

CCDciel

Program documentation

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Last version is available from the wiki at
<http://www.ap-i.net/ccdciel/en/documentation/start>

Table of Contents

CCDciel	1
CCDciel is a free image capture software intended for the amateur astronomer.	7
CCDciel features	8
<i>Supported devices</i>	8
<i>Program features</i>	8
Tutorial 1. The program screen	10
Tutorial 2. Connecting the equipment	12
Tutorial 3. Global configuration	14
Tutorial 4. Focusing	15
Manual focus	15
Auto-focus	16
Tutorial 5. Simple capture	17
Tutorial 6. Plate solving	19
Tutorial 7. Automated sequence	20
Tutorial 8. Video tutorial	22
FAQ	23
Can you add support for my device?	23
I cannot connect my ASCOM device	23
Can I change the gain for the camera?	23
Are DSLR supported?	23
Camera image is very slow to download from remote computer	23
How to change the telescope park position	24
The telescope do not slew at the coordinates I asked	24
Plate solved slew do not converge	24
My device do not work with CCDciel	25
I want to run CCDciel as administrator	26
I need black colors as I can see in some screenshot here	26
Edit Menu	27
Device setup	28
Interface	28
INDI devices	29
ASCOM devices	29
ASCOM Alpaca devices	30
Camera	30
Guide Camera	31
Finder Camera	31
Filter wheel	31
Focuser	31
Rotator	32
Mount	32
Dome	32
Weather station	32
Safety monitor	33
Watchdog	33
Switch	33
Cover calibrator	33
Preferences	34
Preferences	34
Files	36
Observatory	38
Camera	39
Preview	41

Custom image type	42
Flat	43
Focus	44
Auto-Focus	45
Astrometry	48
Slewing	50
Meridian	52
Auto-guiding	54
Dome	57
Planetarium	58
Weather station	59
Safety monitor	60
Sequence	61
Performance	64
Notifications	65
Install script	67
INDI settings	68
ASCOM settings	69
Display Menu	70
Image window	72
Connection Tool	73
Preview Tool	74
Autoguider Tool	75
Internal Guider	76
Quick reference guide	76
Introduction	77
System calibration	77
Tab Guider	78
Tab Camera	79
Tab Options	81
Tab Advanced	83
Guide image	85
Tab Spectroscopy	86
Finder camera	90
Planetarium Tool	92
Script	93
Weather station tool	95
Safety monitor tool	96
Focuser Tool	97
Focus Tool	98
Show star profile	98
Measurement values	99
Manual focus	99
Auto-focus	100
Spectral Profile	101
Magnifier Tool	103
Capture Tool	104
Filter Tool	106
Frame Tool	107
Rotator Tool	108
Sensor Temperature Tool	109
Telescope Tool	110
Dome Tool	112

Switch Tool	113
Cover calibrator Tool	114
Sequence Tool	115
<i>Sequence editor</i>	117
<i>Target list</i>	118
Add a target	118
Set a switch	121
Add a script	121
Add an automatic twilight flat	121
Repeat the whole sequence	122
Restarting a sequence	122
Start options	123
Termination options	123
Next sequence	123
Import a mosaic from the planetarium	124
Import observing list from Skychart	124
Import and export targets in CSV file	125
Manage the target list	125
<i>Plan steps list</i>	126
Add a step	126
Manage the steps	128
Video tool	129
Visualisation Tool	131
Logging	134
Clock	135
<i>Tools Menu</i>	136
View FITS header	137
Image statistics	138
<i>Measure telescope cone error</i>	139
<i>Polar alignment without pole visibility</i>	141
<i>Polar alignment near the pole</i>	144
<i>Inspection and collimation</i>	148
Image inspection	148
9 panel image	150
Single star	151
<i>Focuser calibration</i>	153
<i>Sensor analysis</i>	156
Right click menu	160
<i>Plate solving functions</i>	160
Resolve	160
Resolve and Slew to image center	160
Resolve and Slew to cursor	161
Resolve and Sync the mount	161
Resolve and Rotate	161
Resolve and Sync the rotator	161
Resolve and annotate DSO	161
Resolve and annotate galaxies (Hyperleda)	162
Resolve and show image in planetarium	162
Resolve and show image frame in planetarium	162
View last resolver log	162
<i>Photometry</i>	162
<i>Preview functions</i>	162
Preview preprocessing	162
Preview debayer	162
Noise filter	162

Image inspection	163
Image cleanup	163
Unselect star	163
Photometry	164
File Menu	165
Open FITS or picture file	166
Save FITS file	167
Save picture file	168
Bad/Hot pixel map	169
Information	169
Create from the camera	169
Create from a dark file	169
Clear the bad pixel map	170
Check the bad pixel map	170
Possible errors	170
Dark frame	171
Information	171
Create from the camera	171
Load a dark file	171
Clear Dark frame	172
Check the dark frame	172
Flat frame	173
Information	173
Create from the camera	173
Load a flat file	173
Clear flat frame	173
Check the flat frame	173
Quit	174
Help	175
The status bar	176
The status web page	177
TCP/IP Status server	178
Simple socket command	178
CCDciel Script	179
Script editor	179
Script debugger	180
Script example	181
Script reference	183
Python scripts	183
JSON-RPC method	183
Methods that return a value	184
Methods that invoke a command without parameter	186
Methods that invoke a command with parameter	187
Specific status method	189
Command line options	191
Image preprocessing	192
Using Siril	192
Usage requirement	192
Take and process Bias	193
Take and process Dark	193
Take and process Flat	194
Take and process Light	194
Installation on Ubuntu, Debian	196
Specific instruction for DSLR	196

Installation on Linux	197
Specific instruction for DSLR	197
Installation on Windows	198
Installation on macOS	199
Install Hyperleda database	200
ASCOM	201
INDI	202
Linux	202
macOS	202
Windows	202
Additional utilities	202
Install Python	203
Python on Windows	203
Python on macOS	204
Python on Linux	204
ASTAP	205
Astrometry.net	206
Astrometry.net on Linux	206
Astrometry.net on macOS	206
Astrometry.net on Windows	207
PlateSolve 2	209
Apache reverse proxy	210
CCDciel status page	210
ASCOM Remote Server	210
Compilation of the source code	212
Install the compiler and IDE	212
Install CCDciel source code	212
Install the required components	212
Compile CCDciel	212
Running and debugging the program	213
Automatic build and packages creation	213
Documentation index	214
Tutorial	214
Reference Manual	214
Installation	214
External dependencies	215
Credit	215
Tools	215
Developer	215
License	215

CCDciel is a free image capture software intended for the amateur astronomer.

CCDciel has all [functionality](#) required for advanced imaging of celestial objects including sequences for fully automated unattended operation. But it is also easy to use to make simple capture in a manual way.

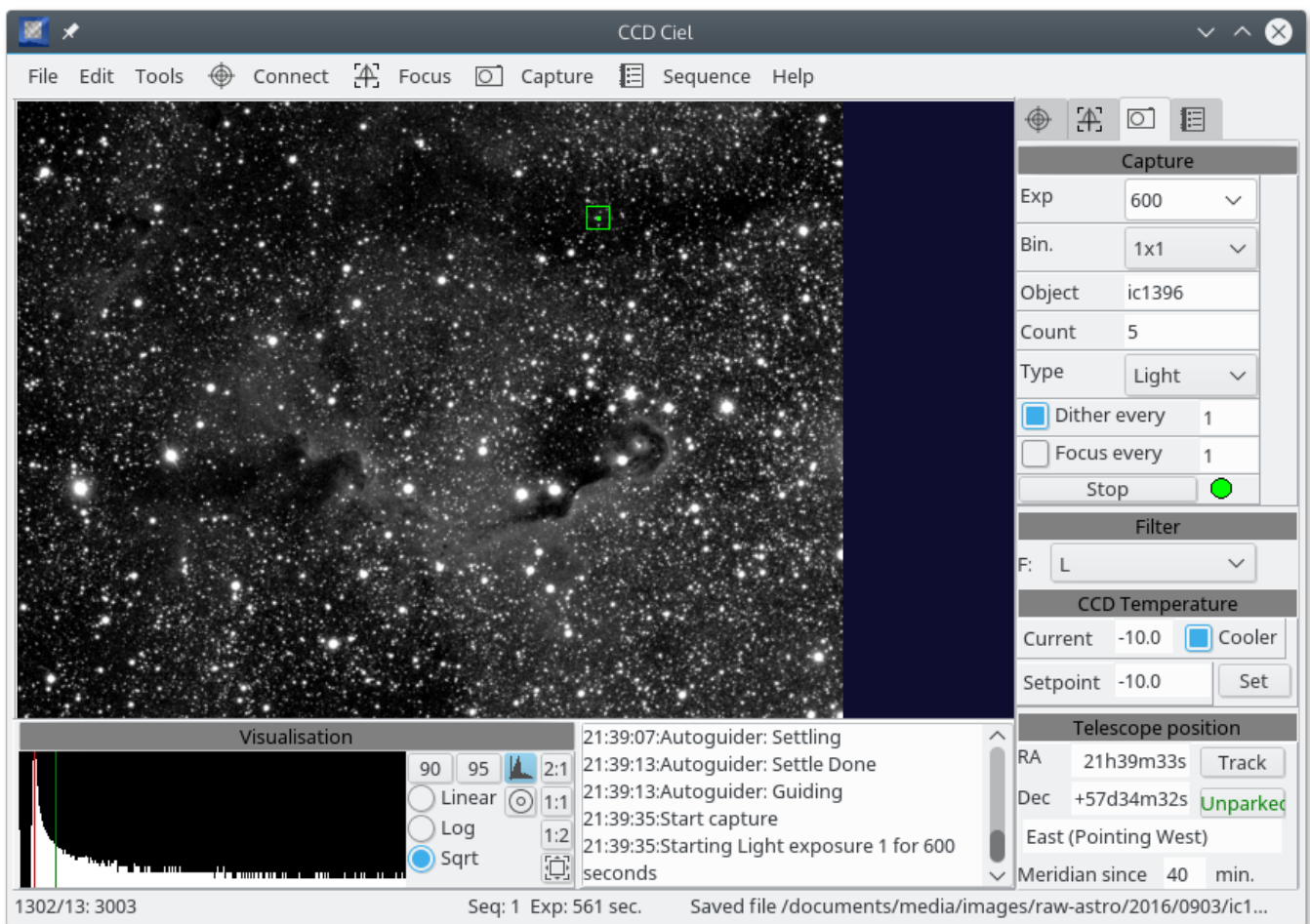
For devices connection it uses the [INDI](#), [Alpaca](#) and [ASCOM](#) standards drivers. It can control the CCD/CMOS camera, focuser, filter wheel, rotator and telescope mount and uses image resolving software such ASTAP for accurate positioning. It can serve both the beginner astro photographer as the advanced who can take a nap while the equipment is imaging.

You can use CCDciel on Windows, macOS or Linux.

To install the program, look at the [installation instruction](#) for your computer and [download from SourceForge](#) for the platform you need, always get the latest version as it is frequently improved!

The program is still in beta version but it is now stable and run smoothly on every platform.

If you need to test the very latest code you can also install the [nightly build](#).



A copy of [the program documentation](#) in pdf format is included with the program.

You can ask the [user group](#) for any question about the software usage.

In any case I will appreciate your help for testing this software and [reporting any bug](#) or other problem you may encounter.

The source code is available from [GitHub](#)

[Contact](#)

CCDciel features

Supported devices

- Any ASCOM, Alpaca or INDI camera, filter wheel, focuser, rotator, telescope mount, dome, switch, weather station, observing condition device, safety monitor
- ASCOM driver can be a classic local driver or a remote Alpaca device
- ASCOM Alpaca devices can be used on Linux and macOS
- Device connection can be a mix of local and remote devices using different protocols
- NO native support for any device

Program features

- Easy to use configurable interface
- Translated in your language
- Separate settings for preview and capture
- Can start a quick capture without the need to parameter a full sequence
- Quick and easy polar alignment procedure
- Collimation aid
- Parameters for saved files include options for the capture folder name and the file name
- Improve the preview image display with predefined histogram truncation and gamma
- Predefined zoom level or free zoom with the mouse wheel
- Add movable crosshair to the preview image
- Show saturation on the preview image
- Image magnifier at mouse position
- Debayer the preview for color sensors
- Can stack preview images with single star alignment and dark subtraction
- Can set a bad pixel map to remove hot pixel in auto-focus and plate-solving preview images
- Select subframe with the mouse
- Camera temperature control
- Select camera readout mode depending on the frame use.
- Automatic sky flat
- Automatic panel flat
- Choose of auto-focus method
- Can auto-focus with field stars or by slewing to a bright star
- Support for filter offset and exposure factor
- Focuser temperature compensation
- Options for periodic refocusing during capture
- Automatic meridian flip with many options
- Connection to multiple switch devices
- Show selected star profile with HFD and FWHM
- Image inspector show stars HFD, sensor tilt and field curvature
- Simple photometry measurement
- Message log with severity filter
- Video control and recording with supported INDI camera, including DSLR LiveView
- Powerful scripting function using Python language
- Custom image type with activation by script
- Run automated action if the conditions are not safe.

Plate solving

- Automatic precision Goto using plate-solving
- Precision Goto can Sync the mount or use a local offset
- Can use a separate finder camera if the main camera is not suitable
- Automatically recenter a target that drift during a sequence.
- Slew to any point of solved image
- Rotator calibration and rotation from plate-solving
- Plot DSO in solved images
- Arrow show North direction, or mark the position of the Pole if in the image frame.
- Show solved image in planetarium
- Show solved image frame in planetarium

Auto-guiding

- Use of internal guider or connection to phd2 software
- Automatically manage the guiding start/stop/pause during the different operations
- Options for automatic auto-guider dithering
- Backlash compensation
- Specific options for spectrograph
- Show guiding graph and statistics
- Recovery from auto-guiding problem

Automated sequences

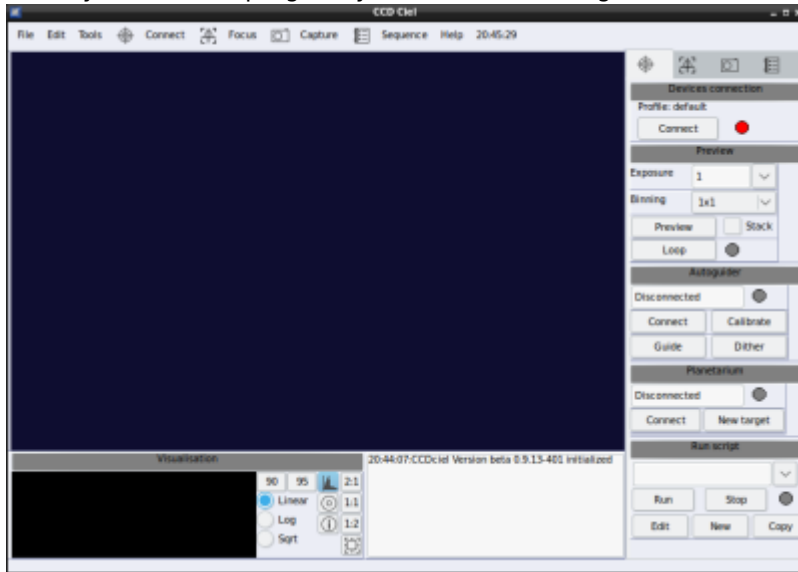
- Automated sequences with many sequential targets
- Sequence contain a list of target and can indicate a start/stop time and repetition options
- Target is defined by a name, coordinates, rotator angle, start/end time
- Target coordinates can be set from the planetarium
- Import mosaic from the planetarium.
- Import Cartes du Ciel observing list.
- A moving target can have it's coordinates updated from the planetarium at the time of the observation
- Target option include plate-solving Goto, auto-focus position, skip or wait if the observing condition are not reach
- Use horizon profile for objects rise/set time
- Every target use a predefined plan to not have to type everything again
- Plan are multi-steps, with number and type of frame, exposure time, binning, filter, auto-focus and dither options
- A target can also be a script or an automated sky flat at dusk or dawn
- Restart an interrupted sequence at the last check point
- Pause the sequence if the observing condition are not optimal
- Get the program status in a web browser
- Receive notifications by email

Interface with other software

- Interface with four different local plate-solving software (Astep, Astrometry.net, Platesolve2/3)
- Interface with auto-guiding software (Phd2)
- Interface with two planetarium software (Cartes du Ciel, Hnsky)
- Interface with any SAMP application (Aladin, Topcat, ...)
- Interface with processing software (Siril, specINTI)

Tutorial 1. The program screen

When you start the program you see the following screen:



On the top you have the standard menu: [File](#), [Edit](#), [Tools](#), [Image](#), [Display](#), [Help](#), and four menus with a icon: Connect, Focus, Capture and Sequence. The four menus with icons are the same as on the right tabbed menus.

These four tabbed menus are used for connecting the equipment, focusing the camera, take a capture or run a sequence of operation.

On the bottom left there is the [visualisation](#) control for the picture preview and on the right a text log with activity messages.

The taken or loaded images will be displayed in the middle.

The plate solving functions are available from the image [right click menu](#).

The layout is customizable under the [Display](#) menu for either a small monitor or laptop. You can uncheck the Tools you not use, but this is done automatically to remove the tools for the devices not present in the current profile. The minimal screen size is 1024×600

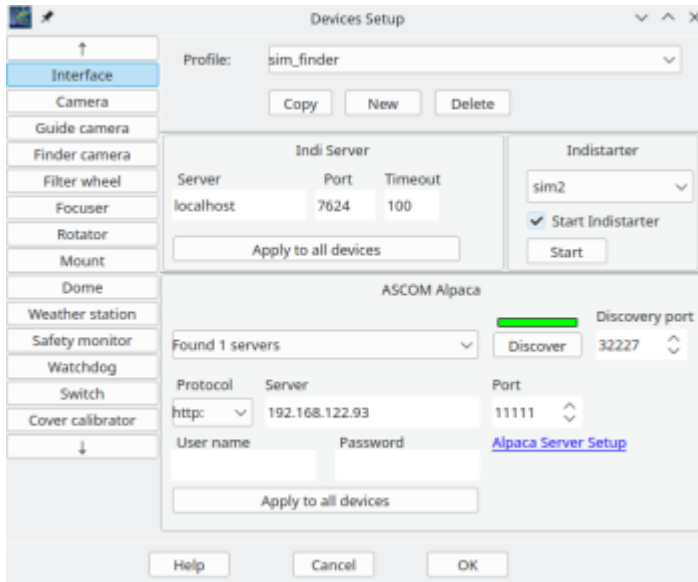
At the bottom of the menu is a selection to reset the default settings, using either one or two column layout. You can drag and drop every tool to another part of the screen. Just hold left mouse button down and drag the tool title to one of the screen border and drop it by releasing the mouse button.

Tutorial 2. Connecting the equipment

When you are a first time user, you have to select first the correct equipment drivers and set some settings. The first time it is run the program will automatically open the **Edit→devices setup** menu.

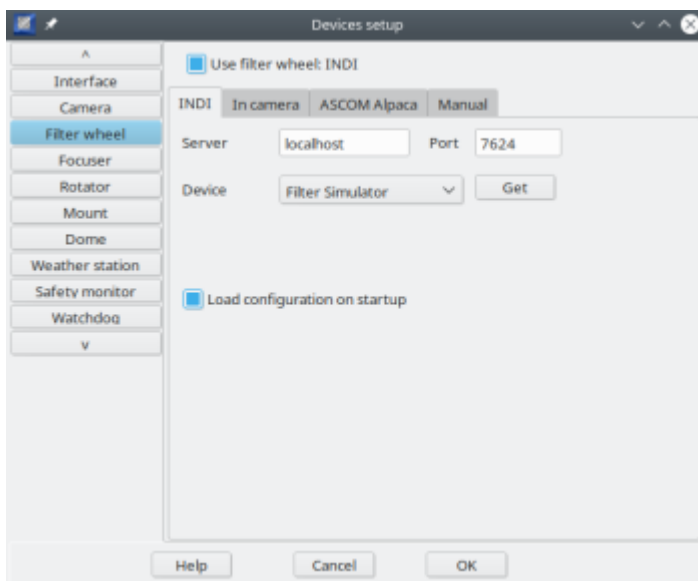
Create a new profile for your equipment.

All the devices and all the program options will be stored in this profile, allowing to have completely different settings for your different equipment or locations.

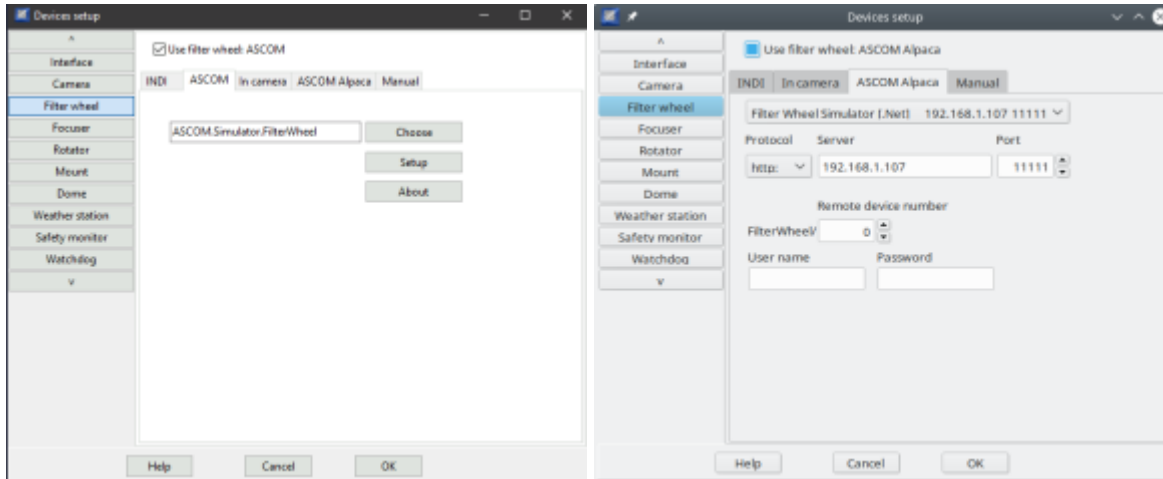


The devices can be connected locally to your computer, or remotely via a INDI or ASCOM Alpaca. You can mix devices using different protocol and managed by different server.

For **INDI** it is important the INDI server with all the driver is running before you can click the **Get** button to list the available devices. You can use **IndiStarter** for that.



For [ASCOM](#) it is important you install the ASCOM platform and every required driver before to start CCDCiel. ASCOM can also be connected remotely from CCDCiel running on Linux or macOS.



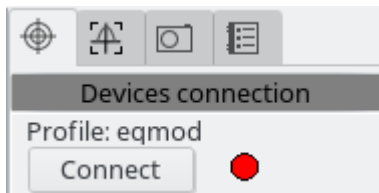
Be sure to select the mandatory camera driver and other equipment like mount or focuser but that can also be done later.

Click okay and program will create a new default profile for your equipment. You could later create an additional profile with different settings, equipment or location.

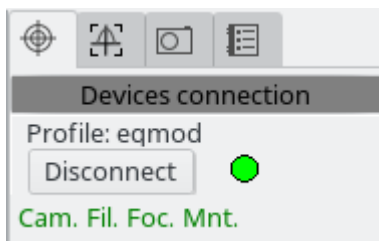
Next menu will show the [default options](#). The first thing to do is to set the capture folder to something like in Linux to /home/username/capture which or for windows from the default C:\ to something like C:\CCDCiel

When ready click the OK button.

Select the left tab (pointer icon) and locate the Connect button at the top. The red dot indicates no connection to any device. Below the connect button you will see the mandatory camera, mount if selected and any other equipment.



Click on Connect and after a few seconds the light should change to green if all listed equipment is connected.



In the connection phase, the indication light will first turn orange and finally green if all equipment is successfully connected. In case of a connection failure or if an error occurs, the indication light will turn red. All program activities and errors will be logged, so in case of device connection problem have look to the [log](#) for an error indication.

Devices with a connection problem could be disabled temporary in **Edit→devices setup** menu. As a bare minimum only an imaging camera is required to operate.

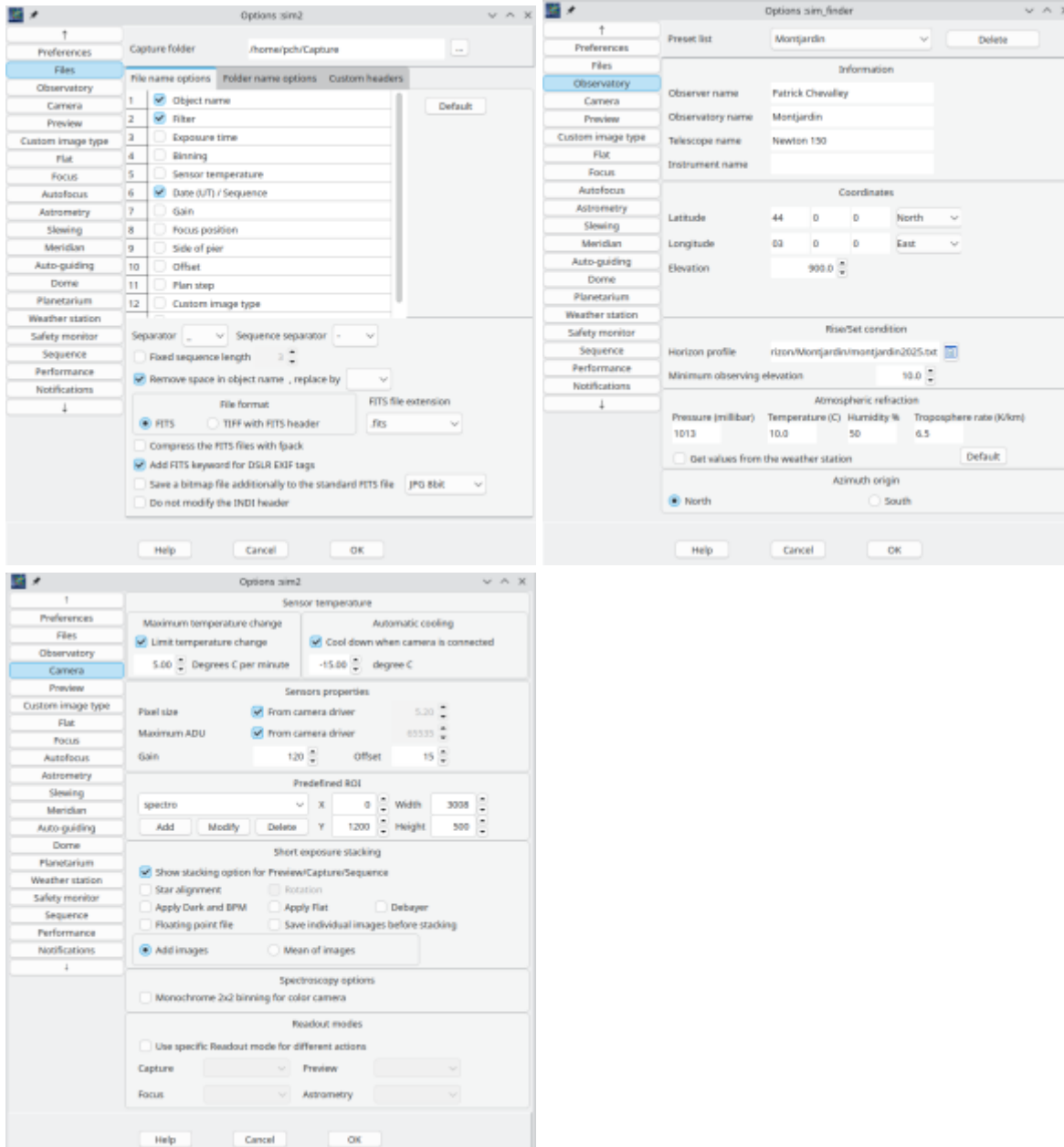
[Next tutorial >>](#)

Tutorial 3. Global configuration

You access the global configuration from the menu **Edit**→**Preferences**.

All this options will be stored in the current profile.

There are a number of options for every part of the program and many can be [examined later](#).



To start it is essential you set:

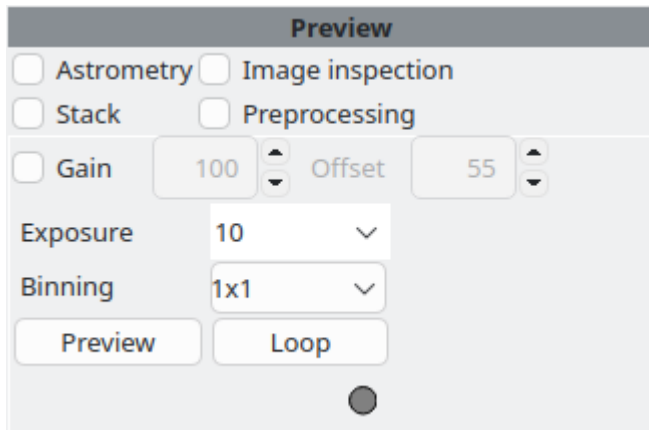
1. a valid folder for the captured images.
2. be sure the temporary folder path contain only ASCII characters.
3. your observatory latitude and longitude since they are used in several program functions.
It is also important the right observatory coordinates are set in the mount.
4. review and set the camera gain and offset to use.

[Next tutorial >>](#)

Tutorial 4. Focusing

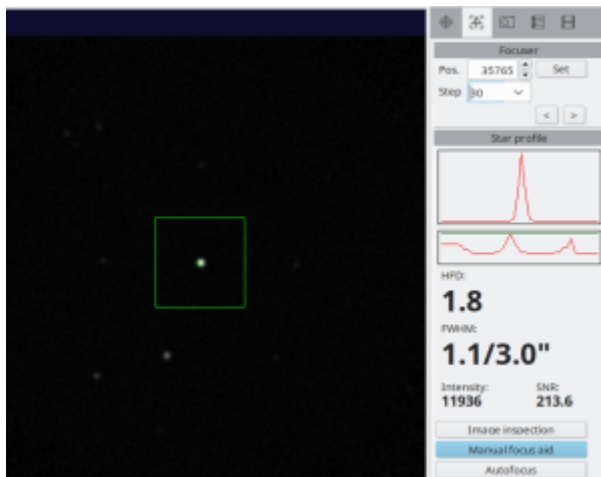
Manual focus

Point your telescope somewhere high in the sky and set the [Preview](#) exposure time and binning. Click on the Loop button.



If you are way out of focus start first with a long 10-15 seconds exposure time to see some large out of focus stars disk and move the focuser to reduce the size. If you near the correct focus reduce the exposure time to 1 seconds less.

Leave the preview looping and click on the Focus tab to show the [focuser](#) and [star profile](#)



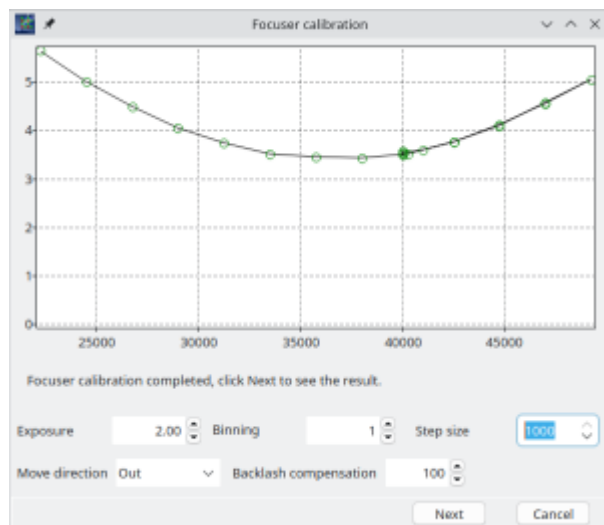
Double click on a star in somewhere the middle of the captured image. Check the recorded star intensity for saturation or have look to the star profile. The intensity value should be smaller then the sensor maximum value of typically 65535. In case of saturation select a fainter star or reduce the exposure time. Checkmark the "Manual focus aid" to magnify the star image.

Use the focuser buttons or manually adjust the focuser to make the star image as small and bright as possible. It could be beneficial to use a very short exposure time to reduce the seeing and have a quick visual feedback.

When ready uncheck "Manual focus aid".

Auto-focus

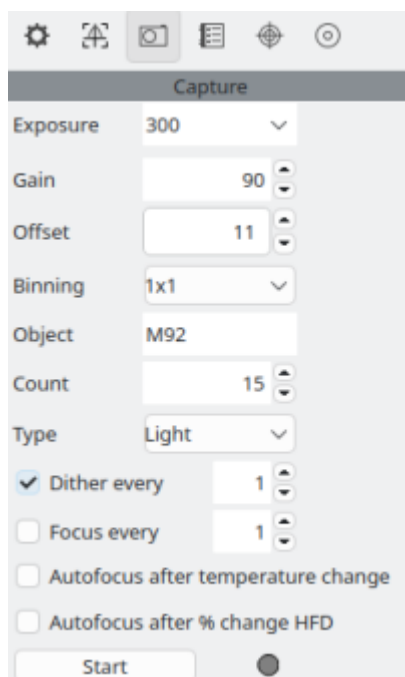
To configure the auto-focus use the Tools→[focuser calibration](#) to help you set the different parameters specific to your setup.



Later you can refine them in the [auto-focus preferences](#).

[Next tutorial >>](#)

Tutorial 5. Simple capture



Open the [Capture](#) tab and set the required options:

- The exposure time
- The binning
- The name of the object
- The number of exposures to take
- Be sure the type is Light, other setting may let the shutter closed!

You can also choose to dither between exposures and to regularly adjust the auto-focus.

Dither introduces a small artificial cyclic drift typically required for CMOS sensors when imaging very faint objects. It helps to smoothen out unequal sensitivity of the individual pixels. Leave this option off in the beginning

Binning combines pixels if they are too small to record any details and reduces noise. Typically you set this on 1x1 or for large sensors on 2x2.

If you have a [filter](#) wheel you can specify the filter to use.

You can specify the [frame](#) dimensions if you don't want to use the full sensor surface.

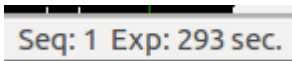
If you have a rotator the green/red light indicate if it is [calibrated](#) or not. Then you can set the rotation angle.

And if you can control the [CCD temperature](#) enter the desired value in Setpoint, and click the Set button.

When all settings are correct click on the START button to start capturing.

The telescope box will indicate the telescope position, the park and tracking status and the remaining time to reach the [meridian](#).

The [status bar](#) shows the image number (count) in progress and the remaining exposure time

A screenshot of a status bar with a black background and white text. The text reads "Seq: 1 Exp: 293 sec.".

After each exposure is finished, the image is shown and the file is saved according the settings. A message in the status bar indicates the last saved file

A screenshot of a status bar with a black background and white text. The text reads "Saved /home/pch/Capture/M27_G_20160522_203117.fits 1380x1040".

it will continue for the number of exposures (=count) set.

After finishing you could change the filter and start the next series. Or automate it fully using a sequence.

[Next tutorial >>](#)

Tutorial 6. Plate solving

Many function in CCDciel rely on plate solving so it is important this is correctly set.

If not already done [install](#) a plate solving software now.

Because we want the solving time to be just a few seconds we must help the solver software by giving the most accurate information about the image to prevent a blind solving that can long for many minutes.

But wrong information is even worst, in most case it make the solving to fail.

The important points to check in the configuration are:

- The camera pixel size in microns in the [camera options](#). It is important to check the driver return the correct size, if not you can override the value.
- The telescope focal length in millimeter in the [astrometry options](#). This must be the effective focal length taking account for any corrector or focal reducer. Do not trust any label on the equipment, the best way to get the real focal length is to do a [blind plate solving](#), look at the result for “Pixel scale” and use the formula:
$$\text{Focal_Length} = 206.265 * \text{Pixel_Size} / \text{Pixel_Scale}.$$
- The telescope must return good enough coordinates to use as the starting point. The [astrometry options](#) “Maximum search radius” must be large enough for any error in the initial position.

Then select the software to use and set any of it's specific [options](#).

When all is ready take a preview image that show enough stars, right click and select [Resolve](#).

Wait until it complete, in case of success it show a message with information about the image position and size. The solved image is loaded in the viewer, an arrow indicate the direction of North and East and moving the mouse over the image show the RA/DEC coordinates.

In case of error you can right click and select [View last resolver log](#).

The content depend on the selected software, some are very verbose but with other you just get the command line used by CCDciel.

This command line let you try the solve command in a terminal window out of CCDciel to check what is wrong.

When your images are reliably solved you can look at the next configuration tab, [Slew](#). This set additional options to automatically position the telescope with a given precision.

[Next tutorial >>](#)

Tutorial 7. Automated sequence

A [sequence](#) allows you to fully automate the imaging. At the sequence tab you can specify all the steps required for unattended operation.

This sequence example will first image the objects M13 and M92, then wait for dawn to take some sky flat.

Sequence Targets: M13			
Object	Template	RA	Dec
M13	LRGB-4H	16h41m38s	+36d28m41s
M92	LRGB-4H	23h20m04s	+61d05m43s
SkyFlat	Dawn	-	-
Switch	power switch	-	-

M13, Plan: LRGB-4H				
Desc.	Exp.	Count	Type	Filter
L	300	24	Light	L
R	300	8	Light	R
G	300	8	Light	G
B	300	8	Light	B

Load	New	Edit
Status	Reset	Manage
Start	Pause	Stop
Restart exposure	Autofocus	

☒ ☐ Run unattended

Attached to the M13 and M92 objects is the same LRGB-4H plan specifying 24 images using a luminance filter (L), 8 images using a red filter (R) and finally 8 images using a blue filter (B). All images with an exposure of 300 seconds and the total duration of the plan is around 4 hours.

After that it wait for the dawn to take a series of sky flat.

When all is finished it can park the telescope and warm the camera or run other script to close the dome and power off the observatory.

Running this sequence should keep the equipment unattended busy for around 8 hours.

The current implementation support only sequential processing of the targets, with options for repeating or skipping some target.

To take full advantage of this automation you need to configure and test individually:

- all the previous [tutorial pages](#)
- the [global sequence](#) options
- the [camera](#) options
- the [astrometry resolver](#) for plate solving and the [slewing](#) options
- the [focuser](#) and [autofocus](#) options and [calibration](#)
- the [rotator](#) connection and calibration.
- the [autoguider](#) connection and preferences
- the [planetarium](#) connection to help to set the object coordinates
- the [automated meridian flip](#) options
- the [flat automatic exposure](#) options
- the [weather station](#) options
- the [safety monitor](#) options

And most important you must be sure your telescope mount and all the equipment include a way to protect themselves against an unwanted operation. This include hardware slew and tracking limit on the mount.

You can read more on how to edit a sequence in the specific [sequence](#) page.

[Next tutorial >>](#)

Tutorial 8. Video tutorial

Han Kleijn prepared a set of video tutorial to show you the operation of the software.

The basic operation of the program (30 min):

https://youtu.be/Uq_Rb9AdjrA

Introduction to the program configuration (18 min):

<https://youtu.be/13sZL0gY4zs>

Polar alignment without seeing the celestial pole:

https://youtu.be/vfZd_Fejv5U

Introduction to sequences (30 min):

<https://youtu.be/mKluORA3l1Q>

Demonstration of automatic object selection (12 min):

https://www.youtube.com/watch?v=F-u_mOs27nw

Demonstration of preview live stacking (3 min):

<https://www.youtube.com/watch?v=A2YZnAaxReY>

Autofocus on the Moon:

<https://youtu.be/8eWxTQTmYBk>

Imaging of CTB1 supernova remnant using a sequence:

<https://youtu.be/ilmgjN6HWmA>

Imaging of a comet using a sequence:

<https://www.youtube.com/watch?v=7XQcfgr0dg>

Live session recording using CCDCiel, Skychart, PHD2 and INDI by Linux Astro:

<https://youtu.be/rt1AiAucOFw>

FAQ

Can you add support for my device?

With CCDciel you can use any device with a ASCOM, INDI or Alpaca driver.

The program is made to be totally independent of the device itself and only use the standard properties published by this drivers. This ensure the developement I make using my devices will work with any device that use a ASCOM or INDI driver.

As an application developer I cannot develop driver for every existing device because I not have the time and I not own them to make any testing.

You must check before to buy if the device include the required ASCOM, INDI or Alpaca driver. This is the only way you can ensure the device will work with any software.

I cannot connect my ASCOM device

Beware many ASCOM driver work only with 32bit application, even on Windows 64bit.

CCDciel must show an explicit message in this case, and the ASCOM Chooser can show an error with: "System.BadImageFormatException", "Incorrect format".

The solution is to ask the device manufacturer for a 64bit or universal driver. In the mean time you can install the 32bit version of CCDciel as a work around.

Can I change the gain for the camera?

You can set the gain and offset in CCDciel if this is implemented in the camera ASCOM or INDI driver.

Be sure to configure the gain/offset to use for the different operation in the [Camera preferences](#).

A separate gain can be set temporarily in the [Preview](#) for testing purpose.

Are DSLR supported?

Yes CCDciel support DSLR using INDI or ASCOM driver.

For ASCOM see [ASCOM.DSLR - ASCOM driver for dslr cameras \(Canon, Nikon, Pentax, Sony\)](#)

For INDI, CCDciel support image type of FITS or native RAW or JPEG, you must set it in the INDI panel with all the other option you need, then save the setting in the Option tab. Sure use JPEG only for preview.

See: [Indi DSLR documentation](#)

To reload this settings every time you connect the camera to CCDciel you have to check "Load configuration on startup" for the [INDI camera](#)

In every case CCDciel save the image file in FITS format to take advantage of the information stored in the header. Most EXIF tags are recorded as FITS keywords.

To be able to change the ISO in CCDciel you have to [unlock](#) the Gain setting.

LiveView is supported by the [Video](#) tool.

Camera image is very slow to download from remote computer

This problem is typically encountered when the camera is connected by INDI to a Raspberry Pi and CCDciel run on another computer. The same issue can be expected with Alpaca camera.

The network speed is the critical point in this case, specifically with big sensors. Remember a 20Mpx camera will produce a 40MB FITS file to transfer over the network. And this network time is added to the "USB time" to transfer the image from the camera to the RPi.

This is very critical when using a WiFi connection, in this case it can take about 8 seconds if the signal is very good but can take up to 40 seconds if it fallback to 11Mbps, and even more if retries are necessary. The best solution in this case is to replace the WiFi connection by a direct Ethernet cable between the RPi and the computer, just configure a static IP address in the same range on both computer. No router is required so this work fine even in the field.

With this cable you can expect a download time of 3-4 seconds for the same image.

If using a DSLR you can set the image type to native RAW, this make the data size two or three time smaller than FITS.

How to change the telescope park position

This is normally not to the imaging application to do that, but if you not have another solution process as follow. With INDI use the options in the "Site management" tab to set this position.

With ASCOM create a script named for example setpark.js with notepad and add the following content after replacing My.ASCOM.Telescope.Driver by the name of the driver for your telescope:

```
var driver = "My.ASCOM.Telescope.Driver";
var telescope = new ActiveXObject(driver);
telescope.SetPark();
```

Orient the telescope at the desired position and double click to run this script. After that a Park command will return to this position. You only need to do it once and it changes the parking positions permanently.

If you want to run it from CCDciel create an [internal script](#) with the following content:

```
begin
  run('C:\Windows\System32\cscript.exe
C:\Users\username\Documents\scripts\setpark.js');
end.
```

The telescope do not slew at the coordinates I asked

The object coordinates set in the sequence must be ICRS/J2000 because this is the standard with current catalog. This way the sequence is not dependent of the date, you can reuse the same sequence file next year or in 10 years without problem.

But the real sky is not J2000, it is represented by the Local coordinate system that depend on the current date because the Earth orientation change with the time and so the polar axis of the telescope mount.

The main difference between J2000 and the Local system are because of the precession, nutation and aberration.

Most of the telescope use naturally the Local system so the program automatically convert the coordinates from J2000 to Local to slew the telescope. This make the number for RA and Dec you see in the log to be different to what you setup, but this ensure the telescope is finally pointed at the right position.

Plate solved slew do not converge

There is two possible case:

You [set](#) a too small value for the target precision that cannot be reached by your mount because of backlash, flexion, or other mechanical problem.

You use a pointing model using N stars alignment and the weight of the new point you sync near the target is insufficient to influence the pointing result. When using plate solving it is best to disable this pointing model, or at least make the new points to not be added to the model but used as an offset.

For Eqmod ASCOM:

In the Alignment/Sync box click the two button with a red cross “clear align data” and “clear sync data”.

For User Interface select “dialog based”, for Alignment Behavior select “nearest point”.

For Eqmod INDI:

In the Sync tab set “sync mode=standard sync” and click “clear sync delta”.

In the Align tab for “manage list” click “clear list” and set “alignment mode=nearest point”.

My device do not work with CCDciel

First read again the documentation from your device manufacturer and how to set the device [configuration](#) and [preferences](#) in CCDciel.

Also be sure you installed the latest version for any required driver.

Many devices issues are because of bad cable or insufficient USB power. Be sure to test with a different cable, with and without a powered USB-hub, and by connecting only this device to the computer.

We can never exclude a device failure, try with another software, on another computer. With INDI you can exercise all the device functions with a simple INDI client.

Try the same operation in CCDciel with a simulator, this is the first thing to do to [isolate the problem](#). Both ASCOM and INDI have many simulator drivers for all kind of devices. If you can reproduce the error with the simulator please open directly a new issue in the [CCDciel bug tracker](#), otherwise see below.

If you think there is compatibility issue between the device and CCDciel do the following depending on the kind of driver you use:

ASCOM driver:

- Install the ASCOM conformance checker: <https://ascom-standards.org/Downloads/DevTools.htm>
- Connect the device to the computer.
- Start Conform from the Windows main menu under ASCOM Platform.
- If your driver work only in 32bit, open the menu Options, Conformance options, and check “Run as 32bit on 64bit OS”. It restart and you see “32bit mode” on the first line.
- Open the menu Option and select the type of device you want to test (telescope, camera,...).
- Open the menu Option, Select driver. Select in the list and click OK.
- Open the menu File, Check conformance. Beware this will move/activate the device, be particularly careful when testing the telescope or dome.
- After it complete, right click in the text, Select All, Copy.
- If the result show an error message you must contact the device manufacturer for a fix.
- If there is no error, create a new issue in the [CCDciel bug tracker](#), give a description of the issue, and past the Conform result in the Additional information box, this report give me very important information about your device.

INDI driver:

- Connect the device to the computer.
- Start the INDI server with the option -vvv, for example: `indiserver -vvv indi_qhy_ccd`
- Start a INDI client GUI, click Connect for the device.
- In a terminal type the command: `indi_getprop`
- Launch CCDciel and repeat the failed operation.
- Create a new issue in the [CCDciel bug tracker](#), give a description of the issue, and past the `indi_getprop` result and the console log from the indiserver in the Additional information box.

I want to run CCDciel as administrator

You must not run this software or any other astronomy application with administrator right. CCDciel will refuse to start if you try, this is to help new user to do it right from the start.

If you are currently running your astronomy software in administrator mode it is time to change because this is totally useless and create many unwanted issues.

The important point is you run all your software with the same user. But running all with the standard user is much simpler and better than running all in administrator!

I need black colors as I can see in some screenshot here

The program use the system theme color, so change them to a dark theme.

But there is some subtleties and you may need the following.

- On Linux: Use a dark Qt theme, for example Breeze-dark. When using a GNOME or Xfce desktop you need to install qt5ct to set the theme, and set the environment variable `QT_QPA_PLATFORMTHEME=qt5ct`
- On macOS: Since macOS 10.14 you can set a dark theme in the preferences.
- On Windows:
 - Open the Windows settings, search “night light”, turn it on and adjust the color.
 - Or download a compatible dark theme, for example [GreyEveTheme](#). Extract the zip and double click on the .theme file

Edit Menu

The **Edit** menu contain the configuration settings:

- [Devices Setup](#)
- [Preferences](#)
- [Install script](#)

-
- [INDI settings](#)

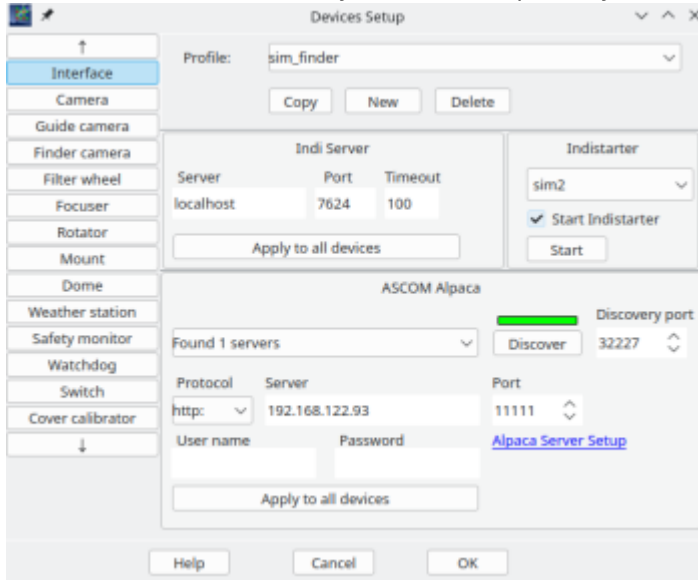
-
- [ASCOM settings](#)

Device setup

Open this window from the menu Edit → Device setup to configure the devices to use with the program.

Interface

The first tab “Interface” let you select the profile you want to use.



All the devices and all the program [preferences](#) will be stored in this profile, allowing to have completely different settings for your different equipment or locations.

The **Copy** button copy the current profile to a new one, allowing to change a piece of the equipment but keep the other settings.

The **New** button create a totally empty profile, with no equipment and no options. This can be use to create a profile for another observatory and be sure to not left behind an incompatible option.

Use the **Delete** button to remove a profile you no more need.

Next you can define the default server host name or IP and port for the [INDI server](#) and [ASCOM Alpaca server](#) and apply this settings for all the corresponding devices.

You can use [IndiStarter](#) to start the INDI server automatically. Check **Start Indistarter** and select the corresponding profile.

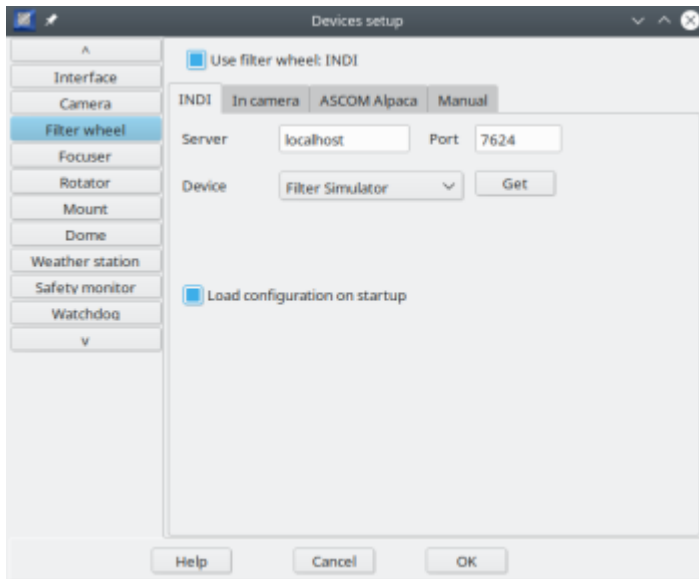
The ASCOM Remote server is assumed to be already running and configured with the drivers you need. Click the “ASCOM Remote” icon in the Start menu of the remote computer.

You can search for Alpaca server and devices on your local network by using the button **Discover**. This require that discovery and management interface are active in the Alpaca server. You can adjust the discovery port if you change this value in the server configuration.

When the discovery fail a new button **Scan this server** appear, this allow to search for devices in a server not in the broadcast range, for example across the Internet.

You can use at the same time devices connected to different server and using different protocol. For example the camera using a local ASCOM driver, the mount connected by INDI to a Raspberry PI and the focuser to a remote ASCOM Alpaca server.

