

# ASTROART 3.0

## CCD CONTROL - USER INTERFACE Version 3.03

### TABLE OF CONTENTS

1	Manual Conventions.....	2
2	Installation .....	2
2.1	Installing two or more CCD cameras .....	2
3	Let's Start .....	2
3.1	Hardware setup .....	2
3.2	Software setup.....	2
4	The Image Page.....	3
5	Filter wheel.....	4
5.1	The Filter wheel Setup page.....	5
5.2	The Filter wheel Filters page .....	5
6	Telescope Control .....	5
6.1	GOTO Control panel.....	7
7	Guiding.....	8
7.1	Tutorial.....	8
7.2	Manual Guiding.....	10
7.3	Autoguiding.....	10
7.4	Selfguiding .....	13
8	The Settings Page.....	14
9	Focusing.....	15
10	The Dark/Flat Page.....	16
11	The Sequence Page .....	17
12	History.....	18
13	Contact Information.....	18

## 1 Manual Conventions

Welcome to the CCD User Interface of Astroart 3.0. This document contains information about control of CCD, Telescopes and Filter wheels. This manual uses the typefaces and symbols listed below:

- The menu bar, sub-menu and floating menu items are highlighted in bold and embraced in square brackets: submenus commands are noted with an arrow (i.e. **[Tools]** ⇒ **[Plug-in Commands]**) this means that you should click on the **[Tools]** menu, then click **[Plug-in]** on the submenu.
- The buttons to click are highlighted in bold and enclosed in a box (i.e. **Setup CCD**) means to click the button labelled 'Setup CCD').

## 2 Installation

The “CCD User Interface” is a plug-in for Astroart which provides a high sophisticated control for your CCD camera. To install this plug-in copy the file **piccdgui.dll** into the Astroart directory. To command a camera you need also a specific driver, available for free at the CCD page of the Astroart web page:

[www.msb-astroart.com](http://www.msb-astroart.com)

### 2.1 Installing two or more CCD cameras

To command two or more CCDs at a time simply run two instances of Astroart. On the first one select the main camera in the CCD user interface, on the second one select the guide camera.

An another method of controlling two or more CCD cameras is to create a copy of the DLL file **piccdgui.dll** and renaming it **piccdgui2.dll**.

## 3 Let's Start

The Astroart CCD User Interface contains two simulators, CCD and Telescope, which let you test all functions indoor before using your real hardware. Take a look at chapter 7 for a quick tutorial.

### 3.1 Hardware setup

At first check the camera position and linking: be sure to securely attach the camera at your focuser: remember that the telescope is a moving object and camera's cables may tug the camera as you move the telescope. Once you have safely connected the camera to the personal computer you can turn on all the hardware.

Now, start Astroart and select from the menu **[Tools]** ⇒ **[Plug-In commands]** ⇒ **[CCD Camera]**: this will display the *Setup Page* (see Fig. 1).

### 3.2 Software setup

The first option to select is the CCD model: select your CCD camera within the combo box (you may need to download and install the appropriate CCD drivers<sup>1</sup>) then click on **Check CCD**. If the camera is

<sup>1</sup> Read carefully the instructions included with the CCD driver of the selected camera.

not correctly detected, we suggest to consult the documentation of the CCD Driver, which is specific for every model. To make some indoor tests use the “CCD Simulator” integrated in Astroart.

The Setup Page contains some hidden options which can be showed clicking on the button:

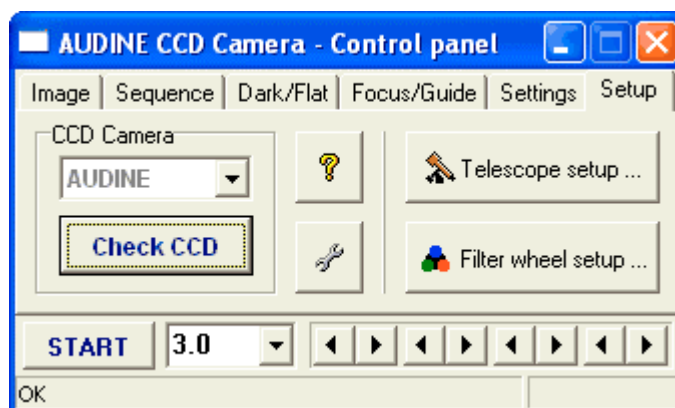


Fig. 1 – The Setup Page

**Visualization (automatic and custom).** The view mode for every new image. If “Auto visualization” is not selected then it’s possible to set the minimum and maximum visualization threshold and the transfer function for every new image, for more details see the Astroart on-line guide. The option “Auto (soft)” provides a natural look, “Auto (hard)” is useful for asteroid and supernova search.

**Sound on.** Plays a sound to alert the user about important events, likes the lost of the guide star.

**Black background.** Displays a black frame below the Astroart desktop to hide the *Windows Desktop* and all the other applications.

**Visible progress bar.** Enables or disables the red gauge which indicates the download status. On some slow PCs the bar causes stripes over the image.

**High priority.** If selected, during the download the *priority* of Astroart task is increased. This may reduce the noise on some cameras.

**Resync clock.** Select this option to resync the PC clock with the BIOS clock. This can be useful if the CCD driver disables the interrupts. This options does not work under Windows 2000/XP.

## 4 The Image Page

To integrate a new image select the *Image Page* (Fig. 2) write with the keyboard an exposure time in seconds (exampe: “0.002” for two milliseconds) then click the **Start** button. The exposure time can be also set clicking the arrow buttons.

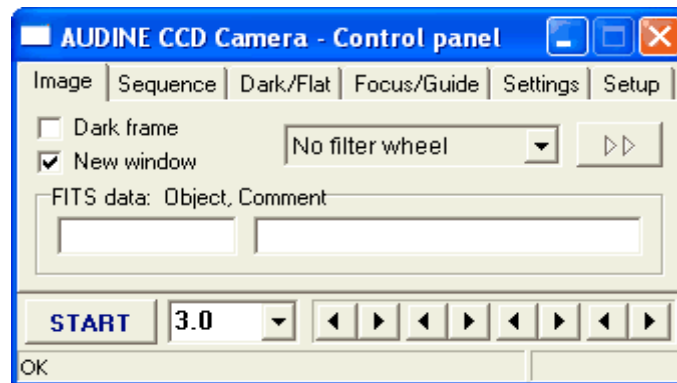


Fig. 2 - The Image Page

**Dark frame.** Select this option to close the shutter during the exposition, if your camera has not a built-in shutter you will have to cover the telescope. Click **Start** to integrate the dark frame which will be stored also in memory: if you select the "Enabled dark frame correction" option in the *Dark/Flat Page* (see Fig. 16) every new image acquired will be automatically corrected with this dark frame.

**New window.** Every new image is usually displayed in a new window, but if this option is disabled the new image will overwrite the previous one (if they have the same size). This is useful when doing test images or sequences.

