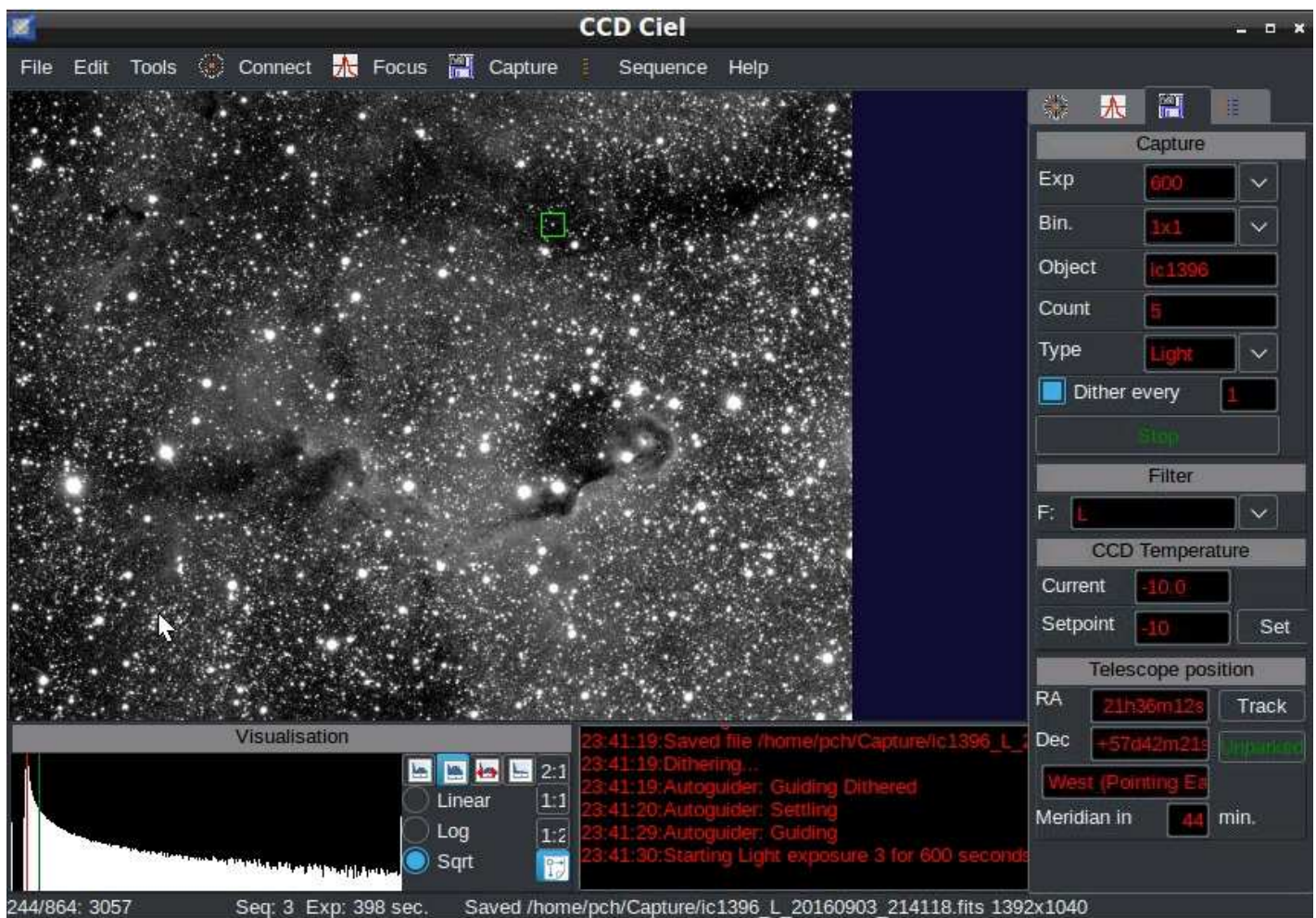


CCDciel

English documentation

Edited: August 27 2017

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



Documentation

You can contribute to these pages ¹⁾.

Tutorial

- [Connecting the equipment](#)
- [Global configuration](#)
- [Focusing](#)
- [Simple capture](#)
- [Automated sequence](#)

Reference Manual

- [Menu File](#)
- [Menu Edit](#)
- [Menu Tools and toolbox](#)
- [Menu Help](#)
- [Right click menu](#)

Installation

- [Installation on Ubuntu, Debian](#)
- [Installation on Linux](#)
- [Installation on Windows](#)
- [Installation on Mac OS X](#)

Dependencies

- [ASCOM](#)
- [INDI](#)
- [Astrometry.net](#)
- [Star Locator Elbrus](#)

License

Copyright (C) 2015-2017 Patrick Chevalley
<http://www.ap-i.net/ccdciel>

This program is free software; you can redistribute it and/or
modify it under the terms of the GNU General Public License
as published by the Free Software Foundation; either version 3
of the License, or (at your option) any later version.

¹⁾ Contribute by using the wiki at <http://www.ap-i.net/ccdciel> [<http://www.ap-i.net/ccdciel>]

Tutorial

1- Connecting the equipment

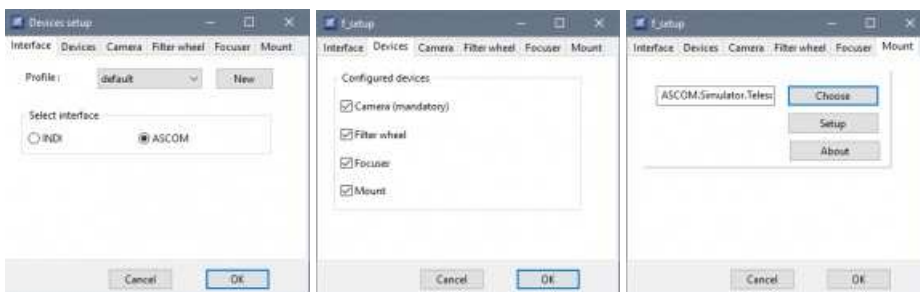
When you run the program for the first time it know nothing about how you intend to connect your equipment and which driver to use.

The first thing to do is to open the **File→devices setup** menu.

Make the choice to use INDI



or ASCOM drivers.



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 equipments or locations.

