CCDciel

Program documentation

Edited: March 14 2021

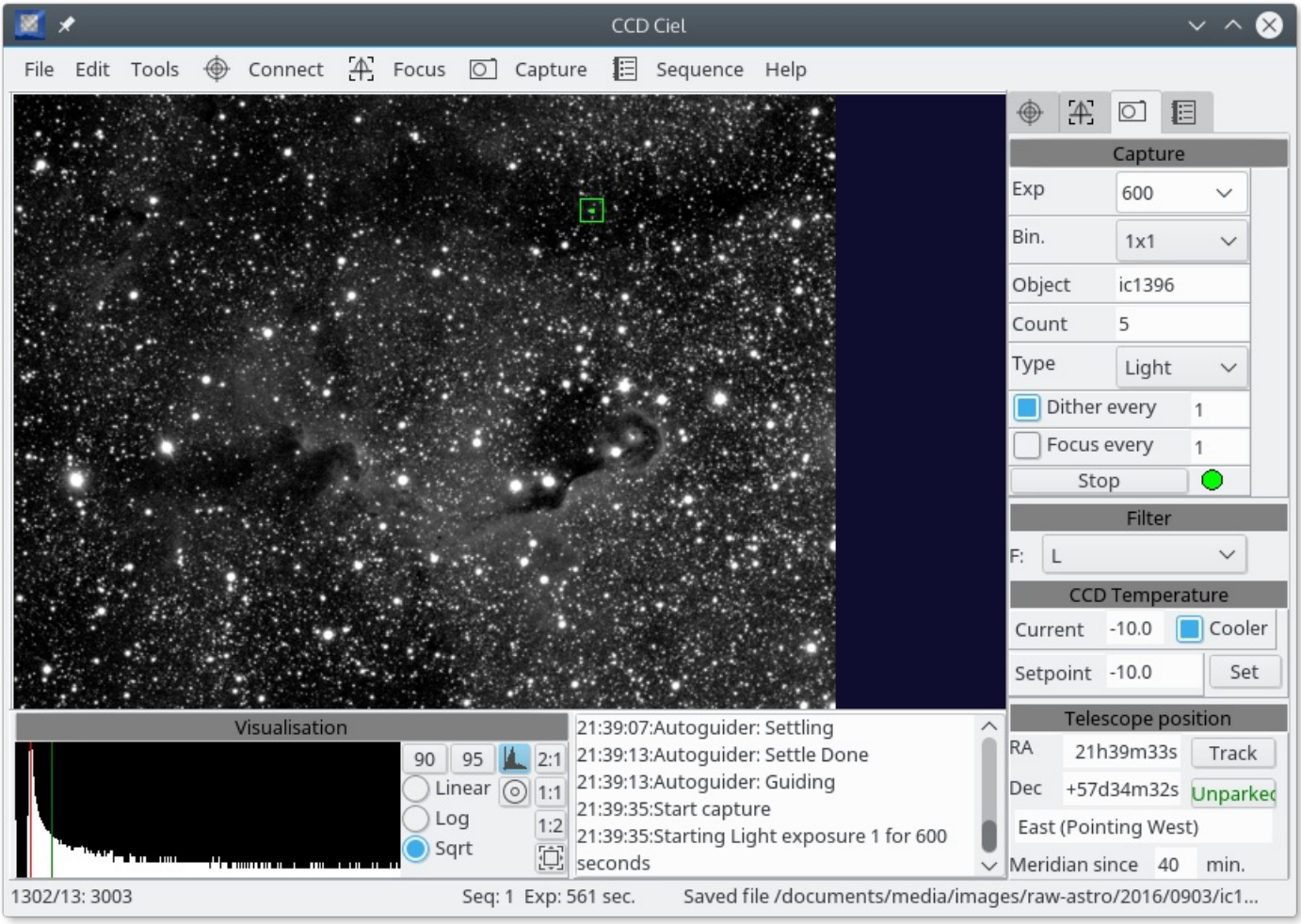
Last version is available from the wiki at
http://www.ap-i.net/ccdciel/en/documentation/start

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 and ASCOM standards drivers. It can control the CCD/CMOS camera, focuser, filter wheel, rotator and telescope mount and uses image resolving software such astrometry.net 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.
The program is still in beta version but it is now stable and run smoothly on every platform
In any case I will appreciate your help for testing this software and reporting any bug or other problem you may encounter.



A copy of the program documentation in pdf format is included with the program.

To install the program, look a the specific instructions for your computer and download from SourceForge the version you need, always get the latest version as it is frequently improved!

You can ask the user group for any question about the software usage.

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, 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 bull eye 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
- Show a reference image on screen to help to manually recenter a frame
- 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 from 4 different auto-focus method the one that best work with your equipment
- 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
- 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 or Pascal language
- 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
- 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

- Automatically manage the guiding start/stop/pause during the different operations
- Options for automatic auto-guider dithering
- 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, gain, 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 (Astrometry.net, Astap, Platesolve2, Elbrus)
- Interface with two auto-guiding software (Phd2, Linguider)
- Interface with two planetarium software (Cartes du Ciel, Hnsky)
- Interface with any SAMP application (Aladin, Topcat, …)
- Interface with processing software (Siril)

Documentation

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
- JSON-RPC interface 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
  - Star Locator Elbrus
  - PlateSolve 2
- **Auto-guider**
  - PHD2 or Lin_guider
- **Planetarium**
  - Cartes du Ciel
  - Hallo Northern SKY, need a version more recent than 4.1.5
- **Image preprocessing**
  - Siril

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

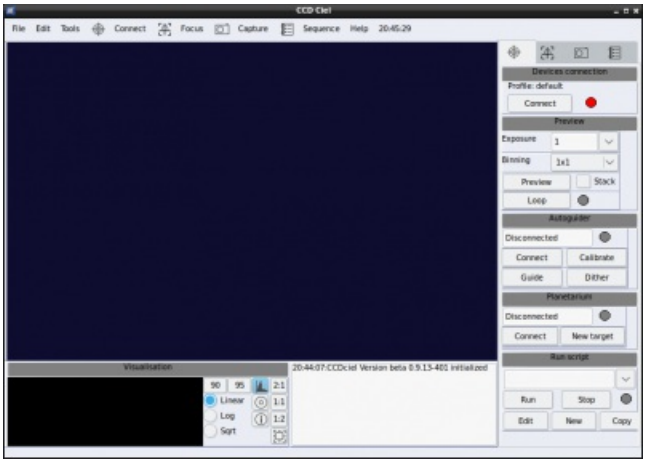
- Patrick Chevalley
- Han Kleijn

The source code is available from GitHub

License

Tutorial 1. The program screen

When you start the program you see the following screen:



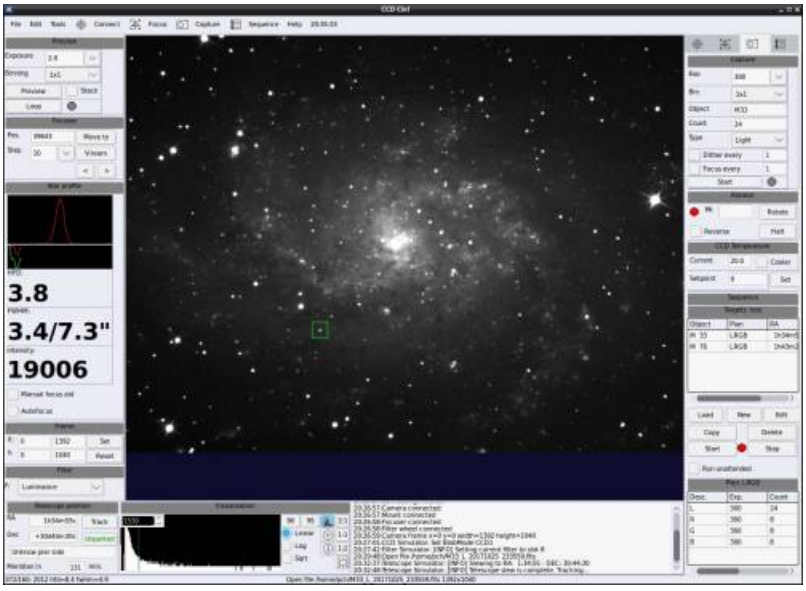
On the top you have the standard menu: File, Edit, Tools, Image, Display, Help, and four menus with a icon: Connect, Focus, Capture and Sequence. The four menus with icons are the same as on the left tabbed menus.

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.



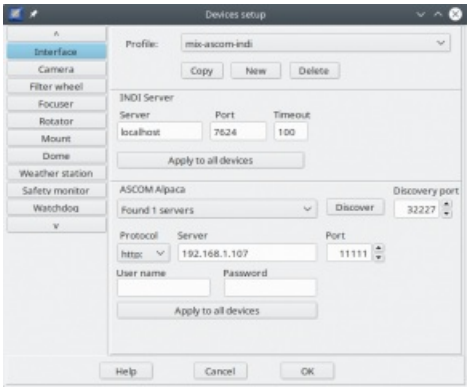
If you have a large monitor, you can make all the controls visible at the same time without using the tabs. You can also adjust the width of the right panel with the mouse depending on your screen size.

Next tutorial >>

Tutorial 2. Connecting the equipment

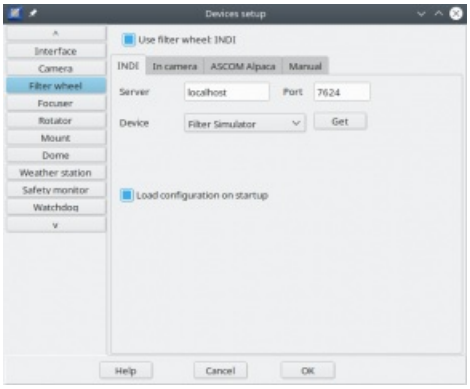
When you are a first time user, you have to select first the correct equipment drivers and set some settings.
The first time it is run the program will automatically open the **Edit→devices setup** menu.

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.

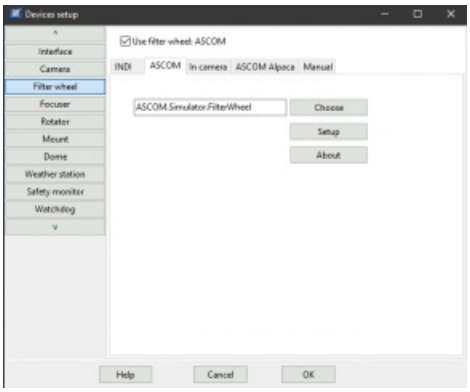


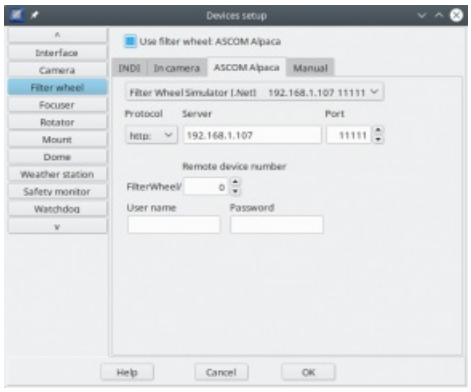
The devices can be connected locally to your computer, or remotely via a INDI or ASCOM Alpaca. You can mix devices using different protocol and managed by different server.

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.





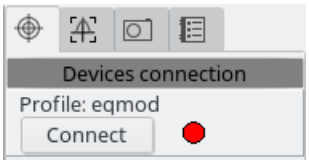
Be sure to select the mandatory camera driver and other equipment like mount or focuser but that can also be done later.

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.

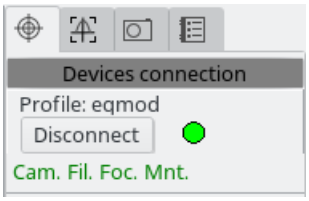
Next menu will show the default options. The first thing to do is to set the capture folder to something like like in Linux to /home/username/capture which or for windows from the default C:\ to something like C:\CCDciel

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 equimpment 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.

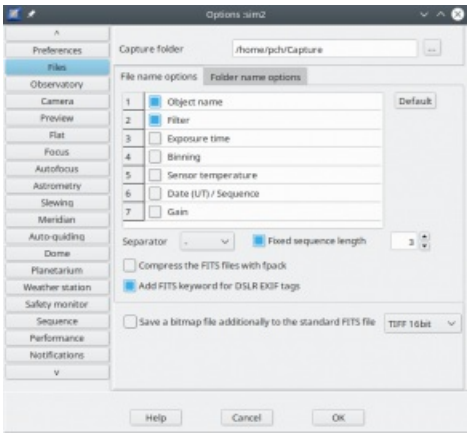
Next tutorial >>

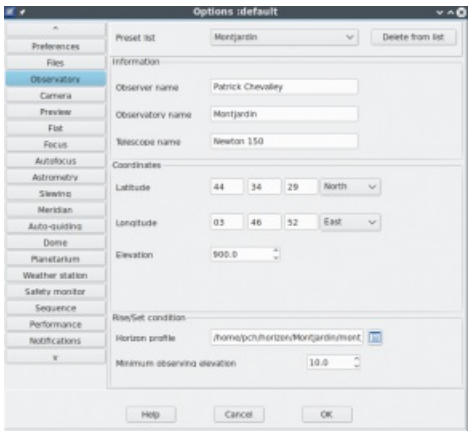
Tutorial 3. Global configuration

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.





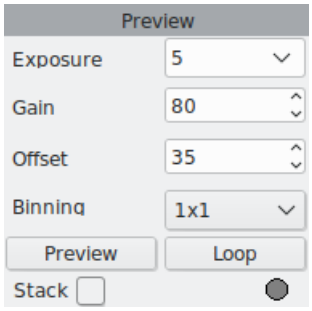
To start it is essential you set:

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.

Next tutorial >>

Tutorial 4. Focusing

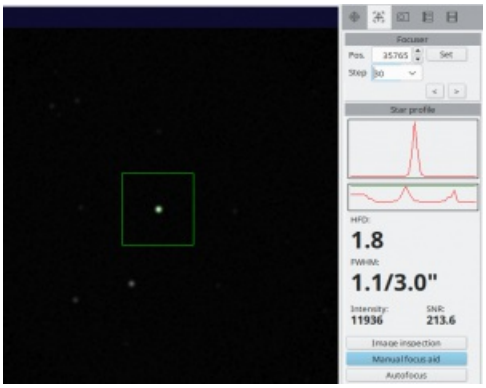
Manual focus



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



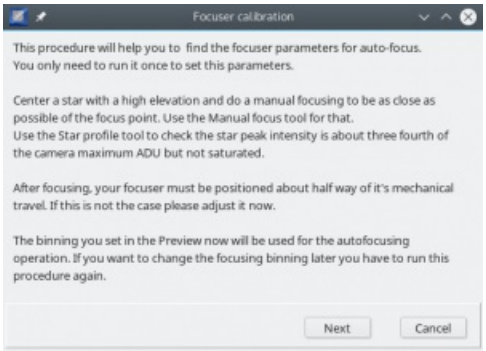
Double click on a star in somewhere the middle of the captured image. Check the recorded star intensity for saturation or have look to the star profile. The intensity value should be smaller then the sensor maximum value of typically 65535. In case of saturation select a fainter star or reduce the exposure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

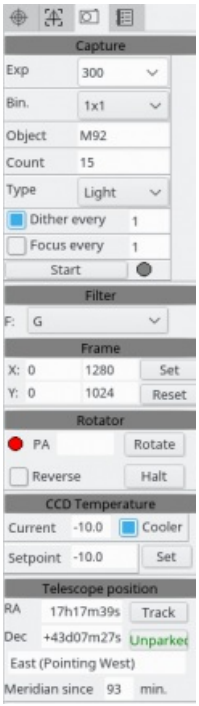
To configure the auto-focus use the Tools→focuser calibration wizard to help you set the different parameters specific to your setup.



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 his 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 1×1 or for large sensors on 2×2.

If you have a filter wheel you can specifiy the filter to use.

You can specify the frame dimensions if you don't want to use the full sensor surface.

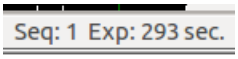
If you have a rotator the green/red light indicate if it is calibrated or not. Then you can set the rotation angle.

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



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

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:
  Focal_Length = 206.265 * Pixel_Size / 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.

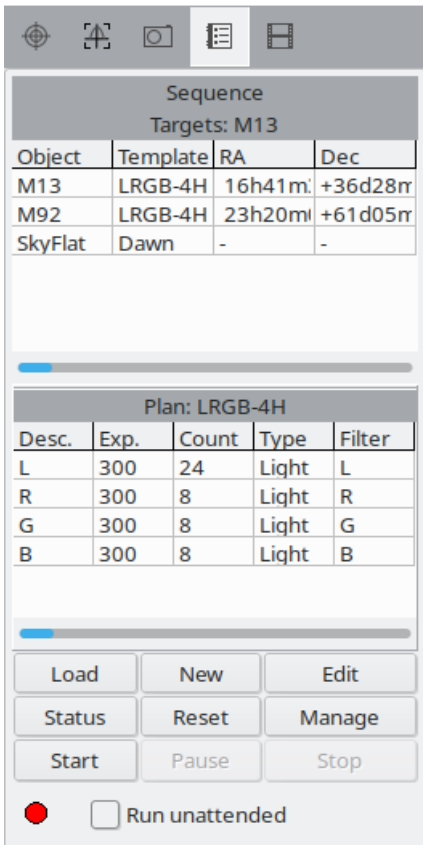
When all is ready take a preview image that show enough stars, right click and select Resolve.
Wait until it complete, in case of success it show a message with information about the image position and size.
The solved image is loaded in the viewer, an arrow indicate the direction of North and East and 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.

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

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

Introduction to sequences (30 min):

https://youtu.be/mKIuORA3I1Q

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/iImgJN6HWmA

Imaging of a comet using a sequence:

https://www.youtube.com/watch?v=7XQcfgbr0dg

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, in Preview, Capture and Sequence step.
But to avoid unwanted effect this setting is hidden by default, in this case the gain always remain what you set in the driver. This is the recommended way to use the camera.
If you really want to set the gain in CCDciel you have to check “Manage the Gain and Offset if available” in the camera preference.
Beware you must be sure to configure the gain/offset to use for the different operation in the program. You must also fully understand all the effect of this setting before to use it for other purpose than camera testing.

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.

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. 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.

Edit Menu

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

- Devices Setup
- Preferences

- INDI settings

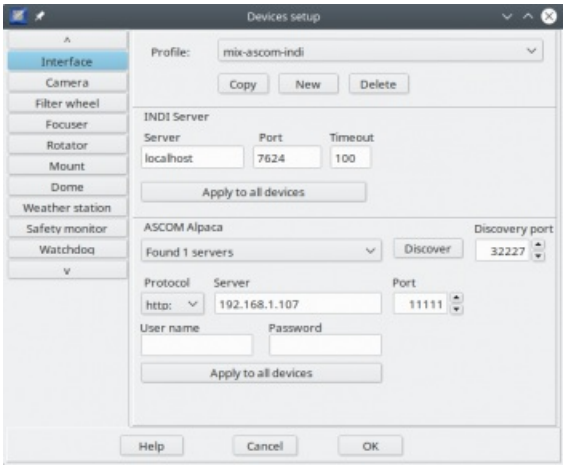
- ASCOM settings

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.