**Filter wheel.** Select the filter name and click the arrow button to move the wheel to the desired position.

**FITS Data.** Here you can write the object name and a comment for the FITS header of the image. All other data like date, time, temperature (if supported by the driver) are added automatically.

## 5 Filter wheel

To activate the filter wheel select the *Setup Page* (Fig. 2), click the **Filter wheel setup...** button, then select your model, the serial port, and click on **Connect** (Fig. 3).

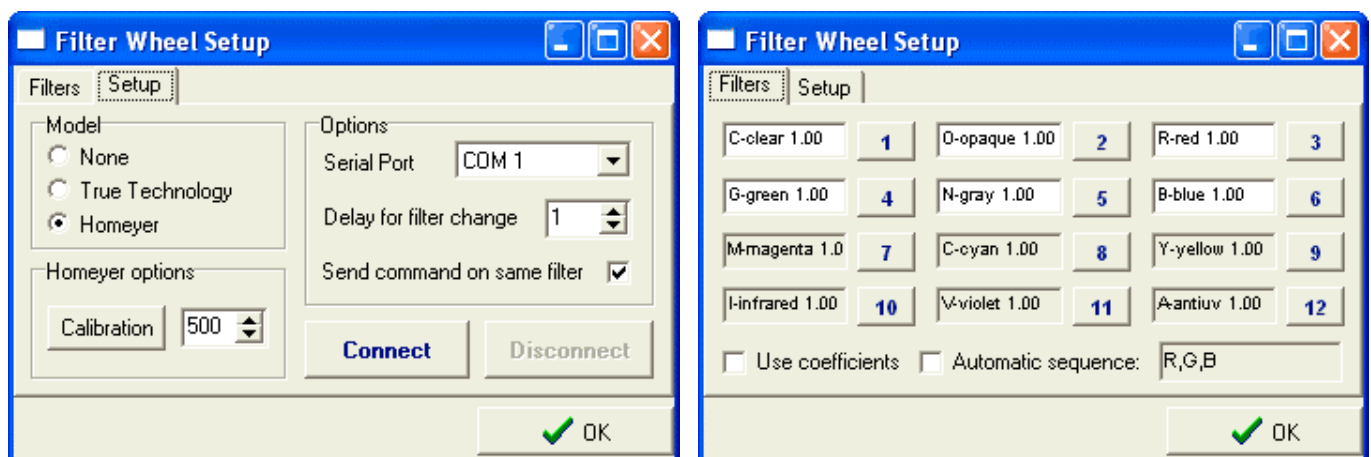


Fig. 3 - The Filters Pages

## 5.1 The Filter wheel Setup page

---

**Model.** Select from the list your filter wheel. The list may change depending on the model of your CCD camera.

**Com Port.** If your filter wheel is controlled via the serial port, select here which port you are using.

**Send command on same filter.** If enabled, Astroart sends commands to the filter wheel also when the filter is in position yet.

**Homeyer calibration.** The Homeyer filter wheel needs to be calibrated with the speed of the PC. If the value measured with the calibration does not work, try to increase it by 10 or 20.

**Delay.** This number indicates how many extra seconds to wait for, after the wheel movements.

## 5.2 The Filter wheel Filters page

---

**Filter names.** Accordingly to your filter wheel, the appropriate number of filters will be highlighted on the filter page. Take care of the following syntax when you modify the filter name in the text boxes: at first write a letter which identifies the filter. This is very important for the automatic sequences (see below). Then write a minus sign followed by the complete name of the filter and a coefficient: this coefficient could be taken into account during a sequence as a multiplicative factor for the exposure time.

Syntax: **[Filter letter]-[Filter name] [Filter coefficient]**

Example: B-Blue 1.50 ; where the first letter is used as a flag in sequences.

**Automatic sequence.** If enabled, the filter wheel will be moved before every exposure of an automatic sequence and the first letter of the filter (example: R for Red) will be appended to the filename.

**Use coefficients.** If enabled, the exposure time of every image will be modified by the given coefficient. This may be useful to compensate the relative sensibility of the CCD with every filter.

## 6 Telescope Control

To control the telescope click the button **Telescope Setup...** in the *Setup Page* (Fig.1).

In the Telescope Window select the appropriate protocol in the *combo box* (or the Telescope Simulator) and click on **Connect**. (Note that it's possible to *connect* also via the *Guide Window*, see chapter 7).

See also the Tutorial available in the next chapter.

**Protocol/Interface.** Select here the protocol used to command the telescope (many new mounts can emulate the GOTO protocol of the LX200, see the user manual of your hardware).