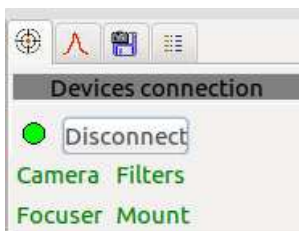
Then indicate the list of devices to use. For example if you not have a motorized focuser be sure to uncheck "Focuser", otherwise the devices connection will failed.

For each device give the driver detail depending if you use INDI or ASCOM.
When ready click the OK button.

Select the left tab and locate the Connect button. The red dot indicate you are not connected to any device.



Click Connect, after a few seconds the light change to green with all the connected device listed below.



If something go wrong one or more device color can change to orange when the program is still trying to connect or red when an error is received.

You can look at the messages box for any indication about the error.

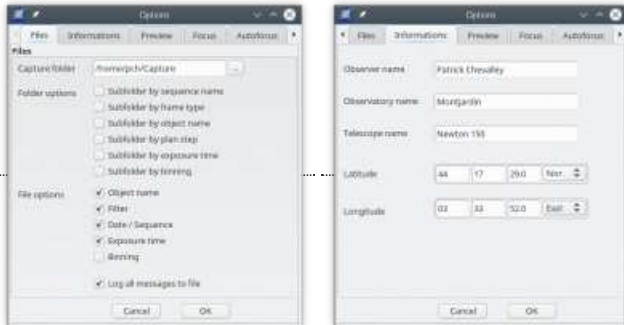
Next tutorial >>

Tutorial

2- Global configuration

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

There is a number of options for every part of the program and many can be examined later.

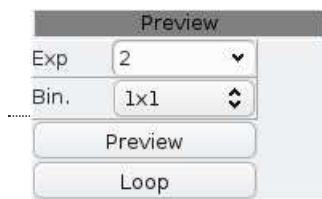


For now be sure to set a valid capture folder to save your images, and your observatory latitude and longitude that are used for different function in the program.

Next tutorial >>

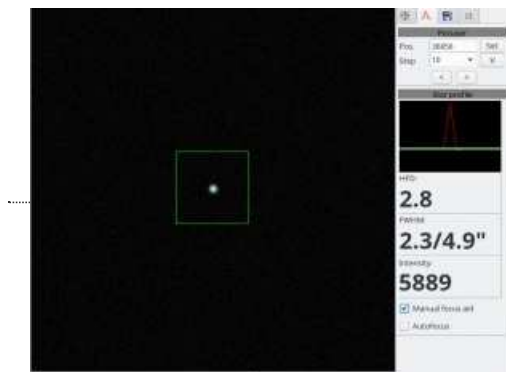
Tutorial

3- Focusing



Point your telescope at the sky and set the Preview exposure time and binning, then click the Loop button.

Start with 10-15 seconds exposure time if you are way out of focus, move the focuser to reduce the size of the star disk, and when they are small enough change the exposure time to about 1 second.



Let the preview in loop and click the Focus tab to show the focuser and star profile

Double click on a star, check it is not saturated, and check "Manual focus aid" to magnify the star image.

You can now use the focuser buttons, or manually turn the knob to make the star as small and bright as possible.

When ready uncheck "Manual focus aid".

Let Auto-focusing disable for now as this require more configuration.

Next tutorial >>

Tutorial

4- Simple capture

The screenshot shows a software interface with several sections:

- Capture:** Includes fields for Exp (300), Bin. (1x1), Object (M92), Count (15), Type (Light), and checkboxes for Dither every (checked, 1) and Focus every (unchecked, 1). A Start button is at the bottom.
- Filter:** A dropdown menu showing 'G'.
- Frame:** Fields for X (0 to 1280) and Y (0 to 1024) with Set and Reset buttons.
- CCD Temperature:** Fields for Current (-10.0) and Setpoint (-10.0) with a Cooler checkbox and a Set button.
- Telescope position:** Fields for RA (17h17m41s) and Dec (+43d07m31s) with Track and Unpark buttons. Below are fields for West (Pointing East) and Meridian in (393 min.).

Open the Capture tab and set the required options:

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

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

If you have a filters wheel also set the filter to use.

You can set the frame if you not want to use the full surface of the sensor

And if you can control the CCD temperature enter the desired value in Setpoint, and click the Set button.

When all is ready click the Capture Start button.

The telescope box show you the current position, the park and tracking status and the remaining time to reach the meridian.

The status bar show the sequence number of the image in progress and the remaining exposure time

Seq: 1 Exp: 293 sec.

After the exposure is terminated the image is show in the screen and the file saved according to your settings. A message in the status bar indicate the last saved file

Saved /home/pch/Capture/M27_G_20160522_203117.fits 1380x1040

And it continue for the number of exposure you set.

You can then change the filter and start the next series. Or look at the next tutorial how you can automate that...

Next tutorial >>

Tutorial

5- Automated sequence

Object	Plan	RA
M13	LRGB-4H	16h42m
M92	LRGB-4H	17h17m
Script	scope_pa	-

Desc.	Exp.	Count
L	300	24
R	300	8
G	300	8
B	300	8

The Sequence tab allow you to automate a full night of observation.

The example on the right will first go to M13 for a four hours image, consisting of 24 luminance, 8 red, 8 blue and 8 green exposures of 300 seconds each.

Then it go to M92 and do the same.

Finally a script park the telescope at the end of the night.

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

- the [astrometry resolver](#) for plate solving and the [slewing](#) options
- the [focuser](#) and [autofocus](#) options and [calibration](#)
- the [autoguider](#) connection and preferences
- the [planetarium](#) connection to help to set the object coordinates
- the [automated meridian flip](#) 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.

File Menu

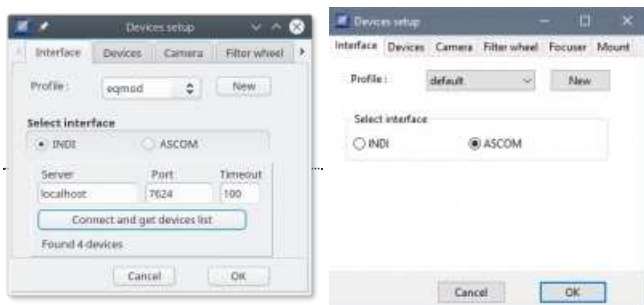
The **File** menu includes the following options:

- Devices Setup
- Bad pixel map
- Open FITS file
- Save FITS file
- Open reference image
- Clear reference image
- Quit

Device setup

Open this window from the menu File → Device setup before to connect to any devices.