INDI devices



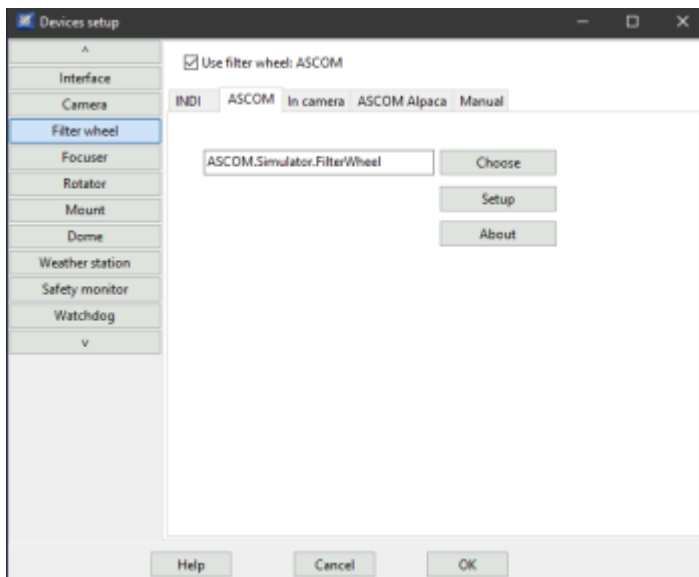
Select the INDI tab for each INDI device you want to use and check the server host name or IP address is right. If need you can set a different server for every device.

Then click the **Get** button to fill the Device list with the corresponding drivers running on the server.

Select the device you want in the list.

You can select to **load the device configuration** just after the device is connected and if not already connected in INDI. This is the same as the INDI client Options/Configuration/Load button, be sure you saved the right configuration from the INDI panel.

ASCOM devices



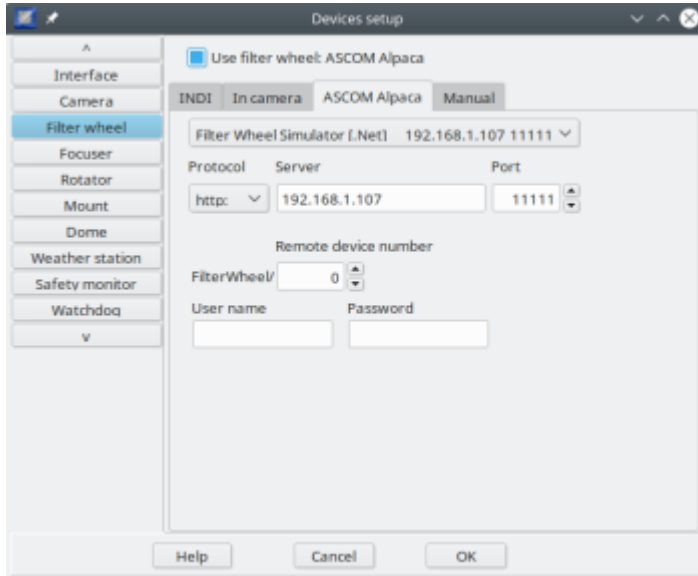
Select the ASCOM tab for each local ASCOM device you want to use. This tab is available only if CCDciel is running on Windows.

Click the **Choose** button open the ASCOM Chooser to select the driver to use.

The **Setup** button let you configure the options specific for this driver.

The **About** button show information about the driver.

ASCOM Alpaca devices

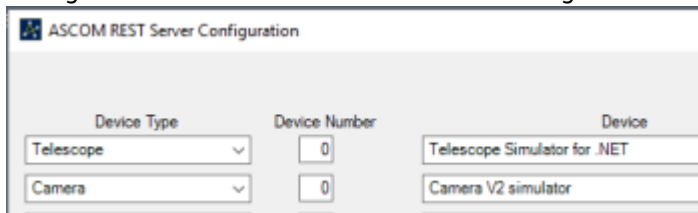


Select the ASCOM Alpaca tab for each ASCOM Alpaca remote device you want to use. You can use a ASCOM Alpaca device also from Linux and macOS.

If you click the button **Discover** on the first tab you can select the devices from the top drop-down list.

Check the protocol, normally http: if not using a [proxy](#), and the server host name or IP address is right. If need you can define a different server for every device. The user name and password can be used for authentication when using a [proxy](#) service.

Then enter the remote device number to use for the device type. This is for example the “Device Number” you configured in the ASCOM Remote Server configuration.



Camera

Select the camera to use with CCDciel, a camera is mandatory so you cannot leave this page unconfigured.

ASCOM, ASCOM Alpaca:

You can select if you want the image to be **flipped vertically** when it is read from the ASCOM driver. Checked from compatibility with Linux version, uncheck for compatibility with many Windows software.

Select if you want the **DATE-OBS** keyword to be from the ASCOM driver. Beware some camera do not respect the UTC rule.

INDI:

The **Sensor** field, visible when a SBIG camera is selected, is to select the sensor to use for dual-chip camera, you probably always want “Main sensor” here.

Select how you want INDI to transfer the image data:

Network the normal transfer mode you can use with local and remote INDI server.

RAM disk may improve the performance if you use a local INDI server. Be sure the path you set point to an in memory disk, it's size need to be two time the size of one of your FITS image.

Guide Camera

Select the guide camera to use with the CCDciel [internal guider](#).

Let this unselected if you use an external guider software.

It is possible to set here the ROI to use with the spectroscopy function of the guider. Give the values for 1×1 binning.

Because of how the slit reference position work it is not possible to set this later.

If the same camera is also used as the finder this ROI is automatically applied to the finder.

This setting has no effect when the internal guider spectroscopy functions are not enabled.

Finder Camera

Select a camera to be used for plate solving if this cannot be done with the main camera.

Typical use is when the main camera is behind a spectrograph, but this can also be used for planetary imaging with very long focal length.

It is possible to use the same camera than the Guide camera because both are never used at the same time.

Just specify the same driver here.

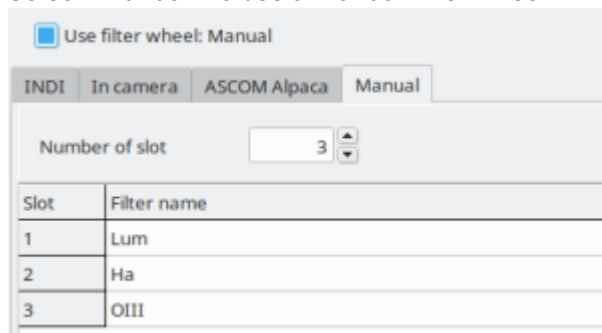
You can change between finder and main camera at any time from the [Slewing preferences](#).

Filter wheel

After selecting the driver, check “Use filter wheel”.

Select “In camera” if the filter wheel is commanded by the camera driver.

Select “Manual” to use a manual filter wheel.



Slot	Filter name
1	Lum
2	Ha
3	OIII

Enter the number of slot and the name for each filter.

The program will pause and ask you to change the filter when required.

Focuser

After selecting the driver, check “Use focuser”.

If a ASCOM weather station is configured and report the temperature, you can check **Temperature from weather station** to use it as the focuser temperature.

Rotator

After selecting the driver, check “Use rotator”.

Mount

After selecting the driver, check “Use mount”.

You can set the following options at your convenience depending on your environment. For example if the mount include a GPS or if you synchronize the site location across different software.

Set mount time from computer: send the time from the computer to the mount.

Set mount site long/lat from configuration: send the site from the [configuration](#) to the mount.

Get site long/lat from the mount: update the [configuration](#) site coordinates by the one set in the mount.

Dome

After selecting the driver, check “Use dome”.

CCDCiel do not position the dome by itself but rely on the available software.

Before to setup here, the dome must be configured using the INDI Dome settings, the ASCOM Device Hub or any other specific dome software.

Be sure the mount is also set to a compatible driver so the dome slaving can be managed.

When using the ASCOM Device Hub it is mandatory to use both ASCOM.DeviceHub.Telescope and ASCOM.DeviceHub.Dome instead of the real drivers.

The [Dome preference](#) let you manage the park/unpark function along with the telescope mount park/unpark.

Weather station

After selecting the driver, check “Use weather station”.

For ASCOM and ASCOM Remote, you can select if you want to use a ObservingConditions or SafetyMonitor driver.

You can define the ObservingConditions limits in the [Preferences](#). If using a SafetyMonitor be sure the limits in the driver are set to ensure good observing condition, for example no clouds.

For INDI the limits are the Warning level of the weather driver.

When the observing condition are not good the sequence is paused until they are good again.

The equipment is NOT put in safety, if required see the Safety monitor below.

If available, the temperature, humidity and pressure are used to improve the atmospheric refraction computation.

Safety monitor

After selecting the driver, check “Use safety monitor”.

For ASCOM and ASCOM Remote, be sure the SafetyMonitor driver limits are set to ensure safe operation. For example no rain.

For INDI the limits are the Alert level of the weather driver.

You can define the action to take when the condition are not safe in the [Preferences](#).

Beware that by default it do nothing!

Watchdog

Check “Use watchdog”, select the INDI driver and set the threshold value in minutes.

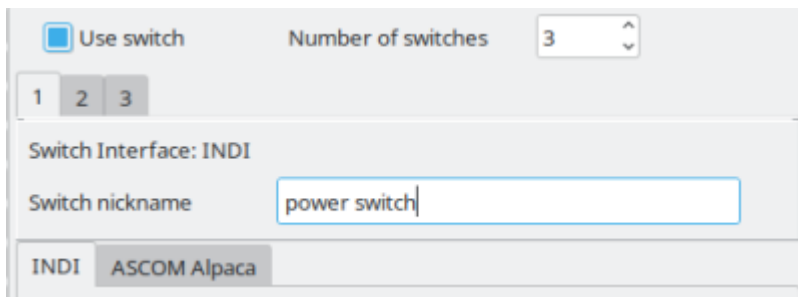
The [watchdog](#) is a specific INDI driver that can park the mount and the dome if the connection is lost with CCDciel for more than the threshold time limit. There is no similar function when using ASCOM drivers.

Switch

Check “Use switch”.

Select the number of different switch driver you want to connect. This add the corresponding number of tab where you can define the connection to the different switch.

Be sure to add a nickname for each switch, this is this name that identify the switch later in the program.



Cover calibrator

After selecting the driver, check “Use Cover calibrator”.

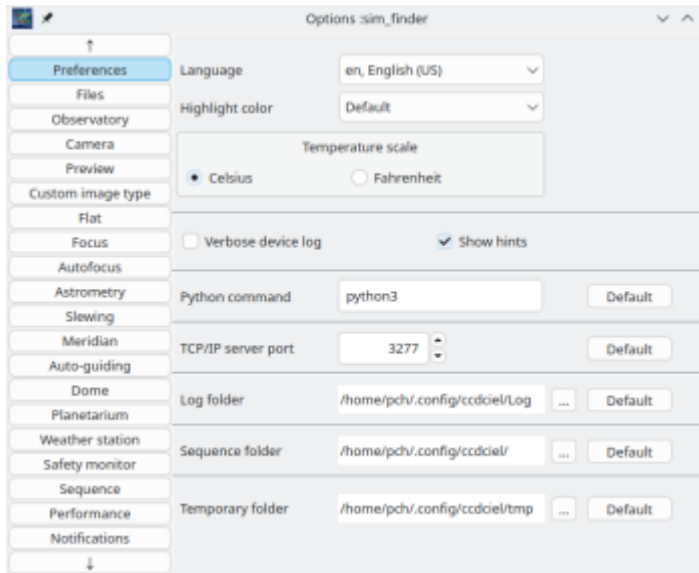
Both the cover and flat calibrator functions are supported.

Click OK after you complete your setting.

Preferences

From the menu Edit → Preferences. Set the global preferences and options for the program.

Preferences



Language

You can change the program language from the list.

The **highlight color** allow to quickly recognize different instances of the program running a different profile.

Select if you want to use Celsius or Fahrenheit **temperature scale** in the program.

Journaling

The program record all the messages to a file. You can look at the log using the function in the [Help](#) menu. It also save the images in the case the auto-focus fail to find stars or when plate solving fail, they can be used later to help to adjust the parameters.

The log file and failed auto-focus images are conserved for a period of 30 days, then they are automatically removed.

In case of problem with a device driver you can get more detailed information by checking **Verbose device log**.

By default the program **show hint** text over the buttons, you can disable this option here.

Python command

Set the command to start a [Python script](#). You can use a specific Python virtual environment by setting the path of the python executable in this environment.

TCP/IP server port

Set the port the TCP/IP server will listen on. Use the default unless it is already taken by another program or if you run multiple instance of CCDciel.

Log folder

The location to save the session log.

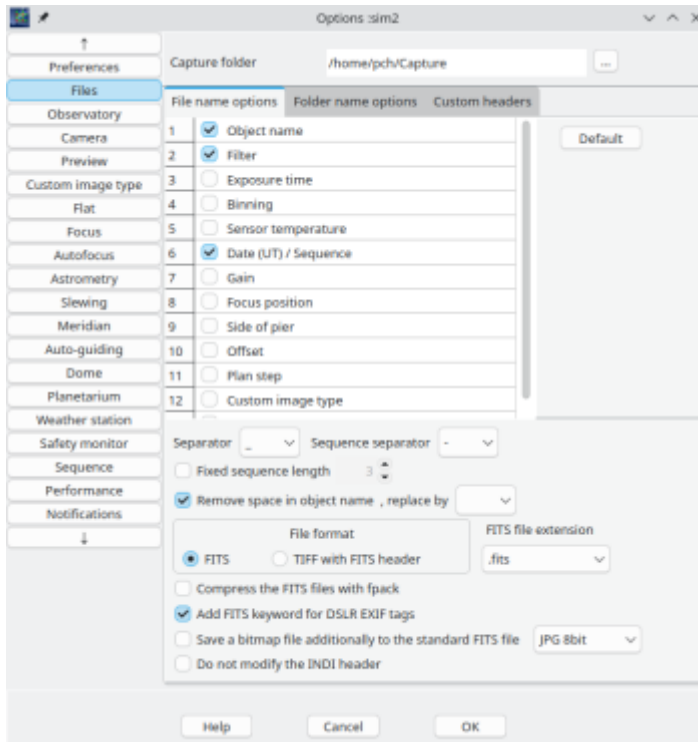
Sequence folder

The location to save and load the sequence files. This can be modified for a more simple file access location.

Temporary folder

Normally you not need to change the temporary file folder. This is only required on Windows if the default path based on your user name contain accentuated non-ASCII characters. Be sure you specify a path with only ASCII characters.

Files



Capture folder

The base capture folder should be specified. The other configured sub-folder are created under this one.

File and folder name

You can specify how the image files are named and if they are stored in named folders. A typical imaging session will produce a great number of files, so this help to select files in the processing software.

One way of working is to make subfolders based on object name and select for file names all details; object name, the filter, a date sequence, exposure time, binning.

For **folder name** you have the choice between two date. One to make a folder with the same UT time as for the file name, the other is based on local time and change at noon to allow to put all the files for a given night to the same folder.

For **file name**, if Date/Sequence is checked the UT date and time is appended, otherwise a sequence number is appended. You can select a **fixed sequence length** or let unchecked for variable length.

You can reorder the different elements with a mouse drag and drop of the sequence number column.

Select the **separator** character you want between the fields, and the length of numeric sequence. It is also possible to **remove space** from the object name if your processing software has difficulties with that.

The file format can be [FITS](#) or [Astro-TIFF](#), a 16bit TIFF file with addition of all the FITS header information that is supported by a number of processing software.

The saved FITS files can be **compressed** with [fpack](#) to use less disk space.

You can save the image in bitmap format in addition to the standard FITS or Astro-TIFF file.

Select also the file format you want. BMP and JPG are stretched 8bit images, PNG and TIFF are saved as linear 16bit, the same as the [Save picture](#) menu.

If you use a customized INDI driver that produce a FITS file exactly the way you need it, you can select to not modify the FITS header in CCDciel.

Custom headers

It is possible to define custom headers to add to every captured FITS file.

Enter valid keyword and values in the table. It is possible to set text or numeric values.

If a keyword is already set by the standard CCDciel processing and you add the same keyword here your value take precedence and replace the standard value.

For example the following input:

Files	File name options	Folder name options	Custom headers
Observatory	Key	Value	
Camera	STRING1	abcd efg	
Preview	STRING2	'56'	
Flat	NUMBER1	56	
Focus	NUMBER2	56.1234	
Autofocus			
Astrometry			

Add the following to the header:

```
STRING1 = 'abcd efg'
```

```
STRING2 = '56'
```

```
NUMBER1 = 56
```

```
NUMBER2 = 56.1234
```

Use the available [script](#) function if you need to add headers with a dynamic value.

The following keyword are reserved and cannot be used in this function:

SIMPLE, BITPIX, NAXIS, NAXIS1, NAXIS2, NAXIS3, XTENSION, END, BZERO, BSCALE, ROWORDER, DATAMIN, DATAMAX, DATE, DATE-OBS, SWCREATE, IMAGETYP, MJD-OBS, EXPTIME, STACKCNT, STACKEXP, STACKOP, STACKALN, GAIN, OFFSET, ISOSPEED, GAMMA, BRIGHTNS, F_STOP, XPIXSZ, YPIXSZ, PIXSIZE1, PIXSIZE2, XBINNING, YBINNING, XBAYROFF, YBAYROFF, BAYERPAT, MULT_R, MULT_G, MULT_B, FRAMEX, FRAMEY, FRAMEHGT, FRAMEWDH, XORGSUBF, YORGSUBF, GUIDEX, GUIDEY

Observatory

Preset list

Each new observatory name is added to the preset list for an easy later retrieval.

This is useful if you transport the same equipment at different location.

But please do not use this option to work with different equipment, in this case you need a specific profile for each.

General information

The information on top will be set in each FITS file for the OBSERVER, ORIGIN, TELESCOP and INSTRUME keyword.

Observatory coordinates

The latitude and longitude of the observatory is used to get the Alt/Az position of the object, or for the scope_alignment script. It is mandatory you set them before you can use the timing functions in the sequence planner.

Rise/Set condition

The “Horizon profile” and “Minimum observing elevation” are used to compute the object rise and set time in the [sequence planner](#). If this values are set the rise/set time are relative to this limits.

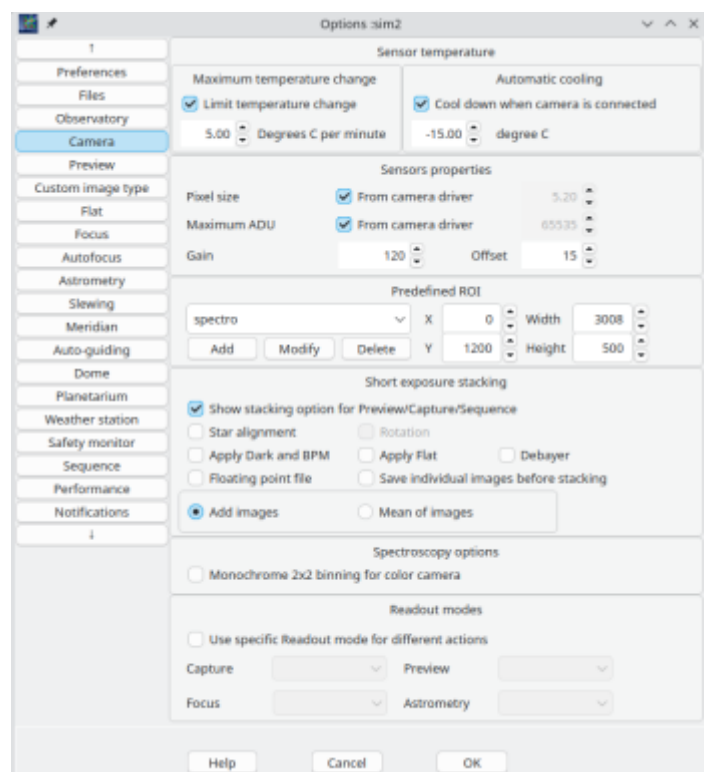
You can set only one value or both. In the last case the highest elevation is used.

The horizon profile file is the same as the local horizon line in [Skychart](#).

Azimuth origin

Select if you prefer to use the azimuth counted from the North or from the South. This only affect some display in the program, the object azimuth recorded in the FITS header is always from the North.

Camera



Sensor temperature

Configure how you prefer to cool down and warm up you CCD sensor.

Consult your camera documentation to know if you need to limit the temperature change.

In this case check “Limit temperature change” and indicate the maximum rate in degree per minute.

Check the corresponding box if you want your camera to start cooling as soon it is connect to the program and indicate the target temperature you want.

Sensor properties

Enter the camera pixel size and maximum ADU, or if applicable for your driver, check the box to get it automatically.

The maximum ADU is used to avoid saturated stars during autofocus and photometry.

The pixel size is required to speedup the astrometry solving by estimating the image scale.

The camera **Gain** and **Offset** to use for the image capture and other operations.

Predefined ROI

Manage a list of subframe size and position that can be quickly selected from the [frame tool](#)

Short exposure stacking

Check **Show stacking option for Preview/Capture/Sequence** if you want to use this options. You can let it disabled to not risk an unwanted use during the imaging session.

- **Star alignment** align the frames on a reference star. Use it for EAA along with the dark, BPM and debayer option. No further pre-preprocessing is possible when any of this option is used.
- **Rotation** correct the alignment for field rotation. This require the [astrometry](#) to be configured.
- **Apply Dark and BPM** apply the setting from File → [Dark frame](#) and File → [Bad pixel map](#).
- **Apply Flat** apply the setting from File → [Flat frame](#).
- **Debayer** the image using the [preview](#) setting.
- **Floating point file** using 32bit FITS file. This ensure the maximum of precision and prevent data overflow. Be careful how to use this kind of image with your processing software.
- **Add images** or **Mean of images** is the operation used to stack the images.
- **Save individual images before stacking** in a specific folder named with the object name and the time the stacking start.

Spectroscopy options

When using a color camera to acquire spectra images it can be good to check this option **Monochrome 2×2 binning** to record a B/W image instead. This make the further processing more easy.

Each B/W pixel is the sum of the blue and red with the mean of the two green pixels.

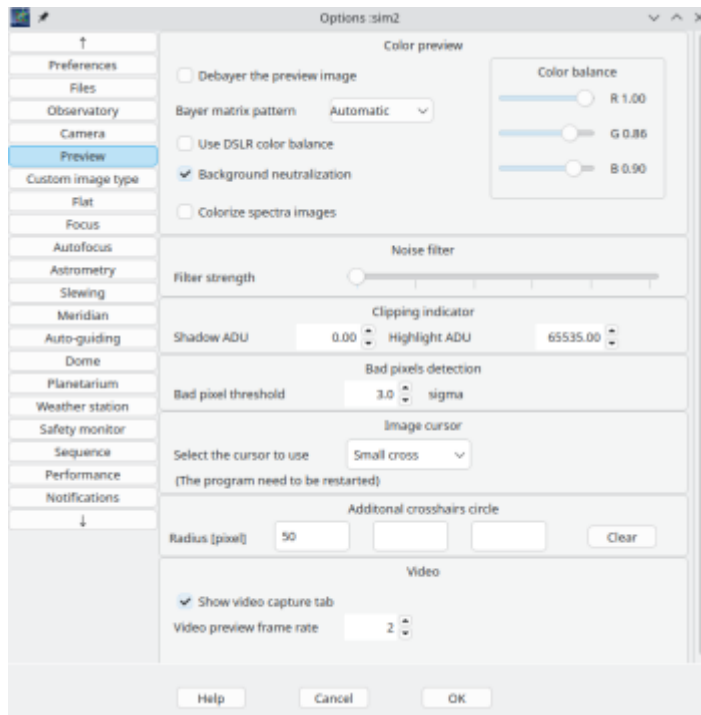
Readout modes

If your camera support different readout modes you can activate the **use of specific readout mode for different actions**.

Then select which one to use for the different operations. Normally you want the select the best quality mode for Capture and a fast mode for the other.

With INDI DSLR this is a combination of the CAPTURE_FORMAT and TRANSFER_FORMAT property to select from RAW, FITS, or different JPEG quality.

Preview



This settings affect only the [preview](#), the FITS files are always recorded in RAW format.

Color preview

If you use a color camera you can **debayer** the preview image by checking the corresponding box and selecting the color pattern for your sensor. The **Automatic** option use the value set by the camera driver of the DSLR raw file. If this not work try the other option in the list. You can also do some color balance with the cursors on the right. For DSLR raw files you can select to use the color balance set in the file. By default the background color is neutralized, this can be disabled if the image do not contain a classic sky background.

When using a slit spectrograph it is possible to **colorize the spectra image** using the wavelength FITS keyword. This also colorize the [spectra profile](#).

Filter strength The noise filter strength in a 1 to 6 range. The higher remove more noise but also some fine details. The filter is applied to the autofocus images and manually using the right click menu.

Image clipping

The image **clipping indicator** level. You can set the low and high threshold in ADU for this indicator.

Bad pixel map

The **bad pixel map** prevent the auto-focus function to lock on a hot pixel. Select the threshold for detection of hot pixels for the [bad pixel map](#).

Image cursor

Select the type and size of mouse cursor you want over the image display.

Additional crosshair circle

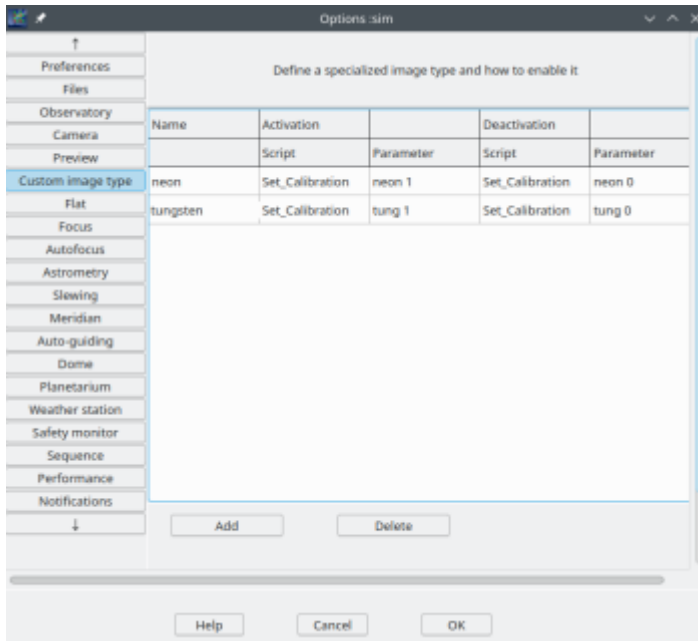
Draw additional circle of specified diameter in orange color with the crosshair display.

Video

Check the box to show the Video tab if available for your camera.

Select the preview rate for the **video**. [Video](#) require a suitable camera and is available only with INDI devices.

Custom image type



This allow to define additional custom image type in addition to the standard Light, Flat, Dark, Bias.

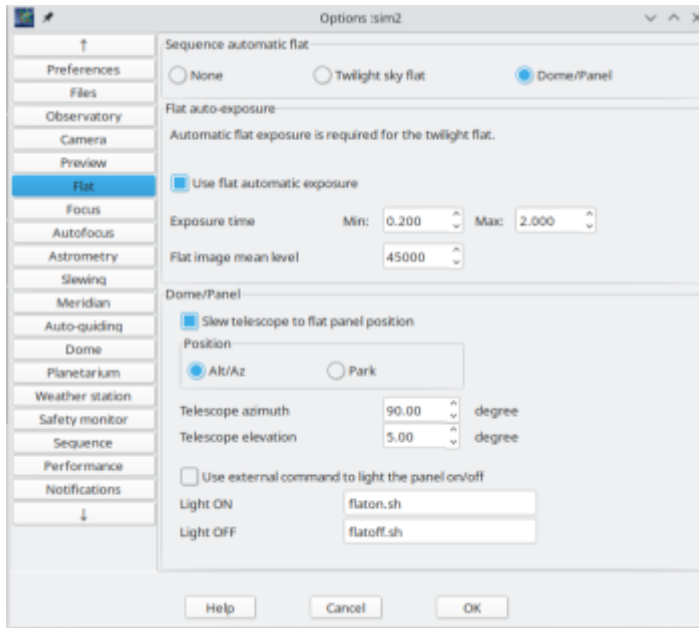
Add one row per type, with a name and optionally a script with parameters to run when this type is selected or unselected.

For the camera driver, all this additional type are of type Light.

A typical use is to light a neon lamp for spectroscope calibration, but this can be use for any purpose, for example to subclassify the Light exposure according to your need.

After definition here, the custom type are available in the Capture or Sequences options.

Flat



Automatic flat

Configure the method to use to capture a flat series from a sequence.

Twilight flat

For the twilight flat it is require to configure the automatic exposure as the sky lightness change a lot during dusk or dawn.

You can also configure this automatic exposure for a use with other light source.

At each exposure the program will adjust the exposure time between the two limits to maintain the image level. Set the shortest exposure time that give an uniform sensor illumination. This depend on the kind of shutter used by the camera.

Set the longest exposure time you want for a flat. You have to take the corresponding dark separately.

Then give an image mean level range that make an acceptable flat. Start with 80% of your camera full range but check there is no saturated part in the center of the flat image, specifically if the vignetting is important.

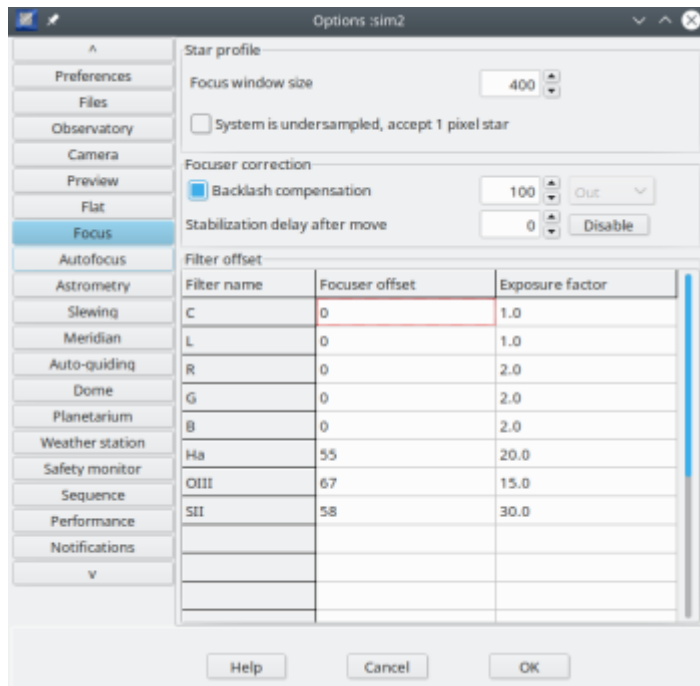
Dome/Panel

Select this method if you use dome flat or light panel.

You can also select automatic exposure, but at the difference of the twilight flat the exposure is adjusted only once for each filter, then the same exposure time is use for the series.

If you need to point the telescope at a specific position to frame the panel you can enter the required azimuth and elevation.

Focus



Star profile

Select the camera ROI size of the zoomed window for the single star and manual focus mode.

Normally a single pixel star is rejected as a hot pixel. If your optical configuration produce undersampled image with single pixel star you can check this box. But be careful to make a [bad pixel map](#) to reject the hot pixel.

Focuser correction

If this is not already done by your focuser driver you can activate a backlash compensation. But be sure to let it disabled if the compensation is done elsewhere. Indicate the number of additional steps to use for the compensation, this must be greater than the actual backlash, don't hesitate to use a large value.

Indicate the direction the focuser will always finish to move, the best depend on your configuration. If you configure the auto-focus this control is disabled and will be set to the same as the focus move direction.

If it take some time for the focus position to stabilize after a move you can set a delay to wait after every focuser movement. This is more likely of use if the motor directly move the primary mirror of a SCT.

Filter offset

For each filter you can set an offset in focuser steps that will be applied to the focuser when you change the filter.

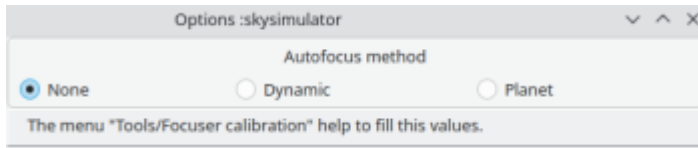
The filter **exposure factor** is used for the auto-focus functions and the [automatic sky flat](#). For example if your R filter require 2x the exposure of the L filter and the Halpha 30x set : L=1 R=2 Ha=30

For narrow band filter this exposure factor can be very large. In this case you can use the option "Allow to select a brighter star for high filter exposure factor" in the [auto-focus](#) preference.

Temperature compensation

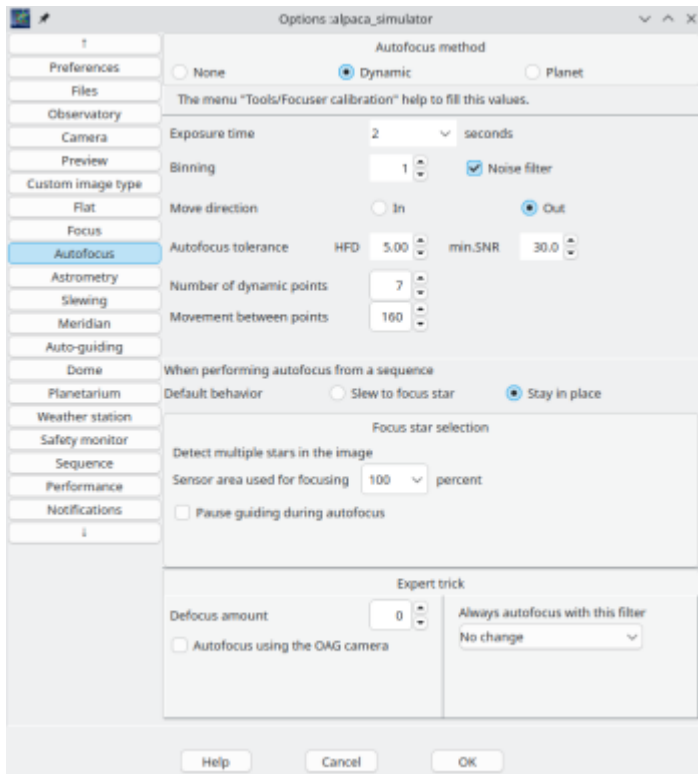
Temperature compensation and automatic triggering of autofocus after a temperature drop can be set in tab [Sequence](#)

Auto-Focus



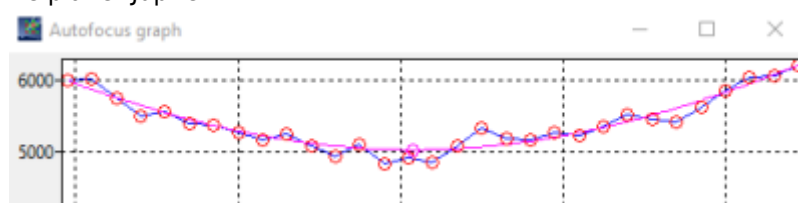
This section is initially empty. It can be hard to fill with the right values for your specific equipment. It is strongly suggested you use the [focuser calibration](#) tool to set the correct default parameters.

After the tool is run it select the preferred Dynamic method. You can return at this page if you want to change the method or adjust some parameters.



Select the auto-focus method:

- **None:** If you want to use your focuser only manually.
- **Dynamic:** (hyperbole curve fitting) This method can be used with either an absolute or relative position focuser. It de-focus the star(s) and tries to fit the corresponding HFD values(s) to a hyperbole function. From the hyperbole function the minima, so the focus can be calculated. This method work well with the option "stay in place" for autofocus, it use multiple stars for reliable detection.
- **Planet** This method is similar to Dynamic but it measures the image sharpness (gradient) instead of the stars HFD. This make it possible to autofocus on the Sun, the Moon or the planets. Note that the difference between the minimum value and maximum is about 40% maximum. So the focus curve is flatter. Set the number of sample points between 20 or 30 to average out noise. At severe de-focus positions the curve will turns into a horizontal line which should be avoided. Reduce the focuser step size till there is maybe 20% difference between minimum and maximum value. Below an example of an autofocus curve of the planet Jupiter:



Common parameters

- **Exposure time** to use for the auto-focus operation. This time is multiplied by the filter exposure factor above.
- **Binning** to use for the auto-focus. Use binning 1×1 unless you are way oversampled.
- **Noise filter** to apply a median filter to the image. This can help with faint star detection.
- **The move direction** of the focuser. Depending on you setting the focuser can work better when moved in or out of focus.
- **Autofocus tolerance** is the maximum HFD that can be considered as a successful focus. If the HFD after and auto focus operation is higher than this value the focuser position is set back to it's previous value.
- **The minimum SNR** of the star during the measurement. If a measurement SNR is lower than this value the auto focus operation is canceled and the focuser position is set back to it's previous value.
- **Number of exposure per point** The number of exposure we take to get a mean HFD value for each focuser position. Increase this value if the seeing is not good. But set to 1 when using multiple stars detection.

Dynamic parameters

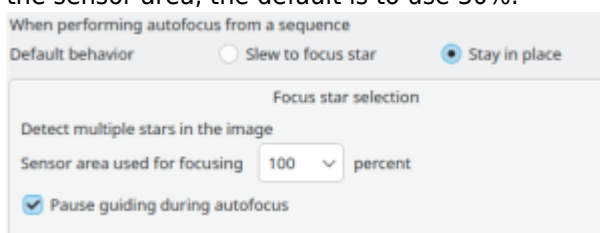
- **Number of dynamic points:** The number of points we take on the curve. Do not set too high as this is done at every focus operation. Recommended default value is 7.
- **Movement between points:** The number of focuser steps we move between each measurement of the curve. It must be set high enough to make a measurable change in star diameter, but not too high so faint stars can still be detected. The HFD value should increase at two above the minimum. So if the focused stars have a typical HFD value of 2.5, the resulting V-curve should reach a HFD value of 4.5 or higher. Larger steps will make it less vulnerable for focus drift but due to the larger HFD values it requires brighter stars for enough signal to noise ratio. The maximum focuser movement in and out of current position will be $(\text{Number of dynamic points}) \times (\text{Movement between points}) / 2$

Planet parameters

- **Number of points:** The number of points we take on the curve. Set high enough to leverage the seeing fluctuation on the planet surface. The default is the value measured for the dynamic focus during the focuser calibration, but it is recommended to increase at least to 15.
- **Movement between points:** The number of focuser steps we move between each measurement of the curve. It must be set high enough to make a measurable change in image sharpness, but not too high because at a certain point more defocusing do not make less sharpness. If the curve show flattening on the top you need to reduce this value. The default is the value measured for the dynamic focus during focuser calibration. The maximum focuser movement in and out of current position will be $(\text{Number of points}) \times (\text{Movement between points}) / 2$ *
- The sharpness detection works better if there is a strong signal. Expose long enough for a bright image of the the planet.

Option valid when running from a sequence

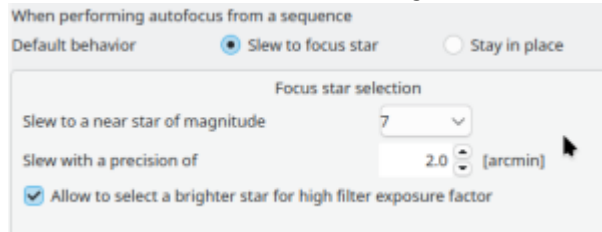
- Default behavior for **Focus star selection** when the autofocus is run from a sequence. Select if you want to slew to a bright star or stay on the object you are imaging to do the auto-focus. This can be selected object by object in the [target editor](#). When using the Autofocus button in the Star profile tool it always stay at the current position, allowing you to manually select the target.
- When measuring multiple stars it is possible to select the **sensor area used for focusing** in percent of the sensor area, the default is to use 30%.



- If you stay on position, you can select to **Pause guiding during autofocus** or not. You must pause

when using a OAG, but it is recommended continue guiding when using a separate guide scope.

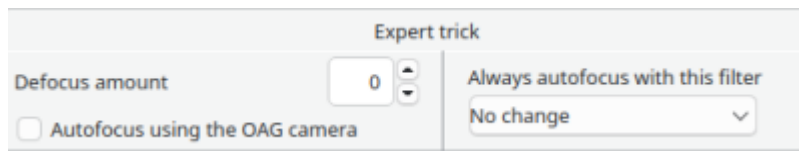
- **Focus star selection** when using “Slew to focus star”.



Select the magnitude of a star that give a good SNR for the auto-focus operation using the above exposure time. The telescope is moved to a nearby star of this magnitude to run the auto-focus. You can set here the precision require for the slew to put the star in half the image height. Use a lower precision than for [target slewing](#) to speedup the process. If **Allow to select a brighter star for high filter exposure factor** the program can use a brighter star to avoid too long exposure time with narrow band filter.

If the auto-focus fails to find stars and the journaling to file is active, the image is saved in the same folder as the log so you can review them later to help to adjust the parameters.

Expert trick



At the bottom of the preference list, you can set a **defocus amount** to apply after the focus point is reached. This can help to image with a constant defocus value when doing photometry measurement with a color sensor.

The option **Autofocus using the OAG camera** is for use with a slit spectroscope or other case where it is not possible to use the main camera for focusing.

The guide camera is used to measure the stars reflected by the slit mirror.

In this case the **defocus amount** can be set to the difference of focus position between the guide camera and the spectroscope.

It is possible to always **autofocus with a specific filter**. Use this option if you cannot autofocus with a narrow band filter, but be sure to set the [focus offset](#) correctly.

Temperature compensation

Temperature compensation and automatic triggering of autofocus after a temperature drop can be set in the [Sequence](#) options.

Astrometry

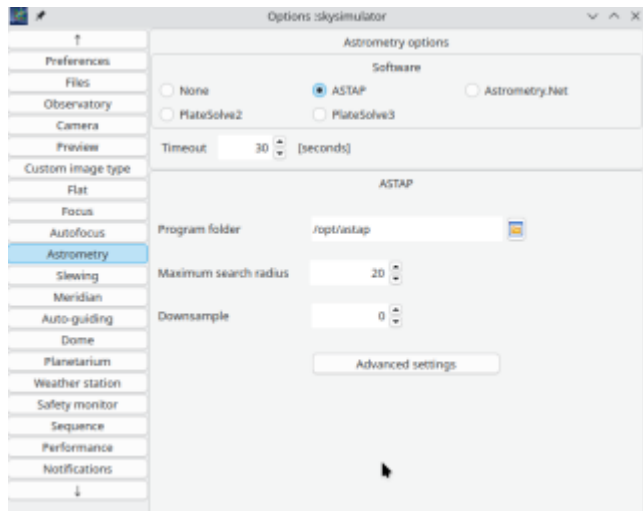
Software selection

Select the software you want to use for the astrometry resolution of the images, you can use [ASTAP](#), [astrometry.net](#) or [PlateSolve2/PlateSolve3](#).

You can also adjust the timeout (in seconds) for a solve operation.

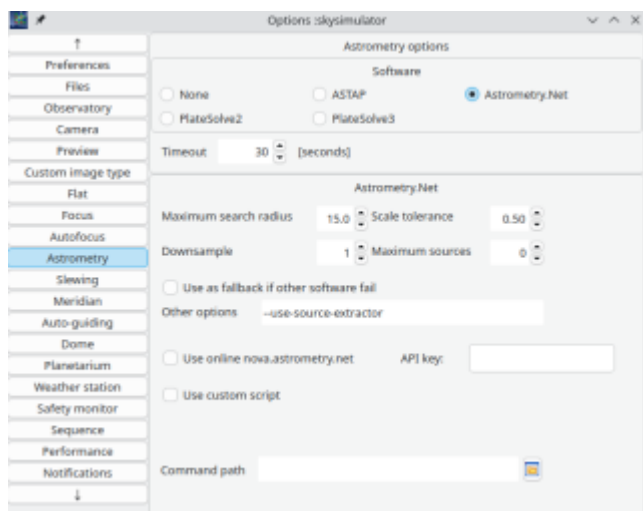
For each software you can adjust a few option to make them work quickly and reliably with your images.

ASTAP options



- Program folder: the folder you install the ASTAP program.
- Maximum search radius: Is a tolerance in degrees to the telescope position. As ASTAP is very fast there is no reason to change the 90° default value.
- Downsample: For large images (>3000 pixels wide) select binning. It is recommended to keep the default value of 0 that let ASTAP select the best depending on the image size.

Astrometry.net options



- Maximum search radius: Is a tolerance in degrees to the telescope position. Set this value high enough if you use the plate solving to make a pointing model.
- Scale tolerance: The tolerance on the pixel scale derived from the focal length and pixel size.
- Downsample: the image by this factor. Use at least 4 or 8 for DSLR images. For CCD it is better to use binning.
- Maximum number of source to consider.

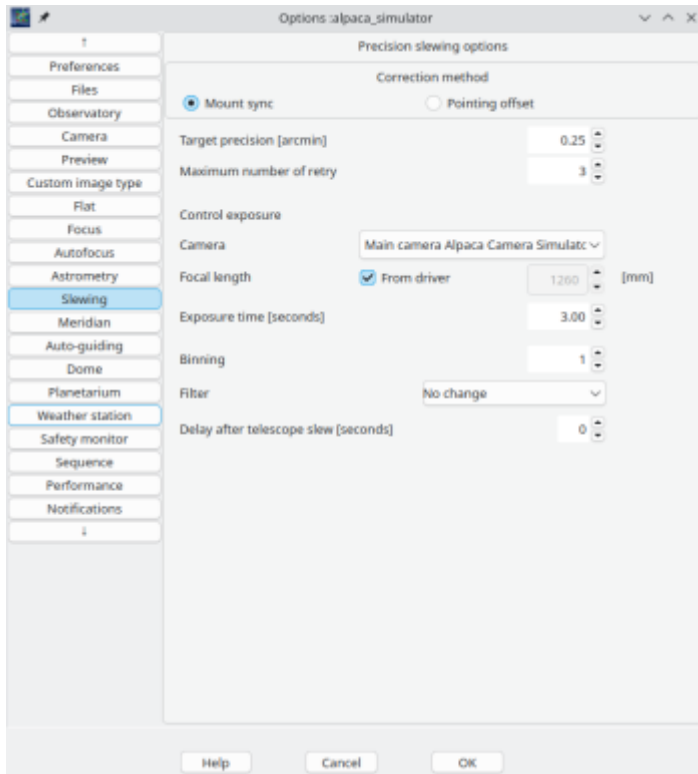
- Other options: any other option you want to give to the solve-field command. See `man solve-field`, for example `--use-sextractor`.
- Use online nova.astrometry.net, in this case specify your API key from this site.
- Use custom script: Use a script instead of the solve-field command. There is two example with the program, one for remote execution using ssh, the other for remote solving with the astrometry.net python script.
- On Linux or macOS you can specify the path to the solve-field program if it is not installed at a standard location. Let this field blank to use the default system search path.
- On Windows only, you need to specify the Cygwin path to where astrometry.net is installed, for example `C:\cygwin`. See the [installation instruction](#) for more details.
- You can setup astrometry.net as the fallback option if the primary configured solver fail. This let you use a faster software like ASTAP as the primary solution and retry with astrometry.net only if it fail because of difficult condition like half cloudy sky.

PlateSolve 2/3 options



- Program folder: the folder you install the PlateSolve2/PlateSolve3 program.
- Wait after solve: the number of second the PlateSolve2 window remain visible after solving is complete.

Slewing



You can adjust how to correct the mount position after plate solving a control picture.

Correction method

- **Mount sync** will send a Sync command to the mount after plate solving before to Slew at the requested coordinates.
- **Pointing offset** will compute the RA/Dec offset and send to the mount a Slew to coordinates modified by this offset.

If your mount allow to sync anywhere select “Mount sync”, if not select “Pointing offset” to make the correction in software.

“Pointing offset” can be useful if your telescope use a pointing model, this avoid any problem by using Sync with the model, but this can result in a wrong position to be reported in other software.

With Eqmod it is best to disable the pointing model and select “Mount sync” here. With EQAscom, in Alignment/Sync select “Dialog based” and “Nearest point”. With INDI EQmod select “sync mode=standard sync” and “alignment mode=nearest point”.

Pointing options

Then set the precision you want/can reach and the maximum number of pointing/correction retry before to give up. Beware that any backlash in the mount drive can limit the possible precision.

Control exposure

If you define a [Finder camera](#) you can select which camera to use.

It is important the program know your telescope focal length to estimate the image scale to speedup the solving process.

Enter the **telescope focal length**, or if applicable for your driver, check the box to get it automatically.

Set the parameters (**exposure time, binning and filter**) for the control exposure. This must give enough stars with your telescope/camera combination for the astrometry resolver to work.

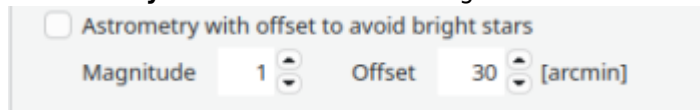
If your mount need some **time to stabilize** after the movement you can increase the delay to wait before to take the plate solving picture.

When using the finder camera you can specify an **alternative solver**, other than the main one.

Sync the rotator

When using the main camera it is possible to sync the rotator angle at each slew using the astrometry position angle.

Astrometry with offset to avoid bright stars.

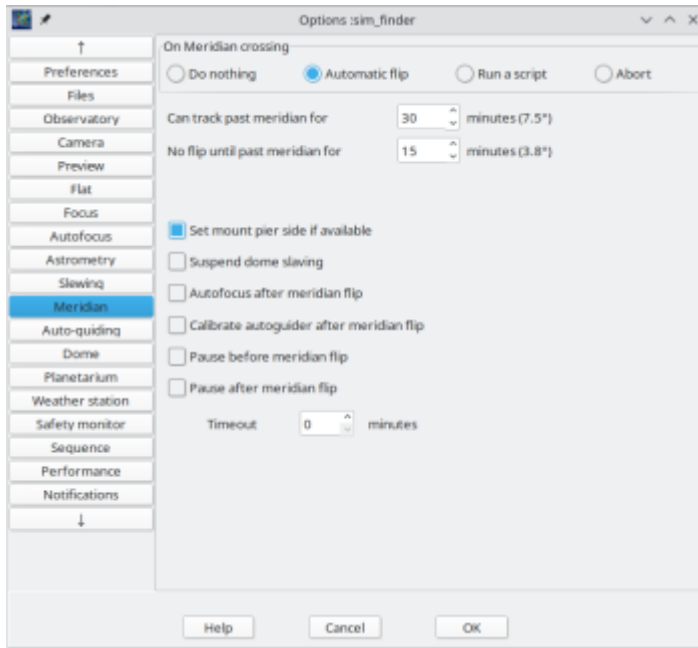


☐ Astrometry with offset to avoid bright stars

Magnitude Offset [arcmin]

This option is visible when using a spectroscope with the finder camera and it is the same as the guide camera. Set the magnitude limit to restrict this function to bright star and the pointing offset. In this case the astrometry is done at this offset from the target before the telescope move to the final position.

Meridian



Configure here what you want to do when the mount reach the meridian.

- **Do nothing:** select this option if your mount is not affected by the meridian (fork mount).
- **Automatic flip:** automatically do a reversal of the mount to continue to track past meridian.
- **Run a script:** run a script that do the meridian flip.
- **Abort:** abort the current capture and stop the mount.

Automatic flip options

The first two parameters allow to loss the minimal time during a capture sequence. Set the difference between them as long as the capture exposure time. Otherwise the sequence can be paused until it reach the time for the flip.

Also be sure the flip do not start too early because this can be the cause of mount sync error in case of polar alignment error or telescope cone error because many mount do not accept to sync across the physical meridian.

To avoid error during the flip procedure it is important the [mount](#) and [program](#) observatory coordinates and time are set precisely.

- **Can track past meridian for:** the number of minute your mount can safely track past the meridian without flip. This depend on the declination, set the smaller value here.
- **No flip until past meridian for:** the minimum number of minute after the meridian we wait before to initiate the flip. Set this value to at least 10 minutes to avoid mount sync error near the meridian. You can set a negative value here to flip before the meridian, be sure the mount can accept that and support to set SideOfPier.

Actions to take as part of the meridian flip:

- **Set mount SideOfPier if available:** Set SideOfPier directly to the mount, otherwise use Goto command.
- **Suspend dome slaving:** This can prevent a full rotation with some dome.
- **Autofocus after meridian flip:** In some case the focus point can move after a flip.
- **Calibrate autoguider after meridian flip:** If your mount do not report the side of pier to the autoguider you can check this option to force a new calibration.
- **Pause before meridian flip:**
- **Pause after meridian flip:** this two checkbox give you a prompt before or after the flip to let you the

time to do some manual operation on the mount (moving the counterweight for example).

- **Timeout:** The maximum time we wait for the pause after the meridian flip, if you not close the prompt after this time the sequence continue automatically.

