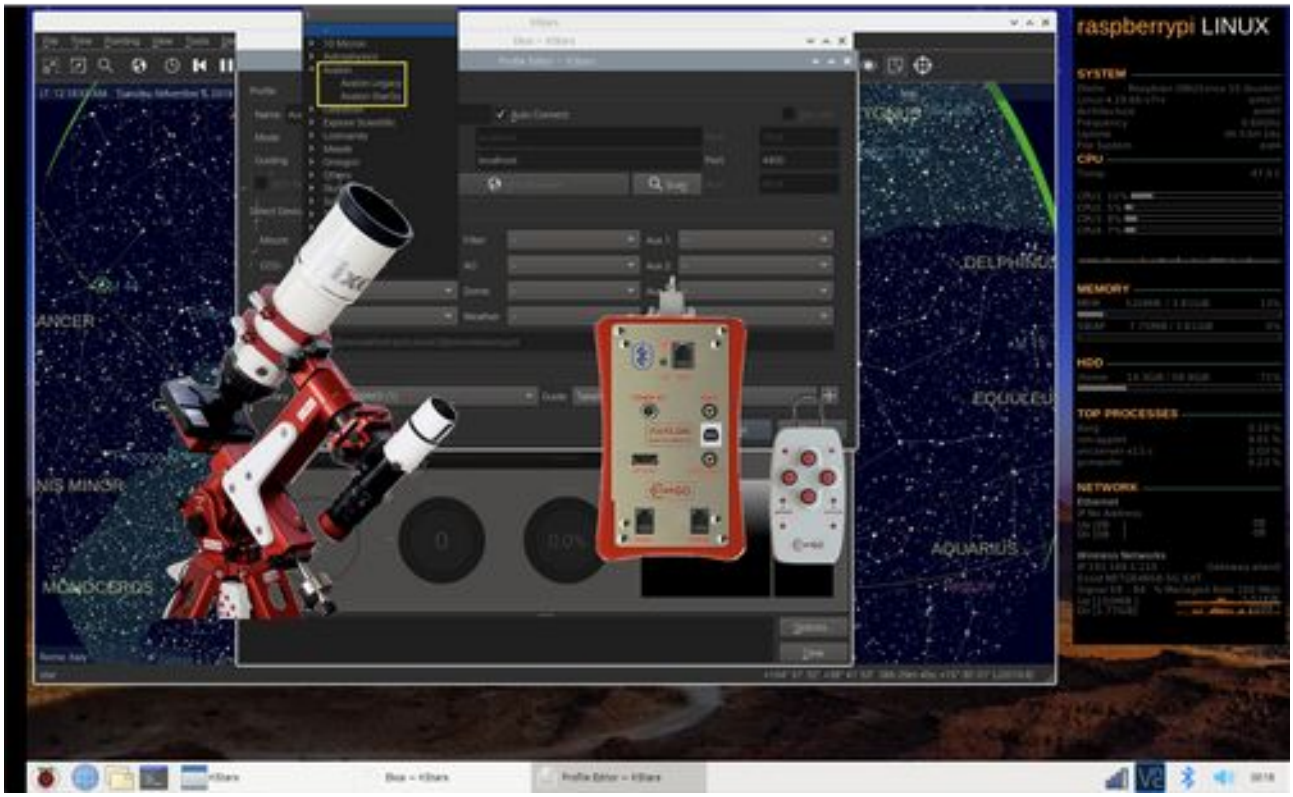
StarGO
Raspberry – INDI



User Guide

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A User Guide to
Avalon Instruments Mount Management
on a Raspberry Pi with INDI drivers
By Mauro Ghiri

Introduction

INDI is the acronym for **Instrument Neutral Distributed Interface.** It consists of a protocol enabling the control and the management of software and hardware astronomical clients under UNIX based operating systems, such as Linux and MacOS, as alternatives to Microsoft Windows.

During the last years INDI has underwent to a quick advancement in performance and reliability (within the already reliable Unix based OSs) and, with the coverage of most of the available astronomy and astrophotography equipment, it is getting a serious competitor to ASCOM for the management of astronomical visual and photographic sessions.

Another advantage of INDI over ASCOM is that it is easily implementable on small super-portable PCs like the Raspberry Pi and others, allowing the amateurs to break the chain with Windows based computer, by managing the astronomy sessions using only a tablet (or smartphone) to wirelessly control a Raspberry mounted directly on the telescope, gaining also a huge improvement on equipment cabling management.

Up to now, the Avalon Instrument mount control system, the StarGo, missed a suitable set of INDI drivers, requiring the mandatory use of a Windows PC for maunt management.

During the last year, several Avalon mount users, leaded by Wolfgang Reissenberger, joined their efforts and, with the Avalon Instruments assistance, have developed a very complete INDI driver for the StarGO, under the coverage of the INDI Initiative (https://indilib.org/devices/telescopes/avalon.html) .

This document will describe how to install INDI on Raspberry Pi (section 1) running specific Linux distributions and the details of the StarGo INDI driver setups and commands (section 2). In addition, in section 3, also a short tutorial on the use of this driver will be provided. Section 4, finally, will deal with the presently available commercial Raspberry Pi based systems.

1. Preparation of Raspberry and Installation of INDI drivers.

The best and quick method to get the set of INDI drivers and the tools to be used for astrophotography on a Raspberry Pi machine is to install the most recent distribution of **kStars** for Linux that can be downloaded by this page: https://edu.kde.org/kstars/. The kStar package embeds all the most updated INDI drivers and a fundamental set of tools for astrophotography called EKOS.

The installation of kStar in a freshly prepared Raspberry PI SSD is easy and doesn't require more than use the "Software Installation" application already presents in any distribution of Linux.

The practical use of the INDI drivers and associated applications for astrophotography requires also the use of numerous other tools for performing ancillary functions such as WiFi hotspot creation, remote control applications, etc. With the purpose of optimization of the astronomical Raspberry PI installations, special distributions and/or special script have been created by INDI users in the Open Source.

Two of this solutions are the **Astroberry Server** based on Ubuntu Mate 16.04 Desktop Linux distribution for Raspberry Pi3B and 3B+ and the **AstroPI3** for all Raspberry versions including the more recent available Raspberry PI 4. We have chosen this last solution for having a more wide application including the new P4s.

AstroPi3 is a special script created by Rob Lancaster that transform a fresh Raspberry SSD in a complete Linux version for astrophotography. This script is compatible with both the version PI3B and 3B+ under Ubuntu Mate or Raspbian and version 4 with the only Raspbian (Ubuntu mate is not yet available for Raspberry PI4).

These are the simple operation to be performed to get a fresh AstroPI3/Linux OS. They are very simplified to allow a successful result also to people very new to Linux and Raspberry. All the comments and figures of this document are referred to a Raspberry Pi4 and Raspbian OS used by us:

First of all be sure to have a good internet connection. The installation will require to download a lot of data.

1. Before to run the script it is necessary to burn a micro SD card (at least 32 GB size) with the chosen operating system following the instructions given in the points 1 to 6 of the **AstroPI3**.(this page will be opened on another device).
2. Start the Raspberry with the micro SD just prepared, execute all the automatically required actions and setup the WiFi to the local network.
3. Launch the Terminal and, this time on the Raspberry, open the AstroPI3 page.
4. Copy/Paste (one by one) the command lines in the points 7 and 8 of the page to the Terminal and press Enter after every line. If required put the password chosen during the startup process.
5. Run the script related the installed system (step 9 of the page). In our case we have chosen the "setupRaspbianPi.sh script.
6. Wait the script to finish. During the scripting process, that will last several tens of minutes, a few questions will be asked (at the beginning of the process). Respond accepting the proposed defaults.

Sometime may happen that the process stops due to random causes (for us it happened a couple of time on about ten attempts. Don't worry, repeat the point 5 above (step 9 of the

AstroPi page), The scripting operations already performed will not be repeated and this time the process will complete quickly!

At the end of the scripting restart the Raspberry. The following figure shows the new desktop obtained. Note that the differences with that of the fresh installed Rasbian are:

The presence of a large frame on the right (the Conky application) with all the more important system parameters and thre new icons on the left: kStars, phd2 and INDI Web Manager.

Your Raspberry is now ready to be installed in your mount and used for all your astrophotography needs.