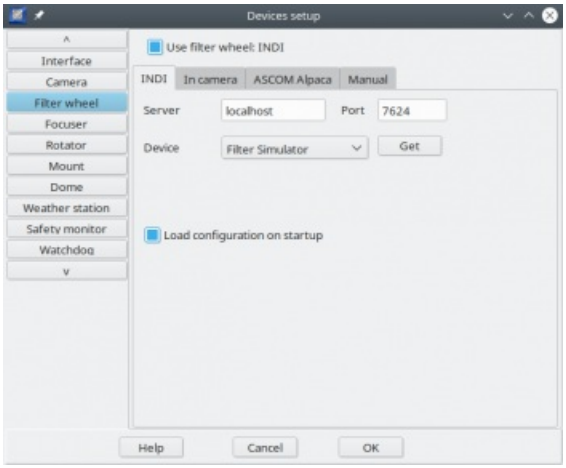
Next you can define the default server host name or IP and port for the INDI server and ASCOM Alpaca server and apply this settings for all the corresponding devices.

CCDciel itself never start the INDI or ASCOM Remote server, even if running locally. It is assumed they are already running and configured with the drivers you need.
For INDI you can start it using the command line, IndiStarter, or Indi Webmanager.
For ASCOM Remote click the “ASCOM Remote” icon in the Start menu.

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.

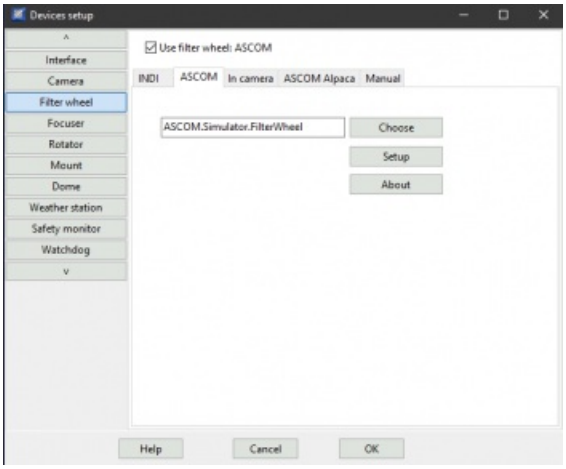
You can use at the same time devices connected to different server and using different protocol. For example the camera using a local ASCOM driver, the mount connected by INDI to a Raspberry PI and the focuser to a remote ASCOM Alpaca server.

INDI devices



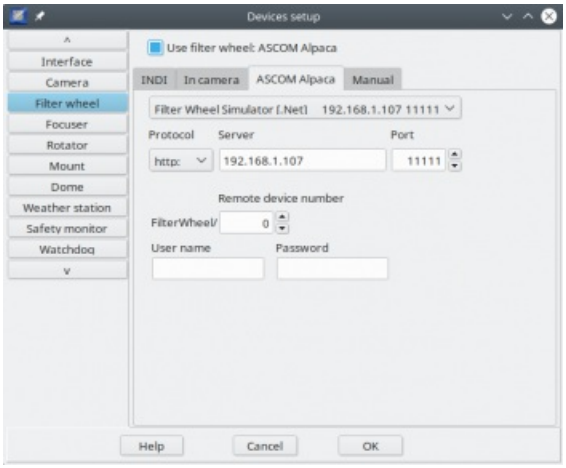
Select the INDI tab for each INDI device you want to use and check the server host name or IP address is right. If need you can set a different server for every device.
Then click the **Get** button to fill the Device list with the corresponding drivers running on the server.
Select the device you want in the list.
You can select to **load the device configuration** just after the device is connected. This is the same as the INDI client Options/Configuration/Load button. Before to activate this function you must be sure this is required for your device and you saved the right configuration from the INDI panel.

ASCOM devices

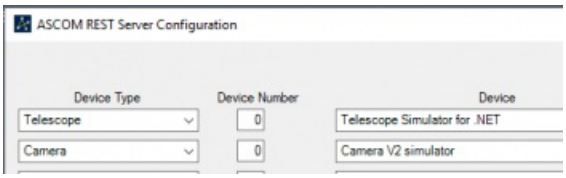


Select the ASCOM tab for each local ASCOM device you want to use. This tab is available only if CCDciel is running on Windows.
Click the **Choose** button open the ASCOM Chooser to select the driver to use.
The **Setup** button let you configure the options specific for this driver.
The **About** button 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.
When **Try to fix pixel range** is selected the program will try to recover the original pixel value depending on the CMOS camera bit depth. For example with a 12bit camera the pixel are stored with a range from 0 to 4095. This revert the multiplication by 16 done by the driver.

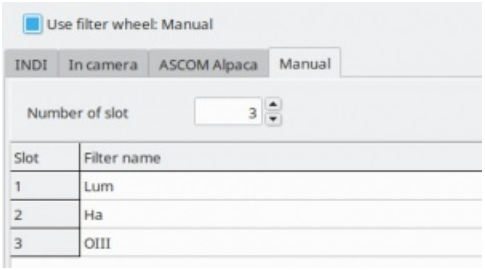
INDI:
The **Sensor** field is to select the sensor to use for dual-chip camera, you probably always want “Main sensor” here.
Select how you want INDI to transfer the image data:
Network the normal transfer mode you can use with local and remote INDI server.
RAM disk may improve the performance if you 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.

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.



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 Dome Control” or any other specific dome software. Be sure the mount is also set to a compatible driver so the dome slaving can be managed.

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.

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.

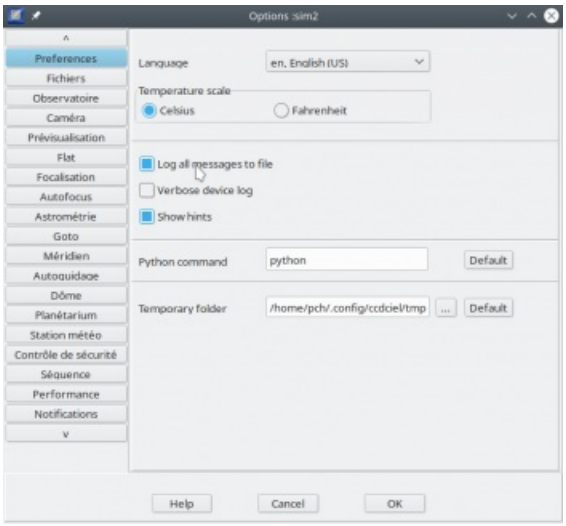
The watchdog is a specific INDI driver that can park the mount and the dome if the connection is lost with CCDciel for more than the threshold time limit. There is no similar function when using ASCOM drivers.

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.

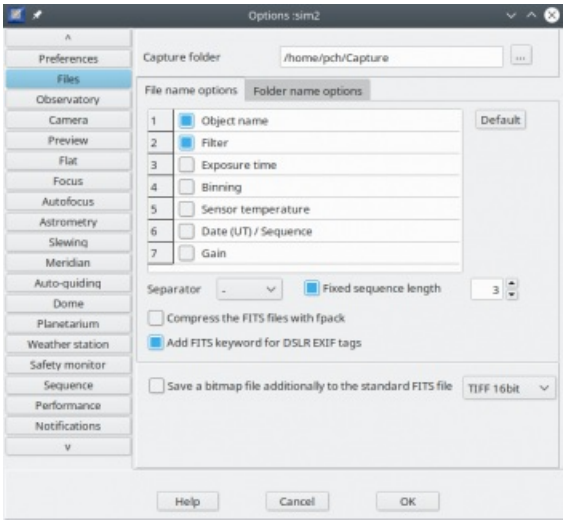
Select if you want to use Celsius or Fahrenheit temperature scale in the program.

Journaling
You can select to save all **log messages to a file** for further inspection or debugging. it is recommended to always let it checked.
You can look at the log using the function in the Help menu.
If this option is checked it also save the images in the case the auto-focus fail to find stars, 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 installation by changing the default value.

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.

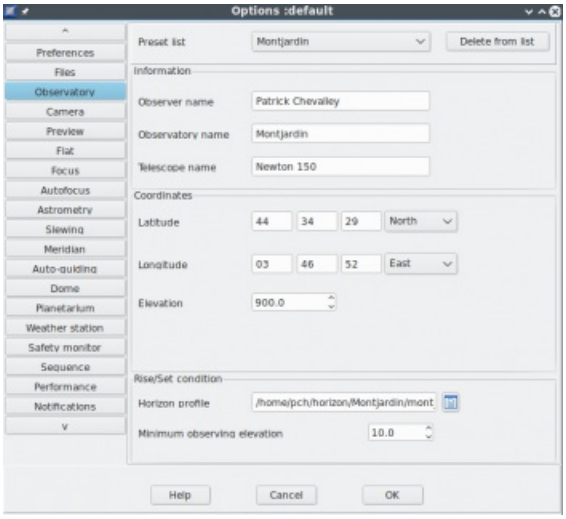
For **file name**, if Date/Sequence is checked the UT date and time is appended, otherwise a sequence number is appended.
You can select a **fixed sequence length** or let unchecked for variable length.
You can reorder the different elements with a mouse drag and drop of the sequence number column.

Select the **separator** character you want between the fields.

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 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.

Observatory



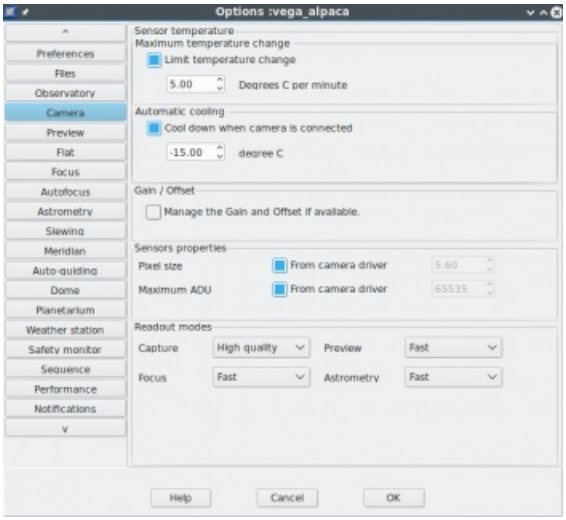
Preset list
Each new observatory name is added to the preset list for an easy later retrieval.
This is useful if you transport the same equipment at different location.
But please do not use this option to work with different equipment, in this case you need a specific profile for each.

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

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.

Gain / Offset

Select if you want to manage the camera gain and offset from CCDciel or use the fixed value set in the camera driver.
If this box is checked you **must** set the gain and offset in the Preview, Capture and Sequence box. You must also set the gain and offset you want for the auto-focus and slewing operation.
This can work only if the camera driver expose this values. For ASCOM driver this is available only with new drivers using the version 3 of the camera interface.

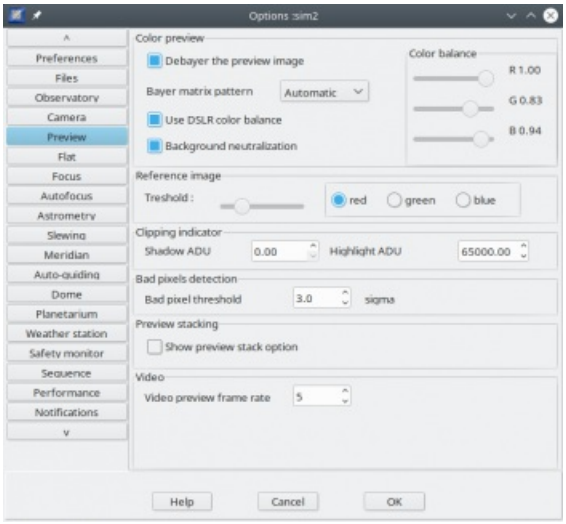
Sensor properties

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.

Readout modes

If your camera support different readout modes you can 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 to allow further preprocessing.

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.

Reference image
The **reference image** help you to frame a previous image, for example to continue a sequence.
Select the threshold and color for the display of the reference image.

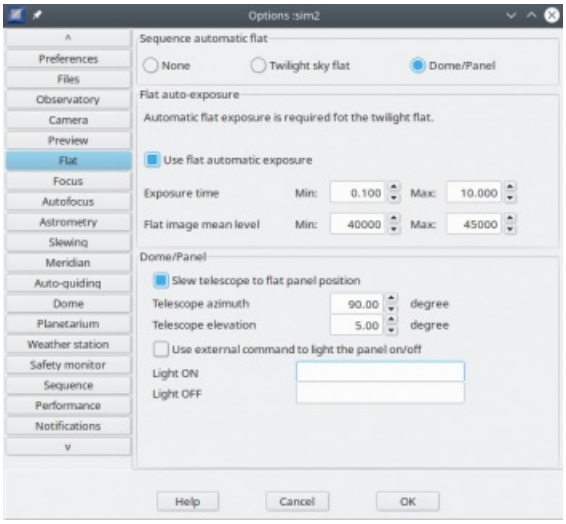
Image clipping
The image **clipping indicator** level. You can set the low and high threshold in ADU for this indicator.

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.

Stacking
Preview stacking allow you to stack the preview frames in real time. This feature is normally use for demonstration in public event.
You can select to disable this option to not risk an unwanted use during your imaging session.
Use the menu **File** → **Dark frame** to define the dark to be subtracted from the images before the addition to improve the result quality.

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

Flat

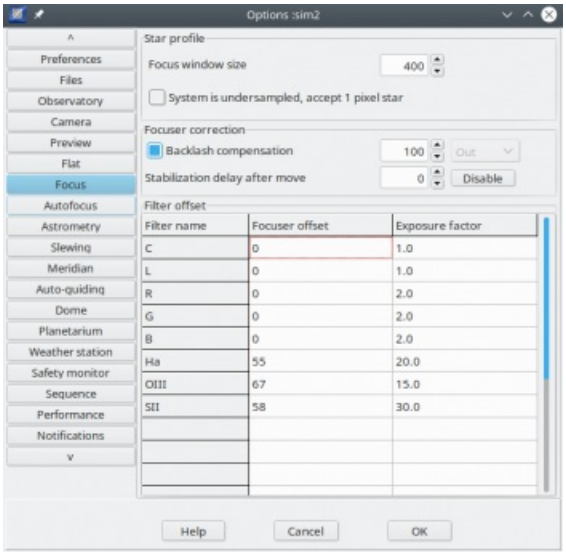


Automatic flat
Configure the method to use to capture a flat series from a sequence.

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



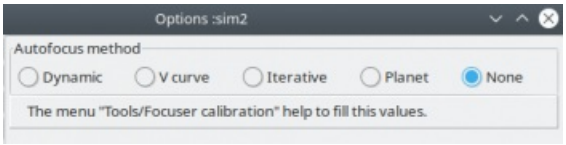
Star profile
Select the camera ROI size of the zoomed window for the single star focus mode.
Normally a single pixel star is rejected as a hot pixel. If your optical configuration produce undersampled image with single pixel star you can check this box. But be careful to make a bad pixel map to reject 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.

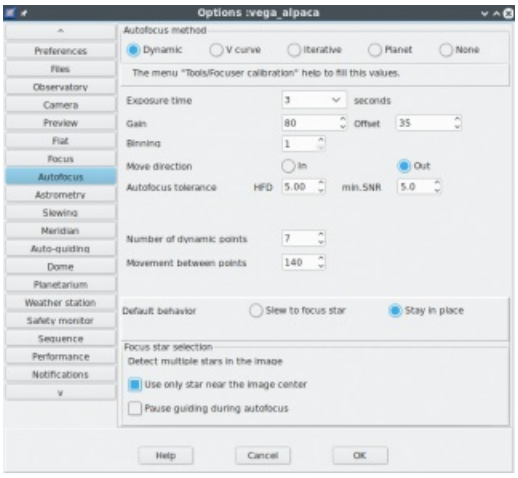
Temperature compensation
Temperature compensation and automatic triggering of autofocus after a temperature drop can be set in tab Sequence

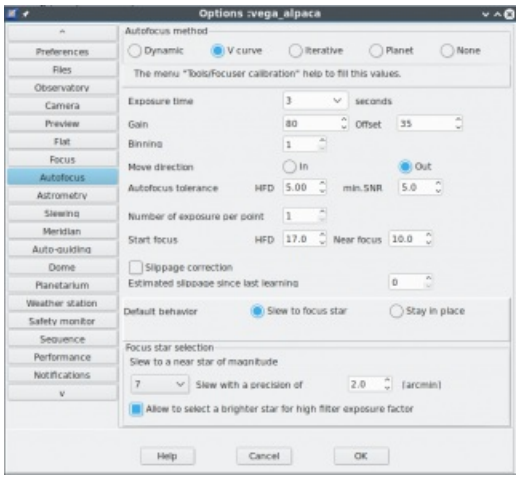
Auto-Focus



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 wizard to set the correct default parameters.

After the wizard 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:

- **Dynamic:** (hyperbole curve fitting) This method can be used with either an absolute or relative position focuser. Like the dynamic method it de-focus the star(s) and tries to fit the corresponding HFD values(s) to a hyperbole function. From the hyperbole function the bottom position so the focus can be calculated. This method has the advantage that it doesn't require a calibration in advance. It also requires less de-focusing of the stars (can work in bottom non-linear part of the curve) and therefore will work with fainter stars.
  This method will work well if you want to use the option “stay in place” for autofocus and it will use multiple stars for reliable detection.
- **V curve:** (asymptote crossing) This is a method for an absolute position focuser. It will measure the size (HFD value) of a de-focused star at several focuser positions to calculate the best focus position. In advance your system has to be analyzed using the V-curve learning tool. This routine will measure the star size (HFD value) as function of the focuser position of your setup. The slope of the two linear lines (asymptote) left and right of the focus position are constant and they cross at the best focus position. Temperature changes, filters and slippage will only shift the focus but not the slope of the two lines.
  Once the V-curve (the slope of the two lines) has been measured accurately and saved using the V-curve learning tool, every auto focus operation will be done quick and efficient.
  This method work best with a single bright star and you need to configure the focus star magnitude you want to slew to before the autofocus routine is executed.
- **Iterative:** A dumb method that move in one direction or another as long the star diameter is smaller. Movement step is reduced at each direction reversal. It has the advantage to work with any kind of focuser, including DC motor, and you can start with a very de-focused star. But it is slow and imprecise.
- **Planet** This method is similar to Dynamic but it use a measurement of the image sharpness instead of the star HFD. This make this method suitable to focus on the Sun, the Moon or the planets.
- **None:** If you want to use your focuser only manually.