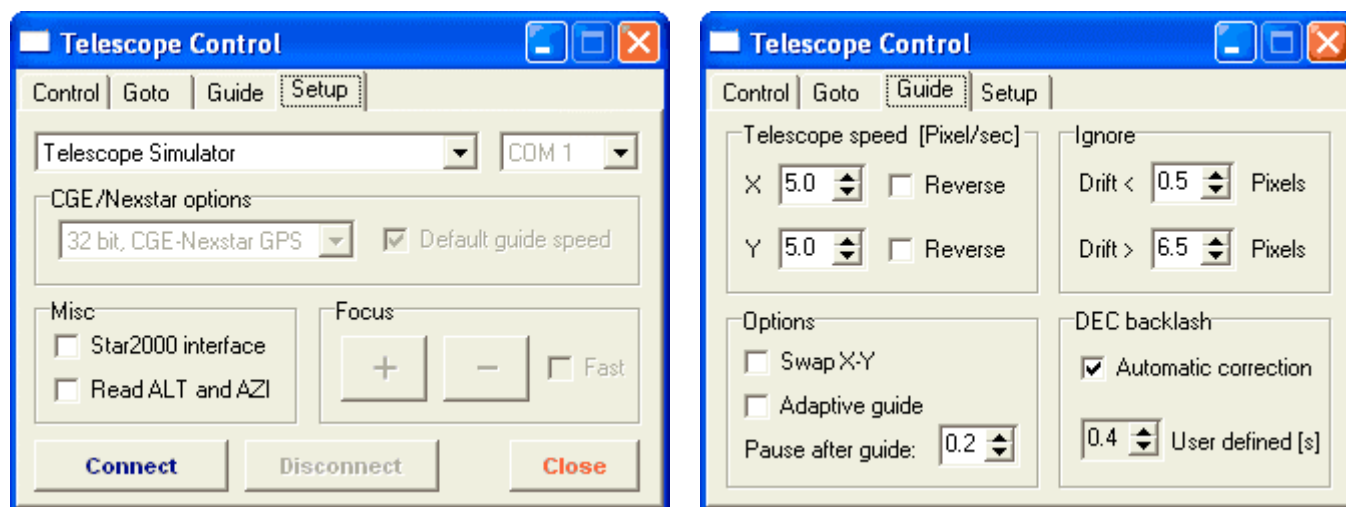


Fig. 4 - The Telescope Setup Page

- **Telescope Simulator.** A useful simulator to test indoor the Astroart telescope control.
- **LX200 or GOTO compatible.** LX200 and GOTO mounts, STAR2000 in LX200 mode.
- **ETX or GOTO compatible.** Meade™ ETX telescopes and simple GOTO mounts.
- **ASCOM driver.** Meade™, Celestron™, Astro-physics™, AstroOptiks™, Gemini™, SkySensor™ and many others. This option needs the Ascom libraries available at: <http://ascom-standards.org/>
- **Celestron CGE/Nexstar.** Celestron CGE and Nexstar series.
- **Starlight-Xpress Relay box, ST4 mode.** Autoguider box and STAR2000 relays output.
- **Cookbook Relay Box 300 baud.** Relay boxes originally designed for the CB245 (300 baud).
- **Cookbook Relay Box 9600 baud.** Relay boxes originally designed for the CB245 (9600 baud).
- **Audine Relay Box.** Relay boxes originally designed for the Audine camera.
- **VSSI direct cable.** Very Simple Serial Interface cable, a simple connection from the serial port to a telescope mount to correct the R.A. errors only. The signal DTR is the command RA+, the signal RTS is the command RA-. If the telescope is well polar aligned this system is sufficient for every purpose.
- **LX200 Shared port with SkyMap PRO.** An inter-process connection with the planetarium SkyMap™ PRO which allows both programs to share the same serial port.
- **MTS-3.** PowerFlex MTS-3 (autoguide and CCD centering only).
- **Interprocess Communication.** Interface with custom programs, see the Plug-in SDK.

**STAR 2000.** Enable this checkbox if you are using a Starlight-Xpress™ STAR2000 interface.

**Read ALT and AZI.** If enabled, Astroart reads the horizontal coordinates from the telescope. This can be slow down the system on some mounts.

**Focus.** These button control the integrated focuser of some telescopes. External focuser will be controlled by future releases of the CCD interface.

**Telescope speed.** The relative speed of the telescope in pixels per second. To measure this value simply move the telescope with the keypad for one second and measure how many pixels it

moves. In Astroart this parameter is not critic, an error of  $\pm 50\%$  will be automatically compensated by the plug-in, this means that there is no means to care about the  $\cos \delta$  factor.

**Com Port.** The serial port where the telescope is connected.

**Swap X-Y.** This options swaps RA with DEC, it's needed if the CCD is mounted rotated by 90 degrees.

**Adaptive guide.** A special mode for extreme conditions (bad seeing, wind), it's not recommended for normal guide. If this option is not selected the guide will be adaptive in any case, but a different algorithm will be used.

**Ignore.** A useful feature to prevent unwanted corrections for small drifts caused by bad seeing. 0.5 pixel is a good compromise between precision and rejection of noise. Values lower than 0.5 can be used only on a very short focal length (photo lens, for example).

**DEC backlash.** Backlash may exist when the declination motor changes its direction. Usually Astroart corrects automatically the DEC backlash (the Automatic correction check box is enabled by default) unless you set a specific time compensation (in seconds): in this case be careful! Backlash corrections should be always under compensated: an over compensation will lead to an excessive correction and to correct a small error, there could be an overshoot. Since guide speeds in Right Ascension typically are less the sidereal time, no reversal occurs in this axis and you don't need correction for RA backlash.

## 6.1 GOTO Control panel

The Telescope Window can also control the computerized mounts which are GOTO compatible (LX200™, Celestron™, etc.)

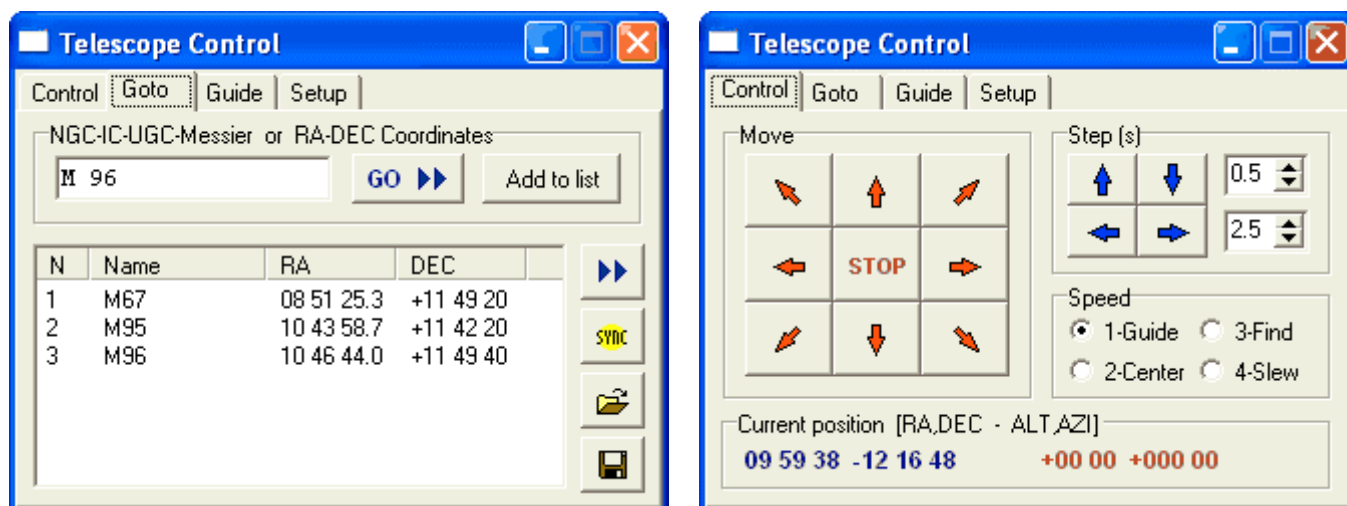


Fig. 5 – The Goto and Control Pages

**NGC-IC-UGC-Messier.** Type here the name of a deepsky object (example: N 4565, M 65, U 345 etc.) or some RA/DEC coordinates (example: 18 34.3 +34 56) then click **GO** to slew the telescope to that object. The blank space between the catalogue and the object number is always required ("N4565" won't be accepted).

**Resync.** Matches the current position of the telescope with the last object coordinates.

**Custom list.** Manages lists of objects. To create a list write a text file (or a Excel file saved as .CSV) where every rows contains: Name, RA, DEC. The format of the coordinates is free, but the declination must contain the sign. The Name of the object cannot contain spaces.

Example:

```
NGC4567 12 34.8 +78 45
UGC5678 8 56 67 -67 76.8
"M 67" 12 34 56 +78 23 23
PK456+789 12 12.2 + 34 34 34
"UGC 3456", 12, 14, 16, +34, 54, 34 // Comments this way.
"UGC 4567", 12.23445, -23.23456
```

The last two rows are CSV [comma separated values] which can be exported and imported by Microsoft Excel. To delete a row click the right mouse button.