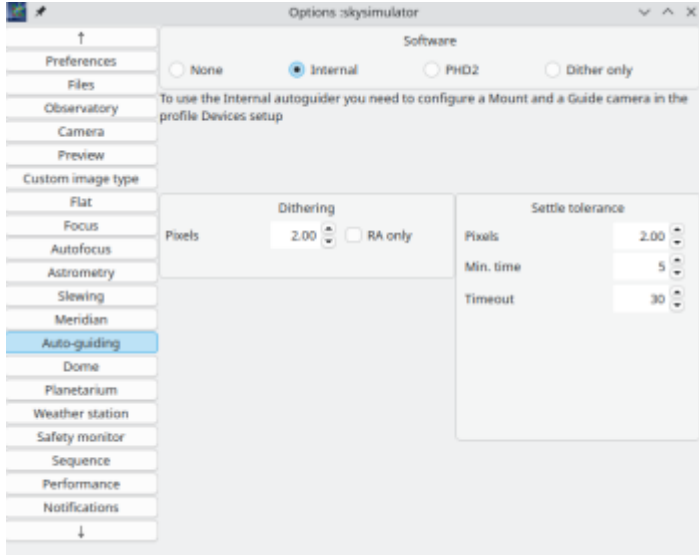
Before the flip the pause is limited by the maximum time the mount can track without a flip.

Precise centering of the target using plate solving after the flip is done automatically and only require you configure the plate solving correctly.

Auto-guiding

Software selection Select your autoguiding software, this can be the [Internal guider](#), [PHD2](#), or only dithering using mount command.

Internal guiders



Setup the guide camera to use in the [devices setup](#).

Dithering

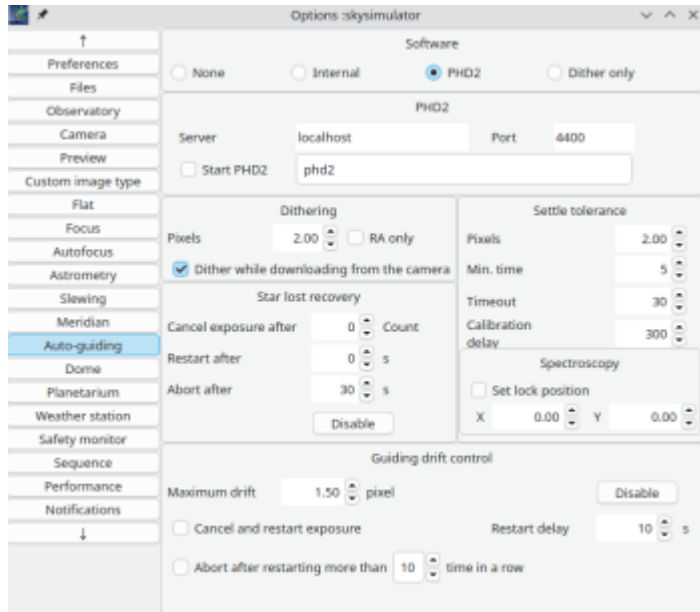
Set the options for dithering between the exposure, the number of pixels (in the guide camera) and if you want to dither only in RA (if you have a lot of DEC backlash).

Settle tolerance

The settle tolerance define how we consider the autoguiding as good after a dither operation or after it start. It must stay within the number of pixel for Min.time. But we wait for the maximum of Timeout if this is not possible.

All the other internal guider specific settings are in the [Internal Guider](#) tab.

PHD2 options



For **PHD2** you need to set the network name of the computer running PHD2 and the port number. Check if you want to **start PHD2** if it is not running when connecting. Indicate the command to start PHD2, the default value correspond to the default PHD2 installation on the current platform.

Define the **Dithering** and **Settle tolerance** options that have the same meaning as above. Set also the maximum time to wait if a new calibration is required.

If the option **Dither while downloading from the camera** is checked the dithering will start as soon the previous main camera exposure is complete, making profit of the image download time to advance on the dither.

Spectroscopy

This set the guide lock position for use with a reflective slit spectrograph.

Star lost recovery

In the case the guide star is lost we can **cancel and restart the current exposure** after a number of guide step without star. This is for the case we know the current exposure will be lost anyway so there is no need to loss more time by completing this exposure.

Then if the star is not recovered after a given time we can try to **restart the guiding**. This is useful if the star as moved just out of the search area. But this can also make the sequence to continue with an unacceptable offset, this can be avoided by checking for [target drift](#). A value of zero disable this function.

Finally we can **abort the current sequence** after some time. Useful if the target is behind tree or cloud, maybe the next target is at a better position.

Guiding drift control

If the current guide position drift by more than the configured value a message is show in the log and eventually **the current exposure is canceled and restarted**. We can wait for the delay to let the guiding to recover before to restart the exposure.

The current sequence target can be aborted if it still drift after a number of consecutive restart.

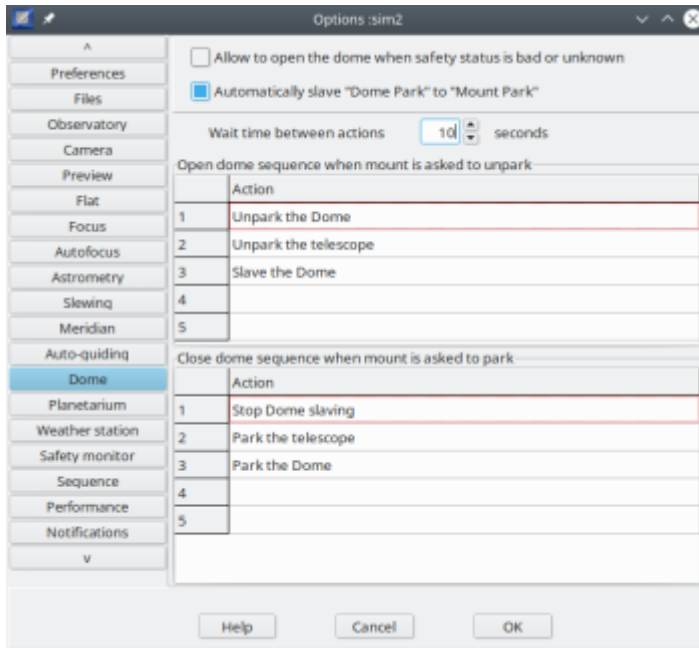
Dither only options

With this option no auto-guiding is done but the program can initiate dithering between the exposure.

Dithering		Settle tolerance	
Pulse duration	5.00 s	Wait time	0
☐ RA only			

Here you set the mean duration of the dithering guide pulse send to the mount. This duration depend on the imaging scale and the mount guide rate. An additional wait time can be configured to let the mount stabilize after the dithering.

Dome



The Dome preference let you configure if you want to automatically manage the dome with the mount park/unpark function.

If you check the box **Allow to open the dome when safety status is bad or unknown** there will be **NO** check for the safety before to open the dome. Use this setting only if your safety monitor is not functional until the dome is open.

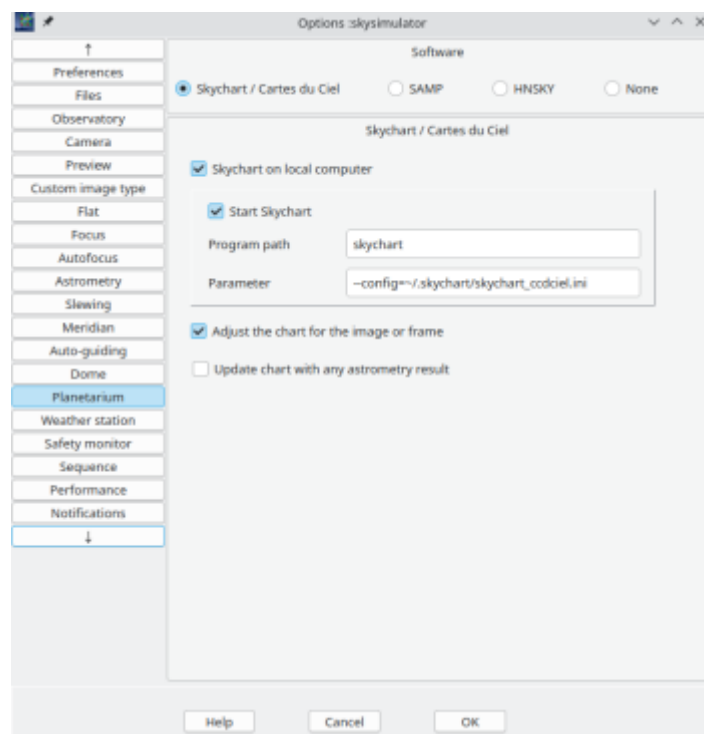
If you check the box **Automatically slave "Dome Park" to "Mount Park"**, every time you unpark the mount from CCDciel the sequence to open and initialize the dome will be taken. And every time you request to park the mount the corresponding action to close and park the dome will be taken.

Beware to carefully test this procedure before use and be prepared if something go wrong. What to expect if for example the telescope do not respond to the park request but the roof is then closed and hit the telescope? This case can be secured by using hardware switch on the mount that prevent the roof motor to start. If you are not sure please do not use this function and open/close your dome with manual action and visual inspection.

For each of the unpark and park function you need to select the action you want in the order require by your setup. For some configuration you need to open the dome first or unpark the telescope first. If some action is not require by your setup just ignore it, you not need to fill all the rows. For example if unparking the dome also open the shutter select only "Unpark the Dome". But be sure to put "Unpark the telescope" and "Park the telescope" somewhere, otherwise the telescope will never be unparked and any slew will fail.

You can also wait for an additional delay between each operation to let time for the mechanical part to stabilize.

Planetarium



Select the planetarium application you want to use.

You can use the planetarium to select a target, or to display a solved image or image frame.

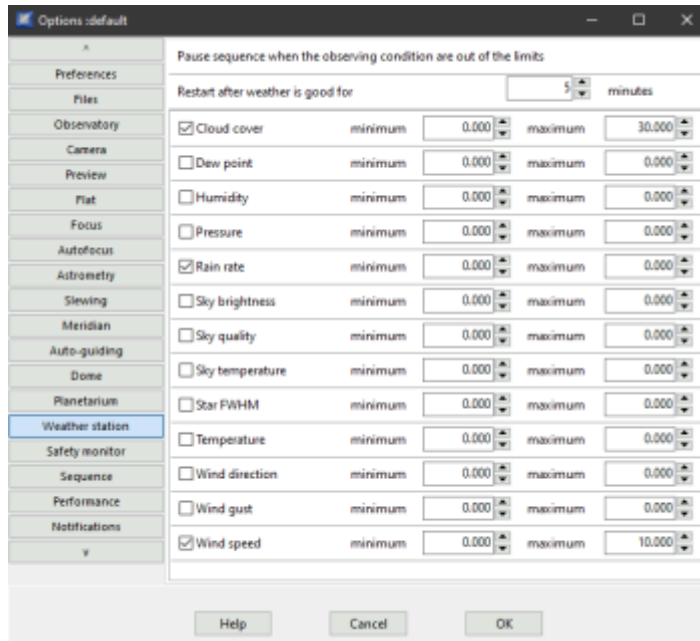
You have the choice between [Skychart](#), [HNSKY](#), or a [SAMP](#) application like [Aladin](#) or [Topcat](#).

Check if you want to **start Skychart/SAMP/HNSKY** if it is not running when connecting. Indicate the command to start the program and eventual parameters, the default value correspond to the default installation on the different platform, but you may have to adapt for 32bit version on Win64 for example.

There is two additional options for Skychart.

- **Adjust the chart for the image frame** to automatically zoom and center when a frame is send. When unchecked the chart is not modified.
- **Update chart with every astrometry result** when checked a mark is set on the chart every time an image is plate solved.

Weather station



Beware this settings will never close your observatory, even in case of rain! See the [Safety monitor](#) below if you need this actions.

You define here the parameters to pause a running sequence when the weather condition are not optimal. When bad condition are detected the program do the following:

1. wait the end of current exposure
2. stop telescope tracking and autoguiding
3. wait for the sky to be clear again

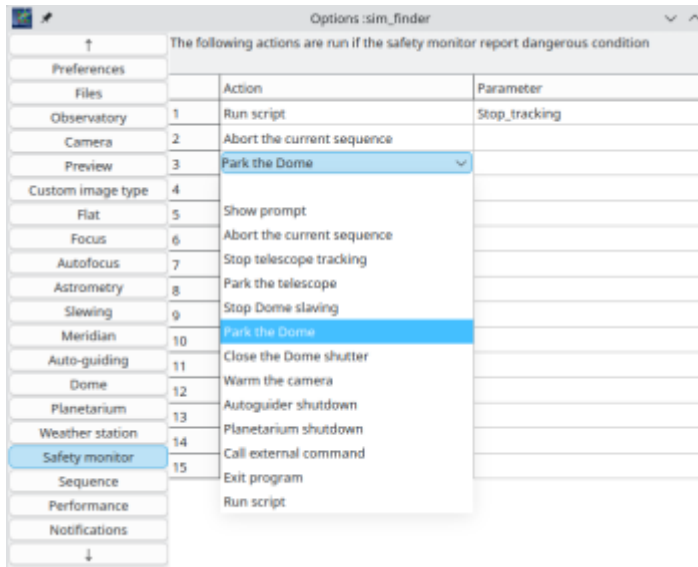
When it is clear again it run the target initialization procedure, the same as when the target is first selected, checking for time range, slew with plate solving, start autoguiding, eventually going to the next target if this one is no more observable.

When you select to use a [ASCUM ObservingCondition driver](#), you need to set the limits for every sensors here. For INDI the limits are the Warning level of the weather driver.

You can also set a delay to wait after the weather is good again to avoid to start/stop continuously if a sensor is just at the limit. See also if your driver can average the measurement over a period to avoid this behavior.

A script can be defined to run every time the weather change between good and bad. The script receive the parameter 1 when the weather is good, 0 when it is bad.

Safety monitor



Select the actions you want to run when the Safety monitor detect dangerous conditions.

Beware that by default it only stop the sequence!

The order to run the different actions depend on your specific equipment and need to be carefully tested. For example if it rain you want to close the dome as soon as possible, but maybe the mount need to be parked first. In this case you must also test what it do if the telescope cannot park because of cable disconnection or other reason.

It is mandatory to stop the current sequence, a sequence cannot run under dangerous condition. But you can move it's row below other actions if need.

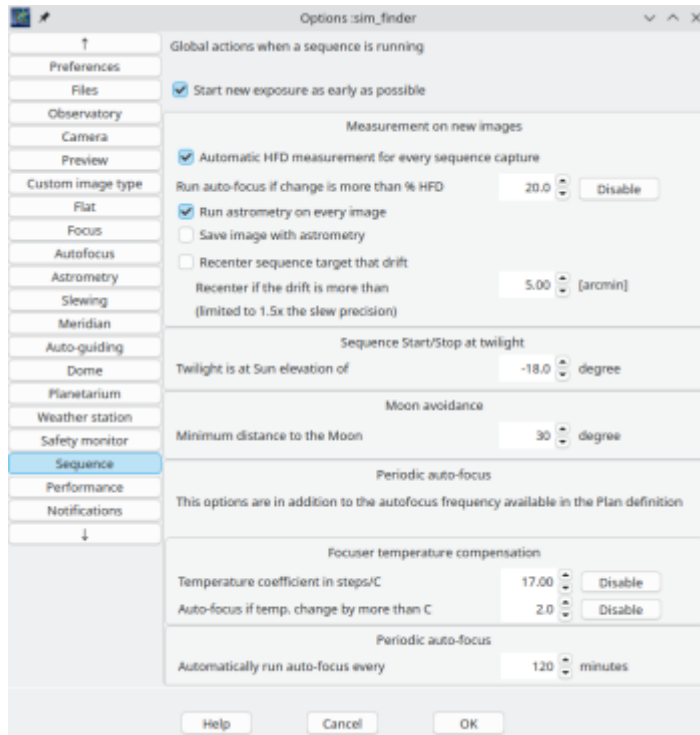
Use the function "Run script" or "Call external command" if you need additional actions not available in the dropdown list.

For two actions you need to set a parameter:

- Show prompt: the time to wait before to continue automatically, in seconds.
- Run script: the script name and it's parameters
- Call external command: the full path of the command or script to be executed.

If you configure the [Dome](#) operation to be slaved to the mount park/unpark you only need to use the "Park the telescope" action here to also park and close the dome as configured.

Sequence



This let you set some global actions taken during the [execution of a sequence](#).

You can select to **Start new exposure as early as possible**, without waiting for the previous image to be saved and displayed. With this option checked you can save a few seconds between each exposure, the gain is more important when using a big camera sensor with short exposure time.

This apply to capture sequence and preview loop.

When the previous option is active you can do some measurement on every image.

The **Automatic HFD measurement** let you monitor the image quality and record the mean HFD in the log. The [exposure time](#) must be at least of 30 seconds to let the time for this measurement without perturbation of the sequence.

A trend of the measured HFD values is plotted in the trend tab of the [focus tool](#).

The measurement can also be used to trigger a new autofocus when the HFD change by more than a given percentage.

The HFD Focus Monitoring goes through three states, each of which is logged when running:

1. Reset: All previous measurements and reference data is cleared. This forces the process into the 'measurement' state.
2. Measurement: During this stage three images are collected and the median HFD value is measured for each. After the third image is collected and measured, the average of the three median HFD values is calculated and this becomes the reference HFD going forward. When completed the process enters the Active state.
3. Active: With each new image a running average of the median HFD is calculated and this new average is compared to the reference HFD from step 2. If the running average varies from the reference HFD by the threshold percentage (specified in the Preference/Sequence/% change HFD section), then an autofocus is triggered. If an autofocus is triggered it goes back to the Reset state.

An average is used in the initial reference HFD calculation, as well as for the ongoing active-state measurements, so a single bad image (e.g. a brief gust of wind or a period of bad seeing) doesn't trigger an

autofocus. By averaging these frames together it should only trigger an autofocus if the conditions continue, and should more properly represent changes in seeing rather than temporary issues with the mount, guiding, wind, etc. An autofocus can be triggered when HFD improves or degrades.

Run astrometry on every image

This show the astrometry result in the log and unlock the following two options.

When the option to quickly start a new exposure is active the astrometry is skipped if the exposure time is shorter than the astrometry timeout. To plate solve short exposure images be sure to uncheck the first option above.

Save image with astrometry

After the astrometry is successful the image is saved again with the astrometry result.

Recenter sequence target that drift

For various reason you may observe the target to slowly drift in the image field during the night. The obvious symptom is large black border around the final image after registration and stacking.

You can observe this because you are not auto-guiding. But also when guiding with a separate guide scope because of slow flexion of different mechanical and optical parts.

With this option the program plate-solve every image taken during a sequence to compute the drift from the initial target position. If the drift is larger than the value set, it plan a recenter before the next exposure.

To make this possible it is required the image [exposure time](#) in the sequence is larger than the [astrometry timeout](#).

The last point to check is the drift value you set here must be larger than 1.5x the [slew precision](#) and also larger than 2x or 3x the [dithering](#) if any.

Sequence Start/Stop at twilight

The sequence option to start/stop [at dusk/dawn](#) use the astronomical twilight by default. But there is case you can accept to image when the sky is a bit brighter.

Set here the (negative) elevation in degree you want for the Sun below the horizon. This can be adjusted between the Civil twilight (-12) and the astronomical twilight (-18).

Moon avoidance

Set here the acceptable distance to the Moon when the corresponding Sequence [option](#) is checked.

Periodic autofocus

This options are in addition to the autofocus frequency available in the [Plan definition](#).

Focuser temperature compensation

If your focuser can measure the temperature you can set here the temperature coefficient (in steps per Celsius) used to adjust the focuser position between the exposures, or to shift the auto-focus V curve accordingly. The coefficient is positive if the focuser needs to move UP in position when the temperature drop. The routine will adapt the focuser if the temperature difference is larger then 0.5 degrees.

Note that for a reflector telescope you have to turn the focuser OUT to correct for tube shrinkage. For a refractor you have to turn the focuser IN since the change in refraction coefficient is dominant and much larger than the tube shrinkage.

The temperature coefficient will help to reduce the number of autofocus actions required. It will work best when the temperature drops slowly and all parts of the telescope have time to adapt to the changing ambient temperature.

The compensation factor has to be measured empirically. Start with an almost zero factor=1 and monitor the autofocus focus position in the log as function of the reported temperature. When you have enough data points which show a repeatable temperature coefficient enter the estimated factor in this menu. Some telescopes like

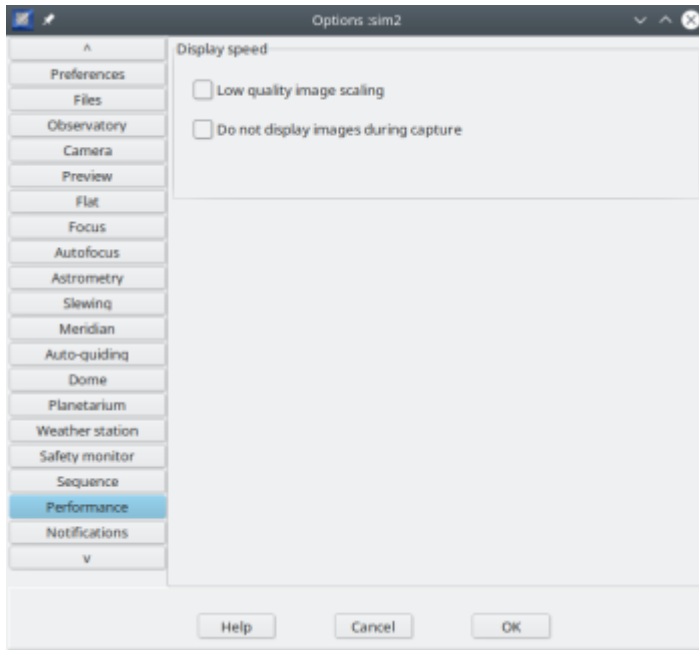
a SCT could have less predictable coefficient and you most likely have to disable the coefficient and rely on the autofocus routine only.

If the factor is set well, the result of each autofocus routine run should be close to the previous focus position. The temperature of the last focus operation in a session is saved to make a first correction the next time you start the program, so if no change was done in the mean time you recover a not too bad focuser position.

You can also request to run an **auto-focus procedure if the temperature change** is more than the configured value.

The **autofocus can also be run periodically** after a given time interval.

Performance

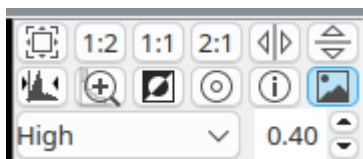


When using a computer with limited resource it is good to use this resources for the main job of capturing images as quickly as possible. This can be improved by reducing the quality of the images show on screen or by totally disabling image display when a sequence is running. None of this option affect the quality of the saved images.

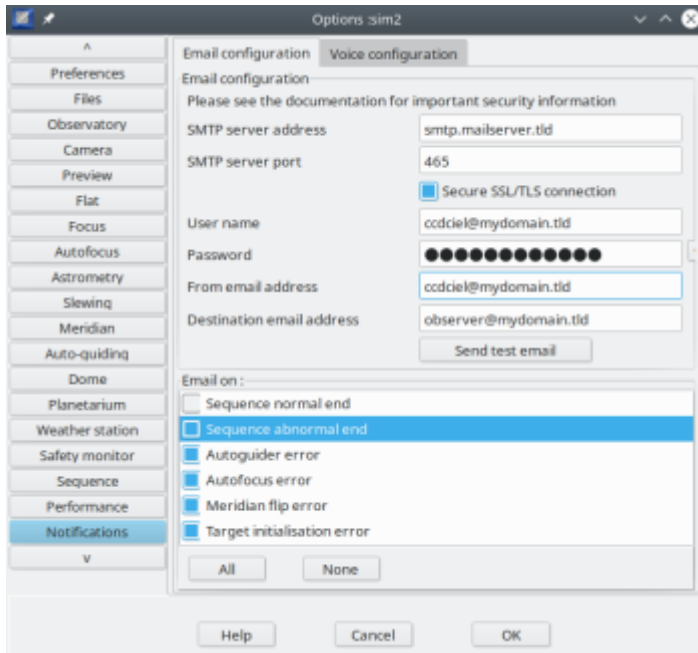
Low quality image scaling use simple pixel resampling to scale the image on screen. This iimprove the speed a lot but can produce moire pattern with OSC sensors.

Do not display image during capture totally disable the display of the image during a sequence. This is a good way to optimize the inter-frame delay, but also look at the option **Start new exposure as early as possible**

When the option to not display the images is set, you can temporarily change this behavior using a new button that appear on the right of the [visualisation](#) tool



Notifications



Email notification

You can configure email notifications that are send by the program on different conditions.

First you need to configure and test the email configuration so the program know how to send you an email. Look at your email provider documentation for the values you need here, there is normally information how to configure an email software.

Important security information. This email configuration is saved on a separate file in the program configuration directory. The user name and password are obfuscated so they cannot be read directly in the file, but they can be read from CCDciel that otherwise cannot send you an email. So be careful to not send this file to anyone, and be sure you **not use an important email account** in this configuration.

It is strongly advised you create a **low privilege** email account to send this notifications.

Set the **SMTP server address** that accept outgoing request on the **SMTP server port**. Check the corresponding box if the server use **SSL/TLS** for the connection.

Indicate the **User name** and **Password** to connect to this server, and the sender **From email address** that is generally the same as the user name.

Finally indicate the **Destination address** that will receive the message. If you prefer to receive the messages on your phone, this destination address can be an email to sms gateway.

You can test this configuration with the button **Send test email**. This show a message if the email can be send or if there is connection error to the server. If the email is send successfully look at the destination mailbox for the message. Do not forget to also look at the Spam box.

Then select the notifications you want to receive. It is probably best to start with all the notifications, then remove the "Sequence normal end" if you want to receive only error notifications.

Voice notification

When you stay near the telescope during the capture it can be good to be alerted by some sound if something require your attention. For this case CCDciel can spell the message that are normally only show on screen.

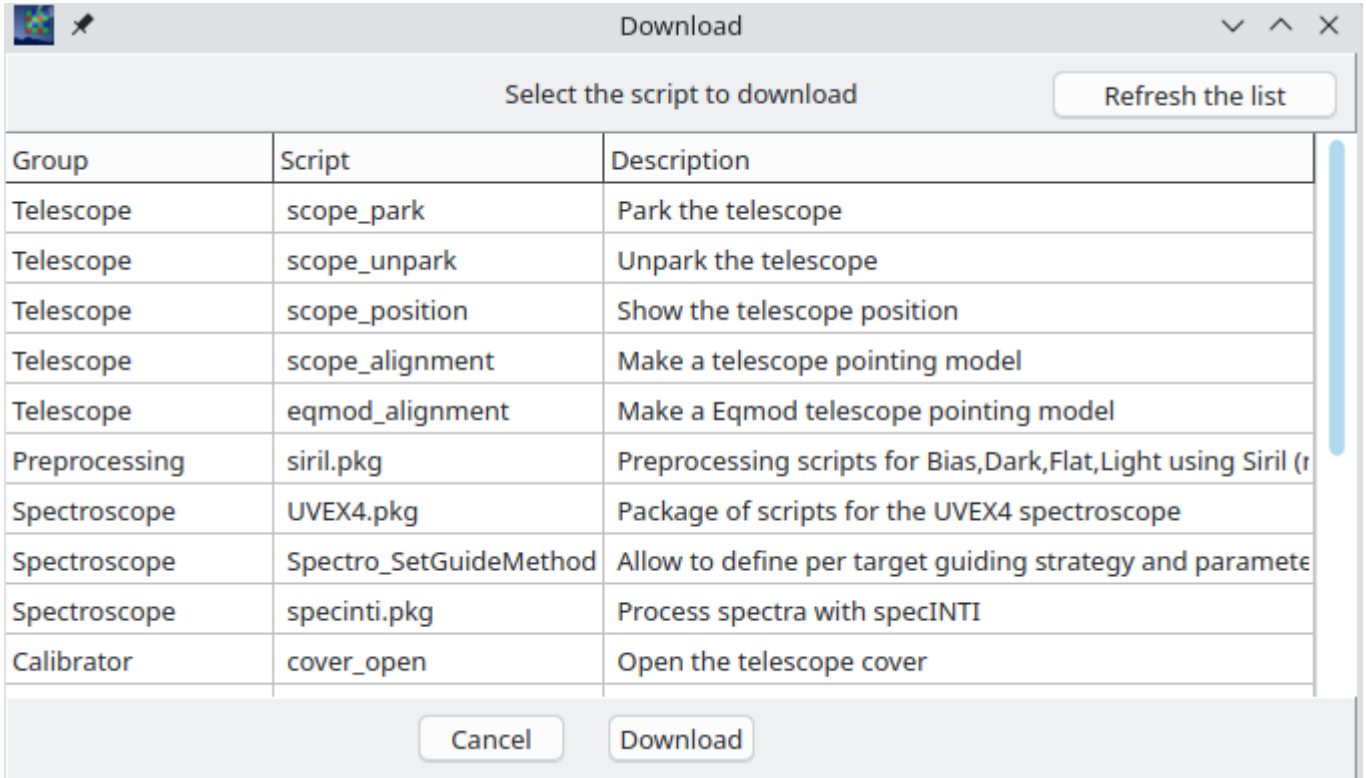
You can configure the kind of message you want to hear from the **Voice configuration** tab.

A **Test** button allow to be sure the voice spelling is working and let you adjust the sound volume with the computer settings.

Install script

From the menu Edit → Install script.

This allow to get script example you can use directly or customize.



Select the row with the script you want and click **Download**.

The script is installed and it open in the [editor](#).

The script packages, recognizable with the “.pkg” in the name, install a group of script for related task.

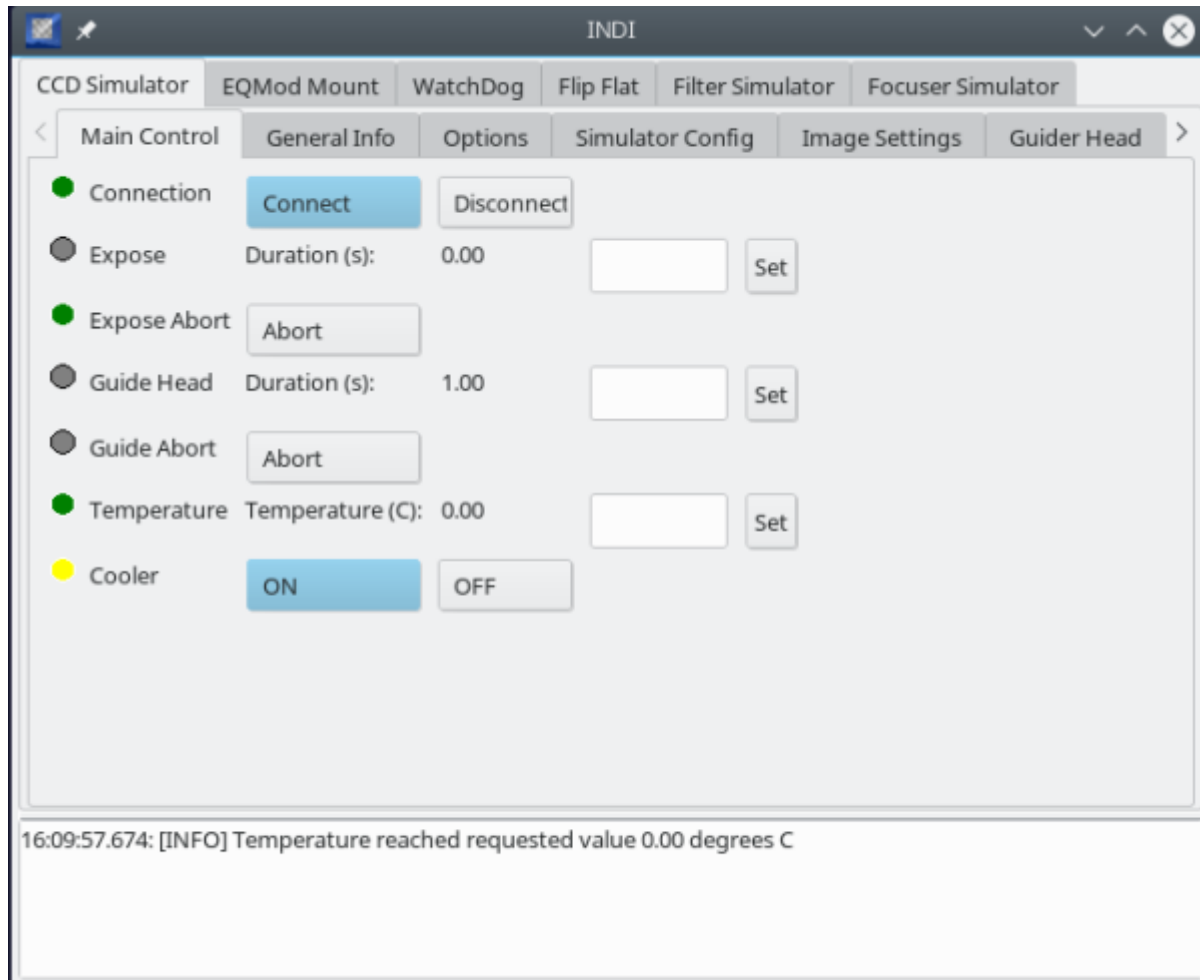
If there is a configuration file for this group it is opened after the installation.

The configuration file is preserved by an upgrade of the script package, you can just install the package again to get the new version.

INDI settings

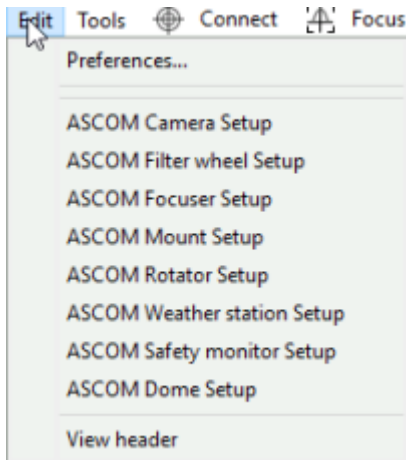
From the menu Edit → INDI settings.

This opens a standard [INDI client](#) window where you can set any specific option for your devices.



ASCOM settings

From the menu Edit → ASCOM ... Setup.



The menu include an entry for each defined ASCOM device. This open the ASCOM driver setup dialog for your device to let you set any specific option for the devices. Please note this setup dialog is not a part of CCDciel but a part of the driver.

Beware that the device must be disconnected before the Setup dialog can be opened. This is from the ASCOM specification and cannot be changed.

If it is already connected a dialog prompt ask your confirmation before to disconnect the device, it is reconnected when the setup dialog is closed.

This fail if the device is also connected to another application because CCDciel cannot act for the other application. In this case you have to disconnect the device from the other application first.

Display Menu

The **Display** menu let you select the tools you want to include or not in your screen.

Check or uncheck each tool to make it visible or not.

You can also move each tool on another part of the screen to suite your need just by dragging the tool title to one of the main window border.

It includes the following options:

- [Image window](#)
- [Connection](#)
- [Preview](#)
- [Autoguider](#)
- [Internal Guider](#)
- [Finder camera](#)
- [Planetarium](#)
- [Script](#)
- [Weather station](#)
- [Safety monitor](#)
- [Focuser](#)
- [Focus](#)
- [Spectral profile](#)
- [Magnifier](#)
- [Capture](#)
- [Filters](#)
- [Frame](#)
- [Rotator](#)
- [CCD Temperature](#)
- [Telescope mount](#)
- [Dome](#)
- [Switch](#)
- [Cover calibrator](#)
- [Sequence](#)
- [Video](#)
- [Visualisation](#)
- [Messages](#)
- [Clock](#)
- Reset to default → 1 column layout → 2 column layout

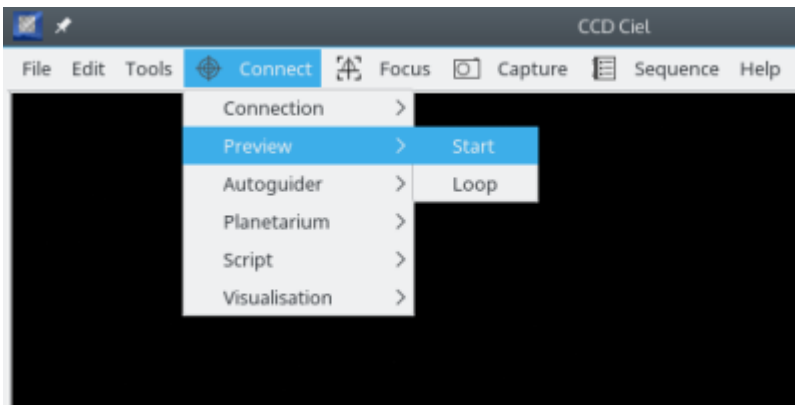
By default many tools are grouped in four tabs on the right of the window. You can adjust the width of the right panel with the mouse depending on your screen size.



This correspond to the main functionality for a capture session.

- Connection and preview
- Focusing
- Simple capture
- Automated sequence

You can use the keyboard F1 to F4 to select one of the tabs. This same function are also available from the main menu:



The F11 key make the captured image full screen. Press any key to return to the standard display.

Image window

This menu is active only when a guider or finder camera is defined in CCDciel.

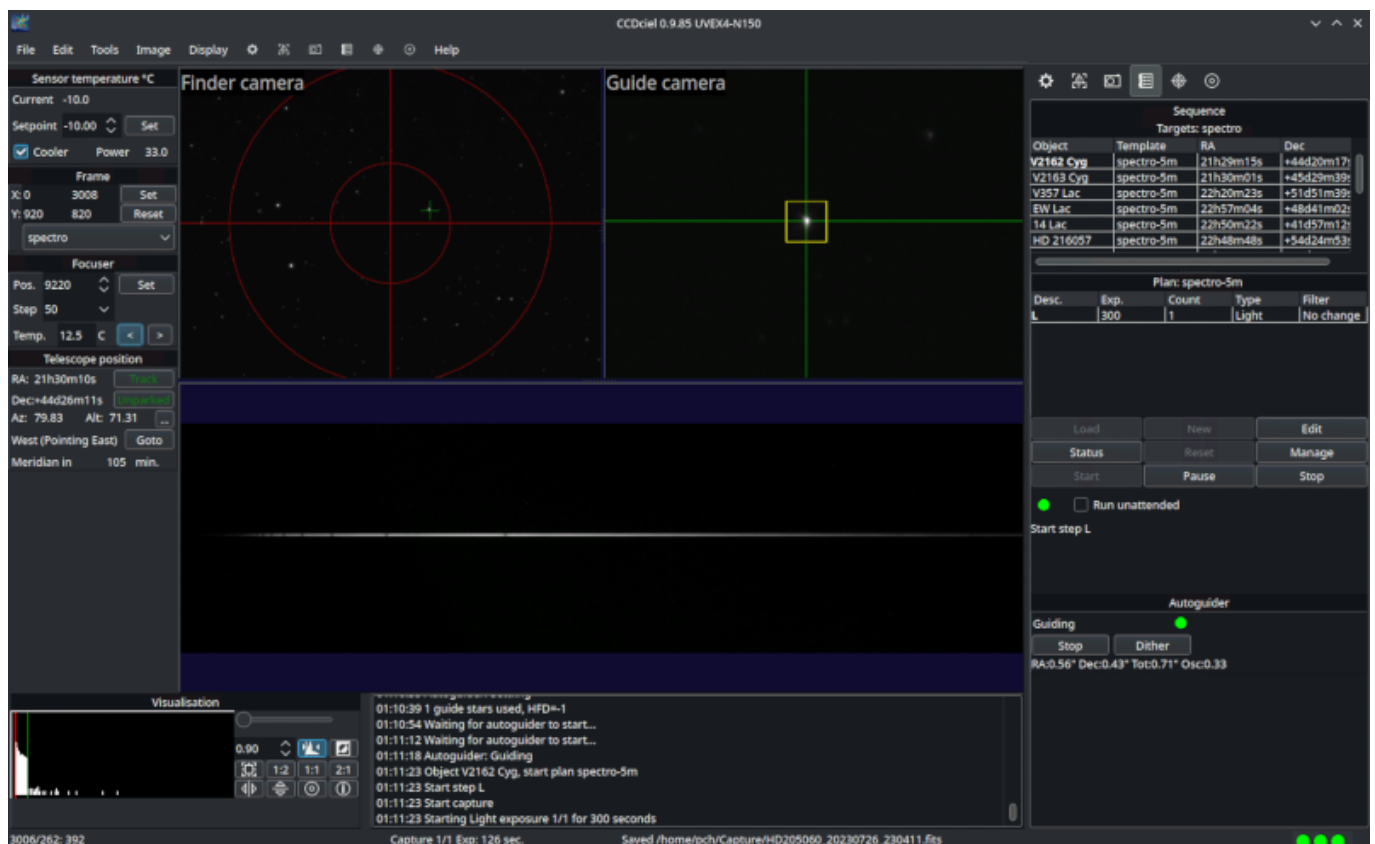
The two options are:

Single Panel to show each camera in the full image area depending on the tab selected on the right. This is the default.

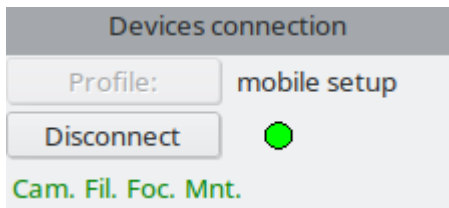
Multiple panel to show up to three camera at the same time in the image area. It is possible to move the slider to adjust each camera size. The main camera is show at the bottom, the guider and finder camera share the top.

This is specifically useful when working with the spectroscope.

The keyboard shortcut Alt+W allow to quickly switch between this two mode.



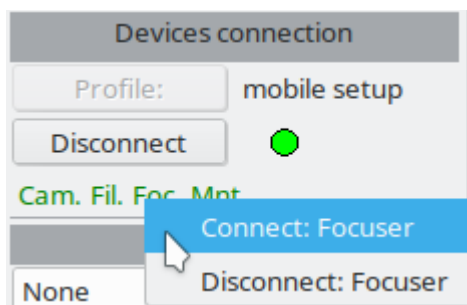
Connection Tool



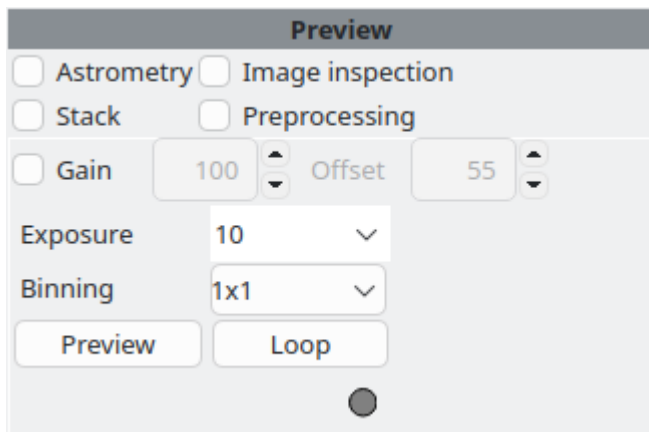
This tool let you connect or disconnect your equipment and monitor the status. It is a mandatory tool as the first thing to do after starting the program is to click the Connect button.

The **Profile** button open the [Devices setup](#) window to modify or select a profile.

After all the devices are connected you can connect or disconnect an individual device by a click on the short device name. This may be useful in case of connection issue with a single device.



Preview Tool



This tool is to take a preview exposure for focusing or centering purpose.

Set the **Exposure time** and the **Binning** to use for the preview.
The camera lens **F-Stop** when using a supported INDI DSLR.

This setting is totally independent of the [Capture](#) setting.

By default the **Gain** and **Offset** use the global setting from the [camera preferences](#). This is the recommended way to use the preview in the same conditions as the captures.

If you want to experiment other values you can check the **Gain** box to unlock. But first look at the predefined truncation level in the [Visualisation](#) tool.

The values entered here are not used in the other part of the program and will reset to the default when the box is unchecked or the program is restarted.

Click **Preview** for a single exposure or **Loop** to take exposure continuously until you stop it with the same button. The light change to green when the loop is active. If supported by the camera driver you can press the Shift key and click the stop button to get the partially exposed image.

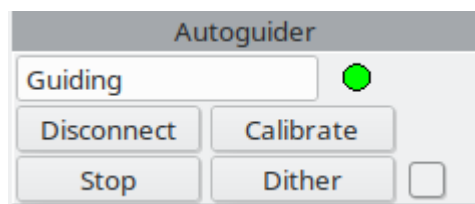
The Option on top let you select an action to do on every preview image.

- **Astrometry** , every preview image is solved and the current center coordinates are shown at the bottom of the preview tool:

```
Apparent: 05h30m19s +35d52m35s
J2000 : 05h28m42s +35d51m17s
PA : 34.0
```
- **Image inspection** , show the [image inspection](#) overlay.
- **Stack** , visible only if you activate the “stacking option” in the [preferences](#)
 When it is checked, every preview loop frame is added to the previous ones. If available the images are processed with [Dark](#) and [BPM](#). If the option is activated the frames can be aligned.
 After you start the Loop, you see the object image to appear progressively in the screen as the number of frame increase. This function is often use in public demonstration.
 You can use the menu [File/ Save FITS file...](#) to record the stacked image after you stop the Loop.
 A new stack is started when you restart the Loop.
- **Preprocessing** , preprocess every image with the loaded [dark](#) and [flat](#) frames.

When the FITS file contain multiple image extension it is possible to navigate from one image to the other using the arrow at the bottom of the image window.

Autoguider Tool

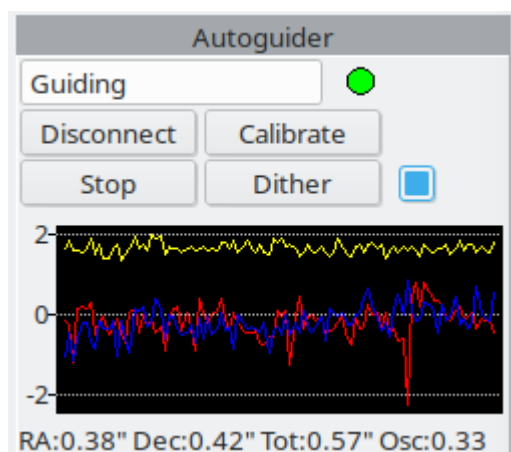


This tool is to interface with the [external autoguider](#).

If you [configure](#) to start the autoguider you can directly click the Connect button. Otherwise be sure the autoguider application is running before to click it.

It show the autoguider status and let you to start or stop autoguiding, force a new calibration, or dither. This functions are used automatically by the [sequence](#) tool when the autoguider is connected.

When using PHD2, check the box on the right to show the guide graph for the last 100 guide frames.

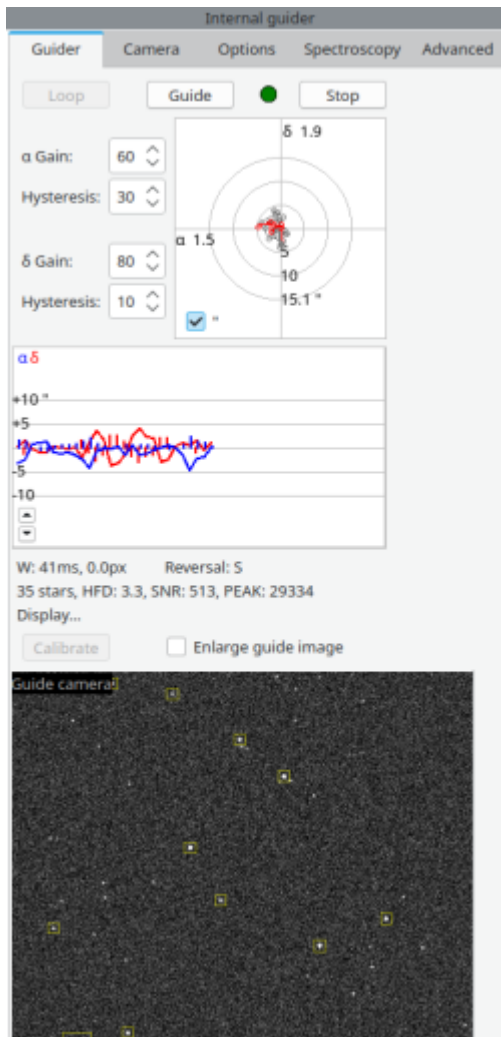


The blue curve represent the RA error, the red the Declination error and the yellow is the star mass. The vertical scale is in arc-second. It is adjusted automatically for the current range, so don't be afraid by large apparent variation as long the total range is small.

Below the graph is the current RMS error and RA oscillation index of the last 100 guide frames.

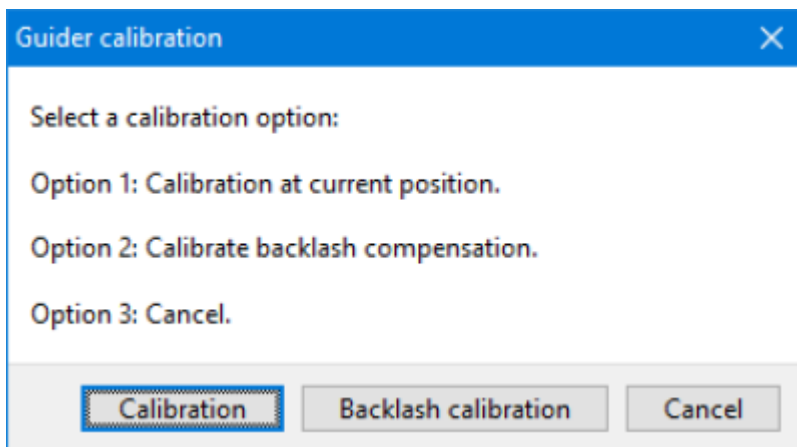
Double click on the graph to clear the graph and start new statistics.

Internal Guider



Quick reference guide

The internal guider requires a system calibration once. Click on the calibration and select option 1 or option 2 depending on your mount and driver.



Option 1, first slew the telescope manually to a point in the sky at least 45 degrees away from the celestial pole, click on the **Calibration** button and wait till the calibration is finished.

Once calibration is finished click on the **Guide** button and check if guiding is satisfactory. Tune the **Gain** and **Hysteresis** settings if required. For the best star detection sensitivity make a master dark for dark subtraction in guider [tab camera](#).

The trend scale can be adjusted with the up/down button in the graph. The trend unit is default in pixels. With the checkmark "in the XY-graph you can set the unit to arcseconds. Note that the conversion factor from pixels to arcseconds is measured during calibration. See documentation below.

Trending is suspended during dithering. Dither events are marked in the trend with a sinus $\sim$ character.

The XY-graph numerical values indicates the standard deviation of the right ascension (α) and declination (δ) trends. At a typical seeing conditions you can expect having guiding trends around one arcseconds standard deviation equals about 0.4 pixels standard deviation at a 2.5 "/px scale.

A guide log CCDciel_GuideLog_YY-MM-DD_HHMMSS.txt in "PHD2" format is written to the log directory (Windows: %LocalAppData%\ccdciel\log) and can be analyzed in existing log viewers. To allow open and view CCDCiel guide logs you have then enter *.txt search pattern in the log viewer file&open menu.

Introduction

The internal guider is used to correct for small errors in a mount's tracking like any guider software. This guider is build-in and doesn't require an external program. The guider takes short exposures with the guide camera. From the star movements in the images it calculates the drift and send corrections to the mount to compensate. Note that it can not correct for the fast effects by seeing. So the right ascension and declination will always fluctuate typically about one arc seconds (or 0.4 pixels at 2.5 "/px) as indicated by the standard deviation values in the XY-graph.

Note: The tab internal guider will only be visible if you select the internal guider for guiding in [preferences, auto-guiding](#) and a guide camera in [device setup, guide camera](#).

System calibration

Prior to use the internal guider requires a system calibration. During system calibration the guider will take an image, detect stars and then send guide pulses to the mount in direction East, West, North and South. Then it takes a second image and measures the movement of the same stars. By this it knows the effectiveness of the mount guide pulses and the orientation of the guider camera. This calibration takes a few minutes maximum. The calibration will be done in two phases. As soon the calibration phase one is finished without errors you can start guiding.

