Nighttime Imaging 'N' Astronomy

An astrophotography imaging suite

N.I.N.A. contributors

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1. Documentation

1.1 Introduction

1.1.1 About N.I.N.A.

Welcome to N.I.N.A. - Nighttime Imaging 'N' Astronomy. If are reading this document, you have likely downloaded the software - congratulations!

N.I.N.A. is designed for automated DSO imaging using the sequencing model. Whether you are new to the world of DSO imaging or are a seasoned veteran, the goal of N.I.N.A. is to make your imaging sessions easier, faster, and comfortable. N.I.N.A. attempts to make complex concepts and operations easy to understand and effect so that more time is spent on imaging rather than minding equipment.

The N.I.N.A project is also a FOSS application that is licensed and distributed under the provisions of the Mozilla Public License Version 2.0 license. Its maintenance, maturation, and further development is realized by a team of dedicated volunteers from around the world. If you have an interest in helping the project or contributing to it, please join the project's Discord server (see below) and reading the contributor guidelines.

1.1.2 About this Documentation

This document aims to describe the functionality of N.I.N.A. so you can utilize it to its full potential.

> **🔥 Tip**
>
> Important notes will appear in boxes similar to this throughout the documentation. If you see one, do not skip over it!

1.1.3 Getting Help or Helping Out

The N.I.N.A.'s Discord chat server is a great way to chat with the creator Stefan Berg the N.I.N.A. contributors and fellow users. Ask questions, share your photos, make suggestions, and help other users. To research past questions, bug reports, or file your own bug report or question, please use the Issue Tracker.

> **✏️ Notice**
>
> Please note that images in this manual might not always reflect what you see as updates and additions to the manual may lag behind the code development process.

1.2 System Requirements and Device Support

1.2.1 Minimum System Requirements

The following represents the minimum system resources required to operate N.I.N.A.

- A dual-core x64 CPU
- 3GB of RAM
- Windows 10 (64 bit) or later
- 500MB of free disk space without the optional SkyAtlas image data or framing cache data (3GB with)

> **ℹ️ Info**
>
> Some users have reported successful operation of N.I.N.A. on small, low-power embedded systems such as the Intel Compute Stick and similar platforms. As expected, experiences will vary in such resource-constrained environments. Technically, N.I.N.A. should be able to run on a single core, but this will certainly lead to a highly undesirable experience and is certainly not recommended. However, if forced to choose between the two, more RAM is desirable over CPU power.

1.2.2 Recommended and Optional support software

The functionality of N.I.N.A. shines through when paired with a supporting cast of other applications. Please consider the items in the following lists to access the full breadth of N.I.N.A.'s capabilities.

- ASCOM Platform (recommended)
- PHD2 Guiding
- Metaguide Guiding
- Any of several supported plate solving applications (recommended)
- ASTAP
- All Sky Plate Solver
- Local Astrometry.net (ansvr)
- PlateSolve2
- PlateSolve3
- TheSkyX ImageLink
- PinPoint
- Any of several supported planetarium applications (optional)
- Cartes du Ciel
- HNSKY
- Stellarium
- TheSky X
- C2A
- SkyTechX
- SkyAltas image data (optional at the bottom of the download section)

1.2.3 Supported Devices

Direct (native) camera support

N.I.N.A. can directly interface with a wide range of popular cameras without the need for an intermediate ASCOM driver. Direct camera control is recommended over accessing the camera through ASCOM for performance reasons and to access additional camera controls that cannot be manipulated through ASCOM.

- Altair
- Atik
- AstcamPan
- Canon
- FLI
- MallinCam
- Nikon
- PlayerOne
- OGMA
- Omegon
- QHYCCD
- RisingCam
- ToupTek
- SBIG
- SVBony
- ZWO

> **Note**
>
> Certain older Nikon DSLRs require a serial shutter cable for bulb exposures. Please consult your camera's documentation regarding its requirements for long exposure operation using a USB or other remote cable.

The list of supported cameras can change and expand as N.I.N.A. developers gain access to relevant hardware or support is contributed.

ASCOM Standard

Astronomy-related equipment often has an ASCOM driver for it. N.I.N.A. supports accessing the following types of devices through their associated ASCOM drivers, as long as the drivers are fully compliant with the relevant ASCOM frameworks.

Cameras that lack direct support in N.I.N.A. but do have an ASCOM driver may also be utilized this way. The following ASCOM device classes are supported:

- Cameras
- Mounts (aka "Telescopes")
- Filter Wheels
- Flat Panels (ASCOM Cover Calibrator)
- Focusers
- Rotators
- Weather data (ASCOM ObservingConditions)
- Domes
- Switches
- Safety Devices

> **🔥 Tip**
>
> Be aware that ASCOM drivers that are provided by their vendor in a 32 bit-only form will **not** be directly accessible by a 64 bit N.I.N.A. or any other 64 bit ASCOM client application. If this is the case for you, try to connect via the ASCOM Device Hub instead

> **ℹ A note to ASCOM driver developers**
>
> If it has not already been done, please consider making both 32 and 64 bit varieties of your driver(s) available to your users or customers, and ensure that the driver passes all ASCOM Conformance tests. Please refer to the relevant documentation on ASCOM's website for more information.

ASCOM Alpaca

Similar to the ASCOM support N.I.N.A. also offers ASCOM Alpaca device discovery and direct connection to ASCOM Alpaca devices through the network. All types of devices that are mentioned in the ASCOM Standard section are also supported via the ASCOM Alpaca protocol.

Additional Device Support

While N.I.N.A. offers extensive support for a wide range of devices directly and through ASCOM drivers, there are plugins available that can directly or indirectly integrate other devices, providing even more flexibility and options.

- AstronSCIENTIFIC Rotarion System
- Although Rotarion is not directly integrated into the application, it can be fully controlled using the available ASCOM drivers as well as the Connector Plugin to switch between different profiles that are set up for the different instruments that are attached to the Rotarion system

Guiding Applications

N.I.N.A. supports several guiding applications to guide, dither, and monitor tracking accuracy. Telemetry from these applications are also displayed inside of the Imaging tab. The guiding applications N.I.N.A. supports are:

- PHD2
- MetaGuide
- MGEN2
- MGEN3
- SkyGuard
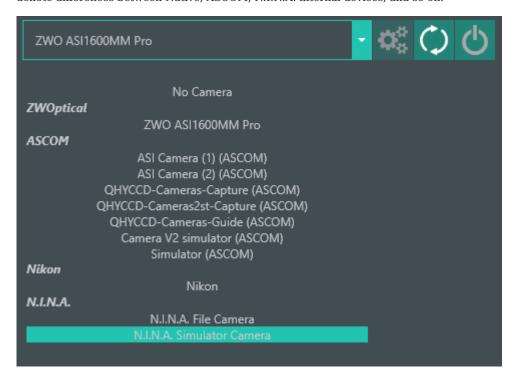
1.3 Tabs

1.3.1 Overview

The Equipment tab is where one manages the hardware that N.I.N.A. controls. The classes of hardware devices that N.I.N.A. supports are separate sub-tabs.

Selecting Equipment

Each tab has a drop-down box that lists the devices and drives that were detected. Devices are organized into categories to denote differences between Native, ASCOM, N.I.N.A. internal devices, and so-on.

In the above example of a list of cameras, the `ZWO ASI1600MM Pro` is listed under the `ZWOptical` category. You would select this device to connect to the camera directly. If connecting to the camera via ASCOM is desired, you would select the appropriate `ASI Camera` driver under the `ASCOM` section. Driver categories exist so that it is clear how the device is accessed and operated.

Management

Next to the drop-down box is a series of buttons:

1. A drop-down box that lists all detected devices.

2. Buttons to the right of the drop-down box may be used to:

1. Configure the selected device or ASCOM driver

2. Refresh the list of identified devices

3. Connect to or disconnect from the selected device

> **Tip**
>
> If you connect a device to your computer after starting N.I.N.A., you may press the Refresh button (2b) to have N.I.N.A. perform a system scan and update the list of devices.

Information and Controls

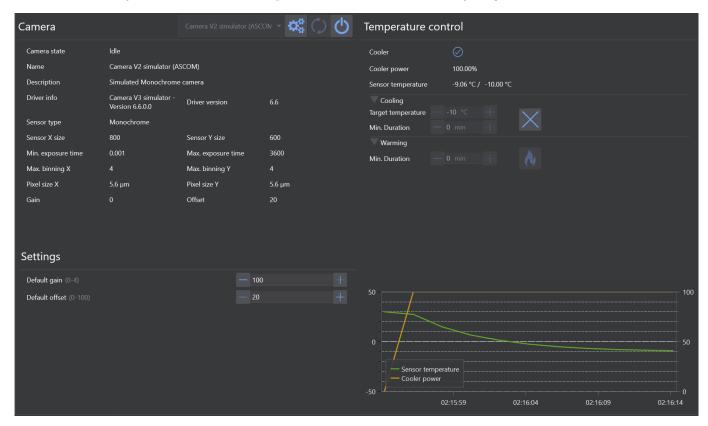Any device tab also displays information that pertains to the device that was selected and connected. Specific devices may also display control functions in this area.

1.3.2 Equipment

Camera

The Camera Tab lets you connect an ASCOM-compatible camera or one of the natively integrated drivers

1. **Camera Info Panel**

- This section provides info about the camera in general, like sensor dimensions, sensor type, pixel size etc.

2. **Camera Settings** Default camera settings. These settings are used by default if not overridden by different inputs in other parts of the application

TEMPERATURE CONTROL

When a cooled camera is connected, this section allows the user to control cooling and warming

1. **Info Panel**

- Provides info about the current camera cooler status, power usage and chip temperature (actual / target)

2. **Cooling**
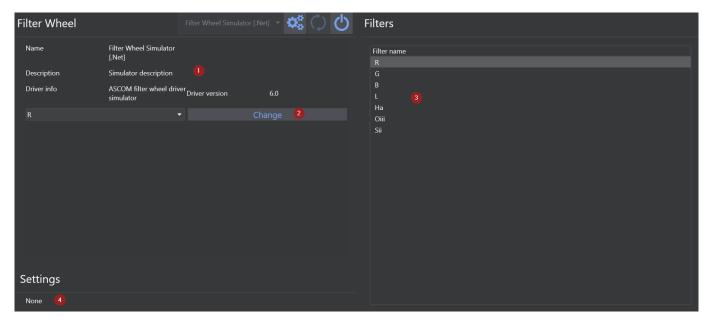
- Define a target temperature and activate camera cooling with the ice icon. Min Duration is optional and lets you define a minimum duration for cooling, most cameras drivers already regulate the cooler power automatically and will gradually decrease the temperature.

3. **Warming**

- Gradually warms the camera to ambient temperature with the fire icon. Min Duration is optional and lets you define a minimum duration for warming, most cameras drivers already regulate the cooler power automatically and will gradually increase the temperature.

4. Camera Cooler Power chart

5. Chip Temperature chart

Filterwheel
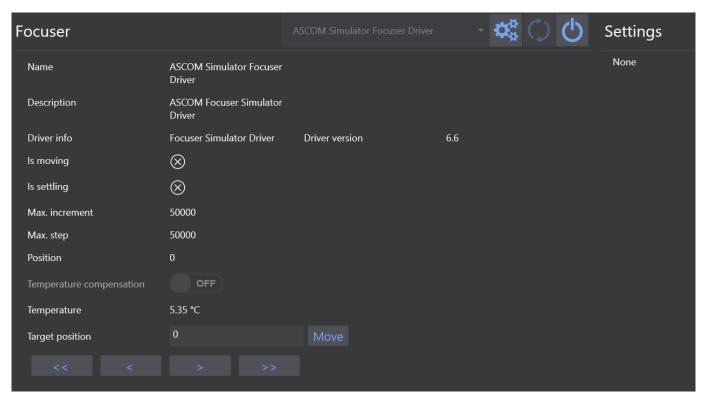
The Filter Weel Tab lets you connect an ASCOM-compatible filterwheel

1. Filter Wheel information

2. Select a filter from the combobox you want to switch to and select the change filter button afterwards

3. List of current filters as imported from ASCOM driver and specified in the Filter Wheel Options

Focuser

The Focuser Tab lets you connect an ASCOM-compatible focuser

1. Various focuser informatio ncan be found on this page

2. Temperature compensation can be turned on or off here. Note that this is the in-driver temperature compensation.

   Temperature compensation must be configured in the focuser driver

3. If the focuser has a temperature probe this will report the current temperature

4. To move the focuser to a target position (steps) you need to enter a value into the target position and hit the move button

5. Focuser movements:

 • Single arrow < > : half the Auto Focus Step Size

 • Double arrows << >> : five times the Auto Focus Step Size

Rotator

The Rotator Tab lets you connect an ASCOM-compatible rotator. A Manual Rotato option is also available

1. Rotator information

2. Reverse the direction of the rotator (if available). Enable this option, when the rotator moves into the wrong direction during centering and rotation. This is for example required on setups like a Hyperstar where the horizontal image axis is flipped.

3. Move the rotator to the selected angle

> 🖉 **Note**
>
> The rotator angle will be synced to the sky angle after a center+rotation happened and will display the sky angle instead of the mechanical angle instead.
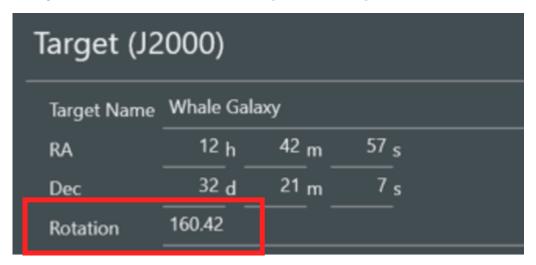
MANUAL ROTATOR

Manual Rotator is a very useful tool for those setup that do not have a motorized rotator but still want to be able to match the framing angle as defined in the Framing Tab

To enable manual rotator you must:

1. Define a Rotator Tolerance in Options->Platesolving

2. Connect the manual rotator in the Rotator tab

3. Frame your object in Framing and Add as Sequence Target

4. Enable Rotate Target in legacy sequencer or use the Slew, center & rotate instruction in the advanced sequencer

5. Start the sequence

Once the sequence is started and the mount has finished slewing to the target, N.I.N.A. will perform a platesolving to determine the current framing coordinates and rotation angle. If the difference between the angle determined by the platesolving and the angle specified in Sequence ->Rotation is above the Rotator Tolerance, a pop-up will appear indicating the degrees and direction you need to rotate the camera. Rotate the camera and close the manual rotator window, a new platesolve will be performed. If the angle is still above the Rotator Tolerance the process will be repeated.
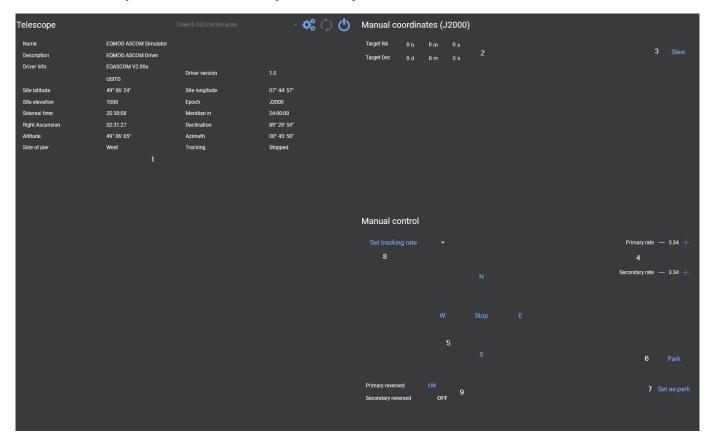
> **Tip**
>
> If you want to set camera rotation before starting the main imaging sequence you can use a dummy sequence with exposure 1s to kick the manual rotator in

Telescope
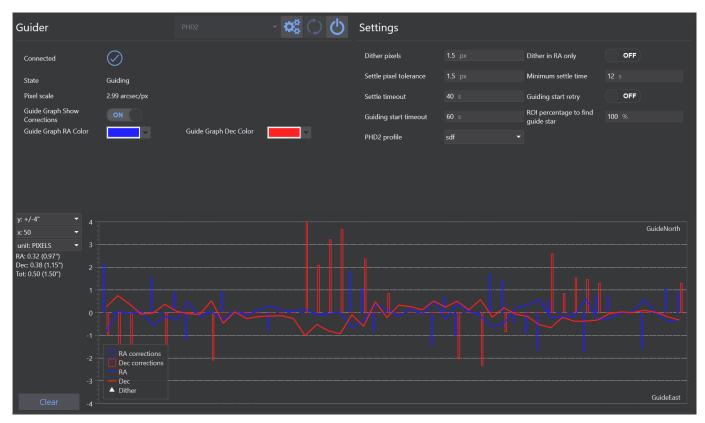
The Rotator Tab lets you connect an ASCOM-compatible telescope mount.

1. Telescope information

2. Define manual target coordinates

3. Slew to manual target coordinates

4. Define movement rate

5. Manual movement commands

6. Park mount

7. Set current position as parking position

8. Set a specific tracking rate by selecting the desired tracking rate in the combo box

9. Reverse the primary and/or secondary axis direction
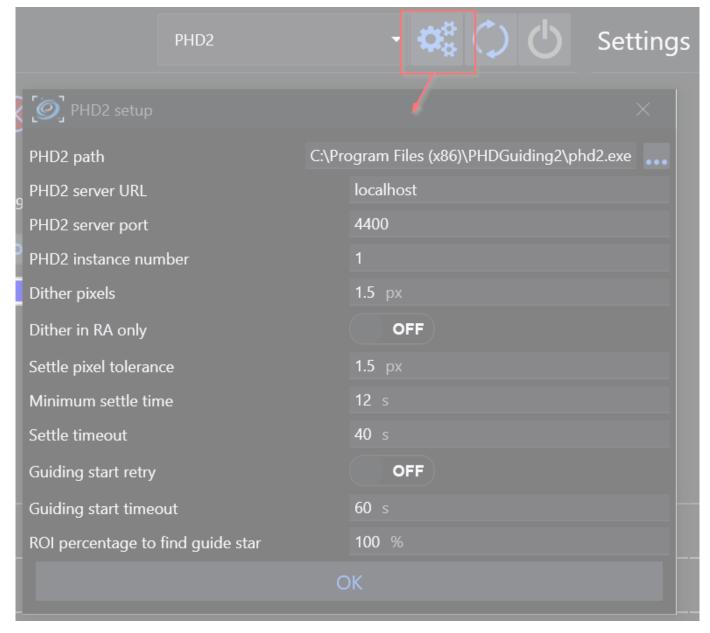
Guider

The Guider Tab lets you connect to autoguiders

1. Guider information can be found on the left side. Furthermore the guide chart colors can be customized here.

2. On the right side you can find guider specific settings. The available settings depend on the type of guider that is connected.

3. On the bottom you can find the guider graph showing the corrections and drift of the guider

PHD2 SETUP

PHD2 Path

PHD2 installation path. This is used to start PHD2 when it is not already running.

PHD2 Server URL
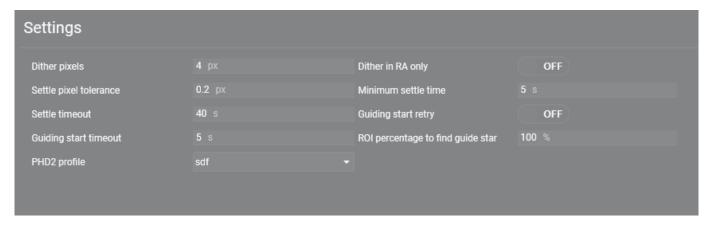
You can set the PHD2 server settings here

Usually the defaults should work fine. You also need to enable PHD2 server in PHD2.

PHD2 Server Port

PHD server port, usually the default 4400 works fine. If you are using multiple instances of PHD2, each instance will add 1 to the port number. So instance 2 will run on port 4401, instance 3 on 4402 etc.

PHD2 SETTINGS

Dither Pixels and Dither RA Only

The amount of guide camera pixels to dither in PHD2. If "Dither RA only" is checked, the dither movements will only be performed in RA.

> 🔥 **Tip**
>
> Refer to Dithering in Advanced documentation topics for more information about Dithering and how to set the above parameters

Settle Pixel Tolerance

The threshold expressed in guide camera pixels that will determine a dither settling completion after a dither move.

> 🔥 **Tip**
>
> A dither will be considered settled if, after for the duration of "Minimum Settle Time" and before the "PHD2 Settle Timeout", the guide movements in PHD2 will be below the "PHD2 Settle Pixel Tolerance".

Minimum Settle Time

The minimum time the settling should wait after a dithering process until the process is complete

Settle Timeout

The maximum time N.I.N.A. should wait during a settling process until it starts the next action.

Guiding Start Retry

If PHD2 fails to restart guiding - N.I.N.A. will send a new start guiding command again until a successful guiding is initiated.

Guiding Start Timeout (seconds)

Seconds to wait before sending a new start guiding command to PHD2.

ROI percentage to find guide star
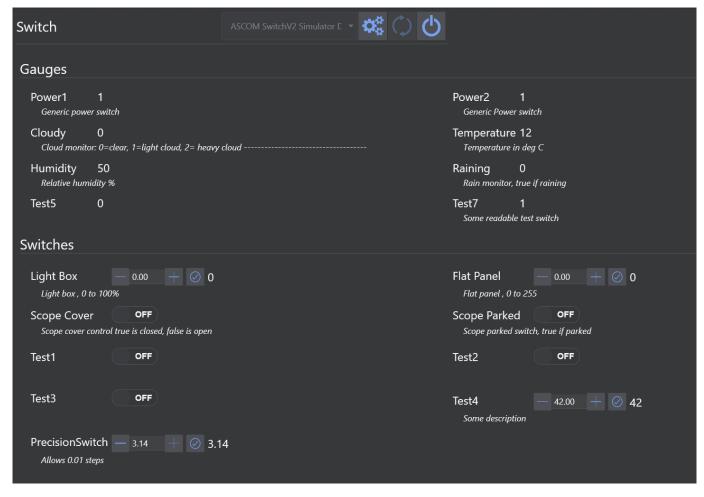
A region of interest expressed in a percentage of the full frame with the center of the frame as reference. If you want to prevent guid star selection near the edges of the frame, decrease this percentage.

PHD2 profile

Select from the list of available PHD2 profiles to switch to

Switch

The Switch Tab lets you connect and control ASCOM-compatible switches.

GAUGES

In this section all readonly switches will be displayed
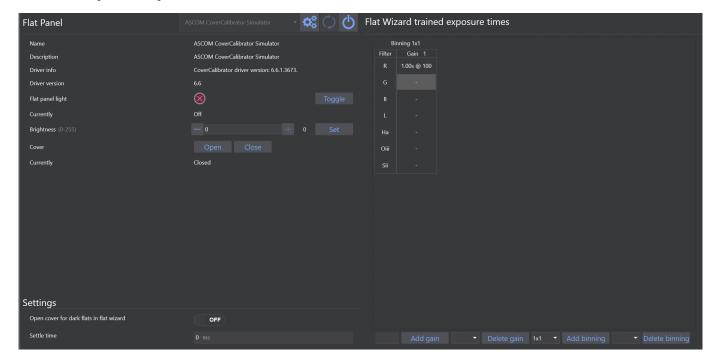
SWITCHES

Here all controllable are shown. Switches can be turned on or off as well as switches with a range of values can be set by selecting a target value and then hitting the checkmark button next to it

Flat Panel

The Focuser Tab lets you connect and control one of the following flat panels:

- Alnitak Flip-Flat
- Allpro Spike-a-flat
- Artesky flat box
- Pegasus Astro Flat Master
- ASCOM compatible flat panel

1. On the left side you will find the flat device info provided by the driver

2. To toggle the light on or off you can press the Toggle button

3. Using the brightness slider you can specifiy a target brightness for your panel. Hit the Set button to set your panel to the chosen brightness

4. Using the open/close button lets you open or close the panel if it supports it.

5. On the bottom you can customize settings for your flat panel

Trained Flat Exposure Times

Trained exposure table will automatically populate when running the Flats Wizard and will report the gains/exposure times for each Filter, remembering the relative flat panel brightness.
Furthermore you can manually add or remove columns to it by using the buttons on the bottom. Clicking into the values lets you customize the exposure time (left value) and flat panel brightness (right value) for the filter and gain.

> **Tip**
>
> Follow these steps to fully automate the acquisition of flat frames during an imaging session:
>
> 1. Populate the Trained Exposure Times Table
>
> 2. Create a new sequence (or load a pre-defined sequence) in the advanced sequencer and add a sequential instruction set to it (let's call it "Flats").
>
> 3. Populate the instruction set with the "Trained Flat exposure" and select it for the specific filter you want to take flats for as well as the amount of flats to be taken.
>
> When N.I.N.A. runs this instruction it will look up the trained exposure time and the panel brightness to automatically set those and automate the flat taking process

Weather

This tab lets you connect a compatible or ASCOM-compliant weather observing station

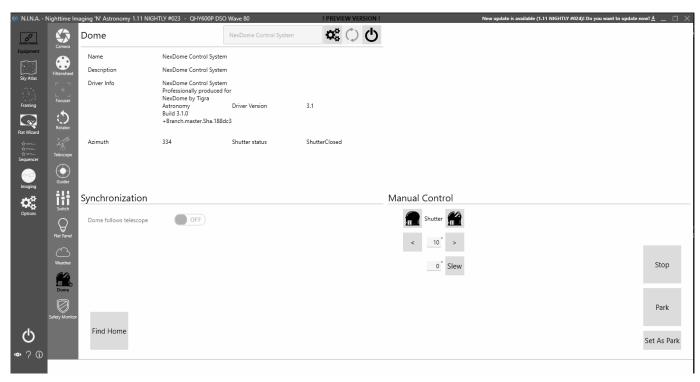| Weather	ASCOM Observing Conditions Simulator ▼	⚙ ↻ ⏻	Settings
			None
Name	ASCOM Observing Conditions Simulator		
Description	ASCOM Observing Conditions Simulator		
Driver info	ASCOM Observing Conditions Simulator. Version: 6.6.0.0	Driver version	6.6
Temperature	5.57 °C	Humidity	50.25%
Dew point	-3.97 °C	Pressure	1021.10 hPa
Cloud cover	0.25%	Rain rate	0.00 mm/h
Wind direction	178.37°	Wind gust	2.50 m/s
Wind speed	0.39 m/s	Star FWHM	0.88
Sky quality	18.10 Mag/arcsec²	Sky brightness	85.50 lx
Sky temperature	-27.85 °C		

Currently the following devices are compatible with N.I.N.A.:

1. Any ASCOM-compatible devices

2. OpenWeatherMap (see Equipment)

3. Pegasus Ultimate Powerbox V2

Dome

The Dome Tab lets you connect an ASCOM-compatible Dome.

N.I.N.A. provides some useful capabilities when connected to a Dome. They include:

1. **Telescope Following**

   When a Telescope is connected, enabling Dome follows telescope ensures that the Dome azimuth (where the opening of a Dome is) is centered wherever the Telescope is pointed. This covers several different cases:

   • Tracking - As the telescope follows the rotation of the Earth, the Dome stays in sync with it.

   • External Slew - If a program other than N.I.N.A. slews the telescope, then the Dome will rotate until the telescope stops and they are lined back up. This movement can be jerky however - some Domes (such as NexDome) don't allow changing the destination azimuth while it is rotating, so N.I.N.A. repeatedly sends slew commands based on wherever the telescope is pointing at the time. You can disable this behavior in the Options tab.

   • N.I.N.A. Slew - If N.I.N.A. issues a slew command to the telescope (such as from the Framing Wizard), then the Dome will go directly to the target azimuth that would be in sync with the telescope at its destination.

2. **Find Home Before Park**

   This setting can be found in the Dome Options. Domes with a Home position (such as NexDome) use a sensor to synchronize the physical azimuth with what is in the software. This is conceptually similar to star alignment with a mount. Finding the home position before parking increases the reliability of finding the precise park location, which can be important if that is where batteries recharge.

3. **Wait for Dome Synchronization**

   When the telescope moves, the Dome typically needs extra time to follow it and re-synchronize their azimuths. N.I.N.A. waits until the telescope stops slewing and the Dome is synchronized with it before starting operations that take images (such as Plate Solving and Auto Focus).

4. **Manual Shutter Control**

   The Dome shutter can be directly opened and closed, and the dome can be rotated either directly to an azimuth or in configurable increments.
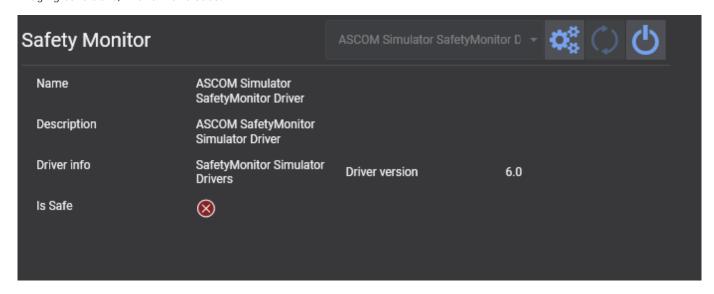
> ✏️ **Note**
>
> There is no rotation control where you hold a button until you're where you want to be. Unfortunately, the ASCOM standard doesn't provide operations that would make this possible.

5. **Sync Azimuth**

   Sometimes the dome rotation can get off a few degrees - for example if a gear slips or there aren't exactly the right number of gear teeth. If your dome supports "Sync Azimuth", then a "Sync" button will be available in the lower left corner that sets the dome azimuth to wherever the telescope is currently pointing. You'd use this by manually lining up the dome with the telescope before syncing. You should not have Dome Synchronization enabled while you do this, but you can turn it back on right afterwards.

SafetyMonitor
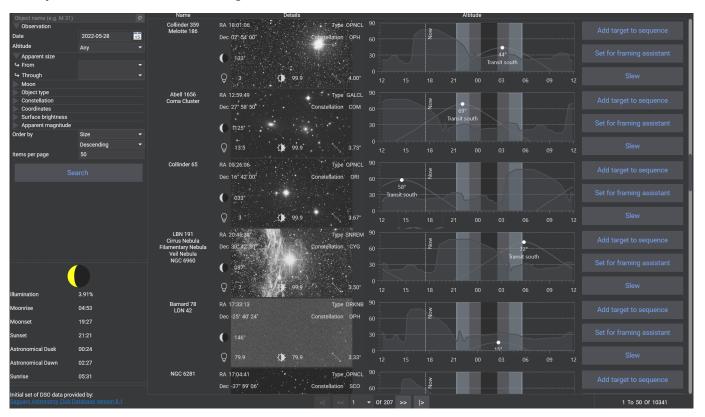
The Safety Monitor lets you connect and control ASCOM-compatible safety monitors. These devices are utilized to report unsafe imaging conditions, like rain or clouds.

1.3.3 Sky Atlas

The Sky Atlas allows you to search for various objects in the sky using N.I.N.A.'s own database of deep sky objects. Filters and sorting options can be applied to search results. Additionally, you may set selected objects as a Sequence target, or to send them to the Framing Assistant.

The Sky Atlas interface consists of following elements:

SEARCH FIELD

Search for the object by name or various catalog designations. Some familiar names (e.g., "Andromeda") are not implemented at the moment

RESET

Next to the search field there is a small button to reset. This will reset all filters that have been set.

FILTERS

Filtering and modifying a search can be done by various object criteria and parameters. Only objects matching the filter criteria will be shown on a search.

Observation filter

To easily find suitable targets for the current night an altitude filter can be used in conjuction with a from and through time and how long the target should be visible.

Using this filter can give you a great preview of what to expect for the night as you will then only see targets that are visible during the specified time range for at least the specified amount of time.

SEARCH RESULT ORDER

Search results can be ordered by one of several criteria: Size, Apparent Magnitude, Constellation, RA, Dec, Surface Brightness and Object Type. Display order can be either Descending or Ascending, and you can specify the number the items displayed per page.

> 🔥 **Important**
>
> Be aware that a large number of search results may lead to performance issues

SEARCH

Press the Search button to initiate the search
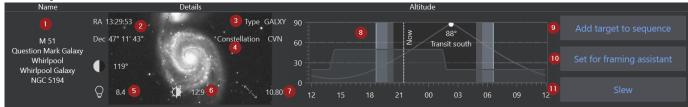
> 🔥 **Important**
>
> Utilizing the Sky Atlas requires your current location information to be set in the Astrometry settings area in the general settings. Not doing so, or inputting inaccurate information will cause Sky Atlas to display inaccurate data!

MOON PHASE AND DAY INFORMATION

Displays the current moon phase and other day information. The accuracy of this information depends upon the correct latitude and longitude being specified under **Options > General > Astrometry**.

Object List Display

An example of a search result:

1. The name of the object in question with any available alternatives. Spoken names like "Whirlpool Galaxy" are not yet implemented

2. The Coordinates of the object in RA and Dec, should you want to save the coordinates or manually slew to them

3. The object type. Types are abbreviations to conserve visual space. The filter uses the full type name instead of the abbreviation

4. The object's constellation, abbreviated

5. Apparent magnitude of the object, if available. This determines the peak brightness

6. Surface brightness of the object, if available. The actual full brightness of the object. A value of 99.9 indicates an unknown surface brightness

7. Apparent size of the object, if available. Shows you the apparent size in arcminutes or degrees, depending on size.

8. Displays the target object's altitude, the direction point at which it will transit, the darkness phase of the current day, and includes a vertical marker for the current time. The accuracy of the altitude curve requires that the latitude and longitude be set under **Options > General > Astrometry**.

- Tthe line with a specific peak is the actual altitude of the object at any given time, generally: the higher, the better. Transit north or south tells you whether the object will pass to your south or north.

- The Now line shows you your current time so you can cross reference the current altitude of the object.

- The darker lines show you the start of the nautical and astro dark.

- Furthermore a custom horizon will be displayed if it is set in the Astrometry settings

9. Sets the selected object as a sequence target for the legacy sequencer or the advanced sequencer using a specific template based on the selection

10. Sets the selected object as the target in the Framing Assistant

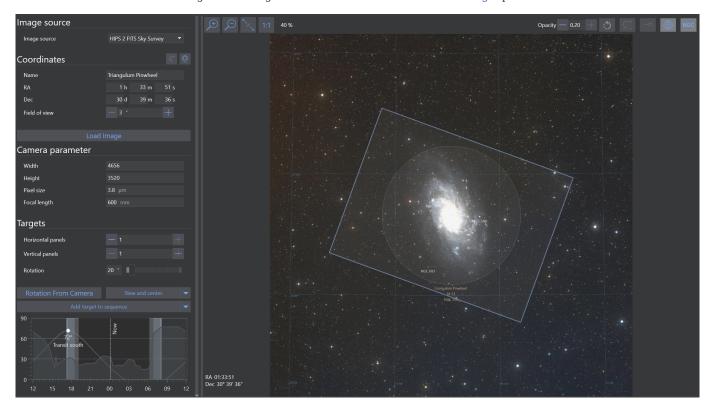11. Slew to the targetSlews the mount to the selected object

> **Tip**
>
> If the optional Sky Atlas Image Repository has been installed and the path to it specified under **Options > General > General > Sky Atlas Image Directory**, a small image of the object is displayed.

1.3.4 Framing Assistant

Framing Assistant allows you to frame the next shot perfectly via several online sky survey services, an inbuilt planetarium, or a user-supplied image. It can utilize plate solving to perfectly align your telescope and rotator (if equipped) to match the position of the framing rectangle.

For further information about using the Framing Assistant refer to the Advanced Framing topic.

Image source

IMAGE SOURCE SELECTION MENU

- Allows you to specify the source of an image to utilize in the Framing Assistant. Possible options are:
- **Digital Sky Survey**: Fetch an image of the object from a sky survey server. This requires an internet connection
- **Offline Sky Map**: N.I.N.A.'s own database of objects. Circles representing approximate target sizes will be displayed
- If you have images in your Sky Survey Cache, they will be shown in the offline sky map
- A prerendered cache of cache images spanning the whole sky can be downloaded on the homepage. This cache can be used to have a fast and complete offline framing tool.
- **From File**: Load an existing JPEG, GIF, PNG or TIFF image of an object. When an image is provided through **From File**, the configured Solver is used to determine the coordinates and orientation of the image. Alternatively, for FITS and XSIF files the WCS header coordinates are used if present.
- **Cache**: Load images directly from a local cache of images that have already been downloaded from one of the Digital Sky Survey servers or loaded in from files
- Successfully-solved or downloaded local and sky survey images are cached automatically

PLANETARIUM SYNC

- Pressing the Planetarium Sync button fetches the coordinates of a selected object from the configured external planetarium program. If no objects are selected in the planetarium the center of frame coordinates are selected as a fallback.

Camera parameters

COORDINATES

- The RA, Dec, and Field of View of a location in the sky may be manually entered here
- RA, Dec and Field of View are initially unavailable when loading an image from file, however these fields will be populated once the image has been automatically solved

LOAD IMAGE

- Starts the image download when using a sky survey
- Starts the plate solving mechanism when using **From File**. If the uploaded file already contains WCS headers these will be used instead of attempting a new platesolve.
- Attempts to load an image from the cache using the provided coordinates

WIDTH, HEIGHT, PIXEL SIZE AND FOCAL LENGTH
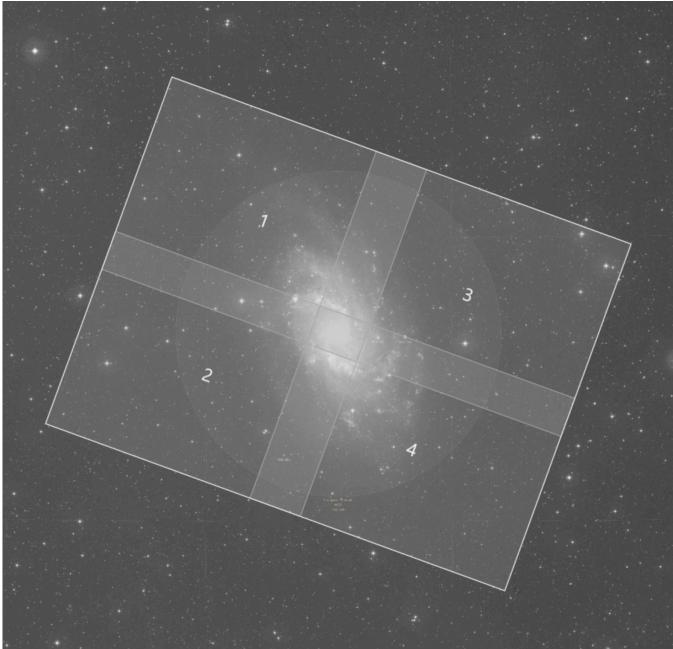
- Values will be set from the connected camera automatically, if available
- These settings are not available to DSLR users
- The specified Focal Length is **not** synchronized to the your Telescope settings. This allows you to experiment with various focal lengths
- These parameters determine the size of the framing rectangle (15)

  These parameters are only used for displaying the framing rectangle. For camera and focal length parameters used in platesolving refer to Options

Targets

MOSAIC PANELS AND ROTATION

- Rotation can be set freely and should match your camera's orientation as determined by plate solving
- You can specify the number of panels for an N x M size mosaic
- You can specify the % overlap between each panel
- Furthermore it is possible to enable "preserve alignment" which becomes relevant the further away from the celestial equator (declination at 0) the object is. Having this option enabled will adjust each mosaic panel separately with its own rotation to

perfectly align to a big rectangle. Keep in mind that this will require separate rotation between each panel.

ROTATION FROM CAMERA

- This will take an exposure from your connected camera, platesolve it and determine the rotation of the frame. Afterwards the rotation of the framing is updated.

SLEW AND CENTER

- Slews the mount to the coordinates of the center of the framing rectangle (16) and uses platesolving to recenter the mount to be precisely on target
- In addition when clicking on the arrow the operation can be adjusted to only slew to the target without solving or also consider the rotation (when a rotator is connected)

ADD TARGET TO SEQUENCE

- Takes the name, coordinates of the RA and Dec and the angle of the framing window and adds it as a sequence target for either the legacy sequencer or the advanced sequencer using a deep sky object template

- In addition when clicking on the arrow and clicking on "Add target to target list", the target can be added to the advanced sequencer's target tab instead
- A third option is to click on "Update Existing Target in Sequencer" which becomes available when there is already a target inside the sequencer and the target should be updated with the new framing instead

ALTITUDE BROWSER

- Displays the altitude of the target over time, indicating current position and meridian

Main tab

IMAGE DISPLAY CONTROLS

- From left to right: Zoom in, zoom out, fit image to screen, show image in original resolution

ANNOTATION CONTROLS

- From left to right: Rotate image instead of rectangle, Opacity of framing rectangle, constellation boundaries, constellation annotation, equatorial grid, annotate DSOs

IMAGE

- The image as downloaded from the sky survey, cache, Sky Atlas or provided by **From File**

FRAMING RECTANGLE

- Depends on the camera and focal length parameters (5)
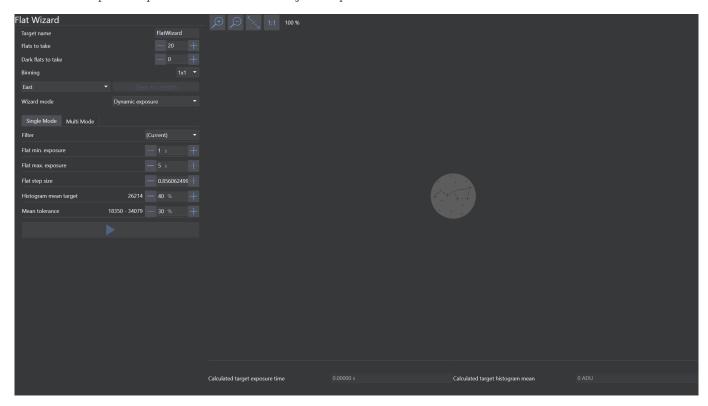- Can be dragged around with the mouse
- Can be rotated with (6)

RA/DEC COORDINATES

- The coordinates of the center of the framing rectangle. These are used as a sequences target coordinates

1.3.5 Flat Wizard

The Flat Wizard offers the possibility to automate flat image capture. It takes multiple exposures until it finds an optimal exposure time for the settings specified. There is also Multi Mode. Multi Mode automates flat acquisition for each filter for users with electronic filter wheels.