Performance comparison V-curve and dynamic focusing:

Method	Target field	V- curve focusing	Dynamic focusing
Slew to database star	Always a bright star	+++	+++
Slew to database star + Allow to select a brighter star	Narrow band filter	+++	+++
Stay in place	Medium bright stars	++	+++
Stay in place	Faint stars	+	++
Stay in place	Narrow band filter + faint stars	-	-
Dynamic focusing can work in the bottom non-linear part of the V-curve. HFD as low as 4 (twice minimum)			
V-curve focusing requires a peak HFD value of typical 15 to 20. Below peak value HFD is 10, the focus result will be less accurate.			

Common parameters

- **Exposure time** to use for the auto-focus operation. This time is multiplied by the filter exposure factor above.
- **Gain** and **Offset** to use for the auto-focus operation. This require you activate the camera option
- **Binning** to use for the auto-focus. Use binning 1×1 unless you are way oversampled.
- **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.
- 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 **use only stars near the image center** or on the whole sensor.
- 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.

Dynamic parameters

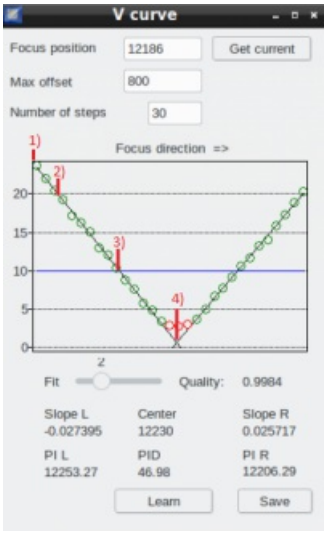
- **Number of dynamic points:** The number of points we take on the curve. Do not set too high as this is done at every focus operation. Recommended default value is 7.
- **Movement between points:** The number of focuser steps we move between each measurement of the curve. It must be set high enough to make a measurable change in star diameter, but not to high so faint stars can still be detected. The HFD value should increase at least twice 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 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 (Number of dynamic points)*(Movement between points)/2

V curve parameters

- **Start focus HFD:** The focus starting point on the V curve used to determine the Near focus position. Use a high value near the top of the V curve but inside the measurement area. A typical value is 20.0.
- **Near focus HFD:** We move the focuser to get this HFD to make the measurement on the V curve. This is **not** the focus HFD, it must be half way on the linear part of the curve. For example if your focus HFD is 3.0 and you make a V curve up to a HFD of 20.0, you can set 10.0 here.
- **Slippage correction** If your focuser is prone to slippage you can activate a correction here. You must have configured the **filter offset** and the focuser **focuser temperature compensation**, so we can be confident that the remaining offset is slippage.

The autofocus routine finds the focus in four focus movements using the slope information from the V-curve learning.

1. Move beyond the **Start focus HFD** to (1) taken into account any temperature drift. This to fix any mechanical hysteresis in your system.
2. Move to calculated **Start focus HFD** (2) taken into account any temperature drift. Here a number of exposures is taken and the average new start HFD is calculated.
3. Based on the average new start HFD of step 2) move using the slope factor to the calculated **Near focus HFD** position (3). This (3) will be already adapted to any focus drift and should be spot-on. Take a number of exposures and use the average new near HFD and slope factor to calculate the new focus position.
4. Move to the new calculated focus position (4).



- - If the SNR, signal to noise is too low, the routine is aborted.
- - Any focus drift will result in a drift of the new start HFD but not in the new near HFD.

Iterative parameters

- **Initial movement** in focuser steps. This is the movement we use between measurement on the first iteration. It is then divided by two every time we change the direction.
- **Final movement** in focuser steps. When we reach this movement value we consider we are at the focus. This is typically the focus tolerance of your optical system.

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 (Number of points)*(Movement between points)/2

Temperature compensation
Temperature compensation and automatic triggering of autofocus after a temperature drop can be set in Sequence

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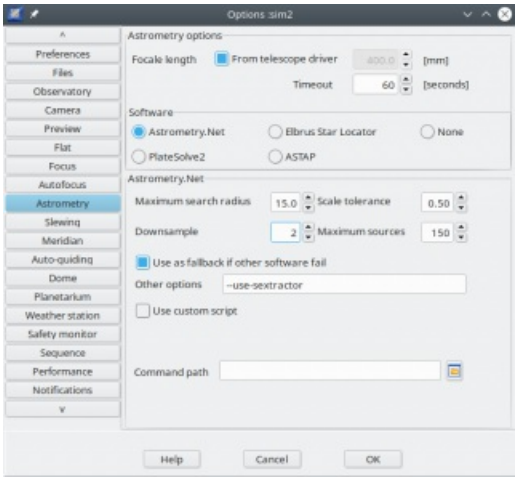
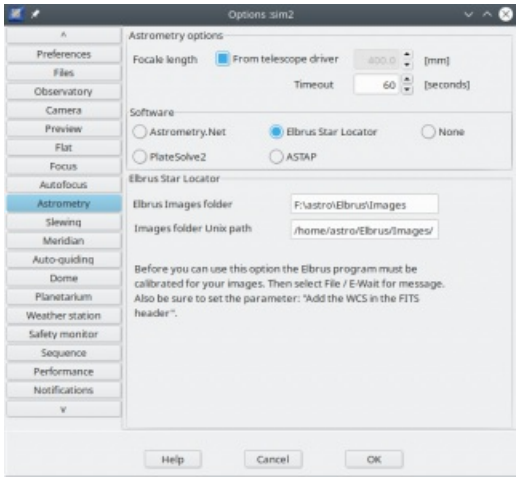
Astrometry





Global options
It is important the program know your telescope focal length to estimate the image scale to speedup the solving process. Enter telescope focal length, or if applicable for your driver, check the box to get it automatically.

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

Software selection
Select the software you want to use for the astrometry resolution of the images, you can use astrometry.net , Star Locator Elbrus , PlateSolve 2 or ASTAP.

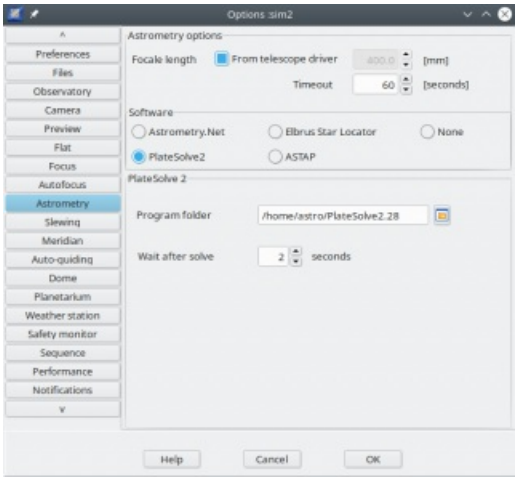
For each software you can adjust a few option to make them work quickly and reliably with your images.

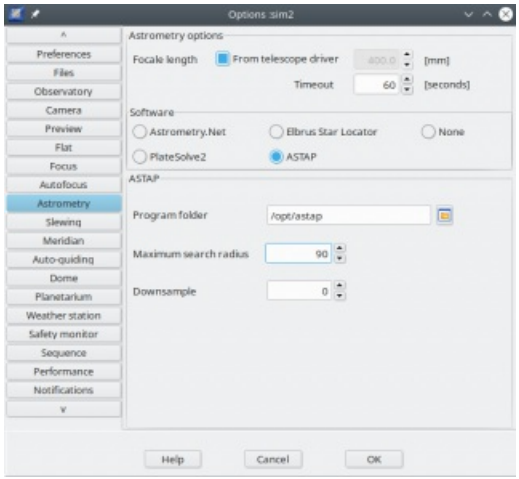
Astrometry.net options

- 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 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.

Elbrus options

- Elbrus images folder: the folder where Elbrus wait for new images to solve.
- Images folder Unix path: **Unix only**, the unix path corresponding to the previous one where CCDciel save the image for measurement.





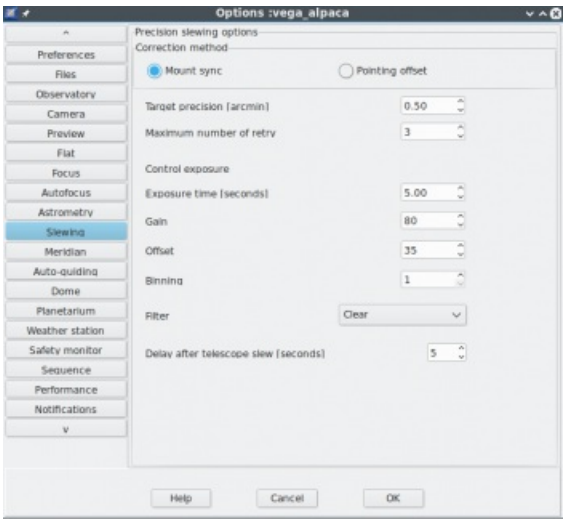
PlateSolve 2 options

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

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.

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.

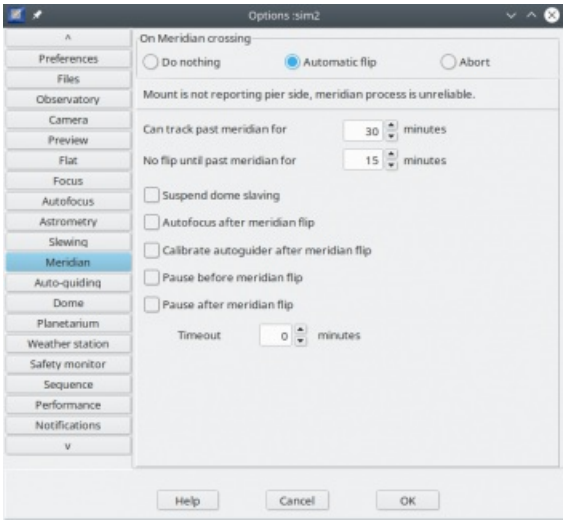
If your mount allow to sync anywhere select “Mount sync”, if not select “Pointing offset” to make the correction in software. “Pointing offset” can be useful if your telescope use a pointing model, this avoid any problem by using Sync with the model, but this can result in a wrong position to be reported 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.

Set the parameters (exposure time, gain, offset, 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.

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.
- **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.

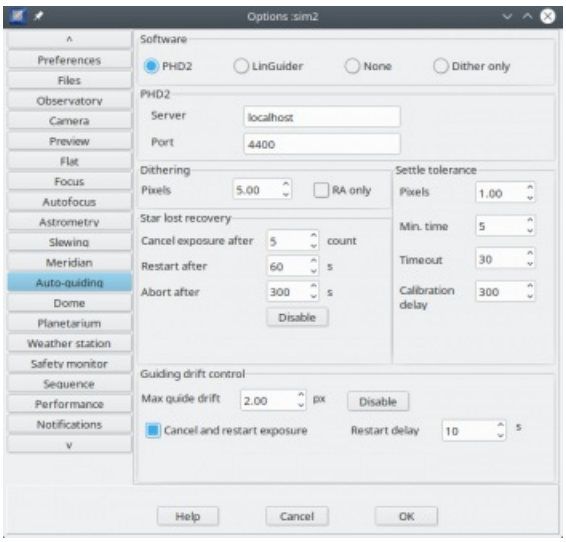
- **Can track past meridian for:** the number of minute your mount can safely track past the meridian without flip. This depend on the declination, set the smaller value here.
- **No flip until past meridian for:** the minimum number of minute after the meridian we wait before to initiate the flip. Set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

Actions to take as part of the meridian flip:

- **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 PHD2, Lin_Guider or only dithering using mount command.

PHD2 options
For **PHD2** you need to set the network name of the computer running PHD2 and the port number.

Dithering
Set the options for dithering between the exposure, the number of pixel (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.
Set also the maximum time to wait if a new calibration is required.

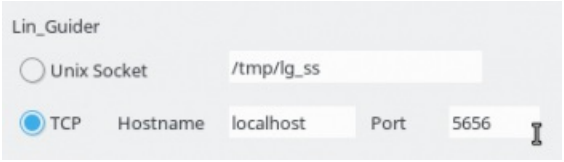
Star lost recovery
In the case the guide star is lost we can **cancel and restart the current exposure** after a number of guide step without star. This is for the case we know the current exposure will be lost anyway so there is no need to loss more time by completing this exposure.

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.

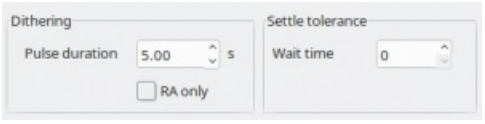
Lin_Guider options
For **Lin_Guider** you can choose to communicate by a local Unix socket or by the TCP network, on Windows only the TCP option is available. The selection must correspond to the one in the Lin_Guider general setting.



Dithering
Set the number of pixels for dithering between the exposure.

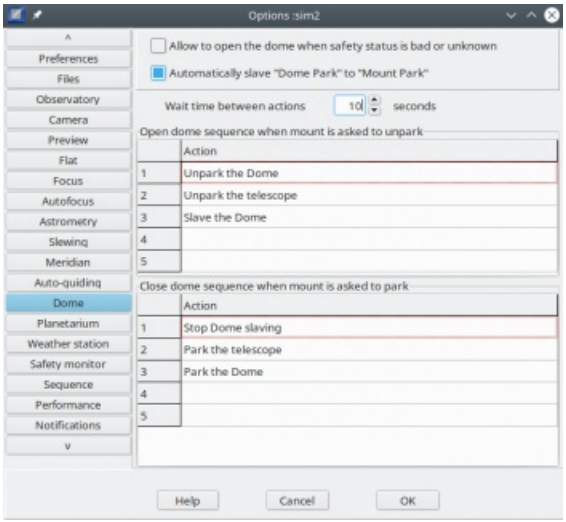
Dither only options

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



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.

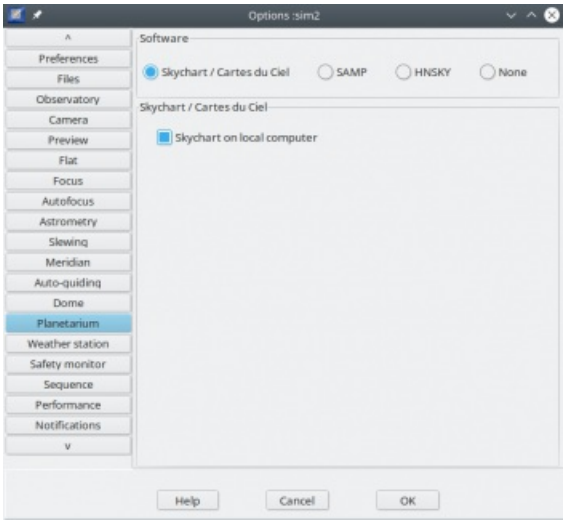
If you check the box **Automatically slave “Dome Park” to “Mount Park”**, every time you unpark the mount from CCDciel the sequence to open and initialize the dome will be taken. And every time you request to park the mount the corresponding action to close and park the dome will be taken.

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

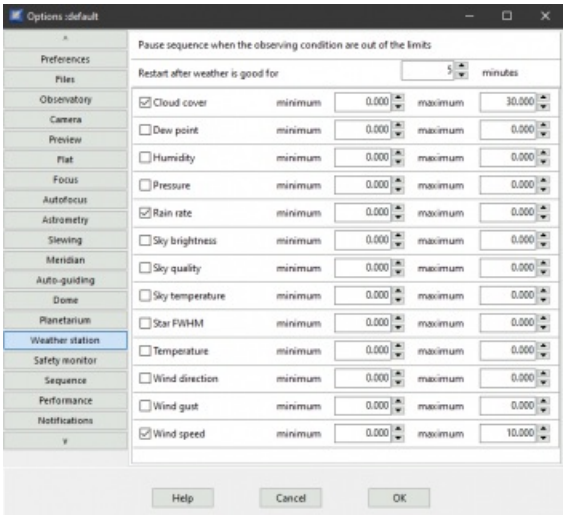


Select the planetarium application you want to use.

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.

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:

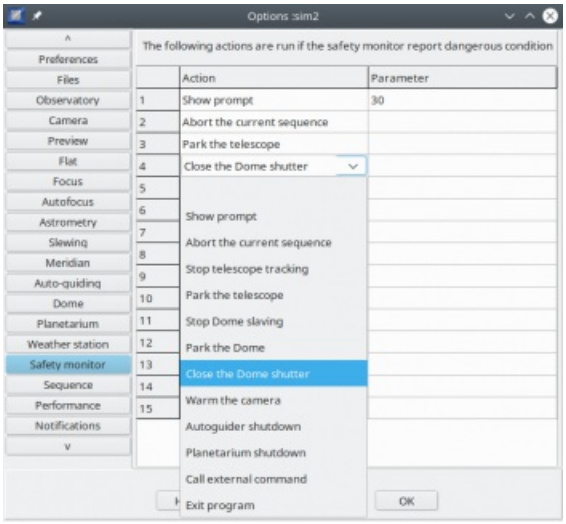
1. wait the end of current exposure
2. stop telescope tracking and autoguiding
3. wait for the sky to be clear again

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 ASCOM 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.

Safety monitor



Select the actions you want to run when the Safety monitor detect dangerous conditions.
Beware that by default it do nothing!

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.

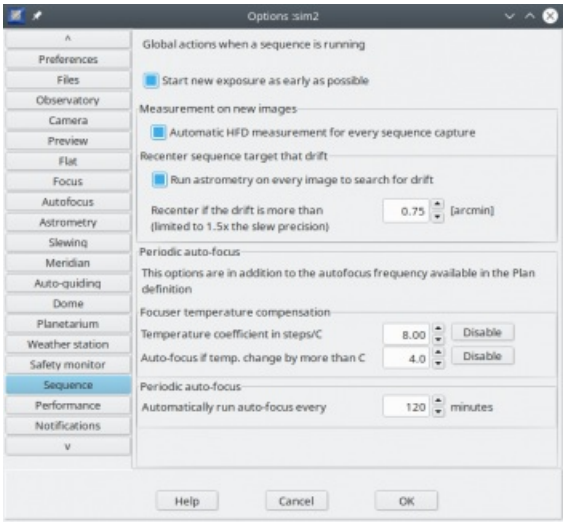
Use the function “Call external command” if you need additional actions not available in the dropdown list.

For two actions you need to set a parameter:

- Show prompt : the time to wait before to continue automatically, in seconds.
- 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.

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.

Periodic autofocus

This options are in addition to the autofocus frequency available in the Plan definition.