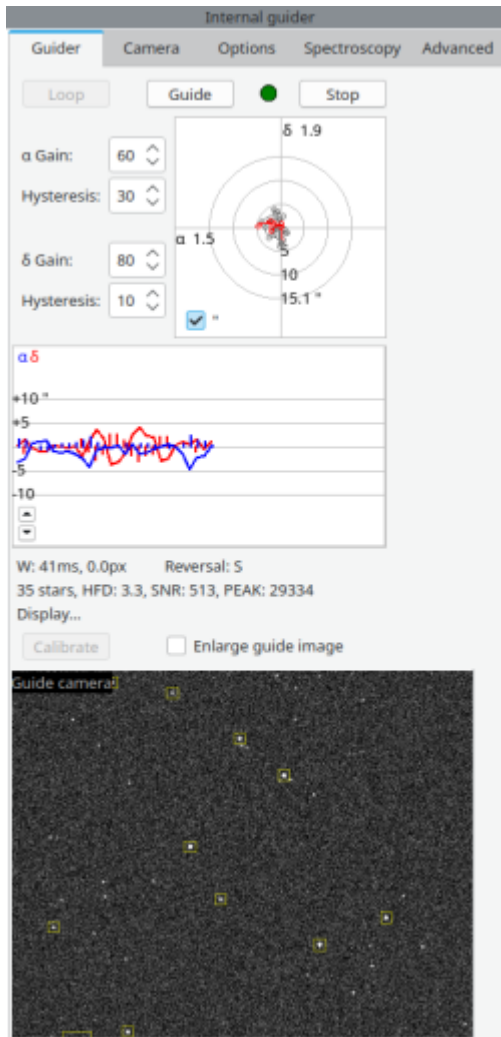
Note that as soon you slew to the other side of the meridian and start guiding a quick second calibration phase will be executed only to test the pulse direction. For more details see section [tab advance](#).

Once the full calibration is done no more calibration is required unless you change something in your setup like binning setting, a new camera or telescope. The calibration is saved with the CCDCiel settings.

Set in [tab camera](#) the guider exposure time to a value between 3 and 5 seconds. Start a simple looping with the **Loop** button and check if the guider camera is in focus and some stars are visible. Stop the loop and go to the **Guider** tab and click on button **Calibrate**. After a few minutes maximum the calibration should be completed.

Backlash calibration: This measures the backlash when the direction of the declination movement changes. The measured value is stored in the Option tab. If required you could activate the backlash compensation in the option tab.

Tab Guider



By default the guide image is show below the control. Check **Enlarge guide image** if you prefer the multi-image feature or to show in full in place of the main image. This is useful for focusing the guide camera for example.

Guiding is started with the **Guide** button in the first [tab guider](#). Star detection is fully automatic. Even if guiding is interrupted by a cloud, the guiding software will recover automatically and continue with guiding unless an other action is programmed in a sequence.

For control there are two settings available for both right ascension and declination.

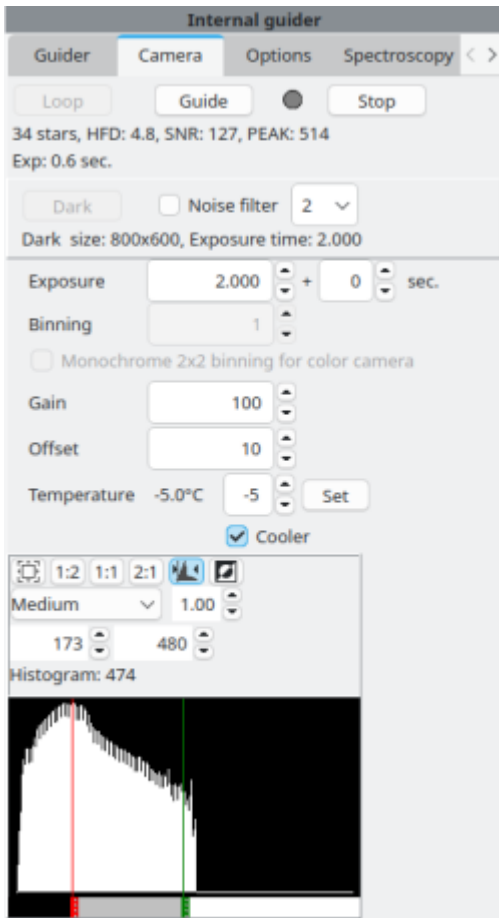
Gain. This sets the proportional corrective action in % on an offset. For right ascension typically set at 50%. For declination it is typically set at 50-70 %. If set too high the controller will overreact resulting in a oscillation. During oscillation the control action bars will show an East, West, East, West.. pattern or North, South, North, South... pattern. In this case reduce the gain.

Hysteresis. A percentage value. The controller will rely with the specified percentage on the last corrective action and reduce the new corrective action accordingly. Hysteresis is typically set at 30% for right ascension and 70% for declination.

The declination controller has an output filter to prevent switching between North and South pulse corrections. There have to be at least three correction pulses in a different direction before they are passed unless there is a large correction pulse (>3 x min pulse duration).

In the XY-graph there is small checkmark to change the unit from pixels to arcseconds.

Tab Camera



In this tab you can set the exposure time and binning. For guiding use exposure times around 3 to 4 seconds. Note that guiding can only compensate for mount fluctuations and not for seeing effect.

Noise filter. Apply a median filter with a strength between 1 and 6 to the image to help to detect faint stars with noisy sensors. This is particularly useful with CMOS sensor subject to RTS noise that cannot be removed using a dark.

Exposure. Set the guide camera exposure time. Typical set between 3 and 4 seconds. It is possible to add a delay in seconds between the exposures to not make too frequent guide corrections.

Binning. Binning of the guide camera pixels. In most cases binning set at two works best. The calibration is automatically adjusted when the binning change, no re-calibration is need.

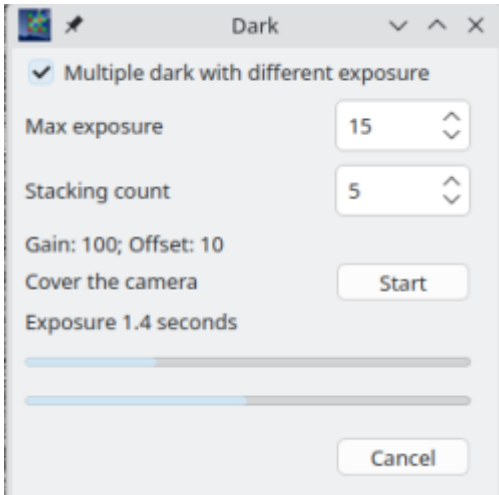
Monochrome 2×2 binning for color camera Check to remove the bayer matrix using the sum of the blue and red with the mean of the two green pixels.

Gain. Camera gain. Set high enough for the short exposure used for guiding. See you camera manual.

Offset. Use a value high enough to prevent low level truncation, this depend on the Gain.

Temperature. If the guide camera has temperature control you can set the value here.

Dark button. This allow to load a dark file, or create it from the camera. During guiding the dark will be automatically subtracted from the guide image improving star detection for noisy guide cameras. It is possible to use a single or multiple exposure.

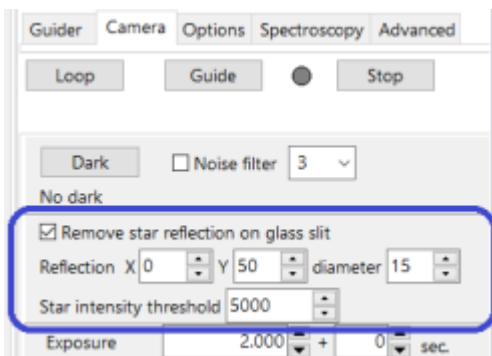


Below is the histogram display to adjust the preview image. It work the same as the [visualisation](#) tool.

Remove star reflection on a glass slit option (Only visible when spectroscopy is activated)

If in tab [tab_spectroscopy](#) the option “Activate spectroscopy functions” is checked then a new option becomes visible to deal with reflections of a glass slit. These ghost reflections typically result in a fainter ghost star above and below the real star. Since they are not real and have a different best focus point, they could disturb the auto focusing and astrometric solving.

By activating this option “Remove star reflection on a glass slit” two round areas will be made fully black removing the ghost reflections from the image. The threshold [0..65535] so the pixel level to detect the original bright star and x, y position and diameter of the areas to blackout have to be specified.



Tab Options

Options

- **Shortest guide pulse.** This setting will ignore guide pulses shorter than the setting. Too short guide pulses have a more unpredictable effect and the resulting error can become larger than the intended correction. Ignoring too short pulses will improve the guiding stability. Default is 40 ms.
- **Longest guide pulse.** The longest pulse correction used. This is also the value used to remove the backlash during calibration. For telescopes with a very long focal length you may have to reduce the default value of 2500 .
- **Minimum HFD.** Any star with a half flux diameter below this setting will be ignored. This setting can help to ignore hot pixels. If hot pixels are seen as stars and are annotated during guiding increase this value. To assist with setting this value the mean star HFD is reported in the log.
- **Minimum SNR.** Any star with a signal-to-noise value below this setting is ignored. If your guide system detects sufficient stars you could increase the setting to filter out the faintest stars.
- **Frame size.** Normally the full sensor area (=Max) of the guide camera is used for guiding. In case the guide camera has a very large sensor or the CPU load of the (small) computer used for guiding is too high you could set a smaller frame size. For example if you specify 100 then the software will download a 100×100 pixels frame only for guiding. As center of the 100×100 frame the brightest star location is used. Any other star found in this frame is also used for guiding. This smaller frame will reduce CPU load and download time significantly. For small frame sizes the guider will find and therefore use only one star (the brightest) for guiding.
- **Activate solar object tracking.** This will allow the telescope to follow a solar object using the two parameters below. If checked the object will be sharp in the image but stars will form streaks.

- **Solar object apparent motion.** The apparent motion of a solar object like a comet or minor planet.
- **Solar object apparent motion PA.** The angle of the apparent solar movement CCW from north. Either filled by the connected planetarium or manual entered.
The solar motion values can be imported from the connected planetarium program together with the object position. For this select “update position from planetarium program” in a [sequence](#). Else the values have to be entered manually from [MPC](#)
- **Use backlash compensation** activate the automatic backlash compensation. Use the backlash calibration to set the initial value. Note this is only a starting point value and the backlash is automatically adjusted based on the result during guiding.
- **Disable guiding.** This will temporary stop all guide actions but the trend will continue. This can be useful to study the mount behavior without guiding.
- **Dither mode.** This will make the dithering to follow an increasing spiral or move randomly around the starting position.
- **Use the rotator angle.** Check it if a rotator is connected and only if the rotation affect the guide camera (OAG, spectroscope). In this case no re-calibration is necessary when the angle change.
- **Initial calibration step** is the time in milliseconds of the first calibration move. Change only when using very long focal length with narrow guide image field.
- **Set guide speed,** Set the guide speed or correction rate you want for the RA and DEC axis. If unchecked the correction rate set in the mount driver will be used. The setting is limited to 0.9 siderial maximum. The idea behind it to avoid stopping the RA movement for correction. So with the maximum setting of 0.9 a pulsed RA axis correction will either slow down from 1 x siderial rate (15 arcsec/sec) to 0.1 * siderial or increase to 1.9 * siderial rate. Typical setting for both axis is 0.5 * siderial.
- **Measure pixel scale ["/px] by stop tracking.** The last field of the calibration result contains the conversion factor arcseconds/pixel. This value is used only for the trend to convert pixels to arcseconds and does not influence the guiding in anyway. It is measured by setting the pulse guide ratio of your mount software (e.g EQASCOM) to a pulse rate 0.5x and 1.5x times the normal guide rate. If the option **Measure pixel scale ["/px] by stop tracking** is check marked then the conversion factor will be measured differently during calibration. It will measure the conversion factor by stopping the mount tracking a few times for a 0.5 second and measure the total drift. It takes more time then the first method. Both methods should give about the same conversion factor in arcseconds/pixel. A third method is to solve the guide image and enter the found arcseconds/pixel manually.

Tab Advanced

Internal guider

Guider Camera Options Spectroscopy **Advanced**

Calibration results:

Camera angle [°]

pulse gain East [px*cos(δ)/sec]

pulse gain West [px*cos(δ)/sec]

pulse gain North [px/sec]

pulse gain South [px/sec]

Measured at [E/W]

Pixel scale ["/px]

Pulse North direction[cal/flipped]:

Last calibration:

Date

Declination

Binning

RA Speed

Dec Speed

Issue

Calibration results

Normally you should not change these calibration values. Just check if **East** and **West** values are about the same and the **North** and **South** values are the same. The field **Pixel scale estimate ["/px]** contains the measured conversion factor from pixels to arcseconds. See options.

There are three types of equatorial mount behavior. Type "A" is typical for equatorial mounts controlled by Ascom. Type "I" for mounts controlled by Indi. Type "F" for fork mounts and some equatorial mounts where the software adapt the pulse guide direction to the site of pier.

Type	Mount software	Pointing in direction	Reported pulse guide directions
A	EqAscom	East	E-->E, N-->S
		West	E-->E, N-->N
F	GS Server	East	E-->E, N-->N
		West	E-->E, N-->N
I	INDI Eqmod/Ioptron	East	E-->E, N-->N
		West	E-->E, N-->S

The calibration goes in two phases. Assume you have an equatorial mount with EqAscom mount control software and you calibrate your setup with the telescope pointing west. After the calibration you will see this:

- Measured at[E/W]: **W**
- Pulse North direction [cal/flipped]: **N, ?**

Guiding will work fine. Calibration of the other side of the meridian (east) is outstanding which is indicated by the "?"

As soon you slew to the other side of the meridian (east) and start guiding a quick calibration phase will be executed and the following will be shown:

- Measured at[E/W]: **W**:
- Pulse North direction [cal/flipped]: **N, S**

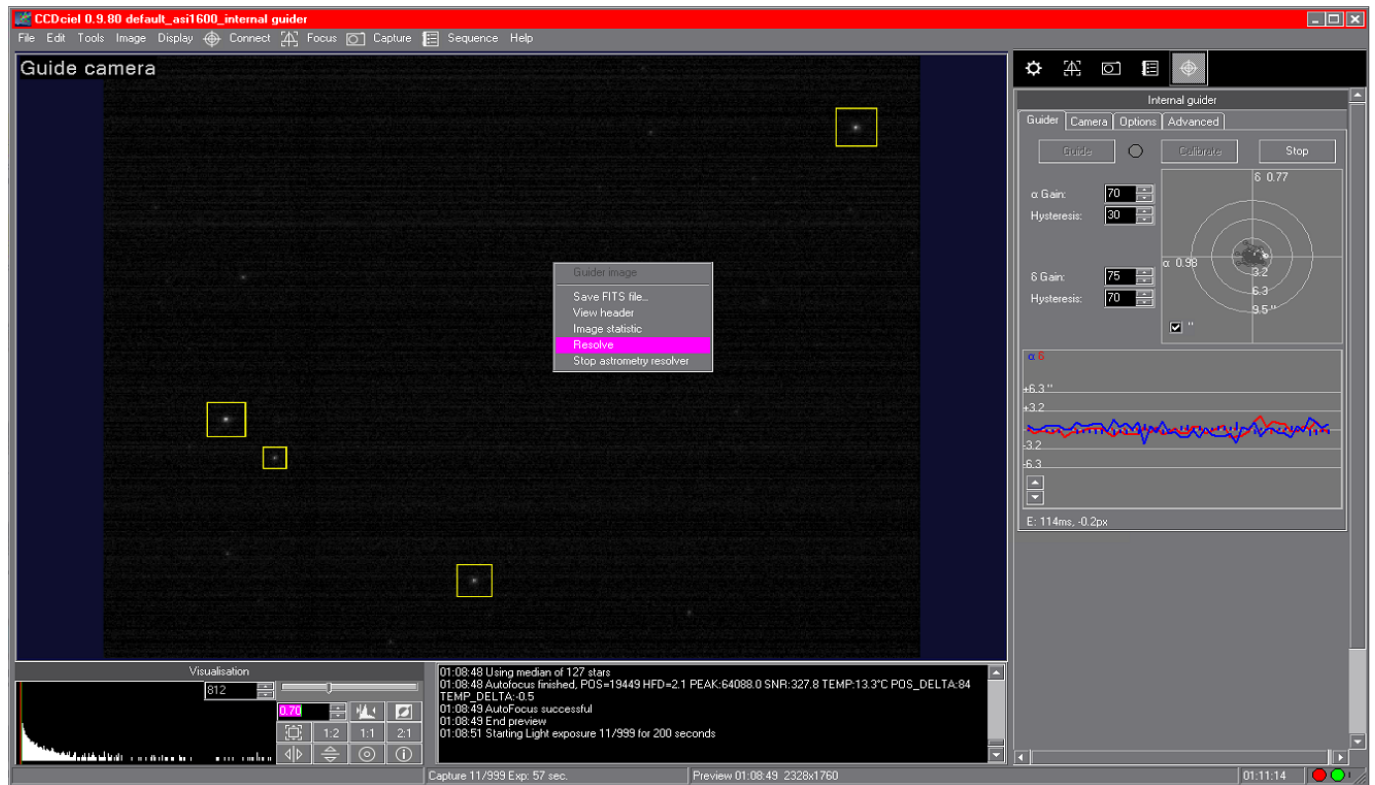
If you start calibration at the east side of the meridian, you will get this result for EqAscom:

- Measured at[E/W]: **E**
- Pulse North direction [cal/flipped]: **S, N**

The last calibration date is reported and any issue. Note that the calibration does not age. Re-calibration is only required if your system setup changes.

These setting are overwritten after each calibration. The reported “pulse guide directions” are reported in the log during calibration. For some mount software like GS Server is is required to use the special calibration. This will simple set the option “pulse guiding is reversed after meridian flip”.

Guide image

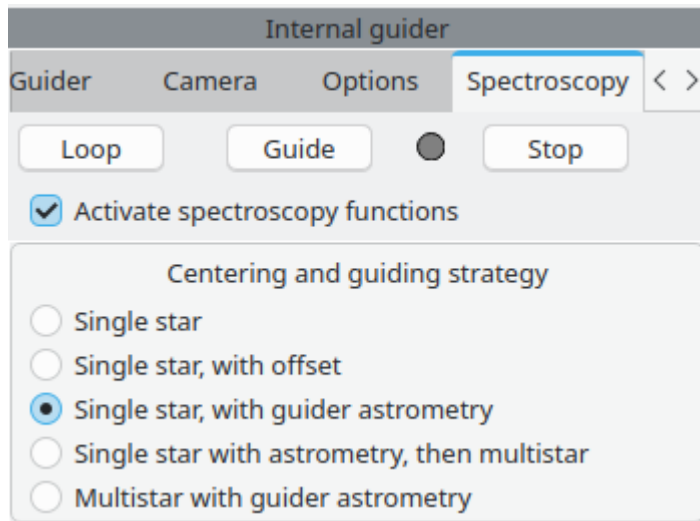


The guider image is displayed similar as the images from the main camera. It is possible to zoom, save, swipe and solve the guide image.

Tab Spectroscopy

This tab activate special auto-guiding function for use with a reflective slit spectrograph.

Check **Activate spectroscopy functions** on top to enable the other options.



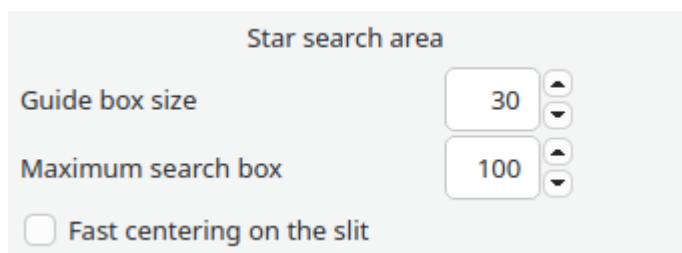
Select the best suited centering and guiding strategy depending on the telescope, spectroscope and target. Prefer the method with astrometry if the field of the guide camera is large enough for a reliable plate solving, the other method are available when this is not the case.

It is possible to change the guide strategy, and other guide parameters, per target in a sequence using the initialization script `Spectro_SetGuideMethod`. See the explanation in the script itself.

In all the case be sure the settle timeout in the [auto-guiding options](#) is large enough to allow to move the target at the slit position.

* Single star

This method is quick and simple, but limited to relatively bright star without disturbing neighbor. After slewing, it try to find a star near the guide position within the size of the **guide box**. If none is found it retry with the **maximum search box**. It move the star at the slit position and the guiding start. You can also manually select the star you want with a double click or the right click menu, be sure to start the image loop to ensure the position are current. This can also be done when the guiding is running.



By default it will not move the star by more than the guide box size to prevent the loss of the star if the mount do not react as expected, for example because of backlash. This can result in long delay to center the star if it start far of the guide position. When using a good mount it is possible to move faster, up to the configured **Longest guide pulse**, by checking **Fast centering on the slit**.

* Single star, with offset

This method is useful to measure a faint target when a nearby star can be used for guiding. The guiding is also smoother than the previous method.

The offset X,Y is the difference of position in the image between the target and the guide star.

For a manual use, click the button **Click on the image to set the offset and guide**, click first on the target,

then on the guide star, the guiding start immediately using this two position. You can temporarily increase the exposure time if the target is not clearly visible.

For an automated use from a sequence, use the initialization script `Spectro_SetGuideMethod` to give the guide star coordinates and let the program compute this offset. Be careful to not use any quote in the coordinate format, use something like : `18h38m38.58s -03d41m24.4s`

In this case it is necessary to plate solve the guide camera once to get the precise image scale and orientation. The easiest solution is to point a rich field of star, take a long enough exposure and click **Resolve**. The calibration remain valid as long the guide camera is not moved or rotated.

* **Single star, with guider astrometry**

The astrometry ensure the right target is selected on the guide camera, even when a brighter neighbor is present.

After slewing, the guide image is plate solved the to identify the target star and move it to the slit for guiding. An additional parameter is the exposure time for the astrometry image.

* **Single star, with astrometry, then multistar**

This work the same as the previous method, but once the target star is located on the slit the guiding automatically switch to multi-star for better stability, preventing oscillation around the slit.

* **Multistar with guider astrometry**

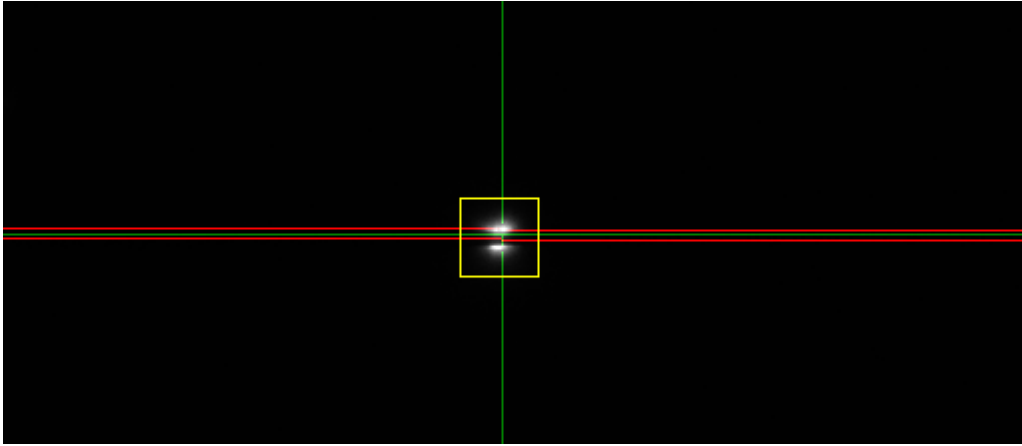
This method allow to measure a faint target but it not require a specific guide star to be know, the astrometry identify automatically the offset to apply to the multiple guide stars to put the target on the slit.

The guiding is also more stable with multiple guide stars. The main difference with the previous method is how the target is moved to the slit.

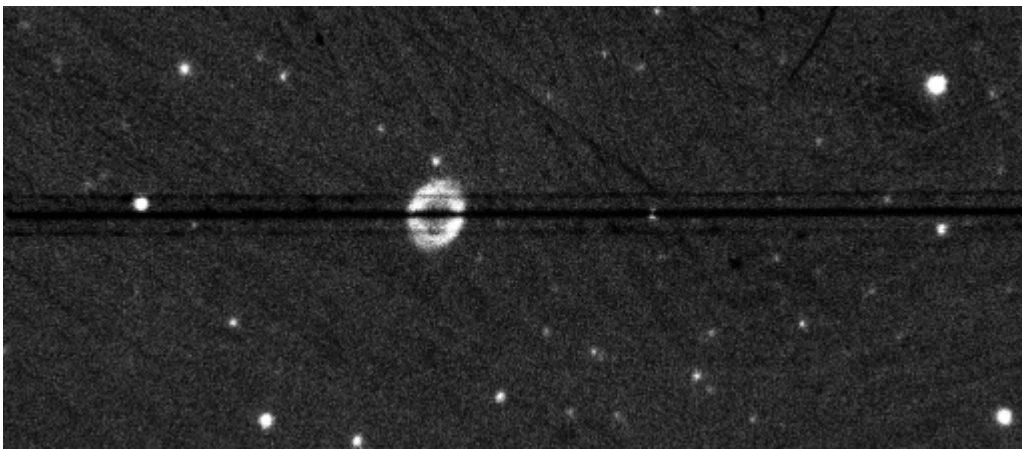
The guide offset x,y are set automatically after the astrometry is done. But you can also adjust them manually, this is a way to measure a faint target when astrometry is not possible.

For a manual use, click the button **Click on the image to set the offset and guide**, click on the target, the guiding start immediately using offset from this position.

Example of guiding a single bright star directly on the slit:



The multi-star method is better suited to measure faint stars or nebula.



Gost reflections caused by a glass slit

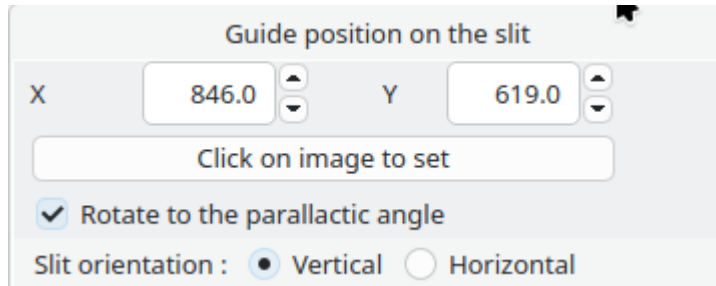
Bright stars can cause ghost reflections which can confuse either the auto focusing or astrometric solving. In [tab_camera](#) there is an option "Remove star reflections on a glass slit" to blackout them.

Setting the guide position

Indicate the guide position you want on the slit, this is where the target star is moved using one of the method above.

You can enter the pixel position directly or click on the image. The calibration light can help to locate the slit in the dark.

This position is indicated by the large green cross. It is automatically adjusted if the camera binning change.



Guide position on the slit

X: 846.0 Y: 619.0

Click on image to set

☒ Rotate to the parallactic angle

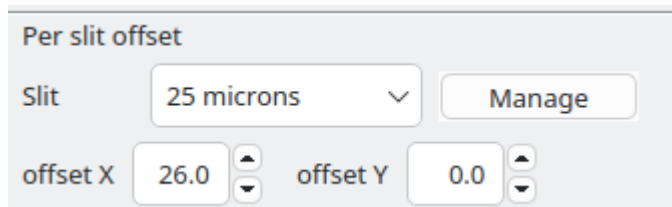
Slit orientation : ☒ Vertical ☐ Horizontal

When using a rotator it is possible to automatically rotate the spectroscope so the slit orientation follow the parallactic angle to maintain the slit vertically relative to the local horizon.

The rotator angle must be initialized with the correct orientation of the slit. The most easy is to take an image of a star rich field, use the right click menu to plate solve and sync the rotator. Then select if the slit is horizontal or vertical in the camera field.

When using a spectroscope with multiple slit widths you can set an offset to apply for each slit. This can be used with fixed photometric slit or with motorized slit.

A script command is available to select an offset. This is done automatically when using the script UVEX4_Set_Slit, be sure the name in the list match the name in the [UVEX4](#).



Per slit offset

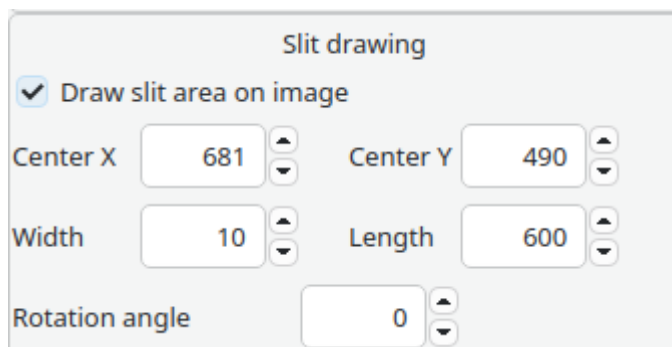
Slit: 25 microns Manage

offset X: 26.0 offset Y: 0.0

Draw slit area on the image

This draw a red rectangle in the image where you can indicate the extension and rotation of the slit.

This is not necessary but this can help in some case.



Slit drawing

☒ Draw slit area on image

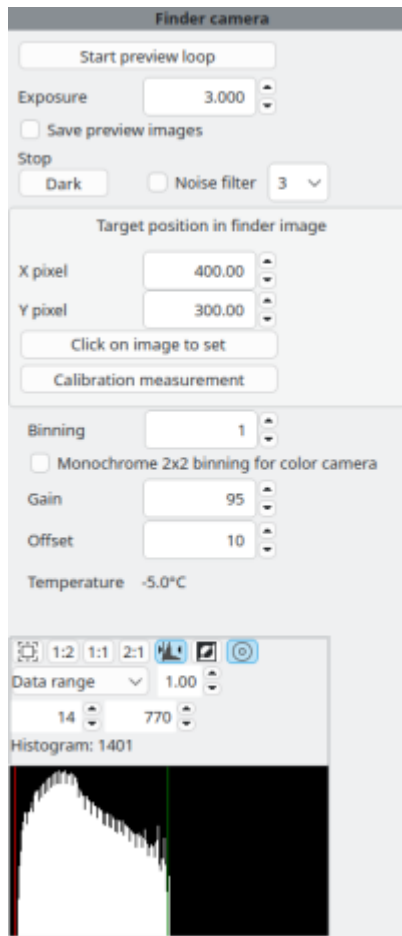
Center X: 681 Center Y: 490

Width: 10 Length: 600

Rotation angle: 0

Finder camera

This tool is to manage the finder camera, it is visible only when a [device is defined](#) and selected in the [Slewing preferences](#).



You can adjust the exposure parameters, gain, offset, cooling and binning. To improve the star detection in the image it is possible to load a **Dark** or to apply a **Noise filter**. The histogram display is to adjust the preview image. It work the same as the [visualisation](#) tool. The target position is automatically adjusted when the binning change.

It is possible to start a preview loop to adjust the focus and exposure for the camera. Be careful to not let this loop active when using the same camera for autoguiding. When the option is checked it is possible to save every images from this camera.

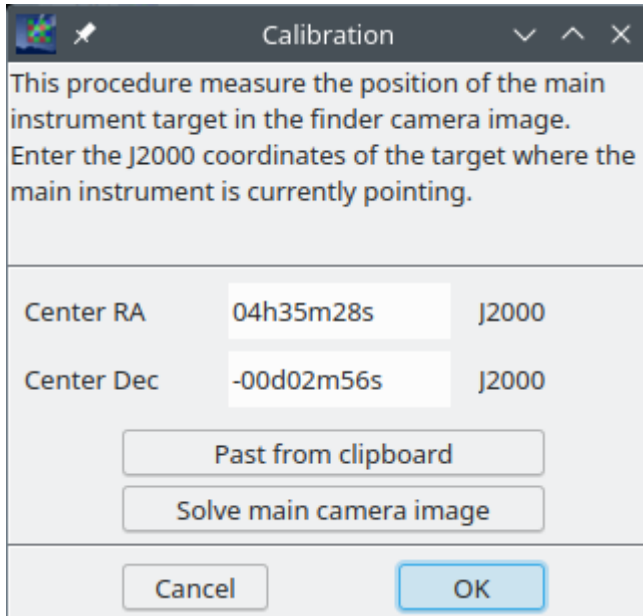
To help to identify targets in the field the right click menu allow to plate solve and annotate the image,

To work more precisely to center a target in the main instrument it need to be calibrated for the offset between the finder and main instrument.

You can enter manually the X,Y position of the main instrument in pixels or use the **Click on image to set** button.

But for the maximal precision it is recommended to use the Finder Calibration tool.

Start by pointing the main instrument at an easy to find target, for example a bright star. Be sure it centered at the exact location you want, for example on the spectrograph slit. Note the J2000 coordinates of this star. Click the button **Calibration measurement**.



The Calibration dialog box has a title bar with a standard icon, a maximize button, and close buttons. The main text area contains instructions: "This procedure measure the position of the main instrument target in the finder camera image. Enter the J2000 coordinates of the target where the main instrument is currently pointing." Below this are two input fields: "Center RA" with the value "04h35m28s" and "J2000", and "Center Dec" with the value "-00d02m56s" and "J2000". There are two buttons: "Past from clipboard" and "Solve main camera image". At the bottom are "Cancel" and "OK" buttons.

Center RA	04h35m28s	J2000
Center Dec	-00d02m56s	J2000

Past from clipboard

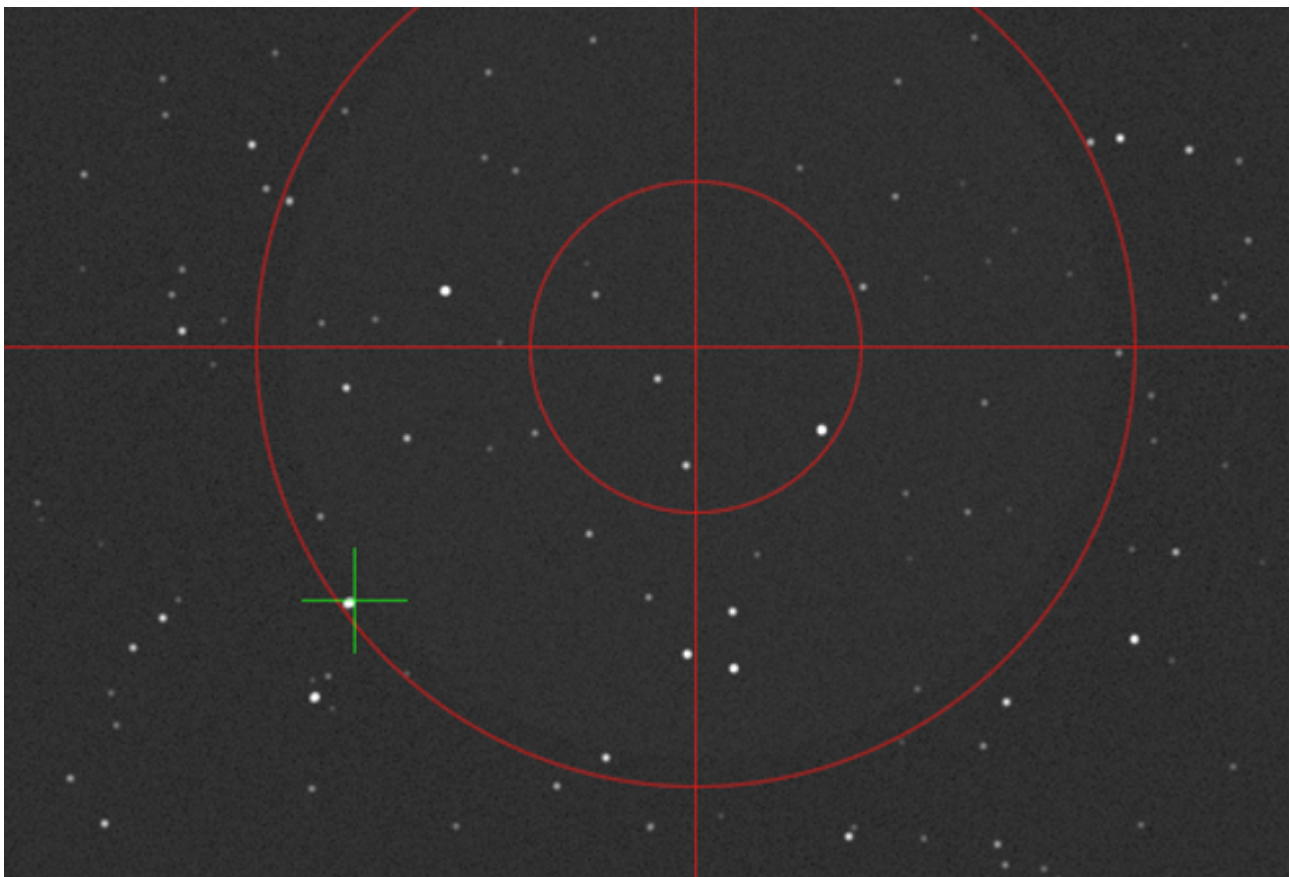
Solve main camera image

Cancel OK

Enter the J2000 coordinates you note before, really the coordinate of the star, never use telescope coordinates here. You can past them from the clipboard, or plate solve the main camera image if this is possible.

Click the button **OK**, it take an image, plate solve, and compute the offset automatically.

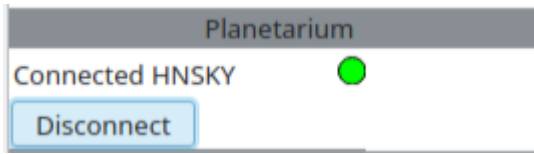
The result is a green cross indicating the center position of the main instrument.



It is possible the cross do not show if the offset is larger than the finder image size. This not affect the precision if not too wrong but you may want to adjust the finder mechanical pointing to reduce the offset.

You are now ready to point any target in the main instrument from a sequence or using the [mount Goto tool](#).

Planetarium Tool



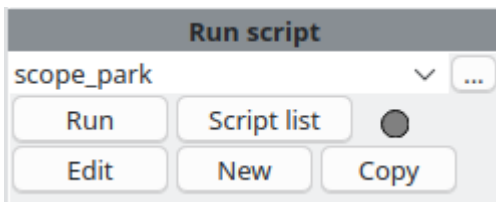
This tool is to control the connection to the [planetarium](#).

It is used to display an astrometry resolved image with the right click menu, or to set the targets coordinates in the [sequence](#) preparation.

If you [configure](#) to start the planetarium you can directly click the Connect button. Otherwise be sure the planetarium application is running before to click it.

In previous version of the program there was a button here to slew to a target selected in the planetarium. This function is now integrated in the [telescope mount](#) Goto button.

Script

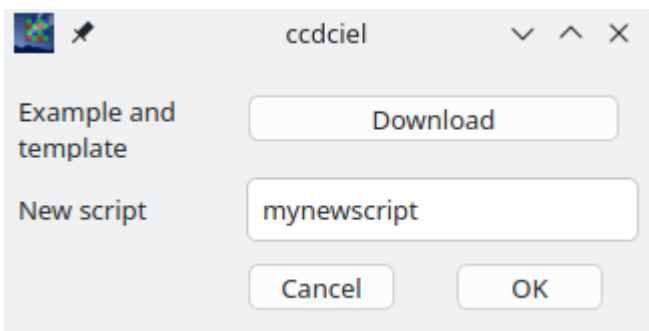


This tool let you create or run a [script](#)

The scripts can be used to automate some task in CCDciel or to interface with external program for example to manage your observatory and equipment.

The same scripts can be used as a step in a [sequence](#), or in specific conditions, but this box is a convenient way to create, test and quickly run any script.

To create a new script click the **New** button, a prompt ask you for the script name.



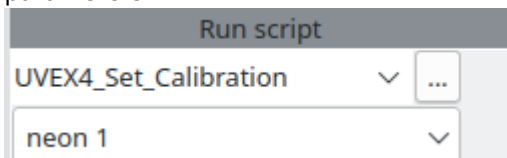
This create a new script with the following template, see the full [reference documentation](#) and how to use the [editor](#) for the details.

```
# Python program for CCDciel
# see: https://www.ap-i.net/ccdciel/en/documentation/jsonrpc_reference

from ccdciel import ccdcielex
```

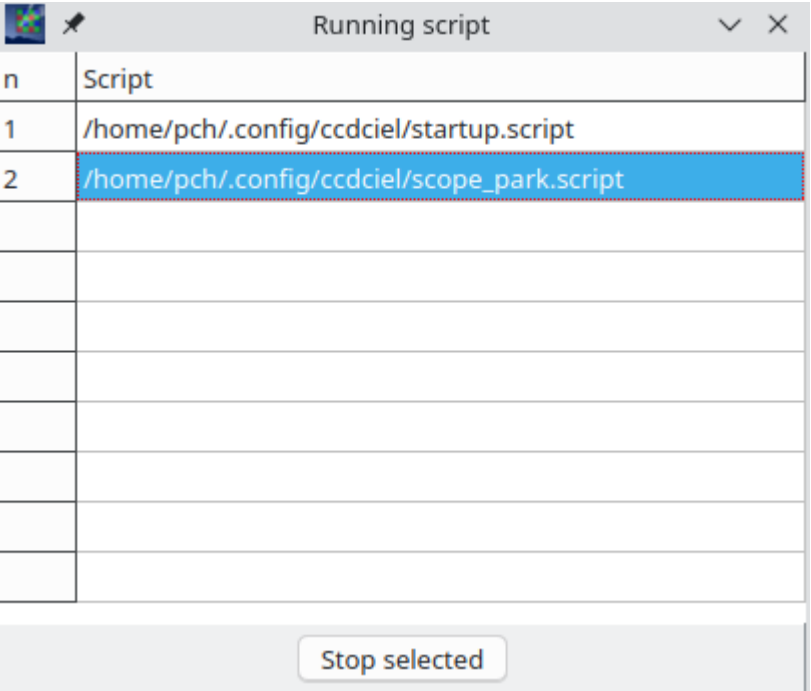
The button **Download** allow to get [script example](#) you can directly use or customize.

To specify the arguments for the script click the button "...". This add an input box where you can type the parameters.



The **Script list** button open a list of the script that are currently running.

If you want to stop one of this script, select the corresponding row and click **Stop selected**

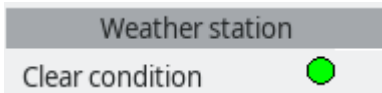


The screenshot shows a window titled "Running script" with a table of running scripts. The table has two columns: "n" (index) and "Script" (path). The second row is selected, highlighted in blue. Below the table is a button labeled "Stop selected".

n	Script
1	/home/pch/.config/ccdciel/startup.script
2	/home/pch/.config/ccdciel/scope_park.script

Stop selected

Weather station tool



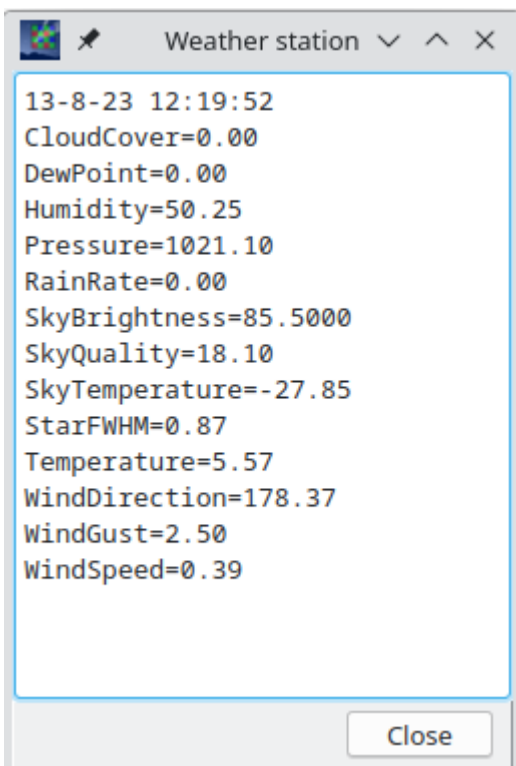
This tool shows the status of the weather monitor, when the light is green the observing conditions are good, for example there are no clouds.

If a sequence is running when the weather goes bad, the sequence is paused until the conditions return good.

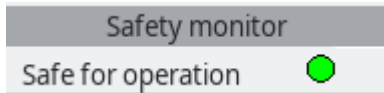
For this tool to work you need to [setup the driver](#) and eventually [configure the sensors limits](#)

This is related but independent of the [Safety monitor](#).

The Detail button opens a window with all the current sensor values:



Safety monitor tool



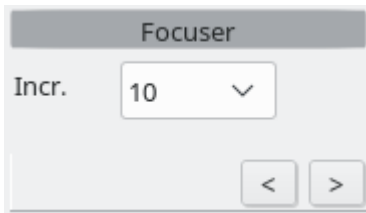
This tool show the status of the safety monitor, when the light is green it is safe to open the observatory for observing, for example it not rain.

For this tool to work you need to [setup the driver](#) and eventually [configure the actions](#) to take automatically when the condition change to bad.

This is related but independent of the [Weather station](#). Some sensors of the safety monitor can be related to the weather but not only. You can also be interested to monitor the UPS status to be sure you have enough battery to close the dome in case of power outage.

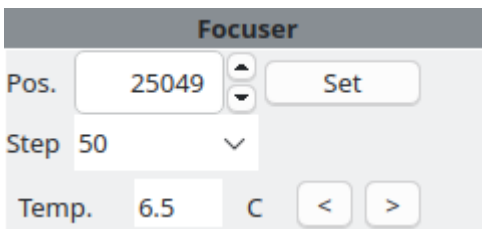
Focuser Tool

With this tool you can control your motorized focuser manually. The control are adapted if you use an absolute or relative focuser. The temperature is reported if available.



The screenshot shows a window titled "Focuser". It contains a label "Incr." followed by a text input field containing the number "10" and a dropdown arrow. Below this, there are two buttons: a left-pointing arrow "<" and a right-pointing arrow ">".

With a relative focuser you can set the desired movement in steps, then click the arrow buttons < > to move the focuser in or out.



The screenshot shows a window titled "Focuser". It contains three rows of controls. The first row has a label "Pos." followed by a text input field containing "25049", a small up/down arrow button, and a "Set" button. The second row has a label "Step" followed by a text input field containing "50" and a dropdown arrow. The third row has a label "Temp." followed by a text input field containing "6.5", a unit selector "C", and two arrow buttons "<" and ">".

With an absolute position focuser you can set the movement as with the relative focuser, or set an absolute position and click **Set**.

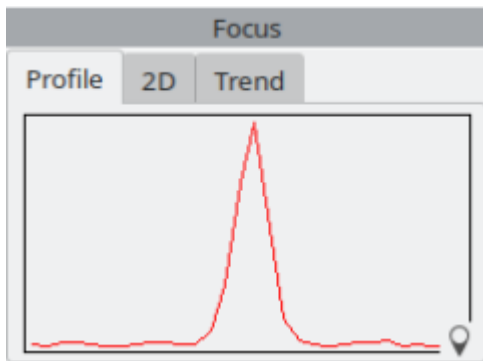
Focus Tool

With this tool you can check the focus or start an autofocus run. It can be used with [motorized focuser](#) or manual focuser.

If the [autofocus mode](#) is set to **Planet** all the reference to HFD are replaced by Sharpness but the tool work the same.

Show star profile

When you double click on a star, it's profile and information about it's sharpness are show here.



The top part of the tool show three tabs with graphical representation.

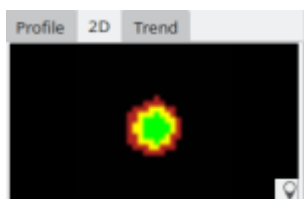
The curve in the **Profile** tab is a cross-section of the star image intensity.

The narrower it is the better and sharper is the star image.

Take a specific attention to the top of the curve. A flat top indicate a saturation, a rounded top is indication of bad focus or oversampling.

A curve that enlarge too much on the foot can be an indication of optical issue, light cloud in the sky, or frost on the lens.

The **2D** tab is an extreme zoom on the star image colorized to enhance the view.



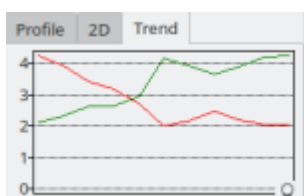
The area in green has a level higher than half maximum, it represent a 2D view of the FWHM.

The area in yellow has a level higher than 9% above the background.

The area in red is the foot of the profile curve with a level between 3% and 9% above the background.

Look for the roundness of the image with each color area as narrow as possible.

The **Trend** tab show the history of the previous measurement.



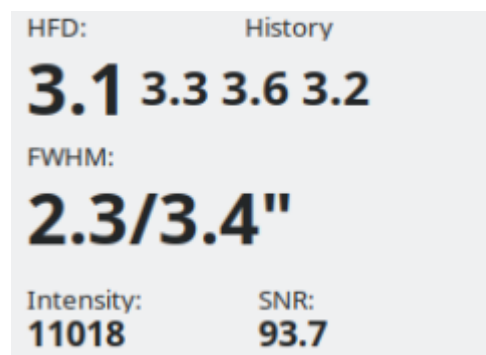
This is the main help for the manual focus tool, adjust the focuser position to reach the minima of the red curve

and the maxima of the green. The HFD is in red and the intensity in green.
Double click on the graphic to clear and start a new graph.
Move the mouse cursor on the curve to show the exact value in the [status bar](#).

Each of this graphic can be opened in a separate window with a click on the button  on the bottom right. This allow make the graph larger and to monitor both at the same time, even when the Focus tool is not show.

Measurement values

Below are the measurement value for the current star image.



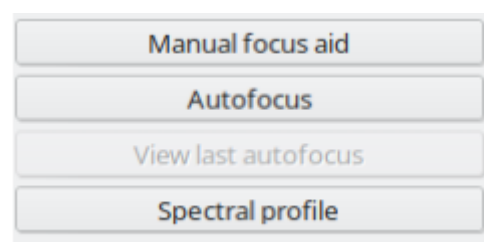
The **HFD** (Half Flux Diameter) unit is pixels. The **history** of the previous three measurement is show on the right.

The **FWHM** (Full Width at Half Maximum) units are pixels and arc-seconds.

The star peak **intensity** should not be saturated. And the **Signal/Noise ratio** must be high enough.

Manual focus

When focusing on a star, make first a [preview](#) exposure and double click on a non saturated star you want to use for focusing.



Click **Manual focus aid** to start a [preview](#) loop on the selected star area, configurable by setting the [focus window size](#).

Optimum focus is reached when the Sharpness or HFD / FWHM are at minimum value, and the intensity is at the maximum value.

Auto-focus

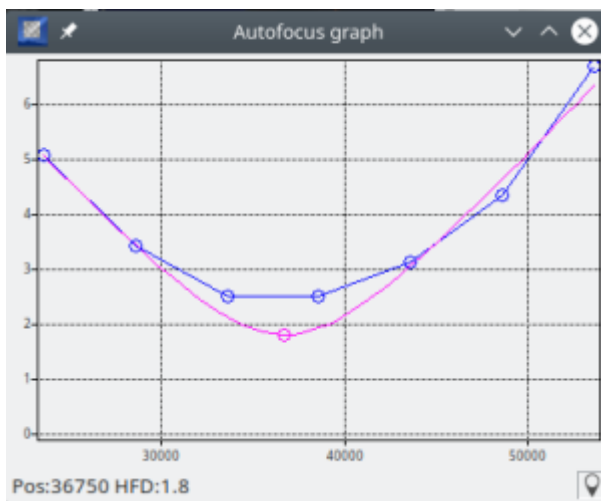
Click **Autofocus** to start the auto-focus procedure on the selected star. You must have configured the [auto-focus](#) in advance.

This button do not execute the action that are specific to autofocusing from a sequence, it will not stop autoguiding, and not slew to a nearby bright focus star.

When the autofocus is running it show a plot of the HFD or Sharpness versus the focuser position. The aspect of the plot depend on the selected focusing method. For dynamic focus the pink curve is the resulting hyperbola fit.

If you move the mouse over the graph it display the values of the focuser position and HFD.

You can click the button  to open the graph in a separate window and not close the graph when the auto-focus is completed to let you more time for examination. Click the button again to close the graph.

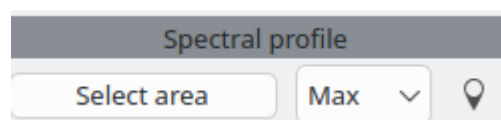


You can review this graph later using the button **View last autofocus**.

Spectral Profile

When you use a spectrograph to image a spectrum it can be useful to quickly show the profile. This immediately give a better idea of what we get, and allow to check for a risk of saturation in some part of the spectra, specifically in emission lines.

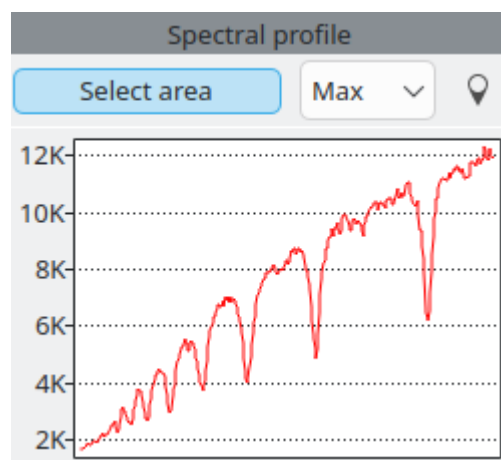
If the tool is not visible you can select it from the [Display](#) menu. By default it is located in the Focus tab when using a single column.