**Move.** A “virtual keypad” to move the telescope, useful to center an object. The option “**Step**” will force the duration of every movement of the telescope to a given number of seconds, useful for mosaics and surveys. Please note that some Ascom drivers do not support this function.

**Speed.** The telescope speed, this option is not supported by some telescope. Remember to select “guide” before autoguiding.

## 7 Guiding

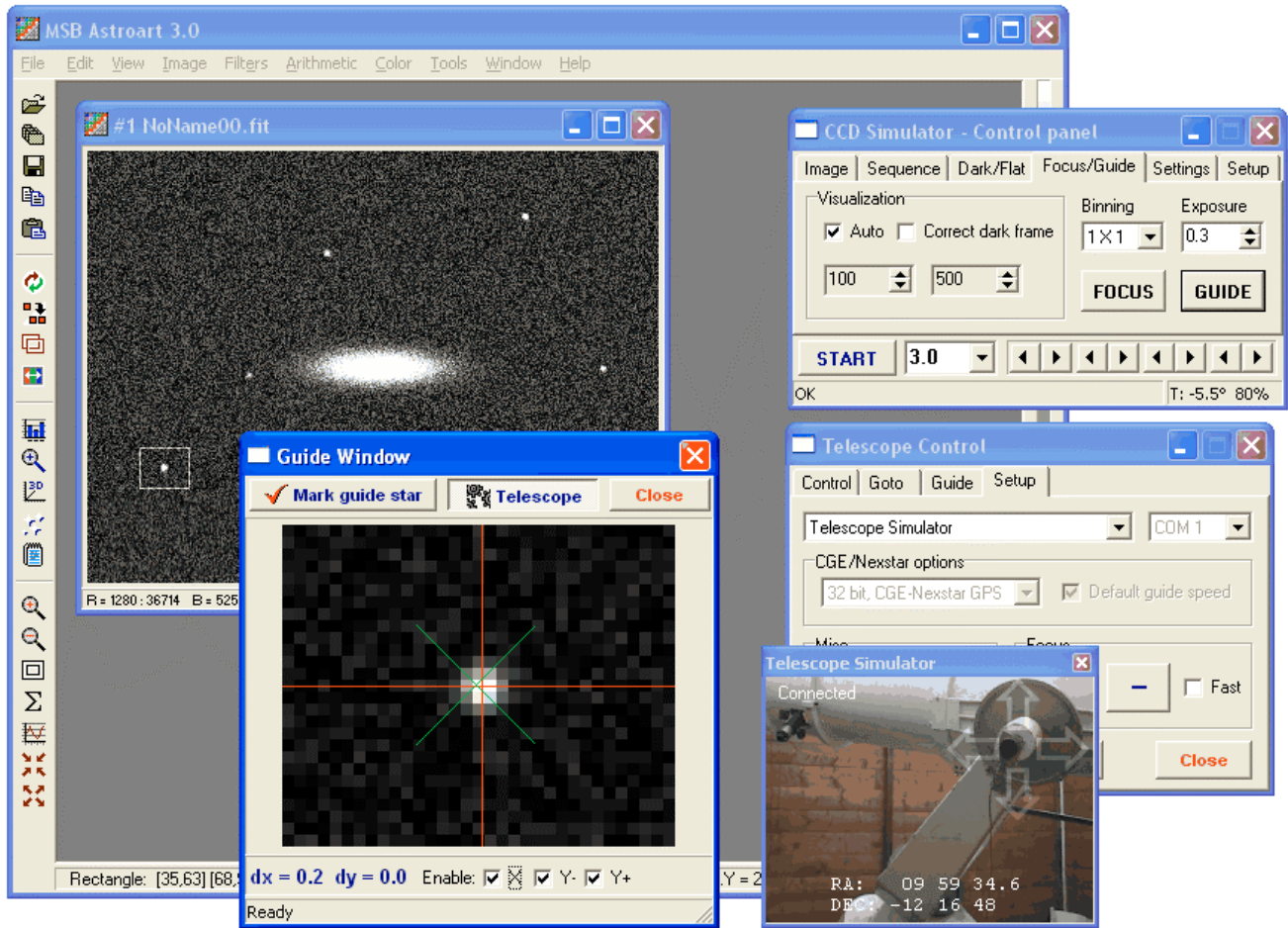
If you follow a star with your telescope at high magnification, you will notice that the position of the star changes, this movement is caused by three causes:

1. A poor polar alignment which could cause a slow drift and a slow rotation of the field of view.
2. The periodic error in the mount’s tracking rate: this error results from gears that are slightly out of round. Some mounts have a built-in periodic error corrector called ‘PEC’.
3. The random errors due to many causes as dirt, dents and variations in the gears. If the random errors are large and fast enough, they may make an unguided exposure almost impossible.

### 7.1 Tutorial

To quickly understand how the CCD and Telescope work together during an autoguide session, try this step by step tutorial:

1. Open the CCD User Interface, clicking on “CCD Camera” in the plugins menu.
2. Select “SIMULATOR” in the list and click on “Check CCD”.
3. Click on “Telescope setup”, select “Telescope Simulator” and click “Connect”.
4. Click “Start” to start an exposure.
5. Draw a small rectangle around a bright star and click “Guide” in the Focus/Guide page.
6. Click “Mark guide star”.



The telescope simulator will now guide on the reference star. To stop it, click the button "Telescope" in the guide window, the star will slowly drift away. Click again "Telescope" to restart the guide.

Remember that for a real guided exposure the tracking CCD should be aligned with the axes of the telescope so that motions in Right Ascension and Declination cause the star to move parallel to the CCD array (see Fig.6). Nevertheless Astroart tolerates a quite wide range of rotation, up to 25 degrees.

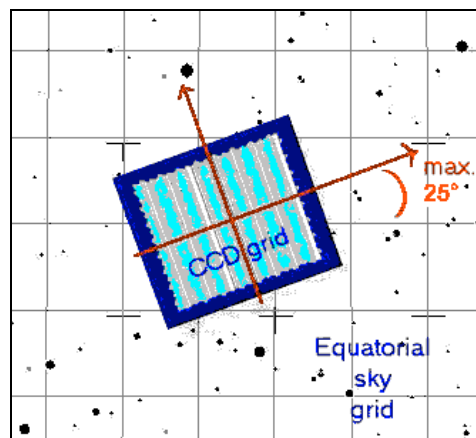


Fig. 6 – Aligning the CCD grid

The CCD User interface is designed to support three kind of guiding: *Manual guiding*, *Autoguiding* and *Selfguiding*.

## 7.2 Manual Guiding

This is the simplest way to guide your exposures and goes back to the times when digital imaging did not exist and the astronomers had to guide with a control pad and an eye at the guide telescope. Now, with the software tools in Astroart you can guide watching the monitor of your PC.