Flat Wizard takes 3 test exposures and attempts to calculate the optimal exposure time for a flat image by using linear extrapolation. Should that not be sufficient to derive a suitable exposure time, it will continue to take test exposures until it can determine the optimal exposure time or will ask to adjust the parameters when it fails to find one.

Settings

TARGET NAME

When using the image file pattern $$TARGETNAME$$ this field can be used to control how the pattern will be filled for the FLAT and DARKFLAT frames

FLATS TO TAKE

The number of flats to take for each filter

DARK FLATS TO TAKE

The number of dark flats to take for each exposure time

BINNING

Which binning mode should be used for taking the flats

GAIN

Determines the camera gain to be used during flat exposure

SLEW TO ZENITH

Depending on the selected value inside the combobox next to the button the telescope will slew to zenith with pier side east or west

WIZARD MODE

This mode will switch the operational behavior for the flat wizard for different scenarios

- Dynamic Exposure
- In this mode the flat wizard will try to find an exposure time (for a fixed panel brightness if a flat panel is connected)
- Dynamic Brightness
- For a fixed exposure time the flat wizard will try to find a flat panel brightness to match the desired exposure time. This requires a controllable flat panel to be connected.
- Sky Flats
- A mode when no flat panel is available, but rather the sky at dusk or dawn should be used to take flat exposures. During the runtime of the flat wizard the exposure time will be constantly adjusted for the changing sky brightnes, so the exposures will all have a different exposure time

Single Mode

IMAGE PREVIEW

- The most recent flat image is displayed in this area while determining the optimal flat exposure time. Note that this area will not be updated once the optimal exposure time is determined. This is to speed up the flat acquisition process.

FLATS & DARK FLATS TO TAKE

- The number of flats and dark flats the wizard should capture

BINNING

- Sets camera binning level for the exposures

GAIN

- Sets the gain of the camera to use for the exposures. The camera and driver needs to support gain control

ZENITH SLEW

- Slews scope to point at zenith on either east or west side

SINGLE MODE

- The mode to take flats for a single filter or no filter at all

MULTI MODE

- The mode to take flats for multiple filters

FILTER

- If a filter wheel is connected, a filter can be chosen for single mode

FLAT MIN EXPOSURE

- The minimum exposure time Flat Wizard should use

FLAT MAX EXPOSURE

- The maximum exposure time Flat Wizard should use

FLAT STEP SIZE

- Sets the step size (in seconds) that Flat Wizard should use when comparing test flats while determining the optimal exposure time

HISTOGRAM MEAN TARGET

- Sets the mean ADU that the flat image histogram should use.

- A percentage can be specified on the right or with using the slider. The number left of the percentage displays the ADU value of the desired percentage

MEAN TOLERANCE

- Determines how large the tolerance of the flat mean from the mean target (12) should be
- A percentage can be specified on the right or with using the slider. The number left of the percentage displays the ADU range of the desired tolerance percentage based on the mean target (12). A tolerance value of 20-30% should be typical

START FLAT WIZARD

- This button starts the flat acquisition process using the current settings
- First, Flat Wizard will calculate the optimal exposure time using test exposures, and then take flat the full course of flats as set in (2). You will be prompted to extinguish any light source prior to taking Dark Flats.
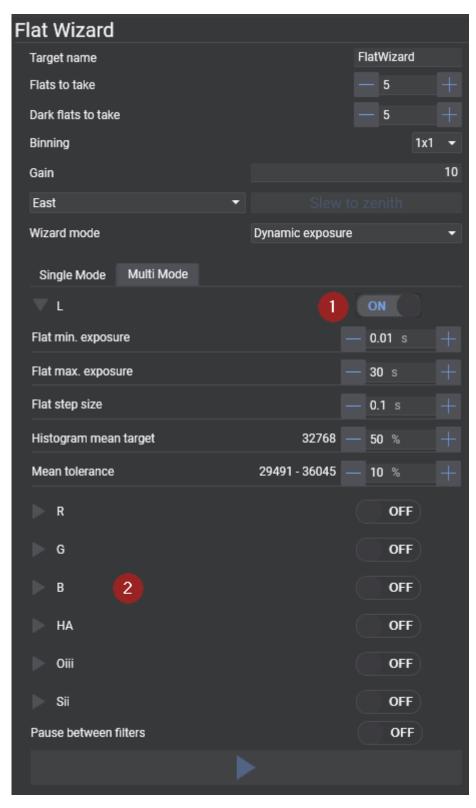
CALCULATED TARGET EXPOSURE TIME

- Once Flat Wizard determines the necessary exposure time, it will use that to take all flats

CALCULATED TARGET HISTOGRAM MEAN

- Once Flat Wizard determines the necessary exposure time and resulting ADU, the ADU mean will be displayed here

Multi Mode

In essence, Multi Mode works just like Single Mode, but for multiple filters. The majority of controls are identical to Single Mode.

In Multi Mode, Flat Wizard settings are saved on a per-filter basis and do not transfer to Single Mode.
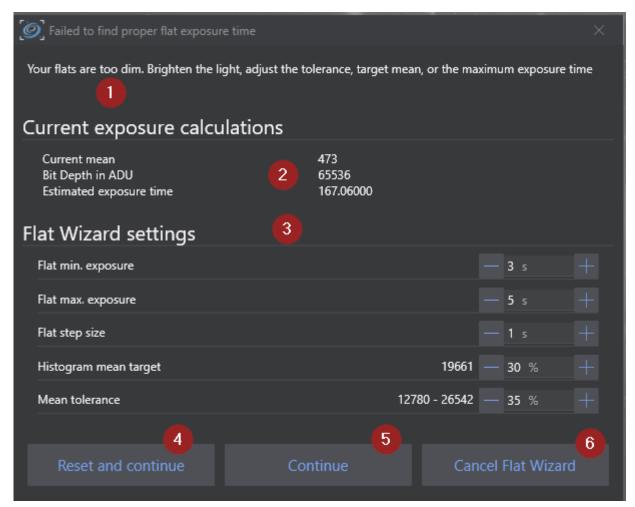
FILTER TOGGLE

• Enables a specific filter for flat capture

FILTER LIST

- Displays all available filters by name and can be expanded by clicking the > icon

Error Handling

If Flat Wizard cannot determine the necessary exposure time or there is a conflict with the specified settings, it will display this dialog.

ERROR MESSAGE

- Flat Wizard will display what the issue with the current configuration is and what should be done to fix the issue

CURRENT EXPOSURE CALCULATIONS

- Flat Wizard will display current calculated metrics, as the current mean, the maximum bit depth of the camera in ADU and the estimated exposure time
- Use those to adjust the values in (3)

FLAT WIZARD SETTINGS

- Specify settings for the current flat capture to get successful flats
- For further detail, see the description of the settings in the Single Mode section

RESET AND CONTINUE

- Pressing this button will lead to Flat Wizard re-starting from the Flat Min Exposure as set in the settings (3)

CONTINUE

- This button will continue the flat capture with the currently determined exposure time, even if outside the defined threshold

CANCEL FLAT WIZARD

- This button will abort Flat Wizard's sequence

1.3.6 Sequencer

1. **Add new Target**
   Creates a new empty target and opens the Legacy Sequencer

2. **Load Target**
   Load a target from a saved target file and opens the Legacy Sequencer

3. **Open Target Set**
   Load a whole target set consisting of multiple targets for the Legacy Sequencer

4. **Import Target**
   Import a list of targets from an external source into the Legacy Sequencer

5. **Advanced Sequencer**
   Plan a sequence step by step from scratch using the Advanced Sequencer

1.3.7 Imaging

The Imaging tab is your imaging cockpit.
Here N.I.N.A. will display a variety of information regarding the captured images and will let you control all the vital parameters of your imaging session.

The Imaging tab is organized in windows that can be arranged dynamically to create your own layout. Available windows can be activated and deactivated from the top bar. To arrange a window simply drag it from the window header and drop it according to the suggested placeholders.

The top bar is divided in two main sections: **Info** and **Tools**
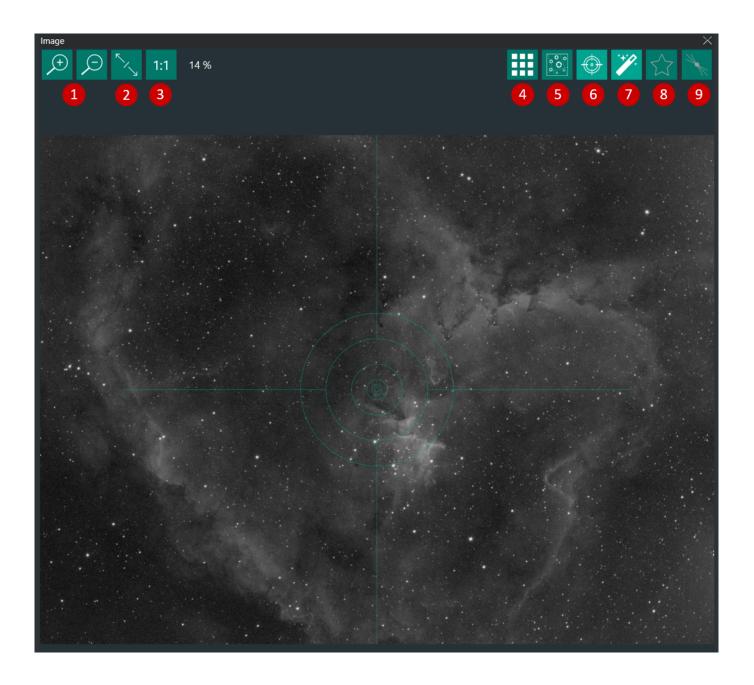
Info

These windows provide important status information about captured images and connected equipment

A. IMAGE
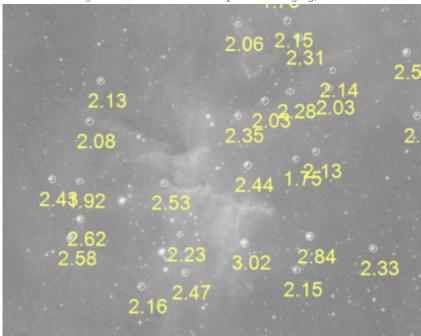
The image panel is the central part of the Imaging tab and is used to display the latest captured images

1. Zoom In/out

2. Zoom to Fit

3. Zoom 100% (1:1)

4. Opens a 3x3 crop mosaic of the current image to check for distortion and tilt

5. Initiates a platesolving routine for the current image

6. Toggles crosshair overlay on/off

7. Toggles automatic display of the displayed image (for autostretch settings refer to Options)

8. Toggles automatic HFR (Half-FLux-Radius) star detection analysis. HFR is used for Autofocus routines. When HFR detection is ON, the average HFR value for each captured image are plotted in the HFR History window (M)

If Annotate Image is switched ON under Options->Imaging, the calculated HFR values will be displayed on the image

9. Activates the Bahtinov Analyzer aid tool for manual focusing with a Bahtinov Mask.

B. CAMERA

This panel displays the main camera and sensor properties and cooling status
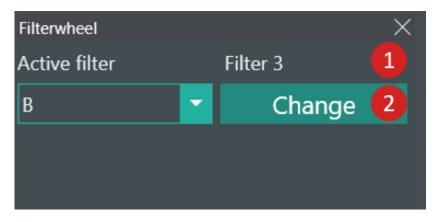
Requires a connected camera

1. Camera status details

2. Camera cooling properties

3. Camera warming

C. FILTER WHEEL

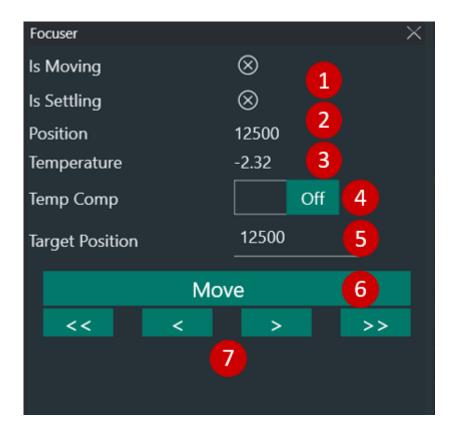When a Filter Wheel is connected, this panel displays the current filter (1) and lets you manually switch filters by selecting them with the drop-down menu (2)

D. FOCUSER

This panel displays the focuser status and lets you manually move it to the desired position

Requires a connected focuser

1. Focuser current status (Moving or Settling)

2. Focuser current position (for absolute stepper motor focusers)

3. Focuser temperature (if the focuser is equipped with an ambient temperature sensor)

4. Toggles focuser temperature compensation

5. Here you can set the target focuser position for the focuser to move by clicking on "Move" (7)

6. Moves the focuser to the Target Position defined in (6)
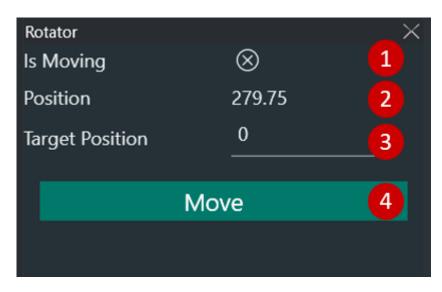
   It is convenient to set the target position as the position of near-focus for your setup. This position can be determined by using a Bahtinov mask on a bright star (see **Manual Focus Targets**). Once the near-focus position is determined, input the number of steps indicated in "Position" (3) in Target Position field. You can then instruct the focuser to move to this position at the beginning of each imaging session before starting the Auto-Focusing routine

7. The arrows will move the focusers back and forth of a pre-defined amount related to the Auto Focus Step Size defined under Options - Equipment:

 • Single arrow < > : half the Auto Focus Step Size

 • Double arrows << >> : five times the Auto Focus Step Size

E. ROTATOR

Here you can control the Rotator

Requires a connected ASCOM Rotator

1. Rotator current status

2. Rotator current position

3. Input the Rotator target position

4. Moves the rotator to the Target Position

F. TELESCOPE

The telescope panel provides all important information about your telescope like tracking status, sidereal time, time to meridian passing and current telescope coordinates.
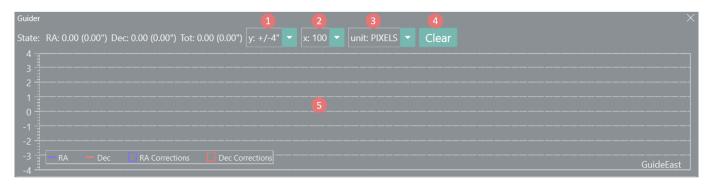
Requires a connected ASCOM telescope

G. GUIDING

The guider panel replicates the PHD guiding graph in real time.

PHD2 must be connected for the Guider to display the guiding trends and pulses (RA and DEC).

1. Select the scale range of y-axis

2. Select the scale range of x-axis

3. Select the units for y-axis:

 • Pixels: guide camera pixels

 • Arcseconds: units in arcseconds (this is calculated by PHD2 based on your guide camera pixel size and guide scope focal length)

4. Clears the chart

5. Chart area, this is where the PHD2 graph will be visualized

H. SEQUENCE

Sequence panel lets you start/stop imaging sequences and provides information on the sequence run in a compressed format. To learn how to set up a sequence refer to the Sequence section.

I. SWITCHES

This panel will let you control the active switches

Requires connected switches

1. Available switches and status

2. Manually select switch

3. Toggle active switch ON/OFF

J. WEATHER
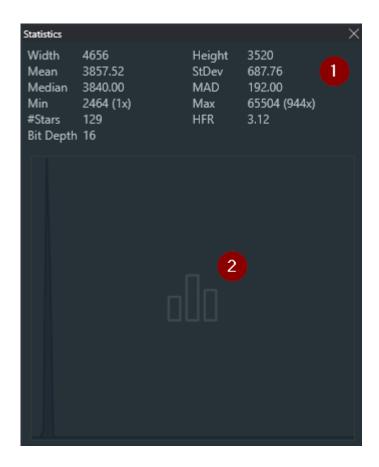
Weather and temperature information from OpenWeatherMap

OpenWeatherMap API key must be set under Options Equipment

K. STATISTICS
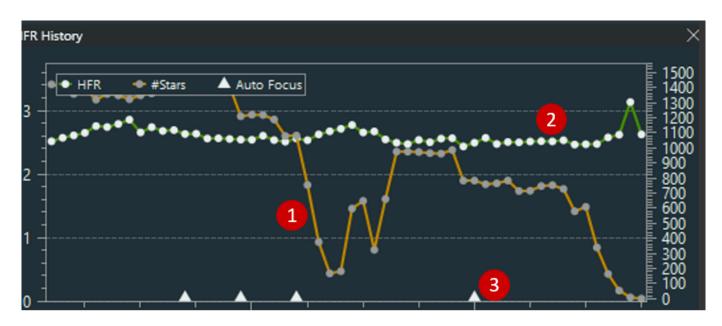
In this panel all the important information about the last captured image are reported

1. Basic statistics relative to the last captured image:

 • Width and Height, in pixels

 • Mean, Standard Deviation, Median and MAD values in ADU

 • Minimum and Maximum ADU values in the image

 • Number of detected stars and mean HFR > Stars and HFR will only be displayed if Automatic HFR is active

 • Bit Depth as reported by the image header

2. Image histogram of the last captured image

M. HFR HISTORY

When automatic HFR (Half-Flux-Radius) star detection is ON, this panel will diplay the history of HFR values and number of stars used to evaluate the HFR for each exposure. The chart is limited to displaying a moving window of the last 100 exposures.
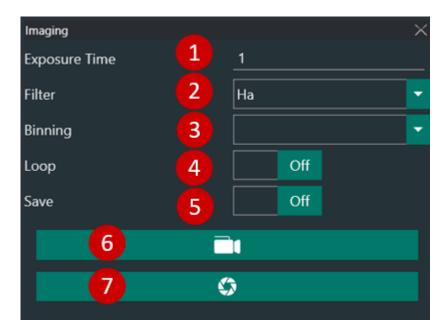
By default the HFR History shows the HFR values and the number of detected stars throughout the imaging session. The fields can be changed by hovering over the panel to different statistics. 1. Green line: Left y-axis 2. Yellow line: right-axis 3. Triangle marks: AF runs

Tools

N. IMAGING

The imaging panel allows you to take a single exposure or live view when supported by the camera

1. Capture exposure time in seconds
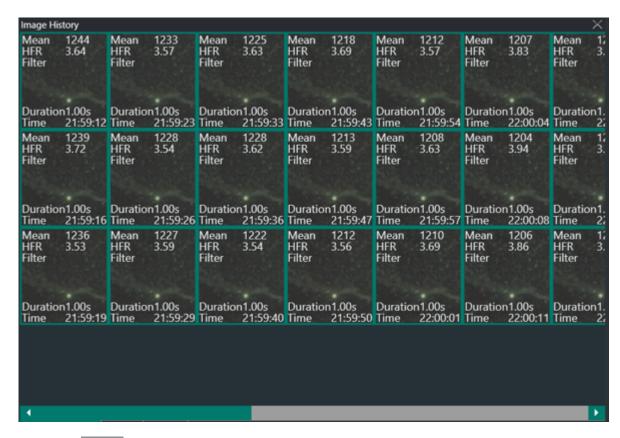
2. Filter to be used for the capture (if a Filter Wheel is connected)

3. Camera Binning

4. Toggles ON/OFF image looping. This is particularly useful for manual focus with a Bahtinov mask

5. Toggles ON/OFF the saving on HD of the current capture

6. When supported by the camera, this will activate the Live View mode

7. Takes the exposure

O. IMAGE HISTORY

The Image History panel shows a list of thumbnalis of the current sequence captured images with basic statistics: Mean value in ADU, average HFR, Filter used, duration and capture time.

By double-clicking on any of the thumbnails the relative image will be opened in the Image panel (A)

P. PLATE SOLVING

Platesolving is a very important step in the imaging process, for further information on the Plate Solving process refer to Platesolving in the advanced topics. This panel lets you perform a manual platesolving and keeps the history of all platesolving sessions.
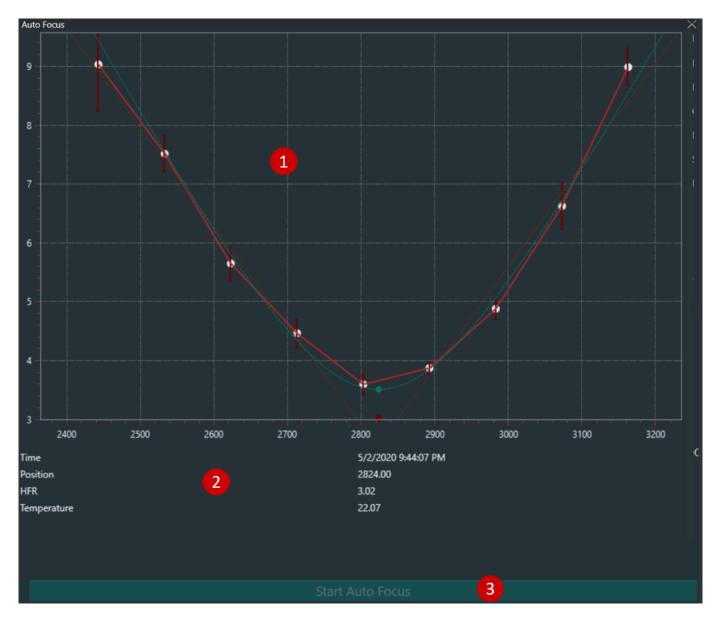
Prerequisites for platesolving to work are: * An external Platesolver is defined in Options Platesolving * Telescope focal length is defined in Options Equipment * Camera pixel size is defined in Options Equipment * The image to be plate solved has been captured with the specified focal length and pixel size

1. Plate solving results

2. Toggles ON/OFF syncing the telescope mount with the plate solved coordinates

3. Toggles ON/OFF re-slewing and re-centering the mount to the plate solved coordinates if the plate solved position is not matching with the expected one

4. Error threshold for (4)

5. Exposure that will be used to capture the image for plate solving

6. Filter that will be used to capture the image for plate solving

7. Captures an image for plate solving

8. History of plate solving sessions

R. AUTO FOCUS
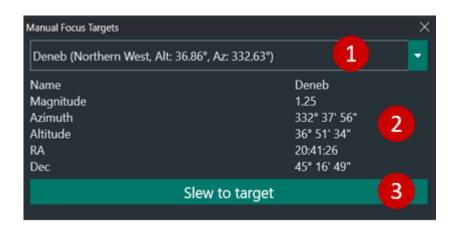
This panel lets you manually trigger an Auto Focus routine based on the Auto Focus parameters set in Options Equipment.

1. Autofocus curve

2. Last Auto Focus run parameters

3. Starts Auto Focus routine

S. MANUAL FOCUS TARGETS

When you have to manual focus your scope this tab lets you conveniently choose among the current visible brighter stars according to your location and time.
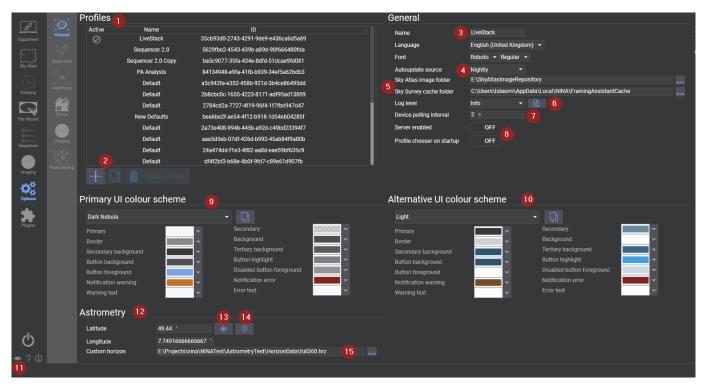
1. List of stars to choose from

2. Selected star properties

3. Slews telescope to the selected star

1.3.8 Options

General

The General Settings tab allows you to manage N.I.N.A. in terms of all general settings. Settings here affect the whole application.

PROFILES

- Lists all user defined N.I.N.A. profiles
- The name of the currently loaded profile can be changed using the form to the right (3)

Profile Buttons

- The user may add, duplicate, delete or load a profile using these buttons

  A profile cannot be loaded if the current one has a device connected

GENERAL

Name, Language and Font settings

- Sets the name of the currently loaded and active user defined profile
- The Language setting changes most labels, tooltips and buttons to the specified language

  A wide range of languages are supported. If you want to contribute to localization, check out the localization guide

Auto Update Source

- Selects which version branch to check for updates

- Currently there are 3 version branches, Nightly, Beta and Release

  Nightly offers the latest developments including bugfixes and feature additions. These builds are not as well tested as the beta or released versions but should be stable for imaging runs

  Beta versions are considered feature complete and are typically very stable. They will undergo a series of testing and bug fixing with incremental updates before becoming a release version

  Release offers the most reliability and stability for your imaging runs

Sky Atlas & Survey Directory Settings

- If the Sky Atlas images have been downloaded, N.I.N.A. must be pointed to them by setting the directory here

- Survey images downloaded when using the framing tool are stored in this directory

Logging

- Specifies the level of logging done by N.I.N.A for troubleshooting and debugging purposes

- The level of logging can be set (in ascending order) to 'Error', 'Warning', 'Info', 'Debug' or 'Trace'

- The button here opens the directory containing the logs, logs are typically located in %localappdata%\NINA\logs

Device Polling Interval

- This sets the interval of device polling in seconds. Default works well in most situations.

Server enabled

- N.I.N.A. offers a basic REST server to receive commands from other applications. Currently very limited to specific use cases.

COLOR SCHEMES

Current UI Color Scheme

- Enables customisation of the color scheme of N.I.N.A.

- Offers many different themes via the drop down menu

- Alternatively, the user can define each colour for each specific element and save to the custom theme by clicking the button

Alternative UI Color Scheme

- Identical functionality to (9) however this scheme is intended for use in the dark (i.e. a black/red theme to preserve night vision)

Color Scheme Toggle

- Clicking this eye icon will toggle between the current and alternative UI color scheme

  This can be done from anywhere in the application

ASTROMETRY SETTINGS

- Hemisphere, Latitude and Longitude can be set here

NMEA GPS Button

- Loads coordinates from a NMEA GPS device if connected
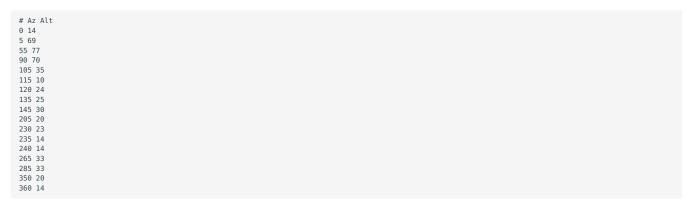
Planetarium Button

- Loads coordinates from a user connected planetarium software
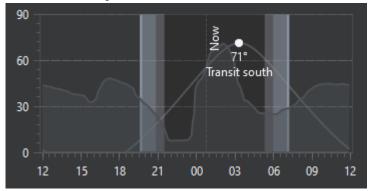
  Planetarium can be connected in the Planetarium menu

Custom Horizon

- To have a visual indicator about a local horizon and to also utilize a horizon for the advanced sequencer, a custom horizon file can be referenced here.
- The file format follows a simple style of azimuth altitude pairs to define the horizon. Gaps between azimuths are interpolated. A minimum of two azimuths altitude pairs are required for the file to work.
- Here is an example of a horizon file:

```
# Az Alt
0 14
5 69
55 77
90 70
105 35
115 10
120 24
135 25
145 30
205 20
230 23
235 14
240 14
265 33
285 33
350 20
360 14
```

- Once a horizon is specified it will be reflected in all altitude charts of the application

Equipment

This is the tab where you set up all the parameters related to your equipment.

CAMERA

Pixel Size

- The Pixel Size of your camera sensor in micrometers. This field will be automatically populated by the camera, if it provides the information.

  This field together with the values in "Telescope" is used for Platesolving operations

Bit Depth

- Specify the bit-depth of the images outputted by the camera in use.

  For DSLRs using DCRAW set this to 16 bit. If you're using FreeImage set to match the bitdepth of the camera

  For ZWO, QHY, SBIG, FLI, PlayerOne and Atik cameras set this to 16bit since they are rescaled by the camera drivers.

  Touptek, Risingcam, Altair, Mallincam, Omegon and SVBony do not scale, so set to match bit depth of the camera

  For other CCD/CMOS cameras ask to your camera manufacturer.

Bayer Pattern

- Specify the bayer pattern for DSLR/OSC cameras. Leave it to Auto for auto-selection from camera drivers.

Enable bit scaling

- Indicates if data should be shifted to 16 bits. Only relevant for Touptek, Risingcam, Altair, Mallincam, Omegon and SVBony cameras

Bulb Mode

- Allows you to change the bulb mode of the camera. Native will work in most cases.

  RS232 and Mount is available as well and might be necessary for older Nikon cameras For usage of RS232 and Mount shutter refer to Usage: Using RS232 or Mount for bulb shutter

Raw Converter

- Only for DSLR: select the RAW converter, options are DCRaw and FreeImage

  DCRaw will utilize DCRaw and stretch your images to 16bit, applying the cameras specific color bias profile.
  FreeImage will deliver the frame exactly as your camera provided it and can be slightly faster for image download on slower machines.

> ✏️ **Note**
>
> Both raw converters will deliver you the raw frame of your DSLR, but they might vary in color. Saving the raw frame without adding the camera specific profile with FreeImage can deliver more faint and less colorful raw images than you are used to.

Camera Timeout

- Specifies how long N.I.N.A. should wait after the exposure time for the frame download before timing out and proceeding.

ASCOM allow odd pixel dimensions

- In previous versions of N.I.N.A. the pixel dimensions were always truncated to have even width and height due to OSC cameras. This switch allows to utilize the full sensor size for mono cameras when using the ASCOM driver.

TELESCOPE

Telescope

- This section lets you enter the parameters of your telescope that will be used for Platesolving.

  If you change telescope, remember to update these settings or to switch profile under Options/General.

Settle time after slew

- Time in seconds to wait after a scope slew before imaging again

No Sync

- When active it prevents sending syncs to the mount during centering. Instead an offset is calculated to center the mount.

  Can be useful when you have a permanent setup and a good mount and created a solid pointing model in order not to interfere with it.

WEATHER

API Keys

- Input your personal API key for the various weather sources.

  Click on the question mark to open the respective page for the API key

FILTERWHEEL

Filterwheel

- If a Filter Wheel is connected in Equipment this window lists the available filters and names.
- Position: filter position
- Name: name of the filter as imported from ASCOm driver
- Focus Offset: offset values that are used at each filter change if "Use FilterWheel Offset" is enabled
- Auto Focus Exposure Time: it is possible to specify an AF exposure time for each filter

Filter + - Buttons

```
 * These buttons add and remove filters from the filterwheel list (24)
```
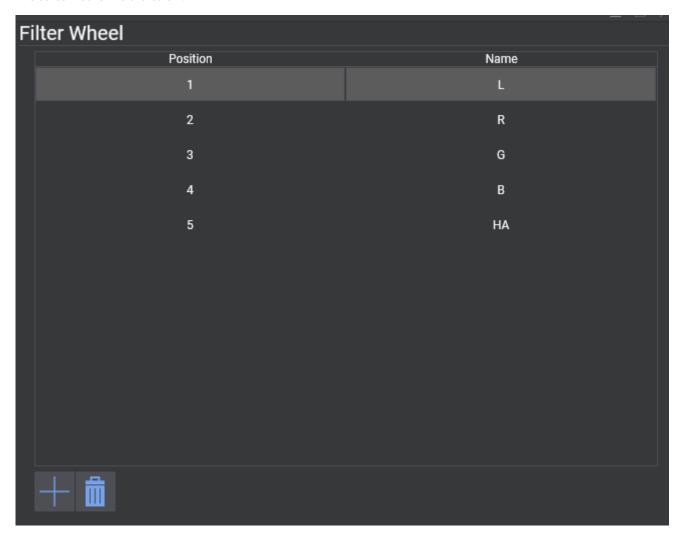
Filter Wheel Configuration

The Filters defined in the Filter Wheel list are used in various places in N.I.N.A., especially in:

- The Sequencer: certain places can specify a filter for capture
- The Plate Solving routine: it can be set to use a particular filter, to have lower exposure times for plate solving (e.g. using L rather than HA for example)
- The Auto-Focus routine: like plate-solving, autofocus can be set to use a particular filter, as well as having filter specific autofocus options

For the above to work well, it is necessary to define the proper filters available.

The screen looks like the below:

Adding filters

Typically the first step for a user when first setting up the filter wheel is to connect to a filter wheel. This will take the information about the filters from the filter wheel itself, and automatically populate the list in N.I.N.A. based on that information.

If this doesn't work, it is possible for the user to use the + and - buttons to manually add or remove filters. Note that the Position order of the filters in this tab should match the order of the physical filters in the filter wheel.

For example, if a filter wheel has the following filters:

1. Luminance filter at position 1

2. Red filter at position 2

3. Green filter at position 3

4. Blue filter at position 4

5. H-Alpha filter at position 5

then the screen should be configured as per the screenshot above, starting with the L filter, and going in order until the HA filter.

PLANETARIUM SETTINGS

The Planetarium section contains settings for each of the 4 supported planetarium programs. Currently N.I.N.A. supports Stellarium, Cartes du Ciel, TheSkyX and HNSKY. The connection allows a one way communication of coordaintes from the planetarium software to N.I.N.A.

If a planetarium program is configured, coordinates can be imported anywhere in the program that has the Planetarium Sync Button.

Preferred Planetarium Software

- This drop down menu selects the planetarium software to be used

Host

- This is the address the planetarium server is hosted on
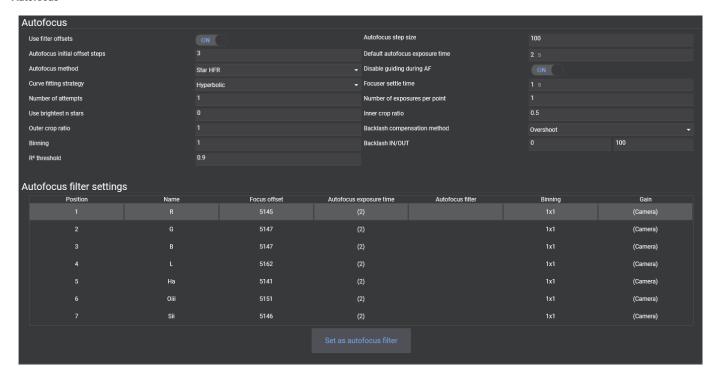
  The default 'localhost' will work if you're running the planetarium software on the same machine

Port

- Each software's server operates on a different port

  It is recommended to leave this at default

Autofocus

GENERAL SETTINGS

Use FilterWheel offset

Determines whether the focuser should move per the defined offset in the list at the bottom when the filter wheel changes filters. See below for more details.

Autofocus Step Size

The number of focuser steps that the autofocus routine will move by between autofocus points. This setting is highly dependent on the telescope and focuser.

Autofocus Initial Offset Steps

The number of focus points that will be used on each side of perfect focus by the autofocus routine.
The default value should work for most cases

Default Autofocus Exposure Time

The exposure time in seconds that will be used by autofocus, if filter specific times in the list below are not set

AF Method

Method used to detect datapoints for autofocus.

- Star HFR: This is the default method that will work reliably with images containing stars
- Contrast Detection: An alternative method to focus on terrestial objects or planets

AF disable Guiding

Activate to pause guiding during AF routines. Enable this setting when using an Off-Axis Guider. For Guidescopes it is recommended to be left off.

AF Curve Fitting

Fitting that should be used to determine ideal focus position out of the measured data points. A traditional autofocus curve follows a hyperbolic shape, so Hyperbolic method is recommended.

Focuser Settle Time

The amount of time, in seconds, that should be awaited after a focuser move before starting a new exposure. Some focusers will require a small settle time to not lose steps and to prevent vibrations.

AF Number of Attempts

The number of attempts the autofocus routine should be retried in case of unsuccessful focusing. Be careful when increasing this, as this can unnecessarily lengthen the AF routine when no focus can be achieved anyways, due to for example clouds. Better to be handled with the advanced sequencer

AF Number of Frames per Point

The number of frames whose HFR or contrast will be averaged per focus points. For most of the time only one point per focus point is enough.

Use brightest n stars

The number of top brightest stars that the autofocus routine will use - 0 means there is no limit and all stars are considered.

AF Inner Crop Ratio

Inner ratio that will determine a centered region of interest for autofocus

AF Outer Crop Ratio

Outer ratio that will determine a centered region of interest for autofocus

Backlash Compensation Method

This controls the backlash compensation method used. The method can only be changed when the focuser is not connected!

- Absolute: When the focuser changes directions, an absolute value will be added to the focuser movement. Backlash IN: when the focuser changes from moving outwards to moving inwards the Backlash IN value will be added Backlash OUT: when the focuser changes from moving inwards to moving outwards the Backlash OUT value will be added
- Overshoot (recommended): This method will compensate for Backlash by overshooting the target position by a large amount and then moving the focuser back to the initially requested position. Due to this compensation the last movement of the focuser will always be in the same direction (either always inwards or always outwards)

Backlash IN/OUT

The focuser backlash in the IN (decreasing position) and OUT (increasing position) directions, expressed in focuser steps.

> **Tip**
>
> When Overshoot is chosen, only ONE value between Backlash IN and OUT must be set! When setting IN, the amount will be applied on each inward movement, so the final movement will always be outwards. For Backlash OUT, it will be the other way around. The recommended direction is OUT, as then the autofocus routine will need less compensation. Use IN only when your equipment requires this direction to work properly.

Binning

The binning to be used for Autofocus exposures, if filter specific binnings in the list below are not set

R² Threshold

This setting refers to the coefficient of determination which is used to grade the calculated fitting of an autofocus run to the actual datapoints. When an autofocus run leads to an R^2 value that is below this threshold, the autofocus run will be deemed as failed. This can happen due to bad parameters, clouds rolling in and other problems during an autofocus run. An ideal autofocus run will have an R^2 value that is easily beyond 0.95.

AUTOFOCUS FILTER SETTINGS

Filter offsets

Most filters are not exactly par focal, meaning that when changing filters, the ideal focus distance changes slightly. This will cause an imaging system that was in perfect focus with one filter to be slightly out of focus with another filter. This can be a big problem for precise imaging, requiring an additional autofocus run each time the filter is changed.

To avoid this, it is possible to set filter offsets, which are the amount of focuser steps that the focuser should move by when switching from one filter to another.

For example, I could run the autofocus routine on each of my filters one after the other (with hopefully very little temperature change in between), with the following results:

- L filter achieves perfect focus at focuser position 5000
- R filter achieves perfect focus at focuser position 4990 (10 steps fewer than L filter)
- G filter achieves perfect focus at focuser position 5030 (30 steps more than L filter)
- B filter achieves perfect focus at focuser position 5045 (45 steps more than L filter)
- Ha filter achieves perfect focus at focuser position 4988 (12 steps fewer than L filter)

If we take the L filter as the reference filter, we can set up all the filter offsets relative to the L filter, as below:

- L filter offset 0 (reference filter)
- R filter offset -10 (10 steps fewer than L)
- G filter offset 30 (30 steps more than L)
- B filter offset 45 (45 more steps than L)
- HA filter offset -12 (12 steps fewer than L)

This is what has been done in the above screenshot.

Note that for this to work, the Use FilterWheel Offsets parameter under the Focuser Options needs to be set to On.

Autofocus Exposure Time

The ideal auto-focus time can change per filter, particularly between broadband and narrowband filters (in the above example, the narrowband filter requires an exposure time 5 times longer than the broadband filters). This can easily be set up here.
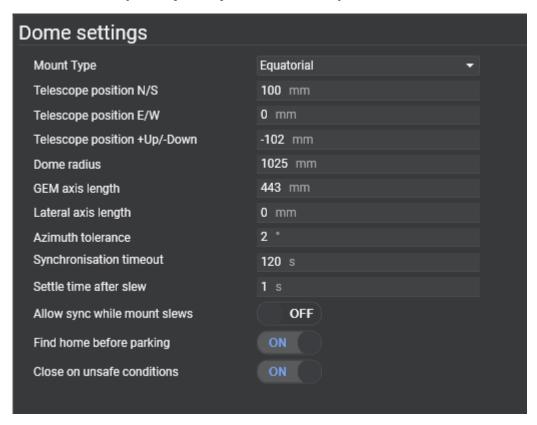
Finding a good exposure time for autofocus is further explained in the Auto-Focus section

Autofocus Filter

From the filter list, it is possible to set (or unset) an autofocus filter, which will be used by the autofocus routine (if the Use FilterWheel Offsets setting is enabled). This can be done by simply selecting a filter in the list, and clicking on the Set as Default AF Filter button. The same button can be used to unset the autofocus Filter.

Dome

This is the tab where you set up all the parameters related to your dome.

Mount Type

Specify if your mount is an equatorial mount or a fork on a wedge. This will affect the calculation.

Scope Position +N/-S (mm)

Measure the North or South offset (in mm) of the center of the mount from the center of the dome. North is true north - the same direction a polar aligned telescope would point. Use a positive number for North, and a negative number for South.

Scope Position +E/-W (mm)

Measure the East or West offset (in mm) of the center of the mount from the center of the dome. East/West is relative to true north - the same direction a polar aligned telescope would point in the northern hemisphere. Use a positive number for East, and a negative number for West.

Scope Position +Up/-Down (mm)

Measure the height difference (in mm) of the center of the mount axis relative to the base of the dome. For an Alt/Az mount, this is from the center of the Altitude axis, and for an EQ mount this is where the RA and DEC axes intersect. A positive number indicates the center of axis is higher than the base of the dome, and a negative number means it is lower.

Dome Radius (mm)

Measure from the center to the rim of the dome, along the base.

GEM Axis Length (mm)

If Alt/Az, this should be 0. For an EQ mount, slew RA to +/- 90 degrees, and measure the lateral distance (in mm) from the axis to center of the telescope aperture.

> ✏️ **Note**
>
> The purpose of this setting is to determine what should point to the center of the Dome aperture. If you have a guide scope, you should add half the length from the OTA to the top of the guide scope. For example, if the guide scope mount is 40mm and the guide scope aperture is 60mm, you should add 70mm to **GEM Axis Length**.