2. kStar and Ekos setup

The kStar planetarium application can be launched by double clicking the relative icon on the left of the desktop. Its windows represents a portion of the sky with a lot all small icons below the main textual menu. From here it possible to choose objects, modify the appearance of the planetarium and perform few other tasks that are very important for our purposes.

The most important is Ekos that can be launched clicking on the icon  .

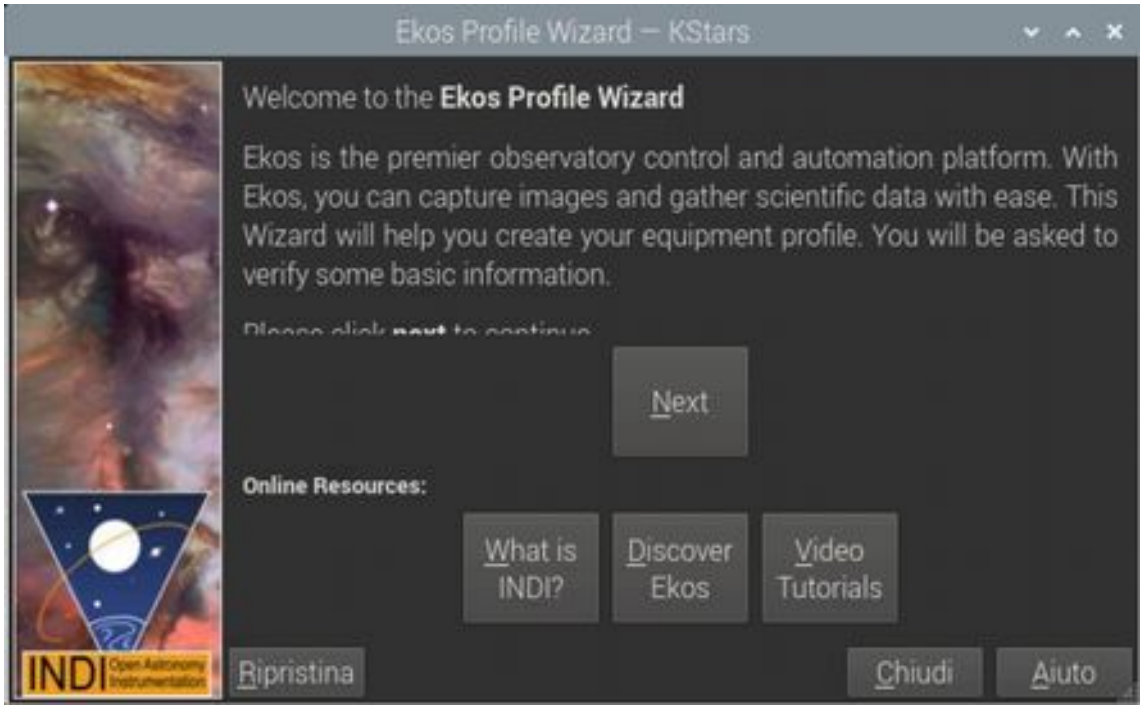
From indilib.org Ekos page site we report in few words what Ekos is:

"Ekos is an advanced cross-platform (Windows, OSX, Linux) observatory control and automation tool with particular focus on Astrophotography. It is based on a modular

extensible framework to perform common astrophotography tasks. This includes highly accurate GOTOs using astrometry solver, ability to measure and correct polar alignment errors, auto-focus & auto-guide capabilities, and capture of single or stack of images with filter wheel support. Ekos is shipped with Kstars.

It control your telescope, CCD (& DSLRs), filter wheel, focuser, guider, adaptive optics unit, and any INDI-compatible auxiliary device from Ekos."

At the first launch presents the Ekos Profile Wizard window will be presented.

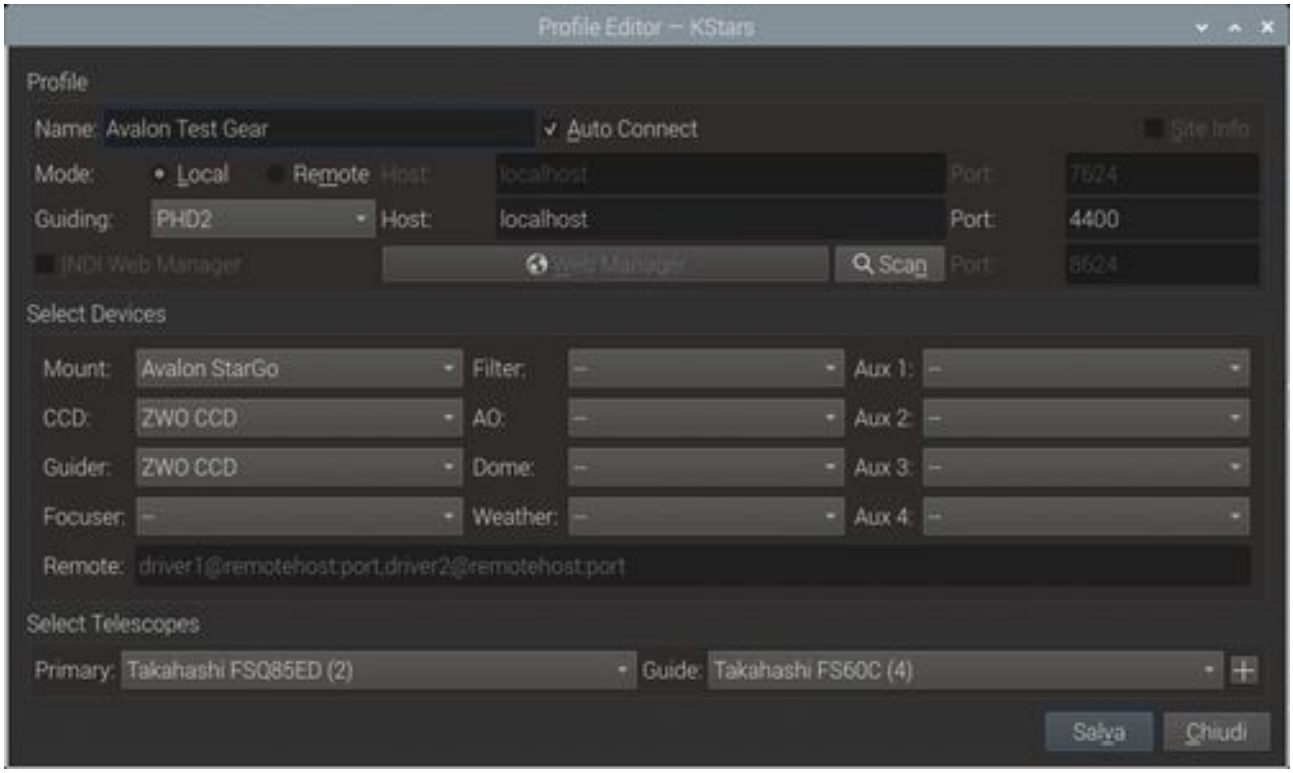


This window allows to consult several Online Resource. We recommend to do that to get a better confidence with its feature and characteristics. To go ahead press Next.

Two options are presented. Because we are going to use our Raspberry as the control computer of our setup, the equipment is connected to it directly or through an USB hub if the devices exceed the number of four. Therefore we press the upper button.

The next window allows to name our setup, to chose the autoguider type and, if available to connect additional HW/SW. Once filled following our need we can select the big button with the green check sign.