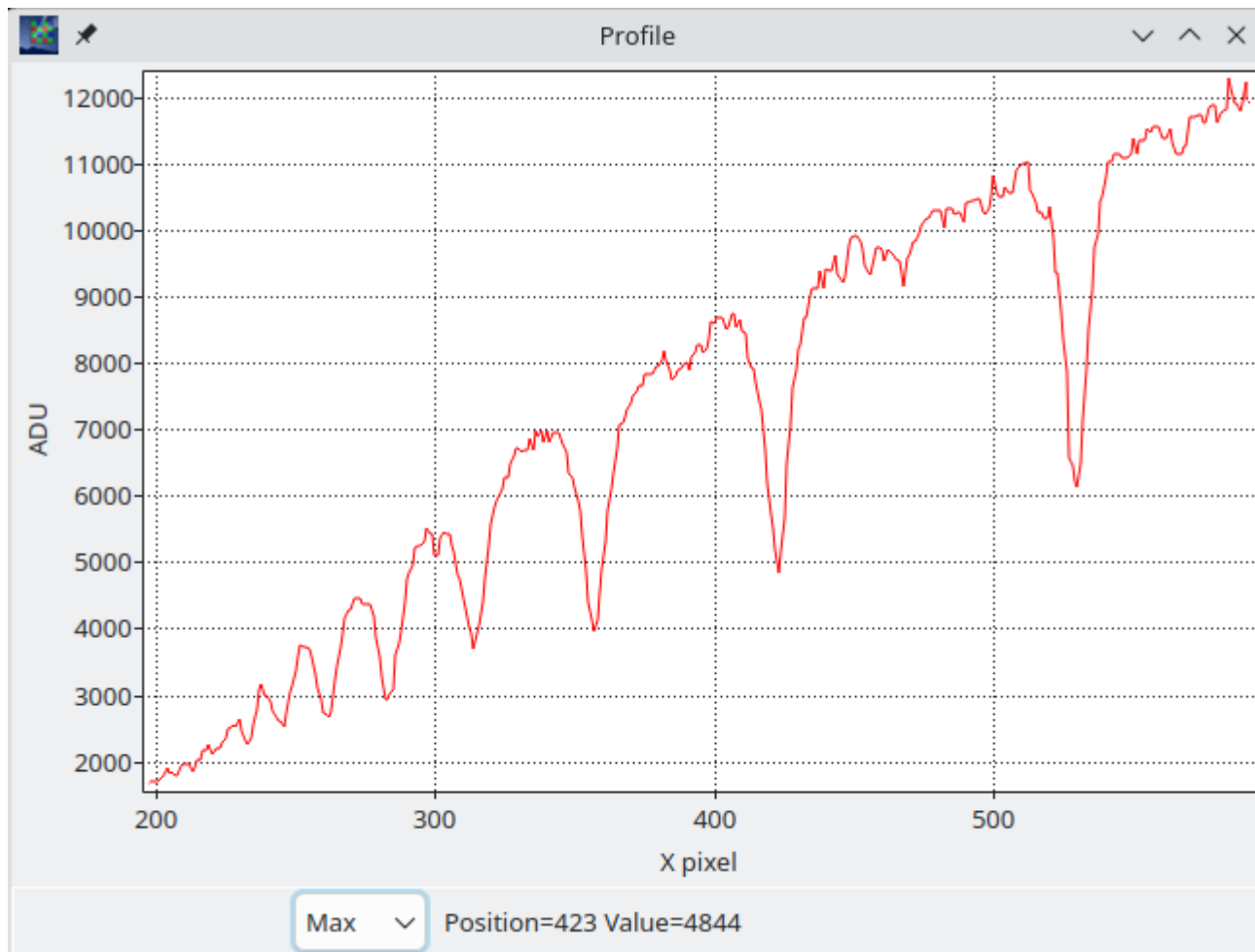
Select if you want to show the average or maximum values, then press the button **Select area**. Mark the horizontal area you want on the image by pressing the Shift key + Left button and move the mouse. You can quickly select a full width area with a double click at the spectra position.



If required the scale is show in thousand ADU to save space.



The profile can be opened in a separate window with a click on the button  on the top right. The scale is show in ADU and pixel position because this is totally uncalibrated.

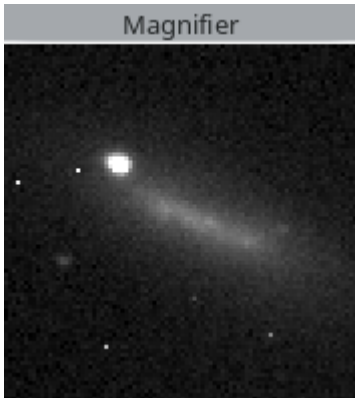


When you move the mouse over the graph it show the position and the spectra value, average or maximum, at this position.

It is possible to zoom on a part of the spectra with the mouse left button and move the position with the right button.

Magnifier Tool

This tool show a magnified part of the image below the mouse cursor.



The zoom level is at least of 2x, or 3x the main image zoom level.

Capture Tool

This tool is to take a series of exposures.

At the top is a reminder of the current camera gain settings, click on this text to directly open the [camera preference](#) to modify them.

Set the **Exposure time** and the **Binning** to use. Also the camera lens **F-Stop** when using a supported INDI DSLR.

If you activate the “stacking option” in the [preferences](#) you also see a **Stacking count** value. This is the number of exposure it accumulate to save in a single file.

Enter an **Object name**. The object name will be used for the file name and stored in the FITS header at keyword OBJECT.

Set the **Count** number of consecutive exposures to be taken. If the filename use a sequence number the **Overwrite** option is visible, when checked it restart the sequence at 1, overwriting any file with the same name.

Select the **Type of frame**: Light for sky exposure. Bias, Dark, Flat for the calibration. This selection will be used for the folder name and stored in the FITS header at keyword IMAGETYP. If your camera has a shutter, it will be closed for Bias and Dark.

When BIAS is selected the exposure time selection is disabled and exposure time is set to zero.

If **Dithering** is required, put a checkmark and enter the image interval. Dithering requires the autoguider to be connected, [configured](#) and guiding from the [Autoguider](#) tool before you start capturing.

if **Autofocus** is required, put a checkmark to the option you want. It is possible to refocus after a given number of image, after a temperature change, or after a HFD change.

Autofocus must have been configured in [auto-focus](#) and [V curve learning](#) should have been run and result

saved. For autofocus the telescope will automatically slew to a database star of configured magnitude. The slew to and return will only work accurately if you have configured the [plate solver](#) and [slewing](#) options.

The **Script** to use with this capture. When selected this show the additional options for when to execute it.

- **at start of the series** will be executed when the Start button is clicked, parameter is -1
- **before each exposure** will be executed just before to start the exposure, parameter is 0,exptime,stackcount,current frame,total frames.
- **after an image is saved** will be executed after each image, parameter is 1.
- **at end of the series** will be executed after all the images are taken, parameter is 2 for normal end or 3 for abnormal.

An [example script](#) that show how to read the parameters is available.

Click the **Start** button to begin the exposure series. The same button can be used to interrupt the series when it is running. If supported by the camera driver you can press the Shift key and click the stop button to save the partially exposed image.

The remaining time is displayed next to the button.

Filter Tool

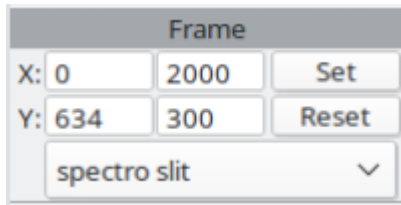


With this tool you can control your filter wheel.

It will show the currently mounted filter.

To change the filter, select one from the list.

Frame Tool



Frame		
X: 0	2000	Set
Y: 634	300	Reset
spectro slit ▼		

This tool is to set the sensor area used for imaging.

The first row is the horizontal starting point and width.

The second row is the vertical starting point and height.

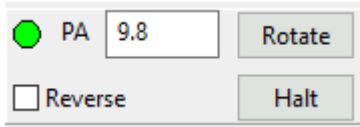
You can set the values with the mouse on a preview exposure. Press the Shift key and the mouse left button to draw the frame.

A list of predefined ROI can be set in the [Camera preferences](#). When the list is not empty it is show here for selection. Be sure to always click the Set button after changing the selection.

Click the Set button to send the values to the camera.

Click the Reset button to reset to full frame.

Rotator Tool



With this tool you can control your motorized rotator.

To rotate to a new position type the new Position Angle and click **Rotate**.

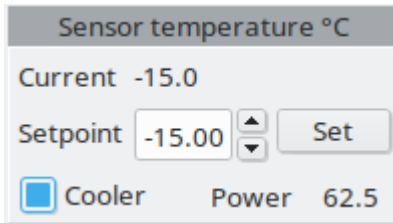
Check **Reverse** if your optical configuration require to reverse the rotation to match the celestial position angle.

The light is red when the PA field is the rotator raw value without calibration.

Use the [right click menu](#) **Resolve and sync the rotator** to calibrate the rotation angle. After that the light is green and PA field indicate the celestial position angle.

The last calibration is restored when the rotator is connected.

Sensor Temperature Tool



The screenshot shows a software window titled "Sensor temperature °C". Inside, there are three main sections: 1. "Current" with a value of "-15.0". 2. "Setpoint" with a numeric input field containing "-15.00", a small up/down arrow control, and a "Set" button. 3. A section with a checked checkbox labeled "Cooler", the word "Power", and a value of "62.5".

With this tool you can set the camera cooling setpoint and read the current imaging sensor temperature.

To start cooling, enter the temperature **Setpoint** (target) and click on the **Set** button. Automatically the **Cooler** check mark will be checked.

To stop cooling un-check **Cooler**

When active the cooler power level, in percent, is show.

If you have configured a [maximum temperature rate](#) the button text change to "Cancel" to let you cancel the current temperature change.

Telescope Tool

Telescope position

RA: 03h40m25s Track

Dec:+14d01m01s Unparked

Az: 127.78 Alt: 49.40

Handpad Goto

West (Pointing East)

Meridian in 128 min.

This tool display the current telescope RA/DEC and Alt/Az position, the side of pier if reported by the driver, the time to or from the meridian.

You can **Park** or **Unpark** the mount using the corresponding button.
The **Track** button start or stop the mount tracking.

The **Handpad** button open a virtual handpad to manually move the telescope.
You can use the buttons or the keys Ctrl or Alt + an arrow key.

Handpad

Centering

Flip N/S

☐ ^

☒ v

E N W S

Click the **Goto** button to move the telescope to a new position.

Goto

Search object name, click on planetarium or type the coordinates

Object name M 15 Search

Center RA 21h29m58s (J2000)

Center Dec +12d10m01s (J2000)

Azimuth 82.62

Elevation 10.16

☒ Use astrometry to refine the position

Cancel Goto

There is tree way to define the new telescope coordinates:

- Enter an object name and click **Search** to get the position from the internal database, if not found and you are connected to Internet, it continue the search using Simbad and NED online.

- Select the object in the connected [planetarium](#).
- Type directly the RA and Dec J2000 coordinates, using decimal value or the hms/dms format with a variety of separator .

Center RA	21.4877	(J2000)
Center Dec	+12 10 01	(J2000)

After the coordinates are entered, the target Azimuth and Elevation is show, so you can check if it is safe to slew the telescope there.

If you not want a precise centering of the object you can uncheck **Use astrometry to refine the position**. In this case a simple Goto is done, without plate solving.

When using the spectroscopy auto-guiding with an astrometry method, an additional box allow to start guiding at the specified coordinates.

There is an indication the Goto is in progress and you can stop it using the **Stop** button. Wait 10 to 15 seconds for terminating all the running tasks.

Telescope position	
RA: 03h50m17s	Track
Dec:+23d55m36s	Unparked
Az: 113.76	Alt: 55.12
Handpad	Stop
GOTO in progress...	
Meridian in	0 min.

If guiding was active before the Goto operation it is restarted at the new position.

You can also use the [sequence](#) tool to automatically move the telescope at a new location from CCDciel.

Dome Tool



This tool show the status of the dome.

The first light is green when to dome shutter is open, it is red when closed.

If applicable, the second light is green when the dome is slaved to the telescope position, it is red when not slaved.

CCDciel do not take any action to initialize the dome, do homing, unpark or open the shutter. But this is checked before to start a sequence and the dome can be closed and parked at the [end of a sequence](#) or when the [condition are not safe](#).

To initialize and slave your dome at the beginning of the night you can use the software provided by the dome manufacturer, the ASCOM Dome Control Panel, or the INDI control panel.

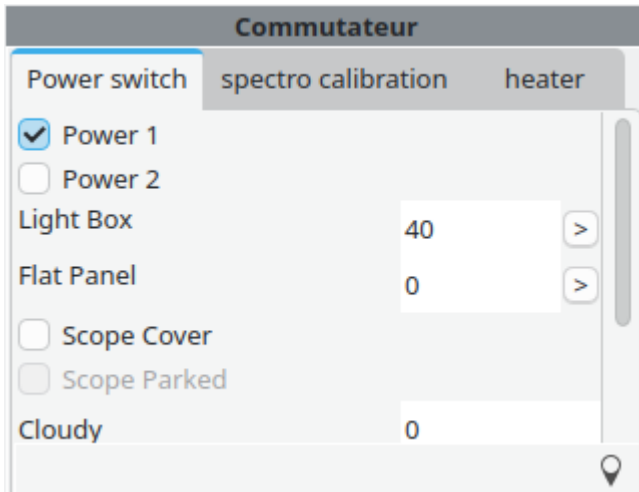
If you have a script to initialize the dome you can run it when you launch CCDciel, part of the [Startup script](#). Or if you prefer in a script you run at the [beginning of the sequence](#).

Only two common function have a button to take an action:

- **Park** to park the dome at the end of the night.
- **Slave** to start mount slaving.

But if you want you can also define in the [dome preference](#) to park/unpark the dome along with the telescope mount.

Switch Tool



This tool show and let you change the status of the different switch.

Each tab correspond to a switch box driver connection defined in the [Device setup, Switch](#).

The list of individual switch is returned by each driver, you can configure them in the driver setup.

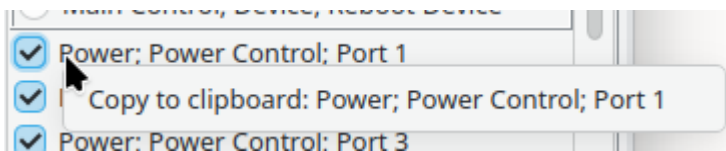
When you click on a checkbox the state of the switch is immediately modified by the driver.

To change a numeric value, edit the number and click the  button.

Box without this button or grayed checkbox cannot be modified, this is indicator gauge that report a value.

Click the  button to detach the tool to a new window you can enlarge to show everything.

It is possible to right click on a row to copy the exact switch name to the clipboard. This is particularly useful when writing script to control INDI switches.

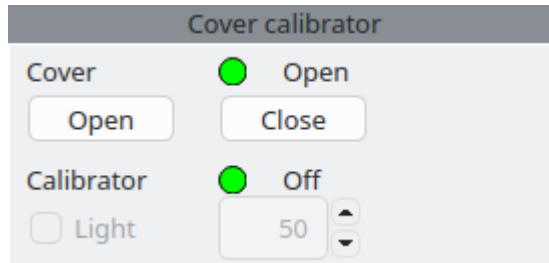


Cover calibrator Tool

This tool allow to open/close the cover and light the flat calibrator.

The calibrator section is not visible if the device include only a cover without the calibrator light.

Similarly a flat panel not attached to a cover do not show the cover section.

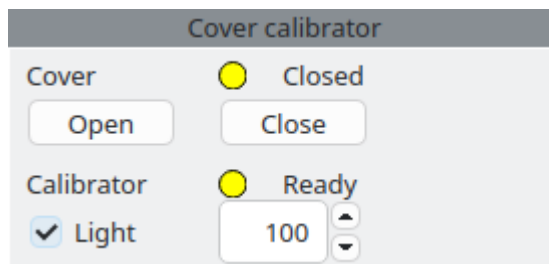


The light are green when the telescope is ready for imaging with the cover open and light off.

Click the **Open** / **Close** button to change the cover status.

When the cover is closed it is possible to check **Light** and set the desired brightness.

Some devices do not change the brightness instantly, Wait the light change to yellow to indicate the ready status.



Uncheck **Light** to stop the light and keep the cover closed, or click **Open** to stop the light and open the cover.

Sequence Tool

Sequence			
Targets: M13			
Object	Template	RA	Dec
M13	LRGB-4H	16h41m38s	+36d28m41s
M92	LRGB-4H	23h20m04s	+61d05m43s
SkyFlat	Dawn	-	-
Switch	power switch	-	-

M13, Plan: LRGB-4H				
Desc.	Exp.	Count	Type	Filter
L	300	24	Light	L
R	300	8	Light	R
G	300	8	Light	G
B	300	8	Light	B

Load	New	Edit
Status	Reset	Manage
Start	Pause	Stop
Restart exposure	Autofocus	

☒ Run unattended

This tool is to control a sequence of exposure on one or more objects.

The current implementation support only sequential processing of the targets, with options for repeating or skipping some target.

The top grid show the current list of targets. You can enlarge the right pane with the mouse to see all the column.

You can **Load** an existing file with a list of target, create a **New** one or **Edit** the current list.

Using the **Manage** button you can **Copy**, **Delete** or **Edit** any sequence present on the computer.

Use the **Start** and **Stop** button to start or interrupt a sequence.

The **Pause** button allow to pause the sequence after the current exposure is completed.

The **Restart exposure** button abort the current exposure and restart it immediately. To be use if you know for sure the current exposure will be damaged for any reason.

The **Autofocus** button force a new autofocus before the next exposure. Can be use in addition of all the automatic autofocus options.

The **Status** button show the detail of the current completion status of the sequence.

The **Reset** button remove all the completion status about the images already done, allowing to restart a sequence from the beginning.

The button you cannot use at any moment are show in light gray and disabled.

The **Run unattended** check box control how the program react in case of error.

- If not checked a message prompt you on the screen what you want to do. After a delay without response the operation is canceled.
- If it is checked the operation is canceled. Also the termination actions are always taken anyway the sequence is stopped.

The bottom grid show you the plan for the current target. A plan name ending with a "*" indicate it is modified

from the base template.

When the sequence is running the current target and step are highlighted.

You can edit a sequence while it is running but there is some limitation to ensure consistency and be sure you get the required number of exposure with the new parameters:

- The option “Record restart information” must be checked.
 - No autofocus or slewing operation are now active.
 - Current camera exposure continue normally during the editing but a new exposure is not started until the editor is closed.
 - Change to future target is applied without limitation.
 - Change to already complete target is used only for an eventual future repetition.
 - The following action are taken if the running target is modified:
 - If changing only the repeat count or the autofocus option the sequence will continue.
 - If changing the object name, the coordinates or the rotator angle, the sequence is stopped and restarted with the new parameters.
 - The following action are taken if the running step is modified:
 - If changing only the total number of exposure, the dithering or autofocus frequency, the sequence will continue.
 - If changing the description, exposure time, frame type, binning, filter, the current step is interrupted and the sequence is restarted with the new parameters.
-

Sequence editor

After you click **New** or **Edit**, the target editor let you modify the list of target and the plan steps.

At the top of the screen is the global sequence option, when it start and end, how restart is managed, what action to take when it start and end.

Then is a list of target with the name, exposure template, coordinates, time constraint. On the right is a list of additional options for the currently selected target.

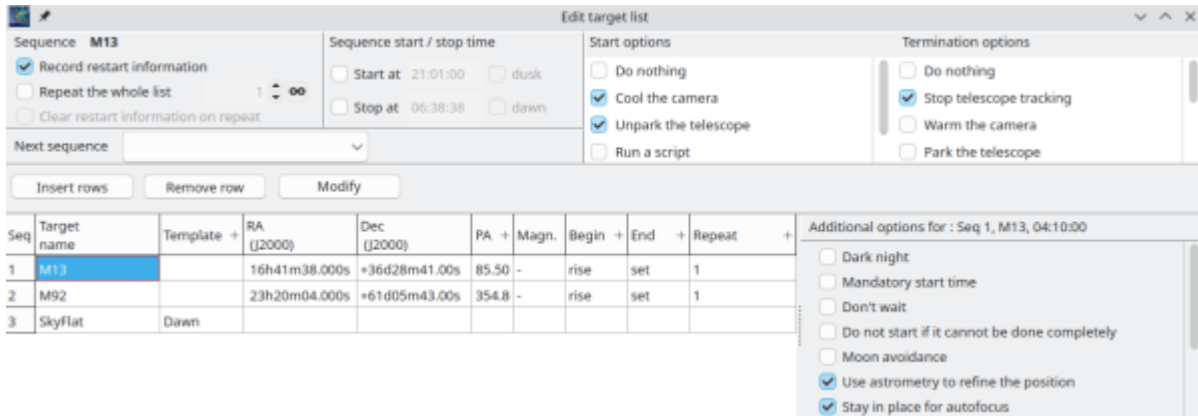
At the bottom is the list of exposure steps for the selected target. This give all the capture parameters for each exposure series. This can be selected from a template or be specific for only this target.

You can adjust the size of the target and exposure steps list depending on your needs.

For a monochrome camera with a filter wheel you typically want 3 or 4 steps for each filter. But with a color camera a single step is generally used, in this case you can reduce the step list to get more space for more targets.

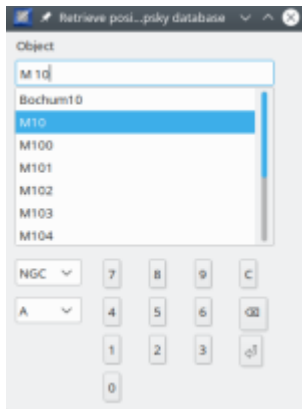
Target list

Add a target



A target can be an object you want to take the images, a switch to set, a script to run in the sequence, or a series of twilight flats. Click the button **Insert rows** and select the desired option to add the target you want. When already editing the target list you can add more rows using keyboard shortcut. Use **Ctrl+a** to add an empty row, or **Ctrl+o** to add an object from the internal database. You can edit a value directly in the table or change the values for a whole column by a click in the column title. Click the **Options** button to access more parameters for the target.

When you add a **New object**, or click the **Search** menu, the program will search for the object coordinates in the internal database.



You can use wildcard to list all the matching objects. For example if you enter NGC you will get a list of all NGC objects in the database. But if you enter NGC100 you will get the coordinates of NGC100 because this object exists. To get all object starting with NGC100 in the list, you have to enter NGC100*.

If the object is not found in the database, you can enter the coordinates directly or click the **Planetarium** menu to select the object in the connected [planetarium](#) application.

If you are connected to the Internet you can also select **Search online** for an extended search in the Simbad and NED database.

The coordinates can also be selected by plate solving the **current image**.

Or click the **No move** menu to clear the coordinates and not change the telescope position.

Note that the target coordinates are always J2000 and could differ from those show by the mount or the planetarium if they use local apparent coordinates.

Depending on the source the target magnitude can be automatically added, including for different pass band when using the online search. This magnitude can be used for star auto-exposure for photometry or spectroscopy measurement.

Select the template exposure plan to apply to this target using the dropdown box, or type a new plan name to

create a new empty plan. If you not want to use a template you can even let it blank. After a plan is selected you can change it's properties on the [lower part of this screen](#).

The template are saved in separated files and can be used by many target list. When the exposure properties for the current sequence differ from the saved template this is indicated by a "*" at the end of the template name.

Type the desired value in the **PA** column to move the [rotator](#) at the specified angle.

You can also use the current image orientation after plate solving.

Be sure the rotator is calibrated before to start the sequence if you use celestial PA.

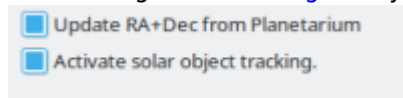
If you are imaging a fast moving asteroid or comet you can check the **Update RA+Dec from planetarium** additional option to ask the planetarium for the object coordinates just before the telescope is slewed to the target.

Be sure the planetarium is connected before to run the sequence.

Check the name of the object is compatible with the search function of the planetarium. No problem if you set the coordinate and name from the planetarium.

The planetarium must be set to follow the system time, otherwise the asteroid position is not updated.

When using the [internal guider](#) you can automatically set the object motion and activate tracking on the object.



Check **Use astrometry to refine the position** option to refine the telescope position with an [astrometry](#) solved control exposure. This ensure the selected object is framed exactly as required.

You can check the **Stay in place for autofocus** option if you are sure the center of the image field contain suitable stars for auto-focus. It is recommended to use the Dynamic focus method in this case.

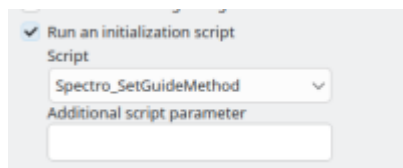
If unchecked, the telescope is first moved to a focus star of the magnitude defined in the [auto-focus preference](#), and returned to the target after the operation.

The default value for this option is set in the auto-focus preference.

Check **Do not change autoguiding state** if you want to manage the autoguiding status by script for a group of target.

By default autoguiding start with the first Light frame, this allow for calibration frame at the start of the plan.

It is possible to run an initialization script before to slew to the target. It receive the following parameters separated by a coma: object name, plan name, RA, DEC, magnitude. Additional parameters can be specified. If the script exit with a code of 2 the target is skipped.



Click the button **Apply to all targets** to set this additional parameters to all the targets of the sequence.

Set the begin and end time

You can set a time range for this target to be imaged, it will wait for **Begin** time to start. If **End** time is reach during the exposure plan it is stopped and the next target is selected.

By default the **Begin** time can be delayed if the previous target is not complete. You can force a start at the specified time by checking **Mandatory start time** in the options on the right. In this case the previous target can be aborted at this time.

You can enter any time using the format hh:mm:ss, for example 23:45:12, but you can also use the following

special time.

The default is **rise** or **set** if the object coordinates are set. This automatically use the rise or set time of the object above the limits you define in the [Observatory](#) configuration, for the date of the observation. Similarly you can select a time from meridian crossing for the begin or end time. The default is no time constraint if the coordinates are not set.

To reset to the default values, click the **Any time** menu.

You can also select to **not wait** a target that not meet the begin/end condition. In this case it process the other targets instead of waiting. This can be useful if you have a list of target you repeat over the night using the option **Repeat the whole sequence** and take the object when they are visible, or at a given time from the meridian.

By default a target is started if there is enough time for at least one image before the stop time. This can be changed by checking **Do not start if it cannot be done completely**

Check **Moon avoidance** to not select a target that is too close to the Moon. The default distance is 30°, this can be modified in the [Preferences](#).

You can also select to skip a target if it is not fully **dark night** because of the twilight or because of the Moon. This way you can skip the faint target when the Moon is up and take them at the next repetition after the Moon is set.

Begin +	End +	Repeat +	Additional options for
rise	MC	1	☐ Dark night
rise	MC	1	☐ Don't wait
			☒ I know, nothing is impossible

You can also define when the whole sequence start and stop.

Check the box **Start at** or **Stop at** and enter the time you want.

Check **dusk** or **dawn** to adjust the time for the twilight at the date of the observation. By default this is the astronomical twilight, but this can be modified in the [Preferences](#)

Sequence start / stop time

☒ Start at 20:00:00 ☐ dusk

☒ Stop at 06:41:43 ☒ dawn

Repeat a target

You can set this target to **repeat** it's whole plan for a number of time at a given interval between two consecutive start. Set the number of repetition in the target list.

To temporarily skip a target but keep it in the list you can set it's Repeat count to zero.

Repeat
3
1

Repeat: Interval 120 ☒ Preview 0.10 [seconds]

More option are available in the repeat panel that appear when the count is greater that one. The **interval** is measured between two consecutive start of the sequence, this is not the delay to wait. If the interval is smaller than the total plan duration the next repetition start immediately.

You can also start a **preview loop** while waiting for the next repetition, this is useful to keep the Sun or Moon centered if you do an eclipse sequence.

Set a switch

To set a [switch](#), select the nickname for the switch connection, the switch to modify, and the new value to set. Set the value to 1/0 for ON/OFF switch or the numeric value for multi-state switch.

A switch can also be added in a plan step, see below.

Add a script

To add a [script](#) you just have to select the one you want from the list, or create a new script here.

It is possible to specify the arguments specific for this instance of the script.

A script can also be added in a plan step, see below.

Add an automatic twilight flat

To add an automated flat click the **Sky flat** button.

Note: to take a dome/panel flat set a standard **No move** target and use a plan with an image type = Flat.

Set if you want the flat series to be taken at **dusk** or at **dawn**, this change the position on top or bottom in the list.

Select the number of flat to take for each filter, the binning, F-Stop and finally check the filters to use.

The automatic exposure time must be configured in the [flat preferences](#).

To better manage the changing sky luminosity the filter are selected from the darker to the lighter at dusk, from the lighter to the darker at dawn. This require you configure the [filter exposure factor](#).

When you add a sky flat to the plan this disable the “Start at dusk” and “Stop at dawn” global options. Do not re-enable them otherwise the sequence will not run during the twilight and the flat are bypassed.

For the same reason you must be careful the sky flat remain in first or last position in the list. The only acceptable steps before or after them are script to manage the equipment because they will run in full daylight. The flat and this scripts are run only one time if the **Repeat the whole sequence** option is set.

Normally a dusk flat can run until the Sun is 16° below the horizon, then it wait until 18° before to start the first

target. When in summer this condition are never set but you still want to make some observation you can set an absolute start time for the first target after the dusk flat, this allow the flat to run until this time, then the sequence continue.

Repeat the whole sequence

You can also repeat the whole list a number of time by checking the box at the top of the list. The Infinity button set a value of 999999.

There is no option for the interval here, the repetition is immediate. But you can add [scripts](#) in the sequence to delay the execution in a more flexible way.



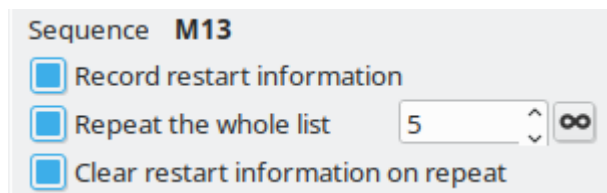
Restarting a sequence

When running a long sequence you may find it not finish totally and you need to restart it to complete the missing frames. There can be a number of reason for that, maybe you just put too many frames to be taken in a single night, or you need to stop the sequence to fix something with the equipment.

When a sequence is fully completed, the restart information is cleared so it can be reused later.

To allow a sequence to be restarted at the point it was interrupted you need to activate the **Record restart information** option. It is active by default for a new sequence but not for the one created by a previous version before this function exists to keep the compatibility.

Normally you want this option to be active. A typical case to disable it is if you run a survey, for example for asteroid or variable stars, and want to always restart the same full sequence every night even if it not complete.

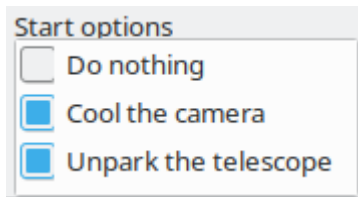


The option **Clear restart information on repeat** define how **Repeat the whole list** manage the completion of individual targets.

- If checked (default option), the targets already completed on the previous pass are re-done completely from the start. If the target plan define 5 images of M13 and the number of whole list repetition is 10 you end with 50 images of M13.
- If unchecked, the target completion is not reset when the whole list is repeated. This meant that targets already completed are not done again. In the previous example you only get 5 images of M13. A typical use is a "Messier marathon", you want 1 image of every Messier object taken when the elevation is high enough. For that you repeat the full Messier list of targets all the night and not redo the objects previously taken, only the new that are now high enough.

You can force a sequence to restart from the beginning by using the **Reset** button in the Sequence tool.

Start options



Start options

☐ Do nothing

☒ Cool the camera

☒ Unpark the telescope

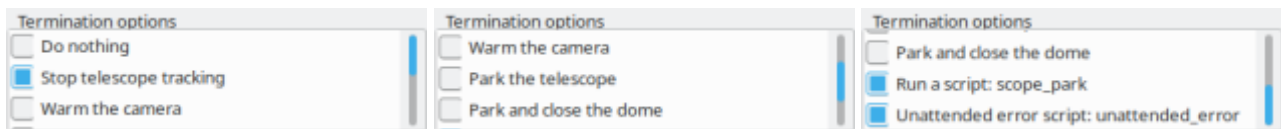
The start options will be executed immediately after the sequence start.

Cool the camera: The cooling of the camera is typical [configured to start after camera connection](#) and is the preferred option for most users. If not (to save power) the cooling will start when the sequence becomes active and start imaging. If the above option “Cool the camera” is checked the camera cooling is started at the beginning of the sequence as [configured](#) even if it is waiting for reaching “begin time”.

Unpark the telescope: The mount/telescope is unparked when the sequence is started. Note in the [dome park slaving](#) configuration it is possible to keep dome closed until “begin time” is reached.

Run a script: to do more action when a sequence is started.

Termination options



Termination options

☐ Do nothing

☒ Stop telescope tracking

☐ Warm the camera

Termination options

☐ Warm the camera

☐ Park the telescope

☐ Park and close the dome

Termination options

☐ Park and close the dome

☒ Run a script: scope_park

☒ Unattended error script: unattended_error

You can configure the action to take after the sequence is finished normally.

Select the actions you want from the list, for more actions you can use a script.

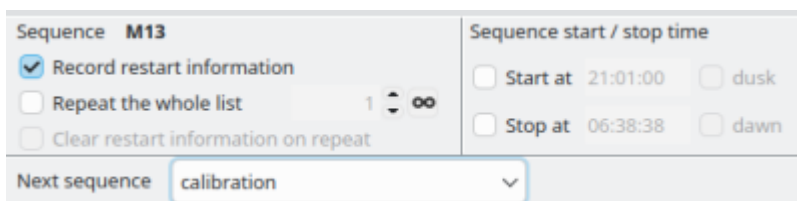
In case of error an additional script can be configured for more actions. A selection box to select the script is show when the action is checked.

The action **Warm the camera** completely stop the cooler only if the [temperature ramp](#) is configured, otherwise it just set the temperature to 20°C.

This actions are not taken when you voluntarily stop a sequence with the Stop button and the Unattended checkbox is not checked.

Beware that **Do nothing** let the mount tracking after the sequence is terminated.

Next sequence



Sequence **M13**

☒ Record restart information

☐ Repeat the whole list 1

☐ Clear restart information on repeat

Sequence start / stop time

☐ Start at 21:01:00 ☐ dusk

☐ Stop at 06:38:38 ☐ dawn

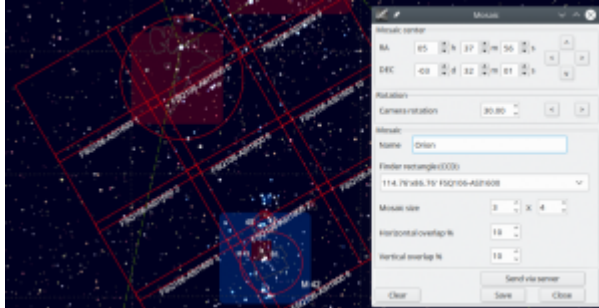
Next sequence

Specify here if you want another sequence to be loaded and started after this one is complete.

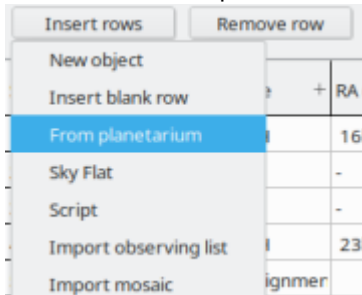
Import a mosaic from the planetarium

You can import a mosaic definition from the HNSKY or Cartes du Ciel/Skychart planetarium. Be sure you connect to the planetarium before you start.

- Take a preview image, plate solve and [send the image frame](#) to the planetarium. This ensure the planetarium know your exact CCD frame size and orientation.
- Use the instruction from the planetarium software [HNSKY](#) or [Skychart](#) to create the mosaic.



- Give a name to the mosaic frame, this will be the target name prefix in the sequence.
- In the CCDciel sequence editor, click the “Insert rows” button, select the menu “From planetarium”.



- For HNSKY select from the right click menu “Export via server / All frames”.
- For Skychart click the button “Send via server”. You can also save the mosaic to a file, then use the menu “Import mosaic”.
- Close the planetarium import tool and adjust any option you want to take the images.

Seq	Target name	Template	+	RA (J2000)	Dec (J2000)	PA	+	Begin	+	End	+	Repeat	+
1	Mosaic_01	LRGB-4H		12h26m56s	+12d59m27s	-		rise		set		1	
2	Mosaic_02	LRGB-4H		12h26m56s	+13d17m43s	-		rise		set		1	
3	Mosaic_03	LRGB-4H		12h26m57s	+12d38m41s	-		rise		set		1	

You can also use this import tool to input as many object you want from the planetarium, as long this tool is open any click in the planetarium insert a new row in the sequence.

Import observing list from Skychart

You can import an [observing list](#) from Cartes du Ciel / Skychart or other software that produce file in the same format.

Click the **Insert rows** button and select the corresponding menu to open the observing list you have saved from Skychart. All the objects from the list are imported with their coordinates.

The other options like the plan to use, the astrometry or the autofocus options are copied from the current target. If you import to an empty sequence you can set the template globally afterward by a click in the “+” column header.

Import and export targets in CSV file

It is possible to import a list of target using the button **Insert rows / Import CSV**.

This can be a file with all the column produced by the Export function, or a minimal file with only the object name and coordinates.

After selecting the file a prompt ask for the file format.

The column separator can be coma, semicolon, vertical bar or tabs. The text can be enclosed in quote, double quote or none.

To export the current target list to a CSV file use the same button / **Export CSV**. This include the same column as the table view.

Manage the target list

You can add a new target, switch, script, flat or delete one with the buttons at the top of the list.

A value can be change for a whole column by a click on the "+" in the column header.

The list can be sorted by name, RA or DEC by a click in the "v" column header.

You can also change the target order with a mouse drag/drop on the first column of the list.

Seq	Target name	Template	+	RA (J2000)	Dec (J2000)	PA	+	Begin	+	End	+	Repeat	+
1	M13	LRGB-4H		16h41m38s	+36d28m41s	85.50		rise		set		1	
2	M92	LRGB-4H		23h20m04s	+61d05m43s	354.80		rise		set		1	
3	SkyFlat	Dawn											

The target list is saved when you click the **Save** or **Save as..** button at the bottom right of the window.



Plan steps list

Template **LRGB-4h***

Seq	Description	Type	Exposure	Star auto-exp	Stack	Binning	Filter	Count	Autofocus before to start	Autofocus every	Dither every	Script	Parameter	Run script
1	L	Light	300		1	1x1	L	24	☒					
2	R	Light	300		1	1x1	R	8	☒					
3	G	Light	300		1	1x1	G	8	☒					
4	B	Light	300		1	1x1	B	8	☒					

Use the plan list to specify the exposure steps to take of a target.

Add a step

A click to the **Add Step** button show a menu to select Capture, Script or Switch.

Capture step

Give a description of the step that can be used to make a [subfolder](#).

Set the type of frame, exposure time, binning, filter, number of exposure, F-Stop, autofocus, dither and script as in the [Capture](#) tool.

Check corresponding box if you want to run an auto-focus at the start of this step.

For long steps you can also repeat the auto-focus after a given number of images or when the temperature change, as configured in the [focus options](#).

The Gain and Offset always use the setting in the [camera preferences](#). Use a script if you need modify them during a sequence.

The Stack column is visible if you activate the “stacking option” in the [preferences](#). This is the number of exposure it accumulate to save in a single file.

Seq	Description	Type	Exposure	Stack	Binning	Filter	Count
1	R	Light	30.000	10	1x1	R	8
2	G	Light	30.000	10	1x1	G	8

In this case it will save 8 files with the R and G filter, each file is a stack of 10 x 30 seconds exposure.

The Script column allow to specify a capture script for this step.

See the description in the [capture](#) tab documentation for the standard parameters.

You can also specify additional parameters and specify when to run it.

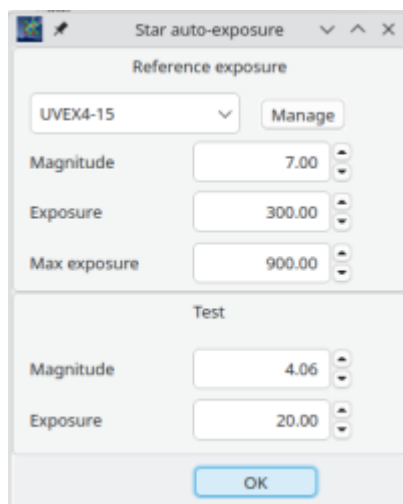
This can be use for example to light a side calibration lamp during spectra acquisition, or to modify the camera gain for this step.

ther ery	Script	Parameter	Run script
	CalibrationLight		Before and after image

For star photometry or spectroscopy you can use an automatic exposure time based on the star magnitude by selecting a specific profile. This is particularly useful for large survey when it can be tedious to manually set an exposure time for each star. Do not try to use this function for DSO, this not work!

Seq	Description	Type	Exposure	Star auto-exposure	Binning
1	Spectra	Light	237	UVEX4-15	1x1

To define an autoexposure profile for your equipment click the button **Star auto-exposure** at the bottom.



The dialog box titled "Star auto-exposure" contains two sections. The "Reference exposure" section has a dropdown menu set to "UVEX4-15" with a "Manage" button next to it. Below this are three input fields: "Magnitude" with a value of 7.00, "Exposure" with a value of 300.00, and "Max exposure" with a value of 900.00. The "Test" section has two input fields: "Magnitude" with a value of 4.06 and "Exposure" with a value of 20.00. An "OK" button is at the bottom.

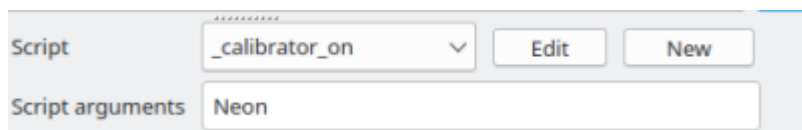
Select a name for the profile and set a reference exposure and magnitude, i.e. how long you need to expose for a star of this magnitude.

Bellow set the maximum allowable exposure time for the case the target magnitude is too faint.

At the bottom you can test the setting with different magnitude and look at the resulting exposure time.

Script step

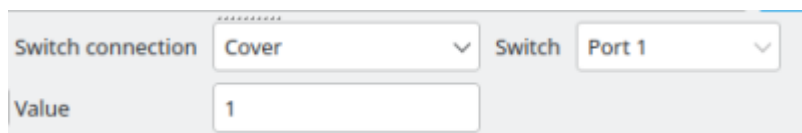
When adding a script, set the script name and parameters in the box:



The configuration box for a script step. It has a "Script" label followed by a dropdown menu showing "_calibrator_on" and buttons for "Edit" and "New". Below this is a "Script arguments" label followed by a text input field containing "Neon".

Switch step

When setting a switch, set the switch nickname, name and value in the box:



The configuration box for a switch step. It has a "Switch connection" label followed by a dropdown menu showing "Cover" and a "Switch" label followed by a dropdown menu showing "Port 1". Below this is a "Value" label followed by a text input field containing "1".

Both script and switch appear as special entries in the plan.

This can be saved in a template along with the other steps.

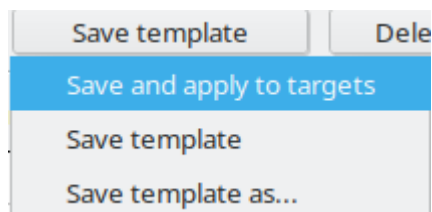
Seq	Description	Type	Exposure	Binning	Filter	Count
1	Cover, Port 1=1	Switch				
2	_calibrator_on Neon	Script				
3	Neon_calibration	Light	10.000	1x1	No change	5

Manage the steps

You can add a new step or remove one with the two button at the top of the list.

You can change the steps order with a mouse drag/drop on the first column of the list.

The template is saved when you click the **Save template** button and select an option from the menu.



Save and apply to targets save the template file and update all the targets using the same template with the new exposure parameters.

Save template save the template file, the other targets are not modified.

Save template as... save the template file with a new name.

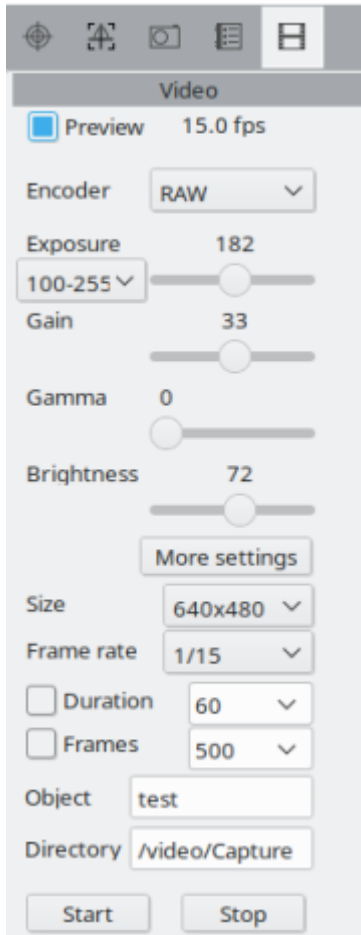
If you no more need this template you can delete it with the **Delete template** button. This not modify the exposure parameters for the current target or any other targets.

Video tool

This tool is only available for INDI camera with video stream capability, specifically on Linux and Mac. Because of the way INDI record the video, the file is written on the computer running the INDI server.

You must first set the preview rate in the [Preview](#) options. Do not use a too high value as this preview frames have to transit by the network.

The video tool appear in a new tab after the Sequence if the INDI camera you connected as video stream capability.



Select the **Encoder** to use for the images frames. Use RAW for best quality or MJPEG for quick preview. With **DSLR LiveView** the MJPEG option give a color preview of the full frame, the RAW option give a raw central crop you can use for planetary imaging.

Select the exposure range, depending on the camera it can be a direct input box or a the drop down box and a cursor.

Depending on the camera there can be other settings for the **Gain**, **Gamma** or **Brightness**. The **More settings** button open the INDI client for this camera, this let you to access some properties specific to your camera.

Two more drop down list are to select the **Image size** and the **Frame rate**.

Check **Preview** on top to visualize the frames without recording.

Next are the video capture options, you can limit the video **Duration** in seconds or the number of **Frames**.

The **Object** name is use as a part of the filename.

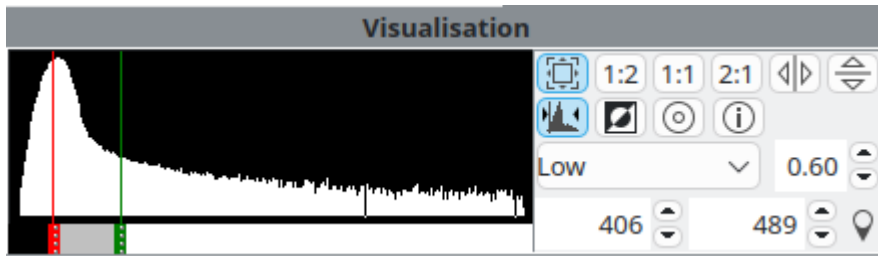
The **Directory** where to save the video file on the computer running the INDI server.

Click the **Start** to start recording. The recording to the video file is always directly done by the INDI driver without any action from CCDciel.

Use the **Stop** button if you want the stop the recording before the planned end.

Visualisation Tool

This tool is to control the aspect of the preview image. None of this setting have any influence to the image saved as a FITS file. They are only to help you to view the most of detail on the single raw images.



On the left part is the histogram display with the two vertical line that indicate the current truncation level. This lines can be moved using the red/green button at the bottom. They can be moved directly with the mouse or by a click in the bar. The position of the histogram below the mouse cursor is show at the bottom of the screen.

The color of the bar remind that only the part in the gray section is show in the image, below truncation it is black, and white above.

The default truncation level for a new image is selected in the dropdown list on the right.

- **Data range** preserve the highlight and is good for well exposed images.
- **Very Low** cut 0.01% of the highlight, this is useful when this is only hot pixels.
- **Low, Medium, High** and **Very High** can be used for DSO images.
- **Extreme** is to show the faintest details above the sky background.
- **Manual** do not modify the current truncation level when a new image is loaded.

Right of this is the Gamma value that control the stretching between the truncation levels. A value of 1.0 is linear, values between 0.3 and 0.5 are a good stretch for DSO.

On the last row are the exact minimum and maximum truncation level, the value can be modified here.

At the bottom right is the button  to detach this box to a separate window. It can be resized for a more precise use of the histogram display.

On the top-right part are the geometric adjustment button. Four button are preselected zoom level for the image. You can also get other zoom level using the mouse wheel rotation.

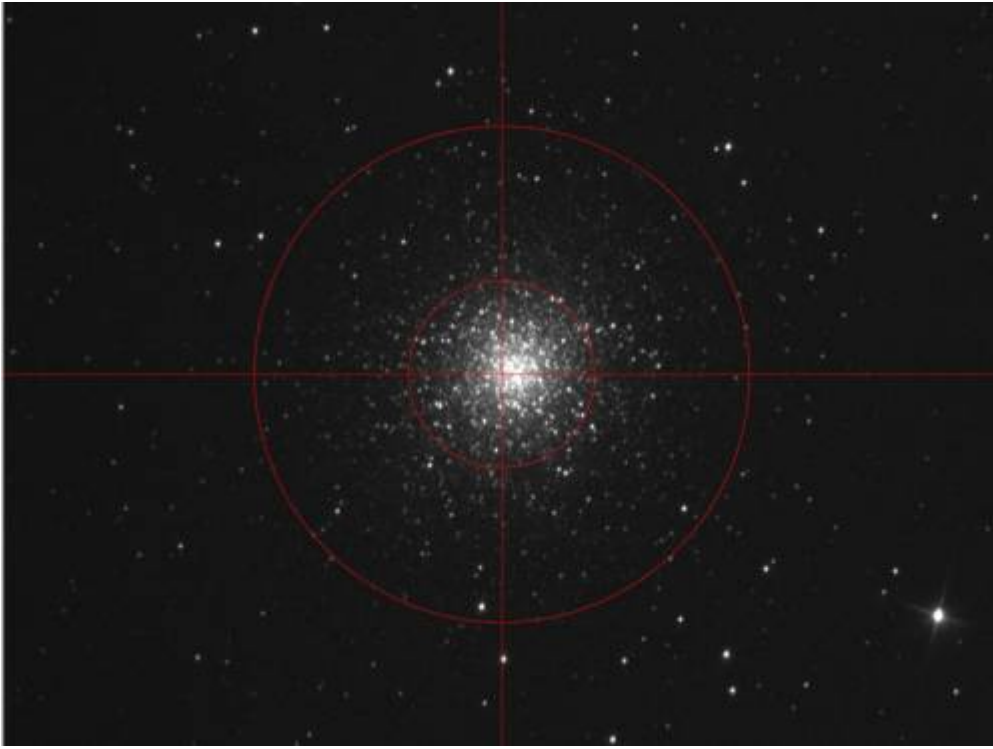
When the zoomed image is bigger than the screen you can move it with the left mouse button.

Next are two buttons to mirror the image  horizontally and  vertically,

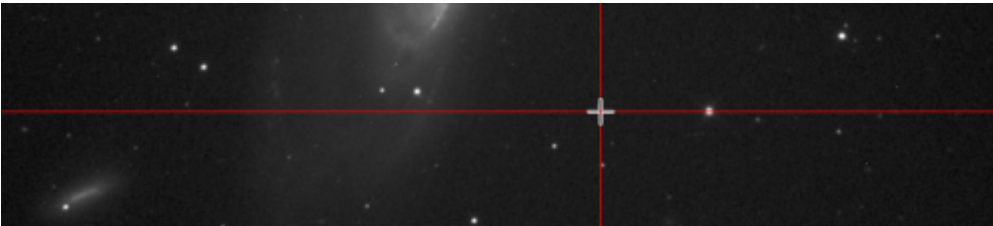
On the second row the button  is to limit the histogram display to the current selection or to show the full range 0-65535 for a quick estimate of exposure margin (not active with floating point images). When checked it make more easy to visualize the data and make a fine manual adjustment.

The button  show a negative image that can help to see faint details.

The  crosshair button show the mark at the center of the image. It is possible to move it at another position using Ctrl + click, or to make it follow a star using a double click.

