OMEA “All Sky” Camera

Installation and user manual

June 20th, 2016 revision

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1 Camera installation

1.1 System installation

The camera works outdoor, it is weather-tight. Warning, the system is not submersible: it is not a diving camera diving. Moreover, it is impervious to intrusion of insects (of size greater than about 50 microns).

The camera has no mechanical shutter. The heat does not cause daytime stops operation of the camera.

Please do not install the camera near a pollution source (like a chimney). Give as much exposure as possible and avoid obstacles:

- OMEA 1.3M field of view is 185 ° x 165 °, 1.8mm fisheye lens focal length provides a wide 8.9 arcmin per pixel on the sky.
- OMEA 2.0M field of view is 185 ° x 175 °, 1.8mm fisheye lens focal length provides a wide 8.4 arcmin per pixel on the sky.

This version of camera has heater that can remove external condensation that can occur on sphere surface and **three** sealed connectors.

The camera has three anchors on the back, these three ISO M6 not thru threaded holes by 10 mm depth. Use the supplied screws to fix or equivalent stainless steel A4 or A2 screw.

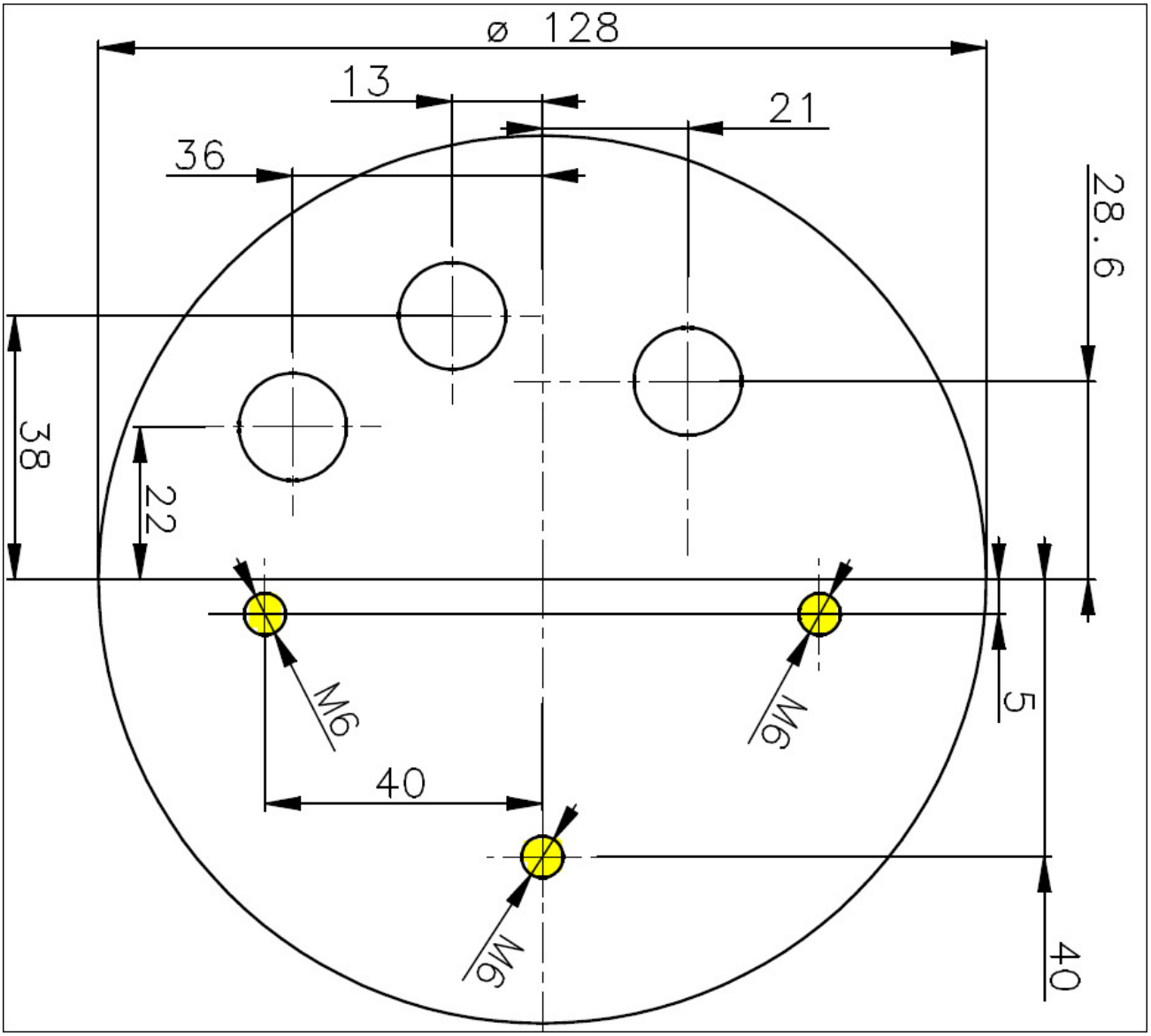


Fig. 1 *The position of the three screws securing the USB camera (yellow holes)*

There are three other "holes" that are filled with waterproof connectors, leave this space free and 100mm underneath to allow the cables to run.

The N, S, E and W direction is defined by rotating the camera accordingly. This is up to the user to define camera orientation according to its needs. Please perform image capture tests before attaching the camera to the pole.

The cables go straight from the camera bottom. If the cables shall be bent, respect what is shown on the picture (Fig. 2)

Fig. 3 *Three cables straight descent.*

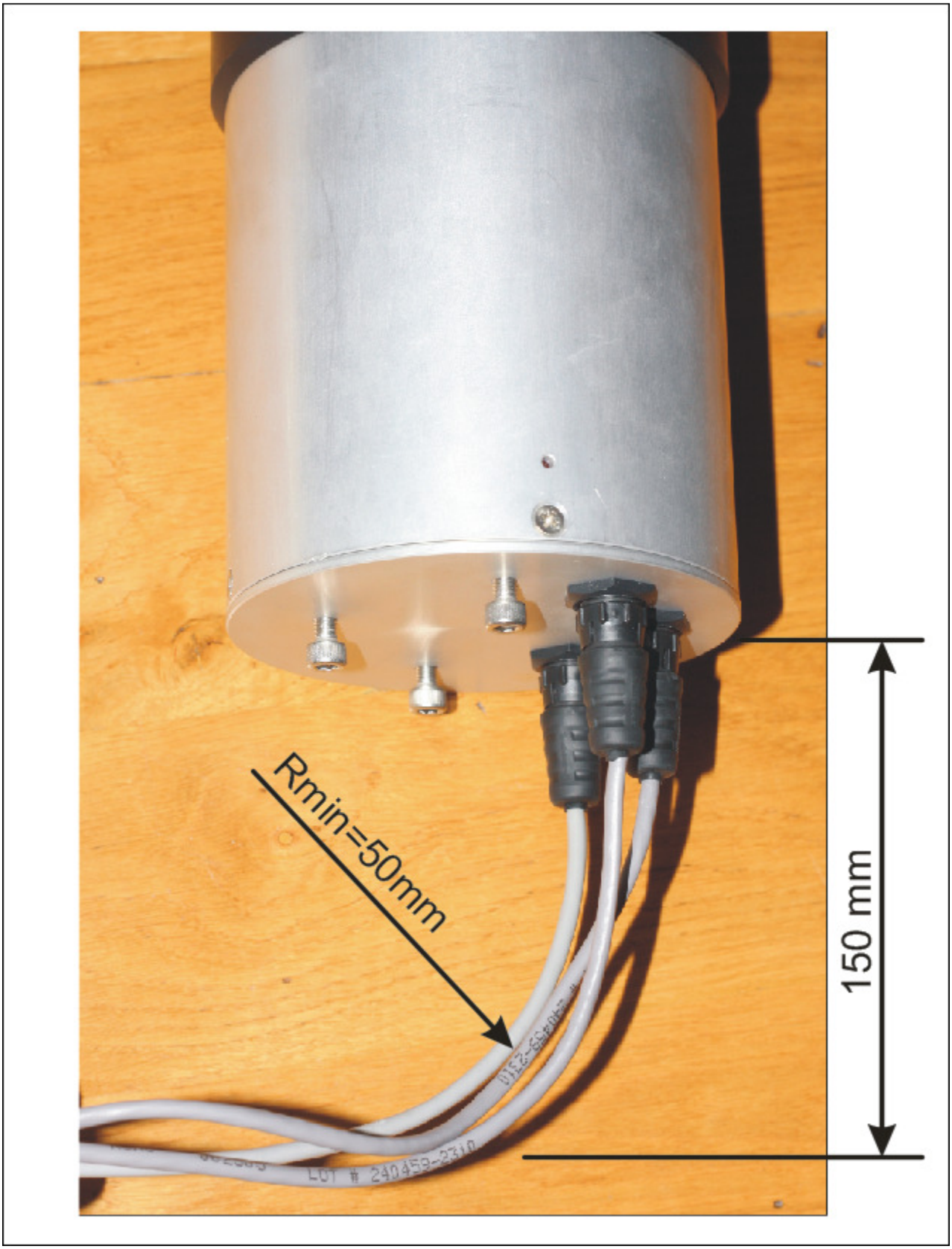


Fig. 4 *Minimum cable radius curvature.*

The waterproof connectors connect as follows:

- Identify the number of connector pins of the camera, its type (male / female)
- Identify the number of pins of the connector cord and match.
- Identify the key pin inside the camera connector and the key at the connector cord side.
- Apply a rectilinear motion. **If insertion force strength persists please repeat steps for locating the pin number and key. Excessive force applied to connector can cause the destruction of the connector or a bad connection can damage the camera. In case of damage due to trials to attach cable to the wrong connector kind, warranty could be canceled.**

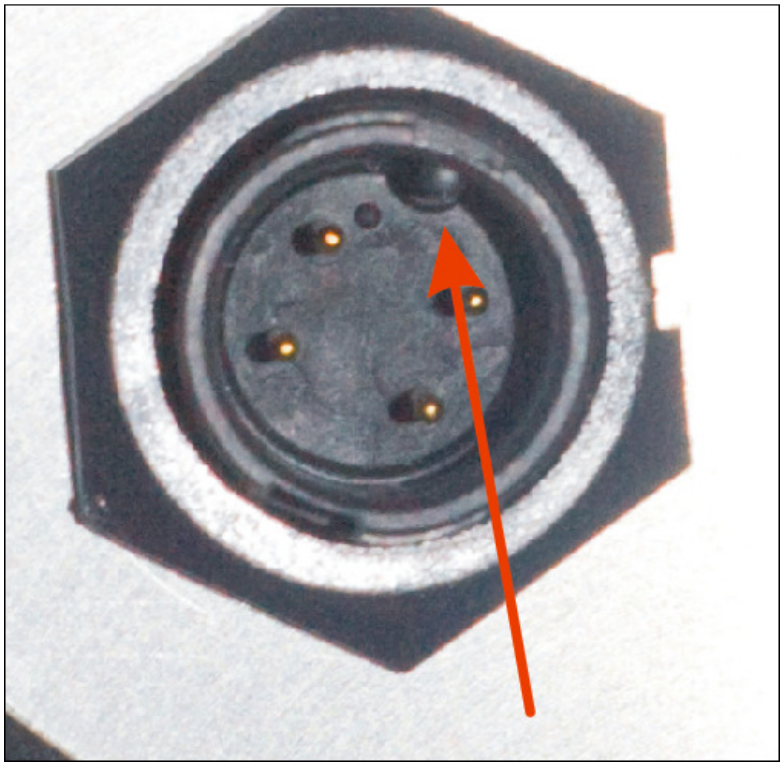


Fig. 5 *Key one of the three connectors (power connector).*

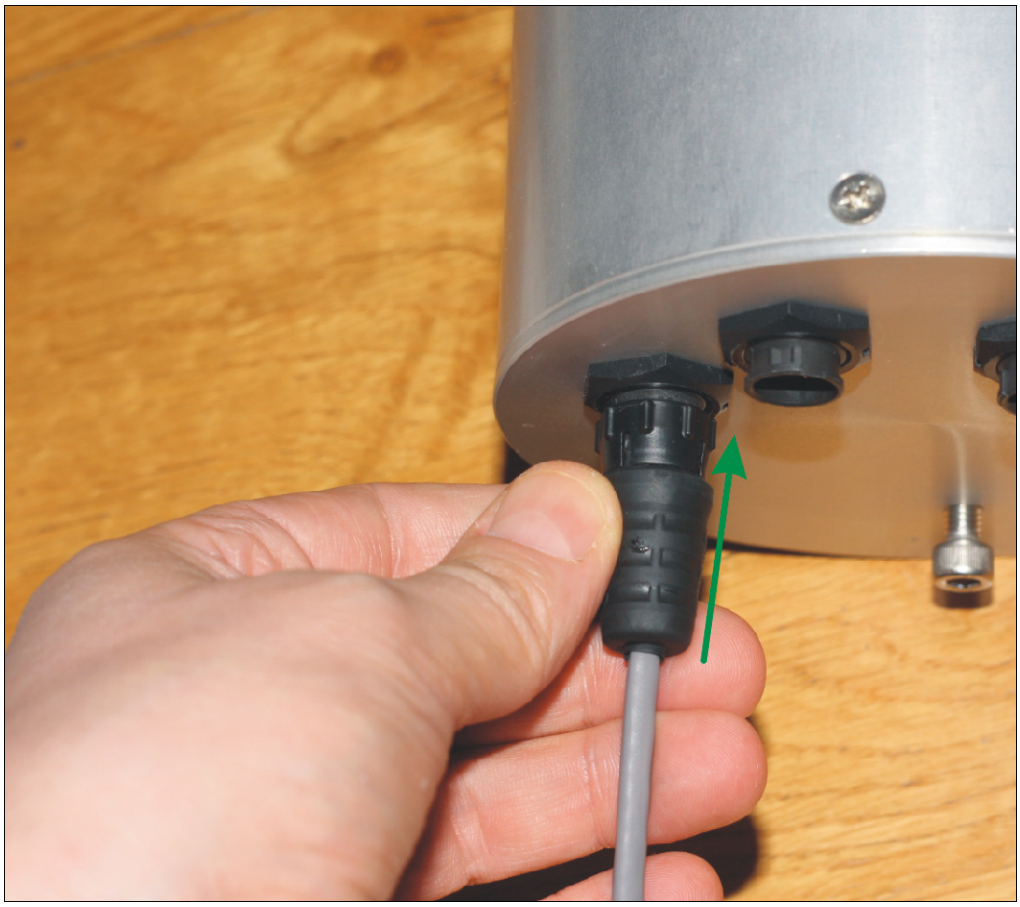


Fig. 6 *Push the connector straight*

Fig. 7 *Then turn the connector's collar in clockwise fashion*

1.2 Camera Features

The OMEA 1.3M camera features a Sony CCD ICX205AL anti-blooming detector providing a resolution of 1280 x 960 pixels. The OMEA 2.0M camera features a Sony CCD ICX274AL anti-blooming detector providing a resolution of 1600 x 1200 pixels. The gain is adjustable from 2.2 to 50 e-/ADU e-/ADU by software.

1.3 Camera optical settings

The focus and the angle adjustment (tilt) of the lens with respect to the CCD are factory made. It is not possible to perform changes from outside for tightness reasons. Access to the inner parts of the camera is not possible. To do so, this would require dismantling the entire camera body and lens protection system.
Concerning the lens aperture, there are two possible cases: lens iris sets to fixed-aperture or be opened/closed with two variable positions.

1.3.1 Fixed iris settings

This is a factory requirement from the customer. There are three options summarized in this table:

F / 1.4	Maximum aperture : The sensitivity is maximized at the expense of some residual aberrations at the edges of the image due to lens optical performance. Configuration for small meteors. Despite the exposure time of 0.1 ms and the lowest gain applied, the possibilities of imaging will be limited during days on a completely clear sky (high saturation).
F / 2	Average opening : The sensitivity is a good tradeoff for very black site. The optical quality is better compared to f/1.4. This is a good compromise for weak light pollution observing sites. Imaging during day time is still possible (saturation limited)
F/2.8	Minimum Aperture : The sensitivity is degraded for very dark sites (no light pollution), especially for color cameras, but is perfect for suburban sites. The optical quality is maximized. Imaging capabilities during day time are very good.

You cannot change the aperture value from outside camera, for reasons of access sealing.