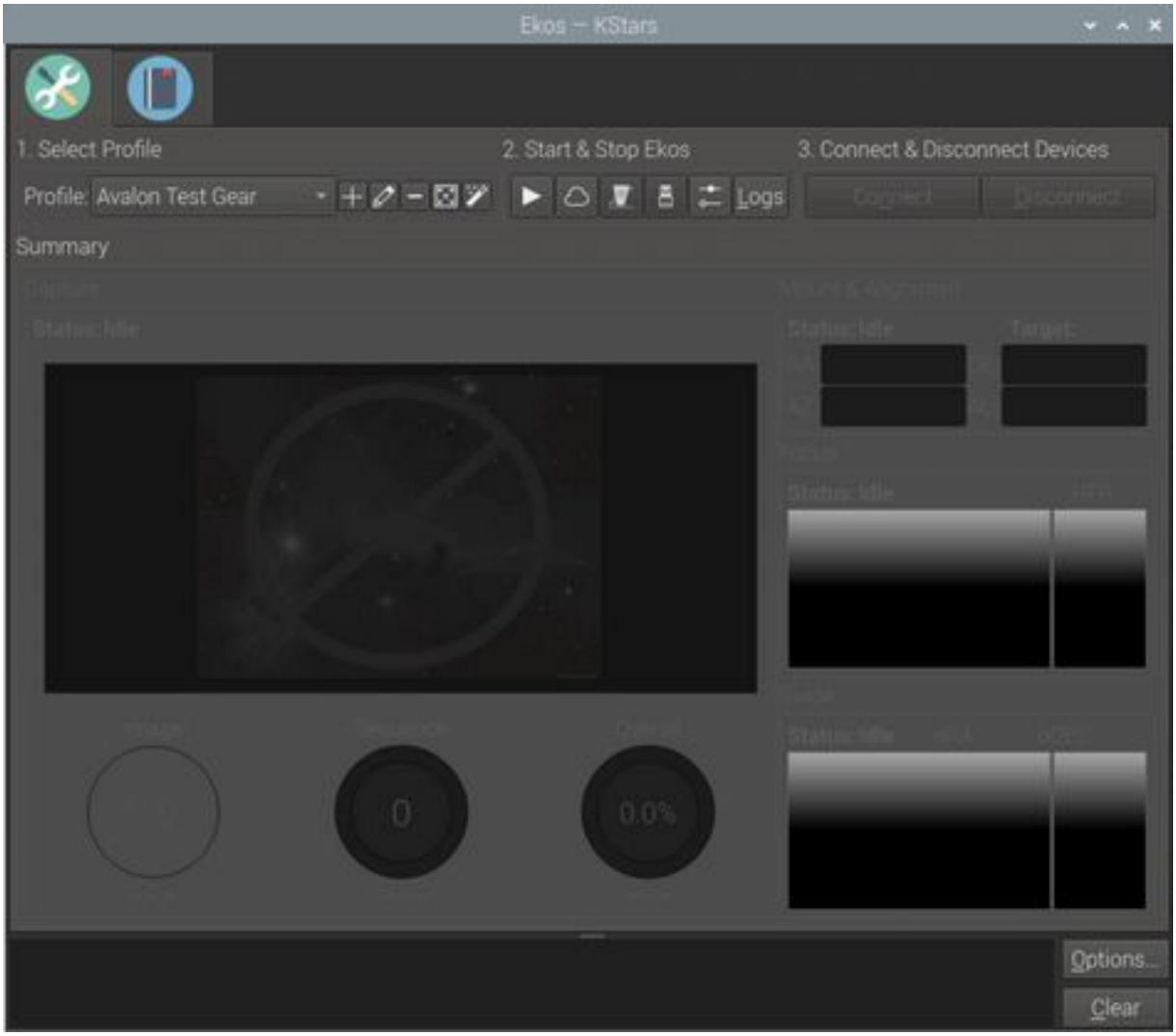
We are now introduced to the Profile Editor Window in which we can edit or profile by choosing our equipment and the type of telescope we intend to use.



In this profile we choose the Avalon StarGO mount INDI driver which is the purpose of this document. From now on we will examine only the Ekos mount module for all aspects regarding the Avalon mounts and StarGo. All other information about the use of other Ekos modules with third part equipment can be obtained from the indilib.org site.

As we will see below the profile we have just set can be in future renamed and modified to add different or additional equipment, to change the telescope type. This is important because the telescope focal length together with the sensor used determine the Field of View of our imaging system and are needed parameters for an efficient plate solving and precise object centering, even in the absence of a direct human control.

Once the profile is saved the second Ekos window is the Star & Stop one.



What is important to know in this window is the meaning of the two raw of icons on the left of the Profile name.

The  icon allows to re-open the profile editor for setup a new profile with different equipment considered.

The icon  will open the Profile Editor panel to make correction/addition to the selected profile.

The  icon delete the selected profile.

The  icon launches a new windows for introducing in the INDI set of drivers a new customized one. It is rarely used.

Finall  the ic  n  will re-launch the Ekos Profile Wizard we already have seen at the beginning of this section.

On the right side of icons just described there is a string of other six larger ones that have the following functions:

 Connects all equipment and open the INDI Control Panel for the selected devices starting with that of the Avalon StarGO. The explanation of this panel will be the argument of the following paragraphs.

 Connect to the EKOS Live Service (outside the scope of this document).

 Re-open in any moment, if needed during the normal session, the INDI Control Panel. This icon is present also in the KStar main windows with the same function.

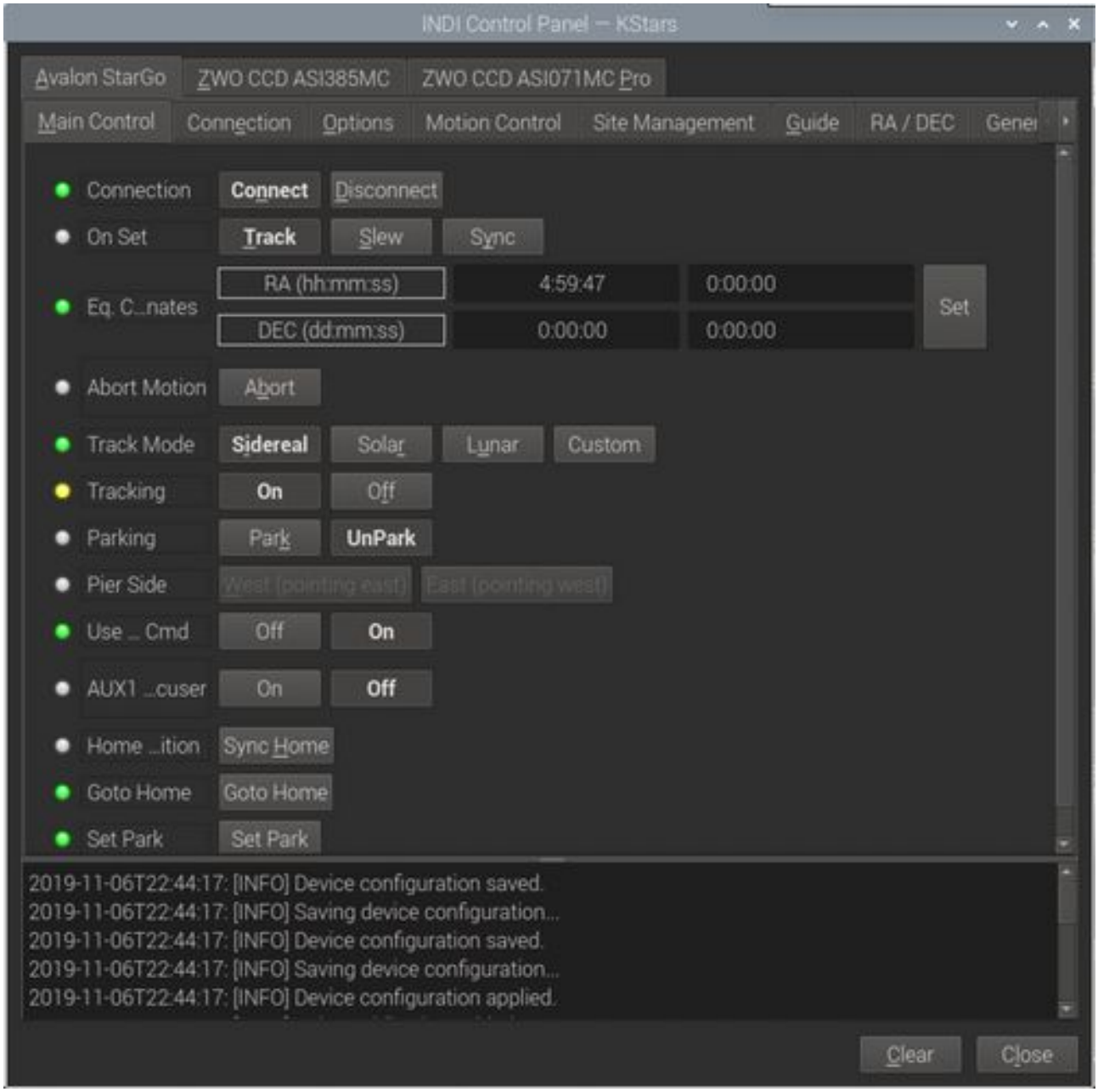
 Open the Serial Port Assistance Panel, needed to resolve any communication problems.