Lateral axis length (mm)

If you have a dual saddle with side-by-side OTAs, this setting specifies offset (in mm) of the center of the OTA from the mount axis. Use a positive number for offsets to the right relative to the RA and DEC axis.

Azimuth Tolerance (degrees)

The Dome slews if the target azimuth is off by more than this amount. Some dome rotators have a maximum precision, so you should set this either at that precision or greater. For example, NexDome could only support 1 degree of resolution when slewing until mid-2020 when high precision slewing was added.

Synchronization Timeout

Actions that require an image to be taken (such as Plate Solving and Auto Focusing) depend on the dome being synchronized with the mount. If Dome follows telescope is enabled, imaging operations will wait until the Telescope has stopped slewing **and** the Dome is pointed to the same azimuth (within the configured tolerance). This settings specifies the maximum amount of time, in seconds, to wait for this synchronization to complete.

> 🔥 **Important**
>
> This value should be no smaller than twice the precision of the Dome rotator. For example, NexDome can only slew to integer granularity, which means its precision is 1 degree. If you own a NexDome, don't set this value smaller than 2 or **Wait for Dome Synchronization** will delay periodically.

Settle time after slew

Add a settle time here if your dome needs to settle down a couple of seconds

Allow sync while mount slews

When an external application or the handset slews the mount, dome synchronization will wait for the mount to stop before it rotates the dome. Turning this option on allows dome synchronization to chase the mount. If rotation is fast, you may prefer to turn this on.

Find Home Before Parking

This is an innovative reliability feature. Some Domes, such as NexDome, require the Park location to be precise so that a battery powering the shutter motor can recharge. If this setting is enabled, the Dome will find the Home position (if the Dome provides one) before parking and closing the shutter. This resynchronizes the Dome azimuth to increase Park accuracy.

> **Note**
>
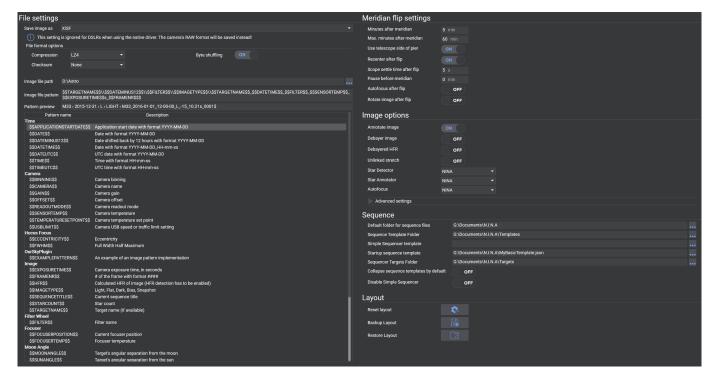> Some Dome vendors also provide manuals to configure many of these same parameters. If you're stuck, try checking some of them out too.

Close on unsafe conditions

When a safety monitor is connected, the dome will automatically close immediately when the monitor is reporting unsafe conditions. This will happen independent of any other action in the application like the sequencer.

Imaging

The Imaging options tab contains settings for file formats, save directories, Automatic Meridian flips, sequencing and image options.

FILE SETTINGS

Image Save File Format

- The format for every image to be saved as

- Available formats: TIFF (zip, lzw compressed), FITS, XISF (lz4, lz4hc, zlib compressed)

- For more information on these file formats see:

- Advanced Topics: File Formats TIFF

- Advanced Topics: File Formats FITS

- Advanced Topics: File Formats XISF

- All formats are saved as 16bit

- If an OSC camera is used, the raw bayered data is saved

Compression

- Select the compression method (if available)

- Compression will require more time to save the image, but the file size will be reduced

Byte Shuffling

- Enable/disable byte shuffling for XSIF compression

Checksum

- Select a checksum method for XSIF (optional)

- Checksums can be used to determine if a file was corrupted

Image File Path

- The file path where images will be saved

Image File Pattern and Preview

- The structure of folders and the filename for saved images can be adjusted here.

- Each keyword will be replaced by its current value when the image is saved.

- A list of all available keywords and their usage are described in the table below the pattern

- Static text is also possible and will be kept

- A preview of the file pattern is also displayed below

- Furthermore you can expand this section to also specify different file patterns for FLAT, DARK BIAS and DARKFLAT images. If no pattern is specified for those, the default image pattern will be used instead

> **Note**
>
> You should avoid using non-ascii characters when filling the Target Name value in `FlatWizard`, `Legacy Sequencer`, `Advanced Sequencer` or `Imaging Snapshot`. Value in these fields will be passed to file pattern `$$TARGETNAME$$`. Due to compatibility requirements on FITS format and other image processing software, `$$TARGETNAME$$` does not allow non-ascii characters. Greek characters are replaced using a special translation table, and other non-ascii characters are replaced with "_", for example
> `, Vega, α Lyr, BD +38°3238 -> __, Vega, alf Lyr, BD +38_3238`

> **Tip**
>
> By using the backslash characters `\\` you can separate your images into various folders and sub folders. For example N.I.N.A. will create separate folders on each new session and create sub folders for Lights Darks etc. and then inside these folders putting the actual image files when using a pattern like
> `$$DATEMINUS12$$\\$$IMAGETYPE$$\\$$EXPOSURENUMBER$$`
> which will result in
> `2020-01-01 -> FLAT -> 0001.fits`
> `2020-01-01 -> LIGHT -> 0001.fits`
> `2020-01-02 -> LIGHT -> 0001.fits`

AUTO MERIDIAN FLIP

- For usage of the automated meridian flip refer to Advanced Topics: Automated Meridian Flip

Minutes after Meridian

- This defines the minimum amount of time passed after crossing the meridian where a flip can be performed

Max. Minutes after Meridian

- With this setting the latest time to flip after crossing the meridian is defined

> **Tip**
>
> When you span a time range with Mintues after Meridian and Max. Minutes after Meridian it is possible to immediately flip without losing any time to waiting. E.g. you set it to 5 Minutes and 10 Max Minutes, and when an exposure finishes in between this time range the application can immediately flip the scope instead of having to wait for the remaining time where an expsoure would not fit in.

Use Telescope Side of Pier

- Almost all mount drivers can tell N.I.N.A which side of the pier/tripod the telescope is on which is either west or east. Having this enabled will make the flip determination logic much more reliable and robust, as no assumptions about the pier state have to be made.
Strongly recommended to be turned on

Recenter after flip

- When enabled, N.I.N.A. will begin a plate solving sequence after flipping to recenter the target
Strongly recommended to be turned on. Requires a plate solver to be set up.

Scope Settle time

- After flipping the scope, waits for the specified number of seconds to settle the scope

  If you observe trailing in your first platesolve attempts after a flip, increase this value

Pause before meridian

- For some setups the equipment can touch the tripod or pier a while before passing the meridian. This setting enables the mount to disable tracking for the defined minutes prior to reaching meridian. Once this time and the defined minutes after meridian are passed, the flip will occur normally.
- **Only set a pause time, when your equipment cannot pass the meridian safely. If your equipment can safely track until the meridian flip time keep this setting at 0!**

Auto Focus after Flip

- Turns ON/OFF the AF routine after flipping.

  Useful for scopes with mirror flop or focus shift after Meridian Flip.

> ✎ **Note**
>
> In previous versions of N.I.N.A. a switch to enable meridian flip was located here. However this approach has been changed and the meridian flip needs to be enabled on sequence level. The legacy sequencer has a target set option to enable it and the advanced sequencer needs to have a meridian flip trigger added to the sequence

Rotate image after flip

- When enabling this option, the image inside the imaging tab will be automatically rotated by 180° after a meridian flip. This is for displaying purposes only and will not alter any raw image data.

IMAGE OPTIONS

Autostretch factor and Black Clipping

- These are the parameters for the display autostretch

  These values refer to the midtone transformation function. The standard values should already work for almost all cases

Annotate Images

- When this setting and HFR analysis in imaging is enabled, displayed images will exhibit annotated HFR values on detected stars

  Note that this is only for display in the imaging tab and has no effect on saved data

Debayer Image

- When a OSC camera is used, enabling this will debayer the images for display purposes only.

Debayered HFR

- If enabled, images will be debayered first before HFR analysis is done. In case you run into star detection problems with OSC camera and autofocus, enable this setting This setting is the memory and processing heavy and should not be activated for resource restricted machines

Unlinked Stretch

- When a OSC camera is used, debayering the image generates 3 channels R,G and B
- By default the autostretch in imaging is linked and may result in unbalanced colour channels

- Enabling this will enable debayer image, and should result in balanced colour channels when stretching This setting is the memory and processing heavy and should not be activated for resource restricted machines

Star Sensitivity

- This changes the sensitivity of star detection used for HFR analysis

  Only change this when the application doesn't properly recognize stars

Noise Reduction

- This changes the amount of noise reduction performed on the image for star detection and HFR analysis

  Only change this when the application doesn't properly recognize stars

SEQUENCE

Default folder for sequence files

- The user can set here the default folder for saving/loading sequences

Sequence Template Folder

- The user can set a default folder where sequence templates should be stored

Legacy Sequencer Template

- The user can set a default user defined legacy sequence template here. When a template is defined adding a new target to the legacy sequencer will use the template to prepopulate the values like centering, exposures etc.

  Templates can be made with the 'Save template as xml' button in the legacy sequence tab

Startup Sequence Template (Adv. Sequencer)

- A full saved advanced sequence that will pre-populate the advanced sequencer on application start. This is useful for startup and end instructions that you want to do each time in the same manner.

Sequencer Targets Folder (Adv. Sequencer)

- The user can set a default folder where advanced sequence targets should be stored

Collapse sequence templates by default (Adv. Sequencer)

- When enabled, templates that will be dragged into the sequencer will be collapsed by default

Disable Legacy Sequencer

- This will remove the legacy sequencer from the UI. Useful if you don't use the legacy sequencer at all and want to remove the then unnecessary decisions between the two sequencers.

> **Note**
>
> In previous versions of N.I.N.A. some options where available to run end of sequence options. These have been moved into the sequencer.

LAYOUT

Reset Layout

- This will reset the layout of docked windows in the imaging tab
- In case the button is greyed out, visit the imaging tab at least once for the layout to be initialized

Backup Layout

- Backup the current layout into a separate file. This file can then be loaded in again at a later time using the "Restore Layout" button
- In case the button is greyed out, visit the imaging tab at least once for the layout to be initialized
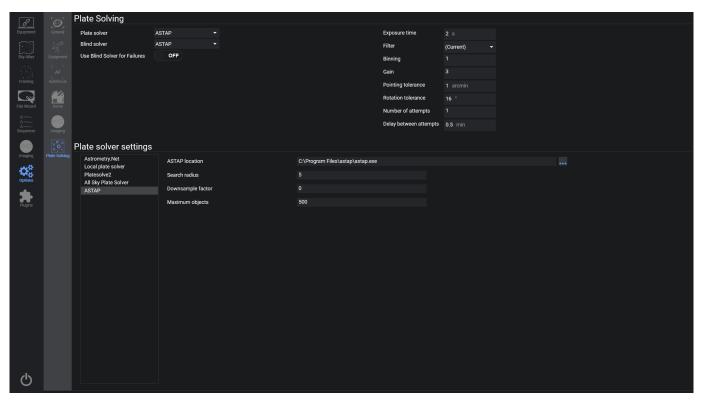
Restore Layout

• Restores the docked windows layout from a backed up file

Plate Solving

The Plate Solving tab contains configuration options for each supported plate solver. N.I.N.A. currently supports Astrometry.Net, a Local version of astrometry, Platesolve2, ASPS and ASTAP.

For usage of the Plate Solver refer to Advanced Topics: Plate Solving

PLATE SOLVING

Plate Solver

- This drop down menu selects the primary platesolver to use

  ASTAP is recommended

Blind Solver

- This drop down menu selects the blind solver that is used for initial solves and or backup solving

  The blind solver will be used in the framing assistant and normal platesolving should the primary solver fail.

Use Blind Solver For Failures

- When a plate solve fails a fallback to the blind solver is attempted. This behavior can be disabled, so that no fallback will be used. This can be useful when it is used in combination with a number of retries.

Exposure Time

- The default exposure time for plate solving frames

Filter

- The default filter to be used for platesolving

Binning

- The default binning to be used for platesolving

Gain

- The default binning to be used for platesolving

  If empty the current camera Gain will be used

Pointing Tolerance

- The threshold of acceptable error for re-centering in arcminutes

Rotation Tolerance

- The threshold of acceptable error in the rotation axis in degrees

Number of Attempts

- Defines the number of attempts for platesolving

  The value of 1 will not reattempt on a completely failed plate solve

Delay between attempts

- The delay between plate solving reattempts in minutes, when number of attempts are greater than 1

PLATE SOLVER SETTINGS

Plate Solver Settings Selection

- This menu displays the currently supported platesolvers in N.I.N.A.
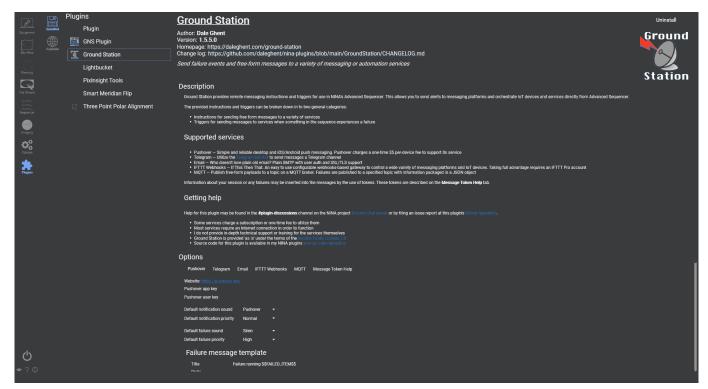- Clicking on each entry will display the corresponding solvers' settings to the right (10)

Platesolver Settings

- Each solver except Astrometry.net will require its install directory to be specified here

1.3.9 Plugins

Installed

In this screen you can manage all plugins that are installed on your machine. Each plugin shows its Information, Homepage, Author and a description on how to use it. Furthermore an optional Options area is available where you can customize general options available for this specific plugin

> **Important**
>
> Plugins are maintained by individual people that may or may not be related to the core N.I.N.A. contributors. When you are facing issues with a plugin, please reach out to the plugin maintainer. In case something is not working properly, try to run N.I.N.A. without plugins to make sure that no plugin is causing these issues.

Available

On the available plugins tab all plugins that have been pushed into the Plugin Manifest Repository will be displayed. (Requires Internet connection). For each plugin you will see detailed information about the author, the homepage, what the plugin is about and the source code location of it. Optionally some screenshots can be seen too.

Furthermore you can manage your plugins here by easily installing the plugins as well as updating those that have a new version.

- Installed plugins that can be updated to a newer version are listed at the top.

- Plugins that have been updated or installed will require the application to be restarted.

- For all available plugins that have neither been updated nor installed no icon is listed next to them. These can be installed by clicking on their list entry and hitting the install button on the top right

- Plugins that have already been installed and have no update available will be listed at the bottom

> **Important**
>
> Plugins are maintained by individual people that may or may not be related to the core N.I.N.A. contributors. When you are facing issues with a plugin, please reach out to the plugin maintainer. In case something is not working properly, try to run N.I.N.A. without plugins to make sure that no plugin is causing these issues.

1.4 Sequencer

1.4.1 Overview

N.I.N.A. offers a broad range of capabilities to automate your imaging run. To do so there are two different approaches available.

Approach 1

The Legacy Sequencer

This kind of sequencer is targeted for the more traditional approach like intervalometers with a restricted set of capabilities to offer automation for the most common types of equipment and workflows that will run for a specific number of images. While limited it offers a good starting point for beginners to set up a new sequence and get it running quickly.

Approach 2

The Advanced Sequencer

Due to the vast range of different equipment and use cases in the astrophotography area, the needs of the legacy sequencer couldn't serve the more specialized use cases. Adding more and more edge cases to the legacy sequencer was no option as that would clog up the user interface for the majority of users that won't even need these special features. Out of this need the advanced sequencer was born. This new approach offers a completely different way of setting up sequences on a fine granular level.

Instead of restricting the user to a specific workflow, the workflow itself can be customized to specialized requirements with simple building blocks that can be arranged together.

1.4.2 Legacy Sequencer

Overview

The legacy sequencer offers the traditional experience of planning complete sequences for the most common use cases. The capabilities range from cooled cameras, goto mounts, automated focusers, filter wheels and guiders. With this sequencer you can plan straight forward sequences with a set amount of exposures for specific filters and some basic added automation like centering of targets and keeping the objects in focus using auto focus.

For more advanced use cases refer to the advanced sequencer which offers a lot more planning granularity, capabilities and supports more types of equipment.

Sequence Target Set Options

In this section you can adjust which instructions should be considered for the complete set of targets.

When Cool Camera and Unpark Mount are enabled, these instructions will be executed before the first target.

The same applies to the Warm Camera and the Park Mount option, except that they will be run after the last target.

In additon to that there is the option to enable the auto meridian flip feature that will be enabled for the complete sequence run.

Sequence Target Tab List

Multiple sequences can be loaded into N.I.N.A., with each residing in its own tab at the top of the Sequence window. When

multiple sequences are opened, N.I.N.A. will run each sequence in order after the prior sequence is completed. This allows you to specify multiple targets to image over the course of a night, each with their own settings and behaviors.

1. **Target tabs**

• Clicking on a tab will switch to that target's sequence

• Sequence settings are specific to the target

• Hovering the cursor over a tab will reveal the Reset Progress and Delete buttons

2. **Prioritize target**
   Move the current target further to the left in the list of targets

3. **Deprioritize target**
   Move the current target further to the right in the list of targets

4. **Save target**
   Save the current target

5. **Add target**
   Add a new empty target

> **Tip**
>
> If a **Sequence Template** file is specified under **Options > Imaging > Sequence**, that template will be automatically loaded in the new tab.

Target General Options

1. **Delay start**
   Specifies a delay (in seconds) before the first operation when the sequence starts.

2. **Sequence Mode**
   Specify the preferred mode of sequence entry advancement.

• **One after another**: N.I.N.A. processes each sequence entry in full before advancing to the next sequence entry.

• **Loop**: N.I.N.A. takes a single exposure from the sequence entry and then advances to the next entry. The entire sequence will loop until all sequence entries are completed.
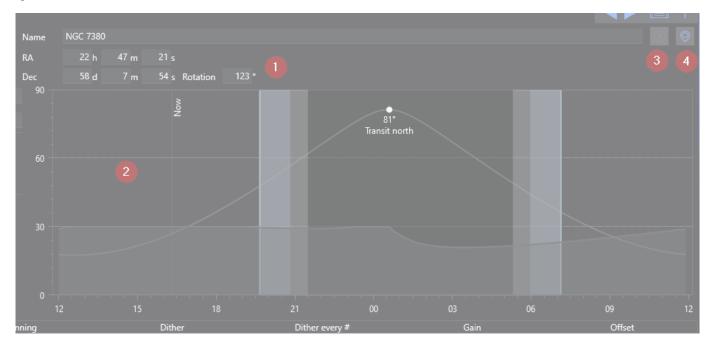
3. **Estimated Download Time**
   By default, the value here will be automatically populated with the average download time of a single image from the camera, as measured by N.I.N.A. If the user wishes, this value may be changed by editing it. This time specified here will effect the Estimated Finish Time.

4. **Estimated Finish Time and Estimates time for this target**
   Displays the time and duration (in the computer's configured time zone) that N.I.N.A. estimates the entire sequence/active sequence will complete. This estimation takes into account the number and length of the sequence/sequences exposures, as well as the time required to download each exposure from the camera (See Also: Estimated Download Time.)

Target Information

1. **Target coordinates**
   Displays the target name, right ascension, declination, and desired rotation angle. These may be edited as needed. The right ascension, declination, and rotation angle specified will be used to slew, center and rotate on target start (if enabled)

2. **Target altitude**
   Displays the target object's altitude, the direction point at which it will transit, the darkness phase of the current day, and includes a vertical marker for the current time. The accuracy of the altitude curve requires that the latitude and longitude be set under **Options > General > Astrometry**.

3. **Send to framing assistant**
   This button will send the current coordinates and rotation back to the framing assistant to re-plan the target

4. **Import from planetarium**
   Using this button, the application will import the selected coordinates and rotation from the planetarium that is set up

Target start options

1. **Slew to target**
   At the beginning of the sequence, N.I.N.A. will command the mount to slew to the coordinates that are specified in RA and Dec fields. This does not plate solve to verify it is on target.

2. **Center target**
   When set to on, N.I.N.A. will use the configured plate solver to ensure that the target is centered on the specified RA and Dec coordinates.

3. **Rotate Target**
   If a rotation angle is specified and a rotator is configured and connected (See Also: **Equipment > Rotator**), N.I.N.A. will rotate the camera to the desired angle. If the Manual Rotator is in use, the sequence will be paused and the user prompted to manually rotate the camera. The prompt will specify the necessary amount of degrees clockwise or anti-clockwise to rotate the camera, and N.I.N.A. will verify the rotation angle again until the angle is within the tolerances configured under **Options > Plate Solving > Rotation Tolerance**.
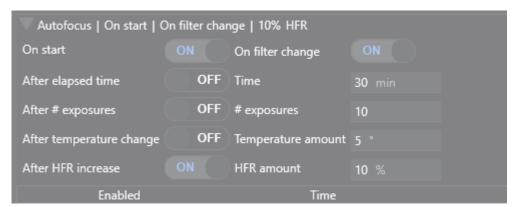
4. **Start Guiding**
   When Start Guiding is set to On, N.I.N.A. will command PHD2 to choose a guide star and begin guiding when the sequence starts. N.I.N.A must be connected to PHD2 (See Also: **Equipment > Guider**.)

> ✏️ **Note**
>
> Since sequences typically start with a slew and centering process, the guider will be stopped at the beginning of the sequence and only restarted if this option is set to On.

Auto Focus behavior

Due to the large number of auto focus options that can be configured in a sequence, they are grouped under an expandable menu. When the menu is not expanded, a summary of the activated options will be displayed. Expanding the menu by clicking on the arrow will reveal the auto focus settings and make them available for altering.

Many of the options are self-explanatory, however two in particular may require some clarification:

- **After temperature change**
  Triggers an auto focus operation if the temperature changes the specified amount since the previous auto focus operation. The temperature used is sourced from the focuser, if it provides it. This option does not yet use a Weather source if the focuser does not have a temperature reporting capability.

- **After HFR increase**
  If measured HFR from the previous exposures is more than the specified percent of the baseline, an auto focus operation will be triggered. The baseline HFR is determined from the first exposure after an auto focus operation.

Sequence entries

Sequence entries define the image acquisition order and behavior of N.I.N.A. Each sequence entry consists of up to 11 columns which determine how the images will be exposed:

- **Progress**: Displays the current progress of the sequence entry in terms of exposures completed out of the total number specified

- **Total #**: Specifies the number of frames to expose

- **Time**: Specifies the exposure time, in seconds

- **Type**: Specifies the type of the exposure and sequence entry. BIAS, DARK, LIGHT, FLAT.

- **Filter**: Specifies the filter to be used

- **Binning**: Specifies the camera binning level

- **Dither**: When enabled, N.I.N.A. will command a dither operation. To save time, dither operations are initiated while the preceding image is being downloaded from the camera

> 🔥 **Important**
>
> Dithering will work only when a guider is connected. See **Equipment > Guider**

- **Dither Every # Frame**: Initiates a dither operation after the specified number of frames are exposed
- **Gain**: Specifies the camera gain to use for the entry. This option is available only if camera is capable of setting exposure gain
- **Offset**: Specifies the camera offset to use for the entry. This option is available only if camera is capable of setting an exposure offset

Sequence Buttons

On the bottom left area the target specific buttons can be found. Explained from left to right:

1. Go back to the sequence dashboard
2. Adds a new row to the sequence (new rows will be defaulted to the previous one)
3. Deletes the active sequence entry
4. Resets the progress of the selected sequence entry to 0
5. Moves the selected entry up
6. Moves the selected entry down
7. Saves target to the previous location
8. Saves target as a XML file in the specifed folder
9. Loads a saved Sequence. The opened sequence's settings will overwrite all settings in the current sequence.

On the bottom right are the target set buttons.

1. **Build Sequence**

   Pressing this button will generate an advanced sequence and send it to the advanced sequencer. This will allow a much more granular adjustment of the sequence.

   > ✏️ **Note**
   >
   > Pressing the build sequence button after having changed something on the advanced sequencer will overwrite the whole advanced sequence that was already present in the advaanced sequencer tab!

2. **Start Sequence**

   Pressing the start button starts the sequence, either from the beginning or from where it was last stopped. Once a sequence is started. Cancel will abort any active operation (including any in-progress exposures) and stop the sequence.

Sequencing

SEQUENCE TEMPLATES

When creating a new sequence item via Framing or when just adding a new target from anywhere in the application the default values of a Sequence will most likely not be satisfactory for a user. Therefore N.I.N.A. offers the possibility to create a sequence template and set this template inside the settings.

Exporting a sequence Template

To create a sequence template you just need to setup a standard sequence to your liking. In the example below I have set up a sequence for broadband. Once all sequence settings are done, just click on the save button to store the sequence xml on your hard drive. Once a template is set, each new Sequence you create will be pre-populated with this template. As you currently can only have one template for one profile, you can have two copies of your profile with different templates and take one profile for narrowband and one for broadband as an example.
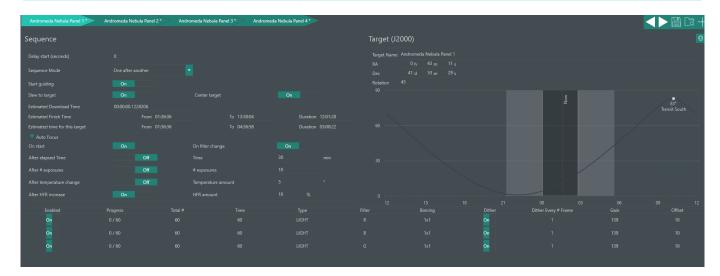

This exported sequence can then be set as a template inside **Options->Imaging->Sequence**
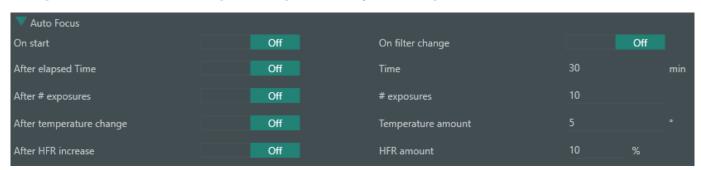
> **Tip**
>
> The best use for these templates are sequences created out of the Framing Assistant. For example when you have the broadband sequence set, that were mentioned earlier, you can just set up the mosaic, click "Replace Sequence" and the following sequence is created based on the template

SEQUENCE AUTO-FOCUS

When having a motorized focuser, the sequence offers a variety of options to ensure that the focus is as good as possible during the sequence run. Let's look into each option and explain their usage in more depth.
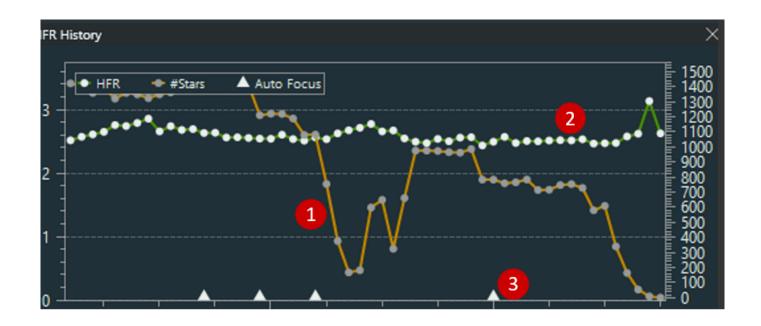

On start - This one is rather obvious. Most of the time you want to have this on in your first target to ensure that the initial focus position is good.

On filter change - This option is useful when you don't know or don't have your filter offsets set and your filters aren't parfocals and thus having a different focus position. This is a good option when you only have a few filter changes during the course of the night. Otherwise it is beneficial to measure and set filter offsets instead.

After elapsed time - Triggering an autofocus after an elapsed time is almost always just a guesstimate and should be avoided. A better metric is the option to focus after an HFR increase.

After temperature change - This will use the focuser temperature probe as reference and refocuses every time the temperature drifts by the specified amount in reference to the last initiated auto focus. When you know that your equipment will shift focus after a certain amount of temperature change, this is a good option.

After HFR increase - This method will only trigger when the measured HFR trend is going up by a certain percentage. Having just one sub with worse focus won't necessarily trigger this, as it could just be one sub with bad guiding or worse sky conditions. In general this is a good way to ensure best Auto Focus during the run and can be used almost always. A visual representation of the HFR history can be seen in the imaging tab which is used to determine the baseline.

1.4.3 Advanced Sequencer

Overview

The advanced sequencer makes it possible to completely plan and customize an imaging run based on specific needs for each user by giving the capability to plan on a very granular level. Equipment can be controlled step by step with various available instructions and each instruction can be further customized by specific parameters for each individual person.
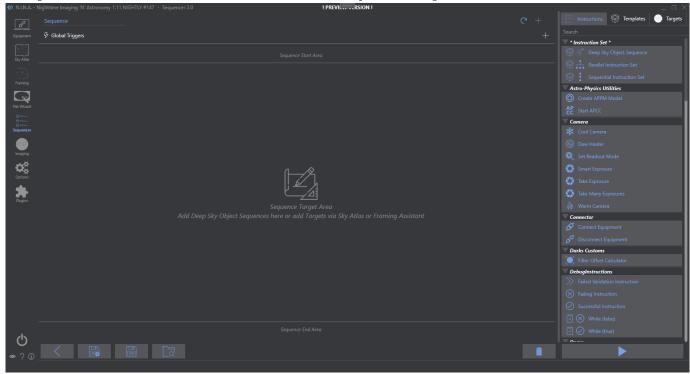
NAVIGATING

The main area will contain the actual instructions. There it is possible to add the instructions, customize the parameters and see the progress of the sequencer.
Additionally the area is split into three sections to manage sequence start instructions, target instructions and end of sequence instructions.
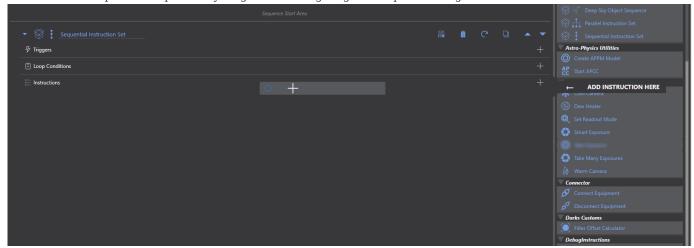
On the bottom left it is possible to save and load a complete sequence run while on the bottom right it is possible to start and stop a sequence.
The right sidebar will show all available instructions as well as templates and targets. These are described in more detail below.

Everything inside the advanced sequencer is enabled to use drag and drop. For example an instruction can be grabbed by holding the left mouse button and then dragged into the sequencer area to add an instruction at the mouse location.

However it is also possible to plan everything without using drag and drop at all using the available '+' buttons
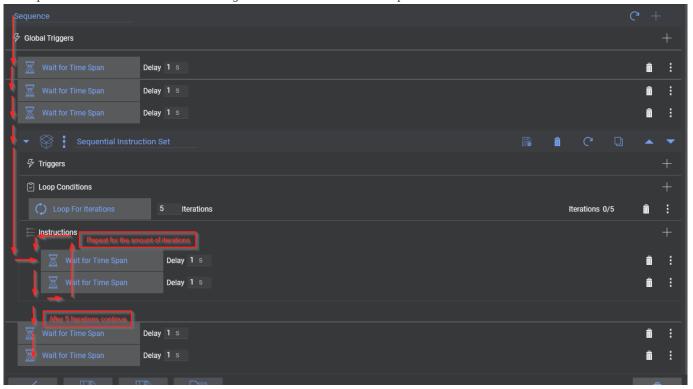

THE FLOW OF THE SEQUENCER

On a high level, the concept of the advanced sequencer is quite simple. A sequence will consist of small building blocks that will execute some logic and the sequencer will execute these blocks one by one from top to bottom.

In addition to single building blocks so called Instruction Sets can be added too. Think of these as a logical group of instructions. These groups will function in the same way as the whole sequencer, as they will execute the blocks that are part of the group from top to bottom.

The Instruction Sets can contain so called Loop Conditions which will change the flow of operation slightly, as the Instruction Set will repeat its set of instructions for as long as all condition that these loop conditions define are met.
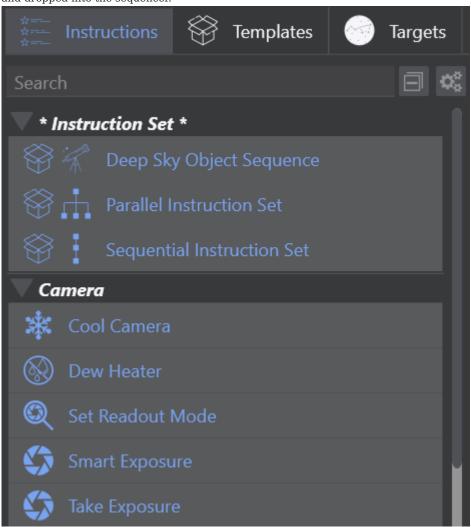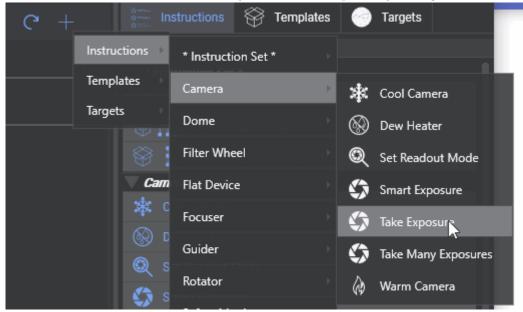

INSTRUCTIONS

An instruction is a single command that the sequencer will execute. Each instruction has a different purpose and can control various types of equipment, set parameters or are utility functions to automate the imaging process.

A complete list of available instructions can be found on the right side of the advanced sequencer and each instruction will have a small description as well as a tooltip of its purpose. The Instructions page will also describe each available instruction in detail. Instructions can be added to the sequencer and the specific parameters can be set there. The sequencer will then go through each instruction and process them. From the available list, instructions can be dragged over from the right side to the left side
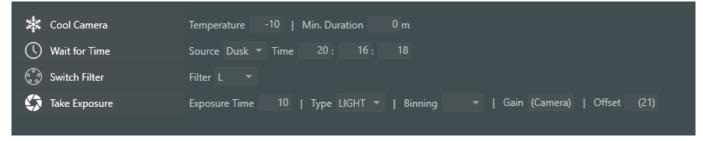
and dropped into the sequencer.

Furthermore instructions can also be directly added into the sequence by clicking on the + button on the top.
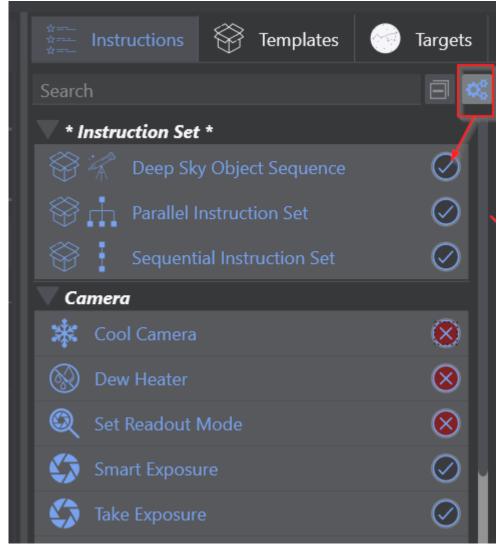
Once an instruction is part of the sequencer, it will show the specific options for each instruction to customize the behavior. For example an item can be set to cool down the camera to a specific temperature, another item set to switch to a specific filter etc.
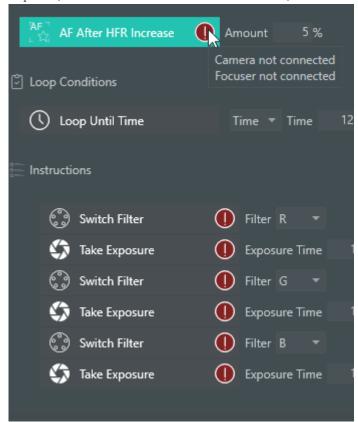

Customizing the list of instructions

With the gears icon in the sidebar a customizing mode can be enabled. In this mode you can flag each instruction to be hidden. When it is flagged the instruction will no longer be visible in the sidebar or in the contextmenus. This is useful if you don't have a specific type of equipment for example and don't want to see instructions for it cluttering your user interface. Instructions that are part of the sequence, but are hidden from the sidebar will still be visible and active in the sequence.

Validations

Each instruction is capable of doing some degree of validation and will check if the preconditions are met. A red exclamation mark will appear next to an instruction, when an issue is detected. Hover over the red indicator to get more details.
For example when a camera is connected without a cooling element, and a "Cool Camera" instruction is dragged into the

sequence, the instruction will show a visual indicator, as well as a tooltip showing that the camera is not capable of cooling.
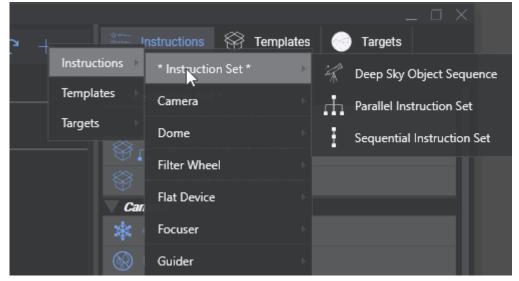

> ### Tip
>
> Instructions that report issues will always be skipped, indicate that there was an error and will not run at all!

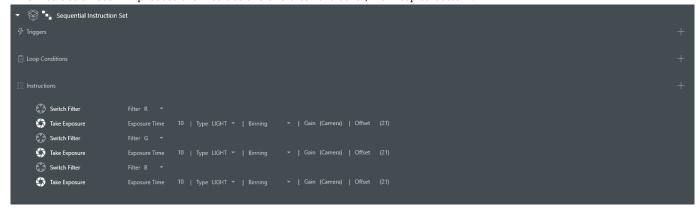INSTRUCTION SETS

Instruction sets are groups of instructions. Each set will process its content, based on the parameters inside the set. Their behavior can be further controlled by loop conditions and triggers, which are described further below. Instruction sets can be added to the sequencer in the same way as instructions. Furthermore it is possible to nest instruction sets inside of each other.

Sequential Instruction Set

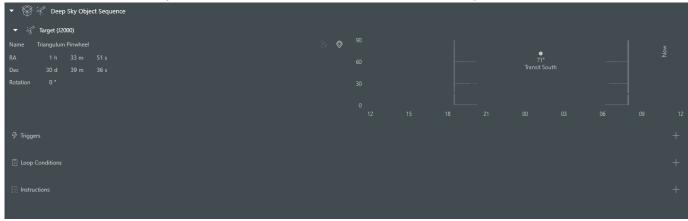This instruction set will process the instructions one after the other, from top to bottom.

Parallel Instruction Set

All instructions inside this special instruction set will be processed in parallel. As everything will run in parallel there are no conditions or triggers available for this set.

Deep Sky Object Set

This special set of instructions behaves similar to a sequential instruction set. The main difference here is, that a specific target can be specified with coordinates and rotation and then all instructions that are dependent on coordinates or rotation will pick up these coordinates automatically, so a user does not need to enter these coordinates multiple times.

LOOP CONDITIONS

Loop conditions will drive the behavior of an instruction set. Without a condition, an instruction set will just process each sequence item inside once and is finished. This behavior will be changed, when loop conditions are attached. When an instruction set has a loop condition attached, it will process its items and loop itself again as long as the attached loop conditions are fullfilled. Once at least one of these loop conditions is not fullfilled anymore (e.g. a condition to loop until a specific time and the time has passed) the current instruction will be finished and afterwards the rest of the instructions inside this set will be skipped as well as the instruction set marked as finished. Conditions will be evaluated after each instruction. These conditions can be dragged and dropped into the loop condition section inside an instruction set.
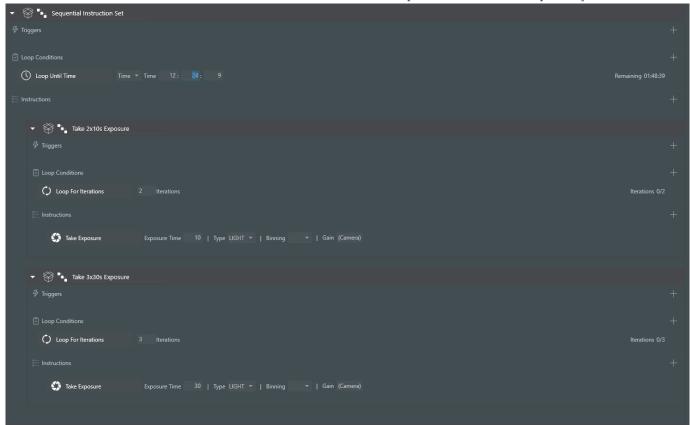
Loop conditions can also be directly attached to an instruction set by clicking the + icon next to the loop conditions section inside an instruction set.

As instruction sets can be nested, the loop conditions are also evaluated for the current instruction set and all loop conditions that are in a parent instruction set.

Let's take a look at the below example to give an example. The top level instruction set has a condition attached to loop until 12:24:09h. Then there are two further instruction sets inside that should loop 2 times and 3 times respectively.

The following will happen in this case:

- The first instruction set will loop 2 times. After each instruction the parent condition will be checked too, that the remaining time is still sufficient to continue.