Focuser temperature compensation

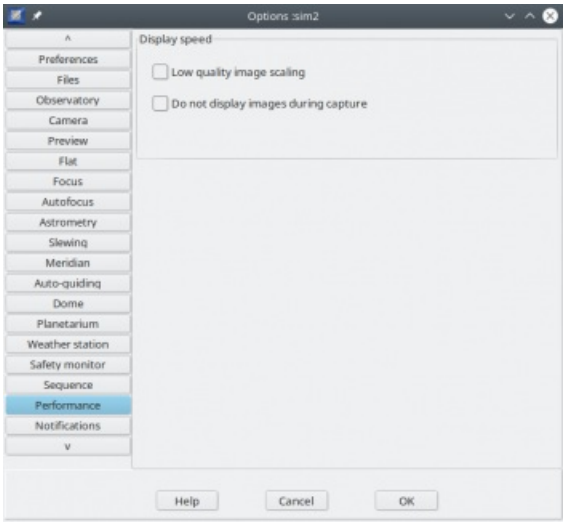
If your focuser can measure the temperature you can set here the temperature coefficient (in steps per Celsius) used to adjust the focuser position between the exposures, or to shift the auto-focus V curve accordingly. The coefficient is positive if the focuser needs to move UP in position when the temperature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

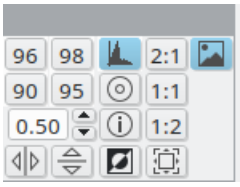


When using a computer with limited resource it is good to use this resources for the main job of capturing images as quickly as possible. This can be improved by reducing the quality of the images show on screen or by totally disabling image display when a sequence is running.
None of this option affect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

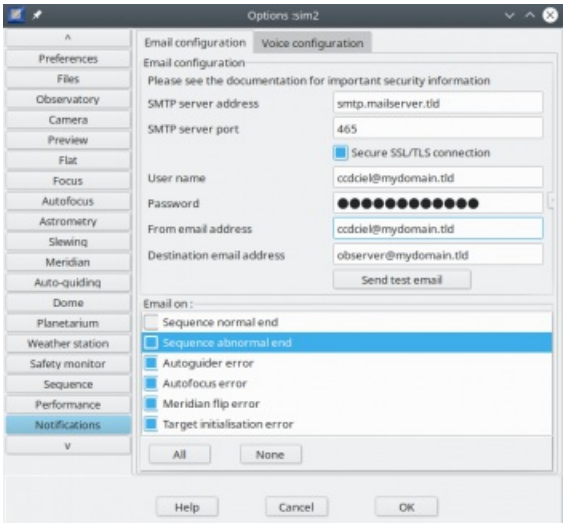
Low quality image scaling use simple pixel resampling to scale the image on screen. This iimprove the speed a lot but can produce moire pattern with OSC sensors.

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.

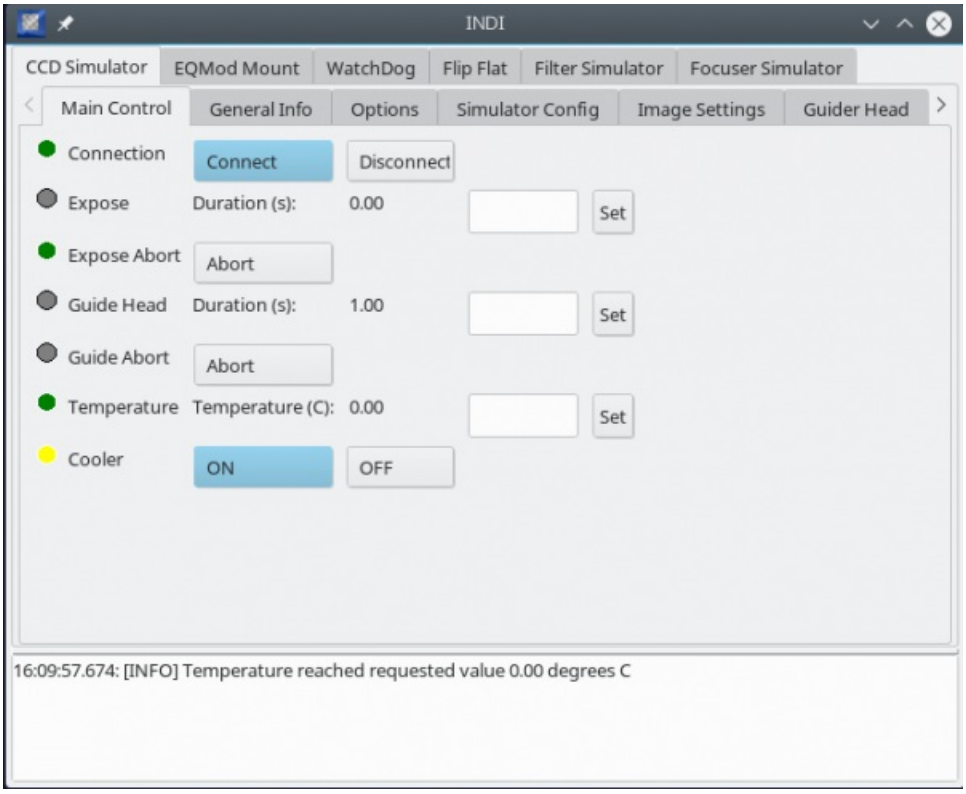
You can configure the kind of message you want to ear from the **Voice configuration** tab.

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

INDI settings

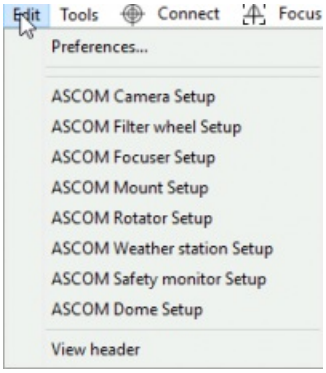
From the menu Edit → INDI settings.

This open 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:

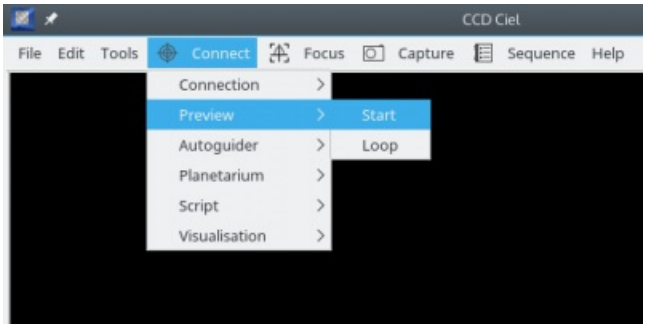
- Connection
- Preview
- Autoguider
- Planetarium
- Script
- Weather station
- Safety monitor
- Focuser
- Star profile
- Magnifier
- Capture
- Filters
- Frame
- Rotator
- CCD Temperature
- Telescope mount
- Dome
- Sequence
- Video
- Visualisation
- Messages
- Clock
- Reset to default → 1 column layout → 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.

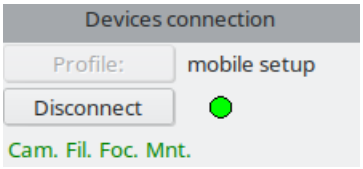
This correspond to the main functionality for a capture session.

- 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:



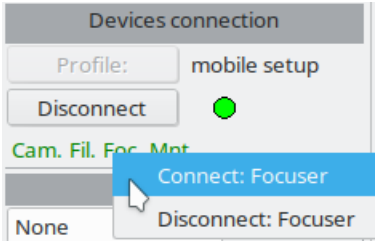
Connection Tool



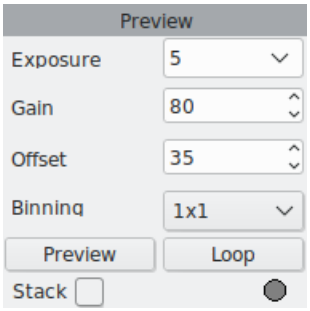
This tool let you connect or disconnect your equipment and monitor the status. It is a mandatory tool as the first thing to do after starting the program is to click the Connect button.

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.
You can also change the **Gain** and **Offset** or the “ISO” if supported and activated in the options
The camera lens **F-Stop** when using a supported INDI DSLR.

This setting is totally independent of the Capture setting.

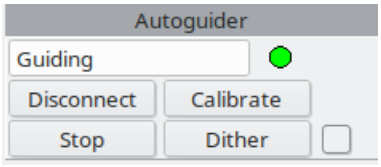
Click **Preview** for a single exposure or **Loop** to take exposure continuously until you stop it with the same button. The light change to green when the loop is active.

If you activate the “preview stacking” in the preferences you also see a **Stack** check-box.
When it is checked, every preview frame is added to the previous ones.
Use the menu **File** → **Dark frame** to define the dark frame to subtract from each image before the addition.
If a bright enough star is present the frames will be aligned on this star.

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 start the Loop, or after you take a preview without this option.

Autoguider Tool

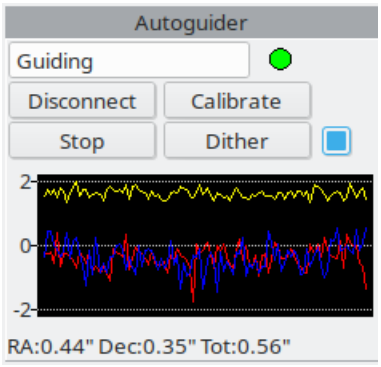


This tool is to interface with the external autoguider.

Start the autoguider application and then click the Connect button.

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.

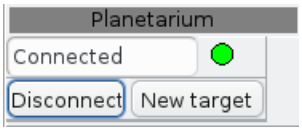


The blue curve represent the RA error, the red the Declination error and the yellow is the star mass.
The vertical scale is in arc-second. It is adjusted automatically for the current range, so don't be afraid by large apparent variation as long the total range is small.

Below the graph is the current RMS error of the last 100 guide frames.

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

Planetarium Tool



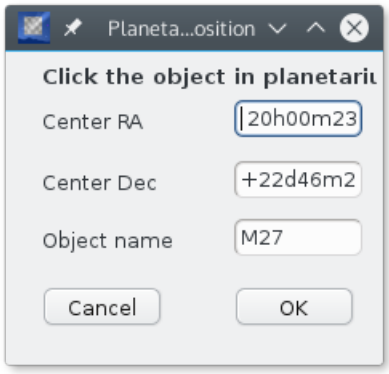
This tool is to control the connection to the planetarium.

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

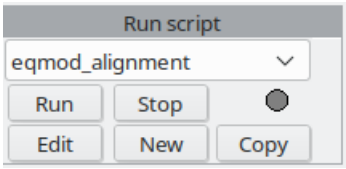
Click the **New target** button, click or search an object in the planetarium, then click OK.
This make a plate solved slew to the object position and set the object name in the Capture tool.
You must have a camera and mount connected before you can use this function.

The same box is used in the sequence editor to set the target coordinates.

Note that the target coordinates are apparent and could differ from the planetarium if the planetarium displays the position in equinox J2000 coordinates.



Script

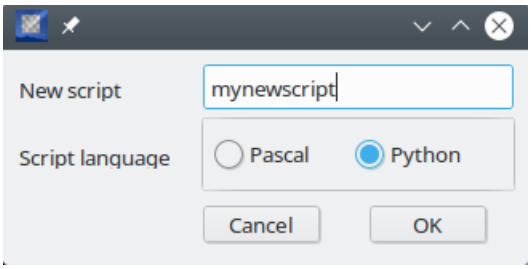


This tool let you create or run a script

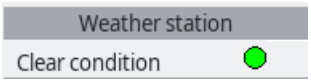
The scripts can be used to automate some task in CCDciel or to interface with external program for example to manage your observatory and equipment.

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.

After you click the **New** button, a prompt ask you for the script name and the programming language you want to use.



Weather station tool



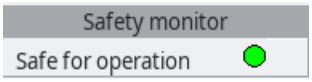
This tool show the status of the weather monitor, when the light is green the observing condition are good, for example there is no clouds.

If a sequence is running when the weather go bad, the sequence is paused until the condition 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.

Safety monitor tool



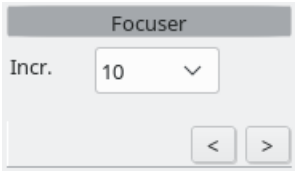
This tool show the status of the safety monitor, when the light is green it is safe to open the observatory for observing, for example it not rain.

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.

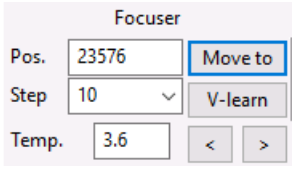
This is related but independent of the Weather station. Some sensors of the safety monitor can be related to the weather but not only. You can also be interested to monitor the UPS status to be sure you have enough battery to close the dome in case of power outage.

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.



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



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

If you select Vcurve in the autofocus preferences the button **V-learn** is visible to start the V-curve learning.

V curve learning

If you not already do it, it is strongly suggested you use the focuser calibration wizard to set the correct default parameters before to use this procedure.

Introduction
In case you have an absolute position focuser and want to use the V-curve auto-focus you have to run the V-curve learning routine first.

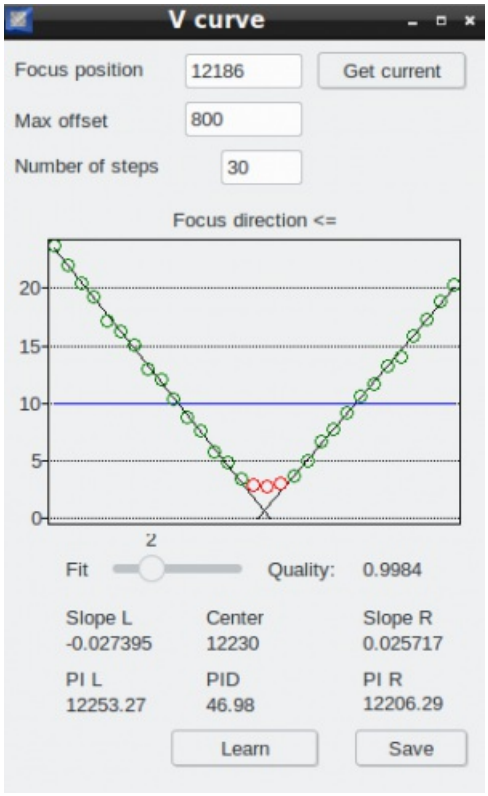
The routine steps the focuser and measures at several positions the size (HFD value) of a star. This will result in a typical V-curve of two lines left and right of the focus point, The slope of the lines will be used later in the autofocus routine for finding the focus. in this screenshot the routine will step from position 12186+800 to position 12186-800.

The focus position shown as 12186 should be approximately the best focus position. The maximum offset 800 as shown should be selected such that the HFD value at the beginning and end is above the **Start HFD focus**=20 so in this example 25.

Steps to follow
If you are using filters, select the luminance filter. Start an preview loop of about one second exposure and center on and select a bright star. Run the manual focus aid and check if the peak intensity indication is about 80% of saturation level using the star_profile tool. If not adapt the exposure accordingly or select an other star.

Be sure to stop the preview loop and press the **V-learn** button

The first time you launch this tool all the settings and graphic are empty.



Indicate the most accurate focus position you can estimate, as you make a manual focus just before you can click the **Get current** button here.

Set the Max offset value such that moving to the best focus position plus this offset give a defocused image with an HFD around 25.

Set the number of step to 30, this is a good value that allow for precision curve. But for the first try you can save some time by setting it to 10. Just remember to repeat with 30 when you are accustomed with the procedure.

When this three numbers are set click the **Learn** button on the bottom.

This curve is slowly build up until the procedure is finished. Progress in is also reported in the Log and Star profile tools.

After the measurement are completed the curve should look as in the screen shot here. The graph shows the HFD value as function of the focuser position.

Check the following important points before you continue:

- The curve must be centered with top left and right about at the same level focus in the middle.
- It must extent to about the double of the value of Near focus HFD in the options, indicated by a blue line here.
- The two branches of the V must show a long linear part, specifically on the side of the base of the focus direction arrow (right on the screen shot).
- The branches must not flatten on the top. If you remark such behavior you must reduce the Max offset value.
- The move direction should be such that the learn routine moves the focuser in the same the direction as you have to adjust the focuser manually during the night when it is cooling down. If not change the direction in settings. For a reflector (mirrors) type of telescope you typically have to turn the focuser out if the temperature drops. For a refractor (lenses) type of telescope you typically have to turn the focuser in.

At the center of the V with the points marked in red.
It is important to exclude this points from the linear regression and you can use the **Fit** cursor to exclude more or less points.

When you adjust this cursor, look to maximize the Quality value on the right but also check the aspect of the black regression line across the green circles. The linearity must be specially good at the intersection with the blue line.

When you are satisfied by the result click the **Save** button. This will save the curve parameters and mean temperature for use in the auto-focus routine.

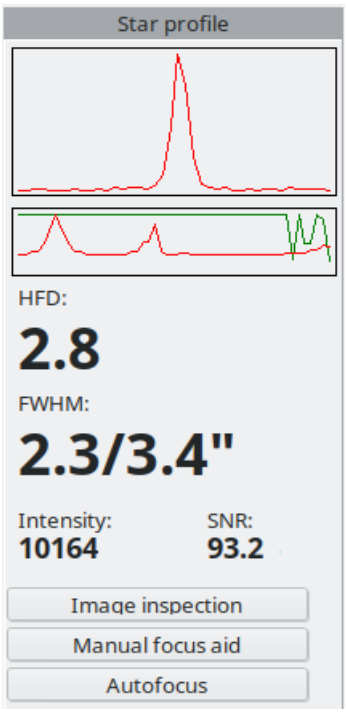
You can now try the Autofocus in the Star profile tool.

Star profile 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.

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.

The top curve is a cross-section of the star image. Try to make it as narrow as possible.

Below the previous relative HFD measurement in red and the intensity in green.

The **HFD** (Half Flux Diameter) unit is pixels.

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

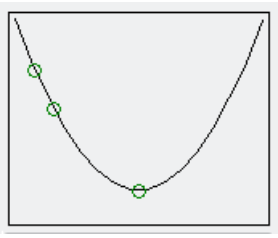
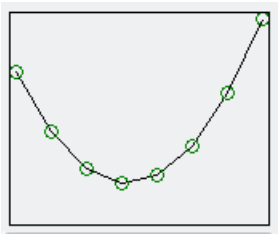
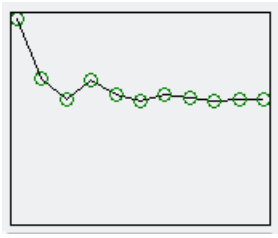
Optimum focus is reached when Sharpness or HFD / FWHM are at minimum value.

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

Auto-focus

Click **Autofocus** to start the auto-focus procedure on the selected star. You must have configured the auto-focus in advance and if applicable run the V curve learning tool and saved the result.

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.

Vcurve	Dynamic / Planet	Iterative
		

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.