1.3.2 Auto-iris

The system embeds a small board that switches from f/2 to f/8 automatically using a photodiode that measures the ambient light level. The f/2 to f/8 toggling process occurs at twilight without any external software/hardware.

A hole at the top of the camera allows entry of light toward photodiode which deals with the auto-iris. Please never obstruct!

Fig. 8 *Entry of light for auto-iris system measurement*

1.4 OMEA camera connections

Connectors keying and different amount of pins are preventing connection errors. However, user must look at the number of connector pins at the end of the cord before connecting the camera, in order to avoid forcing the pins and damage the camera connector.

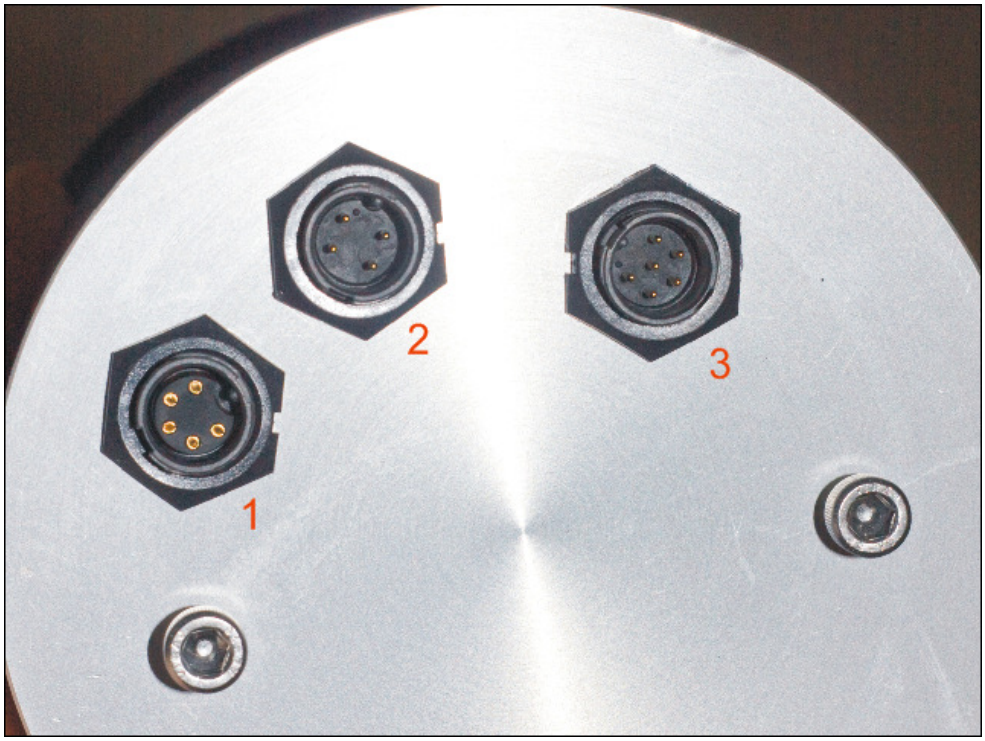


Fig. 9 *Rear of USB camera*

Connector	Role	Genre (on camera)
#1	Temperature / Humidity sensor Weather module	Female 5 pts Female 12 pts
#2	Power connector and RS232 link	Male
#3	USB link	Male

1.4.1 Temperature sensor and humidity connector (#1)

It is a 5-pin connector. The probe located at the end of the cord will be placed preferably in the shade, as far as possible from the camera, **and always with two set Ø4mm screws with the direction given in the next frame and horizontally. It put upside down, this can destroy the sensor and warranty will no apply.**

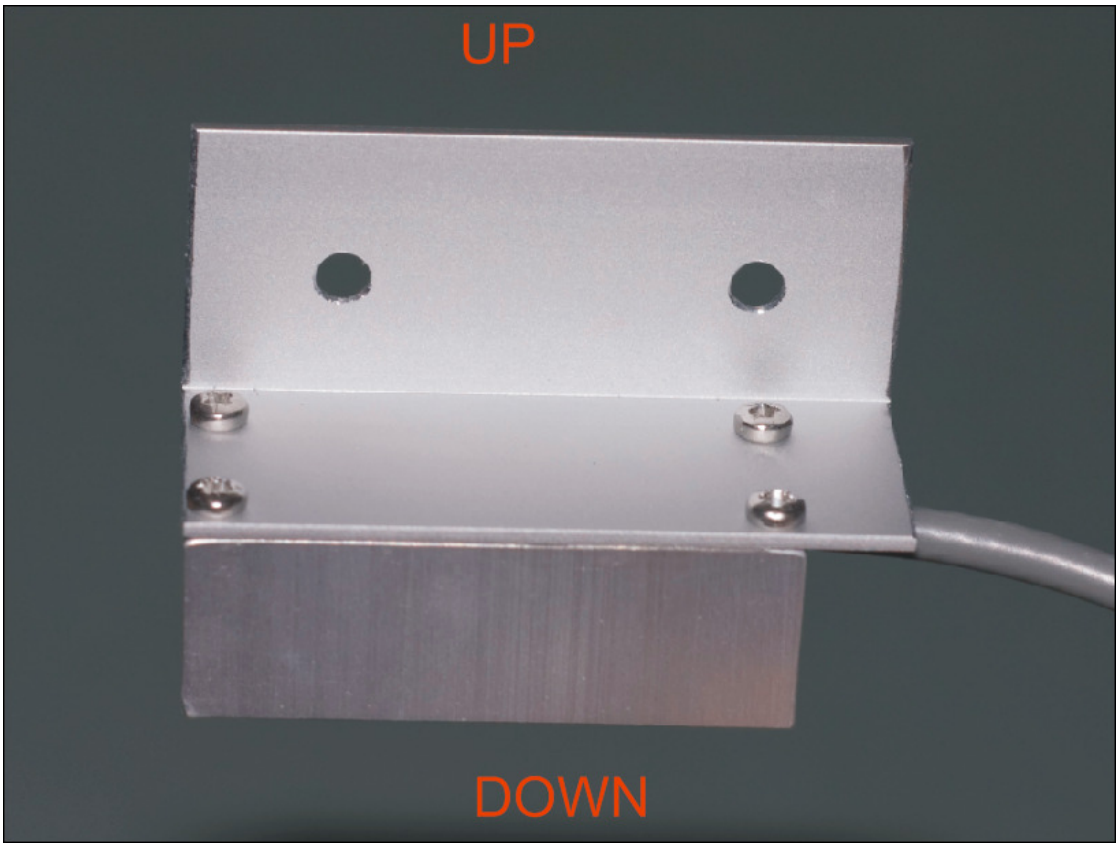


Fig. 10 *Up / down and horizontal temperature sensor and humidity directions for installation*

1.4.2 Power connector and RS232 (#2)

This is providing power to the camera and RS232 link.

The RS232 connector is a DB9 connector type female and attaches to the serial port of the PC. New PCs are not equipped with serial port, and must be equipped either:

- By a RS232 – USB converter (very moderate cost, FTDI,ATEN devices)
- By RS232 PCI card (Low cost device, not suitable for laptops)
- By Serial to Ethernet (MOXA devices, http://www.moxa.com/product/nport_device_server_1.htm) Product type is Nport.

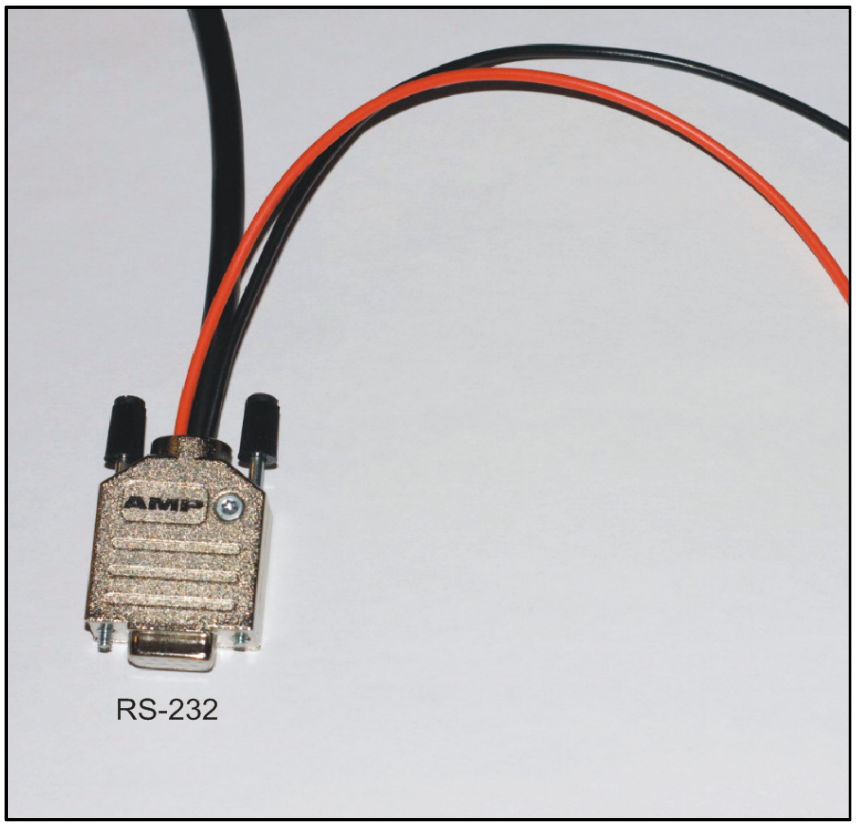


Fig. 11 *RS232 connector and power wires (black and red power wire are attached to a power supply provided by Alcor-System)*

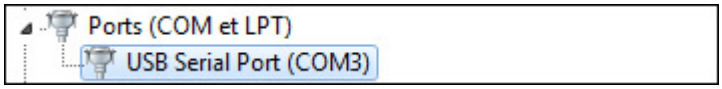
The power supply is provided as 12V or 24V, 110V 60Hz and 220V 50Hz compliant. The current provided by the PSU is enough to power the camera and the dome heater. Three kind of plugs are provided on request: EU, US and UK type.

Fig. 12 *12 or 24V power supply*

A the end of the RS232 cable, a USB to RS232 high quality converter is used Once connected to the PC, the driver is loaded automatically for Windows 10. For other OS, please go here to pick up the proper driver:

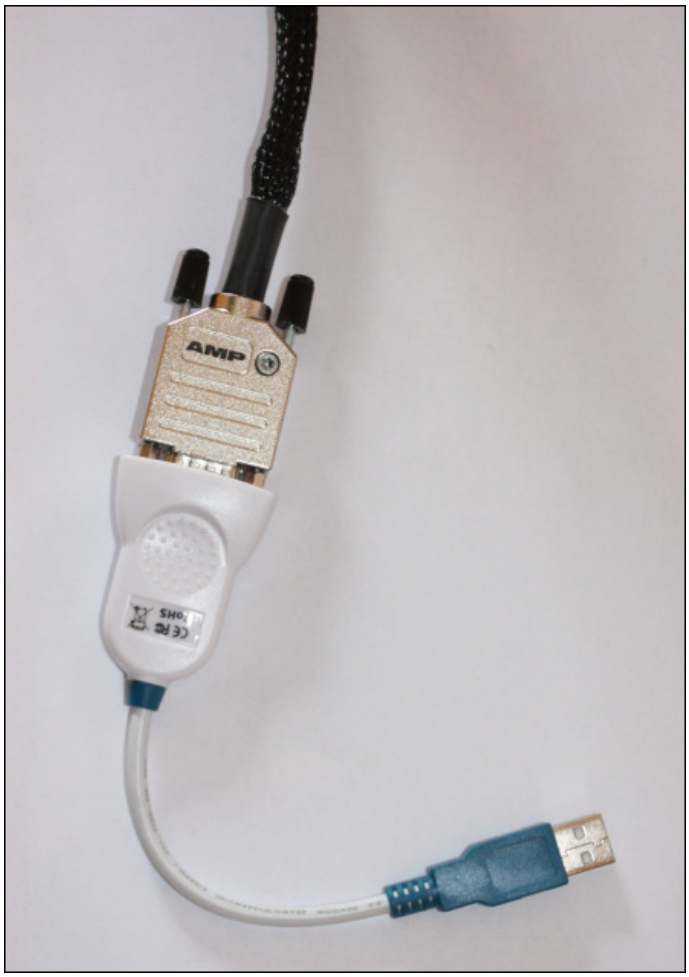
http://www.ftdichip.com/FTDrivers.htm

Under windows 7, it will appear as UC232R in device manager and driver must appear as follows after driver installation (can be another COM number port).



Under Windows 8, ask windows device manager to update this device from internet, and driver will be installed automatically.

In the end the PC, must have TWO USB port free for the system, one for the camera Data stream, and another for this RS232 to USB link.



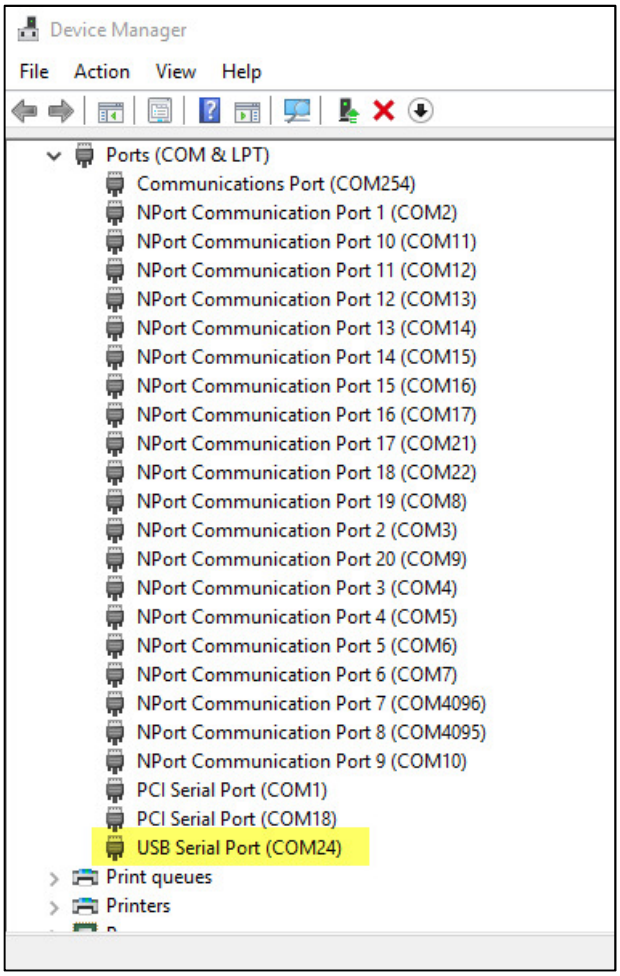


Fig. 13 *RS232 to USB converter*	Fig. 14 *COM port under Device manager, warning it can be another number than COM24*

The device manager properties for this COM port should be seen as follows once connected:

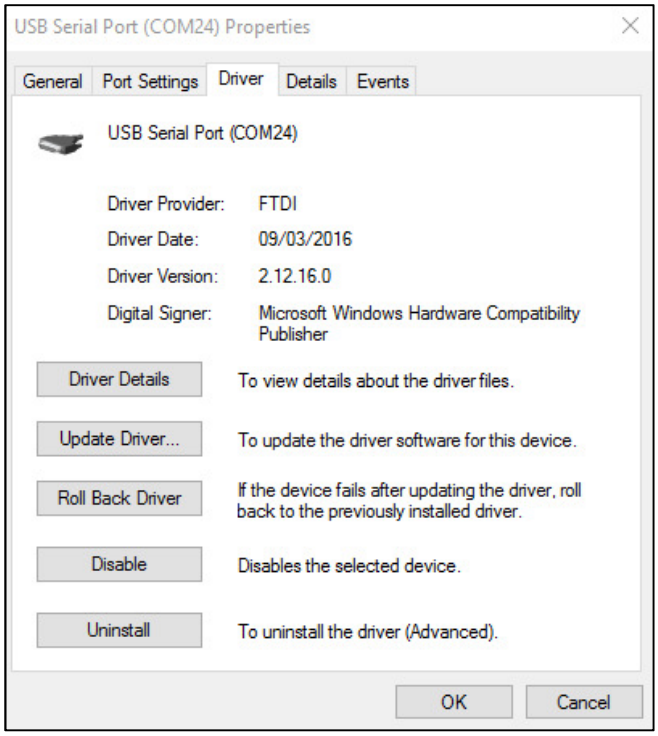


Fig. 15 *Serial to USB converter, as it appears in the device manager*

1.4.3 USB connector (#3)

This is tied up to a 6 pin connector. Please always connect the camera first and then connect to PC second. The cable that goes to the PC is 20m length.