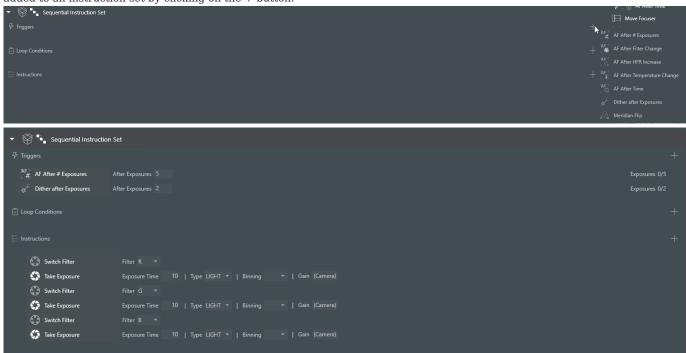- Afterwards the second instruction set will loop 3 times. After each instruction the parent condition will be checked too, that the
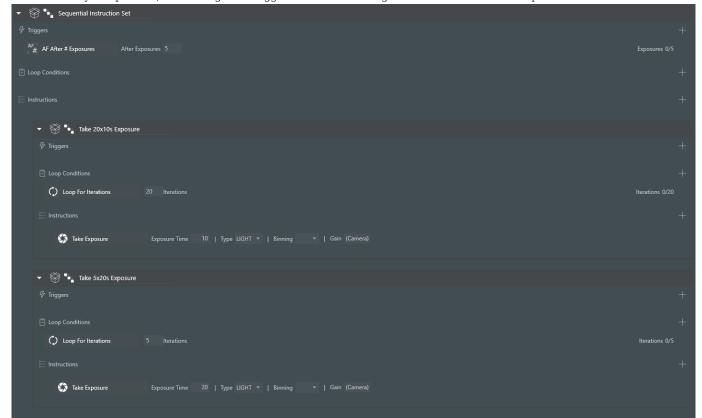
remaining time is still sufficient to continue.
- Once both instruction sets are finished, the whole set will be reset again, as the "Loop Until Time" condition is still valid
- This behavior will repeat until the Time is up. Once this happens all items inside this whole set will be skipped

TRIGGERS

Triggers are instructions that should only happen when certain events occur. These triggers can be attached to an instruction set. When attached, they will get evaluated after each instruction inside the set, similar like loop conditions are evaluated. When the defined event occurred for the trigger to fire, the trigger will execute its instruction. An example is to trigger something after a certain amount of exposures. The lightning icon next to an instruction on the right side will indicate that the instruction is in fact a trigger. These can only be dragged into the trigger section of an instruction set. Additionally a trigger can directly be added to an instruction set by clicking on the + button.

As triggers are evaluated in the same fashion as loop conditions, you can set triggers on a higher level and they get still evaluated when the current instruction that is executed is part of a nested instruction set. In the below example the trigger will

fire after every 5 exposures, even though the trigger is defined on a higher level than the actual exposure item.
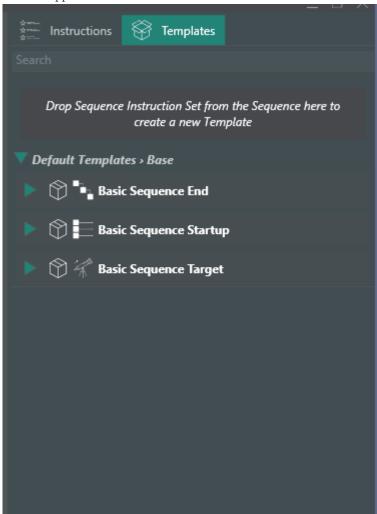
TEMPLATES

A template is a set of various customized instructions set up with predefined values to be re-used constantly. To be able to quickly set up a sequence for an imaging run, the templates will take a key part and enable the possibility to easily create specific types of sequences in a matter of no time.
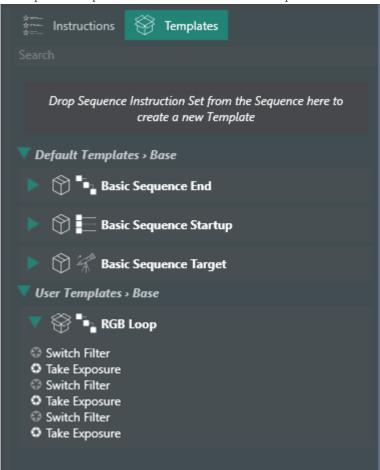
Each instruction set is capable of being templated. When a set is templated, all its content and the values set inside are saved and put into the template. When the template is then added to the sequence again, it will create a copy of it and create an instruction set that is exactly set up like the templated set.

The templates are located on the right sidebar when switching to the templates tab. A couple of basic templates are provided

with the application.
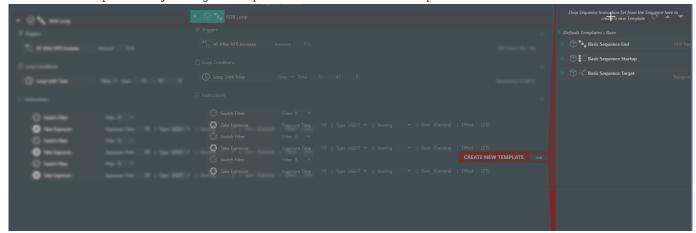
User specific templates are listed below the basic templates.

To create a user template an instruction needs to be added to the sequencer. Then the desired instructions, triggers and loop conditions should be added to the instruction set. Once the instruction set is set up with all desired parameters a click on the save button next to the instruction set will save it as a template. Then the name of the instruction set will be taken for the template name and a new template will be shown in the sidebar. When a name is already taken, the application will ask if the existing template should be overwritten.

Furthermore it is possbile to just drag and drop the instruction set into the template area to create a new one.
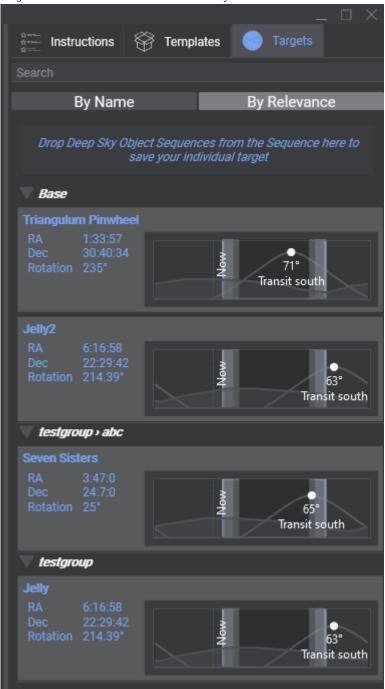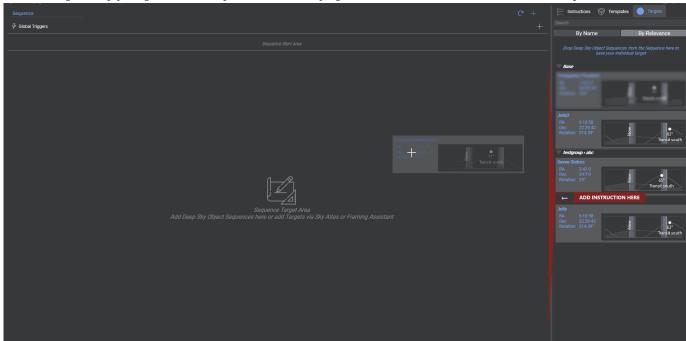
> **Tip**
>
> Templates using a Deep Sky Object Set will be available for selection in the sky atlas and framing assistant to be used to add targets to a sequence

TARGETS

The targets tab offers the ability to store targets for later use. They contain a deep sky object sequence and can be dragged and dropped into the sequencer just like templates. In contrast to templates, these deep sky object sequences will auto populate the
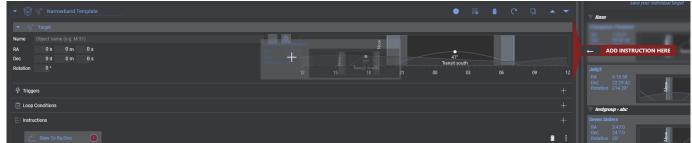
target coordiantes and rotation info as they were saved.

To use a target, simply drag it into the sequencer. Its underlying instructions will then be loaded into the sequencer.
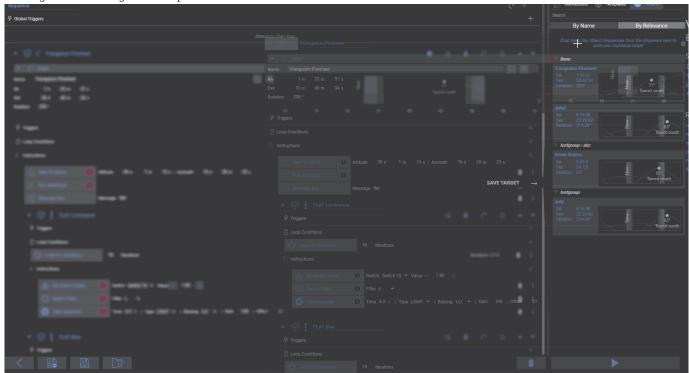
An alternative to just dragging them into the sequence, it is also possible to update an existing deep sky object sequence with a specific target by dragging the target from the target tab into the target area of the deep sky object sequence. Then only the target information of that set is updated.

To save a target in the target area, simply click the save target button in the header of the deep sky object sequence.

Or drag it into the target tab drop area.
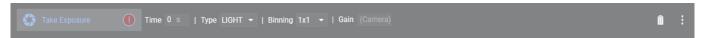
SHORTCUTS
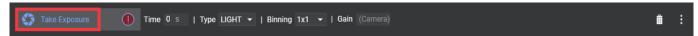
Key	Command	Note
Ctrl+S	Saves the current sequence	
Ctrl+Shift+S	Saves the current sequence to a new file	
Ctrl+O	Opens an existing sequence	
Alt	Duplicate the current instruction or instruction set	When in the process of dragging an instruction or instruction set to a new location

Instructions

GENERAL
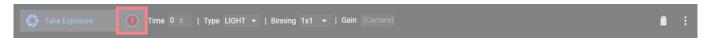
An instruction is a single command that the application will execute. Each instruction has a different purpose and can control various types of equipment, set parameters or are utility functions to automate the imaging process.

Each instruction can be identified by its name and its icon.
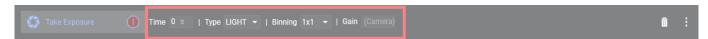
Validations

Instructions are capable of validating prerequisites and warn the user about potential issues. When a red exclamation mark is visible next to the instructions, not all prerequisites to run this instruction are met and when hovering over the red circle, the details which prerequisites are missing is shown.
Important: An instruction that does not meet its prerequisites will be skipped and the instruction is considered as failed.

Options
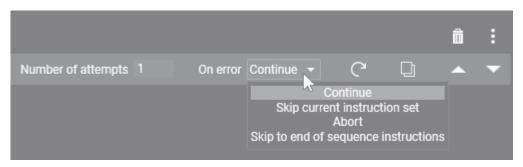
Most instructions also come with a variety of options to adjust their behavior at runtime. For example you can adjust the exposure times, gain and offset for an instruction that should take an exposure with your camera. Each instruction has a different set of options which are explained in more detail below.

Buttons

On the right side of the instructions are a bunch of buttons available to delete, copy, move or adjust advanced settings that exist for all instructions.

Advanced settings

When clicking on the three dots on the right side of an instruction, an advanced section will appear where advanced settings for an instruction are revealed.

Number of attempts
This drives how many reattempts an instruction should make in case of failure

On error
When all attempts have been unsuccessful this setting will drive how to continue with the sequence.
- Continue: The sequencer will just continue with the next instruction
- Skip current instruction set: The currently running instruction set will be skipped

- Abort: The sequence will be completely stopped
- Skip to end of sequence instructions: Skip any remaining instructions from the start and target area and continue with the instructions in the sequence end area

Reset
This button will reset the state of the instruction, like progress exposures etc.

Copy
Create an exact copy of the current instruction set and add it below the current instruction

Move up
Moves the instruction one row above. If it is already the first instruction of an instruction set, it will move to the parent instruction set above the current instruction set instead. If the previous instruction is an instruction set that is not collapsed, the instruction will move to the bottom of that instruction set

Move down
Moves the instruction one row below. If it is already the last instruction of an instruction set, it will move to the parent instruction set below the current instruction set instead. If the next instruction is an instruction set that is not collapsed, the instruction will move to the top of that instruction set

CAMERA

Control basic functions of a Camera. Each instruction in this category requires at least a Camera to be connected.

Cool Camera

Cool your camera to the specified temperature and the specified minimum duration. For most cameras the duration can be left at 0 as the driver will handle the cooling duration. Once the camera has reached the specified temperature the instruction is completed.
Requires a camera that is capable of set point cooling

Warm Camera

Warm your camera to ambient temperature using the specified minimum duration. For most cameras the duration can be left at 0 as the driver will handle the cooling duration. Once the camera has reached the ambient temperature the cooler is turned off and the instruction is completed.
Requires a camera that is capable of set point cooling

Dew Heater

This instruction will turn on or turn off the camera dew heater
Requires a camera that has a controllable dew heater

Set Readout Mode

Set your camera to a specific readout mode. The number indicates the index of the readout mode from the camera dropdown - starting with 0.
Requires a camera with settable readout modes

Take Exposure

Take Exposure — Time 180 s | Type LIGHT ▾ | Binning 1x1 ▾ | Gain (50) | Offset (255)

This instruction will take an exposure using the specified exposure time, binning, gain and offset.

Take Many Exposures

Take Many Exposures — # 2 | Time 180 s | Type LIGHT ▾ | Binning 1x1 ▾ | Gain (50) | Offset (255)

Similar to the "Take Exposure" instruction, but with the added ability to specify a number of exposures to complete before proceeding.

Take Subfame Exposure

Take Subframe Exposure — Time 30 s | Type LIGHT ▾ | Binning 1x1 ▾ | Gain (100) | ROI 50 %

Similar to the "Take Exposure" instruction, but with the added ability to specify a subframe percentage relative to the center.

Smart Exposure

Smart Exposure — # 2 | Time 180 s | Type LIGHT ▾ | Binning 1x1 ▾ | Gain (50) | Offset (255) | Filter (Current) ▾ | Dither every # 1

Similar to the "Take Many Exposure" instruction, but with the added ability to also specify a specific filter and to dither after a specific amount of exposures.
Keep dither after exposures to 0, to skip the dither completely.
Requires a connected filter wheel to switch filters and a connected guider to dither

> 🔭 **Note**
>
> A fun fact - the "Take Many Exposures" and "Smart Exposures" are actually instruction sets with static content that is just displayed like a normal instruction and is bundling together most common imaging operations for convenience

DOME

Control basic functions of a Dome. Each instruction in this category requires at least a Dome to be connected.

Close Dome Shutter

Close Dome Shutter

Closes the dome shutter
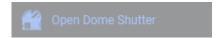Requires a controllable dome shutter

Enable Dome Sync

Enable dome sync

Enables the automatic background synchronization of the telescope and the dome
Requires a telescope to be connected

Disable Dome Sync

Disable Dome Sync

Disables the automatic background synchronization of the telescope and the dome
Requires a telescope to be connected

Open Dome Shutter

Opens the dome shutter
Requires a controllable dome shutter

Park Dome

Parks the dome to its specified home positon
Requires a dome driver that is capable of parking

Slew Dome Azimuth

Slews the dome to a specific azimuth position
Requires a dome driver that is capable of setting azimuth

Synchronize Dome

Synchronizes the dome to the current telescope position

FILTER WHEEL

Control basic functions of a Filter Wheel. Each instruction in this category requires at least a Filter Wheel to be connected.

Switch Filter

Switches the filter wheel filter to the specified filter. Like all filter wheel changes the focuser offset will be applied, when available.

FLAT PANEL

Control basic functions of a Flat Panel. Each instruction in this category requires at least a Flat Panel to be connected.

Close Flat Panel Cover

Closes the flat panel
Requires a flat panel that can open and close itself

Open Flat Panel Cover

Opens the flat panel
Requires a flat panel that can open and close itself

Set Brightness

Sets the brightness of the panel to the specified value. (Does not turn on the panel automatically).

Toggle Light

Turns the flat panel light on or off depending on the setting

Trained Flat Exposure

This instruction will look up the trained flat exposures according to the specified filter, exposure time, gain and offset, close the flat panel (if available), set the flat panel brightness, turn it on, take the flat frames for the given amount, turns off the flat panel and finally opens the cover again (if available and if "keep closed" is off)

Requires a camera to be connected and trained flat values being set in the flat panel tab that match the values in the instruction

Trained Dark Flat Exposure

This instruction will look up the trained flat exposures according to the specified filter, exposure time, gain and offset, close the flat panel (if available), turn it off, take the dark flat frames for the given amound and finally opens the cover again (if available and if "keep closed" is off)

Requires a camera to be connected and trained flat values being set in the flat panel tab that match the values in the instruction

FOCUSER

Control basic functions of a Focuser. Each instruction in this category requires at least a Focuser to be connected.

Move Focuser

Moves the focuser to the specified absolute position

Move Focuser By Temp.

Moves the focuser to a position that is based on the temperature reported by the focuser. This can be used to "follow" the point of best focus in its temperature dependency.

The dependency is modeled with a simple linear model. This can work in two ways:

- Absolute mode: New focus position = Slope * Current Temperature + Intercept
- Relative mode: New focus position = Current focus position + Slope * (Current Temperature - Temperature at last focuser movement)

When used in relative mode, if the focus position change is less than one step, the focuser doesn't actually move, but the fractional part is carried over for the next time the Move Focuser By Temp. element is executed, so that even very gradual temperature shifts are not lost due to rounding errors.

Requires a focuser with a temperature probe

> **Note**
>
> To determine the slope and intercept, you can use the history of your autofocus runs and run a linear regression on these best focus points. The intercept will be the the cross of the y-axis at 0°C and the slope will be the temperature gradient.
> For the best fit try to only use autofocus points from a single session and make sure the telescope is cooled down fully. The plugin `Autofocus Report Analysis` can help you in determining these parameters, but be careful to have good data points with a good fit, otherwise these values will be error prone.

Move Focuser Relative

Moves the focuser to a target position based on the current position and a specified amount from that position

Run Autofocus

Starts an autofocus run based on the autofocus settings

GUIDER

Control basic functions of a Guider. Each instruction in this category requires at least a Guider to be connected.

Dither

Issues the guider to dither

Start Guiding

Starts guiding if not already started. In addition a toggle to force the calibration can be enabled. Then the guider will be forced to run a calibartion, even if a valid calibration is already available. When this toggle is off, the guider will determine by itself if calibration is necessary.

Stop Guiding

Stops active guiding when guiding is active.

ROTATOR
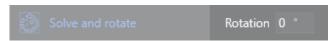
Control basic functions of a Rotator. Each instruction in this category requires at least a Rotator to be connected.

Rotate By Mechanical Angle

Rotates the rotator to the specified mechanical absolute angle

Solve and Rotate

Takes an image from the current position the telescope is pointing at, platesolves it and moves the rotator to the specified sky angle. It will repeat until the rotator is within the rotation tolerance.
This instruction will not move the mount, it will just sync and move the rotator to the target sky angle!

SAFETY MONITOR

Control basic functions of a safety monitor. Each instruction in this category requires at least a safety monitor to be connected.

Wait Until Safe

Waits until the safety monitor is reporting safe conditions again

SWITCH

Control basic functions of a Switch. Each instruction in this category requires at least a Switch to be connected.

Set Switch Value

Sets a switch to a specified value. When no switch is connected, a list of generic switches by number are available. The list will update itself to the actual switches on device connection. When a specified switch value is out of range, the instruction will show a validation error.

TELESCOPE

Control basic functions of a Telescope. Each instruction in this category requires at least a Telescope to be connected.

Find Home

Move the mount to the home position.
Requires a mount driver that is capable of finding the home position

Park Scope

Moves the mount to the park position. A mount that is parked, will not accept slew commands. Requires a mount driver that is capable of parking

Set Tracking

Enables mount tracking to the specified tracking rate.

Slew And Center

Stops Guiding (if it was active), slews to the specified coordinates, calls the platesolver to center to the specified coordinates and resumes guiding (if it was stopped at the start).
When this instruction is part of a "Deep Sky Object Sequence" the coordinates will be inherited and no coordinates need to be entered here
Requires a plate solver to be set up

Slew To Alt/Az

Slews to the specified coordinates.

Slew To Ra/Dec

Stops Guiding (if it was active), slews to the specified coordinates and resumes guiding (if it was stopped at the start).
When this instruction is part of a "Deep Sky Object Sequence" the coordinates will be inherited and no coordinates need to be entered here

Slew, Center And Rotate

Stops Guiding (if it was active), slews to the specified coordinates, calls the platesolver to center to the specified coordinates as well as considering the rotation together with a rotator and resumes guiding (if it was stopped at the start).
When this instruction is part of a "Deep Sky Object Sequence" the coordinates will be inherited and no coordinates need to be entered here
Requires a plate solver to be set up and a rotator to be connected

Solve And Sync

Uses the current mount position to solve the position and sync it based on the plate solver result. **This instruction will not center the mount, it will just sync the mount to where it is currently pointing at!**
Requires a plate solver to be set up

Unpark Scope

Unparks the mount so it is able to receive slew commands.
Requires a mount driver that is capable of parking

UTILITY

The instructions in this category are utility commands that don't necessarily depend on any equipment and have useful tools and helpers to improve the sequence

Annotation

This instruction will not execute anything. It is purely there to have custom text annotations inside the sequence to remind you of things, or taking notes to clarify certain sequence arrangements etc.

External Script

An instruction to start a custom executable file from your file system. Click on the three dots to browse through the file explorer and set a file path.

Message Box

When this instruction is starting it will spawn a message box and pauses the sequence until the user action to confirm the box is taken. The box can be used for example to stop the sequence and notify you to put a cover on to take flats etc.

Wait For Altitude

For the given target coordinates, this instruction will simply wait until the altitude has been reached. When this instruction is part of a "Deep Sky Object Sequence" the coordinates will be inherited and no coordinates need to be entered here

Wait For Time

Wait until a specific point in time. The time can either be set manually or automatically determined based on criteria as well as an offset specified in minutes.

Time: Manually entered time
Sunset: The time when the sun gets below 6° of the horizon
Nautical Dusk: The time when the sun gets below 12° of the horizon
Astronomical Dusk: The time when the sun gets below 18° of the horizon
Astronomical Dawn: The time when the sun gets above 18° of the horizon
Nautical Dawn: The time when the sun gets above 12° of the horizon
Sunrise: The time when the sun gets above 6° of the horizon
Meridian: When a target is set this will be the time the target will cross the meridian

> 📝 **Note**
>
> **When using a manual time:**
> As there is no day attached to the instruction, the roll over for a new day happens at noon (similar to the altitude charts). This brings a few advantages to not wait unexpectedly when you are already past the specified time. Examples:
> Current time: 18:00h | Wait for time: 19:00h -> Wait for one hour
> Current time: 20:00h | Wait for time: 19:00h -> Instruction will be skipped
> Current time: 18:00h | Wait for time: 02:00h -> Wait for eight hours
> Current time: 02:00h | Wait for time: 03:00h -> Wait for one hour
> Current time: 04:00h | Wait for time: 03:00h -> Instruction will be skipped
> Current time: 08:00h | Wait for time: 18:00h -> **Instruction will be skipped** because the roll over at noon has not happened yet
>
> **When using calculated times for dawn and dusk:**
> Instead of using noon to roll over to the next day the rollover will instead happen at the "opposite" side of the instruction. For example when you wait until dusk, the roll over will be at sunrise

Wait For Time Span

Wait for a specific period of time.
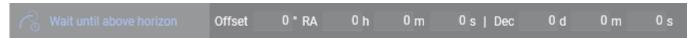
Wait If Moon Altitude

Waits for as long as the moon matches the specified parameters.

Wait If Sun Altitude

Waits for as long as the sun matches the specified parameters.

Wait Until Above Horizon

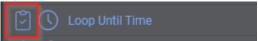This will wait for as long as the specified target is below the horizon. When a custom horizon is set, the custom horizon will be considered as the altitude to be above of. When no custom horizon is set, 0° of altitude will be considered. Furthermore an altitude offset can be specified.
When this instruction is part of a "Deep Sky Object Sequence" the coordinates will be inherited and no coordinates need to be entered here

Loop Conditions

Loop conditions will drive the behavior of an instruction set. Without a condition, an instruction set will just process each sequence item inside once and is finished. This behavior will be changed, when loop conditions are attached. When an instruction set has a loop condition attached, it will process its items and loop itself again as long as the attached loop conditions are fullfilled. Once at least one of these loop conditions is not fullfilled anymore (e.g. a condition to loop until a specific time and the time has passed) the current instruction will be finished and afterwards the rest of the instructions inside this set will be skipped as well as the instruction set marked as finished. Conditions will be evaluated after each instruction.

Conditions can be identified by the highlighted icon next to them in the sequencer sidebar.
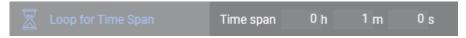

Loop For Iterations

Loop the instruction set for the specified amount of iterations.

Loop For Time Span

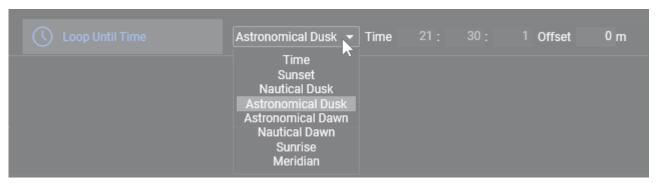Loop the instruction set for the specified amount of seconds.

Loop Until Altitude Sets Below

For a given target coordinates the condition will loop until the altitude sets below the specified amount. When this condition is part of a "Deep Sky Object Sequence" the coordinates will be inherited by this set and no coordinates need to be entered

Loop Until Time

Loop an instruction set until a specific point in time. The time can either be set manually or automatically determined based on criteria and an offset specified in minutes.

Time: Manually entered time

Sunset: The time when the sun gets below 6° of the horizon

Nautical Dusk: The time when the sun gets below 12° of the horizon

Astronomical Dusk: The time when the sun gets below 18° of the horizon

Astronomical Dawn: The time when the sun gets above 18° of the horizon

Nautical Dawn: The time when the sun gets above 12° of the horizon

Sunrise: The time when the sun gets above 6° of the horizon

Meridian: When a target is set this will be the time the target will cross the meridian

> 📝 **Note**
>
> **When using a manual time:**
> As there is no day attached to the condition, the roll over for a new day happens at noon (similar to the altitude charts). This brings a few advantages to not loop unexpectedly when you are already past the specified time.
> Examples:
> Current time: 18:00h | Loop until time: 19:00h -> Loop for one hour
> Current time: 20:00h | Loop until time: 19:00h -> Condition will be skipped
> Current time: 18:00h | Loop until time: 02:00h -> Loop for eight hours
> Current time: 02:00h | Loop until time: 03:00h -> Loop for one hour
> Current time: 04:00h | Loop until time: 03:00h -> Condition will be skipped
> Current time: 08:00h | Loop until time: 18:00h -> **Condition will be skipped** because the roll over at noon has not happened yet
>
> **When using calculated times for dawn and dusk:**
> Instead of using noon to roll over to the next day the rollover will instead happen at the "opposite" side of the condition. For example when you loop until dawn, the roll over will be at sunset

Loop While Altitude Above Horizon

| Loop While Altitude Above Horizon | Offset | 0 ° RA | 0 h | 0 m | 0 s | Dec | 0 d | 0 m | 0 s |

This will loop the instruction set for as long as the specified target is above the horizon. When a custom horizon is set, the custom horizon will be considered as the altitude to be above of. When no custom horizon is set, 0° of altitude will be considered. Furthermore an altitude offset can be specified.
When this condition is part of a "Deep Sky Object Sequence" the coordinates will be inherited by this set and no coordinates need to be entered

| Loop While Altitude Above Horizon | Offset | 0 ° |

Loop While Safe

| Loop while safe |

Loop for as long as the safety monitor is reporting safe conditions. When the state of the safety monitor switches to unsafe, the currently running instruction will be cancelled and the rest of the instruction set will be skipped.
It is recommended to use this condition in conjunction with another condition, to not run in an endless loop when the safety monitor is reporting safe conditions for the whole time.
Requires a safety monitor device to be connected

Loop While Unsafe

| Loop while unsafe |

Loop for as long as the safety monitor is reporting unsafe conditions. When the state of the safety monitor switches to safe, the currently running instruction will be cancelled and the rest of the instruction set will be skipped.
It is recommended to use this condition in conjunction with another condition, to not run in an endless loop when the safety monitor is reporting unsafe conditions for the whole time.
Requires a safety monitor device to be connected

Moon Altitude

| Moon Altitude | Loop until: Altitude | > | 0 ° |

Loop for as long as the moon matches the specified parameters.

Moon Illumination

Loop for as long as the sun matches the specified parameters.

Sun Altitude

Loop while the sun altitude is above or below the specified amount of degrees

Triggers

Triggers are instructions that should only happen when certain events occur. These triggers can be attached to an instruction set. When attached, they will get evaluated after each instruction inside the set, similar like loop conditions are evaluated. When the defined event occurred for the trigger to fire, the trigger will execute its instruction. After the trigger has finished its execution, the sequence will continue where it left off.

Triggers can be identified by the highlighted lightning icon next to them in the sequencer sidebar.

DOME

Trigger actions for a dome. Each trigger in this category requires at least a dome to be connected.

Synchronize Dome

N.I.N.A. has the capability to automatically synchronize the dome with the telescope pointing direction. However in some scenarios, for example with a heavy dome, the vibrations of movement can affect imaging quality. Therefore this trigger exists to only synchronize the dome in between instructions, instead of having it constantly adjusted. This will also prevent dome movement during exposures.

Requires dome following to be disabled

FOCUSER

Trigger actions for a focuser. Each trigger in this category requires at least a focuser to be connected.

AF After # Exposures

A trigger to simply run an autofocus after a set amount of exposures. As the amount of exposures is an arbitrary metric, this trigger is not recommended.

AF After Filter Change

When the filter wheel changes its filters and no filter offsets have been calcualted to automatically adjust the focuser position for the change of focus due to the filter shift, this trigger can help to mitigate the problem by running an auto focus run when a filter changes during imaging.

AF After HFR Increase

This trigger will monitor the history of images done during the sequence. It will take all exposures up until the last autofocus (or all if no autofocus has happened yet) and filter them for the currently active filter. The first point after the autofocus will be taken as reference point as well as the last n points, where n is the specified sample size. Out of the last n points the trend will be determined and compared to the reference point. If the trend is above the specified amount of percentage an autofocus will be triggerd.

This is a decent generic trigger if you don't know about the temperature sensitivity of your equipment, but it requires that your autofocus results are consistent and that the seeing is not bad.

AF After Temperature Change

When the temperature rises or falls most equipment will slightly shift its focus. When you roughly know at which temperature your equipment shifts focus enough to be out of the critical focus zone, this trigger can help you to automatically run the autofocus run when a specifed amount of temperature drift has happened. Requires a focuser with a temperature probe
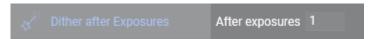
AF After Time

A trigger to simply run an autofocus after a set amount of time. As the amount of time is an arbitrary metric, this trigger is not recommended.

GUIDER

Trigger actions for a guider. Each trigger in this category requires at least a guider to be connected.

Dither After Exposures

Using this trigger will initiate a dither operation after the set amount of exposures. For more information about dithering, visit the dedicated page about it.

Restore Guiding

This trigger will start guiding each time after an instruction inside its context. When guiding is already started, no action will be taken. Using this trigger makes sure that the guiding software reacquires a guide star after some failures, like clouds.
This trigger is best used in combination with the "Center After Drift" trigger to guard against interruption from clouds and thus drifting off target.

TELESCOPE

Trigger actions for a telescope. Each trigger in this category requires at least a telescope to be connected.

Center After Drift

After the set amount of exposures, this trigger will plate solve the saved image in the background. When the distance of the solved coordinates are above the specified amount of arcminutes compared to the current target coordinates, this trigger will initiate a recenter operation.
Requires a plate solver to be set up and the trigger needs to be inside a deep sky object sequence to have a target reference
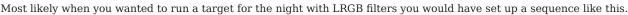
Meridian Flip

When the telescope passes the meridian according to the meridian flip settings in the options, this trigger will initiate the meridian flip.
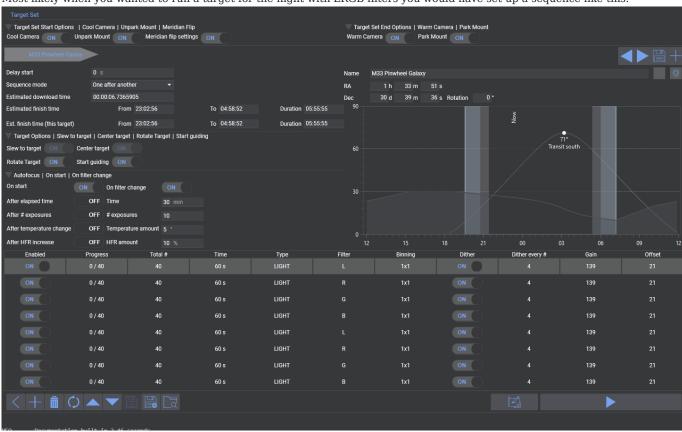More information on the settings and how the flip works is available on the meridian flip page

From Legacy To Advanced

This page is intended to give some hints in how to transition from the legacy sequence to the advanced sequence as well as optimizing the imaging run using the capabilities of the advanced sequencer.
In this section we will cover a single target for the night and we will utilize the capabilities of a camera, a goto mount, a filter wheel and a focuser.

Most likely when you wanted to run a target for the night with LRGB filters you would have set up a sequence like this.
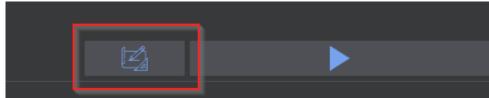

The goal here is to get exposures of each filter for having usable color data and to autofocus after the filter change when the batch of exposures is completed. Furthermore the number of exposures are added based on the estimated duration to fully fill the night. This approach however has some downsides, which we want to fix utilizing the advanced sequencer step by step. (For simplicity the AF after HFR or other conditions is ignored, as this is dependent on the current night's conditions and not a problem of the general setup)

• Problem 1: Repeating yourself - The rows 5-9 repeat the same thing that row 1-4 have already defined

• Problem 2: The estimation could be off - most likely it will take longer - so you will end up with uneven amount of exposures as the last exposures will be unusable. Additionally you have to fiddle around with the amount of exposures to fill the night.

• Problem 3: Clouds could roll in or sky conditions could worsen, resulting in further subs to be bad and having an uneven amount of good exposures

• Problem 4: Autofocus runs are required when changing to the next filter, taking up some imaging time (7x after the initial one)

• Problem 5: Dithering will be necessary and in this example we have chosen to dither after 4 exposures. Dithering takes up quite a bit of imaging time. For this example run it will take 80 Dithers. (When we estimate about 20 seconds per dither, this will already take up almost half an hour of image time)

TRANSFORMING TO AN ADVANCED SEQUENCE

To get rolling with the advanced sequencer, there is a tool button on the bottom right to easily generate an advanced sequence

out of the legacy sequence.

> ✏️ **Note**
>
> **Did you know?** The legacy sequencer is actually running an advanced sequence behind the scenes. The User Interface is just
> wrapped around to give the traditional experience of the legacy sequence. This will ensure that the effort to maintain the code for
> the sequencer is not doubled and that everything is working the same way. This approach also makes it possible to keep the legacy
> sequencer alive.

Let's break apart how the sequence will look compared to the advanced sequence. Remember that on a high level the advanced
sequencer will run the instructions from top to bottom.

Target Set Start Options -> Start Area

The legacy sequence had toggles set to on for Cool Camera, Unpark Mount and to perform Meridian Flips. These options will be
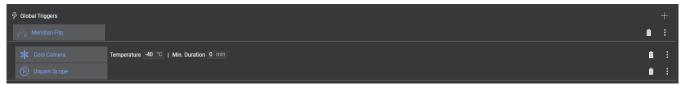put into the topmost section of the advanced sequence.

- Meridian Flip: This options is basically a trigger. As the meridian flip is always relevant it is put into the Global Trigger section.
  This means that the trigger will watch for the whole sequence run if a meridian flip should be performed or not.

- Cool Camera and Unpark Mount are put into the start area on the top of the sequencer. These will be executed as the first
  action.

Target Set End Options -> End Area

Just like the start options, the end options will be put into the bottom most part of the sequencer. For the end options the legacy
sequence had Warm Camera as well as Park Mount enabled.

- Warm Camera and Park Mount will just be put into the bottom. Also these operations can run in parallel, that's why these are
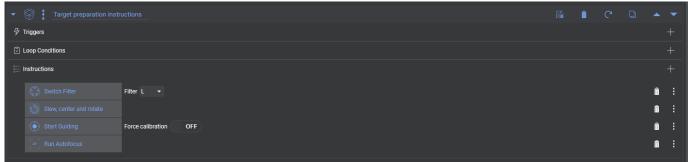 inside a Parallel Instruction Set.

Target -> Target Area

What's left now is in the middle section of the sequencer. This area is reserved for all the targets that you want to image. A deep
sky object sequence per target will be generated here containing all imaging instructions as well as instructions to prepare the
target, e.g. centering the target, starting guiding and running an initial autofocus. To show a high level view of the target, the
next screenshot shows the internal instructions collapsed for a better overview. Simply said, a target has a similar structure like

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the outer seqeunce, as it has start instructions, imaging instructions and end instructions.
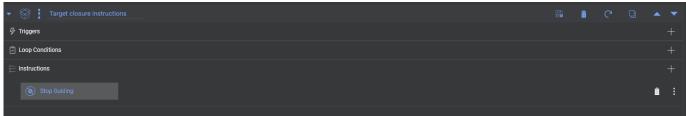

Target Options -> Target preparation instructions

When starting the target, the target options from the legacy sequencer are put into this Target preparation instructions area. In the simple seuquencer it was enabled to slew, center & rotate, to start guiding and to start autofocus on start. The first imaging instruction was set to the L filter, so the start needs to switch to that filter too. These options are directly translated into the preparation block.

Target closure instructions

This one is an implicit instruction from the legacy sequencer, as there was no toggle to do it there and it will only contain the Stop Guiding instruction. The reason is that when a target is finished, that guiding is no longer necessary as you will most likely park the mount or slew to a different target. It will just be added at the closure of the target to be safe.
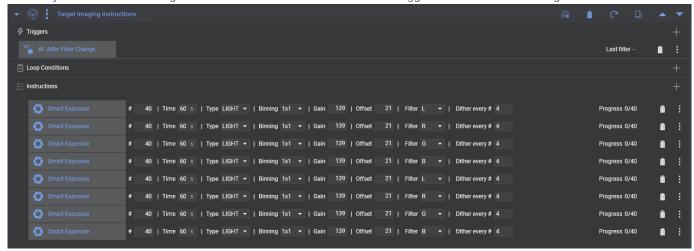

Exposure Rows -> Target imaging instructions

Now let's finally look into the important part which is the actual gathering of light frames. Each row of the legacy sequencer will be directly translated to an instruction that is called Smart Exposure. This instruction should look quite familiar to you, as it contains all the same information as the rows of the legacy sequencer.
One additional option that was enabled in the legacy sequencer, was to make sure that an autofocus run is triggered when the filter changes. This is directly added to this imaging set in the form of a trigger in the Triggers section and it is also called the

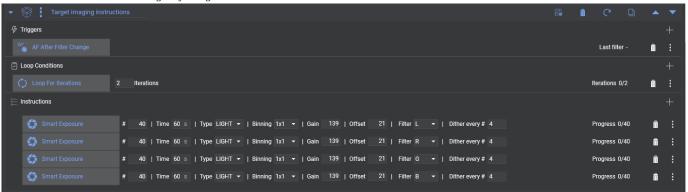same way AF After Filter Change and will make sure that an autofocus is triggered when the filter changes.

Hopefully this explanation gives you a good overview about how an advanced sequencer will look like and how it will operate when directly compared to a legacy sequence screen. The user interface looks quite different, but it should be much clearer about what will happen and when it will happen, as it will explicitly show all the individual steps.

So why bother with the advanced sequencer? Well, now that we understand the basics, we can tackle the problems that were mentioned earlier.

PROBLEM 1 - STOP REPEATING YOURSELF

The advanced sequencer can utilize Loop Conditions to repeat sequence blocks. These loop conditions have, as their name suggest, certain conditions that should be fullfilled and for as long as these conditions are fullfilled they will loop the instruction set they are placed inside.
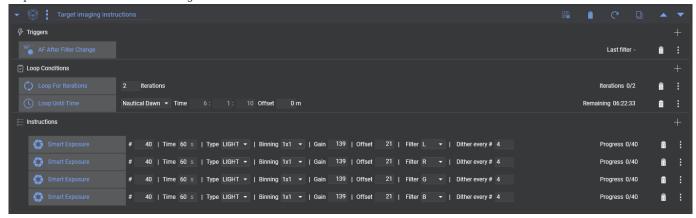
So for this example we could utilize a condition called Loop for iterations and set it to two iterations. Then we can remove 4 of the instructions without losing anything.

PROBLEM 2 - ESTIMATIONS MAY BE OFF

While the imaging loop runs the time to take these exposures might still exceed the remaining time of the night. Estimations can be off due to dithering that will take longer, an autofocus run that takes a bit longer etc. To make sure that the image run will stop on time, other loop conditions can be added. One that is a staple for the advanced sequencer is the Loop Until Time condition and having it set to (Nautical) Dawn. Now with two loop conditions, whichever of the two has its end condition met first, will cause the sequencer to stop the current instruction set and continue with the next target or with the end of the
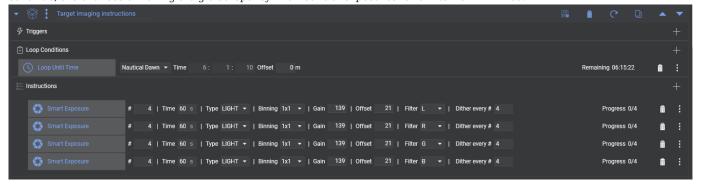
sequence if there is no further target.

PROBLEM 3 & 4 - UNEXPECTED EVENTS CAUSING UNEVEN EXPOSURES AND AUTOFOCUS RUNS BETWEEN EACH FILTER CHANGE

To solve Problem 3, we also need to solve Problem 4. This can be solved by setting up filter offsets. Filter offsets are a very powerful feature and with these it will no longer be necessary to re-focus when switching between filters, as the focus shift due to slightly different optical paths with different filters will be counteracted by these.
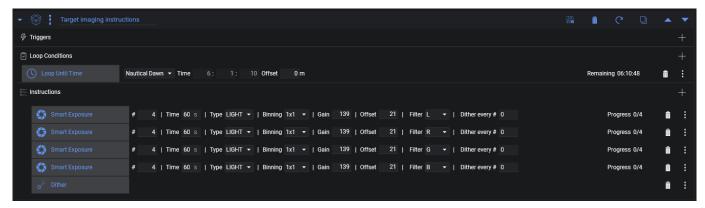
Setting these up is explained in detail on the linked page, so before continuing please determine the offsets and maintain these in the autofocus options.