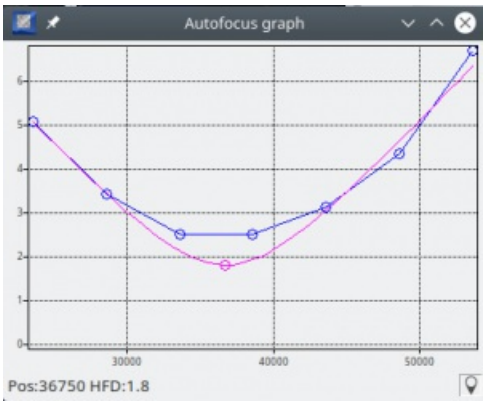
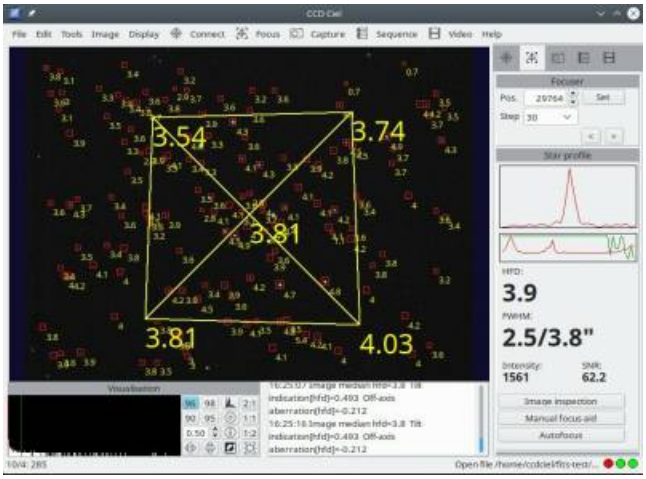


Image inspection

Click **Image inspection** to measure the median hfd value, sensor tilt and curvature.



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:

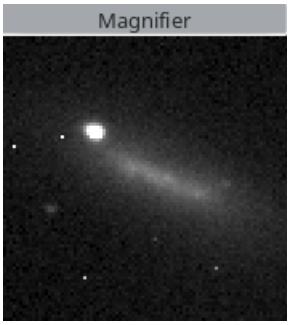
Image **median hfd** which is an excellent indicator of the quality of focusing. The lower the value the better the focusing, the sharper the stars are. The value is also depending on the astronomical seeing and the quality of the optics.

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.

Magnifier Tool

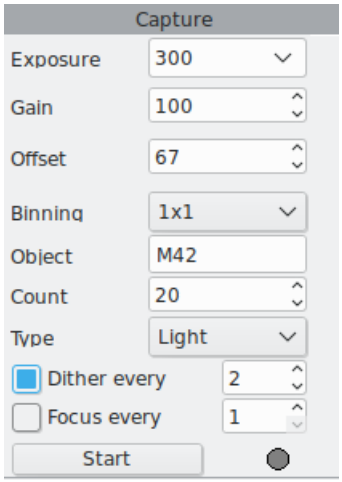
This tool show a magnified part of the image below the mouse cursor.



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.



Set the **Exposure time**, the **Gain** and **Offset** if supported and activated in the options, and the **Binning** to use. Also the camera lens **F-Stop** when using a supported INDI DSLR.

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 **Number of consecutive exposures** to be taken.

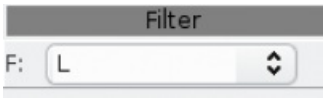
Select the **Type of frame**: Light for sky exposure. Bias, Dark, Flat for the calibration. This selection will be used for the folder name and stored in the FITS header at keyword IMAGETYP. If your camera has a shutter, it will be closed for Bias and Dark.

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 and enter the image interval. 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.

Click the **Start** button to begin the exposure series. The same button can be used to interrupt the series when it is running.

Filter Tool

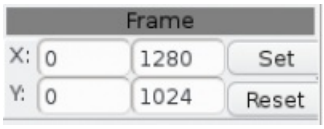


With this tool you can control your filter wheel.

It will show the currently mounted filter.

To change the filter, select one from the list.

Frame Tool



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

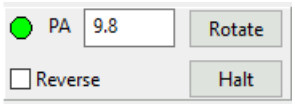
The first row is the horizontal starting point and width.
The second row is the vertical starting point and height.

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.

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**.

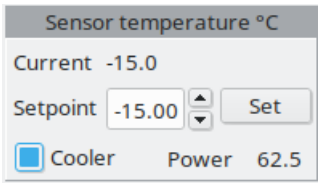
Check **Reverse** if your optical configuration require to reverse the rotation to match the celestial position angle.

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



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

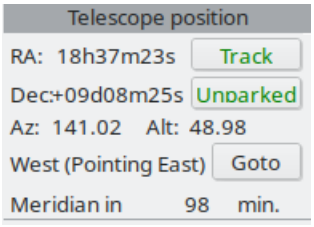
To start cooling, enter the temperature **Setpoint** (target) and click on the **Set** button. Automatically the **Cooler** check mark will be checked.

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.

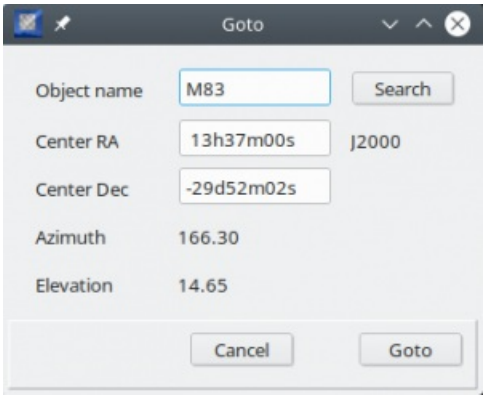
Telescope Tool



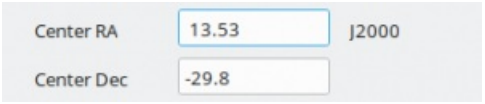
This tool display the current telescope RA/DEC and Alt/Az position, the side of pier if reported by the driver, the time to or from the meridian.

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

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



Enter an object name and click **Search** to get the position from the internal database.
You can also type directly the RA and Dec J2000 coordinates, using either the hms/dms or decimal format.



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.

You can also use the planetarium or the sequence tool to 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.

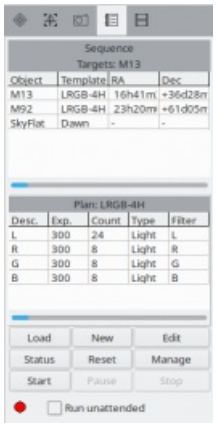
If you have a script to initialize the dome you can run it when you launch CCDciel, part of the Startup script. Or if you prefer in a script you run at the beginning of the sequence.

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.

Sequence Tool



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 **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.

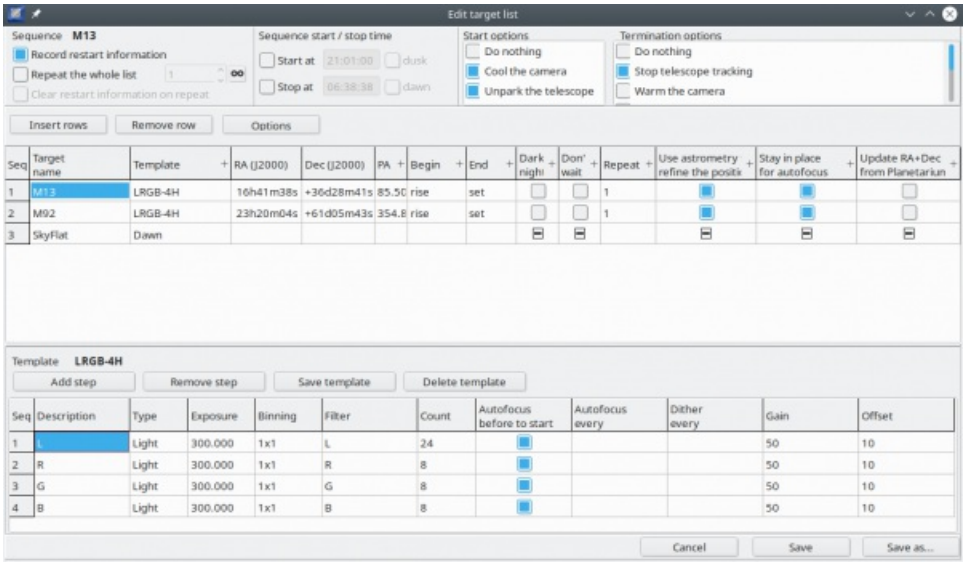
The bottom grid show you the plan for the current target. A plan name ending with a “*” indicate it is modified from the base template.
When the sequence is running the current target and step are highlighted.

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, gain or offset, 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.

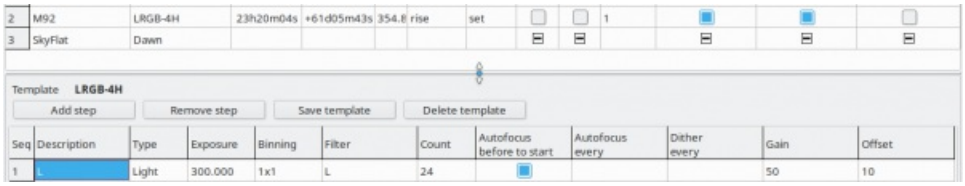


At the top of the screen is the global sequence option, when it start and end, how restart is managed, what action to take when it start and end.

Then is a list of target with the name, exposure template, coordinates, time constraint, slewing and autofocus options.

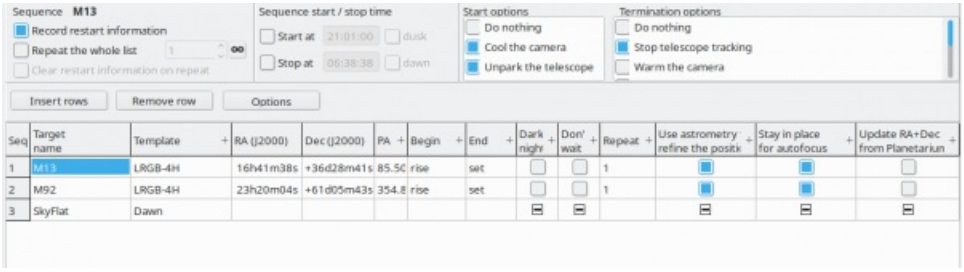
At the bottom is the list of exposure steps for the selected target. This give all the capture parameters for each exposure series. This can be selected from a template or be specific for only this target.

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 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.
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.

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.

If you are imaging a fast moving asteroid or comet you can check the **Update RA+Dec from planetarium** column 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.

Check **Use astrometry to refine the position** column to refine the telescope position with an astromery solved control exposure. This ensure the selected object is framed exactly as required.

You can check the **Stay in place for autofocus** column 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.

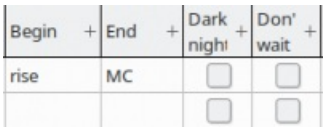
Type the desired value in the **PA** column to move the rotator at the specified angle.
You can also use the current image orientation after plate solving.
Be sure the rotator is calibrated before to start the sequence if you use celestial PA.

Set the begin and end time

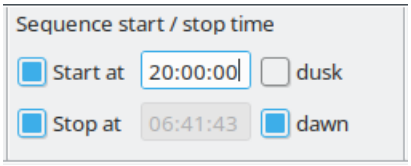
You can set a time range for this target to be imaged, it will wait for **Begin** time to start. If **End** time is reach during the exposure plan it is stopped and the next target is selected.
The default is **rise** or **set** if the object coordinates are set. This automatically use the rise or set 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.

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.

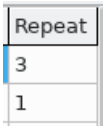


You can also define when the whole sequence start and stop.
Check the box **Start at**“ or **Stop at**” and enter the time you want.
Check **dusk** or **dawn** to adjust the time for the astronomical twilight for the date of the observation.



Repeat a target

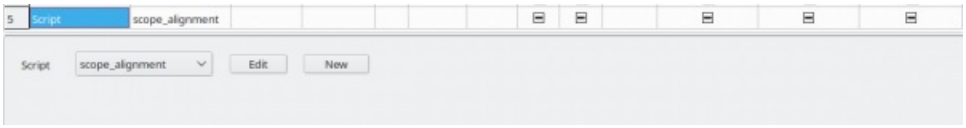
You can set this target to **repeat** it's whole plan for a number of time at a given interval between two consecutive start. Set the number of repetition in the target list.
To temporarily skip a target but keep it in the list you can set it's Repeat count to zero.



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.

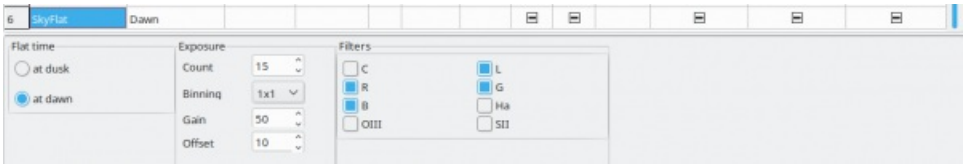
Add a script

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



Add an automatic twilight flat

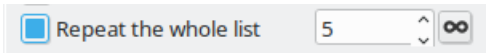
To add an automated flat click the **Sky flat** button.
Note: to take a dome/panel flat set a standard **No move** target and use a plan with an image type = Flat.



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, gain, offset, 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.

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.

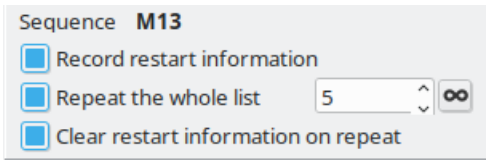


Restarting a sequence

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.

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.

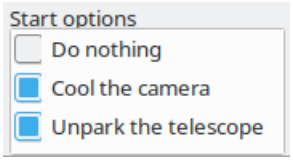


The option **Clear restart information on repeat** define how **Repeat the whole list** manage the completion of individual targets.

- 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

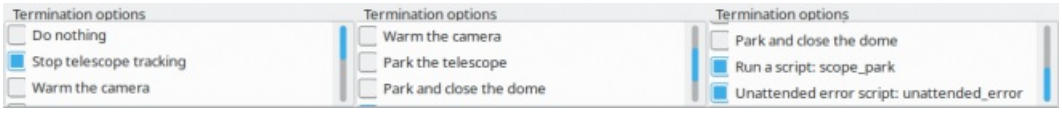


You can configure the action to take when the sequence actually start, after the start time is reach.

It is possible to start cooling the camera using the configured automatic cooling temperature. This way you can disable cooling at the camera connection so it is at ambient temperature when waiting for the start of the sequence.

You can also unpark the mount only at this point. When the dome park slaving is configured this allow to let the dome closed until the time the sequence start.

Termination options



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.

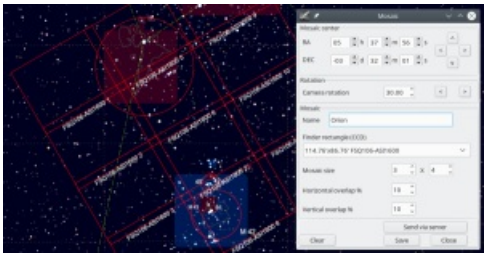
This actions are not taken when you voluntarily stop a sequence with the Stop button and the Unattended checkbox is not checked.

Beware that **Do nothing** let the mount tracking after the sequence is terminated.

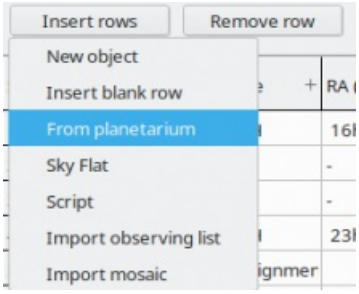
Import a mosaic from the planetarium

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	Dark night	Don' wait	Repeat	Use astrometry refine the positi
3	mosaic_01	LRGB-4H	0h45m28s	+41d41m59s	0.00			☐	☐	1	☑
4	mosaic_02	LRGB-4H	0h45m27s	+41d18m29s	0.00			☐	☐	1	☑
5	mosaic_03	LRGB-4H	0h45m26s	+40d55m00s	0.00			☐	☐	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.

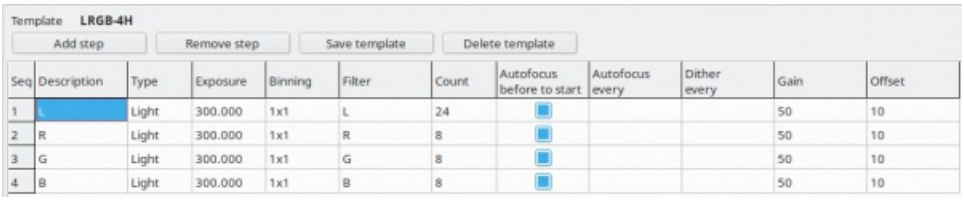
Manage the target list

You can add a new target, 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	Dark night	Don' wait	Repeat
1	M13	LRGB-4H	16h41m38s	+36d28m41s	85.5(	rise	set	☐	☐	1
2	M92	LRGB-4H	23h20m04s	+61d05m43s	354.8	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



Seq	Description	Type	Exposure	Binning	Filter	Count	Autofocus before to start	Autofocus every	Dither every	Gain	Offset
1	L	Light	300.000	1x1	L	24	☑			50	10
2	R	Light	300.000	1x1	R	8	☑			50	10
3	G	Light	300.000	1x1	G	8	☑			50	10
4	B	Light	300.000	1x1	B	8	☑			50	10

Use the plan list to specify the exposure steps to take of a target.

Add a 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, gain, F-Stop, autofocus and dither 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.

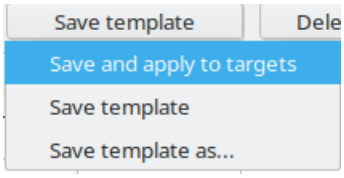
The Gain and Offset column are only visible if supported by the camera and the option to manage the gain from the program is checked.

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.

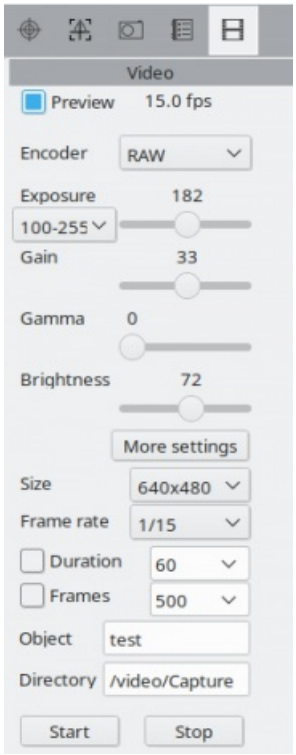
If you no more need this template you can delete it with the **Delete template** button. This not modify the exposure parameters for the current target or any other targets.

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**.

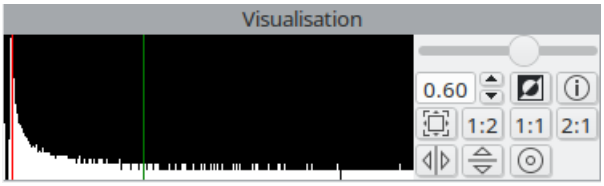
The **Object** name is use as a part of the filename.
The **Directory** where to save the video file on the computer running the INDI server.