2 Software

Camera drivers can be found into our web site:

http://www.alcor-system.com/us/AllSkyCamera/softwares.html

Installation has four parts:

1. Camera USB driver
2. ActiveX interface to the camera (common to all models)
3. The XVID compression codec
4. The camera control software

2.1 Camera driver installation software

The camera system is based on the camera provided by "IMAGING-SOURCE" company: DMK41, DFK41, DMK51 or DFK51 models.

2.1.1 USB Version

Connect the camera to the USB port of your PC where it needs to work with. In the Windows device Manager form, the camera should appear with an icon tagged exclamation point on a yellow background.

Fig. 16 *Lists of Windows' devices*

The driver must be downloaded here:

http://www.alcor-system.com/common/allSky/sw/icwdmuvccamtis.en_US.zip

Once the file **icwdmuvccamtis.en_US.zip** downloaded, unzip to a directory (any).The following files are visible. Then launch " ***drvInstaller.exe*** "(Whatever version of Windows 32 or 64 bits).

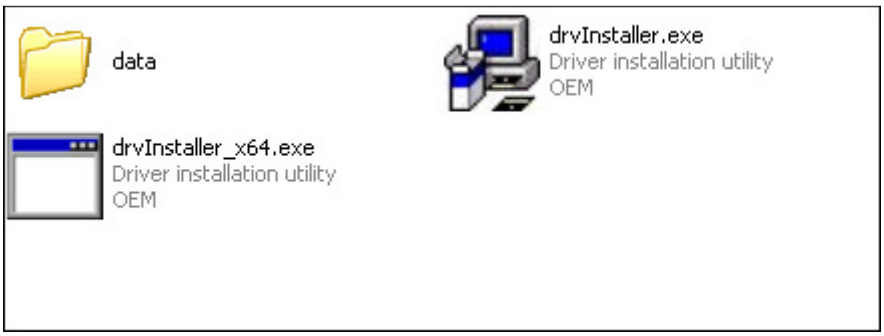


Fig. 17 *USB camera driver files*

The form appears in the right to accept the installation of an unsigned driver, click “Continue Anyway”. Do not disconnect the camera during this phase.

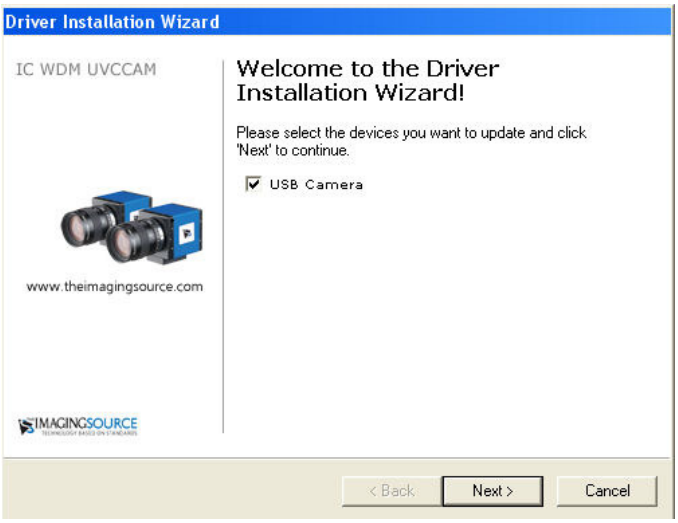


Fig. 18

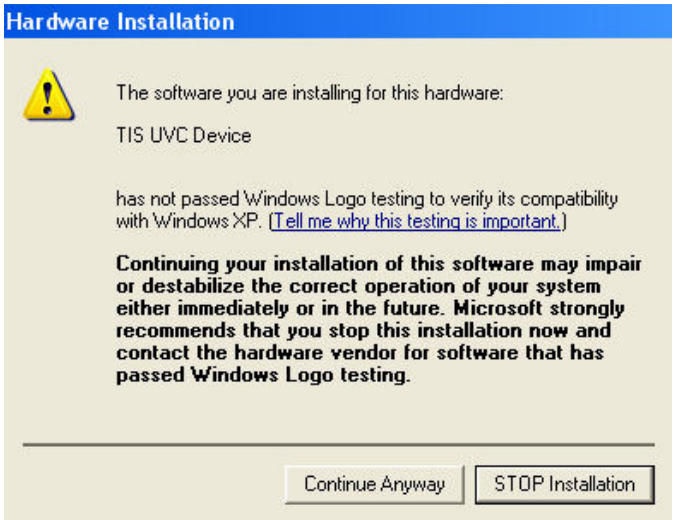


Fig. 19

After camera driver is installed, into the device manager, the yellow exclamation point will disappear and provides the actual name of the camera.

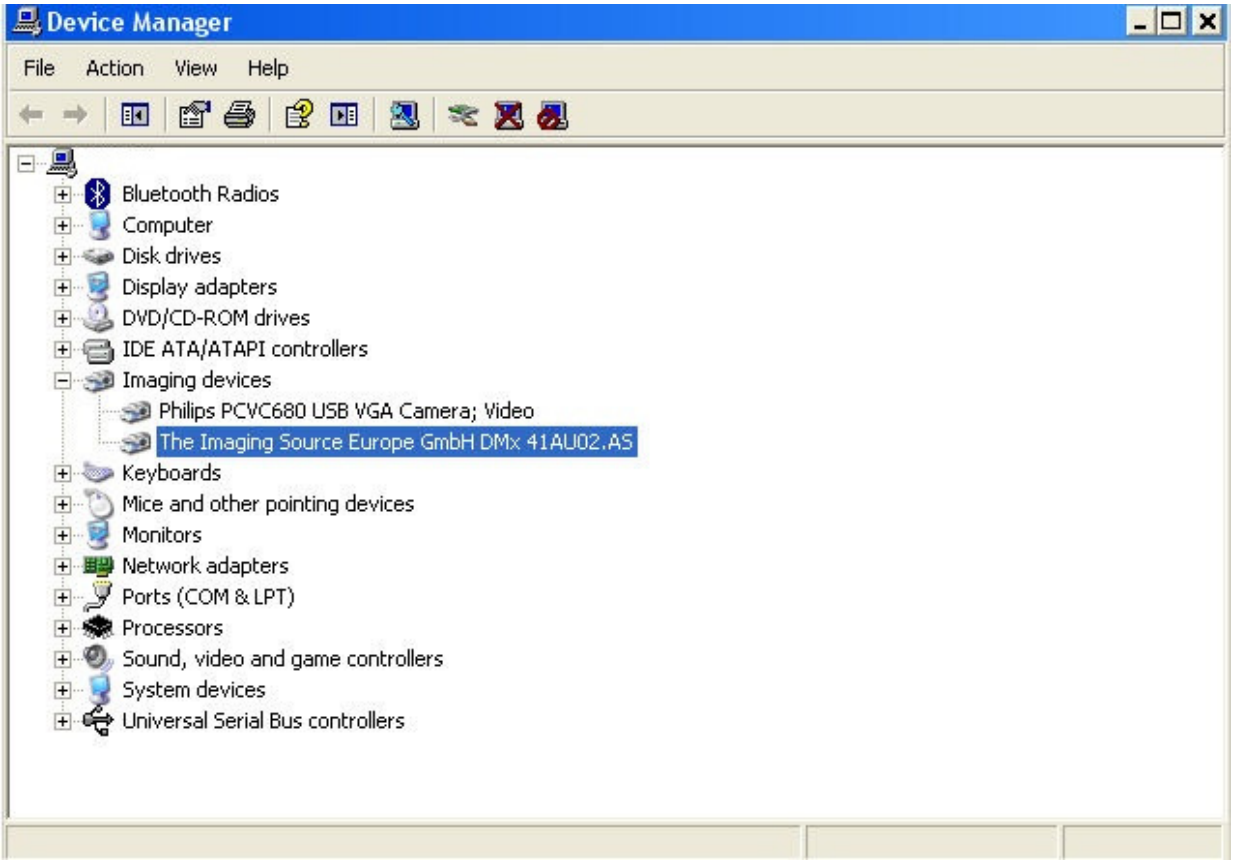


Fig. 20 *Windows Device Manager, once the camera driver is installed and loaded.*

More recent drivers can be found here:

http://www.theimagingsource.com/support/downloads-for-windows/

2.2 Installing the camera ActiveX interface

Click ***icvb6runtimesetup.exe.*** Installation of this interface is essential; otherwise the control software will not work and will not detect any camera.

It can be downloaded here: http://www.alcor-system.com/common/allSky/sw/icvb6runtimesetup.zip

Fig. 21

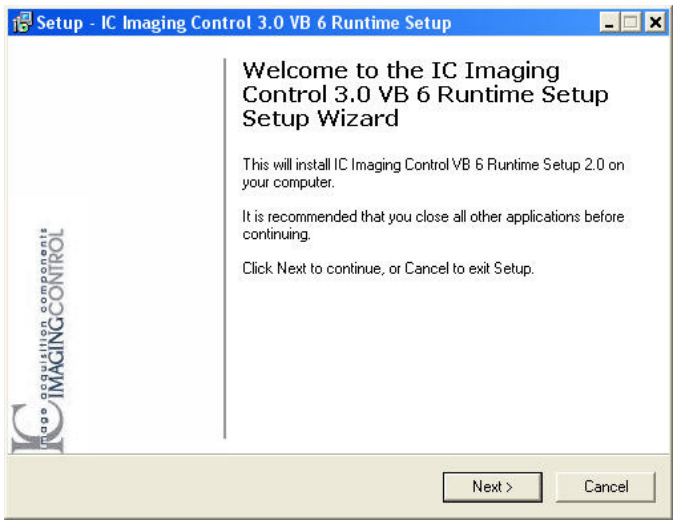


Fig. 22

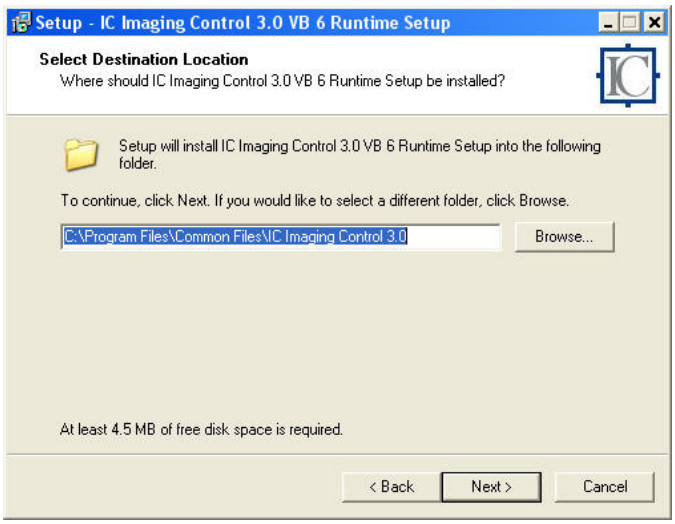


Fig. 23

Once installed, it is possible to control the correct installation by checking out ***"C: \ Program Files \ Common Files"*** under the 32-bit operating systems and under "C: \ Program Files (x86) \ Common Files" under the 64-bit operating systems.

The directories ***"IC Imaging Control 3"*** and ***"IC Imaging Control 3.0"*** should appear.

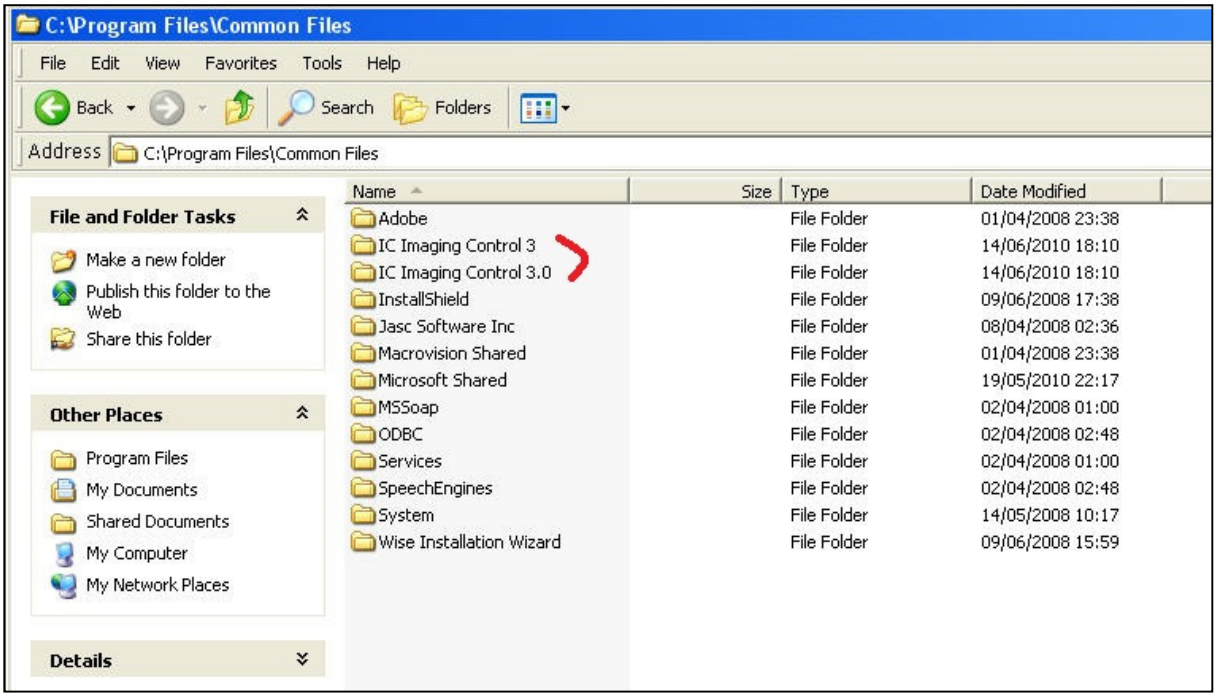


Fig. 24

2.3 Installing the XVID Codec video compression

This codec, free of rights, can compress the video created by the software, while maintaining a high quality image.

It can be downloaded here: http://www.alcor-system.com/common/allSky/sw/Xvid-1.2.2-07062009.exe

Click ***Xvid-1.2.07062009.exe***

Fig. 25

Installation is fairly trivial and fast:

Fig. 26

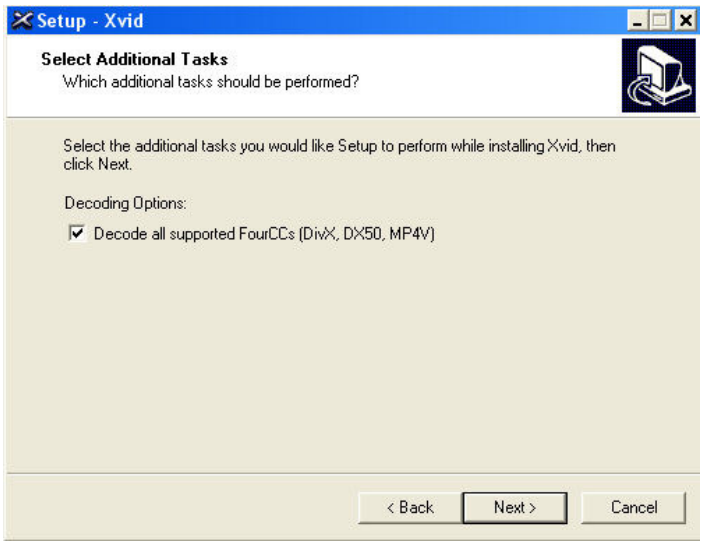


Fig. 27

2.4. **Installing the camera control software**

The software can be downloaded here:

http://www.alcor-system.com/us/AllSkyCamera/software/setup_en.zip

This is the software used to control the camera, click on ***"setup.exe"***

Fig. 28

The dot NET 3.0 platform is required; if this is missing to your system, please get it here.

http://www.microsoft.com/download/en/details.aspx?displaylang=en&id=31

Installation is quick and trivial.

