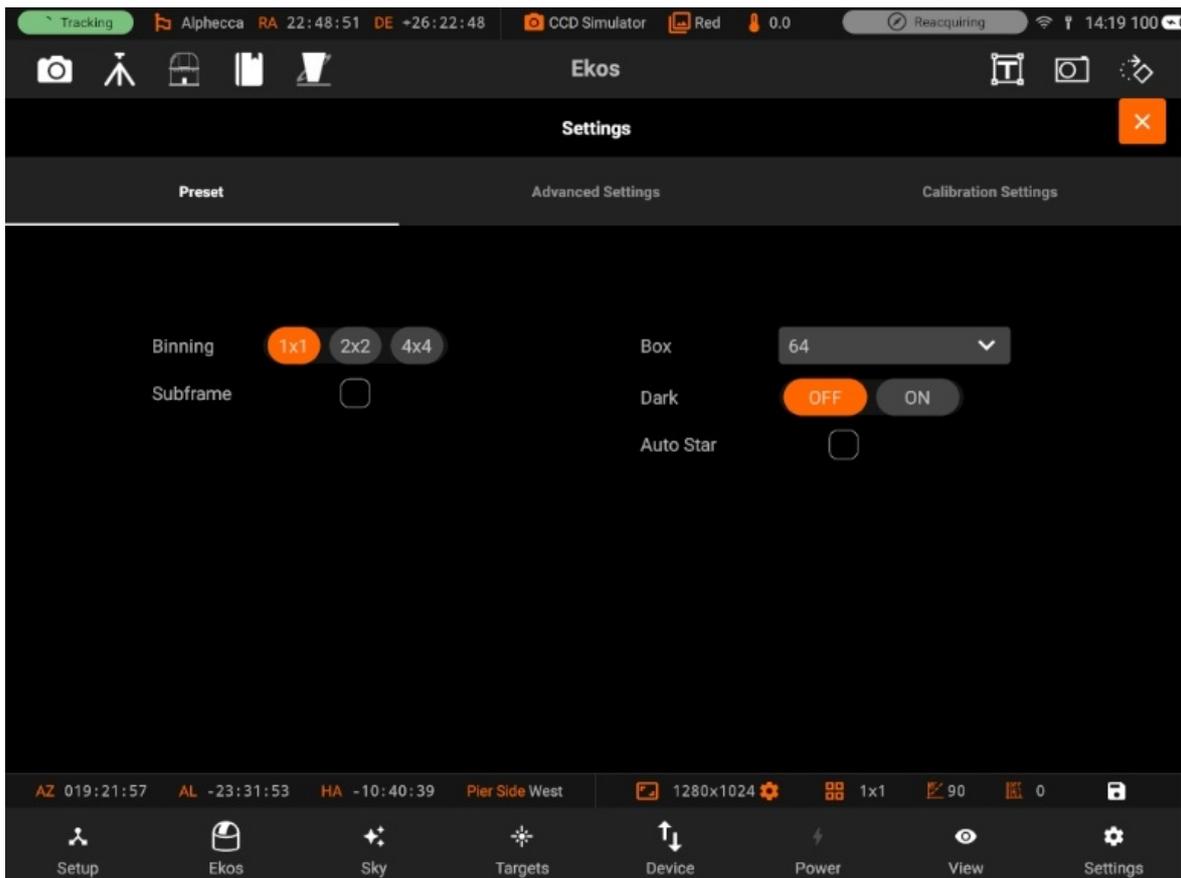
- **Subframe:** Subframe the image around the guide star. Or for PHD2, receive the Guide Star Image instead of the full image frame. For the Internal Guider, before checking this option, you must first capture an image and select a guide star. Uncheck it to take a full frame again.
- **Box:** Guide star tracking box size. Box size must be set in accordance to the selected star size.
- **Dark:** Subtract dark frame. If no dark frame is available, a new dark frame shall be captured and saved for future use.
- **Auto star:** Automatic control

Advanced
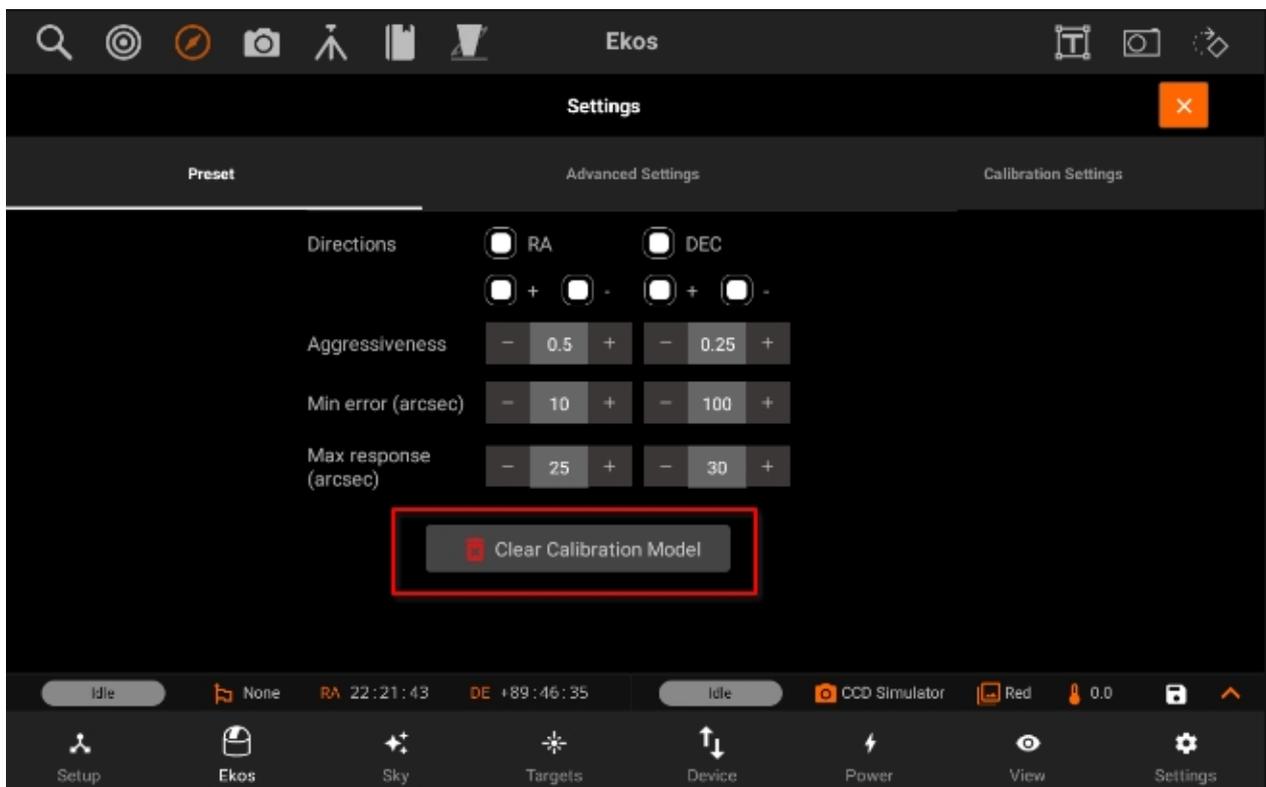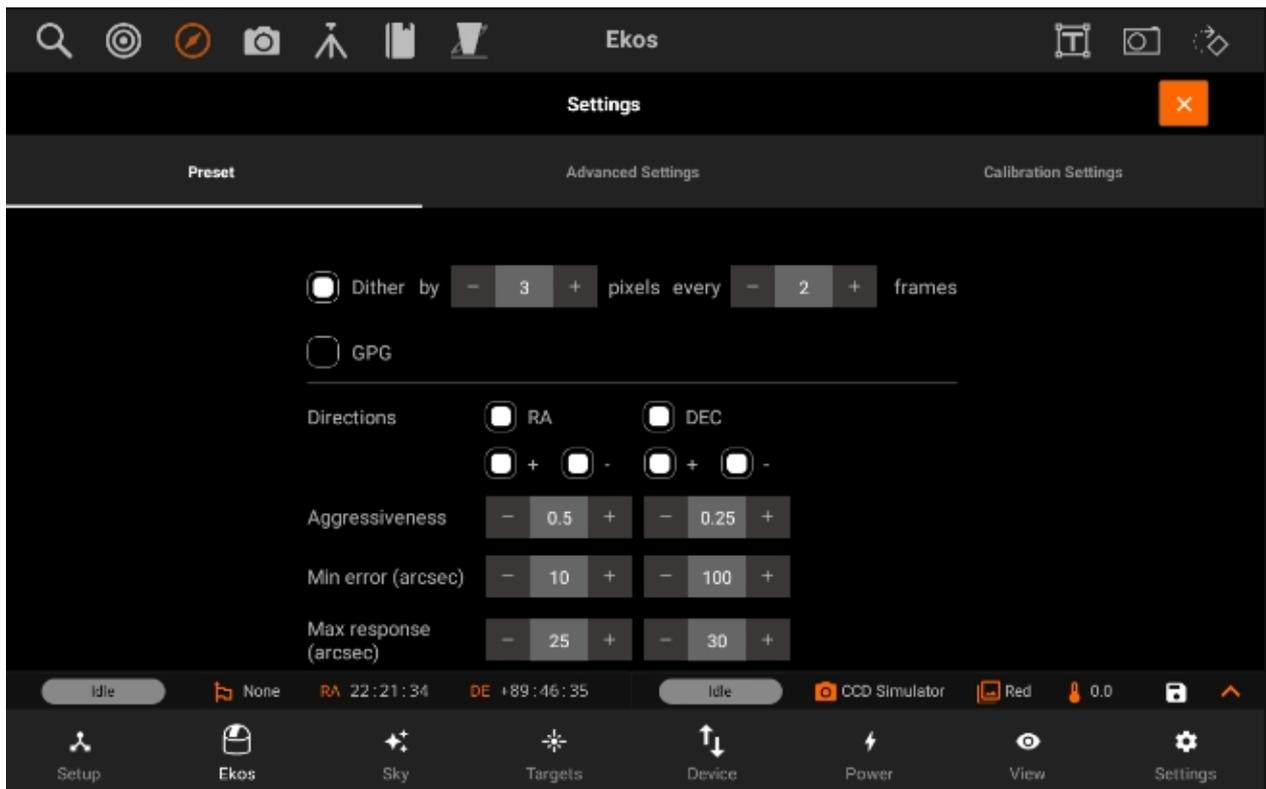
- **Dither**: Allows manual dithering.
- **GPG**: It can be used with all Guide star-detection algorithms but has been tested most

and is recommended with SEP Multi-star.

- Directions: Shows the values of RA and DEC.
    - RA: Guide Right Ascention Axis
        - +: East Direction Guiding
        - -: West Direction Guiding
    - DEC: Guide Declination Axis
        - +: North Direction Guiding
        - -: South Direction Guiding
- 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.
- 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.
- 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.
- Clear calibration model: Clears all the calibration data for the guiding process.

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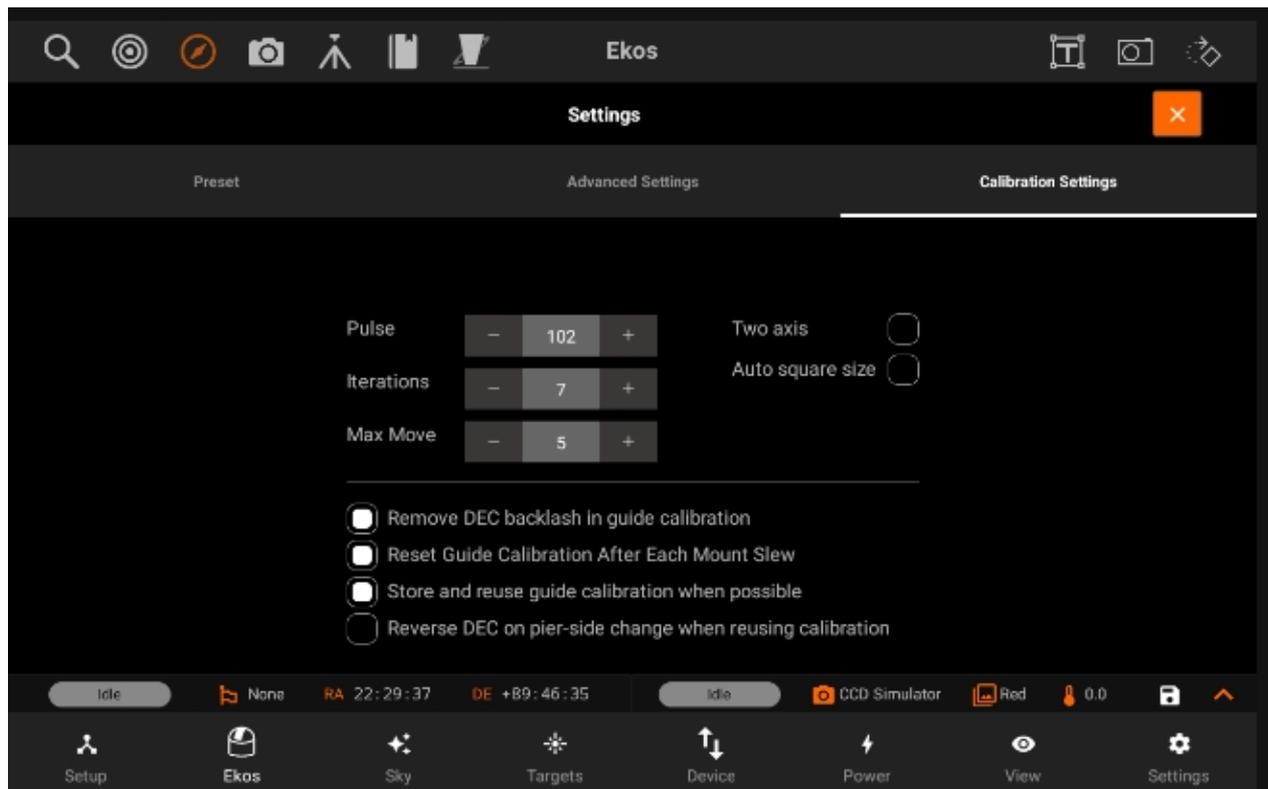
- **Pulse**: Initial pulse size for calibration.
- **Iterations**: Maximum number of iterations calibration should use per phase. It may use fewer (If max move is reached).
- **Max move**: Maximum number of pixels the calibration should move. Once it exceeds this amount, it will finish the calibration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

Checkbox options:

1. Removes the effect of DEC backlash when calibrating guider.
2. If checked, always re-calibrate when guiding is started. This is often not necessary when a good quality calibration has previously been done and the guide camera has not been rotated or re-installed.
3. Store and attempt to reuse calibrations. This only works on opposite sides if the

meridian if the pier-side can be automatically determined from your mount. The "Reset Guide on Slew" option above must be unchecked for this to be attempted.

4. When re-using a calibration, reverse the DEC angle if the current pier side differs from the one at calibration. This only applies when re-using calibrations, The value you need is a property of your mount that should be restricted.

Capture

The Capture module is where you create sequences to capture your targets. In the typical astrophotography workflow, Capture module is used last after you finished Focusing, Aligning, and Guiding your target. Let us first define some common terms:

Train

You can Select / Edit the train specifically for Capture module. Each module has it's own train. Visit Optical trains topic for more.

Capture Presets has the following structure:
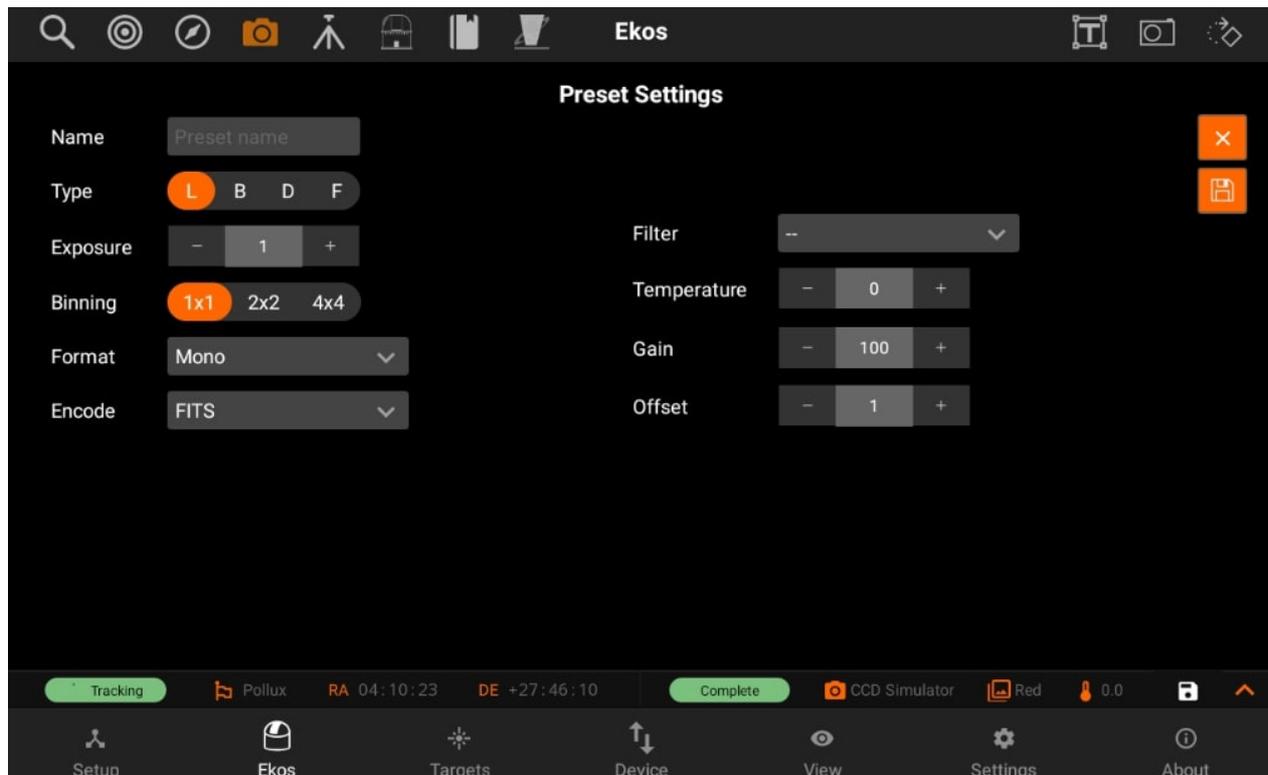
1. **Preset name:** Name of the preset.
2. **Frame Type:** Specify the type of desired camera frame. Options are Light, Dark,

Bias, and Flat frames.

3. **Exposure:** Specify exposure duration in seconds.

4. **Binning:** Specify horizontal (X) and vertical (Y) binning.

5. **Format:** Specify capture save format. For all CCDs, only FITS option is available.

6. **Encode:** For DSLR cameras, you can an additional option to save in Native format (e.g. RAW or JPEG).

7. **Filter:** Specify desired filter.

8. **Temperature:** Set the desired temperature, if you 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

9. **Gain:** Specify the value of gain. Leaving it to -- would not change the current gain set in the camera

10. **ISO:** For DSLR cameras, specify the ISO value.

11. **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.

Duplicate Preset

Now you can duplicate an existing preset with the same information and save it as an new Preset.

Duplicate preset contains "(1)" after the name.
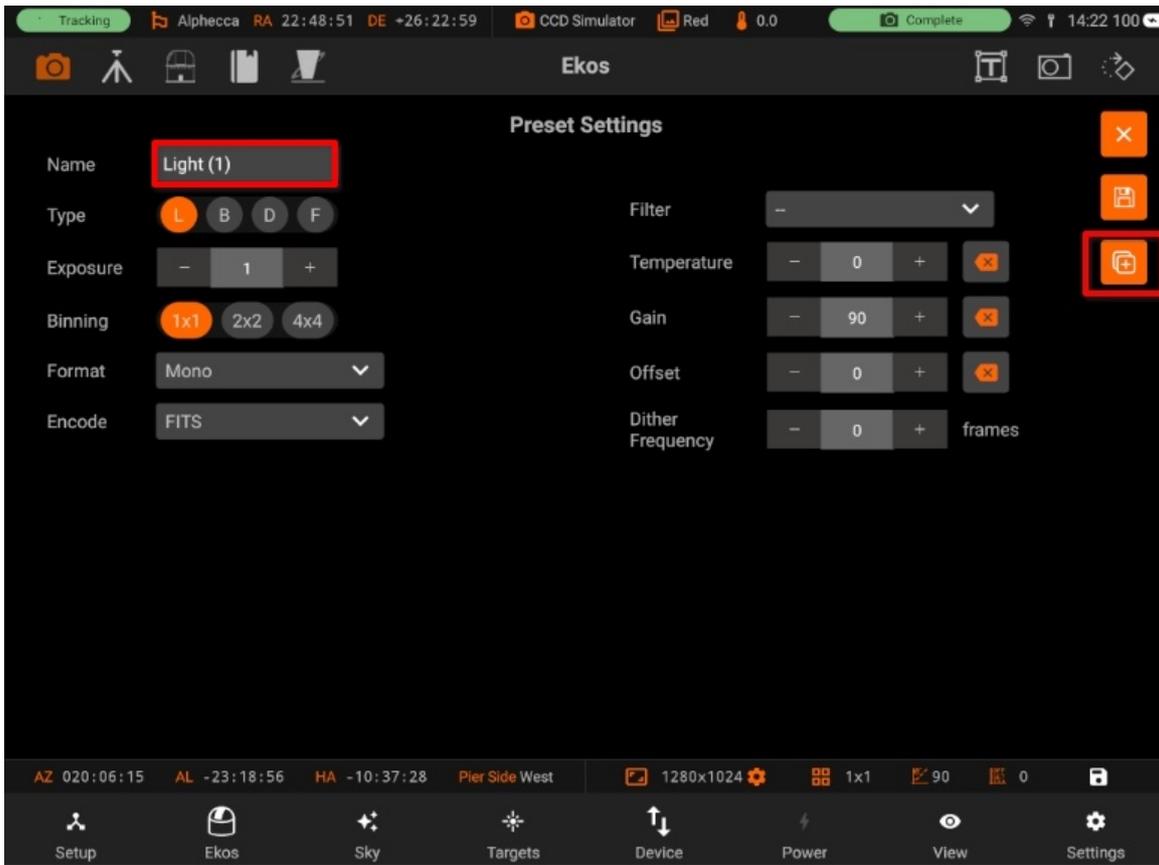
After saving the preset, it is added as a new preset.
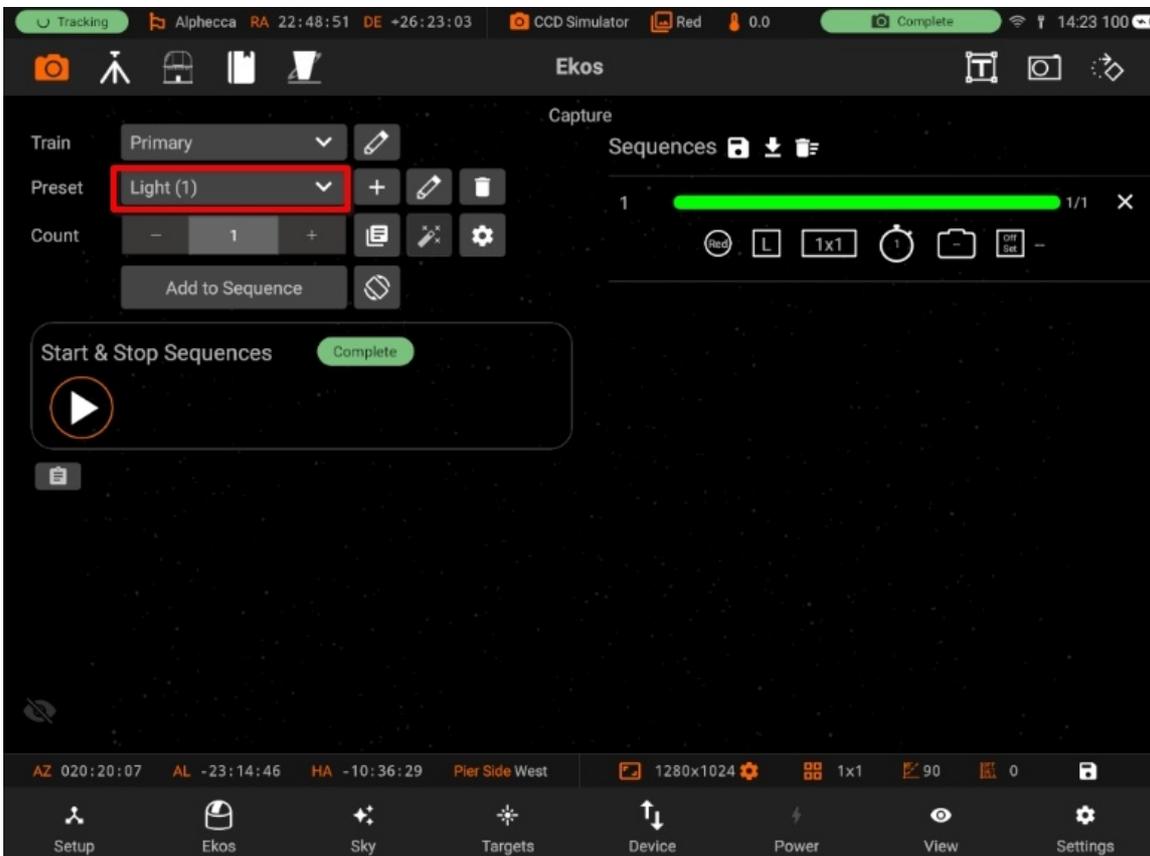
Count: Number of sequences you want to capture.

After creating your presets, you can now tap on the preset dropdown in order to select the preset you want, and then tap on Add to Sequence, so the sequence can be added to the sequence list.

In the below example, you can see that there are 3 different jobs in the sequence list as shown by the filter in the beginning of each one. (red, green, and blue)

- **Sequence:** Capture a number of images with the settings specified in a preset.
1. The count field in capture module specify the number of images to capture using that preset.
2. Delay parameters is used to introduce a delay in seconds between each captured image and default to zero.
3. A sequence is also referred to as Job
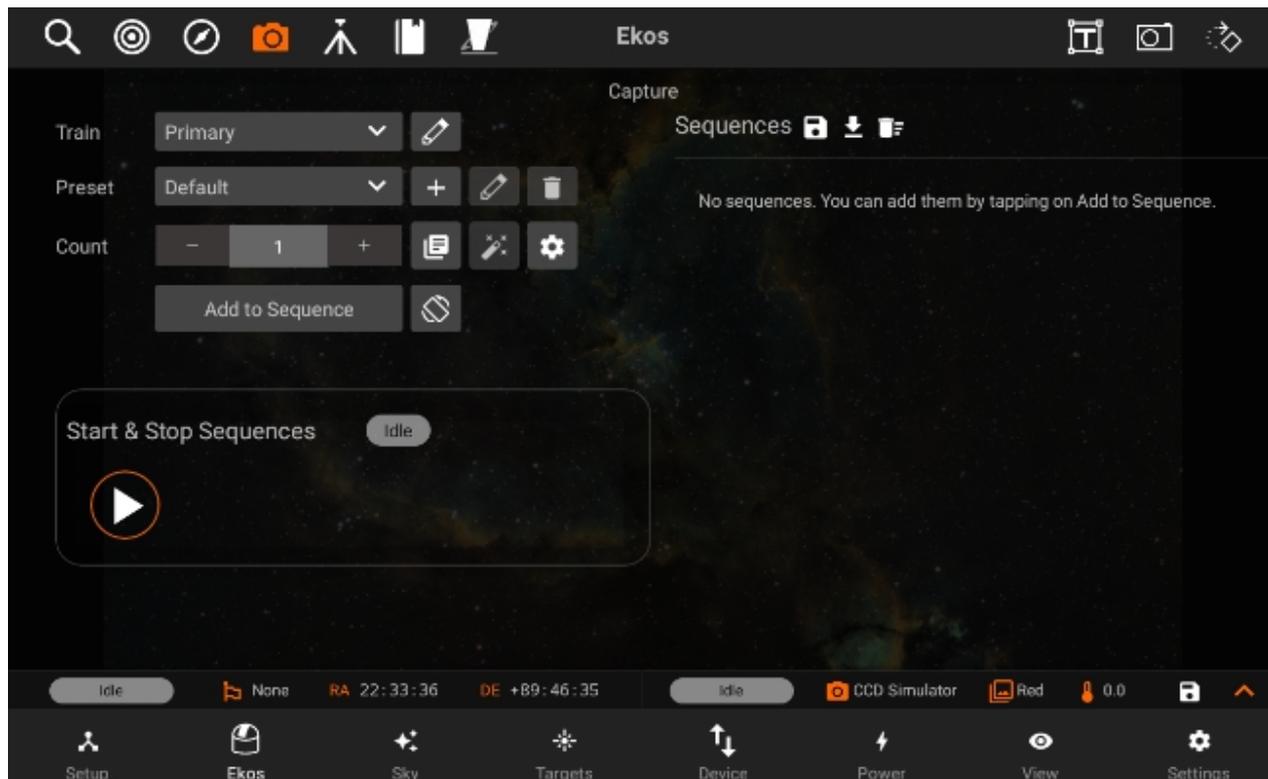
- **Creating a sequence**

To create a sequence, you should first create a new preset by tapping on the + button next to the preset dropdown box.
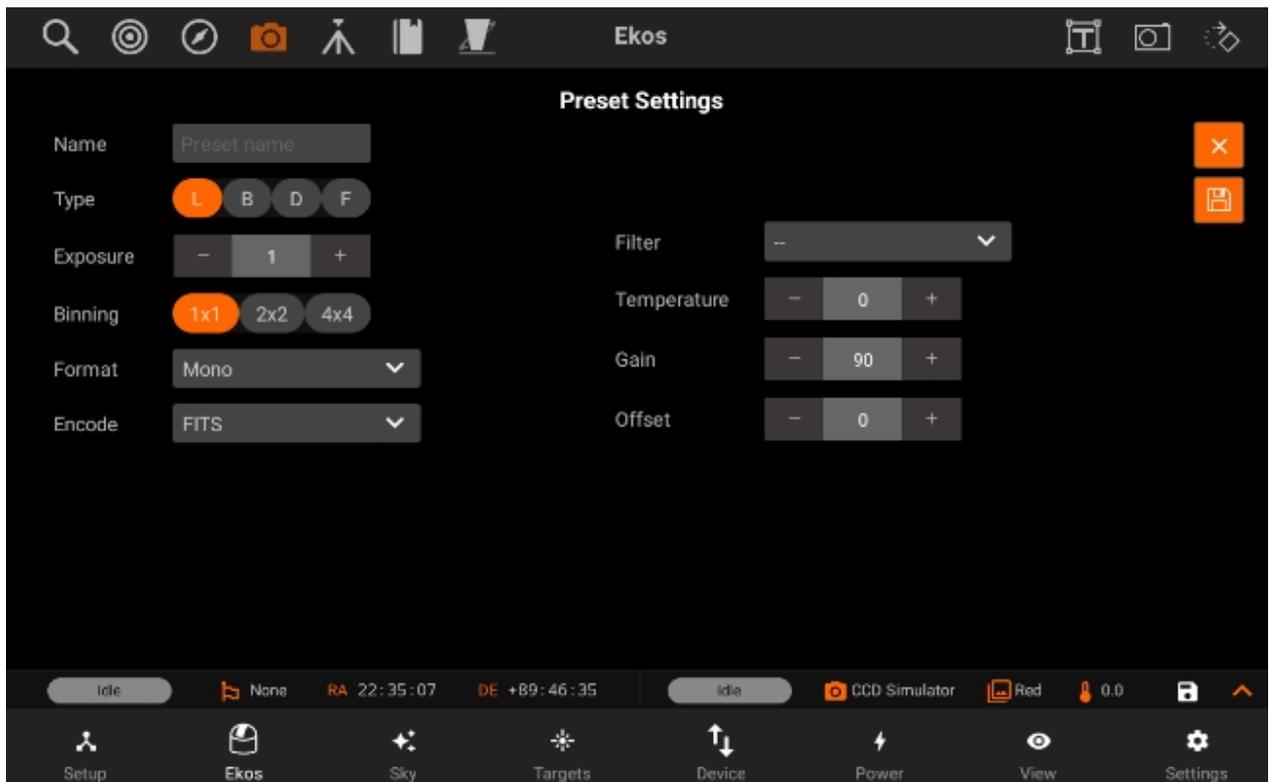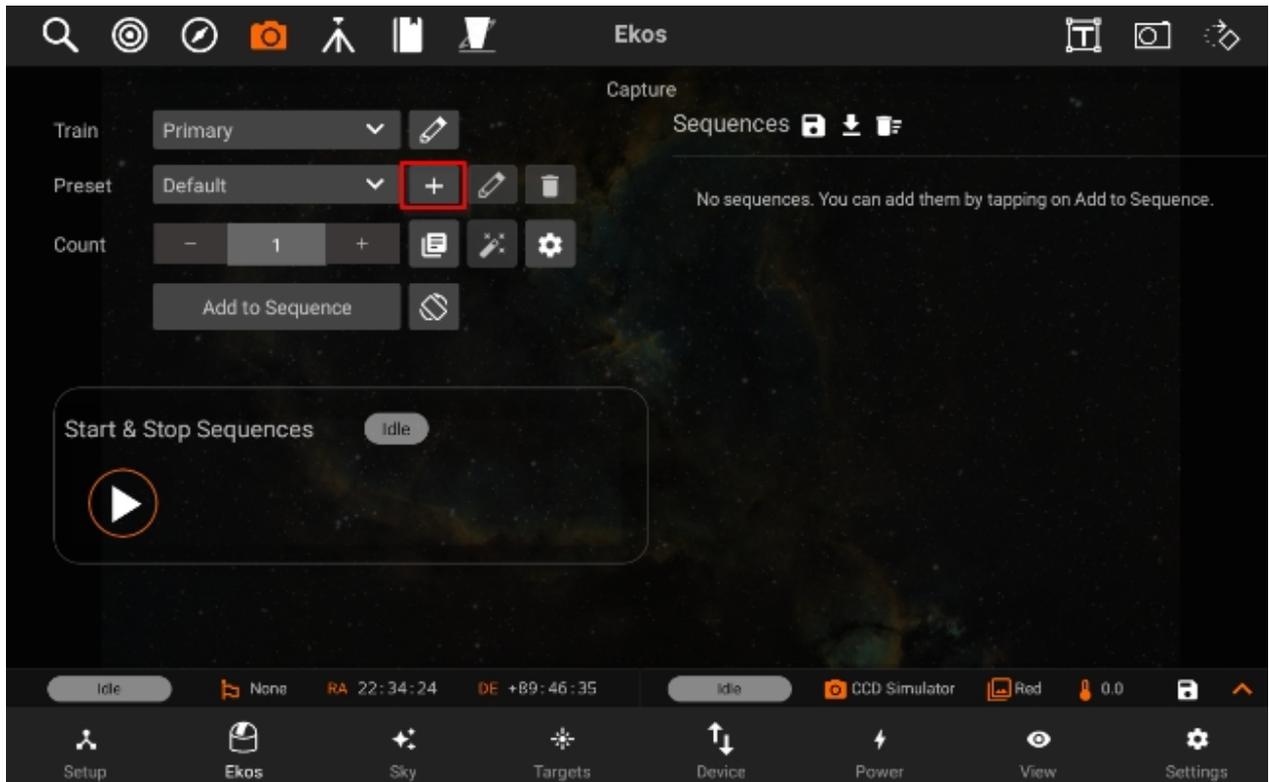
After filling the preset settings, you need to add a sequence
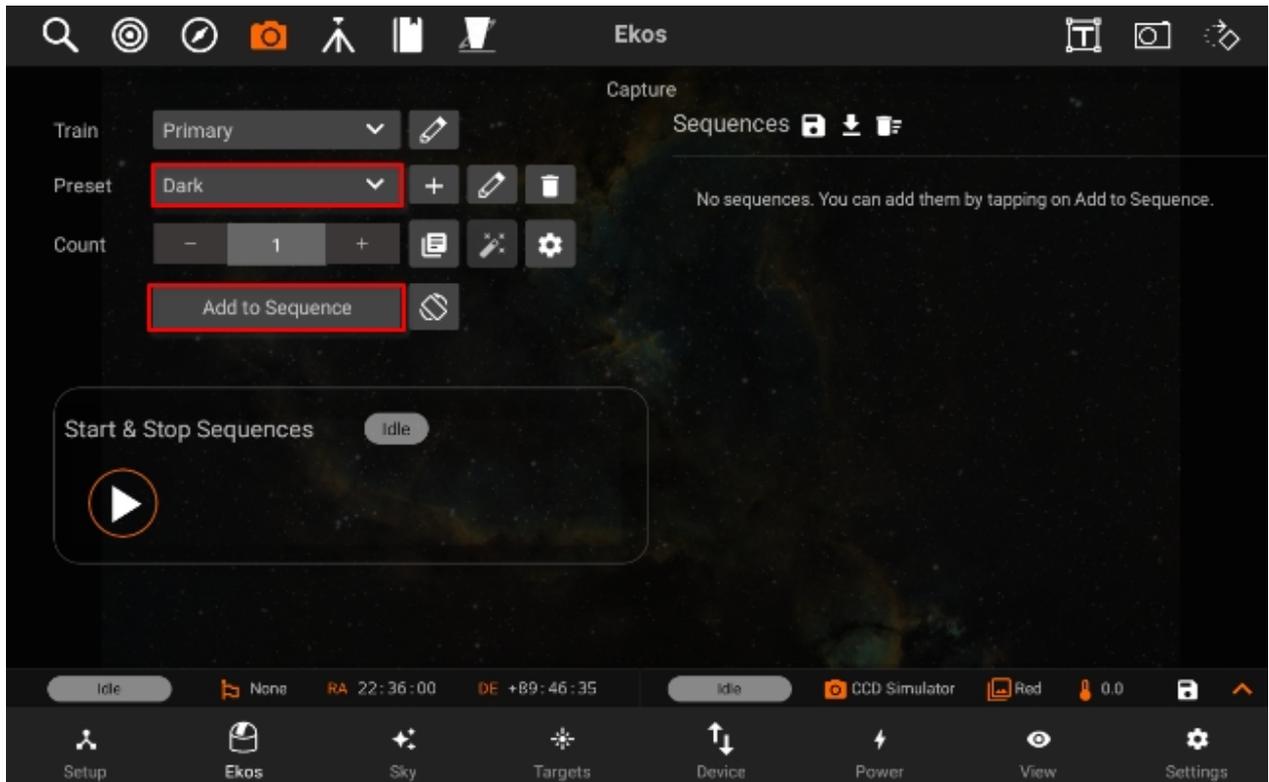
Once the sequence is added, you have to tap on the Save Icon on the top-right.
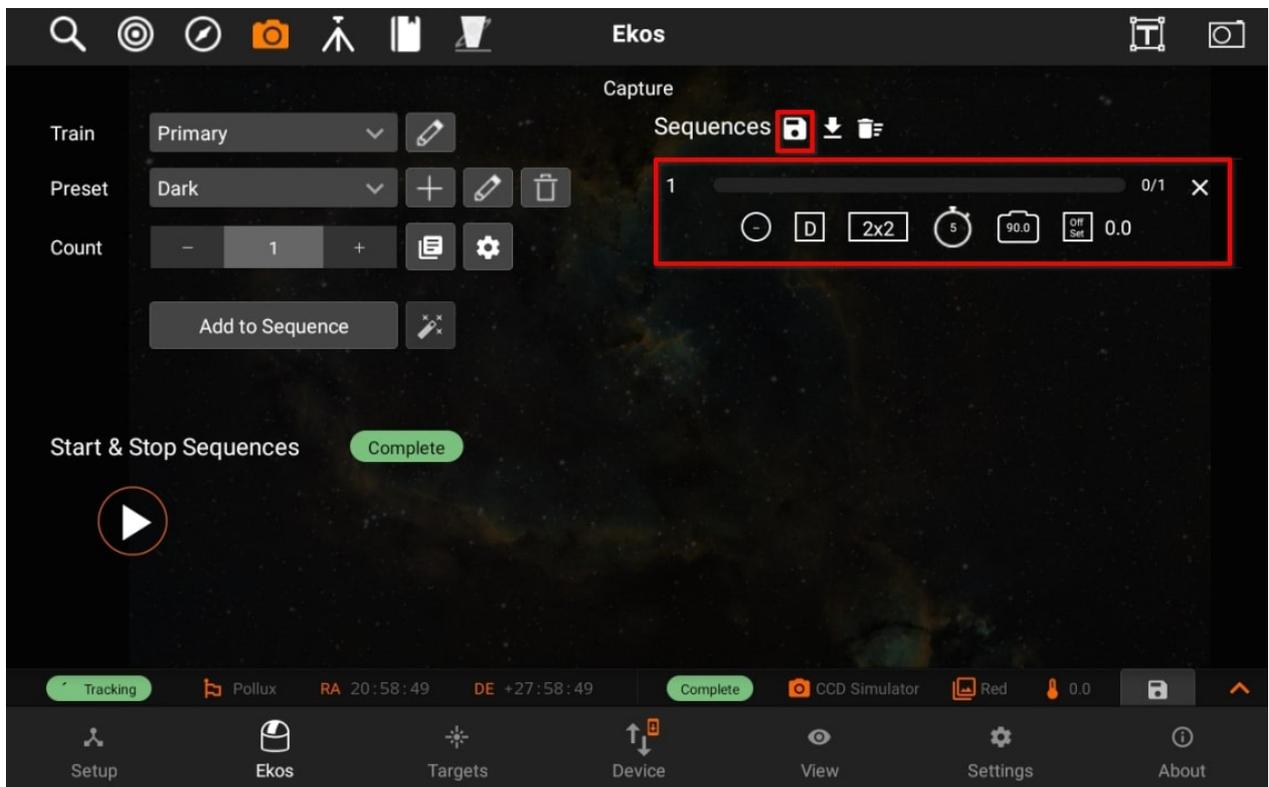
The default directory is under "Pictures". You can go back to previous directories by going back.
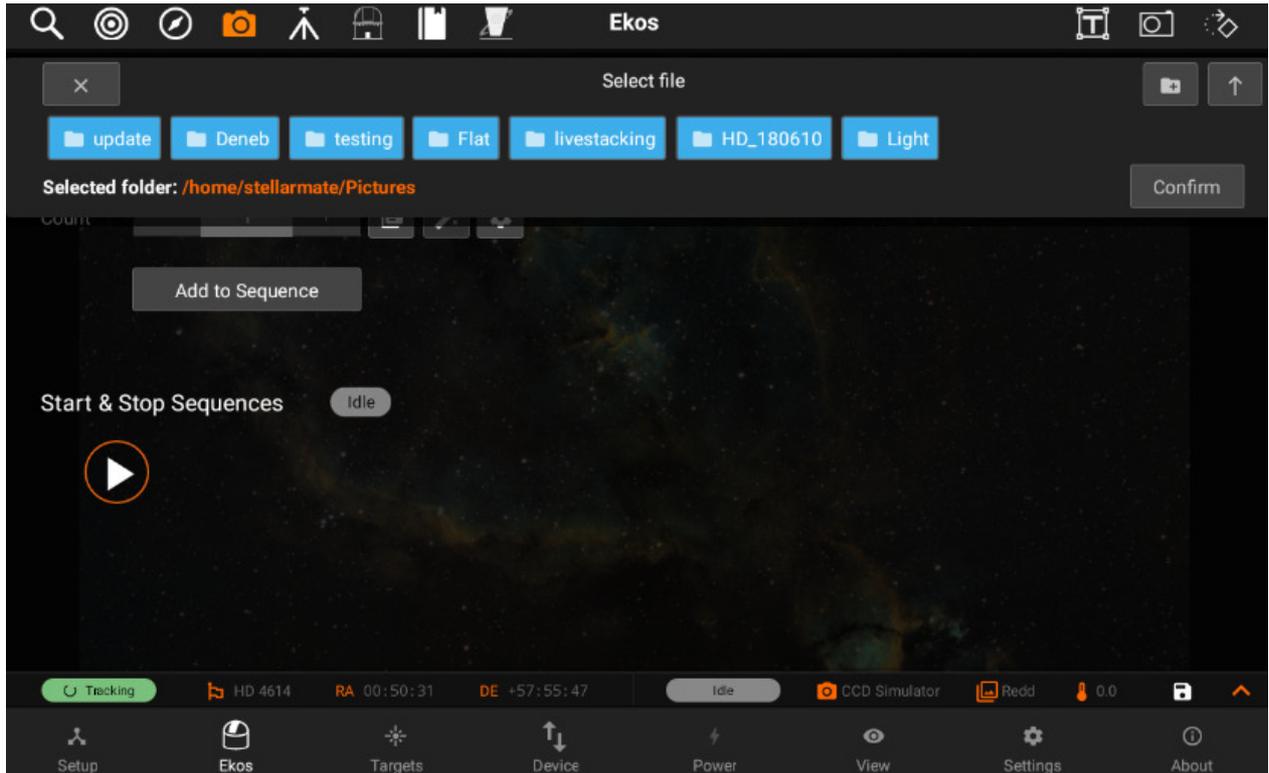
Sequence files are saved in **"/home/stellarmate/sequences"** path with respect to camera name.
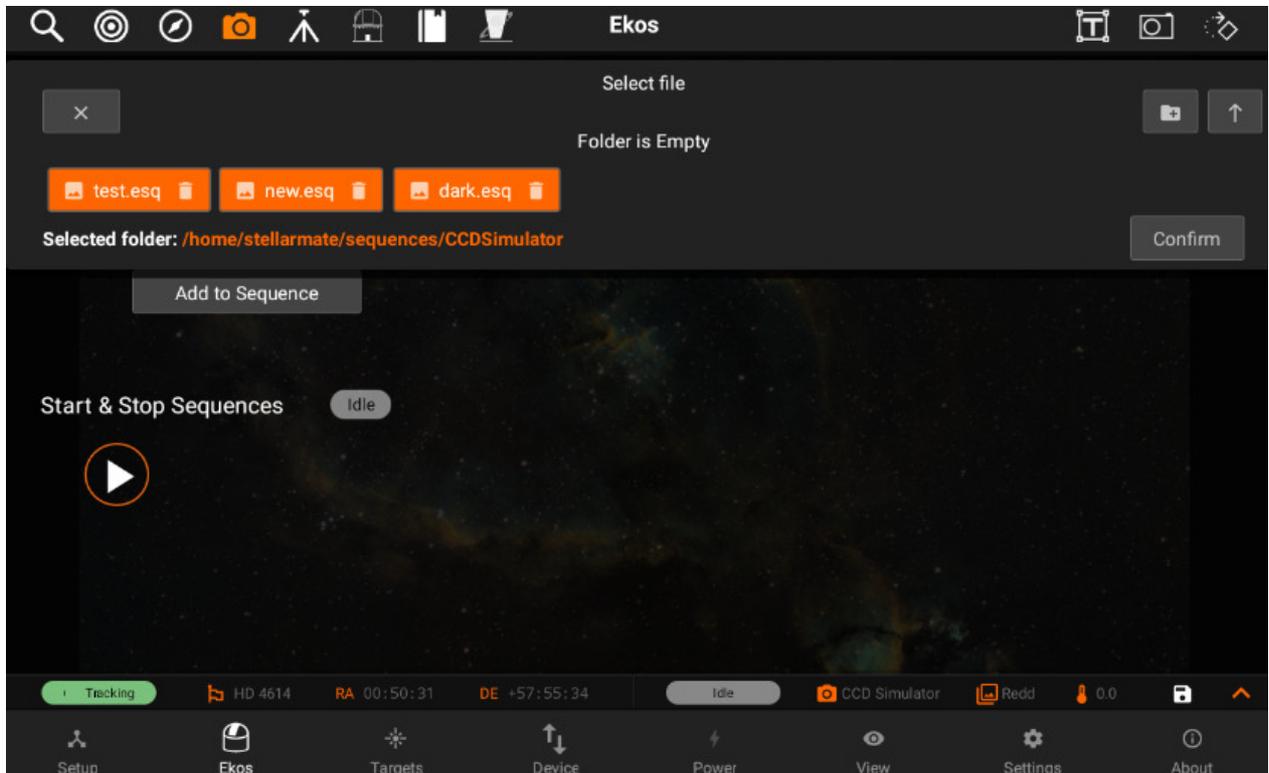
By selecting the sequence file, you will be able to add a sequence in your sequences and

can capture your images accordingly.
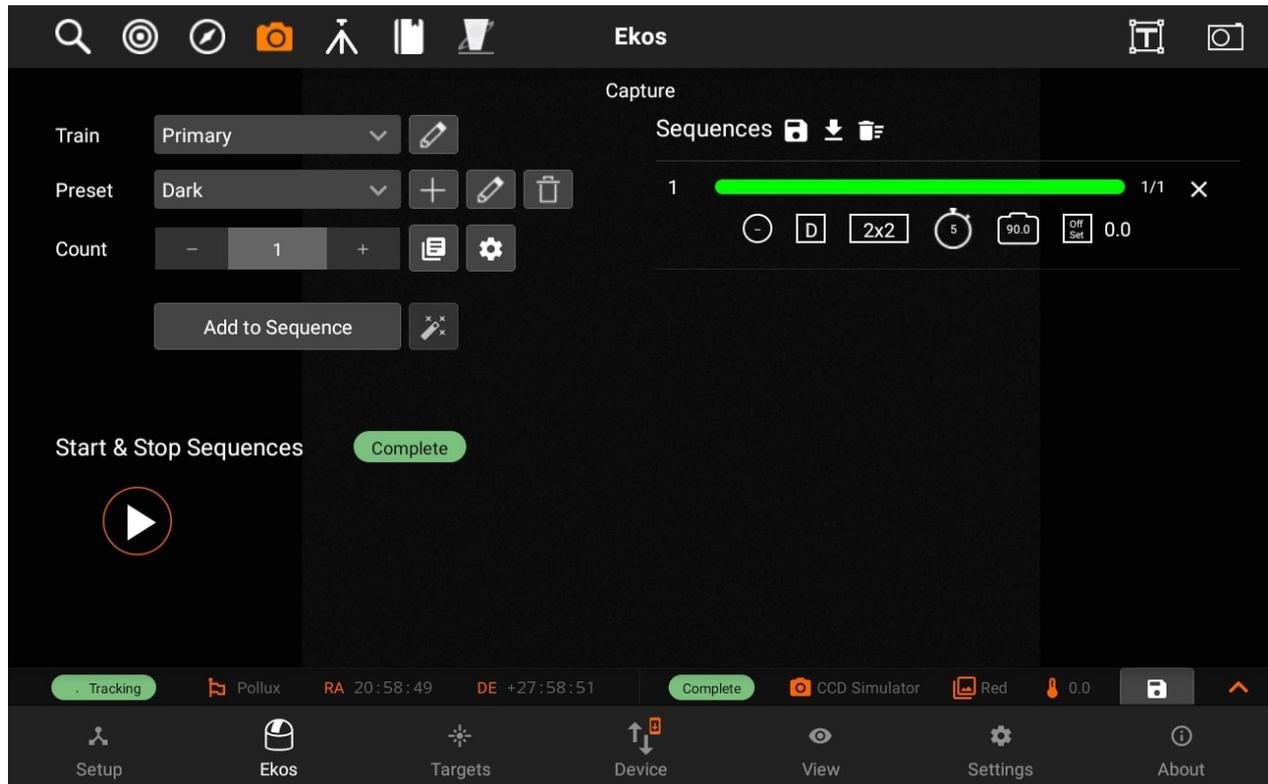
Sequences have the following structure, displayed through icons for simplicity:

- **Top row**
    1. Job Number
    2. Job Progress Bar
    3. Count Progress
    4. Delete Job

- **Bottom row**
    1. Filter
    2. Frame Type
    3. Binning
    4. Exposure
    5. Gain/ISO
    6. Offset
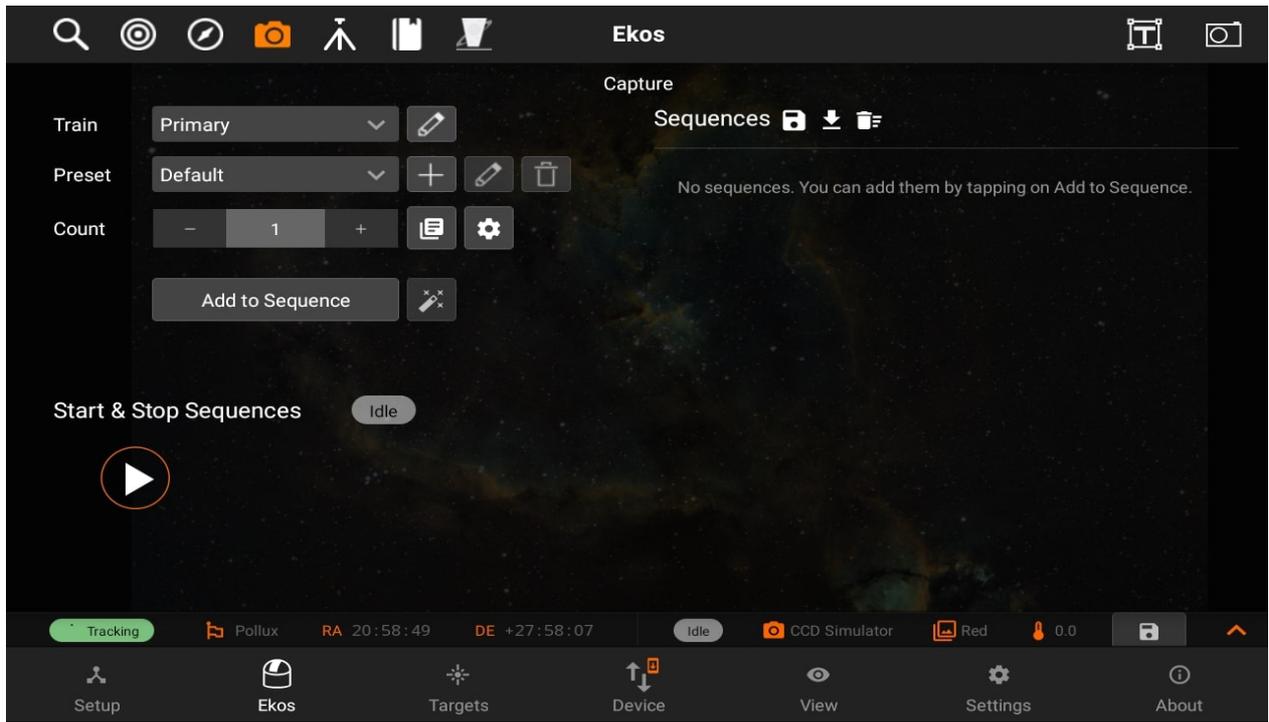
After adding the sequences, tap on the **Play** button under the Progress header to start the sequence.
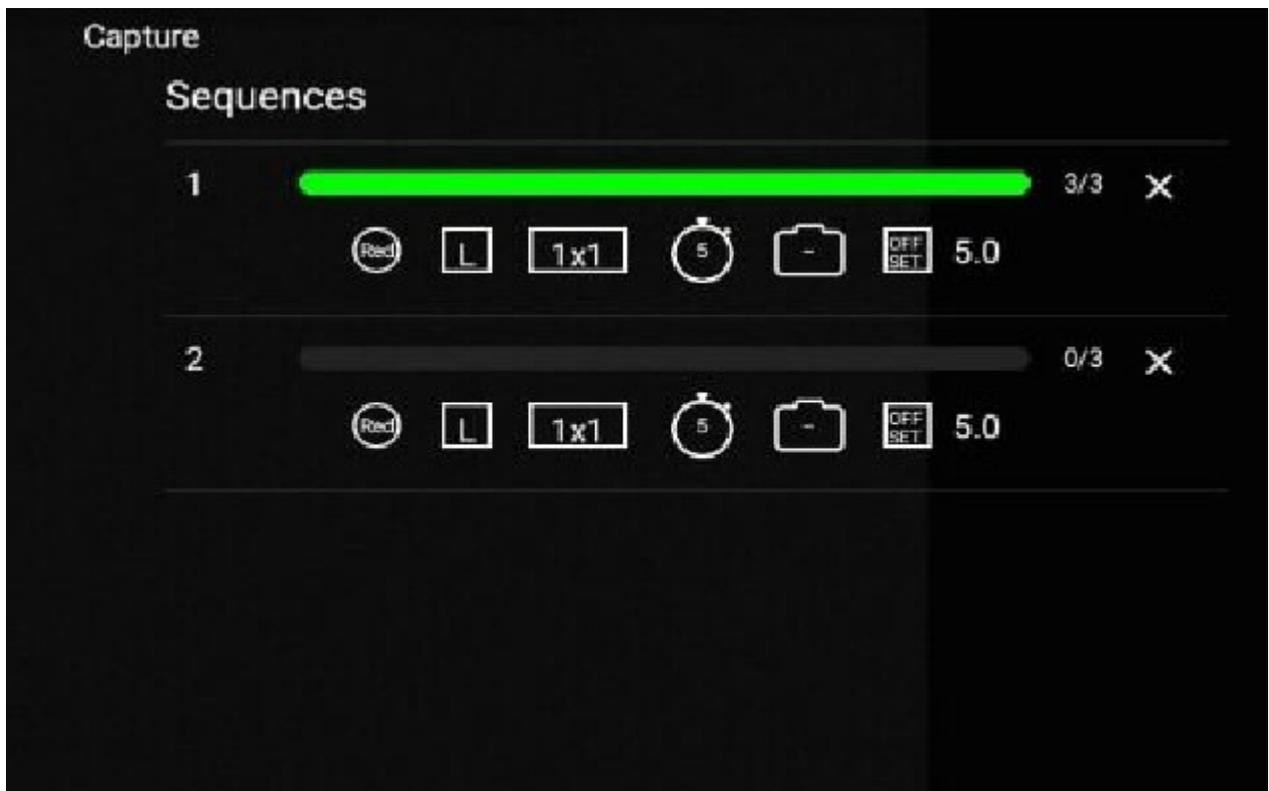
During the capture, a soft "ding" sound will be played for each capture (you can turn on sounds by switching from Ekos Tab to Settings Tab and then toggling sounds on). After the

capture is complete, you will see a notification message that says "CCD capture completed" and a "complete" sound will be played. In the case of the capturing processing aborted for any reason, an "error" sounds will be played, and a notification message will be shown.
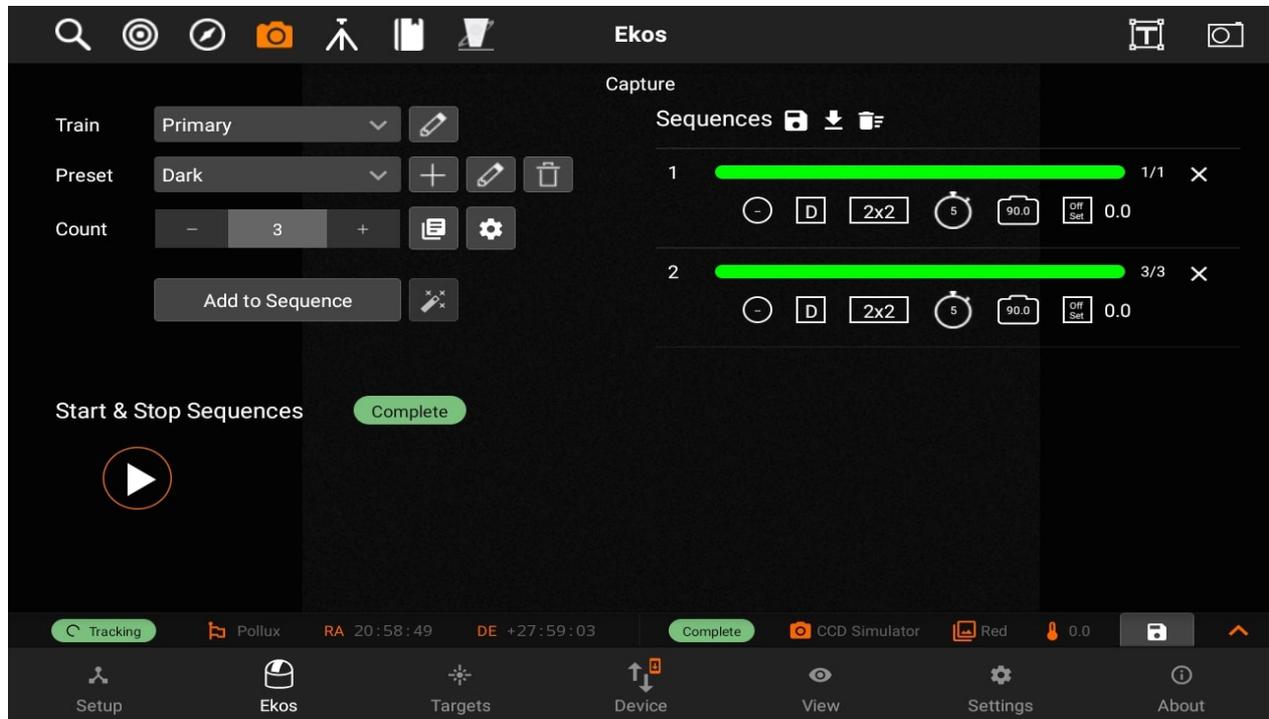
Dark Library

Dark Library 📚
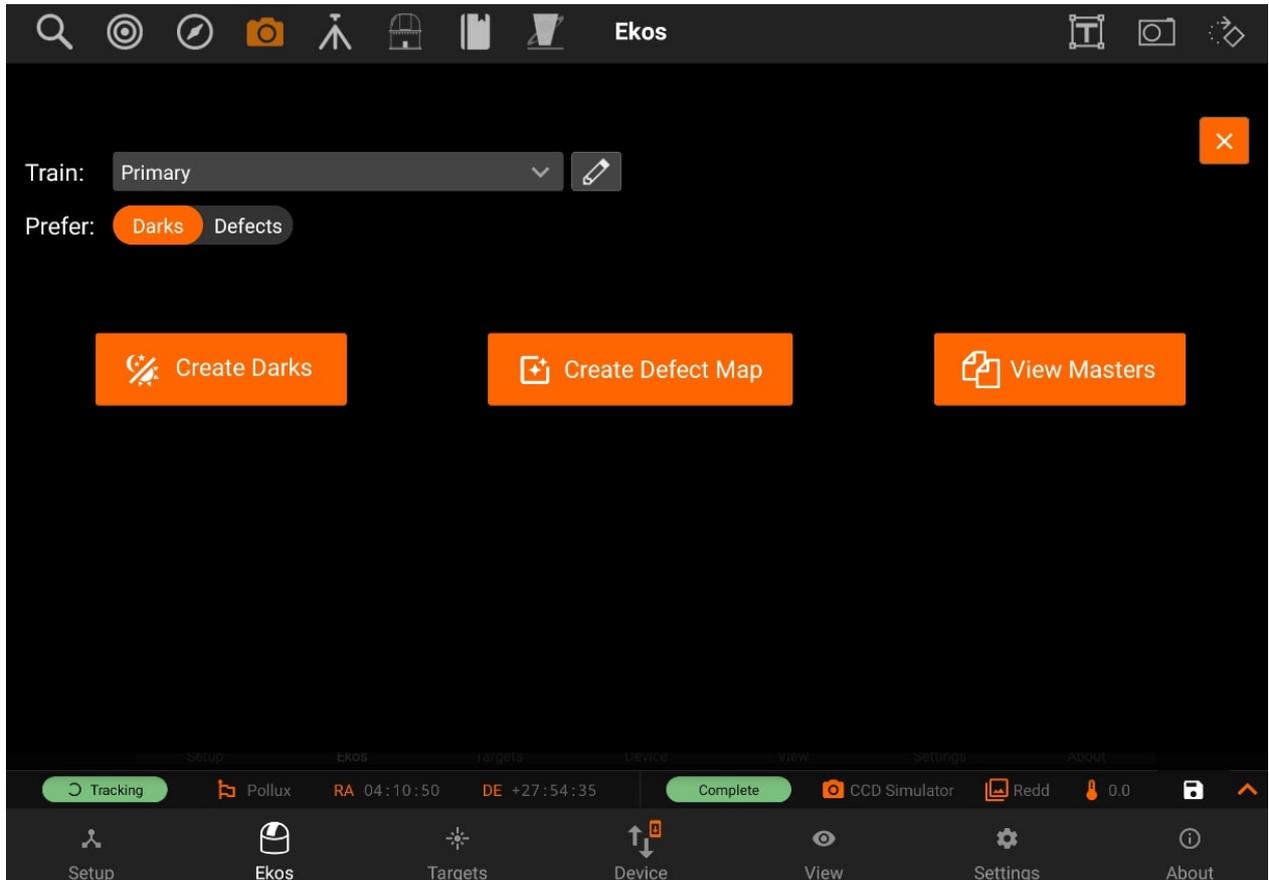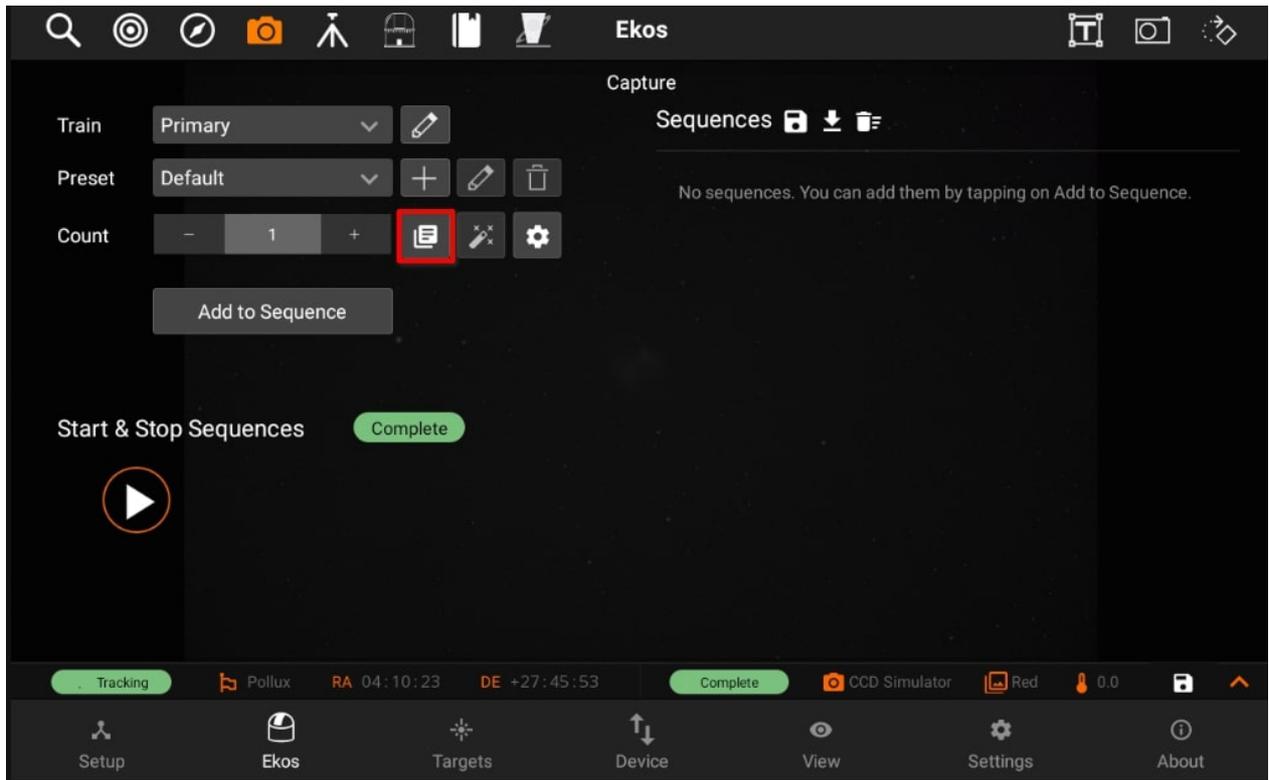
The Dark Library is a collection of dark frames captured from your cameras under different

settings. There are basically five primary types of frames:

1. **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.

2. **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.

3. **Bias:** A very short exposure with the shutter closed.

4. **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.

5. **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:

1. **Dark Subtraction**: The dark frame is simply subtracted from the light frame. This is the recommended method when using a cooled camera.

2. **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:**
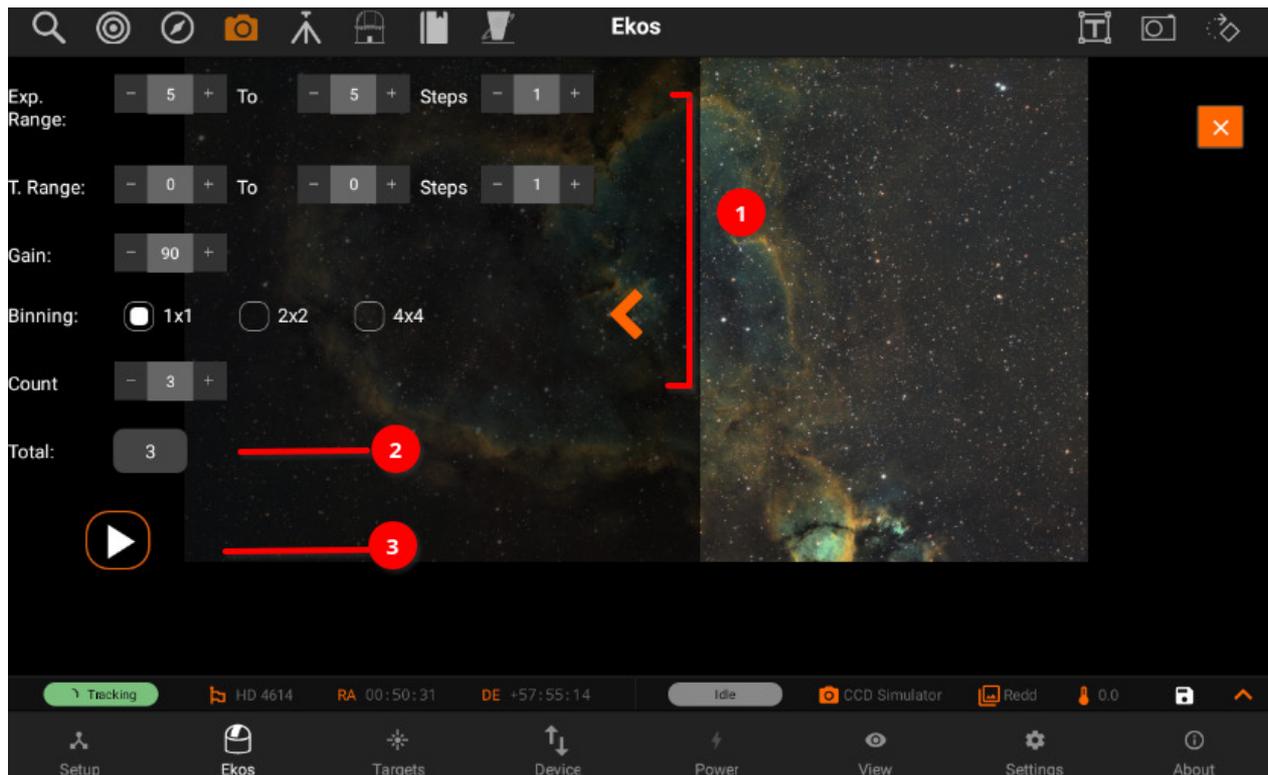
Create a **master** dark frame by capturing and averaging a number of individual dark frames.

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:
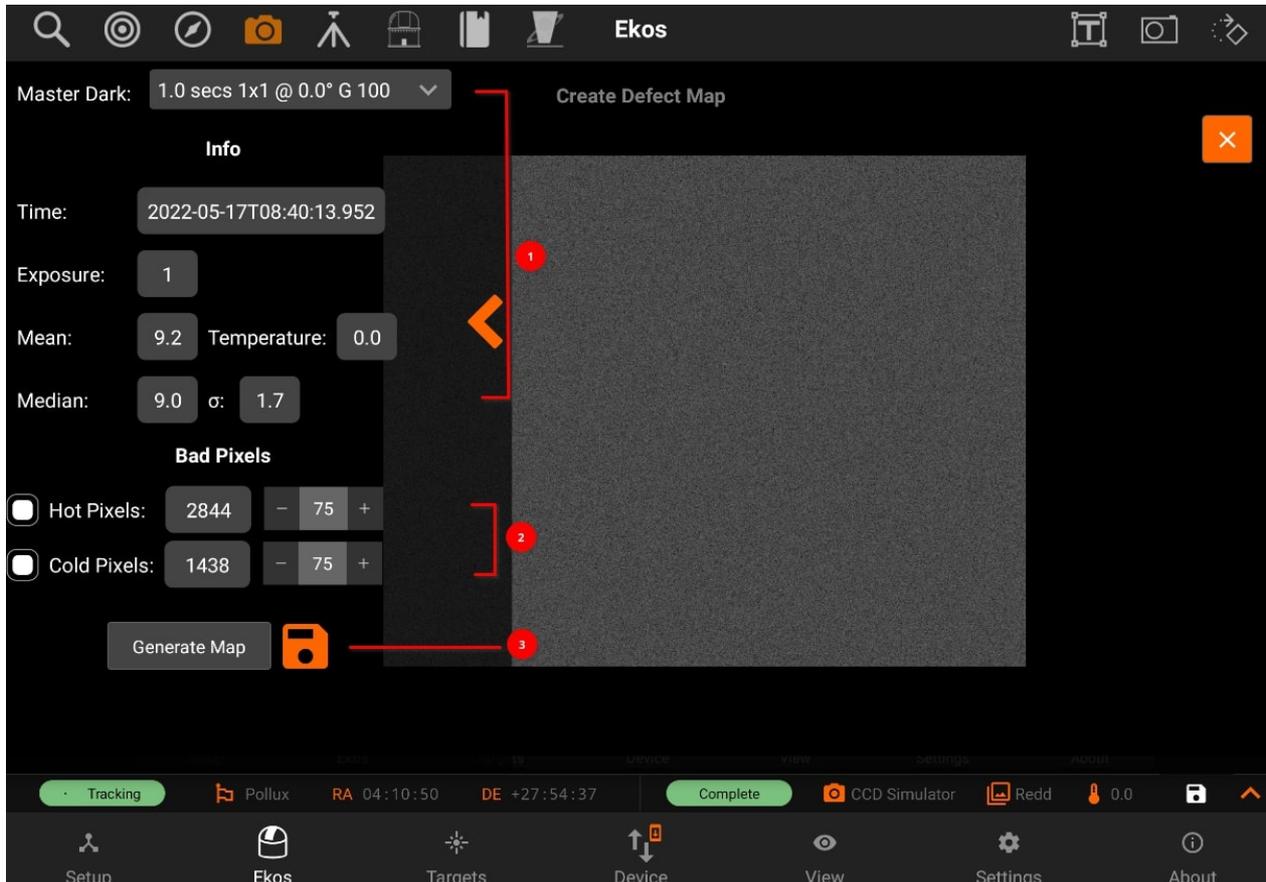
After creating a master dark, you can create a defect map for your camera. Usually, defect maps are used when dark frame subtraction does

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:
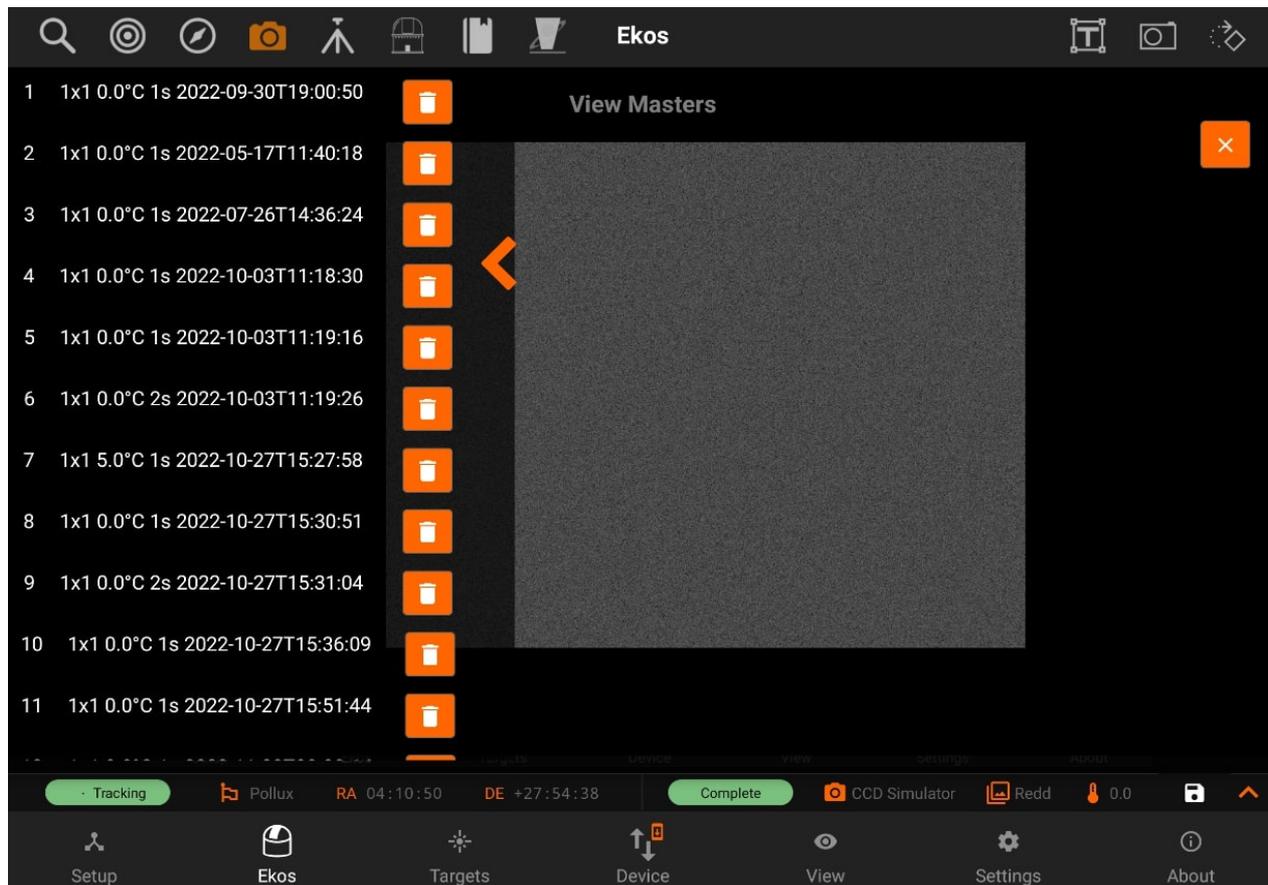
Inspect master frames of a specific camera.

Rotator Control

Rotator control settings are available if Rotator is selected in the active train.
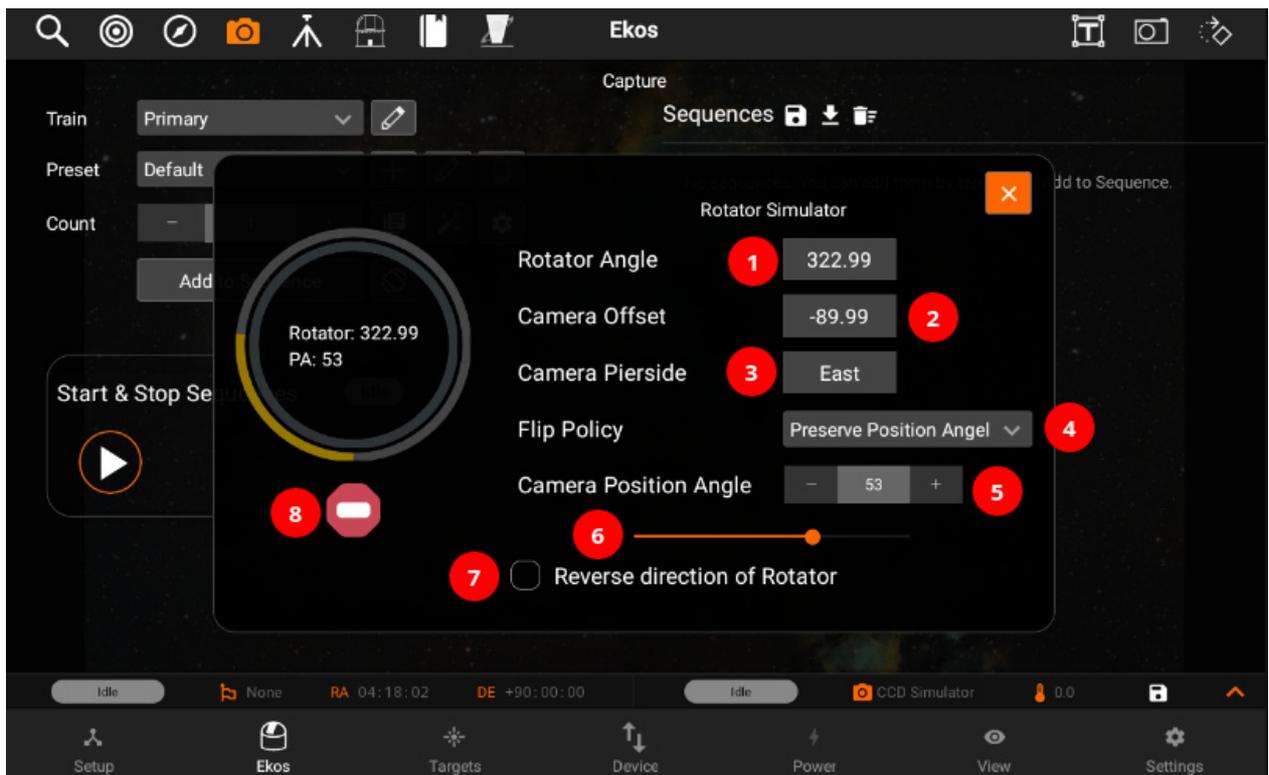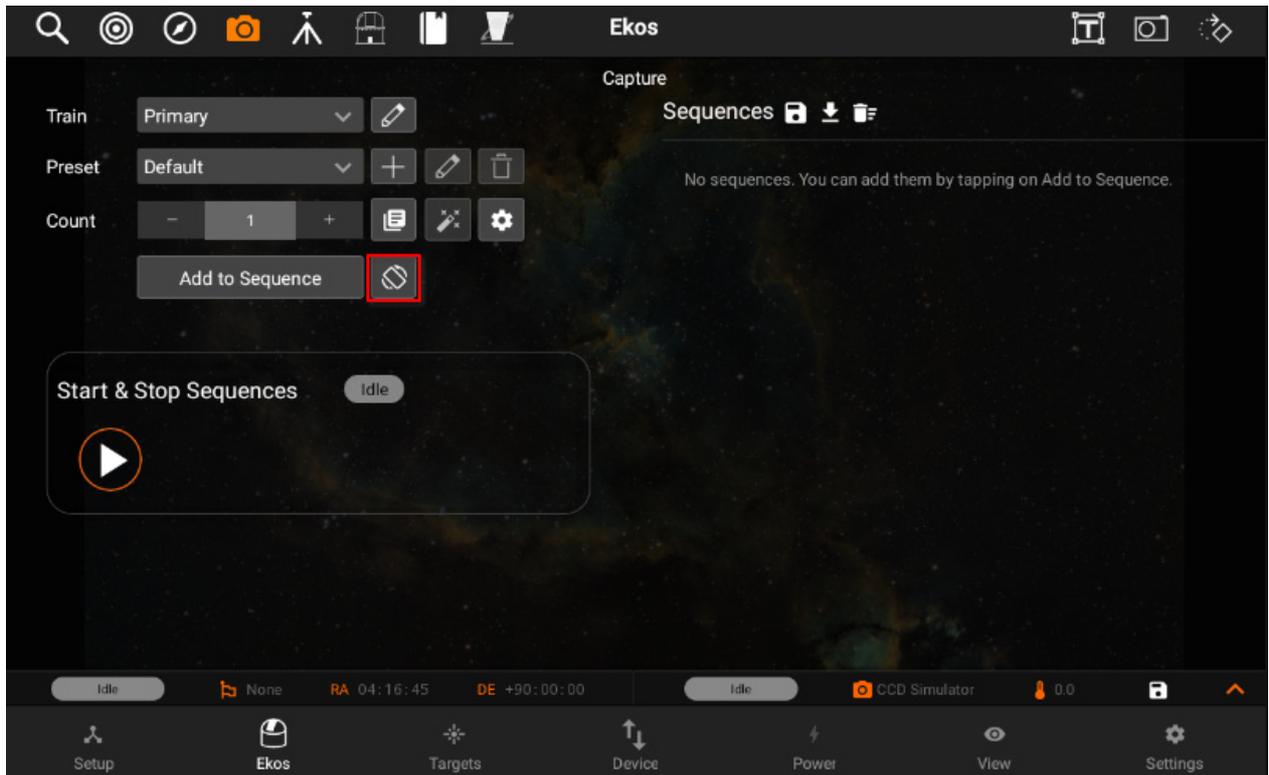
1. The raw rotator full circle angle of the rotator device, which is calculated as the difference of the rotator origin (zero angle) respective to North on pierside WEST or respective to South on pierside EAST.
2. The angle of the camera upright direction (see FOV) respective to the rotator origin

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.

Logs View

Pressing on the Logs button toggle the Logs from Capture module. All recent logs are displayed.