 Open the Kstar Configuration Panel

 Enable the log and allows the selection of the set of information to be registered and the PC directory where to save the logs.

To start the mount operation it is sufficient to simply click the  icon that will cause the opening of the INDI Control Panel. Below the panel you can glimpse a set of new large and colorful icons that are populating the EKOS -KStars panel Beneath. These are the icons related to our setup. One of them will constitute the argument of the remaining part of this document.

We can see that the INDI Control Panel is made up of several tabs, one for each connected device. In our case we have only three tabs because in our profiles there are only two ASI CCD (for photo shooting and guiding functions) in addition to the mount tab.



The Avalon StarGO tab in the INDI Control Panel has a function comparable to that of the setup tabs present in the Windows version of the StarGo software, i.e. it will show all the most relevant parameters of the mount and will allow the fine setting of many of these parameters. It has several subtabs, each dedicated to a particular function of the mount.

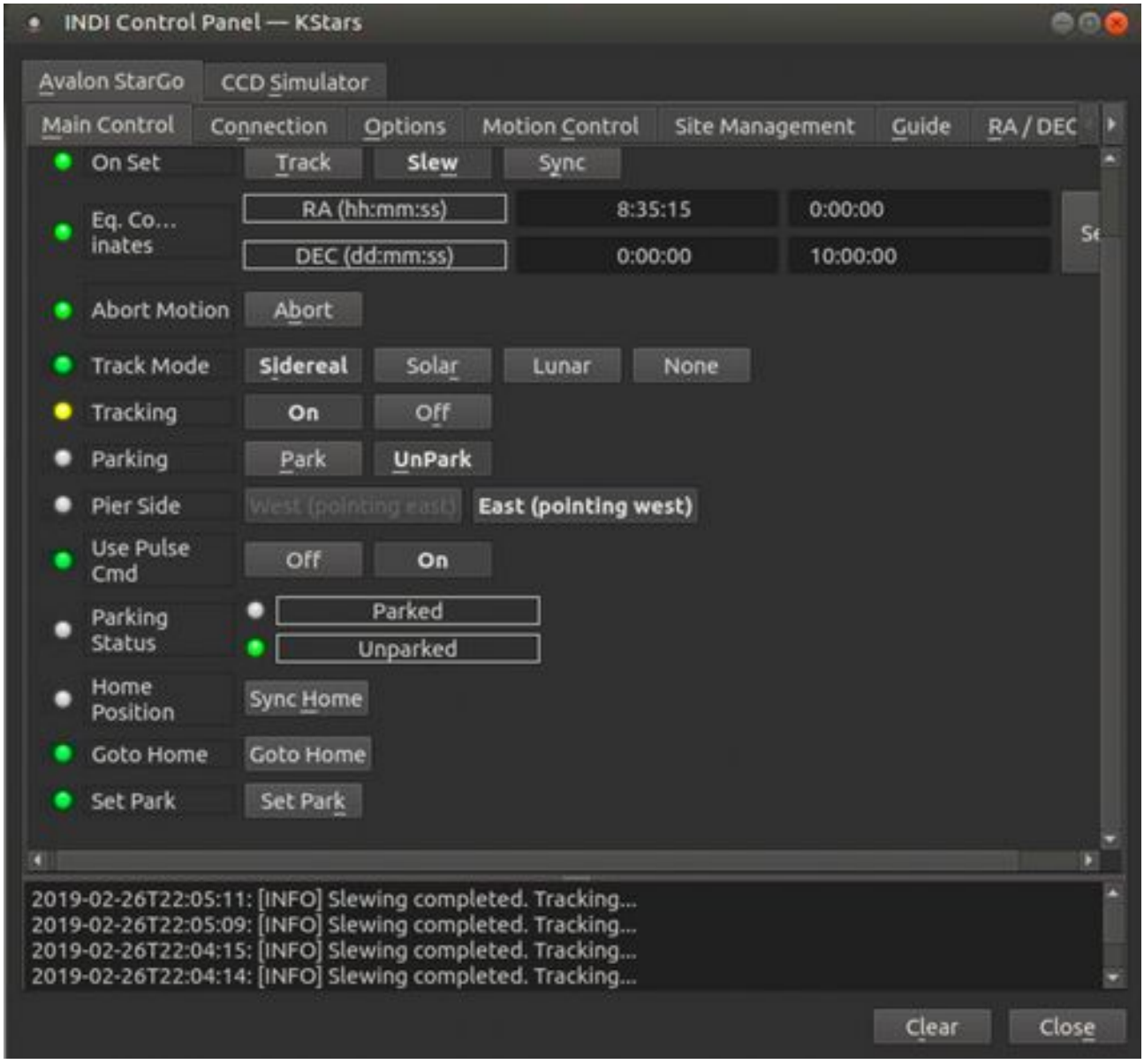
Even the mentioned colorful icons are very important because they allow the access to the controls of the single devices. The Avalon mount is accessed by clicking on the third icon representing a tripod.

3. Avalon StarGO INDI Contro Panel

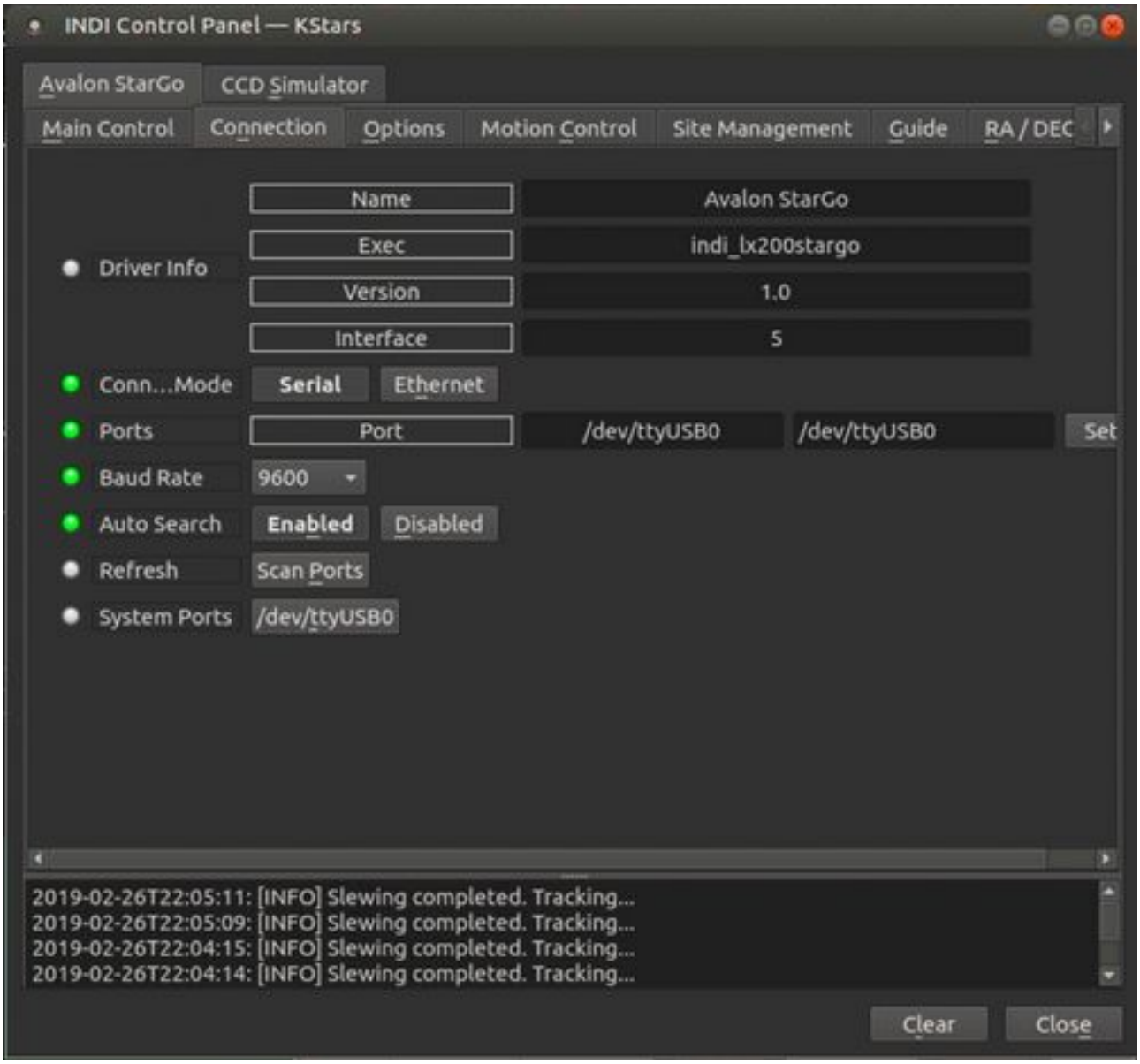
In this section the single sub-tab panels of the Avalon StarGO tab in the INDI Control Panel will be briefly described. Many of them are self-explained and will not be further analyzed.