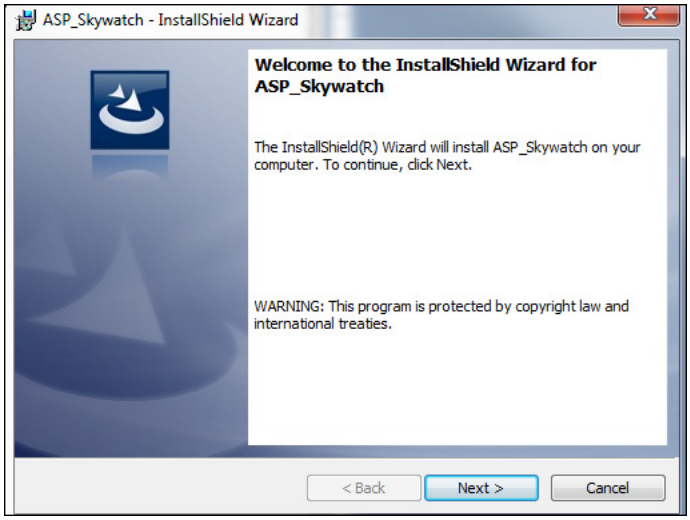


Fig. 29

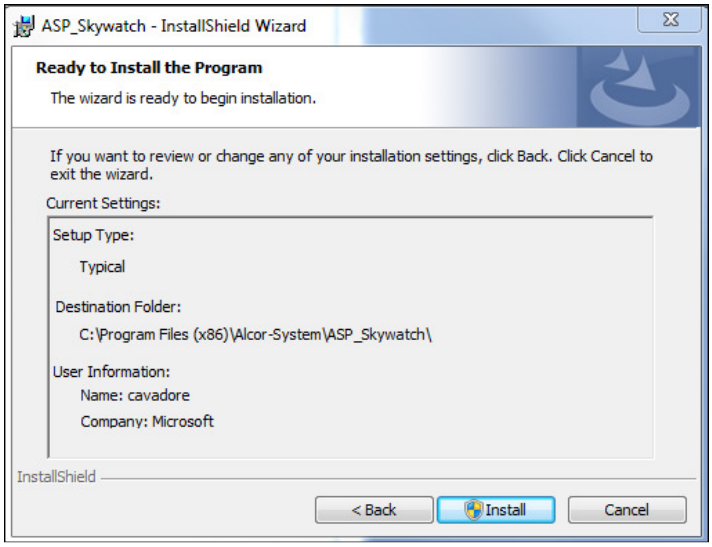


Fig. 30

The software creates an icon to your desktop. We must double-click it to start the camera control software.

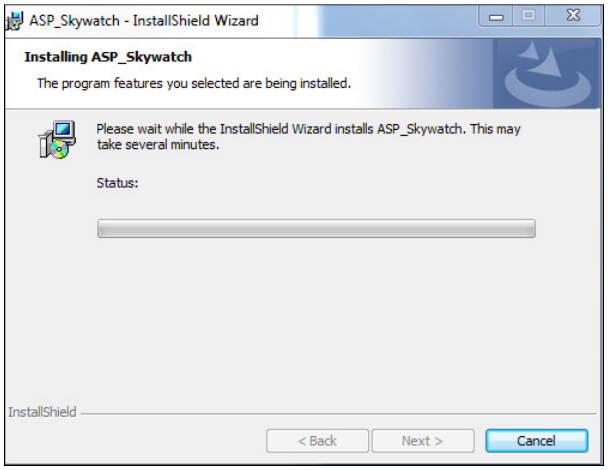


Fig. 31

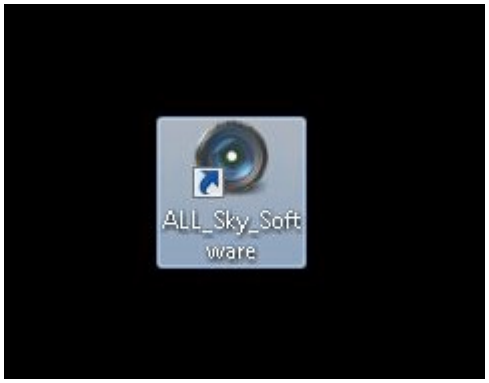


Fig. 32

- Software installations are now completed -

3 Using the camera software control

This software is fairly intuitive; the documentation will focus on features that are more difficult to use.
Access to the menu bar is located in the upper left, and a flying window in the foreground can quickly adjust the software settings.

3.1 Initializing

To get stable image capture and continuous 24/24 run, it requires installing the previous set of drivers from us.
It is easy to check the menu "***Misc. / TIS drivers***"

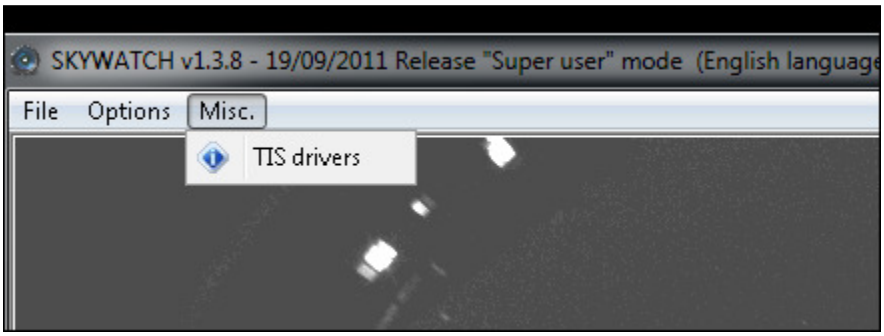


Fig. 33

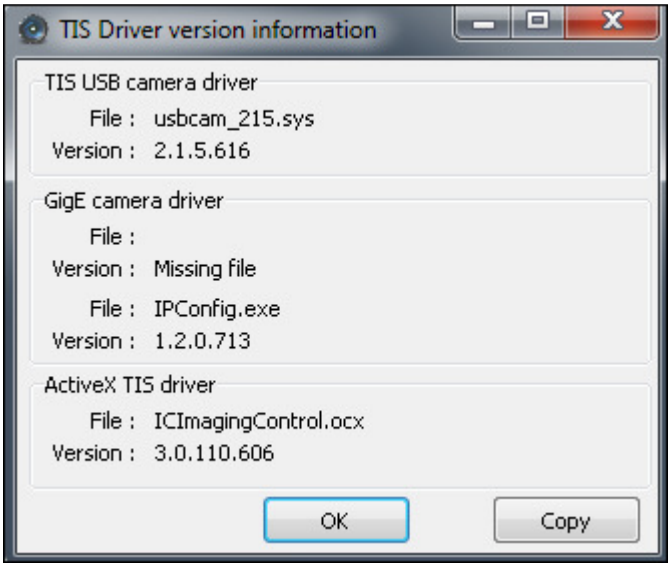


Fig. 34

The ActiveX interface installation is also visible by the presence of the file ***ICImagingControl.ocx.***

At first launch, the software is configured on a camera simulation mode.

To establish the link to the proper camera, follow the menu of the figure (Fig. 35)

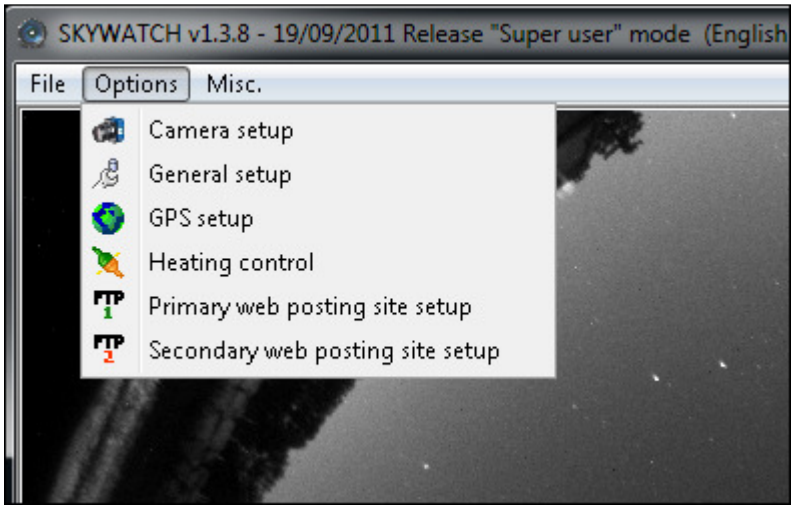


Fig. 36

Select ***"TIS IMAGING SOURCE Camera"***

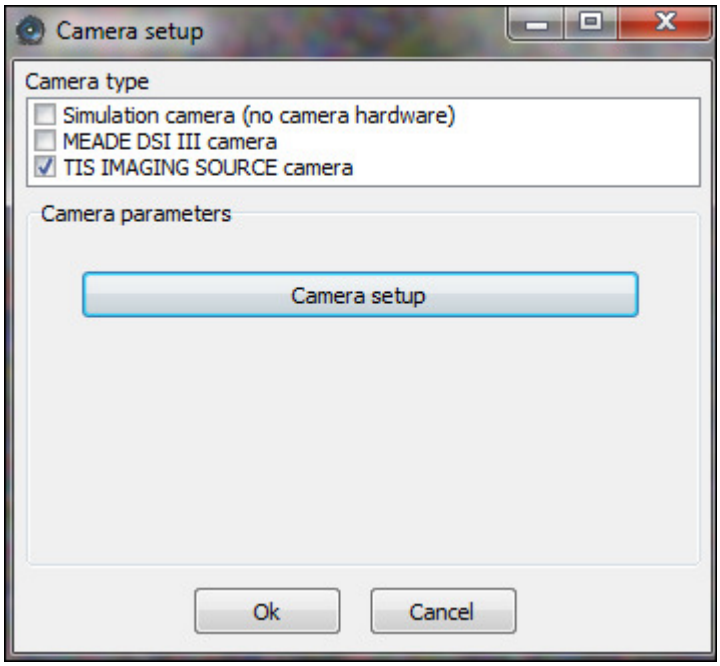


Fig. 37

Then the **"Camera setup"** button

Fig. 38

Once the camera is selected (***"Device Name"*** field)**,** the software takes care of defining all parameters, by himself:

- Video format
- The image frame rate (fps frame rate), it will be always set to the lowest.
- Disables all automatic gain, exposure time ...

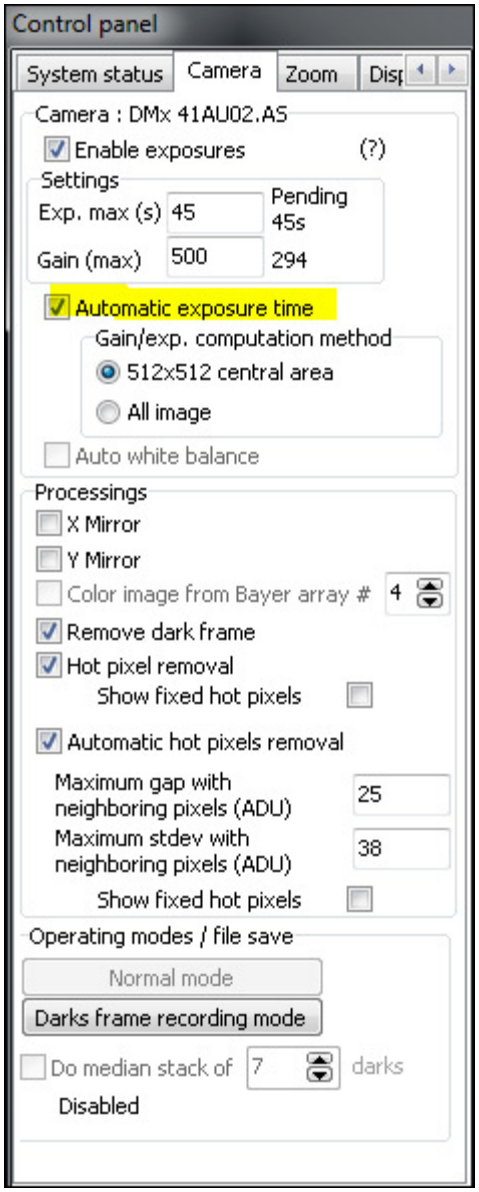


Fig. 39

Once the camera is selected, the exposures start immediately. Then, do not forget to check the "***Auto Exposure***" box after the first image has been displayed

Special mention regarding the color balance (color camera only) is disabled by default. But it can be restored by the control panel.

The color balance used to remove a color trend, such as the orange color that affects sky background due to light pollution at night.

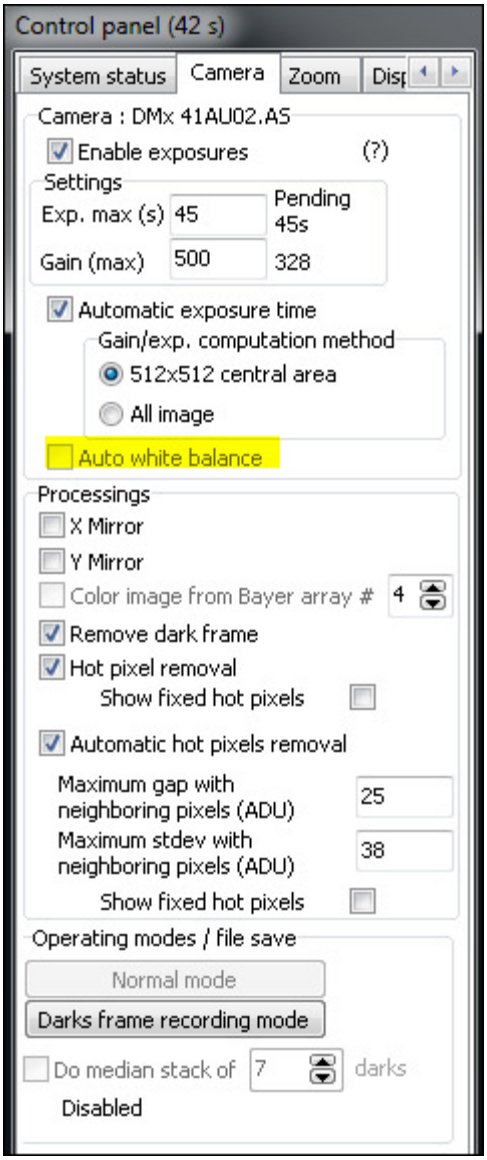


Fig. 40

It is possible to disable / enable the white color balance automatically far day time image recording or night time.