Usually you will use two imaging devices: one camera for guiding (a CCD camera or a WEB-cam) installed on a guide scope, and one camera for imaging (a conventional film camera or a bigger CCD camera) installed on the main telescope.

You will need also a motorized mount with a control pad. The Astroart Guide Window will let you easily guide the telescope watching a reference star on the screen. See: Fig.9.

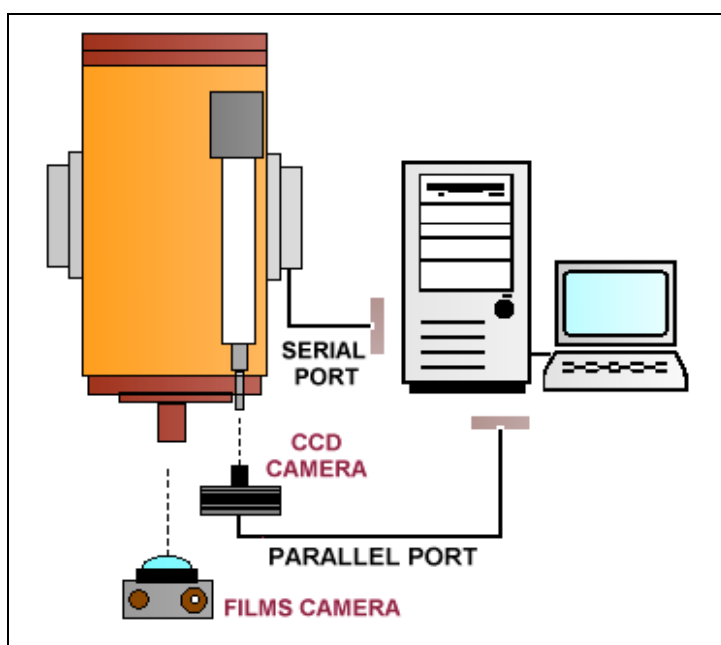


Fig. 7 – A typical telescope set-up for manual guiding: the CCD camera could be a simple WEBCAM.

## 7.3 Autoguiding

Autoguiding means to use a CCD camera (or a WEBCAM) to guide the telescope for an another instrument. Astroart measures the position of a reference star (the guide star) on the tracking CCD, and sends the appropriate commands to both the axes of the telescope mount to correct the guiding errors.

As explained in fig.8 three scenarios are possible:

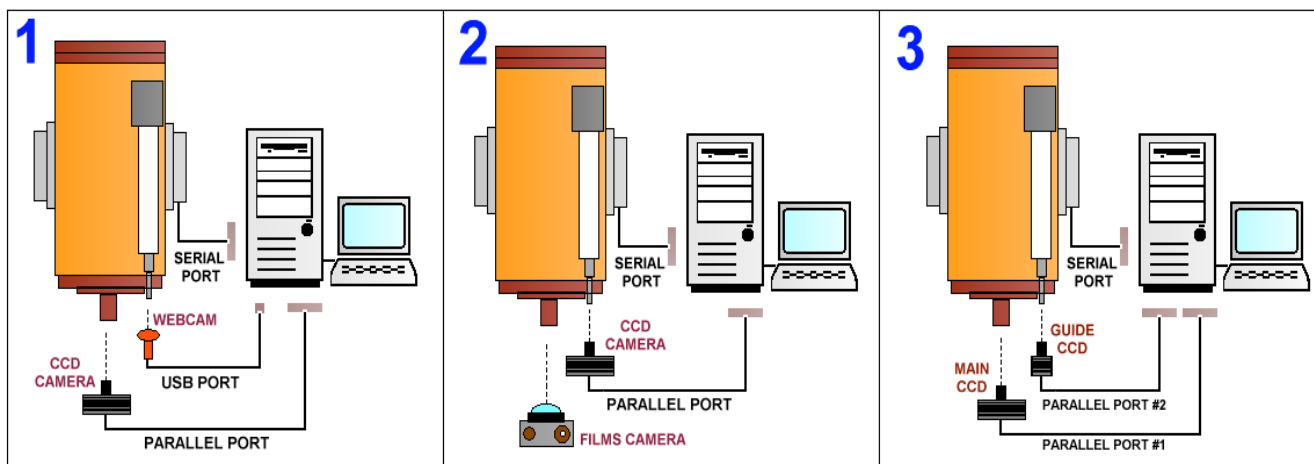


Fig. 8 - Three ways for autoguiding

- **A CCD camera and a WEBCAM as autoguider** : Fig.8-1. You need a conventional CCD camera and a WEBCAM (via USB). Due to the poor sensitivity of most WEBCAMS you'll be able to guide only with a bright star in the field.
- **A FILM camera and a CCD camera as autoguider** : Fig.8-2. Film cameras can still produce stunning images, sometimes better than CCDs. With this setup you can use a CCD or a WEBCAM to guide a film exposure.
- **Two CCD cameras** : Fig.8-3. A main CCD camera as imager and a low cost CCD camera as autoguider.

A further possibility is *selfguiding*. This is equal to the third option (Two CCD Cameras), but the autoguider CCD and the imaging CCD are integrated in the same camera.

To start a guided session using a CCD camera or a WEBCAM with Astroart, you should follow these steps:

1. Take an image with a short exposure time (example: one second): the exposure should be sufficiently long to identify a guide star in the field of view of the CCD, but short enough to let the guiding system works correctly with the same time: you should not exceed 1.5 - 2.0 seconds. To improve the sensitivity of your camera, change the binning (from 1x1 to 2x2).
2. Draw a rectangle around the guide star. A brighter guide star will allow you to use a shorter *exposure guide time* but if your mount is accurate and very stable, you can use longer exposure and therefore dimmer guide stars.
3. Go to the Focus/Guide Page (see Fig. 14), select in the combo box the same exposure time ("exposure guide time") and the same binning of your test image, then click the Guide button.
4. After a while the guide star will appear in the *Guide Window* (see Fig. 9). Click on the **Mark guide star** button: a green cross will automatically mark the initial position of the guide star, while a big red cross will follow the star while its shifts from the original position. If you are going to guide manually you simply have to act on your telescope control pad to keep the green cross over the red one.