You can also press "X" clear button to clear the previous logs.
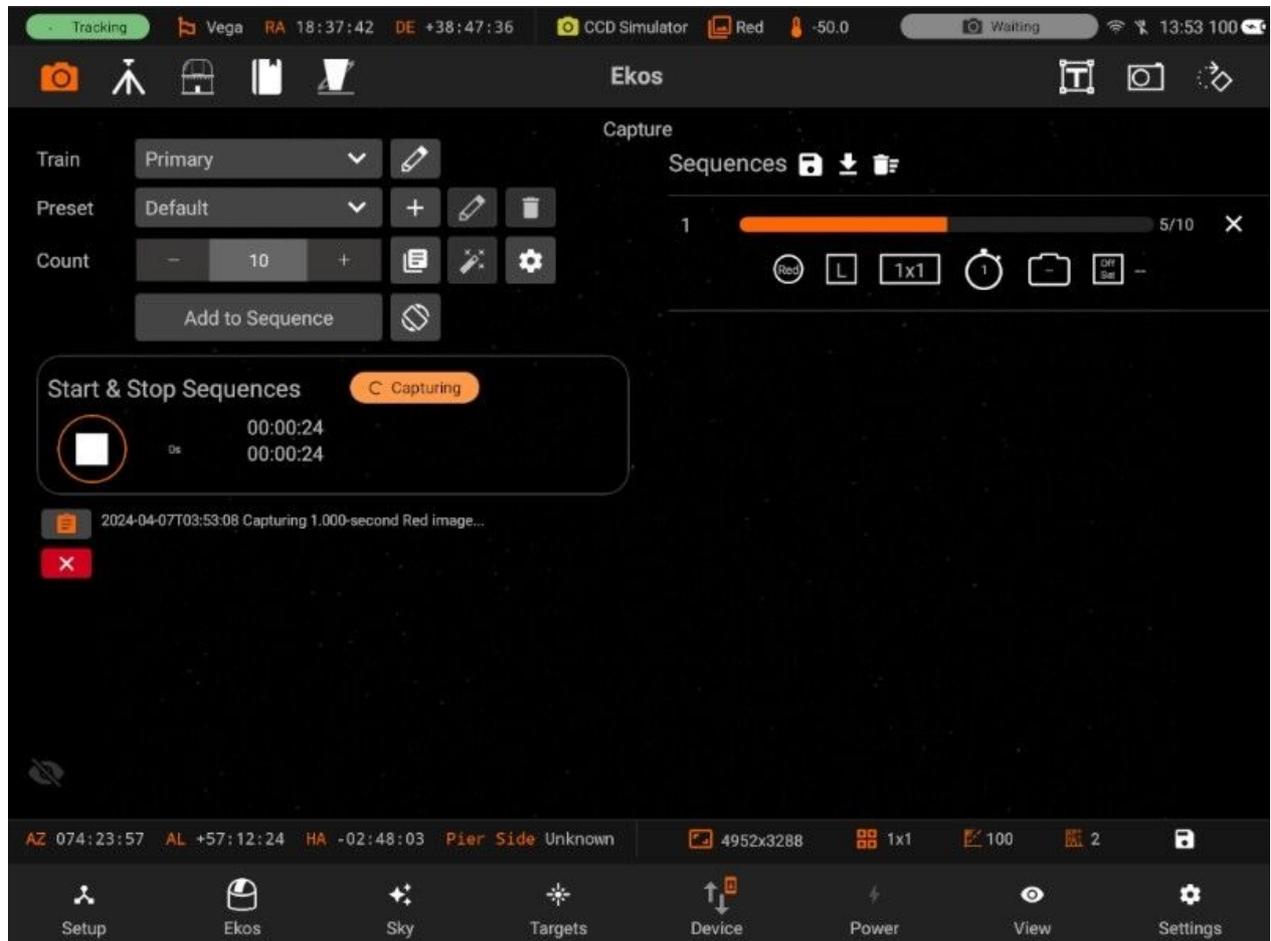
Settings

Following are the settings from Capture module:
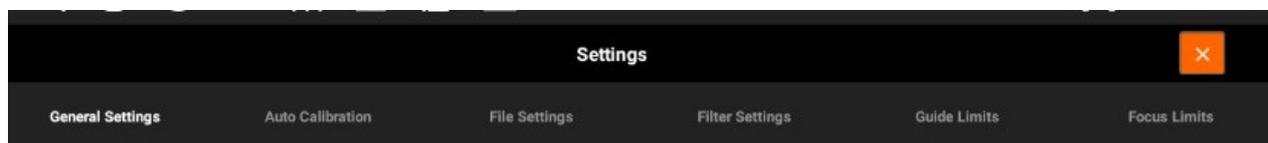
- [General Settings](#)
- [Auto Calibration](#)
- [File Settings](#)
- [Filter Settings](#)
- [Guide Limits](#)
- [Focus Limits](#)

General
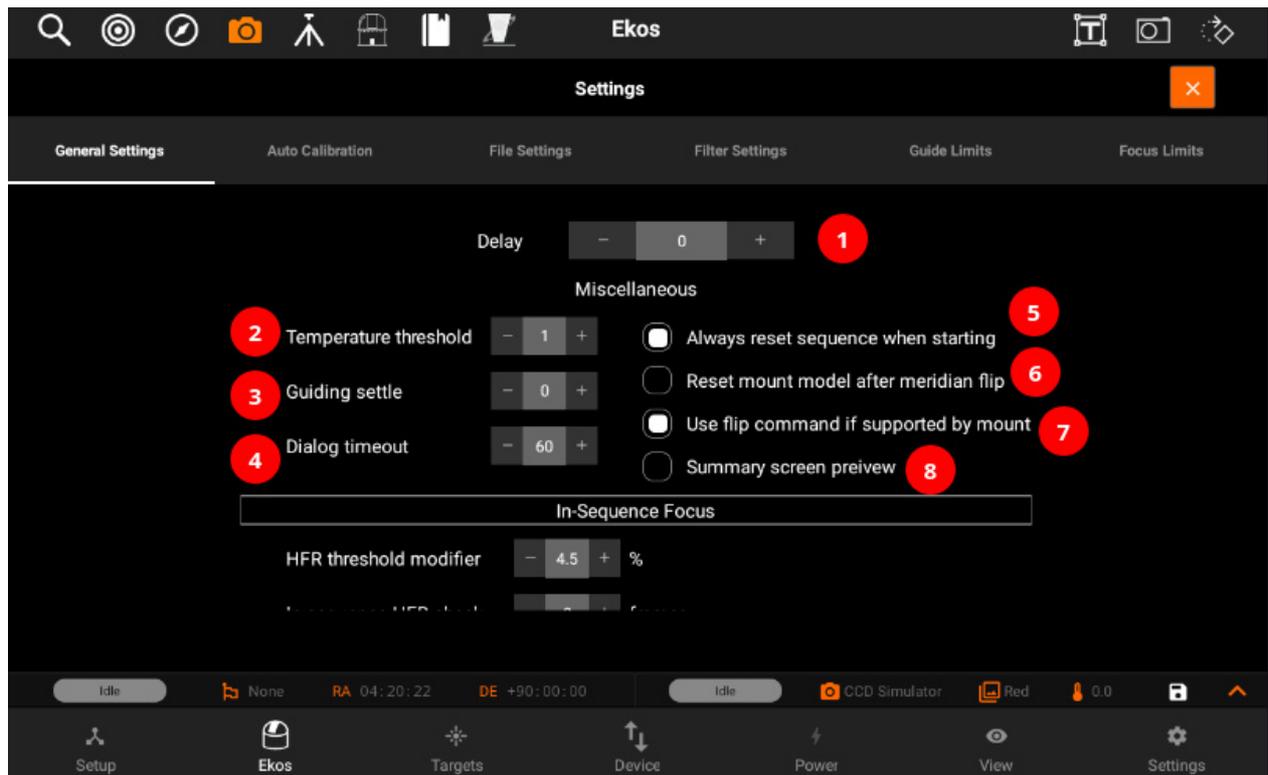
1. Delay in seconds between consecutive images.
2. Maximum acceptable difference between requested and measured temperature set point. When the temperature threshold is below this value, the temperature set point request is deemed successful.
3. Wait this many seconds after guiding is resumed to stabilize the guiding performance before capture.
4. Cover or uncover telescope dialog timeout in seconds
5. When starting to process a sequence list, reset all capture counts to zero. Scheduler overrides this option when Remember job progress is enabled.
6. Reset mount model after meridian flip
7. Use flip command if it is supported by the mount.
8. Display received FITS in the Summary screen preview window.
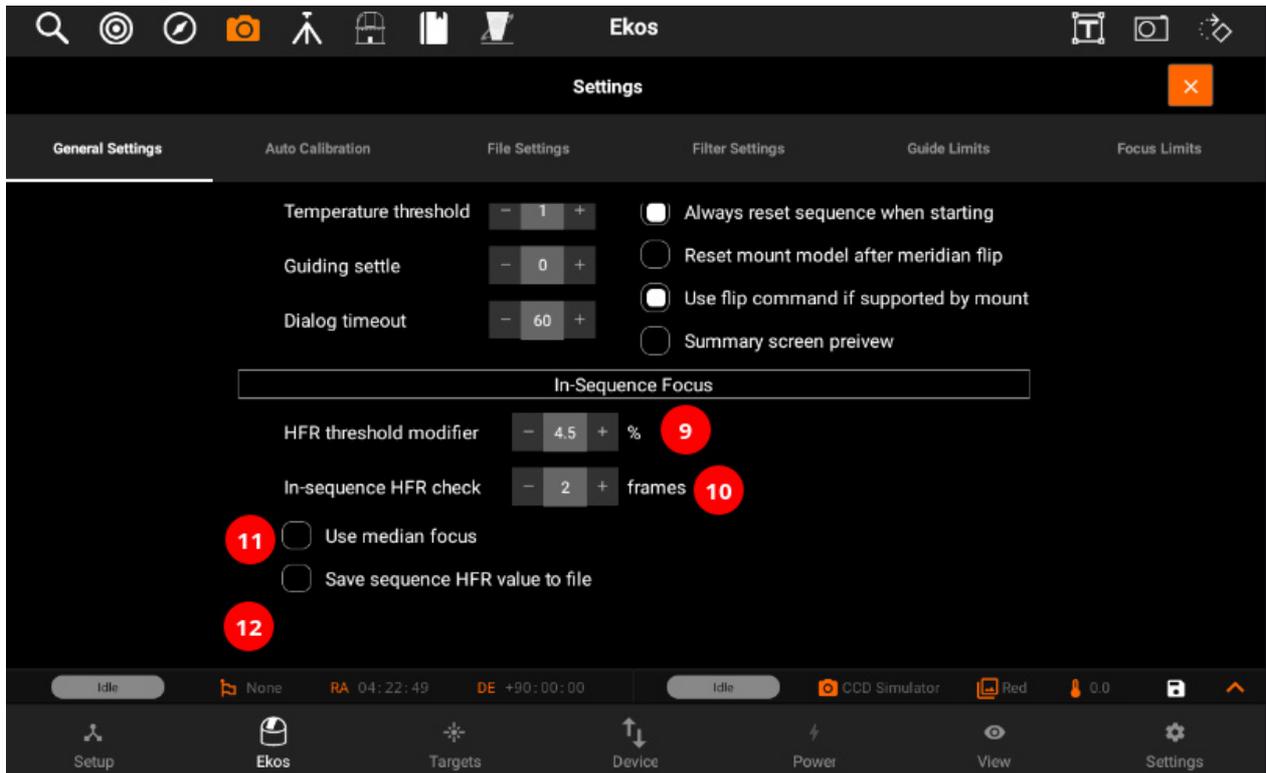
9. Set HFR Threshold percentage gain. When an autofocus operation is completed, the autofocus HFR value is increased by this threshold percentage value and stored within the capture module. If In- Sequence-Focus is engaged, the autofocus module only performs auto-focusing procedure if current HFR value 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.

Auto Calibration

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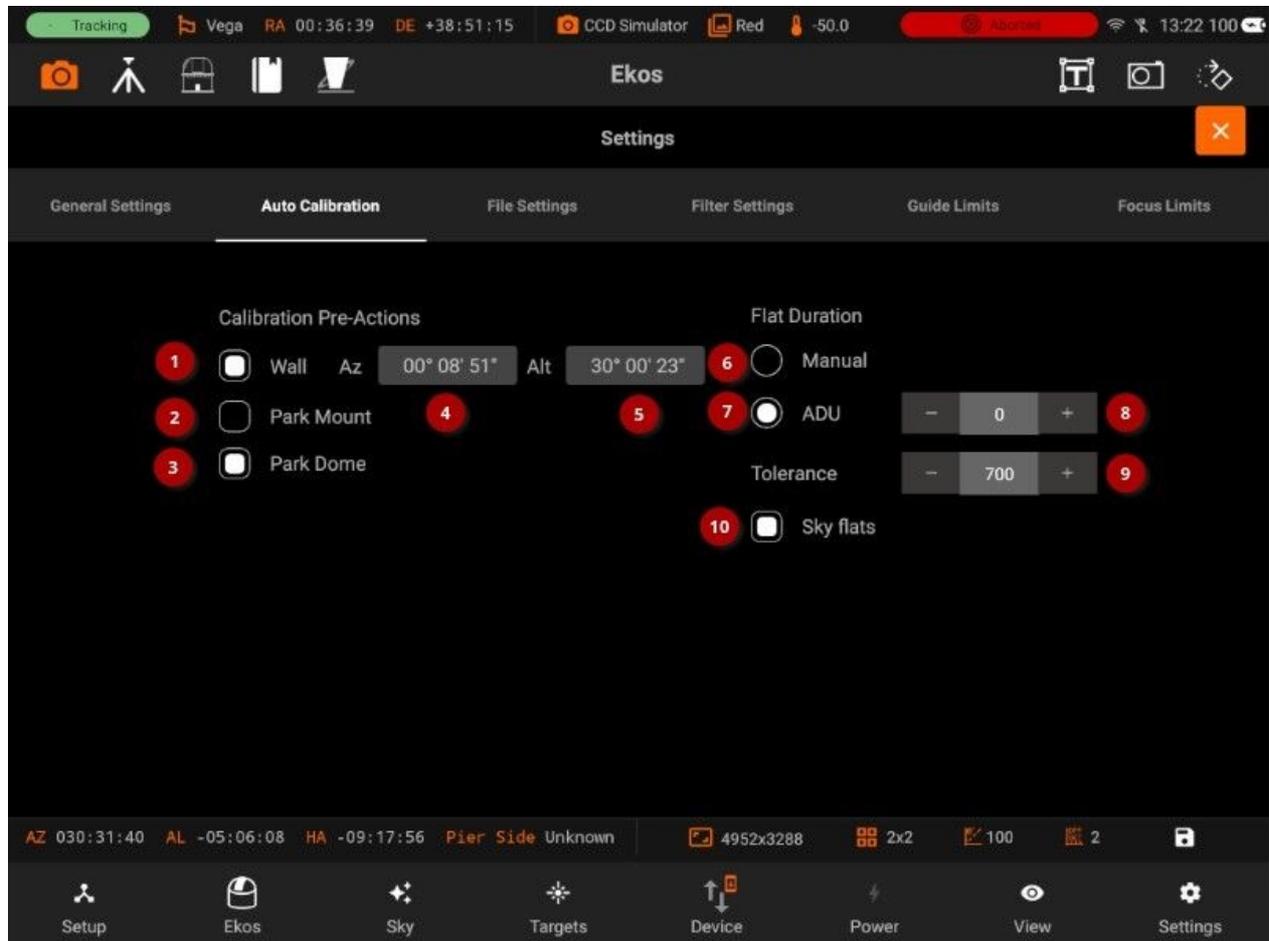
Note: You can only edit calibration settings for capture jobs that have the frame type as Bias (B), Dark (D), or Flat (F).

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.

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

2. **Park mount:** Select which actions to perform before a Bias/Dark/Flat frame is captured.

3. **Park dome**: Select which actions to perform before a Bias/Dark/Flat frame is captured

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

5. **ALT:** Select which actions to perform before a Bias/Dark/Flat frame is captured

6. Flat Field Duration:

7. **Manual:** Use the frame exposure value

8. **ADU:** Calculate optimal exposure time given the required ADU. If a controllable device is selected, calculate optimal brightness.

9. **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 f 9900 and 10100 shall be accepted.

10. **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.

Files

File Settings

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.

Format is used to define the image file names by the use of placeholder tags.
• **Placeholder %f or %filename**: The name of the .esq file, without extension.
• **Placeholder %D or %Date/time**: The current time and date when the file is saved.
• **Placeholder %T or %Type**: The frame type e.g: 'Light', 'Dark'
• **Placeholder %e or %exposure**: The exposure duration in seconds.
• **Placeholder %E or %exp**: The exposure duration in seconds as plain number, without any unit as suffix.
• **Placeholder %F or %Filter**: The active filter name.
• **Placeholder %t or %target**: The Target name.
• **Placeholder %C or %temperature**: The camera temperature of capturing.
• **Placeholder %B or %bin**: The binning configured for capturing.
• **Placeholder %G or %gain**: The gain configured for capturing.
• **Placeholder %O or %offset**: The offset configured for capturing.
• **Placeholder %I or %iso**: The ISO value(DSLRs only).
• **Placeholder %P or %pierside**: The current mount's pier side

Format: /%t/%T/%F/%t_%T_%F_

• **Placeholder %t or %target**: The Target name.
• **Placeholder %C or %temperature**: The camera temperature of capturing.
• **Placeholder %B or %bin**: The binning configured for capturing.
• **Placeholder %G or %gain**: The gain configured for capturing.
• **Placeholder %O or %offset**: The offset configured for capturing.
• **Placeholder %I or %iso**: The ISO value(DSLRs only).
• **Placeholder %P or %pierside**: The current mount's pier side
• **Placeholder %s or %sequence**: The image sequence identifier where * is the number of digits used (1-9), This tag is mandatory and must be the last element in the format
Arbitrary text may also be included within the Format string, except the % and / characters. The / Path character can be used to define arbitrary directories.
Notes:
• Tags are case sensitive in both their short and long forms
• Only use the %Datetime tag in the filename portion of the format, not in the path definition.

Format: /%t/%T/%F/%t_%T_%F_

- **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.
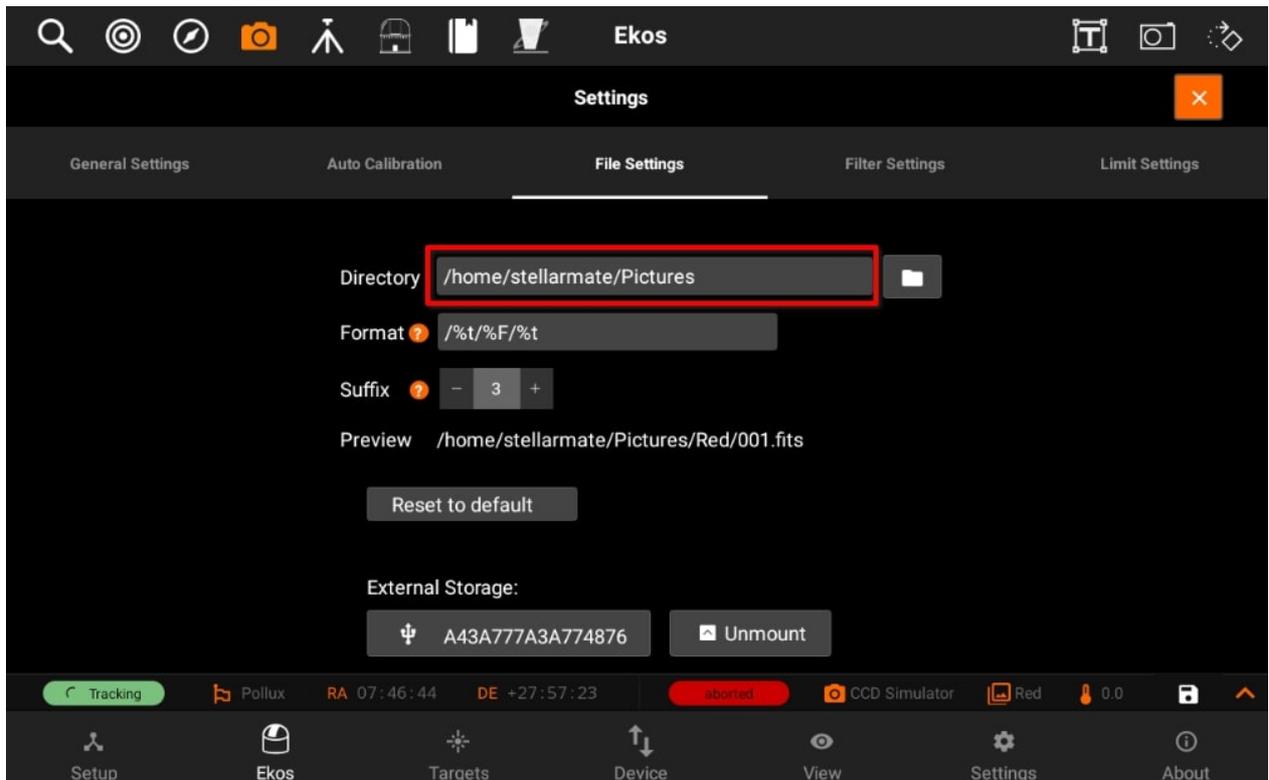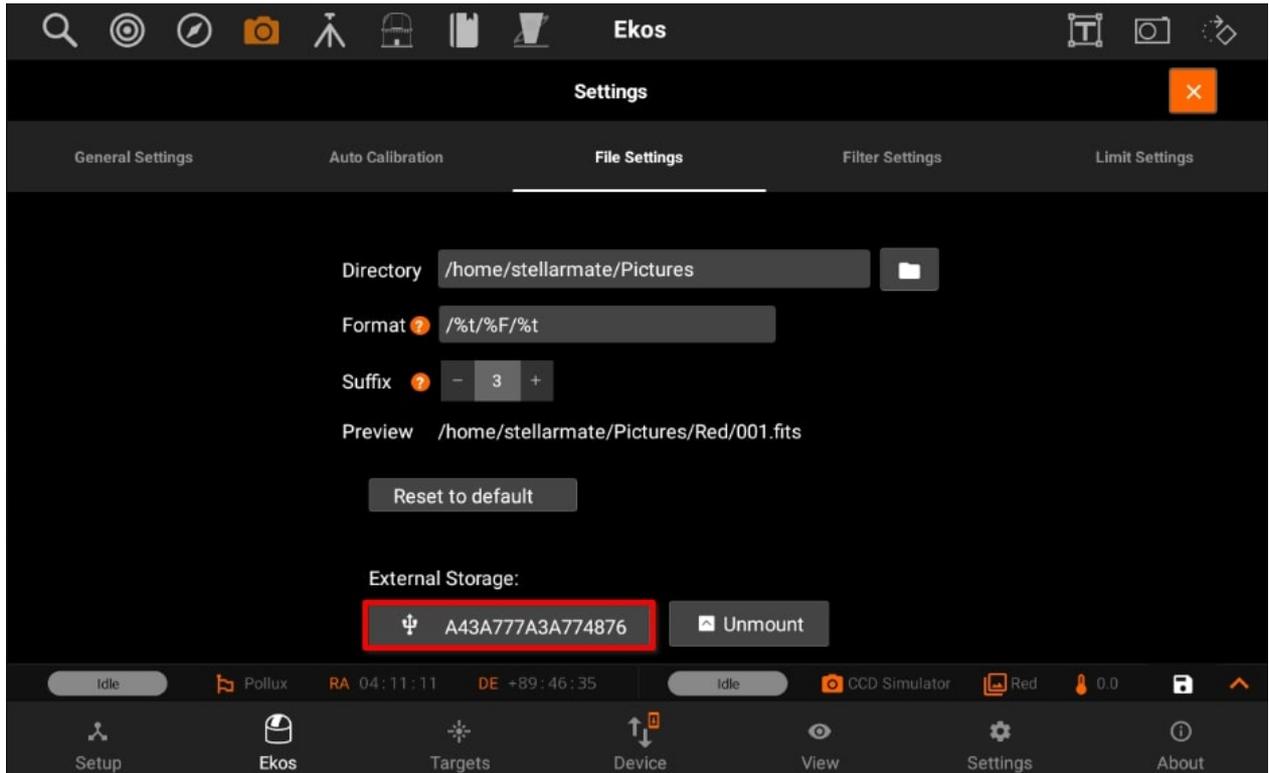
Filters

Filter Settings

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 Lumonisity is specified as the locked filter and auto-focus is checked, the filter is changed to Lumonosity

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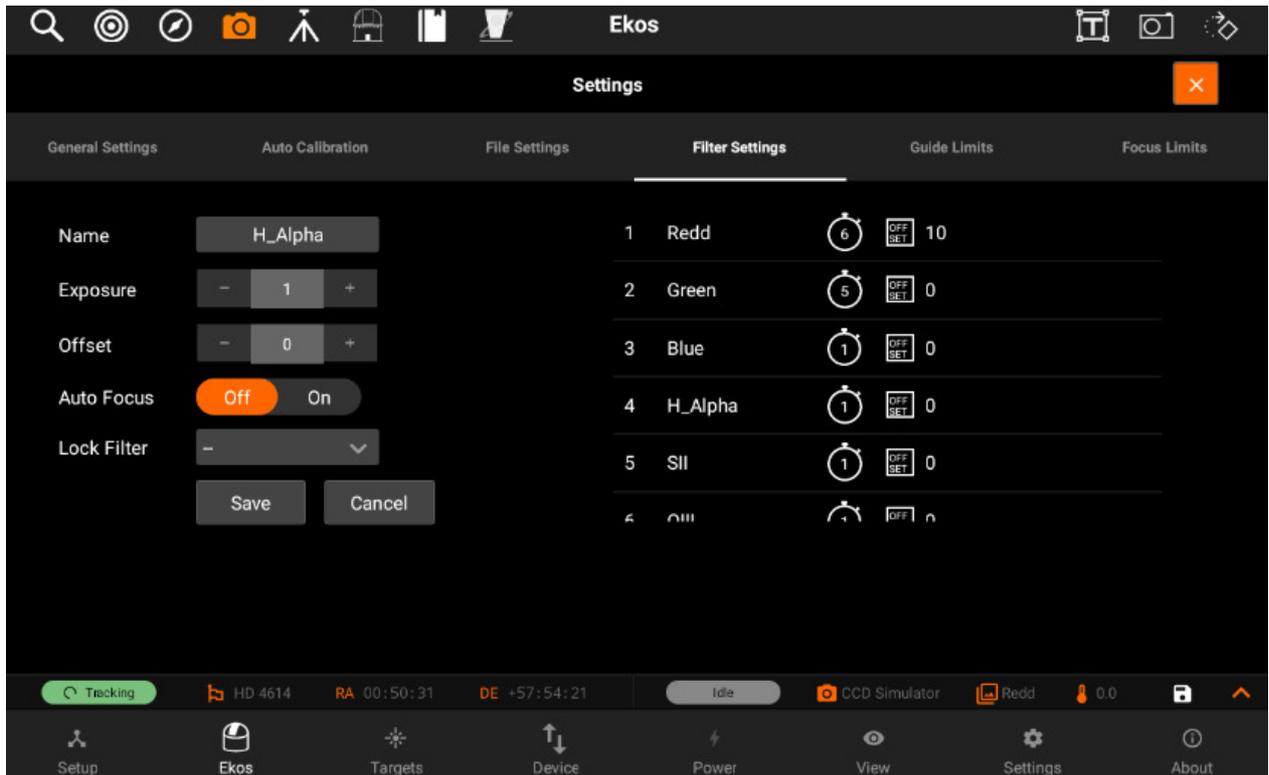
To edit a filter, tap on it on the panel on the right-side of the page. All of its details will be filled in the panel on the left-side to be edited.

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.
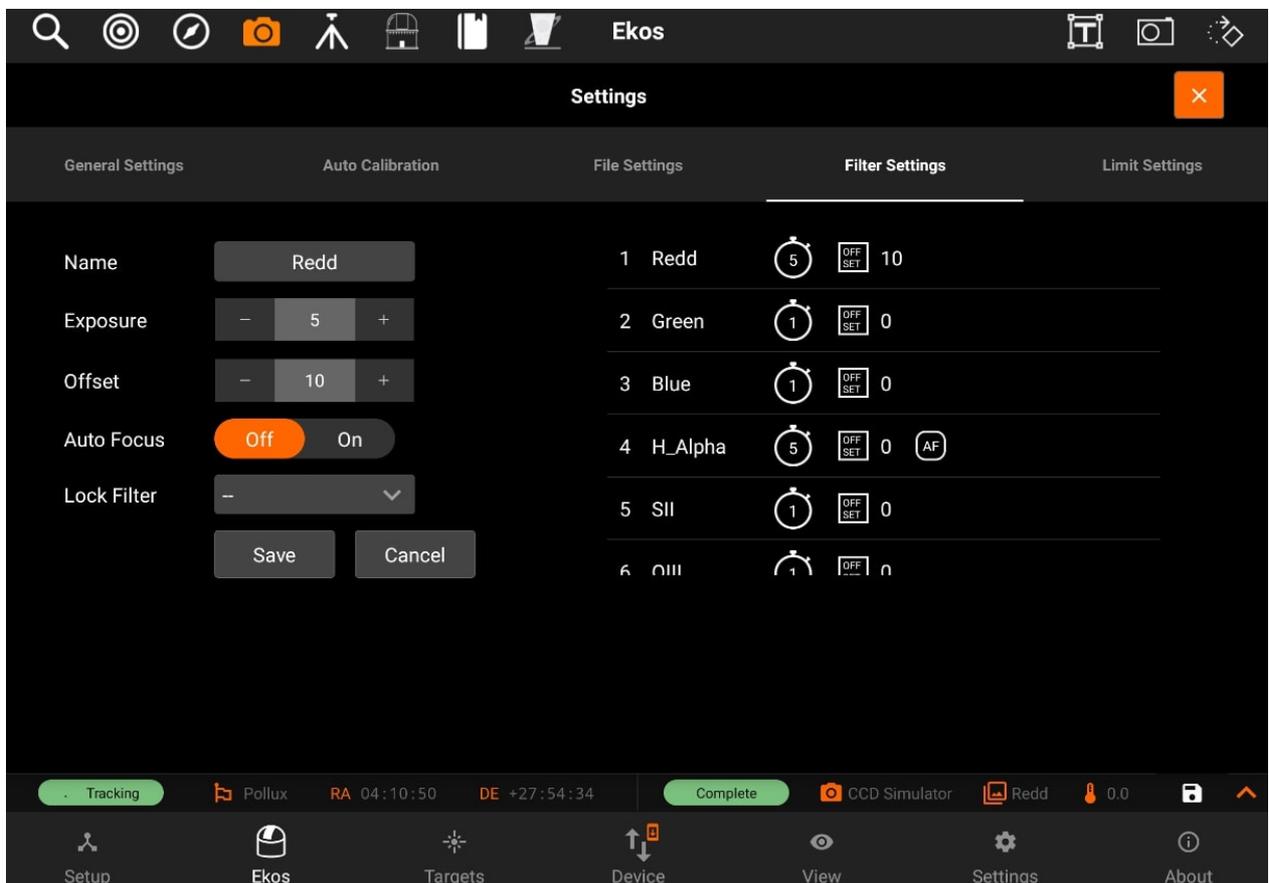
Guide

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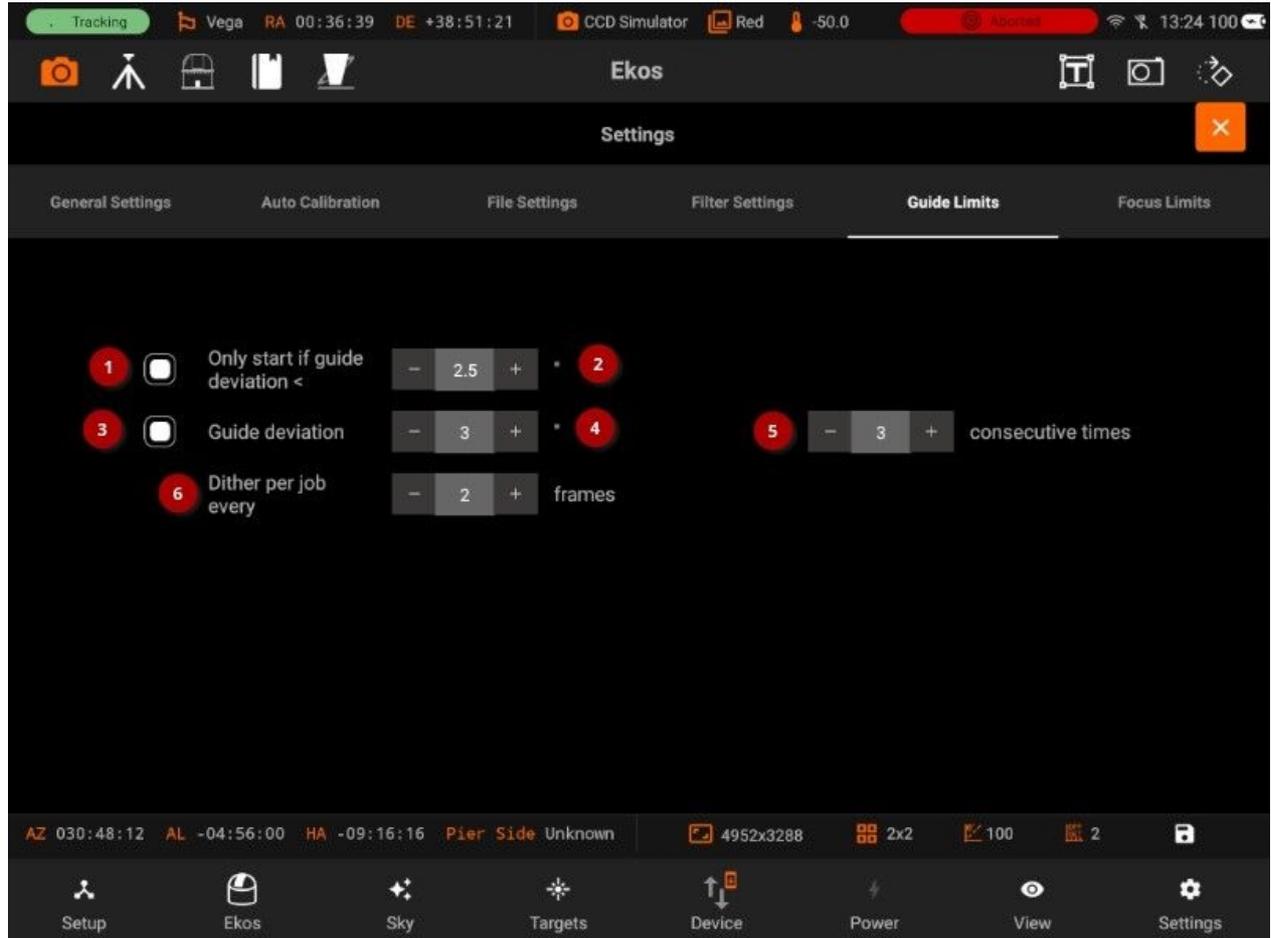
Guide limit settings are applicable to all the images in the sequence queue. When a limit is exceeded, Ekos shall command the appropriate action to remedy the situation as explained below.

1. **Only start Guiding Deviation**: Start capturing only if guide deviation is below the given threshold (ignored for previews)

2. **Only start Guiding** Deviation Value

3. **Guide Deviation**: Abort sequence if guiding deviation exceed this value N consecutive times

4. **Guide Deviation Value**

5. **Consecutive times:** Abort sequence if guiding deviation exceed this value N consecutive times

6. **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.

Focus

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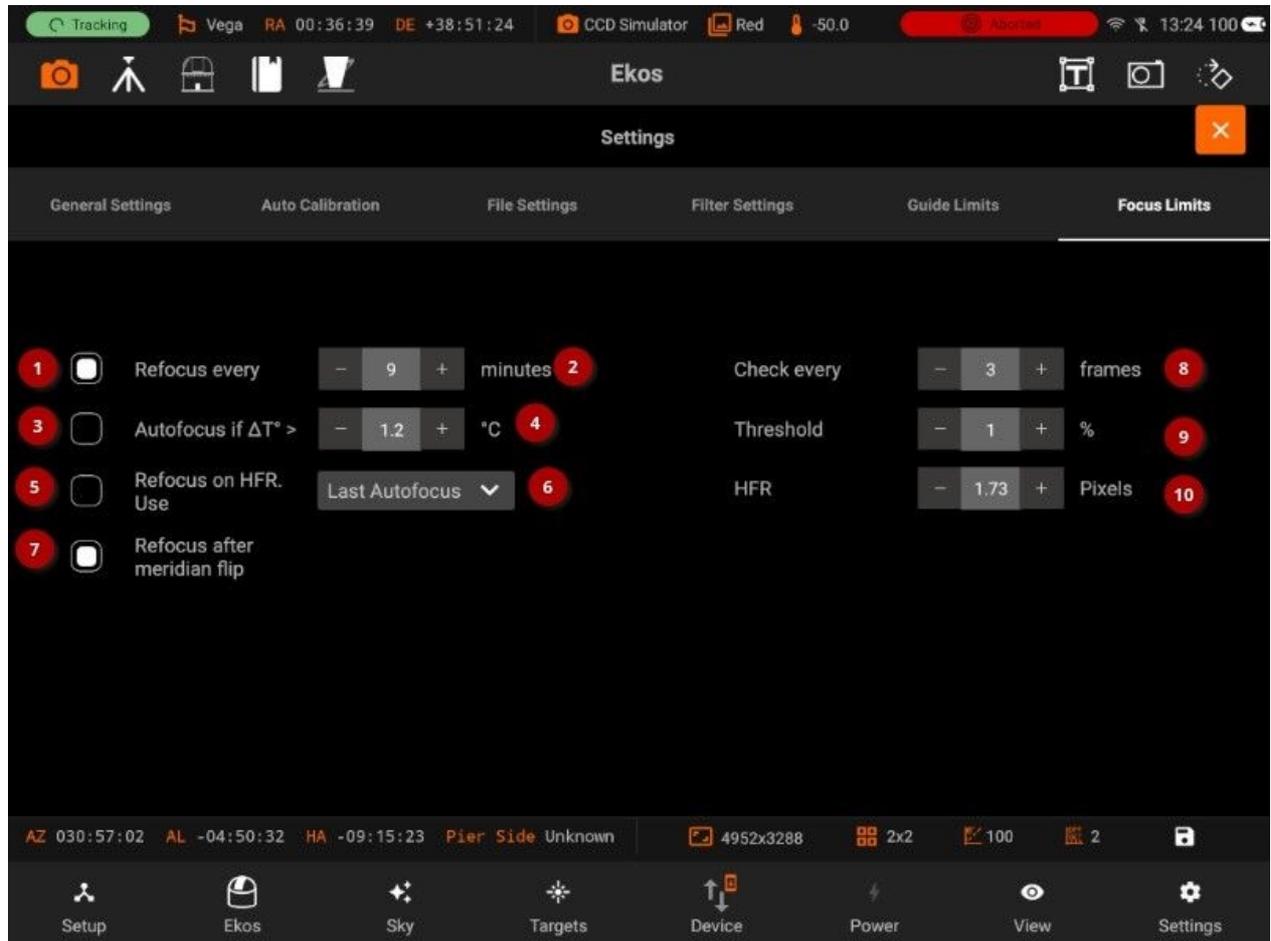
Focus limits settings are applicable to all the images in the sequence queue. When a limit is exceeded, Ekos shall command the appropriate action to remedy the situation as explained below:

1. **Refocus every:** Check to force an Autofocus every N minutes. Timer is reset at each Autofocus.
2. **Refocus** value in minutes
3. **Autofocus**: Check to force an Autofocus when the change in temperature since last focus exceeded this value. Reference temperature is reset at each Autofocus.
4. **Autofocus** value in Celsius
5. **Refocus on HFR**: Check to perform an HFR Check between Subframes. The Check may result in an Autofocus.
6. **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.

7. **Refocus meridian flip:** Check to force an Autofocus after a Meridian Flip**.**

8. **Check every frames:** Run HFR check after this many sub-frames.

9. **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.

10. **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.

Mount

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

- Manage / Select [Optical trains](#).
- Tracking On/Off
- Mount Park/UnPark
- Meridian Flip
  - o **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.
  - o **Pier Side:** Shows the pier side direction.
- Limit Settings: You enable Altitude Limits or Hour Angle Limits if you do not wish your mount to move past a specific limit. The values are expressed in hours. Setting a 1 hour (HA) limit means your mount is restricted to 15 degrees east and west of the meridian. Setting it to 3 HA (3*15) means your mount is free to move 45 degrees east and west of the meridian.
- Auto Park
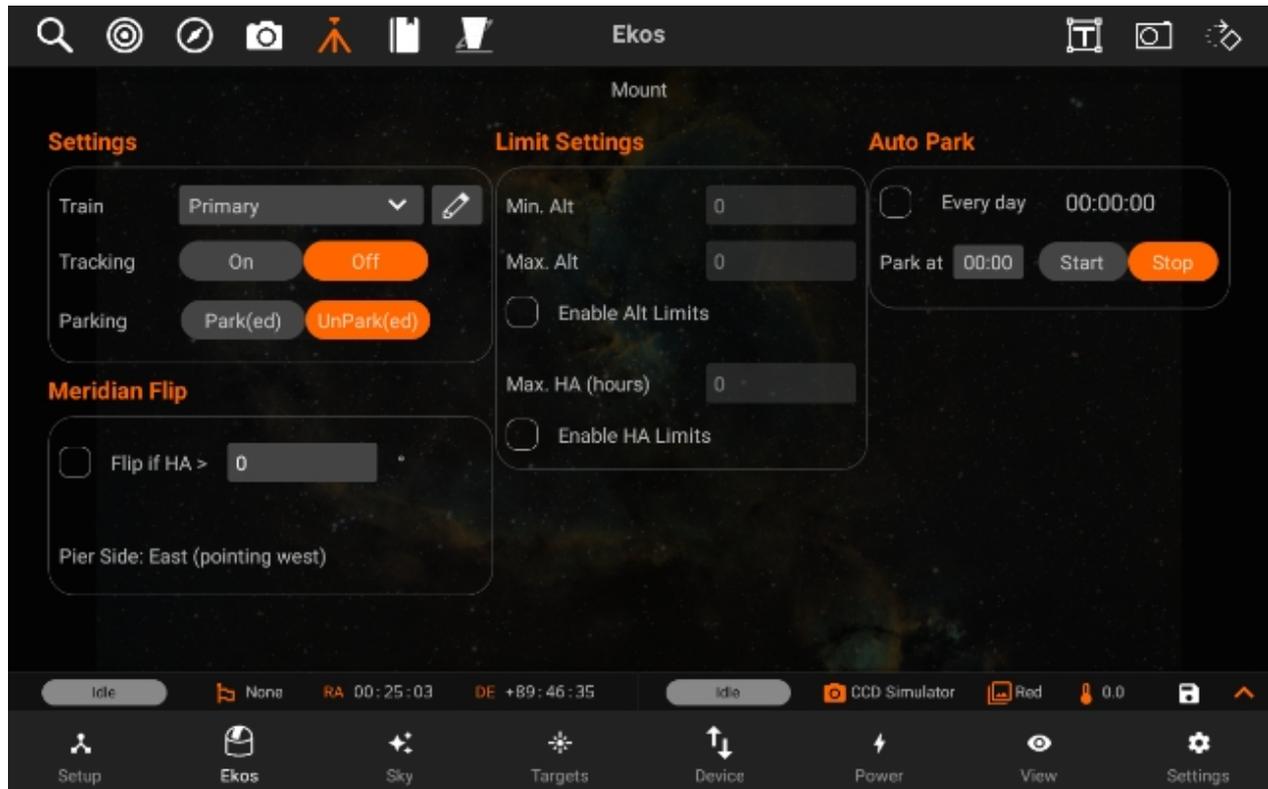
Train

You can Select / Edit a train specifically for Mount module. Each module has it's own train.
Visit Optical trains topic for more.

Meridian Flip

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 commended to flip. The mount must begin tracking east of the meridian in order to the meridian flip to be commanded in Ekos.

When commanding a meridian flip, Ekos will suspend the auto-guiding process and waits 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 form 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.

Auto Park

To enable auto park every day, check the Every day box. Otherwise if the desire is only to park it once, keep it disabled.
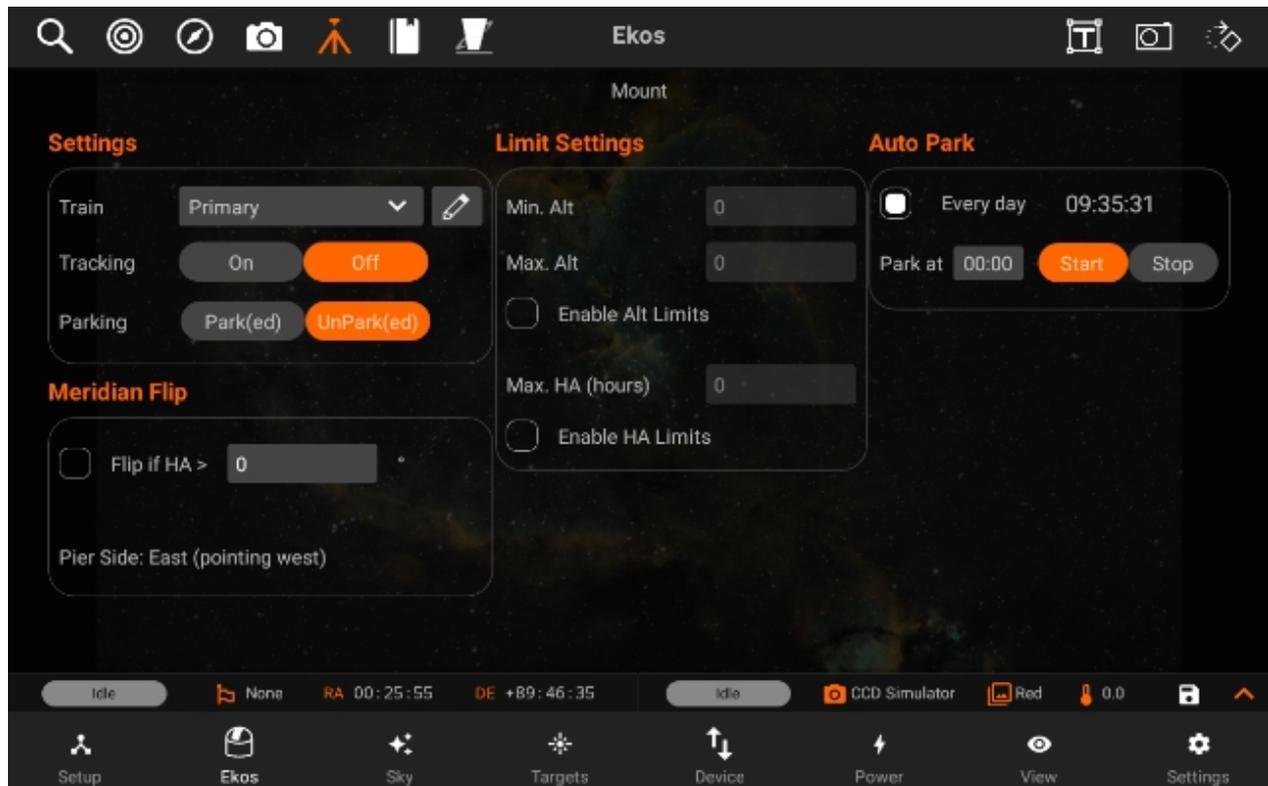
Select the time you want to park the mount.
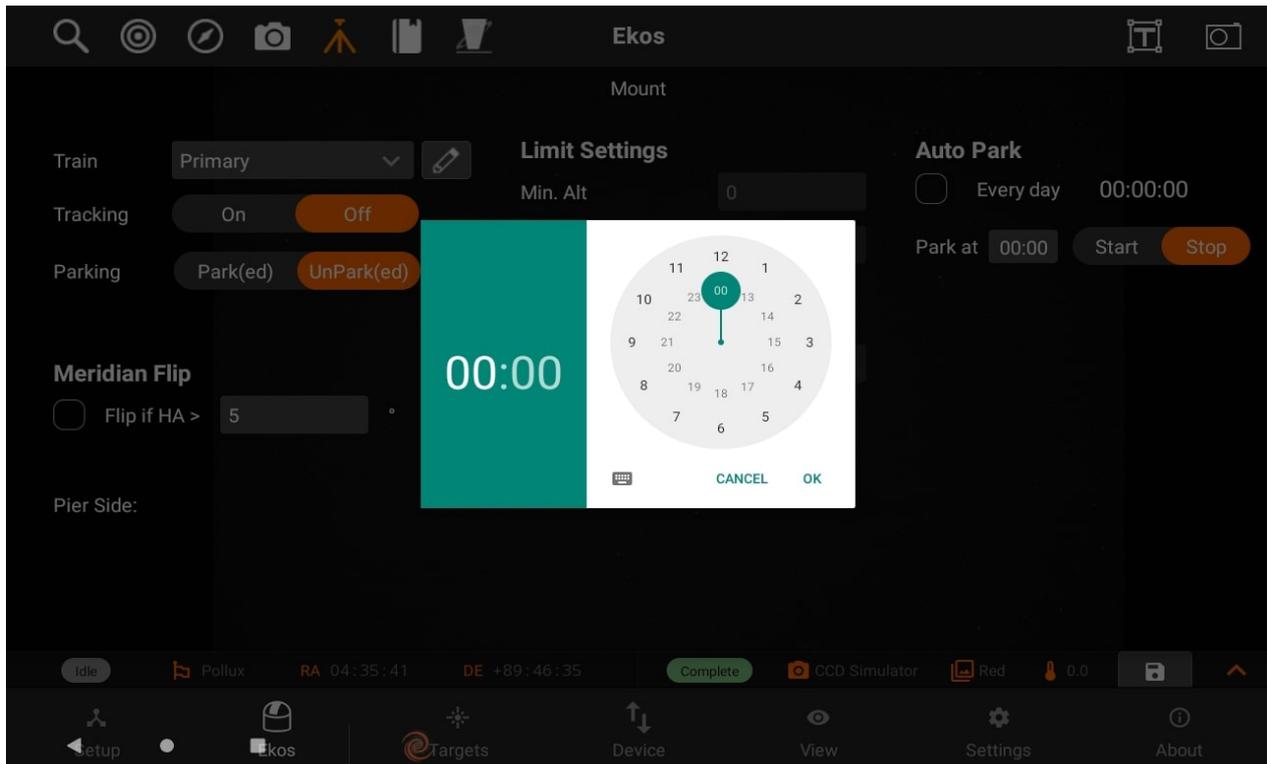
Observatory

The Observatory module allows you to control your Dust Cap and Dome/Roll-off roof, it has the following features:
- Dust Cap Park/UnPark
- Dome Park/UnPark
- Roll-off roof Park/UnPark
- Abort Dome Motion
- Goto Absolute Dome Angle
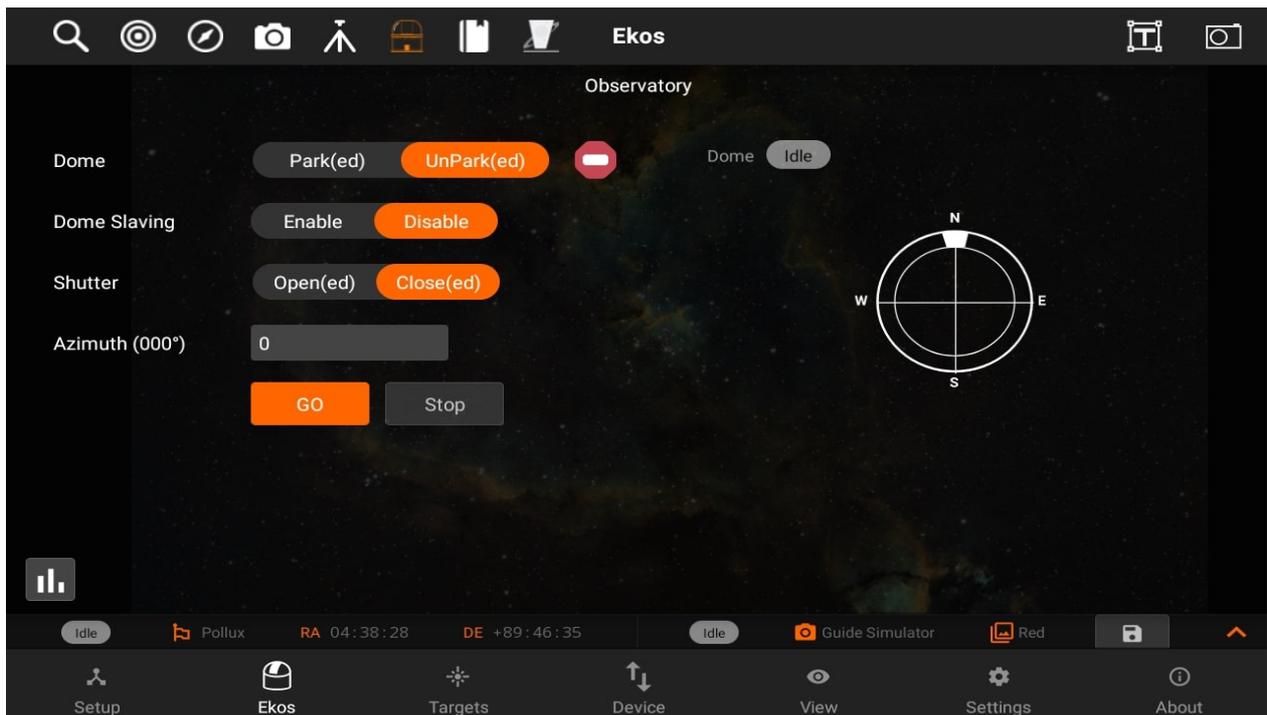
Changing Dome settings

To change the settings, click on Parameters:
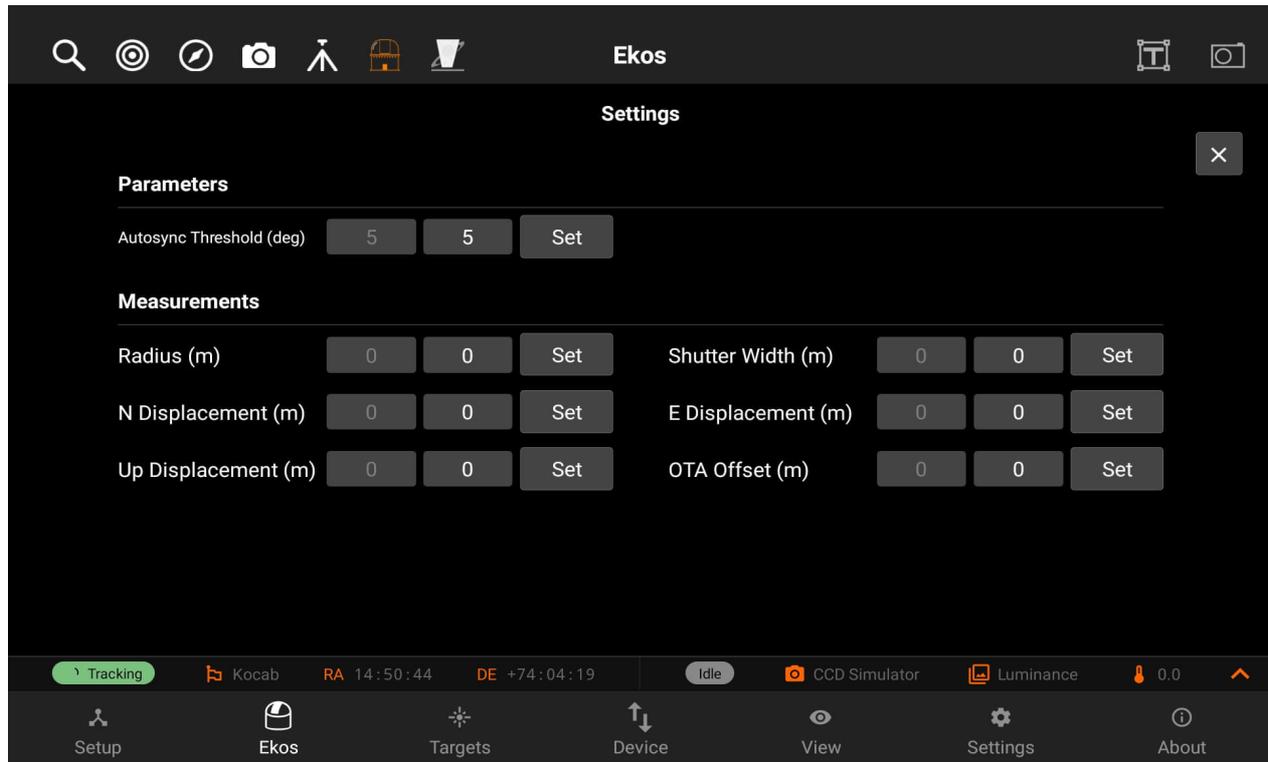
Going to an absolute angle position

You can go to an absolute angle position on your dome by tapping on the text-box next to the Azimuth label and setting the angle value to go to. Now tap on the GO button to go to that angle position. The dome will now try going to that position, the dome status badge will show what type of rotation the dome is doing, and a compass preview will show a representation of the dome angle. After the movement is complete, you will be able to see the status badge change to "Tracking".
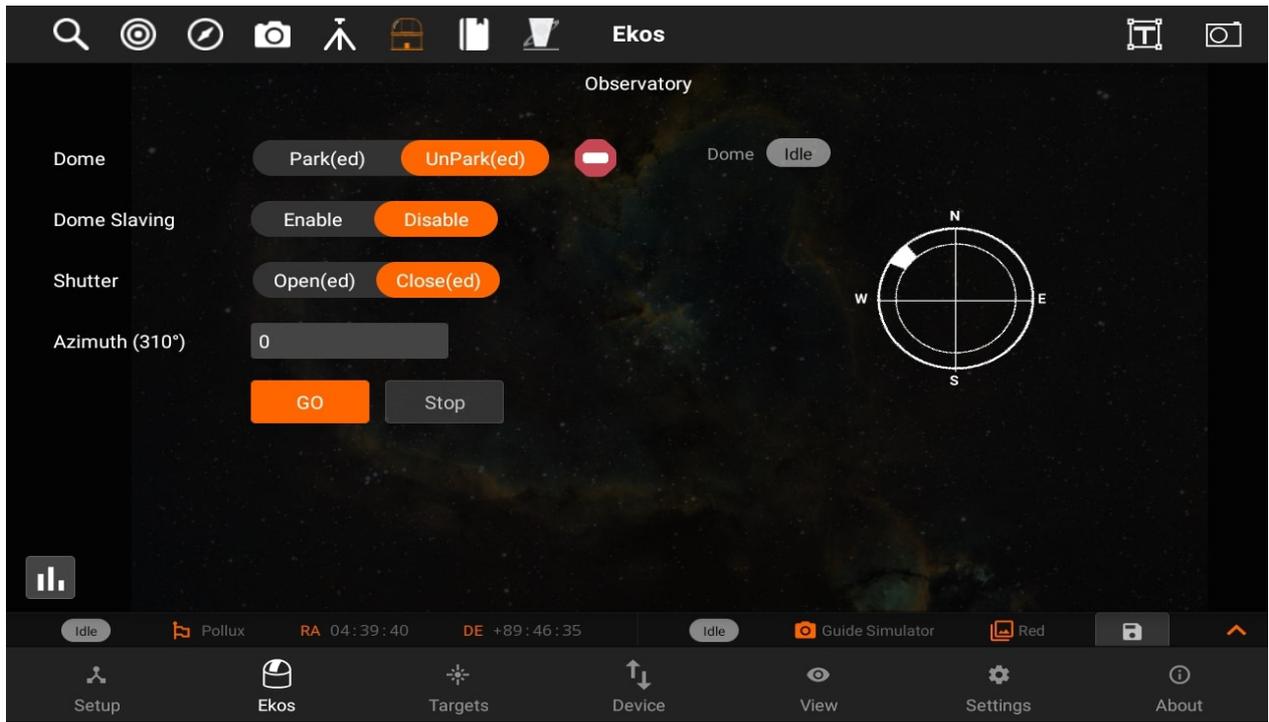
INDI Control Panel

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.
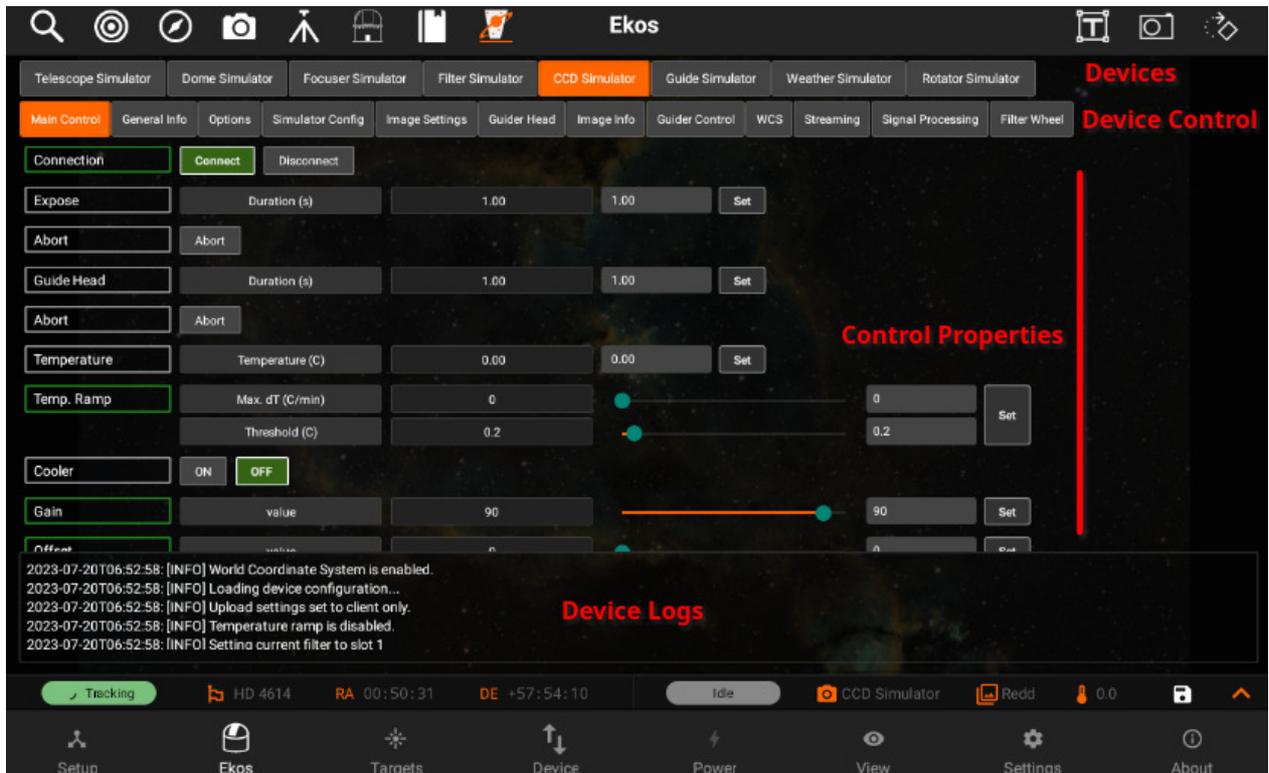
The connected devices are show at the top (1). Selecting one will show it's control groups (2). Selecting one of the control groups displays it's properties in (3).
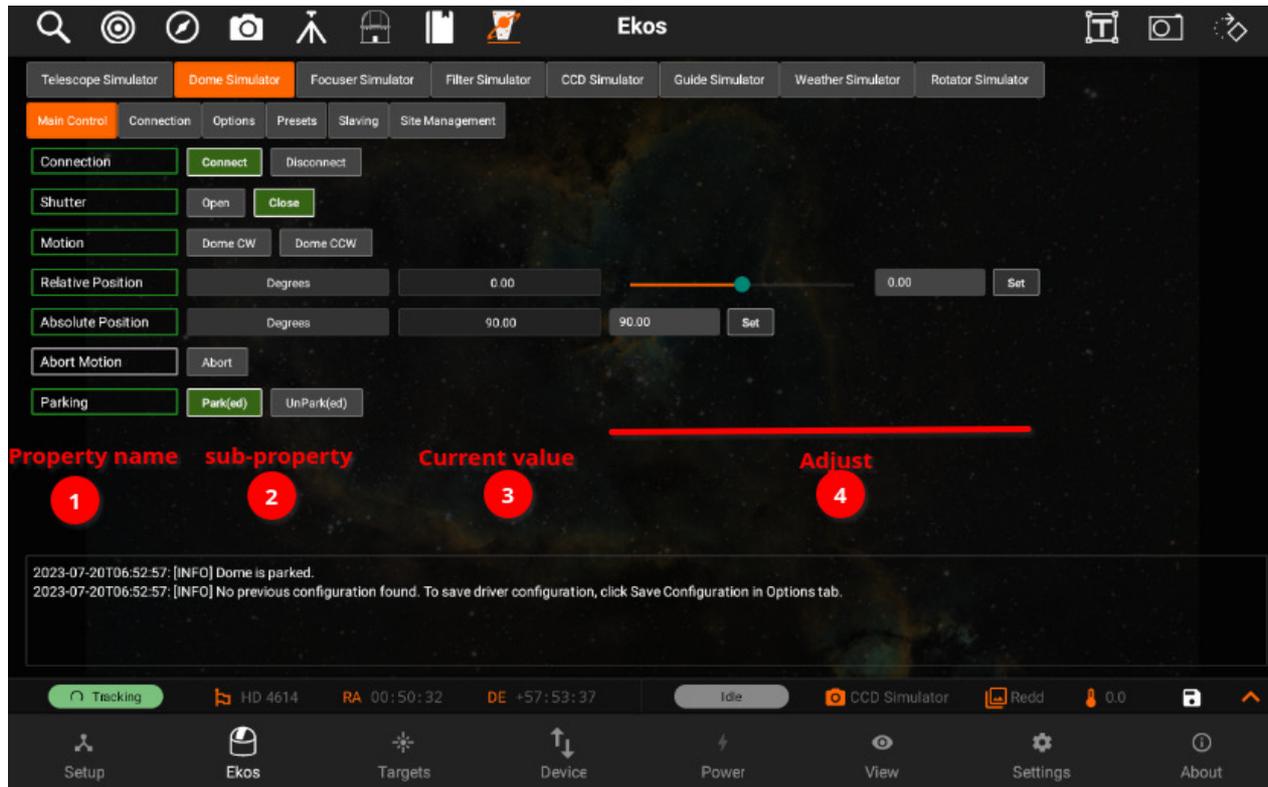
Each property (1), can have multiple sub-properties (2). The current value for the sub-property is shown at (3). The status of the property (1) would change from gray (idle) to green (successful), red (failed) or yellow (in-progress) when any changes have been set.

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.
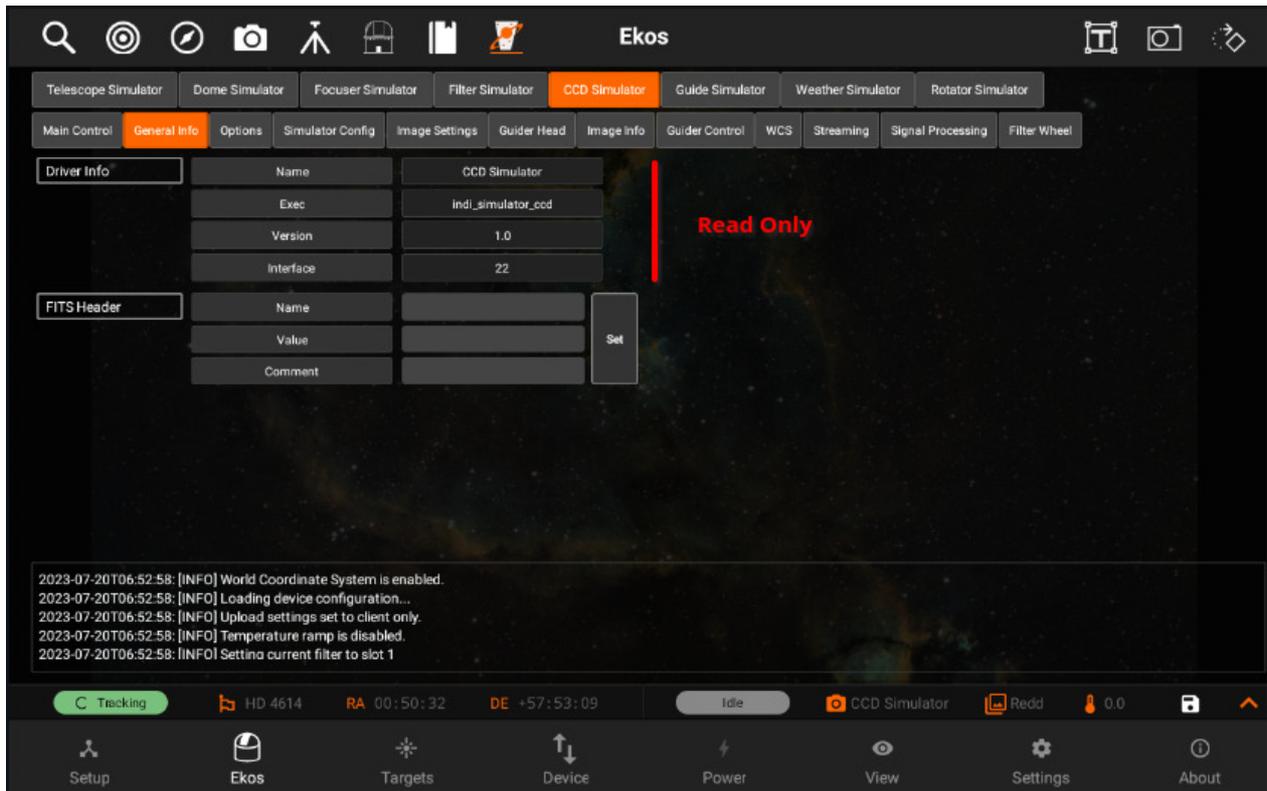
Some properties are read only and cannot be changed.
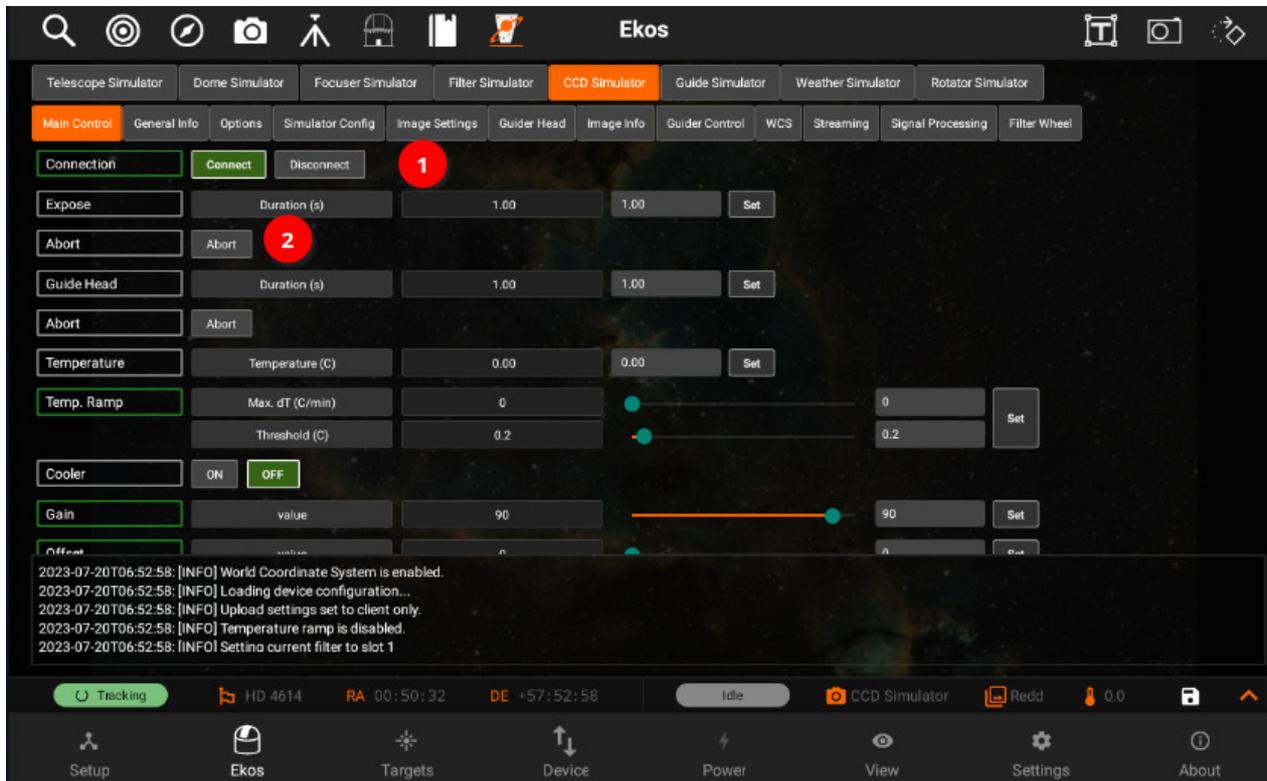
Some buttons show the active button (1), and a different button can be set active simply by pressing it. Other buttons (2) only send the action once pressed and we can tell if it was successful from the property status (3).

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.
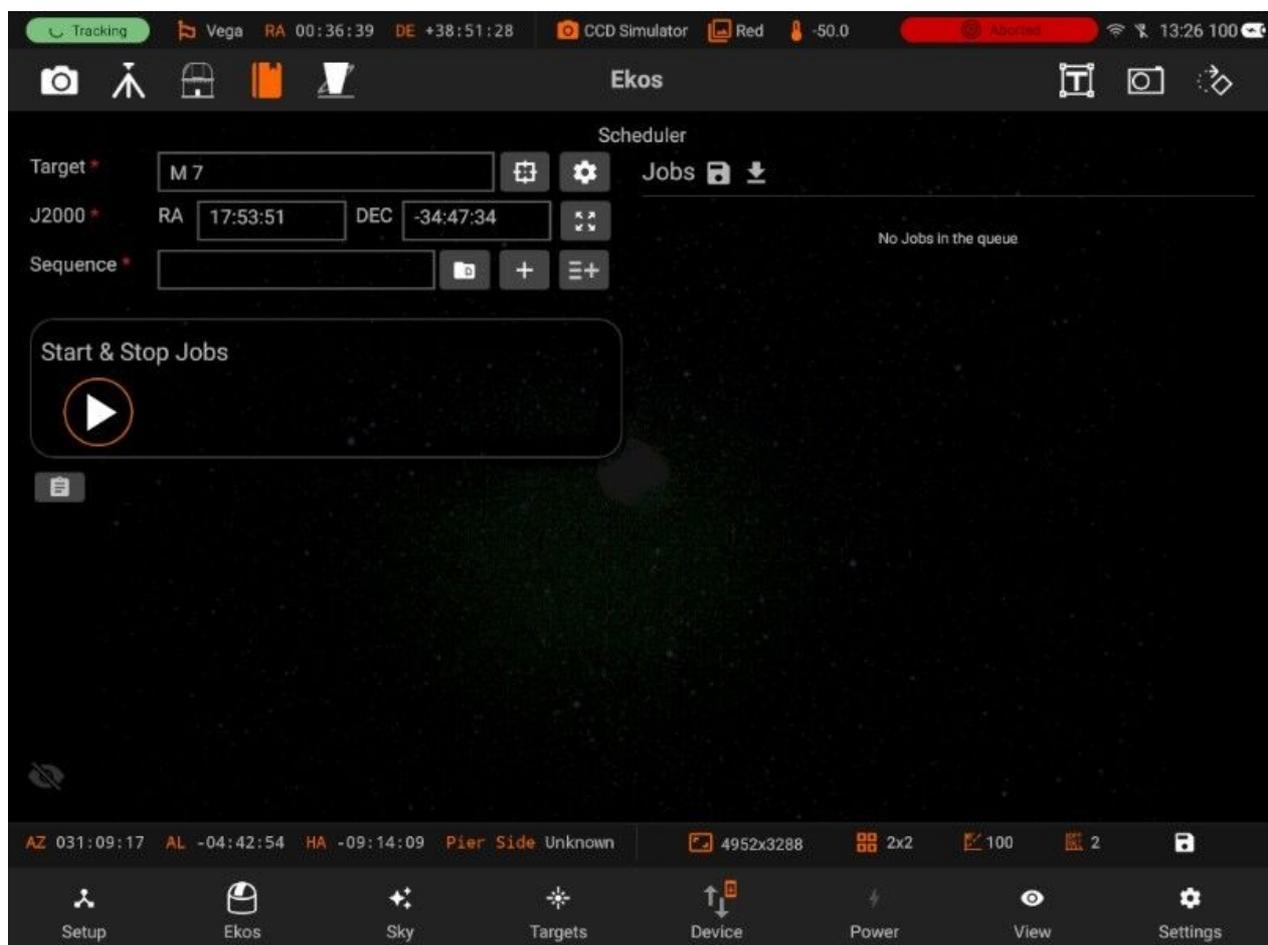
Ekos Scheduler provides a simple interface to aid the user in setting the conditions and constraints required for an observation job.

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 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.

Settings
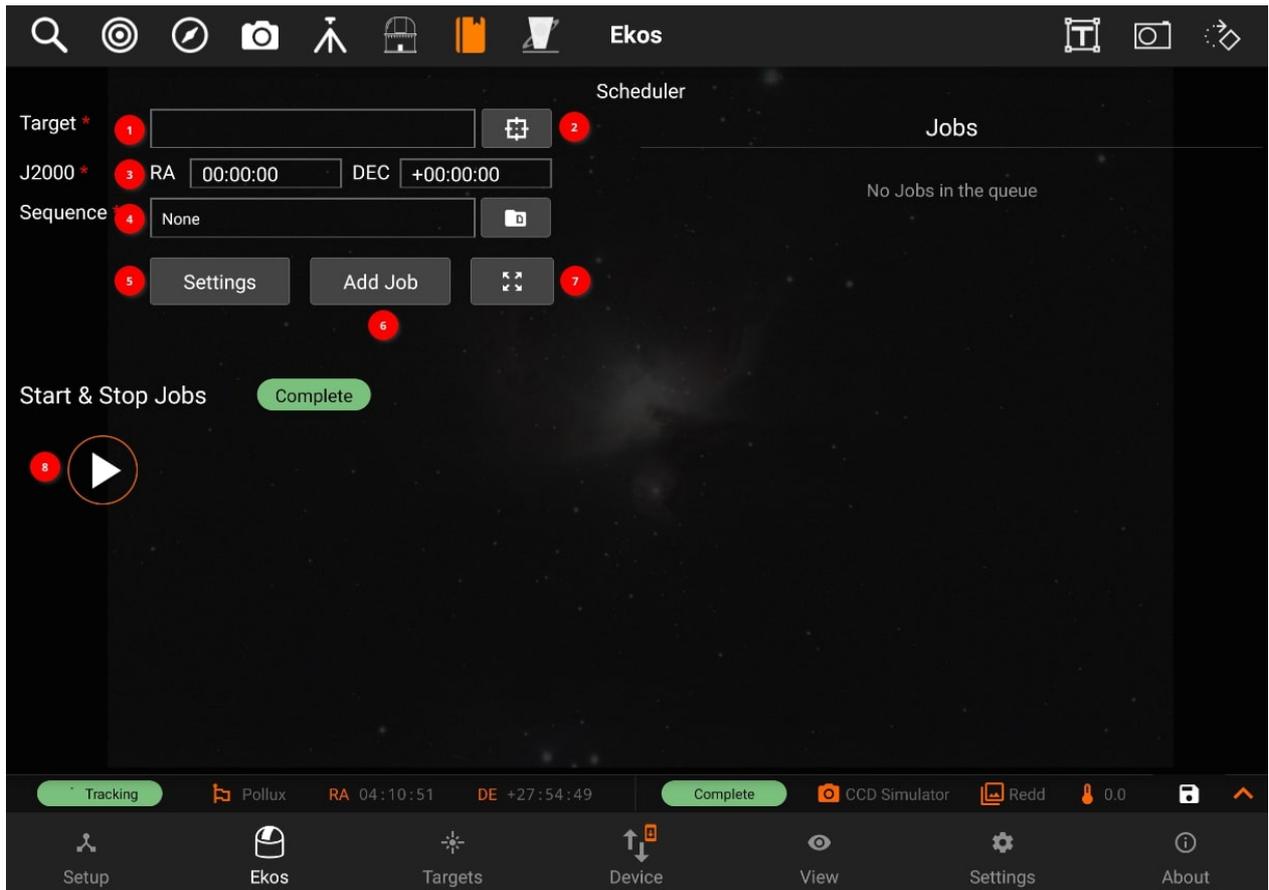
1. Target name: Target designation is automatically filled. It can be adjusted manually..

2. Target Selector: Search for targets by category and name. Targets can be also selected from the Targets tab when Ekos is offline.

3. **J2000**: RA and DEC are displayed of a specific target.

4. **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. You can select the file using [Directory browser.](#)

5. **Settings**: Contains all of the settings of Scheduler module.

   o **General Settings**:
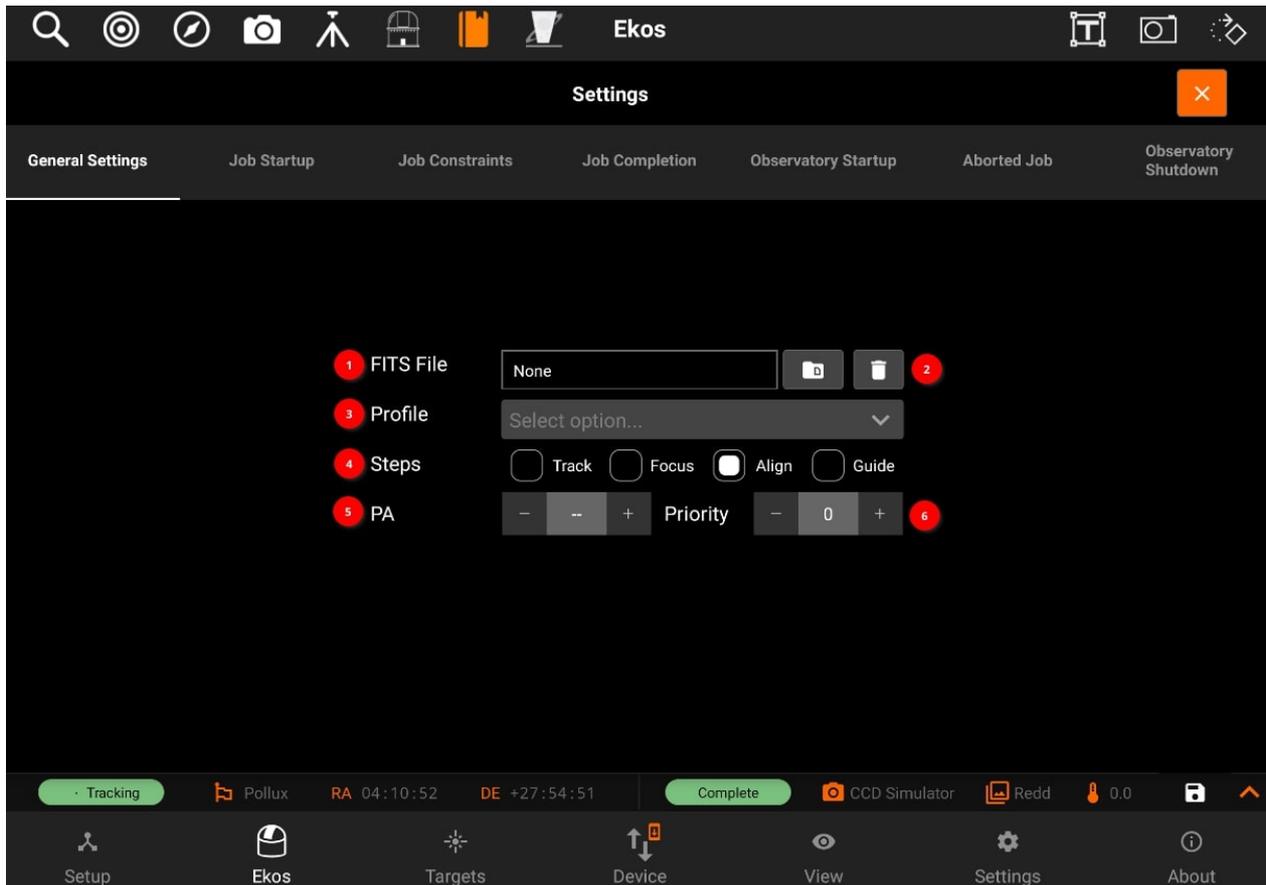
1. Optional FITS file: If a FITS file is specified, the astrometry solver shall solve the file and use the central RA/DEC as the target coordinates. You can select the file using Directory browser.

2. Removes selected FITS file.

3. Profile: Select which equipment profile to utilize when starting Ekos. If Ekos & INDI are already started and online, this selection is ignored.

4. 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

5. 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.

o Scheduler
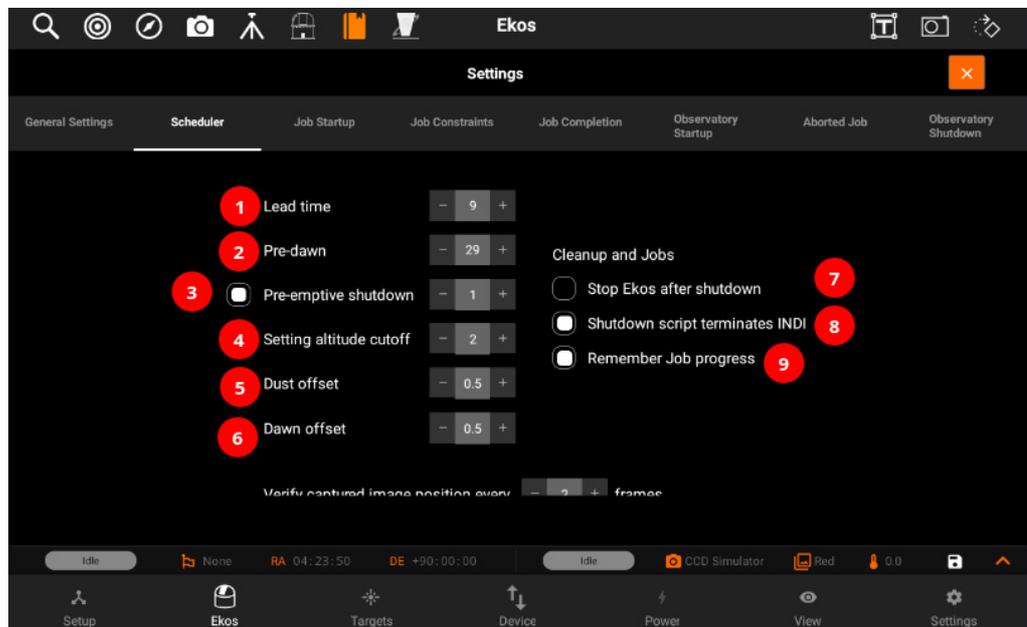
1. Lead time is the minimum time in minutes between jobs. The scheduler starts execution of a job before its scheduled startup time by this lead time. Early execution is useful as focusing, alignment, and guiding procedures may take prolonged periods to time to complete.

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. Do not permit jobs to be scheduled less than this many degrees before the altitude restriction. Actual execution proceeds until the altitude limit.

5. Offset astronomical dusk by this many hours. This positive or negative value adjusts the twilight restriction.

6. Offset astronomical dawn by this many hours. This positive or negative value adjusts the twilight restriction.

7. After shutdown procedure is successfully executed, stop INDI and Ekos.

8. If the shutdown script terminates INDI server, enable this option so that no disconnection errors are generated.

9. When processing a scheduled job, resume the sequence starting from the last image present in storage.
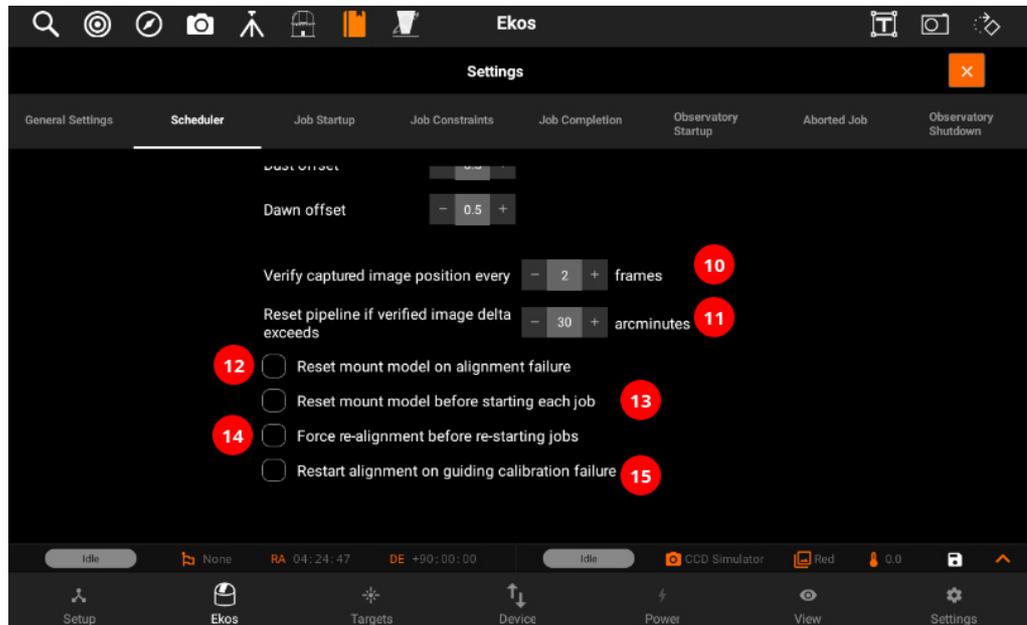
10. When calculating position after captures, compute it every Nth capture. Set to 0 to disable.

11. If captured position exceeds target position by more this many arcminutes, abort capture and reschedule the pipeline.