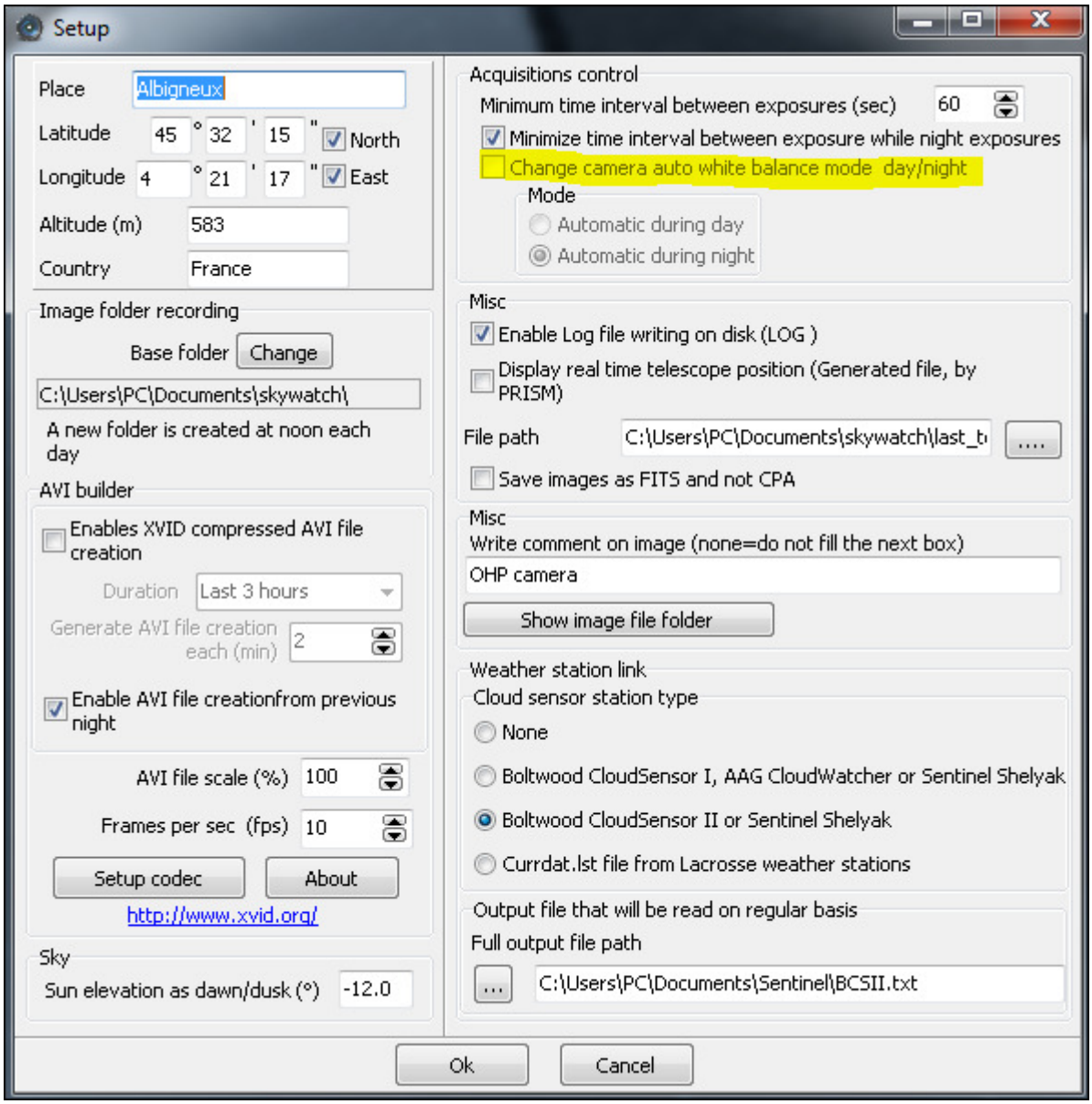

Setup
Place
Albigneux
Latitude
45 ° 32 ' 15 "
North
Longitude
4 ° 21 ' 17 "
East
Altitude (m)
583
Country
France
Image folder recording
Base folder
Change
C:\Users\PC\Documents\skywatch\
A new folder is created at noon each day
AVI builder
Enables XVID compressed AVI file creation
Duration
Last 3 hours
Generate AVI file creation each (min)
2
Enable AVI file creationfrom previous night
AVI file scale (%)
100
Frames per sec (fps)
10
Setup codec
About
http://www.xvid.org/
Sky
Sun elevation as dawn/dusk (°)
-12.0
Acquisitions control
Minimum time interval between exposures (sec)
60
Minimize time interval between exposure while night exposures
Change camera auto white balance mode day/night
Mode
Automatic during day
Automatic during night
Misc
Enable Log file writing on disk (LOG)
Display real time telescope position (Generated file, by PRISM)
File path
C:\Users\PC\Documents\skywatch\last_t
....
Save images as FITS and not CPA
Misc
Write comment on image (none=do not fill the next box)
OHP camera
Show image file folder
Weather station link
Cloud sensor station type
None
Boltwood CloudSensor I, AAG CloudWatcher or Sentinel Shelyak
Boltwood CloudSensor II or Sentinel Shelyak
Currdat.lst file from Lacrosse weather stations
Output file that will be read on regular basis
Full output file path
...
C:\Users\PC\Documents\Sentinel\BCSII.txt
Ok
Cancel

Fig. 41

Fig. 42 *when white color balance is off: the sky can be affected by orange color due to light pollution.*

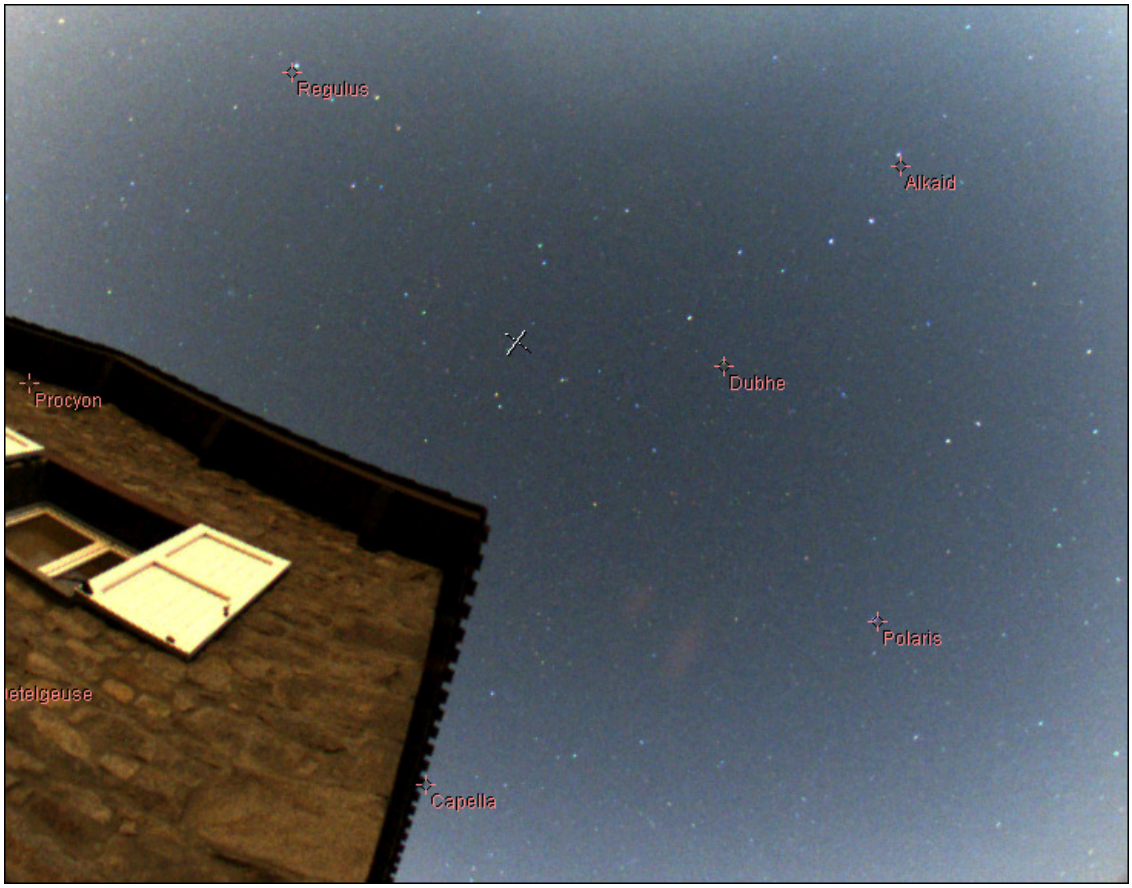


Fig. 43 *white color balance is enabled; orange color due to light pollution is eliminated.*

3.2 Storage of files produced by the camera control software

The software stores all the files it produces into a directory that is specific to the user.
This directory (and subdirectories) is created automatically by the software.

For example, under Windows XP: *"C: \ Documents and Settings \ **[username]** \ My Documents \ SKYWATCH"*
with ***[username]*** = Name by which you connect on Windows XP.

Fig. 44

Under Windows 7 or Vista : *"C: \ Users \ **[username]** \ My Documents \ SKYWATCH"*

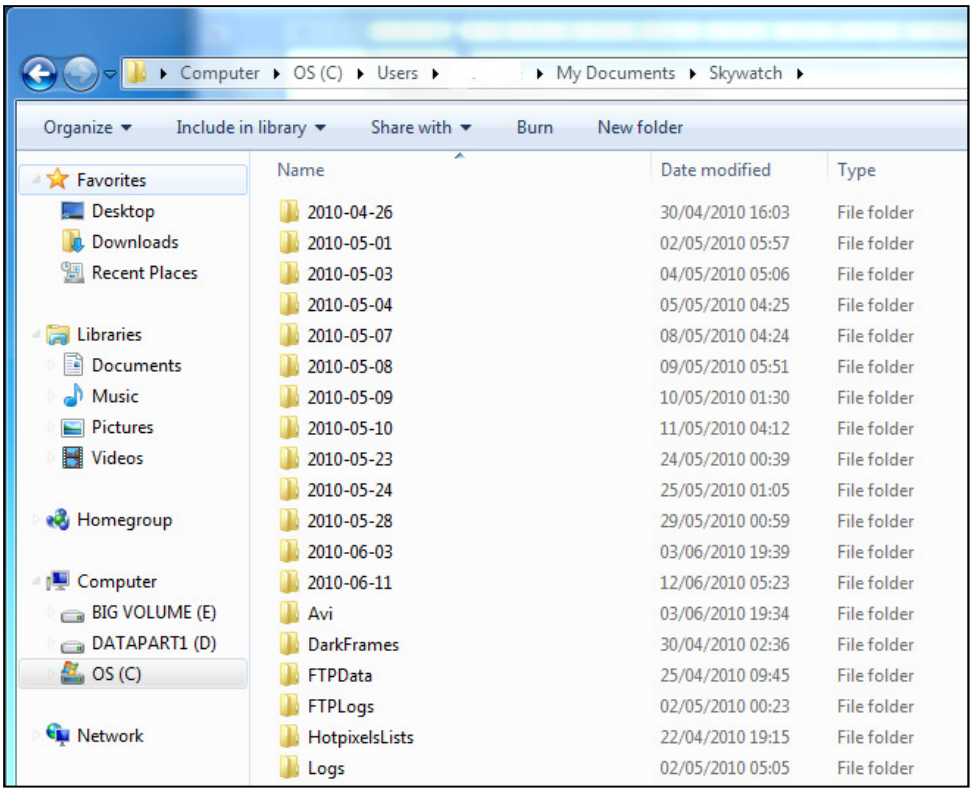


Fig. 45

- The subdirectory *AVI:* contains the latest videos generated by the camera control software.

- The subdirectory *darkframes* : contains the images needed for camera hot pixels removal. All CPA files found there are tried by the software to find the best dark frame to be used to remove camera hot pixels.

- The subdirectory *FTPData*: contains the final JPEG image produced to be uploaded on user's website

- The subdirectory *FTPLog*: contains the log files generated for each image transfer to the website. These logs help to find out issues when transferring files to user's website.

- The subdirectory *HotpixelsList*: contains the *hotpixlist.cos* file used to make hot pixel corrections that were not removed by the subtraction of the optimized dark master frame.

Hotpixlist.cos this is an ASCII file where each line describes the correction to be made to a given X/Y pixel

For instance:

```
fill 103 360 1
fill 289 570 1
fill 304 125 1
fill 664 326 1
```

The first line indicates that the pixel located at X = 103 and Y = 12 and a single pixel size shall be corrected by its neighbors pixels.

This correction takes into account that the image is a Bayer pattern array (color camera) and picks up neighbors pixels accordingly.

This file can be automatically generated from a feature from this software (see next paragraph)

- The *logs* files subdirectory: contains the log files of the software, in which are written the software actions and events as a text file. This is for debugging purposes. A new file is created each time you startup the camera control software.

The log file is enabled into the main's software setup panel. Just enable it in case of issues, because log file can make large files.

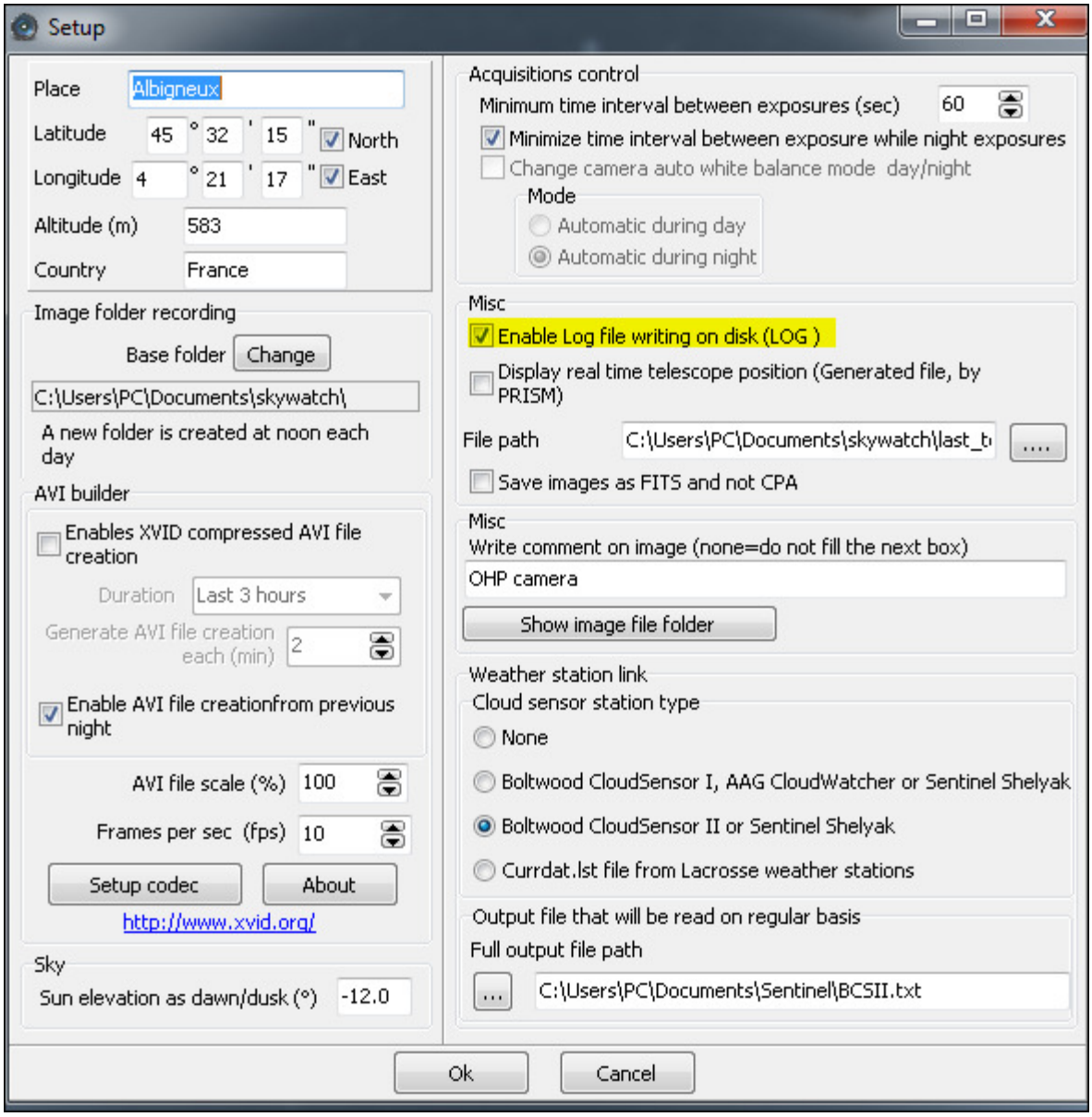


Fig. 46

- The subdirectory *Year_month_Day:* contains image files that are saved automatically by the software as jpegs files or CPA/FITS files.
  The directory is used from noon to noon. For instance images created from 12:00 on May 10th 2010 till May 11th, 2010 at 11:59 will all be stored inside 2010_05_10 subdirectory.

3.3 Camera exposure time and gain

The software features two modes:

3.3.1 Manual mode

The user enters the exposure time and gain as he wishes. No adjustment is made by the software.

3.3.2 Automatic mode

The software manages the exposure time with focusing on the camera gain. It is up to the user to set the maximum gain and maximum exposure time he wants to use. The software uses a calculation area of 512x512 pixels at the center of the whole image, with the aim to adjust the gain / exposure time to get a signal level located at half the camera dynamic range.

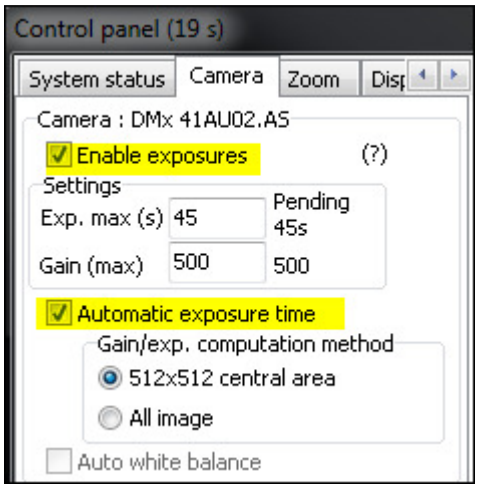


Fig. 47

When determining the maximum exposure time, the user shall bear in mind that the minimum exposure time is 100µs (0.0001sec) and the maximum exposure time will depend on when the stars will start to leave traces due to earth rotation. For black and white camera, the maximum recommended exposure is 60 seconds, for color camera, 75s.