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.

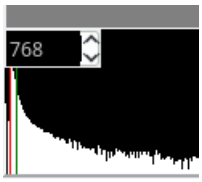
Visualisation Tool

This tool is to control the aspect of the preview image. None of the setting here 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.



It is separated in two part, an histogram of the image and the control buttons.

On the top, a cursor control the range of histogram drawing, using 90% to 100% or the active histogram range. Reducing the histogram range make the image lighter and help to see the faint nebulae in the image.

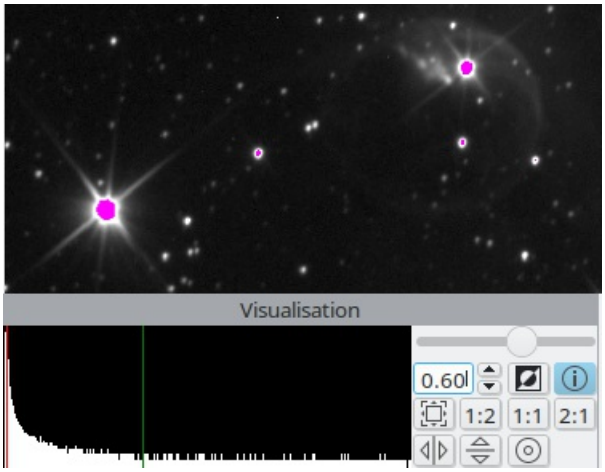


On the histogram you can move the high (green) and low (red) clipping bar with the mouse.
You can also directly edit the low and high threshold by moving the mouse cursor to the top left or right to display the edit box.

Bellow the cursor, the numeric value let you adjust the Gamma for the display. This also help to better see the faint part of the image but without saturation of the bright area. A value of 0.45 in this box allow to convert a linear image to a display image with a standard gamma of 2.2.

The next button show a negative image that can help to see faint details.

The button let you check for saturation in the image.

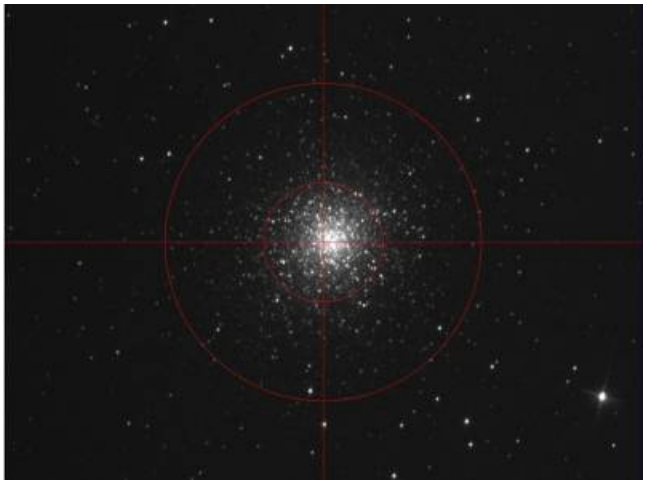


The overflow in the highlight area is marked in pink.
The clipped shadows area is marked in yellow.
You can define the clipping level for your camera in ADU in the preferences, the default are 0 and 65535.

On the next row, the 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.

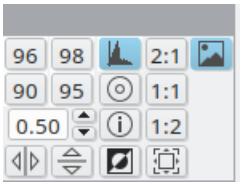
On the bottom row you can mirror the image horizontally and vertically,

The bull eye button show the mark on the image.

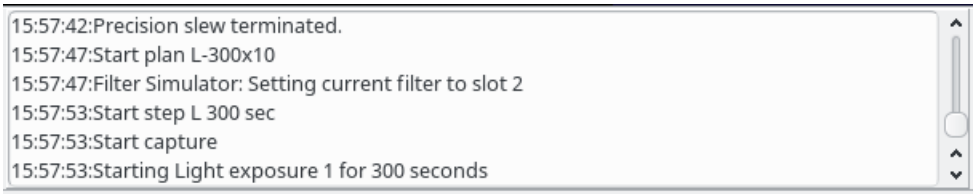


If the image is plate solved it also display an arrow with the North and East direction and print the image rotation angle.
A focus star can be automatically selected in the square that circumscribe the external circle.

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



This text window will report all messages (Log) from the program and drivers.

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

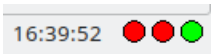
Windows:
C:\Users\[your user name]\AppData\Local\ccdciel\log

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

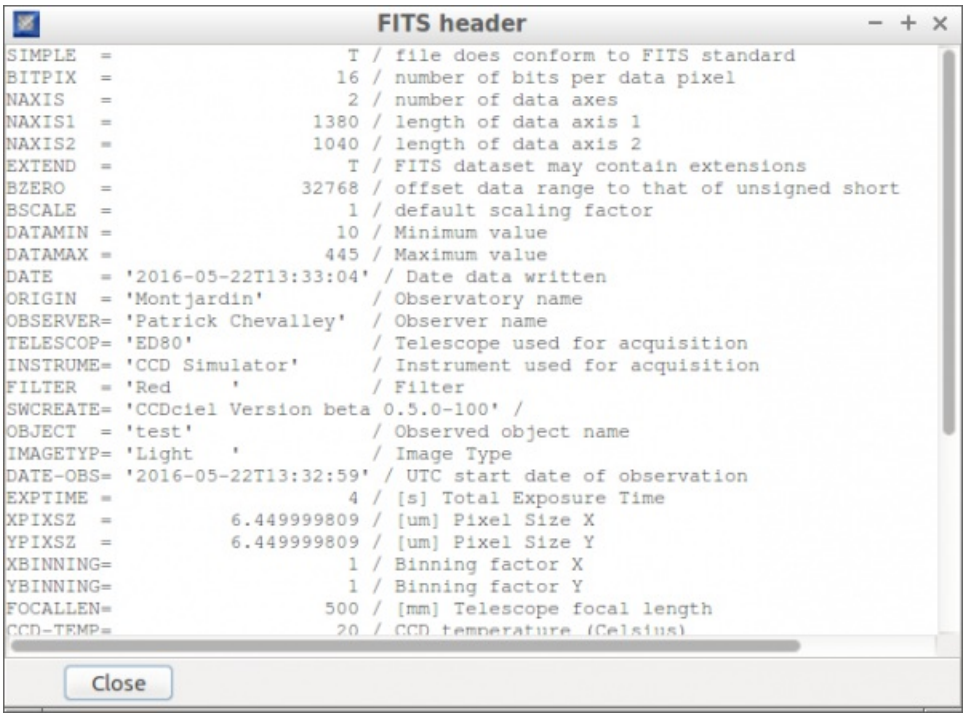
The **Tools** menu include some useful tools:

- View FITS header
- Image statistics

- Polar alignment
- Collimation
- Focuser calibration

View FITS header

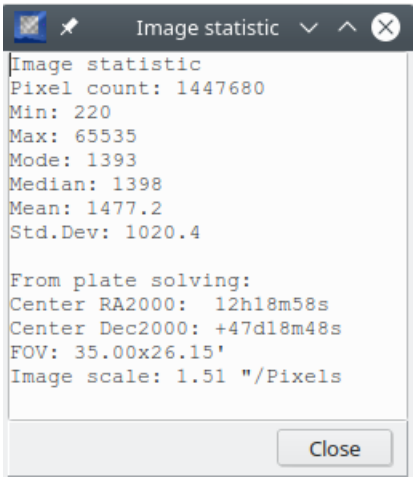
From the menu Tools → View header.



Show the FITS header of the current file.

Image statistics

From the menu Tools → Image statistics



Show statistics about the pixel values in the current image.

This show the following:

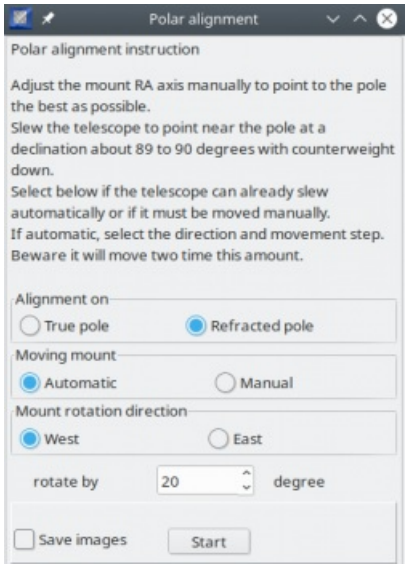
- **Min:** The minimal value of a pixel.
- **Max:** The maximal value of a pixel.
- **Mode:** The mode of the image, i.e. the most frequent value. This is a good estimate of the sky background.
- **Median** The median value of the image.
- **Mean:** The mean value of all the pixel.
- **Std.Dev:** The standard deviation from the mean value.

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.

Polar alignment

This tool is designed to be as quick and easy to use as possible to help to refine the mount polar alignment.
To start the procedure select the menu **Tools → Polar alignment**



Before starting this tool the mount must be pole aligned as good as possible. The camera must be connected and if possible the mount must be initialized to allow to automatically slew at the required position.
Point the telescope near the pole, at a declination between 89° and 90°. It is important that the pole is not exactly at the image center.
The camera uses the Slew setting exposure, binning and filter. Be sure this setting give a fast enough image refresh.

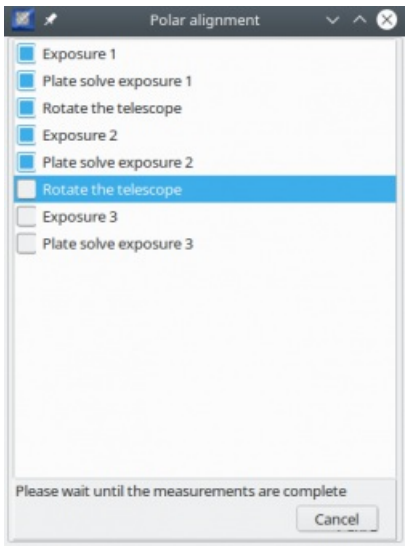
In the first window, select if you want to align on the true or refracted pole. The default is the refracted pole if the observatory latitude is higher than 30°. The true pole give better result in the tropical zone.

Select if the mount can slew automatical y. This generally require the handpad is initialized and a quick star alignment was done. Select Manual if you prefer to move manually or if the mount is not connected to the program.

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.

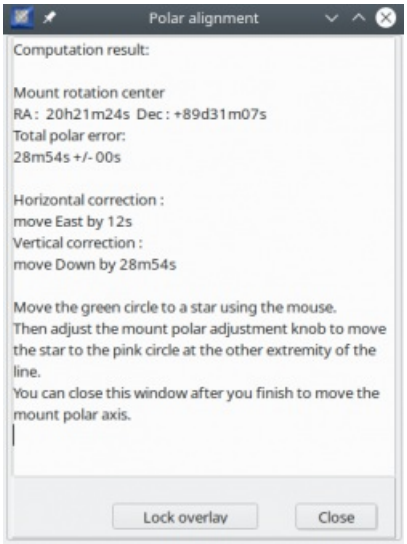
If you select the automatic telescope move you have nothing to do until this step is complete.

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.

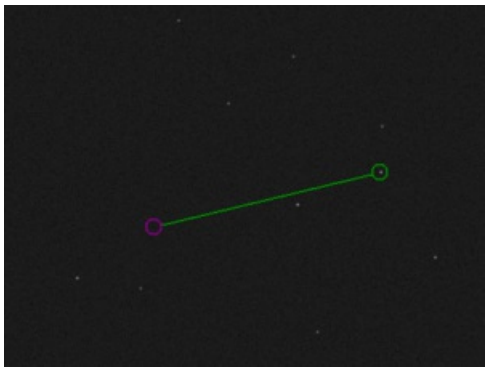
This show the result of the computation with the current mount axis direction and the total polar alignment error. Be careful at the value after the +/- sign, if it is not zero this indicate an inconsistency in the measurement.



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.



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.
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.

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.

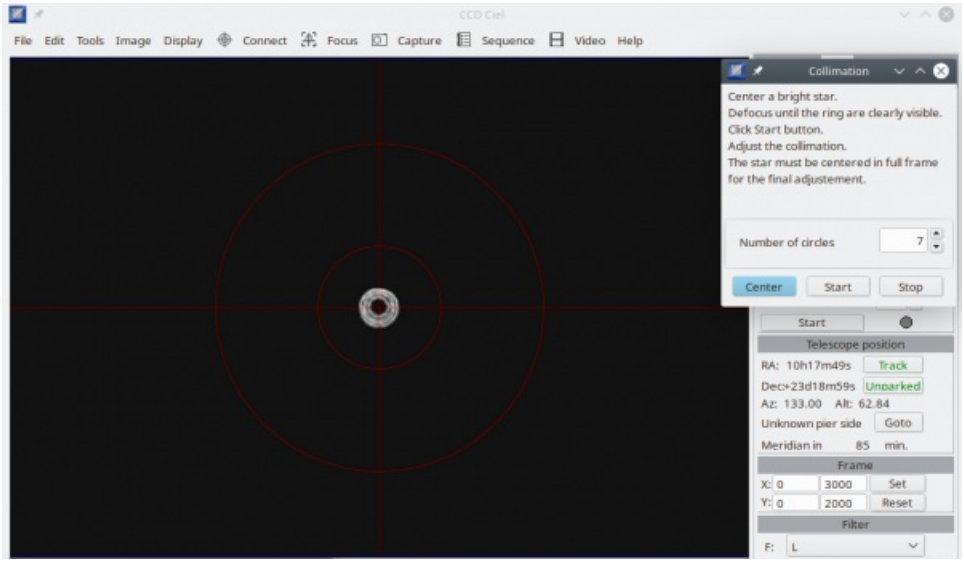
In the case the alignment error is bigger than the camera sensor size you cannot show the pink circle on the image. In this case move the star to the point the green line exit the image field. Then redo the full procedure until the polar error is small enough to show the two circle.

Collimation

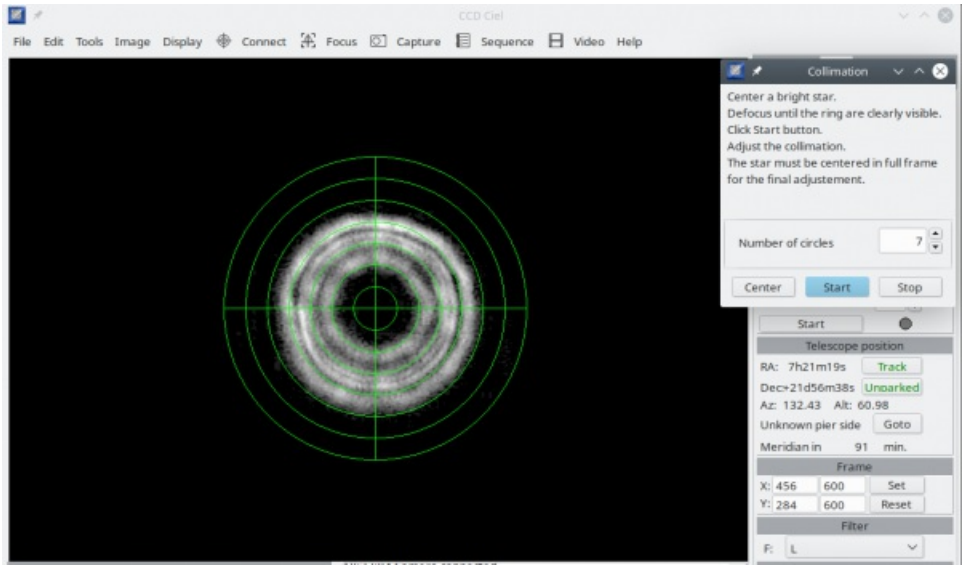
This tool can help to get a good collimation for the telescope optic.

This is for use with reflector telescope, astrograph refractor must only be adjusted by the manufacturer.
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.

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.



Now adjust slowly the telescope collimation screw to make the ring concentric.
Always go by small touch because every adjustment move the position of the star. The program try to automatically follow the star by modifying the camera ROI.
But the collimation must be done with the star at the center of the field, so periodically click the **Center** button to recenter the star in the bull eye then the **Start** button to continue the adjustment.

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.

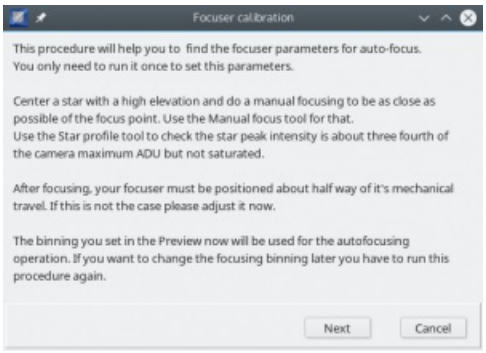
Focuser calibration

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.

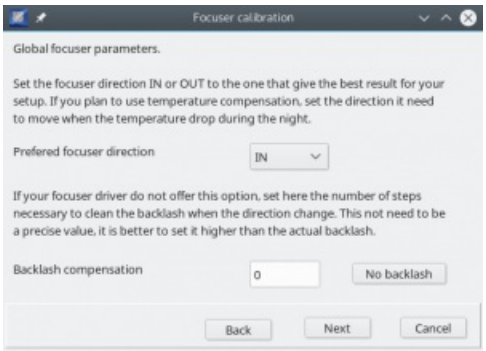
The principle is you start by centering and manually focusing a star that is used by the procedure to find how the star diameter change with an increasing movement of the focuser.

At the end it propose you new auto-focus parameters you can save to the configuration.

To start the procedure select the menu **Tools** → **Focuser calibration**

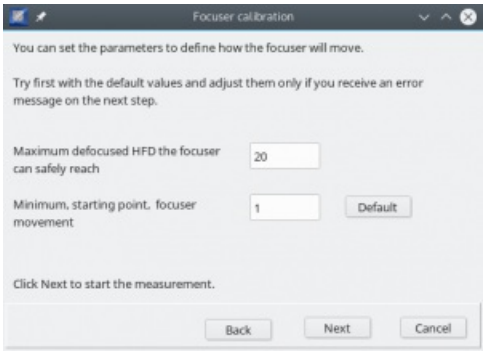


The first screen give you information about centering, focusing and correctly exposing the star.
Do it now, before to click the Next button.



The next screen let you select the direction you want to move the focuser in the auto-focus operations. Depending on you setting the focuser can work better when moved in or out of focus. If you want to configure the temperature compensation, set the direction to compensate when the focuser cool down during the night.