Interface



The first tab “Interface” let you select the kind of drivers you want to use, INDI or ASCOM if running on Windows.

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 equipments or locations.

For INDI you have to enter the network name or IP address, and the port of the INDI server, then click the button “Connect and get devices list” to make the program know which devices are available.

For ASCOM there is no additional information.

Note that the program will close and restart if you change between INDI and ASCOM.

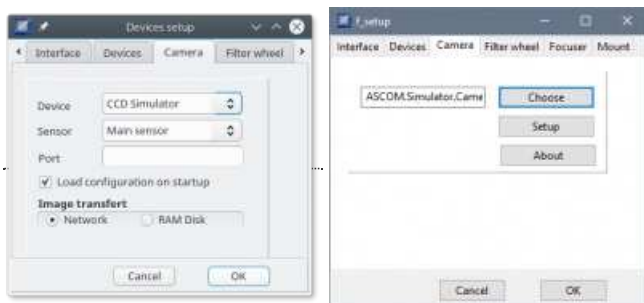
Devices



In the tab “Devices” you must check the devices you want to connect to CCDciel.

Only the camera is required to run the program but any other device checked here must be present to allow the program to work.

Camera

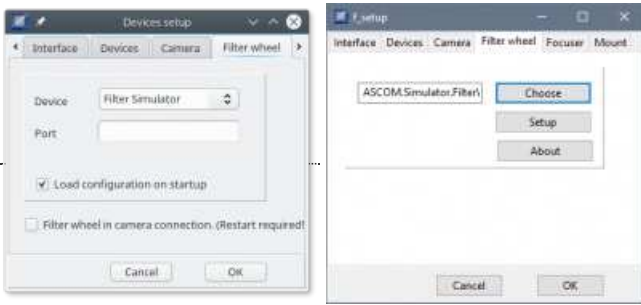


Select the camera to use with CCDciel, from the dropdown list for INDI or using the ASCOM chooser.

For INDI the “sensor” field is to select the sensor to use for dual-chip camera, you probably always want “Main sensor” here.

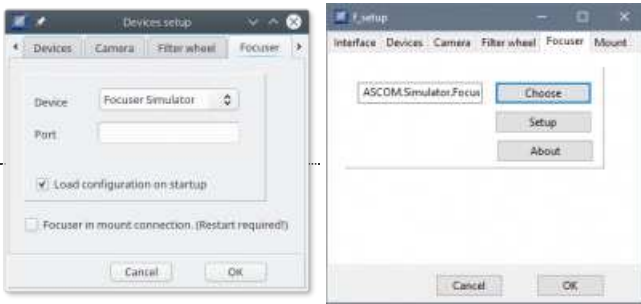
Check the corresponding box if you want to automatically load the INDI saved configuration when the device is connected.

Filter wheel



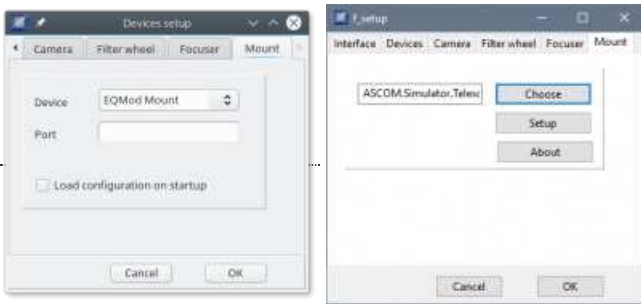
Select the filter wheel to use with CCDciel, from the dropdown list for INDI or using the ASCOM chooser. Or check the corresponding box if the filter wheel is commanded by the camera driver.

Focuser



Select the focuser to use with CCDciel, from the dropdown list for INDI or using the ASCOM chooser. Or check the corresponding box if the focuser is commanded by the mount driver.

Mount



Select the telescope mount to use with CCDciel, from the dropdown list for INDI or using the ASCOM chooser. Click OK after you finish your setting.

Bad pixel map

The bad pixel map prevent the auto-focus or slewing function to lock on a bad pixel.

It is only use for the preview images, when running a focus or slewing function, the capture image are never processed for bad pixel.

You first need to configure the bad pixel detection threshold in the preview options.



Increase this value if you get too much bad pixels, there is a limit to 1000 and you get an error message if you reach it.

Decrease the value if you get too few, specifically if you use a low dynamic range camera.

Next set the Preview tool, use the same binning as for the focus and slewing, and set the exposure time to get a dark with enough visible bad pixels. Depending on your camera this can be from 10 to 60 seconds.

Cover the camera or telescope as to take a dark image. If your camera as a shutter it will remain closed during the exposure.

Then select the menu **File / Bad pixel map / Create bad pixel map**



Click Continue.

It take the dark and show the number of bad pixels in the log window.

Now take a preview image and check the bright bad pixels are removed.

If you no more want to use the bad pixel map select the menu **File / Bad pixel map / Clear bad pixel map**

Open FITS file

From the menu File → Open FITS file.

This let you load a FITS 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.

But note this is not a general FITS file viewer, it is intended to display the images from a camera but it will fail to open a FITS file with complex data.

Save FITS file

From the menu File → Save FITS file.

This let you save to a FITS file the image in the preview window.

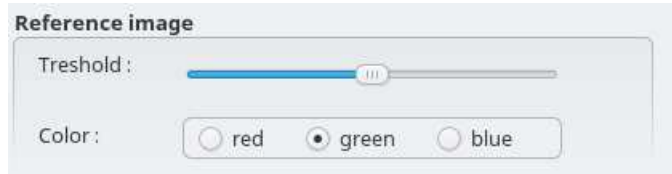
This is not used part of the capture sequence as the files are automatically saved, but this can be useful to save an image taken with the Preview function or loaded with File → Open FITS file.

Be careful this Preview image can be processed for bad pixel if you create a bad pixel map.

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.

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.