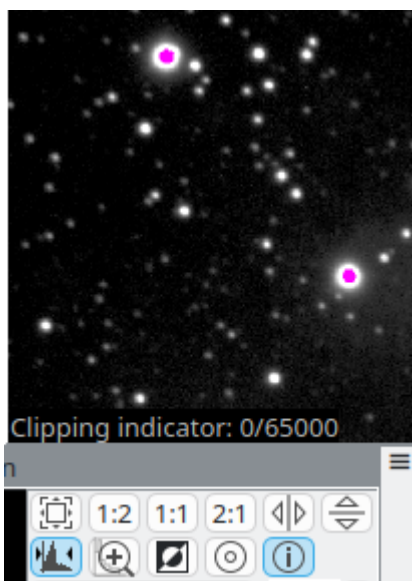


It is also possible to temporarily show a large cross at the cursor position by pressing the Alt or Meta key at the same time as the left mouse button.



If the image is plate solved it also display an arrow with the North and East direction and print the image rotation angle.

Finally the  button let you check for saturation in the image.



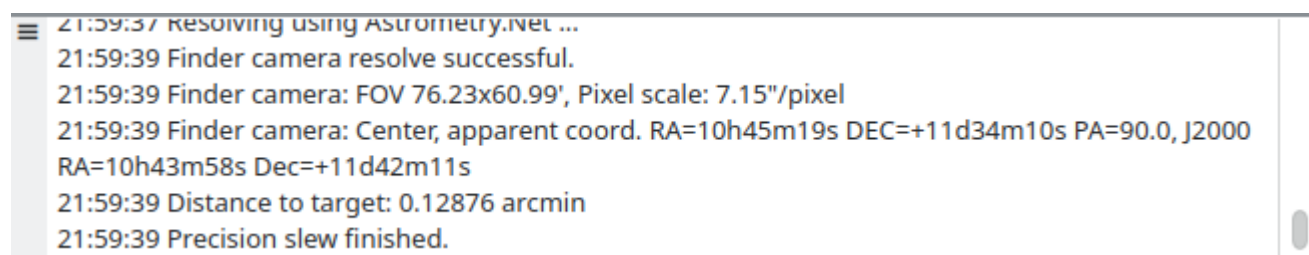
The overflow in the highlight area is marked in pink.

The clipped shadows area is marked in yellow.

You can define the clipping level for your camera in ADU in the [preferences](#), the default are 0 and 65535.

When using the [option](#) to not display the images during a capture, a new button  appear on the right, allowing to temporarily show the captured images.

Logging

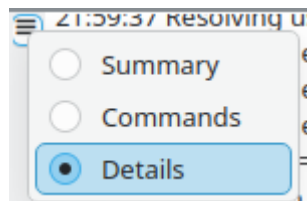


```

21:59:37 Resolving using Astrometry.net ...
21:59:39 Finder camera resolve successful.
21:59:39 Finder camera: FOV 76.23x60.99', Pixel scale: 7.15"/pixel
21:59:39 Finder camera: Center, apparent coord. RA=10h45m19s DEC=+11d34m10s PA=90.0, J2000
RA=10h43m58s Dec=+11d42m11s
21:59:39 Distance to target: 0.12876 arcmin
21:59:39 Precision slew finished.

```

This text window will report all messages (Log) from the program and drivers.



The top left button allow to select the level of detail to display.

If [configured](#), the messages (log) will be also stored in a text log file for further study. It essential to use this option if you let the program run unattended.

The file location is:

Linux:

/home/[your user name]/.config/ccdciel/Log

Windows:

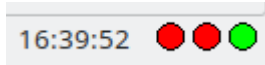
C:\Users\[your user name]\AppData\Local\ccdciel\log

Note that above folders are typically hidden.

The [Help](#) menu provide a quick access to this folder and the current log file.

Clock

This tool show the current local time in the status bar.



This is useful if you not have another clock on the computer screen but you may want to disable it if you use some remote desktop display on a slow network.

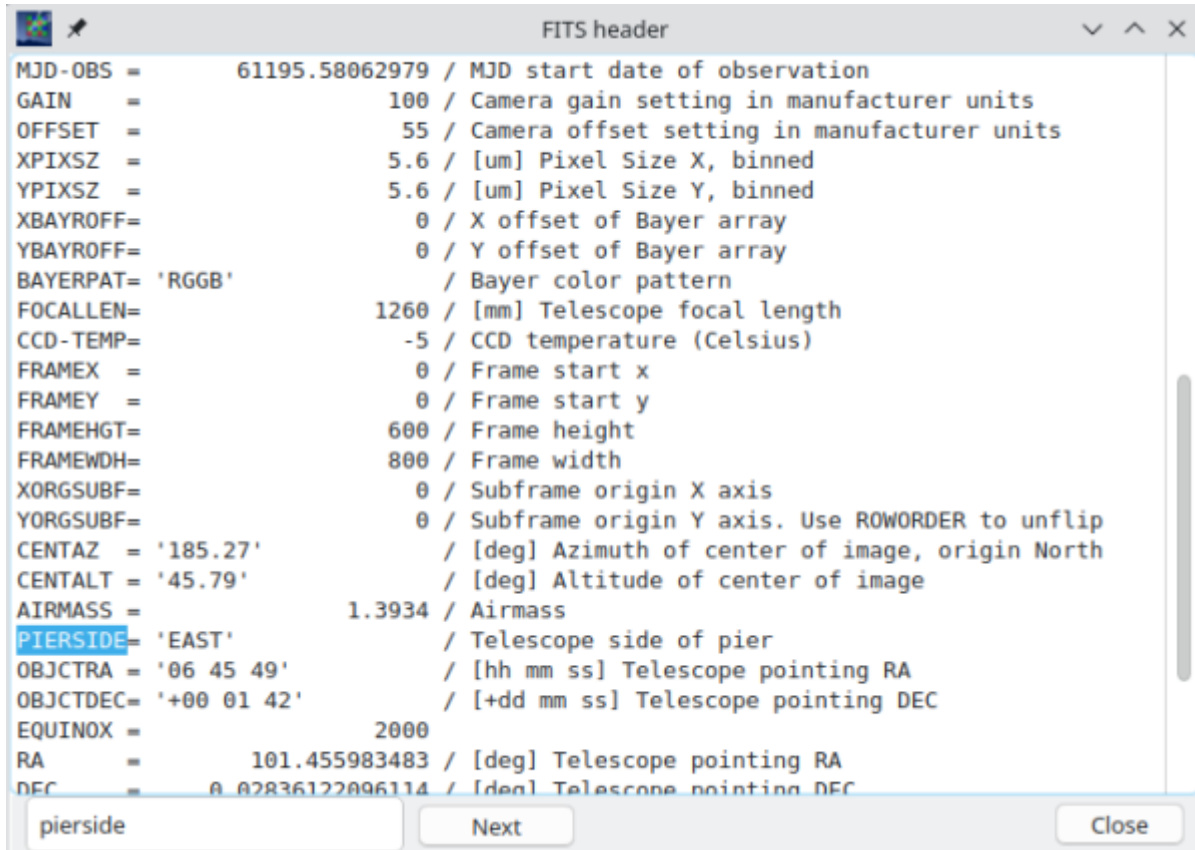
Tools Menu

The **Tools** menu include some useful tools:

- [View FITS header](#)
 - [Image statistics](#)
-
- [Measure telescope cone error](#)
 - [Polar alignment without pole visibility](#)
 - [Polar alignment near the pole](#)
 - [Inspection and collimation](#)
 - [Focuser calibration](#)
 - [Sensor analysis](#)

View FITS header

From the menu Tools → View header.

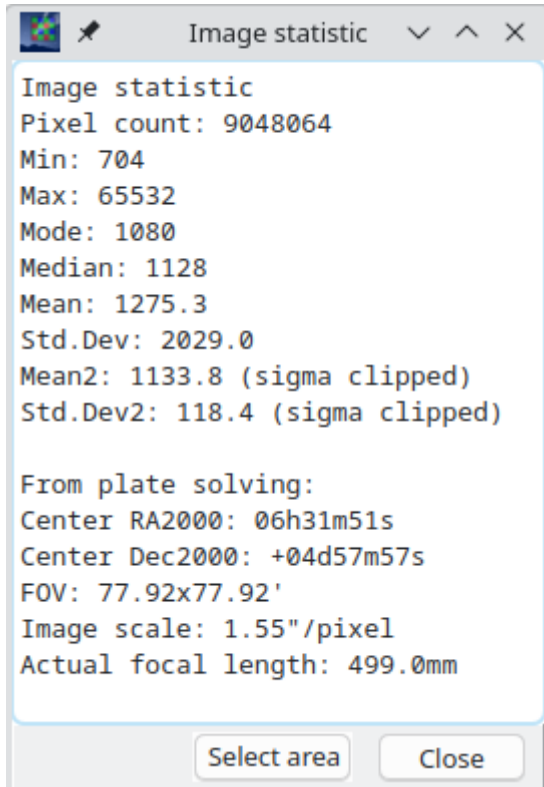


Show the FITS header of the current file.

It is possible to search for a text.

Image statistics

From the menu Tools → Image statistics



Show statistics about the pixel values in the current image.

When the button **Select area** is checked you can select an area of the image to get the statistics from.

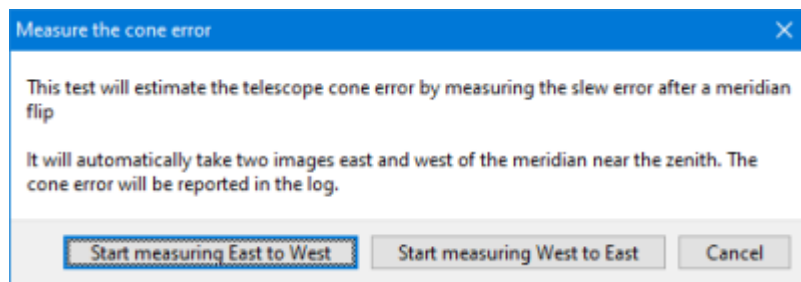
This show the following:

- **Pixel count:** the number of pixel used to compute the statistics.
- **Min:** The minimal value of a pixel.
- **Max:** The maximal value of a pixel.
- **Mode:** The mode of the image, i.e. the most frequent value. This is a good estimate of the sky background.
- **Median** The median value of the image.
- **Mean:** The mean value of all the pixel.
- **Std.Dev:** The standard deviation from the mean value.
- **Mean2:** The sigma clipped mean value.
- **Std.Dev2:** The sigma clipped standard deviation.

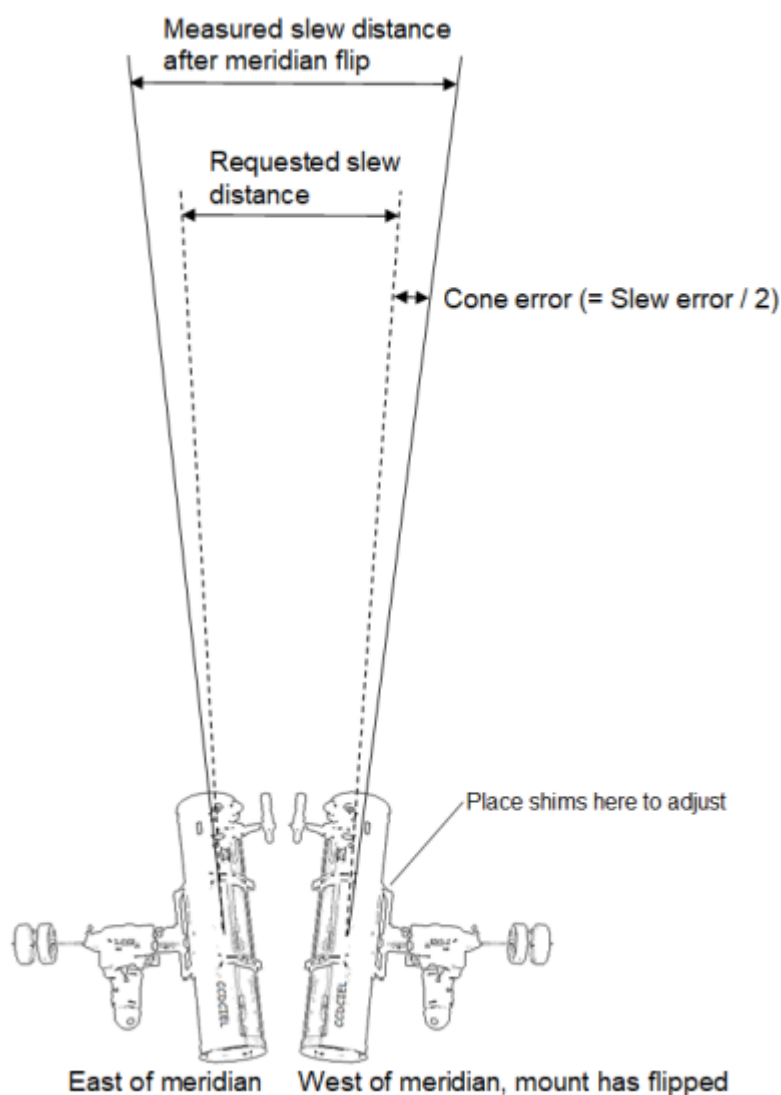
If the image is plate solved the following values are added:

- **Center RA2000:** The J2000 right ascension of the image center.
- **Center Dec2000:** The J2000 declination of the image center.
- **FOV:** The image size width x height in minutes of arc.
- **Image scale:** The image scale in second of arc per pixel.
- **Actual focal length:** The real focal length of the instrument, can be used to update the value in the Preferences.

Measure telescope cone error



The “measure cone error” tool measures the slew error after a meridian flip. This slew error will be twice the cone error.



Cone error is a misalignment of the telescope axis away from or towards the plane of the mount pucker. The front/light inlet of the telescope is either pointing slightly inwards towards the pucker or outwards away from the pucker.

The cone error results in less pointing accuracy of the telescope and continuous drift during guiding. It is typical to have a cone error up to 30 arc minutes but it is better reduce it to a lower value with some shims, sheet-metal ring or a few layers of thick aluminum foil.

With a significant cone error, polar alignment using the drift method will not work.

This tool will only report accurately if mount modelling is switched off or not available.

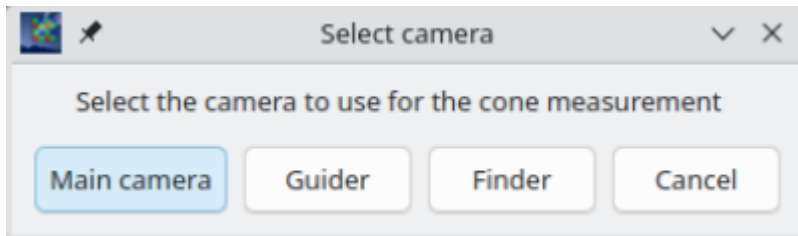
The “measure cone error” slews the telescope to two points high in the sky east and west of the meridian at the same declination position. While crossing the meridian the telescope will flip. At both positions an image is taken and solved. The distance between these two solved positions is compared with the distance between the two mount positions as reported by the mount. The difference is reported as slew error and will be twice the cone error. To assure no other effects are measured it is possible to measure first east then west or the other way around. The reported slew error values should be very equal.

If the reported value is positive then the situation is as above sketch. To correct the positive error the telescope front has to move to the puck. If the reported value is negative then the telescope front has to move away from the puck.

Exposure and binning settings are taken from the preview menu.

The cone error is explained in this [video](#)

When using multiple camera in CCDciel an additional prompt ask the camera to use for the measurement.



This allow to first correct the cone error on the main instrument, then to repeat the measurement with another camera to adjust the guider or finder so they point at the same location relative to the main instrument on both side of the meridian.

Polar alignment without pole visibility

This tool is designed to be as quick and easy to use as possible to help to refine the mount polar alignment. It can be run on any part of the sky and not require pole visibility.

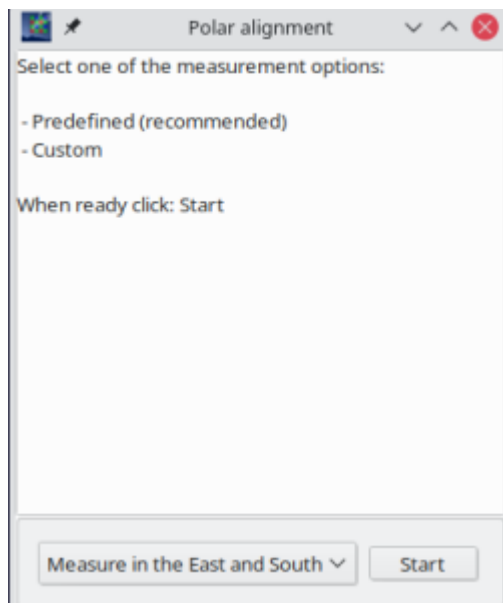
Before starting this tool the mount must be pole aligned as good as possible. The camera must be connected and the mount initialized to allow to slew and report it's coordinates.

It is very important the [observatory location](#) is set in the preferences and the computer time is set with a reasonable precision.

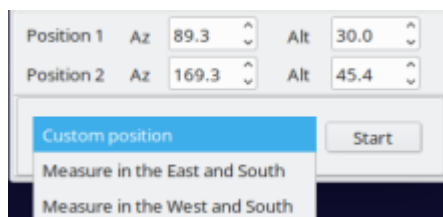
The camera uses the [Slew setting](#) exposure, binning and filter. Be sure this setting give a fast enough image refresh.

If slewing is configured to use a finder camera, this finder is also used for the polar alignment.

To start the procedure select the menu **Tools → Polar alignment, without pole visibility**

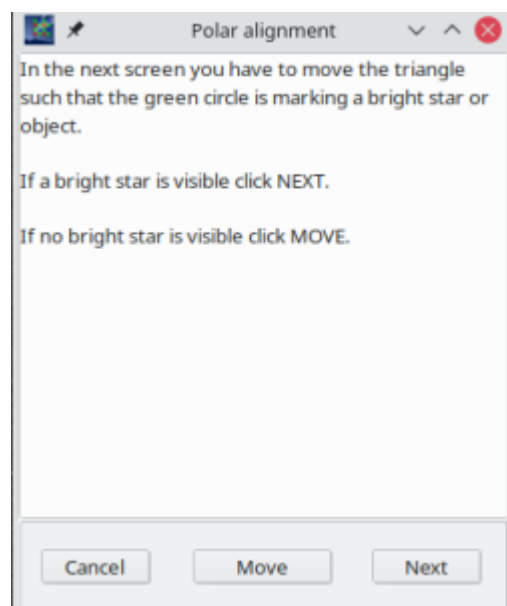


Select where you want to run the measurement. It is recommended to use one of the predefined option, but if all point to obstructed part of the sky you can define the azimuth and altitude of the two measurement points.



When ready click the **Start** button.

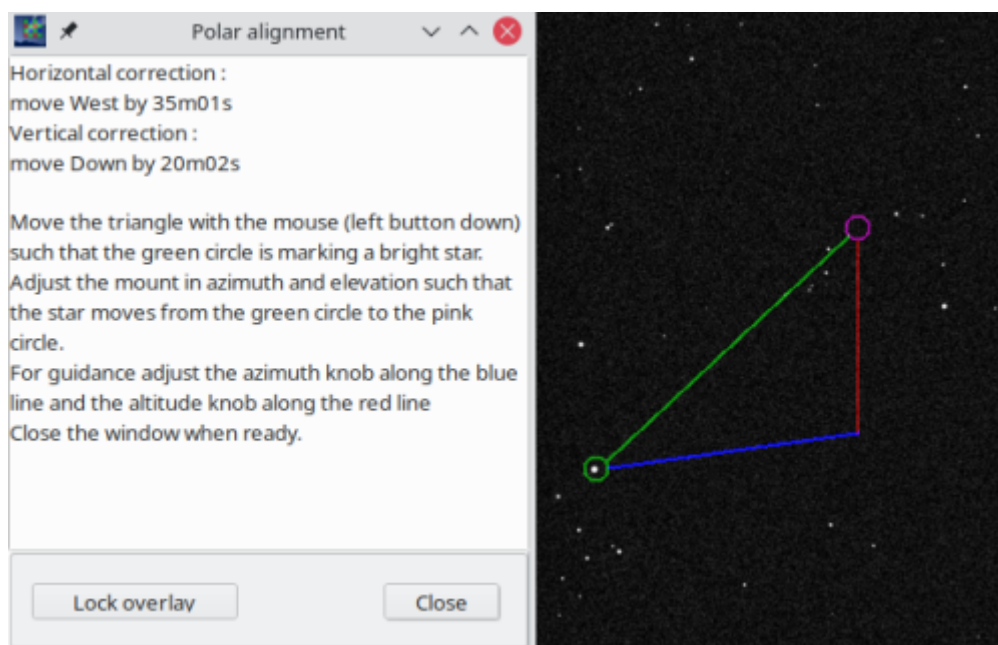
The telescope will move to the two points, take a preview image and plate solve.



After it complete, you have the choice to directly go to the adjustment screen with the **Next** button or to move the telescope a bit to show a bright star or an area that is more easy than the current field.

If you click **Move** the program start an image loop and you can move the telescope with the handpad until it show a bright star. When this is done click **Continue**.

Then it show the correction to do on the mount in both the horizontal and vertical axis.



The direction are to be interpreted this way:

- move East : is moving the mount horizontal knob so the top of the polar axis move to the east.
- move West : is moving the mount horizontal knob so the top of the polar axis move to the west.
- move Down : is moving the mount vertical knob so the top of the polar axis move down.
- move Up : is moving the mount vertical knob so the top of the polar axis tube move up.

Adjust the [luminosity slider](#) so the sky background is dark enough to clearly see the guide lines.

Move the green circle at an extremity of the line to a star you can easily recognize later, for example a star that is part of a small figure, or the brightest star on the image.

You can zoom on the image with the mouse wheel to help to center the star. Press the Ctrl key if you need to move the image instead of the overlay.

It is also possible to double click to select the star nearest to the mouse cursor.

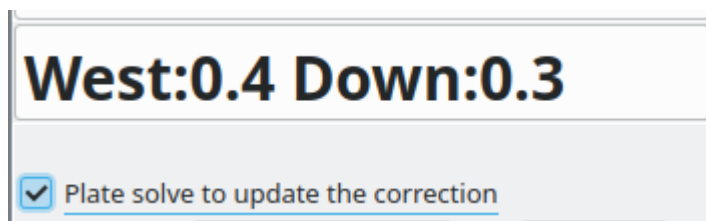
When the overlay is in place, click the button **Lock overlay**, this way you can zoom and move the image without the risk to move the overlay.

Now the goal is to move the star to the pink circle at the other extremity of the line by using only the mount polar axis adjustment knob. To help with this movement the azimuth movement is represented by the blue line and the altitude movement by the red line.

During all this procedure you can change the exposure time of the preview but do not change the geometry of the image, no change of binning or ROI!

After the star reach the pink circle you can close this screen, the alignment procedure is complete.

When using a plate solving application that is fast enough, for example [ASTAP](#), you can check the box **Plate solve to update the correction**



This continuously update the correction value in arc minutes for both direction.

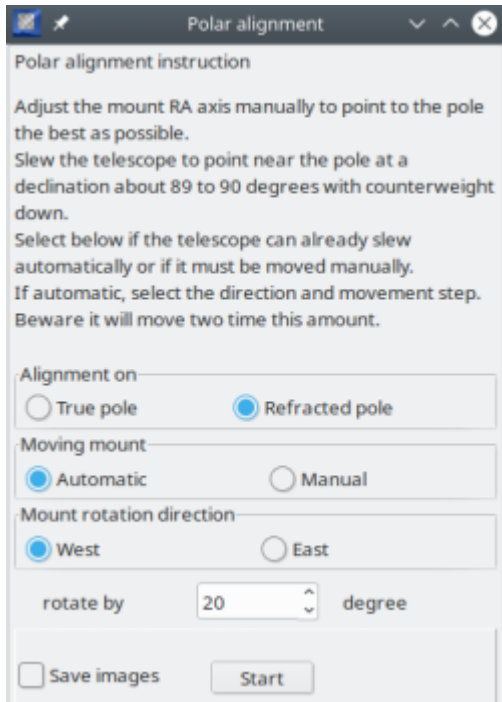
Polar alignment near the pole

This tool is designed to help to refine the mount polar alignment. It require the telescope ra axis to be pointed within 2 degrees of the celestial pole, if this is not possible use the method [without pole visibility](#).

Before starting this tool the mount must be pole aligned as good as possible. For the northern hemisphere you could start by aiming at the star Polaris which is about 40 arcmin from the true celestial pole.

The camera uses the [Slew setting](#) exposure, binning and filter. Be sure this setting give a fast enough image refresh. If slewing is configured to use a finder camera, this finder is also used for the polar alignment.

To start the procedure select the menu **Tools → Polar alignment, near the pole**



Polar alignment

Polar alignment instruction

Adjust the mount RA axis manually to point to the pole the best as possible.

Slew the telescope to point near the pole at a declination about 89 to 90 degrees with counterweight down.

Select below if the telescope can already slew automatically or if it must be moved manually. If automatic, select the direction and movement step. Beware it will move two time this amount.

Alignment on

☐ True pole ☒ Refracted pole

Moving mount

☒ Automatic ☐ Manual

Mount rotation direction

☒ West ☐ East

rotate by degree

☐ Save images

In the first window, select if you want to align on the true or refracted pole. The default is the refracted pole if the observatory latitude is higher than 30°. The true pole give better result in the tropical zone.

If the mount can slew select “Automatic”. This generally requires an initialized handpad and a star alignment. The mount will later automatic slew to a position 2 degrees from the celestial pole,

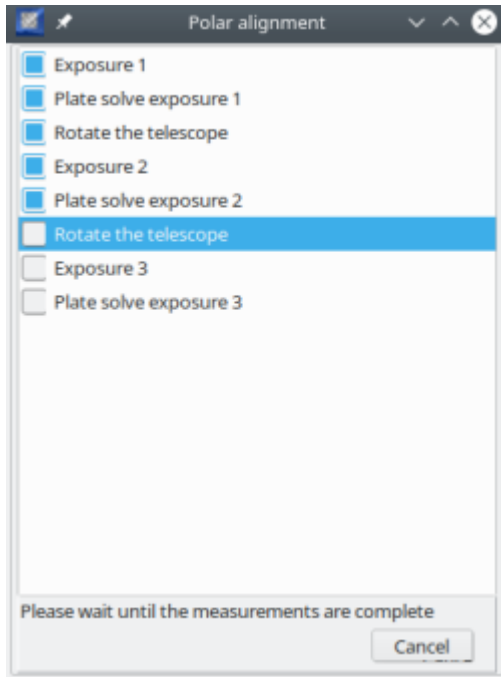
if you prefer to move manually or if the mount is not connected to the program then select “Manual”. Point the telescope manually to a declination of about 88 degrees, so 2 degrees (or more for large errors) from the pole.

Select if the mount will move West or East direction, and the movement between two measurement. The mount will move two time this amount, so be sure there is no obstacle in the path.

If the mount cannot slew automatically, because it is a non-goto mount or the handpad is not initialized yet, you can select to move the mount manually.

When ready click the **Start** button.

The next screen shows the progress of the measurement, take exposure, plate solve, move to next position.



If you select the automatic telescope move you have nothing to do until this step is complete.

In the case of manual move, it will stop at each "Rotate the telescope" step.

Move the telescope only along the RA axis by about 15° to 45°

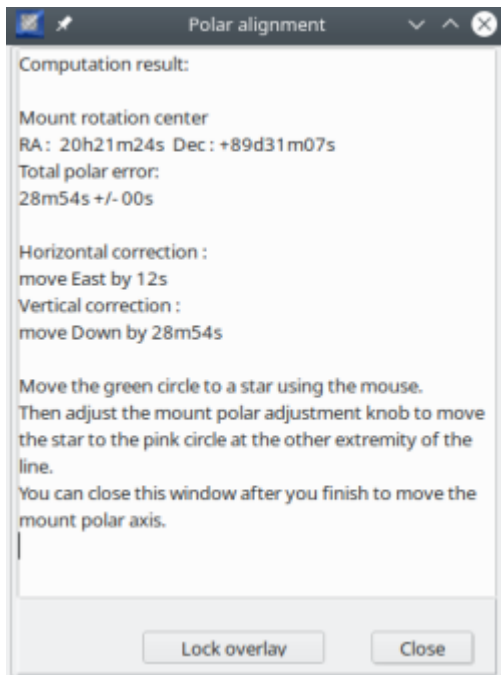
It is very important to not change the declination and to do the two rotation in the same direction.

But it is not important if the amount of rotation is not the same for the two rotations.

You can move the telescope using the handpad or manually by losing the RA axis knob. When the telescope is stable in the new position you can click the **Continue** button.

After all the steps are complete it change to the final screen. Do not close this window until you complete the mount adjustment.

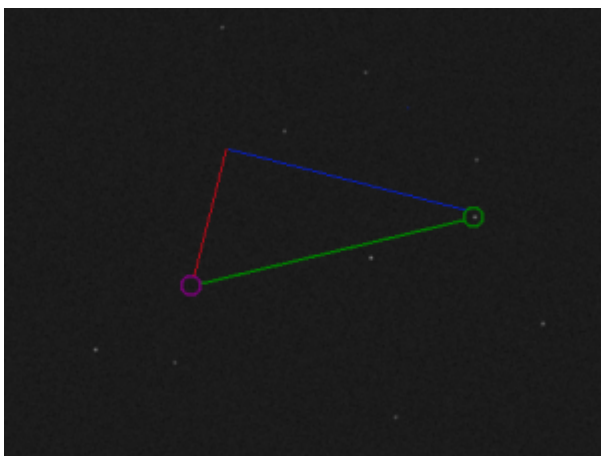
This show the result of the computation with the current mount axis direction and the total polar alignment error. Be careful at the value after the +/- sign, if it is not zero this indicate an inconsistency in the measurement.



Then it show the correction to do on the mount in both the horizontal and vertical axis.
The direction are to be interpreted this way:

- move East : is moving the mount horizontal knob so the front of the telescope tube move to the east.
- move West : is moving the mount horizontal knob so the front of the telescope tube move to the west.
- move Down : is moving the mount vertical knob so the front of the telescope tube move down.
- move Up : is moving the mount vertical knob so the front of the telescope tube move up.

At the same time the camera start a loop of exposure and an overlay is show on the image.



Adjust the [luminosity slider](#) so the sky background is dark enough to clearly see the guide lines.
Move the green circle at an extremity of the line to a star you can easily recognize later, for example a star that is part of a small figure, or the brightest star on the image.
You can zoom on the image with the mouse wheel to help to center the star. Press the Ctrl key if you need to move the image instead of the overlay.
It is also possible to double click to select the star nearest to the mouse cursor.
When the overlay is in place, click the button **Lock overlay**, this way you can zoom and move the image

without the risk to move the overlay.

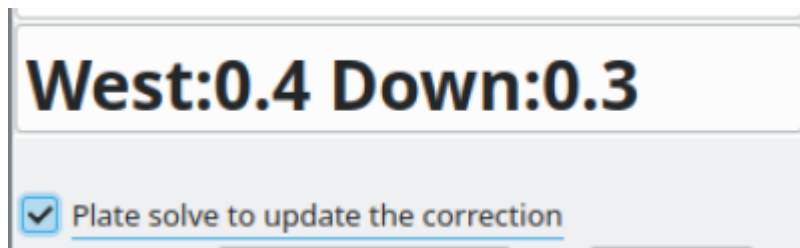
Now the goal is to move the star to the pink circle at the other extremity of the line by using only the mount polar axis adjustment knob. To help with this movement the azimuth movement is represented by the blue line and the altitude movement by the red line.

During all this procedure you can change the exposure time of the preview but do not change the geometry of the image, no change of binning or ROI!

After the star reach the pink circle you can close this screen, the alignment procedure is complete.

In the case the alignment error is bigger than the camera sensor size you cannot show the pink circle on the image. In this case move the star to the point the green line exit the image field. Then redo the full procedure until the polar error is small enough to show the two circle.

When using a plate solving application that is fast enough, for example [ASTAP](#), you can check the box **Plate solve to update the correction**



This continuously update the correction value in arc minutes for both direction.

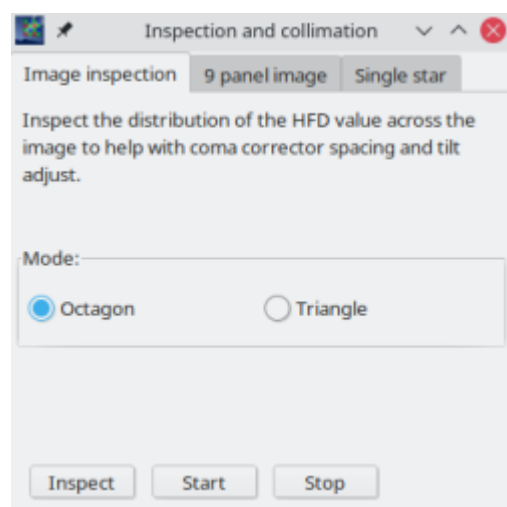
Inspection and collimation

This tool can help to inspect the image and get a good collimation for the telescope optic. It include the image HFD inspection and two collimation method, centering the ring of a defocused star, or examining the deformation in the corner of the image using a 9 panel display.

Before any attempt with this procedure you must carefully read the telescope documentation, Beware that doing it wrong can make the secondary mirror to fall on the primary.

Image inspection

This panel allow to measure the median HFD value, sensor tilt and curvature.



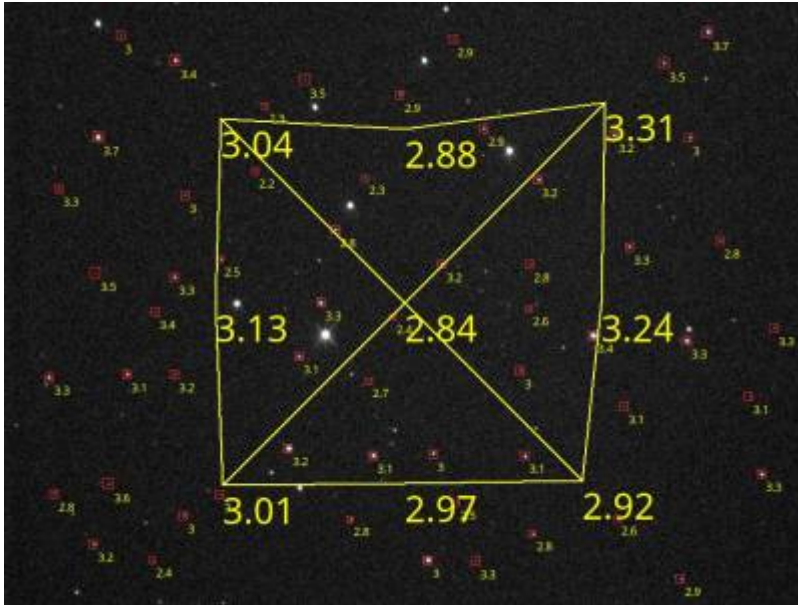
Select the method to display the result:

- **Octagon** based on HFD values at the center and eight peripheral area.
- **Triangle** with adjustable orientation to match the tilt corrector screw.

Click **Inspect** to analyze the current image.

Click **Start** to start a [preview](#) loop and analyze each image.

The routine will detect and annotate the stars with their HFD value and plot a tilt and Off-axis aberration (curvature) indicator in the image.



In the log the following will be reported:

Image **median hfd** which is an excellent indicator of the quality of focusing. The lower the value the better the focusing, the sharper the stars are. The value is also depending on the astronomical seeing and the quality of the optics.

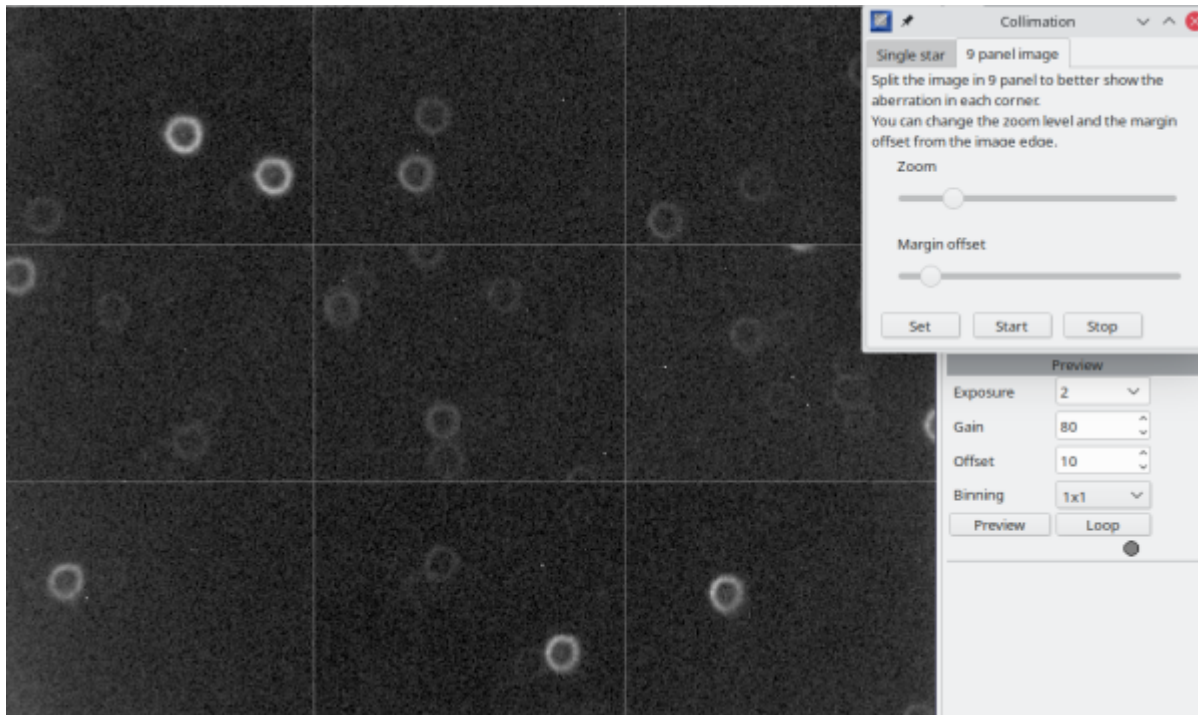
Sensor tilt as the HFD difference between the best and worst corner median values. In addition as a graphical indication it draws a trapezium in the image based on the four median values.

There can be some variation in images of the same series, so a tilt of a few tenths looks normal but anything more indicates a camera mounting problem.

Off-axis aberration as the HFD difference between the center and the corners of the image. This is an help to adjust the optimal distance between the field flattener and the camera. But be careful to first remove tilt and get a precise focus at the image center, otherwise this value is meaningless.

9 panel image

This panel allow to display a zoomed image of the corner and center of the image to help to detect the aberration. This can be used to adjust a comma corrector, a tilt adapter, or to collimate a RC telescope.



Load an existing image for analysis and click the **Set** button or click the **Start** button to loop from the camera. Adjust the **Zoom** and **Margin offset** to clearly see the aberration with enough stars in each box. After every change click the **Set** button to apply. Return to the normal display using the button **Stop** or by closing this window.

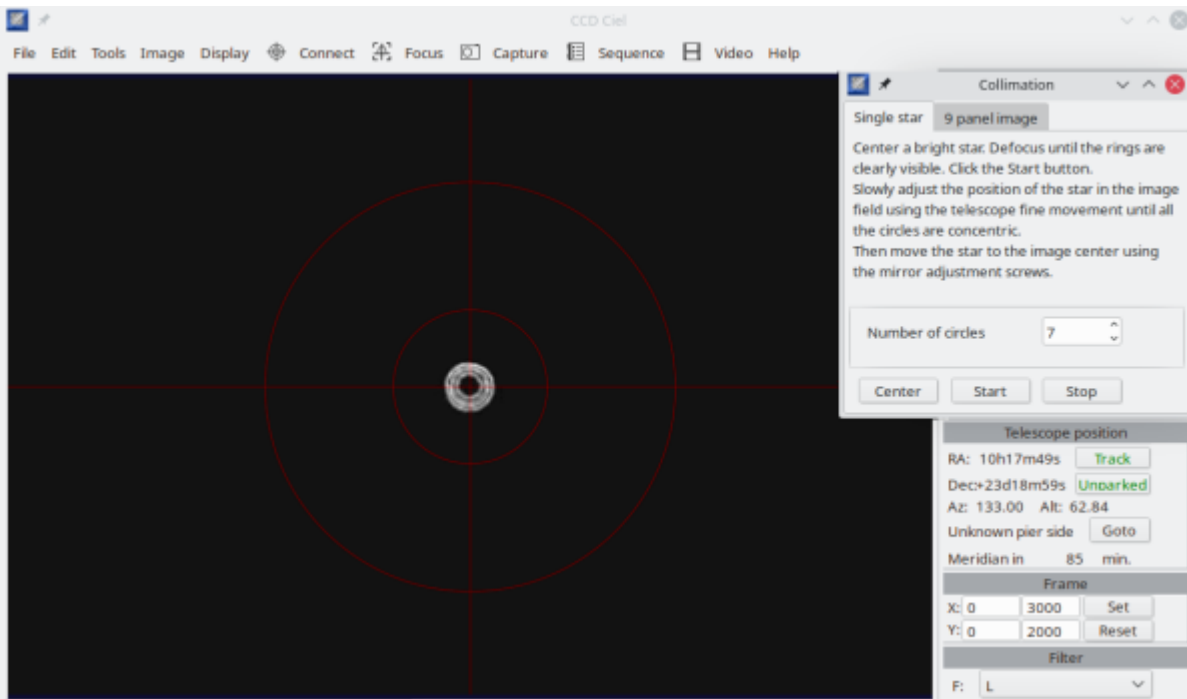
Single star

This method is to adjust the final collimation of a Newtonian or SCT.

To start, point the telescope to a bright star, then select the menu **Tools → Collimation**.

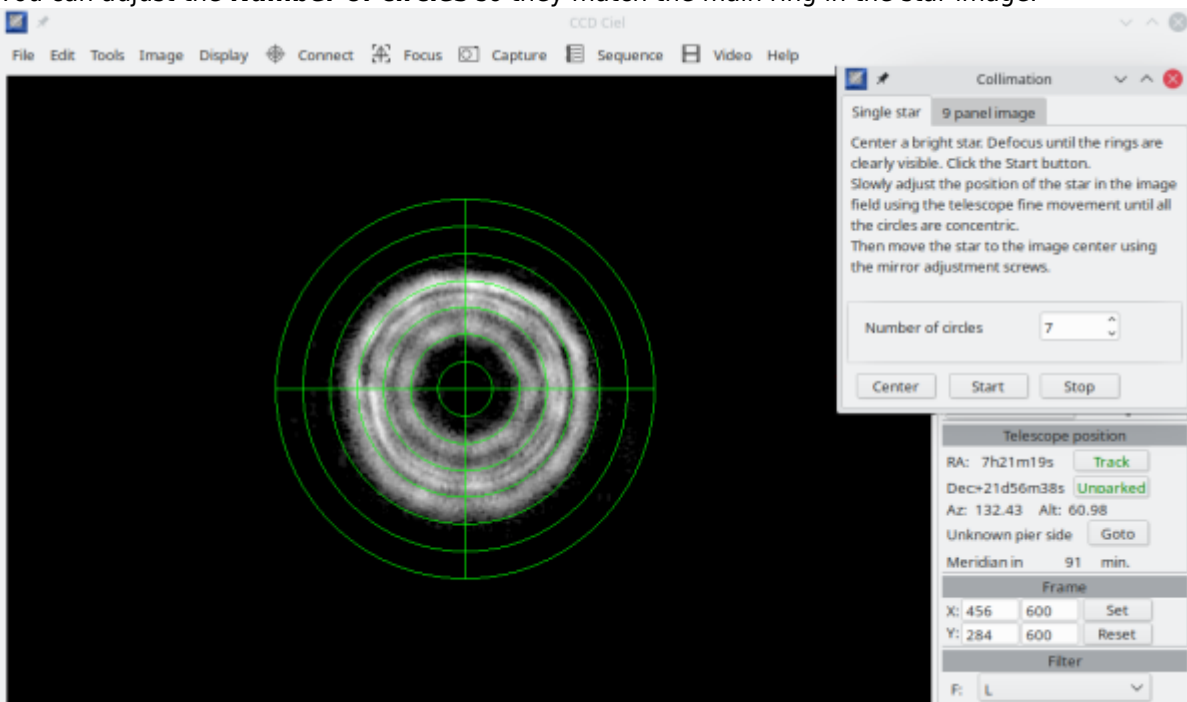
Click the **Center** button.

This start a preview exposure loop. Center the star in the bull eye, defocus enough to see the concentric ring in the image, adjust the exposure time so the image is not overexposed but high enough to mitigate the seeing fluctuation.



When ready click the **Start** button.

This crop the image to the size defined for the [focus window](#) and draw concentric circle centered on the star. You can adjust the **Number of circles** so they match the main ring in the star image.



Slowly adjust the position of the star in the image field using the telescope fine movement (guide speed) until all the circle are concentric. The program try to automatically follow the star by modifying the camera ROI but this cannot work if you abruptly move the star out. When this is done the star is in the telescope optical axis.

Now click the **Center** button and move the star to the image center using only the telescope collimation screw (main mirror for Newtonian, secondary for SCT). This way you make the optical axis to match the center of the image.

If the initial offset is larger than the camera FOV, place the star in the border of the image where the ring are the most concentric, process as above, then retry to finish the collimation.

If no circle are draw after you click the Start button this is probably because the focus window is to small for the size of the defocused star. In this case refocus a bit to make the star circle smaller or increase the size of the [focus window](#).

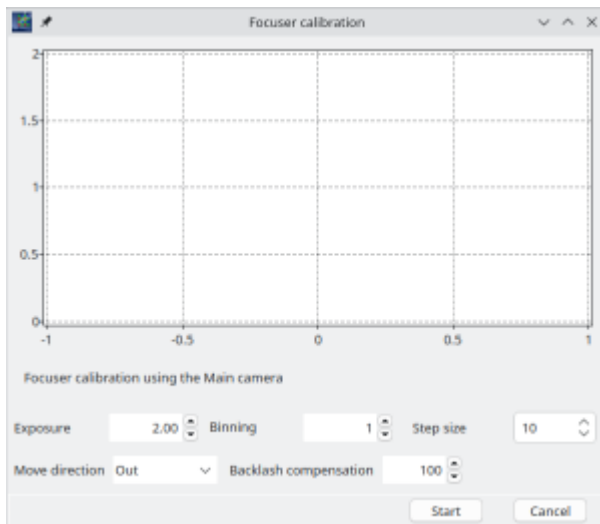
Focuser calibration

This function help you to set the [auto-focus parameters](#) specific to your focuser, telescope and camera because it is not immediately evident what to set for all this numbers.

The principle is you start by centering and manually focusing a star field that is used by the procedure to find how the stars diameter change with the position of the focuser.

At the end it propose new auto-focus parameters you can save to the configuration.

To start the procedure select the menu **Tools → Focuser calibration**

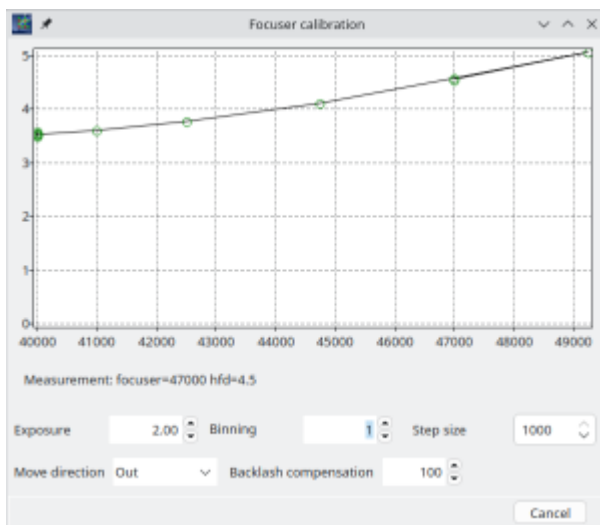


In the first screen, set the **exposure** parameters and the preferred **move direction**, this will also be used later when autofocusing.

Change the value for **Step size**. When the focuser position change by this value there must be a small change in the star diameter in the image. But be sure to not set it too large, it can be increased automatically later in the procedure.

If you already know a value for the focuser **backlash** you can set it now.

When ready click the Start button.

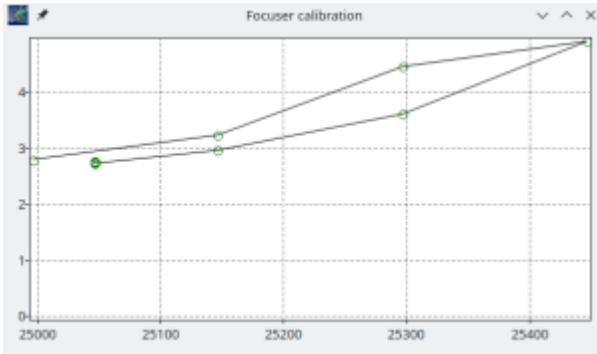


It start by estimating the influence of the seeing condition to the star diameter.

Then it start moving the focuser, this can result in increasing or decreasing star diameter.

Anyway it will continue in the same direction until the diameter is increased by a significant amount.

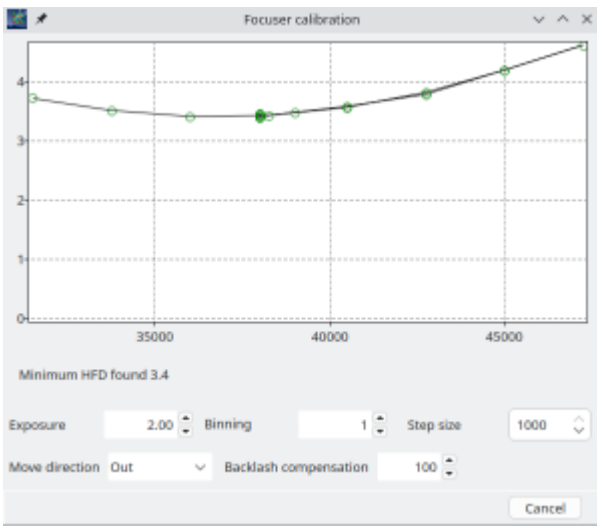
Then it reverse the direction to search for the minimal diameter.



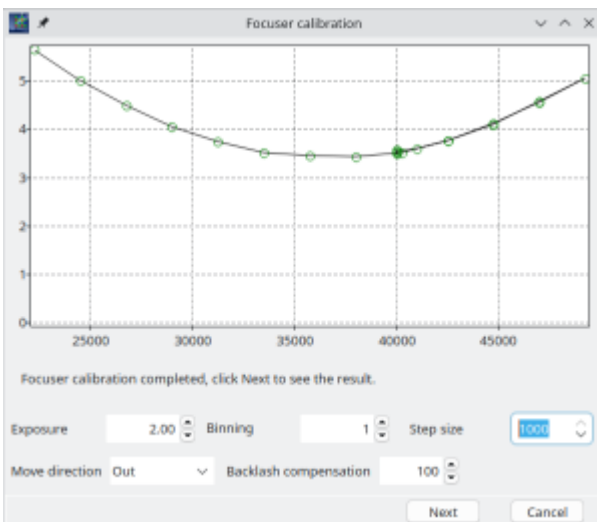
During this move back the two curve must ideally be superimposed. If not this is an indication you must change the Backlash setting.

In this case you can click the **Cancel** button now, modify the **backlash** value and restart.

Increase the backlash value by a bit more than the horizontal distance between the two lines at a given HFD.

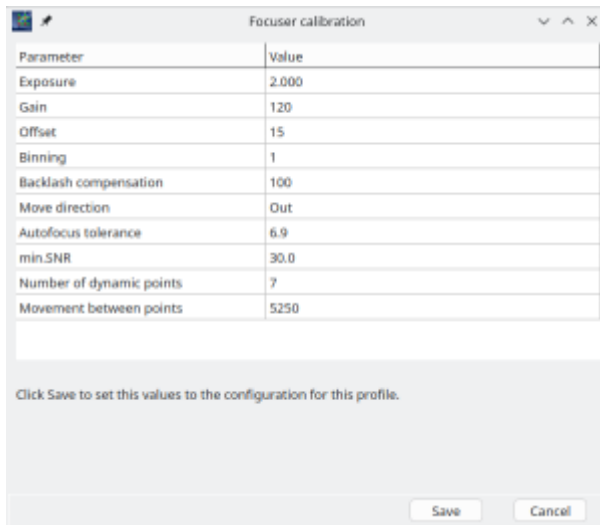


The measurement continue after it found the minimum HFD position.



It stop after there is enough measurement, the focuser is moved to the minimum HFD position. After reviewing

the curve click the **Next** button to show the result.