12. Reset mount model on alignment failure

13. Reset mount model before starting each job

14. If Align is enabled, scheduler would initiate a realignment procedure before restarting any jobs even if guiding is active.

15. If guiding calibration fails then restart alignment process before

proceeding to guiding recalibration process again. This can help recenter the target object in the field of view if the calibration process strayed too far off.

o   Job Startup
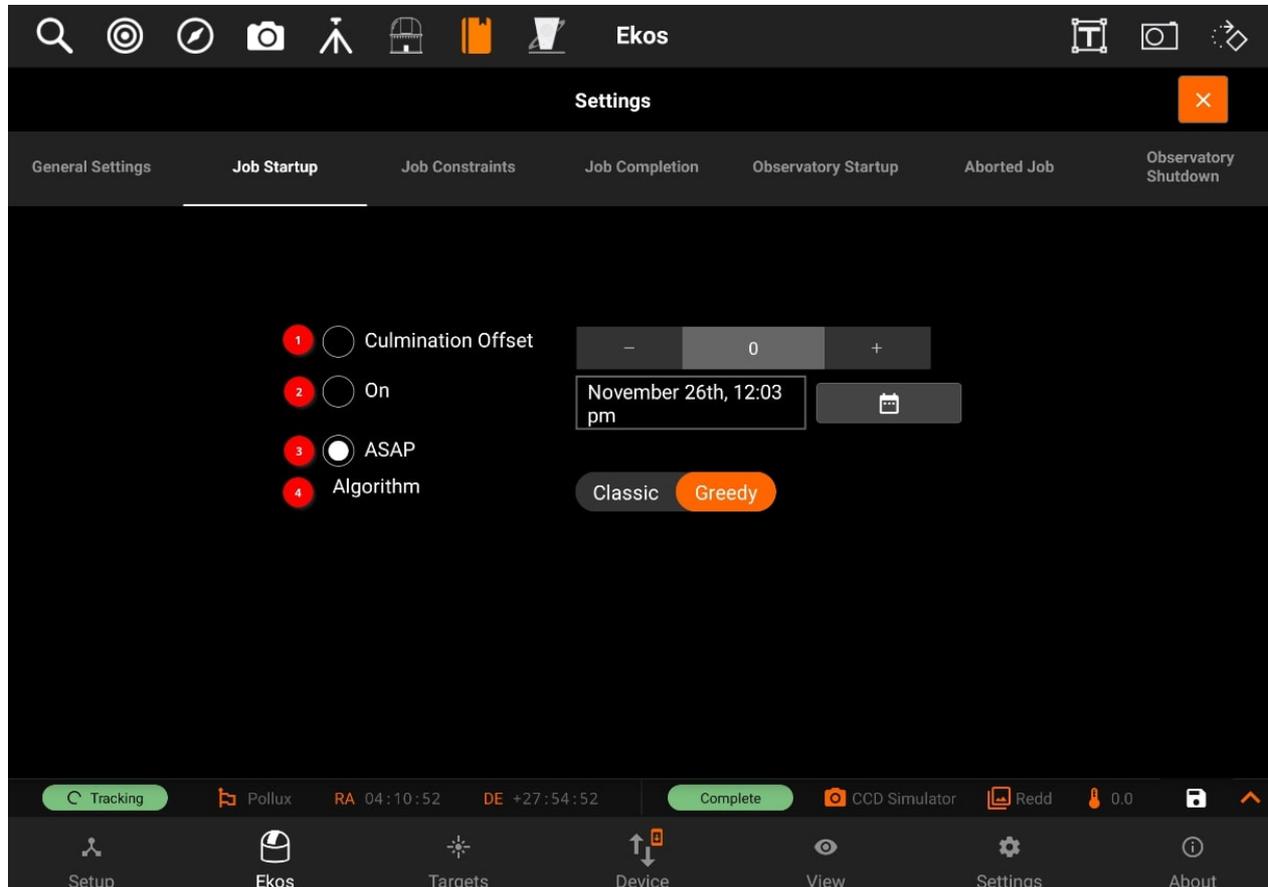
1. Culmination Offset: Start the observation job when the object reaches culmination adjusted for the offset value in minutes. By default, the observation job runs 60 minutes prior to culmination.

2. ON: Start the job on the specified date and time.

3. ASAP: Start the observation job as soon as all the constraints, if any, are met. The best candidate target shall be imaged first.

4. Algorithm:

   •   **Classic**: Start jobs that meet the constraints by priority and score.

   •   **Greedy**: Always attempt to run a job. It picks the highest priority job that can run according to its constraints. It will interrupt running jobs if a higher priority job can run.

o **Job Constraints:**
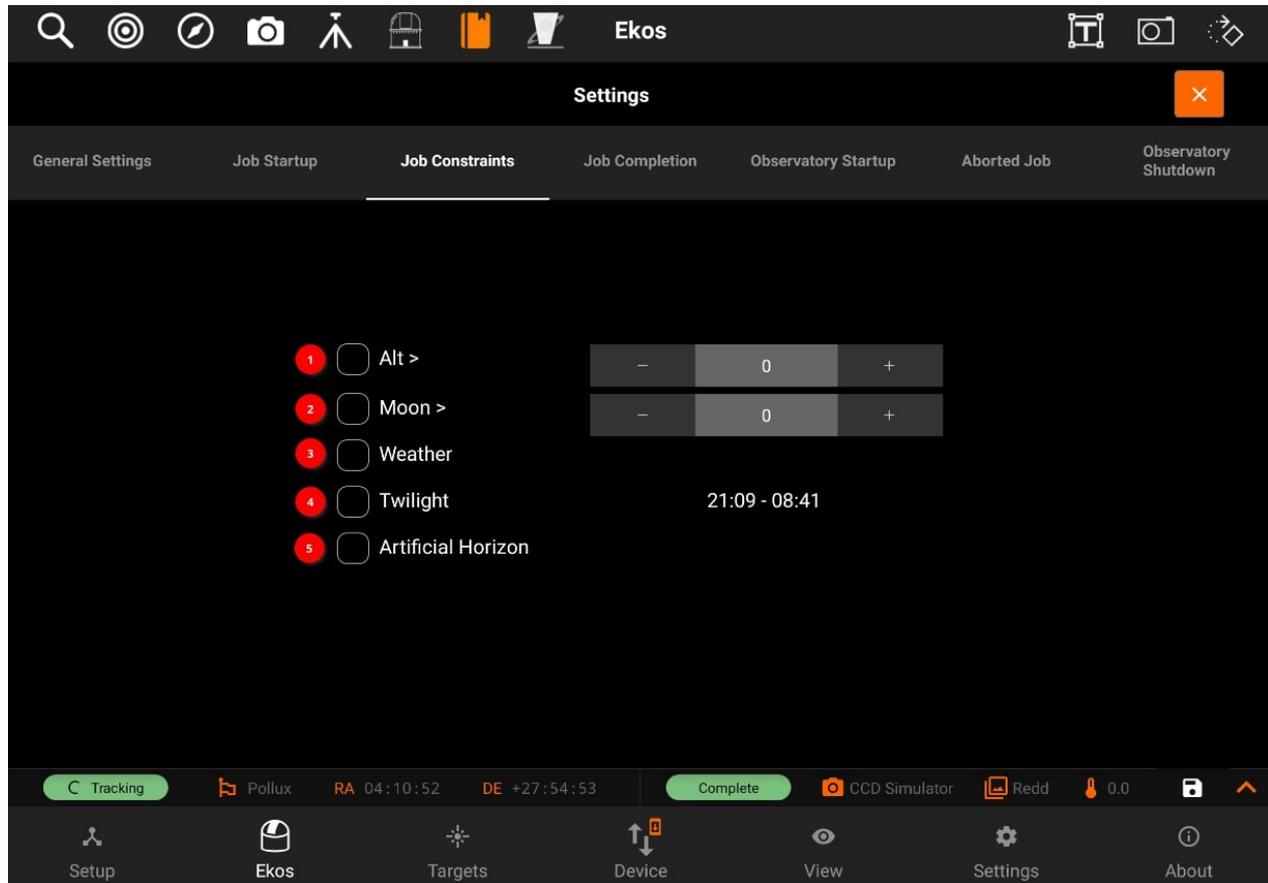
1. **Alt:** The object's altitude must remain equal or higher than the given value.
2. **Moon:** The moon separation must remain equal to or higher than the given value.
3. **Weather:** Weather conditions must remain safe. When weather conditions become dangerous, shutdown procedure is initiated.
4. **Twilight:** The twilight restriction constraints 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.

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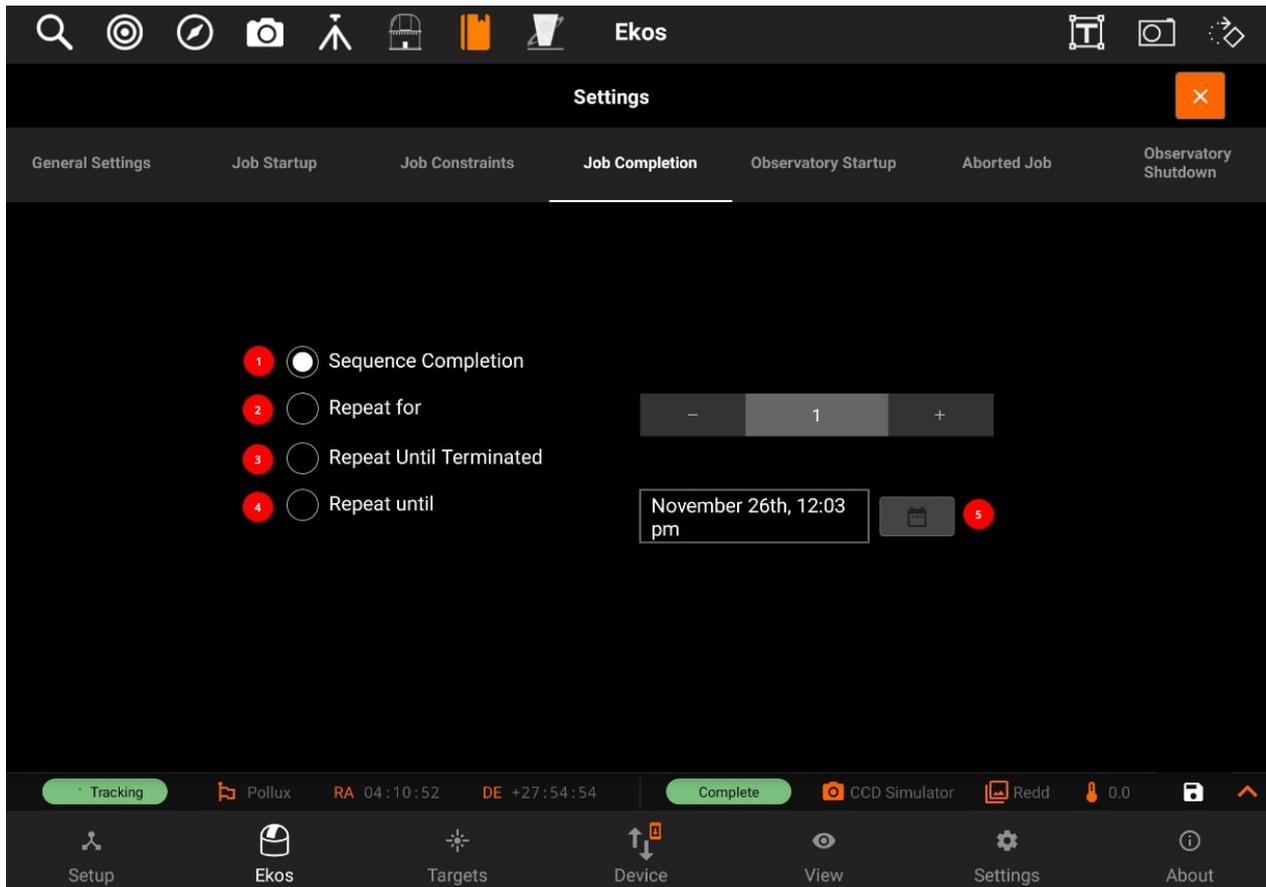
1. **Sequence Completion**: The observation job is completed when the sequence is complete.
2. **Repeat for**: No. of times sequence will repeat.
3. **Repeat until terminated**: Restart the sequence job indefinitely.
4. **Repeat until**: Terminate the job on given date and time.

o **Observatory Startup:**
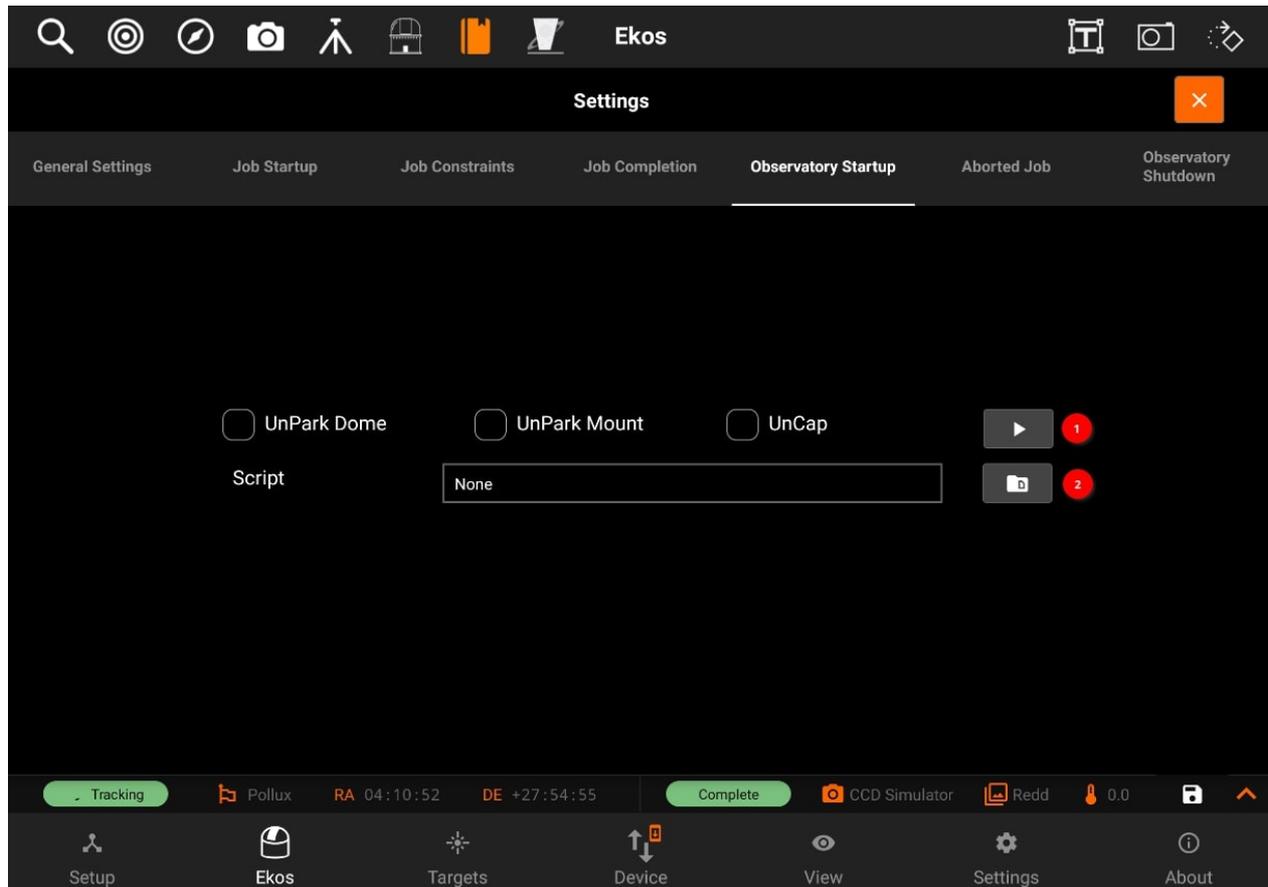
1.
   - **UnPark dome:** Park dome to home position
   - **UnPark Mount:** Park telescope to home position.
   - **Uncap:** Open dust cover.

2. **Script:** One time startup procedure to be executed before starting Ekos. The script is executed before the startup procedures (i.e Unpark scope), if Selected, are executed.
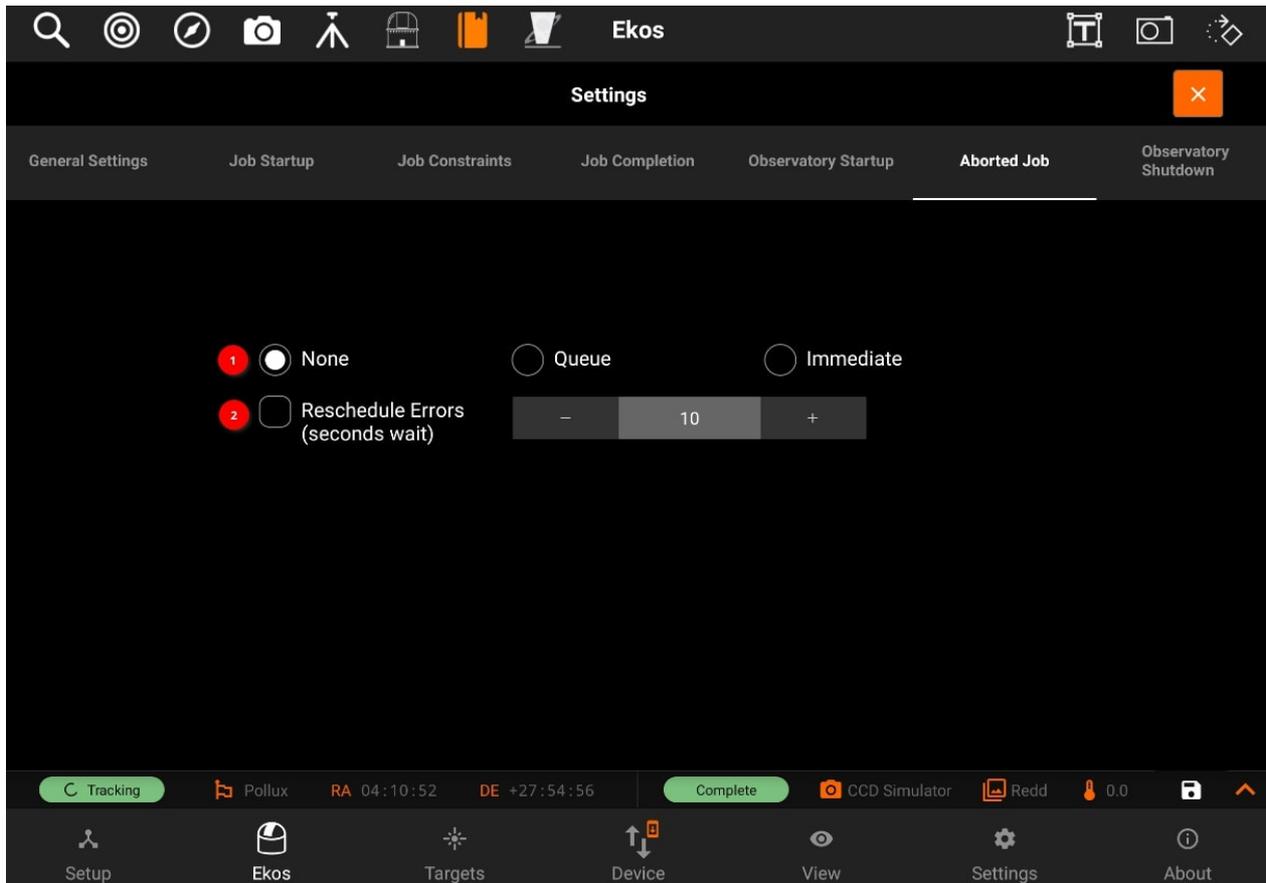
o **Aborted Job:**

1.
- **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.

2. **Reschedule errors:** Treat errors like aborts. (Delay in seconds).

o **Observatory shutdown Procedure:**

▪ For more complex observatory environments, there are usually predefined custom procedures to be executed to prepare the observatory for imaging, and another set of procedures on shutdown. The user may plan to image one or more targets during the night, and expects data to be ready by morning.
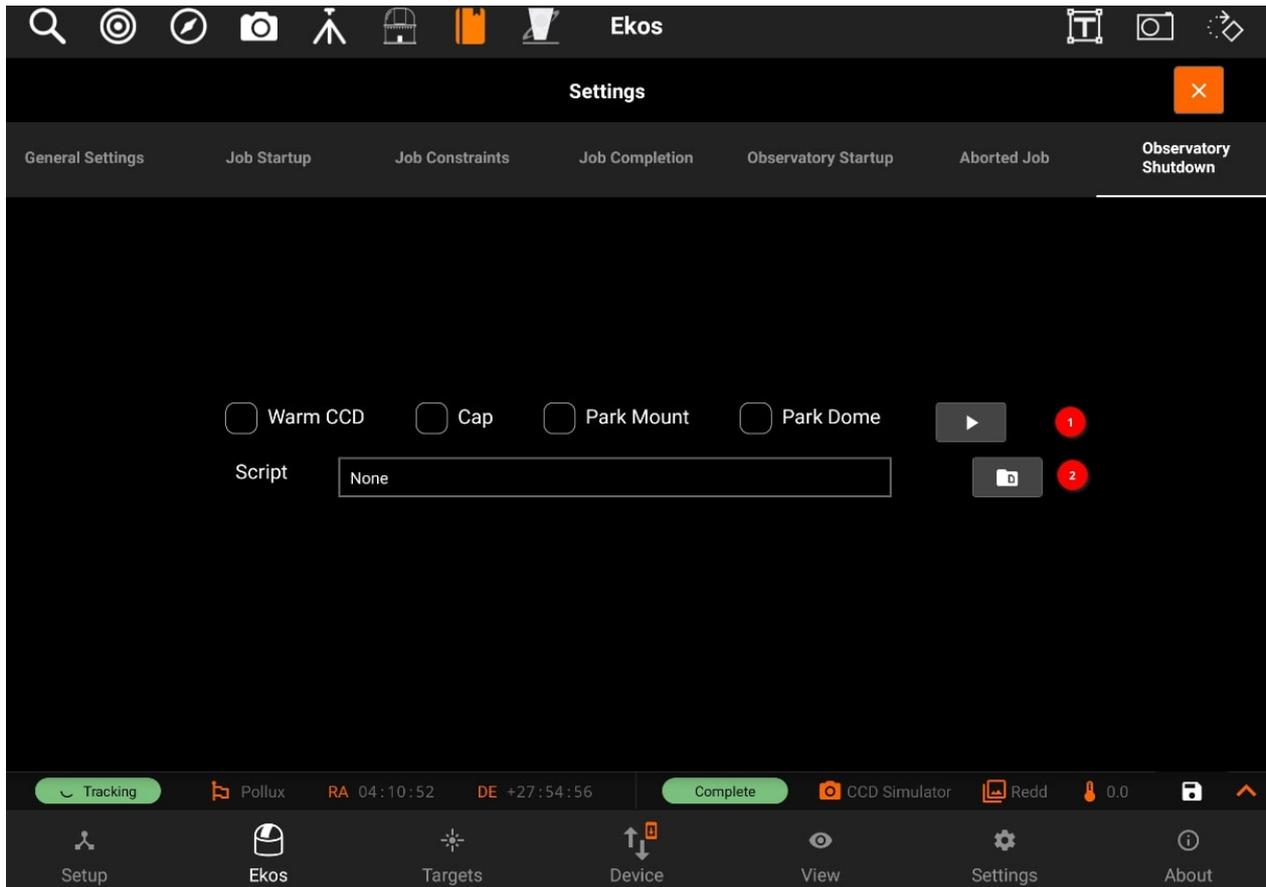
1.

- **Warm CC:** Turn off CCD cooler.

- **Cap:** Close dust cover.

- **Park Mount:** Park telescope to home position.

- **Park Dome:** Park dome to home position.

2. **Script:** One-time shutdown procedure to be executed after all Scheduler jobs are completed. The script is executed after the shutdown procedure (i.e Parking), If selected, are completed.

You can also swap the jobs priority by moving the Jobs to Up/Down
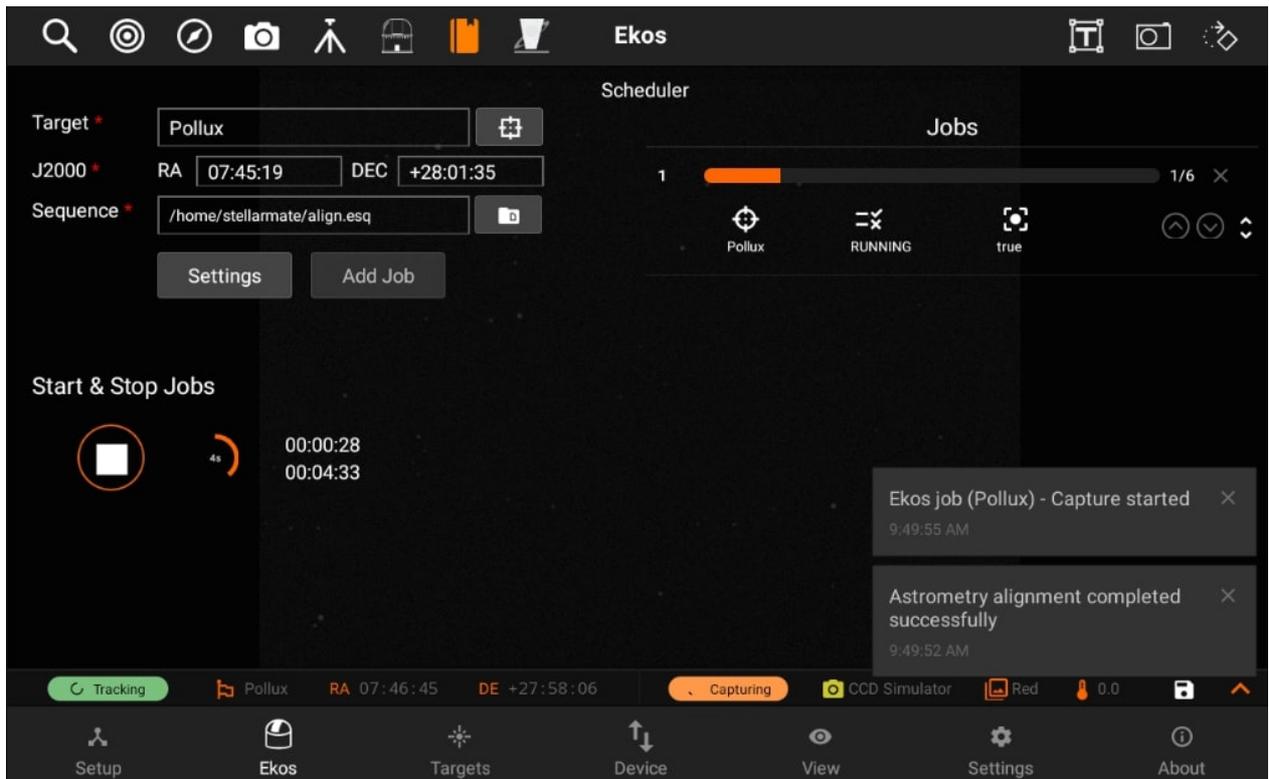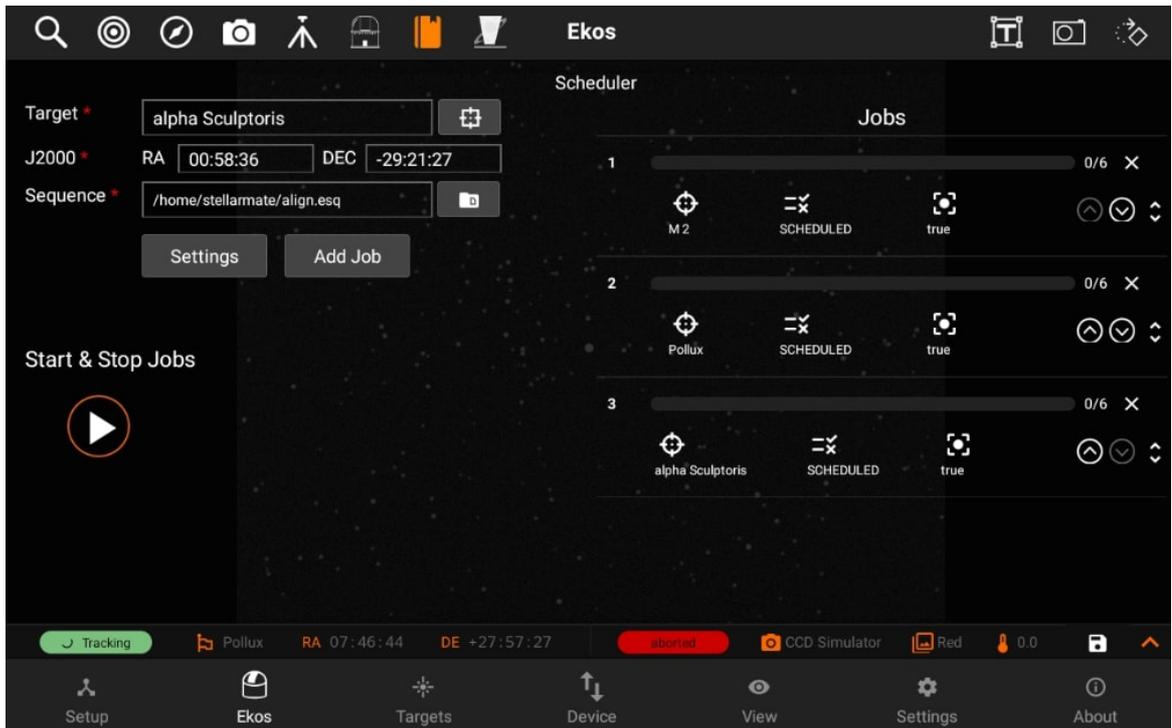
You must select the **Target** and **Sequence** before you can add a job to the Scheduler. When the scheduler starts, it evaluates all jobs in accord to the conditions and constraints specified and attempts to select the best job to execute. Selection of the job depends on a simple heuristic algorithm that scores each job given the conditions and constraints, each

of which is weighted accordingly.

Standalone Sequences
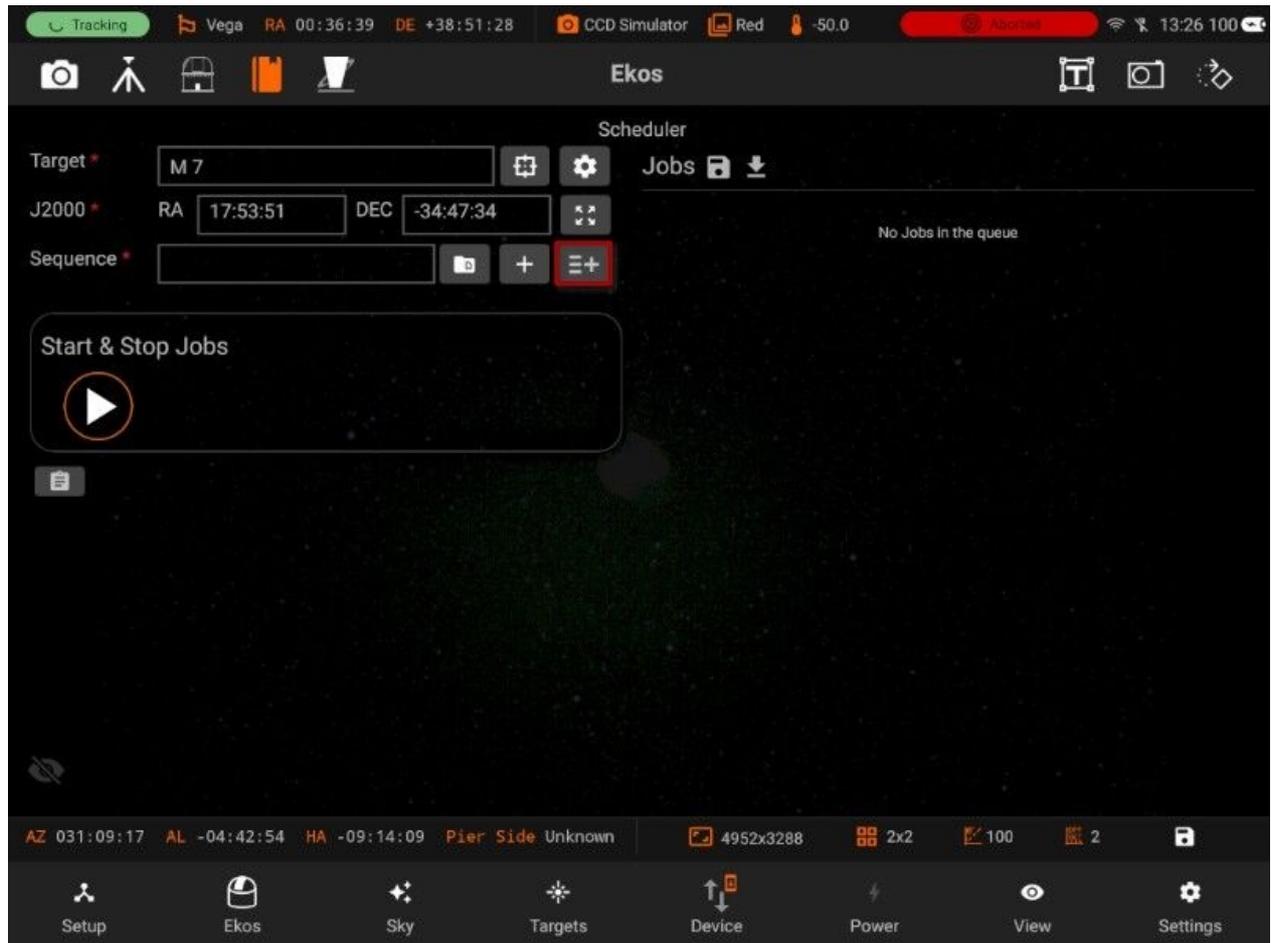
At minimum, a scheduler job requires a target and a sequence file. The sequence files contain the sequence jobs that need to be carried out in the capture module (e.g. capture 60x15 LRGB images). You can create and save sequence files in the capture module. They are saved to Documents/sequence folder so they can be reused in the future.
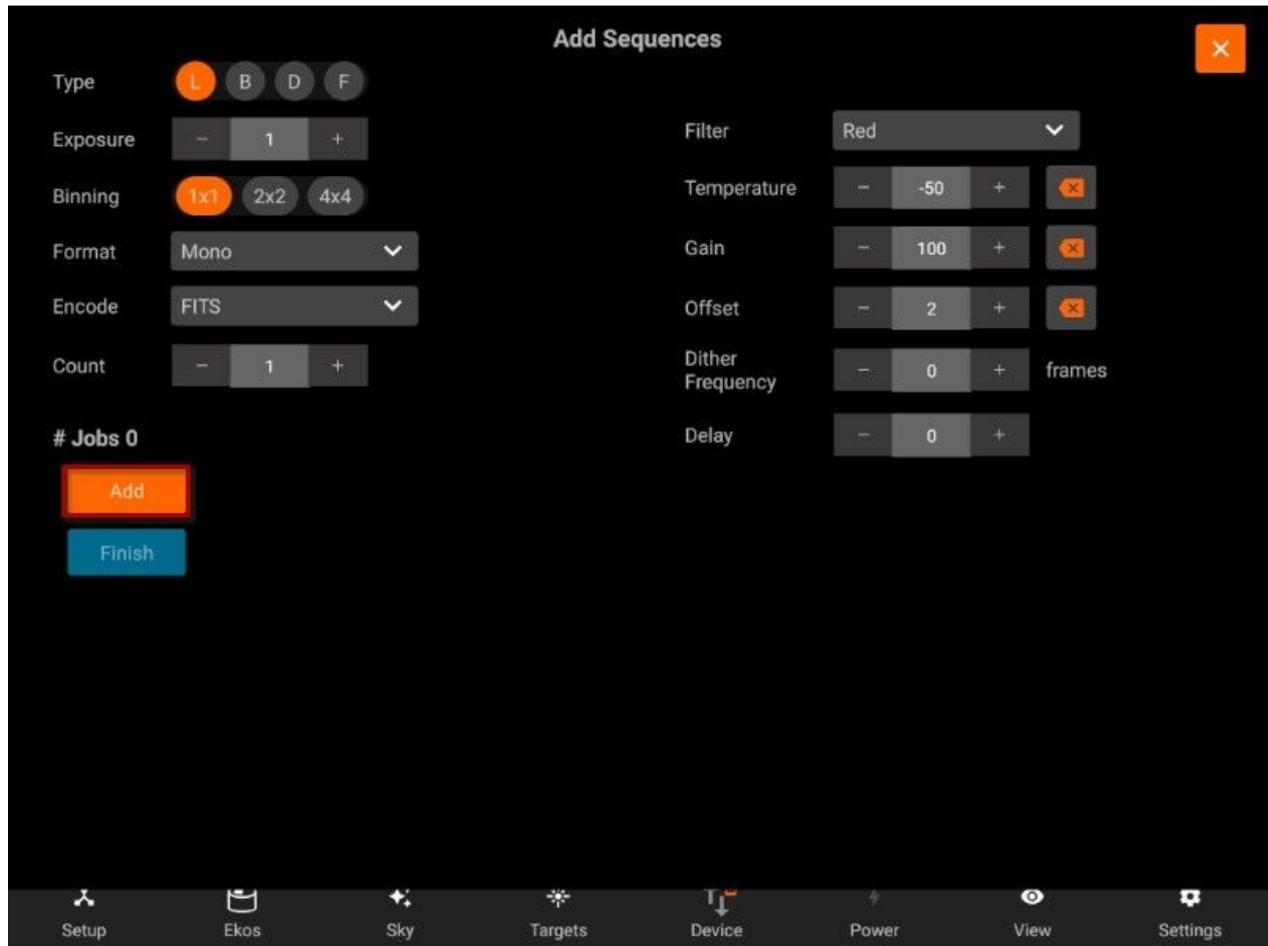
Alternatively, you can generate sequences on the spot with the Standalone Sequence editor. If Ekos is online, the editor will be based on the values of your current setup (e.g. filter list). On the other hand, if Ekos is not started yet, it will rely on settings from your previous session. You can add as many jobs as desired. When done, a sequence file is generated and automatically saved to the sequences folder.
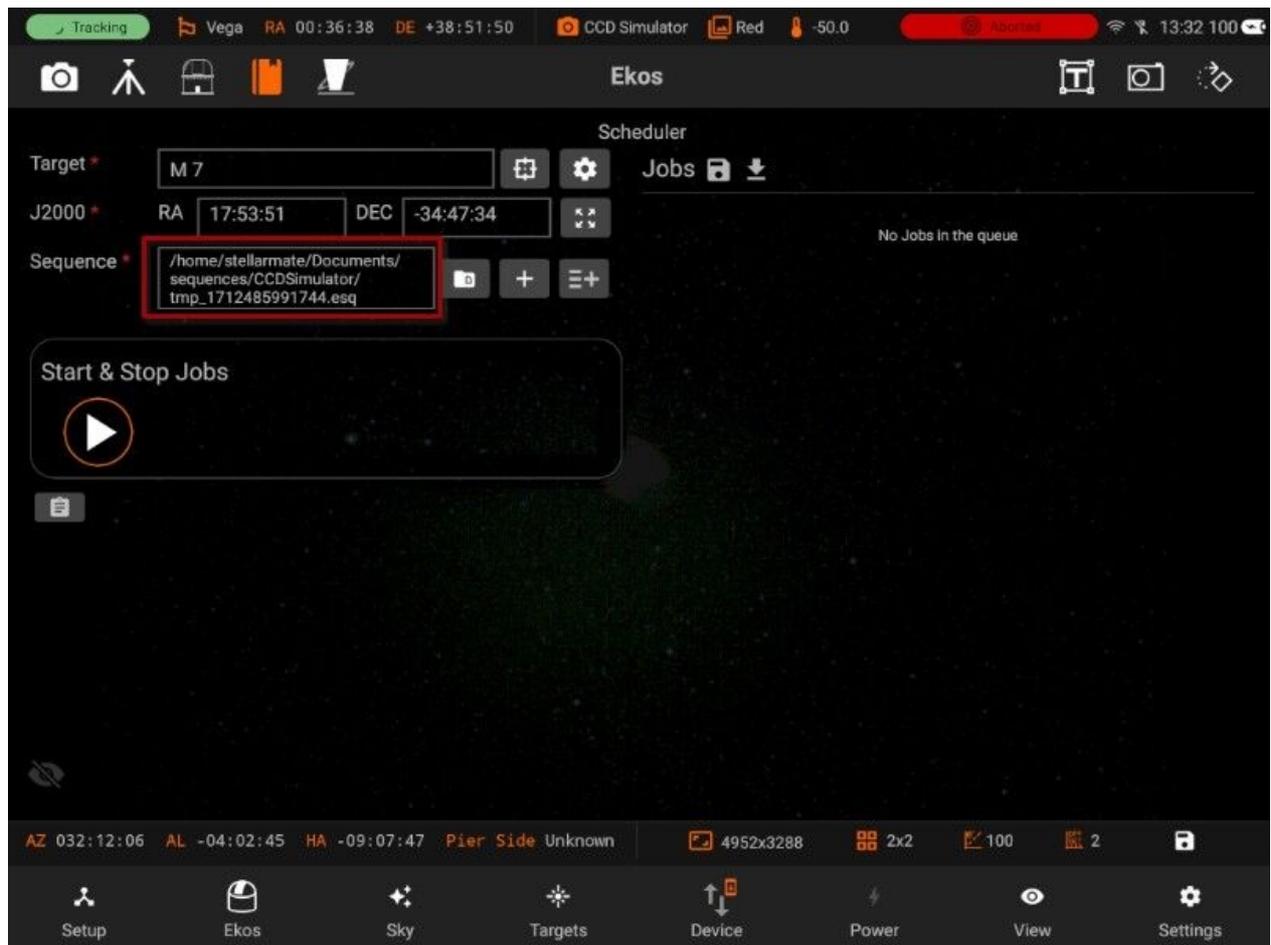
Mosaic Planner

Mosaic planner:

Mosaics can be imported from Telescopius online tool.
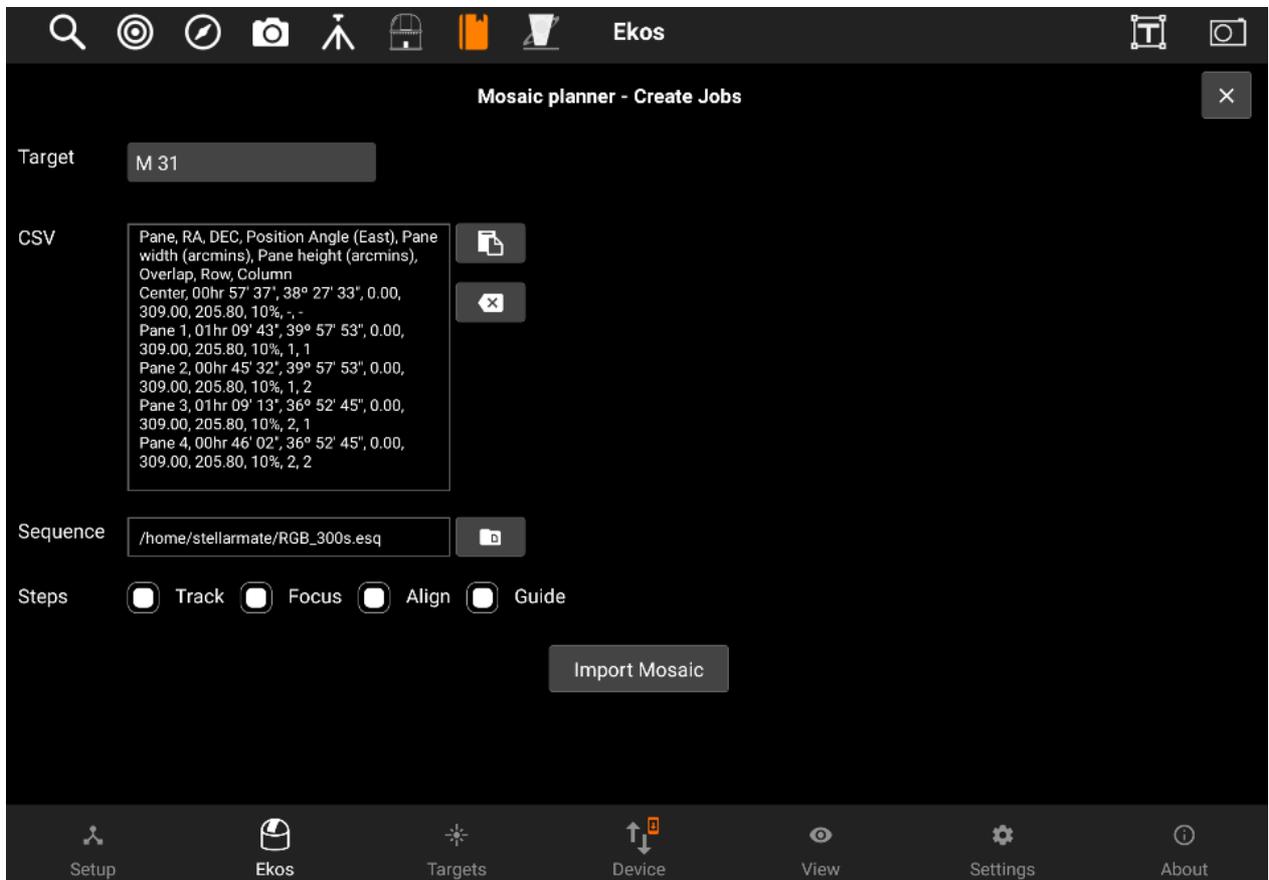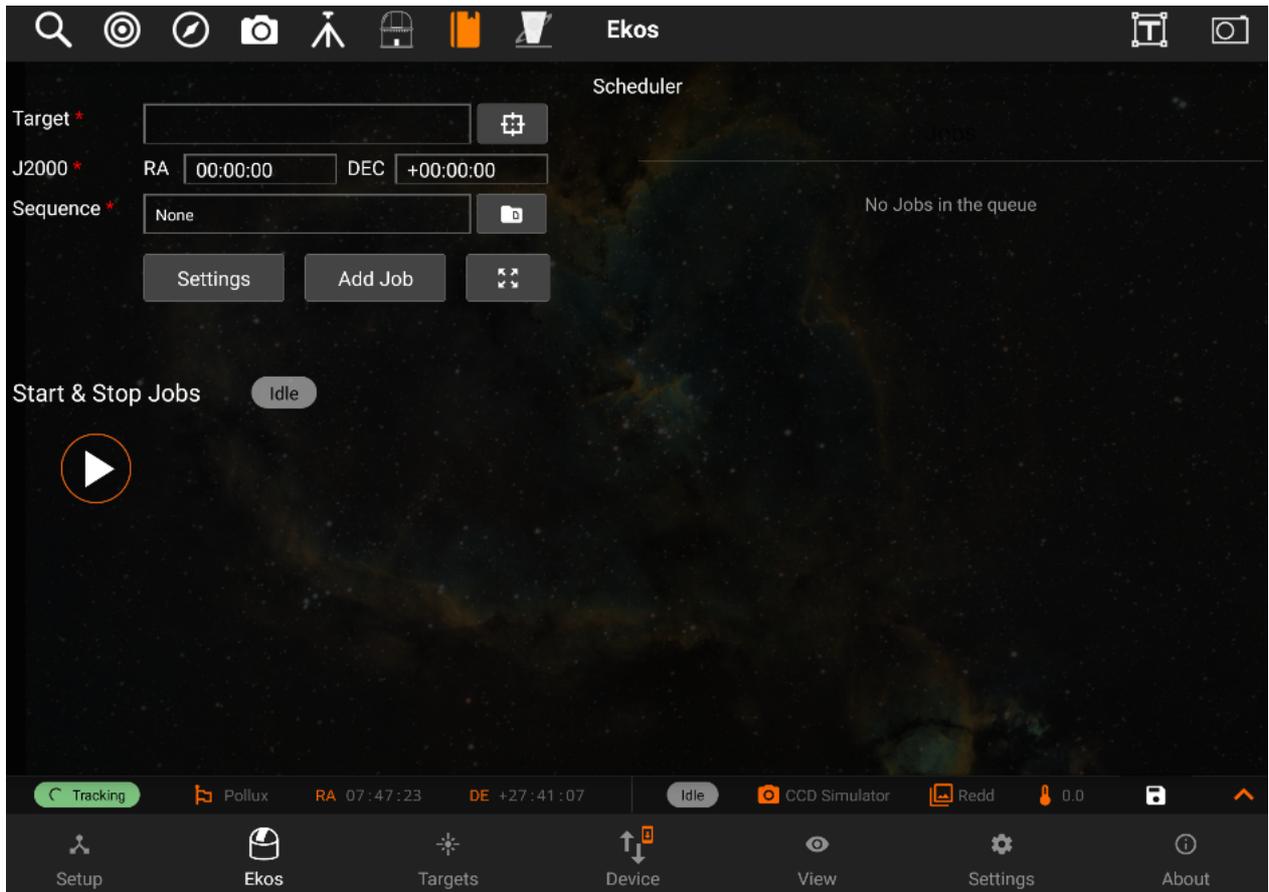
1. **Target:** Name of the target.

2. **CSV:** You can copy coordinates from https://telescopius.com/ and paste it here. Makue 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.
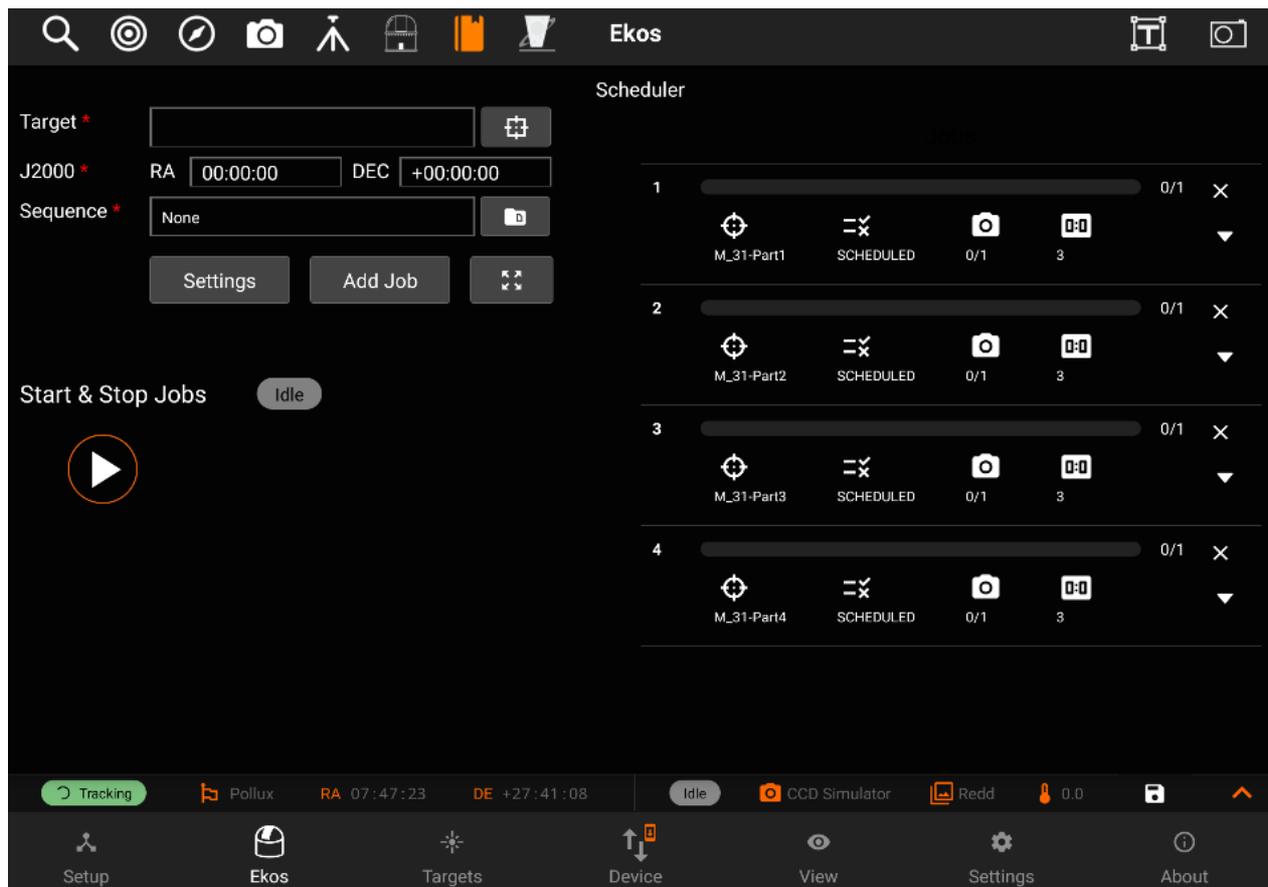
Data acuisition

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 the 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.

Canvas
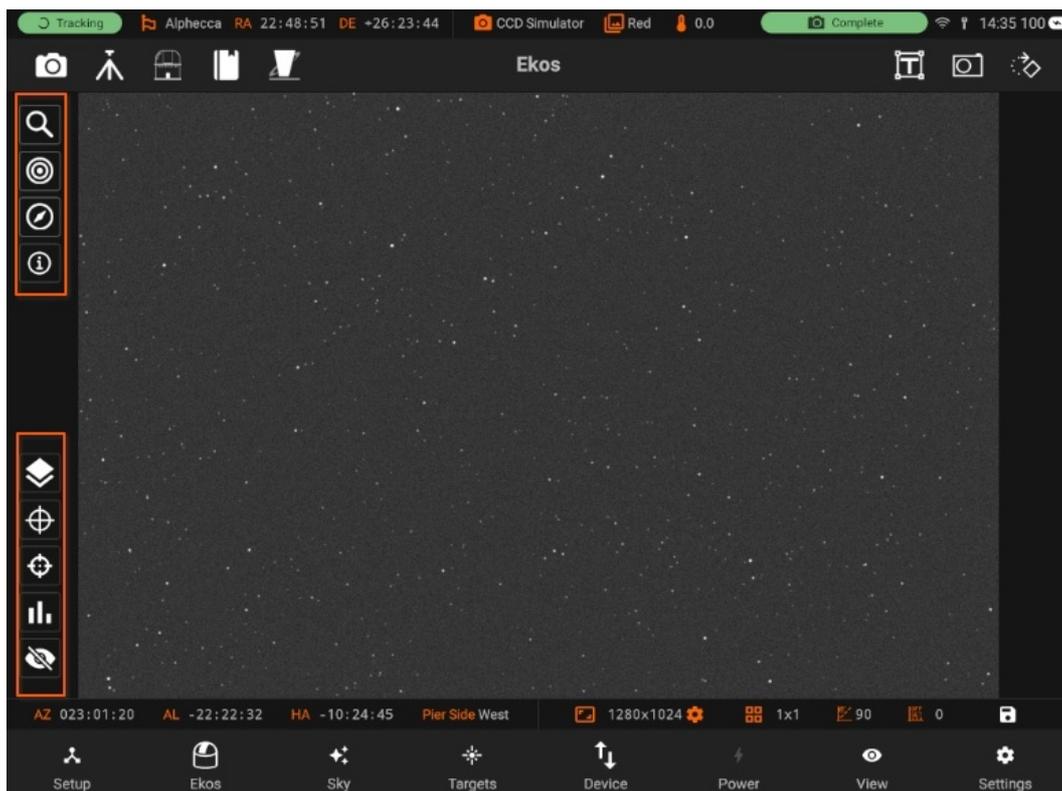
Canvas buttons also includes:

- [Focus](#)
- [Align](#)
- [Guide](#)

- Summary View

These button are on the Upper Side.

Lower Canvas buttons include:

- Histogram

- HiPs Overlay

- Crosshair

- Target GOTO

- Hide/Unhide the Lower Canvas:
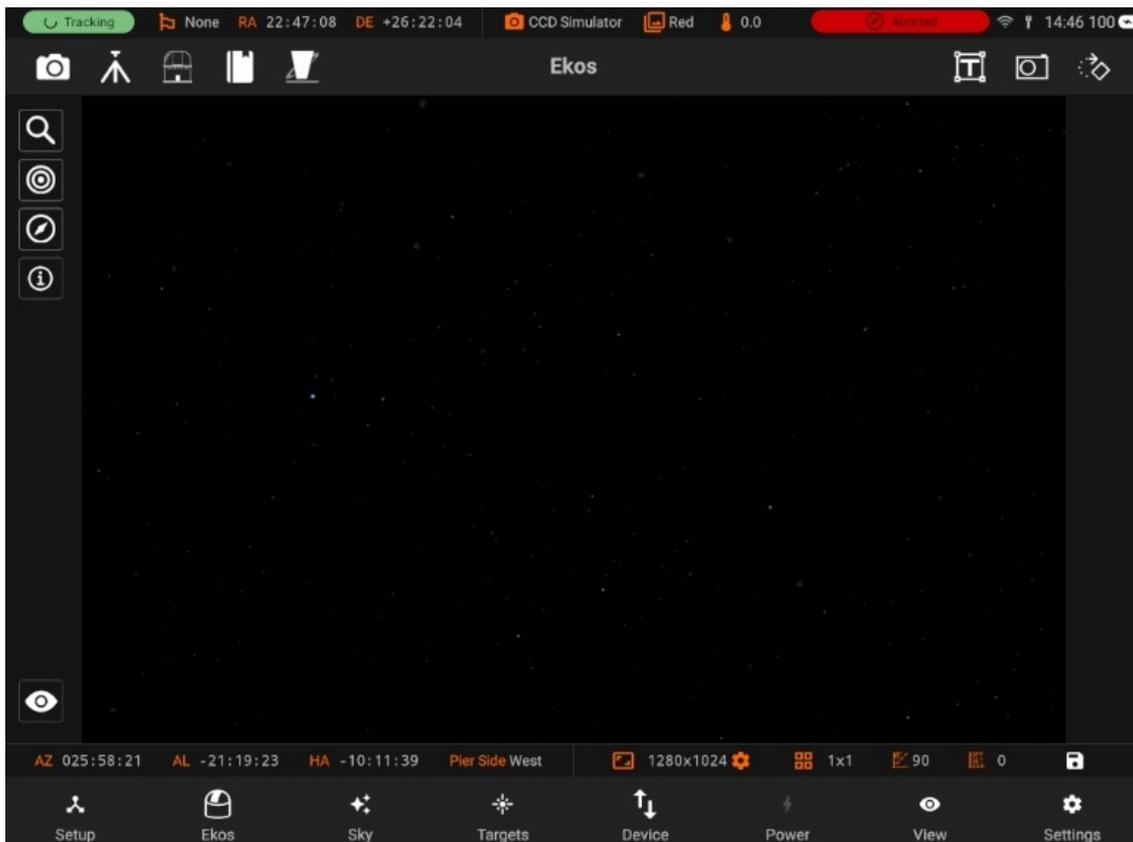
You can center the mount to a specific target in the main image if plate-solving was successful. From Ekos Align module, Capture and Solve an image. If successful, an orange align icon is displayed in the Main Image View indicating that solving is successful. For any subsequent images captured and displayed 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.

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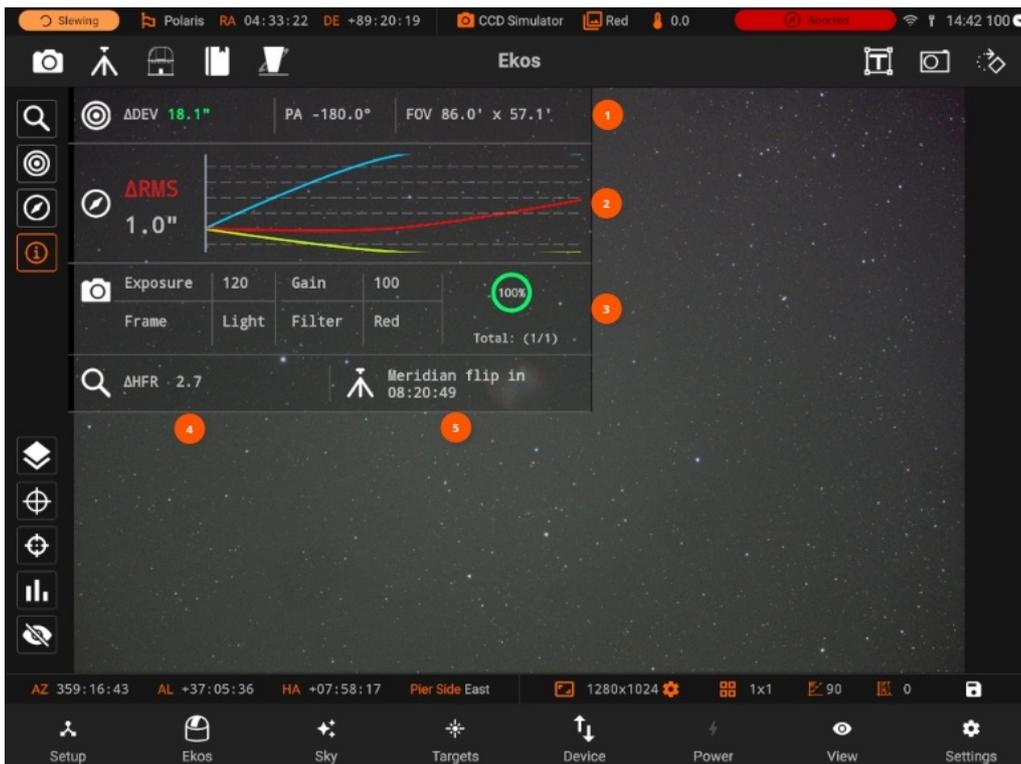
The summary view includes the gist of your astrophotography workflow so you can always take a quick look at the most important parameters without navigating to other screens. Depending on which Ekos modules are active, the information may include the following:

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.

HiPs Overlay

Toggle Overlay to increase the Hips opacity.

It is only available when WCS is enabled, image is plate-solved and once your Camera FOV is 60 arcminutes or more.
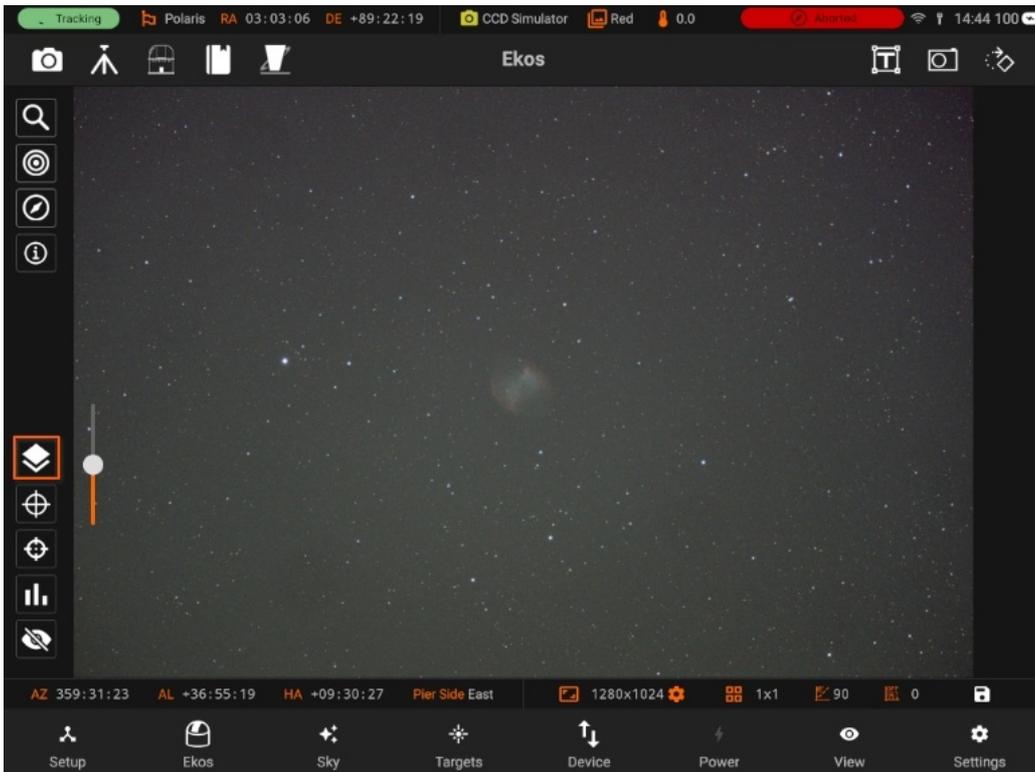
Once preview is captured, you can toggle it and increase/decrease the HiPs opacity.
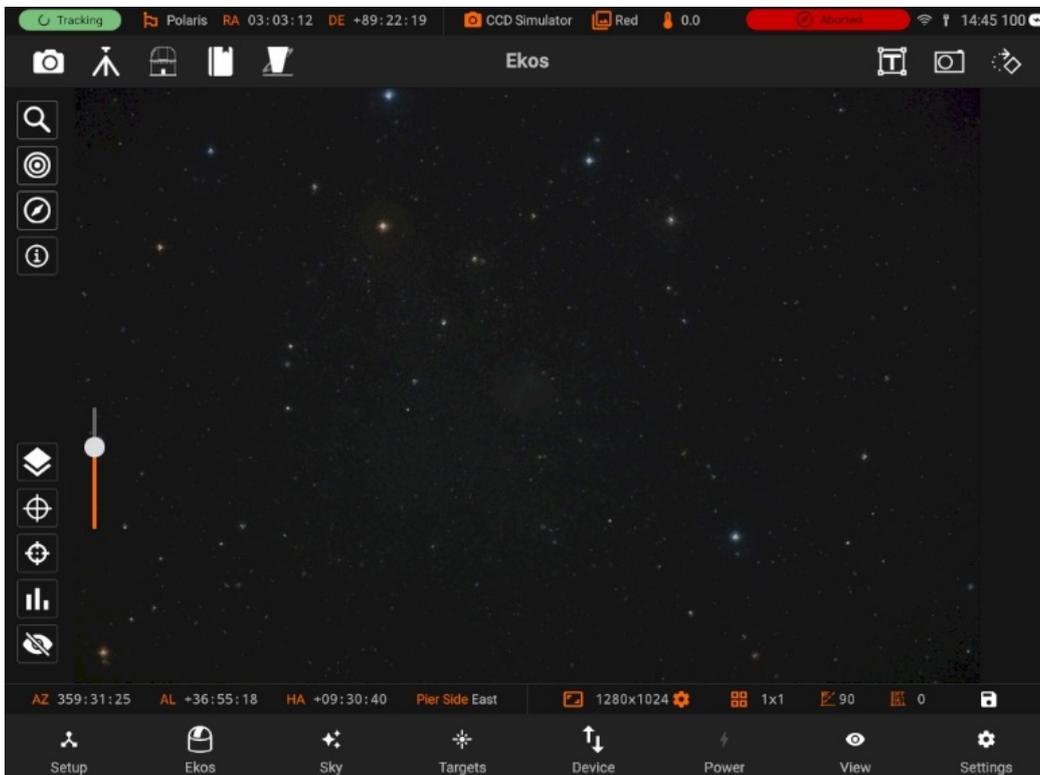
- Histogram

   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.
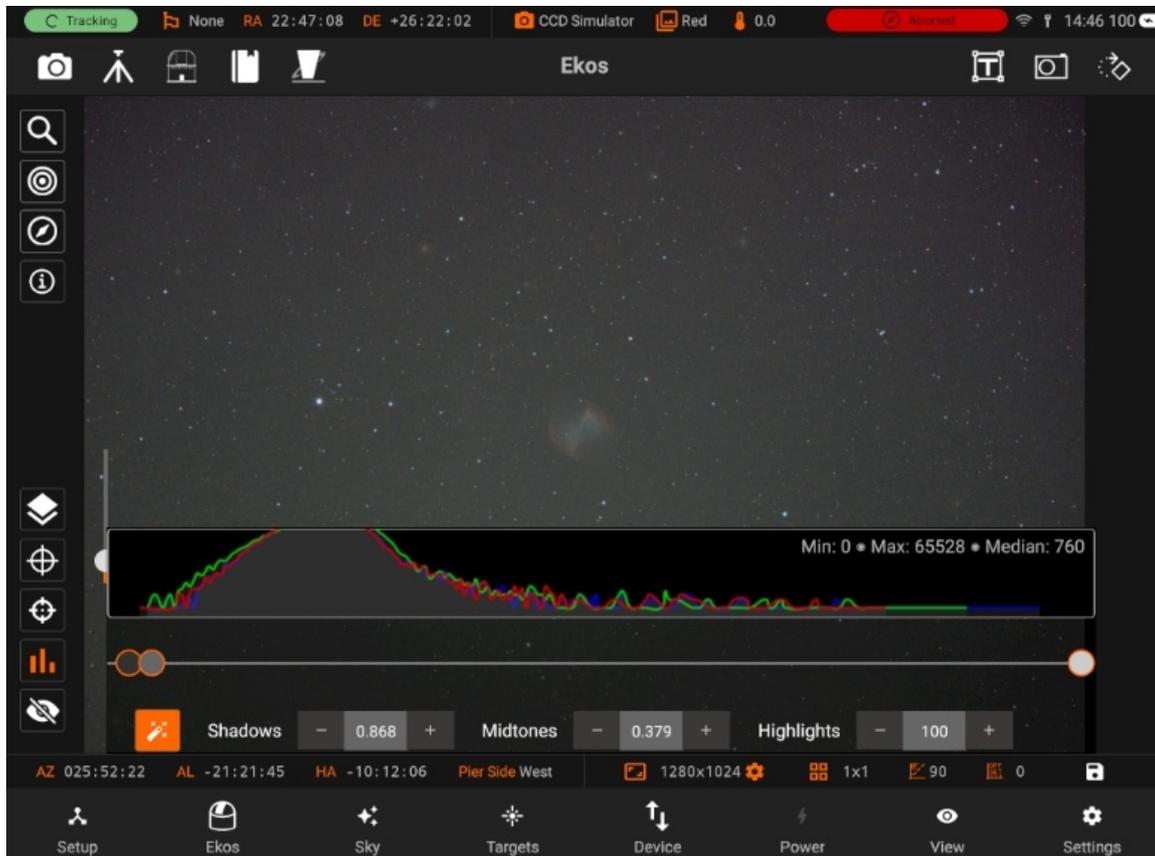
The sliders in the middle control the shadow, midtone and clipping parameters.

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.

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.
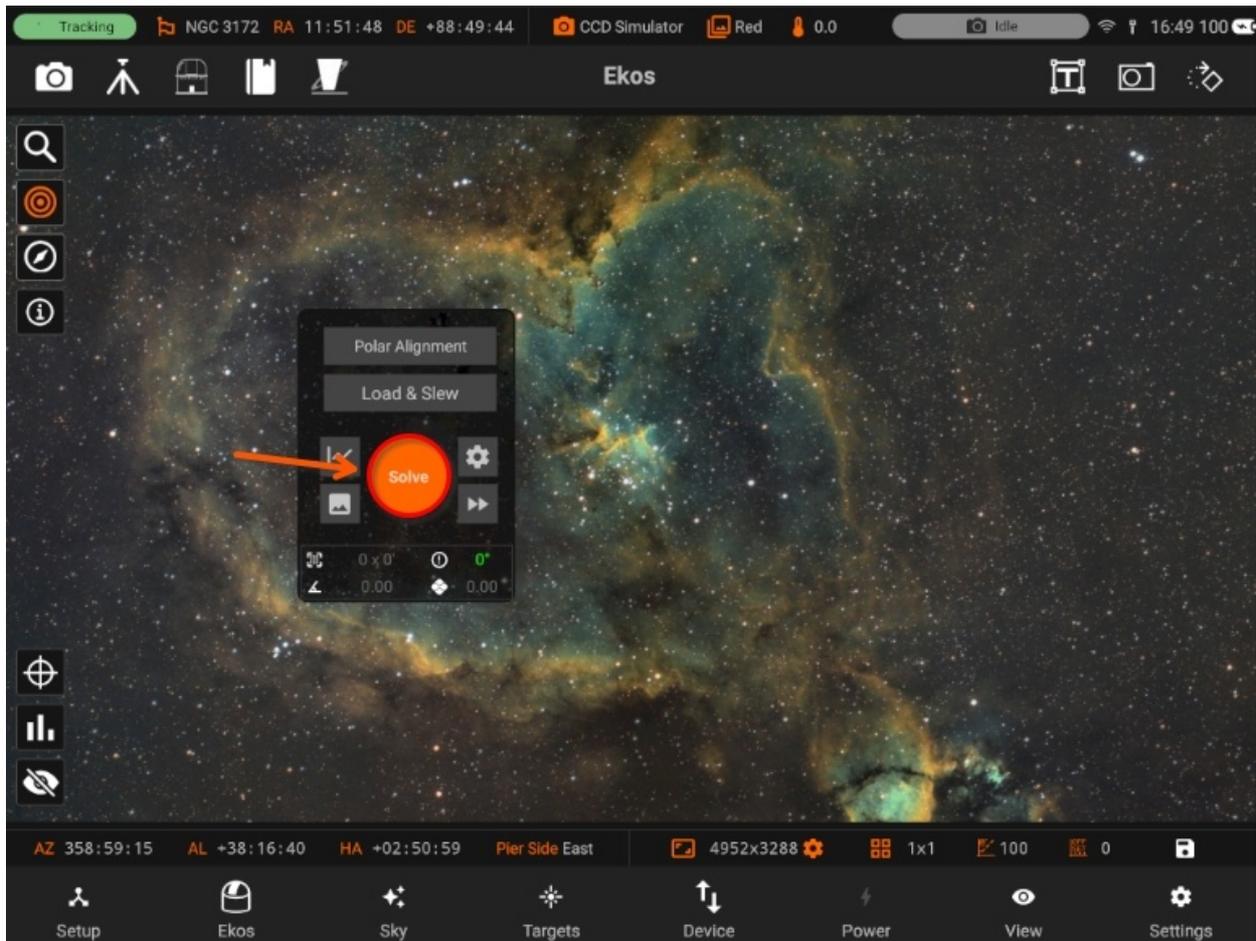
Tap and hold the target for approximately one second to command the mount to slew. If successful, the indicator icon changes to yellow and once motion is complete, it switches to green. Capture a preview to verify the mount indeed centered the target as desired. Repeat if necessary. Hold on your desired target, mount will star moving to that specifc target. Yellow animation will be appeared while it in in process. Can also be seen in the below images.
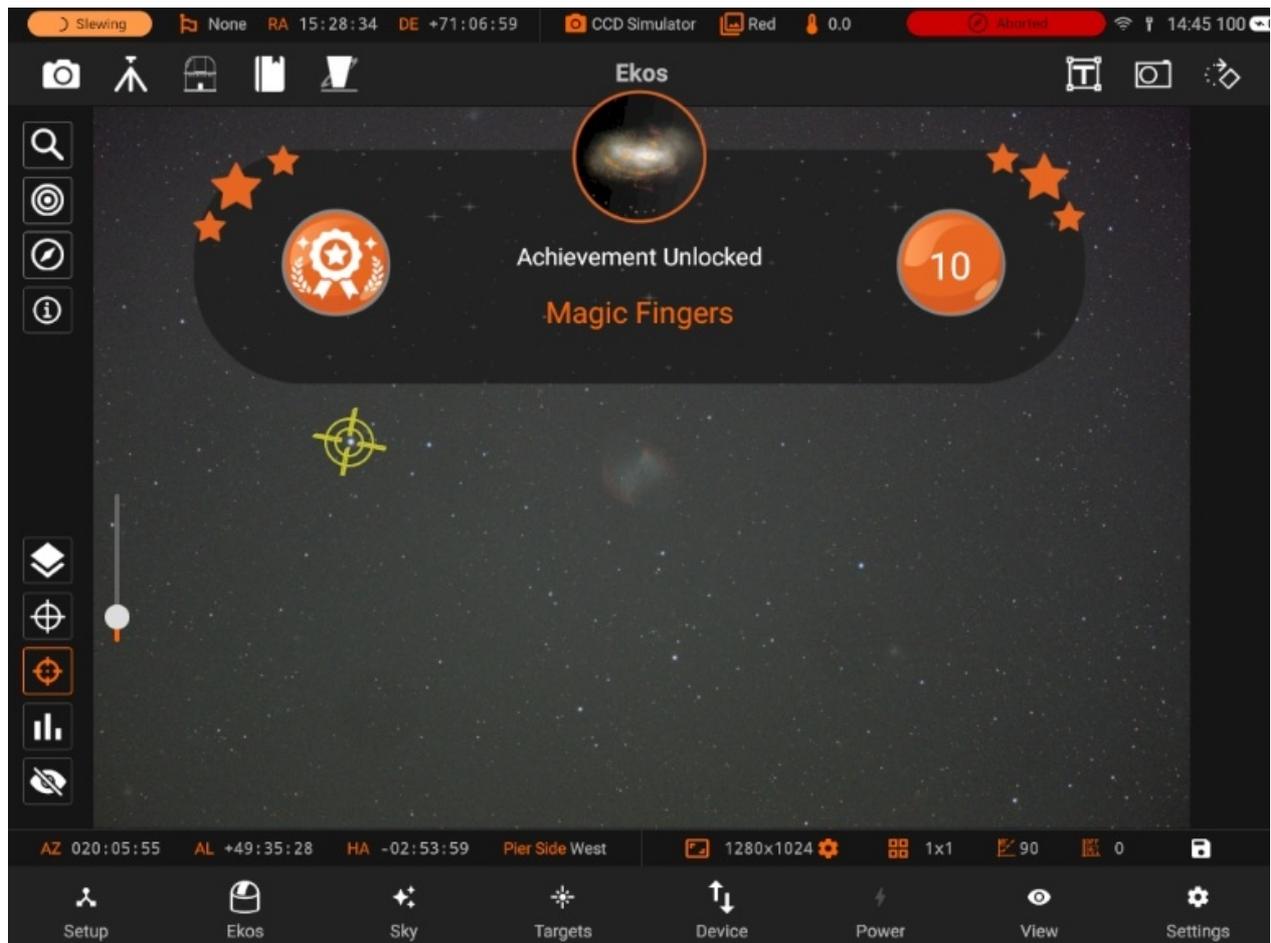
On success, the animation will turn to green.
On capture new image, the target lock animation will be reset to default.
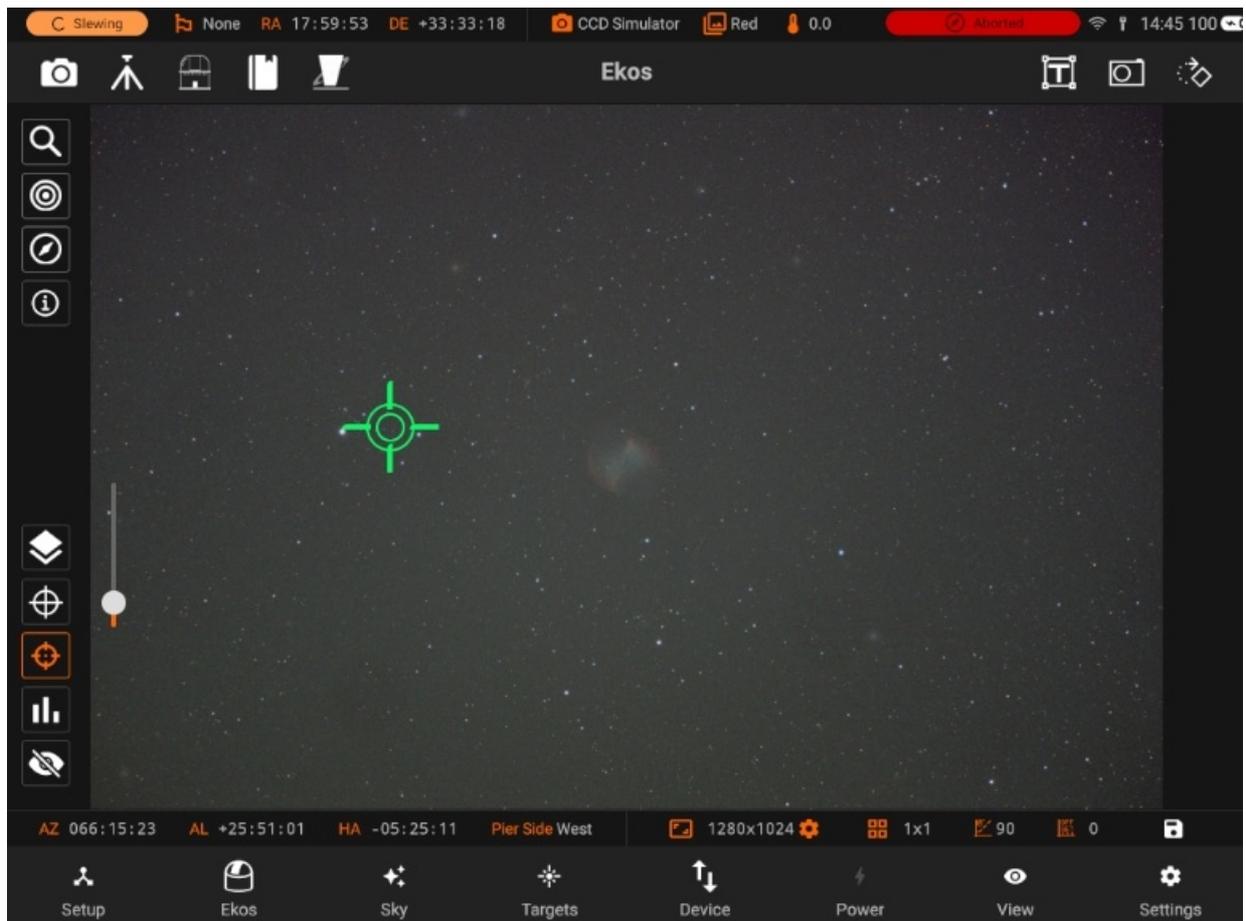
Crosshair

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.
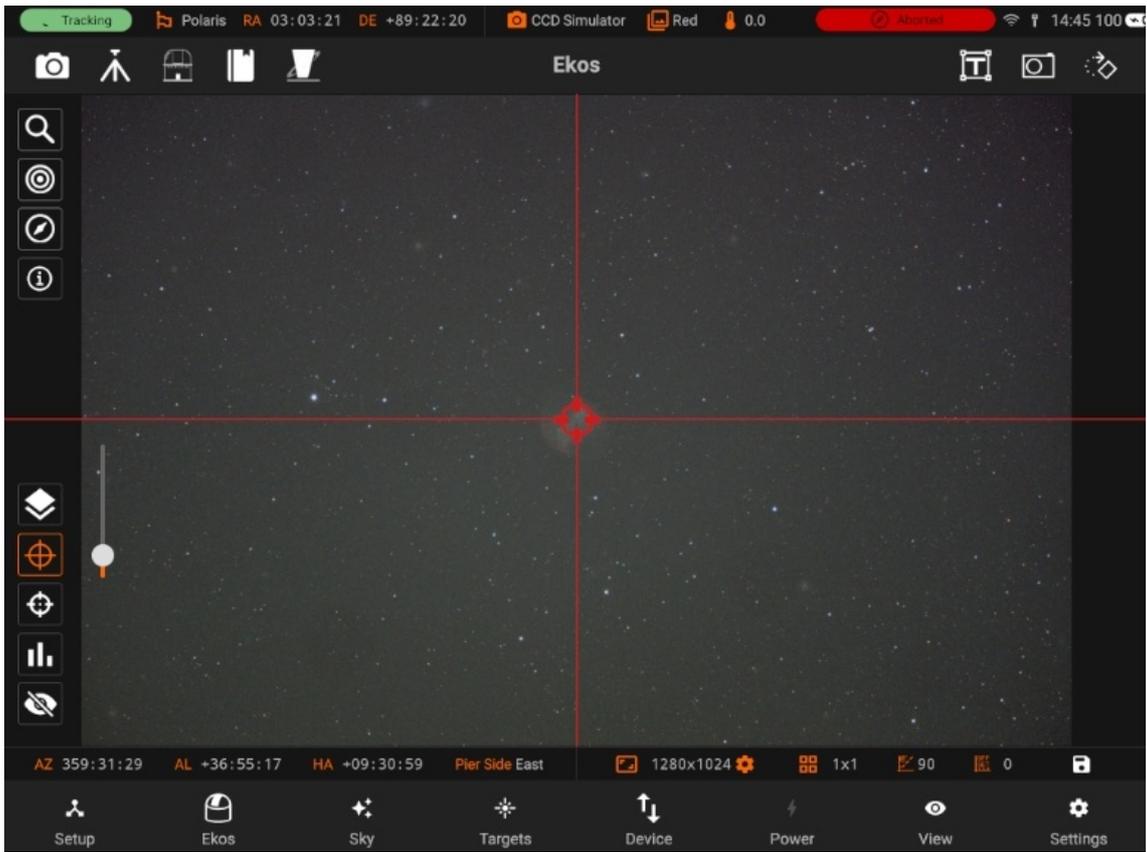
Status bar

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

- Top

- [Bottom](#)

Top

1. Mount:

    1. Shows the status of the mount if it is parking/unparking, slewing, tracking.

    2. Displays the current target object name

    3. Right Ascension,

    4. Declination

2. Camera:

    1. Shows the current status of the camera:

        1. Capturing: When the camera is busy capturing images.

        2. Complete: Sequence or Image is captured successfully.

        3. Idle: Not capturing any images.

    2. Displays the name of the camera.

    3. Active filter name.

    4. Current temperature of the camera

    5. Status: Overall status of an active operation in all modules except Mount since

        mount has its own status badge.