Edit Menu

The **Edit** menu consists of the following items:

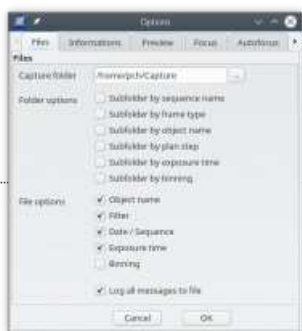
- Preferences
- INDI settings
- View FITS header

Preferences

From the menu Edit → Preferences.

Set global preferences and options for the program.

Files



Set Files options to select how your images sequences will be saved.

Give first the base capture folder to use.

Then select how to make subfolder based on sequence name, frame type, object name or plan step, exposure time, binning.

Then how to name the files based the object name, the filter, a date sequence, exposure time, binning.

The last checkbox is to save all the message log to a file for further inspection or debugging.

Informations



This Informations will be set in each FITS file for the OBSERVER, ORIGIN and TELESCOP keyword.

The latitude and longitude of the observatory is used to get the Alt/Az position of the object, or for the scope_alignment script.

Preview



This settings affect only the preview, the FITS files are recorded in RAW format to allow further preprocessing.

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. If you don't know what to select, make a test on a colorful subject on daytime. You can also do some color balance with the cursors on the right.

Select the threshold and color for the display of the reference image.

Select the threshold for detection of bad pixels for the bad pixel map.

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

Focus



Select the size in pixel of the star detection area and the size of the zoomed window for the focus mode.

For each filter you can also set a focuser 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. For example if your R filter require two time the exposure of the L filter set : L=1 R=2

Auto-Focus



Select the method to use for auto-focus:

- **V curve:** This is the preferred method for absolute position focuser. You do a one time V curve learning procedure and then every auto focus operation is done quickly in a single step starting from any position.
- **Dynamic:** This method can be used with relative position focuser. It require you start very near of the focus position and it make a small V curve every time.
- **Iterative:** A dumb method that move in one direction or another as long the star diameter is smaller. I as the advantage to work with any kind of focuser and you can start with a very defocused star. But it is slow and imprecise.
- **None:** If you want to use your focuser only manually.

Common parameters

- Exposure time to use for the auto-focus operation. This time is multiplied by the filter exposure factor above.
- Binning to use for the auto-focus. Use binning 1×1 unless you are way oversampled.
- The move direction of the focuser. Depending on you setting the focuser can work better when moved in or out of focus.
- The maximum HFD that can be considered as a successful focus. Be careful to not set too low or a sequence at low altitude can be canceled for that.

V curve parameters

- 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.
- n.exp : The number of exposure we take to get a mean HFD value. Increase this value if the seeing is not good.

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

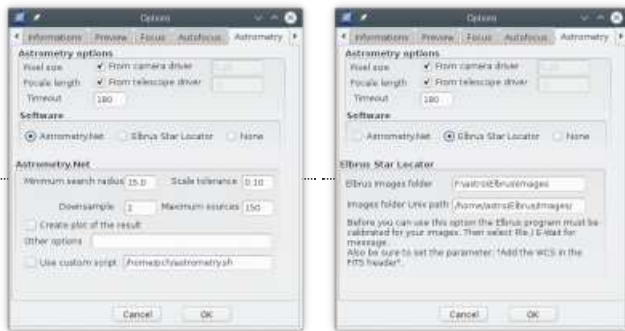
every focus operation.

- Movement between points: The number of focuser steps we move between each measurement of the curve. The maximum focuser movement in and out of current position will be $(\text{Number of dynamic points}) \times (\text{Movement between points}) / 2$

Iterative parameters

- Near focus HFD: the HFD we start to use n.exp exposure to get a mean HFD. When the HFD is higher than this we take a single exposure to speed the process.
- 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.

Astrometry



Enter the camera pixel size and 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.

Select the software you want to use for the astrometry resolution of the images, you can use [astrometry.net](http://astrometry.net/use.html) [<http://astrometry.net/use.html>] or [Elbrus star locator](http://www.astrosurf.com/pulgar/elbrus/elbrusin.htm) [<http://www.astrosurf.com/pulgar/elbrus/elbrusin.htm>]

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

Astrometry.net options

- Minimum 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.
- Create plot of the result: create png image with indication useful for debugging.
- Other options: any other option you want to give to the solve-field command.
- 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 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.

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.

Slew



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

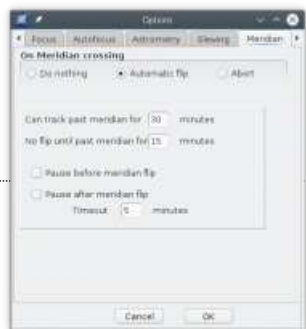
If your mount allow to sync anywhere select "Mount sync", if not select "Pointing offset" to make the correction in software.

Use "Pointing offset" with EQMOD to not fool the pointing model.

Then set the precision you want/can reach and the maximum number of pointing/correction retry before to give up.

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

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

- 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. This two parameters allow to loss the minimal time during a capture sequence, otherwise you can wait for a long as a single exposure time.
- 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 after meridian pause, if you not close the prompt after this time the sequence continue automatically.

Autoguider



Select your autoguiding software, only PHD2 is available at the moment.

Set the network name of the computer running PHD2 and the port number.

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).

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.

In the case of guide star lost (passing clouds...) we can try to restart the guider after some time. This is useful if the star as moved out of the search area, but if the clouds are still there we can start guiding on a hot pixel. A value of

zero disable this function.

Then we can abort the current sequence after some time, maybe the next object on the plan is in a clear area.

Planetarium



Select the planetarium application you want to use.

You have the choice between Skychart [<http://www.ap-inet/skychart/>] on local or remote computer.

Or a SAMP [<http://www.ivoa.net/samp/>] application like Aladin [<http://aladin.u-strasbg.fr/aladin.gml>] or Topcat [<http://www.star.bris.ac.uk/~mbt/topcat/>].

INDI settings

From the menu Edit → INDI settings.

This menu is not active if you select the ASCOM devices interface.

This open a standard INDI client [<http://www.indilib.org/>] window where you can set any specific option for your devices.



View FITS header

From the menu Edit → View header.



Show the FITS header of the current file.

Tools Menu

The **Tools** 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
- Focuser
- Star profile
- Capture
- Filters
- Frame
- CCD Temperature
- Telescope mount
- Sequence
- Video
- Visualisation
- Messages
- Reset to default

By default many tools are grouped in four tabs on the right of the window.