Parameter	Value
Exposure	2.000
Gain	120
Offset	15
Binning	1
Backlash compensation	100
Move direction	Out
Autofocus tolerance	6.9
min.SNR	30.0
Number of dynamic points	7
Movement between points	5250

Click Save to set this values to the configuration for this profile.

Save Cancel

Review the parameters and click **Save** to record them in the configuration and exit the calibration tool.

Later you can view or change this values in the [auto-focus parameters](#).

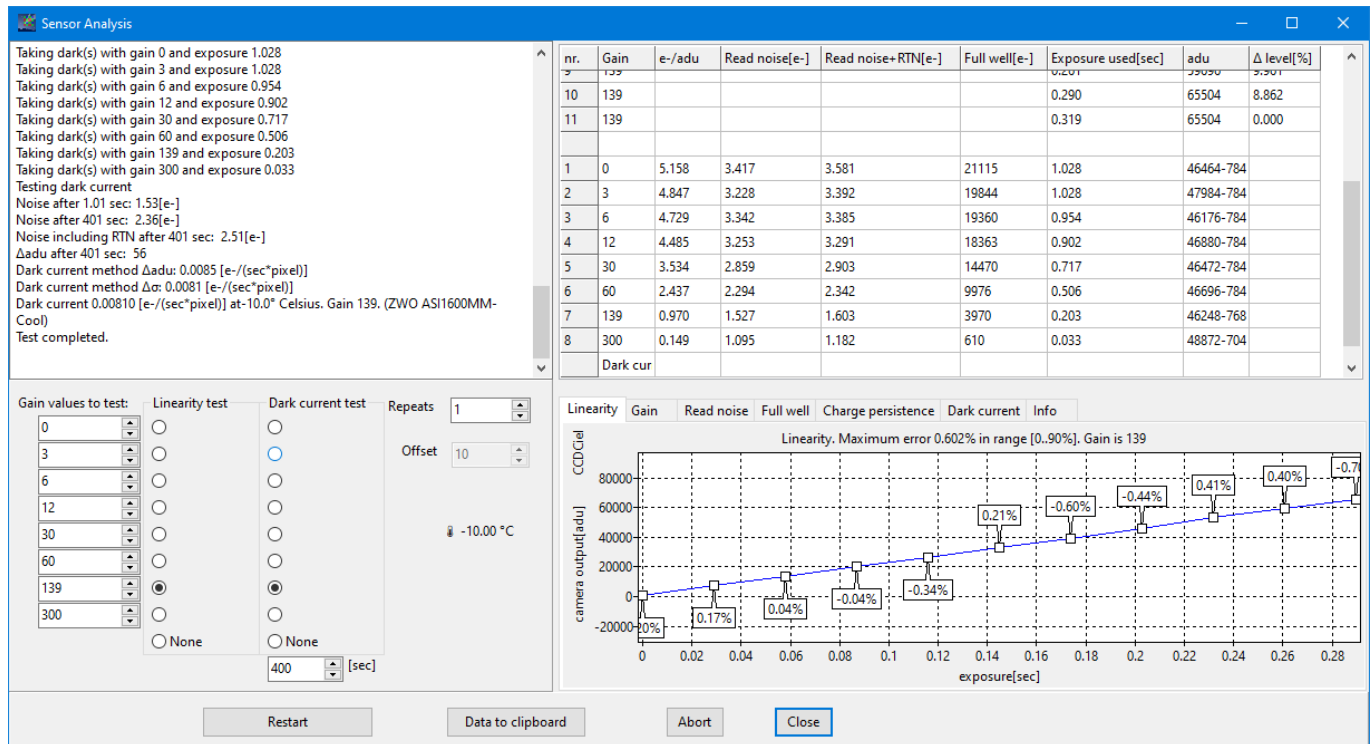
It is good to test this new parameters immediately by using the **Autofocus** button in the [Focus](#) tab.

Sensor analysis

This is a special tool to analyse automatically your camera read noise, sensor gain, well capacity and linearity. You will just need a flat panel or substitute in front of your telescope and a cap to cover your telescope to make darks. Analysing will go fully automatic. Halfway the process the tool will ask you to remove the flat panel and cap the telescope for darks.

It is important that CCDCiel has access to your camera gain setting in menu Edit, Preferences, tab Camera and check mark option "Manage gain and Offset if available". After using the tool you can uncheck it.

The recorded data values can be copied to a spreadsheet/word-processor.



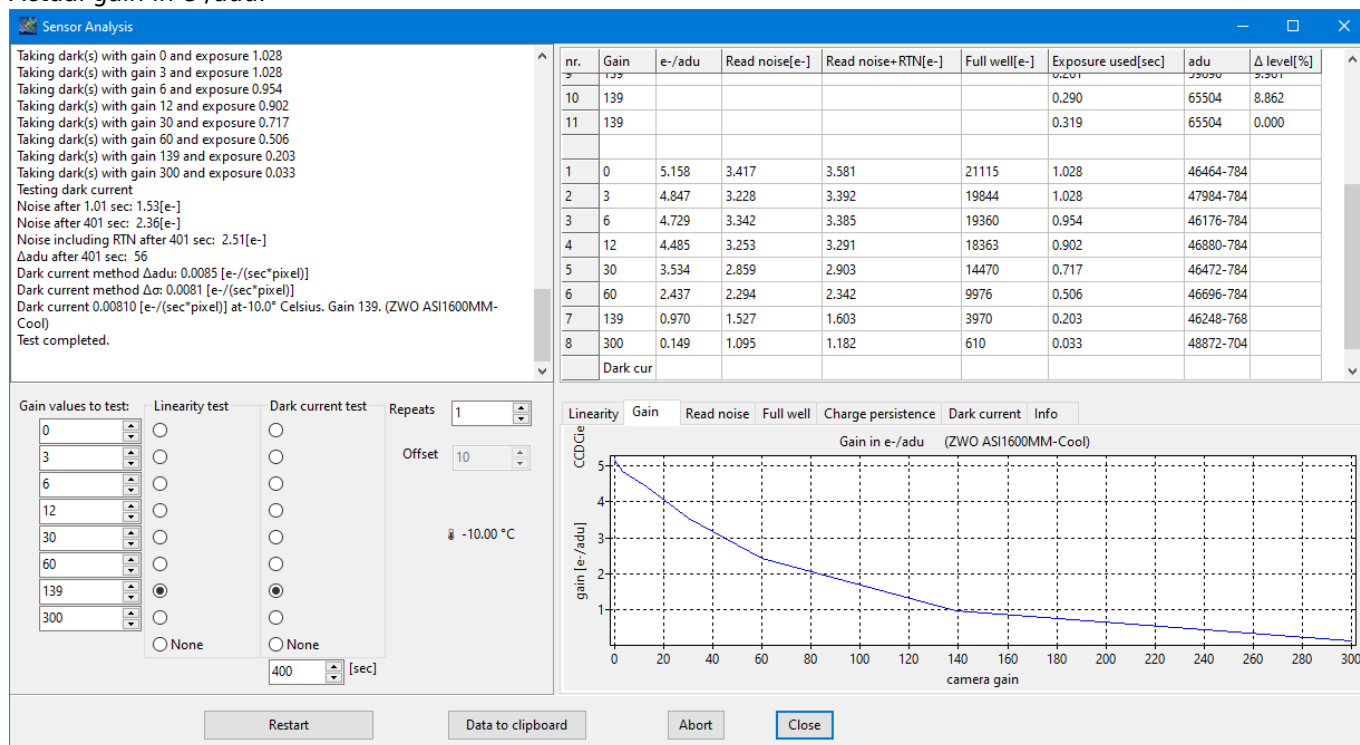
In the main windows you can set the gains to test. If the camera allow to set the offset it is very important you set a value as low as possible that not result in any truncation for the range of gains to test.

The linearity test is optional and can be set for one gain (in screenshot at camera gain 120) .

The dark current test is also optional and can be set for one gain (in screenshot at camera gain 120). To increase the accuracy your could choose to repeat the number of tests from one to three.

At the bottom of the menu there is a setting (400 sec) for the duration of the dark current test. For older cameras you can set it lower at 100 or 200 seconds. For modern cameras with a very low dark current it could be required to increase it to 1000 seconds. The dark current test will abort if the difference recorded is two or less adu.

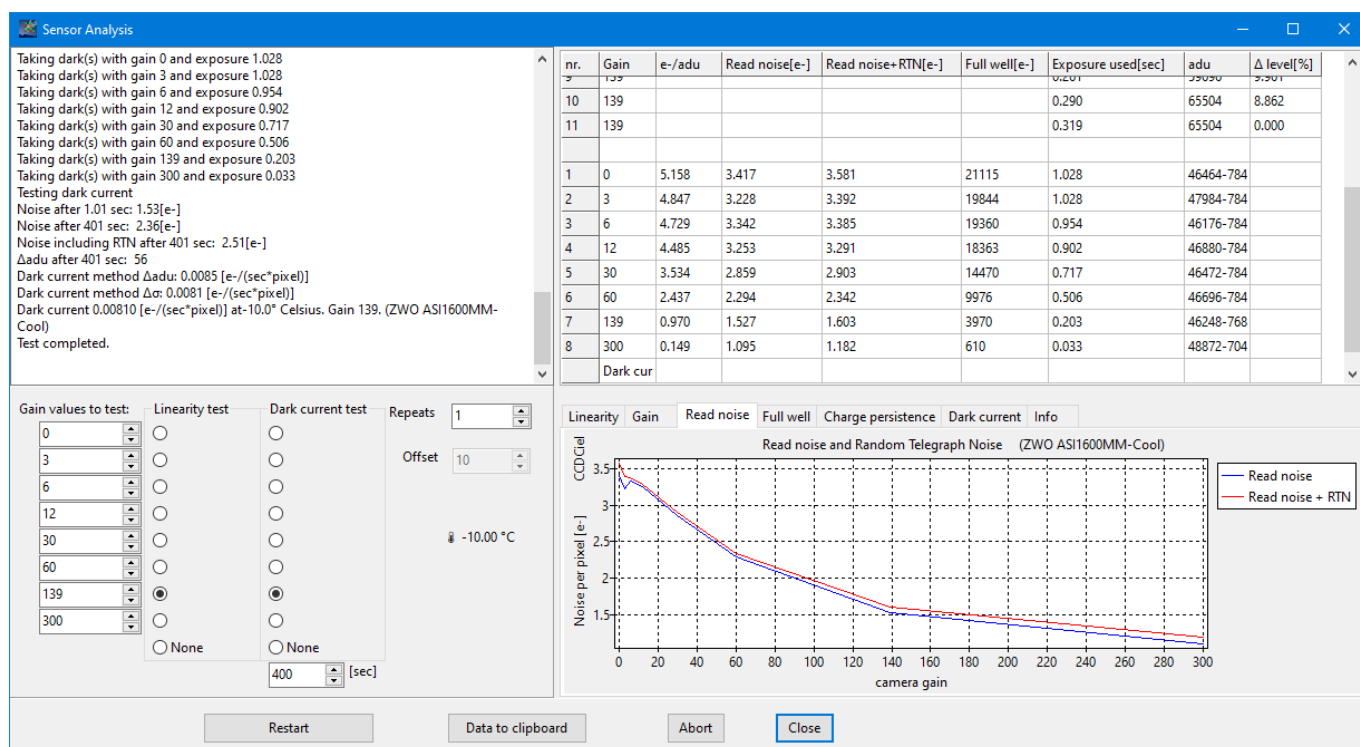
Actual gain in e-/adu:



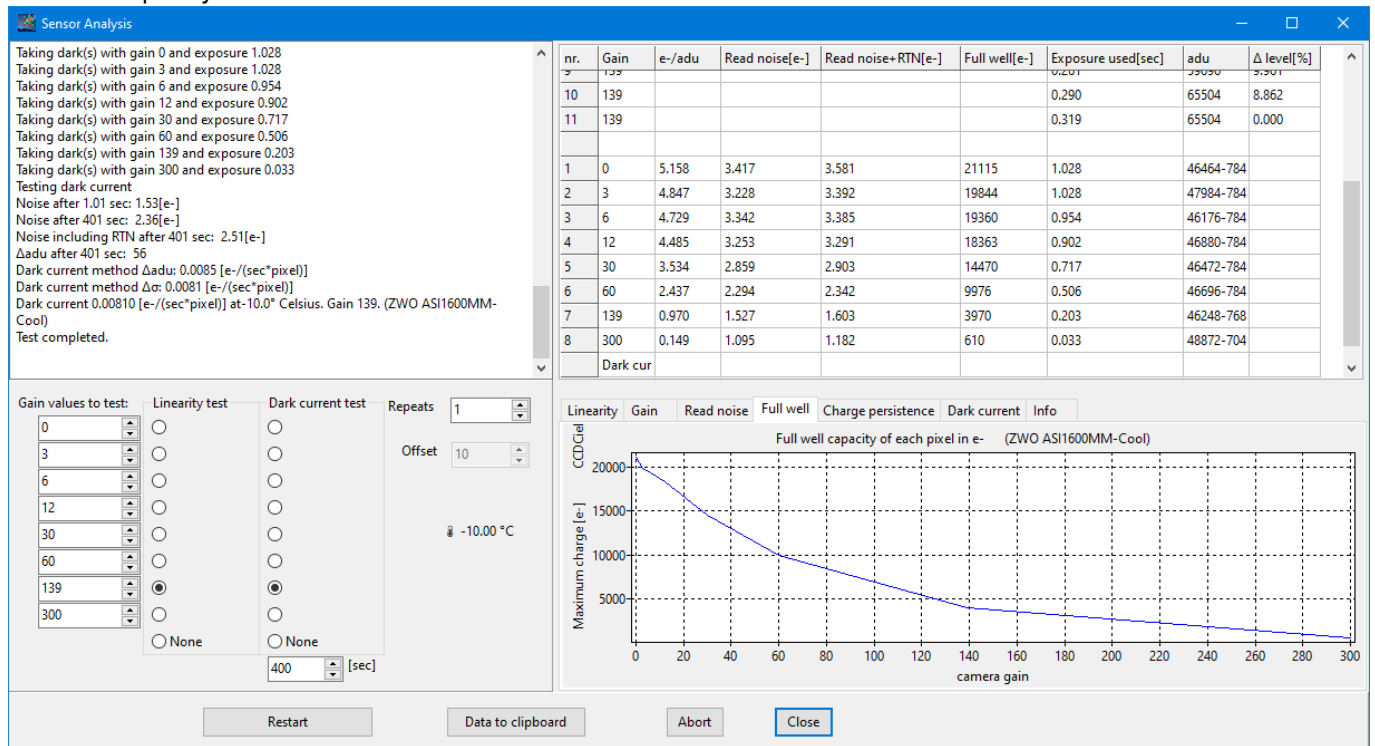
Read noise for each gain. One line is for the pure read noise. The second line is for the combination of read noise and random telegraph noise (RTN), also called salt & pepper noise. The read noise is calculated as follows

```
read noise including RTN := stdev(bias1-bias2)/sqrt(2)
```

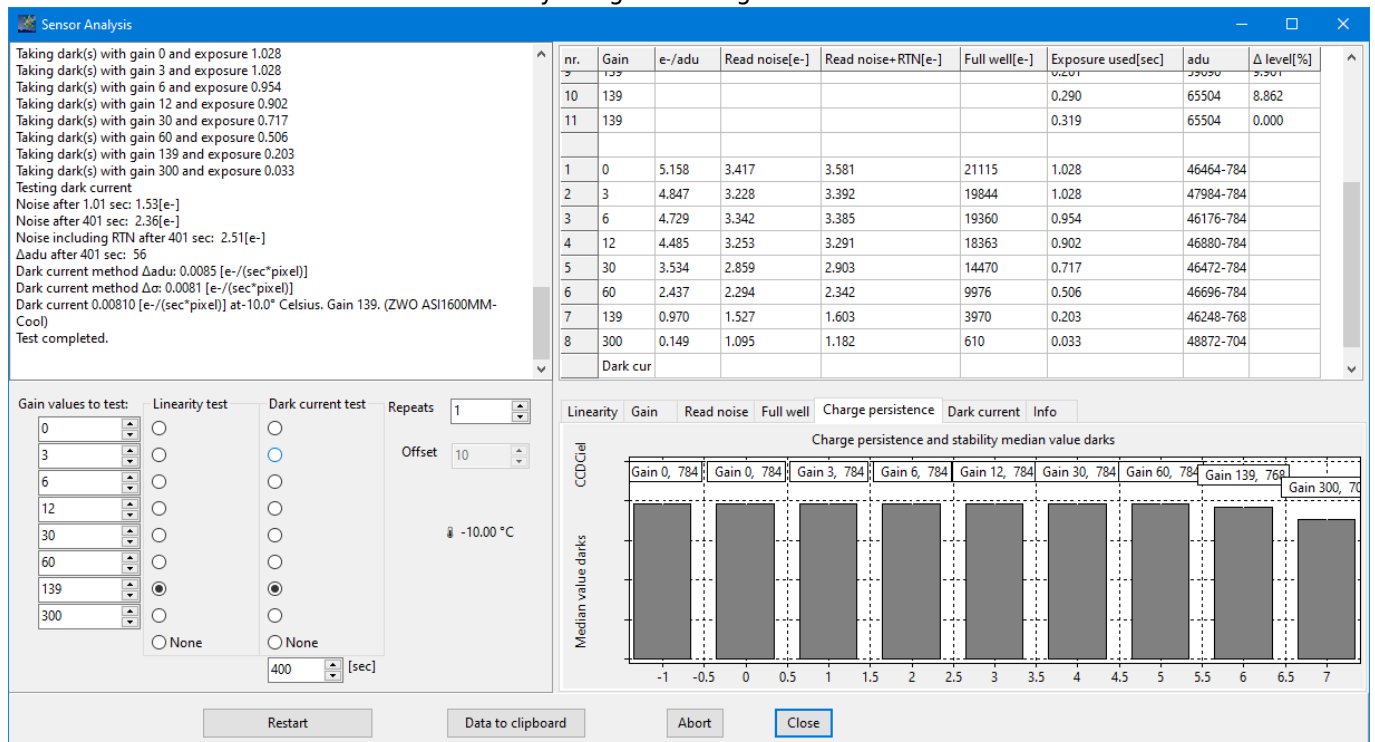
read noise excluding RTN := $\text{stdev2}(\text{bias1}-\text{bias2})/\text{sqrt}(2)$ where stdev2 is using sigma clipping to remove hot pixels.



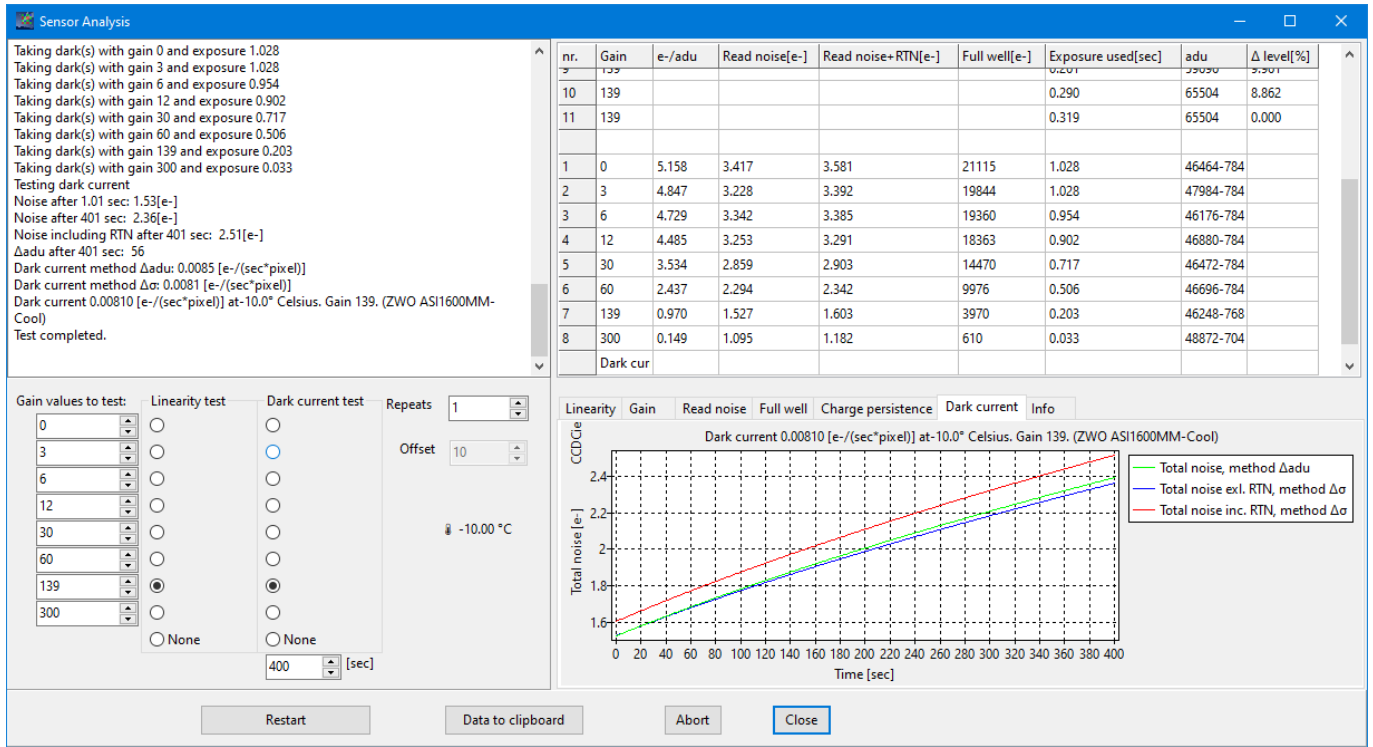
Full well capacity:



Charge persistence (cmos image lag). The bars indicate the median dark pixel values. This dark series is taken directly after the last flat. If the first bar is higher then the second bar (both are for the same camera gain) then there is some minor charge persistent. So there is some charge left from the previous flat image. The height & values of the other bars can be influenced by the gain setting.

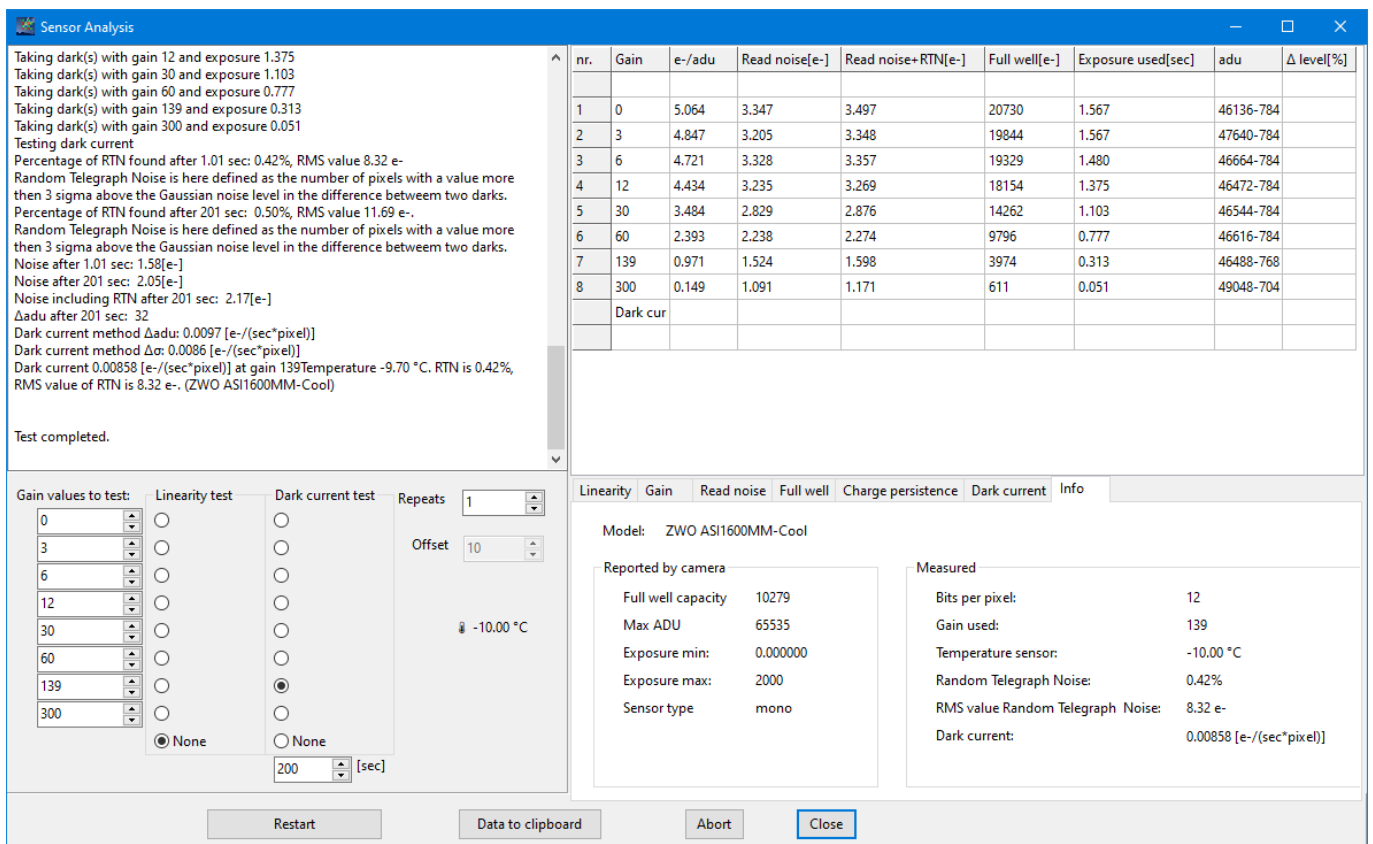


Dark current. The red line indicates the total measurable noise including the random telegraph noise. For some modern cameras it could be required to increase the default dark exposure from 400 up to 1000 seconds. The dark current test will take two dark so the duration will double the exposure time.



Camera info from the camera driver:

Note: The RTN, Telegraph Noise is measured in the difference of two darks. It is defined as all pixels with a value above 3.0 sigma of the the noise. For a clean Gaussian noise only 0.27% of the pixels exceed this value. Any more then 0.27% is defined as RTN. The noise sigma value is determined using a sigma clip routine.



Right click menu

The main menu Image, or a right click on the preview image to show the following menu:

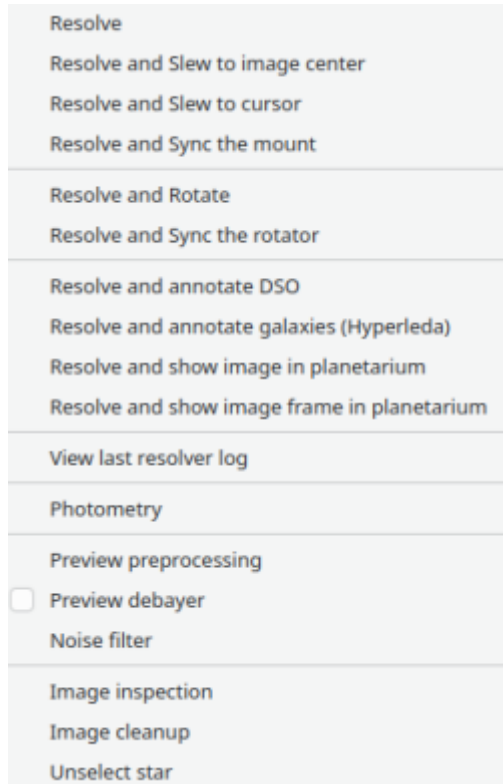


Plate solving functions

The image will be resolved (plate solved) and if successful, the image position, pixel size and orientation will be saved in the FITS file.

Approximate coordinates are read from the FITS header to speedup the process. If this coordinates are not know you are prompted to enter an object name or the coordinates at the center of the image.

A second resolve request for the same image will use the saved solution, for example you can first show the image in the planetarium, and then slew to cursor without running the plate solver again.

Once the image is resolved the astronomical position of the mouse cursor will be displayed at the left bottom status bar in apparent coordinates.

Resolve

Resolve the image using the [astrometry](#) software and load the solved image in the preview.

This force a new resolution even if the image is already solved, contrary to the other selection that reuse the existing solution.

The image show an arrow with the North direction, or a cross at the position of the Pole if in the image field.

You can show the J2000 RA/DEC of the cursor by moving the cursor on the image.

If you save the FITS file now it will include the astrometry solution.

Resolve and Slew to image center

Resolve the image using the [astrometry](#) software and if the resolution is successful move the telescope at the position of the image center.

This useful to center the telescope on an image taken on a previous session.

Resolve and Slew to cursor

Resolve the image using the [astrometry](#) software and if the resolution is successful move the telescope at the cursor position.

Can be useful to refine an object position but be careful of the mount backlash.

Resolve and Sync the mount

Resolve the image using the [astrometry](#) software and if the resolution is successful Sync the telescope at the current position.

If you use Eqmod for your telescope driver, this can be used to set the alignment points.

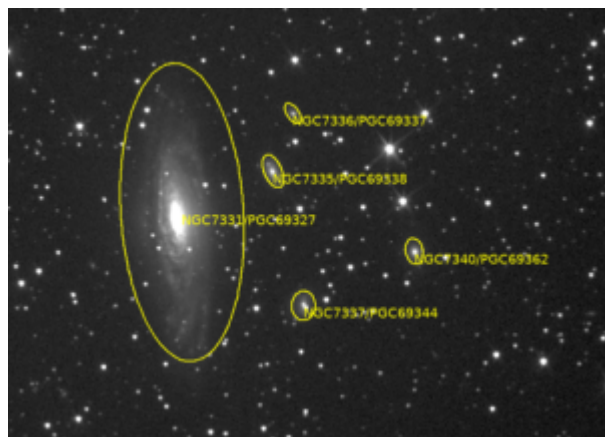
Resolve and Rotate

Resolve the image using the [astrometry](#) software and if the resolution is successful set the [rotator](#) angle to match the image orientation. The rotator must be calibrated before this function can work reliably.

Resolve and Sync the rotator

Resolve the image using the [astrometry](#) software and if the resolution is successful calibrate the [rotator](#) angle to match the celestial position angle.

Resolve and annotate DSO



Resolve the image using the [astrometry](#) software and if the resolution is successful draw the deep sky objects and bright star present in the image.

Resolve and annotate galaxies (Hyperleda)

This is the same as “annotate DSO” but using the [Hyperleda database](#) of more than 2 million galaxies. You need to [install](#) the data separately before you can use this function.

Resolve and show image in planetarium

Resolve the image using the [astrometry](#) software and if the resolution is successful view the image in the [planetarium](#).

Resolve and show image frame in planetarium

Resolve the image using the [astrometry](#) software and if the resolution is successful center the [planetarium](#) at the position and draw a frame of the CCD field.

View last resolver log

You can take a look at the output log of the astrometry resolver to help to solve a problem or to refine the performance.

Photometry

This menu open a new [photometry](#) window with measurement of the star under the cursor. You can let the window open and double click on another star to make a new measurement.

Preview functions

Preview preprocessing

Preprocess the current image with the loaded [dark](#) and [flat](#) frames.

Preview debayer

The default display mode for bayer matrix color images is set in the [preview preference](#). You can switch between the two mode with this menu.

When checked, debayer and display the color image if the current image is a raw color image with bayer matrix.

When unchecked , display the raw image in black/white.

Noise filter

Apply a median filtering to the image. This improve the detection of faint star on CMOS sensor with RTS noise. Use before **Image inspection** if you need to measure more stars.

Image inspection

Show the [image inspection](#) overlay for the current image.

Image cleanup

Remove any marking and redraw the image.

Unselect star

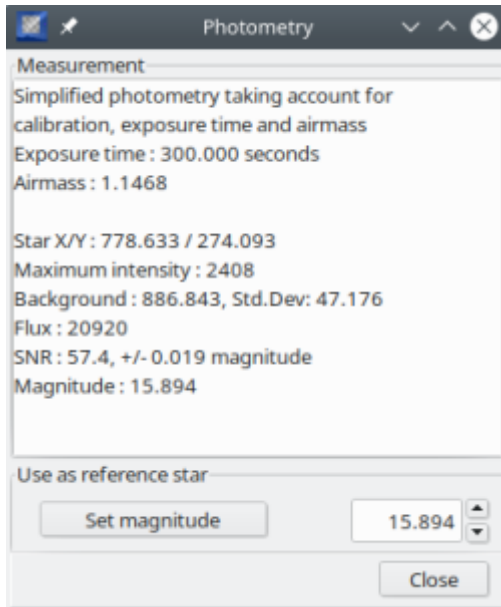
Unselect the marked star show in the [Focus / Star profile](#) tool.

Photometry

You can open the photometry window by a right click on a star and select Photometry in the [popup menu](#).

This tool is intended as a quick way to get a magnitude estimate for a star in an image you just take with your camera.

It must not be used for any precision measurement.



The first time you open this window it need to be calibrated for your setup. Select a star in the image with a know magnitude, type this magnitude in the box at the bottom right, and click the button **Set magnitude**. You need to repeat this operation every time the image is modified, changing gain, using another telescope, camera or filter. Only exposure time change is acceptable.

The magnitude computation take account for change in the exposure time and airmass. Both of this information must be present in the image FITS header, otherwise only the calibration magnitude is used. The first rows at the top of the window show this status.

The measurement include:

- The star X/Y pixel position in the image
- The maximum pixel intensity, in ADU, found in the measurement box
- The sky background level around the star and it's standard deviation
- The total flux of the star, in ADU, background subtracted
- The signal to noise ratio of the measurement and how this affect the magnitude measurement
- The computed star magnitude

File Menu

The **File** menu includes the following options:

- [Open FITS or picture file](#)
 - [Save FITS file](#)
 - [Save picture file](#)
-

- [Bad pixel map](#)
 - [Dark frame](#)
 - [Flat frame](#)
-

- [Save configuration now](#)
- [Quit](#)

Open FITS or picture file

From the menu File → Open FITS or picture file.

You can also open an image file by drag&drop of the file to the CCDciel window.

This let you load a FITS or picture file in the preview window instead of taking the image with the camera.

This is useful if you want to review a previous shot from the capture sequence, or to play with some other image.

The FITS file must contain a 2 or 3 dimensions image in the primary array. The format of the pixel can be 8, 16 or 32 bit integer, 32 or 64 bit floating point. 3 dimensions array are interpreted as a RGB color image.

If the file extension end with '.fz' it is automatically unpacked using [funpack](#)

DSLR raw file can be any format supported by [LibRaw](#) or [dcraw](#).

The picture file format can be one of the following: **png, bmp, jpg, tif, gif, tga**.

This support monochrome picture both 8 or 16 bit per pixel, or color picture 3×8 or 3×16 bit per pixel.

The image is converted in 16 bit FITS format to show in the preview window.

If you want you can then save the picture to a FITS file using the menu [Save FITS file](#).

Note CCDciel is not a multi-purpose FITS file viewer. It is intended to display images from the camera but it could fail displaying FITS files from other programs.

There is also chance CCDciel cannot plate solve a file taken with another software if WCStools cannot find the approximate coordinates and scale of the image.

Save FITS file

From the menu File → Save FITS file.

This let you save to a FITS file the image in the preview window.

If the file extension is '.fits.fz' the file is automatically packed with [fpack](#).

This is not used part of the capture sequence as the files are automatically saved, but this can be useful to save an image taken with the Preview function or loaded with File → Open FITS file.

Be careful this Preview image can be processed for bad pixel if you create a [bad pixel map](#).

Save picture file

From the menu File → Save picture.

This let you save to a picture file the image in the preview window.

The content of the picture depend on the file format you select in the save dialog.

- The PNG and TIFF picture will be saved as 16 bit linear images.
- The BMP and JPG picture are saved in 8 bit, stretched using the current preview settings.

Bad/Hot pixel map

The bad pixel map will prevent the auto-focus or slewing function locking on a hot pixel rather than on a star.

The bad pixel map will be only applied on preview images, focus or slewing images. It is not applied on captured images. Those images are not altered.

Use the menu **File → Bad pixel map → Apply to current image** if you want to apply the bad pixel map to an image you load in the program.

You can identify an image that was BPM processed with a comment at the end of the FITS header.

Information

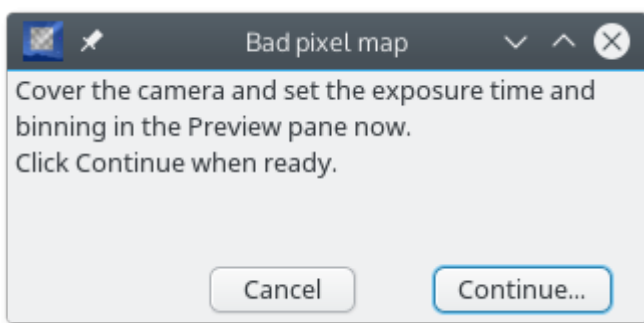
This menu shows information about the current bad pixel map, the number of bad pixels and the size of the image it was taken from.

You have two options to create, using the camera directly or using a processed dark frame. The second option is preferred because the processed dark has less noise and you can use a lower [sigma](#) value to detect fainter deviant pixels.

Create from the camera

Procedure:

1. Camera should be connected and cooling on if available.
2. Set the required binning in [Preview tool](#). Use the same binning as for the focus and slewing.
3. Select an exposure time between 10 and 60 seconds.
4. Cover the camera or telescope similar as taking a dark image. If your camera has a shutter it will remain closed during the exposure.
5. Select menu **File → Bad pixel map → Create from camera**
6. Click Continue. A dark will be taken and number of hot pixels will be reported in the log window.



Create from a dark file

Select menu **File → Bad pixel map → Create from dark file**

Select the dark file from the file dialog.

Clear the bad pixel map

To remove/clear the bad pixel map select the menu **File → Bad pixel map → Clear bad pixel map**

Check the bad pixel map

Take a preview image and check if the bright hot pixels are suppressed.

Or open a saved raw image and use the menu **File → Bad pixel map → Apply to current image**

If you still see some not removed hot pixel you can retry the procedure after setting a lower value for [sigma](#).

Possible errors

Error: If you get an error message: “too many hot pixels”, increase the sigma threshold value in the menu **Edit → Preferences → [preview](#)** options. If successful the program log will report the number of hot pixels suppressed.



A typical threshold value is 5 for CCD and 8 for a modern CMOS sensors. Decrease the threshold value if you want suppress more hot pixels. Normally you should suppress maybe 5 to 30 hot pixels but you can go much higher.

With some camera it is not possible to get a good result here. In this case use a [dark frame](#) instead.

Dark frame

With some camera it is difficult to use a [bad pixel map](#) to cleanup the auto-focus frames. In this case you can define here a dark frame that will be subtracted to remove the hot pixels.

Beware this processing require the dark frame is acquire with the global gain and offset. This also use more resources than the bad pixel map processing. So the bad pixel map must be used in preference if applicable.

This same dark frame is also used with the [image stacking](#) option.

Use the menu **File → Dark frame → Apply to current image** if you want to subtract the dark from the currently displayed image.

You can identify an image that was dark subtracted with a comment at the end of the FITS header.

Information

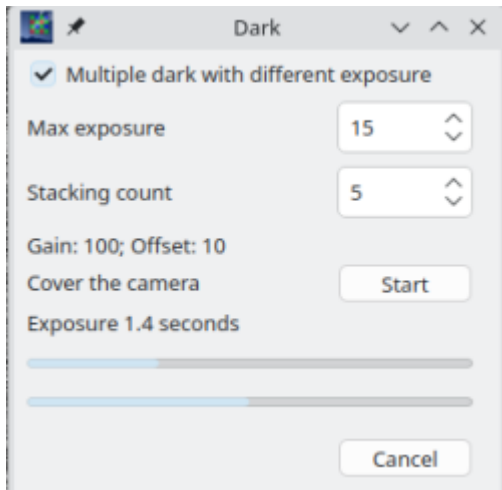
This menu show information about the current dark frame, the exposure time and the size of the image, you can also see the dark file FITS header for more details.

You have two options to define the dark frame, using the camera directly or using a processed dark frame. The second option is preferred because the processed dark as less noise.

Create from the camera

Procedure:

1. Camera should be connected and cooling on if available.
2. Set the required binning in [Preview tool](#). Use the same settings as for the focus and slewing
3. Cover the camera or telescope. If your camera has a shutter it will remain closed during the exposure.
4. Select menu **File → Dark frame → Create from camera**



5. Select if you want a single or multiple exposure. A dark will be taken and saved for future use.

Load a dark file

Select menu **File → Dark frame → Load dark file**

Select the dark file from the file dialog.

The file must be taken with the same binning, exposure time, temperature than used for auto-focus. This file must use a pixel format of 16bit.

Clear Dark frame

To remove/clear the dark frame select the menu **File → Dark frame → Clear Dark frame**

Check the dark frame

Take a preview image, select the menu **File → Dark frame → Apply to current image**
Verify the hot pixels are removed and the processing do not create unwanted artifact.

Flat frame

When using the [image stacking](#) option it can be useful to process the individual frames with a flat before stacking.

This is specially interesting when using star alignment because this preclude the use of a flat later in the processing.

Use the menu **File → Flat frame → Apply to current image** if you want to divide the currently displayed image with the flat.

You can identify an image that was divided by a flat with a comment at the end of the FITS header.

Information

This menu show information about the current flat frame, the size of the image and the mean level, you can also see the flat file FITS header for more details.

You have two options to define the flat frame, using the camera directly or using a processed flat frame. The second option is preferred because the processed flat as less noise.

Create from the camera

Procedure:

1. Camera should be connected and cooling on if available.
2. Set the required binning in [Preview tool](#). Use the same binning used for stacking.
3. Select the same exposure time to get a mean level about 2/3 of the camera range.
4. Use your flat panel or other way to take flat.
5. Select menu **File → Flat frame → Create from camera**
6. Click Continue. A flat will be taken and saved for future use.

Load a flat file

Select menu **File → Flat frame → Load flat file**

Select the flat file from the file dialog.

The file must be taken with the same binning than used for stacking. This file must use a pixel format of 16bit.

Clear flat frame

To remove/clear the flat frame select the menu **File → Flat frame → Clear Flat frame**

Check the flat frame

Take a preview image, select the menu **File → Flat frame → Apply to current image**

Verify the vignetting and dust are removed and the processing do not create unwanted artifact.

Quit

From the menu File → Quit.

Exit the program and save the configuration.

If the devices are connected you are asked if you want to disconnect them.

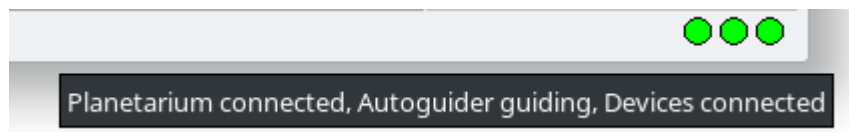
Help

Some help to use the software.

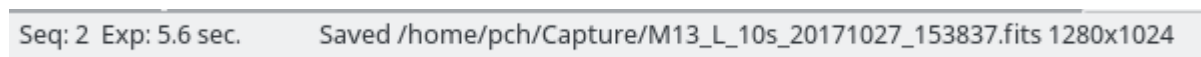
- **PDF documentation** open the PDF documentation installed with the software
- **Online documentation** open the documentation in a web browser
- **User group** open the user group in a web browser. This is the place to ask question about the program use.
- **CCDciel status** open the [CCDciel status](#) page in a web browser
- **Show current log** open the current log file using the default text editor
- **Show INDI log** some INDI driver are very verbose, so any message below the Error level are not show in the console but written directly to this file
- **Browse log files** open the log file folder in the file explorer
- **Report a problem** open the CCDciel bug tracker. You can report here any error you encounter in the program.
- **Download latest version** open the SourceForge download page. Ignore this entry if you use a package from your Linux distribution.
- **About** show the program version and copyright notice.

The status bar

The status bar at the bottom of the program window show a number of information.



On the right, three lamp indicate the status of the [planetarium](#), [autoguider](#) and [devices connection](#).



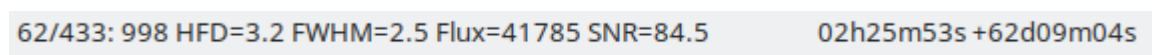
When a capture is running the status bar show the sequence number and the remaining time of the current exposure. On the right it show the name of the last saved image and the size of this image.



When a preview is running it show the remaining time of the current exposure, the time of the currently displayed preview and the size of the image

After the exposure time as elapsed the remaining time is replaced by the advance of the image reading process:

- **Downloading:** the image is transferred from the camera to the driver.
- **Read image:** the image is read from the driver by the program.
- **Display:** the image is processed to show the preview on screen.



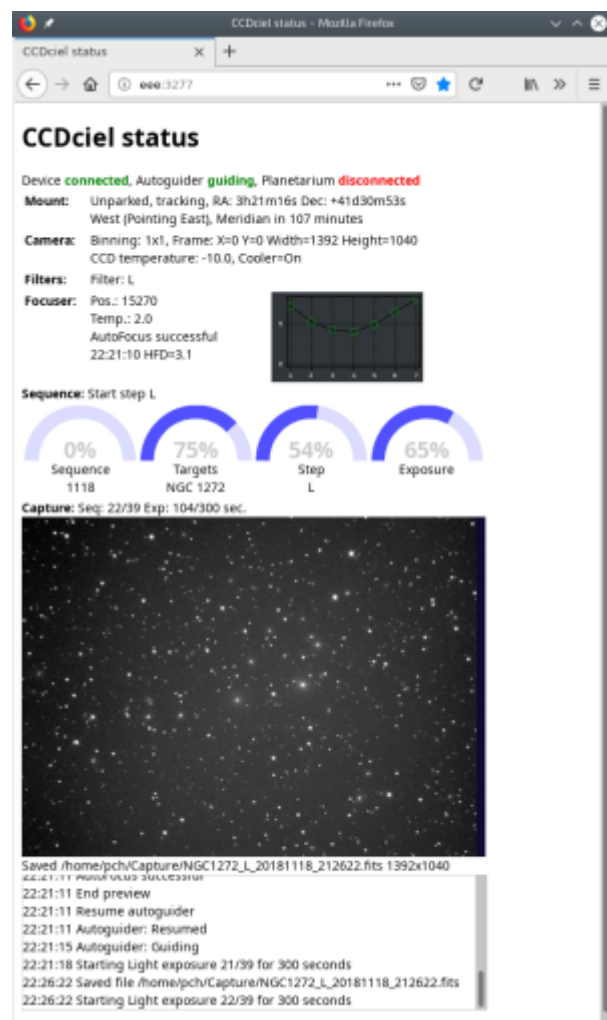
When the mouse cursor is moved over the image the following information is show in the left part of the status bar:

- The X/Y image coordinate of the cursor.
- The pixel intensity.
- The HFD and FWHM of the star under the cursor.
- The star total Flux and Signal-to-noise ratio.
- If the image is plate solved it also show the Right ascension and Declination of the cursor position, using the apparent coordinates if the telescope mount use the coordinates of the date, or J2000 if the telescope use this system. It show the apparent coordinates if no telescope is connected.

The status web page

You can open the status web page from the menu **Help** → **CCDciel status** or directly from your web browser: <http://localhost:3277>

It is also possible to get this page from another computer or phone in the local network or from the Internet if you make the required configuration in your network equipment.



This page give information about the connections, the devices, the focus, the running sequence with completion indicator, the last image and the console log. It refresh automatically every minute. Click on the image to get the full size.

If you want to access this page remotely on the Internet, a safe way is to use a [proxy](#).

You can also get this information from a program, the available options are:

- This [status web page](#).
- The [Simple socket command](#).
- The [JSON-RPC status method](#).

TCP/IP Status server

You can connect locally or remotely to get information about the program.
There is three way to get the information:

- The [status web page](#).
- This [Simple socket command](#).
- The [JSON-RPC status method](#).

Simple socket command

The program listen on port 3277 and use the following command:

status	Return the devices connection status
sequence	Return information about current sequence
capture	The capture information in the status bar
log	The last 10 lines of the current log
quit	disconnect from the server

For example:

```
$ telnet localhost 3277
Connected to localhost.
OK! id=1

status
Planetarium connected, Autoguider guiding, Devices connected

sequence
Targets: test1 Plan: L-3x2 Start step R

capture
Seq: 2 Exp: 19 sec. Saved /home/pch/Capture/M13_Red_20180217_161453.fits 1392x1040

log
17:14:07:Starting Light exposure 3 for 20 seconds
17:14:27:Saved file /home/pch/Capture/M13_Red_20180217_161427.fits
17:14:27:Stop capture
17:14:33:Start step R
17:14:33:Start capture
17:14:33:Starting Light exposure 1 for 20 seconds
17:14:53:Saved file /home/pch/Capture/M13_Red_20180217_161453.fits
17:14:53:Starting Light exposure 2 for 20 seconds

quit
Connection closed by foreign host.
```

CCDciel Script

The scripts allow automation of many CCDciel function but also allow to interact with other component of the observatory. They can be executed from the [script](#) tool or part of a [sequence](#) or [sequence termination](#).

There is also standard script that are executed on defined occasion, create a script with the following name :

- **startup** is executed when the program is launched. This is the place you can automatically start other program, connect the devices, the autoguider and the planetarium. This can also be use to automatically start a sequence when the program start.
- **shutdown** is executed when the program is closed, it can be use to close other software or power off the observatory.
- **beforeconnect** is executed just before the devices are connected to the program, receive the profile name as parameter.
- **connected** is executed after all the devices are connected, receive the profile name as parameter.
- **disconnected** is executed after all the devices are disconnected, receive the profile name as parameter.

The scripts are written using the **Python** programming language.

On Windows, basic Python functionality are provided with CCDciel. But you can [install](#) a full version of Python if you want more functionality like [Astropy](#). In this case adapt the python command to use in the [Preferences](#).

The Python language is very powerful and allow for complex tasks, but this can also be as simple as sending a list of command to different devices.

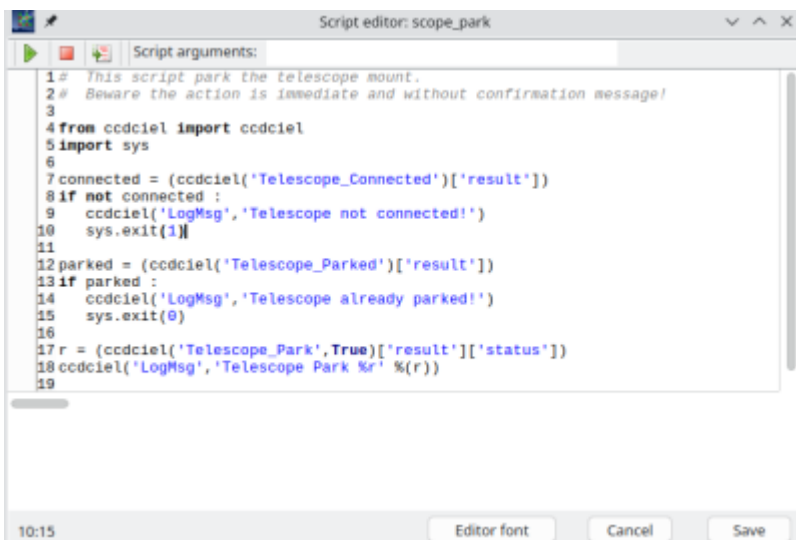
Read this quick [script tutorial](#) first.

It is possible to download [script example](#) for a quick start.

The functions specific to the interface with CCDciel are described in a [separate page](#).

Script editor

The editor allow to write and test a script from within CCDciel.

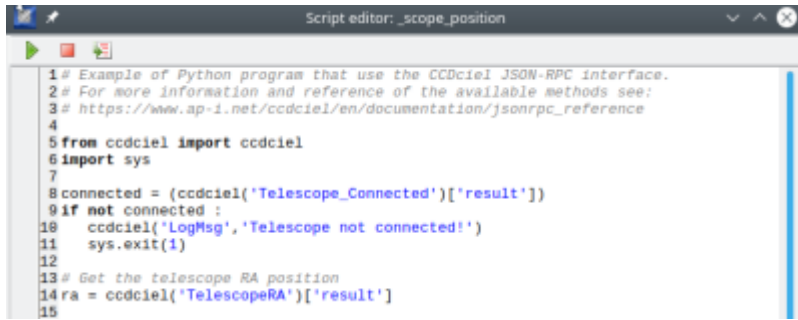


Use the **Editor font** button to select the character font to use.

The **Save** button to record your change and return to the main window.

The top button are related to the debugging function as describe below.

Script debugger



You can run the script with the green arrow button and see the printed output. The Stop button is available to interrupt the execution.