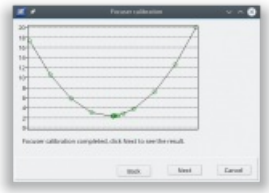
If the focuser need a backlash correction you can enter the value now. But be sure to let it disabled if the compensation is done elsewhere.
Indicate the number of additional steps to use for the compensation, this must be greater than the actual backlash, don't hesitate to use a large value.



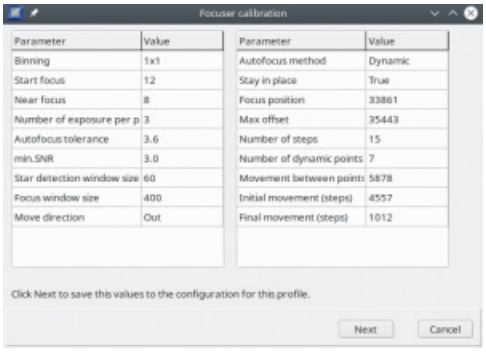
Then it offer you to change two measurement parameters, the maximum defocused star diameter (HFD) it will try to reach, and the initial movement of the focuser in step.

You can change the first parameter if you know what your equipment can achieve, otherwise keep the default and follow the recommendation if the first try fail.
The minimum movement is not really important to change because any way the program will double the value until it see enough change in the star diameter. You can just save a few time if you know your focuser need more steps even for fine focus.





It start slowly, just wait until it reach the maximum diameter.
Then it start to move the focuser on the opposite side, much quickly as it know what speed to use.
You can check if the curve is symmetrical and as not evidence of gross error.



Now the program know how your focusing system react.
You can review the parameters before to click Next to save them to the configuration.
Later you can view or change this values in the auto-focus parameters.

The procedure is completed and you can close this window.

You can now open the auto-focus parameters and without changing any of the detailed parameters you can change the auto-focus method depending on your preferences.

Select also how you prefer to run the auto-focus automatically as part of a sequence.
You have the choice to stay at the current target position and use whatever stars are present, or slew to a nearby star of fixed magnitude.
Later you can also alter this choice target by target in the sequence editor.

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.

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 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.

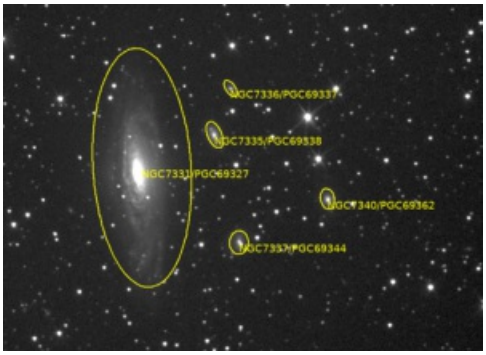
Resolve and Rotate

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

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.

Preview debayer

Debayer and display the color image if the current image is a raw color image with bayer matrix.

Preview raw

Display the raw image in black/white.

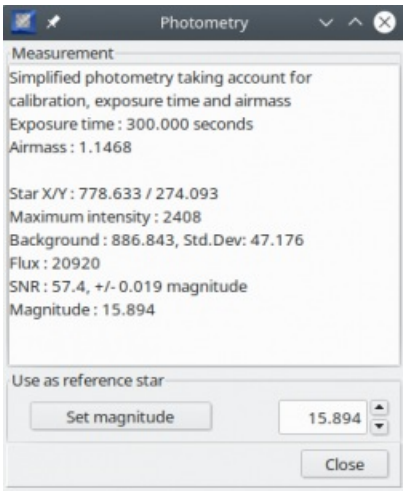
Image cleanup

Remove any marking and redraw the image.

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

- Open reference image
- Clear reference image

- 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 then 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.

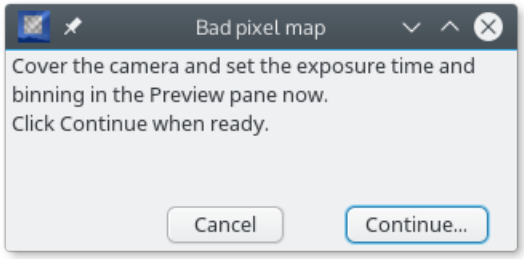
Use the menu **File → Bad pixel map → Apply to current image** If you want to apply the bad pixel map to an image you load in the program.
You can identify an image that was BPM processed with a comment at the end of the FITS header.

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 as 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

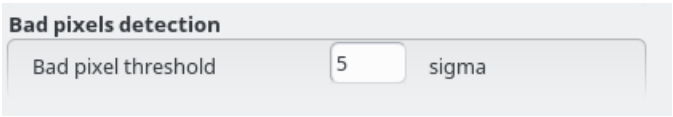
Take a preview image and check if the bright hot pixels are suppressed.

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 same exposure time and at the same temperature than the auto-focus frames. 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 preview 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.

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 binning as for the focus and slewing
3. Select the same exposure time as used for the auto-focus.
4. Cover the camera or telescope. If your camera has a shutter it will remain closed during the exposure.
5. Select menu **File → Dark frame → Create from camera**
6. Click Continue. 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**

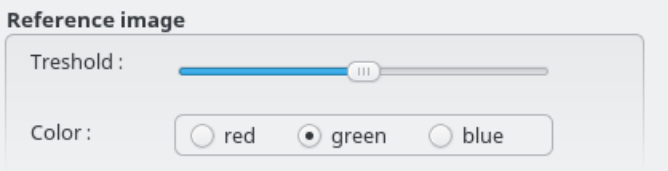
Check the dark frame

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.

Reference image

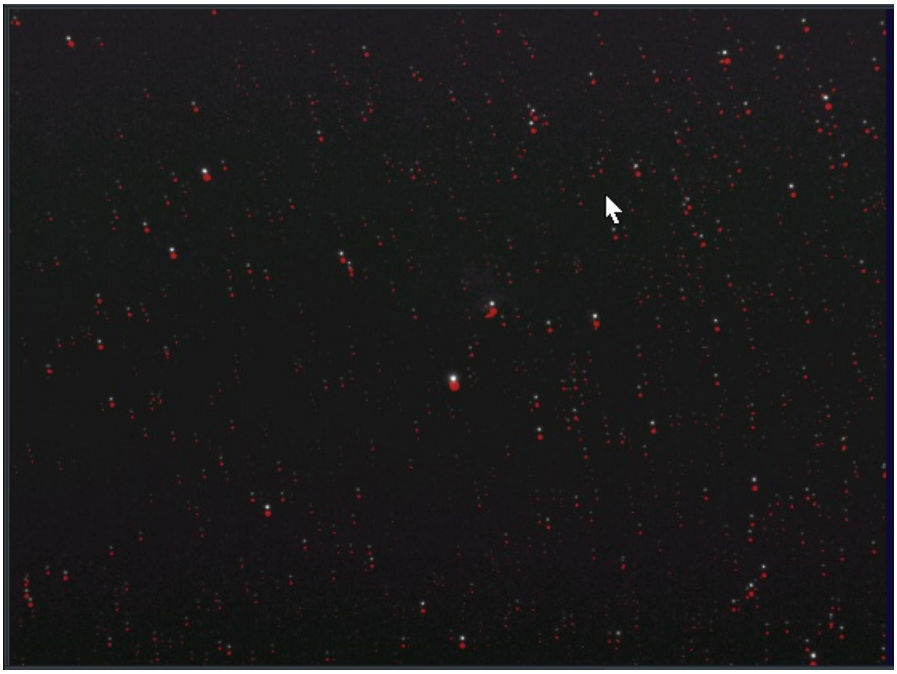
You can load a reference image of the object you want to capture to adjust the position of the telescope and the rotation of the camera. This is very useful to continue a sequence over many night if you cannot use plate-solving.

You can adjust the display threshold and the color of the reference image in the preview options.
Normally you want the threshold to display only the stars from the reference image.



To load the image use the menu **File / Open reference image**

Then start a preview loop, it show the new image over the reference.



You can now move the telescope or rotate the camera to match the reference.

When you are satisfied with the result you can remove the reference image from the menu **File / Clear reference image**

Tips:
To help to center the telescope open first the reference image with File / Open FITS file. Right click on the image and select “Resolve and slew to image center”. After the telescope stop slewing process as above to adjust the rotation.

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.

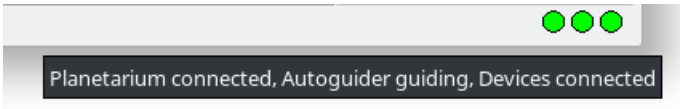
Help

Some help to use the software.

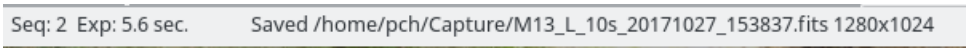
- **PDF documentation** open the PDF documentation installed with the software
- **Online documentation** open the documentation in a web browser
- **User group** open the user group in a web browser. This is the place to ask question about the program use.
- **CCDciel status** open the CCDciel status 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

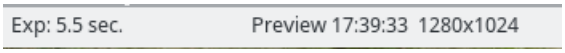
The status bar at the bottom of the program window show a number of information.



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.

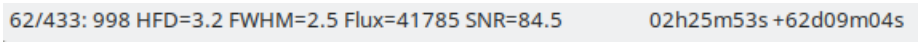


When a preview is running it show the remaining time of the current exposure, the time of the currently displayed preview and the size of the image

---

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.

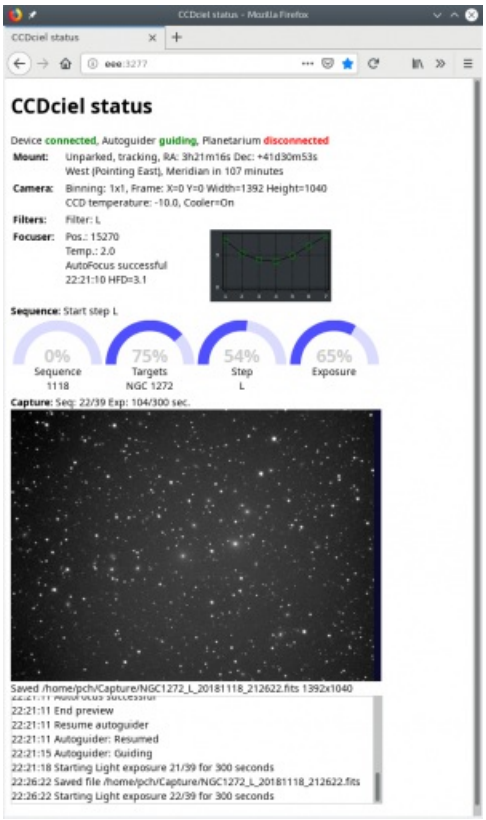


When the mouse cursor is moved over the image the following information is show in the left part of the status bar:

- 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 equipement.



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 can be executed from the script tool or part of a sequence.

There is also standard script that are executed on defined occasion. You can find example in the directory ccdciel/scripts/example/ :

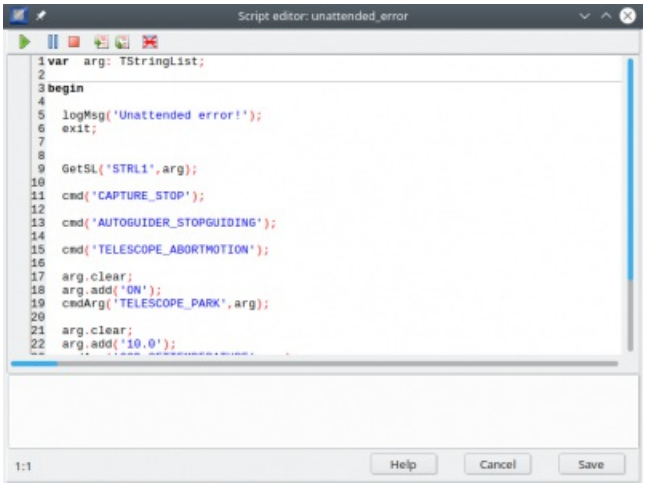
- **startup** is executed when the program in launched, even before any device is connected. This is the place you can automatically connect the devices, the autoguider and the planetarium.
- **shutdown** is executed when the program is closed.

The scripts can be written using the **Python** or **Pascal** 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.
On system with an ARM processor only the Python language is available.

Both of this language are very powerful and allow for complex tasks, but this can also be as simple as sending a list of command to different devices.

Script editor

The editor allow to write a script .



Read the script example page for a quick start.

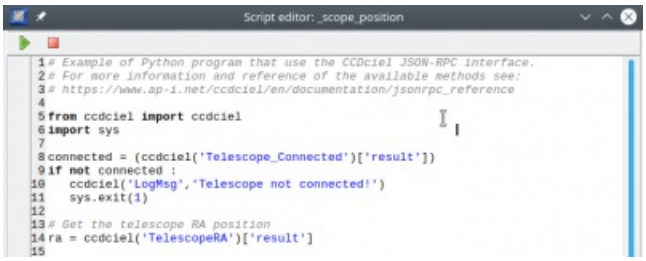
The functions specific to the interface with CCDciel are described in a separate page for Python or Pascal.

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.

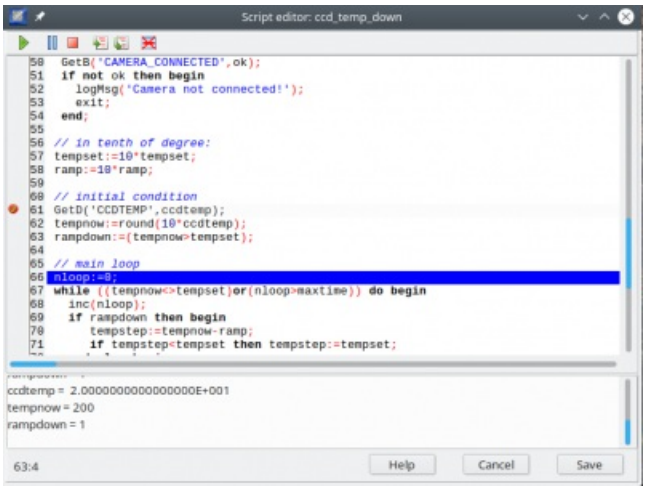
Script debugger

Python debugging



With Python you can only run the script from here and see the printed output. The Stop button is also available to interrupt the execution.
If more complete debugging function are necessary you can run the script externally with the Python debugger

Pascal debugging



To run the script in debug mode press the green arrow **Run** button. The program is first compiled.

In case of compilation error, the corresponding row is highlighted in yellow, and the error message is show in the bottom message area.
If the compilation finish without error the program start to run and stop on the first code line of the main procedure. The current execution position is highlighted in blue.

You can now use the **Step over** button to execute your program line by line.
The **Step into** button do the same, except if the current line is a call to one of your function. In this case **Step into** allow to run the function line by line, but **Step over** execute the function and stop at the main program next line.

You can also set a breakpoint on a specific line to jump directly at this position.
To set a breakpoint click on the leftmost column to show a red icon.
Use the Run button to jump to the next breakpoint. The current line is then highlighted in red.

You can remove a breakpoint by clicking on the red icon or all at at time with the **Remove all breakpoint** button.

You can display the value of variables when the program is in pause at a breakpoint or after a **Step over** click.
Just click on the variable name anywhere in the program source to display the value in the message area.
Note this work only for local variables, not for object properties.

You can use the **Pause** button to pause the program execution. This can be useful to examine the condition of an infinite loop for example.

The **Stop** button terminate the program execution immediately.

Script example

This page give tips and example of scripting functions.
You can also look at the template code provided with the program.

Python language example

We first look in detail at the code of the scope_unpark script you can use to unpark the telescope. To open this script locate the script tool, select “scope_unpark” in the dropdown list and click the Edit button.
The full script code look as following:

```
#  This script unpark the telescope mount

from ccdciel import ccdciel
import sys

connected = (ccdciel('Telescope_Connected')['result'])
if not connected :
   ccdciel('LogMsg','Telescope not connected!')
   sys.exit(1)

parked = (ccdciel('Telescope_Parked')['result'])
if not parked :
   ccdciel('LogMsg','Telescope already unparked')
   sys.exit(0)

r = (ccdciel('Telescope_Park',False)['result']['status'])
ccdciel('LogMsg','Telescope Park %r' %(r))
```

Take a look at each part in detail:

```
#  This script unpark the telescope mount
```

Is a comment, any text following the # character is a comment.

```
from ccdciel import ccdciel
```

Declare the function ccdciel() to interface with the specific functionality of the program. This is added automatically when you create a new Python script.
You can also import any other Python module you need for your script.

```
connected = (ccdciel('Telescope_Connected')['result'])
```

We ask CCDciel to know if the telescope is connected. Because the result of the ccdciel() function is in JSON format we can use the standard JSON syntax to access the different part. Here we are interested by ['result'] that contain the boolean status of the telescope connection.
See the reference page for the detail of every method and what they return.

```
if not connected :
   ccdciel('LogMsg','Telescope not connected!')
   sys.exit(1)
```

We test the result of the previous command, it 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 = (ccdciel('Telescope_Parked')['result'])
```

We continue and we do the same to check if the telescope is parked, with the result in the parked variable.

```
if not parked :
```

If the telescope is not parked there is nothing to do and we can exit.

```
r = (ccdciel('Telescope_Park',False)['result']['status'])
```

The command 'Telescope_Park' with the parameter False will unpark the telescope and the result status is in variable r.

```
ccdciel('LogMsg','Telescope Park %r' %(r))
```

Write a message to the log to show the command result, must be “OK!” if everything work.

Pascal language example

Here is the code of a Pascal version of scope_unpark script you can use to unpark the telescope.

The full script code look as following:

```
{
  This script unpark the telescope mount
}

var ok,parked: boolean;
    arg: TStringList;
    r: string;
begin

  // telescope connected?
  GetB('TELESCOPE_CONNECTED',ok);
  if not ok then begin
    logMsg('Telescope not connected!');
    exit;
  end;

  // get park status
  GetB('TELESCOPE_PARKED',parked);

  if parked then begin
    getSl('STRL1',arg);
    arg.clear;
    arg.add('OFF');
    r:=cmdArg('TELESCOPE_PARK',arg);
    if r<>msgOK then logMsg('Telescope park: '+r);
  end
  else begin
    logMsg('Telescope already unparked');
  end;
end.
```

Take a look at each part in detail:

```
{
  This script unpark the telescope mount
}
```

Is a comment, you can use // {..} (*..*) to enclose your comments.

```
var ok,parked: boolean;
    arg: TStringList;
    r: string;
```

Define the variable we use later in the script.
Important variable type are: integer, double, string, boolean.
The Tstringlist type is use here to send a command argument to CCDciel.

```
  begin
```

The start of our script.

```
GetB('TELESCOPE_CONNECTED',ok);
```

We ask CCDciel about the status of a boolean variable to know if the telescope is connected, the result is in our variable ok.

```
  if not ok then begin
    logMsg('Telescope not connected!');
    exit;
  end;
```

We test the result of the previous command, ok 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 code block starting at “begin” up to the corresponding “end”, this write a message in the log and exit the script.