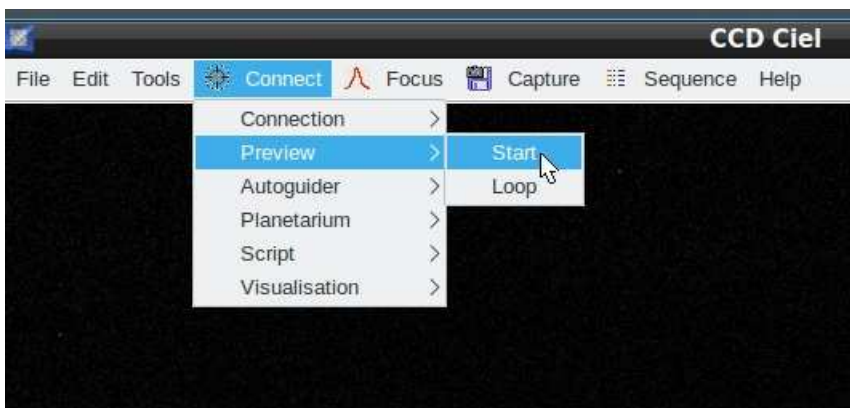


This correspond to the main functionality for a capture session.

- 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:



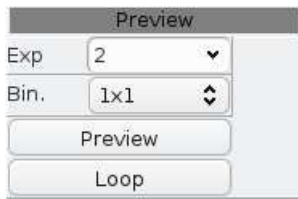
Connection Tool



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.

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. 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.

Autoguider Tool



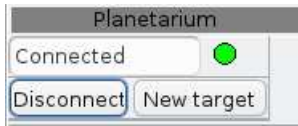
This tool is to interface with the external autoguider.

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.

Planetarium Tool

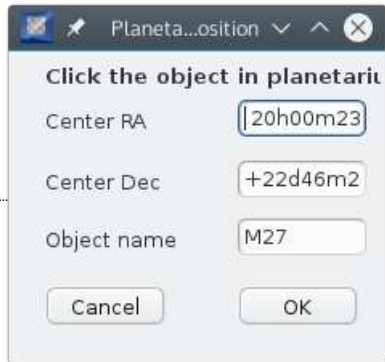


This tool is to control the connection to the planetarium.

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.

This make a plate solved slew to the object position and set the object name in the Capture tool.



Script



This tool let you create or run a script.

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.

Focuser Tool



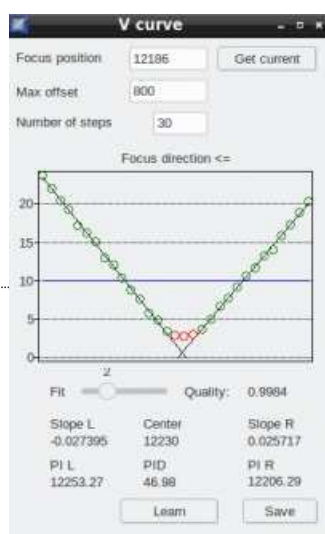
Use this tool to move your motorized focuser.

The tool use different control depending if your focuser use absolute or relative position.

V curve learning

If you use an absolute position focuser and you select to use V curve auto-focus you see a **V** button on the right, this is to learn the V curve.

Before you click this button you must center and select a bright star, set the Luminance filter, start a preview with a one second exposure time, run the manual focus aid and check in the Star profile tool the peak intensity is about 80% of your camera saturation.



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 so that moving to the best focus position plus this offset give a defocused image with an HFD around 20.

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 window is not refreshed until the procedure is finished. But you can follow the progress in the Log and Star profile tools.

After all the measurement are done it display the curve as in the screen shot here. The graph show the HFD value in function of the focuser position.

There is some important check to do before to go further.

- The curve must be centered with top left and right about at the same level.
- 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.

You remark a flat or curved part at the center of the V with the points marked in red.

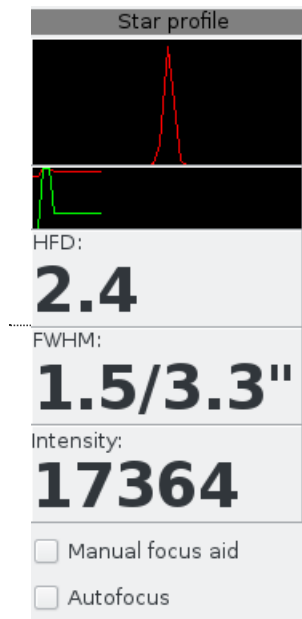
It is important to exclude this points from the linear regression and you can use the **Fit** cursor to exclude more or less points.

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.

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

Star profile Tool



This tool is to control the focus by examination of a star image. It can be used with a manual or motorized focuser.

Take first a preview exposure and double click on a non saturated star.

The top drawing is a cross-section of the star image, try to make it as narrow as possible.

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

The Half Flux Diameter value is show in pixel.

The Full Width at Half Maximum is show in pixel and arc-second.

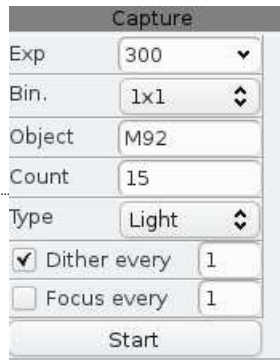
Make this two values as small as possible.

Also check the peak intensity of the star. It is very important it is not saturated.

Check "Focus aid" to start a preview loop on a zoomed area around the currently selected star.

Check "Autofocus" to start the auto-focus procedure on the selected star. You must have previously configured the auto-focus method and parameters, and eventually learned a V curve.

Capture Tool



Capture	
Exp	300
Bin.	1x1
Object	M92
Count	15
Type	Light
<input checked="" type="checkbox"/> Dither every	1
<input type="checkbox"/> Focus every	1
Start	

This tool is to take a simple sequence of exposure.

Set the exposure time and binning you want.

Give an object name, it is used for the file name and the OBJECT keyword in the FITS header.

Set the number of consecutive exposure to take.

Select the type of frame: Light for sky exposure. Bias, Dark, Flat for the calibration.

This is used for the folder name and the IMAGETYP keyword in the FITS header. If your camera as a shutter it will be closed for Bias and Dark.