A general note is that the bottom area in all panels describes all the operations performed on the side of the date and time of performance.

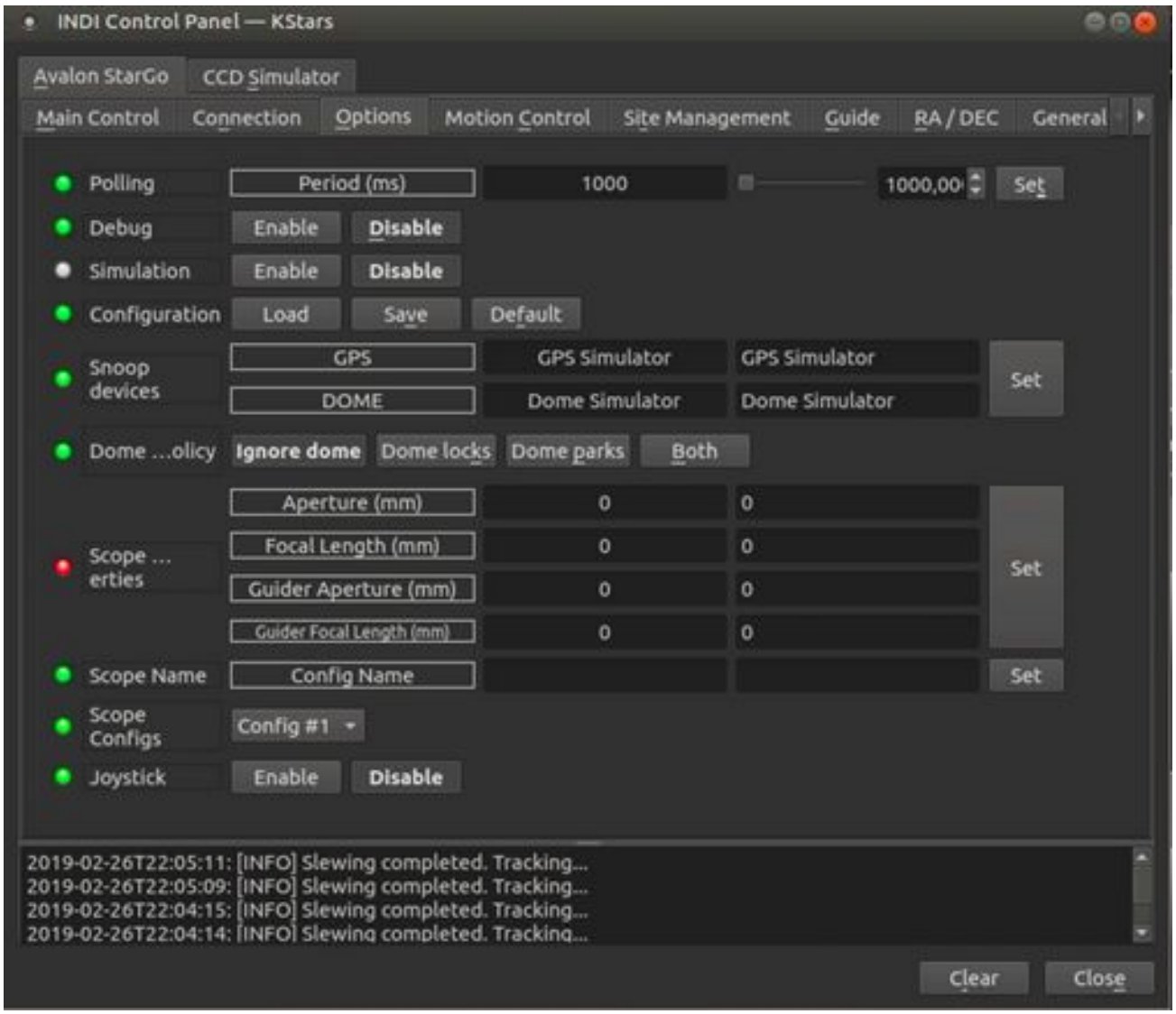
- **Main Control:** allows to set many of the basilar parameters and or the principal operations of the mount such as Connection / Disconnection, Mount Motion mode, Motion Abort, Tracking mode, Parking Operations, Homing Operations, etc.



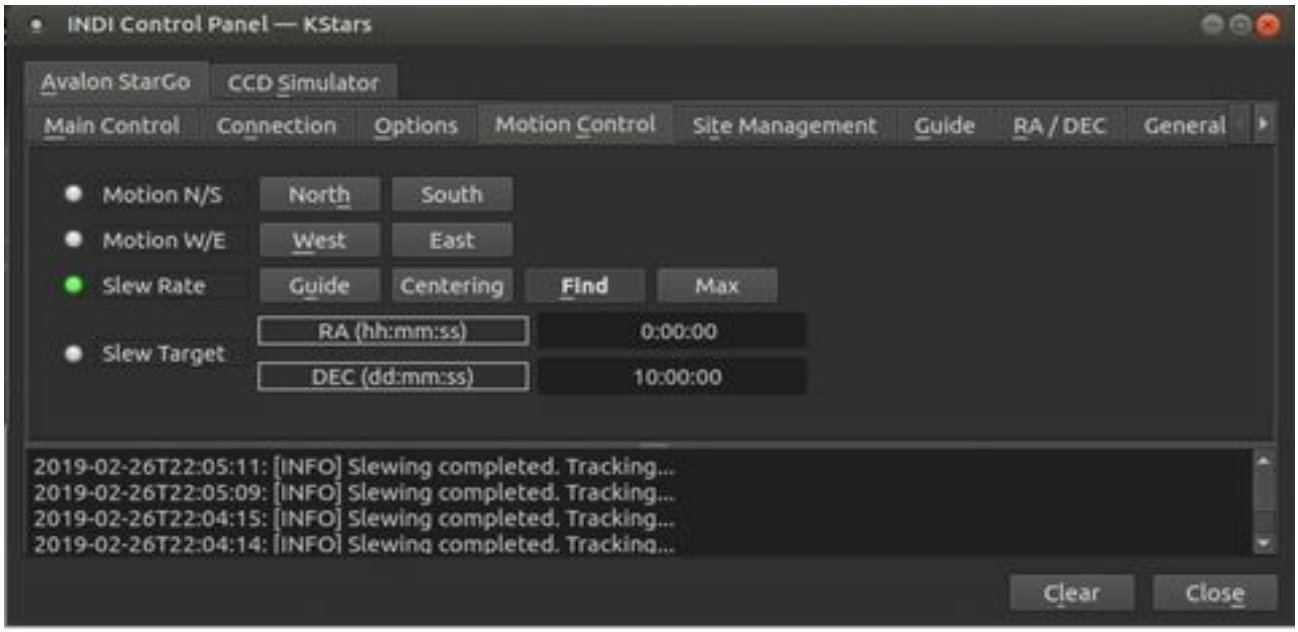
- **Connection :** All USB/Serial connection control and /or setup.