```
GetB('TELESCOPE_PARKED',parked);
```

We continue and we do the same to check if the telescope is parked, with the result in our parked variable..

```
    if parked then begin
```

We test if the telescope is parked, in this case we can unpark.

```
GetSL('STRL1',arg);
arg.clear;
```

Request a TStringList object identified by STRL1. We clear any data that may stay in the object. We need this TStringlist to pass argument to a CCDciel command.

```
    arg.add('OFF');
    r:=cmdArg('TELESCOPE_PARK',arg);
```

Add the argument 'OFF' for the command and execute 'TELESCOPE_PARK' 'OFF'. This effectively unpark the telescope and the result is in variable r.

```
if r<>msgOK then logMsg('Telescope park: '+r);
```

We test the result is different than msgOK, in this case we write a message to the log to show the error from the driver.

```
 end.
```

The end of the script.

Pascal utilities

Wait

To wait for a number of seconds, for example between repetition of a sequence:

```
begin
  Wait(60);
end.
```

To wait until a given time:

```
begin
   WaitTill('02:00:00',true);
end.
```

Open a document

The following code open an html page in the default web browser.
You can use any document type with this function, the document open with the default application the same way as if you double click the document in the file explorer.

```
begin
  OpenFile('document.html');
end.
```

Run a command

There is three different way to run an external command or program, depending if you want to wait for a result or the command completion or not.

No wait

If the command can run for an undetermined time or do not produce an output you need to use the following form.
This example run the Skychart program and exit immediately without waiting you exit Skychart.

```
begin
  Run('skychart');
end.
```

Wait until the end of the command

If you need to wait the end of a command but it only produce an exit code to signal success or failure you can use the following form.

```
begin
  if runWait('/bin/bash -c open_dome.sh') then
    logmsg('Dome opened')
  else
    logmsg('Fail to open the dome')
end.
```

Wait for a result

The following command run the DIR command in the current directory. The result is stored in a stringlist and the first entry is show in the log.

```
var r:TstringList;
begin
  GetSL('STRL1',r);
  r.clear;
  RunOutput('dir',r);
  logmsg(r[0]);
end.
```

Python and JSON-RPC reference

This page contain reference for the JSON-RPC interface.

The program accept JSON-RPC 2.0 request on the port 3277 using both direct socket or HTTP POST.

For HTTP POST set your JSON-RPC procedure to use the following URL:

```
http://localhost:3277/jsonrpc
```

Python scripts

This method are the basis for the Python scripts, both internal or external.
A Python function is provided to simplify the use.
The syntax is:

```
jsonresult = ccdciel(method)
jsonresult = ccdciel(method,parameter)
```

For example:

```
from ccdciel import ccdciel
ra = ccdciel('TelescopeRA')['result']
```

To make Python to find this function in external script you must specify the environment variable PYTHONPATH:

```
set PYTHONPATH=C:\Program Files\CCDciel\scripts
export PYTHONPATH=/usr/share/ccdciel/scripts
```

Methods that return a value

The invocation format for this methods is: {“jsonrpc”: “2.0”, “method”: “method_name”, “id”:1}
The responses for this methods are in the form: {“jsonrpc”: “2.0”, “result”: result_value, “id”: 1}
Method name is not case sensitive.

Method name	Result type	Result value
Devices_connected	bool	True if all the devices are connected
Telescope_connected	bool	True if the telescope is connected
Telescope_parked	bool	True if the telescope is parked
Telescope_eqmod	bool	True if the telescope use the EqMod driver
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
Wheel_connected	bool	True if the filter wheel is connected
Focuser_connected	bool	True if the focuser is connected
Camera_connected	bool	True if the camera is connected
Planetarium_connected	bool	True if the planetarium is connected
Preview_running	bool	True if the preview is running
Preview_loop_running	bool	True if the preview is in loop

Capture_running	bool	True if a capture is running
FocuserPosition	int	The focuser absolute position
TelescopeRA	double	The telescope position right ascension
TelescopeDE	double	The telescope position declination
CcdTemp	double	The current CCD temperature
TimeNow	string	The current local time on the computer running CCDciel
DirectorySeparator	string	The directory separator symbol on the computer running CCDciel
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

The invocation format for this methods is: {“jsonrpc”: “2.0”, “method”: “method_name”, “id”:1}
The responses for this methods are in the form: {“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
Telescope_abortmotion	Stop any telescope movement
Telescope_track	Start telescope tracking
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
Autoguider_connect	Connect to the autoguider software
Autoguider_calibrate	Force a new calibration of the autoguider
Autoguider_startguiding	Start to guide
Autoguider_stopguiding	Stop guiding
Autoguider_pause	Pause guiding
Autoguider_unpause	Restart after pause
Autoguider_dither	Dither now
Autoguider_shutdown	Close the autoguider program
Wheel_getfilter	Get the current filter number in the wheel
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, beware it lock your program
Capture_start	Start a capture
Capture_stop	Stop a capture
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
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
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

Methods that invoke a command with parameter

The invocation format for this methods is: {“jsonrpc”: “2.0”, “method”: “method_name”, “params”: [params], “id”:1}
The responses for this methods are in the form: {“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
Telescope_slew	RA, DEC	Slew to specified coordinates
Telescope_sync	RA, DEC	Sync to specified coordinates
Telescope_park	True / False	Park or unpark the telescope
Wheel_setfilter	number	Set the filter number in the wheel
Ccd_settemperature	temp	Set the CCD temperature
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
Sequence_start	sequence	Load and start the sequence
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

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**.

Pascal script reference

This page contain reference material for scripting functions using the Pascal language. Refer to this page if you want to use the Python language.

See the script description page for general information.

See the script example page for a quick start with the programming functions.

Script language

The language to use is Pascal Script.
For a complete reference of the Object Pascal language your can read the Free Pascal Reference guide. But beware that some feature are not implemented by the script language, for example: no pointer, no assembler, no overloading.

In addition to the standard Pascal Script feature the following CCDciel specific function are added.

Constants

name	value
deg2rad	degree to radian conversion constant
rad2deg	radian to degree conversion constant
msgOK	returned when a CCDciel command complete successfully
msgFailed	returned when a CCDciel command fail

Global variables access

function GetS(varname:string; var str: string):Boolean;	
Get the global string variable identified by varname	
varname	**value**
LASTERROR	The text of the last error
Str1 .. Str10	Ten global variable for your use

function SetS(varname:string; str: string):Boolean;	
Set the global string variable identified by varname for later use	
varname	**value**
Str1 .. Str10	Ten global variable for your use

function GetSL(varname:string; var strl: Tstringlist):Boolean;	
Get the global stringlist variable identified by varname	
varname	**value**
Strl1 .. Strl10	Ten global variable for your use

function SetSL(varname:string; stlr: Tstringlist):Boolean;	
Set the global stringlist variable identified by varname for later use	
varname	**value**
Strl1 .. Strl10	Ten global variable for your use

function GetI(varname:string; var i: Integer):Boolean;	
Get the global integer variable identified by varname	
varname	**value**
Int1 .. Int10	Ten global variable for your use

function SetI(varname:string; i: Integer):Boolean;	
Set the global integer variable identified by varname for later use	
varname	**value**
Int1 .. Int10	Ten global variable for your use

function GetD(varname:string; var x: double):boolean;	
Get the global double variable identified by varname	
varname	**value**
TelescopeRA	The telescope position right ascension
TelescopeDE	The telescope position declination
TimeNow	The current time in TDateTime format
CCDTEMP	The current CCD temperature
Double1 .. Double10	Ten global variable for your use

function SetD(varname:string; x: Double):Boolean;	
Set the global double variable identified by varname for later use	
varname	**value**
Double1 .. Double10	Ten global variable for your use

function GetB(varname:string; var x: boolean):boolean;	
Get the global boolean variable identified by varname	
varname	**value**
TELESCOPE_CONNECTED	True if the telescope is connected
TELESCOPE_PARKED	True if the telescope is parked
TELESCOPE_EQMOD	True if the telescope use the EqMod driver
AUTOGUIDER_CONNECTED	True if the auto-guider is connected

AUTOGUIDER_RUNNING	True if the auto-guider is running
AUTOGUIDER_GUIDING	True if the auto-guider is guiding
WHEEL_CONNECTED	True if the filter wheel is connected
FOCUSER_CONNECTED	True if the focuser is connected
CAMERA_CONNECTED	True if the camera is connected
PLANETARIUM_CONNECTED	True if the planetarium is connected
PREVIEW_RUNNING	True if the preview is running
PREVIEW_LOOP	True if the preview is in loop
CAPTURE_RUNNING	True if a capture is running

Commands

function Cmd(cname:string):string;
Execute a simple command cname in CCDciel.

Valid Cmd() command are:

Command	Description
TELESCOPE_ABORTMOTION	Stop any telescope movement
TELESCOPE_TRACK	Start telescope tracking
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
AUTOGUIDER_CONNECT	Connect to the autoguider software
AUTOGUIDER_CALIBRATE	Force a new calibration of the autoguider
AUTOGUIDER_STARTGUIDING	Start to guide
AUTOGUIDER_STOPGUIDING	Stop guiding
AUTOGUIDER_PAUSE	Pause guiding
AUTOGUIDER_UNPAUSE	Restart after pause
AUTOGUIDER_DITHER	Dither now
AUTOGUIDER_SHUTDOWN	Close the autoguider program
WHEEL_GETFILTER	Get the current filter number in the wheel
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
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
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
AUTOFOCUS	Run auto-focus at the current position
AUTOMATICAUTOFOCUS	Move to a bright star and run auto-focus, return to last position when finished

function CmdArg(cname:string; arg:Tstringlist):string;
Execute a command cname in CCDciel with parameters arg. Add each parameter to the string list.

Valid CmdArg() command are:

Command	Arguments	Description
DEVICES_CONNECTION	ON/OFF	Connect or disconnect the devices
TELESCOPE_SLEW	RA, DEC	Slew to specified coordinates
TELESCOPE_SYNC	RA, DEC	Sync to specified coordinates
TELESCOPE_PARK	ON/OFF	Park or unpark the telescope
WHEEL_SETFILTER	number	Set the filter number in the wheel
WHEEL_GETFILTERSNAME	arg	On return arg contain the name of the filters
WHEEL_SETFILTERSNAME	arg	Put each filter name in arg
CCD_SETTEMPERATURE	temp	Set the CCD temperature
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
SEQUENCE_START	sequence	Load and start the sequence
SAVE_FITS_FILE	filename	Save the FITS file
OPEN_FITS_FILE	filename	Open the FITS file
OPEN_REFERENCE_IMAGE	filename	Load a reference image

Delay functions

procedure Wait(wt:integer);
Wait wt seconds before to continue the execution

function WaitTill(hour:string; showdialog: boolean):boolean;
Wait until the time is “hour”, encoded as 23:30:00 .

If the time is already passed by less than 12h the function return immediately, if it is passed for more than 12h it wait for the next day.
If showdialog is true a dialog with time countdown is show, this dialog also allow to cancel or to continue immediately, it return False if the wait is canceled.

Coordinates conversion

Procedure Eq2Hz(var ra,de : double ; var a,h : double);
Convert Equatorial ra,de to Alt/Az a,h for the location and time of the current chart, all angle in radian

Procedure Hz2Eq(var a,h : double; var ra,de : double);
Convert Alt/Az a,h to equatorial ra,de for the location and time of the current chart, all angle in radian

Formating and conversion

Function ARtoStr(var ar: Double) : string;
Return a string formated Right Ascension of ar value

Function DEtoStr(var de: Double) : string;
Return a string formated Declination of de value

Function StrtoAR(str:string; var ar: Double) : boolean;
Convert a formated string to Right Ascension decimal value

Function StrtoDE(str:string; var de: Double) : boolean;
Convert a formated string to Declination decimal value

Function JDtoStr(var jd: Double) : string;
Format a julian date to YYYY-MM-DD string

Function StrtoJD(dt:string; var jdt: Double) : boolean;
Convert a formated string YYYY-MM-DD to julian date value

Function FormatFloat(Const Format : String; var Value : double) : String;
Format a decimal number according to the Format specification

Function Format(Const Fmt : String; const Args : Array of const) : String;
The Format Pascal function

Procedure StrtoFloatD(str:string; var defval: Double; var val: Double);
Convert a string to a floating point value. Return defval if the string is a invalid number

function IsNumber(str: String): boolean;
Return True if the string represent a valid number

function StringReplace(str,s1,s2: String): string;
Replace all occurrence of s1 by s2 in str

Dialog

function MsgBox(const aMsg: string):boolean;
A message confirmation dialog. Return True if YES is clicked.

Procedure ShowMessage(const aMsg: string);
Display a message.

Procedure LogMsg(const aMsg: string);
Write a message to the log

Run external program

function Run(cmdline:string):boolean;
Execute the specified command. Return immediately without waiting for the execution to end.

function RunWait(cmdline:string):boolean;
Execute the specified command. Wait for termination.

function RunOutput(cmdline:string; var output:TStringlist):boolean;

Execute the specified command, wait for termination and put the stdout to “output”. **Beware** this function can completely lock the main program if it not finish in time.

function OpenFile(fn:string):boolean;
Open a document file using the default program

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 0.9.9 to use this scripts.
Just install the latest version for your system, no specific configuration in Siril is need.

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.

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:

- 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.

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.

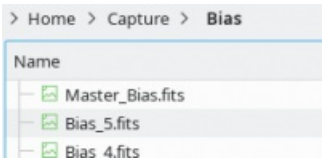
First create a plan to take the bias frames:

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

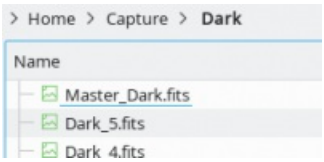
Same as for the bias, create a plan to take the dark frames:

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

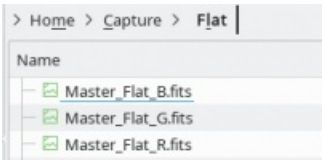
It is required the Master_Bias is available before you can run this script.
We have more options to make the flat frames because it depend if we use a flat panel or sky flat, and if we use a filter wheel or not.
To use a flat panel just create a plan as for the dark but select “Flat” for the type.

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:

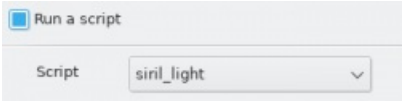


As you probably make flat every day a good place to add this processing is at the end of the sequence, just before to process the light frames. Or you can use a specific flat sequence you run at the beginning of the night.

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.

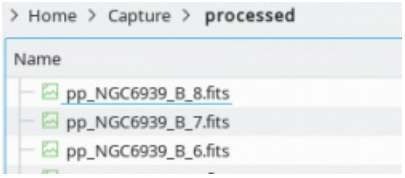
If you use a flat panel a good solution is to use the Script option in the sequence termination options. This ensure it run only once if you set a sequence repetition or if the sequence is interrupted at dawn.



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 same procedure can be used with any system using deb packages (Debian, Mint, Raspbian, …)

CCDciel and it's dependency are available from the same repository as Skychart, but you need the unstable repository as long this program is in beta version only.

1. Install the public key:
   ```
   sudo apt-key adv --keyserver keyserver.ubuntu.com --recv-keys 8B8B57C1AA716FC2
   ```
2. Add Skychart unstable repository:
   ```
   sudo sh -c "echo deb http://www.ap-i.net/apt unstable main > /etc/apt/sources.list.
   ```
3. Update repository:
   ```
   sudo apt-get update
   ```
4. Install CCDciel:
   ```
   sudo apt-get install ccdciel
   ```

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 use ccdciel and libpasastro 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.

The requirement are Gtk2 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.
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

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 7.

The CCDciel installer is available in 32bit and 64bit, but be careful that very few ASCOM driver work with a 64bit application. So it is recommended to install the 32bit version even on Windows 64.

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 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

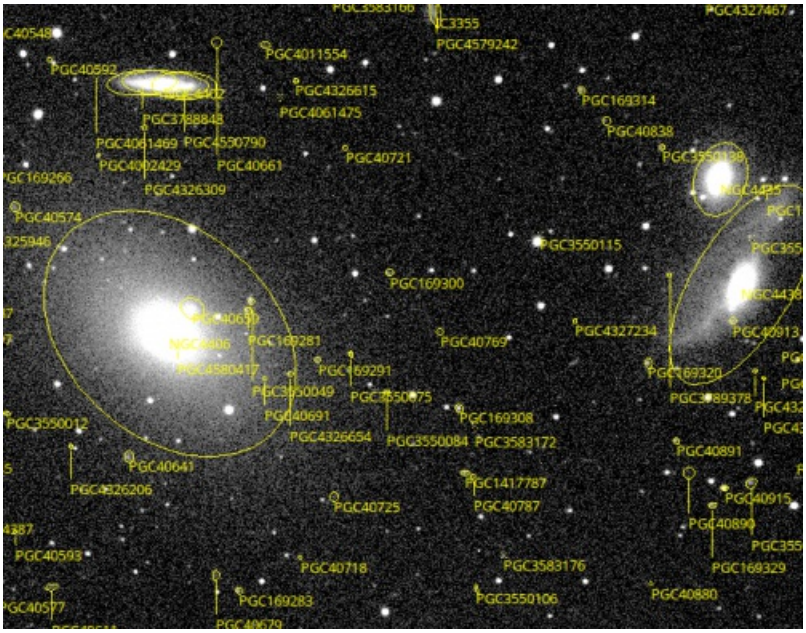
CCDciel can run on a recent version of macOS, the minimal version required to run the program is 10.10 Yosemite.

You can download the CCDciel dmg installer from the Sourceforge download link. 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.

Install Hyperleda database

From the right click menu you can draw an overlay with the position and name of the objects in the image.
By default CCDciel use a database of 30'000 objects, if you need more faint objects you can install the Hyperleda database with more than 2 million objects.



Because of it's size this database is not include with the program and you have to install it once.
You can find the installer for your system (.exe, .dmg, .deb or .rpm) here:

https://sourceforge.net/projects/ccdciel/files/hyperleda/

If you do a custom install the file must be in ccdciel/data/dso/

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.

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.

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
```

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

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.

Windows subsystem for Linux

With Windows 10 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.

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 if the index are 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

ELBRUS

Elbrus star locator can be used to solve the image you just take with your camera.

Look at the program page for instruction http://www.astrosurf.com/pulgar/elbrus/elbrusin.htm

Before you can use it the Elbrus program must be calibrated for your images. Then select File / E-Wait for message.

Also be sure to set the parameter: “Add the WCS in the FITS header”.

This is a Windows only software but I find it easy to install and use on Linux with Wine.
On the astrometry preference you can set both the DOS and Unix path to the image data to help with this use.

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.

PlateSolve 2

PlateSolve 2 can be used to solve the image you just taken with your camera. Astrometric solving wil 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 on 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 run 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.

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