Important: when defining the maximum gain, it is possible to go up to 1023, but it is recommended to stop from 700 to 900 (depending on the observing place and light pollution) in order to limit noise and increase dynamic. OMEA 2.0M must be set with maximum gain of 200.

3.3.3 Bayer pattern reconstruction (color camera only)

The raw image from color camera is a black and white, this is called Bayer pattern image. So the true color image shall be computed. User must check "***Color image from Bayer array #***' checkbox.
The pattern shall be set to # 4 for Color cameras. X and Y Mirrors are taken into account, and it will not be necessary to change the pattern number when mirrors are used. Only the color cameras have this option enabled, monochrome (black and white camera) does not.

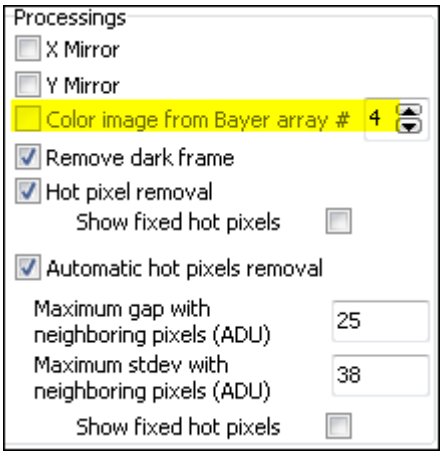


Fig. 48

3.4 Image hot pixel removal using dark frame image

The camera embedded in this system is not cooled sensor camera, but hot pixels can be removed thanks to software features.

Dark frame removal is essential to get rid of hot pixels and is fundamental to get good image quality.

The raw image from the camera must be completely corrected for thermal effects of the camera. These thermal effects result in the presence of hot pixels (as bright / colored pixels). In the case of color camera these hot pixels turns into colored dot with showing pure color (blue, red or green) that affect strongly image quality.

Production of hot pixels depends mainly on the temperature of the CCD camera that is bound to external temperature. More the camera is being used under conditions of high temperatures, more the amount of hot pixels. Exposure time also affects strongly the amount of hot pixels: the higher the exposure time, the higher the number of hot pixels.

The following series of images is quite demonstrative: in case of a black and white camera, the pixels are white hot and occupy a single pixel. It is possible to confuse them with stars, but their existence in areas without light reflects an important problem of image quality.

In the case of a color camera, the effects of hot pixels are even worse: they are strongly colored (red or green or blue), and the eye can detected them very quickly. The image quality is highly degraded, the image is filled with colorful hot pixels altering image rendition.

It is therefore essential to correct these hot pixels using an “dark" master frame, and possibly complete the task with a list of pixels to fix.

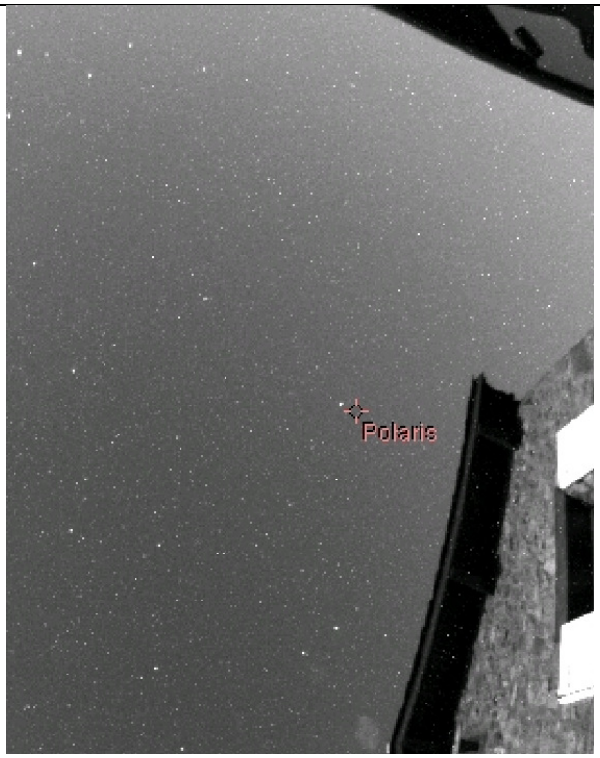


Fig. 49

Without correction of "dark" and hot pixels

Fig. 50

With correction of "dark" and hot pixels

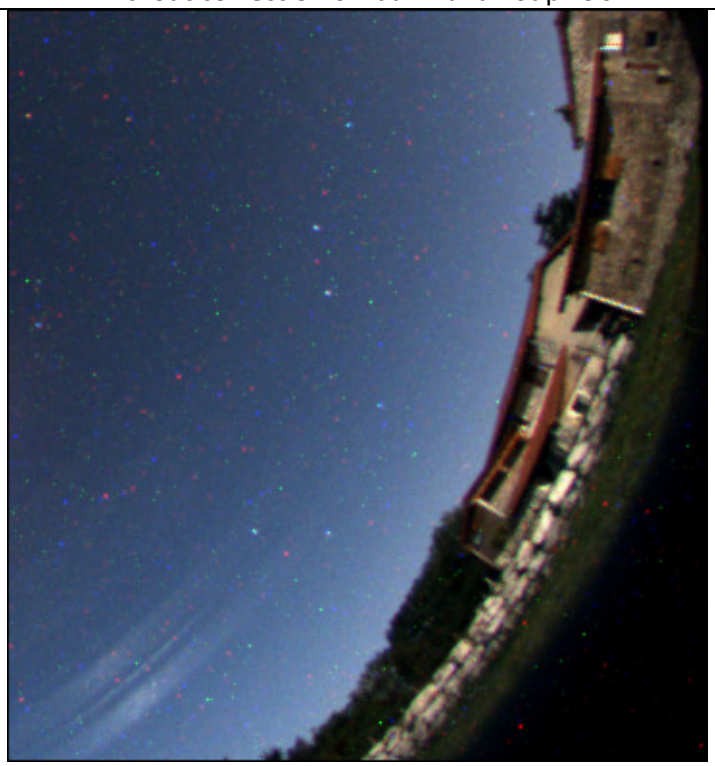


Fig. 51

Without correction of "dark" and hot pixels

Fig. 52

With correction of "dark" and hot pixels

The software performs hot pixels fixing in three ways:

- By subtracting a master dark frame.

- Local pixel correction from a list of hot pixels
- Automatic local hot pixel removal based on two parameters

Activation of these corrections is achieved using the main camera control panel, camera tab, then on the following checkboxes ***"Remove dark frame", "Hot pixel removal"*** based on pixel list coordinates or / and ***"Automatic hot pixel removal"***

The master dark frame is located in this folder:

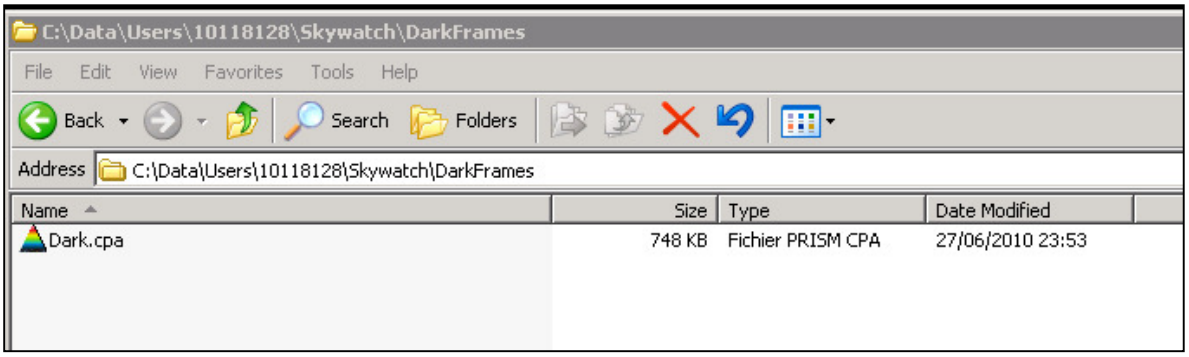


Fig. 53

During day, the dark frame correction is not performed, because negligible, as exposure times of approximately 100µs avoids hot pixels presence. This is not the case at night when the exposure time is 600 000-750 000 times higher than during day.

If no file cannot be found inside this "DarkFrames" folder, if the image file does not have the same size in width or height, or if not the same pixels type, a message error will be displayed in the status tab of the control panel.

This dark frame subtraction is performed through an optimization algorithm of the coefficient to be applied to the master dark frame image. If many files are present, the software will select the master dark frame that provides a result that is closest to 1.0.

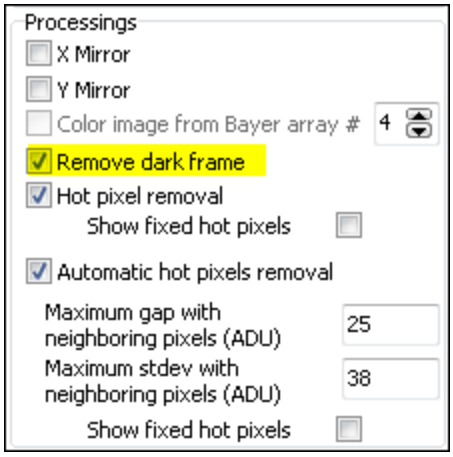


Fig. 54

The software scans the presence of files in the *DarkFrames folder* and will automatically pick up the most appropriate.

This means that if the master dark frame was produced at a given temperature, a given exposure time and a given gain, the software is able to optimize the subtraction of the current image by the best dark frame, even if there was temperature changes. This is performed within a reasonable range of variation. It will be discussed later on the effects and validity of the dark master frame according to the variation of parameters.

As there are still hot pixels that have non-linear behavior and cannot be corrected by the dark master frame, correction using hot pixels list can be achieved, cleaning the image of hot pixels by its neighbors.
Just check the box highlighted in the screenshot below.

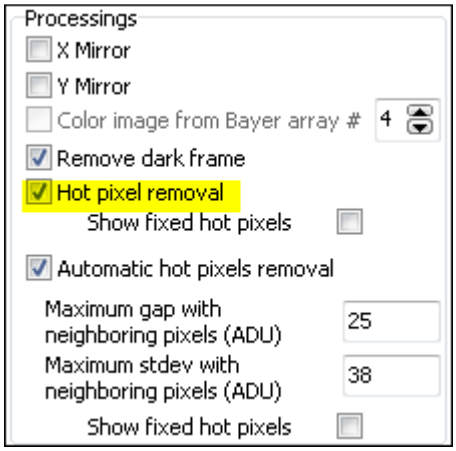


Fig. 55

The file used for this operation can be found here:

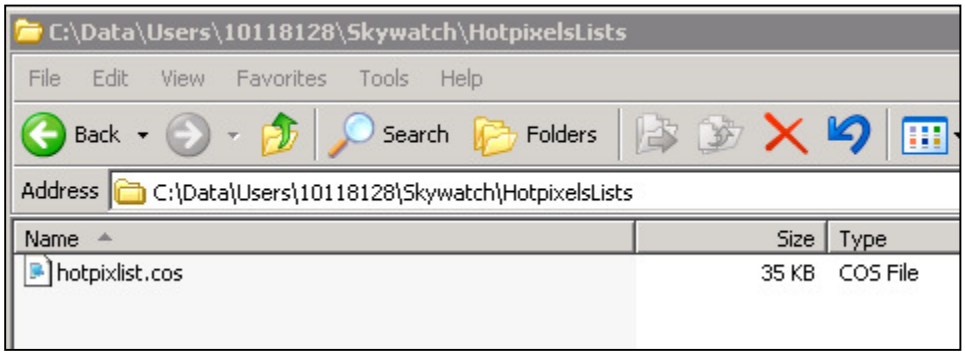


Fig. 56

It contains a list of hot pixels to repair/fix.

3.4.1 Achieving master dark frame

The files located into DarkFrames folder, whose fundamental purpose has been presented above, may, in some cases no longer be adapted to the current image shooting conditions (due to seasonal temperature

changes). This is especially the temperature change that will determine the validity of the master "dark" frame. This validity is above/below 5°C the temperature where the master dark frame has been recorded. Beyond this temperature range, the image hot pixel repair/removal using this dark frame might become poor and not effective.
For example, a master "dark" frame recorded from a set of some dark images at 20 ° C will be valid for images acquired between +15 °C to +25 °C.
It is better to build a small library of "dark master" for each 5°C (outdoor temperature)
The software will automatically select the most appropriate in the “DarkFrames” folder.

How to make a master "dark" frame for a given outdoor temperature?

This is easy. Under “***Camera***” tab, uncheck ***"Auto Exposure time"*** and select an exposure time corresponding to the longest exposure time used during night, for example 60s

Concerning gain, the largest gain used during night, for instance 800 (and then ***"Apply")***

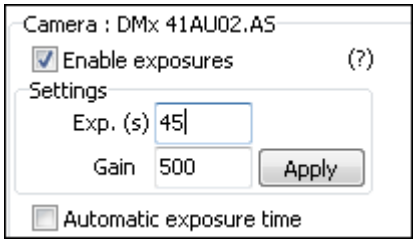


Fig. 57

Operate during night and cover the system (the Plexiglas dome) with a black tissue, or black paper. Be sure that any stray light cannot penetrate to the camera lens. Warning, it's a fisheye that is mounted on the top of the camera, and it able to see 360 ° down to the horizon

A feature has been implemented to achieve a master dark frame, and also can compute a list of hot pixels too.

Press the ***"Dark frame recording mode"*** and check ***"Do median stack of"*** say 5 to 11 "***darks***".

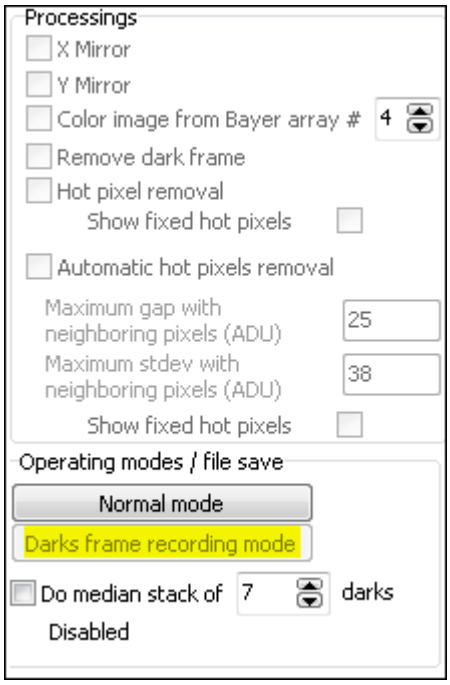


Fig. 58

The software switches into a particular mode that allows it to produce "dark" frames and performs the median stack when the amount a required dark frames have been reached in order to achieve a dark master frame and a list of hot pixels.

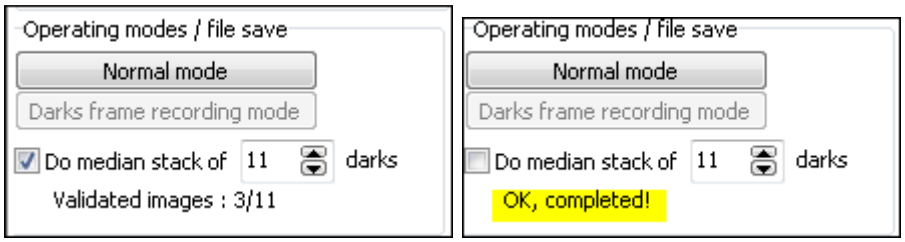


Fig. 59

The resulting files are placed in the proper directories **and are immediately ready for use.**

Once the task is complete, click on ***"Normal mode"***

Enable the following features by checking the following boxes:

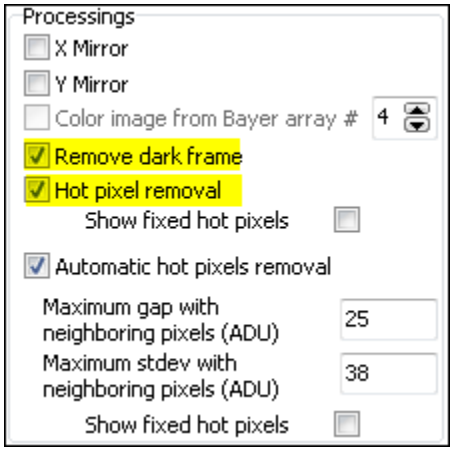


Fig. 60

For each image recorded by the camera, the dark master frame file will be used in the form:

Displayed_image = Raw_Image_brute - k * Master_dark_frame_Image

Where k is a coefficient optimized by the software.
More k is close to 1, the better. In the following scenario, k = 0.95, which is a good value.