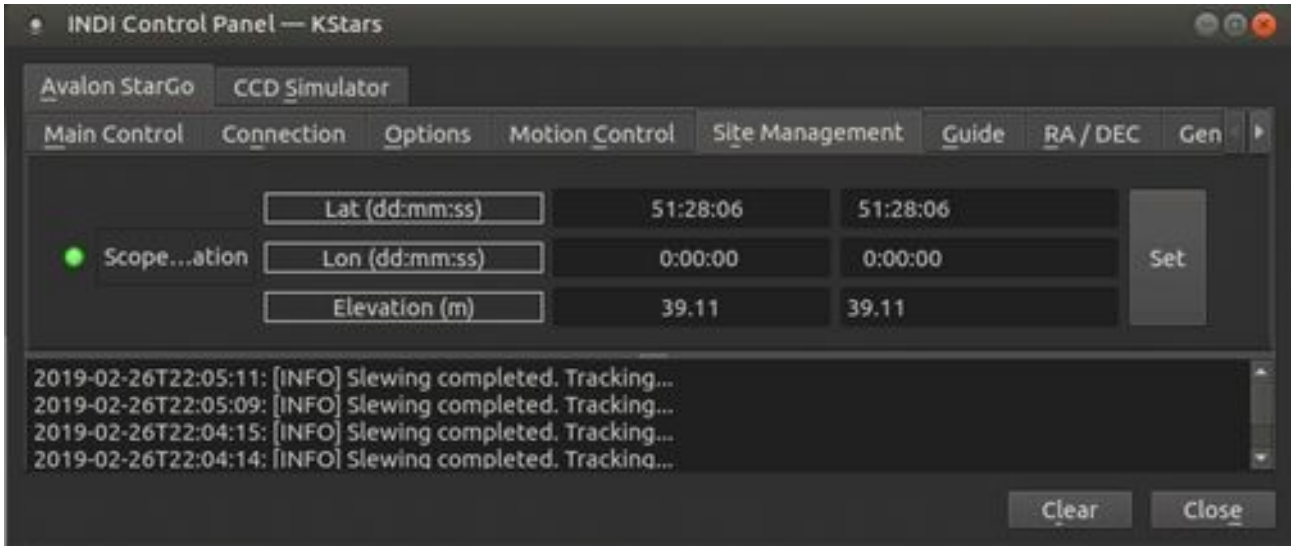
Option: in this panel many auxiliary parameters can be setup and and operations performed, such as: Polling time setting, Debug, Snoop devices setting, Telescope characteristics (will be reported in the output fit files), etc.



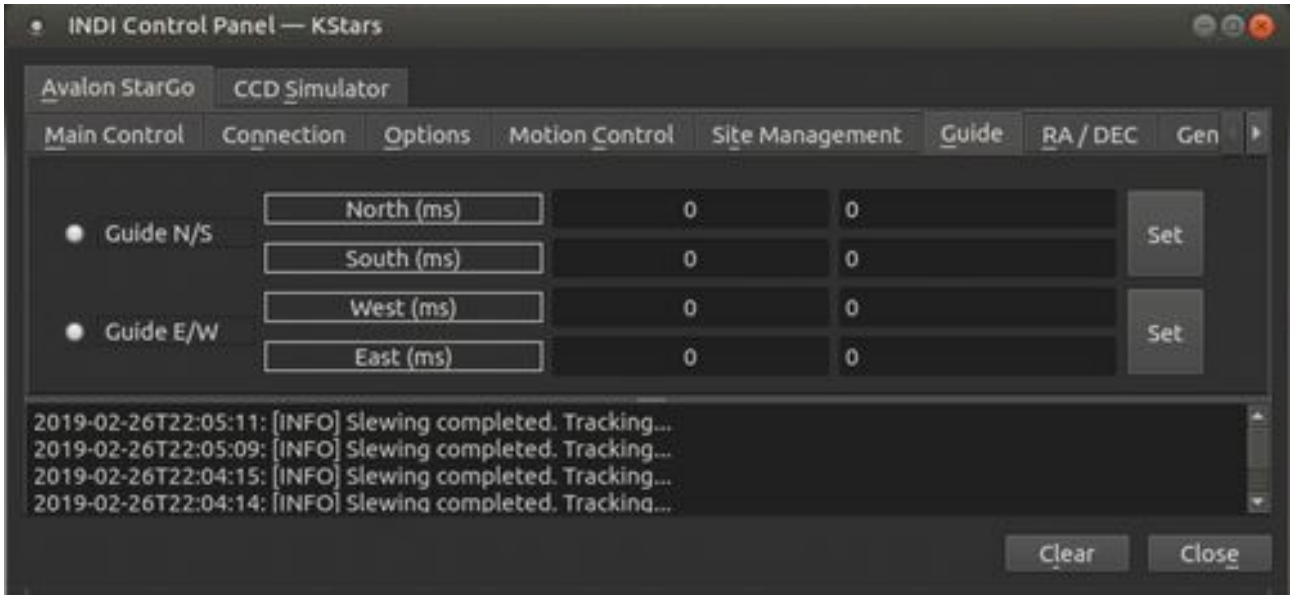
Motion Control: to setup the slew speed (Guide, Centering, Find, Max)



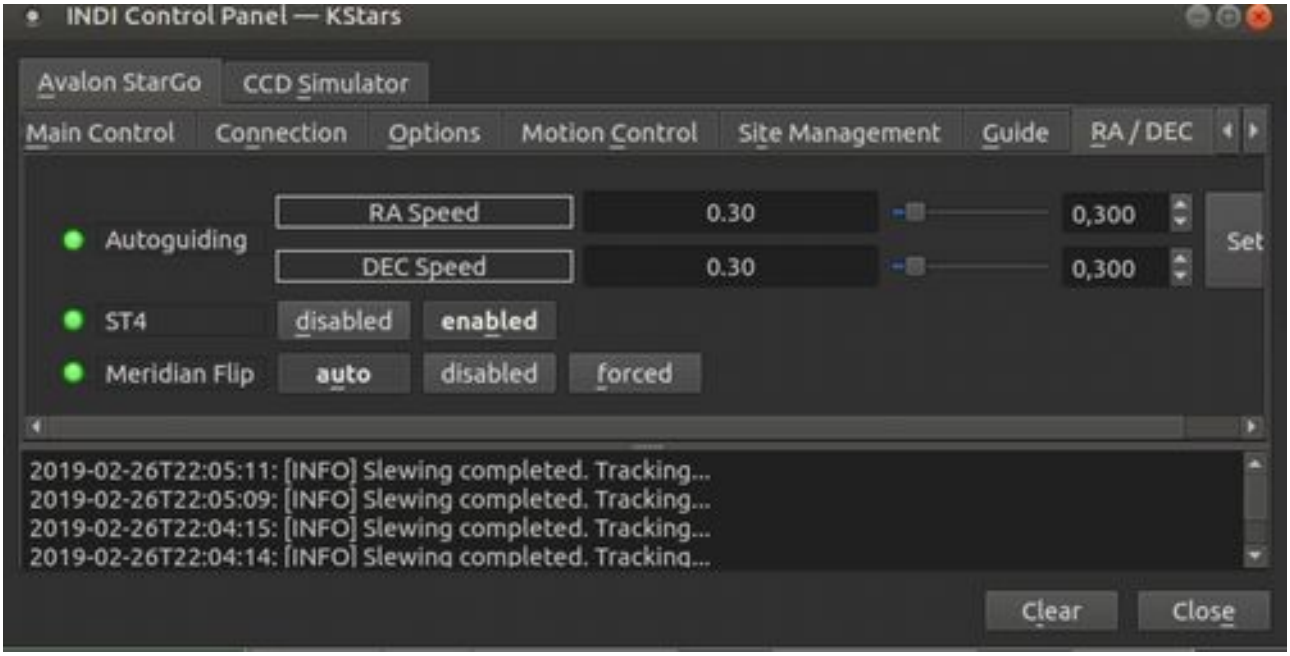
Site Management: for setting up the telescope geographical position.



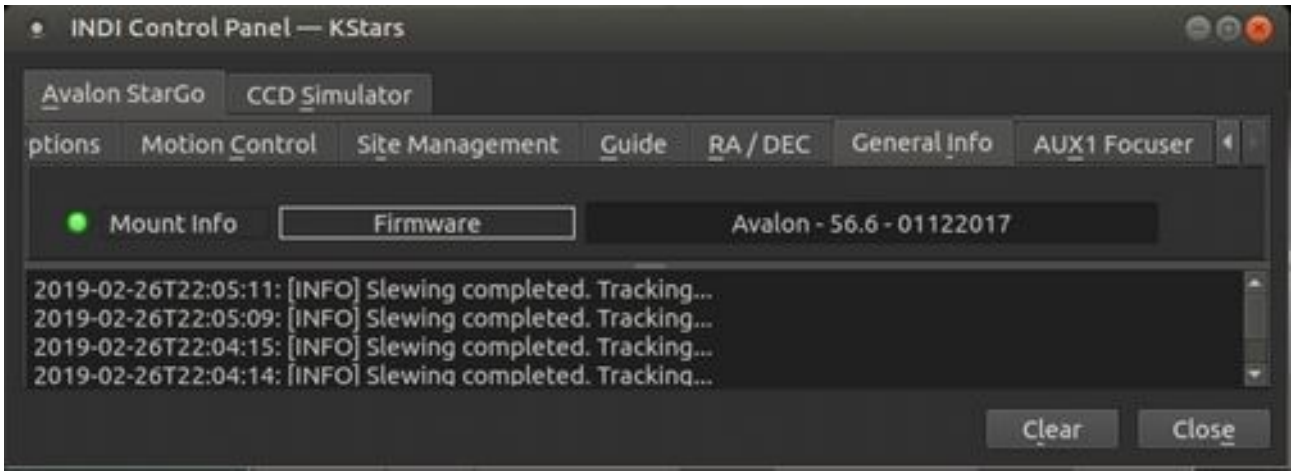
Guide: for the guiding parameters setup.