Now that filter offsets are set up, the AF After Filter Change can be removed. What can also be removed now is the amount of exposures per Smart Exposure. This can be safely turned to four exposure each now. Furthermore the Loop For Iterations can be removed, as the Loop Until Time is sufficient. The sequence will take 4 exposures, dither, go to the next filter and for each of the filters and then repeat it again and again until (Nautical) Dawn. As the individual instructions take only four images and continue, the chances of having a big discrepency in amount of exposures for a filter is minimized.

PROBLEM 5 - DITHERING TOO MANY TIMES

Most of the issues are resolved now and already some time has been saved by removing the intermediate autofocus runs after filter changes. What remains is the amount of dithering. This can be reduced by a factor of 4! Look again at the sequence. Each filter will take four exposures, then dither, then go to the next filter. But why do we need to dither when we switch the filter anyways? Well we don't. We would only need to dither when each set of LRGB is passed. So let's do it, by setting Dither every # to 0 for all Smart Exposures and instead add a Dither Instruction after the last Smart Exposure!

This one is a real time saver!

SUMMARY

So to sum it up, we went from a legacy sequence and having to calculate how many exposures could potentiall fit into a night worth of imaging to a highly optimized sequence, that will run a loop of LRGB filters for the whole night and will get as many frames as possible for the duration of the complete night. We don't have to worry about the amount of subs being taken and will always end up with a set of images to create a full color LRGB image. In addition to that we drastically reduced the amount of dithering required, giving us back at least 20 minutes of imaging time.

> **Note**
>
> Hopefully this guide will help you reduce the fear of using the advanced sequencer and also give you the confidence and tools to create highly optimized sequences. This set of examples is only the beginning and the capabilities to optimize even further and adjust it to your specialized needs and equipment is now possible!

1.5 Advanced Topics

1.5.1 Auto-Focus

Overview

Proper focusing is a critical part of astro-imaging. Poor focus will yield softer images and lower SNR. As such it is common for imagers to focus with precision tools such as a Bahtinov mask prior to imaging. However, most optical assemblies will suffer from focus shift throughout the night whether it be because of temperature shift or other causes. Additionally, the popularity of monochrome sensors used together with narrowband or broadband filters has led to the need to refocus between filters, due to the slight focus shifts introduced. There is therefore a need for automated focusing procedures which can run at the beginning of a sequence, but also throughout the night.

Requirements

For Auto-Focus to be available for use in N.I.N.A. the following must be available and connected via the Equipment tab:
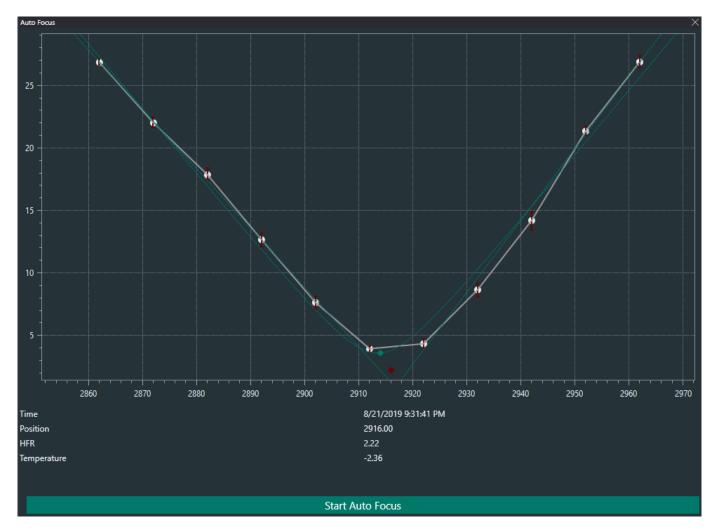
- An ASCOM compatible autofocuser with absolute positioning, properly set up to make sure it has minimal backlash and minimal slippage.
- A camera that is using the imaging train to which the autofocuser is connected.

N.I.N.A. Autofocus

N.I.N.A. is unique in that provides multiple ways to autofocus on star fields, on bright objects such as the moon or planets, or on terrestrial objects. This is done using two methods to measure how far from focus an image is.

STAR HFR

With this method, N.I.N.A. will move far out of focus, take an exposure, detect the stars in the image, compute the Half Flux Radius (HFR) of the stars and take the average HFR across the frame. Then, moving the focuser by some defined amount (the Auto Focus Step Size), N.I.N.A. can repeat the process, until a nice focus curve is available, and the minimum (point of best focus) can be found by different types of fitting (trend lines, hyperbolic, or parabolic). The obtained curve is as the below.
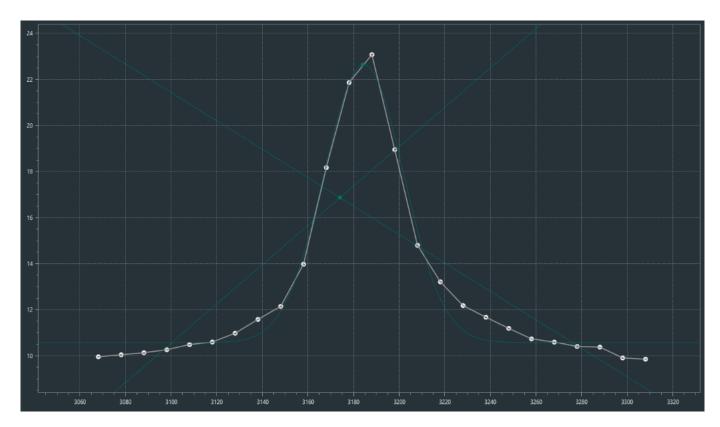
Each of the focus points above represents the HFR at its respective focus position. In addition, the red bars on each point represent the potential error on each of the focus points - wind and other factors can cause this error to be large. The line and curve fitting used to find best focus make use of those errors to take into account points with smaller error more than points with bigger error. The routine is therefore resistant to noise and other factors such as wind.

Note however that for Star HFR measurement to work, stars must be detected in the field of view - as such, the routine will have issues with short exposures and far from focus, where out of focus stars will tend to be very large. The Auto-Focus Exposure time is therefore an important parameter to the autofocus routine.

It is also important to note that if the N.I.N.A Step Size were too big (in the above example we can see it is equal to 10 focuser steps), the curve could become too coarse to be analyzed. The N.I.N.A Step Size therefore needs to be selected judiciously.

CONTRAST DETECTION

A second method is to detect the contrast available in the image - in the same way that a smartphone or mirrorless camera does to perform autofocus. The focuser is moved per the Auto Focus Step Size, exposures are taken per the Auto-Focus exposure time, and contrast is measured via different techniques. The curve obtained is close to a Gaussian Curve, where the maximum of the curve is the point of highest contrast and therefore best focus. An example would be as per the below.
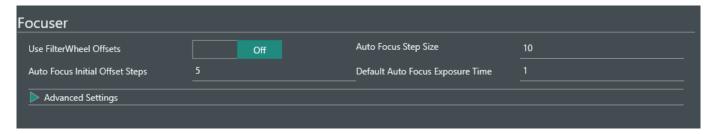
As is visible on the image, N.I.N.A. fits a Gaussian Curve to the focus points to find the maximum, the point of best contrast. Because this method doesn't rely on detecting stars, it can use very short exposures, and use up very little computing time - this makes it good for very quick focus. Note however that the peak can be quite narrow and would be easy to miss entirely - as such the Auto Focus Step Size would need to be narrower than with the Star HFR technique. Getting more points near best focus is also recommended. Since this method uses contrast detection, it will also work on the Moon, solar system objects, or terrestrial objects. However it can be more sensitive to adverse conditions than the Star HFR method, and is still currently experimental.

Please note that both methods above assume that the focus is reasonably near to best focus at the start - please make sure that stars are decently small before launching the routine.

Basic Settings

The main settings for autofocus are under Options -> Equipment -> Focuser section.

As we have seen above, the two main parameters to successful auto-focus are here:

- Default Auto Focus Exposure Time (in seconds)
- Auto Focus Step Size (in focuser steps)

Some additional parameters are available:

- Auto Focus Initial Offset Steps (in N.I.N.A. Auto Focus Steps Sizes, and not focuser steps)
- Use FilterWheel Offsets (which does not directly affect auto-focus)

> 📐 **Note**
>
> The Default Auto Focus Exposure Time won't be used if a filter wheel is connected, and Auto Focus Exposure Times have been set up in the Filterwheel section of the Options -> Equipment view. Instead, the per-filter exposure times will be used depending on the filter set at the time. This can be very convenient for imagers doing both broadband and narrowband (such as HaRGB). More details on how to set this up are available in the Equipment Options Section.

Auto-Focus algorithm

The autofocus logic is as follows:

1. For Star HFR, N.I.N.A. takes an exposure at current focuser position, and computes the Star HFR. This will be the "benchmark to beat", and the final focus point will be checked against this benchmark to ensure better focus has been achieved.

2. Move the focuser outwards (to a higher focuser position value than current) by Auto Focus Initial Offset Steps multiplied by Auto Focus Step Size. In the above example, the focuser would be moved by 5 * 10 = 50 focuser steps to the right.

3. Start moving the focuser inwards (to lower focuser position values), one Auto Focus Step Size (e.g. 10 focuser steps in the above example) at a time, measuring the contrast or HFR at each step.

4. Keep moving inwards until it has found a minimum (for HFR) or maximum (for Contrast) point, and at least Auto Focus Initial Offset Steps (5 in this example) points on each side of that minimum or maximum. If N.I.N.A. finds that it doesn't have enough focus points to the right of the minimum/maximum, it will move back outwards to the rightmost point, then proceed again, one Auto Focus Step Size at a time, until it has enough points right of the minimum/maximum as well

5. Perform a fitting on the points (trend lines, parabolic, hyperbolic, or Gaussian) to find the point of best focus, and moves the focuser to it.

6. For Star HFR, a final validation exposure is taken, the HFR computed, and compared to the benchmark taken in Step 1. If the final HFR is worse than the initial HFR by 15% or more, the autofocus routine is deemed a failure and the focuser returns to its initial focus position, or an additional auto-focus run is attempted.

Determining ideal parameters

As we have seen, there are three important parameters that are used in the autofocus algorithm. It is time to set them up properly - a rule of thumb is as below.

AUTO FOCUS INITIAL OFFSET STEPS

This is typically good at the default value of 4 for Star HFR. For contrast measurement, a value of 6 is preferable.

AUTO FOCUS STEP SIZE

To determine the correct Auto Focus Step Size, a user could start with the focuser slightly out of focus outwards from best focus. Then move the focuser outwards by say 10 steps. If there an obvious difference to the eye, and the star diameter has increased by around 20-30% or so, this is likely a right step size. Another method is the following: starting from a good focus position (e.g. by focusing with a Bahtinov mask) the user can progressively move the focuser inward (or outward) until N.I.N.A. is not able to determine stars HFR in the image. The total increment represents the maximum initial offset. To be on the safe side the user can take 80% of the max initial offset and divide it by the Auto Focus Initial Offset Steps (default = 4). The resulting value represents a good Auto Focus Step size. Star HFR detection and Annotate Image must be turned ON during the process.

Example: assuming a starting point of good focus of 4000 steps, we will move the focuser outward by an amount of 10 steps at the time, and take a new exposure at the end of each increment to check the measured HFR. Let's say that after 12 moves (120 focuser steps) no or just a couple of very defocused stars will still be detected by N.I.N.A. The value of 120 steps will therefore represent be the max increment. Scaling it by 80% (roughly 100) and dividing it by the Initial Offset (4) will give us an Auto Focus Step Size of 25.

Otherwise, the user should keep experimenting until they find a step size that shifts the focus by the right amount.

The above Step Size (in focuser steps) will be correct for Star HFR measurement. For contrast measurement based on Sobel or Laplace methods, this should also work fine. For Statistics-based contrast measurement, it may be appropriate to divide the Step Size by 2 or 3 and use that (as we saw in the previous example, the peak in that case is quite narrow).

DEFAULT AUTO FOCUS EXPOSURE TIME

Under Options -> Imaging -> Image Options, set the "Annotate Image" parameter to On.

For your filter of interest, take an exposure near best focus on an area with many stars. An ideal exposure time for Star HFR would be an exposure that almost saturates the brightest stars, but keeps the majority under the saturation threshold. The stars should be easily visible and identifiable to you. Now enable the Star icon (HFR measurement) on the Image pane of the Imaging tab - N.I.N.A. will highlight the detected stars. If many stars are detected, this exposure time is likely fine.

Then, move the focuser out of focus, by the Auto Focus Initial Offset Steps multiplied by Auto Focus Step Size. Take a frame with the same exposure time, and check that some of the out of focus shapes are still quite bright, with some very obvious borders. Again, using the Star icon, have N.I.N.A. highlight the detected stars - are some of the brightest stars correctly detected? If so, you have the right exposure time.

If both of the above are OK, you have found the correct default auto-focus exposure time for Star HFR. Note that this can change depending on your Imaging Auto-Stretch Settings. If you find that you have problems detecting stars far out of focus, you may want to increase the exposure time, and potentially decrease your Auto Stretch Factor.

Note that for contrast detection methods, it is generally safe to use an exposure time that is shorter than the one used for Star HFR.

USE FILTERWHEEL OFFSETS

Even par focal filters can cause small changes to focus, due to the filter itself, or the optical system and how it deals with different light wavelengths. As such it is possible to set offsets, in focuser steps, for each filter relative to one another. If a filter wheel is used, and offsets are properly defined per filter, this setting should be turned on. Otherwise, it should be kept off. This setting doesn't affect autofocus directly, unless an Auto-Focus filter is set. Defining filter offsets is further explained in the Equipment Options Section.

Important considerations

The basic parameters above should provide good auto-focus. The star HFR measurement and contrast detection calculation are however affected by other settings, which are located under Options -> Imaging -> Image Options

AUTOSTRETCH FACTOR AND BLACK POINT CLIPPING

These settings are used for stretching images automatically so that the target features are visible by human eyes. The stretch factor determines how bright the image becomes (the higher the brighter), and the black clipping determines whether some of the background should be clipped to black, increasing contrast.

Some of the routines used by autofocus use the stretched images as well (for edge detection for example), and are thus affected by this setting. This includes:

- StarHFR routine: stars are detected based on the stretched image
- Contrast Detection routine, with the Sobel and Laplace measurement methods: contrast is measured on the stretched image

In light polluted conditions, if running into issues, it may be worth trying to lower the stretch ratio to values such as 0.1 and the clipping to values such as -2. This will depend on each observer's conditions however, and each user needs to find out their best settings using the techniques highlighted above.

DEBAYER IMAGE, DEBAYERED HFR AND UNLINKED STRETCH

The recommended (and default) value for these parameters is On.

The Debayer setting is for OSC (one shot color) cameras, and will be ignored for monochrome cameras. If enabled, the sensor data (which is monochrome at this stage) will be debayered into a color image and displayed as such in N.I.N.A. In addition, if Unlinked Stretch is set to On, when stretching the image each color channel will be stretched separately, according to its own statistics. This helps achieve images with higher contrast, so it is recommended to keep this On, unless the computer used for capture is very slow.

Since, just as described above, many autofocus measurement methods depend on the stretched image, having this parameter correctly set will help with autofocus. Generally, it is better to leave these set to On.

Similarly, the Debayered HFR option provides a better way to perform HFR calculation when set to On. If set to off, the Bayered sensor data will be used for Star HFR calculation, which can lead to small focus error.

STAR SENSITIVITY

Star sensitivity is a parameter that takes effect during Star Detection, and therefore affects the Star HFR autofocus methodology. More aggressive settings will typically detect more stars, but will become more sensitive to noise as a result, which could lead to miss detecting stars. With the Annotate Stars setting set to On it is possible for the user to see the effects of this setting both in and out of focus. Typically, a value of Normal or High will provide good results.

As making this parameter more aggressive increases noise sensitivity, it can be used efficiently with the Noise Reduction parameter described below.

NOISE REDUCTION

This parameter determines how noise reduction is applied on the image prior to star detection, or some of the methods of contrast detections (Sobel and Laplace). It is only effective on the following autofocus methods:

- StarHFR routine
- Contrast Detection routine, with the Sobel and Laplace measurement methods
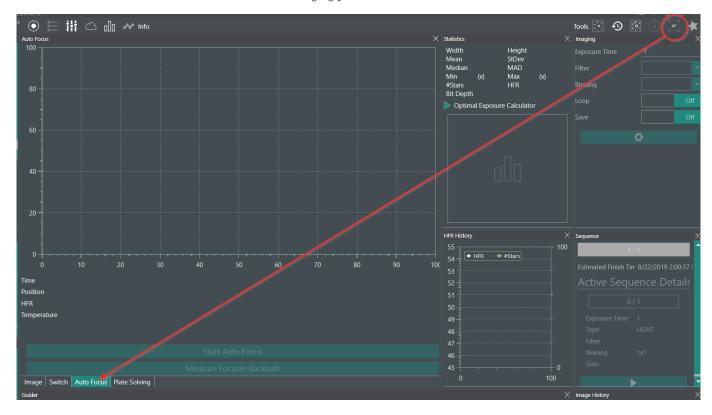
The possible values are as below:

- None: no additional noise reduction is applied prior to star detection or contrast measurement
- Median: a 3x3 Median filter is applied on the full size image prior to star or contrast detection. This is extremely effective at getting rid of hot pixels (which could be recognized as stars), but adds some processing time
- Normal: A Gaussian smoothing is applied to the image prior to star or contrast detection. This is effective at reducing thermal noise. Processing time impact is minimum, but detectable.
- High: A stronger Gaussian smoothing is applied to the image
- Highest: An even stronger Gaussian smoothing is applied to the image

Noise reduction can be very effective when combined with star sensitivity settings - but which values are ideal depend on each user's setup. Good results have been found with Star Sensitivity Normal or High and Noise Reduction Normal.

Launching Auto-Focus

Now that the basic settings of the autofocus routine have been set, it is time to launch an autofocus run. Of course, prior to doing that, the telescope should be pointed to the night sky, and tracking. There are multiple ways to do this:

- Start autofocus manually, from the Imaging tab. To make sure the autofocus window is available, the top right AF button needs to be clicked first. That should create a tab in the imaging pane.
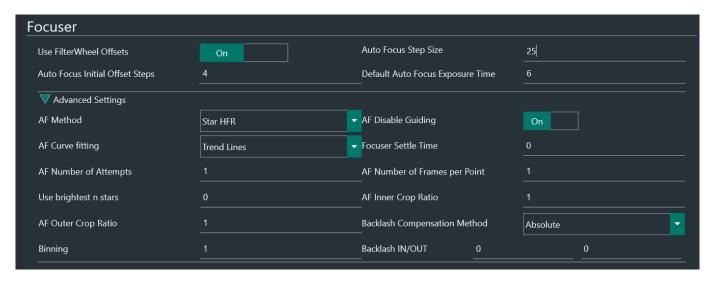

If both camera and focuser are properly connected, the "Start Autofocus" button will be available, and clicking it will launch the routine, as described in the introduction section.

- Start autofocus as part of an imaging sequence (at start, after a certain number of frames, after a user-defined time, after worsening of HFR, etc.). This can be configured from the sequence tab, and is described in more details in the relevant Sequence Section

Advanced Options

Under the Focuser options, there are a range of advanced options that will affect autofocus. The available options are different depending on the focus methodology being used. See Options->Equipment for further details.

AF METHOD

The method used for autofocus. This is either Star HFR or Contrast Detection, both of which have been described in this document. Default is Star HFR.

AF DISABLE GUIDING

Determines whether guiding should be disabled when autofocusing. For OAG or belt focuser users, it may be better to have this option set to On. Otherwise, it can be set to Off.

AF CURVE FITTING

This option is only available when the Star HFR autofocus method is selected (for contrast detection, a Gaussian curve is always used). It determines what methodology should be used for fitting the focus points to a smooth curve.

- Trend Lines: this is the default option, and uses error-weighted trend lines for the left and right side of focus. The intersection of the trend lines is the point of best focus.

- Parabolic: an error-weighted parabolic fit will be done on the focus points, and its minimum determines the point of best focus. This is most appropriate for users whose autofocus step size and offset steps keep them in the vicinity of the CFZ (critical focus zone), so that the asymptotes of the focus curve are usually not reached.

- Hyperbolic: an error-weighted hyperbolic fit will be done on the focus points, and its minimum determines the point of best focus. This is appropriate for most users, for whom the focus curve will resemble a hyperbola, with clear asymptotes on each side of focus.

- Parabolic + Trends or Hyperbolic + Trends: This will fit the focus points with both trend lines and a parabolic or hyperbolic fitting. The point of best focus is then an average between the trend line intersection and the hyperbolic or parabolic minimum.

> **Note**
>
> Which fitting method works best depends on the user and their particular conditions. Poor seeing conditions in particular can make parabolic fitting very appropriate, while Hyperbolic fitting (or hyperbolic + trends) should work best for most users

FOCUSER SETTLE TIME

This is the time, in seconds, that will be waited for after a focuser movement, and before the next exposure. This can be useful for focusing systems that can make the imaging train vibrate, like some belt focusers. For most users, this can be kept at zero.

AF NUMBER OF ATTEMPTS

If a focus run is deemed unsuccessful (which can happen with the Star HFR methodology, which compares the final Star HFR to the initial Star HFR), if there are Auto Focus Attempts left, a new focus run will be attempted. When all the attempts are

exhausted, the autofocus routine will declare failure, get back to its original focuser position, and imaging will continue as usual. For most users, a value of 1 (single attempt, no re-try in case of failure) or 2 (one reattempt in case of failure) is appropriate.

AF NUMBER OF FRAMES PER POINT

For users for whom extremely precise focus is critical (such as users in good seeing conditions and high resolution imaging trains), getting very accurate focus points and thus focus curve fitting is necessary. To accomplish that, the Auto Focus Routine can take multiple exposures (as per this parameter) per focuser position (rather than a single one) and average their Star HFR or contrast measurement - this leads to smoother, more precise focusing curves, at the cost of more time spent autofocusing. For most users, a value of 1 works well.
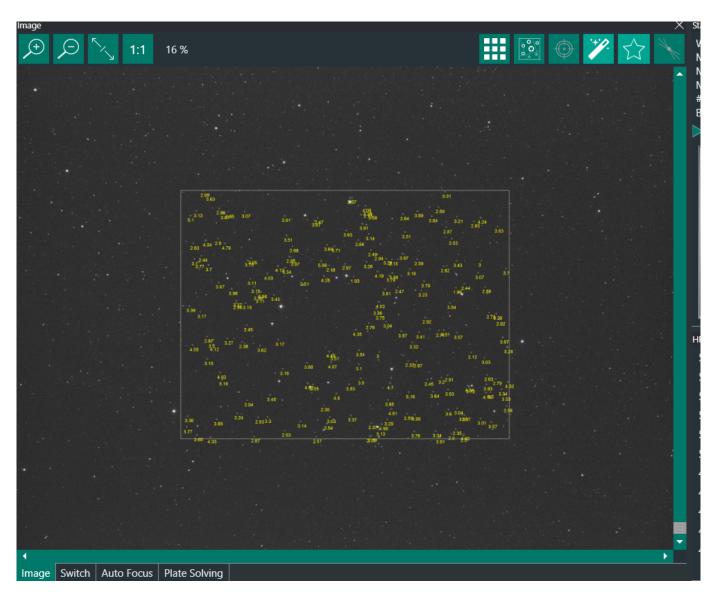
USE BRIGHTEST N STARS

This setting, which is only available for the Star HFR focusing method, will detect the top n brightest stars in the FOV, and use only those stars during the whole auto-focusing sequence. As the positions of the stars can change in unstable imaging trains, or imaging trains subject to mirror shift, this should only be used for very stable imaging setups. For most users, a value of 0 (meaning all the detected stars in the FOV will be used) works best.
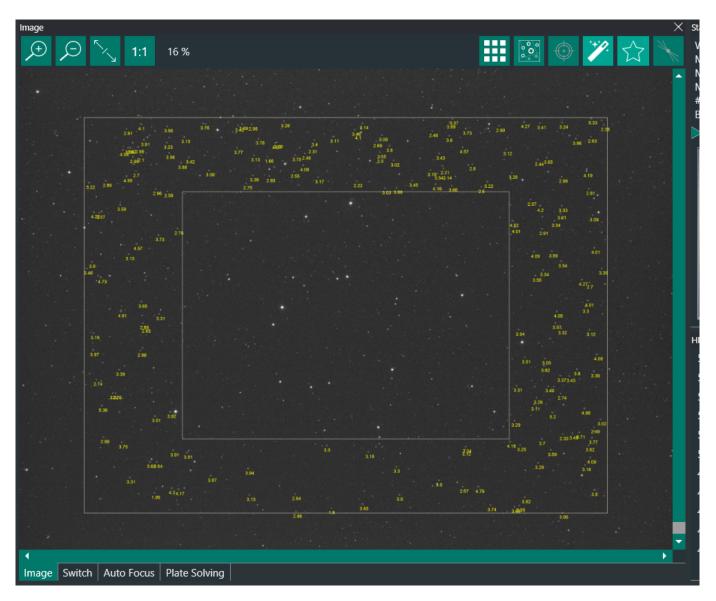
AF INNER CROP RATIO AND AF OUTER CROP RATIO

These settings (numbers between 0.2 and 1) are used to define a region of interest for the autofocusing method. For Star HFR, this is how it works:

• If both ratios are set to 1, nothing is done, the whole frame is used for autofocus

• If Inner Crop Ratio is set to a value below one, such as 0.5, and Outer Crop Ratio is set to 1, a central ROI (Region of Interest - in this case corresponding to 50% of the full frame size) will be used for star detection. If the camera is able to subsample to that particular ROI, it will do so. Otherwise, the full frame will be captured, but only the stars within the ROI will be used. If Annotate Image is set to true, the effect of the setting will then be readily visible, as per the following screenshot.

- If Inner Crop Ratio and Outer Crop Ratio are both set to values less than 1 (note that the Outer Crop Ratio value cannot be smaller than the Inner Crop Ratio), a "doughnut" of sorts is created between the inner rectangle and the outer rectangle - this will be ROI for autofocus. This is good for some optical systems which are best focused at 2/3 of the field of view, like some Takahashi refractors. The result is as below (inner = 0.5 and outer = 0.8).

Note that it is possible to have the inner crop ratio to some value, and the outer crop ratio to a value such as 0.99 to take into account only the outside of the center - this can be useful for centered very dense globular clusters, although they should not pose a big issue to the N.I.N.A. star detection routines.

Note that for Contrast Detection methods, only the inner crop ratio is available. In addition, for the Statistics contrast detection method, it will only work if the camera can subsample to the required ROI.
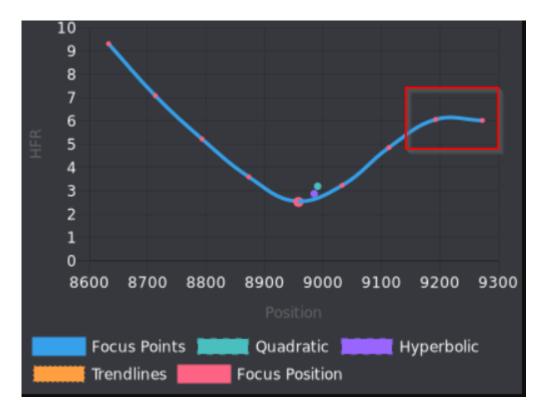
BACKLASH

Most focusers suffer from some degree of backlash, which is a certain amount of "slippage" when reversing directions. That backlash can be precisely measured and compensated in software. For most focusers, the IN (when the focuser switches back to an inwards direction after moving outwards) and OUT (when focuser switches back to an outwards direction after moving inwards) are identical.

Identifying backlash

It is critical for autofocus that all backlash is removed during a focus run. Without it the final focus position will never be reached properly. Therefore the backlash needs to be identified.
An easy way to see this, is by looking at the Autofocus chart itself. The backlash will be prominent on the right side from the starting position and will show as a horizontal line in the chart.

In the above example the amount of backlash is at least 100 steps. Let's explain why the right side will show the backlash like that.

The initial focuser position for the above example was around step 9000. To begin the autofocus routine, the focuser will move outwards to position 9300. The first measurement is taken. Then the focuser needs to travel to position 9200. Here the direction is changed from outwards to inwards. Every time a change of direction happens, the backlash needs to be compensated. As there was no compensation for the above example, the focuser thinks that it moved to position 9200, but due to the backlash the physical movement of the draw tube was none. Therefore the next measurement point will have the same HFR value as before, resulting in a flat line until the backlash was overcome. Finally when the focuser was moving inwards to the last autofocus point at position 8600 it needs to change directions again to move to the calculated focus point. Here again the backlash was not compensated and the focus position will be missed, resulting in a bad end result.

Compensating backlash

N.I.N.A. offers two backlash compensation methods:

- Absolute: When the focuser changes directions, an absolute value will be added to the focuser movement. Backlash IN: when the focuser changes from moving outwards to moving inwards the Backlash IN value will be added Backlash OUT: when the focuser changes from moving inwards to moving outwards the Backlash OUT value will be added
- Overshoot: This method will compensate for Backlash by overshooting the target position by a large amount and then moving the focuser back to the initially requested position. Due to this compensation the last movement of the focuser will always be in the same direction (either always inwards or always outwards)

Absolute is indicated for focusers with relatively small backlash and requires a more accurate measurement of the amount of backlash, while Overshoot is more forgiving and can be safely used for most focusers.

Backlash IN/OUT * The focuser backlash in the IN (decreasing position) and OUT (increasing position) directions, expressed in focuser steps.
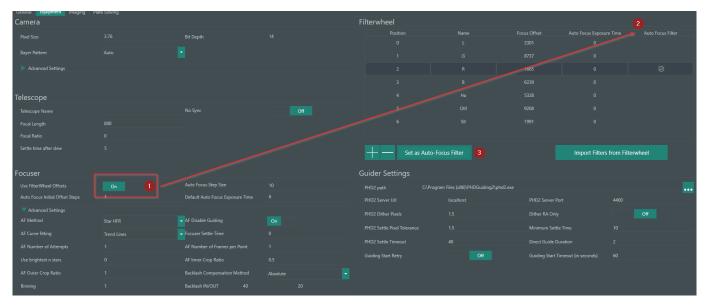
When Overshoot is chosen, only ONE between Backlash IN and OUT must be set! When setting IN, the amount will be applied on each inward movement, so the final movement will always be outwards. For Backlash OUT, it will be the other way around

BINNING

Autofocus can sometimes work more efficiently on binned images. This is a number between 1 and 4, representing 1x1, 2x2, 3x3, and 4x4 binning. This will attempt to bin the camera image to that particular value. For most users, a value of 1 is appropriate.

Auto-Focus Filter

Another parameter that affects the auto-focus routine is the Auto-Focus Filter. It is possible to set an auto-focus filter, as described in the Equipment Options Section. If set, and the Use FilterWheel Offsets setting is set to On, the autofocus routine will use the Auto-Focus filter rather than the currently set filter in the filter wheel, and make sure the focuser offset is applied when switching to the autofocus filter, and when switching back to the imaging filter. This can be particularly useful for Narrowband imagers, where the filters can force long exposures for autofocus, such as 10 to 30 seconds.

Auto-Focus Logs

For each successful Auto-Focus that has been performed a JSON log file is created containing detailed information about the autofocus run. There you can find the used filter, all the steps that were measured and other useful information to evaluate an Auto-Focus run from the past. Furthermore these logs can help greatly in analysing potential issues with Auto-Focus by sharing this file with other people.

These logs are stored inside `%LOCALAPPDATA%\NINA\Autofocus\`

1.5.2 Automated Meridian Flip

Overview

Mount operations known as Meridian Flips are important when using a German Equatorial Mount (GEM). The meridian is an imaginary line that divides the sky into east and west halves. It starts at 180 degrees (south) and passes directly overhead to 0 degrees (north). It is static and does not move with the sky. Imaging an object typically begins when it is in the east half of the sky. As the night progresses, the object will approach the meridian, cross it, and then be in the west half of the sky.

When a GEM's RA axis approaches the meridian, with the telescope on the west side of the mount and looking east, a "flip" must be performed to swap the side of the mount that the telescope is on. This is to avoid the mount tracking past the meridian. Otherwise the counterweights will be higher than the telescope (an undesirable situation on some mounts) and the telescope (or some part of it) contacting the pier or tripod legs. Some mounts and equipment configurations are more tolerant than others to these conditions. Some mounts can track for hours after passing the meridian in a counterweight-up condition. Some telescopes are both short enough in length and height that they will not crash into the pier or tripod legs. Every situation is different, so it is up to the user to know when a meridian flip should be commanded.
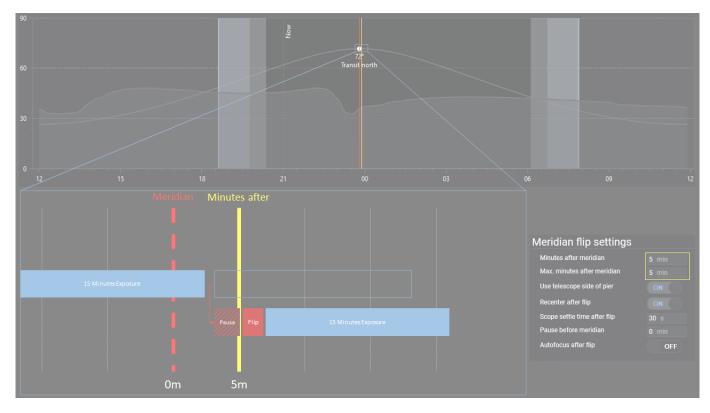
Automating Meridian Flips

An Automatic Meridian Flip operation swaps the telescope to the west side of the mount. Meridian flips prevent that your telescope and camera bump into the mount and do major damage to your equipment. N.I.N.A. has built-in functionality for the automated flip, even if your mount does not support it in firmware. After a flip N.I.N.A. verifies that it is still imaging the desired area of sky through Plate Solving and the imaging session continues.

To enable the Automated Meridian Flip you need to enable it in the legacy sequence target set options or when using the advanced sequencer, the meridian flip trigger needs to be added to the sequence. For customizing the behavior of the meridian flip, the meridian flip settings can be customized.

Meridian flip settings in detail

The meridian flip settings offer a variety of settings that will affect how a meridian flip is performed. Most notable are the `Minutes after meridian`, `Max. Minutes after Meridian` and `Pause before meridian`. These will lead to three different kind of scenarios, depending on how they are set up.

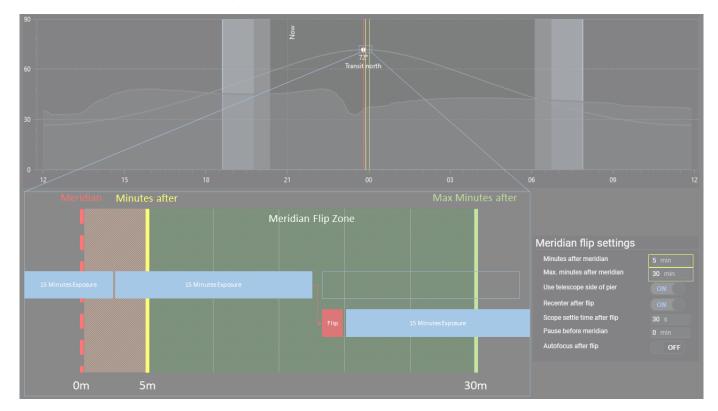**MIN AND MAX TIME AFTER MERIDIAN ARE EQUAL**

In earlier versions of N.I.N.A. there was no `Max. Minutes after meridian` setting and it is synonymous to having both settings set to an equal value.

As you can see in the picture above, the `Minutes after meridian` settings will define the point in time where a flip must happen. N.I.N.A. will try fit in exposures until one exposure is longer than the remaining time to `Minutes after meridian`. When this happens, the application will pause the tracking of the mount and will wait for the point in time to come to actually flip the mount. Once the `Minutes after meridian` time has been reached, the telescope will flip and the sequence will continue afterwards.

A setup like this will result in a little downtime, as some time is spent just waiting until the flip can happen.

MIN AND MAX TIME AFTER MERIDIAN DEFINE A TIME RANGE
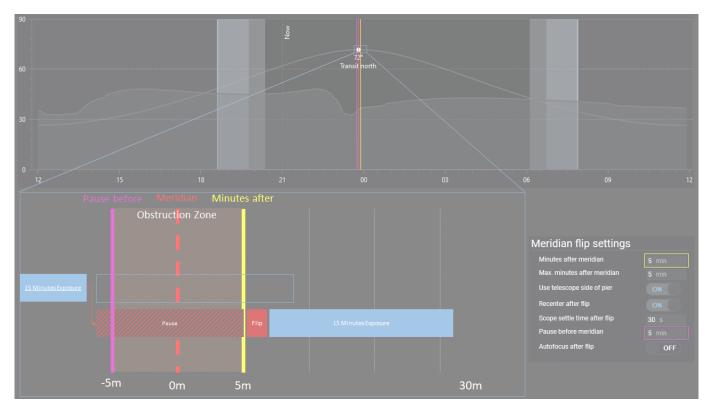

When you set different points in time for `Minutes after meridian` and `Max. minutes after meridian` you can basically define a time range where a flip could happen. Anywhere inside this time range a flip can happen safely.
N.I.N.A. will try to fit in exposures until an exposure ends inside this time range. When the application detects that it is now inside this flip time range, the next exposure will not happen, but instead a flip will immediately be executed without any wait time. Afterwards the sequence will continue as normal.

The big advantage with a configuration like this is that there is absolutely no downtime between exposures except for the actual flip. No time is wasted to waiting.

A PAUSE BEFORE MERIDIAN IS USED

Setting a `Pause before meridian` time as non-zero will result in creating an obstruction zone. This means that your equipment will hit the tripod before actually passing the meridian (e.g. you have a very long telescope tube). During this period of time, no imaging must happen as the telescope cannot safely track past this time before crossing the meridian.
N.I.N.A. will try to fit in exposures until one exposure is longer than the remaining time to `Pause before meridian`. When this happens, the application will pause the tracking of the mount and will wait for the point in time to come to actually flip the mount at `Minutes after meridian`. Once the `Minutes after meridian` time has been reached, the telescope will flip and the sequence will continue afterwards.
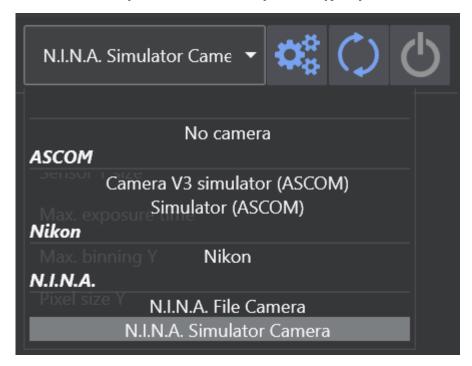
Use this setting only when your equipment hits the tripod before crossing the meridian, as it will result in a long downtime to wait for the object to get out of the obstruction zone!

1.5.3 Camera Simulator

N.I.N.A. offers a built in camera simulator which enables some basic debug utilities to simulate a camera.
It will act like an actual camera, but has the ability to generate images from different sources.
To use the simulator, you can connect to it like you would typically connect to a real camera.
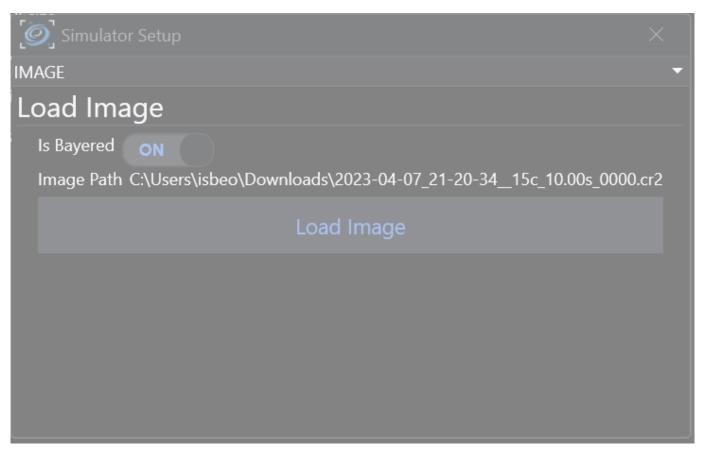

Simulator Setup

Use the gears icon to open the setup screen for the simulator. On the top you can select between different ways to generate an image.
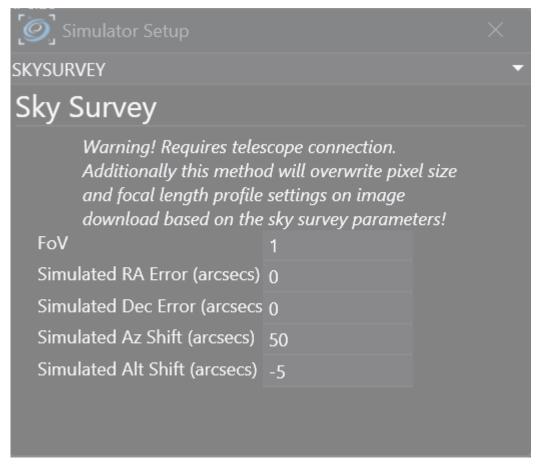
SOURCE: RANDOM

Using this source the simulator will generate an image of the given size with random values for the pixels based on the specified mean and standard deviation.
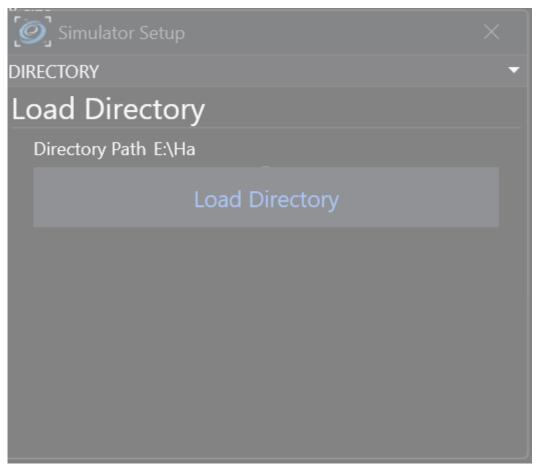
SOURCE: IMAGE

This source will use an existing image as the output. Simply click on the "Load Image" button and it will preload the image into memory. Later when taking an exposure this image will be shown.