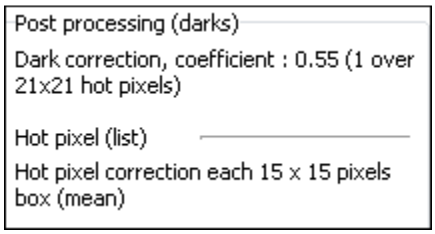


Fig. 61

If k> 1.5 or k <0.5, it means that the master dark frame is not well appropriate to the current outdoor temperature conditions. A warning message will be displayed as a red sentence.

3.4.2 Residual hot pixels repair/fix

Despite the subtraction by a master dark frame, and the repair of hot pixels based on a list of coordinates, some hot pixels are still variable (appear and disappear from one frame to another). To remove these last hot pixels that can't be removed previously, the next checkbox shall be enabled:

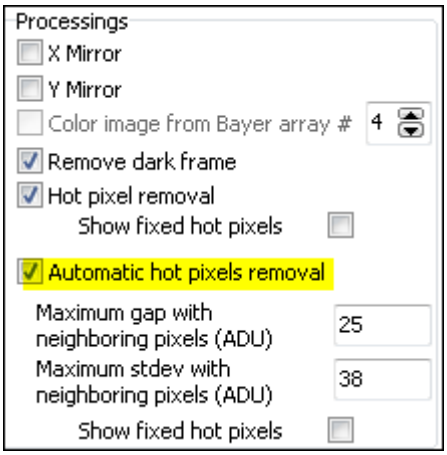


Fig. 62

The algorithm automatically eliminates hot pixels by inspecting all pixels from the incoming image. Two parameters to set two conditions are necessary.
The first parameter defines the difference of the pixel compared to its eight neighbors for which that pixel will be considered as potential hot pixels because it exceeds the defined gap (as ADU).
The second parameter sets the maximum standard deviation of the eight neighboring pixels, if the deviation is less than the defined value; the central pixel is considered as potential hot pixel.

When the two above conditions are met, the hot pixel is fixed automatically.

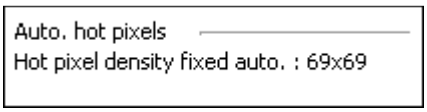


Fig. 63

The figure above shows that the automatic correction is performed on average into one pixel every 69x69 pixel box. To test this feature use a moonless night, and be careful not to remove some stars of the picture by setting a too low maximum gap and too high standard deviation !
You can see how these fixed pixels are spread over the image, by enabling the following checkbox.

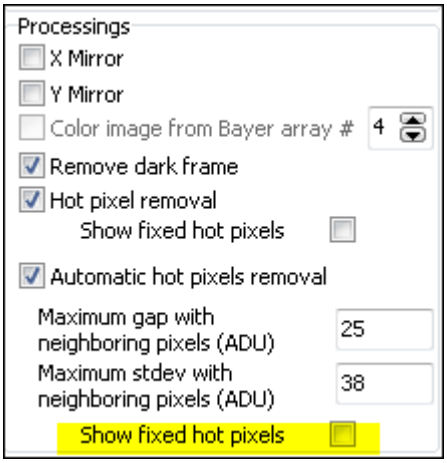


Fig. 64

A pixel density corrected that implies one pixel every 7x7 pixels box is maximum, beyond this density, such as one pixel each 5x5 pixel, you will have to achieve your "dark" frame and the list of hot pixels bound to it.

3.5. Status information

In JPEG image, a cartridges are indicating camera statuses, **"2129"** indicates the number of images taken since the software has been started up.**"D 1.6"** indicates a correction by a factor 1.6 of the dark frame; **"H"** indicates hot pixel correction using a list, for example **"18x18 H"** indicates that an average of one pixel of 18x18 pixel bow is repaired. If **H!** is displayed**,** this means that the hot pixel file was not found. The **"L 9x9"** indicates an automatic correction of hot pixels having an average density of 1 pixel per 9 by 9 pixels.

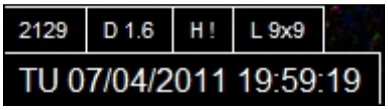


Fig. 65

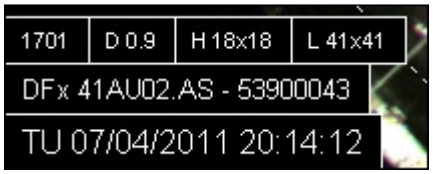


Fig. 66

3.5 Setting the overlay grid

The camera must be installed vertically using a water "buble" level. Otherwise, the setting of this grid will be jeopardized.

Here is the recommended way to set the grid that is used to identify stars on the image: this is not an automatic procedure, this setting shall be performed manually. But once set, this will be set forever (expect the camera is being moved or rotated). In the Control Panel, set the location, latitude and longitude, altitude, and the country.

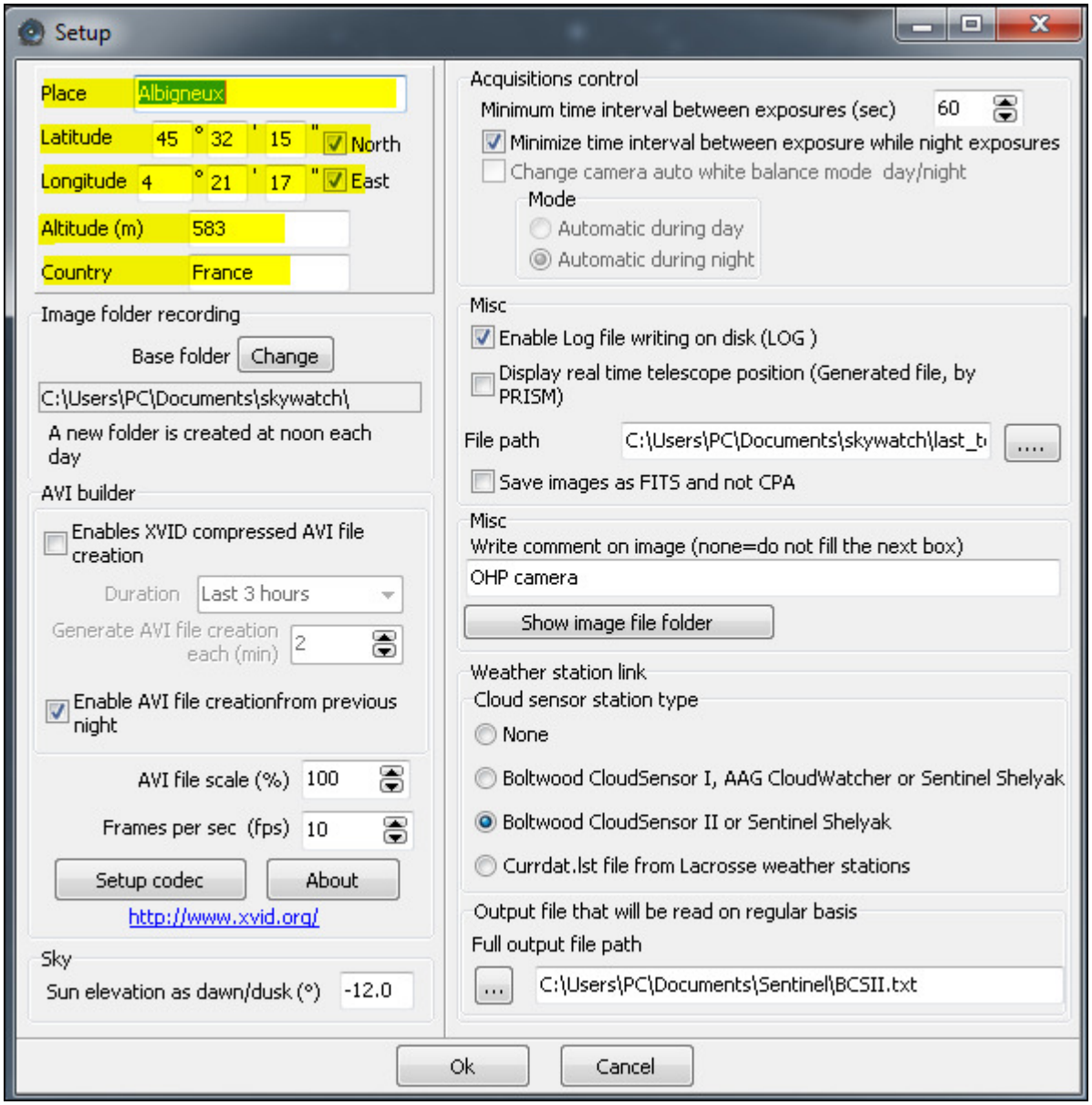


Fig. 67

- Use night time when a star of magnitude 0 to 3 passes to zenith (or say +/- 2° from the zenith)
- Force fixed exposure time of 5s to 10s
- Get to "***Enable grid display***" and "**Show Main object**" (Check "***Only horizon***")
- Find the star that passes nearby zenith and move the cross indicating zenith towards it.
- Change "***X center***" and "***Y center***" figures so that the cross position matches with the star.

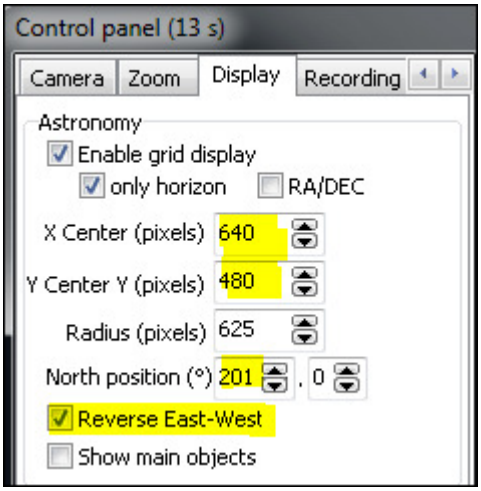


Fig. 68 *displacement in X and Y to adjust the position of the zenith symbol*

Fig. 69 *Star passing nearby zenith (Deneb) and zenith marker*

- Once the zenith marker found, you have to set the "north position" to have the grid (circle and star's name) matching with star position. The grid scale can be changed also.

The grid (or set of stars position) is changing according to the time and geographical coordinates. Be sure to have set theses parameters correctly.

3.6 Cyanogen Boldwood or Sentinel cloud sensors link with camera control software

If you own a cloud monitor from Cyanogen or Shelyak companies, it is possible to display, at the top right of the image, some weather information. In the main Setup Panel, enter appropriate information. The software uses simply the output file generated by each measurement from cloud sensor. It does not use the COM or ActiveX interface. Enter the path of the generated file provided by the software that runs the cloud sensor.

The amount of information depends on the system that is measuring cloud cover. It will be the most complete using Sentinel Shelyak system (wind direction and zenith magnitude per second squared).

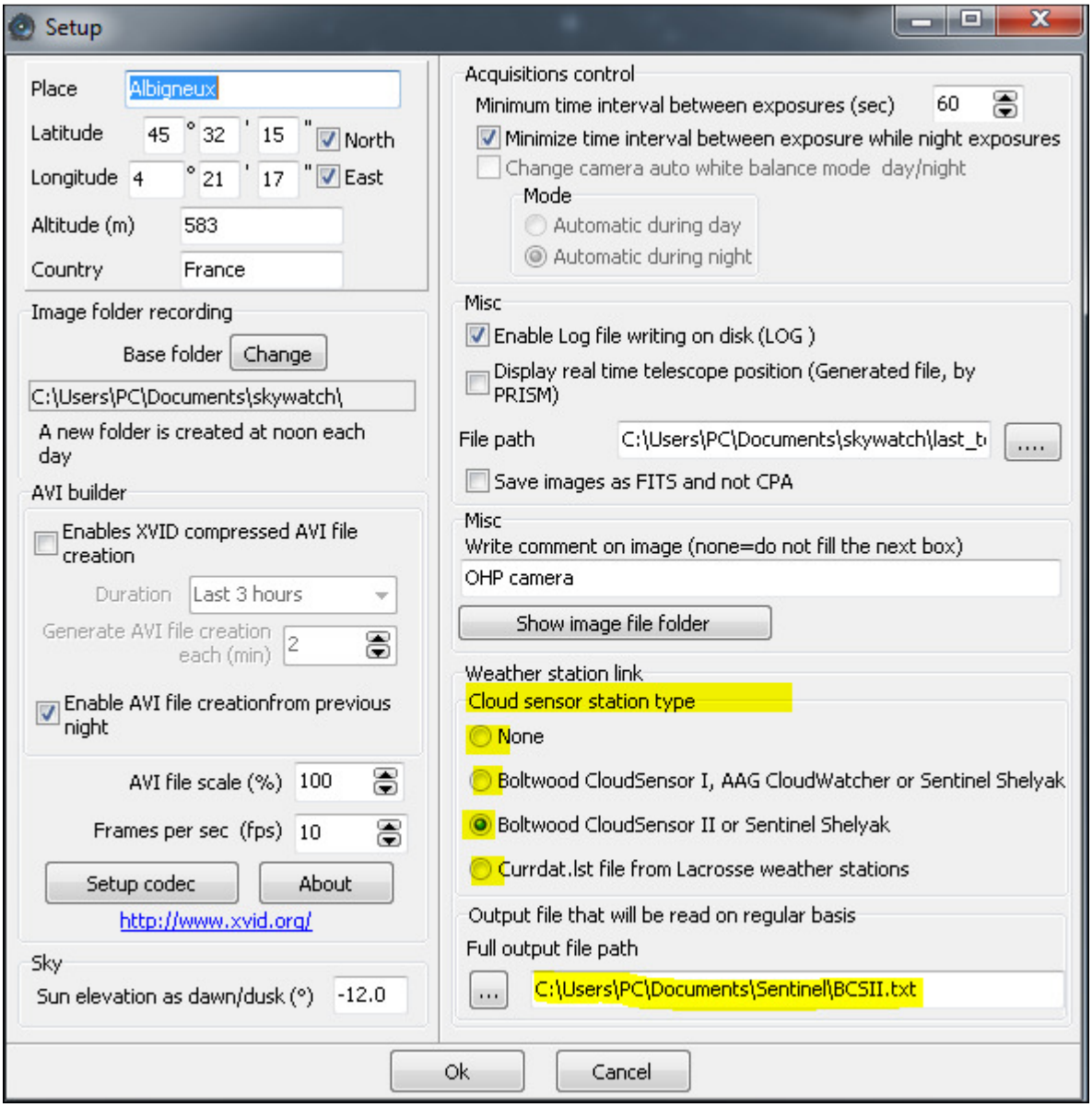


Fig. 70 *group information to provide to connect with cloud sensor system control software.*

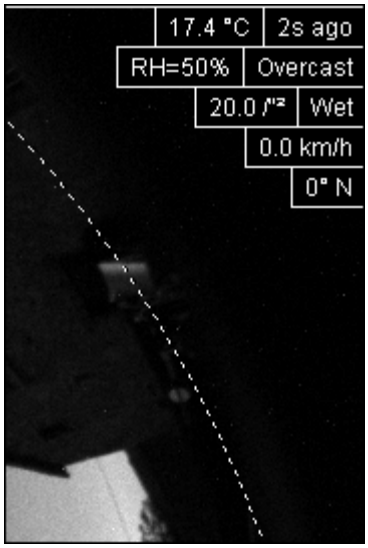


Fig. 71 *List of information coming from Sentinel or Boltwood cloud sensor included in the image*

3.7 Magnitude per square second display image mode

The software allows the calculation of radiometric magnitude per square second across the sky. It works on color and monochrome cameras. In case of color image, only green pixels will be considered (50%).
To do so, you have to open this tab:

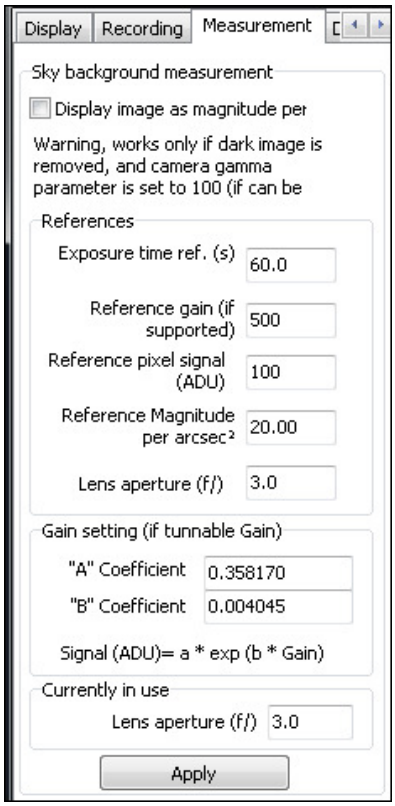


Fig. 72 *Tab used to set magnitude image mode display*

The calculation is based on a reference image, with reference parameters. To perform this, a reference image is achieved with:

- An exposure time reference
- A camera gain reference
- Opening aperture reference (which is usually fixed as the aperture setting is not accessible).
- Subtracting the reference image by a master dark frame
- The camera gamma adjustment must be set to 100.
- Avoid the presence of Milky Way overhead.
- Save reference image as CPA / FITS

Using this reference image, the signal is expressed as ADU. Nearby zenith the signal is measured and is reduced to a pixel, and must be entered in the panel from figure (Fig. 73) "**Reference pixel signal**" field.
It is advisable to use image processing software (such as Prism or equivalent).
At the time of reference image acquisition (during night), using a sky meter measuring device such as Sentinel or SkyQualityMeter (Unihedron), the magnitude per square second will be retrieved and entered as a reference "**Reference Magnitude per arcsec^2**".