        1. Tap the status badge to open Notifications History which is a
           chronological list of the most recent notifications.
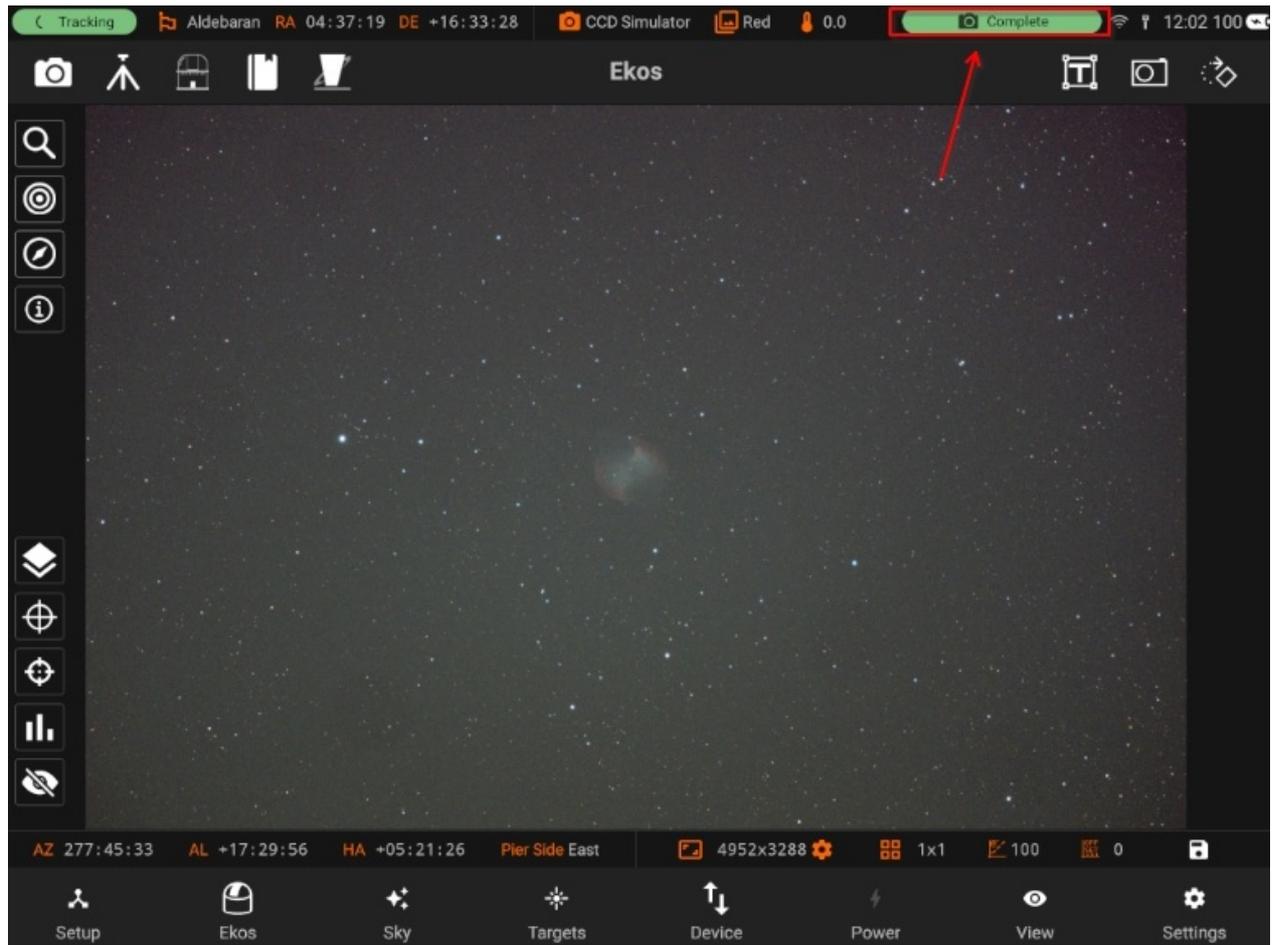
2. Clear all notifications
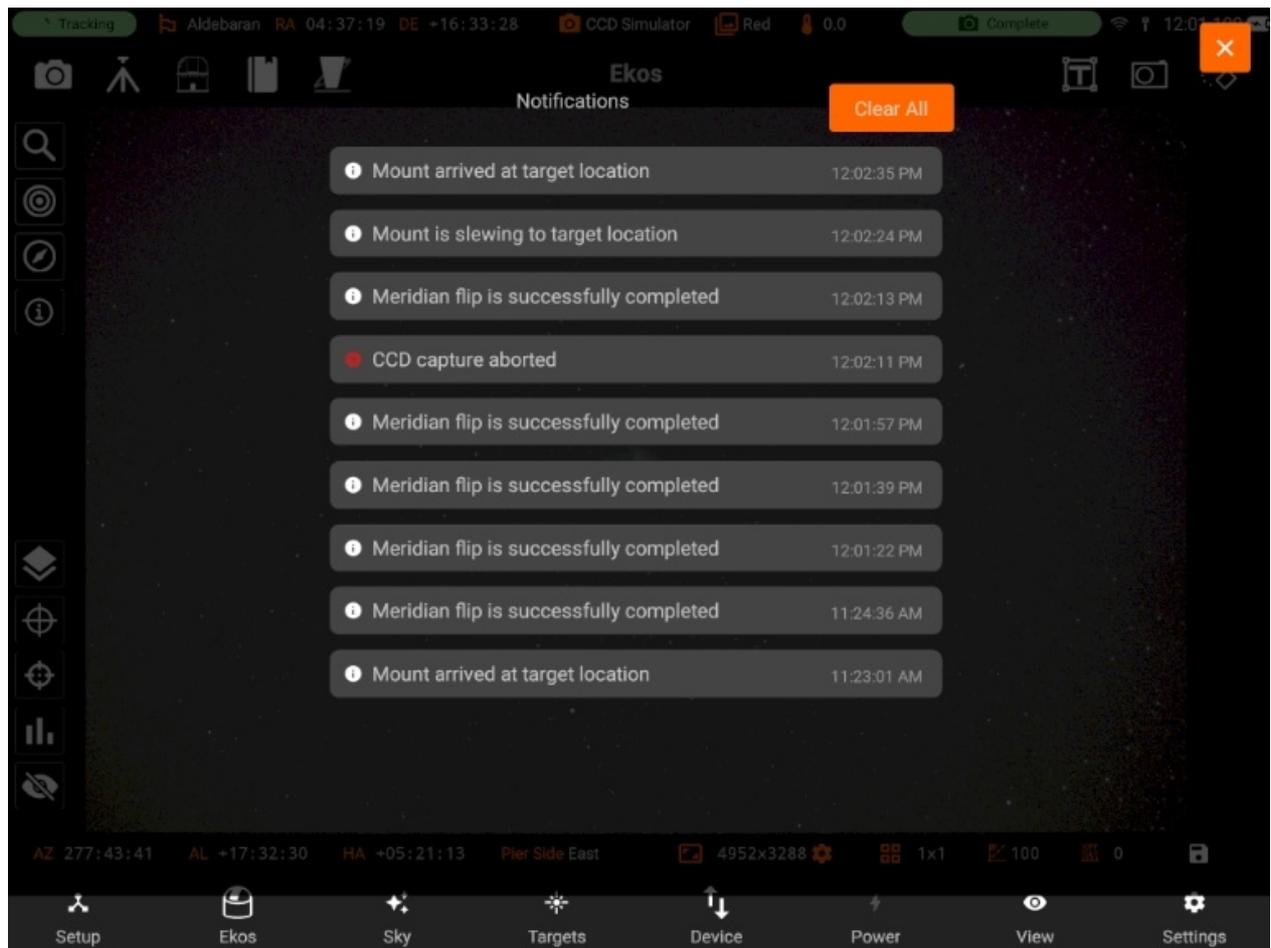
3. **Battery level and connection**
   1. If the WiFi, Ethernet is connected it is shown in the status bar correctly
   2. Displays the current battery level of mobile/tablet.

Bottom

4 – More Mount information:

- Correct AZ, AL, HA values
- Pier Side

5 – More Camera Information

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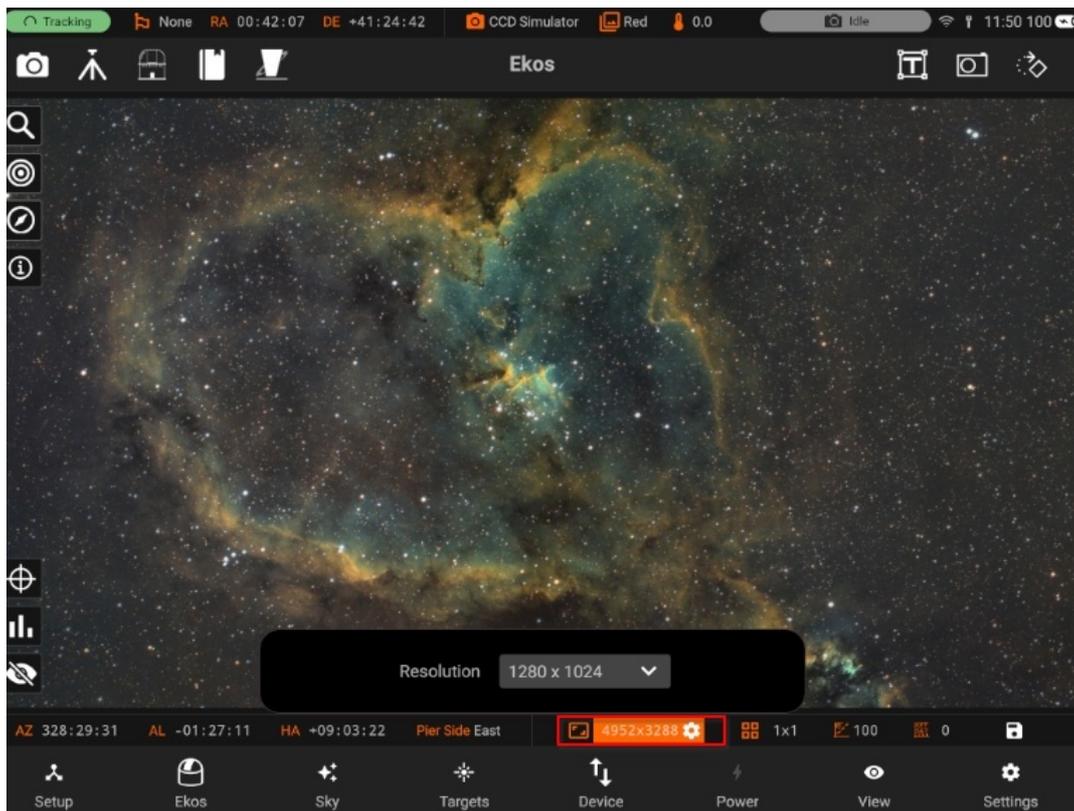
- Binning

- Gain

- Offset

- Save main image

Data Storage

Formats
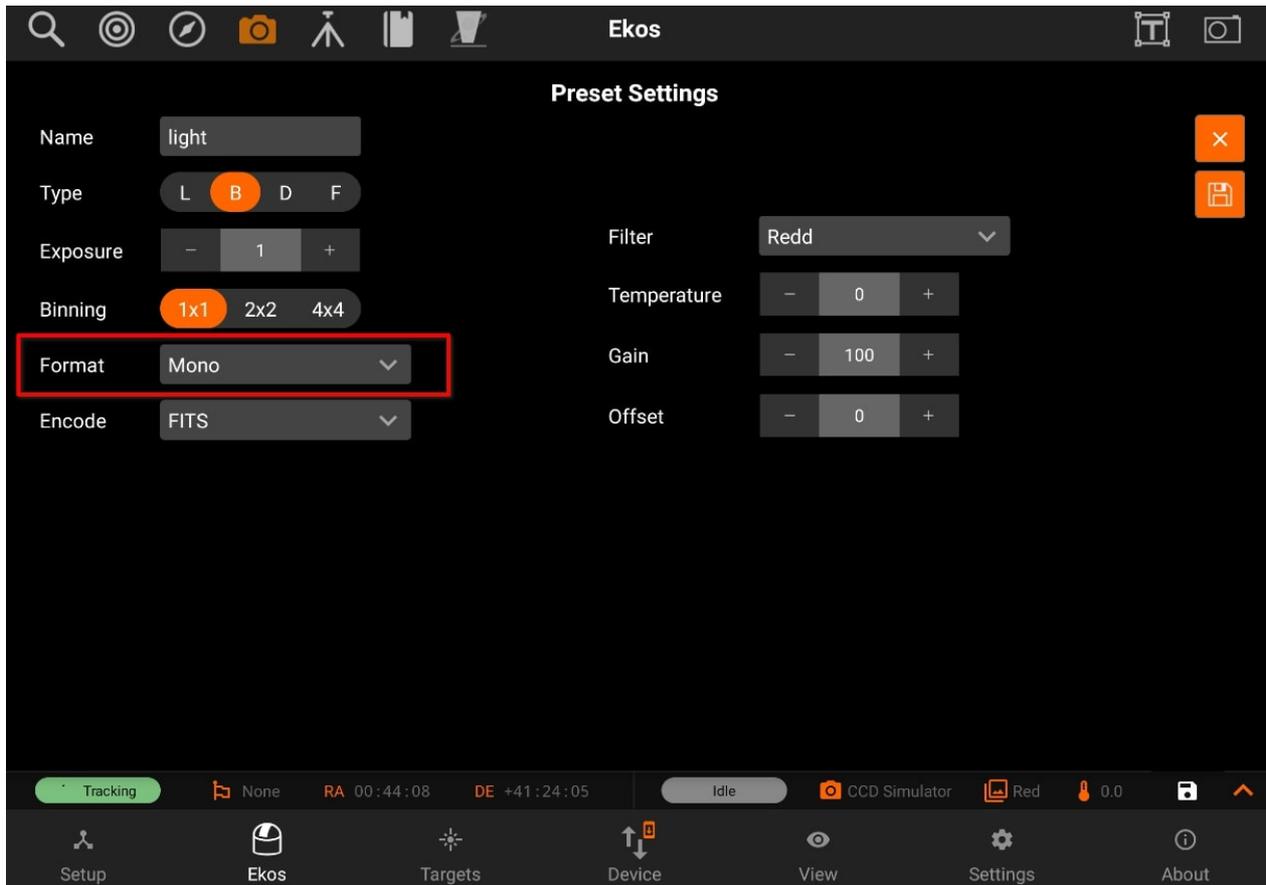
By default, all captured images are saved as FITS (Flexible Image Transport System) files. FITS is the standard image format for astronomical images and is supported by all astronomical image processing software. For DSLR cameras, saving RAW images directly (e.g. CR2) is also supported by editing the 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:
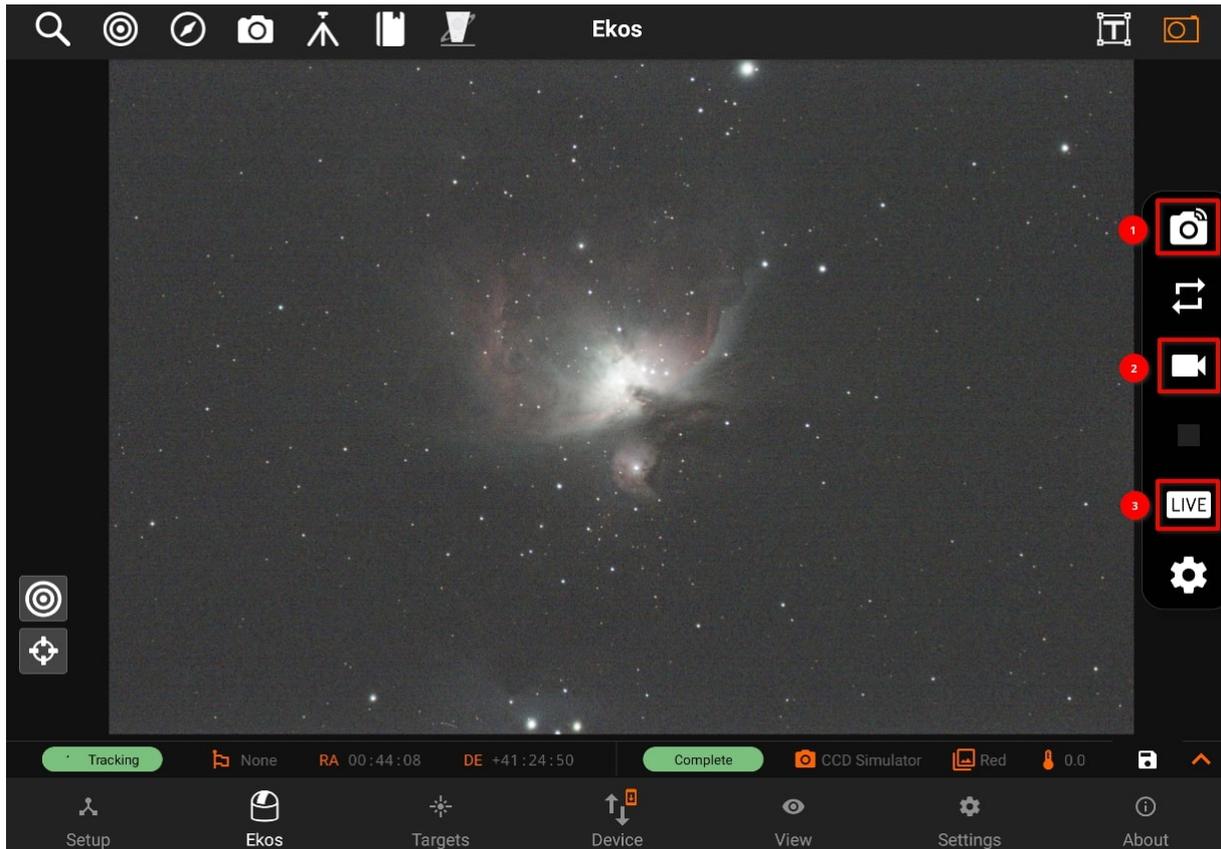
1. **Previews**

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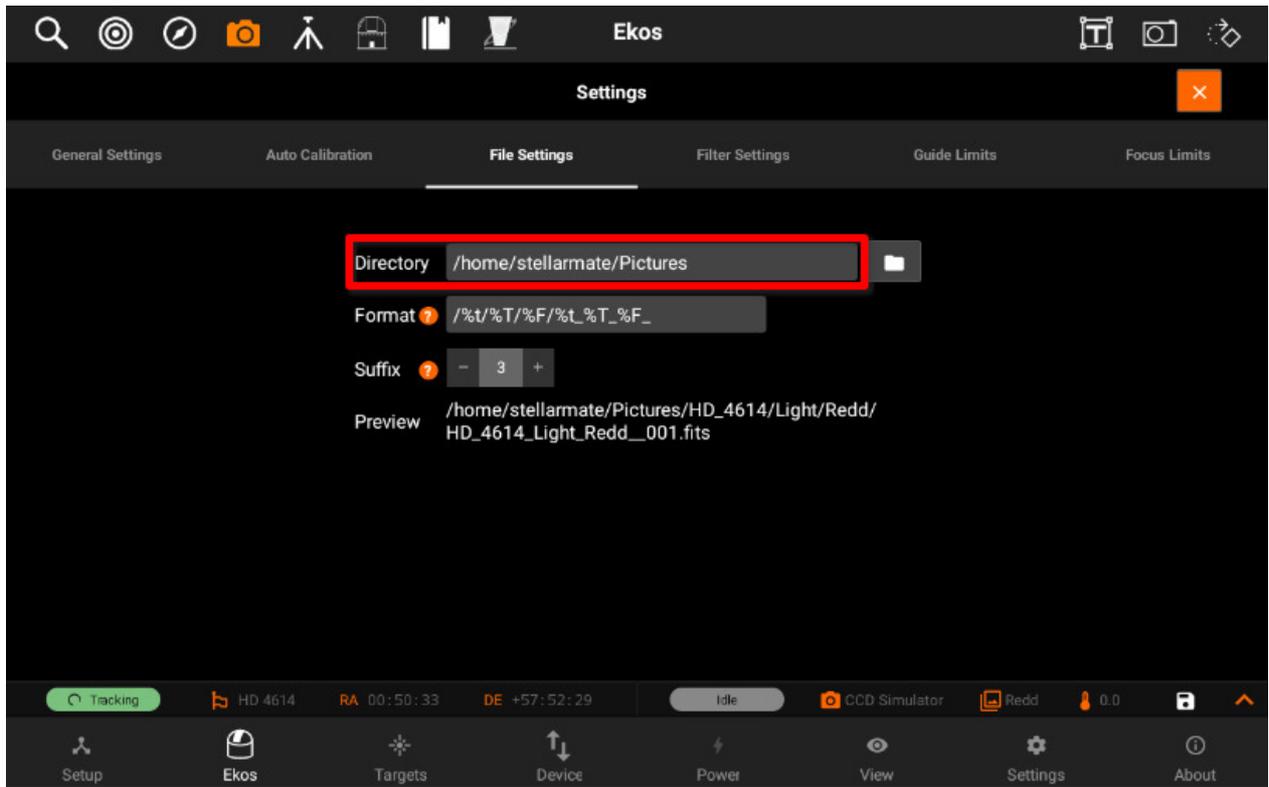
- All sequence images are saved along with their metadata and can be viewed in the View tab.

3. **Live Stacking**
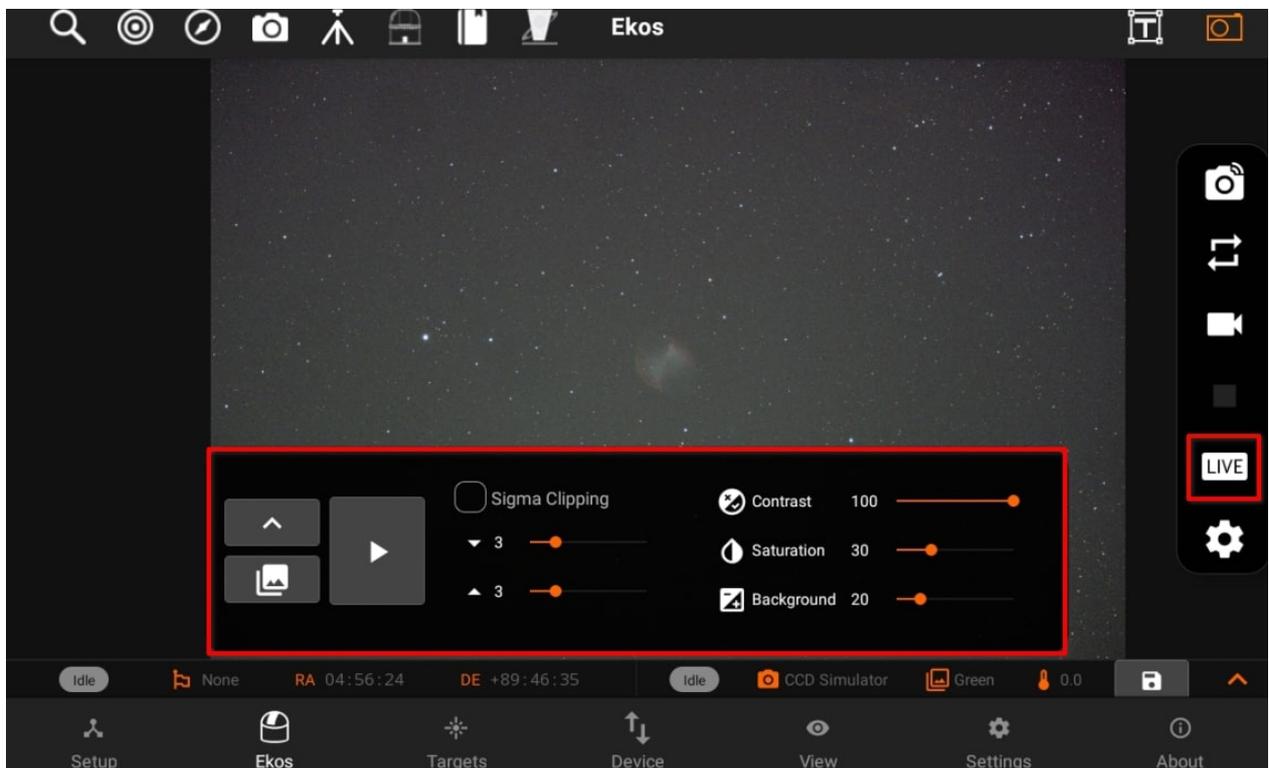
- Live Stacked images are automatically saved to /home/stellarmate/Pictures/livestacking and are also available in the View tab.

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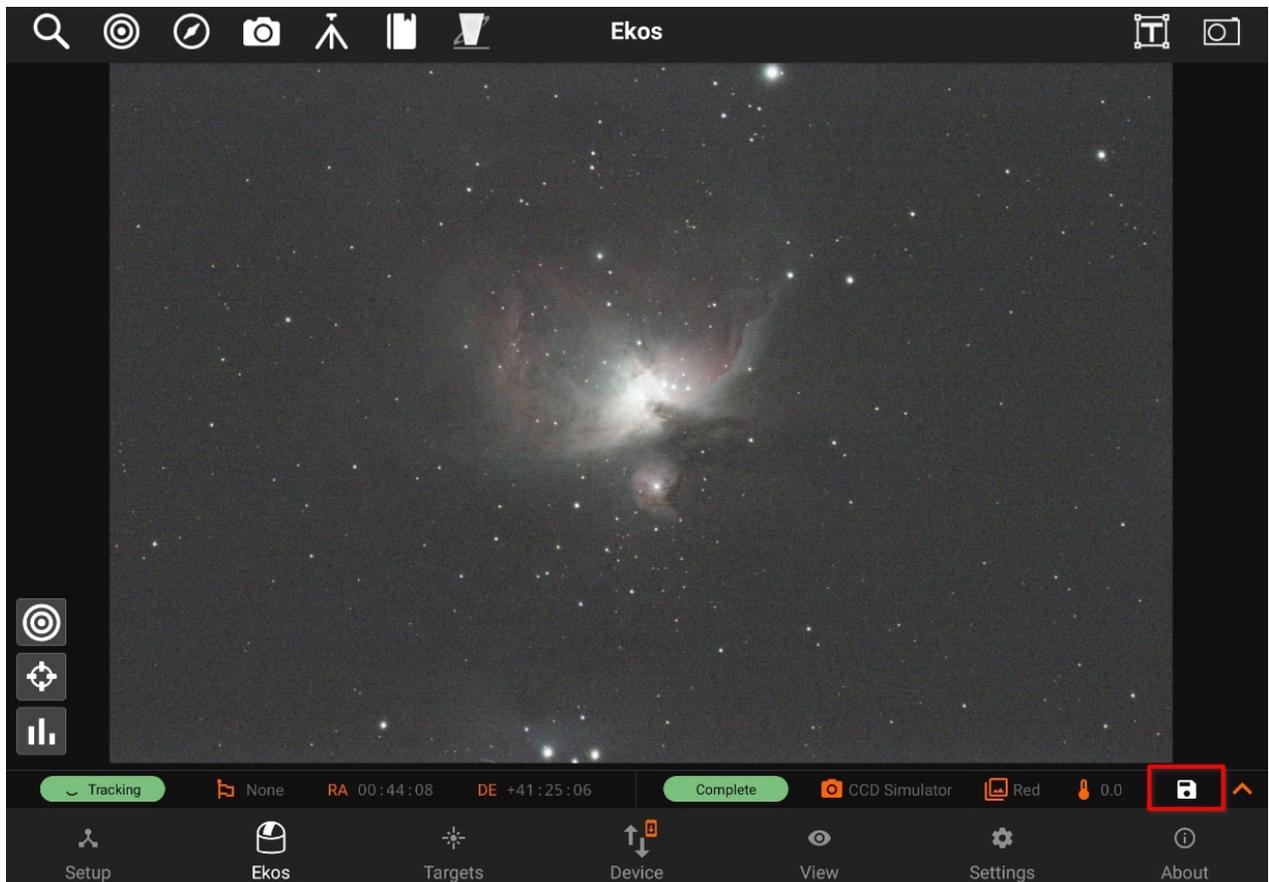
Any images displayed in the main image view can be exported to phone/tablet storage by clicking on the save icon on the camera status bar. It is saved as a time-stamped JPG image.

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.
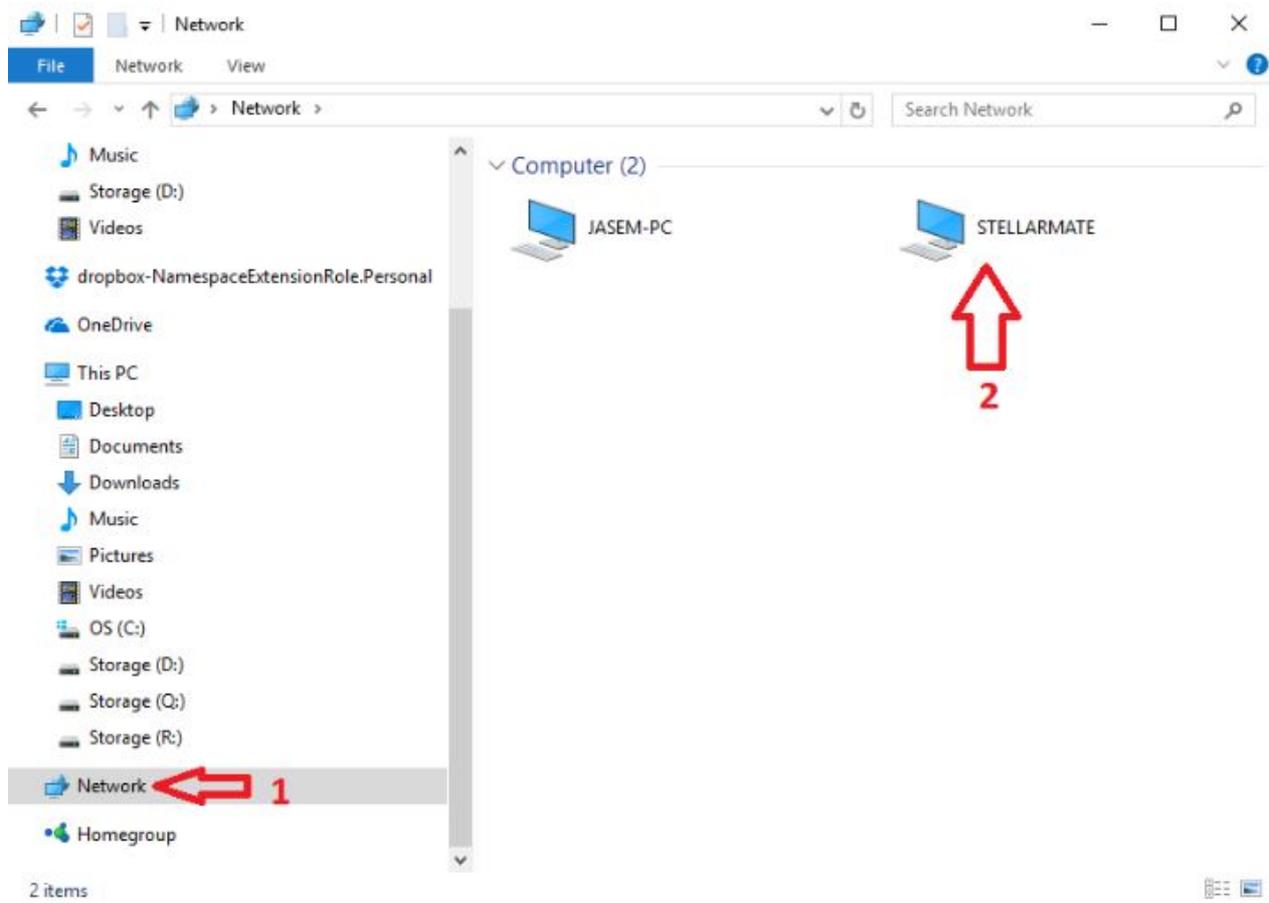
If you do not see the StellarMate network share, please map the network drive as shown in this video:

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.
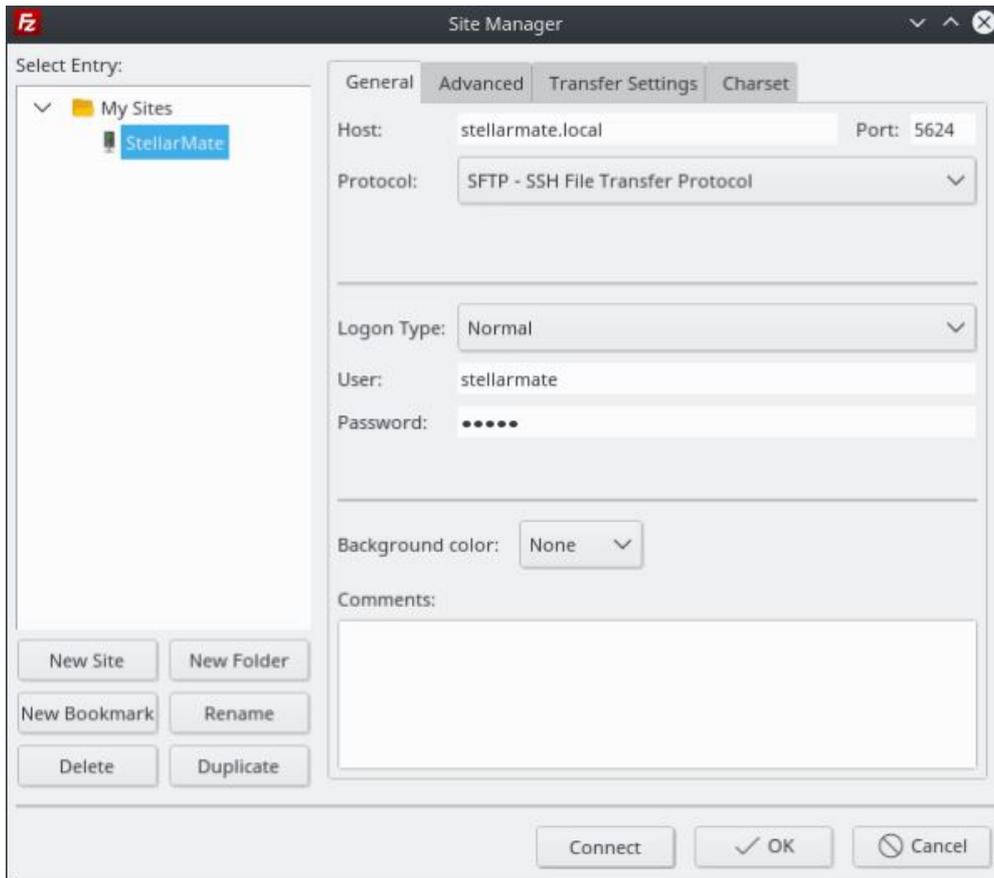
Directory Browser
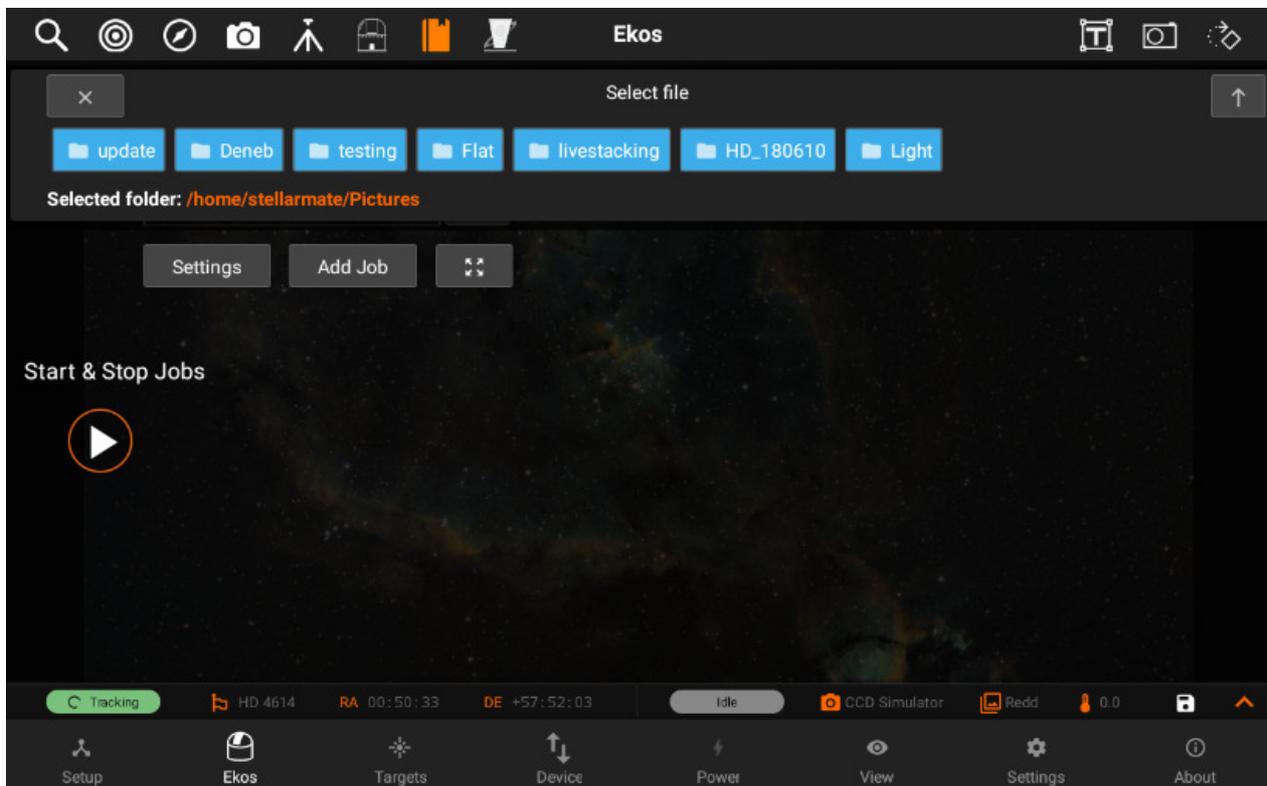
Directory browser:

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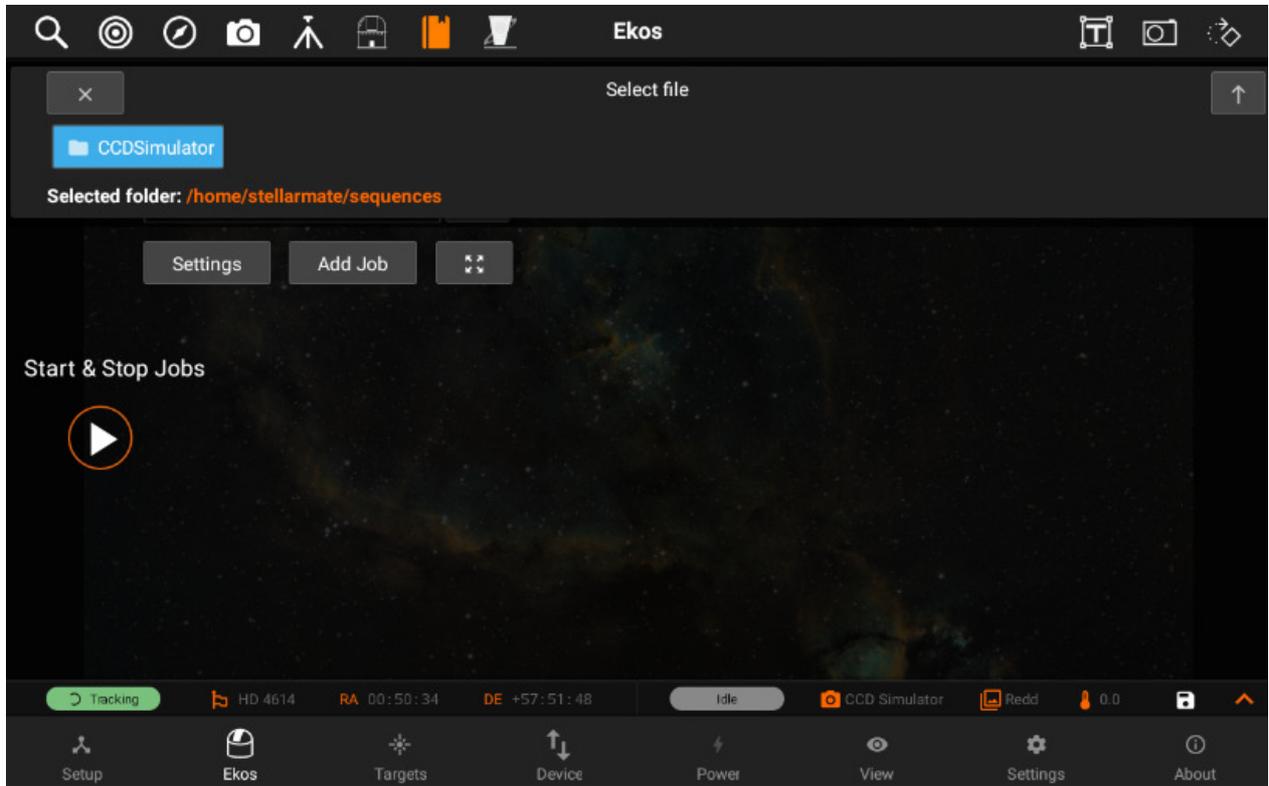
While selecting the sequence file or .fits file for Scheduler, we use Directory browser.

Directory browser is also used in Scheduler Settings in order to add script files.
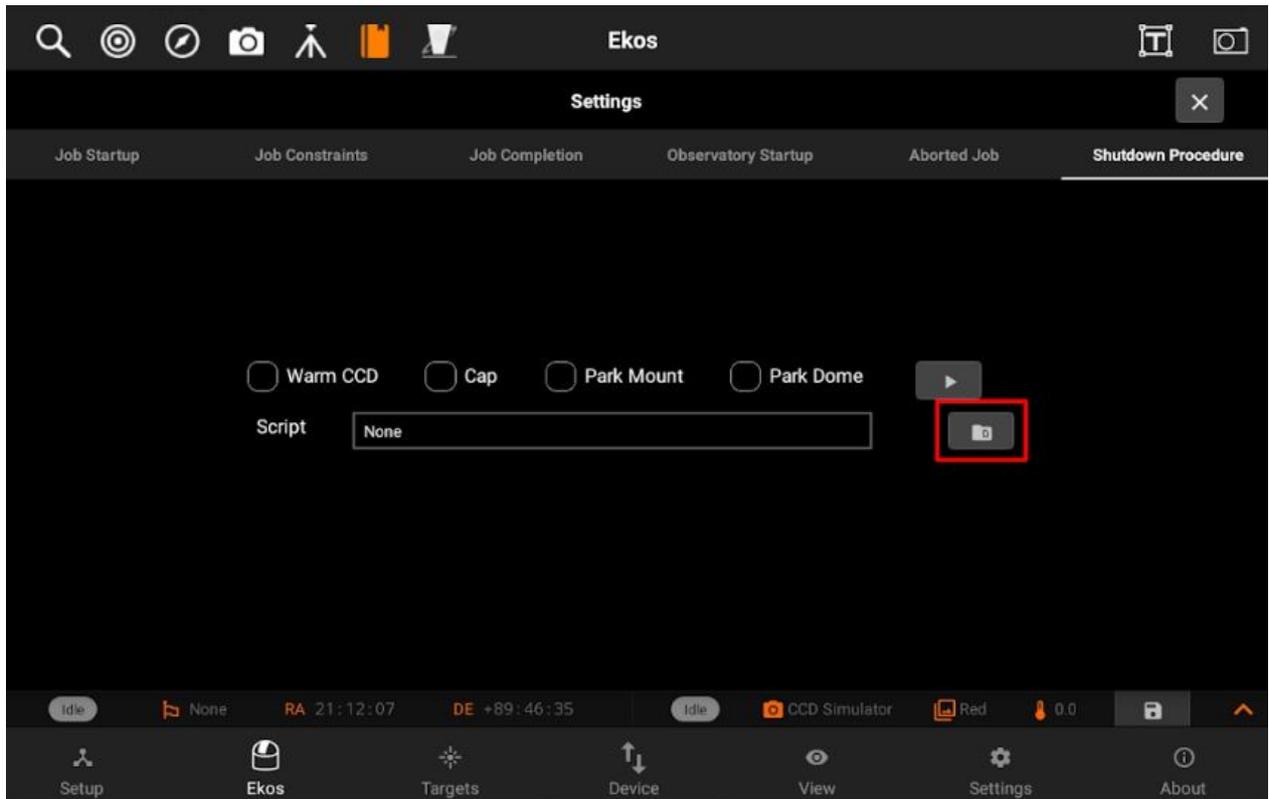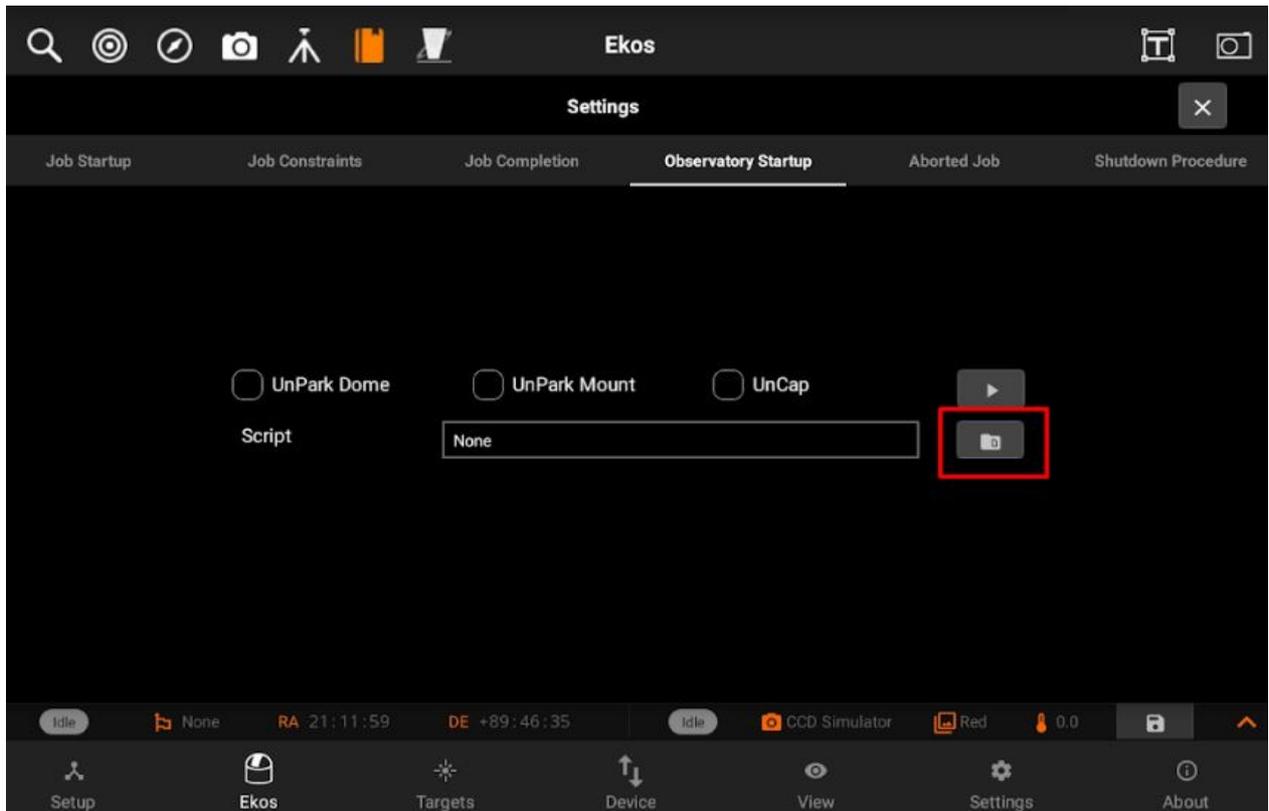
2. Path:

It is also used to set path for images in File Settings & recording settings using Directory browser.
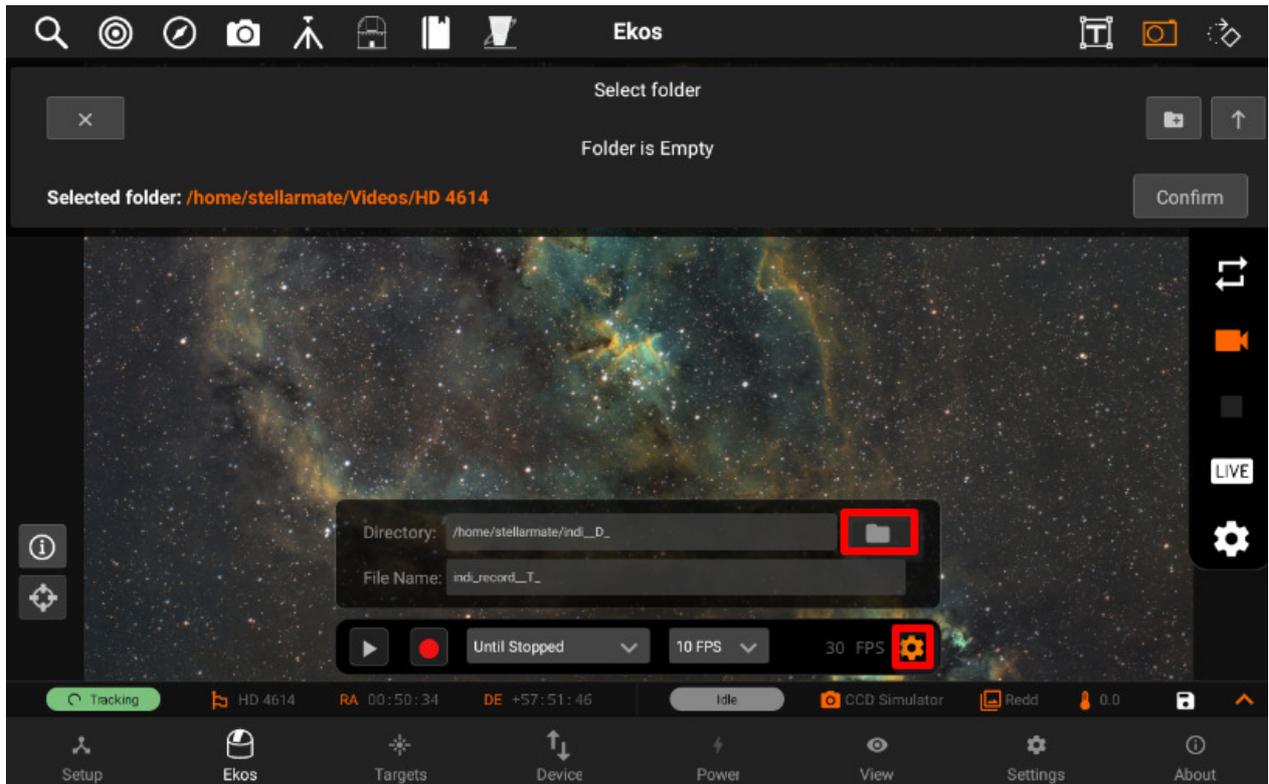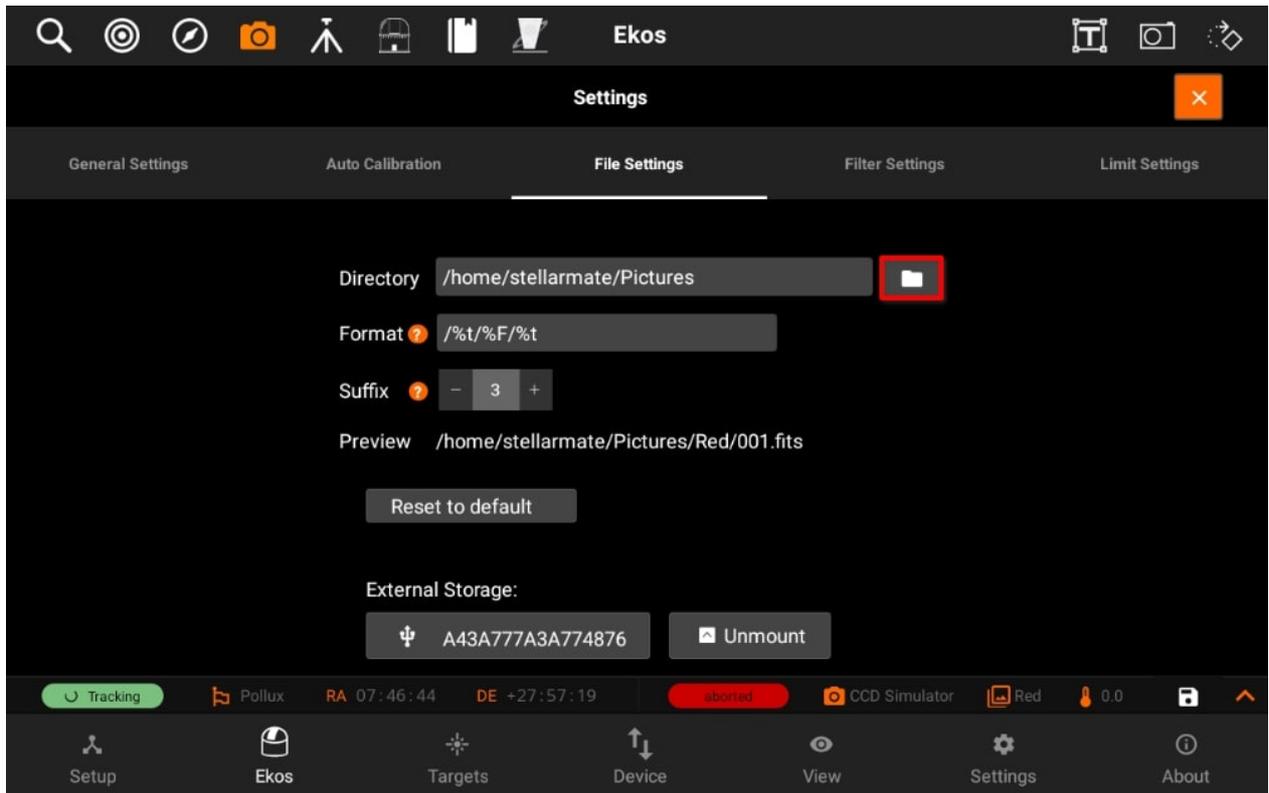
You can also create directories via Directory browser.
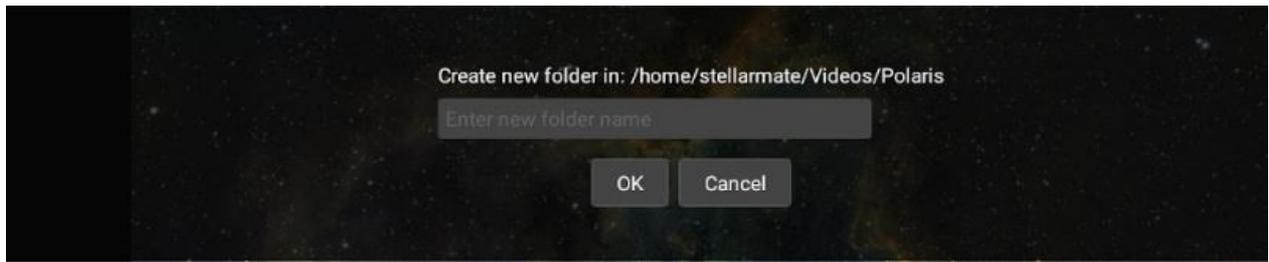
Sky Map

The Sky Map tool provides an interactive all-sky planetarium view with multiple toggle-able layers. It includes solar system objects, stars up to 12th magnitude, galaxies, nebulae, and star clusters. Double tap an object to track it (indicated by orange crosshair). Once tracked, you can zoom in and out without losing track of the object. To exit track mode, simply tap anywhere else on the sky map.

1. **Search**: Search from all catalogs, tap an object to center.
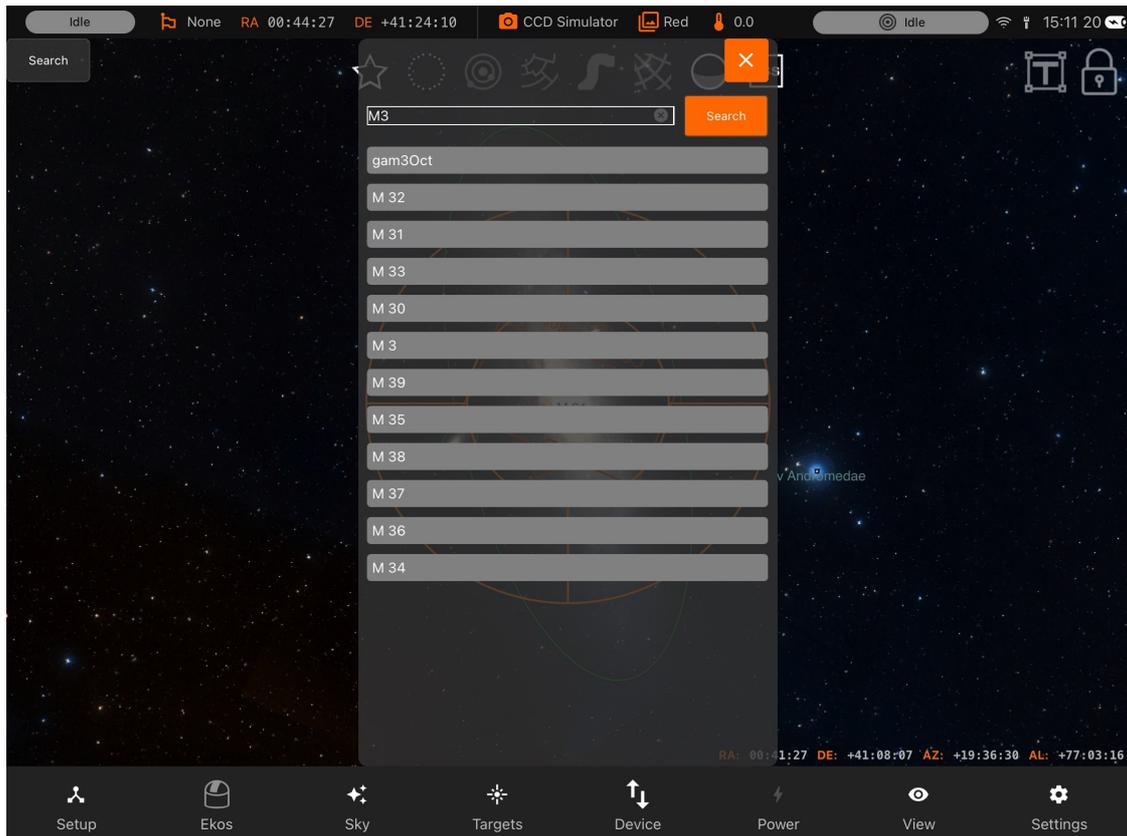
2. **Objects Bar**: Toggle visibility of celestial objects:

   o Stars

   o Deep Sky Objects

   o Solar System

   o Constellation Lines

   o Milky Way

   o Equatorial Grid

   o Horizon

   o Digital Sky Survey (DSS)

3. **Quick Mount Controls**: Exact replica of the Quick Mount Controls in Ekos tab.
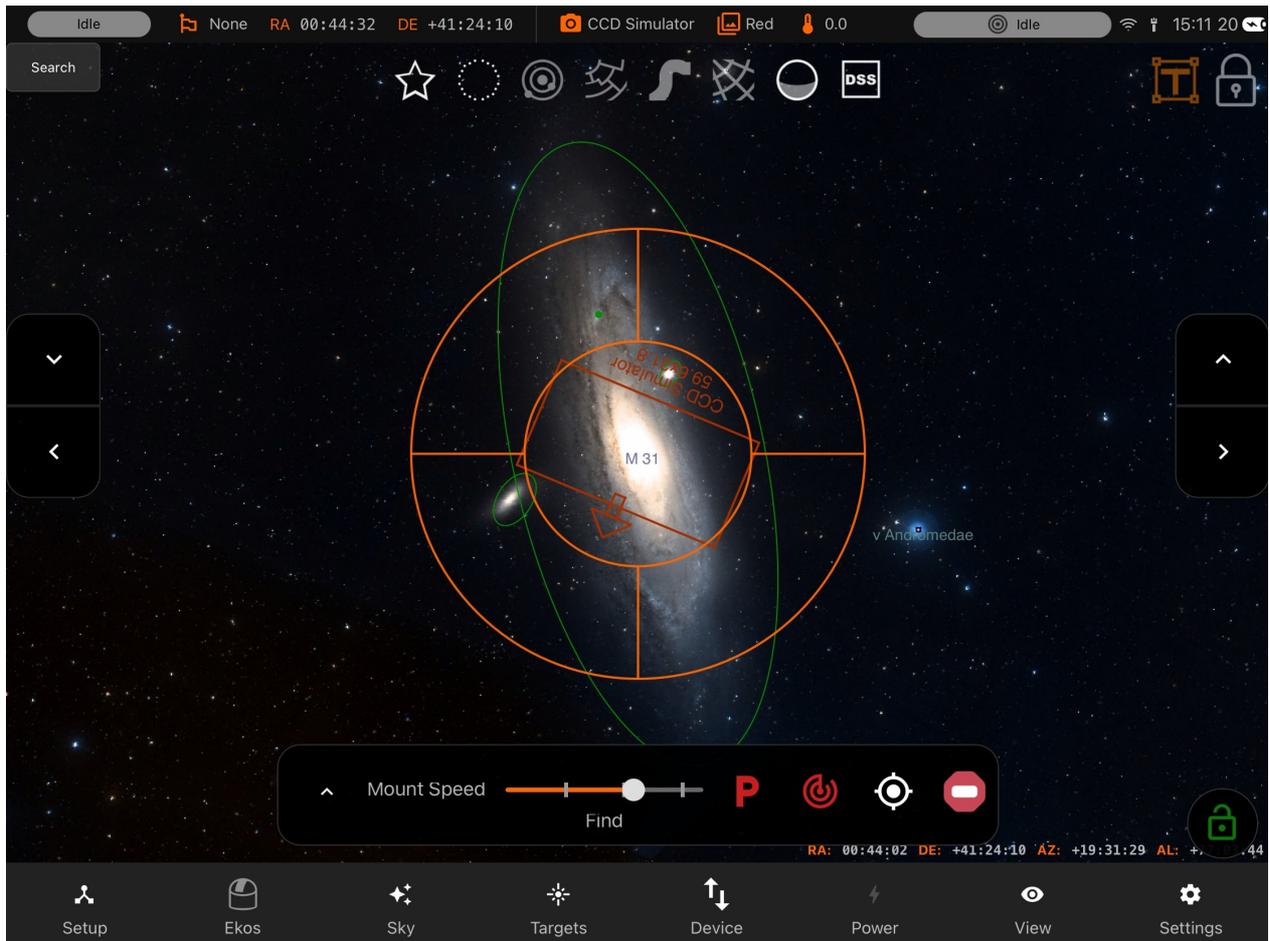
4. Lock Sky Map to mount: Always center the mount cross hair at the center even when the mount moves. This is useful to always keep track of the mount position. Dragging the sky map manually cancels the lock.

5. Object Panel: Tapping any object in the sky map will pop up the Object Panel. It lists the object's magnitude (if available) and its horizontal and equatorial coordinates. You can perform a GOTO, SYNC, or Go & Solve operation. The panel outer rim changes color according to the current ongoing operation:
   o Magenta: GOTO in progress
   o Yellow: Solving in progress
   o Green: Goto or plate solving complete
   o Red: An Error occurred.

- FOV Indicator: At the center of the map, the Field of View (FOV) indicator shows the area in the sky that is visible to the camera's sensor. Changing the camera and/or telescope will affect the field of view size. Below the FOV are the camera name and the width/height in arc-minutes. The up-arrow indicates the top side of the camera's frame   camera's sensor. Changing the camera and/or telescope will affect the field of view size. Below the FOV are the camera name and the width/height in arc-minutes. The up-arrow indicates the top side of the camera's frame

The Sky Map is a simulation of the night sky that uses your phone/tablet current time and location.

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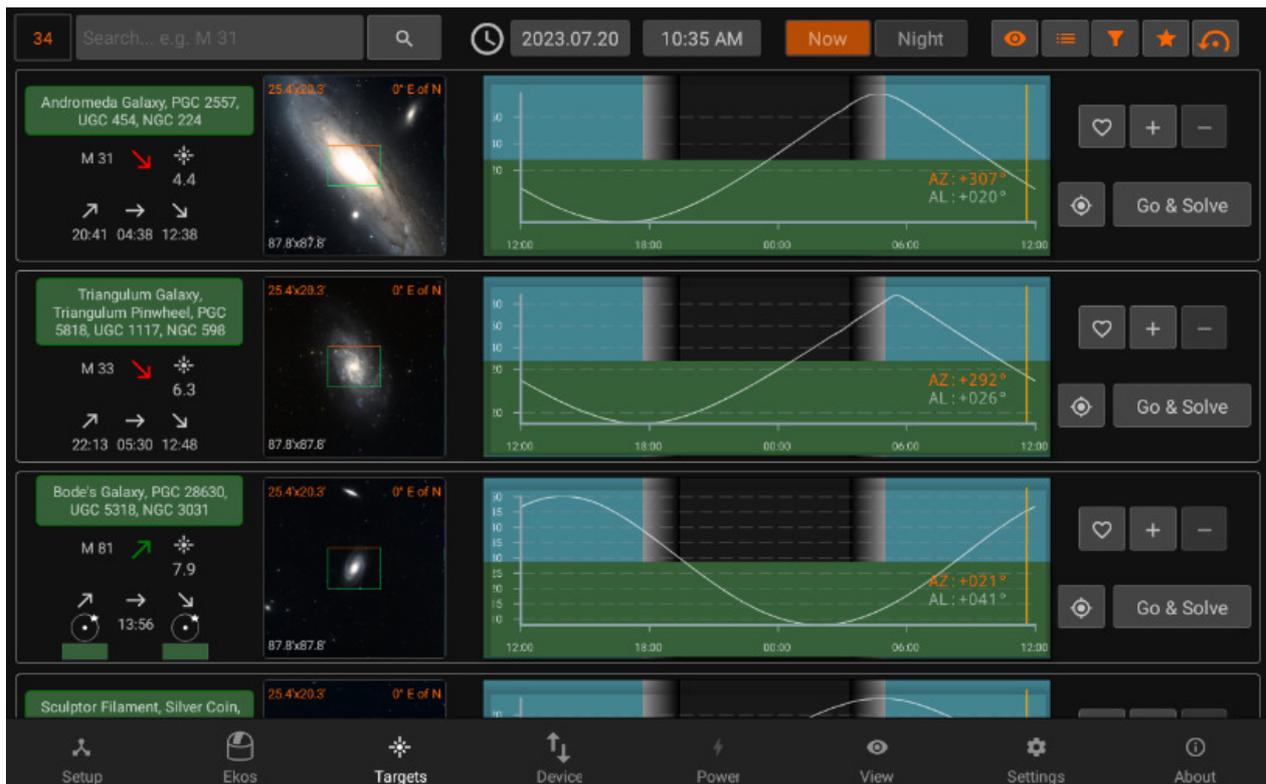
Date & Time:
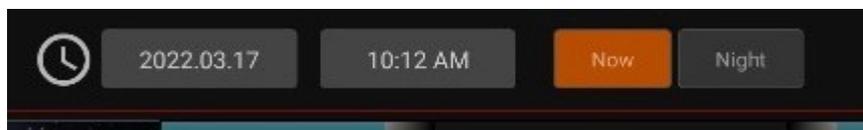
You can preview the targets available at a different date or time by changing the settings (This option is disabled if Ekos is running)

Sun/Moon Visibility

1. Moon rise/set times
2. Illumination percentage and lunar phase name
3. Sunset/Sunrise
4. Astronomical Twilight Dusk/Dawn

Filters
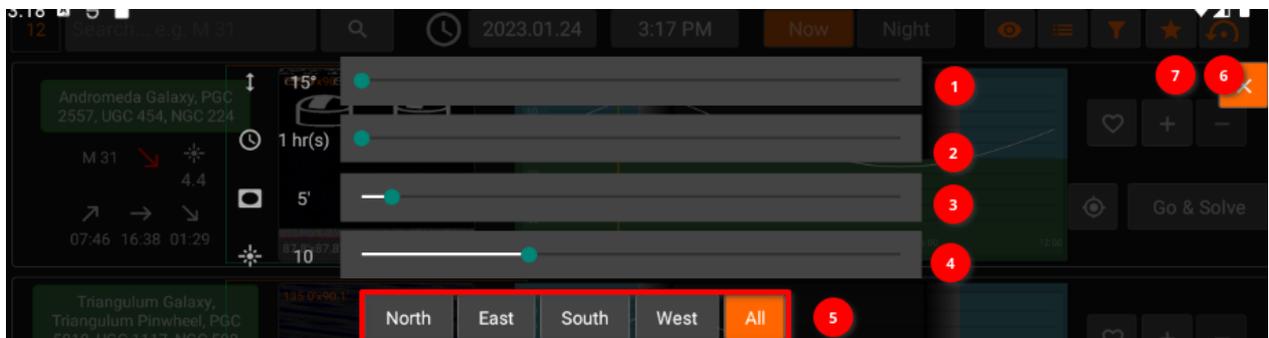
1. Minimum object alititude in degrees.
2. Minimum duration in hours where the object must meet the altitude condition above. For example, if altitude is 20 degrees, and duration is two hours, then only objects that

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.
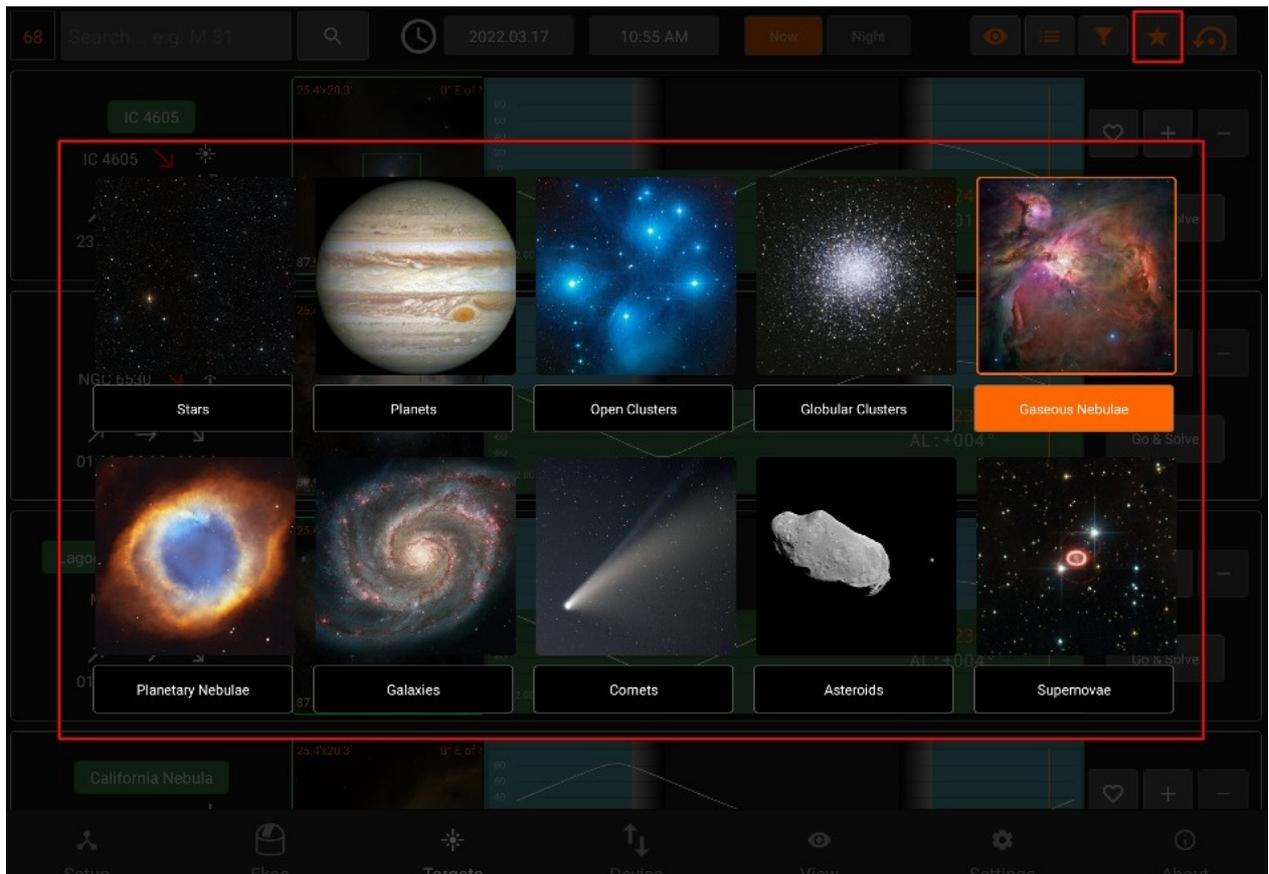
Search Results

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 l 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 (5) opens up the following panel:
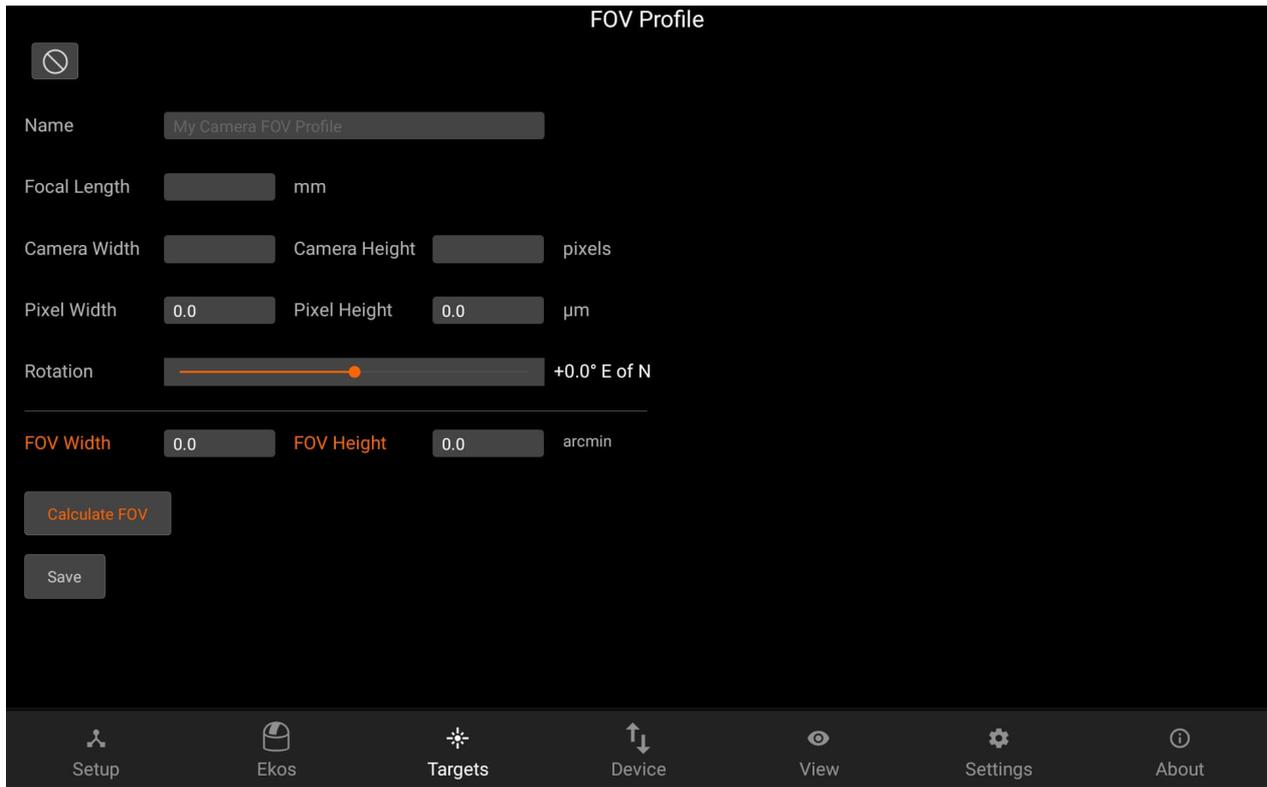
After setting the Focal Length, Camera width & height and pixel width & height, the FOV can be calculated by pressing the Calculate FOV button.

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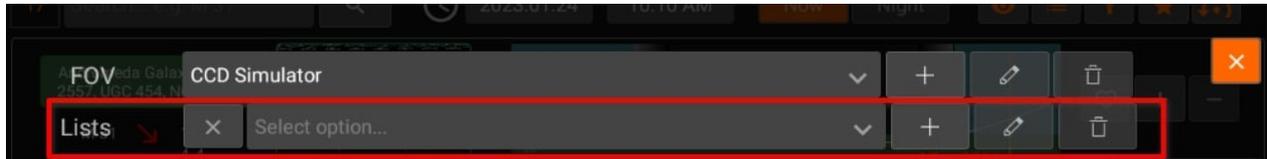
It contains Lists dropdown. Add, Edit the list name or Delete the selected list.

Target Info

1. Object designations.
2. Object name.
3. Object Phase:
    o Green: Object is rising
    o Yellow: Object is transiting the meridian
    o Red: Object is sitting
4. Magnitude
5. Object Image and FOV Overlay
6. 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.
7. Add to Favorites
8. Add to custom list
9. Remove from current list
10. 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](#).
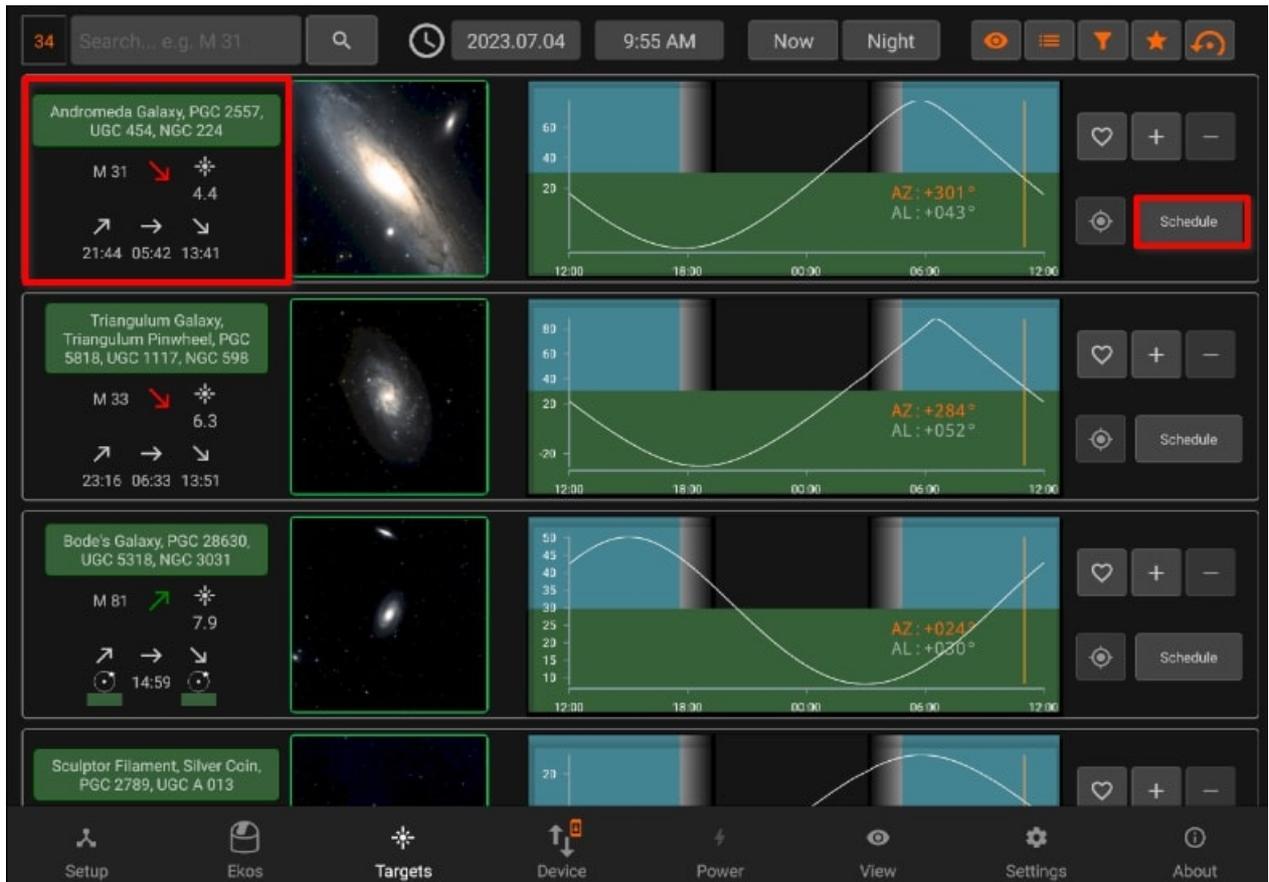
When Ekos is offline, you can also use framing assistant to Schedule the coordinates to [Scheduler](#).

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

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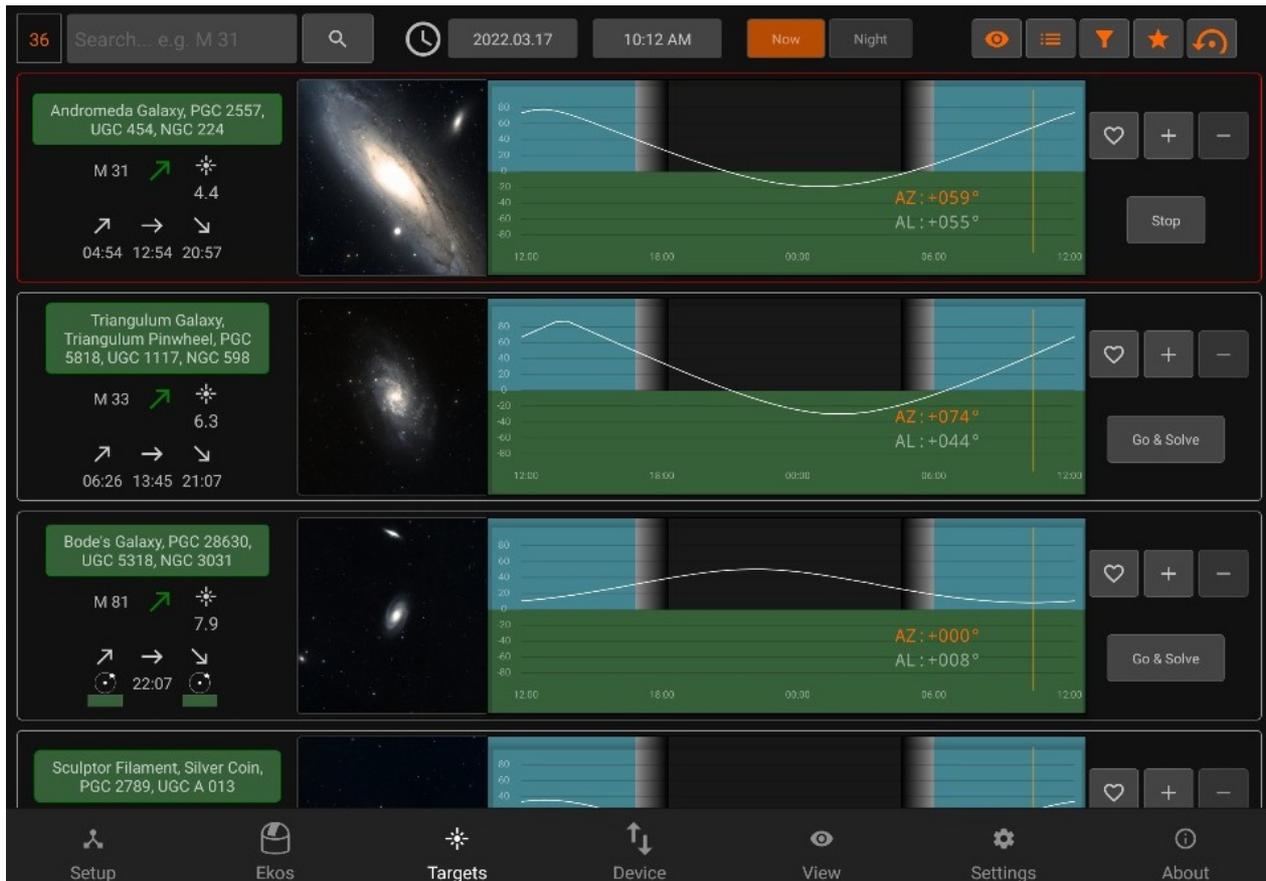
To open the framing assistant, make sure to have selected an FOV Profile and press Go & Solve.