RA/DEC: for the autoguide parameters setup.



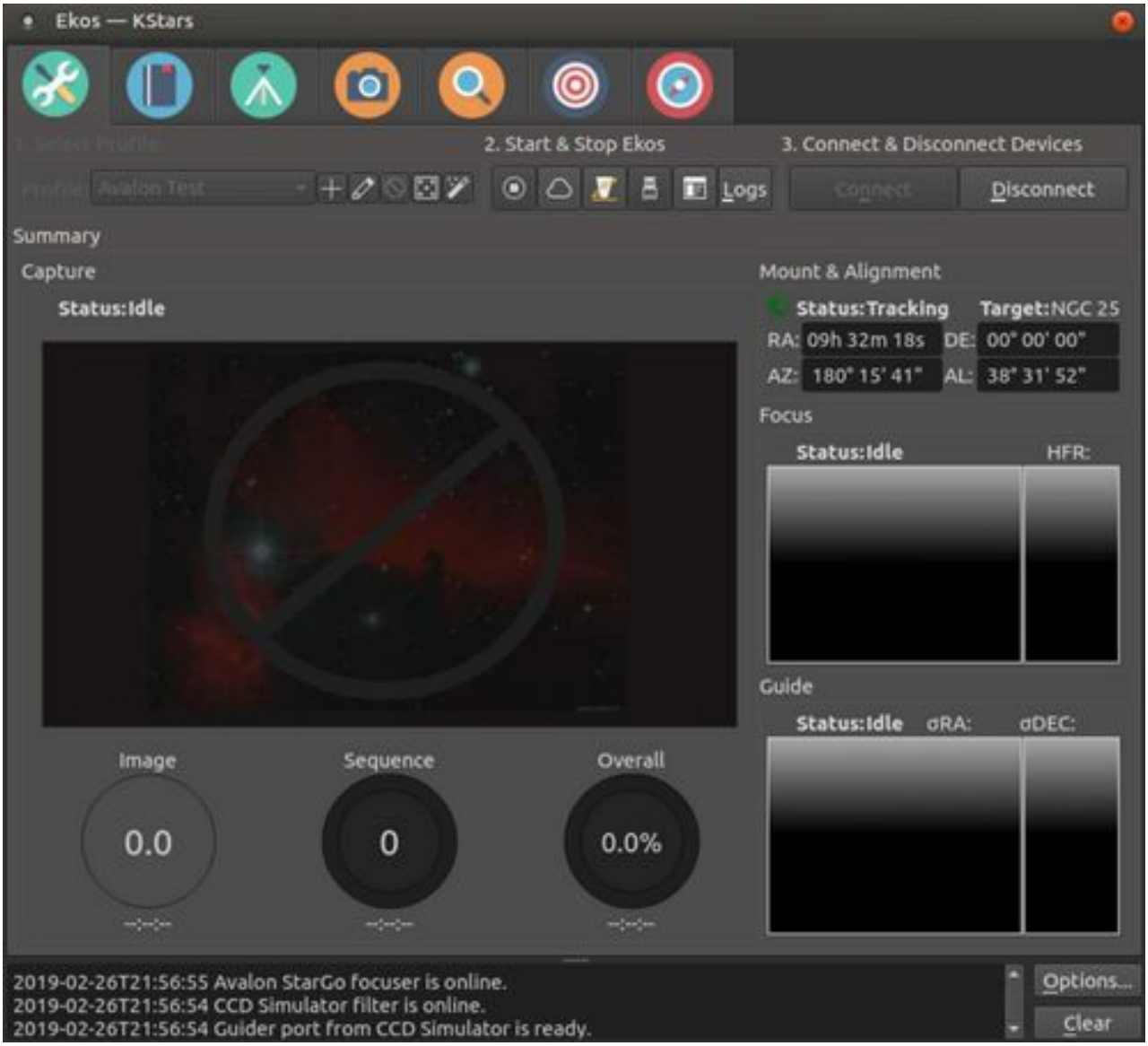
General Info: Contains the Avalon StarGO firmware version number.



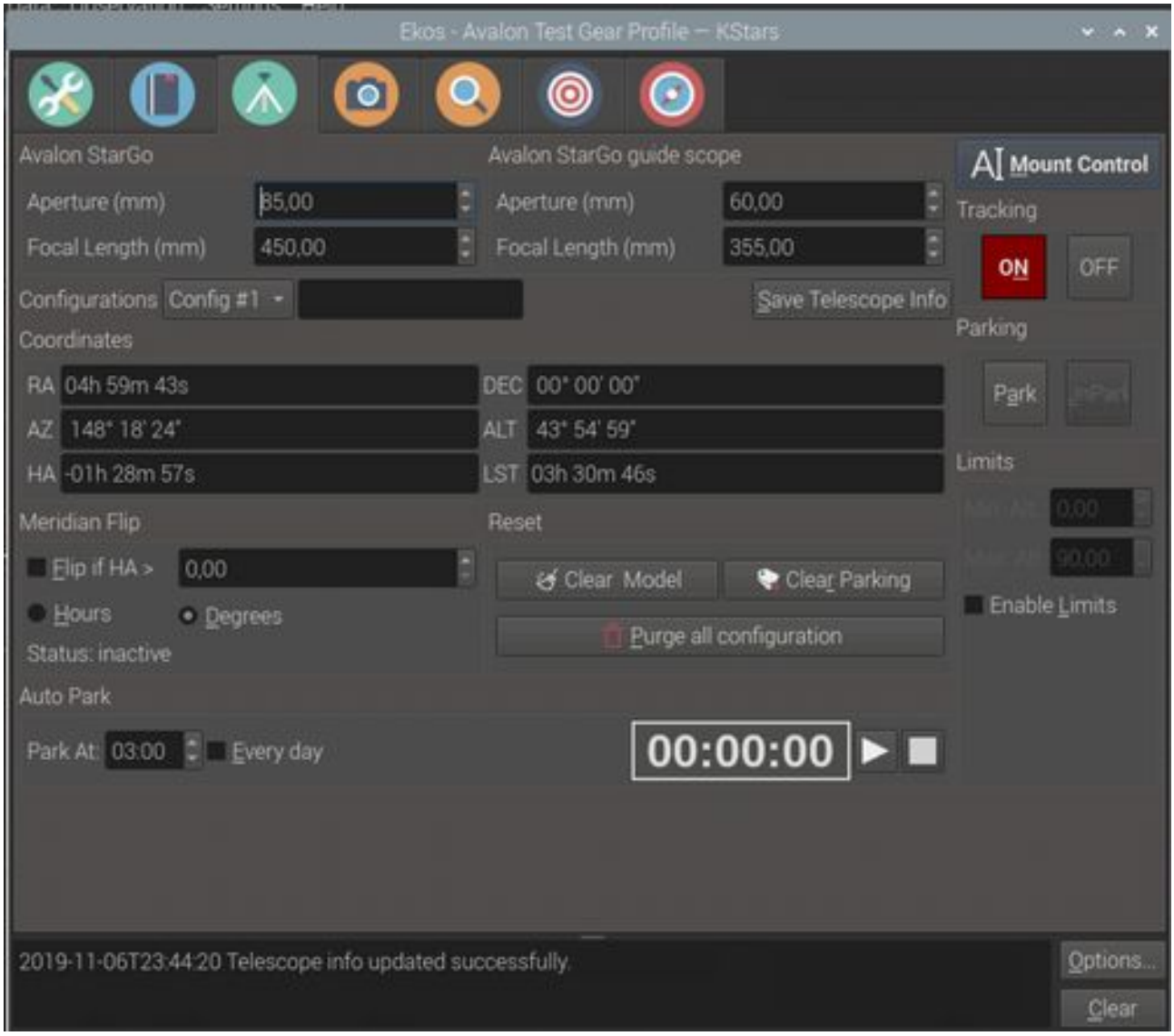
A further panel is foreseen to complete the StarGo contro under INDI. It is the Avalon Ficuser. The driver for this piece of equipment is under devolopment and will be inserted in the INDI set of driver in future version.