SOURCE: SKYSURVEY

A telescope connection is required when using this source. It will download an image from an online sky survey (similar to the framing tab) based on the current telescope coordinates.

SOURCE: DIRECTORY

Similar to the Source: Image this will load images from a directory instead of one static image. Click on "Load Directory" and specify a target directory. Then it will iterate through all images in a directory and start from the beginning again. With this source you can easily replicate an imaging run.

Simulator Usage

The simulator will not automatically populate areas like the imaging tab or others, as it really is a simulation of a camera. To display an image of the simulator, you need to take an exposure like you would with a real camera.
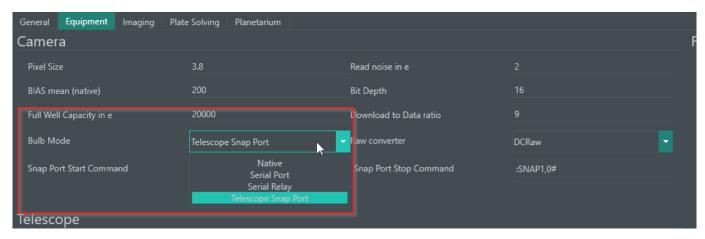
1.5.4 Bulb Shutter Control

If you have a Nikon DSLR that does not allow bulb exposure time over USB this is a solution for you. Instead of native USB mode you can use a self made RS232 shutter cable or use the mounts snap port for shutter (if available). You can test whether you need or don't need an external shutter cable by trying taking an exposure of more than 30s. This will trigger bulb mode on a Nikon DSLR. If your camera won't take a picture you need to look at this section.

> 🔥 **Tip**
>
> Prerequisite for any method of this functionality is that your DSLR has a shutter port!

You can find the necessary settings in the Camera settings.

If your mount has a snap port it is advised to test out the mount for bulb shutter functionality before using the RS232 method for bulb shutter.

RS232 for Bulb Shutter

One way to trigger the shutter mechanism of your DSLR is utilizing a self-made RS232 to bulb shutter cable. There are already some pre-made cables to be bought online for this issue or you can DIY.
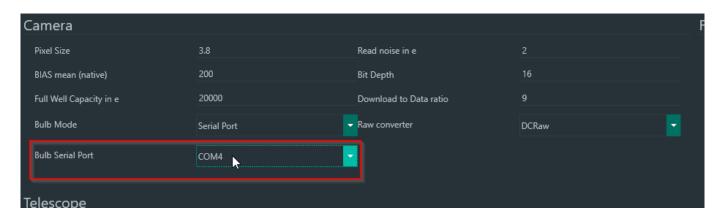
> 🔥 **Tip**
>
> DSUSB cables are not supported since they don't expose a COM Port!

You can find some tutorials on how to build a DIY shutter cable here:

[Nikon MC-DC2]

Once you have built a RS232-Shutter cable you need to connect it to the PC, install drivers for your RS232 adapter and check which COM port is used for it. In N.I.N.A. you need to change the "Bulb Mode" setting to "Serial Port" and change the COM port to the port your RS232 cable is using.

After that you can try and snap an image with an exposure time of longer than 30s. If it works you are done and can now expose for any time that you wish.

Should you face issues with the RS232-Shutter exposure in N.I.N.A. feel free to contact us on our Discord.
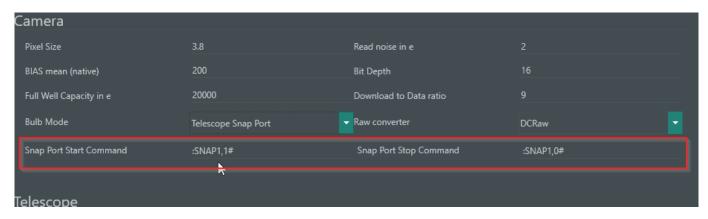
Mount for Bulb Shutter

In case your mount is having a snap port and there is some way to trigger it using command strings you can use that to trigger the bulb shutter mechanism. To enable using the snap port you need to change the "Bulb Mode" setting to "Telescope Snap Port".

> ✏️ **Notice**
>
> Currently confirmed and tested mounts for Mount Bulb Shutter are the SkyWatcher NEQ6-R and AZ-EQ-6-GT using EQMOD V200q

First you need to connect a shutter cable from the snap port of your mount to your DSLR. For that you will likely need a 3.5mm jack to your camera's specific shutter port cable. Once everything is physically connected you need to connect the camera and mount to N.I.N.A.. If your mount has two SNAP ports you can use either. Both will work depending on the next setting. The next step is to set up the command string to communicate with the snap port.

The default settings might already work for you, so feel free to try and take a snap shot that is longer than 30s in N.I.N.A.. If the shutter is triggered, you are done and can take longer exposures than 30s now.

> **Notice**
>
> Command strings for EQMOD are explained here

Should your bulb exposure still not trigger please contact us on our Discord.

1.5.5 Dithering

Overview

Dithering is an important part of the modern image acquisition process. CMOS and CCD sensors suffer from various types of electronic noise, such as fixed-pattern noise, and defects such hot and cold pixels. Photons of light from stellar objects fall onto the sensor and will effectively be lost if the photon falls on a dead or hot pixel. The act of dithering is a commanded move of the mount between successive exposures that very slightly alters, on the pixel scale, where photons fall on the sensor. This means that one exposure can capture light (ie, data) from an object where that same light fell on a dead or hot pixel in the previous exposure. Image alignment issues are easily handled by most astronomy stacking and image post-processing applications. The different positions of single light frames will make it more effective for image integration algorithm that implement an outlier rejection method (like sigma-clipping) to reject fixed-pattern noise ans well as hot and cold pixels. This is because hot and cold pixels are always in the same position in the camera sensor and dither will make them appear in different places for each frame after a dither move.

Because dithering is an operation that must be coordinated with guiding (remember, the mount is being purposefully moved by a few pixels, which guiding would reflexively attempt to counteract), the dithering operation is managed by the guiding applications themselves. The process is simple. N.I.N.A. suspends imaging and commmands the guiding application to execute a dither operation. It performs the dither, and then informs N.I.N.A. when the operation is complete. Any required adjustments to guiding are automatically handled by the guiding application. N.I.N.A. then resumes commanding normal exposures. Normally, a dither operation takes a few tens of seconds (at most) to complete.

Dithering in N.I.N.A.

N.I.N.A. offers three different ways to perform dithering:

1. Standard dithering through PHD2, MGEN2, or MetaGuide
2. Built-in dithering using N.I.N.A.'s Direct Guider function

The desired way of dithering is based on the connected device in the **Equipment > Guider** tab.

STANDARD DITHERING

This is the typical scenario for most users. The user has a single main camera, a guide camera, and a supported guiding application. At the intervals configured in the sequence, N.I.N.A. will pause operations with the main camera and trigger a dither operation. Photography resumes when the dither operation is completed.

BUILT-IN DITHERING

There are some cases where guiding equipment isn't needed or available, but you still want to dither. This can happen if you have a very high end mount with encoders or with small portable setups. N.I.N.A. can perform dithers directly via its **Direct Guider** which manually slews the telescope very small distances.
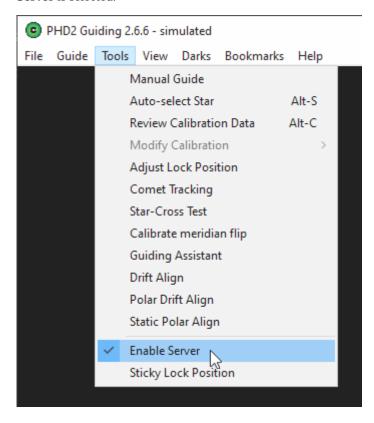
Requirements

N.I.N.A. supports dithering using its direct communication with PHD2 and makes it easy to set up as a part of a sequence. There are a few prerequisites to dither during a sequence:

- A mount needs to be connected
- A supported guiding application needs to be be running, actively guiding, and also communicating with N.I.N.A.
- PHD2
- MGEN2
- MetaGuide
- The guiding-related settings in the Equipment Settings need to be correctly set up
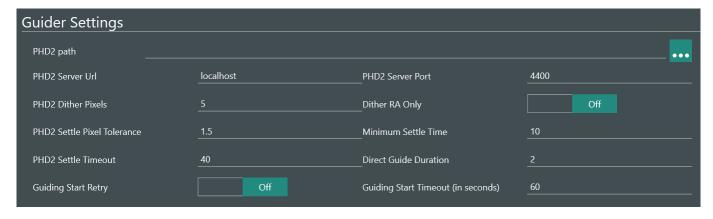- If you need dithering, it should be enabled in the sequence

PHD2 Settings

In order for N.I.N.A. to communicate with PHD2 and command operations such as dithering and for receiving guiding telemetry, PHD2's internal server must be enabled. To enable PHD2's internal server, go to PHD2's **Tools** menu and ensure that **Enable Server** is selected.

N.I.N.A Settings

SETTINGS FOR PHD2

Settings related to guiding and dithering can be found in the **Options > Equipment** tab. The defaults are suitable for most cases. You will need to specify the full path to `phd2.exe` if PHD2 was installed in a non-standard location. This is so N.I.N.A. can automatically start PHD2 as a part of the equipment connection process.

An explanation of the two most important dithering-related settings follows:

- **PHD2 Dither Pixels**: The amount of pixels (on the guiding camera) that the dithering action will shift. This value should take into account the guiding imaging scale and main camera imaging scale, in arcsec/pixels. To select the appropriate value you need to consider how many imaging camera pixels will shift between two exposures as a consequence of a dither move. Obviously, 2 pixels at one focal length and pixel size will cover a different amount of sky than another setup with a different focal length and pixel size. It is usually recommended to dither a number of guide camera pixels that will shift the main imaging camera of about 10 pixels.

> **Tip**
>
> Let's assume to have a guide camera with a pixel size of 3.8µm and a 260mm focal length guidescope, resulting in a guide scale of about 3 arcsec/pixel. The imaging optical train is composed by a camera with a pixel size of 3.8µm and a 520mm focal length scope, resulting in an imaging scale of about 1.5 arcsec/pixel. A guide camera shift of 5 pixels corresponds to a motion of 15 arcsec or 10 pixels of shift for the main imaging camera. In this case a PHD2 Dither Pixels of 5 pixels is therefore appropriate.

> **Note**
>
> The PHD2 Dither Pixel value will be multiplied by PHD2 by the "Scale" value found under Advance Setup>Dither Settings of PHD2. This value will be multiplied by the Dither Pixel set in N.I.N.A. to determine the final pixel shift amount. It is recommended to leave it
>
> Dither Settings
> Mode: ⦿ Random ◯ Spiral
> ☐ RA only Scale: 1.0
>
> at 1 and only change the amount of dither pixels in N.I.N.A.

- **Dither RA Only**: This will cause dithering to happen on the RA axis only and allow the declination axis to continue guiding.

> **Note**
>
> This option should only be checked in the following cases:
> - your mount does not support DEC guiding (i.e. skytracker)
> - a mount that suffers from a high declination backlash
> - you are guiding in one direction only in DEC
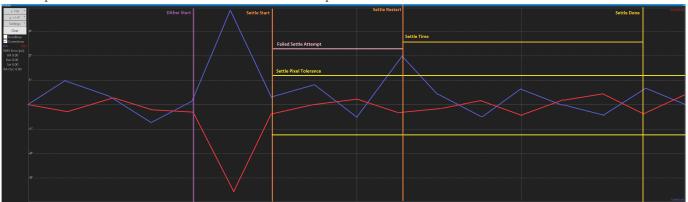
> **Tip**
>
> The pixel scale of your guide camera can be calculated using online tools. By inputting the focal length of your guiding optical train and the pixel size of your guide camera's sensor, you will know how many arcseconds of sky is covered by each pixel (arcseconds per pixel). Such a tool is the CCD Resolution Calculator.
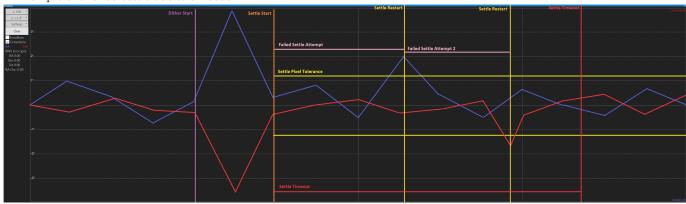
- **Dither Settle Pixel Tolerance and Settle Time**: these are important parameters that define the successful end of a dither move. When a dither is initiated by PHD2 a random move of the mount in RA/DEC is issued, the maximum amount of the random move is defined by **PHD2 Dither Pixels**. The mount then resumes its tracking operations, but depending on the mechanical stability of the gears it might take a couple of seconds to return to its normal guiding conditions. This time represents the settle time and N.I.N.A. lets you define a **Minimum Settle Time** during which the mount has to be inside the pixel tolerance. If the mount is moving outside this tolerance during this timeframe, the minimum settle time timer will restart again. The successful completion of a dither settling is achieved when guiding after a dither move remains within the tolerance defined by the **PHD2 Settle Pixel Tolerance** expressed in guide camera pixels. Once settling is complete N.I.N.A. can continue and start a new capture. Should settling not be achieved after the period defined in **PHD2 Settle Timeout**, the settling will be declared failed and N.I.N.A. will start a new capture.
  PHD2 Dither Pixels depend on your mount guiding capabilities and guiding scale and should be determined by looking at PHD2 logs. A great tool to analyze PHD2 logs is PHD2 Log Viewer that can be downloaded from here

** Example of a successful dither after one failed settle attempt **

** Example of a failed settle due to timeout **

SETTINGS IN SEQUENCES

Regardless of the dither method in use, initiating dithering during the course of a running sequence is simple. Dithering operations can be activated for each step in a sequence, and be initiated every Nth frame in each step. That is, if a step in a sequence specifies that 20 exposures be taken with a dither operation every second exposure, two normal exposures will be taken, a dither operation performed, and then the next two exposures will be taken, etc. N.I.N.A. manages these operations itself in conjunction with PHD2 and the process is entirely hands-off.
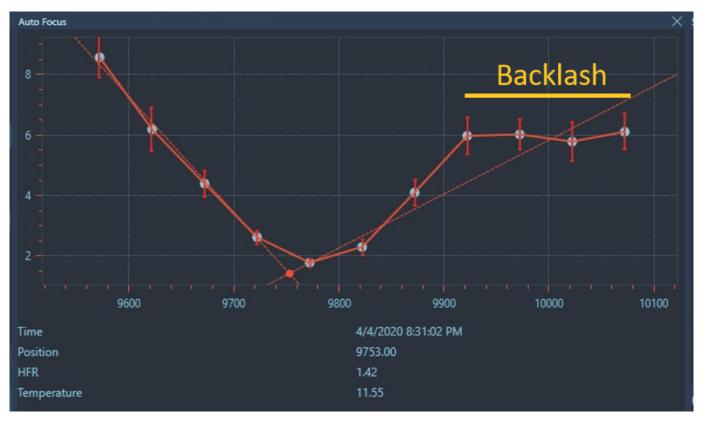
Dithering operations happen while the previous image is downloading from the camera. If you have a camera with slow download speeds, it might be that the dithering operation is completed in time for the camera to be ready for the next exposure.
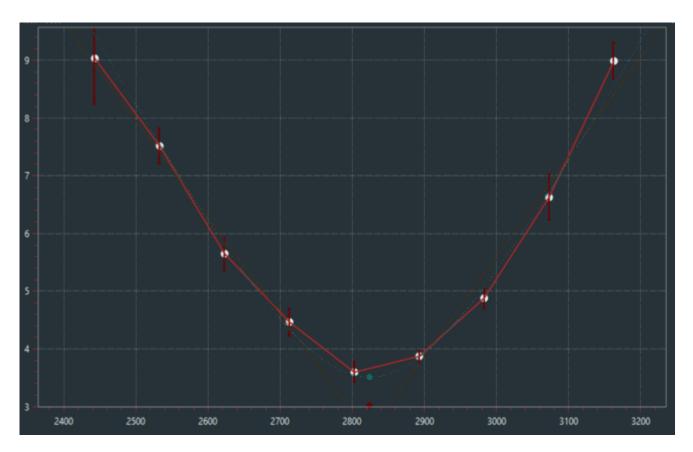
1.5.6 Focuser Backlash Measurement

Overview

Focusers can suffer from backlash when they reverse directions, which is basically the number of focuser steps that "slip by" before the focuser physically moves again during a change in directions.

A typical effect of backlash on the AF curve is show in the image below. In the first part of the curve (from right to left) the HFR remains constant due to the focuser drawtube not moving while the focuser is only compensating for backlash. In this case the curve is showing approximately 150 steps of backlash

A good AF curve should not display any signs of backlash and look similar to the one below:

Several methods can be used to measure the focuser backlash and most of them involve a mechanical measurement of the focuser drawtube movements. For example, by using a dial gauge to measure focuser drawtube movements, backlash is determined by changing focuser movement direction and measuring how many steps are necessary before the drawtube moves

again.

If the drawtube has a marked scale that can also be used in the same fashion as above. Another method involves running a standard AF routine and determine the number of backlash steps as showed in the example above.

N.I.N.A. offers two backlash compensation methods: **Absolute** and **Overshoot**.

When **Absolute** backlash compensation is used. N.I.N.A. will add a fixed amount of steps (as specified in Focuser Advanced options) when the focuser changes directions. This requires a good backlash measurement and is mostly effective with focusers with small backlash with respect to the Auto Focus Step Size.

With **Overshoot** N.I.N.A. compensate for Backlash by overshooting the target position by a large amount and then moving the focuser back to the initially requested position. This method is much more forgiving than Absolute and is recommended for focusers with large backlash or when the backlash measurement is not very accurate. For **Overshoot**, once the user has determined a rough backlash value, this can be increased by an extra 50% and input as IN or OUT compensation. Since this method is very forgiving a trial-and-error procedure is also possible, by using progressively larger compensation values until the AF routine behaves properly and no sign of backlash is shown in the AF curve.

> 🔥 **Tip**
>
> Overshoot can be very useful for SCT users to avoid mirror flop. In fact, when setting the Backlash Compensation to IN, the last focuser movement will always be outwards.

1.5.7 Framing Assistant

Overview

The Framing Tab is a powerful tool, to decide which deep sky object to image and how to frame it. Using the Framing Assistant you can set the perfect framing for your target and if it does not fit into your current frame also set up a mosaic easily. To accomplish this, the application offers a variety of tools. There are multiple online Sky Survey sources available, a powerful offline planetarium like view as well as loading images into the framing from a previous session.

Getting Started

The first choice you have to make, is choosing the image source to suite your needs. A brief summary of each source can be found in the general Framing Tab Overview
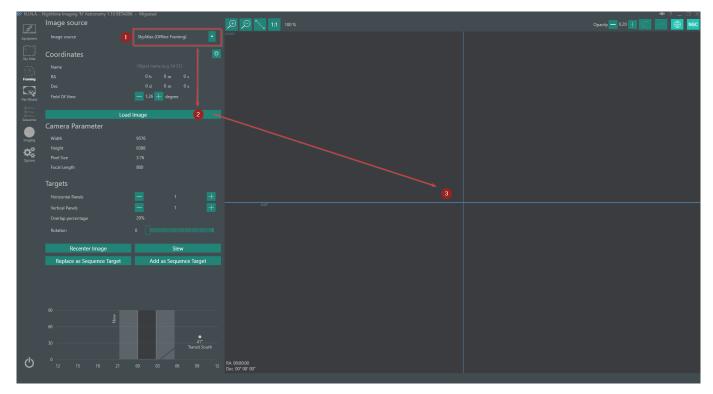To know which source is best suited we will divide the guide into three different use cases:

1. You do not yet know of a good target and want to search for a good opportunity for tonight's imaging run

2. The Target is well known and you want to plan a good framing for it

3. A previous session was already done and you want to continue the session with a similar framing

Choosing an opportunity to image

The framing tab can be utilized to choose a good target for your upcoming night. To achieve this the Offline Sky Survey is a good choice. This source is an interactive Map of the sky and is using Right Ascension and Declination axes as well as a rough circle to display a the outlines of targets. (It does not have any actual images available, but will give a good idea about the size). In conjunction with the altitude chart in the framing tab a perfect target for the night can be chosen.
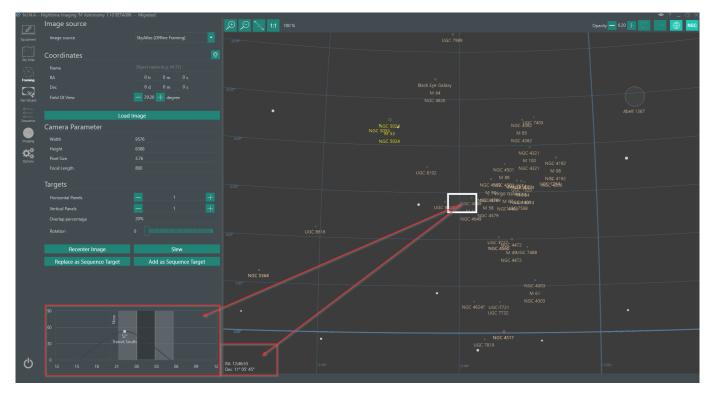
LOADING THE OFFLINE SKY SURVEY

First select the "Sky Atlas (Offline Framing)" as your image source. Then without looking at any coordinates click on "Load Image" and the right side will load the offline map. As you can see below you won't see much there yet, but don't worry this is an interactive map and you will see its potential soon!
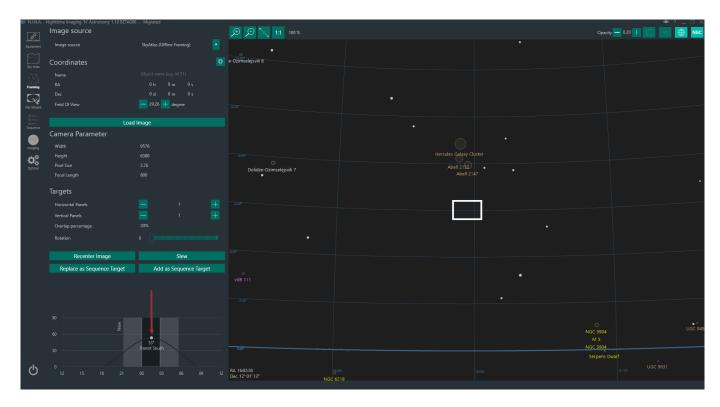

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MOVING AROUND INSIDE THE OFFLINE SKY SURVEY

Once the sky atlas is initialized move your mouse cursor onto the image and use the mouse wheel to scroll out as well as drag the map around using the left mouse button. While moving around the sky atlas and getting yourself familiar with the controls, keep an eye on the coordinates on the lower left corner of the image as well as the altitude chart on the lower left of the tab. Both are displaying the coordinates and altitude for the center pixel of the currently displayed section of the sky!
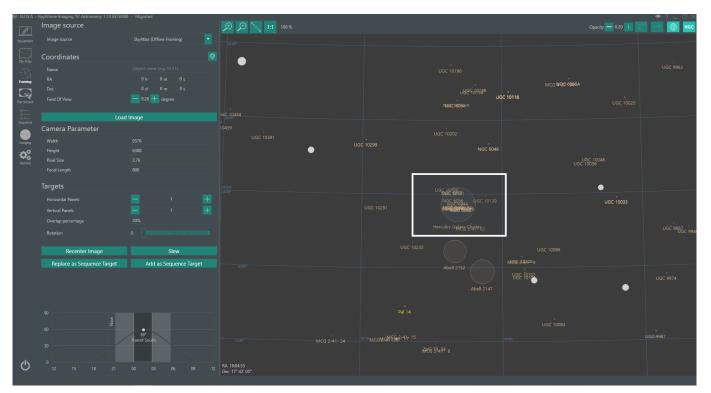

CHOOSING A GOOD TARGET

As a general rule of thumb a good target has its altitude peak in the middle of your imaging run. For this guide I'll assume to image the complete night. Now move the center of the image to a point where the altitude chart has its peak in the center of the night like shown below.
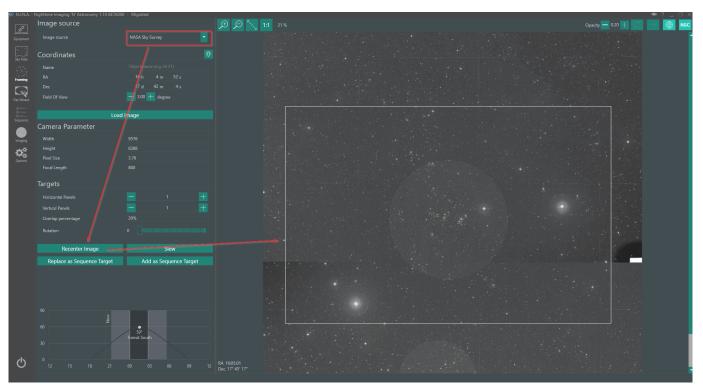
All you have to do now is moving the box up or down, as the peak of the altitude will stay inside the center due to the way the coordinate system is laid out. See which target is near that imaginary vertical line and then drag the rectangle over the target. Remember that you can also zoom in and out to see more or less targets inside the frame. In this example here, I have chosen the "Hercules Galaxy Cluster". As you can see the target fits perfectly into the night and its dimensions will also fit into the current frame.

ADJUSTING THE FRAMING WITH A VISUAL IMAGE (OPTIONAL)

As the Offline Sky Survey does not have any images, you can now finalize the framing using a different source (this will require internet connection). Choose one of the online Sky Surveys from the dropdown on the top left, adjust your Field Of View to a

smaller value that just fits for your framing (alternatively just zoom into the offline framing so that the rectangle almost fills the screen) and afterwards click **"Recenter Image"**. For this example I'm using the NASA Sky Survey. When you hit Recenter the image will be downloaded from the web and then be displayed. This can take a short while. Finally drag and rotate the rectangle to your desired framing.

Framing a specific target

Framing a specific target will follow the same flow as described in the previous section. Basically you skip the steps where you search for a target and directly enter some coordinates for a target and use either the Offline Sky Survey or any of the Online Sky Surveys to frame it.

Continuing a previous session

When you have shot a specific target already and want to have the same framing again, you can conveniently load in an image from a previous session into the application. By choosing the image source "File" you can quickly load in a single image or a stacked image and it will be loaded into the application. Once loaded you just need to drag and rotate the rectangle to your desired framing.

There are three possible scenarios for loading a file:

IMAGE IS ALREADY SOLVED AND HAS ALL REQUIRED HEADER INFORMATION (XISF OR FITS ONLY)

This one is the most convenient type to use. Here an image already contains all info required to be displayed inside N.I.N.A. Just load up the file and it will almost instantly render the image and the rectangle with the correct scale without any need to platesolve it again. Furthermore the target name is set as your current reference.

When an image was not solved already and does only contain header information like the target name and the target coordinates, N.I.N.A. does not know the actual image scale and the center of the frame. For this a quick solve of the frame needs to happen. As the header information is already there for a reference, platesolving should be very quick. A dialog will appear asking you to use the found coordinates as a reference and afterwards solve the image. Once the image is solved it will be displayed for framing.
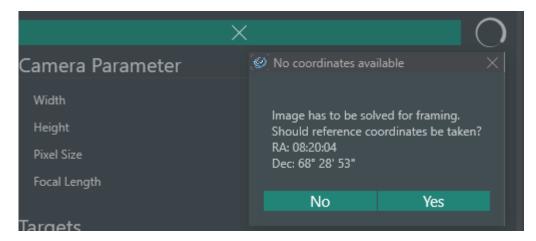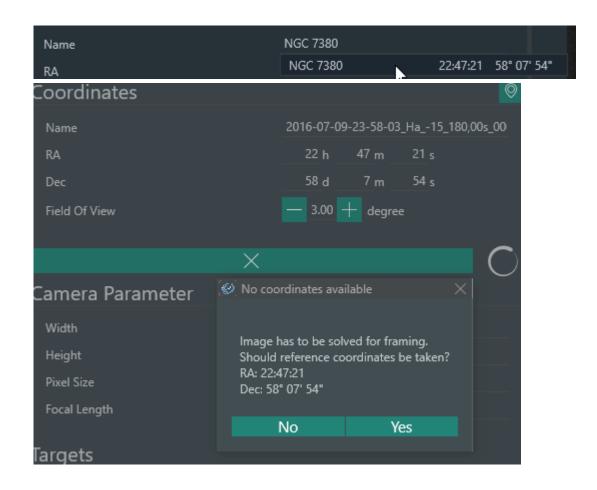

IMAGE DOES NOT CONTAIN ANY RELEVANT INFORMATION

In case your image does not contain the required headers, or the image format does not have any header information at all (e.g. JPG or RAW formats) the application will need some user assistance to grab the correct reference coordinates to be able to solve the image quickly. Instead of clicking on "Load Image" first, you should specify the target's coordinates instead. Either you can do a quick search by typing in a Name inside the **Coordinates** field and if found choose the correct coordinates, or you need to enter in the coordinates manually. Once the coordinates are filled, you click on "Load image" and the application will ask you if these coordinates should be used for solving the image. When the solve was successful the image will finally be displayed.
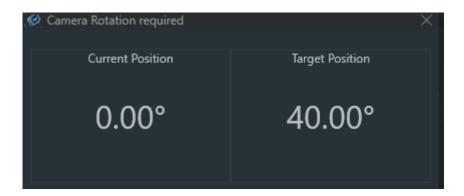
Finalizing the framing

Your rectangle is dragged to where it is supposed to be, your rotation is also settled. To now finalize this process and put it into good use, you need to create a sequence out of it. There are two options for this available:

"Replace as Sequence Target": This will replace **all** currently set sequences and replaces it with the current framing target "Add as Sequence Target": When you have already added a target from a previous framing, you can add this current one to the overall sequences. This is especially useful when you plan on imaging multiple target in one night.
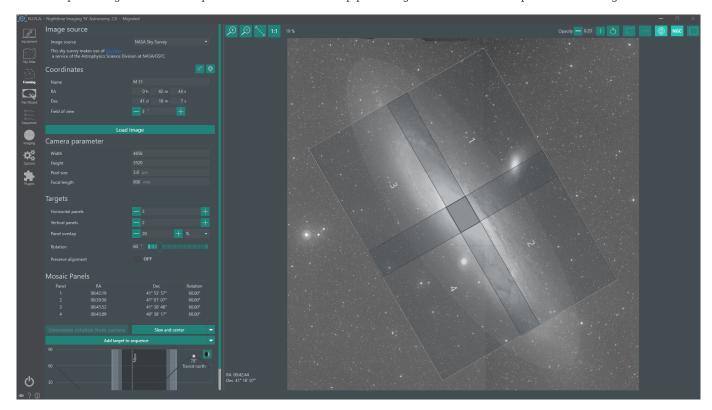
Remember the rotation!

Your framing was done, you start imaging, but the image rotation is completely different from what you have set inside the Framing Tab? Well the application unfortunately can't rotate your camera magically (unless you have a motorized rotator). For the majority of people not having a rotator N.I.N.A. offers a quick way to ensure that the rotation for your sequence will match the rotation you set up for framing.
Inside **Equipment->Rotator** you have to choose the "Manual Rotator" and connect to it. When this little tool is "connected" the application will consider the rotation during `slew, center & rotate` commands. During the centering of the object the platesolver will determine the actual rotation, compare it with the desired rotation and then sends a signal to the rotator to turn. As we have the manual rotator enabled a small pop up window will show and it will prompt you to turn the camera by xx degrees until you are within the rotational tolerance (set inside Options->Plate Solving->Rotation Tolerance).
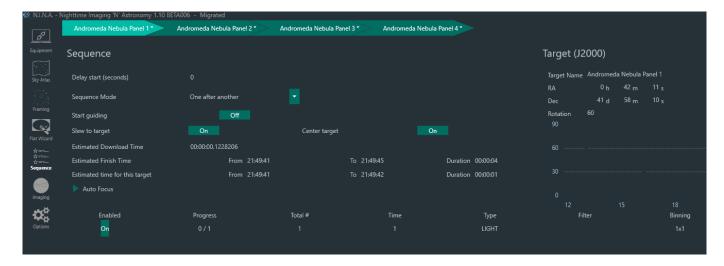
Framing a Mosaic

Framing a mosaic is really simple. You can follow all the previously mentioned steps to choose a good target for the framing and orientation of your mosaic. The only difference will be that you additionally set **"Horizontal Panels"** and **"Vertical Panels"** as well as the overlap of these panels. When having more than one panel selected, the single rectangle gets expanded and divided into multiples using the number of panels as well as the overlap percentage. Furthermore each panel will be assigned a number.

Once you are done with the mosaic planning you can put it into the sequence by replacing or adding it. It is advised to have a sequence template set up prior to adding a mosaic plan to the sequence, so you don't have to set up each panel separately. When adding the mosaic to the sequence, the Target Names will be your Target Name chosen inside the Coordinates section and a postfix of "Panel X" will be appended based on the panel number to easily distinguish these panels. The coordinates will be automatically shifted based on the panels and your mosaic should work without having to worry about anything.

It is important to have the actual camera correctly rotated for a successful mosaic

1.5.8 File Formats

TIFF

Tagged Image File Format (TIFF) is an image file format originally created by Aldus. Currently there is no metadata stored by N.I.N.A. for this specific format.

TIFF RAW

This format stores the image in its pure raw format without using any compression. This type is the fastest, but also largest in size.

TIFF COMPRESSED

TIFF is capable of storing the image in a lossless compressed format. This will reduce the file size considerable without altering the image in any way, but the downside is increased processing time when saving and loading the image. Some software might also not be compatible with compressed TIFF files.

zip vs lzw

Zip and lzw are different algorithms for compression and the result is highly depending on the input data. It could even be possible that the file size increases when the data is laid out in a worst case scenario for the algorithm. For deciding on an algorithm it is advised to try out which one works best for your specific camera and data.

FITS

Flexible Image Transport System (FITS) is a flexible open file format for images, spectra, photon lists, data cubes etc. The data is stored in N-dimensional arrays or tables.

N.I.N.A. is capable of saving images in FITS format. The FITS format offers a variety of header meta information and N.I.N.A. will populate all available information into this header. A detailed list of all available Headers and their conditions is described below. Many applications can make use of these headers (e.g. PixInsight during processing).

STANDARD FITS HEADERS

- SIMPLE: true
- BITPIX: 16
- NAXIS: 2
- NAXIS1: image width
- NAXIS2: image height
- BZERO: 32768
- EXTEND: true
- SWCREATE: N.I.N.A.

IMAGE HEADERS

- IMAGETYP: Type of exposure (LIGHT, DARK etc.)
- EXPOSURE: Exposure duration in seconds
- EXPTIME: Exposure duration in seconds
- DATE-LOC: Locale time at exposure start
- DATE-UTC: UTC time at exposure start
- ROWORDER: TOP-DOWN orientation of the image starting point. Details at free-astro.org

OBSERVER HEADERS

Taken from the Astrometry Options

- SITEELEV: Elevation (currently taken from a connected telescope)
- SITELAT: Latitude
- SITELONG: Longitude

TARGET HEADERS

Available when a target is set inside a sequence.

- OBJECT: Name of object
- OBJCTRA: Right ascension of target
- OBJCTDEC: Declination of target

CAMERA HEADERS

Requires a camera to be connected

- INSTRUME: Name of camera
- XBINNING: X binning factor
- YBINNING: Y binning factor
- GAIN: Gain
- OFFSET: Offset (if camera can set an offset)
- EGAIN: Electrons per A/D unit (only available for some cameras)
- XPIXSZ: X-Pixelsize
- YPIXSZ: Y-Pixelsize
- SET-TEMP: temperature set point (requires a cooling unit)
- CCD-TEMP: actual sensor temperature (requires a cooling unit)
- READOUTM: Sensor readout mode
- BAYERPAT: Sensor bayer pattern
- XBAYROFF: Bayer pattern X axis offset
- YBAYROFF: Bayer pattern Y axis offset

TELESCOPE HEADERS

Requires a telescope to be connected

- TELESCOP: Name of telescope
- FOCALLEN: Focal length (taken from equipment options)
- FOCRATIO: Focal ratio (taken from equipment options)
- RA: Current telescope's right ascension coordinates
- DEC: Current telescope's declination coordinates

FILTERWHEEL HEADERS

Requires a filterwheel to be connected

- FWHEEL: Name of filterwheel
- FILTER: Current active filter

FOCUSER HEADERS

Requires a focuser to be connected

- FOCNAME: Name of focuser
- FOCPOS: Current step position
- FOCUSPOS: Current step position
- FOCUSSZ: Step size
- FOCTEMP: Temperature (requires temperature probe on focuser)
- FOCUSTEM: Temperature (requires temperature probe on focuser)

ROTATOR HEADERS

Requires a rotator to be connected

- ROTNAME: Name of rotator
- ROTATOR: Rotator angle in degrees
- ROTATANG: Rotator angle in degrees
- ROTSTPSZ: Step size

WEATHER DATA HEADERS

Requires a weather data source to be connected

- CLOUDCVR: Cloud cover percentage
- DEWPOINT: Dew point in Celsius
- HUMIDITY: Humidity percentage
- PRESSURE: Air pressure in hPa
- SKYBRGHT: Sky brightness in lux
- MPSAS: Sky quality in mags/arcsecs^2
- SKYTEMP: Sky temperature in Celsius
- STARFWHM: Star FWHM
- AMBTEMP: Ambient air temperature in Celsius
- WINDDIR: Wind direction: 0=N, 180=S, 90=E, 270=W
- WINDGUST: Wind gust in kph
- WINDSPD: Wind speed in kph

XISF

Extensible Image Serialization Format (XISF) is an image file format created by PixInsight. It is a free format open to contributions of anyone interested. For more detailed information about the format itself refer to pixinsight.com/xisf.

N.I.N.A. is capable of saving images in XISF format. The XISF format offers a variety of header meta information and N.I.N.A. will populate all available information into this header. A detailed list of all available Headers and their conditions is described below. Many applications can make use of these headers (e.g. PixInsight during processing).

STANDARD XISF HEADERS

- Version: 1.0
- CreationTime: Time when the file is created
- CreatorApplication: N.I.N.A. - Nighttime Imaging 'N' Astronomy

OBSERVATION NAMESPACE

Time

- Start: UTC time at exposure start

Location

- Elevation: Elevation (currently taken from a connected telescope)
- Latitude: Latitude taken from the astrometry settings
- Longitude: Longitude taken from the astrometry settings

Center

Requires a telescope to be connected

- RA: Current telescope's right ascension coordinates
- Dec: Current telescope's declination coordinates

Object

Available when a target is set inside a sequence.

- Name: Name of object
- RA: Right ascension of target
- Dec: Declination of target

Meterology

Requires a weather data source to be connected

- RelativeHumidity: Relative humidity percentage
- AtmosphericPressure: Air pressure in hPa
- AmbientTemperature: Ambient air temperature in Celsius
- WindDirection: Wind direction: 0=N, 180=S, 90=E, 270=W
- WindGust: Wind gust in kph
- WindSpeed: Wind speed in kph

INSTRUMENT NAMESPACE

- ExposureTime: Exposure duration in seconds

Camera

Requires a camera to be connected

- Name: Name of camera
- Gain: Electrons per A/D unit (only available for some cameras)
- XBinning: X binning factor
- YBinning: Y binning factor

Sensor

Requires a camera to be connected

- Temperature: actual sensor temperature (requires a cooling unit)
- XPixelSize: Pixelsize
- YPixelSize: Pixelsize

Telescope

Requires a telescope to be connected

- Name: Name of telescope
- FocalLength: Focal length (taken from equipment options)
- Aperture: Focal length / Focal ratio (taken from equipment options)

Filter

Requires a filterwheel to be connected

- Name: Current active filter

Focuser

Requires a focuser to be connected

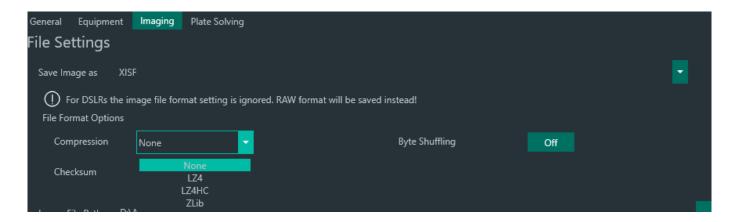- Position: Current step position

> **Tip**
>
> Additionally all information that is explained in the FITS description is stored using the FITSKeyword Core Element.

COMPRESSION

N.I.N.A. offers the possibility to use compression algorithms to try to reduce the file size of your images. There are three algorithms available:

- LZ4: This algorithm is optimized for speed. While not as potent as Zlib it is dramatically faster and will result in an acceptable amount of compression most of the time
- LZ4HC: Basically the same algorithm as LZ4 but with a higher compression rate. A bit more computational heavy than just LZ4.
- Zlib: This algorithm will yield the highest compression result in most scenarios, but takes a long time to process and is by far the most computational heavy algorithm.
- The option for byte shuffling will re-arrange the actual data in an attempt to optimize it for the compression. In most scenarios this will result in a better compressed result, but is a bit more computational heavy.

> **Tip**
>
> For a more in depth info on how the compression works refer to the XISF Data Block Compression

CHECKSUM

This option will store a checksum value into the XISF file to be able to validate data integrity.