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
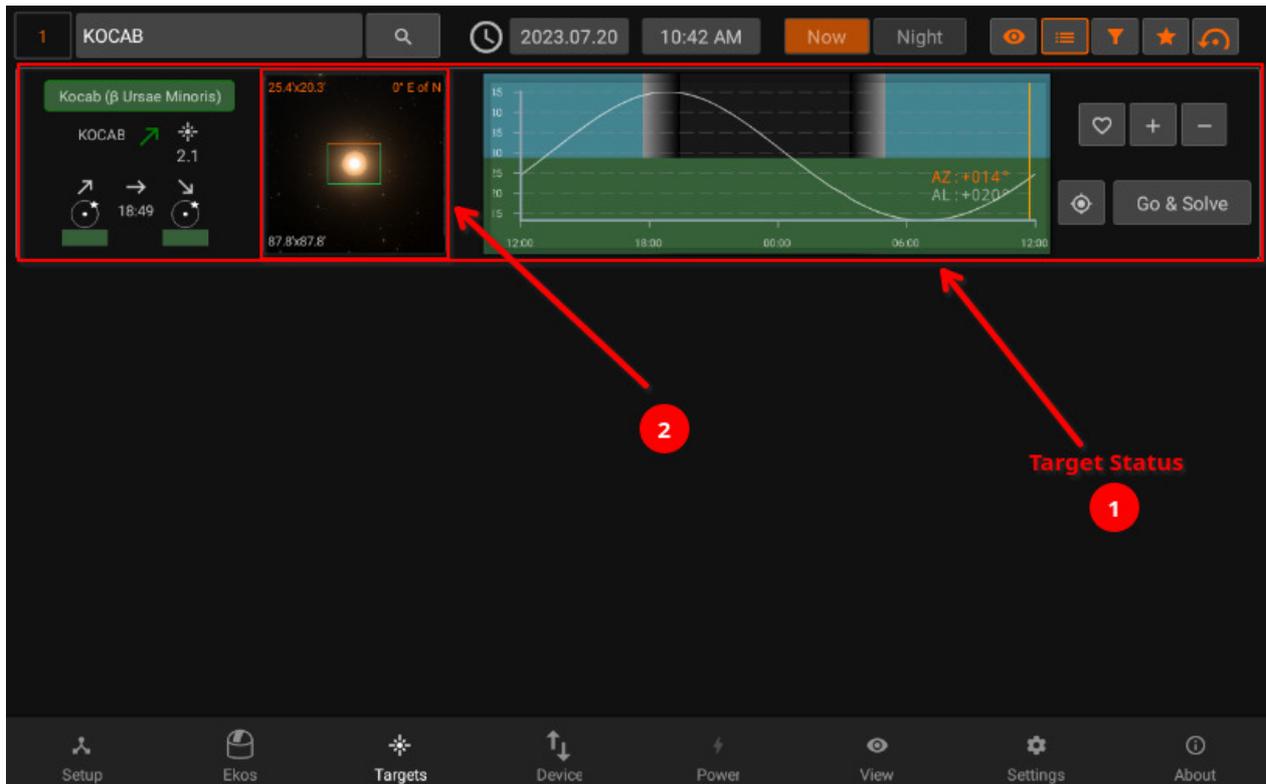
1. Framing Assistant

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 modes to deal with rotation:
   1. Automatic: This mode is available if a rotator device (e.g. Nightcrawler) is coupled with your imaging camera and can rotate it on its axis. With a rotator, no manual intervention is necessary as StellarMate calculates the exact offset required to arrive at the target position angle.
   2. Manual: 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 GOTO & Rotate 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.
   3. Ignore: Completely ignore rotation.
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 & Declication coordinates.
5. Once all the necessary adjustments are made, tap GOTO & Rotate to start the framing process. If a rotation offset is required and the rotation mode is either automatic or manual, Ekos will issue a GOTO command followed by a rotation command if applicable.
6. Reset all adjustments made to the FOV.
7. Add the target to the [Scheduler](#) module. If the rotation mode is either Automatic or Manual, then the target Position Angle is also set in the scheduler. 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.
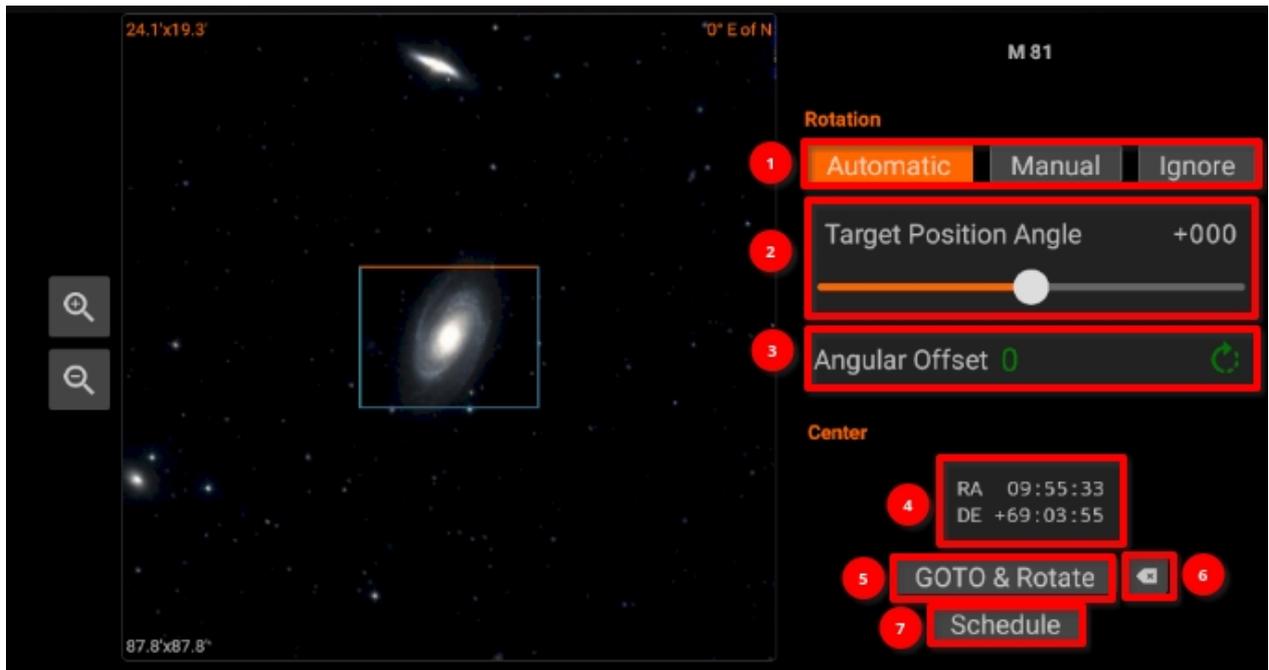
If Ekos is offline, you can Schedule your target coordinates by using framing assistant in Scheduler module.
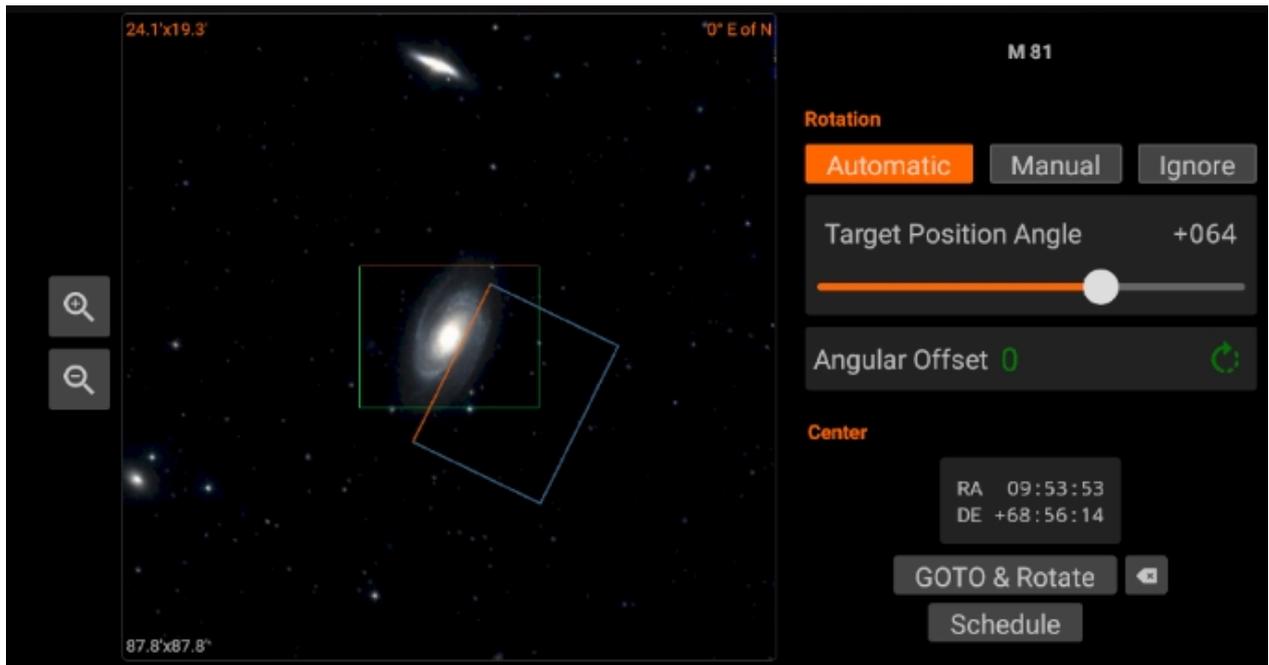
Device
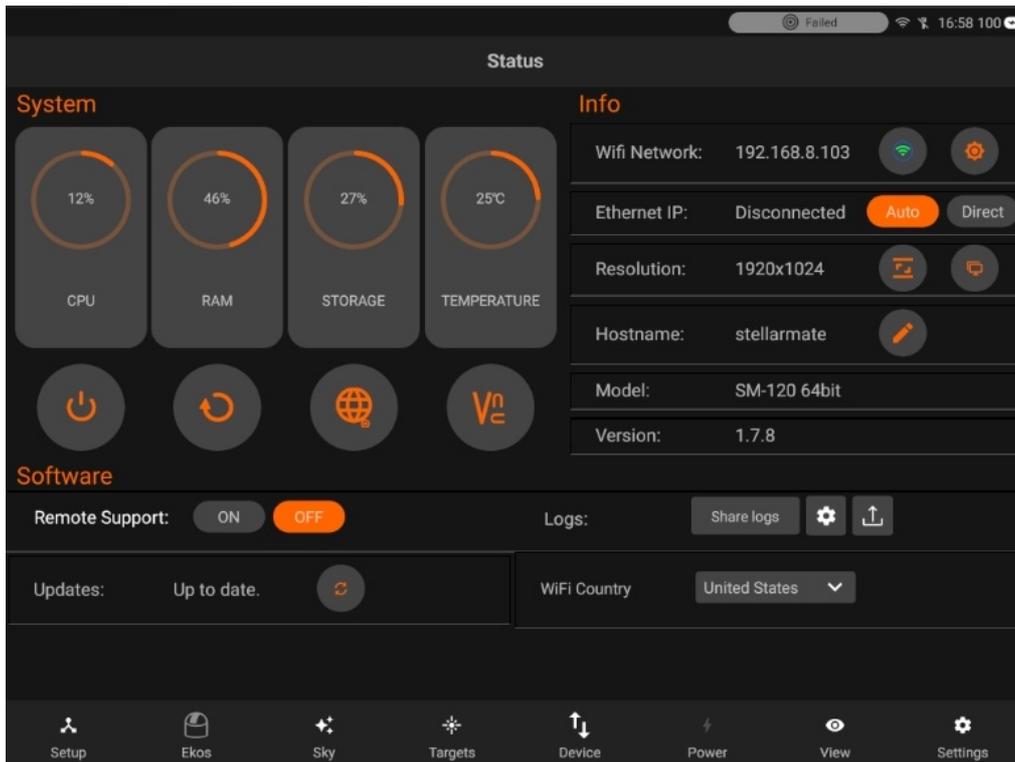
The Device page manages the health, settings, and updates for your StellarMate. It is divided into the following sections:

- **System**
- **Info**
  - WiFi
  - Ethernet
  - Resolution
  - Hostname
- **Software**
  - Firmware Updates
  - Remote Support
- **Logs**
  - Diagram showing how the App works: KStars   Modules   INDI   App
  - Sharing logs

System

System shows the Utilization of SM device. It includes:

- CPU
- RAM
- Storage
- Temperature

It also has main controls i.e

- Power Off the SM unit
- Restart SM, you may also see the change of LED light in RPI 5 and SM X
- Access Web Manager. It can also be accessed from the browser i.e http://localhost:8624
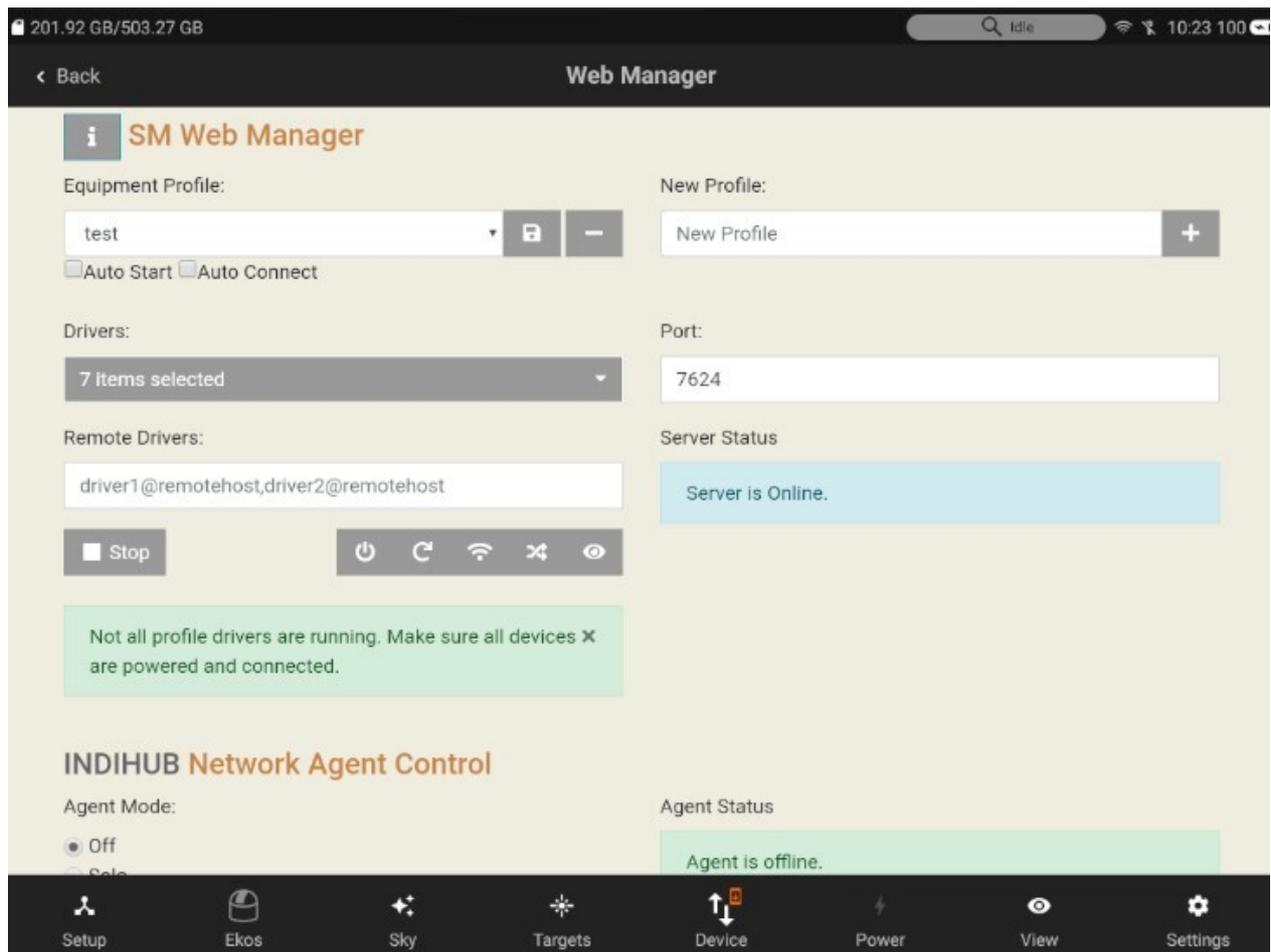
- Access of VNC. Can be accessed from the browser i.e http://localhost:6080
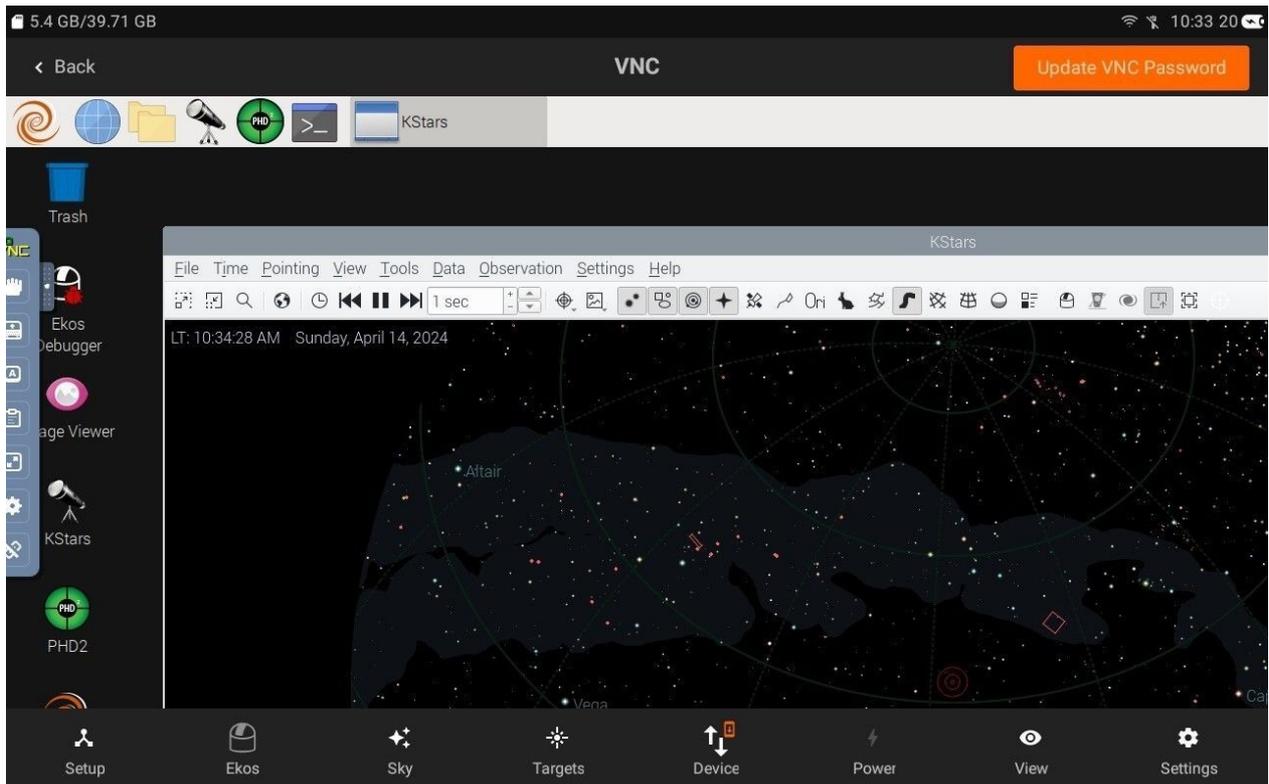
You can also update your VNC password by pressinng on the top right "Update VNC Password"
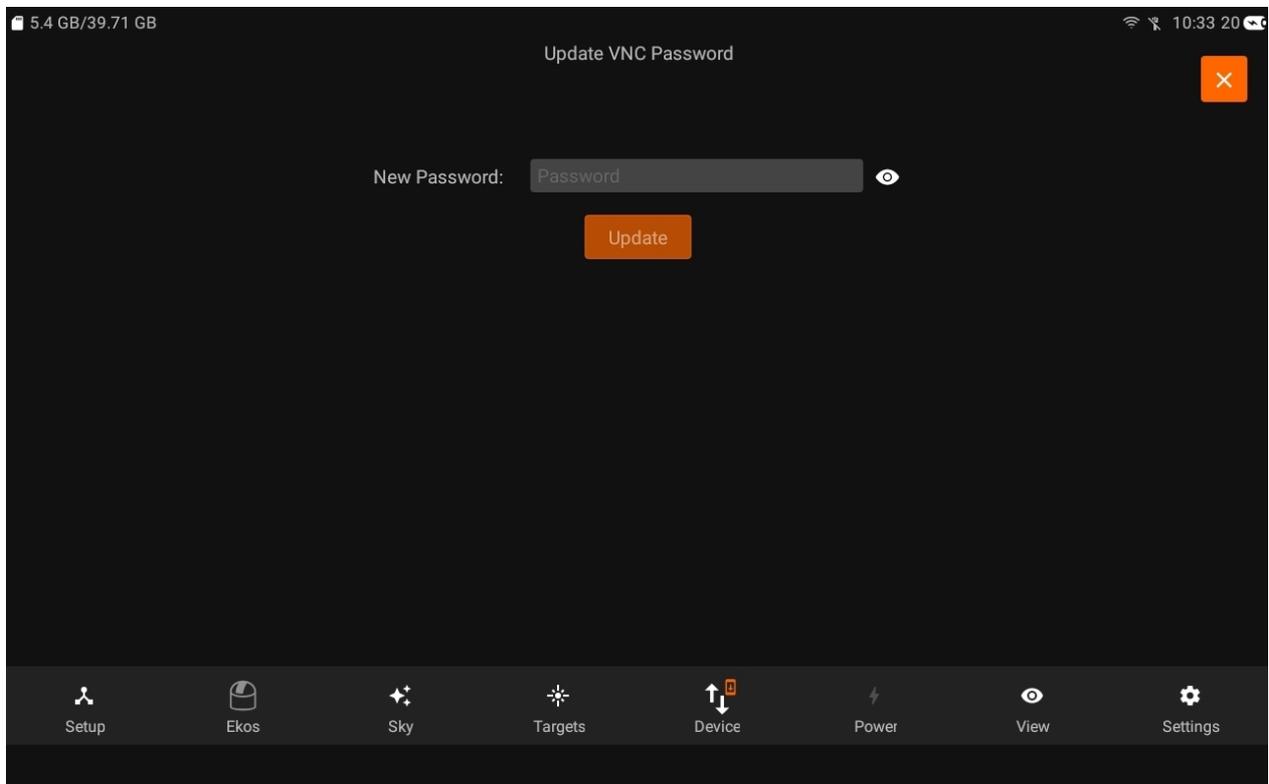
Info

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

WiFi Network
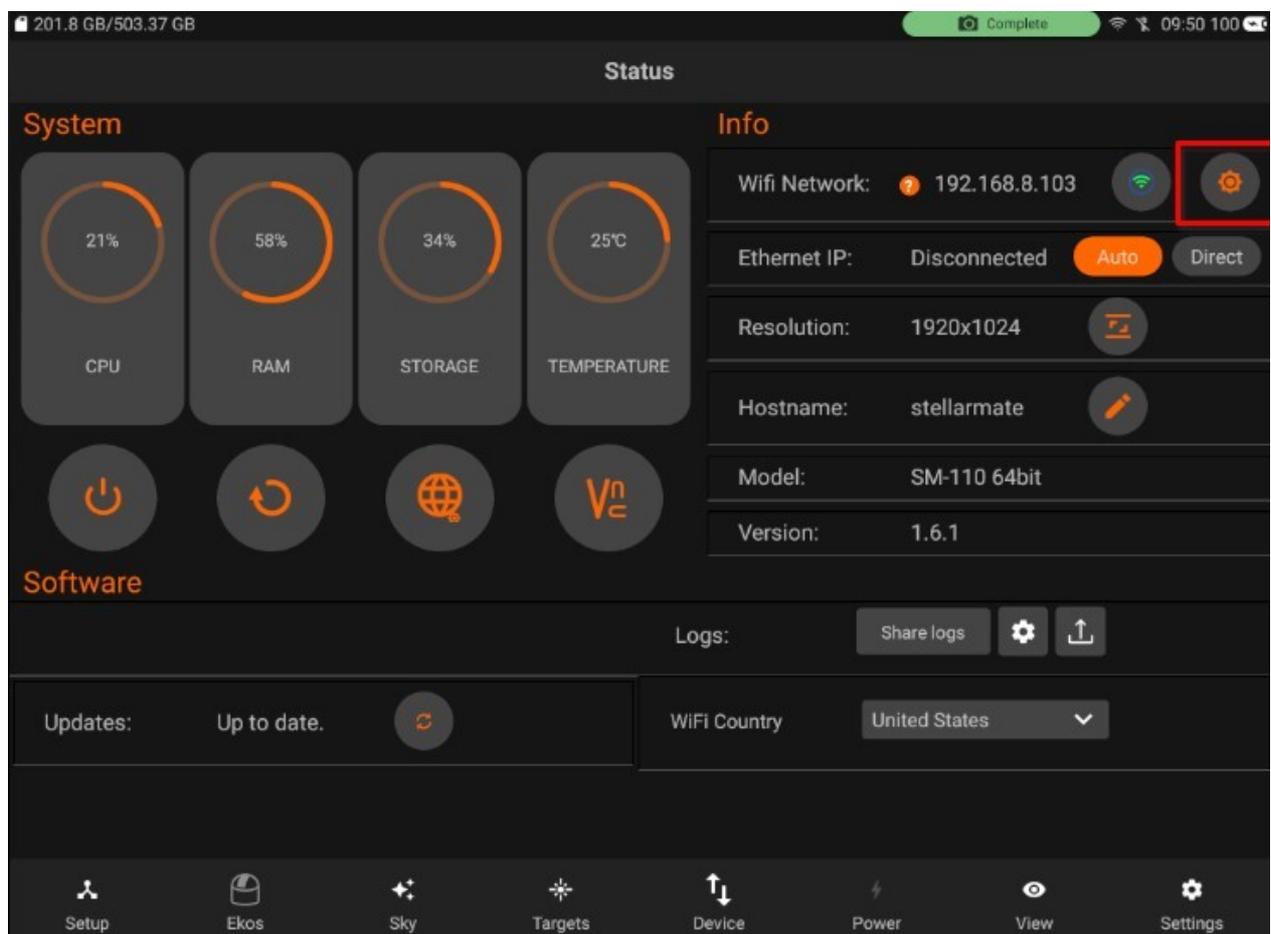
Toggle WiFi network by pressing on the button as shown in the image above.
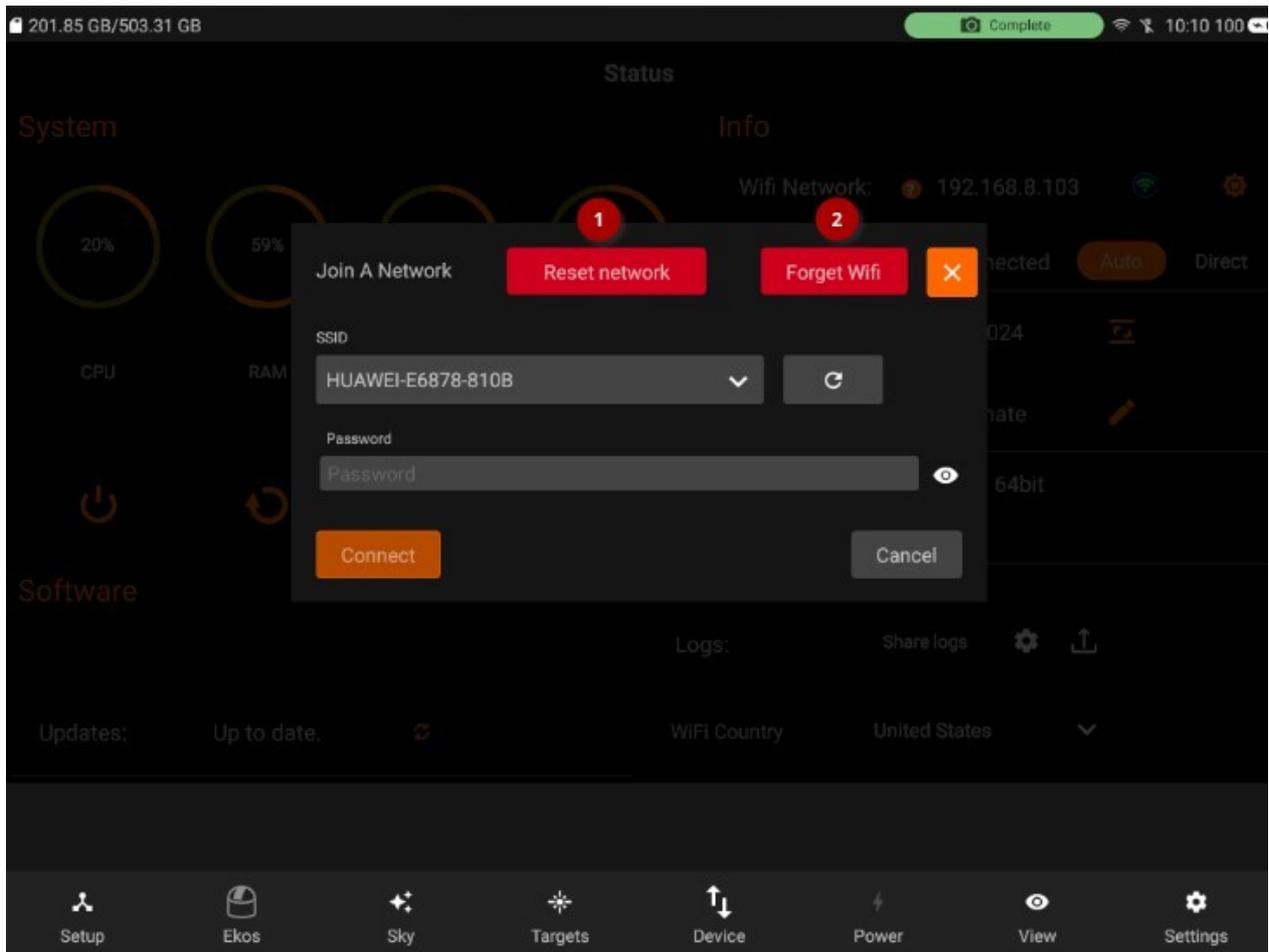
1. **Reset Network**: Network configuration gets reset. Make sure to reboot after resetting.
2. **Forget WiFi:** WiFi network information is removed and StellarMate reverts to HotSpot mode (IP Address 10.250.250.10). If the Unit is connected to your LAN via Ethernet, you can still access it via its LAN IP address like before.
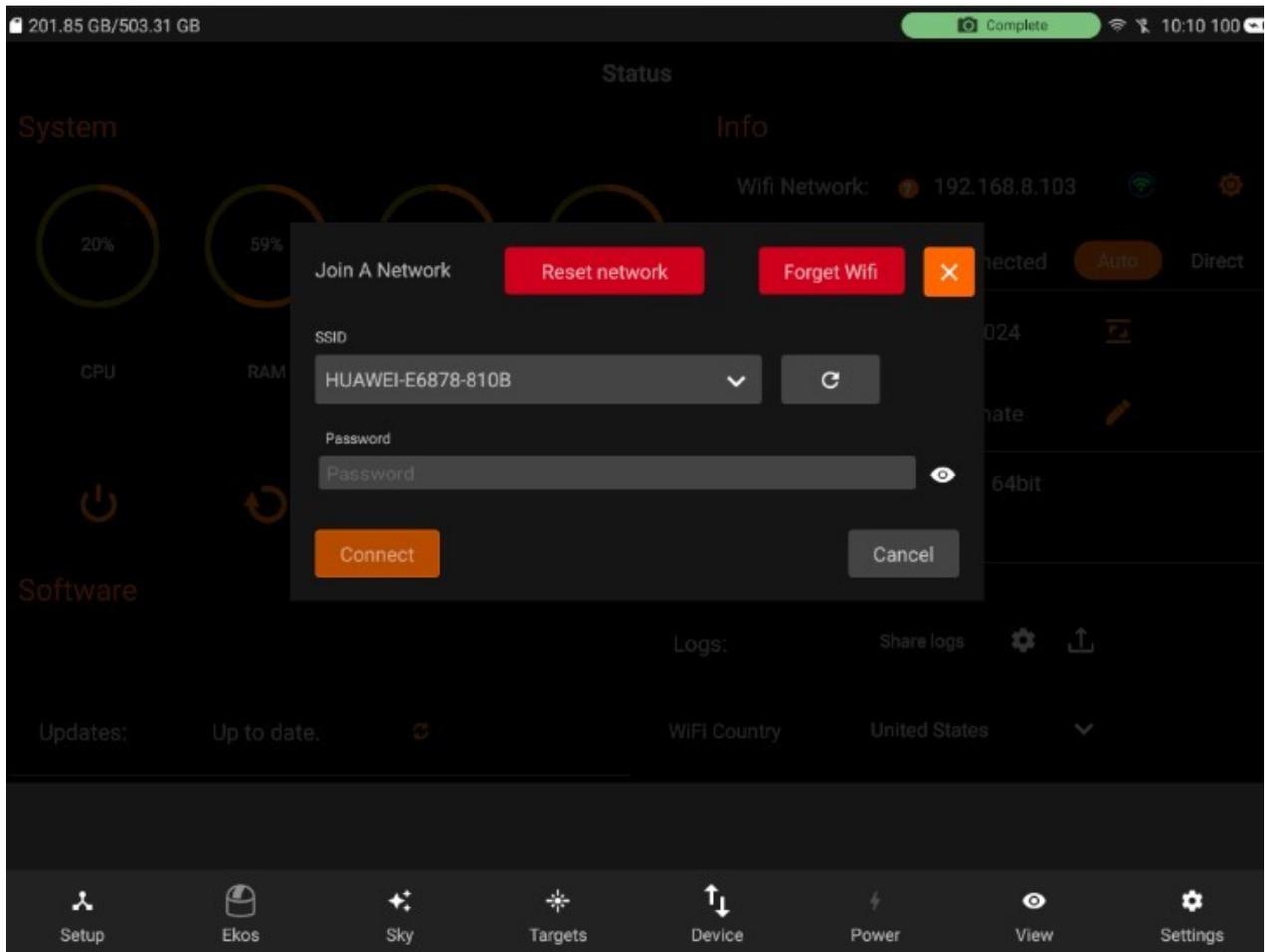
Connect to Home WiFi: Select a WiFi network as detected by StellarMate and then supply the password if it is protected. Press connect, After a successful connection, please wait up to 2 minutes before using any of the unit functions again.
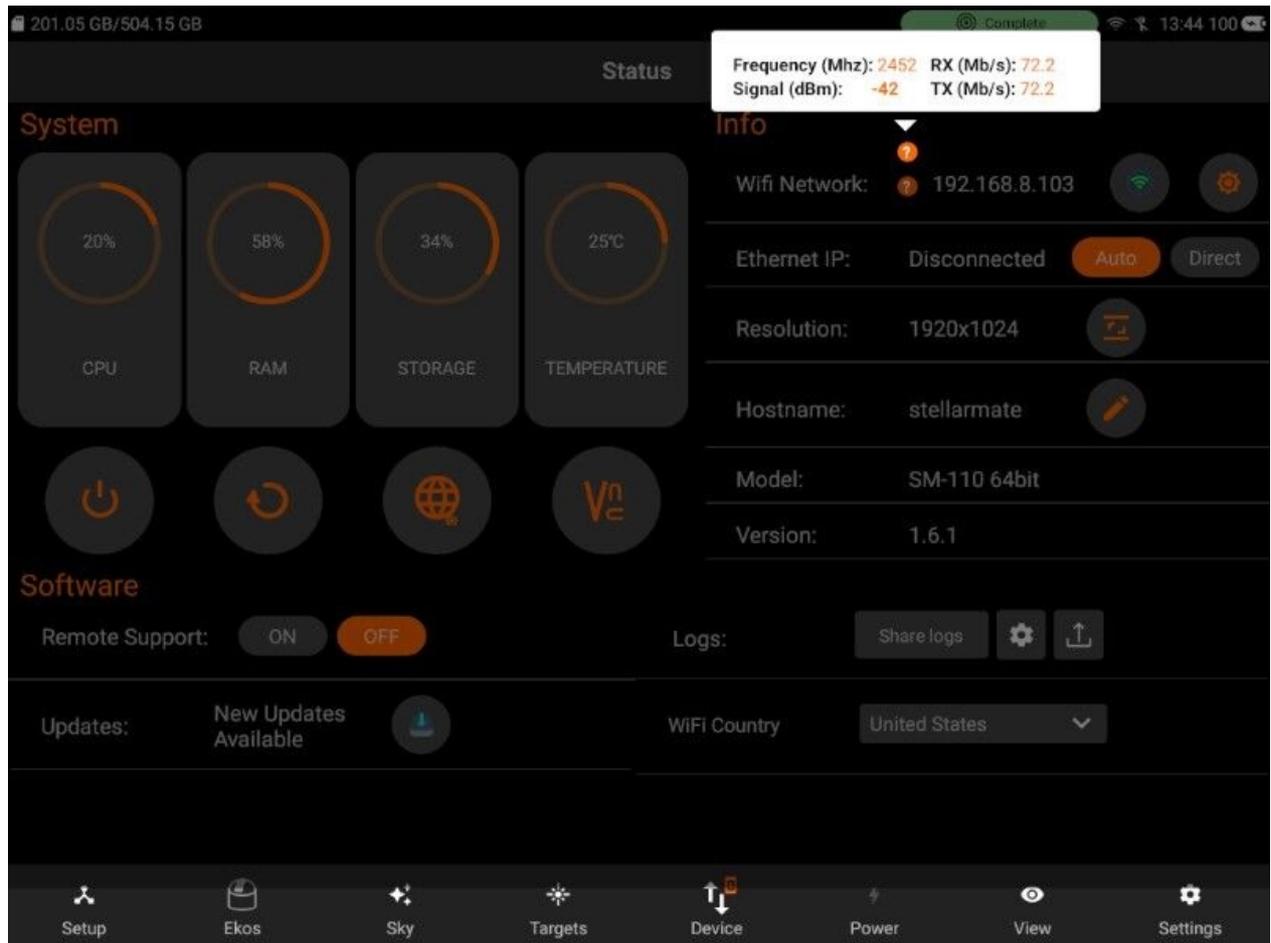
Network Info: Press on the tooltip to see the status of connected WiFI.

The following information is shown:

- **Frequency**: Refers to the range of electromagnetic waves used for transmitting data wirelessly, commonly in the 2.4 GHz and 5 GHz bands.
- **Signal**: The strength and quality of the wireless connection between devices, influenced by factors like distance and interference.
- **RX (M/PS)**: Short for "Receive," indicating the process of a device receiving data over a wireless connection.
- **TX (M/PS)**: Short for "Transmit," indicating the process of a device sending data over a wireless connection.
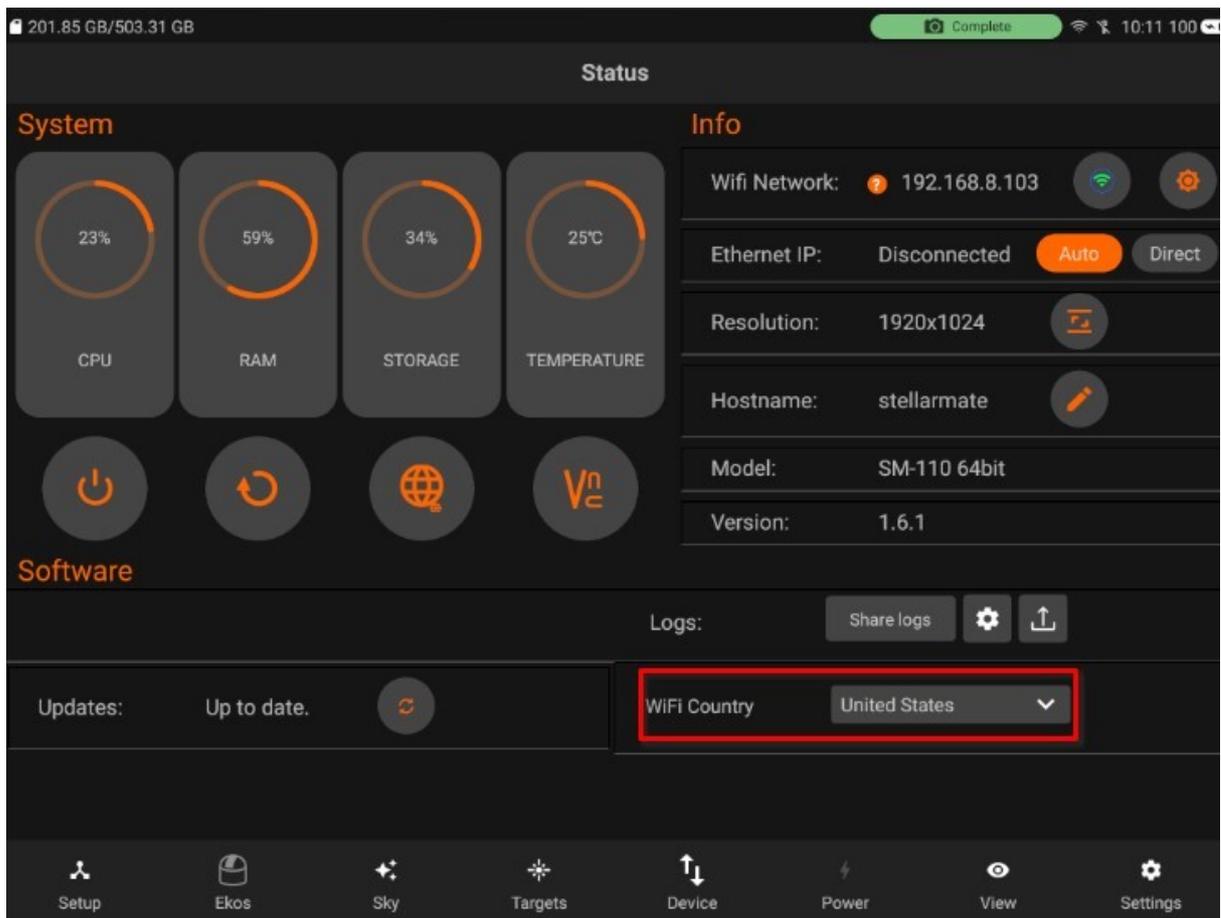
Lets you to select the WiFi country from the Dropdown list
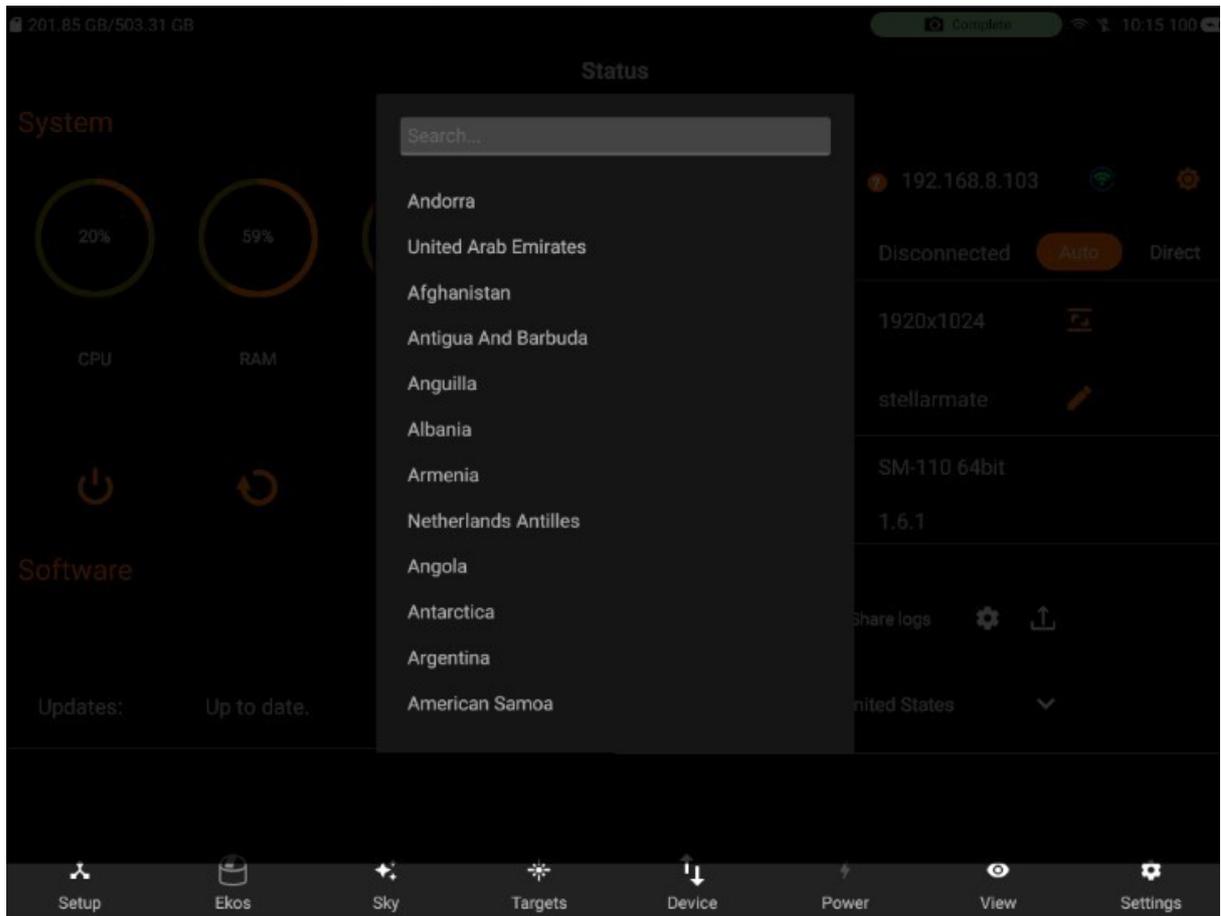
Changing Hotspot WiFi Band

Changing Hotspot WiFi Band

You can change the Hotspot WiFi band by clicking on the settings ⚙ button next to the WiFi Band label.
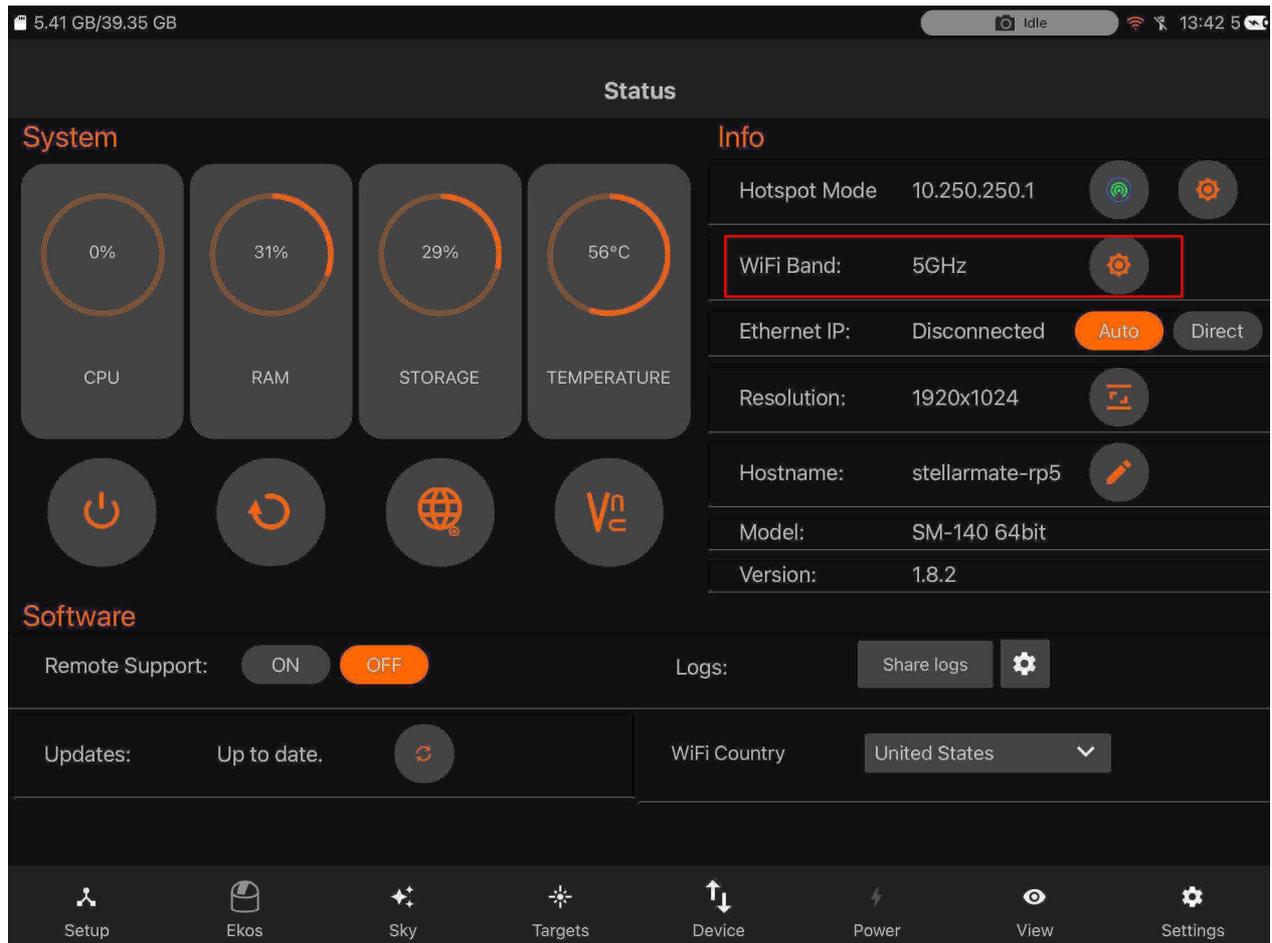
You can now choose the Band you want to switch to, as well as the channel. We recommend using default if you are not sure which Channel to choose. After choosing the band you want to switch to, tap on connect to start the switching process.
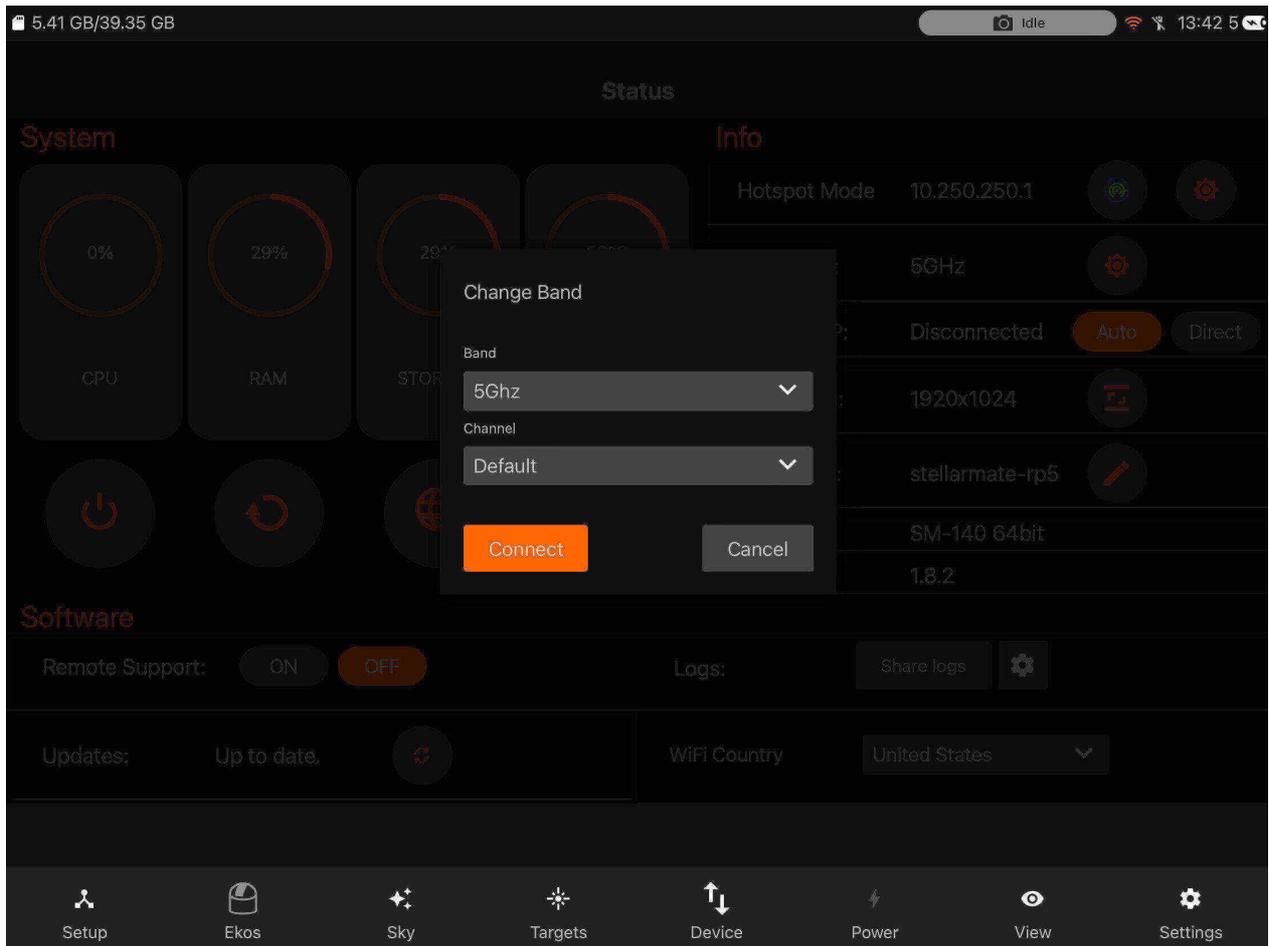
An alert will pop-up informing you about what might happen if you proceed with this operation. Tap on YES to continue with this operation.

⚠ WARNING

StellarMate App could be disconnected and channel switching might fail due to variety of reasons in which case the hotspot will be restored to default settings.
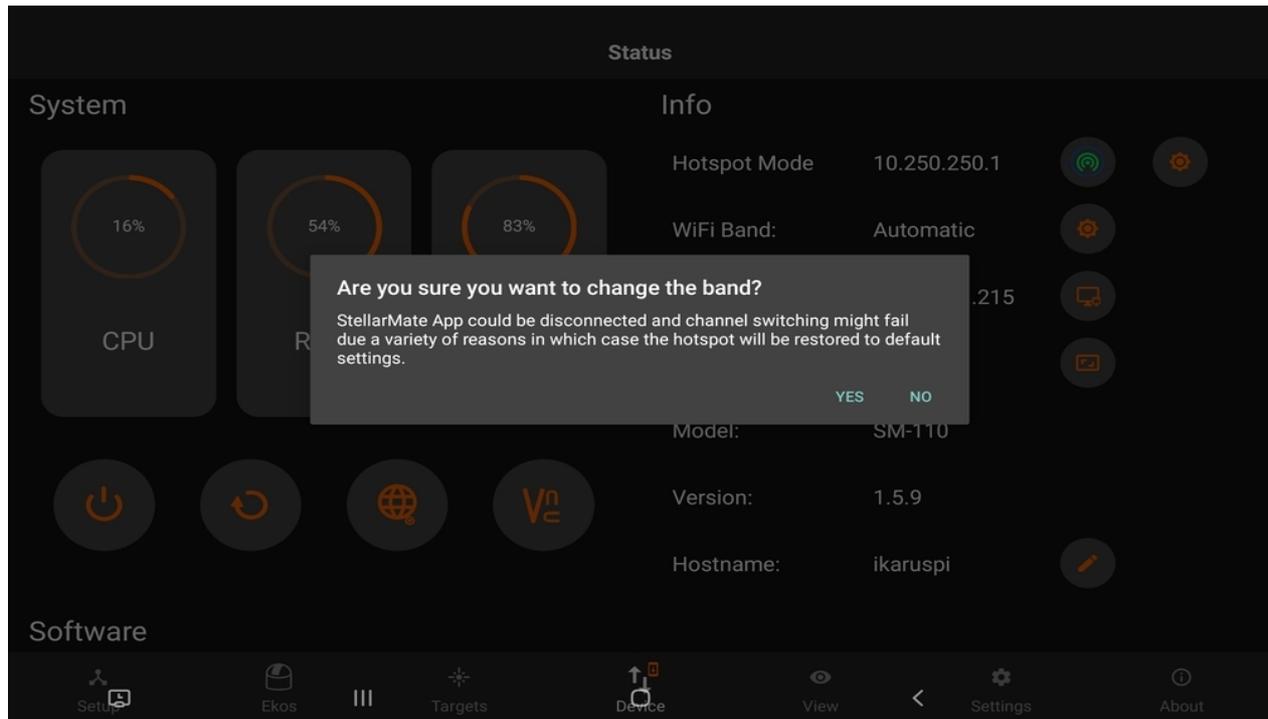
You might have to wait until the hotspot starts broadcasting a Wi-Fi signal again, if it's successful, you will be able to connect back to StellarMate and find that it shows the band you switched to, in the Device tab.

If not, StellarMate will go back to the Automatic band.

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 permenant IP address.

Resolution

- **Change Resolution:** Select available monitor display and change it's resolution.
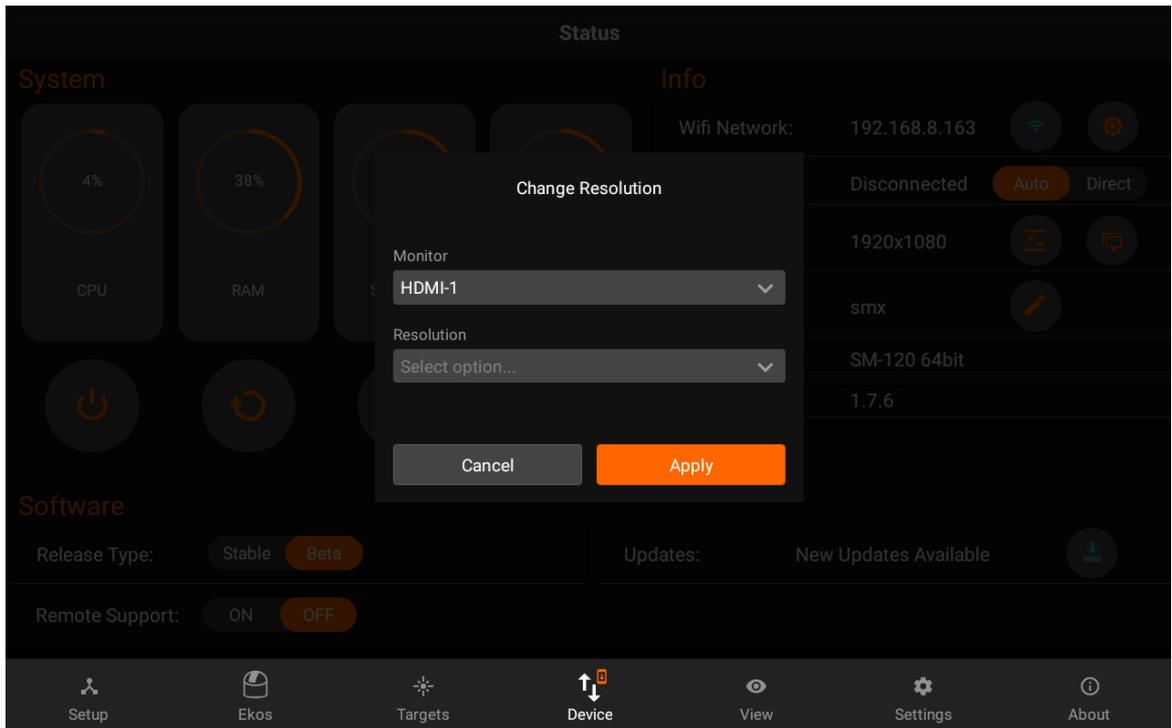
- **Change external monitor:** If you are using model SMA-120 and it's connected with an external monitor. You can select that one.
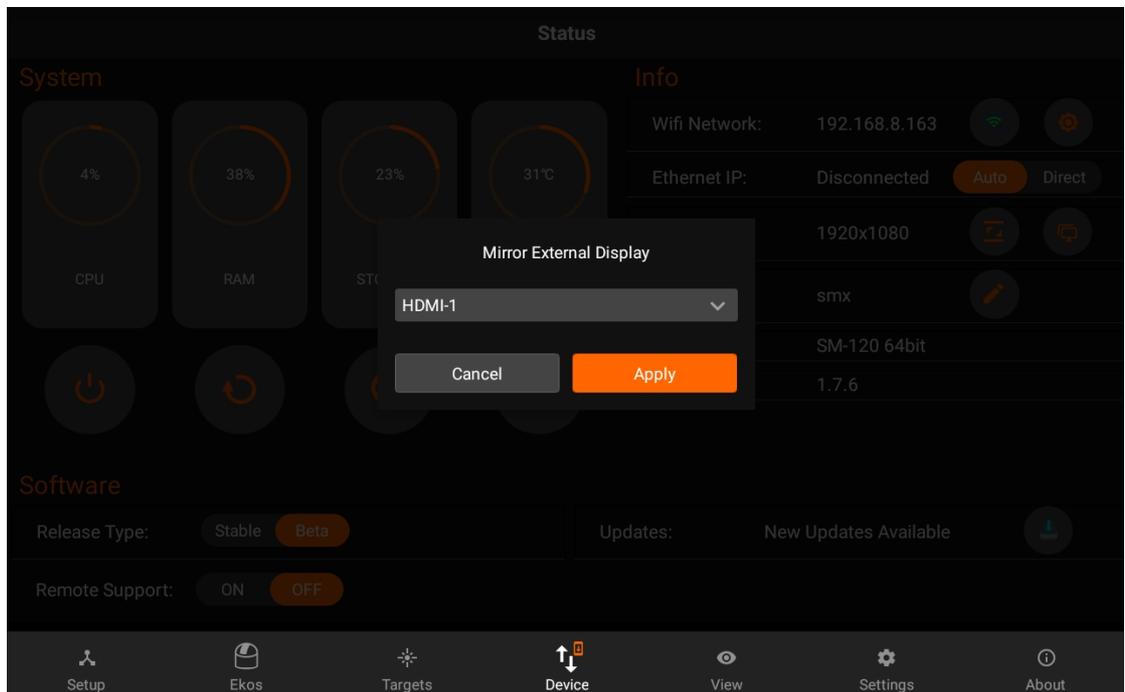
Hostname

- **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.
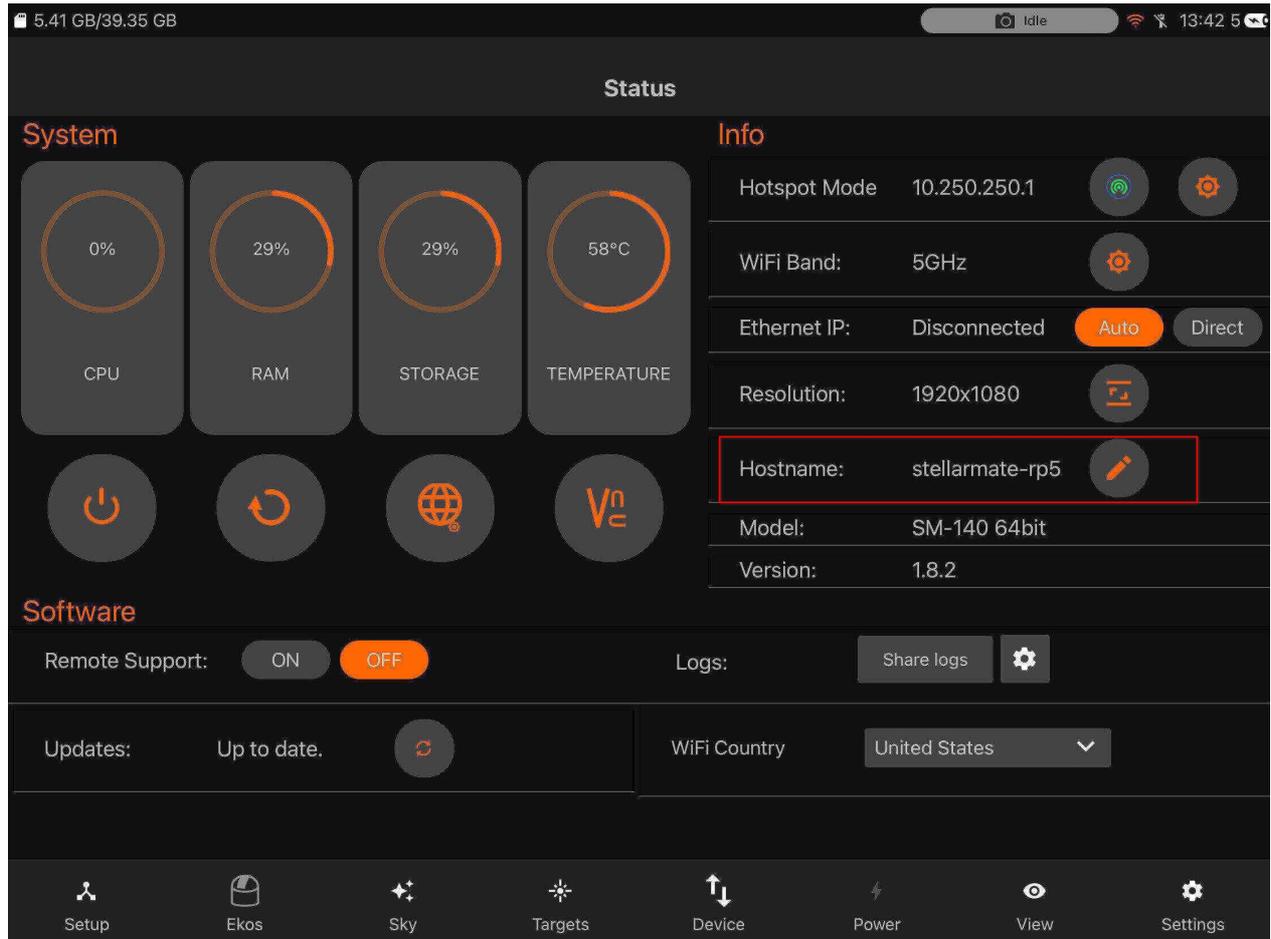
Apply entering desired hostname, press "Apply" and reboot your SM unit to get settings applied all over.
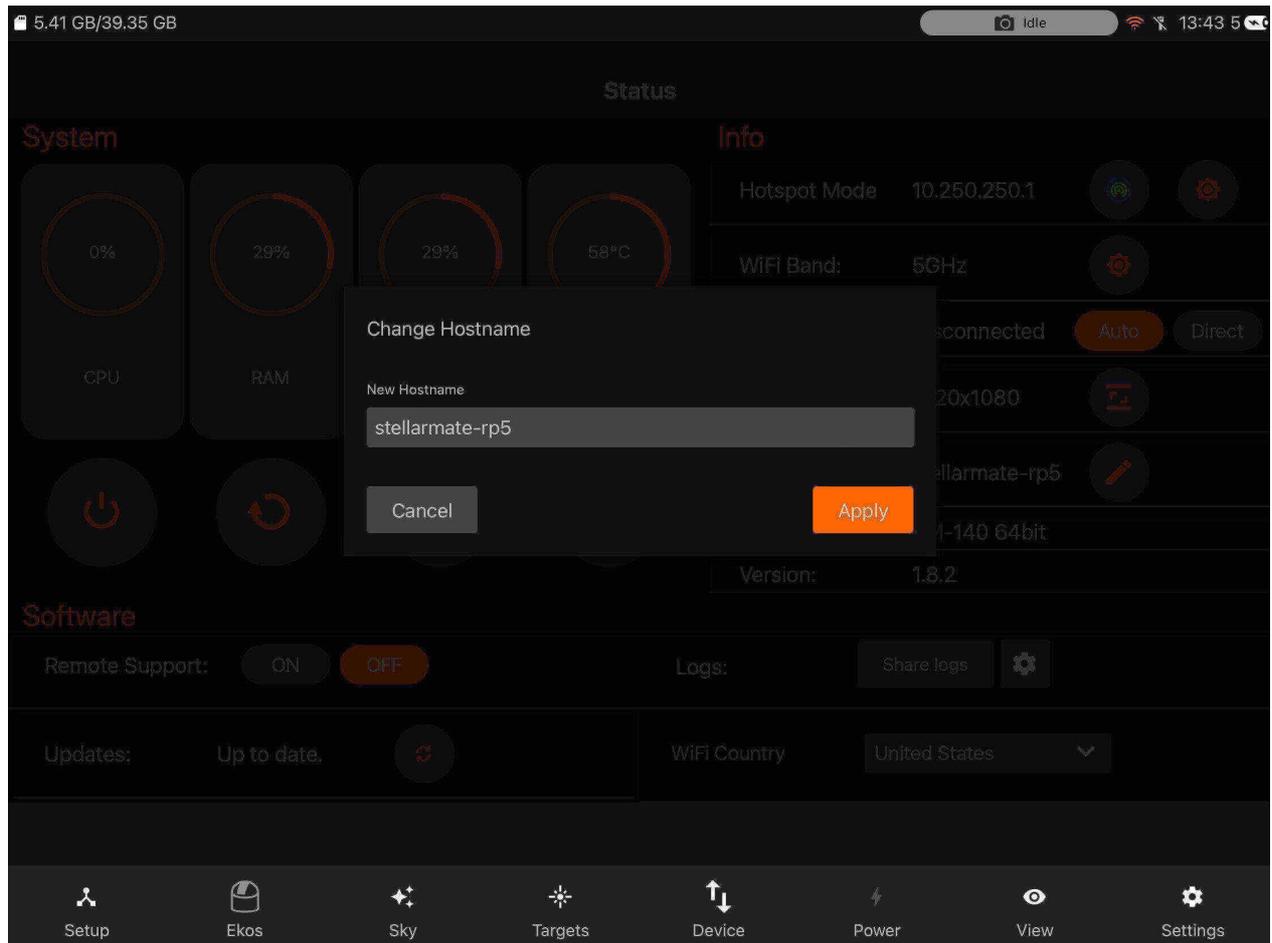
Software

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

- o [Firmware Updates](#)
- o [Remote Support](#)

Firmware Updates

When there is an update available for StellarMate, an icon will show up on Device tab.
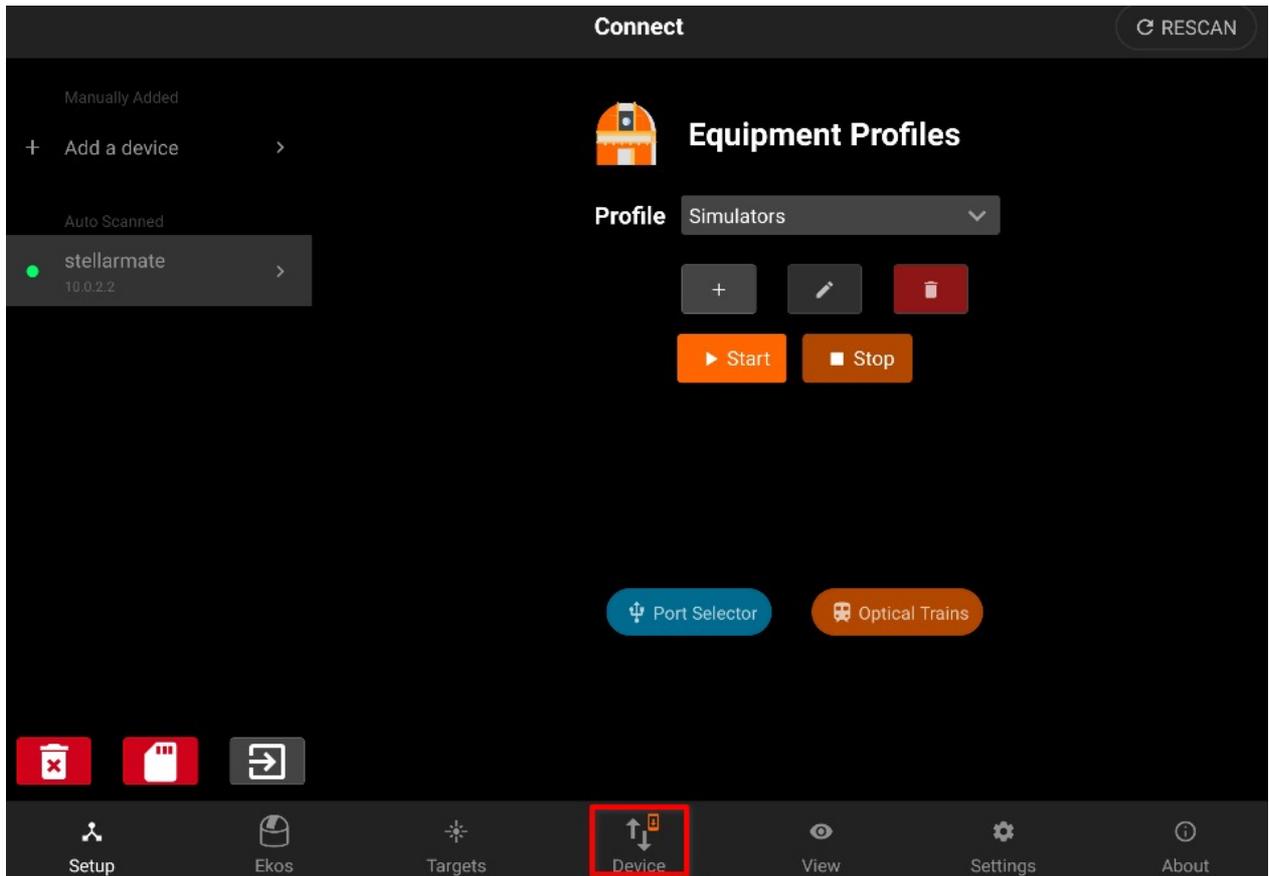
To update StellarMate, simply click the download button and wait for the the process to complete.
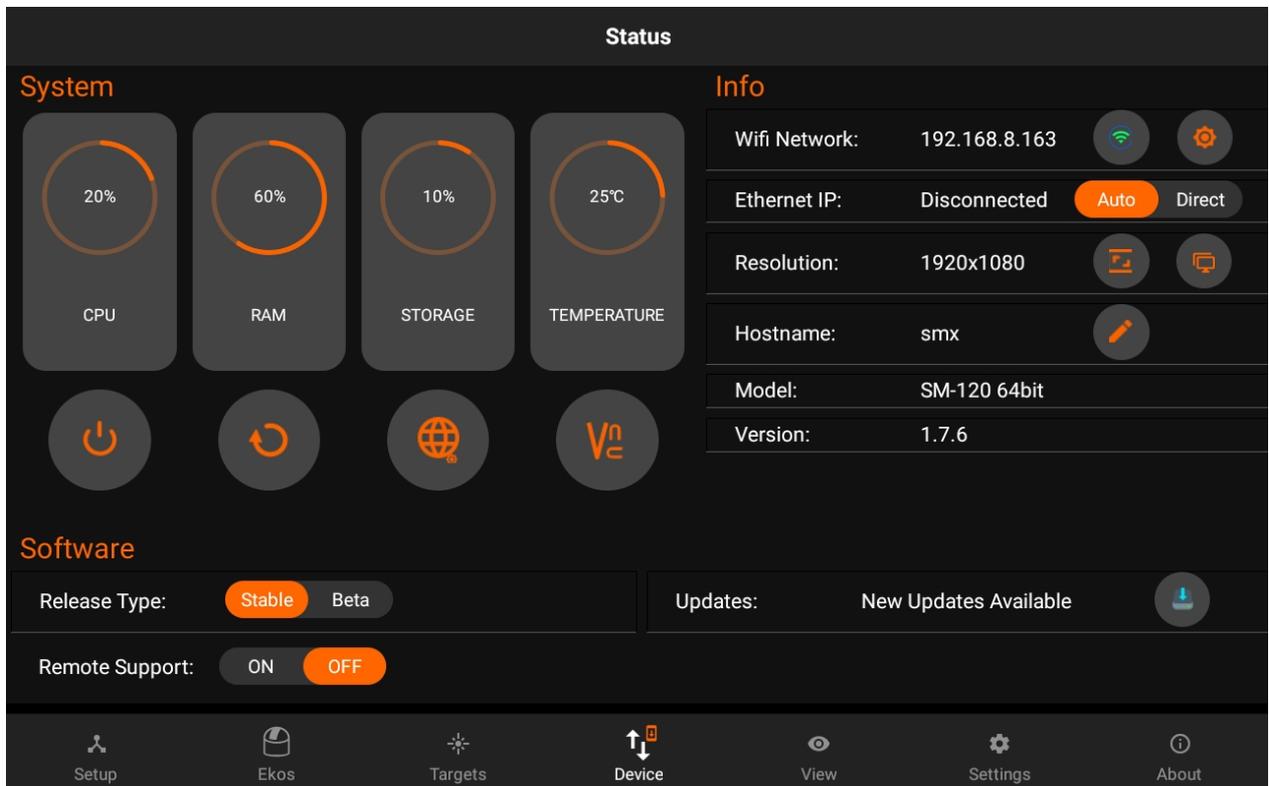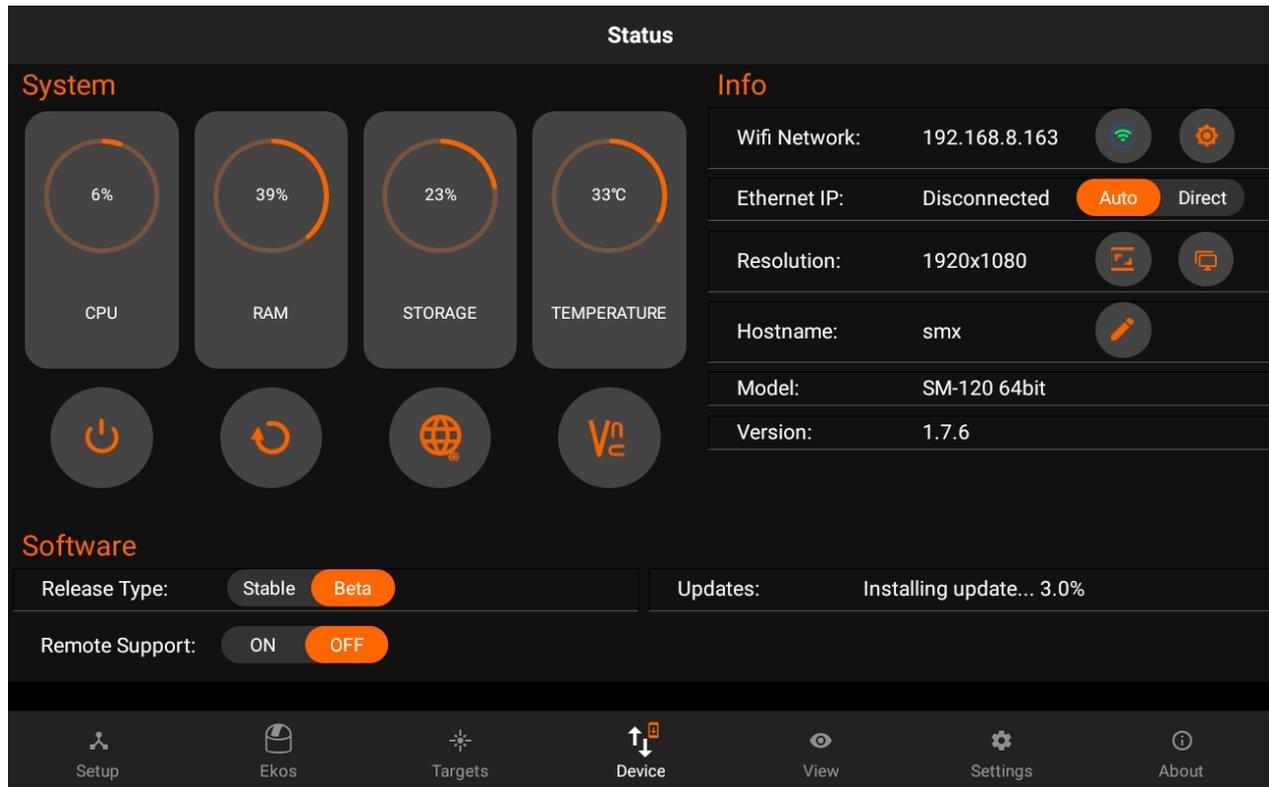
Once the update is complete, you will be prompted to restart Stellarmate for the updates to take effect.

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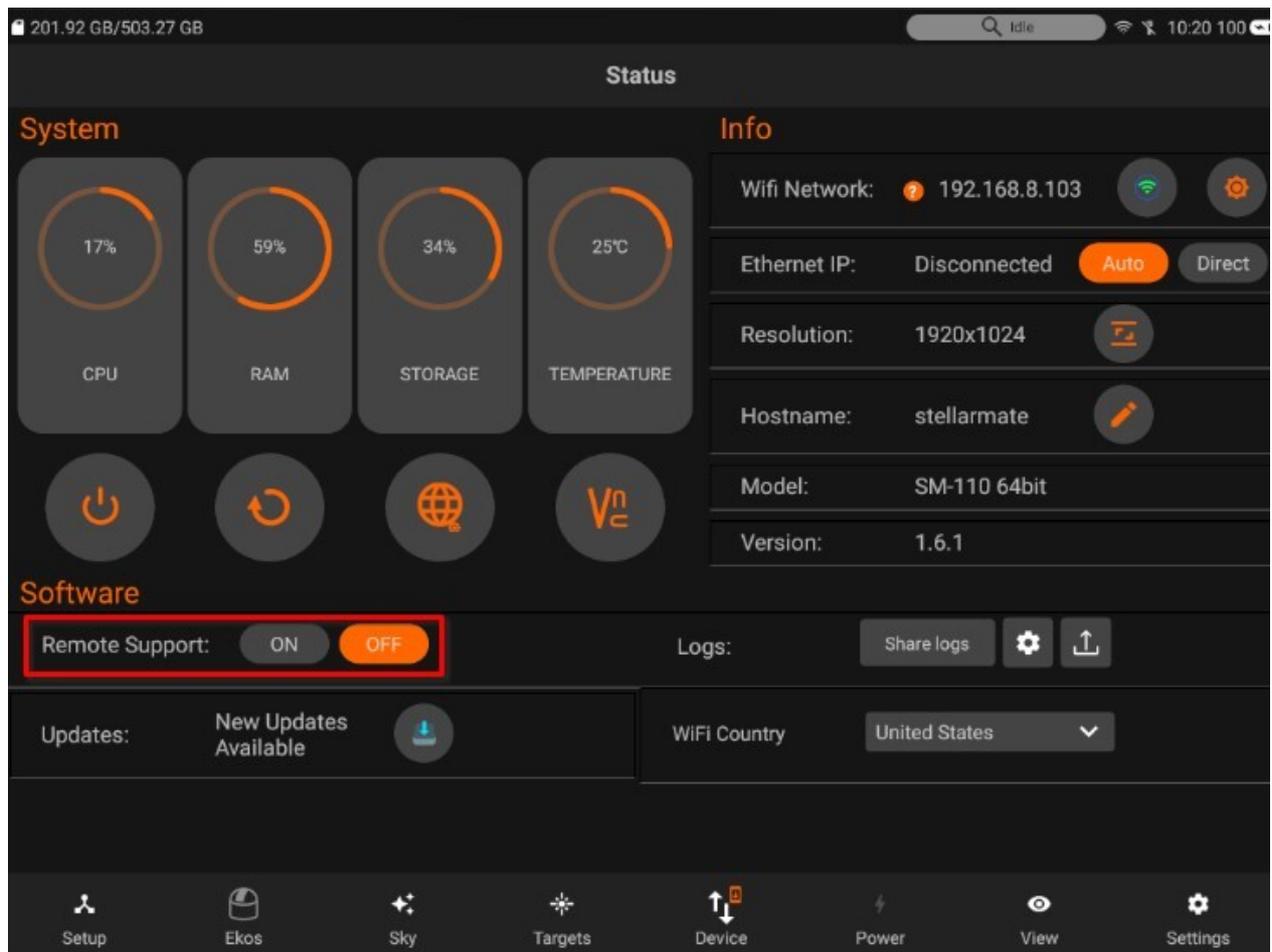
You can toggle Remote support if SM support asks for its access to investigate the issues you face. Once you toggle it ON, You wil see an ID.
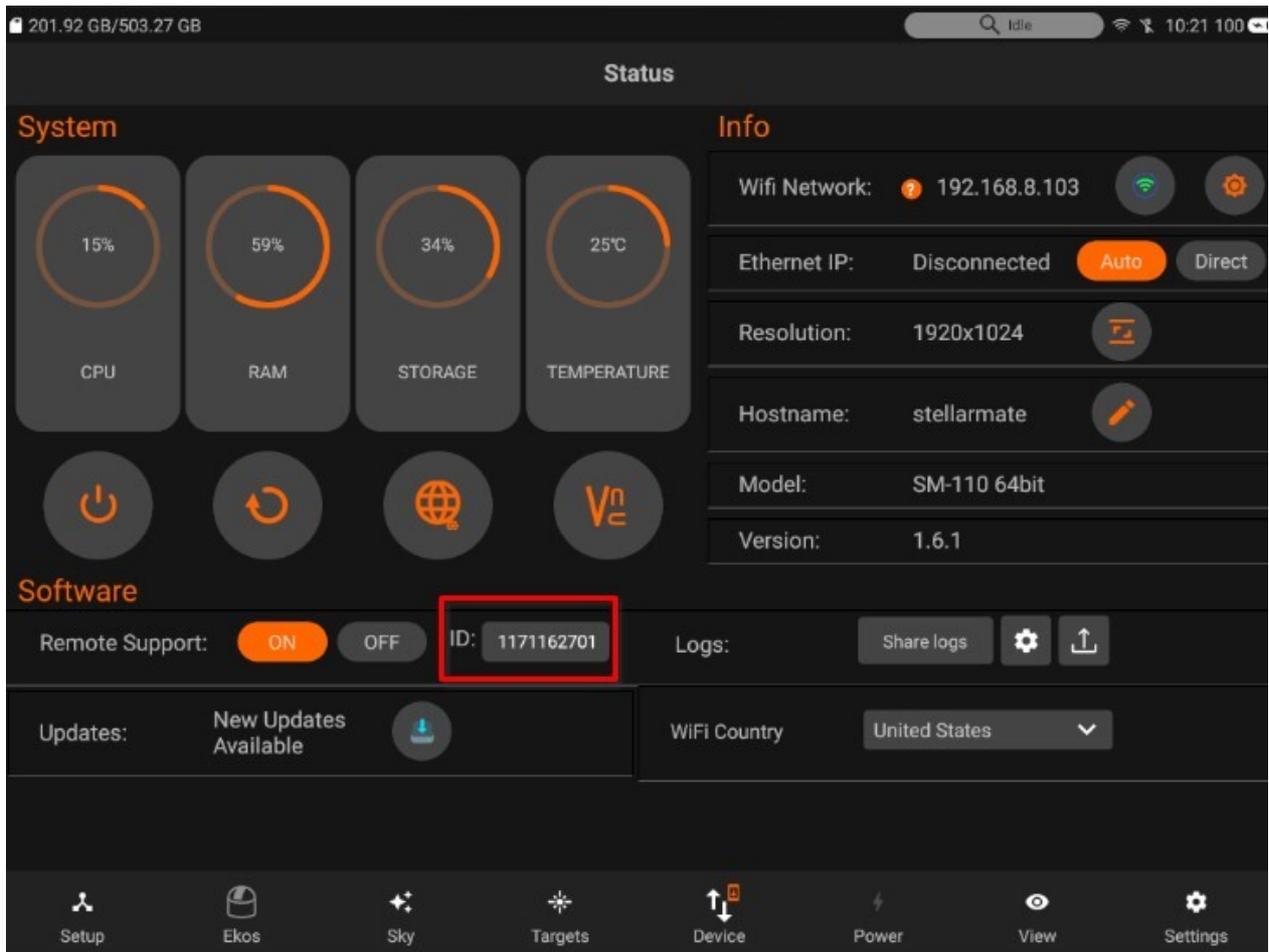
Logs

- **Logs:**

  o Pressing on share logs will generate the latest logs which can be helpful for SM Support.
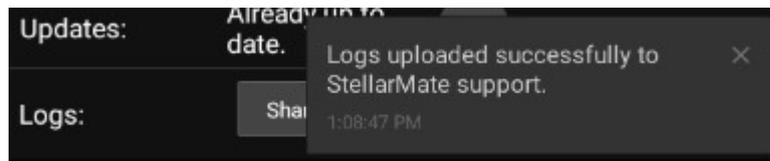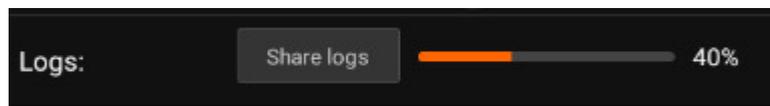
Following necessary logs are mentioned below:
- INDI logs / Configuration files
- EkosLive
- Device manager

- Boot
- Network manager etc..

- **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.
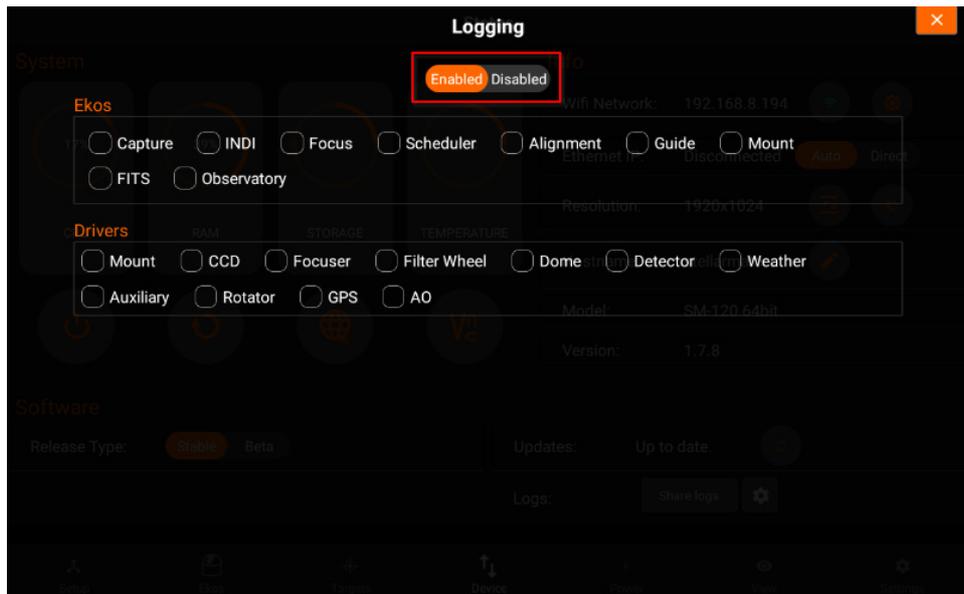
Power

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.

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. Set variable voltage level (3 to 9 VDC)
6. Voltage, Current, and Power measurements.
7. Power Off all ports when equipment profile is disconnected.
8. 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.

9. Toggle All the unit LEDs on or off. This is remembered on the next power cycle.

10. Toggle buzzer

11. GPS Lock indicator

    a. **Yellow**: GPS lock in progress.

    b. **Green**: GPS 3D lock successful.

    c. **Red**: GPS lock failed.