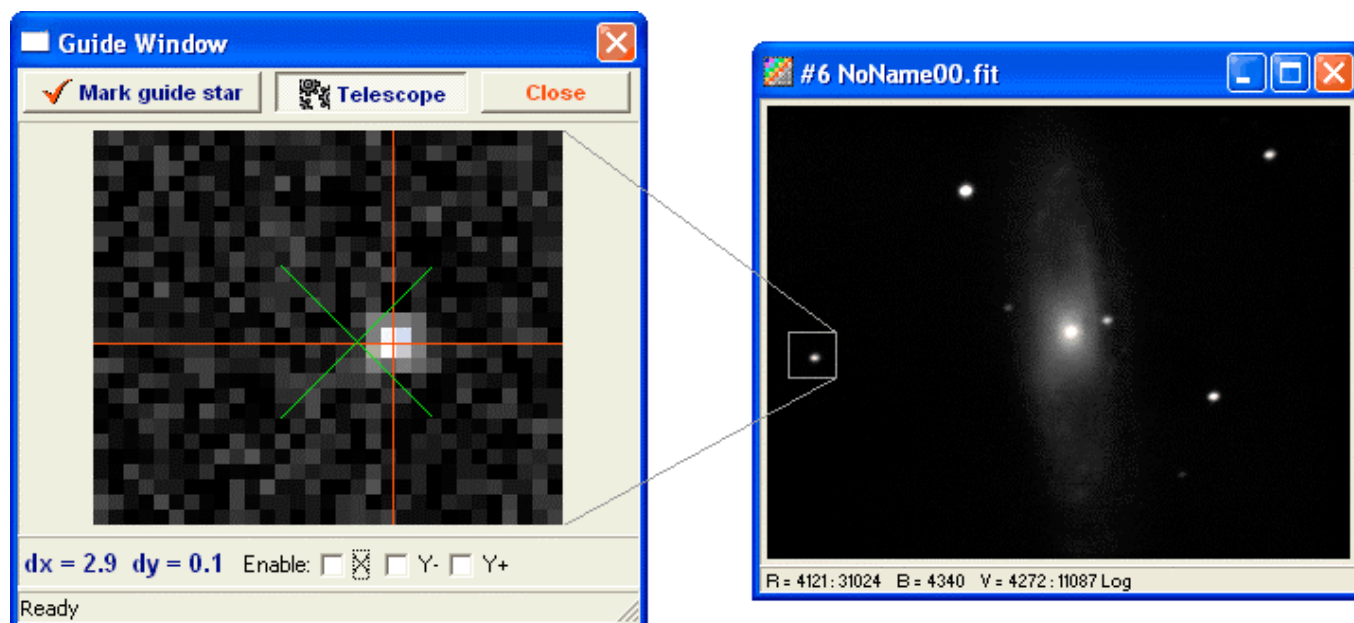


Fig. 9 - The Guide Window

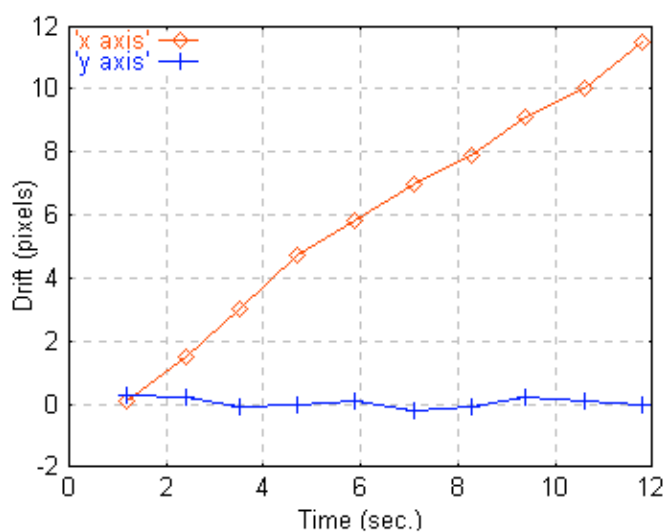
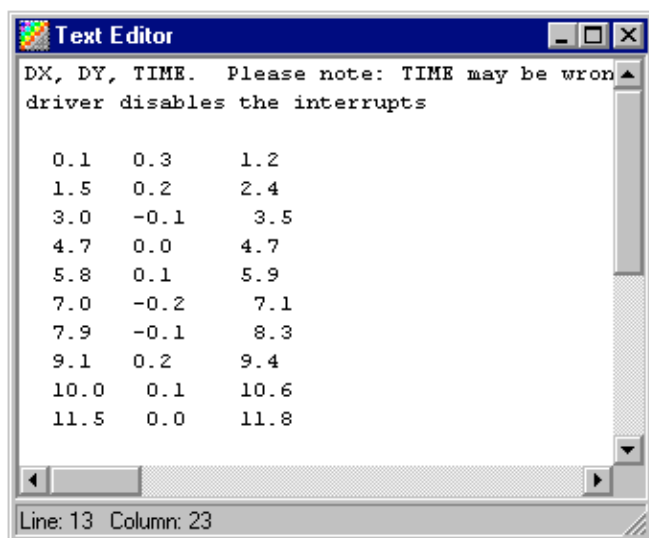
5. Click on the **Telescope** button to activate the telescope and to start the guiding session, remember that the telescope parameters should have been previously set in the *Telescope Window*.
6. If required enable the Guide X and Guide Y checkboxes. If the telescope is well polar-aligned you will obtain better results guiding only in X (RA). If the telescope is not polar-aligned you may enable only the Y+ or the Y- checkboxes (depending on the drift you see), this will prevent unwanted corrections caused by bad seeing.
7. If the corrections go in the wrong direction re-open the *Telescope Setup* window and select *Reverse* for the X axis (or the Y one). If the CCD is mounted rotated of 90 degrees remember to enable the *Swap X-Y* checkbox.
8. Start the film exposure (or the exposure of the second CCD camera).

If the system does not guide well, then it's strongly suggested to watch the behaviour of the star, this will reveal where the problem is, since only 3 scenarios are possible:

- 1) Overcorrection: the scope is much faster than you measured, so every correction brings the star beyond the center. The solution is to increase the option "Telescope speed".
- 2) Undercorrection: the guide is "lazy" and the star is brought to the center too slowly. This happens rarely, to solve it simply measure again the telescope speed.
- 3) Wrong direction: after a few seconds the star is brought away from the center. The direction of one of the axis must be reversed. Enable the option "Reverse X" or "Reverse Y".

To discover the problem quickly it's strongly recommended to try to guide on *one* axis at a time, this will help to understand which problem affects the RA and DEC axis.

**Tip:** you can use the *Guide Window* as a recorder to measure the dX and dY errors of the mount (drifts). In the *Guide Window* deselect the X and Y checkboxes to stop the autoguide and click the *right mouse button* to open a *Popup menu* and start recording. The dX and dY errors will be written into a text file which can be copied into the Clipboard and opened later by the Notepad or the Text Editor integrated in Astroart. In Fig. 10 is reported a clear example of a mount with a serious drifting along the X axis: within only 12 seconds of recording the drift is of about 12 pixels while the Y axis moves randomly around the 0. You can plot the data to clearly see this effect: in this case the red line represent the X drift along the time. With good approximation the slope of the lines gives you the amount of the drift along the time (in this case about 1pixel/second along the X axis and 0 pixel/sec along the Y axis).