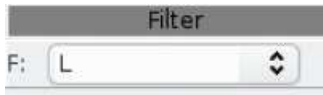
Check if you want to dither every given number of exposure. This require the autoguider is connected, configured and guiding from the Autoguider tool before you start the capture.

Check if you want to auto-focus every given number of exposure. You must have previously configured the auto-focus method and parameters, and eventually learned a V curve.

The telescope move to a star of the configured magnitude to run the auto-focus. To allow to return precisely on your object you must have configured the plate solver and the slewing options.

Click the Start button to begin the exposure. The same button can be used to interrupt the sequence.

Filter Tool



This tool is to control your filter wheel.

It show the currently mounted filter.

To change the filter, select a new one in the list.

Frame Tool

Frame		
X:	<input type="text" value="0"/>	<input type="text" value="1280"/> <input type="button" value="Set"/>
Y:	<input type="text" value="0"/>	<input type="text" value="1024"/> <input type="button" value="Reset"/>

This tool is to view or set the area of the sensor 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.

CCD Temperature Tool



CCD Temperature

Current -9.5 ☒ Cooler

Setpoint -10.0

This tool is to control your CCD temperature.

It show the current CCD temperature and the consign set point.

Change the consign and click the Set button to start the cooler. You can also control the cooler with the checkbox.

If you need to ramp the temperature of your CCD you can use the supplied example [script](#) after customization. The default parameters set the temperature to -10, it ramp down 5 degrees per minutes, and wait a maximum of 15 minutes for the temperature to be stabilized.

```
18 /////////////// Parameters //////////////////////
19 tempset := -10; // final desired temperature
20 ramp    := 5;   // degrees per time unit
21 timeunit := 60; // time unit in seconds
22 maxtime  := 15; // maximum number of time unit to wait
23 /////////////// Parameters //////////////////////
```

Telescope Tool



The screenshot shows a software window titled "Telescope position". It contains several input fields and buttons. The "RA" field is set to "20h00m24" with a "Track" button next to it. The "Dec" field is set to "+22d46m2" with an "Unparke" button next to it. Below these is a text field containing "West (Pointing East)". At the bottom, the "Meridian in" field is set to "25" with the unit "min.".

Telescope position	
RA	20h00m24 <input type="button" value="Track"/>
Dec	+22d46m2 <input type="button" value="Unparke"/>
<input type="text" value="West (Pointing East)"/>	
Meridian in	25 min.

This tool display the current telescope RA/DEC 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.

Use the planetarium or the sequence tool if you want to move the telescope at a new location from CCDciel.

Sequence Tool



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

The top grid show the current list of targets.

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

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

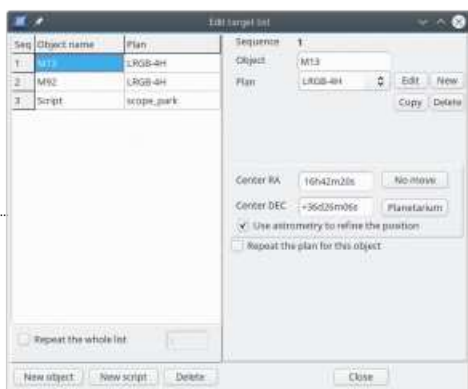
The “Run unattended” check box control how the program react in case of error.

- If is not checked a message prompt you on the screen what you want to do.
- If it is checked the operation is canceled.

The bottom grid show you the plan for the current target.

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

Target editor



After you click New or Edit, the target editor let you modify the target list.

A target can be an object you want to take the images or a script to run in the sequence.

You can type the object name and coordinates in the corresponding box or click the Planetarium button to select the

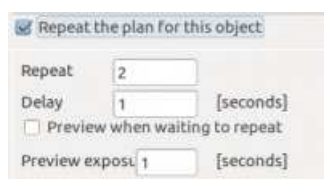
object in the connected [planetarium](#) application. Or click the “No move” button to not change the telescope position.



Select the exposure plan to apply to this target using the dropdown box, or use the New button to create a [new plan](#), or the Edit button to change the plan. You can also copy an existing plan or delete one.

Check the corresponding box to refine the telescope position with an [astrometry](#) solved control exposure. In this case you are ensured the selected object is framed exactly as you want.

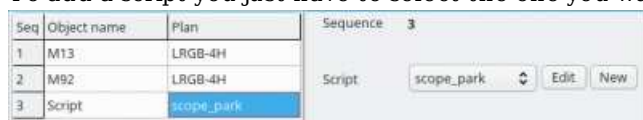
You can repeat the same target after a delay. Set the number of repetition and the delay. You can also start a preview loop while waiting for the next repetition.



You can also repeat the whole list a number of time by checking the box at the bottom of the list.



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

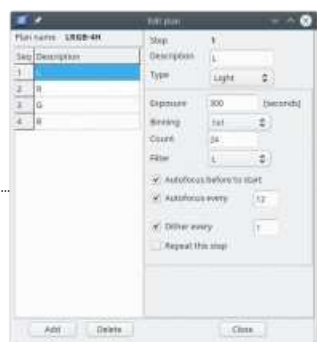


You can add a new target or script or delete one with the three buttons at the bottom of the list.

You can change the target order with a mouse drag/drop on the first column of the list.

The target list is saved when you click the Close button. If this is a new one you are asked for a file name.

Plan editor



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

Give a description of the step that can be used to make a subfolder.

Set the type of frame, exposure time, binning, number of exposure, as in the [Capture](#) tool.

Set the filter to use as in the [Filters](#) 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.

You can repeat the same step after a delay. Set the number of repetition and the delay.

☒ Repeat this step

Repeat

Delay [seconds]

You can add a new step or delete one with the two button at the bottom of the list.

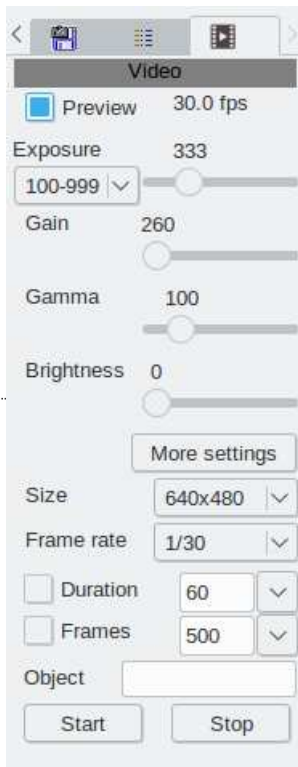
You can change the steps order with a mouse drag/drop on the first column of the list.