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.
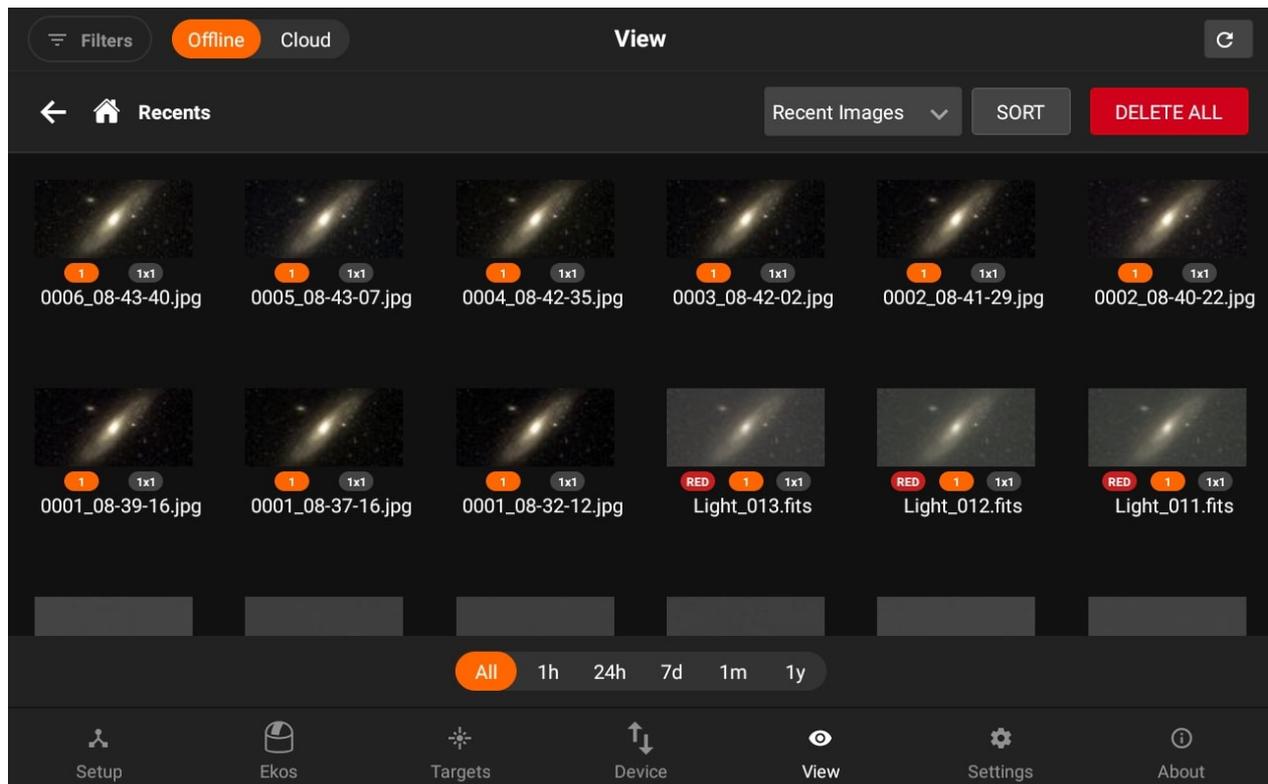
Images are displayed in a grid view, Under each image there are badges for Filter, exposure duration, and binning. By default, all images are displayed in the grid without any filtering or sorting. Click on an image to view the full-size version which also provides further actions such as export and 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.
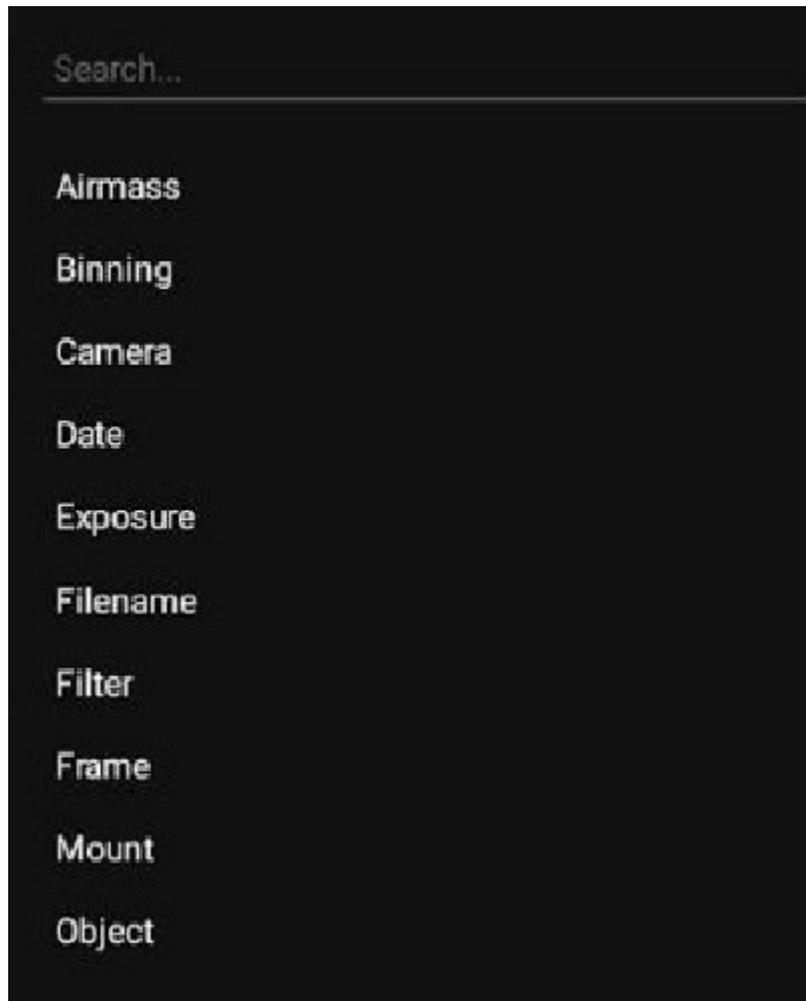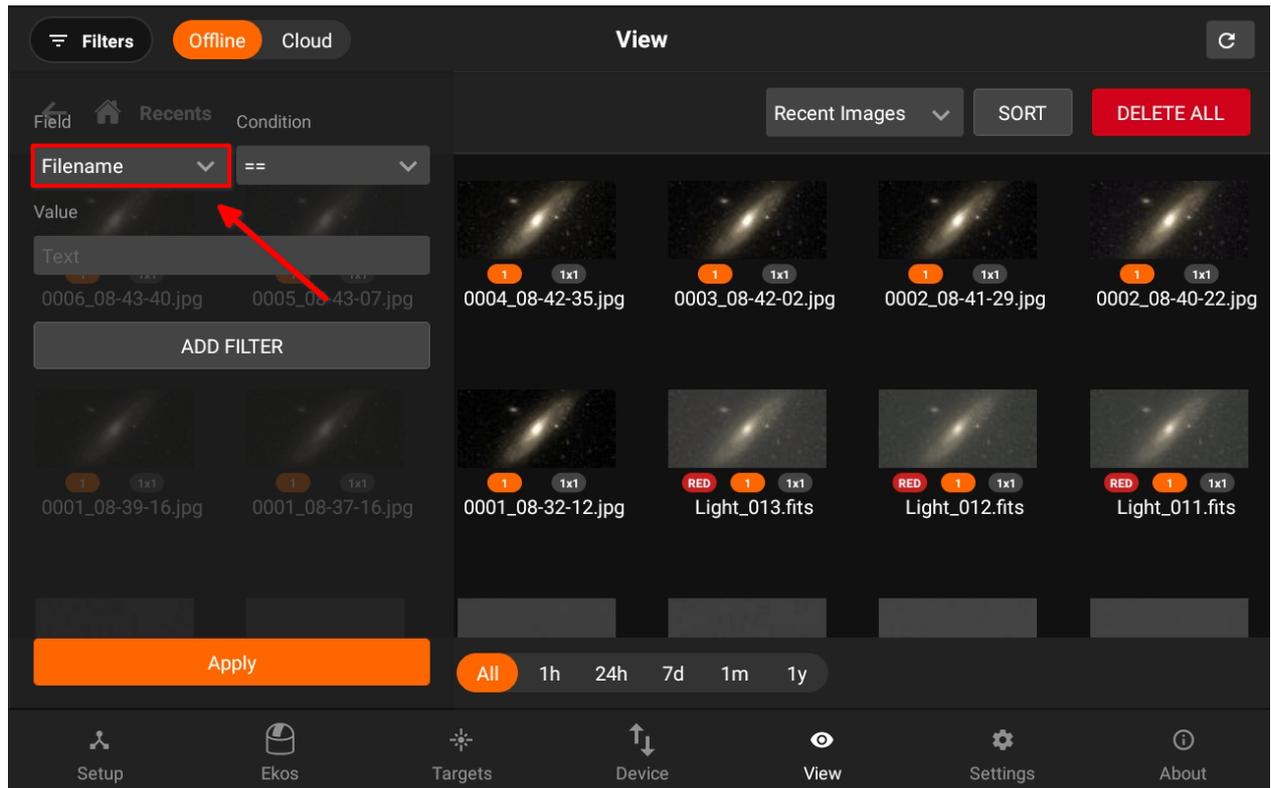
StellarMate aggregates images in Virtual Folders based on the selected Virtual Group:
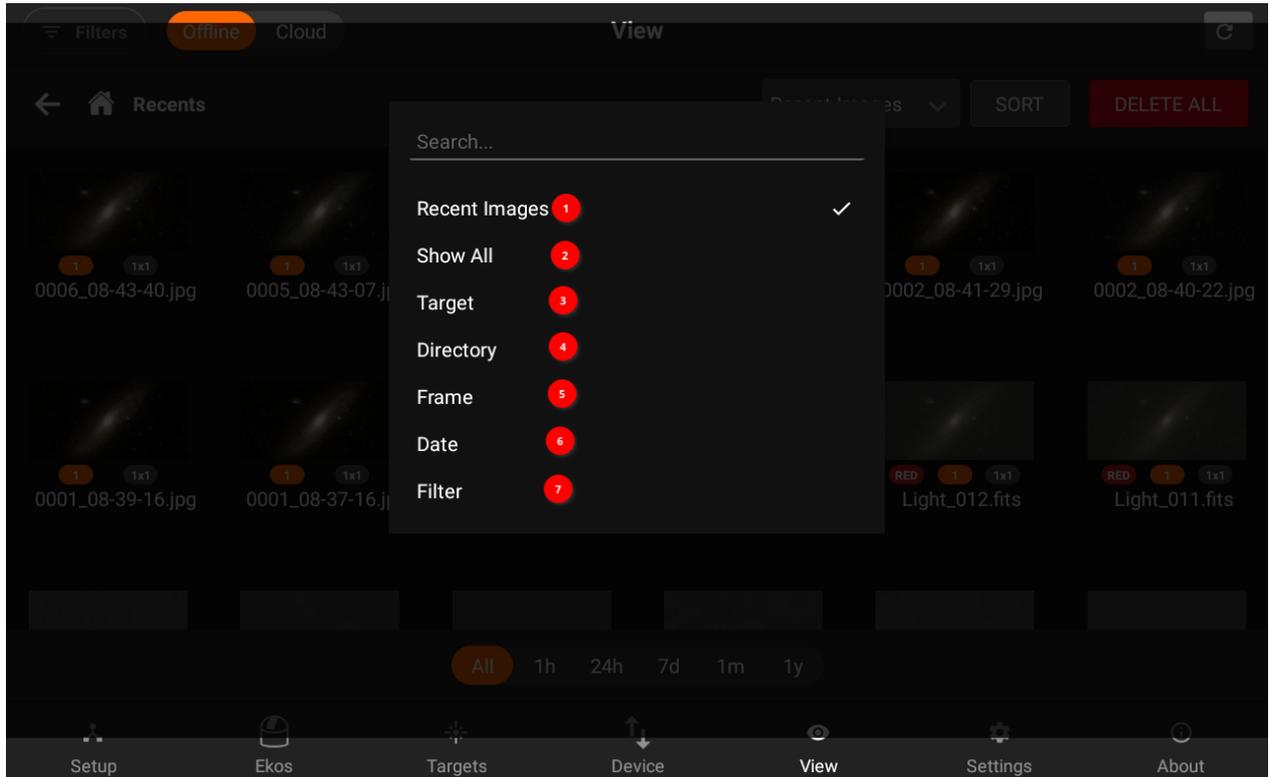
1. Recent Images: Shows 20 latest images captured.
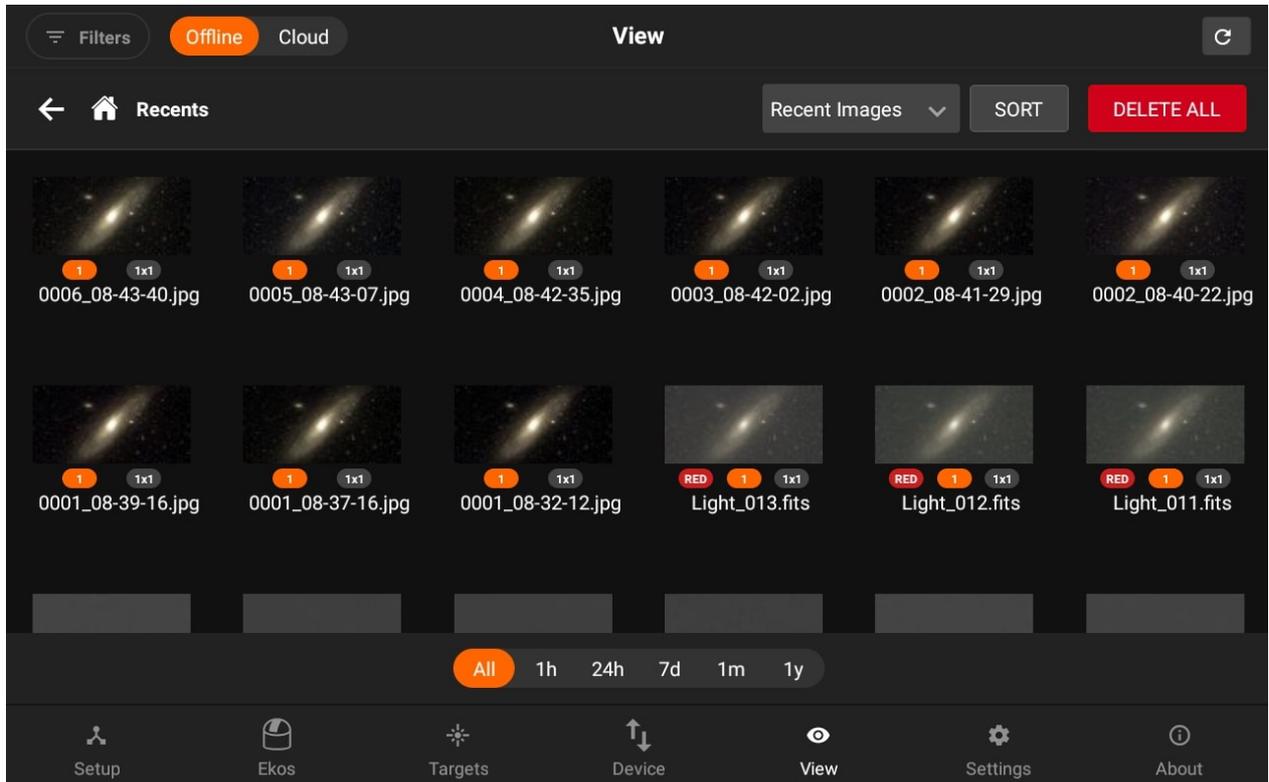
2. **Show all Images**: Show all directories & images under /home/stellarmate/Pictures.
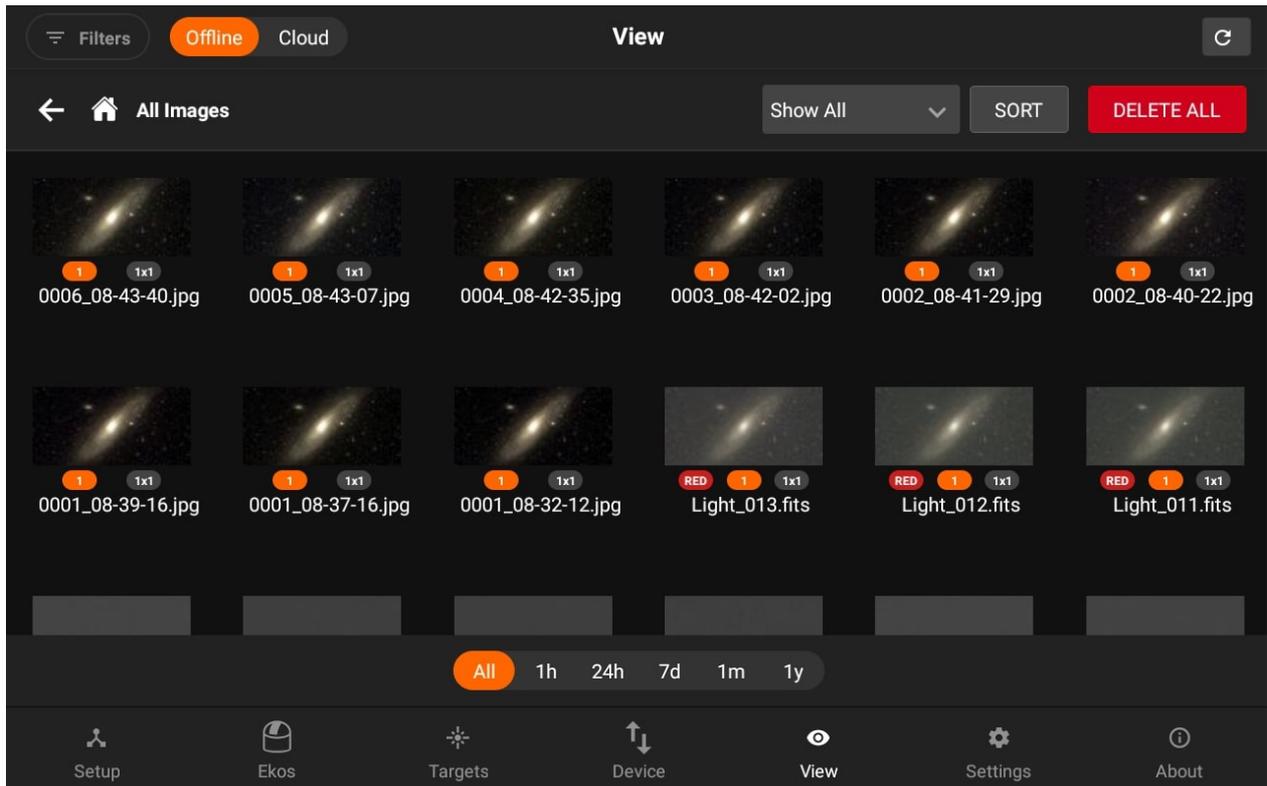
3. **Target**: Group images by each unique target together regardless of where they are physically located on the device.
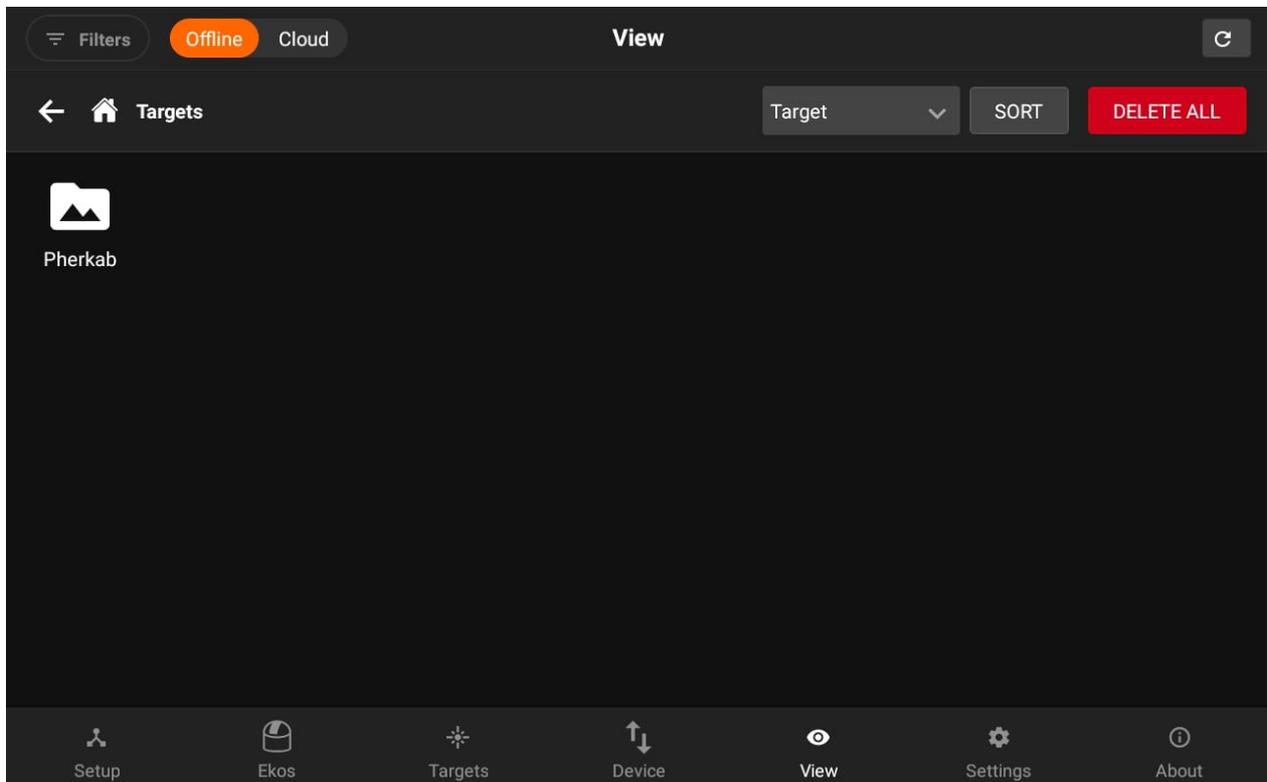
4. Directory (Default): This is similar to a traditional File Explorer where images are

grouped by directory on StellarMate.
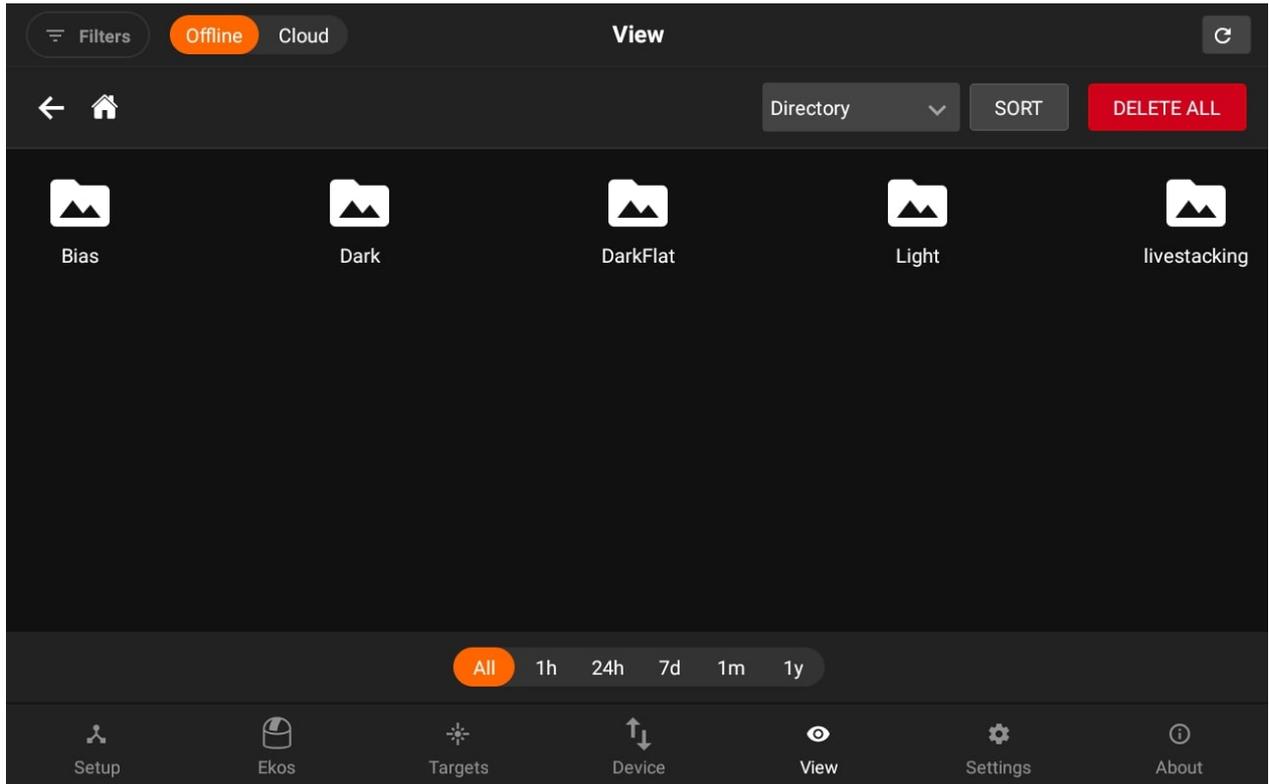
You can now also delete the directories. In order to delete a directory, just visit the directory and you will see the delete icon button beside the directory locatory to delete all images in a directory.
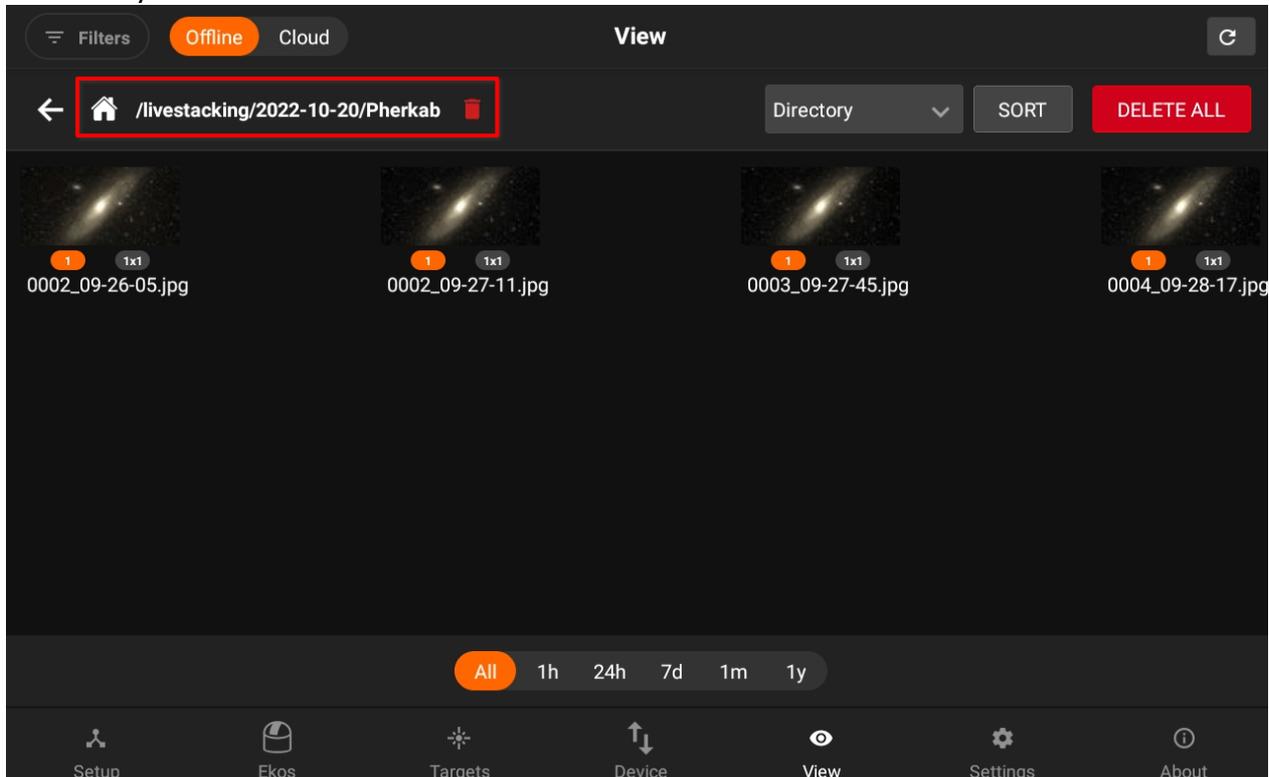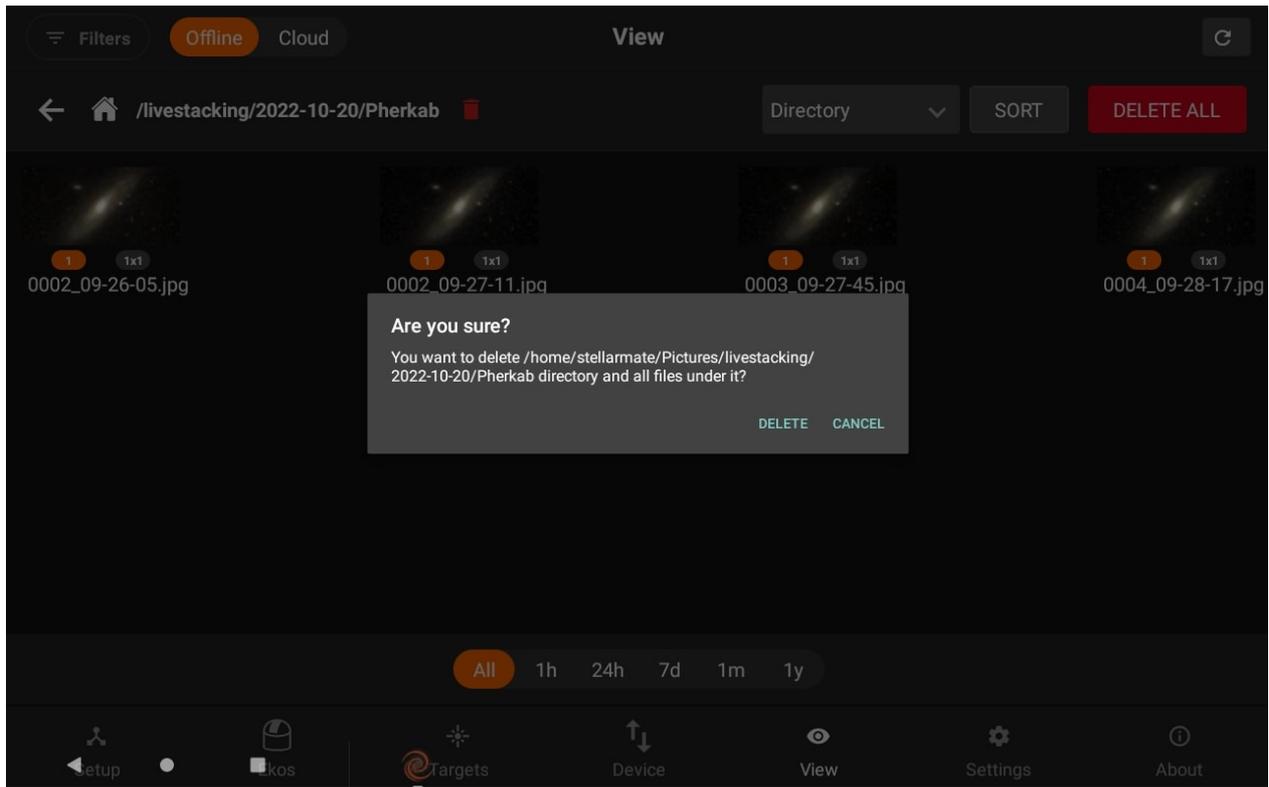
5. Frame: Group images by each unique frame type (i.e. Light, Bias..etc).
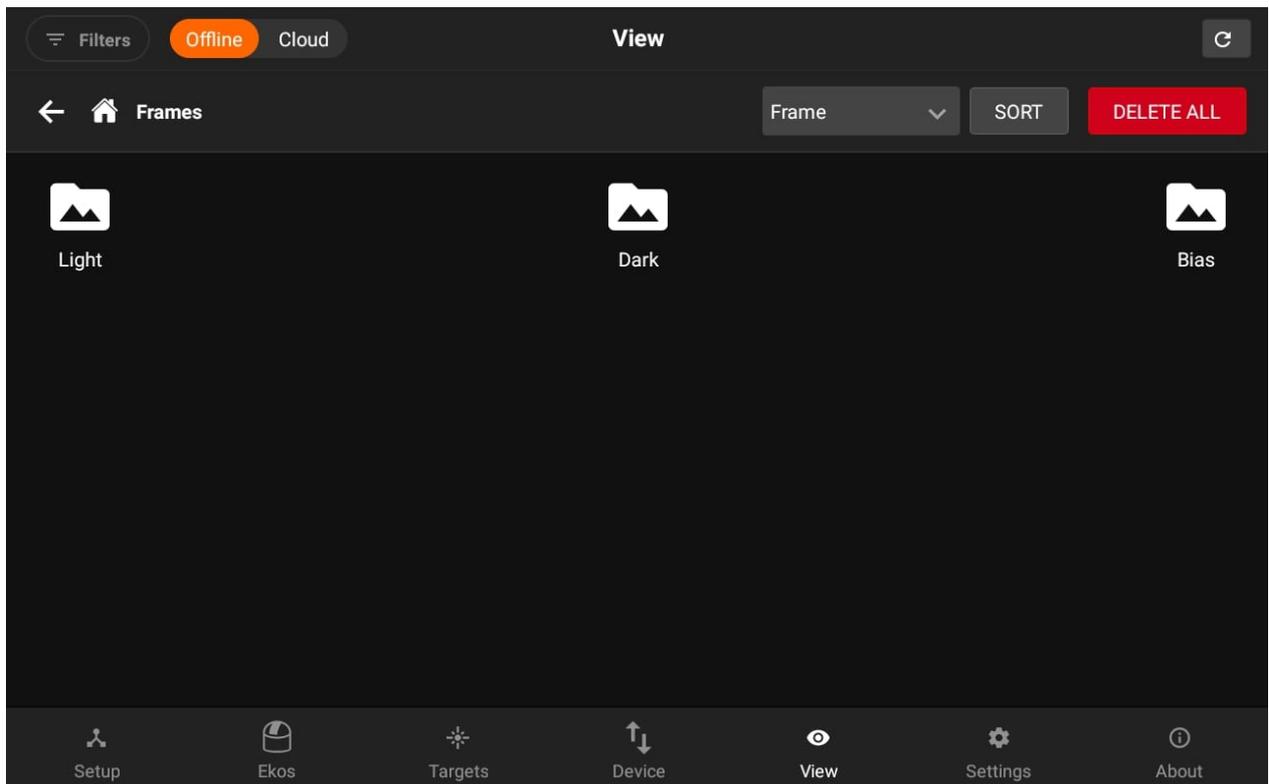
6. Date:Group images by date whereas images captured on the same day are grouped together.
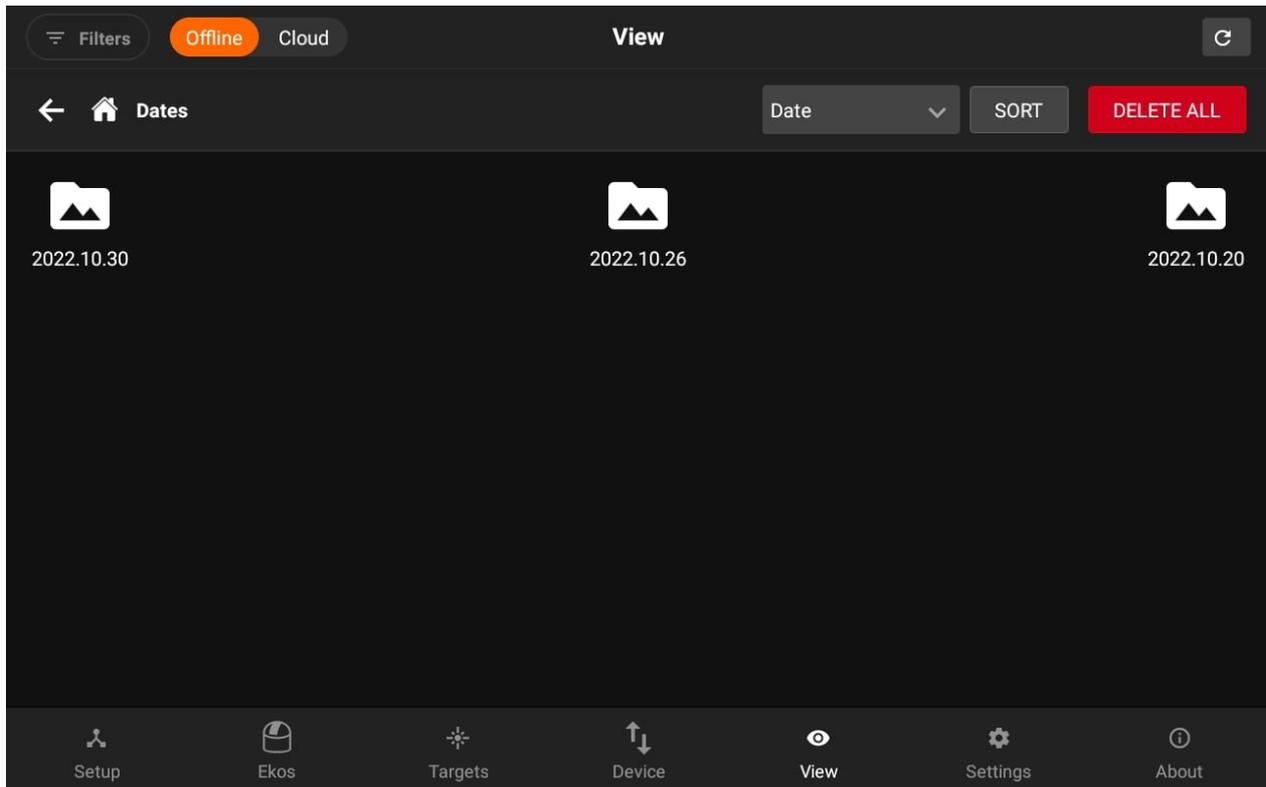
1. Per filter: Images are shown per filter. Those folder directories are Virtual folders.

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.
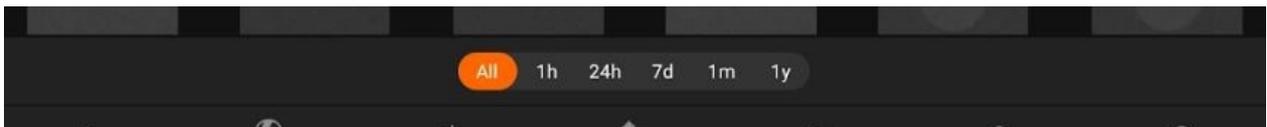
You can view the image in full size by click on a specifc image.

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.
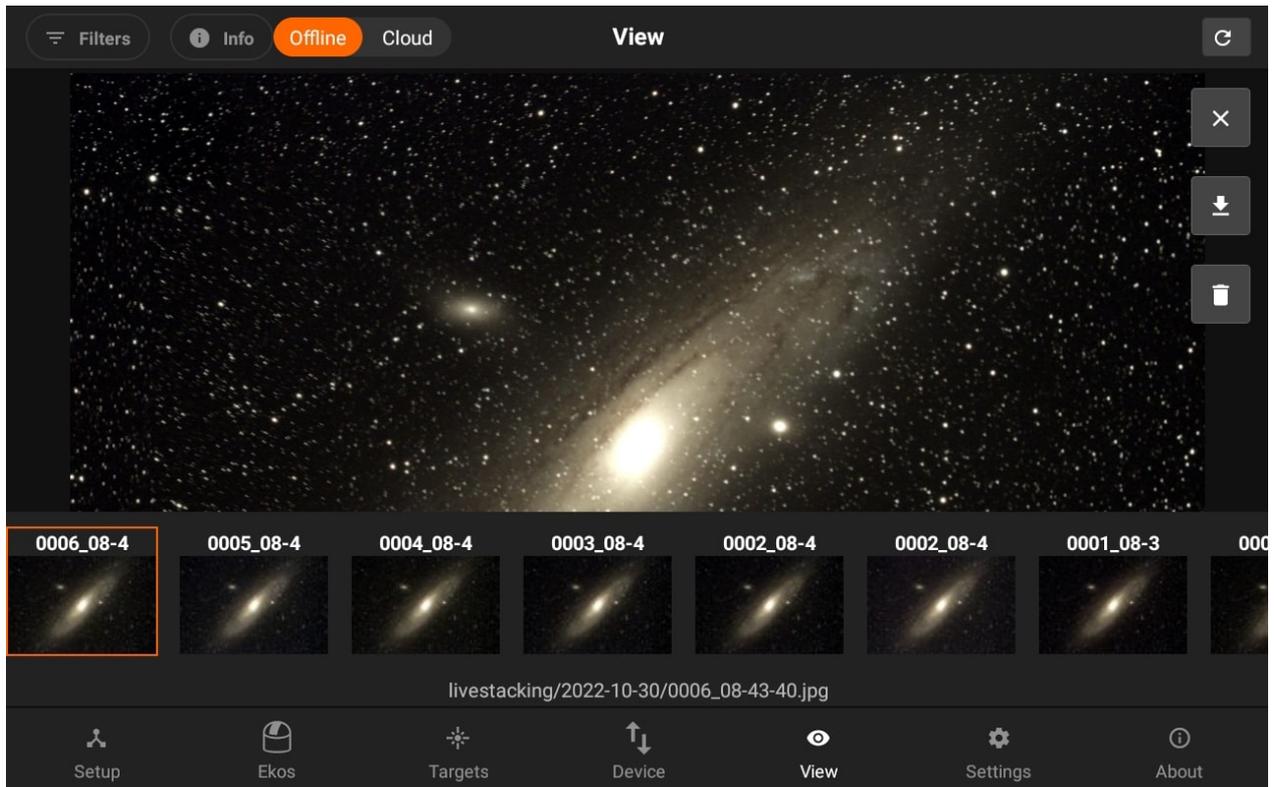
- Sort:

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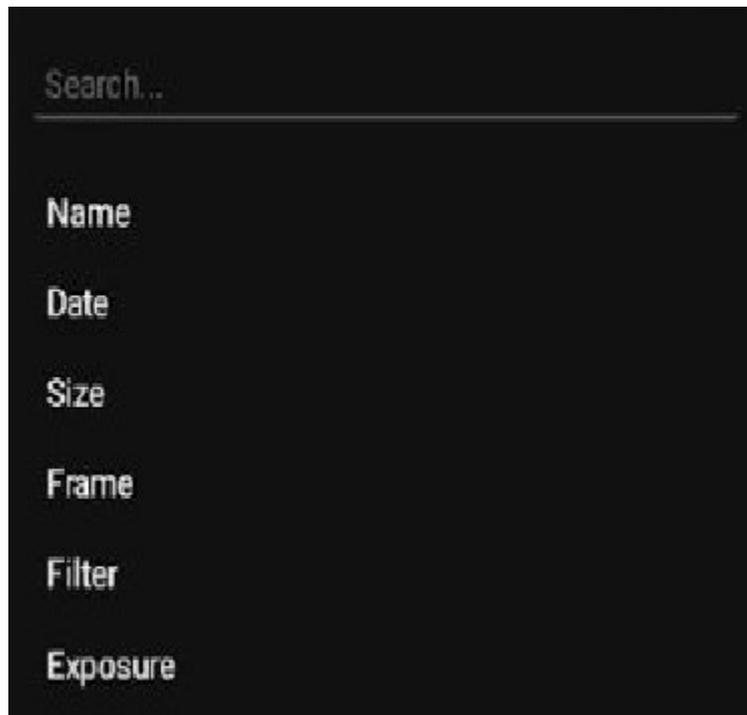
- Delete all:

Deleting all images will delete all the images exists in the specifc 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.
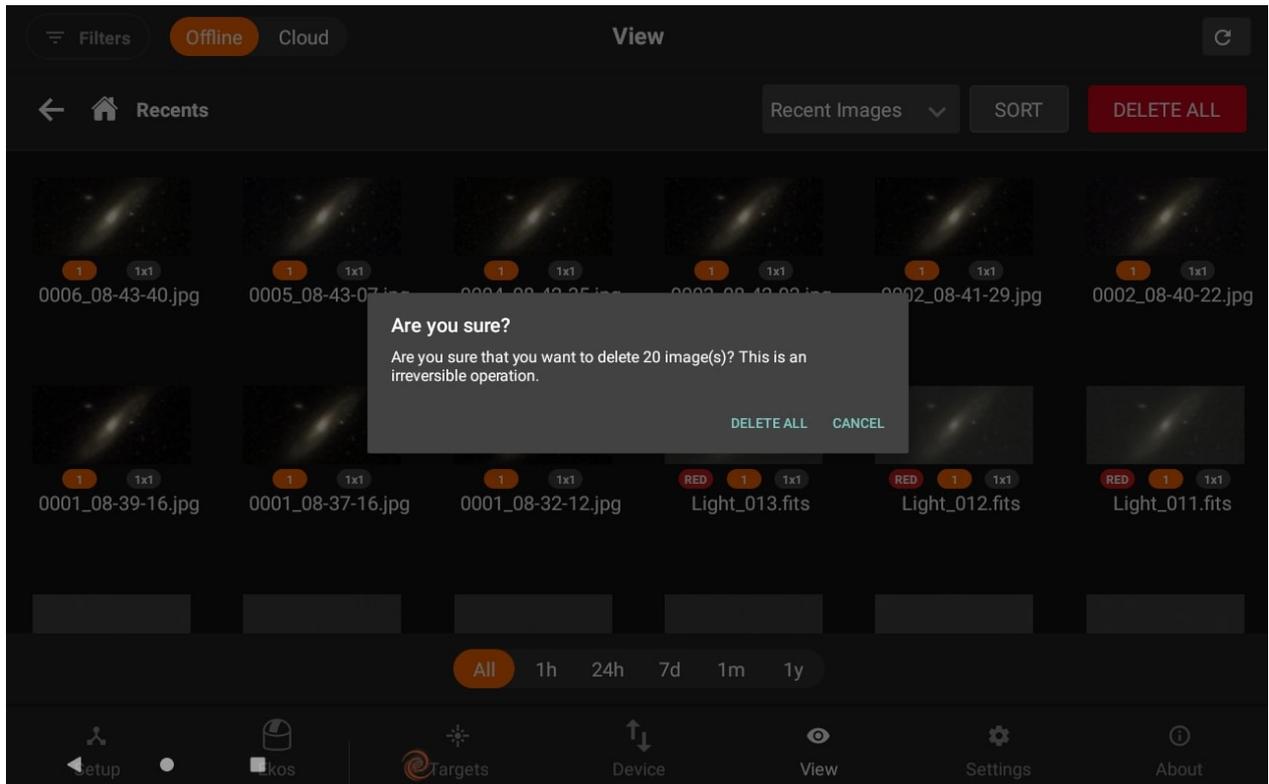
Settings
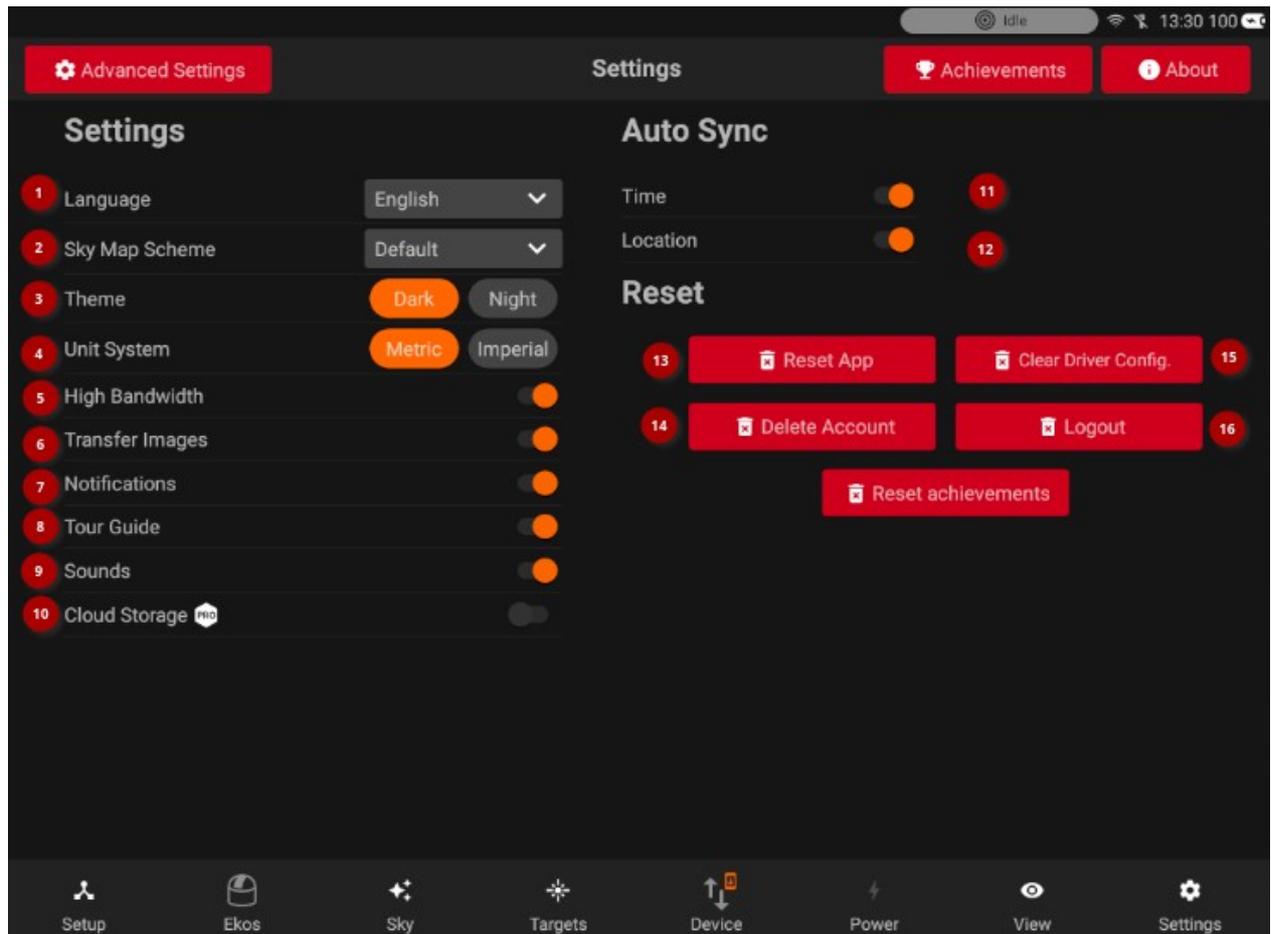
General Settings

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 for more information.

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

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.
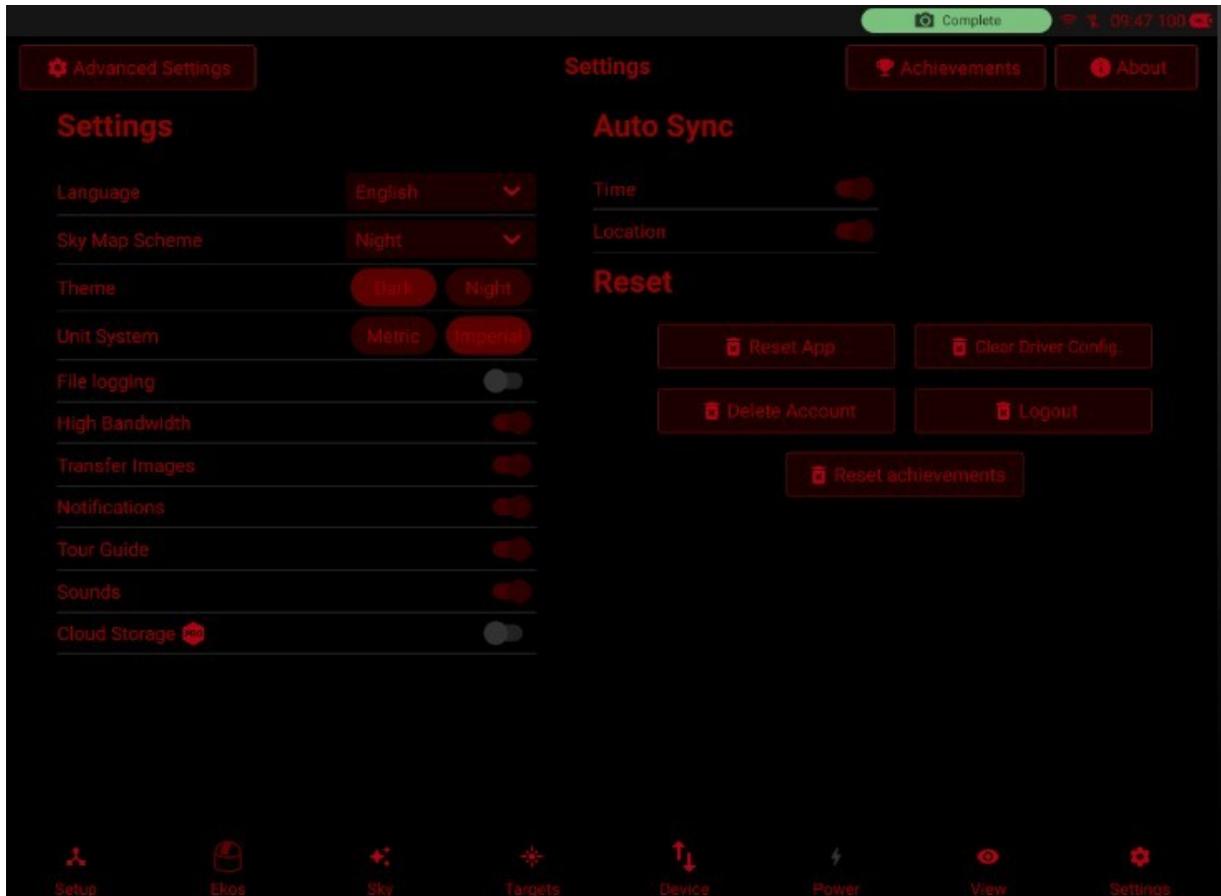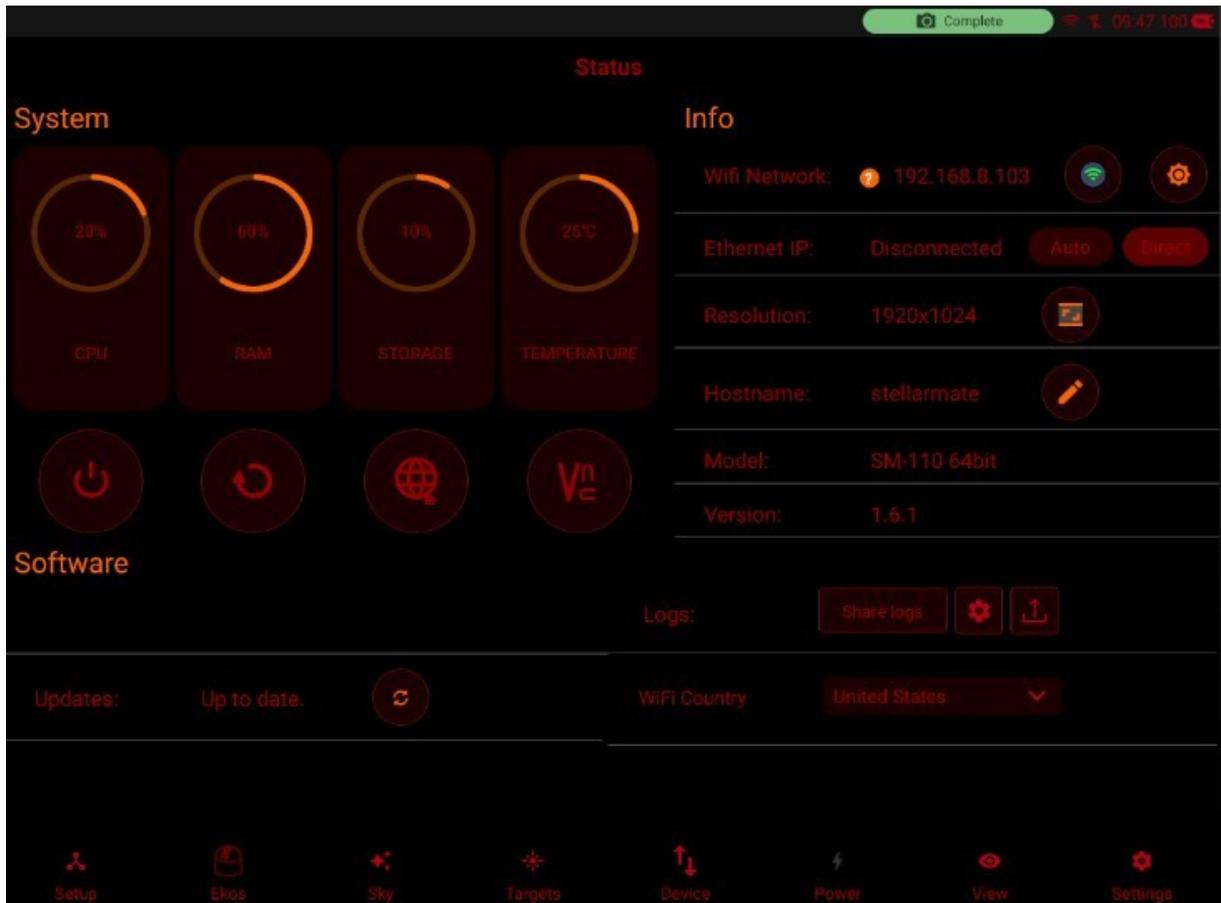
4- Unit System: Unit system used for weather related information. All other units in the App use the Metric System by default unless explicitly mentioned.

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- Transfer Images: Should only be turned off under special circumstances when network communication is unreliable.

7- Notifications: Toggle in-App notifications.

8- Tour Guide: Toggle to re-enable the App Tour Guide.

9- Sounds: Enable sound notifications, the following events trigger a sound notification:

- o When the capture sequence is aborted or completed
- o When the Polar Alignment mount position changes

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.

- o Pro users can enable the Push notifications. If they are enabled, users will be able to get the notifications on their Tablet device.
- o Users who are not subscribed to EkosLive Pro will see a pop up as shown below:
- o In order to subscribe, you can follow the link here.
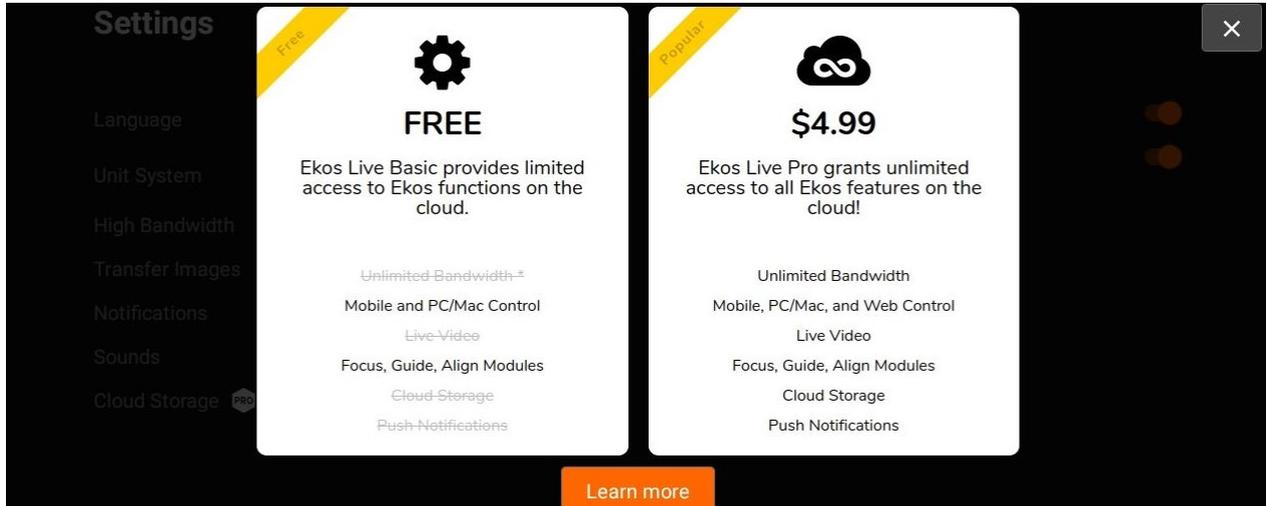
11- Auto-sync Time and Location: When the SM App is started, it syncs tablets time and send to Ekos.

Reset

13- Reset App: Wipes all local data in the StellarMate App. After the reset, restart the App.

14- Delete Account: Delete your account in stellarmate.com. Once deleted, the account and associated data will be permanently deleted.

15- Clear Driver Config: Wipes all INDI driver configuration. Use this only as a last resort.

16- Logout: Sign out of StellarMate App. Only use this if you need to sign in using a different accounts.

Achievements

You can now completed the tasks and earn points just. Achievements's Dashboard can be found in the settings.
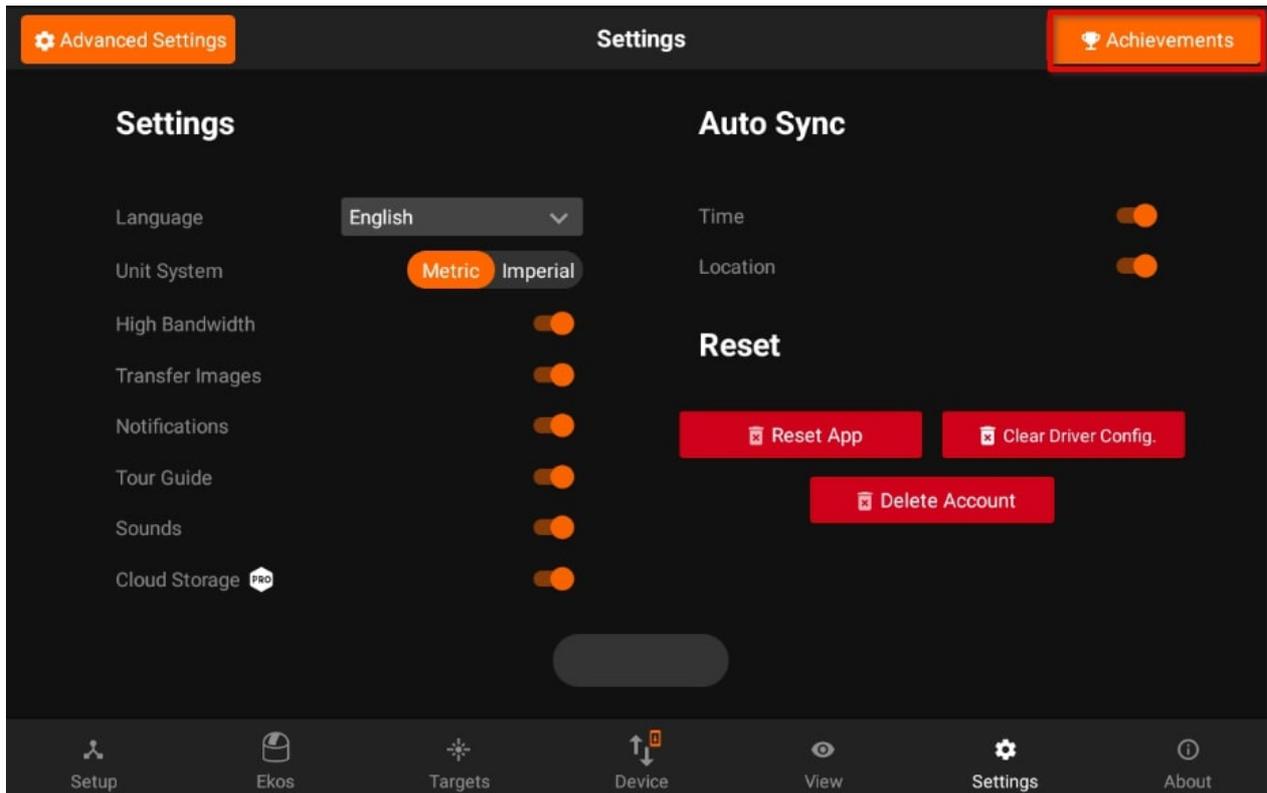
Once you complete the Achievement, Achievement earned pop up is displayed. Which includes the title of the Achievements and it's points. Few of the common achievements are:

1. Capture a preview:
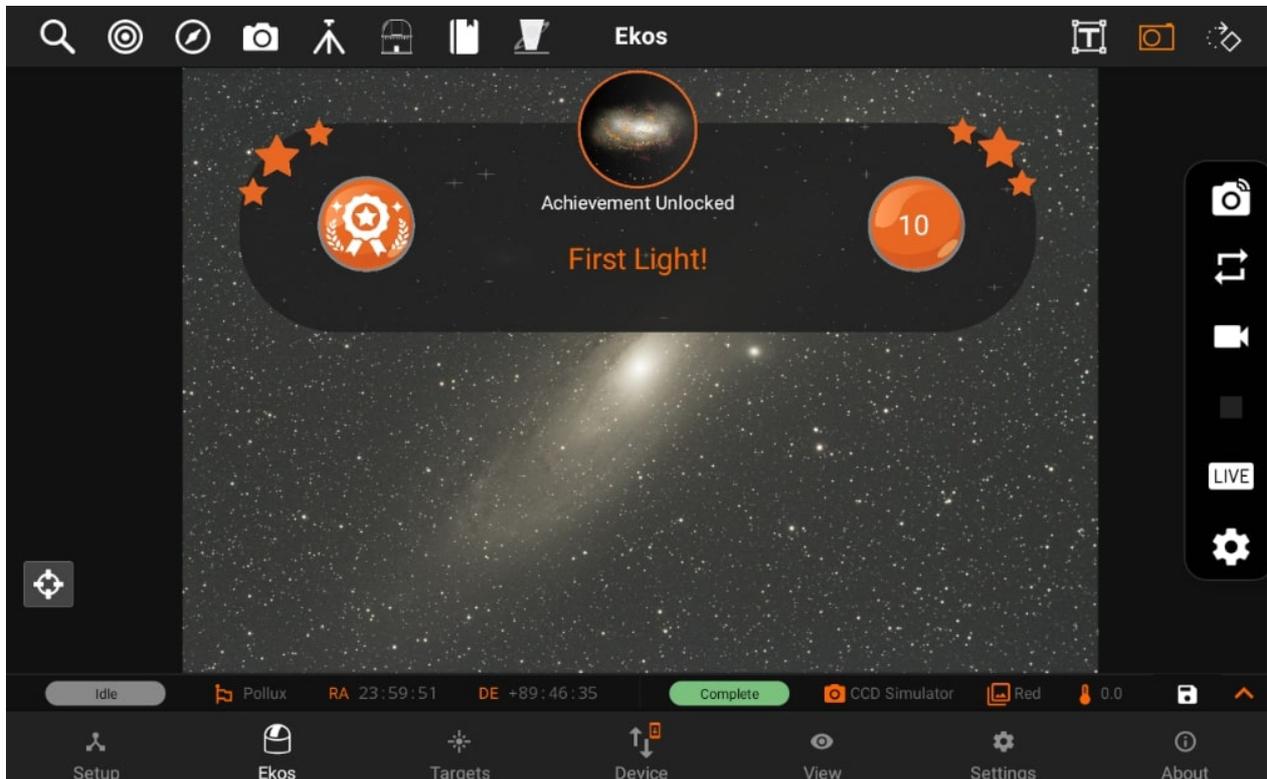
2. Capture ten sequences:

Once the Achievement is earned, it is marked as done in the Dashboard. And the points are added to your total score as shown on the top left.

No.	Achievements	Status	Points
1	FIRST LIGHT! Capture a Preview	✓ At 2023-01-31, 11:48:43	10
2	SO IT BEGINS! Capture a sequence with 10 counts	✓ At 2023-01-31, 13:51:59	10
3	MAGIC FINGERS Use Target GOTO by holding on the object for 3 seconds when the new image is captured	✗	10
4	DIRECTOR'S CUT Record video for 1 minute	✗	10
5	CLOUD MAGNET Use Cloud Map in weather info, Zoom in to at least 8x to check weather	✗	5
6	LET THERE BE DETAILS Live stacking. Perform at least 5 images	✗	15
7	EMBRACE THE DARK SIDE Create Darks of total 50 Images	✗	10
8	COSMIC MAKEUP Generate hot / cold pixels in Defect map above 80	✗	10

Total Score: 20

Achievements Info

Captured messiers are marked here. If all messiers are captured then Achievement is marked as done

Push Notifications

Push Notifications (required EkosLive Pro Subscription) keeps you informed about important updates or activity with StellarMate. For example, if a capture sequence is aborted, then this will fire a Push Notification alerting you to this event.

Notification Verbosity can be controlled depending on the level of information you want to receive. The App provides highly customizable notifications settings:

1. **Category**: Toggle which categories may send notifications (e.g. Mount, Scheduler, Capture..etc)
2. **Severity**: Toggle which severity level can trigger notifications.

Connection Methods

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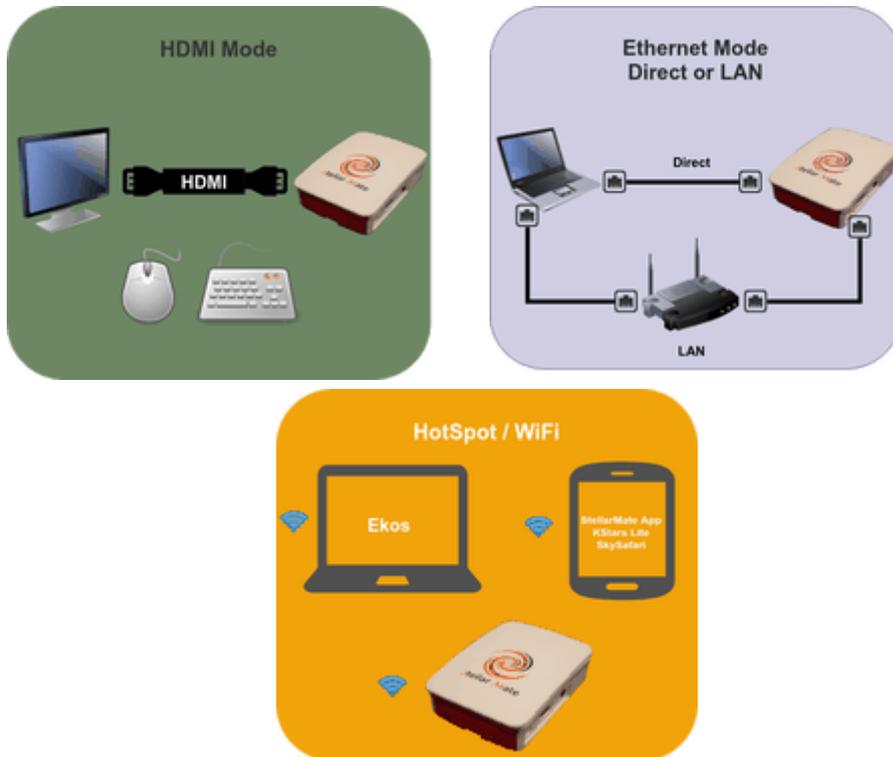
Direct HDMI Connection

> ℹ **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 is to enable you to always access 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.

Connecting your equipment

StellarMate supports connecting to your equipment via WiFi, Ethernet, Bluetooth, or USB. USB is the primary connection method for most astronomical devices. Make sure all equipment is sufficiently powered and initialized before connecting them to StellarMate. For mounts, most mounts need to be already aligned before you connect them to StellarMate.

The following equipment-specific guides provides the standard methods for connecting such equipment to StellarMate:

- [Mounts](#)

- [CCDs](#)

- [DSLRs](#)

- [Focusers](#)

- [Filter Wheels](#)

To learn more about connecting your equipment to StellarMate, find out more in the detailed [equipment connection guide](#).

Connecting from Ekos

Click on [KStars](#) icon on the desktop to launch it. After initial startup, complete the wizard to set up geographical location and download any extra data (Internet connection required).

Launch Ekos either by press Ctrl+K, or by pressing on the Dome-shaped icon in the

Toolbar

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 the wizard-wand icon in Ekos summary screen.
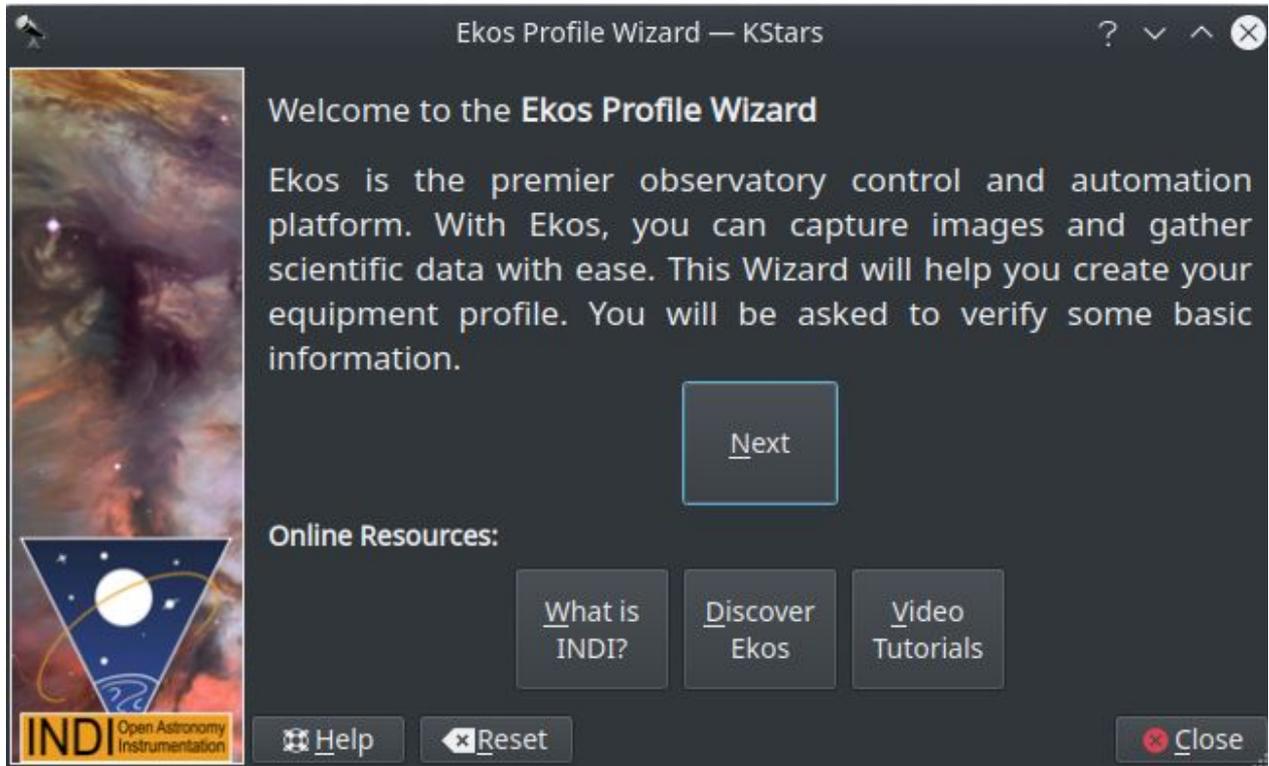
Click Next to proceed to the next screen.
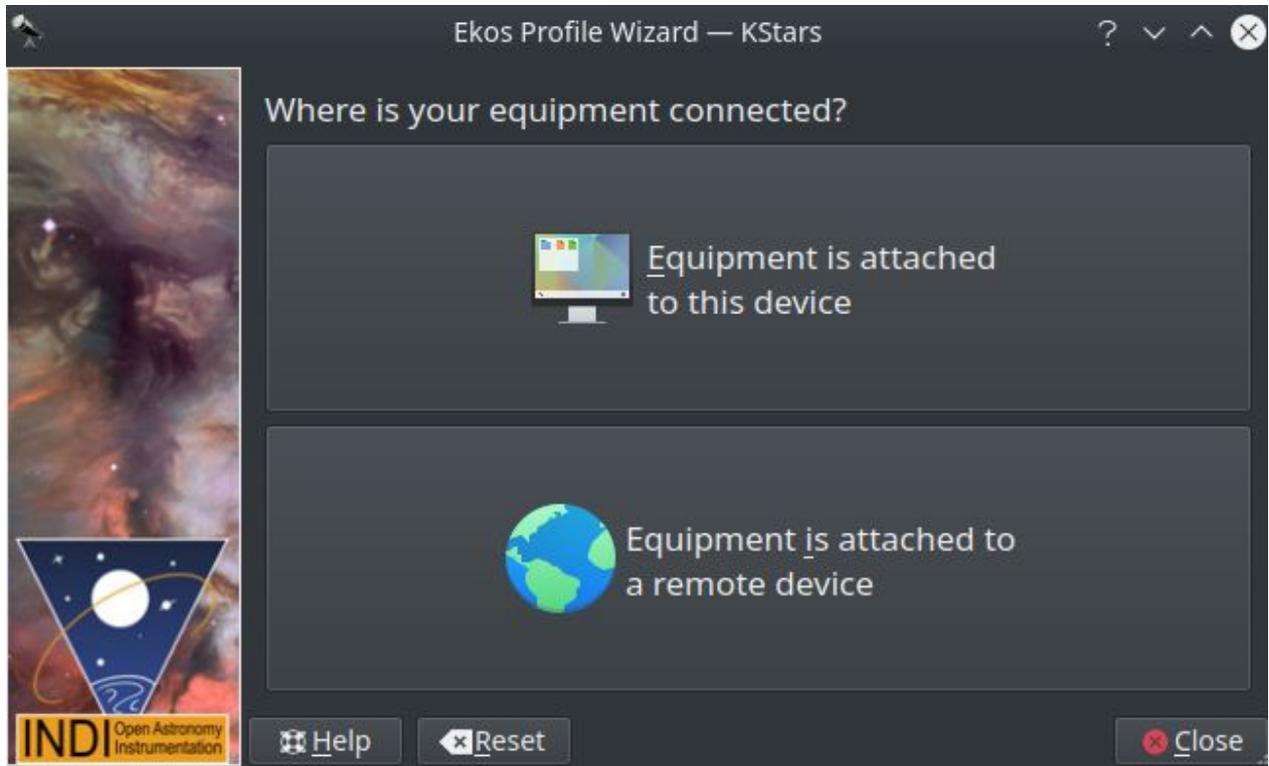
In here you need to select if your equipment is attached to StellarMate or elsewhere. Since you are directly connected to HDMI, then you select Equipment is attached to this device.
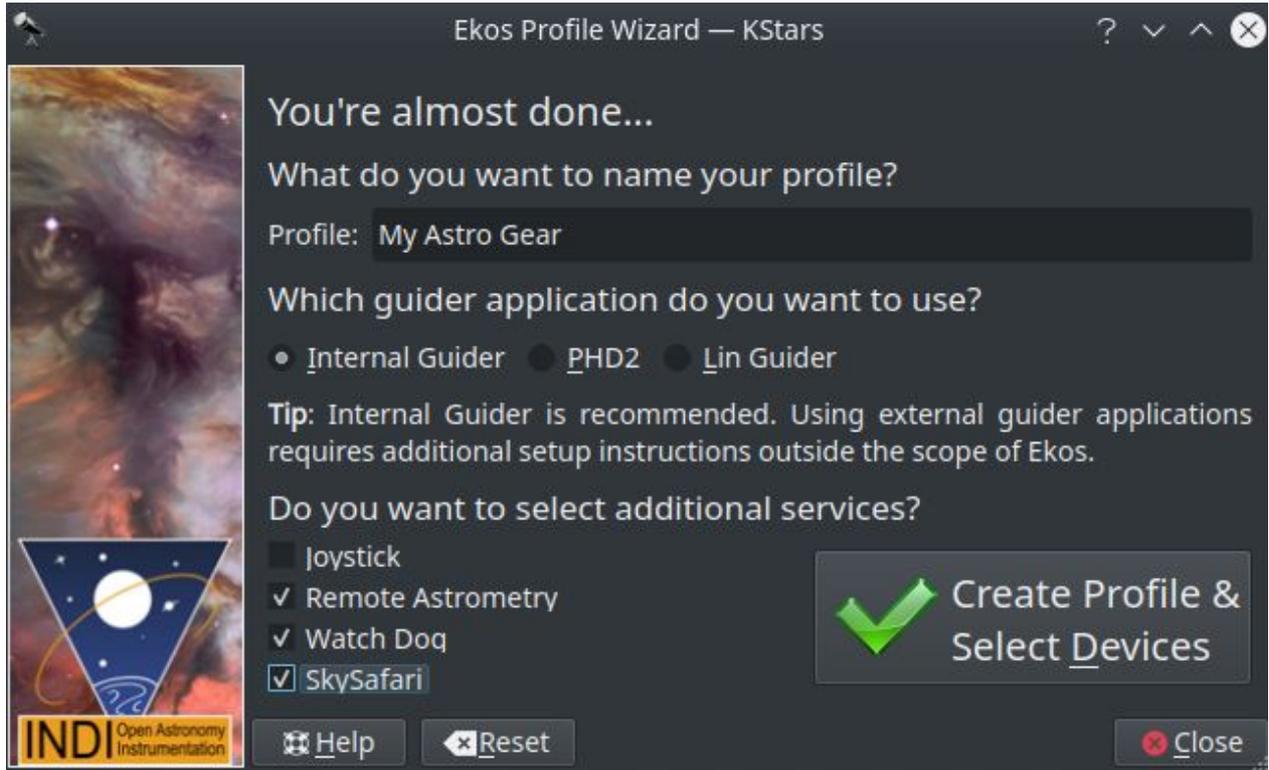
Next, select your equipment profile name and any additional services you want to run then proceed to create the profile.
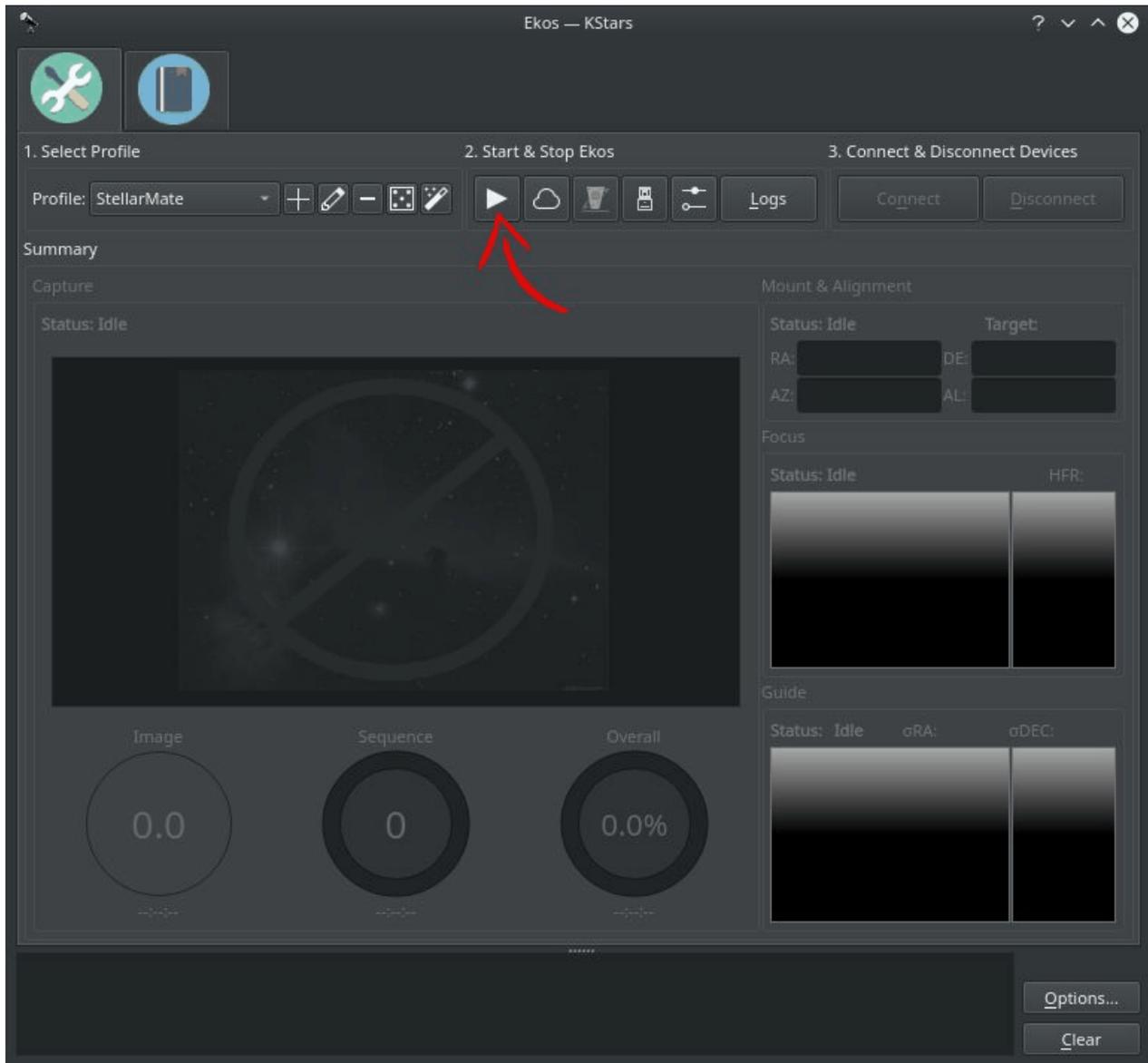
To connect to your equipment and start using Ekos, simply click the Start button as illustrated above.A

Ethernet Connection

ℹ️ 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 is to enable you to always access the device regardless

of network availability.

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

> ℹ️ Note
>
> Alternatively, you can find out the StellarMate WiFi IP address from the My Mates page and then use the IP address directly to access the unit. For example, if the IP address is 192.168.0.12, you can then enter in the browser http://192.168.0.12:8624 to access StellarMate Web Manager.

Connecting your equipment

StellarMate supports connecting to your equipment via WiFi, Ethernet, Bluetooth, or USB. USB is the primary connection method for most astronomical devices. Make sure all equipment is sufficiently powered and initialized before connecting them to StellarMate. For mounts, most mounts need to be already aligned before you connect them to StellarMate.

To learn more about connecting your equipment to StellarMate, find out more in the detailed equipment connection guide.

Downloading Ekos

Ekos is the official astrophotography tool used for StellarMate. It is part of KStars, a popular planetarium application for Windows®, Mac® OS, and Linux®.

Download and setup KStars on your system before proceeding forward.

Connecting from Ekos

Please refer to Connecting from Ekos via Ethernet/WiFi.

WiFi Connection

> ℹ️ 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.

HotSpot Connection

> ℹ️ 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 is to enable you to always access the device regardless of network availability.

Infrastructure Connection

> ℹ️ Note
>
> Infrastructure mode is where StellarMate joins an existing WiFi network. 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.

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 go to Device tab. Here you can see a few controls to configure StellarMate.

Click 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.
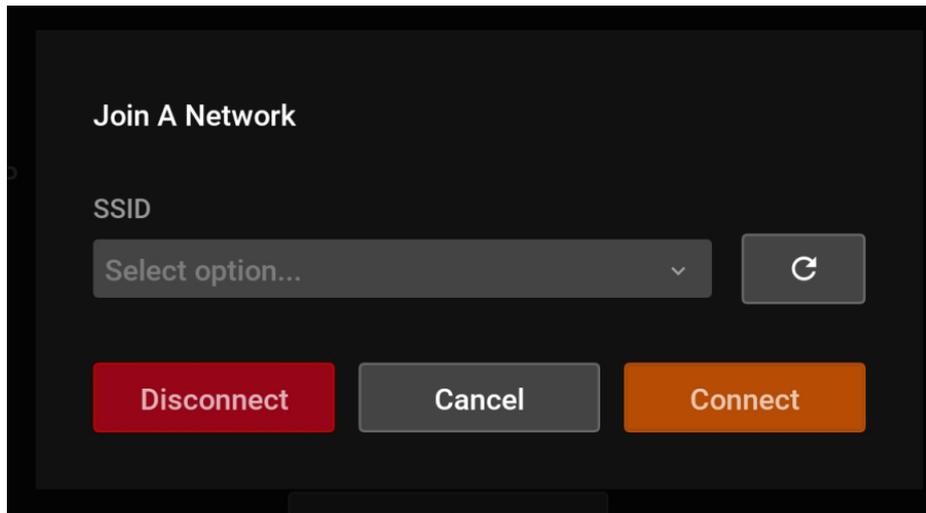
Select the desired WiFi network from the list and press Connect. Enter and double check the WiFi password. A final confirmation warning popup about switching to WiFi infrastructure mode is displayed, press Yes to continue. The App will command StellarMate to join the WiFi network and then begins to scan 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.
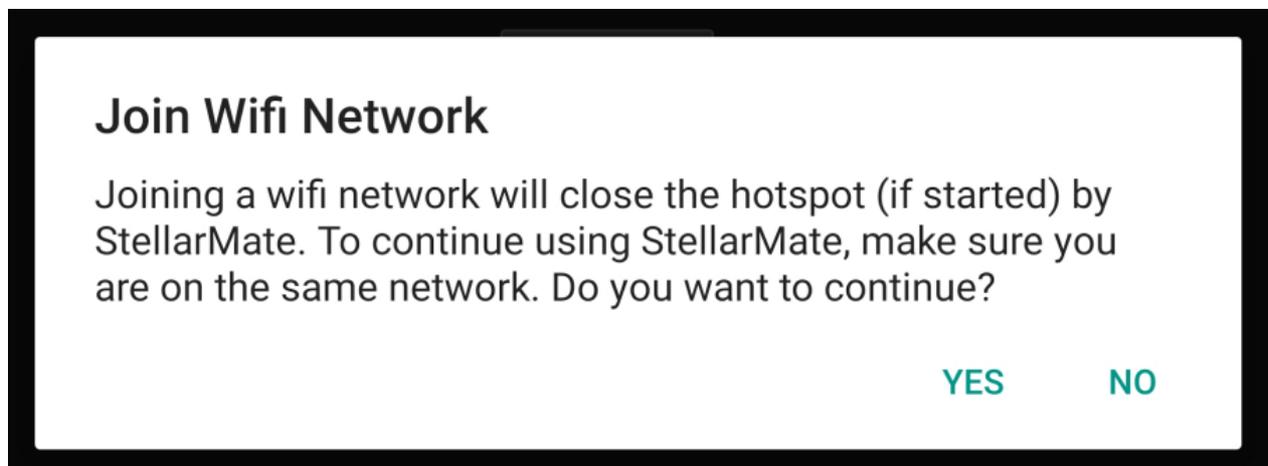
This process can take up to 2 minutes. If successful, the device IP address is going to change the new WiFi IP address. Go back to the setup page to make sure the device is connected. If not, double click on the device to ensure it is connected properly.