The Debug button open a separate windows with the [Python debugger pdb](#) where you can use the standard Python [debugger commands](#).

```
> /home/pch/.config/ccdcie/tmp/tmpscript(5)<module>()
-> from ccdciel import ccdciel
(Pdb) b 14
Breakpoint 1 at /home/pch/.config/ccdcie/tmp/tmpscript:14
(Pdb) c
> /home/pch/.config/ccdcie/tmp/tmpscript(14)<module>()
-> ra = ccdciel('TelescopeRA')['result']
(Pdb) n
> /home/pch/.config/ccdcie/tmp/tmpscript(17)<module>()
-> de = ccdciel('TelescopeDE')['result']
(Pdb) p ra
18.047907
(Pdb) █
```

Script example

Here is the code of the Python script `scope_unpark` you can use to unpark the telescope.
The full script code look as following:

```
# This script unpark the telescope mount

from ccdciel import ccdcielex
import sys

try:
    connected = (ccdcielex('Telescope_Connected')['result'])
    if not connected :
        ccdcielex('LogMsg', 'Telescope not connected!')
        sys.exit(1)

    parked = (ccdcielex('Telescope_Parked')['result'])
    if not parked :
        ccdcielex('LogMsg', 'Telescope already unparked')
        sys.exit(0)

    r = (ccdcielex('Telescope_Park', False)['result']['status'])
    ccdcielex('LogMsg', 'Telescope Unpark %r' %(r))

except Exception as e:
    print('error '+e.message)
```

Is a comment to explain what this script do

```
from ccdciel import ccdcielex
```

Import the Python CCDciel interface module.

```
import sys
```

You can import any other Python module you need.

```
try:
```

Start of exception block that will catch any error in the CCDciel interface.

```
    connected = (ccdcielex('Telescope_Connected')['result'])
```

We ask CCDciel if the telescope is connected, the result is in our variable “connected”.

```
    if not connected :
```

```
ccdcielx('LogMsg','Telescope not connected!')
sys.exit(1)
```

We test the result of the previous command, “connected” is True if the telescope is connected, so we add the negation “not” to test for “not connected”. If the result of the test “not connected” is true we execute the indented code block, this write a message in the log and exit the script.

```
parked = (ccdcielx('Telescope_Parked')['result'])
```

We continue and we do the same to check if the telescope is parked, with the result in our “parked” variable.

```
if not parked :
```

We test if the telescope is already unparked, in this case we exit the script.

```
r = (ccdcielx('Telescope_Park',False)['result']['status'])
```

We call the method 'Telescope_Park' with the argument False to unpark the telescope. This effectively unpark the telescope and the status of the command is in variable “r”.

```
ccdcielx('LogMsg','Telescope Unpark %r' %(r))
```

This write a message to the log to show the status of the command, this can be 'OK!' or 'Failed!'.

```
except Exception as e:
    print('error '+e.message)
```

End of the exception block, this is executed only in case of error with the CCDciel interface.

Script reference

This page contain reference for the Python interface.

Python scripts

The JSON-RPC method are the basis for the Python scripts, both internal (launched from CCDciel) or external (launched from a terminal or another application).

A Python function **ccdciel** is provided to simplify the use. The host,port parameters can be use to send the command to another instance of CCDciel.

The syntax is:

```
jsonresult = ccdciel(method)
jsonresult = ccdciel(method,parameter)
jsonresult = ccdciel(method,parameter,host,port)
```

For example:

```
from ccdciel import ccdciel
ra = ccdciel('TelescopeRA')['result']
```

A failed method return ['error'] instead of ['result'], other command can return ['status'] with a value of 'OK!' or 'Failed!'.

To simplify the testing of this condition you can use the function **ccdciellex** that raise an exception if anything fail. This way you are sure to get the result you want if the except: block is not executed.

```
from ccdciel import ccdciellex
try:
    jsonresult = ccdciellex(method)
except Exception as e:
    print('error '+e.message)
```

This is the preferred method that is used in newly created script.

To make Python to find this function in external script you must specify the environment variable PYTHONPATH, this is not necessary when running the script from CCDciel:

```
set PYTHONPATH=C:\Program Files\CCDciel\scripts
export PYTHONPATH=/usr/share/ccdciel/scripts
```

Use the standard Python functions (argv, getopt, argparse) to retrieve the script parameters. For example:

```
print ('Argument List:', str(sys.argv))
```

JSON-RPC method

The program accept JSON-RPC 2.0 request on the port 3277 using both direct socket or HTTP POST. This can be used directly from script or program written in any language to interface with CCDciel. But only Python is supported for internal script.

For HTTP POST set your JSON-RPC procedure to use the following URL:

```
http://localhost:3277/jsonrpc
```

Methods that return a value

From Python: `result_value = ccdcielx('method_name')['result']`

For JSON-RPC: `{"jsonrpc": "2.0", "method": "method_name", "id": 1}`, response: `{"jsonrpc": "2.0", "result": result_value, "id": 1}`

Method name is not case sensitive.

Method name	Result type	Result value
CCDciel_Version	array	[main version, short revision, full revision]
Devices	array	The driver and connection type for each defined device
Devices_connected	bool	True if all the devices are connected
Camera_connected	bool	True if the camera is connected
Camera_getframe	integer	Camera frame [x,y,width,height]
Camera_GetGain	integer	Get the camera Gain
Camera_GetOffset	integer	Get the camera Offset
CcdTemp	double	The current CCD temperature
Preview_getexposure	double	Get the preview exposure time
Preview_getbinning	string	Get the preview binning
Preview_running	bool	True if the preview is running
Preview_loop_running	bool	True if the preview is in loop
Capture_getexposure	double	Get the capture exposure
Capture_getbinning	string	Get the capture binning
Capture_getobjectname	string	Get the capture object name
Capture_getcount	integer	Get the capture image count
Capture_getframetype	string	Get the capture frame type
Capture_getdither	integer	Get the capture Dither count
Capture_running	bool	True if a capture is running
Capture_getLastfilename	string	The full path name of the last saved file
Sequence_getCurrentDirectory	string	The directory where files from a sequence will be saved, but only for fields that not depend on individual image setting
Sequence_TargetInformation	list	A list object,plan,ra,dec,magnitude for the currently running target
CurrentHeader	key,value list	The FITS header of the currently displayed file
Telescope_connected	bool	True if the telescope is connected
Telescope_eqmod	bool	True if the telescope use the EqMod driver
Telescope_parked	bool	True if the telescope is parked
Telescope_tracking	bool	True if the telescope is tracking
Telescope_trackingrate	string	SIDEREAL, LUNAR, SOLAR, CUSTOM
Telescope_PierSide	string	pierEast, pierWest, pierUnknown, pierNotImplemented
Telescope_slewing	bool	True if the telescope is slewing
Dome_Connected	bool	True if the dome is connected
Dome_Parked	bool	True if the dome is parked
Dome_Opened	bool	True if the dome shutter is opened

Method name	Result type	Result value
Dome_Slaved	bool	True if the dome is slaved with the telescope
Astrometry_Goto_Running	bool	True if the telescope is slewing using astrometry
Astrometry_Goto_Result	bool	True if the last astrometry goto is successful
Slewing_GetAvoidBrightstar	bool	True if set to slew with an offset for spectroscopy
Slewing_GetBrightstarMagnitude	integer	The star magnitude that trigger the slew with offset
Slewing_GetBrightstarOffset	integer	The initial slew offset in arc-minutes
TelescopeRA	double	The telescope position right ascension
TelescopeDE	double	The telescope position declination
Wheel_connected	bool	True if the filter wheel is connected
Wheel_GetfiltersName	array	The name of the filters in the wheel
Focuser_connected	bool	True if the focuser is connected
FocuserPosition	int	The focuser absolute position
Rotator_connected	bool	True if the rotator is connected
Rotator_Angle	float	The rotator current angle
CoverStatus	string	The status of the telescope cover
CalibratorStatus	string	The status of the flat calibrator
CalibratorBrightness	int	The brightness of the calibrator
Autoguider_connected	bool	True if the auto-guider is connected
Autoguider_running	bool	True if the auto-guider is running
Autoguider_guiding	bool	True if the auto-guider is guiding
Autoguider_Getlockposition	x,y	The current guide lock position
Internalguider_Busy	boolean	True when the guider camera is active (looping, calibrating, guiding, in pause)
Internalguider_GetGuideExposure	double	The guider exposure time
Internalguider_GetExposuredelay	integer	The delay in seconds between guider exposure
Internalguider_GetAgressivityRA	integer	[gain,hysteresis] in RA
Internalguider_GetAgressivityDEC	integer	[gain,hysteresis] in DEC
Internalguider_GetSpectrofunction	bool	The value of "Activate spectroscopy function"
Internalguider_GetSpectroStrategy	string	The current spectro guiding strategy: 'SingleStar', 'SingleOffset', 'SingleAstrometry', 'SingleMulti', 'MultiStar'
Internalguider_GetSpectroAstrometryExposure	double	The exposure time for the astrometry
Internalguider_GetSpectroSlitname	string	The selected slit name in the list of slit offset
Internalguider_GetSpectroGuidestaroffset	double, double	The X,Y guide star offset relative to the target
Internalguider_GetSpectroMultistaroffset	double, double	The current multi-star guide offset
Internalguider_GetSpectroRotateParallactic	bool	True if automated rotation of the slit to the parallactic angle is activated
Planetarium_connected	bool	True if the planetarium is connected
TimeNow	string	The current local time on the computer running CCDciel
SiderealTime	double	The current local sidereal time in hour
Obs_latitude	double	The observer latitude
Obs_longitude	double	The observer longitude
Obs_elevation	double	The observer elevation
HostOS	string	The operating system on the computer running CCDciel
DirectorySeparator	string	The directory separator symbol on the computer running CCDciel

Method name	Result type	Result value
AppDir	string	The directory where the program is installed
TmpDir	string	The directory for temporary files
CaptureDir	string	The directory to save the images from capture sequence

Methods that invoke a command without parameter

From Python: `ccdcielx('method_name')`

For JSON-RPC: `{“jsonrpc”: “2.0”, “method”: “method_name”, “id”:1}`, response: `{“jsonrpc”: “2.0”, “result”: {“status”: “OK!”}, “id”: 1}`

Status can be “OK!” if the command is successful, or “Failed!” if not. In this later case it can contain information about why it fail.

Method name is not case sensitive.

Method name	Function
Camera_Resetframe	Reset the camera full frame ROI
Preview_single	Start a single preview
Preview_loop	Start a preview loop
Preview_waitloop	Wait until the user stop the preview loop
Preview_stop	Stop any in progress preview or preview loop
Capture_start	Start a capture
Capture_stop	Stop a capture
Sequence_stop	Stop the sequence
Finder_Stoploop	Stop the finder loop
Telescope_track	Start telescope tracking
Telescope_abortmotion	Stop any telescope movement
Eqmod_clearpoints	Clear EqMod alignment data
Eqmod_clearsyncdelta	Clear Eqmod sync delta
Eqmod_stdsync	Set Eqmod in Standard sync mode
Eqmod_appendsync	Set Eqmod in Add point on sync mode
Wheel_getfilter	Get the current filter number in the wheel
Spectro_Rotate_Parallactic	Rotate the slit for the parallactic angle at the current mount position
Cover_open	Open the telescope cover
Cover_close	Close the telescope cover
Calibrator_light_off	Turn flat calibrator light off
Autofocus	Run auto-focus at the current position, same as the Autofocus button
AutomaticAutofocus	Run auto-focus, same as invoked from a sequence, will eventually move to a bright star
Astrometry_solve	Plate solve the current image
Astrometry_sync	Plate solve the current image and sync the telescope
Astrometry_slew_image_center	Plate solve the current image and slew the telescope
Astrometry_plot_dso	Plate solve the current image and annotate DSO
Astrometry_plot_hyperleda	Plate solve the current image and annotate DSO using the hyperleda catalog
Autoguider_connect	Connect to the autoguider software
Autoguider_calibrate	Force a new calibration of the autoguider
Autoguider_startguiding	Start to guide

Method name	Function
Autoguider_stopguiding	Stop guiding
Autoguider_pause	Pause guiding
Autoguider_unpause	Restart after pause
Autoguider_dither	Dither now
Autoguider_shutdown	Close the autoguider program
Internalguider_ClearSpectroTargetRaDec	Clear the target ra,dec, for spectro guiding
Internalguider_ClearSpectroGuideStarRaDec	Clear the guide star ra,dec, for spectro guiding
Planetarium_connect	Connect the planetarium software
Planetarium_showimage	Plate solve the current image and show in planetarium
Planetarium_shutdown	Close the planetarium software
Program_shutdown	Close CCDciel
Clear_reference_image	Remove the reference image
CustomHeader_clear	Delete all the custom header keywords

Methods that invoke a command with parameter

From Python: `ccdcielx('method_name',param1)` or `ccdcielx('method_name',[param1,param2])`

For JSON-RPC: `{"jsonrpc": "2.0", "method": "method_name", "params": [params], "id":1}`, response:

`{"jsonrpc": "2.0", "result":{"status": "OK!"}, "id": 1}`

Status can be "OK!" if the command is successful, or "Failed!" if not. In this later case it can contain information about why it fail.

Method name is not case sensitive.

Method name	Parameter	Function
Devices_connection	True / False	Connect or disconnect the devices, if a second parameter is present it affect only this device, this can be: camera, guidecamera, findercamera, filterwheel, focuser, rotator, mount, dome, switch, covercalibrator, watchdog, weatherstation, safetymonitor
Ccd_settemperature	temp	Set the CCD temperature
Camera_Setframe	[x,y,width,height]	Set the camera frame size (ROI)
Camera_SetGain	gain	Set the camera Gain
Camera_SetOffset	offset	Set the camera Offset
Preview_setexposure	exp	Set the preview exposure time
Preview_setbinning	bin	Set the preview binning
Capture_setexposure	exp	Set the capture exposure
Capture_setbinning	bin	Set the capture binning
Capture_setobjectname	name	Set the capture object name
Capture_setcount	count	Set the capture image count
Capture_setframetype	Light/Bias/Dark/Flat	Set the capture frame type
Capture_setdither	count	Set the capture Dither count
Set_FinderTargetXY	x,y	Set the position of the target in the finder image
Finder_Saveimage	ON/OFF	Activate the saving of finder image when looping
Finder_Startloop	exposure time	Start the finder loop with the given exposure time

Method name	Parameter	Function
Finder_Snapshot	exposure time, filename, count	Take a series of finder camera snapshot
Sequence_start	sequence	Load and start the sequence
Telescope_settrackingrate	rate	rate = SIDEREAL,LUNAR,SOLAR
Astrometry_Goto_Async	[RA, DEC]	Slew to specified coordinates, use astrometry correction, return immediately
Slewing_SetAvoidBrightstar	bool	True to slew with an offset for spectroscopy
Slewing_SetBrightstarMagnitude	integer	The star magnitude that trigger the slew with offset
Slewing_SetBrightstarOffset	integer	The initial slew offset in arc-minutes
Telescope_slew	[RA, DEC]	Slew to specified coordinates, do not return until the slew is complete
Telescope_slewasync	[RA, DEC]	Slew to specified coordinates, return immediately
Telescope_sync	[RA, DEC]	Sync to specified coordinates
Telescope_park	True / False	Park or unpark the telescope
Dome_Park	True / False	Park or unpark the dome
Dome_Shutter	True / False	Open or close the dome shutter
Dome_Slave	True / False	Slave the dome with the telescope
Autoguider_SetSettleTolerance	px,min,timeout	Set the settle tolerance in PHD2 or Internal guider
Autoguider_Setlockposition	x,y	Set immediately the new guide lock position in PHD2 or Internal guider
Autoguider_Storelockposition	x,y	Store the guide lock position for the next time guiding is started
Internalguider_Save_FITS_File	filename	Save the current guider image to file
Internalguider_Snapshot	exposure time, filename, count	Take a series of guide camera snapshot, guiding must be stopped before to use this command
Internalguider_SetGuideExposure	double	Set the guider exposure time
Internalguider_SetExposuredelay	integer	Set the delay in seconds between guider exposure
Internalguider_SetAgressivityRA	integer	Set the [gain,hysteresis] in RA
Internalguider_SetAgressivityDEC	integer	Set the [gain,hysteresis] in DEC
Internalguider_SetSpectrofunction	bool	Set the value of "Activate spectroscopy function"
Internalguider_SetSpectroStrategy	string	Set the spectro guiding strategy, one of: 'SingleStar', 'SingleOffset', 'SingleAstrometry', 'SingleMulti', 'MultiStar'
Internalguider_SetSpectroAstrometryExposure	double	Set the exposure time for the astrometry
Internalguider_SetSpectroSlitname	string	Select this slit name in list to set the slit offset
Internalguider_SetSpectroGuidestarRaDec	double, double	Set the guide star RA,DEC, offset is computed from target RA,DEC
Internalguider_SetSpectroGuidestaroffset	double, double	Set the X,Y guide star offset relative to the target
Internalguider_SetSpectroMultistaroffset	double, double	Set the X,Y multi-star guide offset
Internalguider_SetSpectroRotateParallactic	bool	Set the automated rotation of the slit to the parallactic angle
Wheel_setfilter	number	Set the filter number in the wheel

Method name	Parameter	Function
Focuser_setposition	number	Set the focuser absolute position
SetFocusXY	X,Y	Select the star at position X,Y for focus operation
SetFocusXYhfd	X,Y	Select the star at position X,Y for focus operation, return the HFD of the selected star
Rotator_Sync	angle	Sync the rotator with the angle in degree
Rotator_Goto	angle	Rotator Goto at the angle in degree
Get_Switch	nickname, switchname	Return the current value for the switch
Set_Switch	nickname, switchname, value	Set the value of the switch
Calibrator_light_on	brightness	Light the flat calibrator at the specified brightness
Planetarium_showimage_fov	FOV [degree]	Plate solve the current image and show in planetarium using the specified field of view
J2000_to_Apparent	[RA, DEC]	Convert J2000 ra,dec to apparent. RA in hours, DEC in degree
Apparent_to_J2000	[RA, DEC]	Convert apparent ra,dec to J2000. RA in hours, DEC in degree
Eq2hz	[RA, DEC]	From apparent ra,dec, return alt,az coordinates. RA in hours, all other angle in degree
Hz2eq	[AZ, ALT]	From az,alt, return apparent ra,dec coordinates. RA in hours, all other angle in degree
Save_fits_file	filename	Save the FITS file
Open_fits_file	filename	Open the FITS file
Open_reference_image	filename	Load a reference image
LogMsg	text	Print text in CCDciel log
CustomHeader_add	[key,value]	Add a new custom header keyword with value. Replace the value if the key already exist
CustomHeader_del	key	Delete all the occurrence of this custom header keyword
CustomHeader	key	Return the value for this keyword
Script_Run	[scriptname, params, params, ...]	Run another script and return immediately with the process number
Script_Running	process_number	Return True if the script identified by process_number is running
Script_Stop	process_number	Stop the execution of the script identified by process_number

Specific status method

This method return a global program status with the same information as the [Status web page](#).

method	status
params	devices planetarium autoguider safety weather dome mount camera wheel rotator focuser sequence capture log

The params field allow to filter the information send by the program.

When the params field is not specified the response include all the information.

Example:

```
$ telnet localhost 3277
Connected to localhost.
{"jsonrpc": "2.0", "method": "status", "params": ["camera","focuser"], "id": 2}

{"jsonrpc": "2.0", "result":{"camera": {"connected": true, "binning": "1x1",
"frame": "0/0/1280/1024", "cooler": false, "temperature": 0.0},
"focuser": {"connected": true, "position": 37200, "temperature": 0.0,
"focusermessage": "AutoFocus successful; 15:03:52 HFD=4.2"}}, "id": 2}
```

There is three way to get the status information:

- The [status web page](#).
- The [Simple socket command](#).
- This [JSON-RPC status method](#).

Command line options

CCDciel accepts the following options on the command line:

Option	Parameter	Function
--basedir -b	Base directory	The base directory to store all the program configuration and work files. The default is in the user profile, %LOCALAPPDATA%\ccdciel or ~/.config/ccdciel Example: --basedir=E:\ccdciel_files , -b E:\ccdciel_files
--config -c	configuration file path	Lets you specify the device configuration file to use instead of the last one you load Example: --config=default , -c default
--run_sequence -r	sequence file path	Automatically connect the devices and run this sequence. the startup script is run before to start the sequence. The camera cooler and the autoguider connection are set according to the configuration. Example: --run_sequence=/tmp/seq1.targets , -r /tmp/seq1.targets
--shutdown -s		Wait 5 minutes and shutdown the program after the sequence specified with --run_sequence is finished. This option as no effect if --run_sequence is not specified. The sequence termination options are run before this option is processed. The shutdown script is run after. Example: --shutdown , -s

Image preprocessing

It is possible to use scripts to preprocess the new images automatically for example at the end of the nightly sequence.

There is standard script you can use directly or if you have very specific needs you can modify them to make your own. This page describe this standard scripts in more detail.

Using Siril

[Siril](#) is a powerful image processing software that can be automated with it's own scripting language. You need at least the version 1.3.4 to use this scripts.

Just install the latest version for your system, no specific configuration in Siril is need.

Install the scripts from the menu [Edit](#), select the line with “siril.pkg” and click Download.

You can select the following from any CCDciel script selection box:

- **siril_bias** : Process the bias files and produce the master bias.
- **siril_dark** : Process the dark files and produce the master dark.
- **siril_flat** : Process the flat files and produce the master flat, one per filter if it apply.
- **siril_light** : Preprocess all the light frame using the master dark and flat.
- **siril_light_color** : Preprocess all the color light frame using the master dark and flat.

You need to follow a standard scheme for the file and folder name, otherwise the script will not work.

In the [file preferences](#) you **must** set the following:

- **Separator** must be _
- **FITS file extension** must be .fits
- For **File name option** you must check only “Object name” and if using a filter wheel also set “Filter”. It is very important that “Date(UT)/Sequence” and any other option remain unchecked.
- For **Folder name options** you must check only “Subfolder by frame type”. It is very important that any other option remain unchecked.

File name options		Folder name options	
1	☒ Object name	1	☐ Subfolder by sequence name
2	☒ Filter	2	☒ Subfolder by frame type

After you run the script you can look at the log file created in the CCDciel [Capture folder](#). This file show all the Siril operations and messages.

Usage requirement

As it is not possible to make standard script that adapt to every use case you must be careful of the following condition before to use them:

- Follow the file and folder naming convention.
- All the light frames must be taken on the same condition with respect to the temperature, gain and exposure time.
- The dark must correspond to the light exposure condition.
- The master flat is mandatory. If you not want to use a flat, create a fits file filled with a uniform value.

Take and process Bias

The following descriptions will use a [sequence](#) as an example, but you can do the same by using directly the [Capture](#) and the [Script](#) tools.

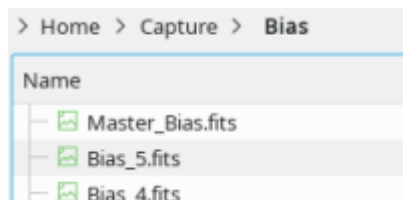
First create a plan to take the bias frames:

Seq	Description	Type	Exposure	Binning	Filter	Count	Repeat
1	Bias	Bias	0.010	1x1	No change	15	1

Then create a sequence to run this plan and preprocess the bias:

Seq	Target name	Plan	RA
1	None	bias	-
2	Script	siril_bias	

After you run this sequence you find in the Bias directory every individual bias frame and the processed master bias:



With a cooled camera you probably not make bias every day, so just keep the file Master_Bias.fits in place so it can be used by the other processing operation.

Take and process Dark

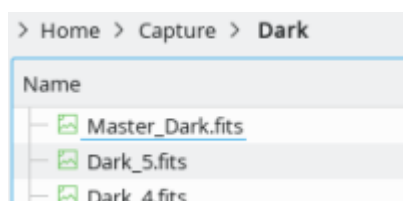
Same as for the bias, create a plan to take the dark frames:

Seq	Description	Type	Exposure	Binning	Filter	Count	Repeat
1	Dark	Dark	300.000	1x1	No change	15	1

Then create a sequence to run this plan and preprocess the dark:

Seq	Target name	Plan	RA
1	None	dark	-
2	Script	siril_dark	

After you run this sequence you find in the Dark directory every individual dark frame and the processed master dark:



With a cooled camera you probably not make dark every day, so just keep the file Master_Dark.fits in place so it

can be used by the other processing operation.

Take and process Flat

It is required the Master_Bias is available before you can run this script.

We have more options to make the flat frames because it depend if we use a flat panel or sky flat, and if we use a filter wheel or not.

To use a flat panel just create a plan as for the dark but select “Flat” for the type.

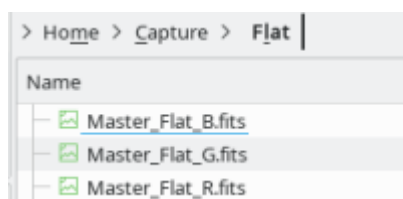
Seq	Description	Type	Exposure	Binning	Filter
1	Flat R	Flat	1.000	1x1	R
2	flat G	Flat	1.000	1x1	G
3	flat B	Flat	1.000	1x1	B

Then create a sequence to run this plan and preprocess the flat.

To use a sky flat add an automatic dusk or dawn [Sky Flat](#) in the sequence.

Seq	Target name	Plan	RA
1	SkyFlat	Dawn	
2	Script	siril_flat	

After you run this sequence you find in the Flat directory every individual flat frame and the processed master flat:



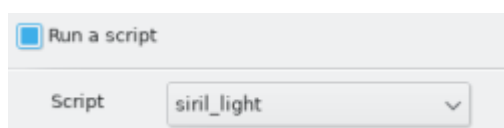
As you probably make flat every day a good place to add this processing is at the end of the sequence, just before to process the light frames. Or you can use a specific flat sequence you run at the beginning of the night.

Take and process Light

It is required the Master_Dark and Master_Flat are available before you can run this script.

Again it depend how you take the flat to chain this process. The important point is it run once at the end of the night after the flat are processed.

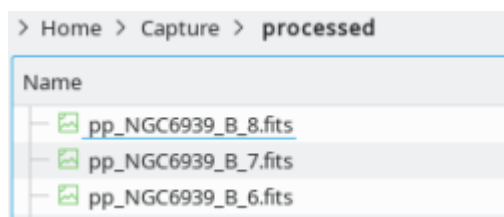
If you use a flat panel a good solution is to use the Script option in the [sequence termination options](#). This ensure it run only once if you set a sequence repetition or if the sequence is interrupted at dawn.



If you use a sky flat you can add the script at the end of the sequence after the flat processing:

Seq	Target name	Plan	RA	Dec	PA
1	M13	LRGB-4H	16h42m17s	+36d26m27s	-
2	M92	LRGB-4H	23h20m53s	+61d12m07s	-
3	SkyFlat	Dawn			
4	Script	siril_flat			
5	Script	siril_light			

After the script is finished you find the dark and flat preprocessed files for all the objects and all the filters in a new directory “processed” under the base capture directory. Every file is prefixed by “pp_” as Siril do to distinguish them from the original files.



By default this script stop here because at this point you probably want to review your files and make some selection before to go further.

But if you want it is possible to continue with alignment and stacking. For that you need to modify the file *template_light.ssf* located in the CCDciel program directory in scripts/siril.

On Windows this is “Program Files\ccdciel\scripts\siril”, on Linux this is “/usr/share/ccdciel/scripts/siril”

In the file remove the # in front of the command “register” and “stack”. If you use a OSC or DSLR camera you also need to add the options “-cfa -debayer” to the preprocess command to debayer the images before the registration.

Installation on Ubuntu, Debian

Bellow installation procedure uses only command line approach, because this is the simpler way to follow instructions just by copy-pasting the commands in terminal. This instructions are tested with the currently supported versions of Debian and Ubuntu.

This same procedure can be used with any system using deb packages (Mint, Raspbian, ...)

This use a script with all the required command to setup the repository,

1. Copy and paste this command to a terminal to install the repository:

```
bash <(wget -qO-  
https://raw.githubusercontent.com/pchev/skychart/master/setup_skychart_deb.sh)
```

Be sure to select the Beta version because this program is in beta version only.

At this point you can install the program using the Software Center or continue using the command line with the instruction below.

2. Update repository:

```
sudo apt update
```

3. Install CCDciel Qt6 on a recent distribution (from Debian Trixie, Ubuntu 26.04):

```
sudo apt-get install ccdciel-qt6
```

On an older distribution install CCDciel Qt5:

```
sudo apt-get install ccdciel
```

When upgrading to a distribution that support the Qt6 version it is recommended to install ccdciel-qt6, this automatically remove the old Qt5 package.

See also the list of the [optional dependencies](#) to install to take full advantage of the software.

Specific instruction for DSLR

To open DSLR raw files you need the library libpasraw to interface with LibRaw.

Unfortunately the LibRaw programming interface is not stable across LibRaw version, so libpasraw must be build specifically for your system or it not work.

For Ubuntu you can simply install libpasraw from this PPA:

<https://launchpad.net/~pch/+archive/ubuntu/ppa-skychart>

then install with `sudo apt-get install libpasraw`

For a few other system you can find a package at:

<https://github.com/pchev/libpasraw/releases>

For other system you need to compile and install libpasraw from source after installing the libraw-dev package.

See <https://github.com/pchev/libpasraw/blob/master/README.md>

As a last resort you can install the libraw-bin or dcraw package, but this is less performant as it need to work with temporary files.

Installation on Linux

If your Linux system use deb packages, see [Installation on Ubuntu, Debian](#).

On Fedora you can install ccdciel packaged with the system.

On Gentoo Linux use the overlay available here: <https://github.com/jamesbates/gentoo-overlay>

For other Linux system you can download rpm or tar packages from the Sourceforge [download](#) link.

For FITS file compression support the fpack, funpack command are required. The installation is not automatic when installing from a RPM file because of inconsistencies between Fedora and OpenSuse. Be sure you install them using the package from your distribution, it can be fpack, cfitsio, cfitsio-utils, ...

The requirement are Qt5, LibQt5Pas or Qt6, LibQt6Pas and [libpasastro](#).

See also the list of [dependencies](#) to install to take full advantage of the software.

You can also compile the [source code](#) using [Lazarus](#).

Specific instruction for DSLR

To open DSLR raw files you need the library libpasraw to interface with LibRaw.

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For Ubuntu you can simply install libpasraw from this PPA:

<https://launchpad.net/~pch/+archive/ubuntu/ppa-skychart>

For a few other system you can find a package at:

<https://github.com/pchev/libpasraw/releases>

For other system you need to compile and install libpasraw from source after installing the libraw-dev package.

See <https://github.com/pchev/libpasraw/blob/master/README.md>

As a last resort you can install the libraw-bin or dcraw package, but this is less performant as it need to work with temporary files.

Installation on Windows

CCDciel can run on any current version of Windows. The oldest supported version is Windows 10.

The CCDciel installer is available in 32bit and 64bit. The 64bit version is recommended, install the 32bit version only if you need an old ASCOM driver that only work in 32bit.

To use the devices connected to your Windows computer you need the latest [ASCOM platform](#) and the most recent drivers for your hardware.

But you can also use the devices connected to a remote Alpaca, or a remote Linux system (a Raspberry PI for example) using the INDI protocol.

You can download the setup installer from the Sourceforge [download](#) link.

See also the list of the [optional dependencies](#) to install to take full advantage of the software.

A very important point when using Windows astronomy software is to

NEVER run anything as administrator

this is the source of many issue when accessing shared resources like a ASCOM driver. No current software need that despite the popularity of this false advice in astronomy forum.

Installation on macOS

CCDciel can run on a recent version of macOS, the minimal version required to run the program is 10.14 Mojave for x86_64, 11.0 Big Sure for arm64.

You can download the CCDciel dmg installer from the Sourceforge [download](#) link.

Select the version macos-x86_64 for a Mac with an Intel processor.

Select the version macos-arm64 for a Mac with Apple silicon.

IMPORTANT

After download open a Terminal, change to the Download directory and run the following command:

```
xattr -cr ccdciel*.dmg
```

Open the dmg file and run the installer.

See also the list of the [optional dependencies](#) to install to take full advantage of the software.

There is a security prompt when CCDciel attempt a network connection for the first time, for example to get a list of devices from a INDI server, you need to allow it.

ASCOM

[ASCOM](#) Platform is the standard astronomical equipment driver for Windows.

Install the latest ASCOM platform and the drivers you need from <http://ascom-standards.org/Downloads/Index.htm> or from your equipment manufacturer.

With [Alpaca](#) you can use the device remotely, from another Windows computer, or from a computer running Linux or macOS. To get started install the [ASCOM Remote Server](#) on the Windows computer where the devices are connected.

A very important point when using Windows astronomy software is to

NEVER run anything as administrator

this is the source of many issue when accessing shared resources like a ASCOM driver. No current software need that despite the popularity of this false advice in astronomy forum.

INDI

INDI Library is the standard astronomical [equipment](#) driver for Linux and macOS.

Linux

You can install INDI with the packages provided by your Linux distribution, but as this is a rapidly moving project it is best to get the [latest version](#) directly from the project.

For example for Debian/Ubuntu see <https://launchpad.net/~mutlaqja/+archive/ubuntu/ppa>

It is also easy to build INDI from source. You can get the script I use myself: [build_indi.sh](#). Be sure to install the prerequisites and add the drivers you need in the setup section at the beginning of the script.

macOS

[INDIWebManager](#) and [INDIStarter](#) distribution include the INDI server and the drivers.

Install INDIWebManager from: <https://github.com/rlancaste/INDIWebManagerApp/releases>

or

Install INDIStarter from: <https://sourceforge.net/projects/indistarter/files/>

Windows

There is no INDI server for Windows but you can run CCDciel on Windows to connect to a INDI server running on a remote computer, a Raspberry Pi for example.

Additional utilities

You can use [IndiStarter](#) to help to manage the INDI server and the drivers.

Download for Linux and macOS are available from <https://sourceforge.net/projects/indistarter/files/>

If you use a EQmod mount it can be useful to install [EQmodGUI](#) to easily control the main options. This also give you a virtual handpad to move the mount.

Download for Linux and macOS are available from <https://sourceforge.net/projects/eqmodgui/files/>

The Indigo server variant may work by using the INDI protocol compatibility but is untested.

Install Python

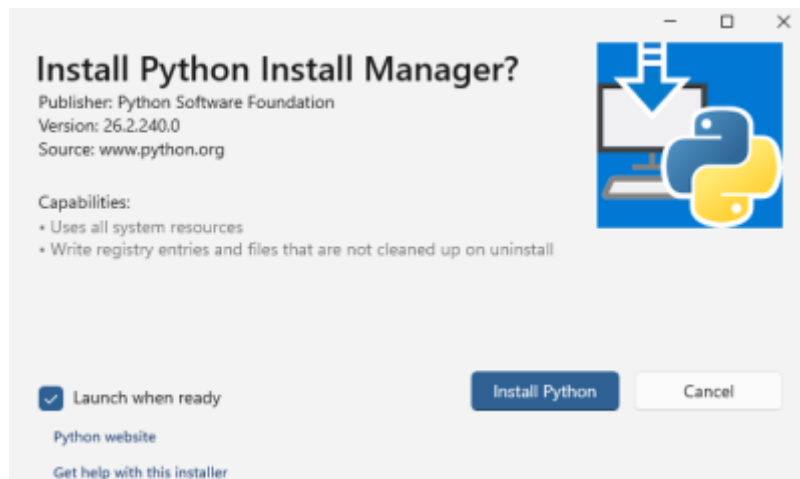
CCDciel include a Python scripting [interface](#).

For simple script it is sufficient to use the default Python included with Linux or installed by CCDciel on Windows. In this case you can ignore the end of this page..

But if you use a Mac or want a more advanced usage that need to install specific astronomy modules, you can follow the instructions below

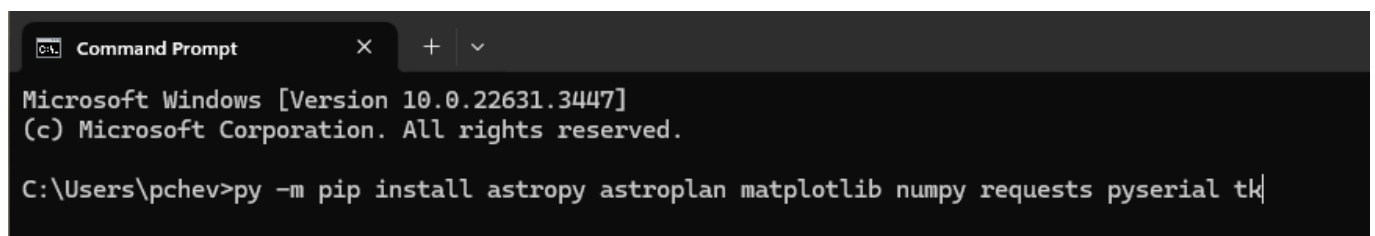
Python on Windows

- Download the latest Python install manager with the bundled python from <https://www.python.org/downloads/windows> or install it from the Microsoft store.
- Run the downloaded installer and click on “Install Python”, follow the next steps to the end.

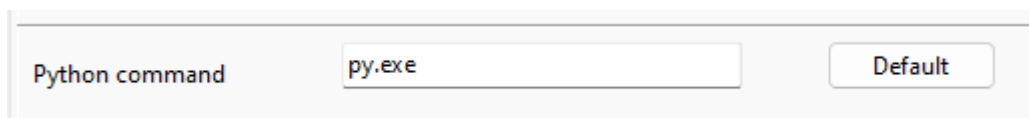


- Open a command line prompt to use pip to install the additional modules you need. For example:

```
py -m pip install alpyca requests pyserial astropy astroplan matplotlib numpy tk
```



- In CCDciel [preference](#) change the Python command to **py.exe**



Python on macOS

Old Mac version used to provide a Python version 2, this is not suitable for our use. New macOS do not provide anything. In all case you need to install Python 3 as describe below.

- Download the Python installer from <https://www.python.org/downloads/macos>, Get the last stable universal installer.
- Open the downloaded installer, follow the steps to the end.
- Open a command line prompt to create a virtual environment:

```
python3 -m venv ~/.venvs/astro
```

- Activate the environment:

```
source ~/.venvs/astro/bin/activate
```

- From the same activated shell install the modules you need:

```
pip3 install alpyca requests pyserial astropy astroplan matplotlib numpy tk
```

- In CCDciel [preference](#) change the Python command to:
/Users/{username}/.venvs/astro/bin/python3

Python on Linux

On Linux Python and many modules are already installed with the system.

If you want more, the best is to create a virtual environment to install the additional modules.

- Create the virtual environment:

```
python3 -m venv ~/.venvs/astro
```

- Activate the environment:

```
source ~/.venvs/astro/bin/activate
```

- From the same activated shell install the modules you need:

```
pip3 install alpyca requests pyserial astropy astroplan matplotlib numpy tk
```

- In CCDciel [preference](#) change the Python command to:
/home/{username}/.venvs/astro/bin/python3

ASTAP

ASTAP, the Astrometric STacking Program, astrometric solver and FITS viewer, is a free stacking and plate solver program for deep sky images. The plate solving capabilities can be accessed by CCDciel

ASTAP runs natively on Windows, Linux (i386 and amd64), Raspberry PI (armhf and arm64) and MacOS. It will require about 500 MB disk space.

Installation instructions and information is available at:

<http://www.hnsky.org/astap.htm>

For plate solving you have to install both the program and the "G17 star database".

Then configure the [program path](#) in CCDciel. For windows this is typical c:\Program Files\astap . For Linux this is typical /opt/astap . For MacOS use /Applications/astap.app/Contents/MacOS .

Two ASTAP settings are accessible in CCDciel:

- **Radius search:** Search radius in degrees. If there is no match, the program will move the search field around in a square spiral and increasing the distance from the initial position up to the radius specified. A radius of 30 degrees could be searched in a few minutes. Blind solving is possible by setting this option above 180 degrees. Scanning the whole sky can be achieved in typical 380 seconds but in most cases offset shall be much shorter and solving much quicker.
- **Binning:** For large images (>3000 pixels wide) it is beneficial to set binning to reduce image size and increase signal to noise ratio prior to plate solving. If your image is around 4000 pixels wide set this binning to 2. If your image is 5000 pixels wide set this option to 2 or 3.

In MS-Windows, the execution of the ASTAP solver will be shown by a small ASTAP tray icon on the right side of the status bar. If you move the mouse to the ASTAP tray icon, the hint will show the search radius reached.

If the search spiral has reached a distance more of then 2 degrees from the the start position then an ASTAP popup notifier will show the actual search distance and solver settings. Clarifications are given at the ASTAP webpage.

Tray icons are default off in the latest Win10 version. To set the ASTAP tray icon on, start a solve in CCDCIEL, go to Windows "**Settings**", "**Taskbar**", "**Turn system icons on or off**" and set the ASTAP tray icon permanent "on"

Images will require a minimum of about 30 focused stars up to more then 1000 stars. Exposure time as short as 5 or 10 seconds will be in most cases sufficient. Oval stars due to tracking errors or severe optical distortion will be ignored and solving could fail. If you have small amount of stars in the image, you could activate in ASTAP the option "small steps" for more reliable stacking. That is normally not required.

In case the plate solving fails a more detailed log is available in ASTAP for fault finding. Execute the ASTAP program manually and test the plate solving by loading an image in ASTAP. Open the "Stack" menu (ctrl+A), open the "Alignment" tab and have a look to section "ASTROMETRIC settings.". You can set the maximum number of stars (500) and tolerance (0.005). Exit the program via menu file, exit will save these settings.

More information is available at [ASTAP documentation](#)

Astrometry.net

Astrometry.net can be used to solve the image you just take with your camera. Astrometric solving will give the exact astronomical position of the image center, its orientation and size.

CCDciel requires a local copy of the Astrometry.net software including the indexes on your computer. It can also run Astrometry.net on a remote host using the provided script.

At page <http://astrometry.net/use.html> you can find detailed instructions how to install the software and indexes.

Astrometry.net on Linux

On Linux astrometry.net is probably packaged by your distribution. This is the easiest and preferred way to install the software.

For example on Debian or Ubuntu just do:

```
sudo apt-get install astrometry.net
```

Then to install some indexes:

```
sudo apt-get install astrometry-data-2mass-08-19 astrometry-data-2mass-07
```

Astrometry.net on macOS

For macOS a good solution is to install astrometry.net using [Homebrew](#).

Follow the instructions to [install Homebrew](#) itself.

Then to install astrometry.net type the following in a terminal:

```
brew install astrometry-net
```

To install the indexes you need in a directory in your Documents folder run in a terminal:

```
mkdir Documents/astrometry
cd Documents/astrometry
curl -O http://broiler.astrometry.net/~dstn/4200/index-42[08-19].fits
```

Repeat with “index-4207-[00-11].fits” if you need more indexes.

Next edit the file `/usr/local/etc/astrometry.cfg`, search a line that begin with “add_path” and replace the path by “/Users/[your user name]/Documents/astrometry”.

In the CCDciel Preferences at the [astrometry tab](#), enter `/usr/local/bin` in the field “command path”.

Another option if you already have astrometry.net packaged with another application is to use the custom script option.

In the CCDciel Preferences at the [astrometry tab](#):

- Check **Use custom script**
- Enter the script name: `/Applications/CCDciel/scripts/astrometry-macos.sh`
- You can modify the script to set the application path, by default it is `/Applications/Astrometry.app`

Astrometry.net on Windows

A number of Windows package include a fully automated install of Cygwin and astrometry.net and it is best to get one of them. CCDciel do not use this applications but the astrometry.net they install. Cygwin is a tool required to run a compiled version of Astrometry.net under Windows.

The following list indicate tested application and give the Cygwin path you must configure in the [astrometry preferences](#).

At the time of writing all these application use the same 2010 version 0.38 of Astrometry.net.

- [ANSVR](#), set Cygwin path to C:\Users\[your user name]\AppData\Local\cygwin_ansvr
Install up to step 10 as indicated in the web based instruction.
- [Astrotortilla](#), set Cygwin path to C:\cygwin
- [All sky plate solver](#), set Cygwin path to C:\Users\[your user name]\AppData\Local\Astrometry
- [Windows subsystem for Linux](#), let you use a more recent version of astrometry.net but it require you install the 64 bits version of CCDciel.

Astrometry.net on Windows subsystem for Linux

With Windows 10 or 11 64bit you can also install the [Windows subsystem for Linux](#). This let you use a more recent version of astrometry.net, the same as with Ubuntu or another available distribution.

But this require a 64 bits build of CCDciel because the Linux environment cannot be initialized from a 32 bits program.

If you want to try the instruction below you have to install the 64bit version of CCDciel first.

You must be sure all your ASCOM drivers work with a 64bit application.

Follow the [instructions](#) to activate the Windows subsystem for Linux on your computer and install the Ubuntu variant.

After the installation is complete, open the Ubuntu window to execute the following Linux commands:

First you need to update the list of packages:

```
sudo apt update
```

Then upgrade the libraries to the latest version:

```
sudo apt upgrade
```

Finally install astrometry.net:

```
sudo apt install astrometry.net
```

Download the index files depending on your [image scale](#), for example down to 16 arc minutes you need the indexes 06, 07, 08-19.

```
sudo apt install astrometry-data-2mass-06 astrometry-data-2mass-07  
sudo apt install astrometry-data-2mass-08-19
```

Alternatively you can also use the index that are already installed on the Windows system by editing the configuration file:

```
sudo nano /etc/astrometry.cfg
```

For example to use the index installed by Astrotortilla in C:\cygwin\usr\share\astrometry\data add a row:

```
add_path /mnt/c/cygwin/usr/share/astrometry/data
```

You must let the Cygwin path blank in the [astrometry preferences](#) so CCDciel use the wsl.exe command to run the solver.

PlateSolve 2

PlateSolve 2 can be used to solve the image you just taken with your camera. Astrometric solving will give the exact astronomical position of the image center, its orientation and size.

Look at the program page for instruction <http://planewave.com/downloads/software/>

Download and install the program and download and extract one of the two available star catalogs e.g. the UCAC3 in a sub folder. Configure the star catalog in the PlateSolve2 program. Then configure the [program path](#) in CCDciel.

You could test its operation manually by loading an image in PlateSolve2. It requires an position and image dimensions if not contained in the image header.

Linux and Mac

This is a Windows only software but it runs on Linux with Wine.

Use winetricks to install the required VB6 dependency:

```
winetricks vb6run
```

To install Wine on Linux or macOS see [Wine web pages](#).

On Linux the best way is to install the wine packages provided by your distribution.

Apache reverse proxy

The Apache reverse proxy can be used to secure the connection when you access resources over the Internet. This concern the [CCDciel Status](#) page and the [ASCOM Remote devices](#).

You need a Apache web server running on a device accessible from the Internet, use the NAT configuration of your Internet router to forward the port 443 to this device.

Setup a default [SSL Apache configuration](#), setup [Let's Encrypt](#) to get a certificate,

CCDciel status page

Install the module proxy_http in your [Apache web server](#) and add the following to a SSL virtual host configuration:

```
<Proxy *>
    Require all granted
</Proxy>
<Location /ccdciel/>
    AuthName "protected area"
    AuthType Basic
    AuthUserfile ../../.htpasswd
    Require user myuser
    ProxyPass http://192.168.1.10:3277/
    ProxyPassReverse http://192.168.1.10:3277/
</Location>
```

Where “/../../htpasswd” is the password file, “myuser” a user name in this file, “192.168.1.10” the IP address of the observatory computer running CCDciel.

Use the [htpasswd](#) command to generate the password file.

You can now access this page with the URL: <https://myhome.server.dynamic.ip/ccdciel/> , give the password for myuser ... et voila.

ASCOM Remote Server

Use a configuration similar to above:

```
<Location /api/>
    AuthName "protected area"
    AuthType Basic
    AuthUserfile ../../.htpasswd
    Require user myuser
    ProxyPass http://192.168.1.104:11111/api/
    ProxyPassReverse http://192.168.1.104:11111/api/
</Location>
```

The password file and user is the same as above, “192.168.1.104” is the IP address of the computer running the ASCOM Remote Server on port 11111.

To use this connection, setup the ASCOM remote protocol to https, the host to the IP of the web server, the port to 443 and the user/password defined in the .htpasswd file.

The ASCOM remote password is stored in the CCDciel configuration in the .credential file. It is not stored in clear

text but it is better if you protect this file in some way, for example: `chmod 600`. And most important do not reuse the same password elsewhere.

Compilation of the source code

CCDciel is written in Pascal language using the Lazarus IDE and can be compiled with the Free Pascal Compiler. By following this steps you can compile, modify and debug the program from the Lazarus IDE.

Install the compiler and IDE

You can download the last version of the IDE from:

<https://www.lazarus-ide.org/index.php>

For Windows a single setup install both the compiler and IDE. On Linux or Mac you need to install the three packages for the compiler, the compiler source and the IDE.

Look also for any specific requirement for your platform. On Mac for example you must install the Xcode command line tools first.

You can learn more in the Lazarus documentation

https://wiki.lazarus.freepascal.org/Lazarus_Documentation

Install CCDciel source code

The best solution to install the source code is using Git.

On Linux install the git package from your distribution.

On Windows install the program from <https://git-scm.com/downloads>

Open a command shell in the directory you want to install the source code and type:

```
git clone https://github.com/pchev/ccdciel.git
```

If you want to submit change to the source code later I suggest you start your own fork on Github instead. This make very easy to submit pull request when need.

Install the required components

Before you can open the project in the IDE you must install the components used by CCDciel. You must skip this step if you already install the packages for Cartes du Ciel.

Start the Lazarus IDE, select the menu Package / Open package file (.lpk)

Navigate to ccdciel/component/ and open the file ccdcielcomponents.lpk

Click the button Compile, wait it finish. Select Use / Install, validate and accept to rebuild the IDE.

After the IDE restart you are ready to use the CCDciel source code.

Compile CCDciel

Open the Lazarus IDE, select the menu Project / Open project...

Navigate to ccdciel/src/, open the file ccdciel.lpi

Select the menu Run / Compile

You can change the compilation option using the "Build mode" button. Most useful is to select Debug.

Running and debugging the program

Before to run the program from the IDE you must tell it where it will find the required data files.

This suppose you also install the latest package for the program executable.

Select the menu Run / Run Parameters

In the field "Working directory" type the following depending on the system:

- Windows : C:\Program Files\CCDciel
- Mac: /Applications/CCDciel
- Linux: /usr/bin

Then select the menu Run / Run

Automatic build and packages creation

The program can also be compiled and build automatically using the scripts in the main directory.

Compilation can be done with ./configure + make. See the build*.sh scripts for more information.

Documentation index

Tutorial

Start by this tutorial to quickly get an idea how the program work.

- [The program screen](#)
- [Connecting the equipment](#)
- [Global configuration](#)
- [Focusing](#)
- [Simple capture](#)
- [Plate solving](#)
- [Automated sequence](#)
- [Video tutorial](#)
- [FAQ](#)

Reference Manual

This give detailed information on every program aspect. The pages follow the order of the main menu.

- [Menu File](#)
- [Menu Edit](#) with the devices and preferences setting
- [Menu Tools](#)
- [Menu Image](#) same as the image right click menu
- [Menu Display](#) to show the different tool box
- [Menu Help](#)
- [Status bar](#)
- [CCDciel status](#) web page.
- [Scripting](#)
- [Script reference](#) for Python and other software.
- [Command line options](#)
- [Image preprocessing](#)

Installation

To install the software look at the page corresponding to your computer.

- [Installation on Ubuntu, Debian](#)
- [Installation on Linux](#)
- [Installation on Windows](#)
- [Installation on macOS](#)
- [Installation of Hyperleda database](#) (all computer)
- [Compilation](#) of the source code

External dependencies

You must install this softwares to take full advantage of CCDciel, at least one in each category:

- **Equipment driver**
 - [ASCOM](#) or [INDI](#)
- **Plate solving**
 - [ASTAP](#)
 - [Astrometry.net](#)
 - [PlateSolve 2](#)
 - [PlateSolve 3](#)
- **Auto-guider**
 - [PHD2](#)
- **Planetarium**
 - [Cartes du Ciel](#)
 - [Halo Northern SKY](#), need a version more recent than 4.1.5
- **Image preprocessing**
 - [Siril](#)
- **Python scripting**
 - [Install Python](#) for extended scripting capabilities

Credit

Tools

CCDciel make use of the following development tools:

- [Free Pascal](#) compiler
- [Lazarus](#) IDE and library
- [BGRABitmap](#) component
- [Synapse](#) library
- [WCSTools](#) library
- [LibRaw](#) library

Developer

- Patrick Chevalley
- Han Kleijn

The source code is available from [GitHub](#)

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