The plan is saved when you click the Close button.

Video tool

This tool is only available for INDI camera, specifically on Linux and Mac.

See this as a proof of concept, for serious planetary work you are encouraged to use the much better softwares that already exists on every platform.



The video tool appear in a new tab after the Sequence if the INDI camera you connected as video stream capability.

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.

Check **Preview** to visualize the frames.

Select the exposure range in the drop down box then adjust with the 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.

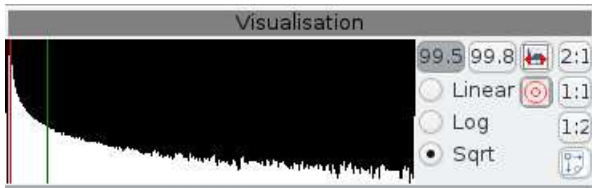
Next are the video capture options, you can limit the capture time or the number of frames.

The object name is use for the filename the same way as the static images.

Click the **Start** to start recording. The recording to the video file is alway 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 histogram you can move the high (green) and low (red) clipping bar with the mouse.

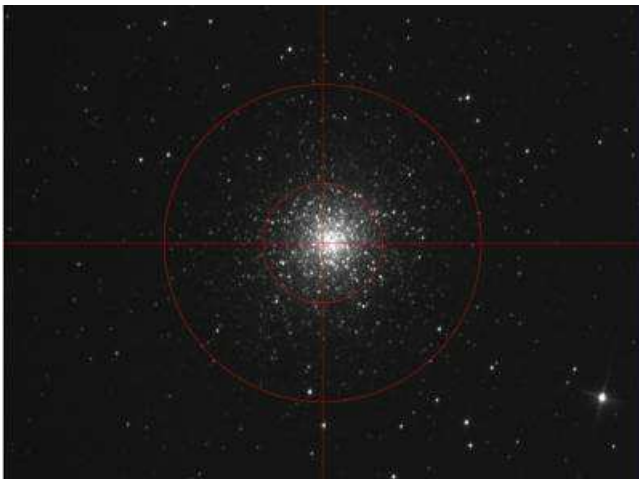
On the top row, the first three buttons are to control the range of histogram drawing, using 99.5%, 99.8% or the full histogram range.

The three left button let you select a linear, logarithmic or square root scale to display the image.

The four right button are preselected zoom level for the image.

When the zoomed image is bigger than the screen you can move it with the left mouse button.

The bull eye button show the mark on the image.



Message Tool

```
16:03:00: Saved file /home/pch/Capture/M27_L_20160522_140259.fl
16:03:00: Start capture
16:03:00: Starting Light exposure 3 for 1 seconds
16:03:02: Saved file /home/pch/Capture/M27_L_20160522_140302.fl
16:03:02: Start capture
16:03:02: Starting Light exposure 4 for 1 seconds
```

This tool display the message log from the program or from the different drivers.

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
- **Report a problem** open the CCDciel bug tracker
- **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.

Right click menu

Right click on the preview image to show the following menu:

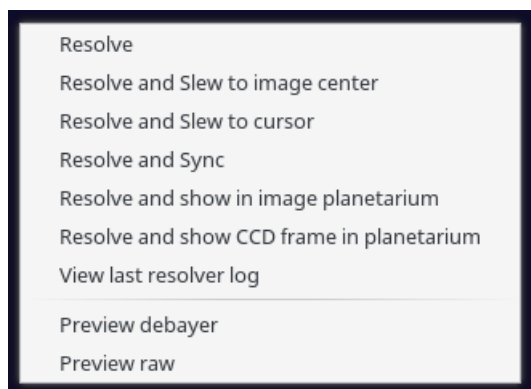


Plate solving functions

If you use more than one of this functions on the same image, only the first used function call the resolver, the other use the astrometry saved in the file.

Resolve

Resolve the image using the [astrometry](#) software and load the solved image in the preview.

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

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 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 CCD 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.

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.

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:

- **startup** is executed when the program is launched, even before any device is connected. This is the place you can automatically connect the devices, the autoguider and the planetarium.
- **end-sequence** is executed when a sequence is terminated. This is the place you can warmup the ccd and park the telescope.
- **unattended_error** is executed when a sequence is aborted, you can do the same as in end_sequence and add more cleanup.

The script language is very powerful and allow for complex tasks.

But this can also be as simple as sending a list of command to different devices.

Script editor

The editor allow to write a script .



The language to use is Pascal Script [http://en.wikipedia.org/wiki/Pascal_Script], based on Object Pascal [http://en.wikipedia.org/wiki/Object_Pascal].

Define first the global variables, then the procedure and function if any, then the private variable, and finally the main code start with **begin** and end with **end**.

Read the script example page for a quick start.

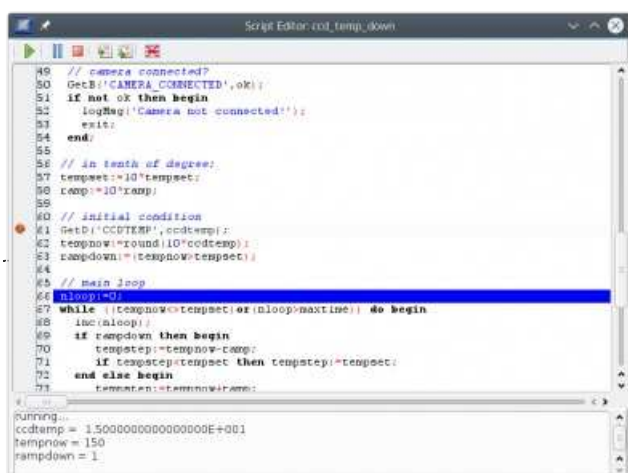
The functions specific to the interface with CCDciel are described in a separate script reference page.

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

Simple debugging function are available to test your code.



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

Script reference

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](https://www.ap-i.net/skychart) [https://www.ap-i.net/skychart], but you need the unstable repository as long this program is in beta version only.