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.

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

> ℹ️ 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).

Connecting your equipment

StellarMate supports connecting to your equipment via WiFi, Ethernet, Bluetooth, or USB. USB is the primary connection method for most astronomical devices. Make sure all equipment is sufficiently powered and initialized before connecting them to StellarMate. For mounts, most mounts need to be already aligned before you connect them to StellarMate.

To learn more about connecting your equipment to StellarMate, find out more in the detailed [equipment connection guide]().

Downloading Ekos

Ekos is the official astrophotography tool used for StellarMate. It is part of [KStars](), a popular planetarium application for Windows®, Mac® OS, and Linux®.

[Download]() and setup KStars on your system before proceeding forward.

Connecting from Ekos

Please refer to [Connecting from Ekos via Ethernet/WiFi]().

VNC

When StellarMate is first started, it shall create a HotSpot (Access Point) named stellarmate. This is HotSpot SSID and the hostname of the unit. This information is required when you connect to the unit from browsers. The HotSpot SSID is protected.

HotSpot SSID: **stellarmate**

HotSpot Password: **stellar@mate**
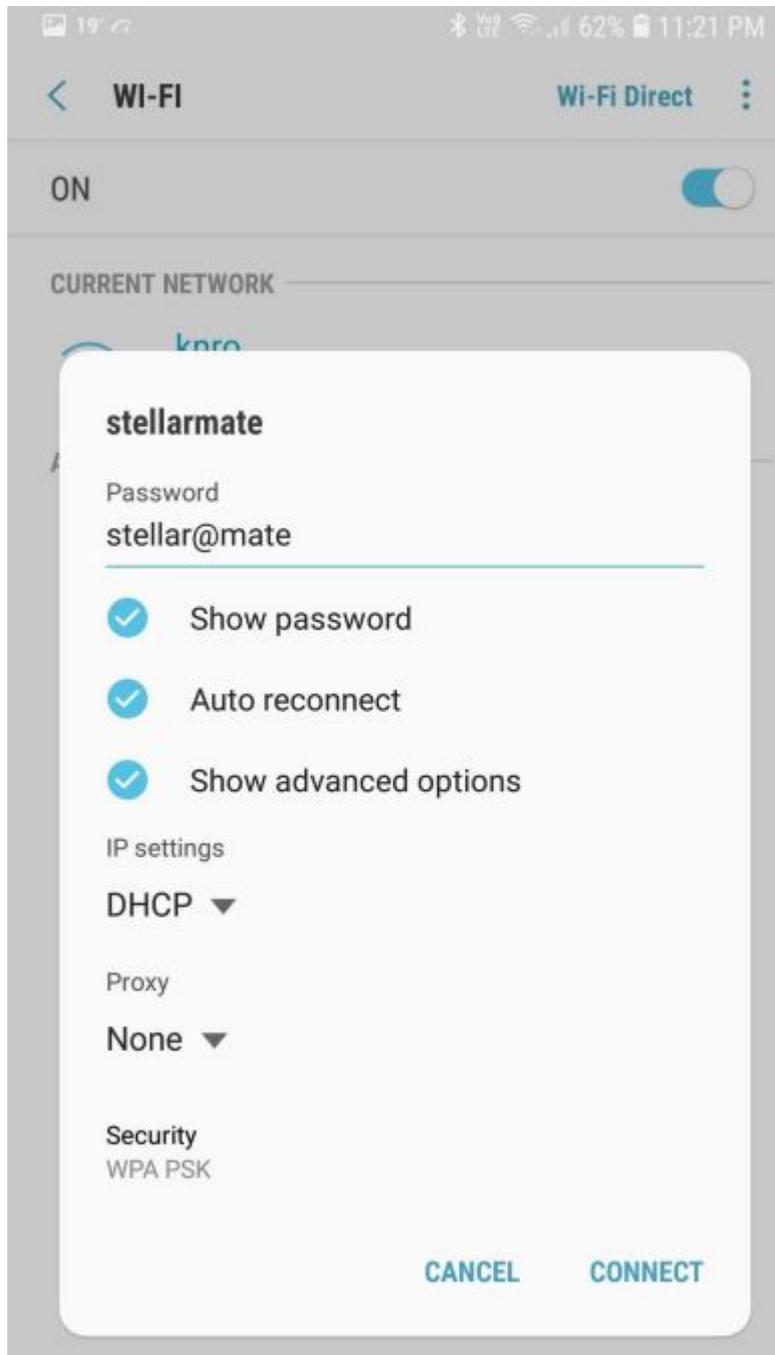
To access StellarMate through VNC, you have to first connect to the WiFi Hotspot and then open your favorite browser and you can either:

- Go to stellarmate.local:6080 directly, click Connect and then use smate as the password.

- Go to stellarmate.local, and then click on the button on the bottom-right corner, then select Desktop, you should be redirected to the VNC portal, click Connect and then use smate as the password.

ⓘ 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).

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.
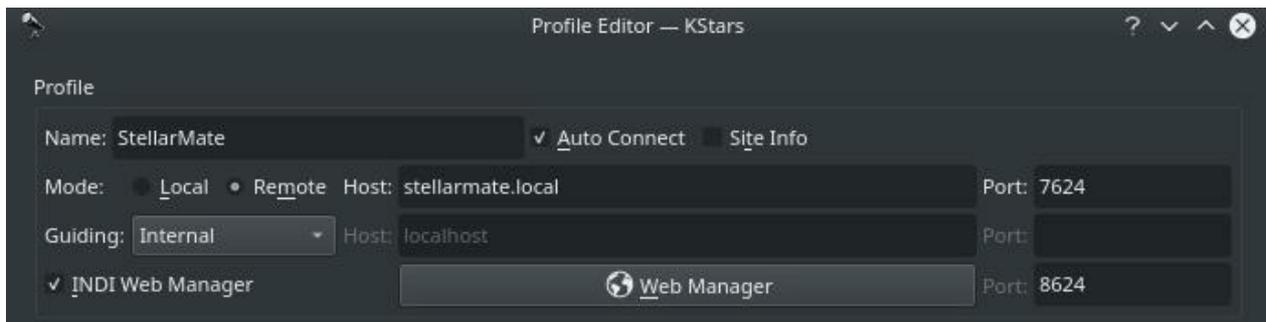
It is recommended to use the Ekos Profile Wizard to set up your first profile. The wizard automatically starts up the first time you fire Ekos in KStars. To start it again, please click on the wizard icon in Ekos summary screen.
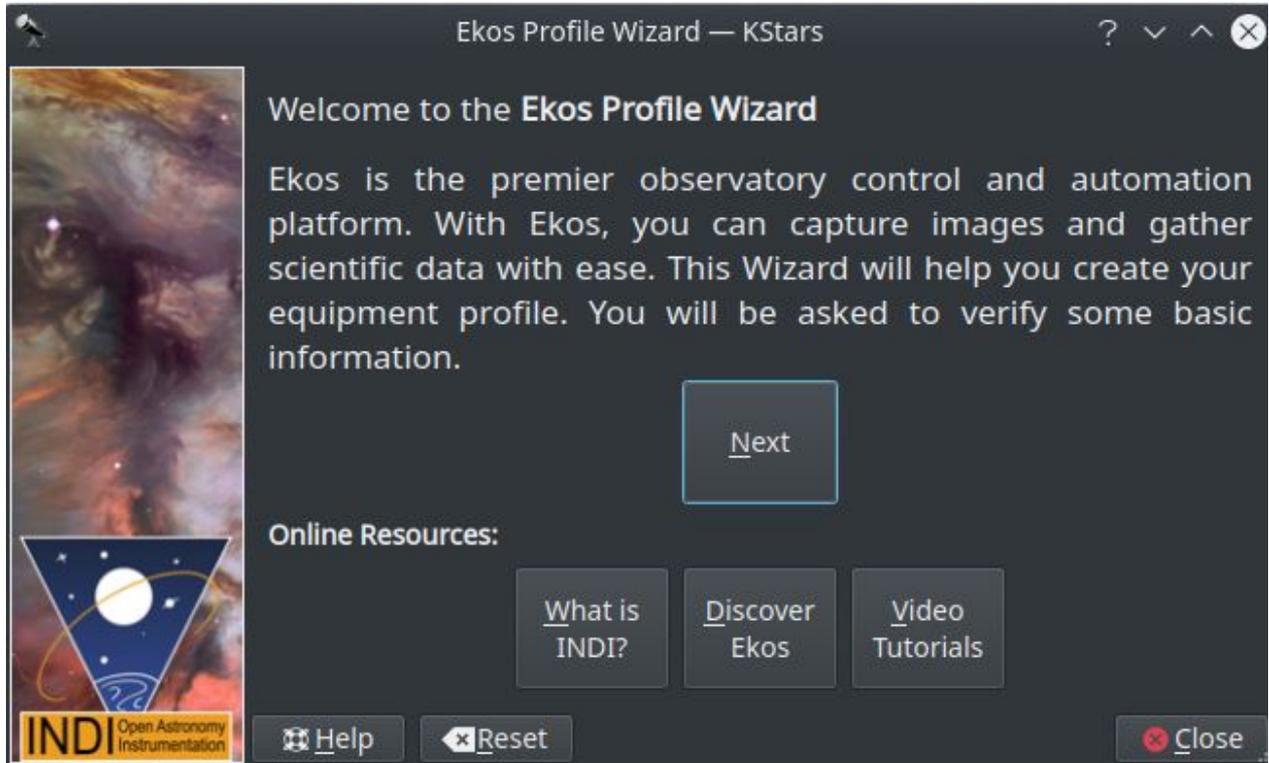
Click Next to proceed to the next screen.
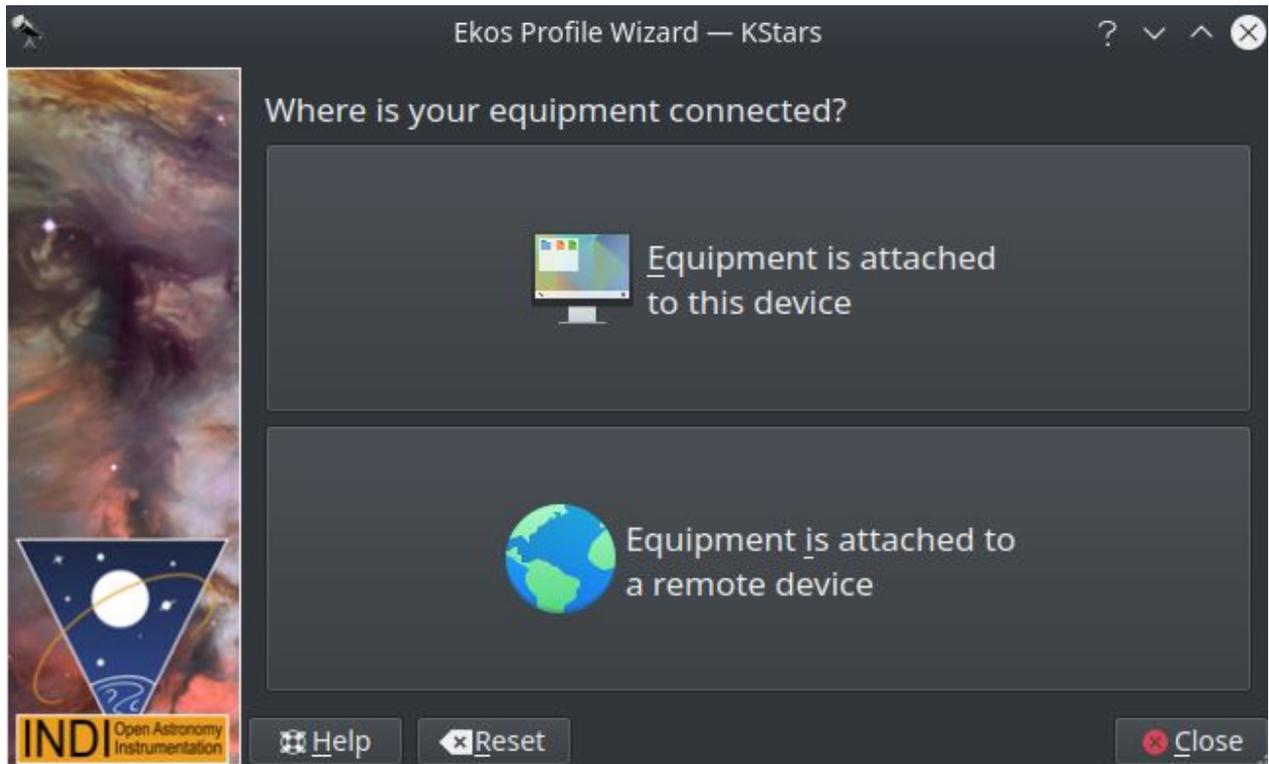
In here you need to select if your equipment is attached to StellarMate or elsewhere:

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.

If you clicked on Equipment is attached to a remote device, this page will show up, click on StellarMate.

If you clicked on Equipment is attached to a remote device before, this page will show up. In this page you have a choice to specify the StellarMate Address & Port. These settings are for advanced usage of StellarMate, so just click the Next.
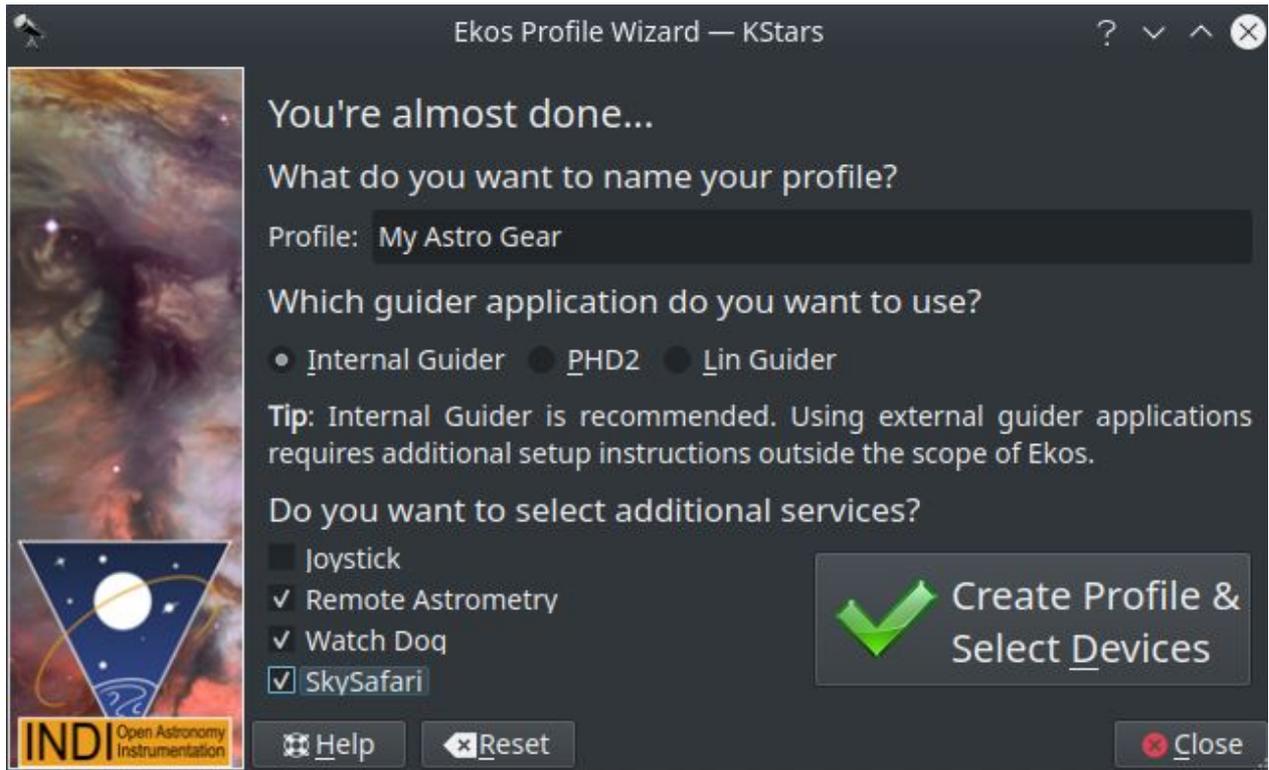
Next, select your equipment profile name and any additional services you want to run then proceed to create the profile.
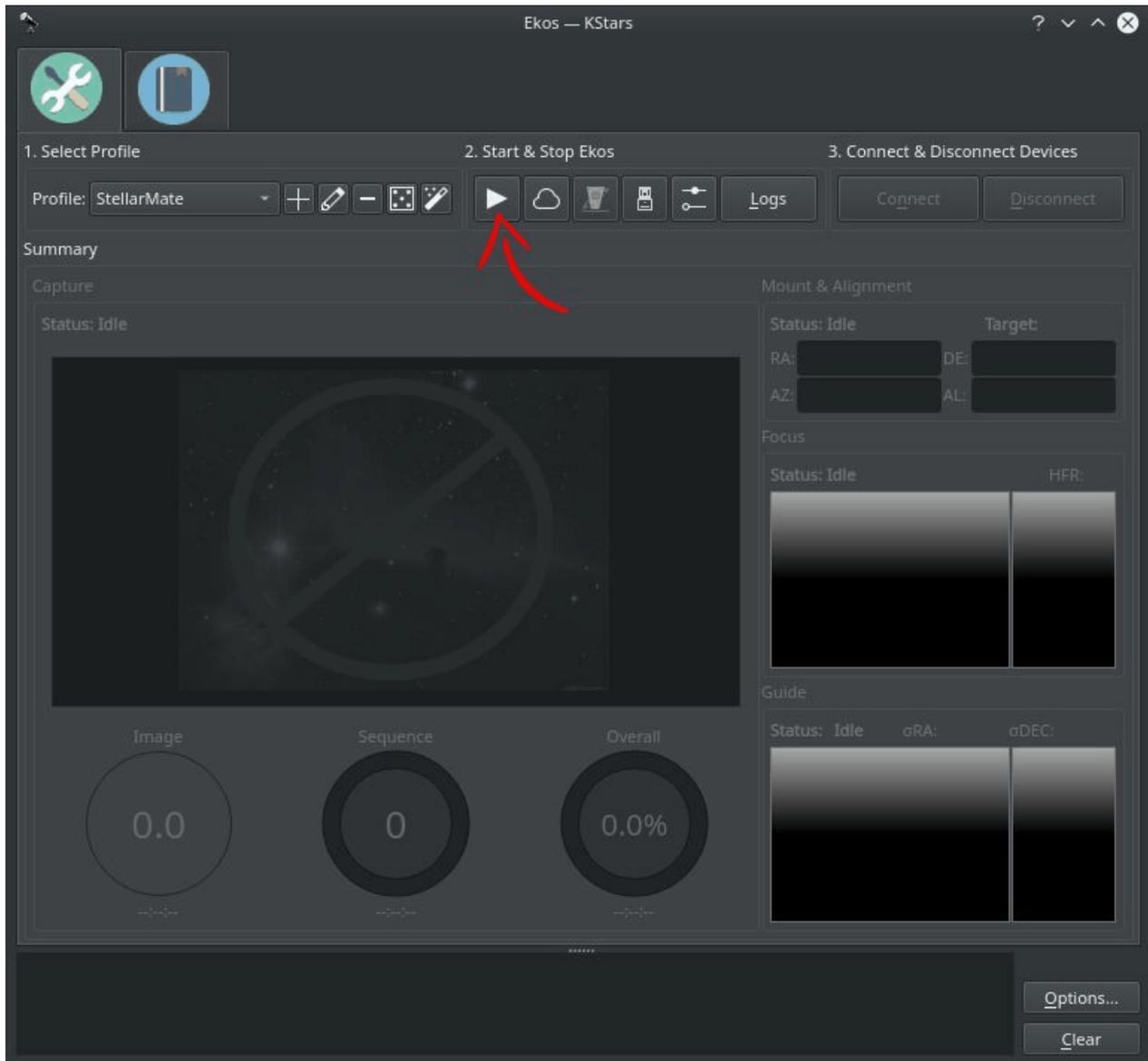
To connect to your equipment and start using Ekos, simply click the Start button as illustrated above.

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 below to connect your StellarMate to PC/Mac.

Video Guide

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](#)

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
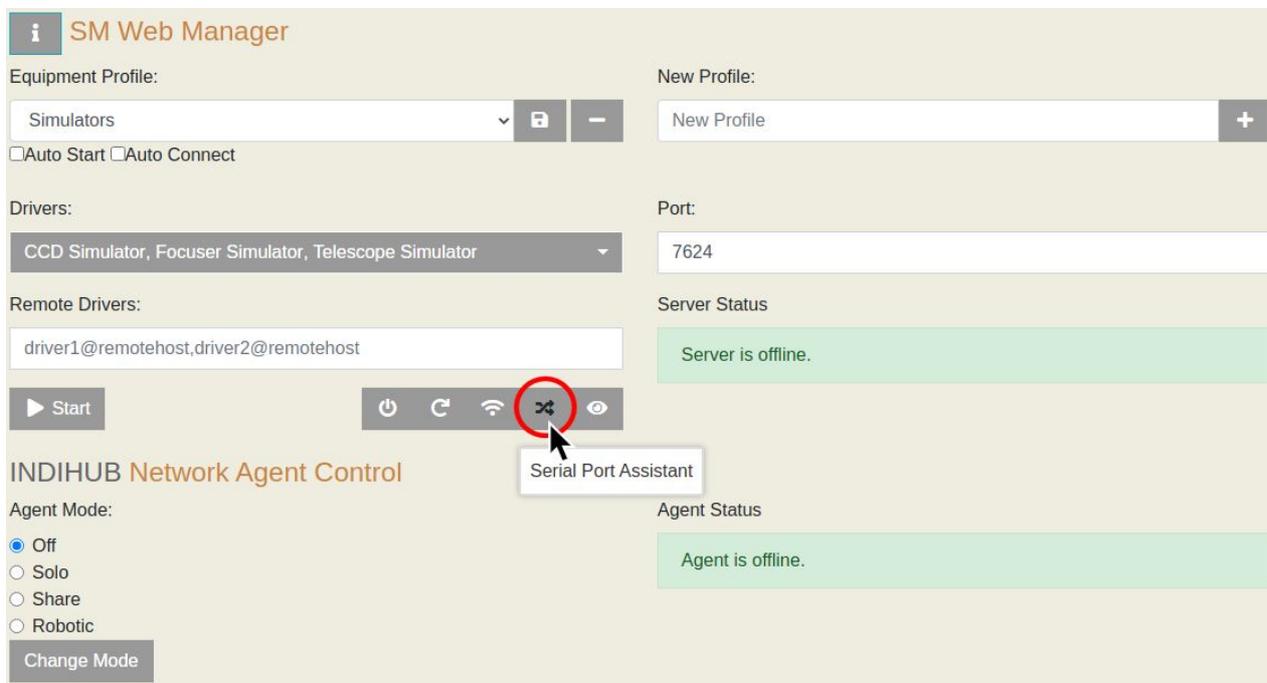
3. Click on   Next.

4. Check the Bluetooth device checkbox, and then click Next.
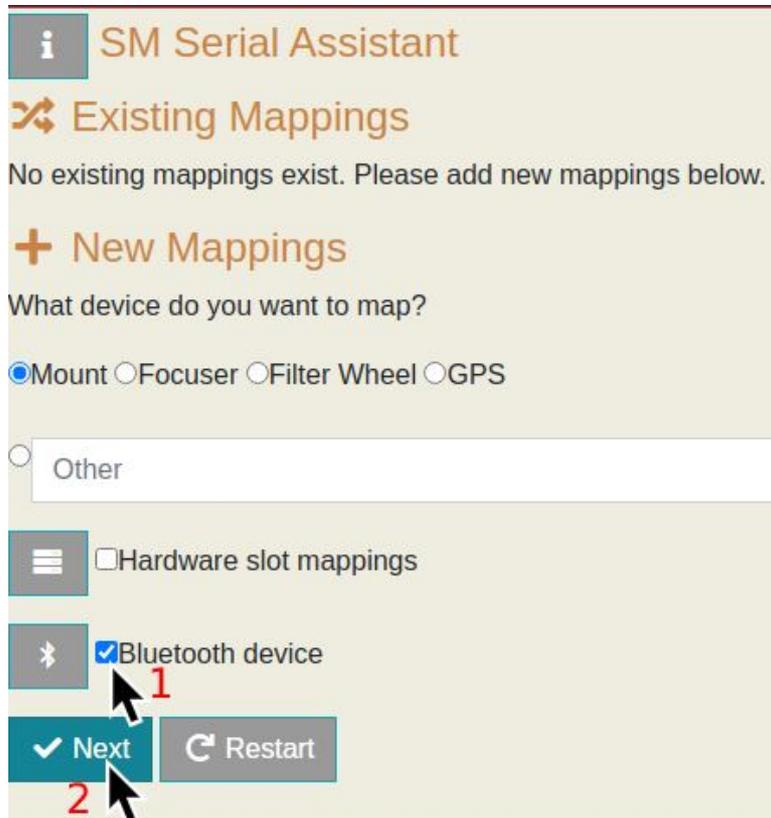
5. If you have already paired your device to StellarMate before, you can set it to Auto-bind on startup by clicking on the Bind button next to the device's details. You will be met with a dialog that confirms that your device has been binded to StellarMate.
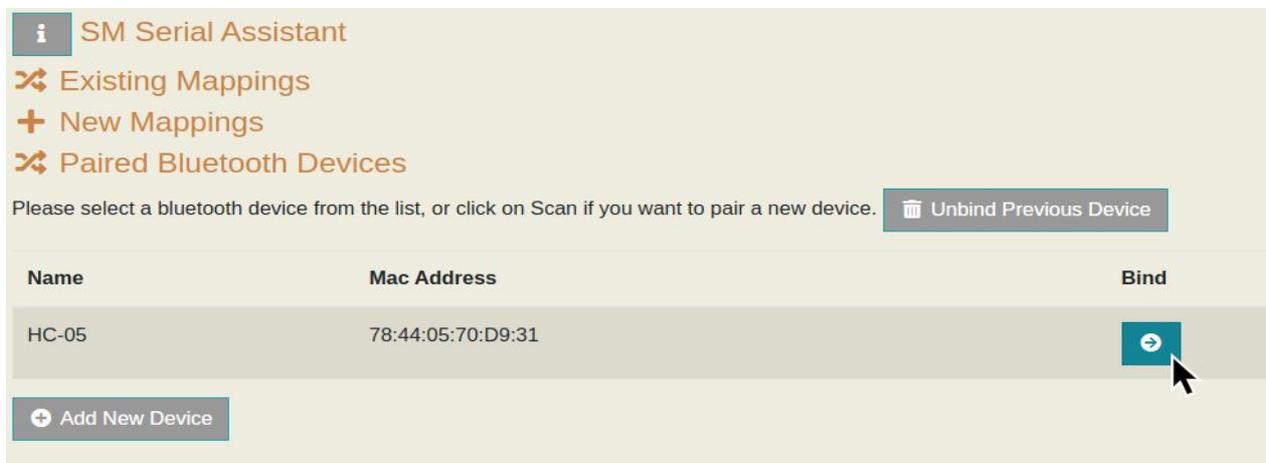
6. If you have not paired your device and would like to add a new device, click on the

Add New Device button.
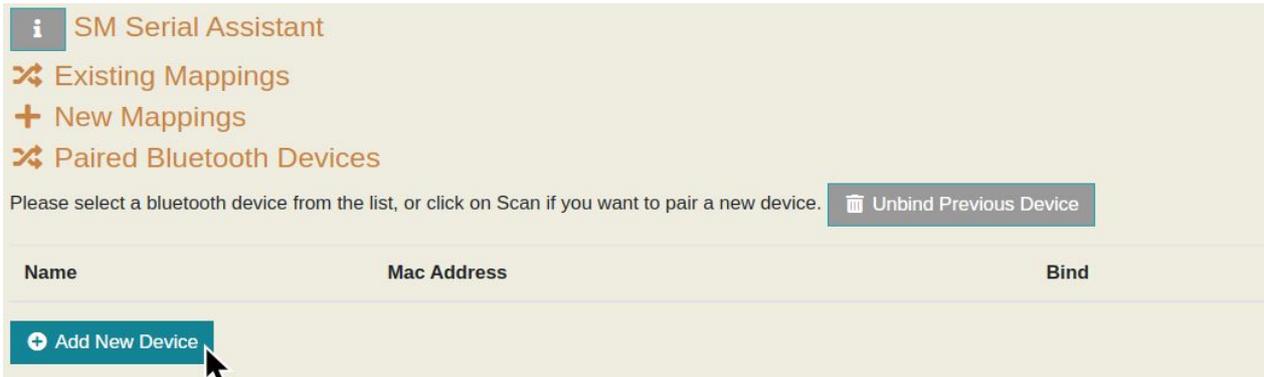
7. The Bluetooth Wizard will now scan for available bluetooth devices.
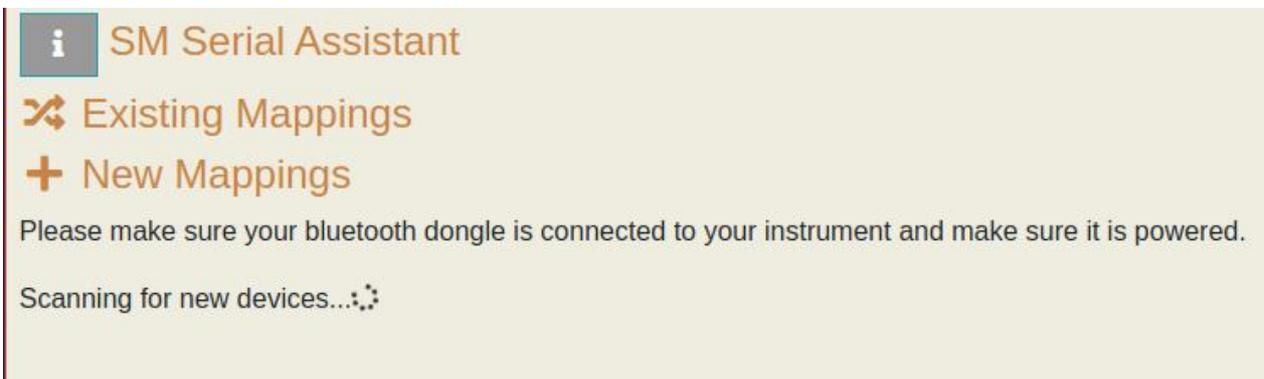
8. If the scanner does not find any devices, click on   RESCAN.
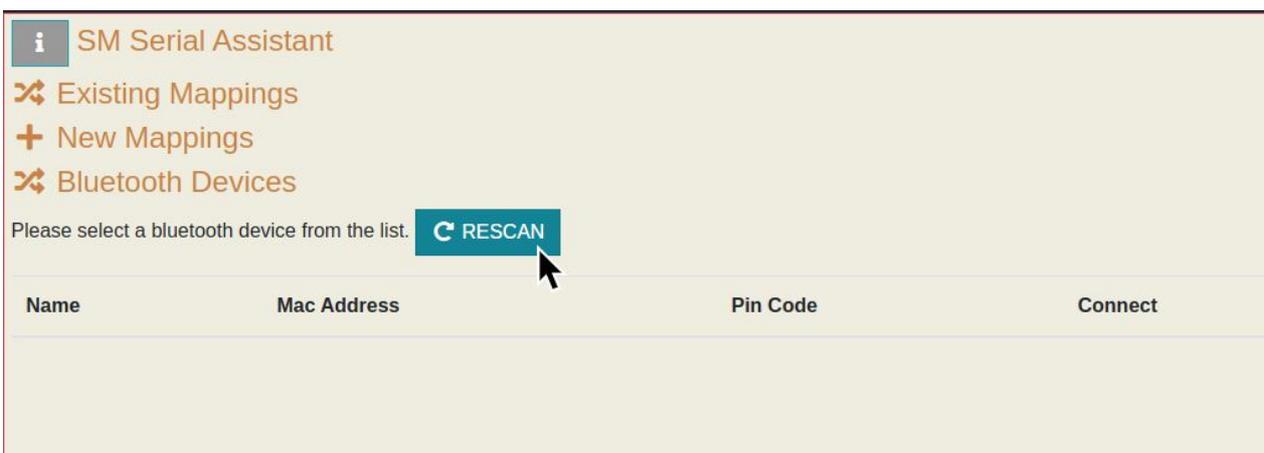
9. If you find your device, enter the pin code and then click on the Connect
 button. (eg. Shoestring Astronomy HC-06's pin code is 1234, you can find the pin code
number by finding the bluetooth device's documentation made by the manufacturer)

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-binded on startup, go to the Bluetooth Wizard by following steps 1-4 and then click on 🗑 Unbind Previous Device.
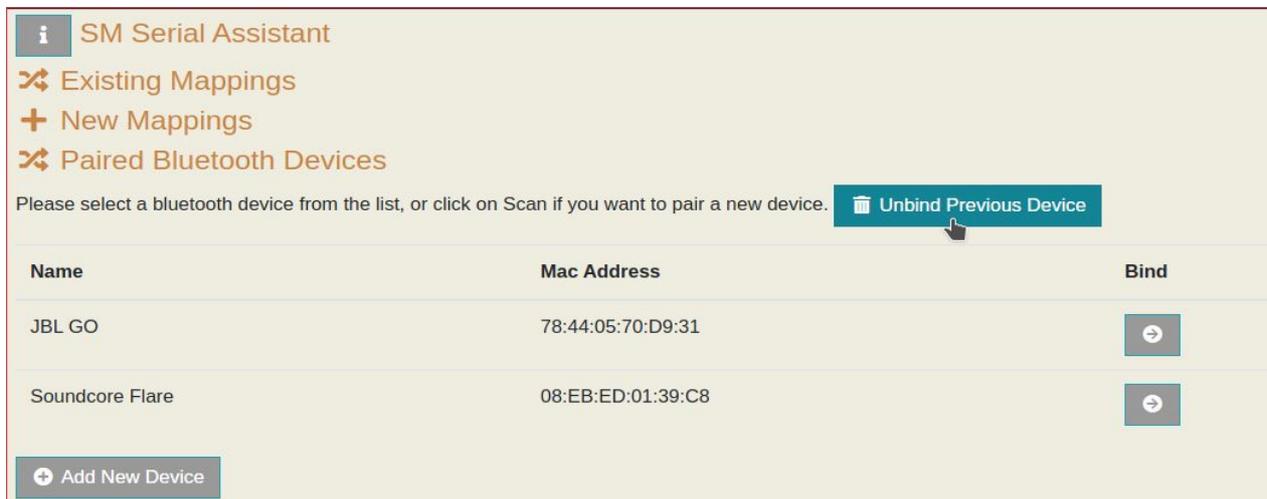
A confirmation dialog will be shown to you.

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.
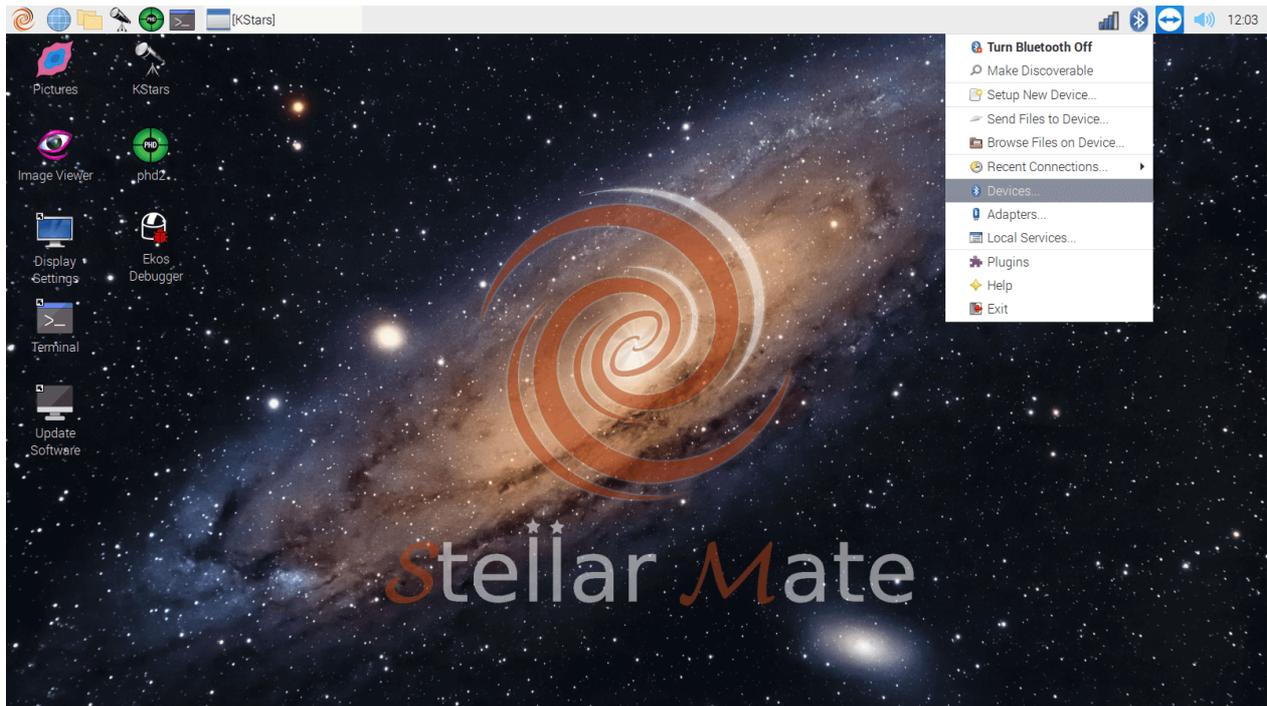
After you pair your device, you should have a bluetooth ported assigned to it (e.g. `/dev/rfcomm0`). This is the port you should use in INDI when communicating with your device.

Connecting CCDs

StellarMate X supports a broad range of camers (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 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 libgphto2 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.
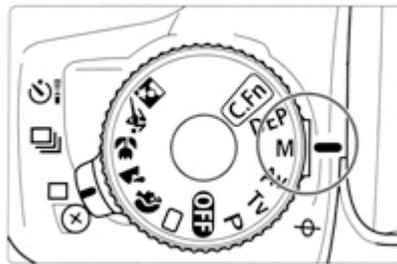
Tip: Some modern cameras do not have a Bulb (B) dial. You can set Bulb Mode by selecting Manual (M) dial and then change the exposure duration until you see BULB in the camera.

ⓘ 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.

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.

Canon

Camera Model	Abilities	Comments
Canon Digital IXUS	Configuration	
Canon Digital IXUS 100 IS		
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	
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	
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		
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	Image Capture, Liveview,	

mode)	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)		
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	
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	
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	
Canon SX 620HS	Image Capture, Liveview, Configuration	
Canon SX 720HS	Image Capture, Liveview, Configuration	
Canon ZR70MC (normal mode)	Image Capture, Liveview, Configuration	

Nikon

Camera Model	Abilities	Comments
Nikon 1 (WLAN)	Image Capture, Liveview, Configuration	Testing (Beta)
Nikon CoolPix 100	Image Capture, Liveview, Configuration	
Nikon Coolpix 2000 (PTP mode)		
Nikon Coolpix 2100 (PTP mode)		

Nikon CoolPix 2100 (Sierra Mode)	Image Capture, Liveview, Configuration	
Nikon Coolpix 2200 (PTP mode)	Image Capture, Configuration	
Nikon Coolpix 2200v1.1 (PTP mode)	Image Capture, Configuration	
Nikon Coolpix 2500 (PTP mode)		
Nikon CoolPix 2500 (Sierra Mode)	Image Capture, Liveview, Configuration	
Nikon CoolPix 300	Image Capture, Liveview, Configuration	
Nikon Coolpix 3100 (PTP mode)		
Nikon Coolpix 3200 (PTP mode)		
Nikon Coolpix 3500 (PTP mode)		
Nikon CoolPix 3500 (Sierra Mode)	Image Capture, Liveview, Configuration	
Nikon Coolpix 3700 (PTP mode)	Image Capture, Configuration	
Nikon Coolpix 4100 (PTP mode)	Image Capture, Configuration	
Nikon CoolPix 4100 (Sierra Mode)	Image Capture, Liveview, Configuration	
Nikon Coolpix 4200 (PTP mode)		
Nikon Coolpix 4300 (PTP mode)		
Nikon CoolPix 4300 (Sierra Mode)	Image Capture, Liveview, Configuration	
Nikon Coolpix 4500 (PTP mode)		
Nikon Coolpix 4600 (PTP mode)		
Nikon Coolpix 4600a (PTP mode)	Image Capture, Configuration	
Nikon Coolpix 4800 (PTP mode)		
Nikon CoolPix 5000 (PTP	Image Capture, Configuration	

mode)		
Nikon Coolpix 5200 (PTP mode)		
Nikon Coolpix 5400 (PTP mode)	Image Capture, Configuration	
Nikon Coolpix 5600 (PTP mode)	Image Capture, Configuration	
Nikon Coolpix 5700 (PTP mode)	Image Capture, Configuration	
Nikon Coolpix 5900 (PTP mode)	Image Capture, Configuration	
Nikon CoolPix 600		
Nikon CoolPix 700	Image Capture, Liveview, Configuration	
Nikon Coolpix 7600 (PTP mode)	Image Capture, Configuration	
Nikon Coolpix 7900 (PTP mode)	Image Capture, Configuration	
Nikon CoolPix 800	Image Capture, Liveview, Configuration	
Nikon Coolpix 8700 (PTP mode)		
Nikon CoolPix 880	Image Capture, Liveview, Configuration	
Nikon Coolpix 8800 (PTP mode)	Image Capture, Configuration	
Nikon Coolpix 885 (PTP mode)		
Nikon CoolPix 900	Image Capture, Liveview, Configuration	
Nikon CoolPix 900S	Image Capture, Liveview, Configuration	
Nikon CoolPix 910	Image Capture, Liveview, Configuration	
Nikon Coolpix 9400 (PTP mode)	Image Capture, Configuration	
Nikon CoolPix 950S	Image Capture, Liveview, Configuration	
Nikon CoolPix 990	Image Capture, Liveview, Configuration	
Nikon CoolPix 995	Image Capture, Liveview,	

	Configuration	
Nikon Coolpix A (PTP mode)	Image Capture, Configuration	
Nikon Coolpix A900 (PTP mode)	Image Capture, Configuration	
Nikon Coolpix AW100 (PTP mode)	Image Capture, Configuration	
Nikon Coolpix AW110 (PTP mode)	Image Capture, Configuration	
Nikon Coolpix AW130 (PTP mode)	Image Capture, Configuration	
Nikon Coolpix B500	Image Capture, Configuration	
Nikon Coolpix B700 (PTP mode)	Image Capture, Liveview, Configuration	
Nikon Coolpix L1 (PTP mode)		
Nikon Coolpix L10 (PTP mode)		
Nikon Coolpix L100 (PTP mode)	Image Capture, Configuration	
Nikon Coolpix L11 (PTP mode)		
Nikon Coolpix L110 (PTP mode)	Image Capture, Configuration	
Nikon Coolpix L12 (PTP mode)	Image Capture, Configuration	
Nikon Coolpix L120 (PTP mode)	Image Capture, Configuration	
Nikon Coolpix L16 (PTP mode)	Image Capture, Configuration	
Nikon Coolpix L19 (PTP mode)	Image Capture, Configuration	
Nikon Coolpix L20 (PTP mode)	Image Capture, Configuration	
Nikon Coolpix L23 (PTP mode)	Image Capture, Configuration	
Nikon Coolpix L27	Image Capture, Configuration	
Nikon Coolpix L340	Image Capture, Configuration	
Nikon Coolpix L4 (PTP mode)		
Nikon Coolpix L810 (PTP mode)	Image Capture, Configuration	
Nikon Coolpix L820 (PTP mode)	Image Capture, Configuration	
Nikon Coolpix L840	Image Capture, Configuration	
Nikon Coolpix P1 (PTP mode)	Image Capture, Configuration	

Nikon Coolpix P100 (PTP mode)	Image Capture, Configuration	
Nikon Coolpix P1000 (PTP mode)	Image Capture, Configuration	
Nikon Coolpix P2 (PTP mode)	Image Capture, Configuration	
Nikon Coolpix P300 (PTP mode)		
Nikon Coolpix P330 (PTP mode)	Image Capture, Configuration	
Nikon Coolpix P4 (PTP mode)	Image Capture, Configuration	
Nikon Coolpix P50 (PTP mode)		
Nikon Coolpix P500 (PTP mode)	Image Capture, Configuration	
Nikon Coolpix P5000 (PTP mode)	Image Capture, Configuration	
Nikon Coolpix P510 (PTP mode)		
Nikon Coolpix P5100 (PTP mode)		
Nikon Coolpix P520 (PTP mode)		
Nikon Coolpix P60 (PTP mode)	Image Capture, Configuration	
Nikon Coolpix P6000 (PTP mode)	Image Capture, Configuration	
Nikon Coolpix P7000 (PTP mode)	Image Capture, Configuration	
Nikon Coolpix P7100 (PTP mode)	Image Capture, Configuration	
Nikon Coolpix P7700 (PTP mode)		
Nikon Coolpix P7800 (PTP mode)		
Nikon Coolpix P80 (PTP mode)	Image Capture, Configuration	
Nikon Coolpix P80 v1.1 (PTP mode)	Image Capture, Configuration	
Nikon Coolpix P90 (PTP mode)		
Nikon Coolpix P900 (PTP mode)	Image Capture, Configuration	
Nikon Coolpix S01	Image Capture, Configuration	

Nikon Coolpix S02	Image Capture, Configuration	
Nikon Coolpix S2 (PTP mode)		
Nikon Coolpix S200 (PTP mode)	Image Capture, Configuration	
Nikon Coolpix S220 (PTP mode)	Image Capture, Configuration	
Nikon Coolpix S225 (PTP mode)	Image Capture, Configuration	
Nikon Coolpix S2500 (PTP mode)	Image Capture, Configuration	
Nikon Coolpix S2600 (PTP mode)	Image Capture, Configuration	
Nikon Coolpix S2700	Image Capture, Configuration	
Nikon Coolpix S2900	Image Capture, Configuration	
Nikon Coolpix S3000 (PTP mode)	Image Capture, Configuration	
Nikon Coolpix S3100 (PTP mode)	Image Capture, Configuration	
Nikon Coolpix S3200	Image Capture, Configuration	
Nikon Coolpix S3300 (PTP mode)	Image Capture, Configuration	
Nikon Coolpix S3600	Image Capture, Configuration	
Nikon Coolpix S3700	Image Capture, Configuration	
Nikon Coolpix S4 (PTP mode)		
Nikon Coolpix S4300 (PTP mode)	Image Capture, Configuration	
Nikon Coolpix S500 (PTP mode)		
Nikon Coolpix S5100 (PTP mode)		
Nikon Coolpix S6 (PTP mode)		
Nikon Coolpix S60 (PTP mode)		
Nikon Coolpix S6000 (PTP mode)		
Nikon Coolpix S620 (PTP mode)		
Nikon Coolpix S6300 (PTP mode)	Image Capture, Configuration	

Nikon Coolpix S6800	Image Capture, Configuration	
Nikon Coolpix S7c (PTP mode)		
Nikon Coolpix S8000 (PTP mode)		
Nikon Coolpix S8200		
Nikon Coolpix S9100 (PTP mode)	Image Capture, Configuration	
Nikon Coolpix S9500 (PTP mode)	Image Capture, Configuration	
Nikon Coolpix S9700	Image Capture, Liveview, Configuration	
Nikon Coolpix SQ (PTP mode)		
Nikon D100 (Sierra Mode)	Image Capture, Liveview, Configuration	
Nikon D2H SLR (PTP mode)		
Nikon D2Hs (PTP mode)	Image Capture, Trigger Capture, Configuration	
Nikon D2X SLR (PTP mode)	Image Capture, Trigger Capture, Configuration	
Nikon D3 (PTP mode)	Image Capture, Trigger Capture, Configuration	
Nikon D50 (PTP mode)	Image Capture, Trigger Capture, Configuration	
Nikon DSC D100 (PTP mode)		
Nikon DSC D200 (PTP mode)	Image Capture, Trigger Capture, Configuration	
Nikon DSC D2Xs (PTP mode)	Image Capture, Trigger Capture, Configuration	
Nikon DSC D300 (PTP mode)	Image Capture, Trigger Capture, Configuration	
Nikon DSC D3000 (PTP mode)	Image Capture, Trigger Capture, Configuration	
Nikon DSC D300s (PTP mode)	Image Capture, Trigger Capture, Liveview, Configuration	
Nikon DSC D3100 (PTP mode)	Image Capture, Trigger Capture, Configuration	
Nikon DSC D3200	Image Capture, Trigger Capture, Liveview, Configuration	
Nikon DSC D3300	Image Capture, Trigger Capture,	

	Liveview, Configuration	
Nikon DSC D3400	Image Capture, Trigger Capture, Liveview, Configuration	
Nikon DSC D3500	Image Capture, Trigger Capture, Liveview, Configuration	
Nikon DSC D3s (PTP mode)	Image Capture, Trigger Capture, Liveview, Configuration	
Nikon DSC D3x (PTP mode)	Image Capture, Trigger Capture, Liveview, Configuration	
Nikon DSC D4	Image Capture, Trigger Capture, Liveview, Configuration	
Nikon DSC D40 (PTP mode)	Image Capture, Trigger Capture, Configuration	
Nikon DSC D40x (PTP mode)	Image Capture, Trigger Capture, Configuration	
Nikon DSC D4s	Image Capture, Trigger Capture, Liveview, Configuration	
Nikon DSC D5	Image Capture, Trigger Capture, Liveview, Configuration	
Nikon DSC D500	Image Capture, Trigger Capture, Liveview, Configuration	
Nikon DSC D5000 (PTP mode)	Image Capture, Trigger Capture, Liveview, Configuration	
Nikon DSC D5100 (PTP mode)	Image Capture, Trigger Capture, Liveview, Configuration	
Nikon DSC D5200	Image Capture, Trigger Capture, Liveview, Configuration	
Nikon DSC D5300	Image Capture, Trigger Capture, Liveview, Configuration	
Nikon DSC D5500	Image Capture, Trigger Capture, Liveview, Configuration	
Nikon DSC D5600	Image Capture, Trigger Capture, Liveview, Configuration	
Nikon DSC D6	Image Capture, Trigger Capture, Liveview, Configuration	
Nikon DSC D60 (PTP mode)	Image Capture, Trigger Capture, Configuration	
Nikon DSC D600	Image Capture, Trigger Capture, Liveview, Configuration	
Nikon DSC D610	Image Capture, Trigger Capture, Liveview, Configuration	

Nikon DSC D70 (PTP mode)	Image Capture, Trigger Capture, Configuration	
Nikon DSC D700 (PTP mode)	Image Capture, Trigger Capture, Liveview, Configuration	
Nikon DSC D7000 (PTP mode)	Image Capture, Trigger Capture, Liveview, Configuration	
Nikon DSC D70s (PTP mode)	Image Capture, Trigger Capture, Configuration	
Nikon DSC D7100	Image Capture, Trigger Capture, Liveview, Configuration	
Nikon DSC D7200	Image Capture, Trigger Capture, Liveview, Configuration	
Nikon DSC D750	Image Capture, Trigger Capture, Liveview, Configuration	
Nikon DSC D7500	Image Capture, Trigger Capture, Liveview, Configuration	
Nikon DSC D780	Image Capture, Trigger Capture, Liveview, Configuration	
Nikon DSC D80 (PTP mode)	Image Capture, Trigger Capture, Configuration	
Nikon DSC D800	Image Capture, Trigger Capture, Liveview, Configuration	
Nikon DSC D800E	Image Capture, Trigger Capture, Liveview, Configuration	
Nikon DSC D810	Image Capture, Trigger Capture, Liveview, Configuration	
Nikon DSC D810A	Image Capture, Trigger Capture, Liveview, Configuration	
Nikon DSC D850	Image Capture, Trigger Capture, Liveview, Configuration	
Nikon DSC D90 (PTP mode)	Image Capture, Trigger Capture, Liveview, Configuration	
Nikon DSC Df	Image Capture, Trigger Capture, Liveview, Configuration	
Nikon DSLR (WLAN)	Image Capture, Liveview, Configuration	Testing (Beta)
Nikon J1	Image Capture, Configuration	
Nikon J2	Image Capture, Configuration	
Nikon J3	Image Capture, Configuration	
Nikon J4	Image Capture, Configuration	

Camera Model	Abilities	Comments
Nikon J5	Image Capture, Configuration	
Nikon KeyMission 170	Image Capture, Configuration	
Nikon KeyMission 360 (PTP mode)	Image Capture, Configuration	
Nikon P950	Image Capture, Liveview, Configuration	
Nikon S1	Image Capture, Configuration	
Nikon S2	Image Capture, Configuration	
Nikon V1	Image Capture, Configuration	
Nikon V2	Image Capture, Configuration	
Nikon V3	Image Capture, Configuration	
Nikon Z5	Image Capture, Trigger Capture, Liveview, Configuration	
Nikon Z50	Image Capture, Trigger Capture, Liveview, Configuration	
Nikon Z6	Image Capture, Trigger Capture, Liveview, Configuration	
Nikon Z6_2	Image Capture, Trigger Capture, Liveview, Configuration	
Nikon Z7	Image Capture, Trigger Capture, Liveview, Configuration	
Nikon Z7_2	Image Capture, Trigger Capture, Liveview, Configuration	
Nikon Z9	Image Capture, Trigger Capture, Liveview, Configuration	
Nikon Zfc	Image Capture, Trigger Capture, Liveview, Configuration	

Sony

Camera Model	Abilities	Comments
Sony Alpha-A3000		
Sony Alpha-A5000 (Control)	Image Capture, Trigger Capture, Configuration	
Sony Alpha-A5100 (Control)	Image Capture, Trigger Capture, Liveview, Configuration	
Sony Alpha-A5100 (MTP)		
Sony Alpha-A6000 (Control)	Image Capture, Trigger Capture, Configuration	

Sony Alpha-A6000 (MTP)		
Sony Alpha-A6300 (Control)	Image Capture, Trigger Capture, Liveview, Configuration	
Sony Alpha-A6300 (MTP)		
Sony Alpha-A6500		
Sony Alpha-A6500 (Control)	Image Capture, Trigger Capture, Liveview, Configuration	
Sony Alpha-A6600 (MTP)		
Sony Alpha-A6600 (PC Control)	Image Capture, Trigger Capture, Liveview, Configuration	
Sony Alpha-A68 (Control)	Image Capture, Trigger Capture, Liveview, Configuration	
Sony Alpha-A68 (MTP)		
Sony Alpha-A7 (Control)	Image Capture, Trigger Capture, Configuration	
Sony Alpha-A7 III (MTP mode)		
Sony Alpha-A7 III (PC Control)	Image Capture, Trigger Capture, Liveview, Configuration	
Sony Alpha-A7 IV (MTP mode)		
Sony Alpha-A7 IV (PC Control)	Image Capture, Trigger Capture, Liveview, Configuration	
Sony Alpha-A77 M2 (Control)	Image Capture, Trigger Capture, Liveview, Configuration	
Sony Alpha-A7III (Control)	Image Capture, Trigger Capture, Liveview, Configuration	
Sony Alpha-A7r (Control)	Image Capture, Trigger Capture, Configuration	
Sony Alpha-A7r II (Control)	Image Capture, Trigger Capture, Liveview, Configuration	
Sony Alpha-A7R III (MTP mode)		
Sony Alpha-A7r III (PC Control)	Image Capture, Trigger Capture, Liveview, Configuration	
Sony Alpha-A7S (Control)	Image Capture, Trigger Capture, Liveview, Configuration	
Sony Alpha-A7S (MTP)		
Sony Alpha-A7S II (Control)	Image Capture, Trigger Capture,	

	Liveview, Configuration	
Sony Alpha-A9 (Control)	Image Capture, Trigger Capture, Liveview, Configuration	
Sony Alpha-A99 M2 (Control)	Image Capture, Trigger Capture, Liveview, Configuration	
Sony Alpha-RX10M4 (Control)	Image Capture, Trigger Capture, Liveview, Configuration	
Sony Alpha-RX1R II (Control)	Image Capture, Trigger Capture, Liveview, Configuration	
Sony DCR-PC100		
Sony DSC RX0 II (PC Control)	Image Capture, Trigger Capture, Liveview, Configuration	
Sony DSC-A100 (PTP mode)		
Sony DSC-A7r IV (Control)	Image Capture, Trigger Capture, Liveview, Configuration	
Sony DSC-A7S III (Control)	Image Capture, Trigger Capture, Liveview, Configuration	
Sony DSC-A900 (PTP mode)	Image Capture, Trigger Capture, Configuration	
Sony DSC-F1		Experimental
Sony DSC-F55		
Sony DSC-F707V (PTP mode)		
Sony DSC-F717 (PTP mode)		
Sony DSC-F828 (PTP mode)		
Sony DSC-H1 (PTP mode)		
Sony DSC-H2 (PTP mode)		
Sony DSC-H5 (PTP mode)		
Sony DSC-HX100V (PTP mode)		
Sony DSC-HX200V (PTP mode)		
Sony DSC-HX20V (PTP mode)		
Sony DSC-HX300 (PTP mode)		

Sony DSC-HX400V (MTP)		
Sony DSC-HX5V (PTP mode)		
Sony DSC-HX60V (MTP)		
Sony DSC-HX80		
Sony DSC-HX90V (MTP)		
Sony DSC-N2 (PTP mode)		
Sony DSC-P10 (PTP mode)		
Sony DSC-P100 (PTP mode)		
Sony DSC-P120 (PTP mode)		
Sony DSC-P200 (PTP mode)		
Sony DSC-P30 (PTP mode)		
Sony DSC-P31 (PTP mode)		
Sony DSC-P32 (PTP mode)		
Sony DSC-P41 (PTP mode)		
Sony DSC-P43 (PTP mode)		
Sony DSC-P5 (PTP mode)		
Sony DSC-P50 (PTP mode)		
Sony DSC-P51 (PTP mode)		
Sony DSC-P52 (PTP mode)		
Sony DSC-P71 (PTP mode)		
Sony DSC-P72 (PTP mode)		
Sony DSC-P73 (PTP mode)		
Sony DSC-P92 (PTP mode)		
Sony DSC-P93 (PTP mode)		
Sony DSC-QX30U	Liveview	
Sony DSC-R1 (PTP mode)		
Sony DSC-RX0 (MTP)		
Sony DSC-RX0 (PC Control)	Image Capture, Trigger Capture, Liveview, Configuration	
Sony DSC-RX1 (PTP mode)		

Sony DSC-RX100 (PTP mode)		
Sony DSC-RX100M2		
Sony DSC-RX100M4	Image Capture, Trigger Capture, Liveview, Configuration	
Sony DSC-RX100M5 (Control)	Image Capture, Trigger Capture, Configuration	
Sony DSC-RX100M5A (MTP)		
Sony DSC-RX100M5A (PC Control)	Image Capture, Trigger Capture, Liveview, Configuration	
Sony DSC-RX100M6 (MTP)		
Sony DSC-RX100M6 (PC Control)	Image Capture, Trigger Capture, Liveview, Configuration	
Sony DSC-RX100M7 (PC Control)	Image Capture, Trigger Capture, Liveview, Configuration	
Sony DSC-RX100V (Control)	Image Capture, Trigger Capture, Configuration	
Sony DSC-RX10M3 (Control)	Image Capture, Trigger Capture, Liveview, Configuration	
Sony DSC-S40 (PTP mode)		
Sony DSC-S60 (PTP mode)		
Sony DSC-S730 (PTP mode)		
Sony DSC-S75 (PTP mode)		
Sony DSC-S780 (PTP mode)		
Sony DSC-S85 (PTP mode)		
Sony DSC-T1 (PTP mode)		
Sony DSC-T10 (PTP mode)		
Sony DSC-T3 (PTP mode)		
Sony DSC-U10 (PTP mode)		
Sony DSC-U20 (PTP mode)		
Sony DSC-V1 (PTP mode)		
Sony DSC-W1 (PTP mode)		
Sony DSC-W12 (PTP mode)		

Sony DSC-W130 (PTP mode)		
Sony DSC-W200 (PTP mode)		
Sony DSC-W35 (PTP mode)		
Sony DSC-W510 (PTP mode)		
Sony DSC-W55 (PTP mode)		
Sony DSC-WX220 (MTP)		
Sony DSC-WX350 (MTP)		
Sony HDR-PJ260VE (PTP mode)		
Sony HDR-PJ710V (PTP mode)		
Sony ILCE-6400 (PC Control)	Image Capture, Trigger Capture, Liveview, Configuration	
Sony ILCE-7C (Control)	Image Capture, Trigger Capture, Liveview, Configuration	
Sony ILCE-7M2 (Control)	Image Capture, Trigger Capture, Liveview, Configuration	
Sony ILCE-7R M2 (MTP)		
Sony ILCE-7RM3A (PC Control)	Image Capture, Trigger Capture, Liveview, Configuration	
Sony ILCE-7RM4A (PC Control)	Image Capture, Trigger Capture, Liveview, Configuration	
Sony MSAC-SR1		
Sony MVC-CD300 (PTP mode)		
Sony MVC-CD500 (PTP mode)		
Sony NEX-3N (PTP mode)		
Sony NEX-5R		
Sony NEX-6		
Sony NEX-7 (PTP mode)		
Sony NEX5 (PTP mode)		
Sony PTP		

Sony RX100M3 (MTP)		
Sony SLT-A35 (PTP mode)		
Sony SLT-A350 (PTP mode)		
Sony SLT-A37		
Sony SLT-A55 (PTP mode)		
Sony SLT-A57		
Sony SLT-A58		
Sony SLT-A58 (Control)	Image Capture, Trigger Capture, Configuration	
Sony SLT-A65V (PTP mode)		
Sony SLT-A77V (PTP mode)		
Sony SLT-A99v		
Sony TRV-20E		
Sony UMC-R10C		
Sony ZV-1		
Sony ZV-1 (PC Control)	Image Capture, Trigger Capture, Liveview, Configuration	
Sony ZV-E10 (Control)	Image Capture, Trigger Capture, Liveview, Configuration	

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,	Testing (Beta)

	Configuration	
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		

Fuji

Camera Model	Abilities	Comments
Fuji Axia Eyeplate		Experimental
Fuji Axia Slimshot		Experimental
Fuji DS-7	Configuration	
Fuji DX-10	Configuration	
Fuji DX-5	Configuration	

Fuji DX-7	Configuration	
Fuji FinePix A330		
Fuji FinePix A610		
Fuji FinePix A800		
Fuji FinePix A820		
Fuji FinePix A920		
Fuji FinePix AV-150		
Fuji FinePix E900		
Fuji FinePix F100fd		
Fuji FinePix F20		
Fuji FinePix F200 EXR		
Fuji FinePix F30		
Fuji FinePix F31fd		
Fuji FinePix F40fd		
Fuji FinePix F50fd		
Fuji FinePix F60fd		
Fuji FinePix F70 EXR		
Fuji FinePix F80EXR		
Fuji FinePix H20EXR		
Fuji FinePix HS30EXR		
Fuji FinePix JX370		
Fuji FinePix S1000fd		
Fuji FinePix S100fs		
Fuji FinePix S1500		
Fuji FinePix S1800		
Fuji FinePix S2000HD		
Fuji FinePix S2500HD		
Fuji FinePix S2950		
Fuji FinePix S2980		
Fuji FinePix S4300		
Fuji FinePix S4850		

Fuji FinePix S5700		
Fuji FinePix S5800		
Fuji FinePix S6500fd		
Fuji FinePix S7000		
Fuji FinePix S8600		
Fuji FinePix S9500		
Fuji FinePix SL1000		
Fuji FinePix T200		
Fuji FinePix X-E1		
Fuji FinePix X-S1		
Fuji FinePix X10		
Fuji FinePix X20		
Fuji FinePix XF1		
Fuji FinePix Z100fd		
Fuji FinePix Z35		
Fuji FinePix Z700EXR		
Fuji Fujifilm A220		
Fuji Fujifilm GFX 100S	Image Capture, Liveview, Configuration	
Fuji Fujifilm GFX 100S (2nd)	Image Capture, Liveview, Configuration	
Fuji Fujifilm GFX100	Image Capture, Liveview, Configuration	
Fuji Fujifilm X-A2		
Fuji Fujifilm X-A5		
Fuji Fujifilm X-E2		
Fuji Fujifilm X-E3	Image Capture, Liveview, Configuration	
Fuji Fujifilm X-E4		
Fuji Fujifilm X-H1	Image Capture, Liveview, Configuration	

Fuji Fujifilm X-M1		
Fuji Fujifilm X-Pro2	Image Capture, Liveview, Configuration	
Fuji Fujifilm X-Pro3	Image Capture, Liveview, Configuration	
Fuji Fujifilm X-S10	Liveview	
Fuji Fujifilm X-T1	Image Capture, Liveview, Configuration	
Fuji Fujifilm X-T10		
Fuji Fujifilm X-T2	Image Capture, Liveview, Configuration	
Fuji Fujifilm X-T20		
Fuji Fujifilm X-T3	Image Capture, Liveview, Configuration	
Fuji Fujifilm X-T30	Liveview	
Fuji Fujifilm X-T4	Image Capture, Liveview, Configuration	
Fuji Fujifilm X100F		
Fuji Fujifilm X100V	Liveview	
Fuji Fujifilm X30		
Fuji Fujifilm X70		
Fuji GFX 50 R	Image Capture, Liveview, Configuration	
Fuji GFX 50 S	Image Capture, Liveview, Configuration	
Fuji IX-1	Image Capture, Liveview	
Fuji MX-1200	Configuration	
Fuji MX-1700	Configuration	
Fuji MX-2700	Configuration	
Fuji MX-2900	Configuration	

Fuji MX-500	Configuration	
Fuji MX-600	Configuration	
Fuji MX-700	Configuration	
Fuji S5 Pro	Image Capture, Configuration	
Fuji X (WLAN)	Image Capture, Liveview, Configuration	Experimental
FujiFilm @xia ix-100	Image Capture	

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 extermal device or computer.

The documentation for each mount, including supported connection methods, are included in the mount-specific documentation on the INDI devices portal.

Mount Connection Guide

In order to know what connections your mount supports, check the following table:

Manufacturer	HC	Direct	WiFi	Ethernet	Bluetooth	Comment	Cables
Meade	Yes	NA	Yes*	NA	NA	WiFi requires external Stella WiFi Adapter	IKA-203 & IKA-204
Celestron	Yes	NA	Yes*	NA	NA*	1. Native WiFi support for Evolution Mounts using INDI Celestron Aux driver. Other models require SkyPortal WiFi Module. 2. Handsets before 2016 with RJ11 port require StellarMate IKA-205 cable. Post 2016 Handset have mini USB port that can be connected directly to StellarMate.	IKA-205
SkyWatcher / Orion	Yes	Yes	Yes*	NA	Yes*	1. Direct connection via StellarMate cables is the best option to gain full control of the mount via INDI EQMod driver. 2. Connecting to Synscan handset is possible but offers limited functionality. 3. Some WiFi mounts (e.g. AZ-GTi) offers direct WiFi communication. Non-WiFi native mounts require external dongle. 4. Bluetooth communication supported with external bluetooth dongles.	IKA-201 & IKA-206
iOptron	Yes	Yes*	Yes*	NA	NA	1. Most mounts are connected from handset to StellarMate via IKA-202 cable 2. Some newer mounts (e.g. CEM70g) support direct connection to RS232 port. 3. Native WiFi mounts are supported.	IKA-202
Astrophysics	Yes	NA	NA	NA	NA		
Omegon	Yes	NA	NA	NA	NA		
Vixen	Yes	NA	NA	Yes	NA		
10Micron	Yes	NA	NA	Yes	NA		
Avalon	Yes	NA	NA		NA		
Paramount	NA	NA	NA	Yes*	NA	StellarMate can control Paramount only via TheSkyX TCP Server. The INDI Paramount driver must connect to TheSkyX server to drive the mount. Both StellarMate and TheSkyX must be on the same network.	
PMC-8	Yes	NA	Yes	Yes	NA		
Losmandy G11	Yes	NA	NA	NA	NA		
Explore Scientific EXOS2	Yes	NA	Yes	Yes	NA		
Explore Scientific iEXOS100	Yes	NA	Yes	Yes	NA		
Losmandy Gemini	Yes	NA	NA	Yes	NA		
Temma Takahashi	Yes	NA	NA	Yes	NA		
TeenAstro	Yes	NA	NA	Yes	NA	Ethernet connection is supported (Firmware > v1.1)	

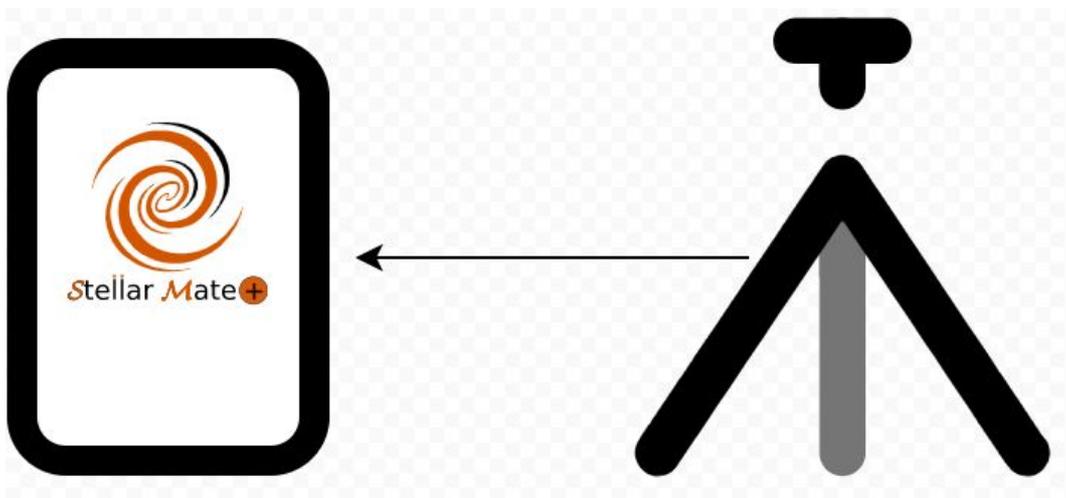|					
SkyWatcher Virtuso	Yes	NA	NA	NA	NA
SkySensor2000PC	Yes	NA	NA	NA	NA
Pulsar2	Yes	NA	NA	NA	NA
AOK SkyWalker	NA	NA	Yes	Yes	NA
OnStep	Yes	Yes	Yes	Yes	Yes
Rainbow RS-125	Yes	NA	NA	NA	NA
ArgoNavis	Yes	NA	NA	NA	NA
Digital Setting Circle	Yes	NA	NA	NA	NA

Methods of Connection

The following diagrams illustrates the methods of connection:

- HC (HandSet Controller)
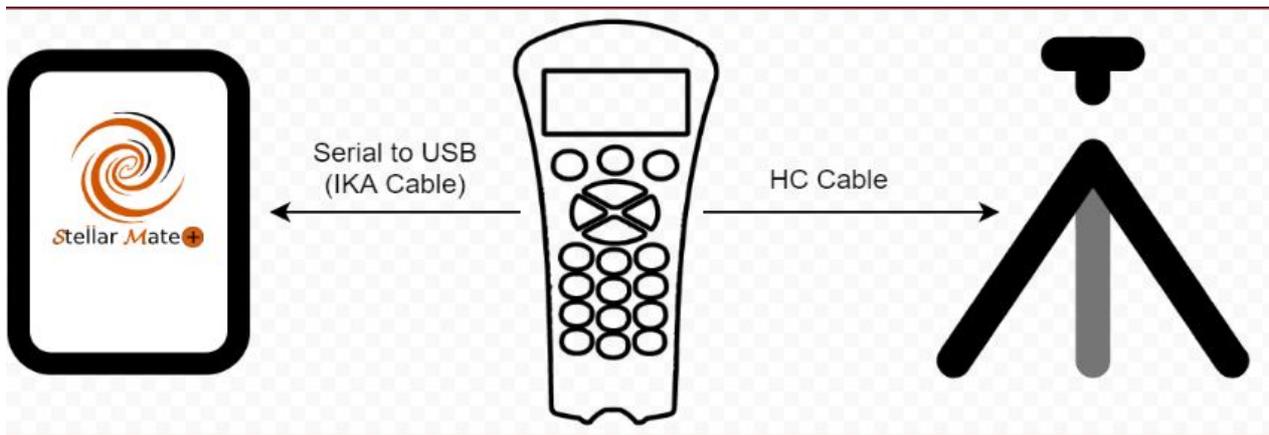
- Direct

- WiFi

1. **HotSpot mode**
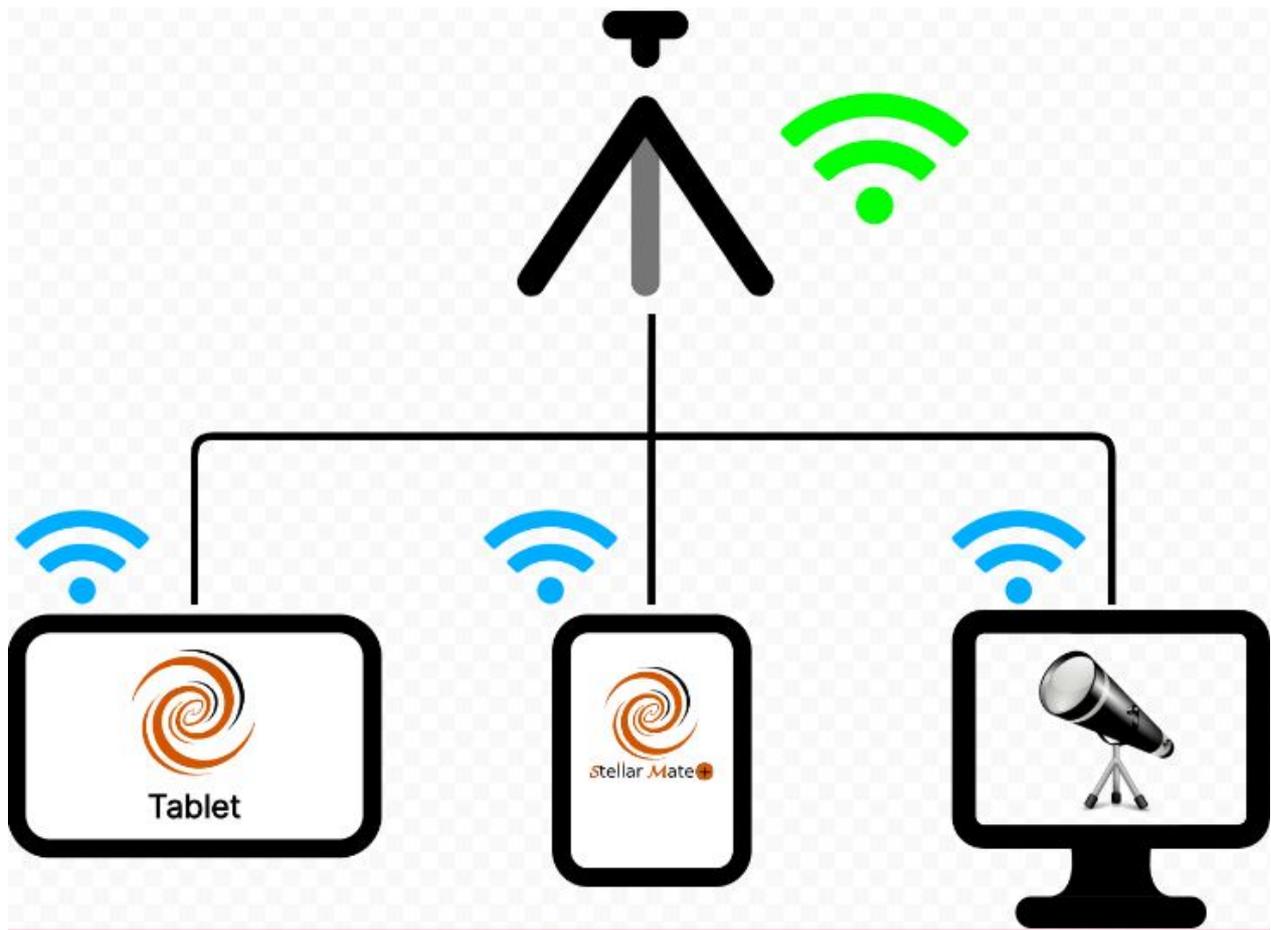
2. **WiFi Infrastructure**
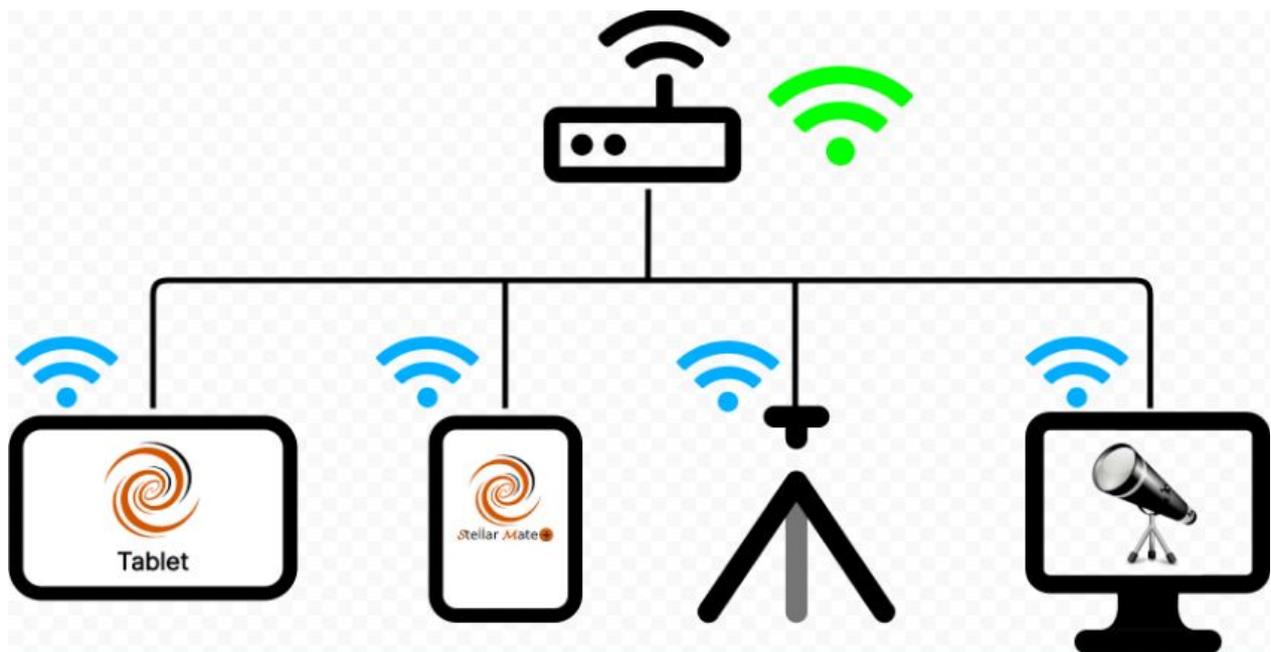
- Bluetooth

Serial to USB

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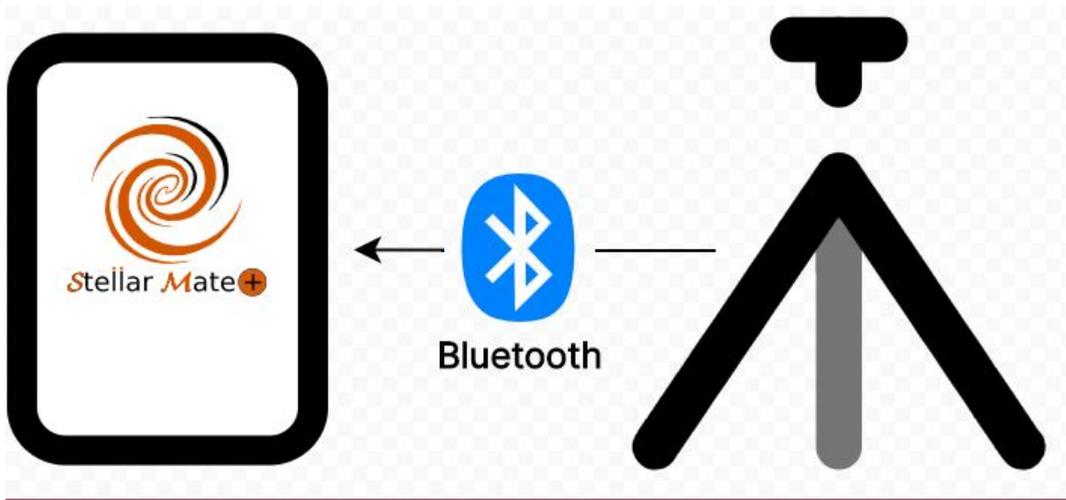
❶ IMPORTANT

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 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!

For many Mounts & Focusers that use RS232 connectors, you need to purchase a Serial-To-USB adapter suitable for your Mount/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 (Web or Ekos versions), you can assign permanent designations for your devices so that they always get the same port whenever they are connected

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.

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 DYI 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 recommened 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.

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.

Focusers

Mount	Driver
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_wheel indi_fli_focu

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
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

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.

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!


Some filter wheels are connected to USB as regular USB devices while others are connected as Serial-To-USB devices. For the latter case, you need to purchase a Serial-To-USB adapter suitable for your filter wheel 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.

If your Filter Wheel mode does not uses a Serial-To-USB chip, you will not see any settings for serial Port settings in the driver and can therefore connect directly.

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).
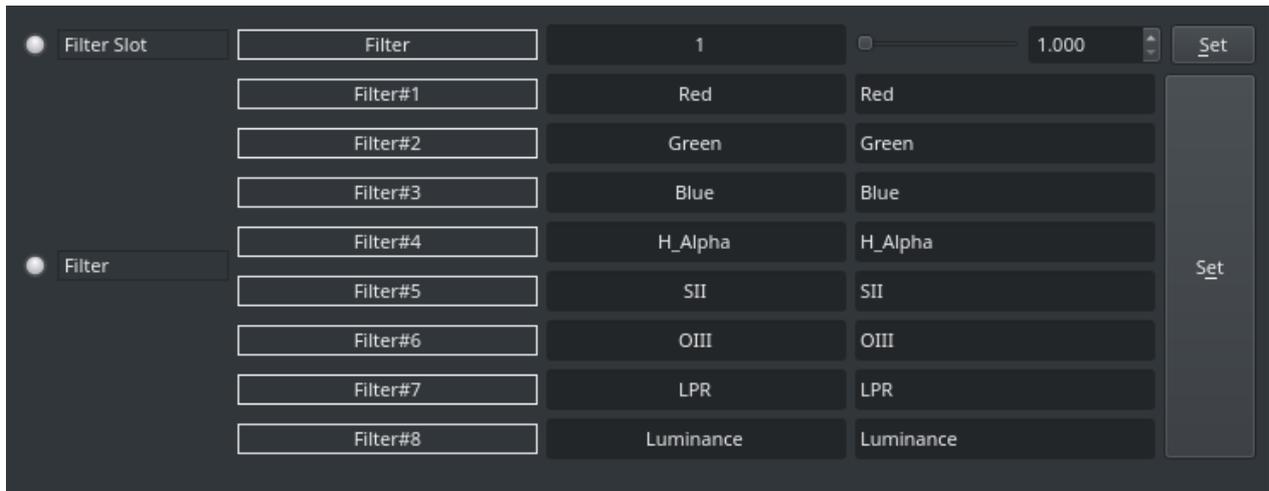
Filter Wheels

Mount	Driver	Devices
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](#)

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
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

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 suffcient 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:

   o Equatorial Mount: Telescope should be looking at the Celestial Pole (Polaris for the Northern Hemisphere) with counter-weights down.

   o Alt-Az Mount: Telescope should parallel to the ground looking exactly North (for Northern Hemisphere) or South (for Southern hemisphere).

   o 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:

   o 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).

   o 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 appropiate driver for your mount usually depends on two factors:

1. Mount model.

2. Naming Convention: Driver labels can indicate which communication method they use

- o HC: Hand Controller or Hand Set (e.g. Celestron Advanced VX HC)
- o Wired: AUX/PC Port (e.g. Celestron Advanced VX Wired)
- o WiFi: WiFi connection (e.g. Celestron Advanced VX WiFi)

3. Connection method (AUX Port, PC Port, Handset, WiFI, ..etc).

Mount	Driver	Connection Method
• Advanced AVX • CGEM / CGEM II • CGX / CGX-L • CPC / CPC Deluxe • Nexstar • Evolution	• Celestron GPS • Celestron CPC HC • Celestron Nexstar HC • Celestron AVX HC • Celestron CGX HC	• Older Nexstar HCs come with RJ9 pl You need Serial-to-USB adapter ca from HC to PC/Device. • Modern Nexstar HCs come with U Type-B port that you can connect dire via a USB cable to your device (no se to USB adapter is required).
• Advanced AVX WiFi • CGEM / CGEM II WiFi • CGX / CGX-L WiFi • Evolution WiFi	• Celestron AUX • Celestron WiFi • Evolution WiFi • Evolution WiFi Wedge • CGEM II WiFi • CGX WiFi • Advanced VX WiFi	WiFi (No handset is required).
• Advanced AVX • CGEM / CGEM II • CGX / CGX-L • CPC	• Celestron AUX • CGEM II Wired • CGX Wired • Advanced VX Wired	Wired AUX or PC Port (located on top of base of the scope).

SkyWatcher

All SkyWatcher & Orion Mounts, including EQMod driver.

Before connecting to your mount

1. Ensure the mount firmware is the latest as provided by your manufacturer.

2. Ensure mount has proper and suffcient 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 two categories:

1. Equatorial Mount: Telescope should be looking at the Celestial Pole (Polaris for the Northern Hemisphere) with counter-weights down.
2. Alt-Az Mount: Telescope should parallel to the ground looking exactly North (for Northern Hemisphere) or South (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:

1. 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).
2. 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 appropiate driver for your mount usually depends on two factors:

- Mount model.
- Connection method (Cable, WiFI, Bluetooth..etc).