> **Tip**
>
> For a more in depth info on how the checksum works refer to the XISF Data Block Checksum

1.5.9 Guiding

Overview

Telescope mounts inherently have imperfections that prevent them from perfectly tracking objects in the sky as the Earth rotates. These issues include: * Imperfect polar alignment * Mechanical errors in drive gearing * Wind and other environmental conditions
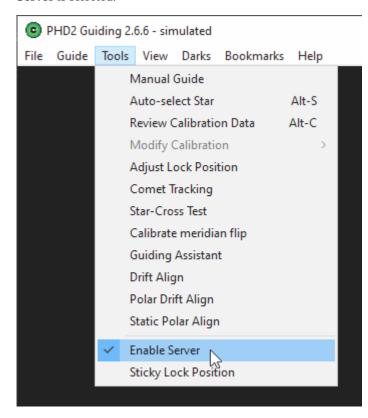
One way of countering these issues to improve long exposure quality is to use a 2nd camera, a guide scope or Off-Axis Guider, and a **Guiding Application**. It works by locking onto a guide star and sending small corrections (pulses) to counteract guide star movements. N.I.N.A. supports the following **Guiding Applications**: * PHD2 * MGEN2 * MetaGuide * Direct Guider

PHD2

PHD2 is the most commonly used guiding application. It is free and open source, and can be found here.

PHD2 SETTINGS

In order for N.I.N.A. to communicate with PHD2 and command operations such as dithering and for receiving guiding telemetry, PHD2's internal server must be enabled. To enable PHD2's internal server, go to PHD2's **Tools** menu and ensure that **Enable Server** is selected.

There are numerous tutorials online for setting up PHD2. One nice feature N.I.N.A. provides is that it can automatically start PHD2 and connect to it after you've set it up the first time.
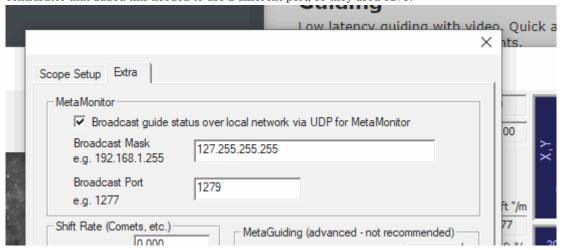
MetaGuide

MetaGuide takes a different approach to guiding than PHD2 by using Lucky Imaging. It is free, and provided by Frank Freestar8n here.
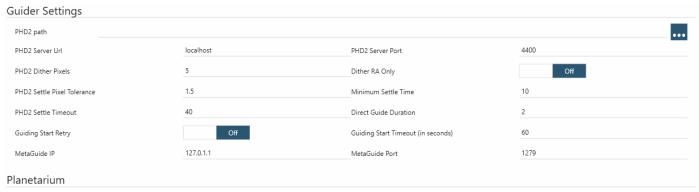
METAGUIDE SETUP

MetaGuide setup is more involved than PHD2, so be sure to carefully read the documentation. After you've set it up, you can do the following to connect it to N.I.N.A.

1. Enable the MetaMonitor server. Using a Broadcast Mask of 127.255.255.255 enables connections only over the local PC, which is what we recommend for security. The Broadcast Port default is 1277, but if this doesn't work for you, try another port. The N.I.N.A. contributor that added this needed to use a different port, so they used 1279.
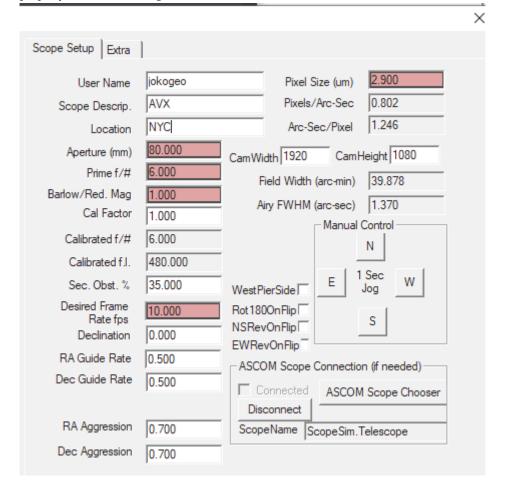

2. Set IP and Port in Equipment -> Guider Settings. The IP address should be 127.0.0.1 if you're following our recommended Broadcast Mask.
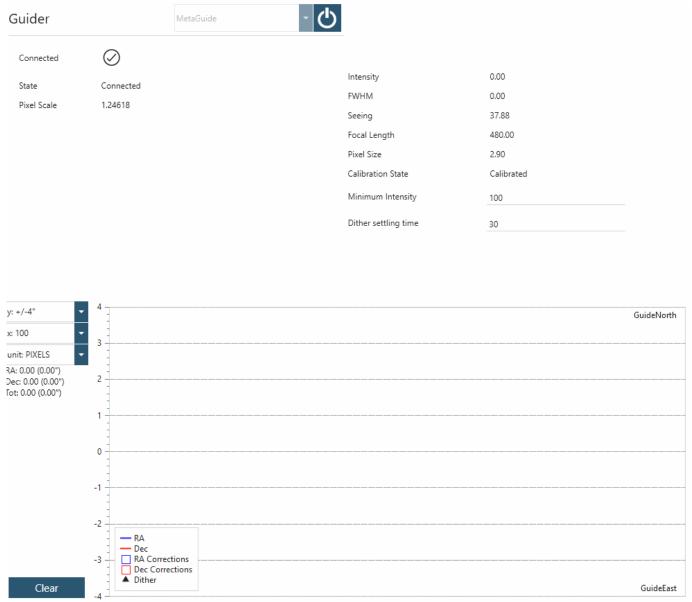

3. Make sure Pixel Size (um), Aperture (mm), and Prime F/# are configured properly based on your guide camera and scope. Pixel Scale (arcseconds per pixel) is based on these settings, and N.I.N.A. uses the Pixel Scale reported by MetaGuide to interact with it

properly (such as dithering the correct amount).

METAGUIDE EXTENDED STATUS

N.I.N.A. provides the same tracking accuracy and status information for MetaGuide that it does for PHD2 as well as some additional information specific to MetaGuide.

1. **Intensity** is a value from 0-255 that represents saturation of the selected guide star. You typically want this close to 255, and could reduce exposure duration in MetaGuide if you're fully saturated. The value can drop during guiding when clouds come in, which is where the next setting comes in.

2. **Minimum Intensity** is the lowest value for **Intensity** that N.I.N.A. will allow guiding to continue. If the **Intensity** falls below this threshold for a few seconds, then guiding will pause until **Intensity** is restored

3. **Dither Settling Time** is how long N.I.N.A. will wait after triggering a dither to resume imaging. This differs from PHD2 which tells N.I.N.A. when guiding has settled after dithering. You'll likely need to tune this based on how your mount behaves in practice.

1.5.10 Plate Solving

Overview

Plate solving is a method used to determine exactly where the telescope is pointing in the sky by comparing the star field in an image to a database of star positions. Upon matching the image's stars, the plate solving application returns the right ascension (RA) and declination (Dec) of the center of the image. N.I.N.A. understands this output, and may be used to synchronise the mount to that coordinate. This gives the mount a very accurate notion of where it is pointing in space, making subsequent slews very precise.

> 🔥 **Important**
>
> Plate solving requires that your camera and telescope settings are correct. The two important settings are the camera's sensor pixel size and the focal length of the telescope. N.I.N.A. will usually be able to detect the sensor's pixel size, but the user **will** need to inform the software of the effective focal length of the optical path. This includes the focal length of the telescope itself and any focal length-affecting devices such as reducers, telecompressors, or barlows.

Manual Plate Solving

To manual trigger plate solve of an image you need to use the Plate Solving tool in the image panel. There clicking on the play button a new image will be captured and solved based on the given parameters. Should the solve attempt fail, N.I.N.A. will prompt if the Blind Solver should be used to solve the image. The reason for this is that while most plate solving software is quite good, none are infallible. Where one fails to solve a given image, another might succeed. Thus, the Blind Solver acts as a back up method.

Before being able to plate solve N.I.N.A., any setup that the primary and blind solvers require must be done in accordance with their respective instructions.

> 🔥 **Tip**
>
> In the event that both the Primary and Blind plate solving applications fail to produce a result, please verify that your image is in focus and, if necessary, increase the exposure time or change the filter type to allow more stars to be adequately exposed. Furthermore the last failure is stored in `%LOCALAPPDATA%\NINA\PlateSolver\Failed` to analyze why it failed

To apply the plate solving results to your mount, you need to enable the Sync option and, if desired, the Reslew To Target option in the Plate Solving panel. The former will synchronize your mount's notion of its pointing position to the position that the plate solver has determined is it pointed. The latter option will make N.I.N.A. slew your mount to the location where it was supposed to be in the first place. This allows skipping the star alignment process that is typically done during a mount's start-up process. For a precise centering with a given error margin use the "Repeat until error <" option.

Automatic Plate Solving

Plate solving is also utilized in the Sequencer to center on a given target and Automated Meridian Flip feature to recenter the scope after a flip occurred. Here plate solving will be triggered automatically and the parameters are used from the Plate Solving Options. This is essential for a hands-off operation of N.I.N.A. and it is recommended that the application is set up to have a blind solver, should the preferred primary plate solver not work as expected.

Important Parameters for Platesolving

In order for plate solving to work properly a couple of important parameters have to be set as precice as possible. When these deviate to some degree from the real world hardware, platesolving software will have a hard time solving the image or even fail all the time.

1. Camera Pixel Size
   Go to Options->Equipment->Camera section, the pixel size needs to be entered in micrometers.

2. Telescope Focal Length
   Go to Options->Equipment->Telescope section and set the focal length of your telescope in millimeters. The value has to be the **effective focal length** considering all correctors and optical elements that could shift the overall focal length

> **Tip**
>
> If you are unsure about the effective focal length, you can use nova.astrometry.net to validate your real focal length. Upload a non binned image of a target that used your current setup. Once the image is solved the "Pixel Scale" is displayed. You can extract the focal length now by using the formula
> "Focal Length = (Camera Pixel Size / Pixel Scale) * 206.26"

Plate Solving Software

N.I.N.A. supports the most popular plate solving software suites available, each of which has its own benefits and drawbacks. The following is a list of support plate solving software and their general characteristics.

ASTAP - *RECOMMENDED*

Author: Han Kleijn
URL: www.hnsky.org/astap.htm

The ASTAP (Astrometric STAcking Program) astrometric solver and FITS file viewer is a powerful standalone plate solve application. It is downloaded and installed in two parts - the application itself, and its star database.

Benefits

- Fast

- Reliable

- Capable of fast blind solves even when the mount is far off the expected position

- Does not require an Internet connection

Drawbacks

- Requires precise parameter setup

Recommendation

- Primary Solver: Recommended

- Blind Solver: Recommended

ASTROMETRY.NET (ONLINE)

Author: Astrometry.Net Project
URL: astrometry.net

N.I.N.A. can upload the image to the API servers of Astrometry.Net for them to plate solve it. This requires the user to register for an account on Astrometry.Net and generate an API key that is then entered into the plate solve settings for Astrometry.Net.

Benefits

• Reliable when the mount's location is unknown or far off the expected position

• Does not need to know the camera's sensor pixel size or telescopes focal length

Drawbacks

• Requires an Internet connection

• Slow

Recommendation

• Primary Solver: Not recommended

• Blind Solver: Recommended when an Internet connection is available

---

LOCAL ASTROMETRY.NET (ANSVR)

Author: Andy Glasso
URL: adgsoftware.com/ansvr/

The local Astrometry.Net plate solver needs to be installed separately. It requires download of index files which can be installed through N.I.N.A., as well as the required index files that you need for your combination of focal length and pixel size. See plate solving settings.

Benefits

• Reasonably fast when the mount's location is unknown or far off the expected position

• Fast when the mounts location is close

• Does not require an Internet connection

Drawbacks

• The downloading and installation of the correct and numerous index files is crucial for performance

• Can mistake hot pixels for stars (a possible issue with DSLRs and other noisy sensors)

• Most installer bundles for Windows deliver rather outdated versions

Recommendation

• Primary Solver: Not recommended

• Blind Solver: Not recommended

ALL SKY PLATESOLVER

Author: Giovanni Benintende
URL: astrogb.com/astrogb/All_Sky_Plate_Solver.html

This application is basically a wrapper for the local astrometry.net client.

Benefits

• Much easier to set up than the local astrometry.net client

• Does not require an Internet connection

Drawbacks

• Same as local astrometry.net client, except the setup part

Recommendation

- Primary Solver: Not recommended
- Blind Solver: Not recommended

PLATESOLVE2

Author: PlaneWave Instruments
URL: planewave.com/downloads/software/

PlateSolve2 is a standalone executable which can be downloaded from Planewave's PlateSolve2 downloads page. It requires the download of at least one catalogue of stars so it can properly work. You need to start the executable once standalone and set the catalog location of the catalog that you want to use. Both the APM or UCAC3 catalogues will work fine, but it is recommended to download both of them should you encounter issues with either one of them.

Benefits

- Very fast when the mount's location is close to expected position
- Does not require an Internet connection

Drawbacks

- Slow plate solves when the mount's location is far off the expected position and the focal length of the telescope is long
- The regional settings of windows need to be set to use a point as the decimal symbol

Recommendation

- Primary Solver: Recommended
- Blind Solver: use as a Blind Solver is not possible

PLATESOLVE3

Author: PlaneWave Instruments (Dave Rowe) URL: PlateSolve 3.80 5GB

Nina has kindly been selected to add the new PlateSolve3 program to its arsenal of platesolvers, courtesy of Dave Rowe. PlateSolve3 is a standalone executable which has been improved to work with longer focal lengths and smaller FOVs with fewer stars. This download has the necessary catalogues already added. Just unpack it into a directory of your choosing and point to it in Nina platesolving options.
You need to start the executable once standalone and select File - Configure directory.
Set the GaiaDr2 location to the 'UD Catalog' directory in the unpacked PlateSolve3.80 directory.
Then set the UCAC4 location to the 'Kepler' directory in the same unpacked directory. You will also need to set your location in View - Parameters

Benefits

- Works really well with long focal lengths and small FOVs. Tested up to 12000mm.
- Very fast (blind) solver
- Does not require an Internet connection

Drawbacks

- A little slow to start up.
- The regional settings of windows need to be set to use a point as the decimal symbol

Recommendation

- Primary Solver: Recommended
- Blind Solver: Recommended

1.6 Troubleshooting

1.6.1 General

General Troubleshooting

Should you encounter any bugs during your usage of N.I.N.A, please report them on the project's Issue Tracker or directly to the team on the Discord chat. If possible, attach the latest log file. It is also helpful to increase the application's logging verbosity to **Debug** or **Trace** under **Options > Log Level**. The logging level of *Trace includes the most information and may lead to the accumulation of large log files. Therefore, it is not recommended to leave that level specified under normal conditions.

Log files may be found in the `%LOCALAPPDATA%\NINA\Logs\` folder.

Installation Issues

INSTALLATION FAILS IN GENERAL

Often, Anti-Virus software can interfer with the installation of N.I.N.A. and cause either an aborted installation or an incomplete one. In these cases, it is advisable to disable any AV software temporarily and reattempt the installation. The likelihood of running into installation issues can vary with the number and types of AV software in use, as well as how strict the AV software is set to operate. No significant problems have been encountered on Windows 10 when using only Microsoft's built-in Windows Defender suite.

ERROR: "THE FEATURE YOU ARE TRYING TO USE IS ON A NETWORK RESOURCE THAT IS UNAVAILABLE"

In case you get this error or are unable to uninstall the application, some of the registry keys got corrupted. Follow the advice on the following page to fix the corrupted keys: https://support.microsoft.com/en-us/topic/fix-problems-that-block-programs-from-being-installed-or-removed-cca7d1b6-65a9-3d98-426b-e9f927e1eb4d
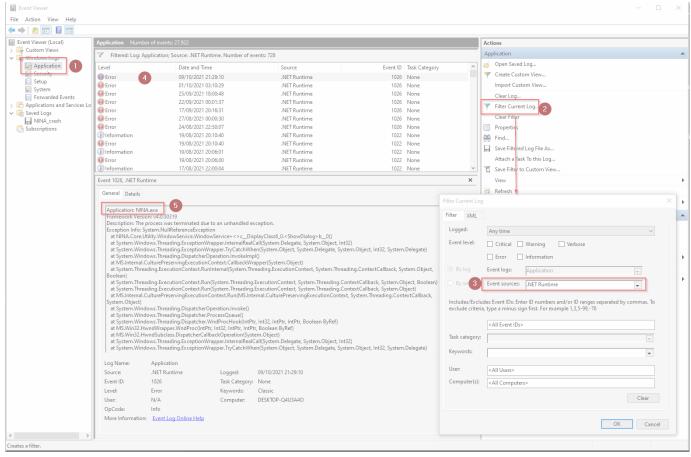
Application Crashes

CRASHDUMP

In case you encounter a hard crash, Windows will create a crash dump file to investigate the problem in detail. Should you encounter such an issue, please provide this crash dump file.

The crash dump may be found in the `%LOCALAPPDATA%\NINA\CrashDump\` folder.

EVENT VIEWER

You can check the Windows Event Viewer for root causes of hard application crashes.
To open event viewer, go to the windows search bar, enter "Event Viewer" and open the app.

Once inside the app, go to the "Windows Logs -> Application" (1). Then go to "Filter Current Log..." (2) and narrow down the "Event Sources" (3) to only select ".NET Runtime" in the pop up window and click "OK".
After the filter is applied, you will find all event source in the list in the middle (4). There head for the message that contains "Appliction: NINA.exe" in the Detail section (5). This will show the complete stack trace of why the application crashed. This is useful information that can be posted to the contributors that can analyze this further.
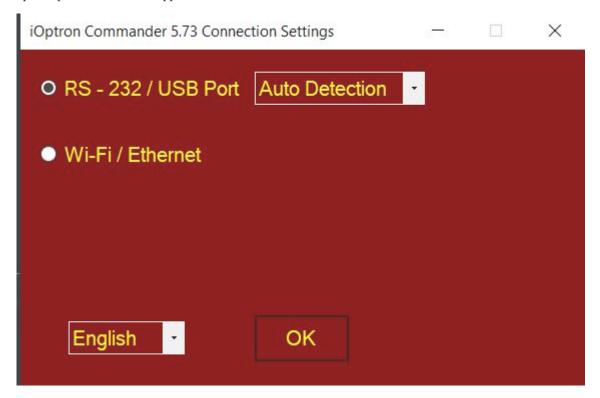
1.6.2 iOptron Mount Setup

These notes are intended to be a quick reference to the usage of iOptron mount and N.I.N.A. for DSO imaging.

This guide is based on iOptron ASCOM Commander v 3.73

Set up your iOptron mount

To connect your mount first make sure the mount is powered and properly connected to your PC (refer to iOptron manual), then open iOptron Commander app and click on connect mount.

Once the mount is connected, open Mount Panel.

Here you want to define a couple of parameters under Preferences tab (please note all these parameters can be configured from the handset as well):
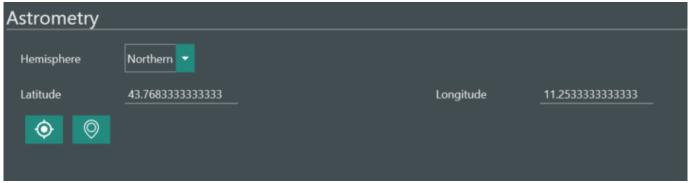
- Tracking rate: set to Sidereal for DSO imaging

- Guiding rate: this is the speed used for guiding pulses (e.g. from PHD2). Typical values are 0.50x to 0.75x sidereal, experiment to find the best value for your setup. Usually you want RA and DEC to have the same guiding speed (tip: remember to re-calibrate PHD2 if you change this parameter).

- Meridian Behavior: this defines what the mount will do when passing the meridian. Since you want N.I.N.A. to manage a meridian flip, do not select "Flip at Designed Position". The alternative "Stop ad Designed Position" will stop the mount tracking after meridian is passed according to the value set in "Degree(s) Past Meridian". This is a safety measure to prevent the mount/OTA from crushing into the tripod/pier. Consult your iOptron mount manual to check how many degrees it can track past meridian. Typical values are from 10 to 15 degrees, equal to 40-60min after meridian passing (remember at Sidereal rate 1°= 4min). Set a value you are comfortable with from 0° to the max of your mount's limit. Note: remember this value as this may affect your Meridian Flip settings in N.I.N.A., see section 2

Click "Apply Settings" and close

Configure N.I.N.A.

a) Launch N.I.N.A., Epoch to JNOW is automatically detected. Set hemisphere, Lat and Long according to your location (when you connect the mount, N.I.N.A. will ask you if you want to sync Lat and Long from the mount if it has an integrated GPS)
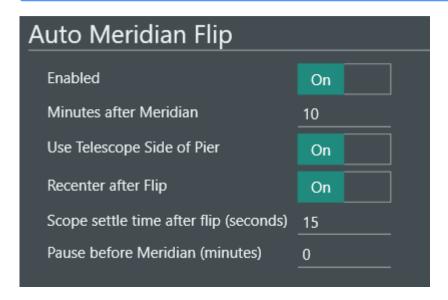
b) In Options>Imaging>Auto Meridian Flip you can define the mount behavior at meridian passing. Please refer to N.I.N.A. documentation here for a detailed description of each parameter.

- Set Enable to "On", this will enable Auto Meridian Flip
- Minutes after meridian defines how many minutes to wait after meridian is passed before N.I.N.A. will initiate the Flip sequence
- Set Use Telescope Side of Pier to "On"
- Set Recenter after Flip to "On". This will platesolve and accurately recenter the scope to the target after the flip
- Scope Settle Time after flip (seconds): set a value from 15 to 30 sec
- Pause before meridian (minutes): if this is set to any n value >0 N.I.N.A. will stop the mount tracking n minutes before meridian passing. Usually you want this enabled when you need time to perform some tasks at the mount before the meridian flip, for example if you need to adjust cabling to prevent them from snagging. If your mount can pass meridian with no problem, then leave it to 0.

> **Notice**
>
> When Pause Before Meridian is set to "0" the mount will keep tracking past meridian until the Minutes after meridian is reached. Make sure that the time you set in Minutes after meridian is shorter than what you set in iOptron Commander, otherwise your mount will stop before N.I.N.A. can perform the flip. For example, if you set 2 degrees (8 min) in iOptron Commander and 15 minutes in Minutes after meridian in N.I.N.A., iOptron Commander will stop the mount 8 minutes after meridian is passed and N.I.N.A. will not be able to perform the flip procedure.

c) Under Equipment>Telescope select iOptron ASCOM Driver for Mount, click on the connect symbol and enjoy our imaging session!
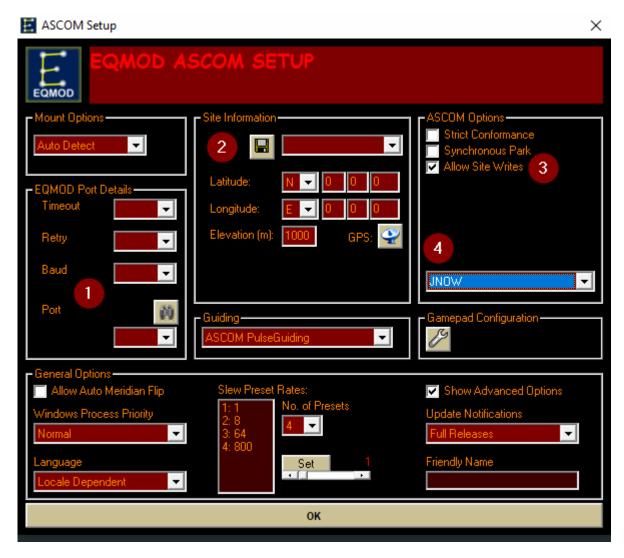
1.6.3 EQMOD Setup

In order for N.I.N.A. to work well with EQMOD some basic settings are recommended.

Setup Screen

To open the setup for EQMOD, select the EQMOD entry in the equipment page and click on the gears icon.

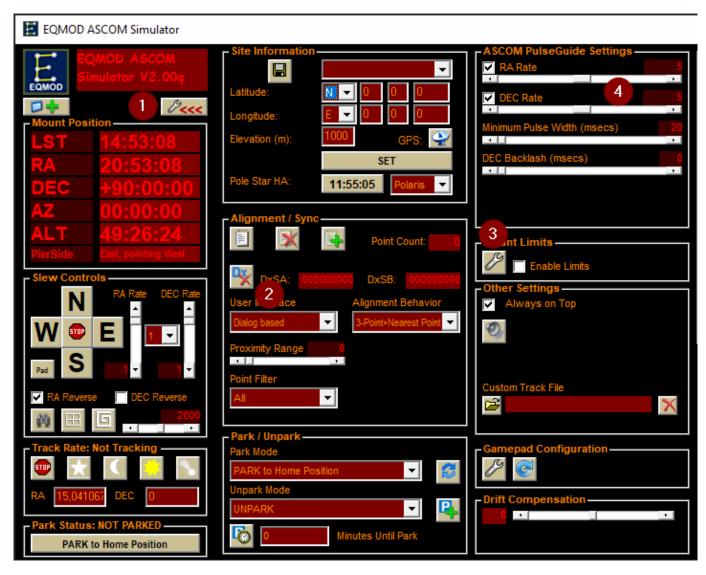A new window will open with the following screen.

Inside this screen fill out the information marked in the screenshot above

1. The Port that your mount is connected to according to the Windows Device Manager

2. Your location information

3. Check to allow site writes, which will allow to sync your location from N.I.N.A. to the telescope, in case you have maintained your location in N.I.N.A. already

4. Change the Epoch setting from Unknown to JNOW

Connection Screen

After these first steps have been filled out correctly you can then proceed to connect to the mount. Once connected EQMOD will launch a separate window showing the current Telescope status. There you need to further adjust some settings.

1. Expand the Telescope panel to reveal the advanced options

2. Set 'User Interface' to Dialog based, which is required when using Plate Solving in N.I.N.A. to properly sync coordinates to the mount

3. Adjust your limits to match your equipment. The limits should be set in a way to not trigger before the time N.I.N.A. issues a meridian flip (which depends on your flip settings in N.I.N.A.), but rather should be the fail safe when something goes wrong

4. In case you are using some guiding software like PHD2 the recommended PulseGuide Rate should be set to at least 0.5, but more likely 0.9 will work best for both RA and DEC
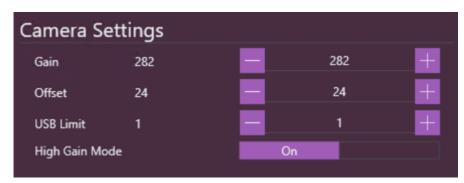
1.6.4 Altair Dual Gain

Introduction

Dual gain cameras from Altair include the 294C and the new 269C. These cameras have two gain settings, LCG (Low Conversion Gain) and HCG (High Conversion Gain). The High Conversion Gain mode effectively gives a gain boost, by a multiplier (usually x2). Cameras using the same dual-gain sensors from most other manufacturers have these settings hidden in their driver; they automatically switch at a certain gain setting, and if you analyse the sensor you can see where it happens. Altair cameras do not make this switch automatically, which is why this technote exists.

Configuration

If your Altair camera has a dual-gain sensor, an option for High Gain Mode will appear in the Camera Settings screen. The default is to use High Conversion Gain. To change from HCG to LCG, simply flip this switch. Like all Camera Settings, once set this will be remembered - so if you swap to LCG to "just try something out", make sure to switch back to HCG once you have finished testing!

Note that switching from HCG to LCG or vice versa does not change the gain value that you have set anywhere else in N.I.N.A. - for example, if you have a sequence set up to take images at gain 430, the camera will be instructed to use gain 430 irrespective of the high/low gain toggle. The same is true for any location in N.I.N.A. where camera gain is set (including the imaging tab, platesolving, autofocus, etc).

Comparison with Other Imaging Software

N.I.N.A. presents Camera Gain to the user in exactly the format that the camera SDK returns. For other brands of camera which automatically switch from LCG to HCG and back, the switch is inherent in the value and transparent to the user. In those cameras, it is impossible to use LCG above the switch point or HCG below the switch point. Altair cameras however allow you the flexibility to use whichever combination you desire, and this is why N.I.N.A., in common with many other suites of Imaging Software (including Altair's very own AltairCapture program), presents the raw Gain value and offers a manual switch to toggle between LCG and HCG.

There is one major piece of imaging software which does not present a manual switch: SharpCap. In order to try and be consistent with the other brands of camera that automatically switch their dual-gain sensors from LCG to HCG, SharpCap implements logic to automatically perform the switch. The way it does this is to present a single scale with the multiplier, above which point HCG is automatically enabled. This is best explained by means of an example.

Example: The Altair 269C

Let's take as our example the Altair 269C, a camera which uses the dual gain IMX269 chip from Sony. This camera has a HCG/LCG switch with a multiplier of x2 and reports gain values of 100-2000. Sharpcap performs the following logic:

- For gain 100-199, use LCG mode
- At gain 200 and above, switch to HCG mode
- Once in HCG mode, go up to gain 2 x max normal gain

This means that SharpCap is able to present this camera as having a single gain setting of 100-4000, even though the camera itself only presents values of 100-2000 for gain. This is roughly equivalent to what the manufacturers of other camera drivers do in their SDK.

This approach does make a lot of sense. In practise it is unlikely that anyone would want to use LCG except to access the lower gain levels and get the maximum possible dynamic range and well depth from the camera. Once gain reaches the point at which the camera gain can be divided by two and HGC enabled, using HCG gives better results with significantly lower read noise.

So what does this mean for N.I.N.A. and other software which allows the user the full flexibility that the camera maker provides via the SDK? Well, it means that SharpCap gain values will be different to equivalent gain settings in N.I.N.A., which is important because SharpCap contains a very powerful sensor analysis routine which is often used to calculate unity gain or make decisions about what gain settings to image at based on well depth and read noise. In order to use SharpCap gain values in other software for these dual-gain altair cameras, we will need to translate the values.

Going back to our Altair 269C, SharpCap presents "Unity Gain", where one electron produced in a pixel results in 1 ADU at the ADC output, as being approximately Gain 564. To set an equivalent gain in N.I.N.A., the user would have to halve this value (as it is above 200, the point at which SharpCap automatically switches to high gain mode) and switch to High Conversion Gain. Thus Unity Gain for the Altair 269C is 282 HCG.

Known Altair dual-gain cameras

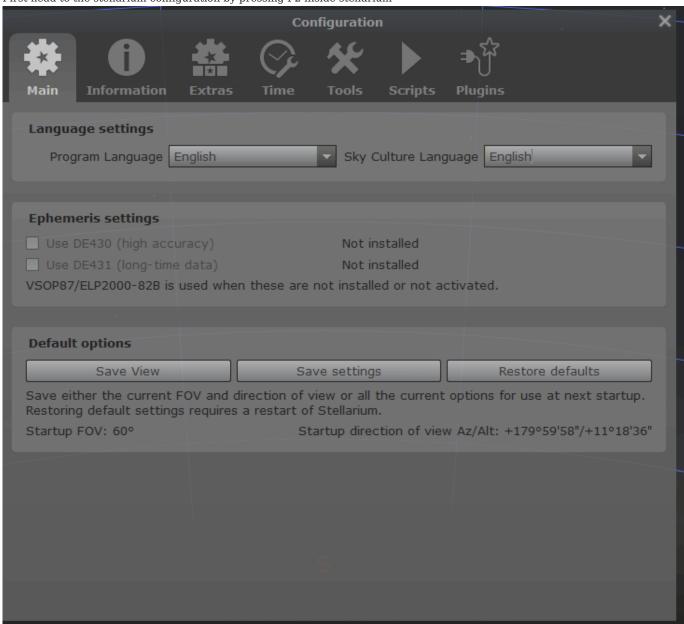At time of writing, the following dual-gain Altair cameras exist:

Camera	Sensor	Multiplier
269C	IMX269	x2
290(M/C)	IMX290	x2
294C*	IMX294	x4.5
385C	IMX385	x2

*note that the 294C should not be used with HCG below a native gain of 200 as the sensor will fail to fully saturate (the histogram will look unsaturated, but it will really be saturated, which will make flats extremely problematic!)
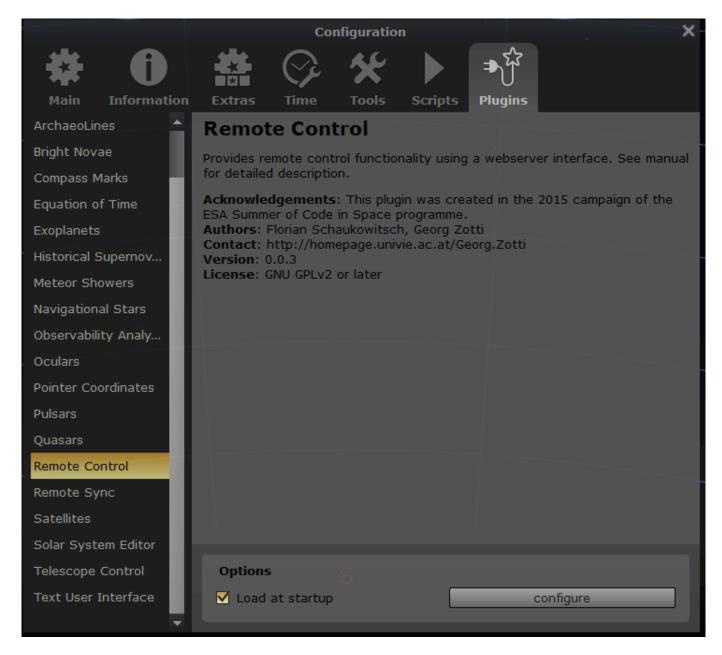
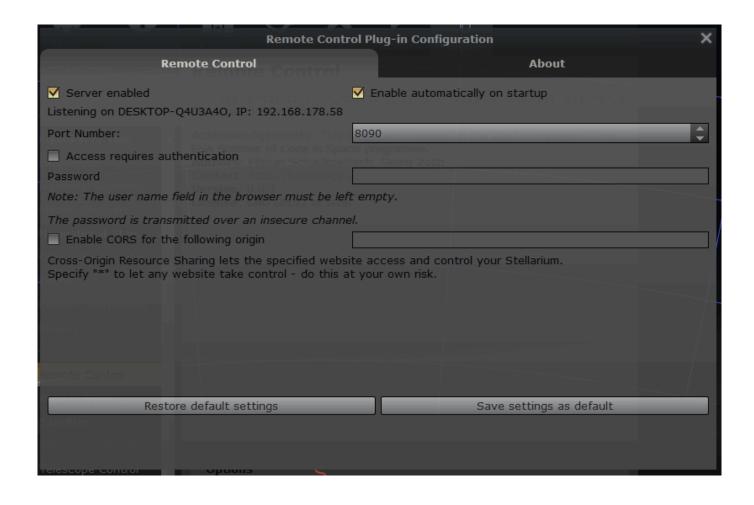## 1.6.5 Setting up planetarium software

Stellarium

For Stellarium being able to sync coordinates to N.I.N.A. the remote plugin needs to be enabled and the server started.
First head to the stellarium configuration by pressing F2 inside stellarium

Head to the plugins tab, search for the "Remote Control" plugin and select it.
On the right side, check the "Load at startup" option.

Once the plugin is enabled, you also need to enable the plugin server. To do so, click on the "configuration" button and check "Server enabled" as well as "Enable automatically on startup" to not have to do this each time.

Remote Control Plug-in Configuration

Remote Control	**About**

☑ Server enabled   ☑ Enable automatically on startup

Listening on DESKTOP-Q4U3A4O, IP: 192.168.178.58

Port Number: `8090`

☐ Access requires authentication

Password

Note: The user name field in the browser must be left empty.

The password is transmitted over an insecure channel.

☐ Enable CORS for the following origin

Cross-Origin Resource Sharing lets the specified website access and control your Stellarium.
Specify "*" to let any website take control - do this at your own risk.

Restore default settings	Save settings as default

1.6.6 QHY Driver

As of N.I.N.A. 1.11 version 21.3.13.17 of the QHY SDK is included with N.I.N.A.. Starting with this SDK version, you will need to make sure that your QHY USB driver is updated to at least version 21.2.20 or later by installing the latest QHY driver All-in-One pack. This is because the version of QHY SDK that N.I.N.A. ships with and QHY USB driver saw a portion of their Cypress FX3 IO libraries updated and the two must stay in sync.

To help with this requirement, these versions are included in the Equipment > Camera screen. Additionally, N.I.N.A. will emit a warning level notification if the detected driver version is lower than 2.1.20:
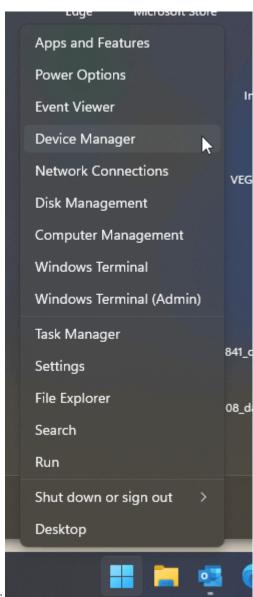
The benefits of this update include improved USB error recovery. This requirement does not apply to cameras that have USB2 interfaces (CCDs, A-Series, and QHY5II 1.25″ cameras).

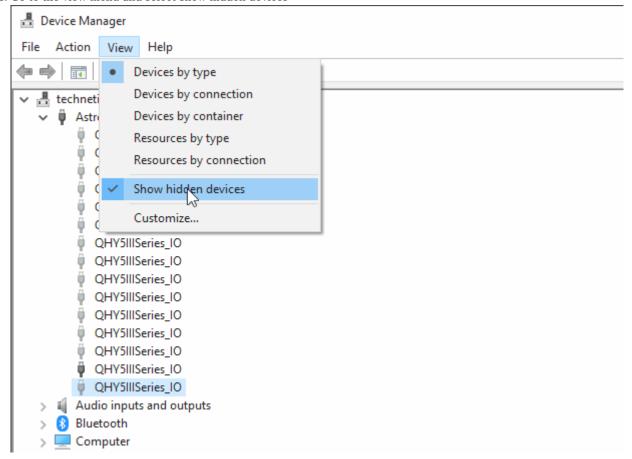**IN CASE OF USB DRIVER UPDATE PROBLEMS**

Some folks have experienced issues updating the USB driver, where it appears that the driver update did not take. There is one thing to try if this is the case:
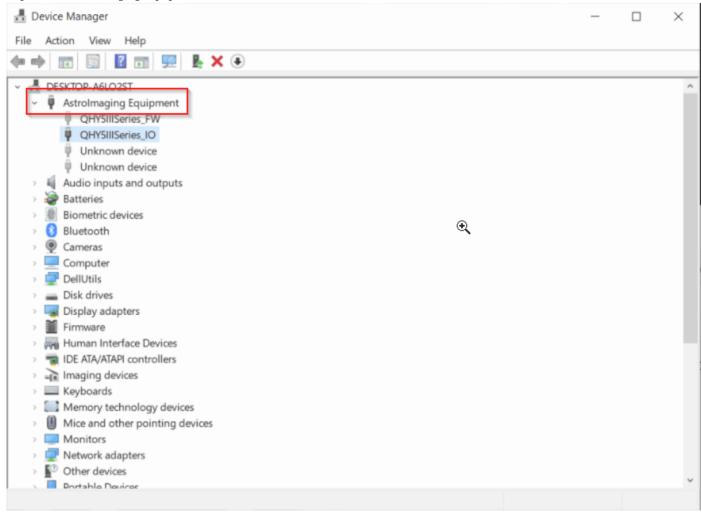
1.

With the camera **disconnected**, right click start and open Device Manager

2. Go to the view menu and select show hidden devices

3. Expand the AstroImaging Equipment section

4. Right click **QHY5IIISeries_FW**, select Properties, and then the Driver tab

5. Press the Update Driver button, and select search automatically for drivers

6. Also do steps 4 and 5 for the **QHY5IIISeries_IO** device

7. Plug in the camera. Verify that it is on the newer device driver version

> After the above steps are done, and barring any deeper issues, the driver and firmware loader for the camera should be updated to the version that was installed. QHY are aware of this issue and are looking into it.
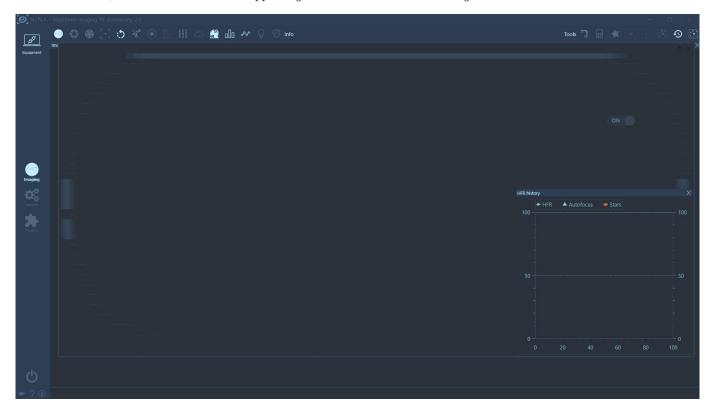
1.6.7 Display Issues

Blank screen when using remote access

When you are experience a blank screen of N.I.N.A. during usage of a remote access software it is most likely caused by not having any screen connected at the target machine. As N.I.N.A. is hardware accelerated and Windows will not render anything that is hardware accelerated when no display is connected, the application will be just a blank screen. To get around this issue, you can disable hardware acceleration in N.I.N.A. by navigating to Options > General > Advanced > Hardware Acceleration and setting it to off. After a restart the application should now show properly when using the remote access software.
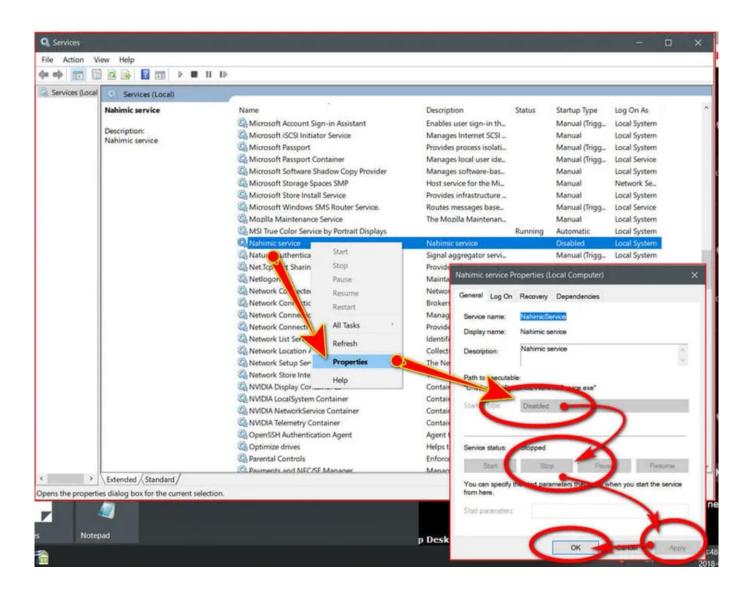
Artefacts and missing graphics

In the past there were reports where the application was not rendering correctly. Follow this guide if your applicaiton looks like the window below, where some icons are disappearing and windows are not rendering:

It has been identified that there is an audio driver service called "Nahimic service" responsible for causing side effects on WPF applications. (WPF is the User Interface framework that N.I.N.A. is built on). Once this service is stopped, the application will render correctly again.