1. Add Skychart unstable repository:

```
sudo apt-add-repository 'deb http://www.ap-i.net/apt unstable main'
```

2. Install the public key:

```
apt-key adv --keyserver keyserver.ubuntu.com --recv-keys AA716FC2
```

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.

Installation on Linux

If your Linux system use deb packages, see [Installation on Ubuntu](#).

For other Linux system you can download rpm or tar packages from the Sourceforge [download](#) [<http://sourceforge.net/projects/ccdciel/files/>] link.

The requirement are Gtk2 and [libpasastro](#) [<https://sourceforge.net/projects/libpasastro/>].

See also the list of [dependencies](#) to install to take full advantage of the software.

You can also compile the [source code](#) [<https://sourceforge.net/p/ccdciel/code/>] using Lazarus [<http://www.lazarus-ide.org/index.php>].

Installation on Windows

CCDciel can run on any version of Windows from XP to 10.

To use the devices connected to your Windows computer you need the ASCOM platform [<http://ascom-standards.org/>] and the drivers for you hardware.

But you can also use the devices connected to a remote Linux system (Raspberry PI for example) using the INDI protocol.

You can download the setup installer from the Sourceforge download [<http://sourceforge.net/projects/ccdcie/files/>] link.

See also the list of the optional dependencies to install to take full advantage of the software.

Installation on Mac OS X

CCDciel can run on a recent version of Mac OS X on a computer with an Intel processor.

To use the devices connected to your Mac computer you need the INDI [<http://www.indilib.org/>] library and the drivers for you hardware, available from CloudMakers [<http://www.cloudmakers.eu/xindi/>].

You can download the dmg installer from the Sourceforge download [<http://sourceforge.net/projects/ccdcie/files/>] link.

See also the list of the optional dependencies to install to take full advantage of the software.

ASCOM

ASCOM [<http://ascom-standards.org>] Platform is the standard astronomical equipment driver for Windows.

Install the ASCOM platform and the drivers you need from <http://ascom-standards.org/Downloads/Index.htm> [<http://ascom-standards.org/Downloads/Index.htm>] or from your equipment manufacturer.

INDI

INDI [<http://www.indilib.org/>] Library is the standard astronomical equipment [<http://www.indilib.org/devices/>] driver for Linux and Mac OS X.

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 [<http://www.indilib.org/download.html>] directly from the project.

For example for Debian/Ubuntu see <https://launchpad.net/~mutlaqja/+archive/ubuntu/ppa> [<https://launchpad.net/~mutlaqja/+archive/ubuntu/ppa>]

For Mac OS X the best option is to get the version from CloudMakers [<http://www.cloudmakers.eu/xindi/>].

There is no INDI server for Windows but you can run CCDciel on Windows to connect to a remote Linux computer. Or use wINDI [<http://www.cloudmakers.eu/windi/>] to use your ASCOM devices with the INDI protocol.

Astrometry.net

Astrometry.net can be used to solve the image you just take with your camera.

CCDciel need a local copy of the Astrometry.net software and the required indexes on your computer. It can also use the web version using the provided script.

Look at this page <http://astrometry.net/use.html> [<http://astrometry.net/use.html>] for instruction to install the software and the data.

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
```

Mac OS X

For Mac OS X the best option is to get the version from [CloudMakers](http://www.cloudmakers.eu/xindi/) [<http://www.cloudmakers.eu/xindi/>].

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.

The following list indicate tested application and give the Cygwin path you must configure in the [astrometry preferences](#).

At the time of writing all this application use the same version 0.38 of astrometry.net.

- [Astrotortilla](https://sourceforge.net/projects/astrotortilla/) [<https://sourceforge.net/projects/astrotortilla/>], set Cygwin path to C:\cygwin
- [ANSVR](https://adgsoftware.com/ansvr/) [<https://adgsoftware.com/ansvr/>], set Cygwin path to C:\Users\[your user name]\AppData\Local\cygwin_ansvr
- [All sky plate solver](http://www.astrogb.com/astrogb/All%20Sky%20Plate%20Solver.html) [<http://www.astrogb.com/astrogb/All Sky Plate Solver.html>], set Cygwin path to C:\Users\[your user name]\AppData\Local\Astrometry

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>
[<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 Mac OS X see [Wine web pages](#) [<https://www.winehq.org/>].

On Linux the best way is to install the wine packages provided by your distribution.

Table of Content

CCDciel	1
Documentation	2
Tutorial	2
Reference Manual	2
Installation	2
Dependencies	2
License	2
Tutorial	3
1- Connecting the equipment	3
Tutorial	4
2- Global configuration	4
Tutorial	5
3- Focusing	5
Tutorial	6
4- Simple capture	6
Tutorial	7
5- Automated sequence	7
File Menu	8
Device setup	9
Interface	9
Devices	9
Camera	9
Filter wheel	9
Focuser	10
Mount	10
Bad pixel map	11
Open FITS file	12
Save FITS file	13
Reference image	14
Quit	15
Edit Menu	16
Preferences	17
Files	17
Informations	17
Preview	17
Focus	18
Auto-Focus	18
Astrometry	19
Slew	19
Meridian	20
Autoguider	20
Planetarium	21
INDI settings	22
View FITS header	23
Tools Menu	24
Connection Tool	25
Preview Tool	26
Autoguider Tool	27
Planetarium Tool	28
Script	29
Focuser Tool	30
V curve learning	30
Star profile Tool	32
Capture Tool	33
Filter Tool	34
Frame Tool	35
CCD Temperature Tool	36

Telescope Tool	37
Sequence Tool	38
Target editor	38
Plan editor	39
Video tool	41
Visualisation Tool	42
Message Tool	43
Help	44
Right click menu	45
Plate solving functions	45
Resolve	45
Resolve and Slew to image center	45
Resolve and Slew to cursor	45
Resolve and Sync	45
Resolve and show image in planetarium	45
Resolve and show CCD frame in planetarium	45
View last resolver log	45
Preview functions	45
Preview debayer	46
Preview raw	46
CCDciel Script	47
Script editor	47
Script debugger	47
Script example	49
Script reference	50
Installation on Ubuntu, Debian	51
Installation on Linux	52
Installation on Windows	53
Installation on Mac OS X	54
ASCOM	55
INDI	56
Astrometry.net	57
Linux	57
Mac OS X	57
Windows	57
ELBRUS	58
Table of Content	59