Mount	Driver	Connection Metl
• HEQ5 • EQ6 \ EQ6R Pro • AZ-EQ5 \ AZ-EQ6 Pro • EQ8 \ EQ8 Pro • EQ3 Pro EQM-35 Pro • Orion Sirrius \ Orion, Atlas	EQMod Mount	EQDirect Cable
• HEQ5 • EQ6 \ EQ6R Pro	EQMod Mount	Bluetooth

- AZ-EQ5 \ AZ-EQ6 Pro
- EQ8 \ EQ8 Pro
- EQ3 Pro EQM-35 Pro
- Orion Sirrius \ Orion, Atlas

- HEQ5 - EQ6 \ EQ6R Pro - AZ-EQ5 \ AZ-EQ6 Pro - EQ8 \ EQ8 Pro - EQ3 Pro EQM-35 Pro - Orion Sirrius \ Orion, Atlas	[EQMod Mount](#)	[Synscan Wifi Adap
- AZ-GTi WiFi (With Equatorial Wedge)	[AZ-GTi Equatorial WiFi](#)	WiFi
AZ-GTi Wired	- Equatorial Wedge: [EQMod Mount](#) - Alt-Az: [SkyWatcher Alt-Az](#)	WIRED cable from USB
- AZ-GTi (Alt-Az) - All SkyWatcher Dobsonian GOTOs - All Orion Dobsonian GOTOs	[SkyWatcher Alt-Az WiFi](#)	WiFi (Native) or [Sy
- Any SkyWatcher/Orion with Synscan Handset (HC)	[Synscan](#)	- Older Synsca RJ11 plug. You adapter c PC/Device. - Modern Synsc USB Type-B connect direct your device adapter is requ
- SkyWatcher Virtuso	[SkyWatcher Virtuso](#)	WiFi
- SkyWatcher Star Adventurer 2i Pro	[SkyWatcher Star Adventurer 2i WiFi](#)	WiFi
- SkyWatcher Star Adventurer 2i Pro	[SkyWatcher Star Adventurer 2i WiFi](#)	USB
- SkyWatcher Star Adventurer	SkyWatcher Star Adventurer	NA

Astrophysics

INDI Library supports Astrophyics 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 you 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
• AstroPhysics Experimental	• indi_lx200ap_experimental	.
• Astrophysis GTOCP2	• indi_lx200ap_gtocp2	
• Astrophysis	• indi_lx200ap	

• AstroPhysics V2	• indi_lx200ap_v2	• Snoop device
		  o GPS
		  o Dome

Omegon

Omegon mounts are a collection of Alt-Az and Equatorial mounts for visual observation and astrophotography.

Mount	Driver	Devices

• EQ500X	• indi_eq500x_telescope

Vixen

Mount	Driver	Devices
• Starbook	• indi_starbook_telescope	

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 appropiate 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:

$$0 < Client\ Limit < Mount\ Limit$$

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 then 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	Devices
[iOptronV3](#)	indi_ioptronv3_telescope	
[GotoNova 8400 Kit](#)	lx200gotonova	The driver supports the following G 8400 based controllers
[iEQ](#)	indi_ieq_telescope	• CEM60 (Firmware 140807 and • CEM60-EC (Firmware 140807 • iEQ45 Pro (Firmware 140807 a • iEQ45 Pro AA (Firmware 14080
[ZEQ25](#)	indi_lx200zeq25	• ZEQ 25 • SmartEQ • iEQ30 • iEQ45 EQ/AA

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	Executable	Devi
• [LX200 Autostar](#)	• indi_lx200gps	• E • L • L • LX2
• [LX200 16](#)	• indi_lx200_16	.
• [LX200 Classic](#)	• indi_lx200classic	

• LX200 GPS	• indi_lx200gps

Orion

Mount	Driver	Devices

• SynScan	• indi_synscan_telescope	• Snoop devices
		   o GPS
		   o Dome

Cameras

CCDs, Autoguiders & Webcams

Cameras	**Driver**
Altair	indi_altair_ccd
Apogee CCD	indi_apogee_ccd
Atik	indi_atik_ccd
Nightscape 8300 CCD	indi_nighscape_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	indi_v4l2_ccd
INDI Webcam	indi_webcam_ccd
ASI CCD	indi_asi_ccd

Focusers

Focusers	Driver	Devices
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_wheel indi_fli_focus	• CCD Driver: **FLI CCD** (indi_fli_ccd) for all FLI cameras. • Filter Wheel Driver: **FLI CFW** (indi_fli_wheel) for all FLI filter whee • Focuser Driver: **FLI PDF** (indi_fli_focus) for FLI Precision D Focuser.
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
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

Filter Wheels

Filter wheels	Driver	Devices
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	

Auxiliary

Auxiliary devices, spectrometers, sensors, encoders, switches, motor..etc

CCDs, Autoguiders & Webcams

Auxialiaries	Driver	Devices
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	i4jRaspberryPiGPIODriver	
MyDCP4ESP32	indi_mydcp4esp32	
Pegasus UPB	indi_pegasus_upb	
Seletek	I4JSeletekDriver	
SQM	indi_sqm_weather	
USB_Dewpoint	indi_usbdewpoint	
Watchdog	indi_watchdog	

Adaptive Optics

Optics	Driver executable	Devices
• Starlight Xpress AO	• indi_sx_ao	

Weather Stations

Weather stations, cloud & rain detectors...

Stations	Driver	Devices
[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	

Covers & Light Sources

Dust Covers & Flat Light Sources

Sources	Driver	Devices
[Wanderer Cover V3](#)	indi_wanderer_cover	
[FlipFlat](#)	indi_flipflat	
[SnapScap](#)	indi_snapcap	
[ALTO](#)	indi_alto	
[GIOTTO](#)	indi_giotto	

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 expereince but can manage to write simple Python script to control your motor.

Customizing the INDI Roll-off driver is optimal if you know some rudementary 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 comminicates 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 haa 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 is is slewing from one object to another, or while tracking. When tracking, the dome would move when the difference between its current and target postion 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 withing 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 offse 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
[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	

Controllers

Joysticks & Game pads

Controllers	Driver	Devices
[Joystick](#)	indi_joystick	

Spectrographs

Spectrographs, radio and optical

Spectrograph	Driver	Devices
[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.

StellarMate Plus Controller is equipped with a Real Time Clock (RTC). This ensures that the internal clock keeps ticking even when the power is switched off. When SM Plus is powered on, it reads the time from the onboard RTC. While this value might drift off by a few seconds over time, it is critical to minimize any large errors that otherwise would accumulate over time unchecked.

🛈 Note

For users who installed StellarMate OS on their own Raspberry PI4 SBCs, it's recommended to invest in installing an DS3231 RTC module or use a GPS dongle.

While the RTC provides acceptable time tracking, it does not offer location information. Therefore, GPS is the recommended solution in the long term. The following are the supported GPS sources:

- Tablet/Mobile GPS: The StellarMate App relays the tablet/mobile time and location information to StellarMate. Everytime the SM App is connected to SM Plus, it automatically synchronizes both time and location information accordingly.
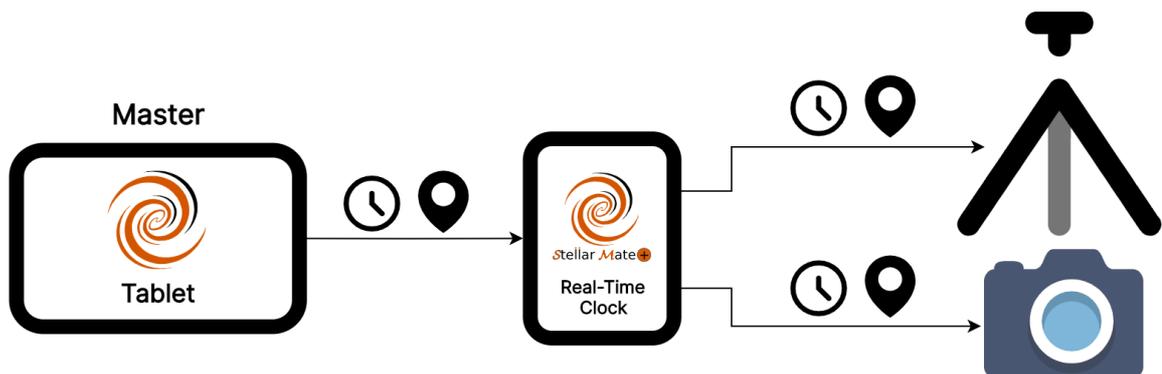
- External GPS Dongle: SM Plus supports a number of dedicated external GPS dongles connected via USB. Once connected, select the GPSD driver in your equipment profile in order to utilize the GPS.
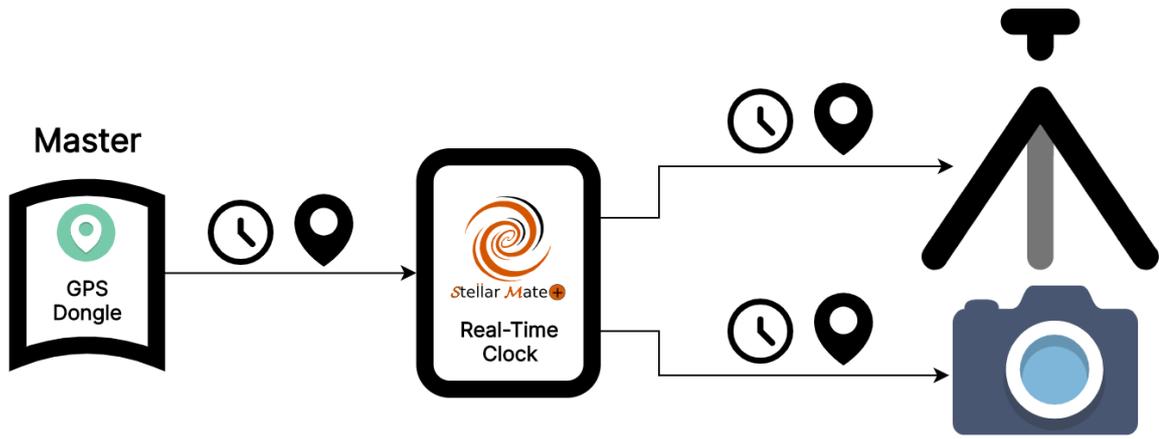
- Mount with GPS: Some mount have internal or external GPS adapters. These adapters cannot be connected directly to StellarMate, they are used to update the time and location on the mount handset. You can select Mount as the source of data if desired.
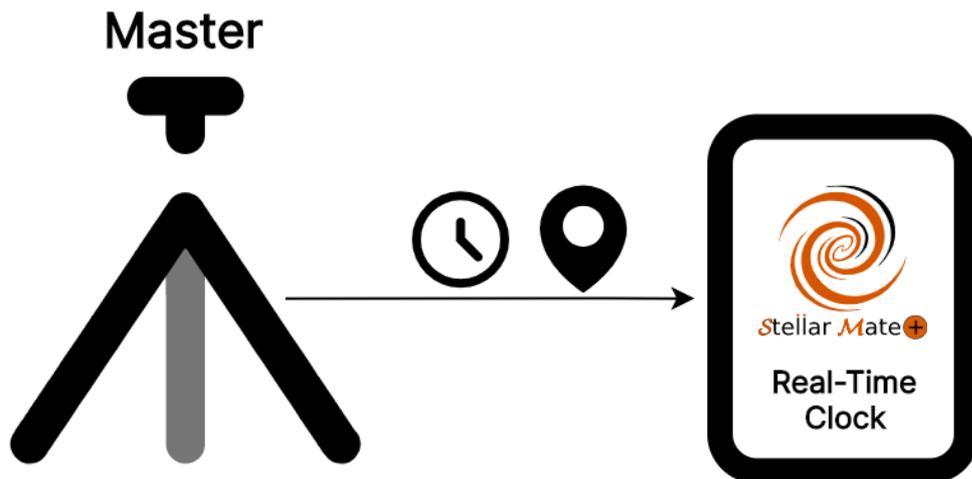
Every time the StellarMate Mobile App is connected to StellarMate, it syncs both time and location information from the tablet/phone GPS. If the SM App is not used (for example, when using Ekos on a PC/Mac), then StellarMate relies primarily on RTC as the time source.

In KStars, it is possible to specify the Time Source. Click on Settings → Configure KStars → INDI.
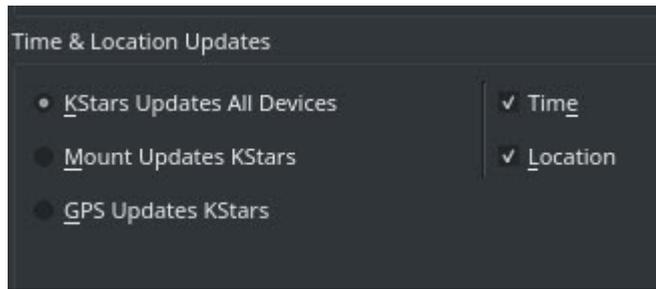
By default, KStars is the source of all time and location information. The KStars time depends on the system time for StellarMate, and therefore depends on the RTC. If StellarMate is connected to the internet, the system would also synchronize the time to online time servers and synchronize the RTC clock accordingly. Now both the internet time and RTC clock are again in sync to account for any drifts that might build up in the RTC.

After connecting the SM App to StellarMate, the KStars' location is updated to the tablet/mobile GPS location. You can also change the KStars location from Settings → Geographic and then select or add a new location.

> ⓘ Tip
>
> You can use 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 setup your astrophotography workflow.

Therefore, in KStars, the time and location information MASTER source can be selected from the following sources:

- KStars Updates All Devices: KStars time and location is the primary source and all connected devices (mounts..etc) are synchronized to KStars time and location. When using SM App, it's recommended to leave this option as is.
- Mount Updates KStars: The mount time and location are used to update KStars time and location. Some mounts are equipped with internal or external GPS, KStars does NOT connect to these mount-specific GPS dongles. Instead, KStars communicates with the mount via the Handset/WiFi to query time and location information and then uses them as the source.

- GPS Updates KStars: When using a dedicated externa GPS dongle, select this option to ensure the GPS dongle is the master source for both time and location. When Ekos detects a GPS device, it will prompt the user to switch to it as the master time & location source.

Therefore, you must select which source is the most accurate and reliable for time & location information. By default, KStars is the master source for time and location data.

⚠ WARNING

Turn off DST / Daylight Saving settings in the handset as this could interfere with correct time settings.

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.
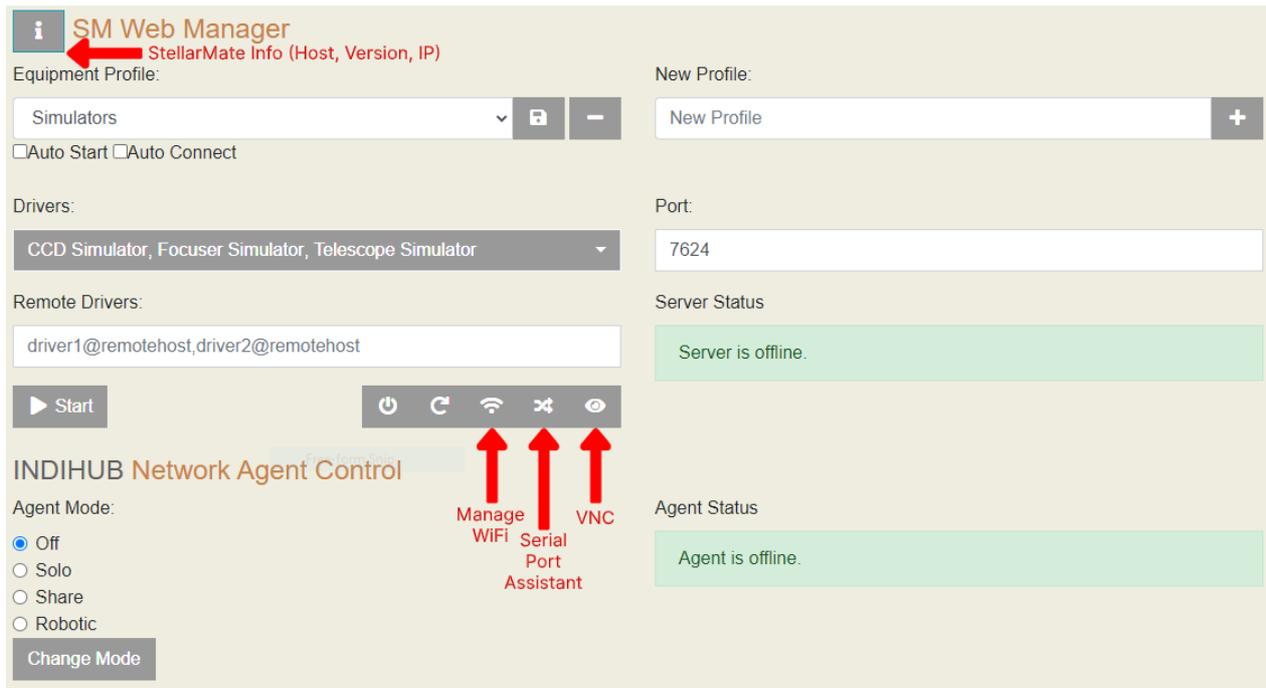
By default, StellarMate is shipped with the Simulator profile. It is composed of the following drivers:

- Telescope Simulator

- CCD Simulator

- Focuser Simulator

You can run the Simulator profile to test the simulators and connect to them from any client.

Web Manager URL

You can access the Web Manager from any browser at this url:

`http://stellarmate.local:8624`

> ℹ️ 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.
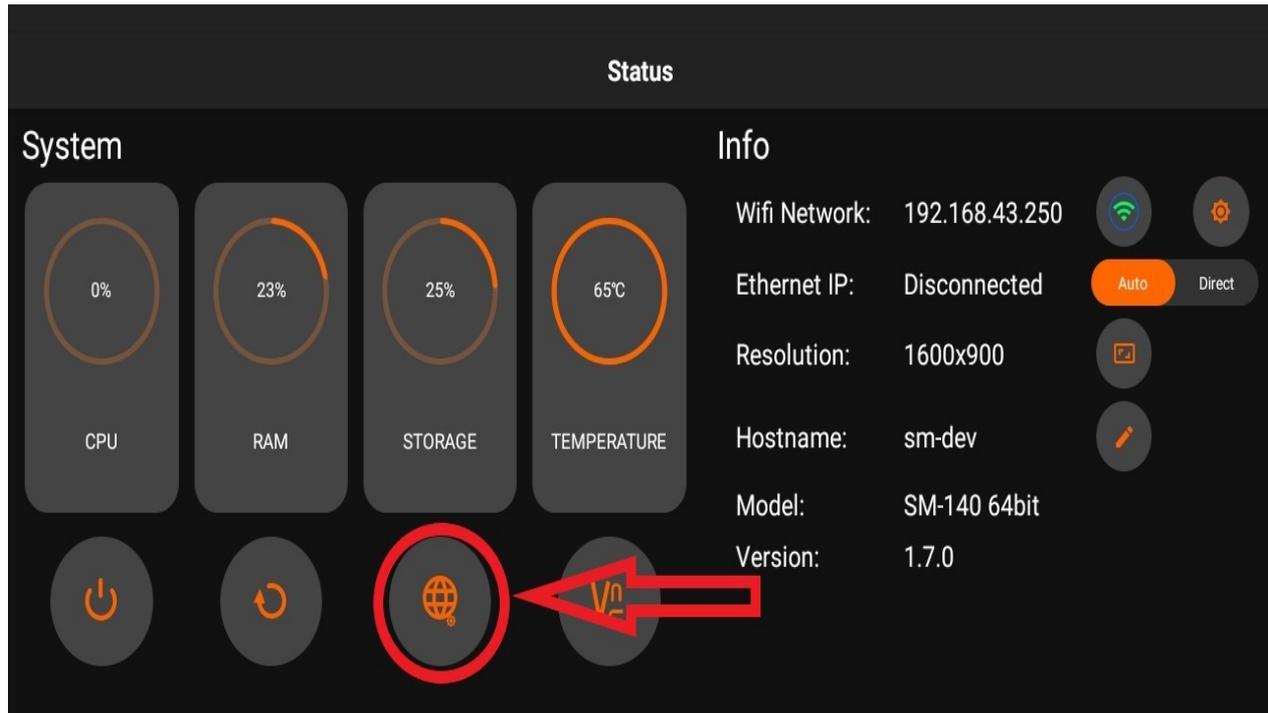
> 🛈 Note
>
> Interacting with the StellarMate Web Manager is usually not necessary since both Ekos and the StellarMate App can operate the equipment profiles directly. The Web Manager is useful when you are not using the StellarMate App and need to remotely manager the drivers directly.

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.

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:

    o **Joystick**: If you plan to use a joystick with your mount, select the Joystick driver from the auxiliary list.

    o SkySafari: To monitor and control your mount from SkySafari, select the SkySafari driver from the auxiliary list.

    o 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.

Removing Profile

To remove an equipment profile, press the Minus sign next to it. Please note this operation is permanent.

Auto Start

If you want to automatically start a particular equipment profile whenever StellarMate is powered on, check the AutoStart checkbox.

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.

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. Simple 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

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.

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.

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 Control Panel

❗ 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.

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 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.
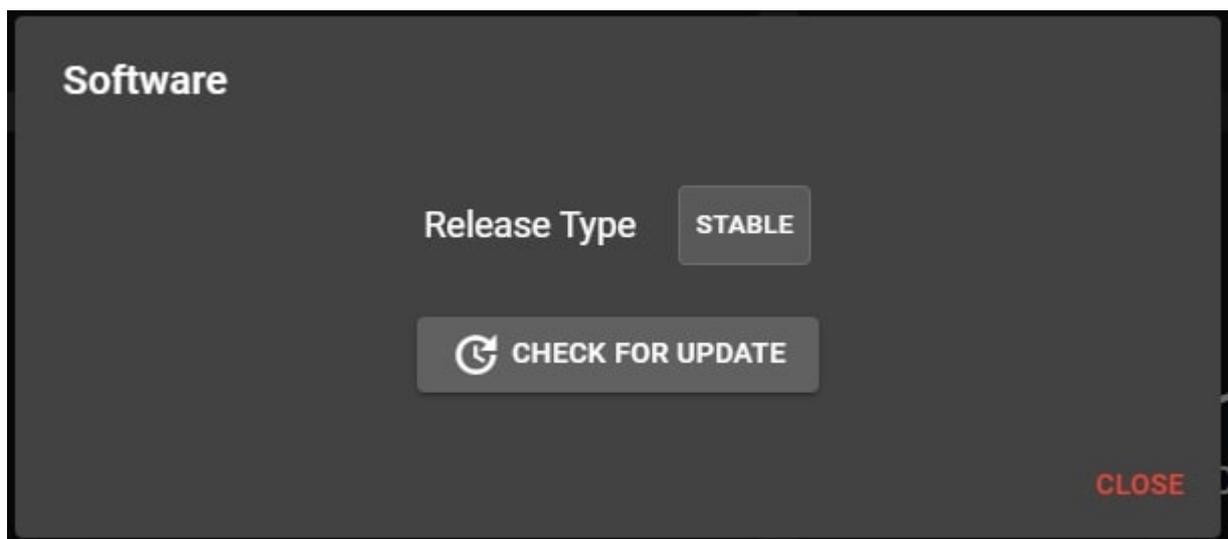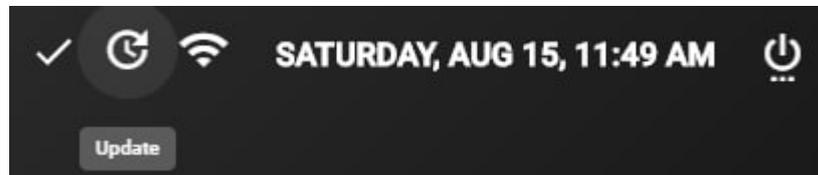
Dashboard
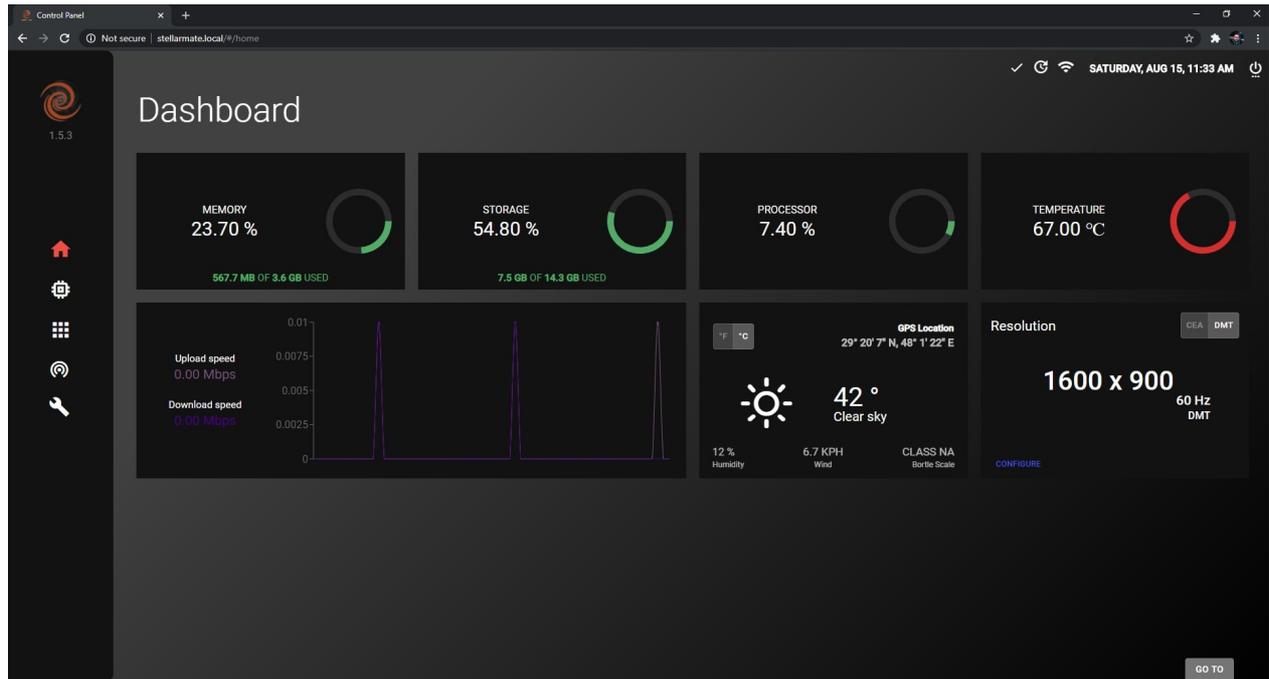
The home page of the StellarMate Control Panel is the Dashboard, which shows the following information:

1. RAM Usage

2. Storage Usage

3. CPU Usage

4. Device Temperature

5. Network Graph

6. Weather and Location Information

7. Screen Resolution

Weather Units

Weather units can be toggled from Metric to Imperial and vice-versa.

Hardware

In this page, you can see all the hardware devices that are connected to StellarMate.
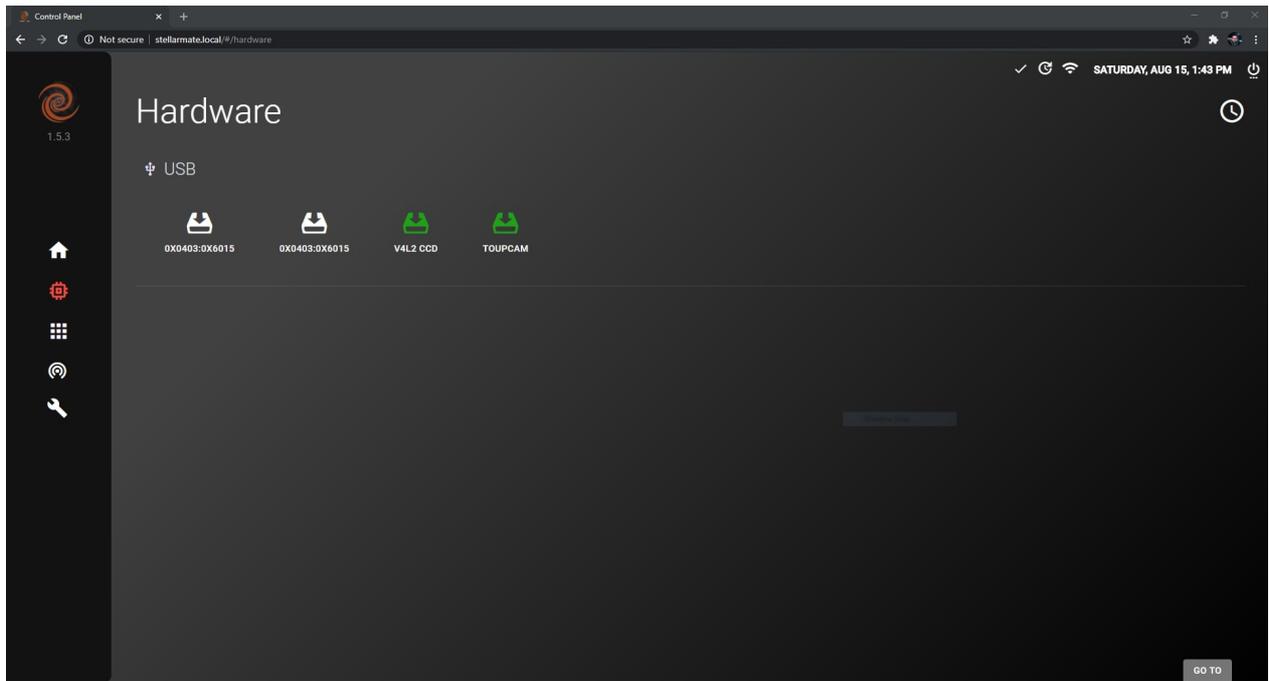
Clicking on a device will show its information, which can be downloaded by clicking on the Download button (cloud icon) on the top-right.
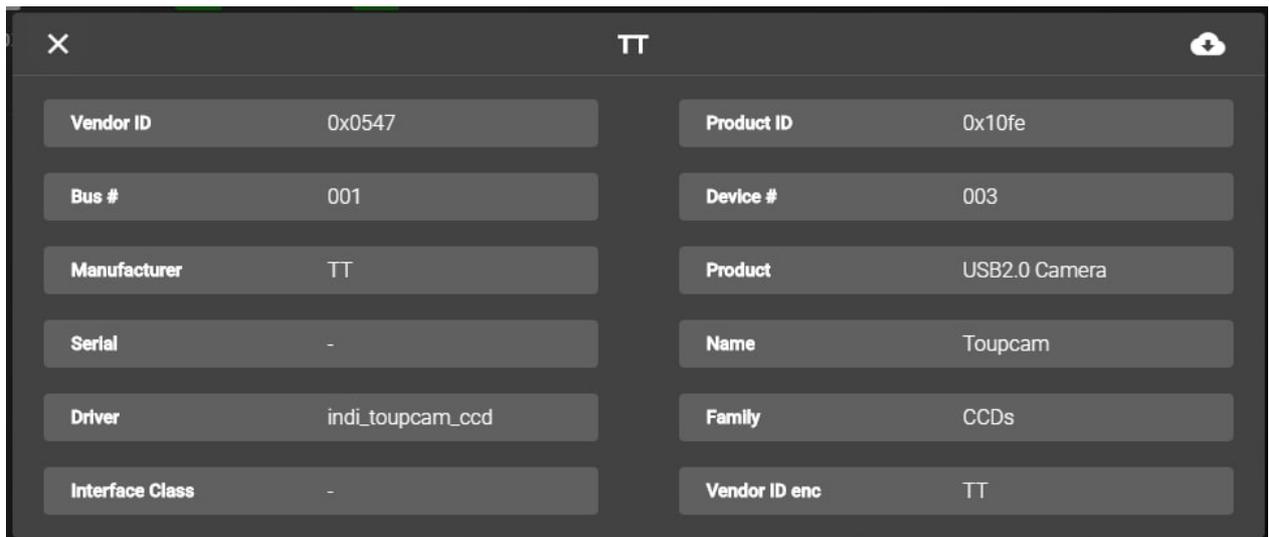
Software
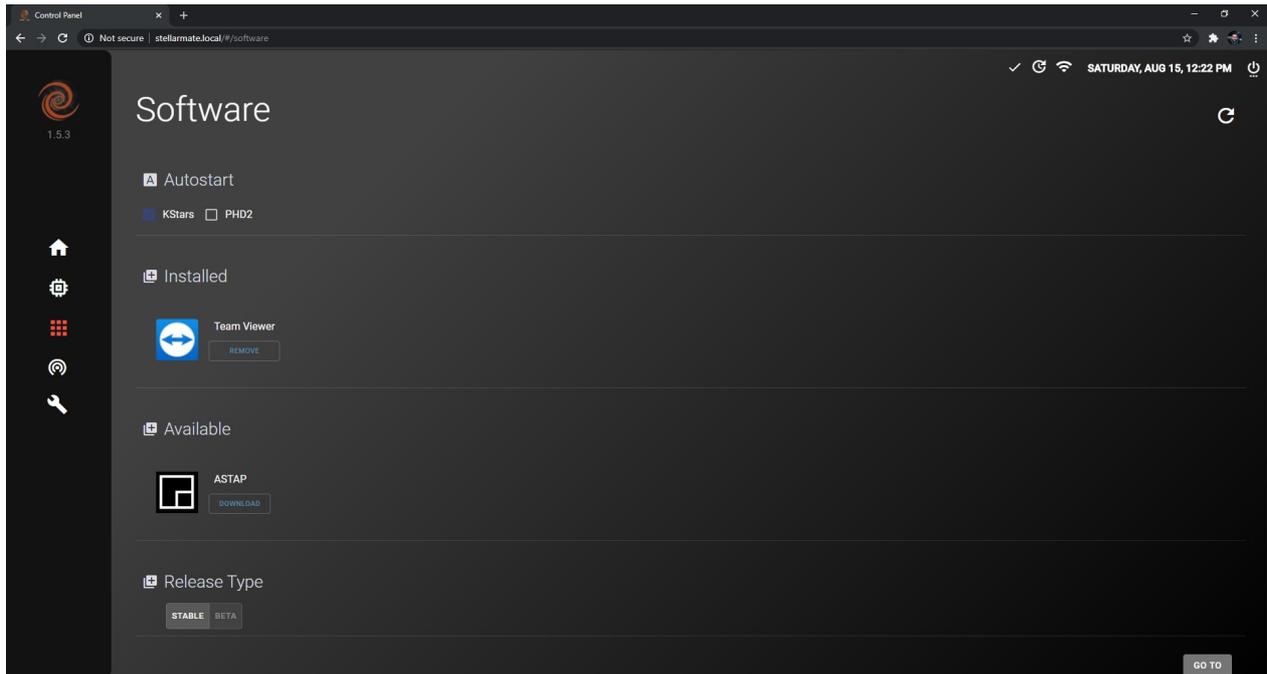
Auto Start

In the software center it is possible to toggle Auto Start for KStars and/or PHD2. If toggled on, it allows KStars and/or PHD2 to start-up with StellarMate OS.

Installed

Installed applications appear in this section and you can remove/uninstall them by clicking on the remove button.

Available

Applications that are available for download appear in this section and you can install them by following these steps:

1. Click on Download
2. Wait for download to complete
3. Click on Install

The application should now be installed on your StellarMate.

Release Type

You can switch between the Stable and Beta releases. The Stable release -as the name

suggests- is stable, has the main features of StellarMate OS and does not contain show-stopping bugs. The Beta release is not very stable, and it has drivers and new features such as incomplete drivers for unsupported devices. The new features might've not been tested completely and can sometimes be buggy since there might be show-stopping bugs which were not caught by StellarMate developers.

Network
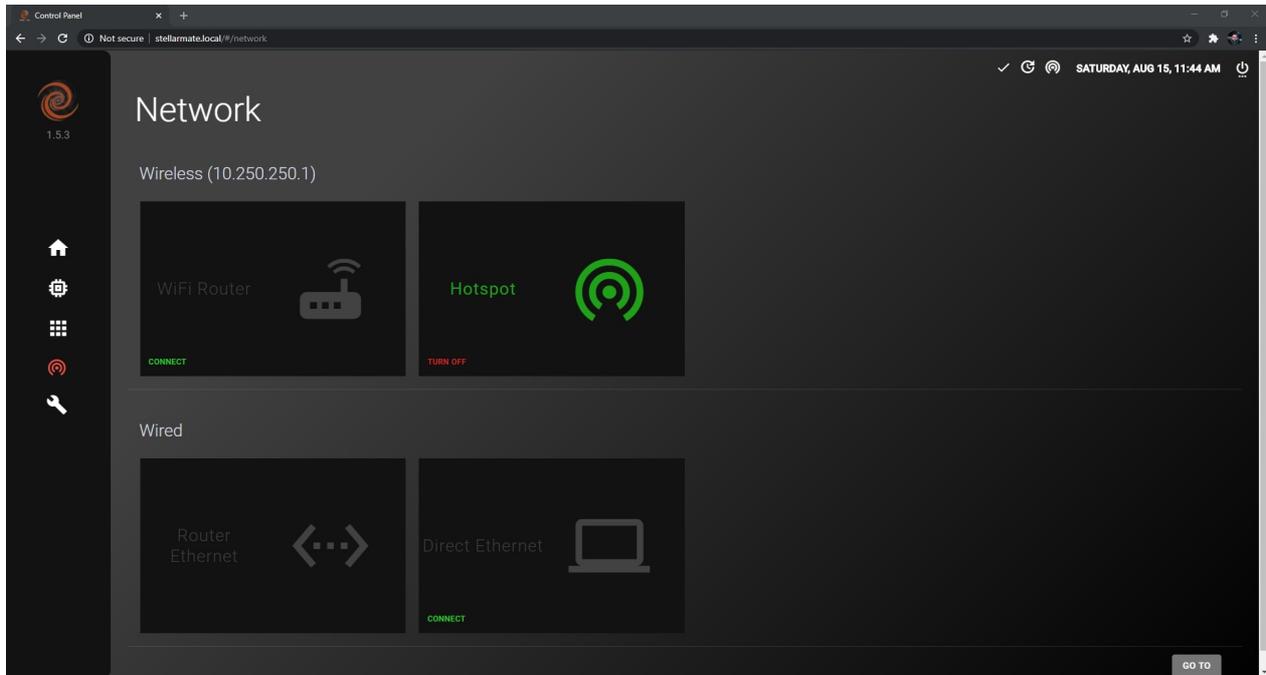
Wireless

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
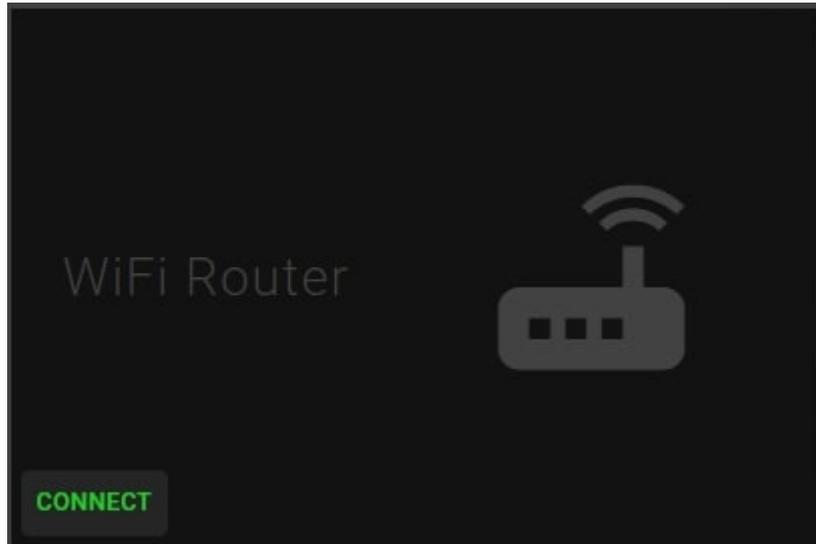
2. **Select** your WiFi Router network connection and then put in the password if there is one, then click on **Connect**.
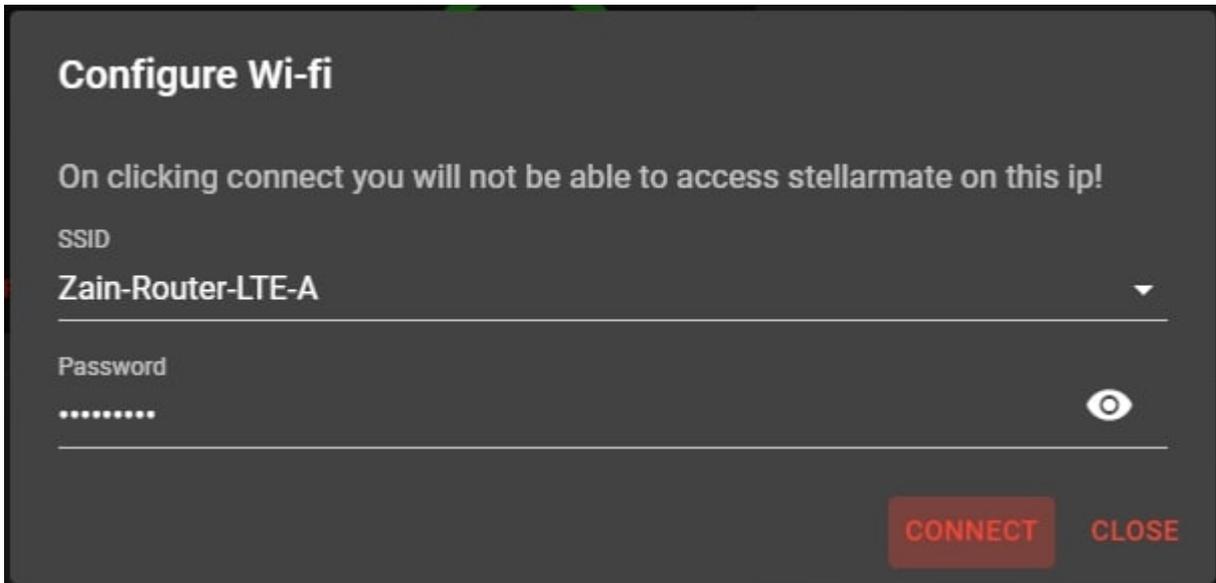
3. Connect to the same WiFi network on your computer/laptop and then refresh the page, the network page should look like the image below.
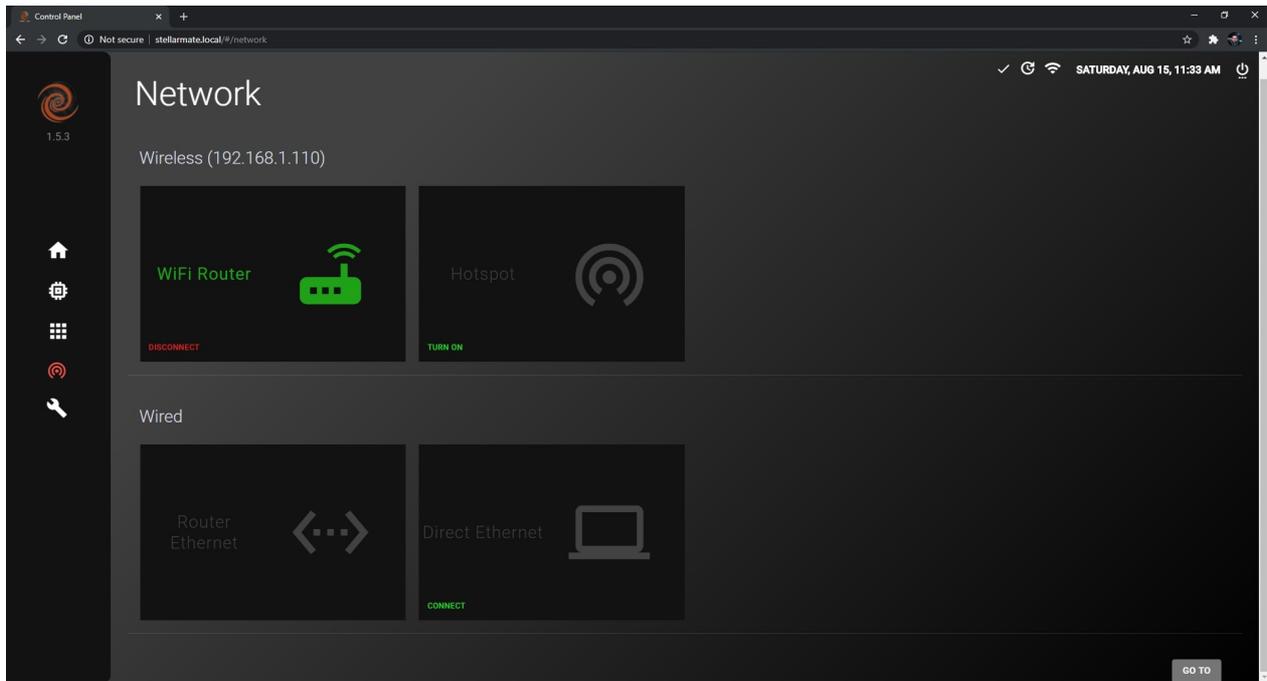
You can always switch back to **HotSpot** mode whenever you want by clicking on the Turn On button under HotSpot.

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.

Diagnostics
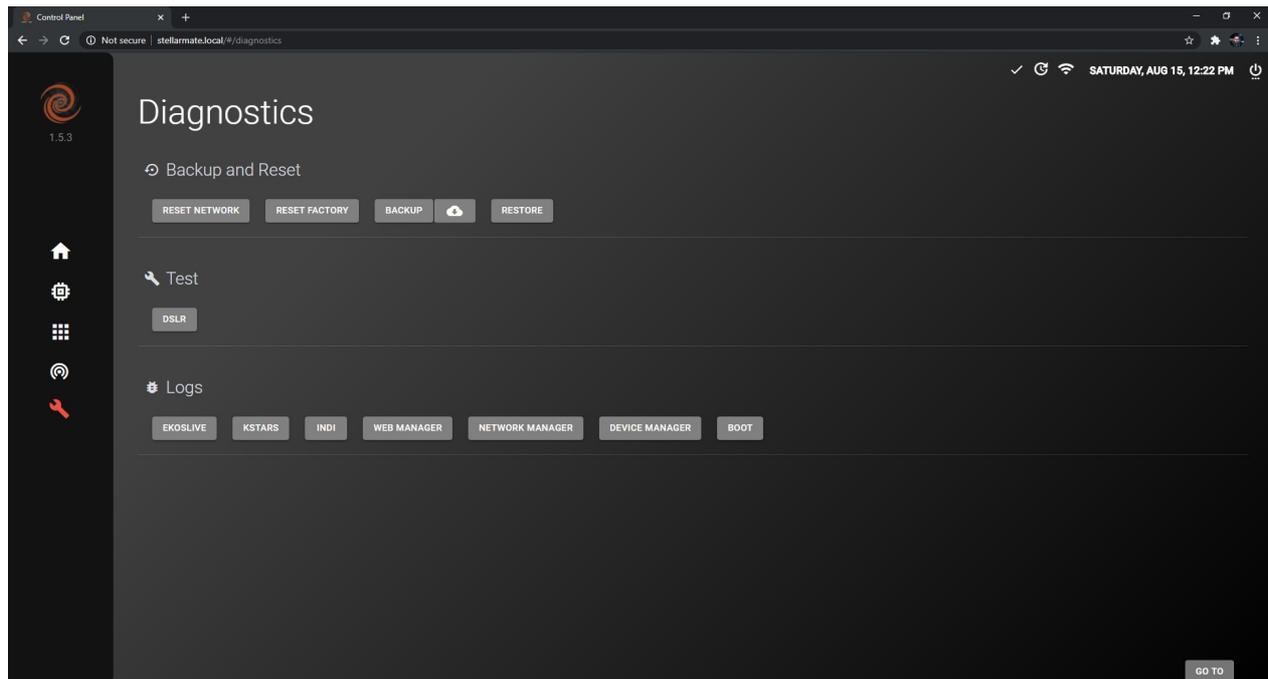
The Diagnostics page contains Backup and Reset functions as well as many important information to help StellarMate developers fix any issues that StellarMate users face.

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 instablities, 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.

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.
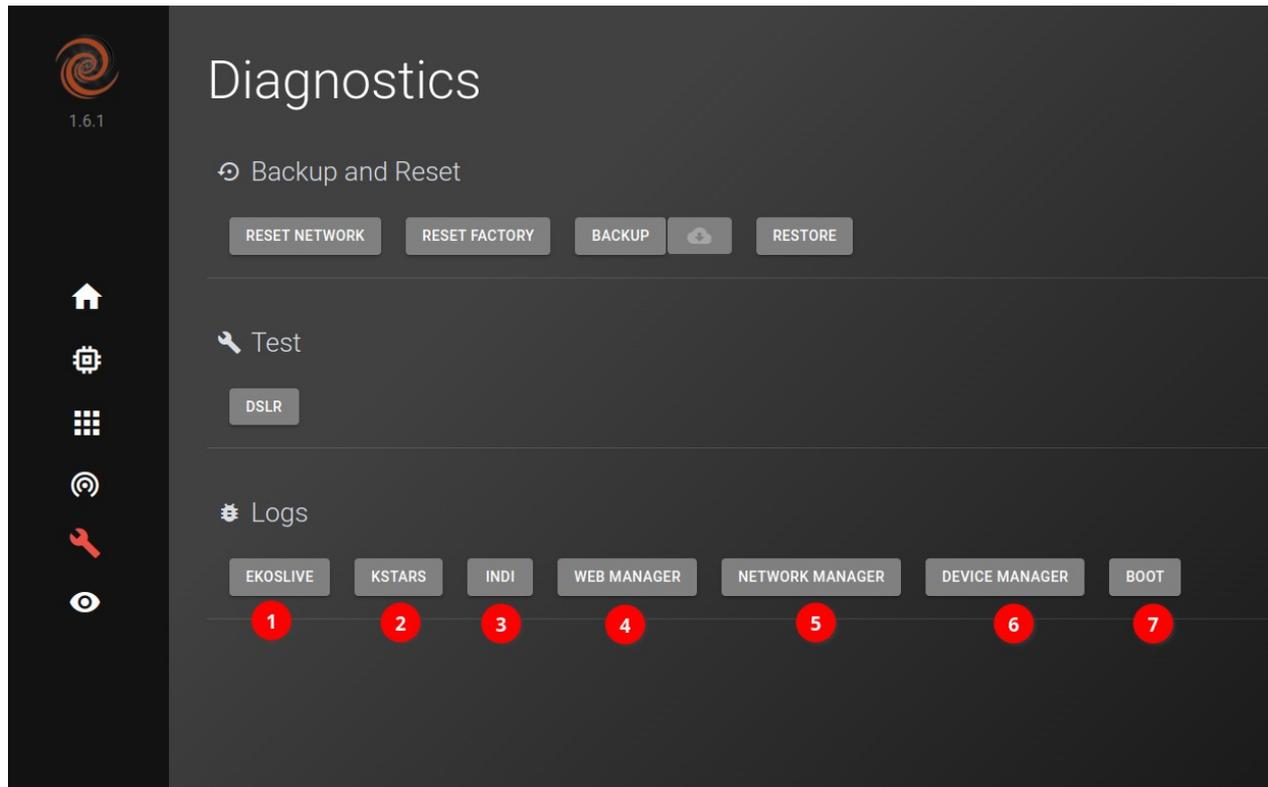
2. Wait for the Backup process to generate a backup file, this might take long if you have lots of images.
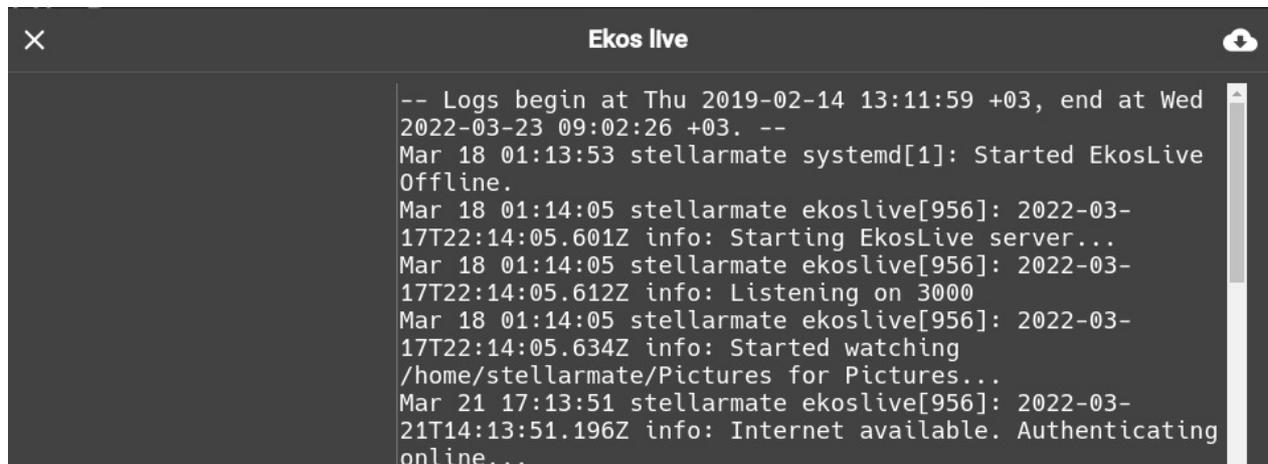
3. Click on the Download button (cloud icon) and select the backup file that has been generated.

4. You should get a Backup Successful message. You should You now have a backup file on your computer that you can use later to restore your StellarMate configuration.
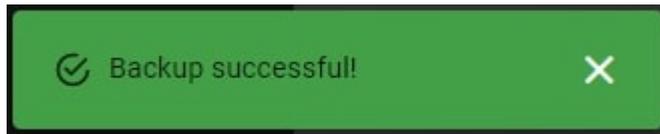
Restoring StellarMate configuration

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**.
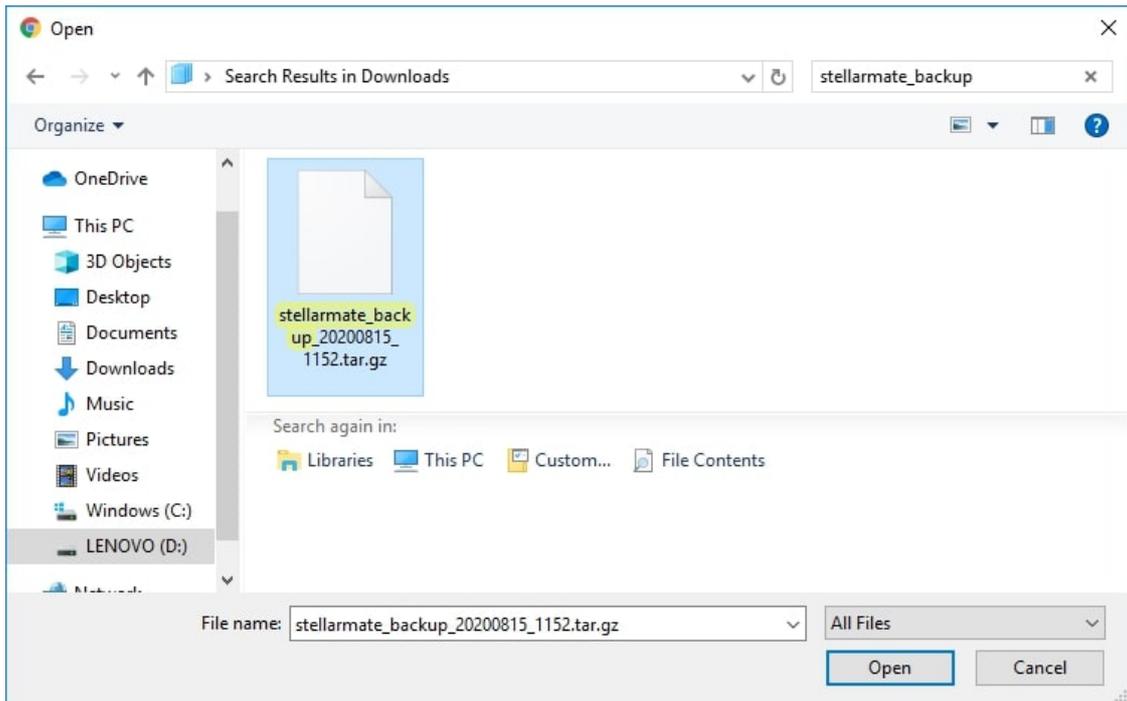
3. Wait for the upload process to complete.

4. You should get a Upload Successful message, which means that the restore was successful.

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.
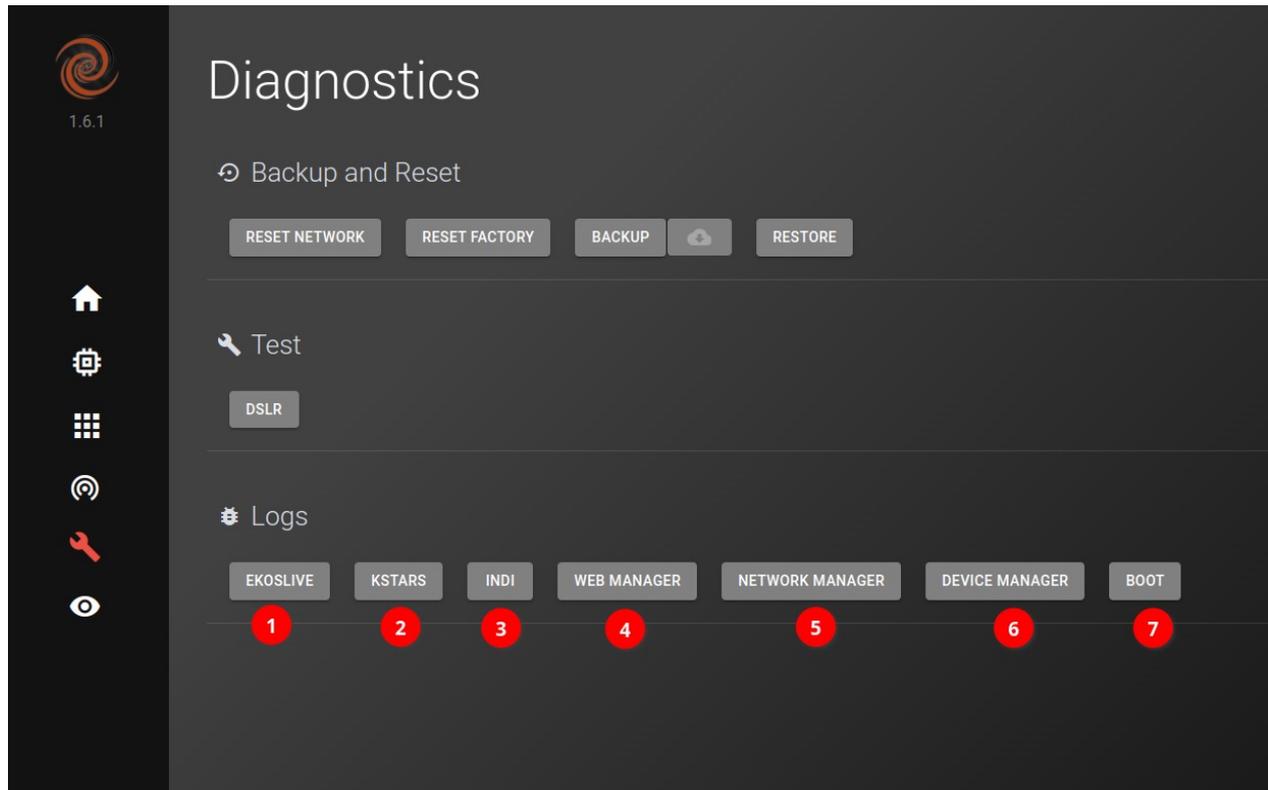
Logs can be viewed and also download from the Icon on top-right side.

1. EkosLive
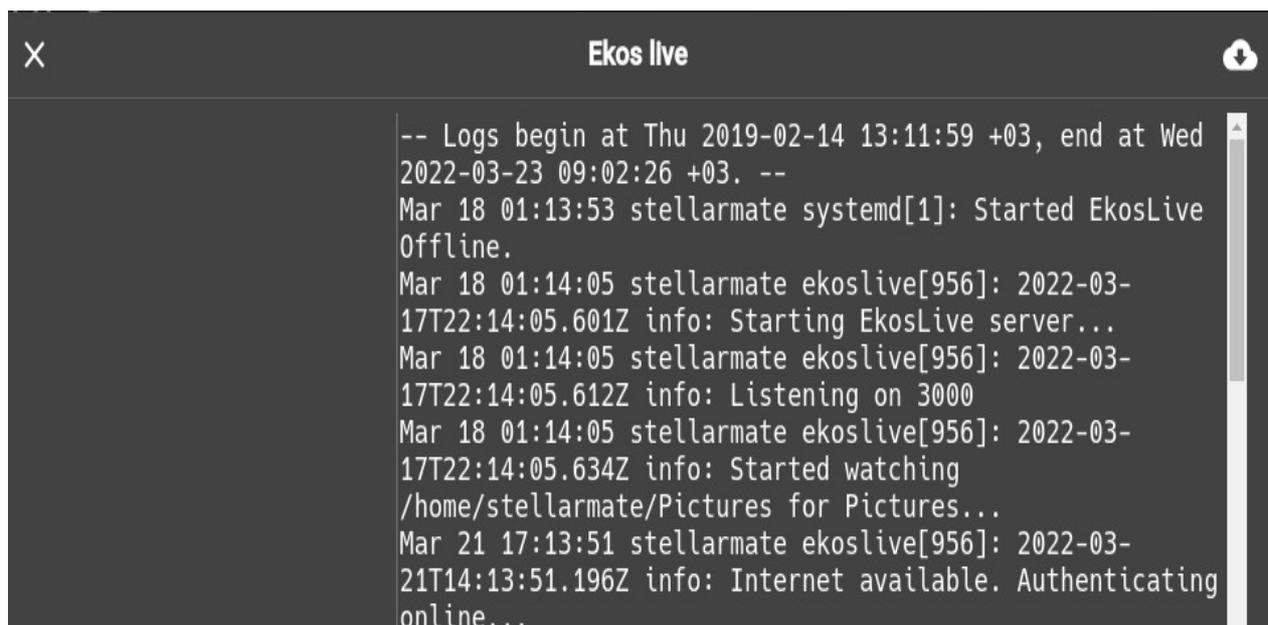
2. KStars & INDI:

You can view the logs for kstars and INDI as well. On the left side, you can see

different files for each day

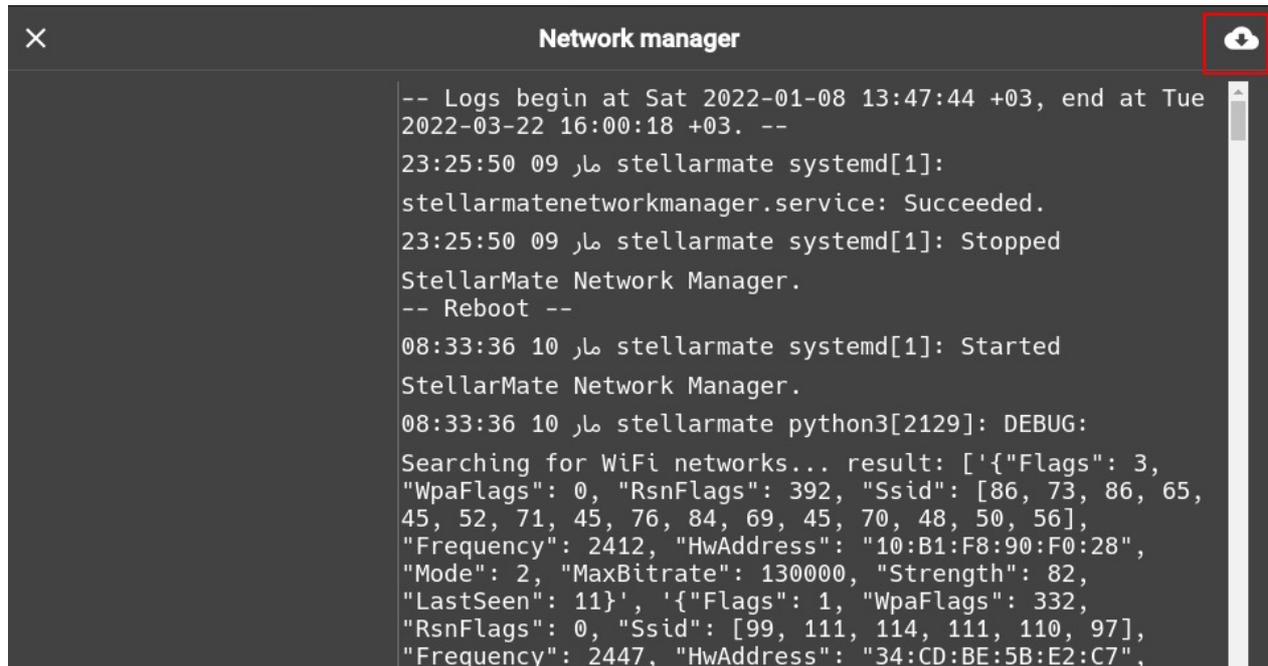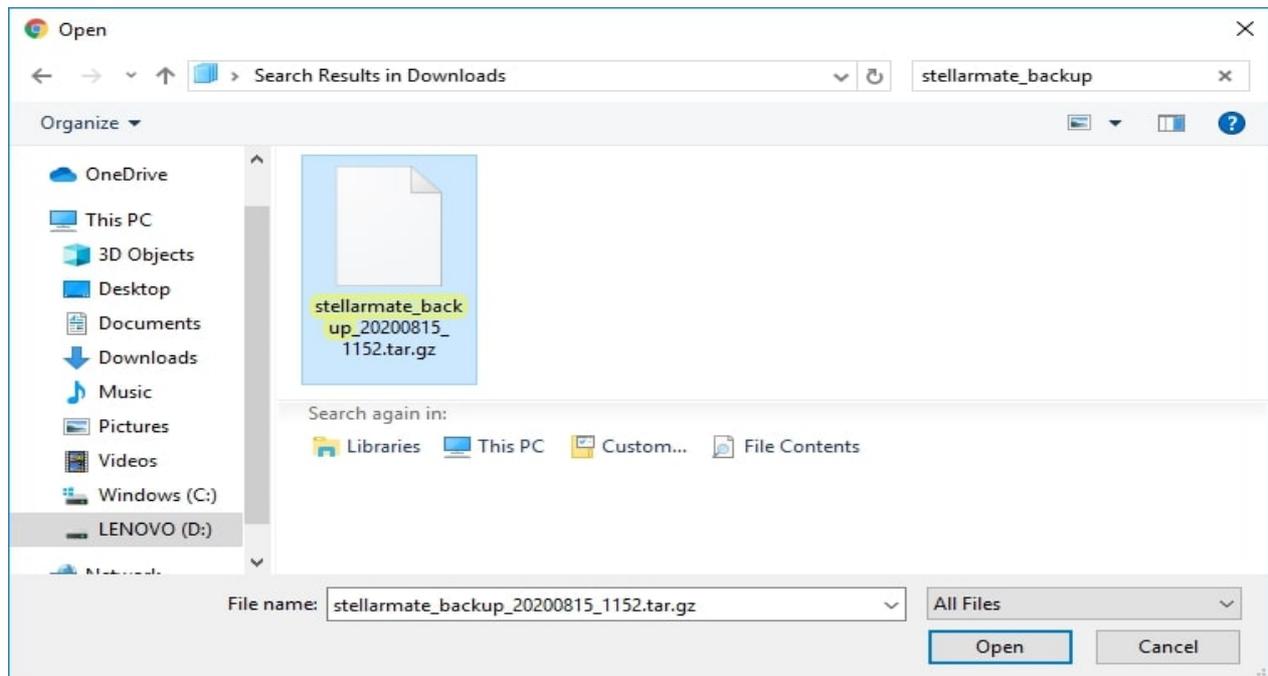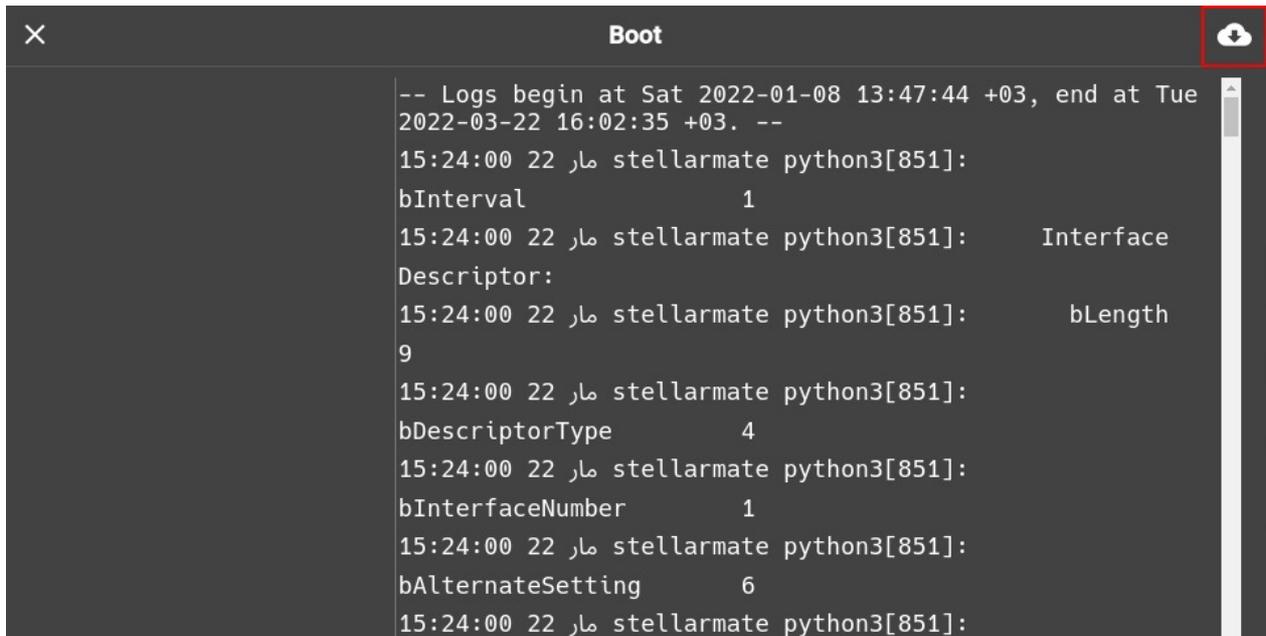Note: You can also watch the Video on how to enable logging in Kstars from the link given below:

https://www.indilib.org/individuals/logs-howto.html

4. Web Manager

5. Network Manager:

6. Device Manager:

7. Boot:

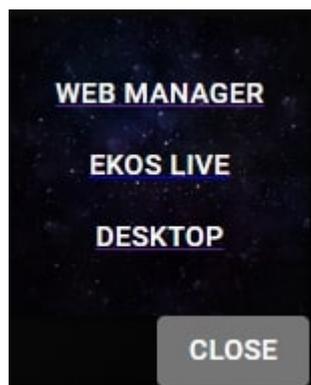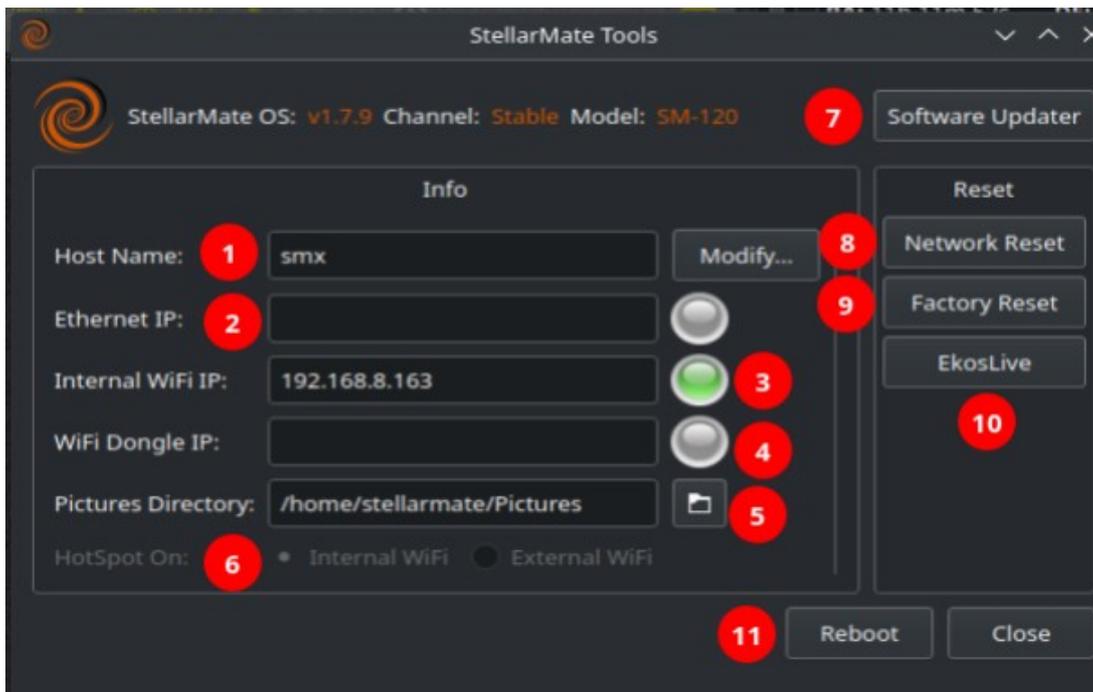## Goto

In every page of the StellarMate Control Panel, there is a GOTO button on the bottom-right corner.

Clicking on GOTO opens up a menu that allows you to navigate to 3 different areas.

- [Web Manager](#)

- [Ekos Live](#)

- [Desktop (VNC)](#)

StellarMate Updater

1. Network name of the unit as it appears to other devices on the network
2. Wired IP address (if a cable is connected)
3. IP address of connected network.
4. IP address for external WiFi dongle (if connected).
5. Change pictures directory to external USB device or to any other folder. Reboot is required after modifying the directory.
6. **HotSpot On:** Select which network interface the StellarMate HotSpot (10.250.250.1) should be running on. By default, StellarMate runs the HotSpot on the built-in WiFi chip. This switch can be used to run the HotSpot using the external WiFi dongle if desired which would leave the built-in WiFi free to connect to other networks
    o **Internal WiFi**: IP address for internal built-in WiFi. This is usually the HotSpot IP address 10.250.250.1 unless the unit is running in station mode and connected to an external network.
    o **External WiFi**: Router network or external network device.
7. Update the StellarMate to the latest version if available.
8. **Reset Network:** Reset all wired and wireless network settings to default.
9. **Factory reset:** Reset all settings to factory default. User images are still available.
10. **Reset EkosLive:** Reset Ekoslive settings including all preview images and thumbnails
11. Restart StellarMate

EkosLive

EkosLive is an online Real Time cloud-based Web Application to remotely control your equipment from anywhere and at any time. Get notifications about the imaging progress, watch a live video feed of planets, align your mount, and auto-focus, auto-guide from one central location. Use it on your phone, tablet, or computer.

The interface is designed to be flexible on whatever platform you prefer. If you're mobile, you can get the best results by using it on your tablet.

Video Tutorial: https://www.youtube.com/watch?v=bc6P9OjYmI0

How does it work?

EkosLive requires an internet connection. A fast and high bandwidth internet connection is recommended since image transfer depends on your internet speed. A low-bandwidth internet for device control is sufficient.
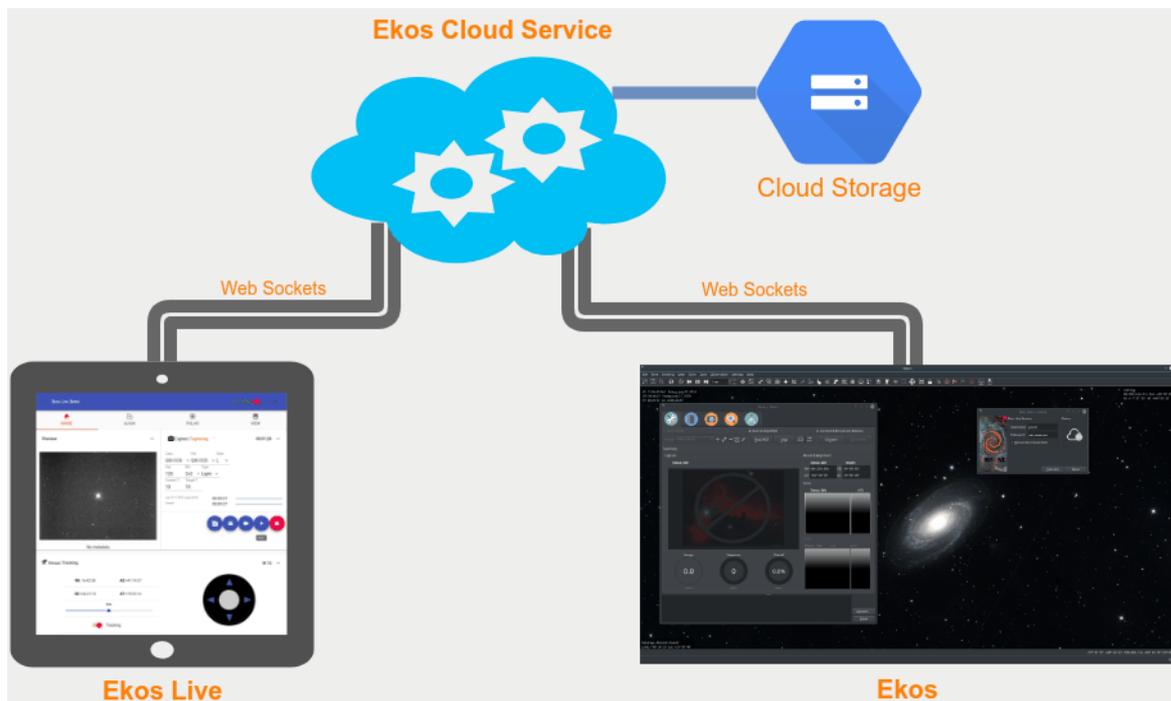
Cloud Storage is available for EkosLive Pro users. Captured images (not preview) may be saved to the cloud as lossless compressed FITS images (.fits.gz). Users can view the cloud images and utilize an advanced metadata system to search and categorize their images.

Supported Browsers

EkosLive is compatible with many modern browsers on desktop & mobile. However, we highly recommend using Google Chrome on all platforms to get the best experience.

Firefox is unfortunately not supported at the moment since it does not support dual websocket technology that is employed in EkosLive.

Getting Started

After you subscribe to EkosLive (Basic or Pro plans), you will be redirected to the EkosLive URL at https://live.stellarmate.com. Bookmark this URL for easy access in the future.

Connecting Ekos to the Cloud

Before you can use EkosLive Web Application, Ekos must be connected to the cloud.

Ekos offers connecting to Cloud and Offline at the same time.

If Online is checked that means you are connected to the Cloud
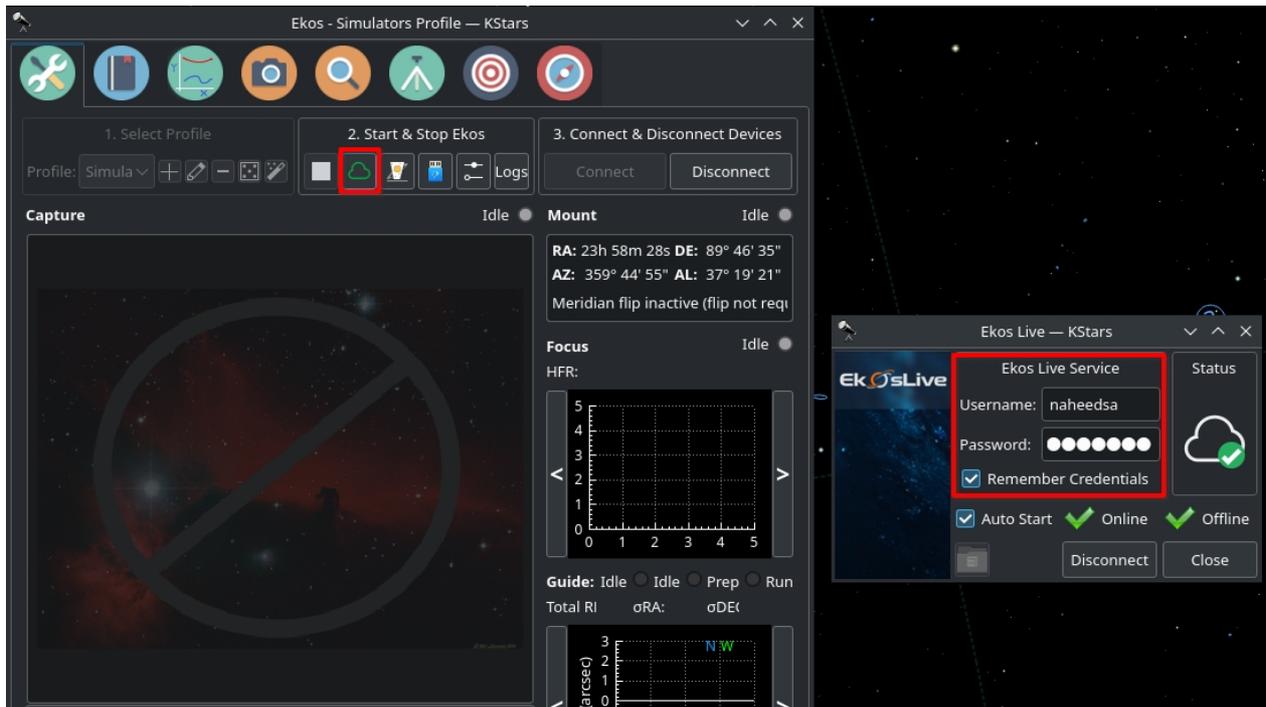
After successful authentication, the EkosLive cloud icon be Checked and Green. Now you are ready to use EkosLive Web Application.

Using EkosLive Web Application

Go to the EkosLive URL and login with your username & password. After login, the EkosLive Home screen should be displayed:

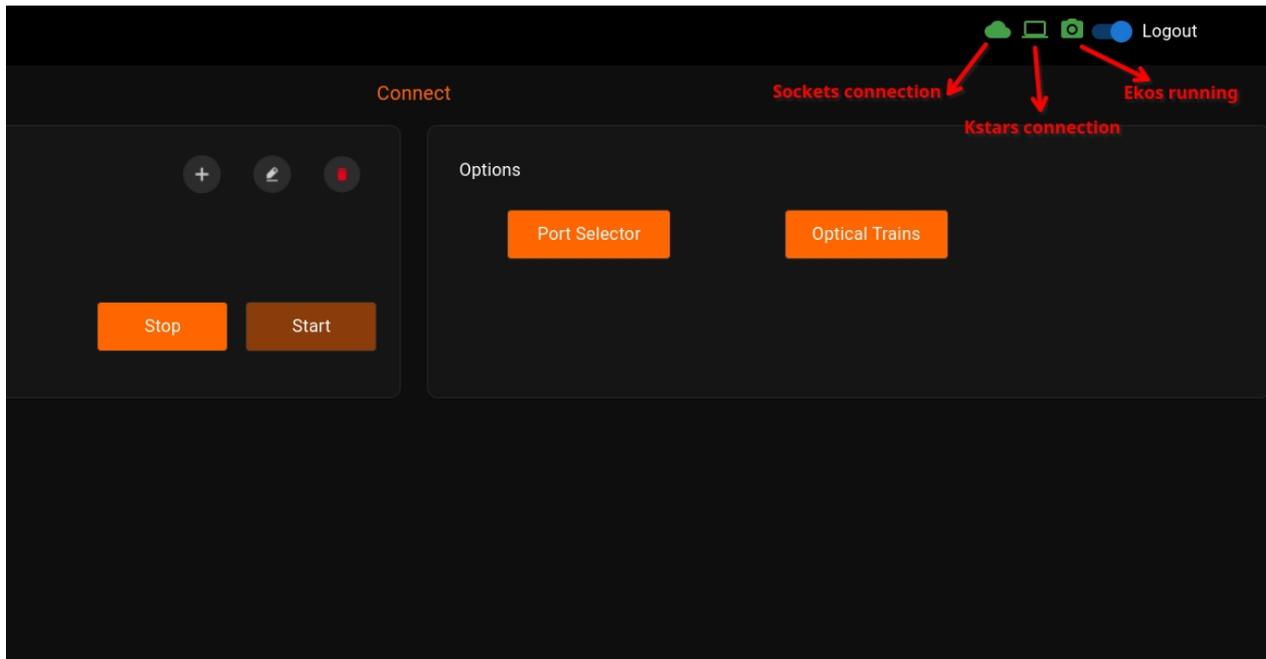In the main toolbar, the following controls/icons are visible:

- **Cloud Status Icon**: This icon shows the status whether you are connected to the sockets through which Ekoslive online will communicate to StellarMate.

- **Kstars Status Icon**: This icon indicates whether Kstars is connected with Ekoslive online.

- **Ekos Status Icon**: When Ekos is connected to your equipment, this icon should turn Green. When no profile is active and Ekos is not connected to your equipment, this icon should turn Red.

If no Ekos Profile was started before connecting to EkosLive, the Ekos Status Icon should be Red. You can either start the Ekos Profile directly in Ekos, or by clicking the Menu, and then selecting Profiles, and then selecting which profile to start. Once the Ekos Profile is active, you can start using EkosLive controls.

EkosLive FAQ

Questions on EkosLive Real-Time Web Application for Observatory Control & Monitoring.

1. What is Ekos Live?
2. Is EkosLive a replacement for Ekos?
3. Is EkosLive free?
4. Is EkosLive Secure?
5. Can I access EkosLive Web App from multiple browsers/phones?
6. How do I access EkosLive?
7. Do I need to purchase StellarMate to use EkosLive?

1. What is Ekos Live?

Ekos Live is a real-time web application that can be run from any browser. It allows you to control many aspects of Ekos right from the browser. It is built around material-ui from Google, so it is very friendly for mobiles & tablets on any platform.

It supports capture, focus, guiding, alignment, and polar assistant tools. Furthermore, it can save your images directly to the cloud where they are stored along with a rich metadata system that enables easy search for images in the future. You can define your own tags to uniquely identifies images of interest.

Turn on sound notifications on to get audible alerts on tasks such as when an image is captured and so on. It supports multiple themes (Normal, Dark, and Night) to suit your seeing preferences.

2. Is EkosLive a replacement for Ekos?

No. EkosLive is a complementary tool to Ekos. It actually requires Ekos in the background. The benefit of EkosLive is that you can access it at any time you have internet access. There is no need to use TeamViewer or 3rd party solutions to log in remotely to your PC to check the observatory status. All of this can be done easily and securely with EkosLive. Since it was designed with mobile in mind, you'll find its user interface particularily suited for tablets and phones.

3. Is EkosLive free?

Yes! We offer two tiers of EkosLive subscriptions:

EkosLive Basic: Free.

EkosLive Pro: $4.99/Month subscription.

The EkosLive Pro version differs from Basic in that you get unlimited bandwidth to upload and view images in addition to cloud storage & video streaming capabilities. But the basic version of EkosLive is already quite powerful and can perform Capture, Alignment, Focusing, and Guiding!

4. Is EkosLive Secure?

Absolutely! EkosLive transmits all traffic over SSL and WSL (for Secure Websockets) using industry-proven encryption at both ends. Your data is securely stored where you are the only party that can download and view them. No data is shared with any 3rd party.

5. Can I access EkosLive Web App from multiple browsers/phones?

No. Currently, only one connection is permitted to EkosLive. If you try to login from another login, you will be logged out from your current location.

6. How do I access EkosLive?

You can access EkosLive from this address https://live.stellarmate.com.

7. Do I need to purchase StellarMate to use EkosLive?

No, StellarMate is not required. You just need KStars/Ekos to use EkosLive.

Using GPS

Time and Location settings are critical to the proper operation of StellarMate. This is even more apparent if you're on the go with a mobile setup. For a fixed-observatory, the only factor you have to worry about synchronizing is time. On the other hand, a mobile setup requires both location and time settings to be accurate.

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.

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 outdoor to receive any satellite signals. They can be connected to any USB slot in StellarMate.

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 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.

The following is a video tutorial that covers all the steps above:

https://www.youtube.com/watch?v=TXE5NFC6Vs8

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.