**Fig. 10 –** You can use the *Guide Window* as a recorder for mapping the guiding errors of your mount: in this simple example, within only 12 seconds of recording we can see a large drift along the X axis (about 1pixel/sec)

## 7.4 Selfguiding

Selfguiding means integrated imaging and autoguiding using a single CCD camera with a built-in autoguider (a second CCD sensor) like the SBIG™ ST cameras or a CCD which can download a part of its image without deleting all the pixels, like the Starlight-Xpress™ MX series.

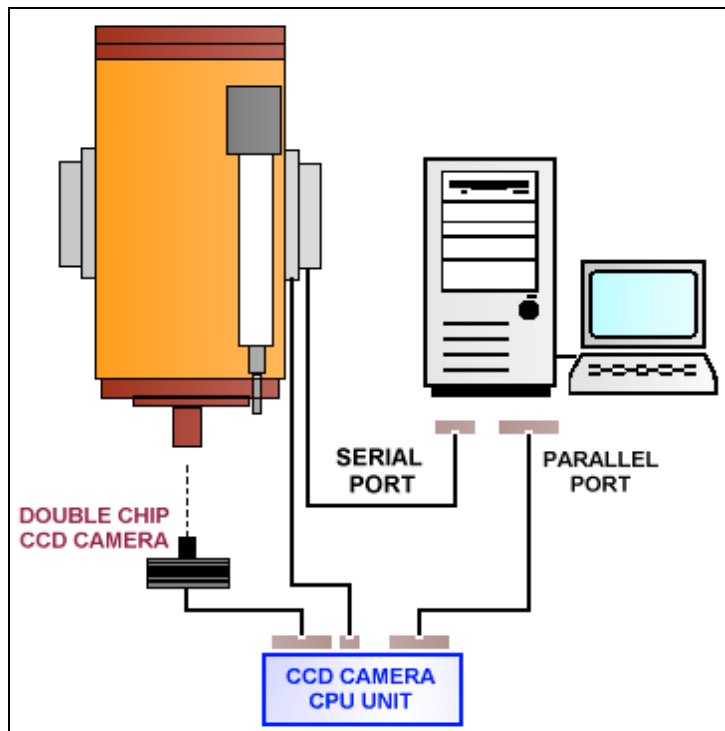


Fig. 11 - A typical telescope setup for autoguiding with a double chip CCD camera

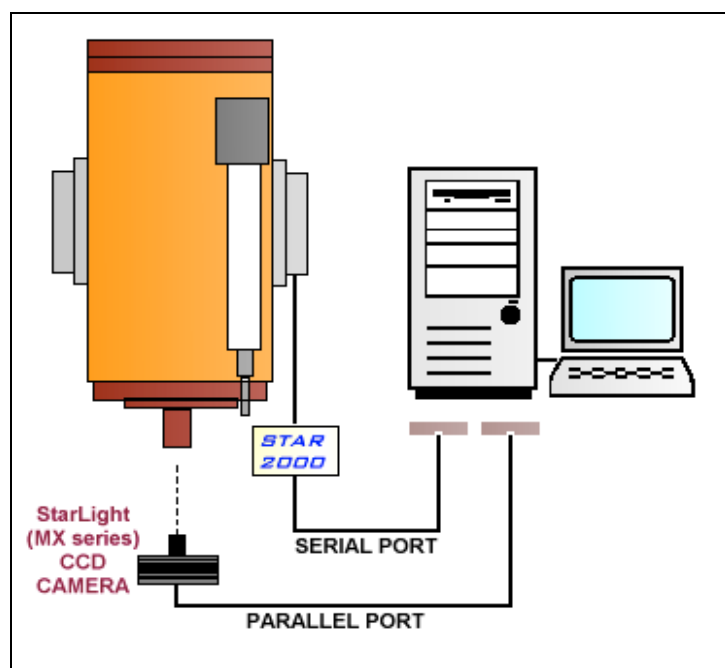


Fig. 12 - The Telescope Setup for Starlight-Xpress MX cameras

## 8 The Settings Page

In this page you will find all the options to control the download of images from the CCD camera.

**Binning.** If 1x1 is selected then the CCD chip works at full resolution (example: 768x512 for a KAF400). If 2x2 is selected then four pixels will be grouped into one and the final image resolution is 384x256 (for a KAF 400). The advantage of binning is a faster download and better signal to noise ratio. 3x3 and 4x4 are useful and fast to find or center an object.

**Delay.** If this value is different from zero, before each exposure there will be a pause of N seconds. This is useful if you need to setup the telescope before each image.

**Sub-frame.** This a useful feature for planetary imaging at high resolution. To speed-up the download and save space on disk it is possible to acquire only a part of the CCD array. To use this feature download a full frame, select a rectangle on it, then click the **Select from...** button. The frame boundaries will be written into the four edit boxes, (as percentage). If needed it is also possible to input these boundaries by hand.

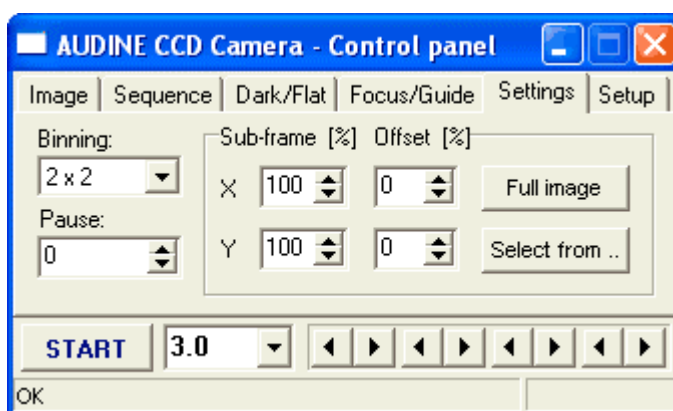


Fig. 13 – The Settings Page

## 9 Focusing

Before focusing integrate a full image and select a rectangle around a bright star. Note that this star should not be saturated.