To disable the service:
- Open the Windows Run menu by holding the keys ⊞ Win + r
- Enter "services.msc" into the window and hit "Ok"
- A new window will open showing all available services.
- Check for a service called "Nahimic Service" and follow the steps in the screenshot below

1.6.8 Folder browser only showing desktop

In case you run into the issue where the folder browser only lets you choose from the desktop you can fix it by going through the steps described here:

https://www.winhelponline.com/blog/browse-for-folder-dialog-empty-in-windows-11/

Basically this is caused by a bug in the Windows 11 22H2 build and is fixed in a later patch.
To get around the problem you need to disable OneDrive sync for the desktop folder.

1.7 Glossary

The following is a list of terms and abbreviations found throughout the documentation with their meanings.

Term	Description
ADU	Analog Digital Unit. The lightness value of pixels.
ASCOM	Astronomy Common Object Model. A Windows-centric API for astronomy-related device drivers.
Bahtinov Mask	A mask which has a specific pattern of light-diffracting openings that may be used to aid in achieving precise focus. Invented by Pavel Bahtinov in 2005.
Dithering	Moving the guiding output by a few pixels thereby shifting how light falls on the sensor. This technique minimizes fixed noise patterns and missing data due to hot or cold pixels.
DSO	Deep Space Object. Anything that is not an individual star or a Sol system object.
DSLR	Digital Single Lens Reflex Camera. Typically a hand-held camera with interchangeable lenses and a mirror for the viewfinder.
GEM	German Equatorial Mount. A common mount design.
Guiding	Using a second camera to lock on to a specific star. The star then acts as a reference point for correcting any unwanted mount movement.
HFR	Half-Flux Radius. A measurement (in pixels) which determines how focussed the average star is. Lower values indicate sharper stars. Focus precision and seeing conditions both affect HFR values.
J2000 and JNOW	Epochs (temporal reference points) based on the position of stellar objects as they were at January 1, 2000 11:58:55.816 UTC (J2000) or at the current moment (JNOW). It is expected that the next epoch will be J2050.
LRGB	Luminance, Red, Green, Blue. A typical color filter combination for creating color images using a monochrome camera.
OSC	One-Shot-Color. An astronomy camera equipped with a color sensor.
Plate Solving	Determining exactly where a telescope is pointing in the sky by comparing an image's stellar field to a database.
SNR	Signal to noise ratio.

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2. Quick Start

2.1 UI Overview

Once you start N.I.N.A. for the first time you will be greeted with this screen. Let's go over the basics for a moment to accustom you with the usage of this software.

The UI is divided in 2 panes. On the left side tabs section (1) you will find all the necessary tabs to connect your equipment, on the right side you usually find the detailed information about the currently selected tab. The currently selected tab is highlighted on the left side (1) so you always know where you are. Feel free to click through all of them; the detailed descriptions for all tabs are provided in the Tabs section. For now let's assume you have a One-Shot-Color camera and mount with no filter wheel or any extras and just want to start a legacy sequence.
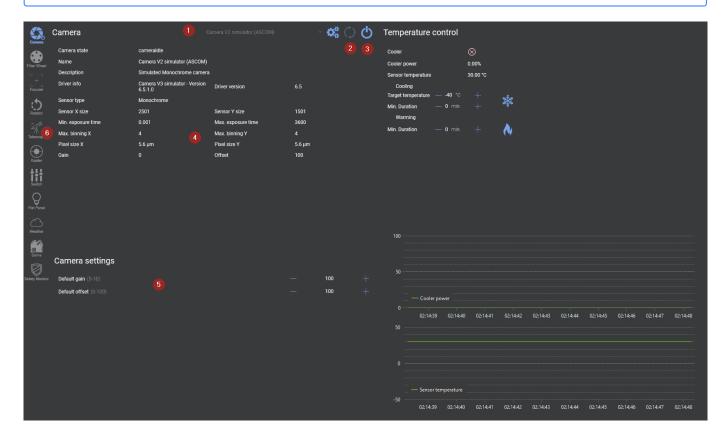
> **Note**
>
> This Quick Start guide assumes you know how to connect your equipment to the computer and have the appropriate drivers for ASCOM and your camera (if necessary) already installed. If you do not, don't hesitate to ask us on the official N.I.N.A. Discord server.

2.2 Connecting Your Equipment

Let us focus now on connecting your camera and mount for the first time.

> **Note**
>
> You should have physically connected your camera and mount to the PC N.I.N.A. is running on already. If you did not, connect it now.

You need to select your camera in the drop down menu (1). If it does not appear in the list press the refresh button (2). Some cameras require a driver to be installed before being able to see them in the list.
Once you selected your camera press the Connect button (3) to connect the device.
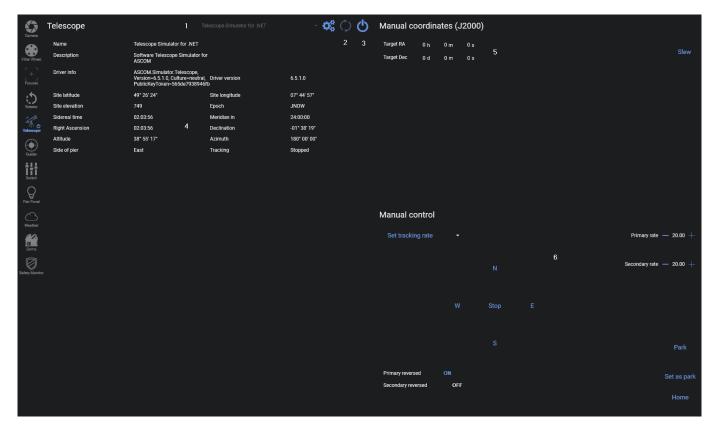
Once your device is connected it will display various information about the camera (if available) in the camera section (4).

> **Note**
>
> Keep in mind that if you are using a DSLR the information might be incomplete or missing. That doesn't deter N.I.N.A. from working, but should you need to find the information you have to look for it online.

When you connect a camera that has the ability to change the gain (ISO) it will be displayed in the camera settings section (5). This is the default gain that will be used and can be overridden by settings during imaging later.

Once you connected your camera you also need to connect your mount. For that we have to switch to the telescope tab (6).

Here we have the same procedure to connect the mount as we have with the camera. Select the mount from the dropdown (1), refresh if not available (2), and press connect (3) to connect to the mount.

In the Telescope section (4) you will find useful information about the latitude, longitude, elevation, sidereal time and when it will arrive at the meridian. You can manually slew to specific coordinates with (5) or control the mount manually in the Manual Control section (6). This is very useful if you do not use a hand controller with your mount.
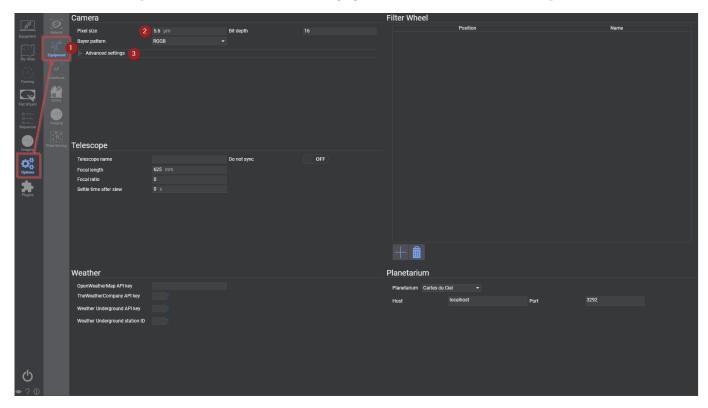
> **Tip**
>
> The time to meridian depends on correct latitude and longitude settings!

2.3 Finalizing Settings

This whole setup routine only has to be done once for a specific profile. Once you have your default mount and camera set up you just need to press the connect button on the lower left after N.I.N.A. is started up to connect to the saved equipment automatically.

We have a few small steps to do before we can start with imaging. For that we need to switch to the options tab.

In the options we go directly to the Equipment tab (1) and have to set a few things first. You should set your pixel size to the pixel size that your camera has, if it has not been set automatically, which is the case with most DSLR and some ASCOM drivers. Search online for the pixel size of your camera and enter the value in (2).
Bit depth will be kept at 16 bit for most cameras, as this does not refer to the sensor bit depth but at the actual raw data depth that the camera driver produces. Most drivers will scale this automatically to be 16 bit. In case you are using a DSLR and have the raw converter selected to be "FreeImage" (in the advanced settings) then you need to enter the real bit depth of your camera instead!

> **Tip**
>
> If you have an older Nikon camera you might not be able to use the native bulb mode, controlled via USB, for exposures that are longer than 30 second. If you have a RS232 (serial) shutter cable or your mount has a camera shutter control port, change the **Bulb Mode** inside the advanced settings (3). Please refer to the Advanced topic using RS232 or mount for bulb shutter.
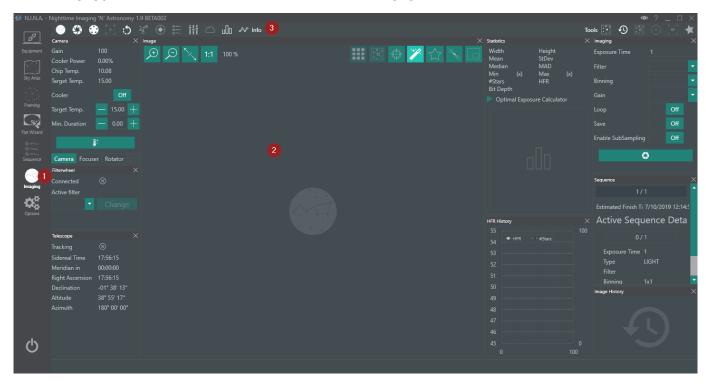
Now we have to set a few other image saving related settings as well. To do that switch to the Imaging tab (1). The images can be saved as TIFF (with two different compression algorithms, too), XISF and FITS (2). FITS is a solid format that can be read by all astronomy related software and this setting can be left unchanged. Feel free to change it though should you prefer a different format.

Next you need to set the Image File path (3). This is the place where your images will be saved. And finally, if you want you can change the Image File Pattern (4). This is how the images will be named after. You can see variables that you can use below the panel and below the pattern you can check how your file pattern will look like. You can leave this setting on default or customize it as you like.

Once you have done that we can move on to to focusing and starting a sequence.

2.4 Focusing
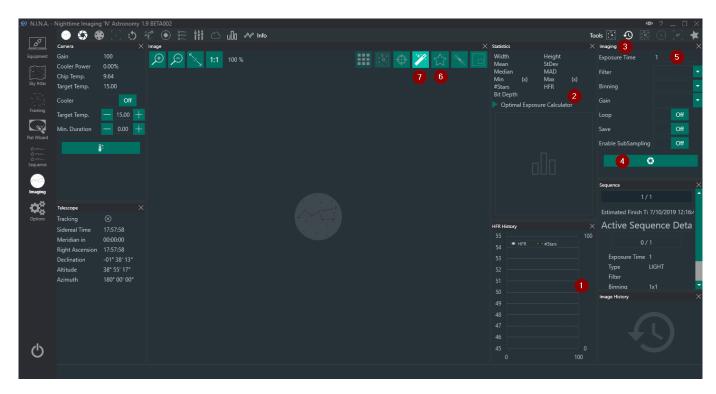
To start imaging you first want to focus. For that, let's switch to the Imaging tab (1).

Once there, you will be greeted with this view. There is a lot of information and panels around, but in general it's divided in two spaces. First, where you can view and interact with the panels (2) and a second where you can enable and disable various panels (3). Since we only use a One-Shot-Color camera and a mount let us disable a lot of those panels to get a better overview. Feel free to enable and disable your panels at will, in this example I will disable the following panels by clicking on their icon:

You can leave those panels enabled, or disable any other at your will. Feel free to experiment around to see what you like. You can also drag the panels around inside the imaging window and rearrange and customize your look and feel. For tutorial reasons, I will leave that be for now.

Since our target now is to focus our telescope to get pinpoint stars, we have to use the following currently enabled panels.
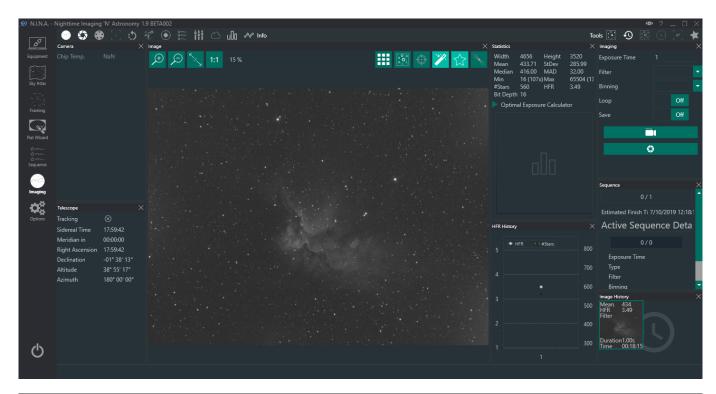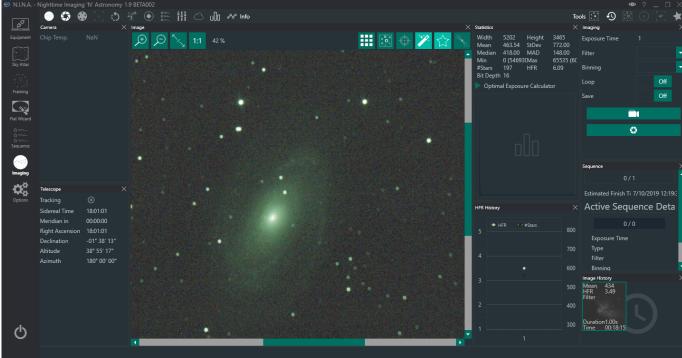
> **Tip**
>
> An alternative to focus is to use a Bahtinov Mask. You can try our experimental feature for Bahtinov Detection by enabling the icon in the Image panel.

With the HFR History (1) you will be able to see how your stars perform in terms of HFR. This is also represented in the Statistics panel (2). The lower your HFR value, the better focused your image will be. To start the manual focus procedure, you have to select the Imaging tab (3) and press on the start capture button (4). Your exposure time for that snapshot can be adjusted as well, should you choose to do so (5).

To enable star detection and HFR analysis, you need to press on the Star Analysis button (6). This will yield a full analysis of the image and will enter the HFR values in the Statistics (2). You will notice that the AutoStretch button (7) will be enabled as well once you enable the Star Analysis button (6).

Here are two examples of a focused and defocused star field.
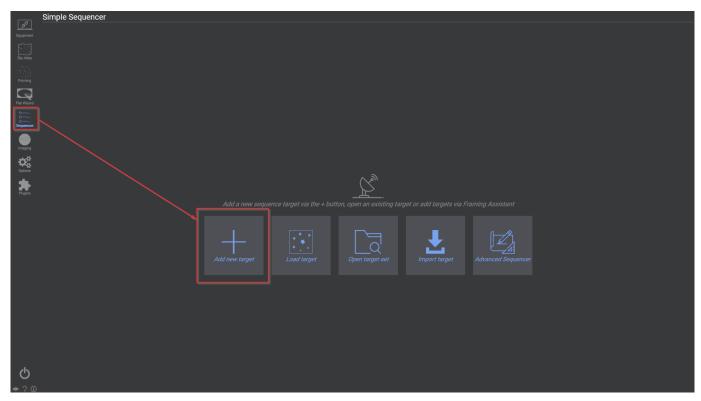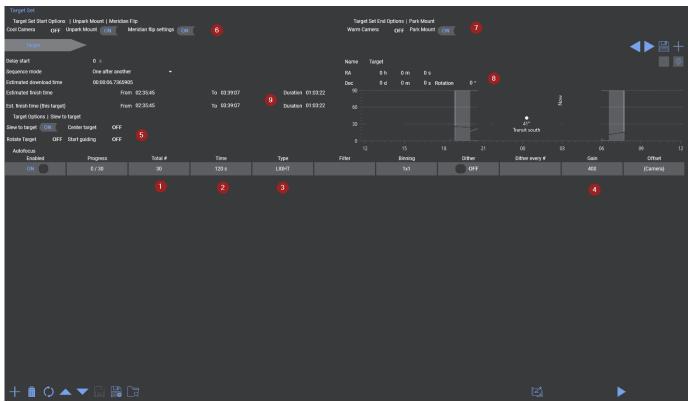
As you can see, the values for HFR have been entered in the statistics. The second image is definitely defocused with a HFR of 6.09, while the first image is in as good focus as possible. Your HFR values will vary because they depend on the focal length of the telescope as well as on the pixel size of the sensor, but you should try and focus your telescope until the HFR is as low as possible.

2.5 Starting a Sequence

Once you nailed your focus you can switch to the Sequence tab. There you should create a new target.
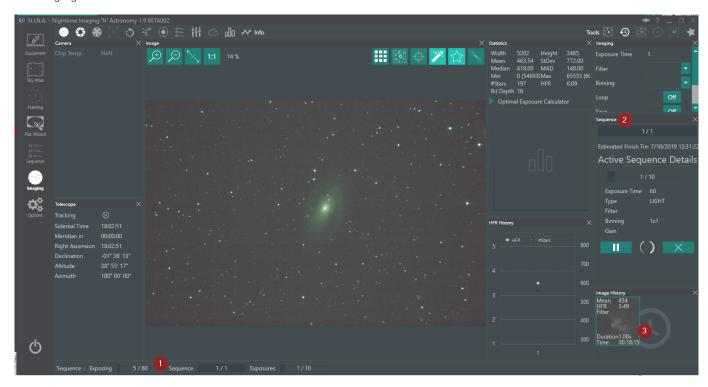
Here we can find various options. For One-Shot-Color users it's a relatively simple matter. Enter the amount of images you want to shoot in Total # (1), enter the time for a single image (2) and the type (3), which likely will be LIGHT at that point. You may also want to change your gain for the sequence in the gain column (4).

Now open up the Target Options (5) and enable "Slew to Target" so that your mount will slew to the specified target. In addition enable to unpark the mount and to enable the meridian flip in (6). To also park the mount after everything is done, enable the Park Mount option in (7).
Now for the slew to actually slew to a specific target, enter the coordinates and name in (8).

You can see an estimation when the sequence is likely going to end (9). This value will change during the sequence depending on the average download time of your camera.
Finally press Start Sequence at the bottom right to start the imaging sequence. Now that your sequence is running, head back to the imaging tab on the left side bar.

Here you will see some small changes about the status of the sequence. At the bottom left (1) you see the current status of the camera which will change depending on what it is doing. In the sequence tab (2) you will see the estimated finish time and information about the image that is getting shot currently. You can also cancel the sequence prematurely using the button at the bottom of the sequence tab. Finally in the Image History (3) you will see the past images you shot and you can open them from there to review them. From here on it's waiting until the sequence completes.

Good luck and clear skies!

For more in-depth information about sequencing head to the Sequence Overview

3. Contributing

3.1 Enhance documentation

3.1.1 Contributing

Thank you for considering a contribution to N.I.N.A.'s documentation!

3.1.2 Prerequisites

The documentation is using MkDocs. A in-depth guide on how to set it up and how to use MkDocs can be found on their project homepage MkDocs In summary you need:
- Python
- Pip `pip install --upgrade pip`
- Install MkDocs and needed plugins: `pip install mkdocs mkdocs-material mkdocs-with-pdf`
- A markdown editor of your choice

3.1.3 Building the docs

MkDocs offers a neat built-in server feature to build and preview the documentation on your local machine on the fly. Each time a file is saved, the local server is updated automatically. To run the server simply run the serve command and open your browser on the indicated address.

`mkdocs serve`

3.1.4 Branching Model

This project is utilizing a standard git flow where it has the following branches
master: all officially released code
hotfix/: used to fix issues inside master
release/: when preparing a release with new features a temporary release branch is created for that new release
bugfix/: issues that are found during a release will be fixed here
develop: a general develop branch that will contain unreleased new features
feature/: new features that will be developed and merged to the develop branch

A more in-depth guide about this model can be found here

The most relevant branches are master and develop. These branches all have a separate page for documentation on the homepage. This enables users that will use for example the released version of N.I.N.A. to have a separate documentation, compared the ones that use the nightly builds and already want to see new features described.

3.1.5 Pull Requests

- For contributing to this documentation you should fork the repository
- Inside your fork you can make your changes
- Once you are finished with your planned changes it is time to put up a pull request from your fork to the master repository
- Make sure that only relevant changes are inside the pull request
- Check that the documentation builds properly using the serve command
- Try to create **one pull request per feature**
- Create your pull requests for new features only against the **develop** branch
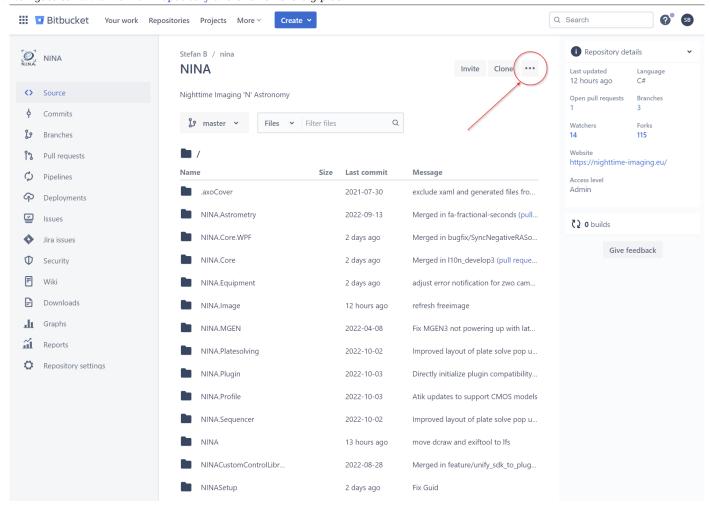
3.1.6 Updating the homepage

The documentation on the homepage is updated automatically via bitbucket pipelines. Each time a pull request is complete, the pipeline will build the docs and upload the changes to the homepage. There is no action required by a contributor for this.
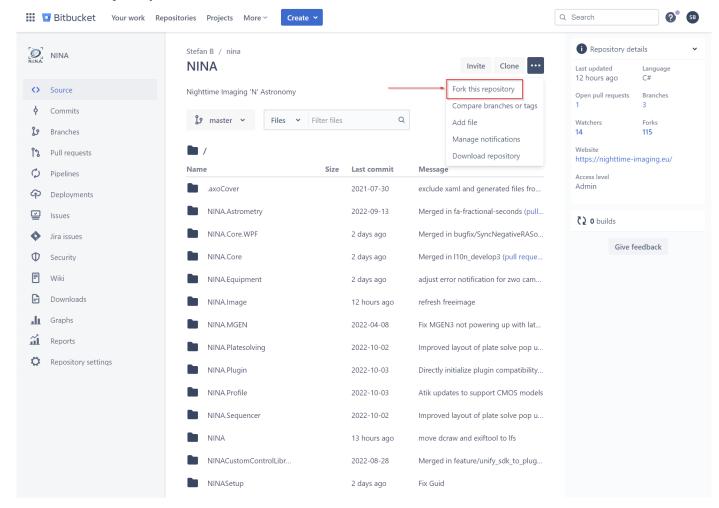
3.2 How to setup the development environment

3.2.1 Forking the repository

1. Login to your bitbucket account

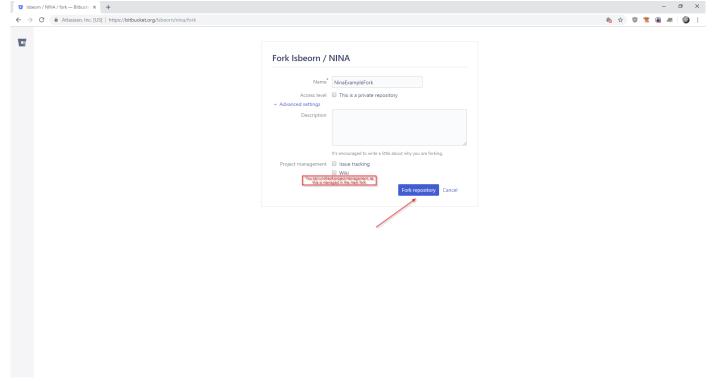2. Navigate to N.I.N.A.'s main repository and click on the big plus

3. Click "Fork this repository"

4. You will see a configuration wizard for your fork.

5. Enter a name for your forked repository. (This guide will use "ninaexamplefork" for reference)

6. Give a short description what your intention is with this fork (optional)

7. Uncheck Issue tracking and Wiki as you don't need this in your fork.

8. Click on "Fork repository"

9. You will be navigated to your new repository at https://bitbucket.org/\<your_username>/\<your_fork's_name>/

3.2.2 Cloning Repository

1. On the top right of your forked repository click on the "Clone" button

2. A pop up will show the command how to clone this repository to your local machine

3. Open a command window

4. Navigate to the folder where you want your repository folder to be created in

5. Enter the command that was shown in step 2.

```
git clone -n -b develop https://<YourUserName>@bitbucket.org/<YourUserName>/<YourForkName>.git
# NOTE: the -n flag for "don't checkout the branch"
# Ignore any LFS smudge errors for now. They are not yet synced and will get synced in a later step
```

6. Navigate to the created folder

```
cd <YourForkName>
```

7. Next you need to add the "upstream" to the root repository (where your fork is based on). This is later required for merging from the main dev branch etc.

```
git remote add upstream https://bitbucket.org/Isbeorn/nina.git
```

8. Bitbucket will not automatically copy over the LFS into the fork repository. This has to be done manually. Run the following commands to sync the lfs

```
git lfs fetch upstream --all
git lfs push origin --all
```

9. Now we need to checkout the develop branch
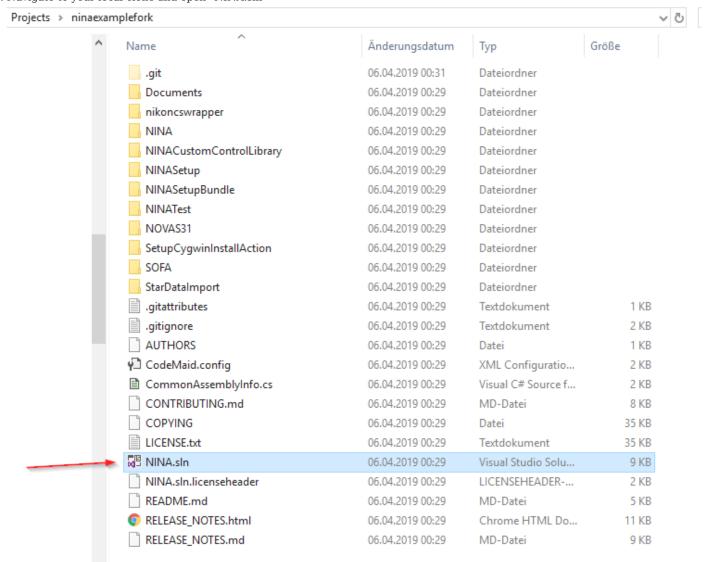
```
git checkout develop
```

10. Fetch the submodules for the external dependencies. These contain all third party vendor DLLs that are not part of any nuget package, e.g. Camera Drivers, VCRedist etc.
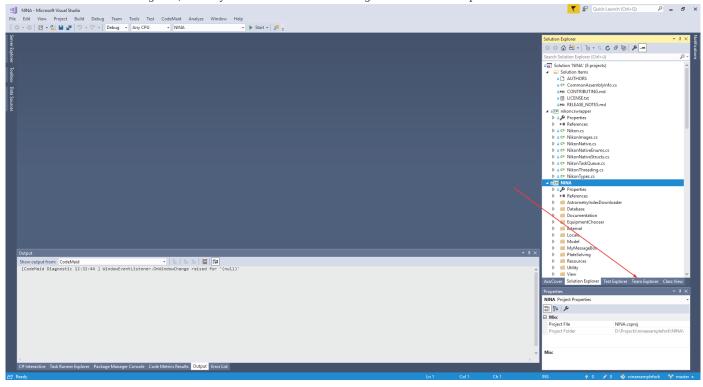
```
git submodule update --init --recursive
```
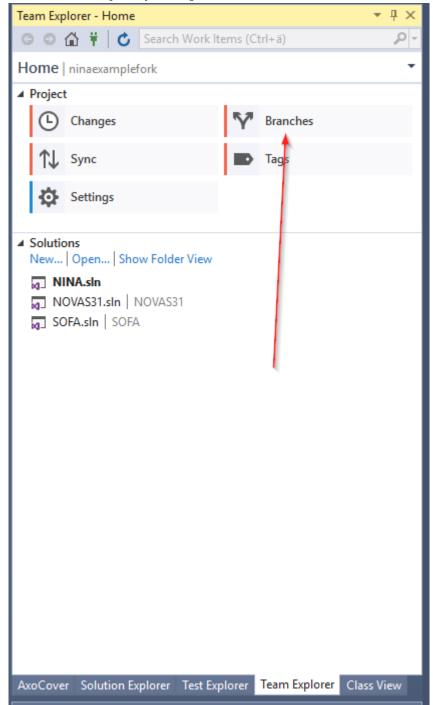
3.2.3 Navigation in Visual Studio

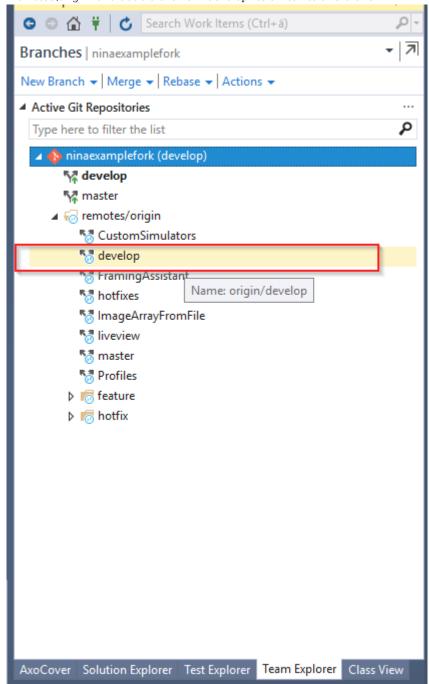1. Navigate to your local clone and open "NINA.sln"

2. Visual studio has a built in git UI, which you can find on the lower right called "Team Explorer"
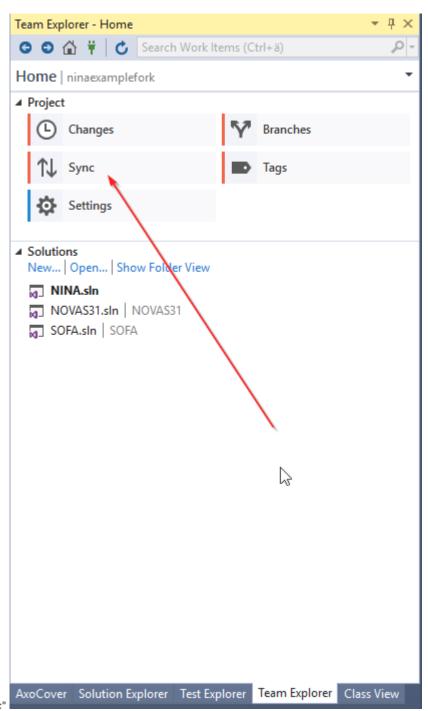
3. Inside the Team Explorer you can get a visual list of all available branches

4. Here you can see all branches of your forked repository. Note that the upstream we added earlier is not yet displayed.4. Expand "remotes\origin" and double click on "develop" to switch to this branch

5.

Click the back button (top left) and click on "Sync"
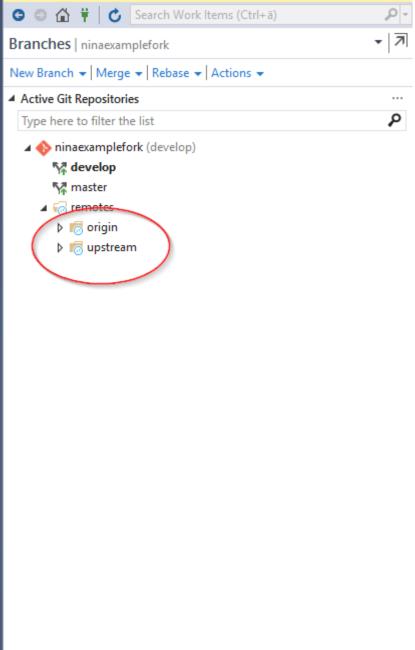
6. Click on "Fetch" and select "upstream" to fetch all branches that are inside "upstream", which is the root repository

7. Now navigate back and select the "Branches" again. Now the "upstream" branches are also available.
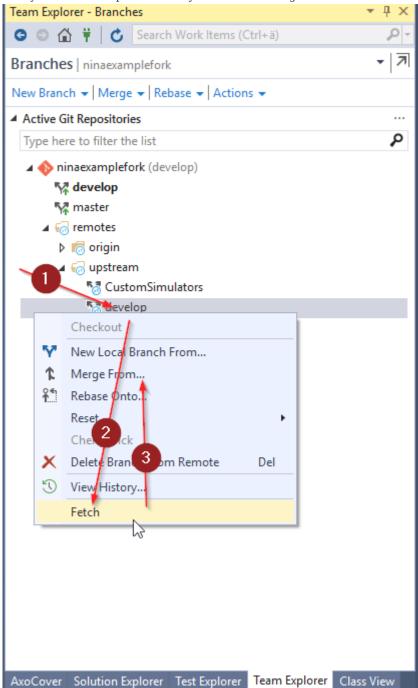
8. To fetch and merge the latest code of the root repository you can right click on "develop", click on "fetch" and "Merge from..." afterwards.

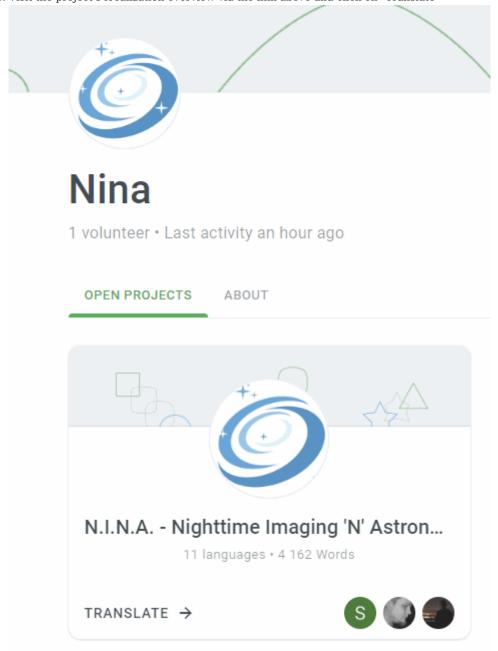9. Now your branch is up to date and you can start coding.

3.3 Localization

N.I.N.A. uses an external translation management software called Crowdin to localize the application. This software offers an easy access for all people that are interested in contributing to the localization without having to know anything about coding. The software can be found at
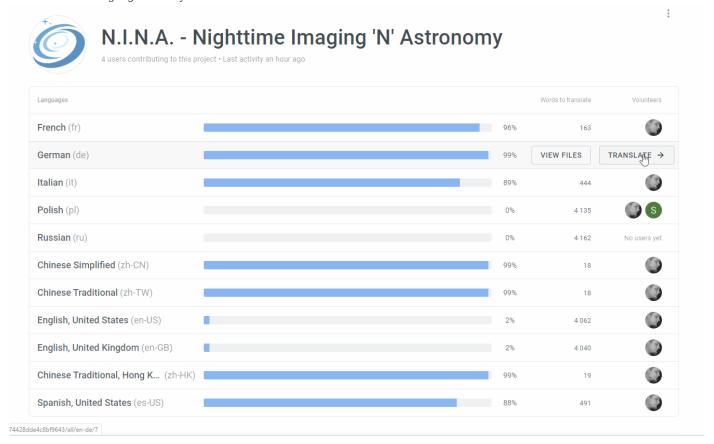
nina.crowdin.com

3.3.1 Quick Start

1. Visit the project's localization overview via the link above and click on "Translate"

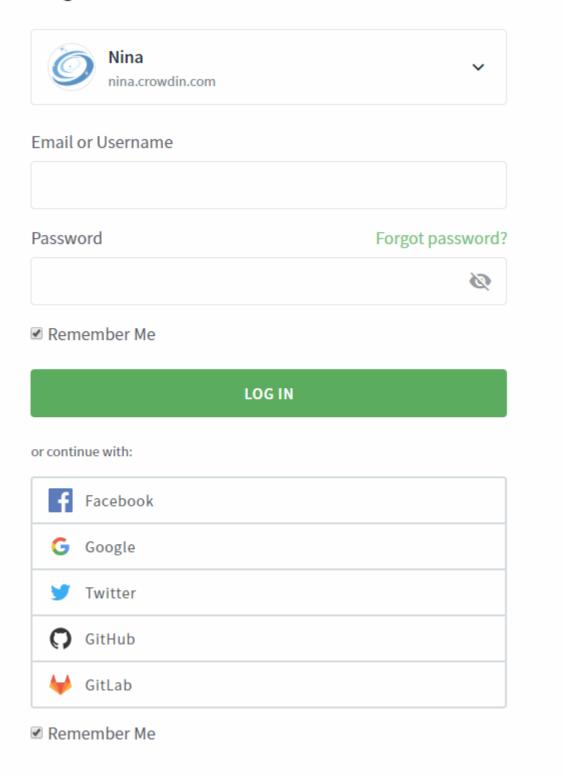2. You will see an overview of all currently available languages where you can add new or improved translations

3. Hover over the language where you want to start and click on "Translate"
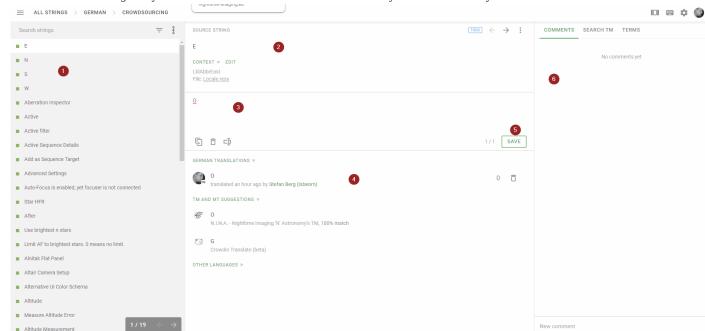
4. In case you are not logged in yet, you need to log into Crowdin now. Either register a new user or use one of the alternative OAauth

Log in to

logins

5. The next screen will greet you with the actual translation interface and you can now start your translations

6. On the left side you can find a list of all available Labels. A red box indicates if no good translation is available yet and these are shown first by default.

7. In the top middle section you will see the original Text of the label for the default language as well as the label code

8. To provide a new translation you have to enter your proposal into the textbox here

9. In the bottom list you can see all previous translation proposals as well as some proposals given by machine learning

10. Once you are happy with your translated string you click on "Save"

11. On the right section you can find comments of other contributors as well as a convenient quick search for some terms and uses.

3.3.2 Integration into N.I.N.A.

The crowdin platform offers an automatic synchronization into the project's bitbucket repository. Every 30 minutes a sync is triggered and new translations will be pushed into a separate branch inside N.I.N.A.'s repository and a pull request will be opened to be reviewed. Once that pull request is approved and the new version is installed, all the translations will be reflected inside the User Interface
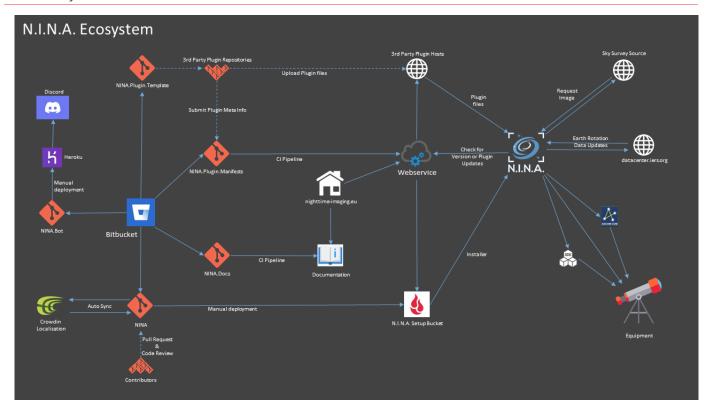
3.4 Plugins

Plugins are intended to add custom functionality into the application, that doesn't fit the general needs and is more specialized for a sub set of users. These plugins can easily be created by creating a specific C# class library.
A plugin template to get a starting point and also a detailed description how to work with the template can be found in the Plugin Template Repository

Furthermore plugins can be made officially available in the plugins tab by submitting a plugin manifest into the main Plugin Manifest Repository. This repository will automatically update the remote host with the available plugins to show them inside the application to download. All details how to create a manifest and how to submit it, can be found in the README of the repository.

3.5 Ecosystem

The ecosystem of N.I.N.A. consists of a whole lot more than just the main application. There is quite a bit of orchestration done in the background to be able to build the application as it is today.

3.5.1 Bitbucket Repositories

Main application - The main application source code
Plugin Manifests - Meta Definition files for plugins can be pushed here
Plugin Template - Serves as a starting point for plugin developers
Documentation - Using mkdocs to define the documentation
Discord Chat Bot - A bot to make life easier inside the discord chat

3.5.2 Crowdin

Crowdin Localization Management
See the dedicated page for Localization for more details

3.5.3 The Homepage

The Homepage serves as the central hub to gather the resources. It also hosts the webservice that will tell you and the application where to get updates, as well as hosting the documentation.