6 Avalon StarGO operation with INDI driver

Once the parameters of the mount have been setup it is possible to close the INDI Control Panel. It can be recalled in case of need by pressing the  icon available in both the Ekos Main Panel and in the kStars menu. The closure of the INDI panel will show the EKOS Main Panel populated with additional informatios such as the telescope tracking status, the RA/Dec position and the coordinated of the target eventually selected for the GOTO. Furthermore are well visible the previously mentioned colorful icons indicating the various tabs for each single Ekos function.



To control the telescope, it is necessary to open the operation window by clicking on the tab with the green tripod icon.



In the upper part of the windows there are the field where are inserted the main telescope and guide telescope information recalled from the telescope configuration previously set.

On the right side of the telescope information there are three buttons needed to launch the mount virtual keypad (AI Mount Control), to activate and to stop the mount tracking

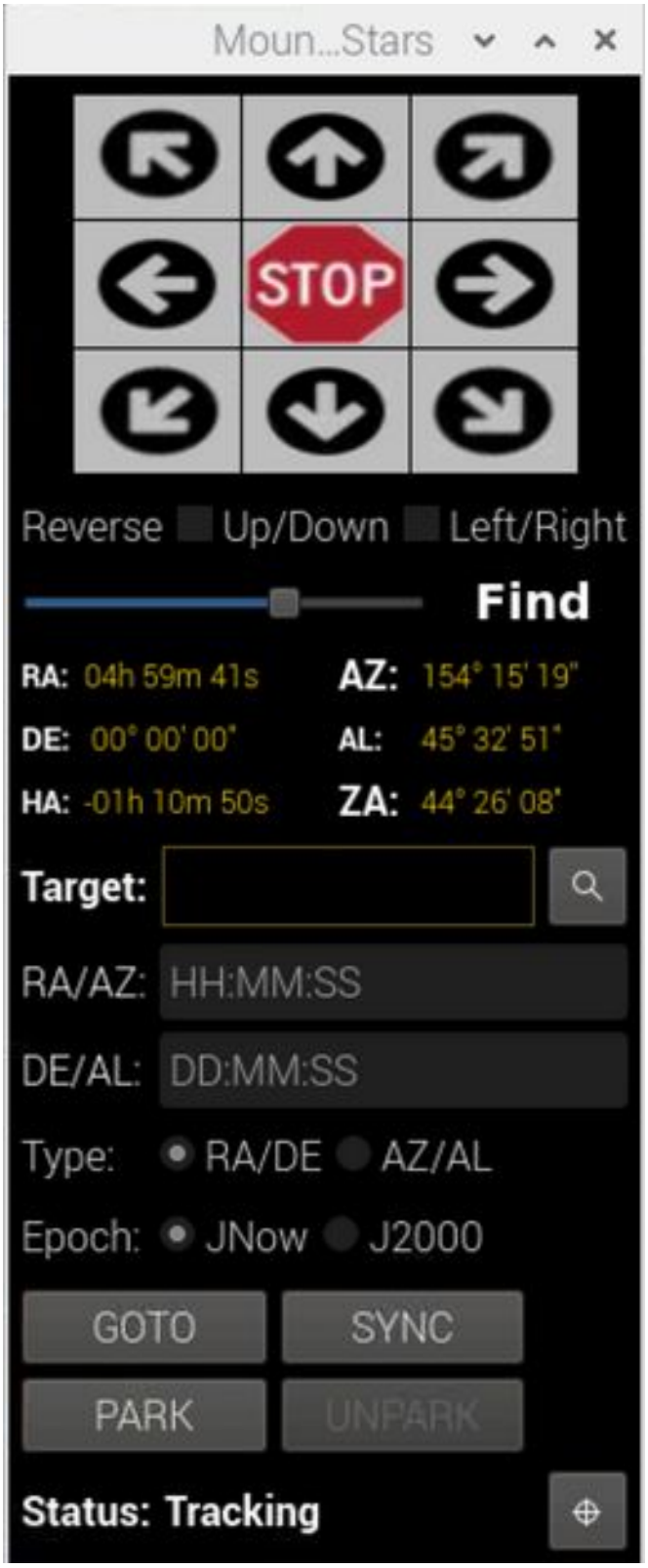
Under these buttons there are another couple of buttons for Parking/Unparking the mount in the position previously set in the INDI Control Panel.

The middle part of the window shows the actual coordinates of the telescope and additional time information. On the right it is possible to enable and set the limits for the telescope movements if deemed necessary.

Below the coordinates displays there are the selection of the Meridian Flip actuation if necessary in term of hour or degree of distance from the meridian itself and other auxiliary commands (Clear Model, Clear Parking, Purge all configuration that are self explaining.

On the bottom there are the commands for auto-parking and on the right there is a large display indicating the time remaining before the auto park is performed.

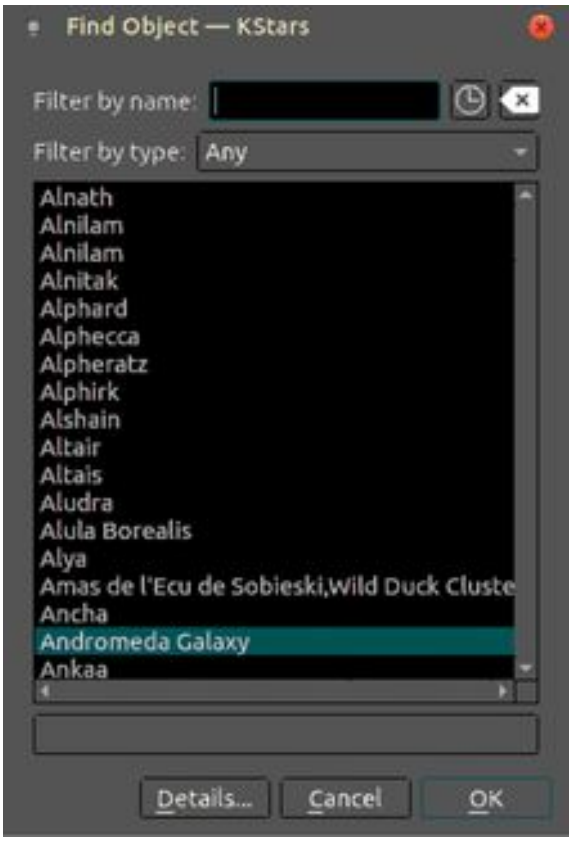
Ipressing the AI Mount control button will launch the mount virtual keypad:



In the upper part of the keypad there are the arrow buttons to move the telescope in eight directions and the commands to reverse (Up/Down and Left/Right) the arrow actions.

Below the cursor there are the actual telescope coordinates and times.

Under the display there is a search tool for celestial objects to point to. Clicking on the lens the Find Object windows appears on which one can choose an astronomical target by name. In our example we choose Andromeda Galaxy.



By double clicking the object name the chosen object is selected, the Find Object window is automatically closed and the Target field on the virtual keypad is populated with the catalog name of the object and its RA / DEC coordinates.

At this point it is possible to perform a GOTO to the chosen object and, after centering it with the arrow controls, to perform a SYNC. It is also possible to execute a PARK telescope at the end of the operation.

7. Conclusions

The introduction of the StarGO INDI driver has made possible to manage the StarGO based Avalon Instrument (as well as third party mounts using StarGO control system) within a complete astronomy and astrophotography eco-system in a very reliable OS such as LINUX and very compact hardware such as Raspberry.

INDI, which is already full of equipment drivers, is continuously enriched with additional ones that are continuously updated by expert amateurs knowing well what other amateur need and want.

In addition, INDI drivers (and their derivatives, INDIGO drivers), KStar and EKOS are available also for MacOS.

These developments are opening the Astrophotography door to all the amateurs that until now have been constricted to the MS Windows world.