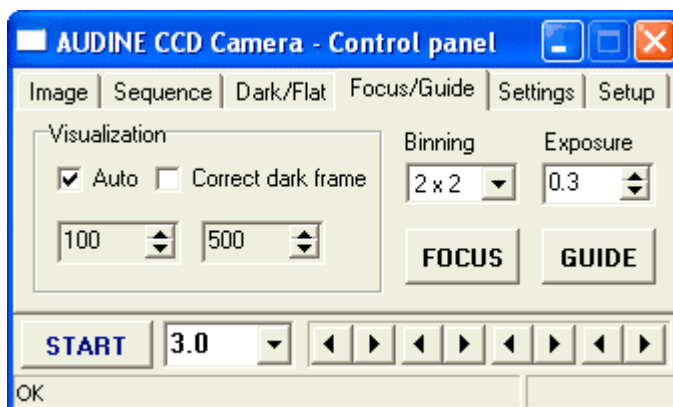


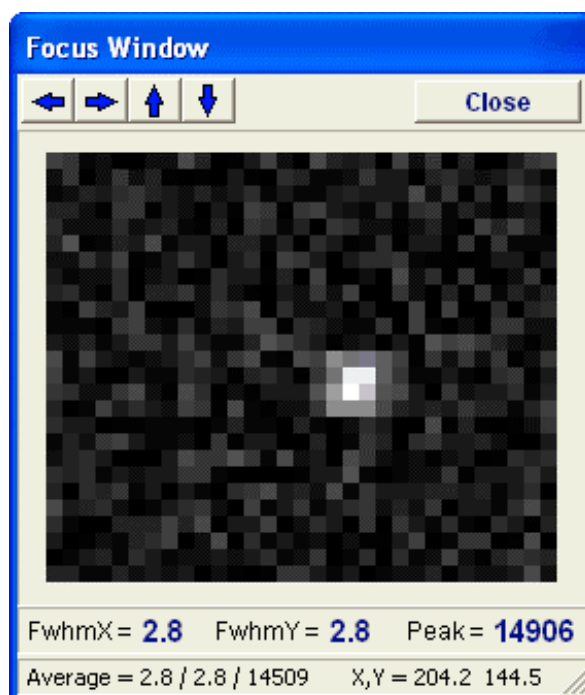
Fig. 14 – The Focus/Guide Page

**Exposure.** The exposure time for every frame (both for focusing and guiding).

**Binning.** The binning factor of every frame, see above.

**Correct Dark frame** : If selected, a dark frame is acquired at the beginning of the focus session: ( if you have not a shutter you should cover the scope before clicking the **Focus** button) Astroart will keep in memory the first frame as a dark frame and every subsequent image will be automatically corrected.

The focus window can be resized in real-time. In the Status Bar take a look at the sharpness indicator (Peak) of the current star: a high value means better focus.



**Fig. 15 – The Focus Window**

**FwhmX, FwhmY**: “Full width at half maximum” is a measure of the size of the star (in pixel). These parameter are useful to estimate the best focus.

**X, Y**: The coordinates of the star relative to the full image.

**Tip**: the Focus Window can be used to center or find the object you are going to image: take a short exposure, select a rectangle as big as the whole image, go to the *Focus/Image Page* and select *4x4 binning* for a fast download and click on the **Focus** button.

## 10 The Dark/Flat Page

This Page manages the dark frames and flat fields.

**Select from desktop**. Click this button to select a dark frame/flat field from the Astroart desktop, this is useful if you use your own sets of dark frames previously acquired. Obviously the selected image must be of the same size of the CCD array.

**Dark frame correction**. Select this option to disable or enable the dark frame subtraction for every new image. If you change the binning factor the correction will be disabled.

**Flat field correction.** Select this option to disable or enable the flat field correction for every new image.

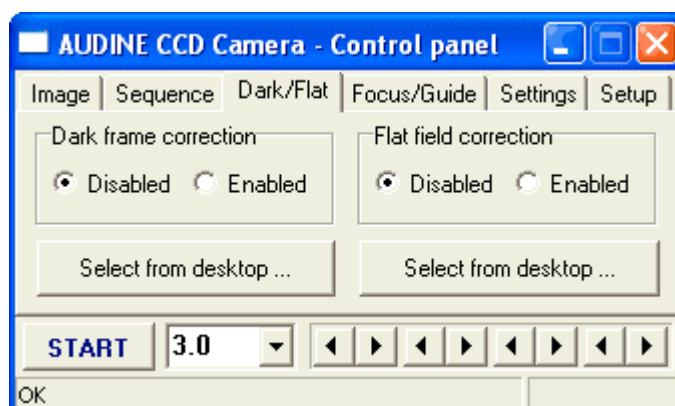


Fig. 16 – The Dark / Flat Page

For best results remember to take 5-10 dark frames and average them to reduce the random noise.

## 11 The Sequence Page

To improve the Signal-To-Noise ratio of CCD images it is often necessary to take a set (sequence) of pictures and average or sum them. This can be done automatically from the Sequence Page clicking the **Start** button.

**Exposures.** The number of exposures to be acquired, from 1 to 999.

**Autosave.** If selected every image will be saved with the filename specified in the edit box plus a ordinal number, into the chosen directory. Every image will be also opened into the Astroart desktop, if there is no need for this, disable *New Window* in the *Image* page. The images will be downloaded with all the specifications given in binning, subframes, dark frame, etc.

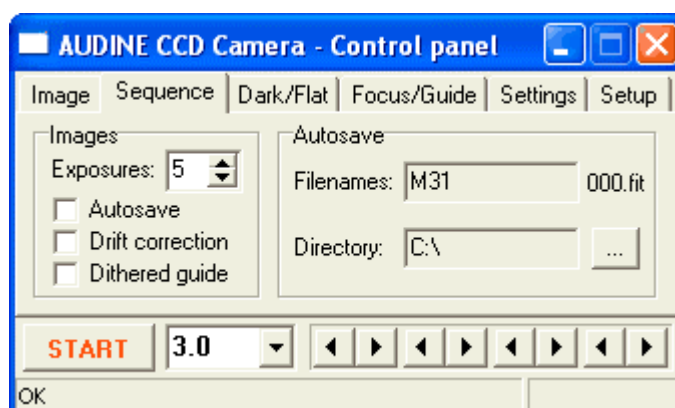


Fig. 17 – The Sequence Page

**Drift correction.** A useful feature for studying variable stars. After each image of the sequence the telescope will be moved to recenter the field. This allows long sequences (many hours) without the worry of drifts caused by bad polar alignment.

**Dithered guide.** This special option can be used during a sequence of autoguided images. Between

each image the telescope will be move randomly by +- 0.5 pixels. This means that every image of the sequence will not be aligned with the next. For advanced users only.

To stop a sequence click the button **Stop** once, and wait a few seconds.

## 12 History

2004/02/09 – Version 3.00, 96 bit color support for webcams.

2004/03/03 – Version 3.01, Supports custom CCD drivers, see the Plug-in SDK.

2004/03/15 – Version 3.02, More “user friendly” interface, CCD simulator.

2004/03/24 – Version 3.03, ASCOM telescopes and Telescope simulator.

## 13 Contact Information

MSB Software.

Via Romea Vecchia 67, Classe

48100 Ravenna RA – Italy

Tel/Fax +39 0544 473589

Dr. Fabio Cavicchio +39 339 2739548

Dr. Martino Nicolini +39 349 4004784

WEB: <http://www.msb-astroart.com>

WEB: <http://www.msbsoftware.it>

E-mail: [info@msbsoftware.it](mailto:info@msbsoftware.it) , [msb@sira.it](mailto:msb@sira.it)

©1998-2004 MSB Software – All rights reserved.