The coefficients "A" (0358) and "B" (0.004045) are specific to the camera law gain and might remain at their default values above, but can be re-calibrated in laboratory for a specific camera.

Once the calibration parameters known, the software calculates the magnitudes map per square second from the last image grabbed from the camera. Median filtering is performed to remove most of the stars. The image pixels are expressed in magnitude per square second, a false-color palette is applied and a color scale indicates the color to magnitude correlation.

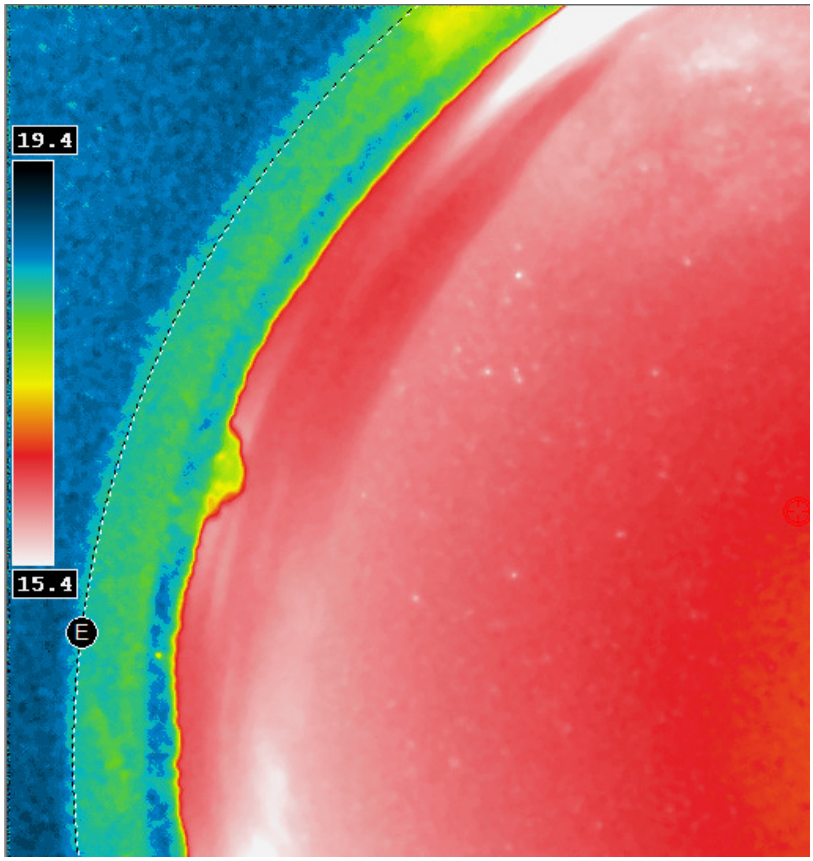


Fig. 74 *Map of the sky expressed as magnitudes per arcsec square with false colors.*

3.8 Telescope control software link

Telescope's pointing direction can be display and embedded to the last all Sky Image. The telescope pointing software shall be able to generate a simple text file, containing date and time of the measured position and equinox 2000 RA/DEC coming from the telescope current position.

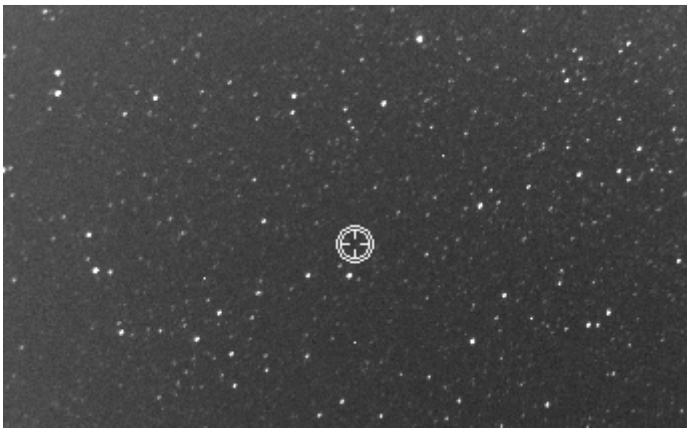


Fig. 75 *Current telescope position merged to the last all Sky image*

If the time gap between the current date and the date of the last telescope position is greater than 10s, the telescope's cross position switches to red color, indicating that the position is no longer refreshed by the software, and thus might not be valid.

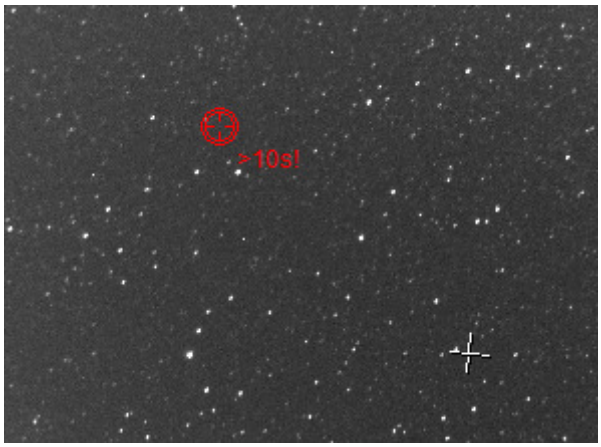


Fig. 76 *Telescope position as red because current date and telescope position date is larger than 10s*

Here is the file format used to read telescope position as ASCII file, 1st line is amount of days since Dec 31st 1899 at 12 o'clock, the second line is RA as radian, the third line is DEC as radian:

```
40307.9796818056
4.3461698620
0.9539777407
UTTime = 09/05/2010 11:30:44 p.m.
RA2000 = 16h36m04.126s
DEC2000 = +54°39'32.03''
```

The other remaining lines are not read and are just provided for information.

3.1 Star count for cloud coverage estimation

During the night, the software is able to extract stars, and count them up. Thresholds can be applied to define what is regarded as clear skies, or mid overcast skies. The software output this data either into a text file, or uses a COM interface that can be used by other any software.

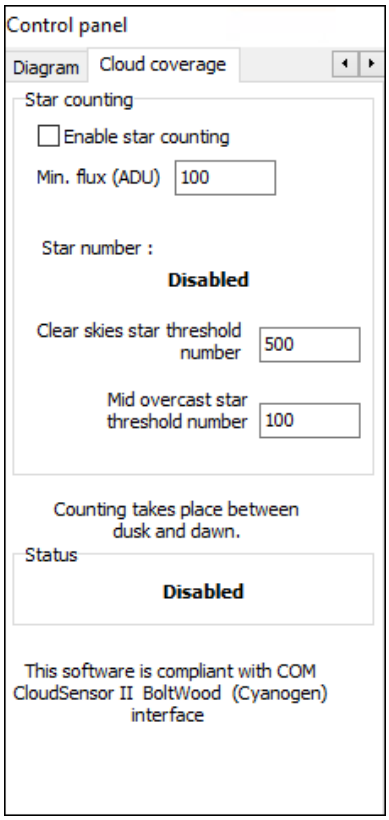


Fig. 77

Star extracted are plotted into the image.

4 Sphere condensation heater management

4.1 Introduction

The heating of the sphere is achieved throughout a set of resistors placed under the sphere base. It can defog or defrost the outside side of the acrylic sphere.
The system is autonomous (works without link to PC and without user's supervision). It sets out the conditions when temperature and humidity levels enable occurrence of water condensation.
As soon as the temperature is below a certain value, and moisture above another value, the heating system is automatically activated. These levels are named **temperature and humidity levels.**
By default, factory set, the default threshold temperature is set to +7 ° C and humidity level to 90%. These thresholds may be inappropriate for a given site and can be adjusted by user input (RS 232 link to camera is mandatory to do so).
Similarly, the heating power is set by default to 50%, it can be changed according to site and circumstances.

4.2 Adjusting and start-up

Use the menu ***"Options / Heating Control"*** from the camera software main's menu.

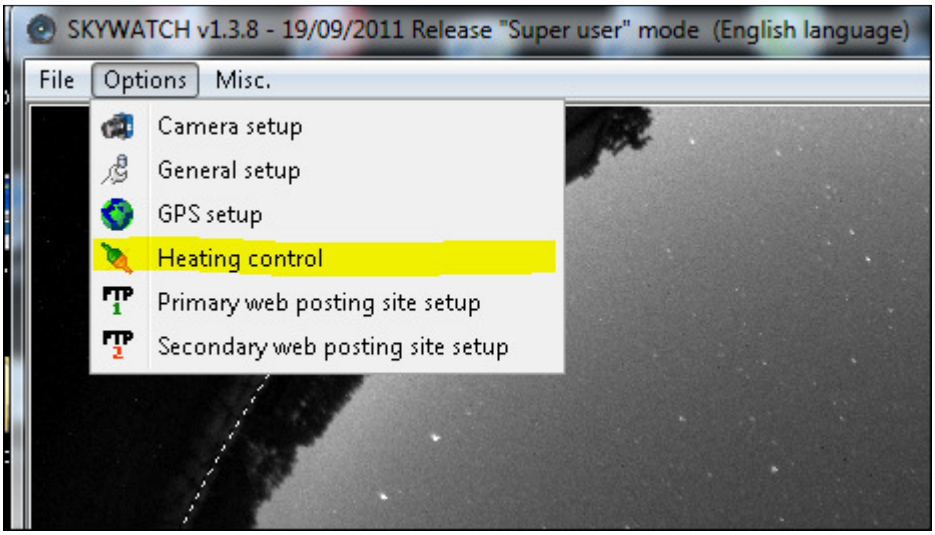


Fig. 78

This window appears to let you selecting the RS2323 serial port number, then click to ***"- Connect -"***

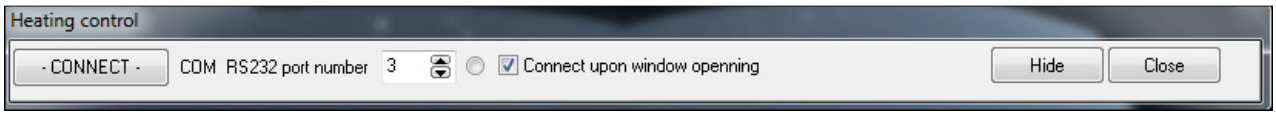


Fig. 79

Once connected, the following window appears:

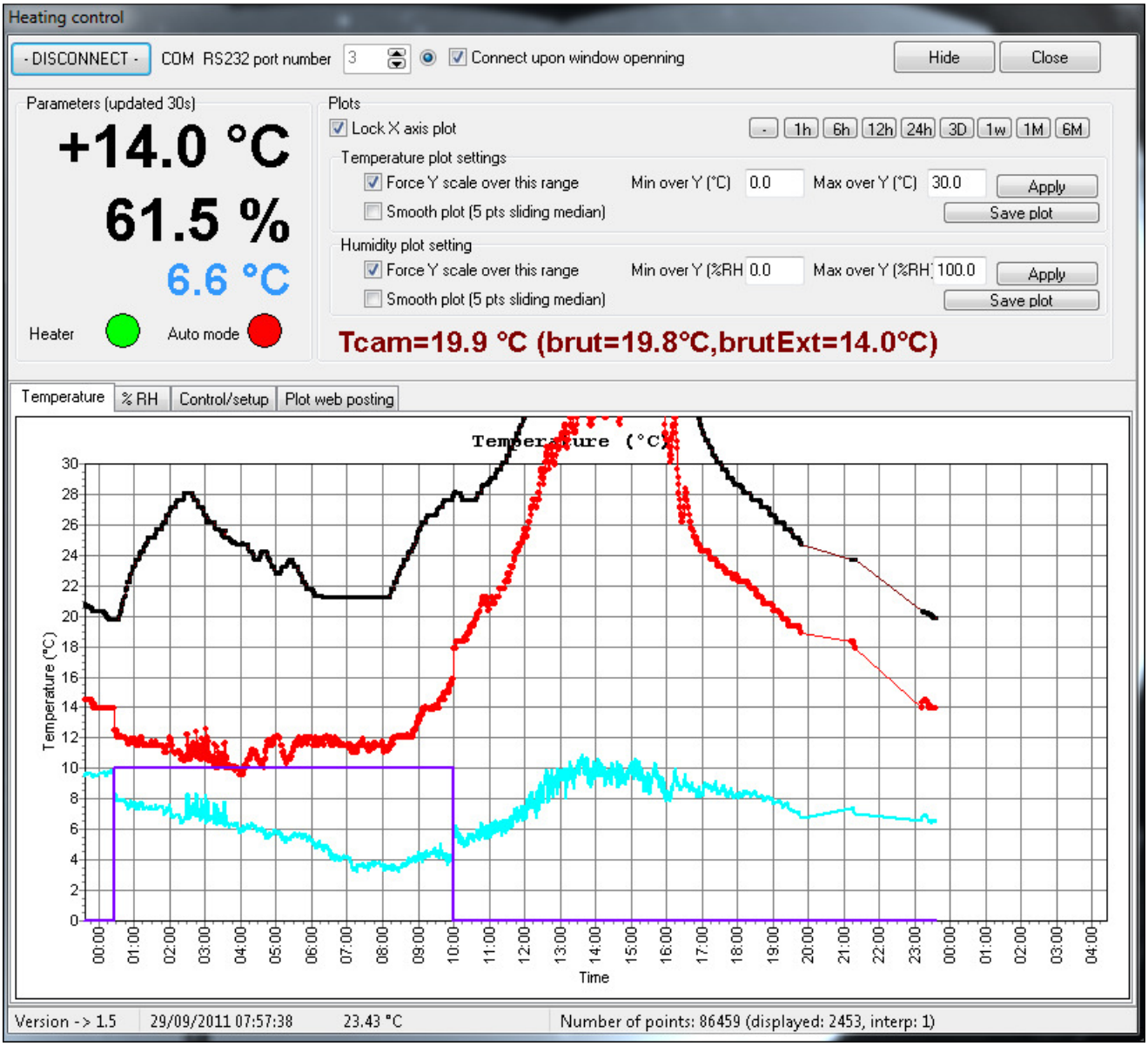


Fig. 80 *Temperature curves*

It provides outdoor temperature, camera temperature, outdoor humidity and dew point (light blue).
The software records the data and curves are constructed progressively (if connected to the PC all the time).

Beware, if this window is closed, recording data cannot occur anymore. We recommend that you simply hide it. Nevertheless, heater activation is achieved by the camera alone without any link to the PC.

The red curve provides outdoor temperature, light blue curve is dew point, and purple indicates the status of heating: no heating when the plot is overlapping the X axis, and heating is enabled when it is up.

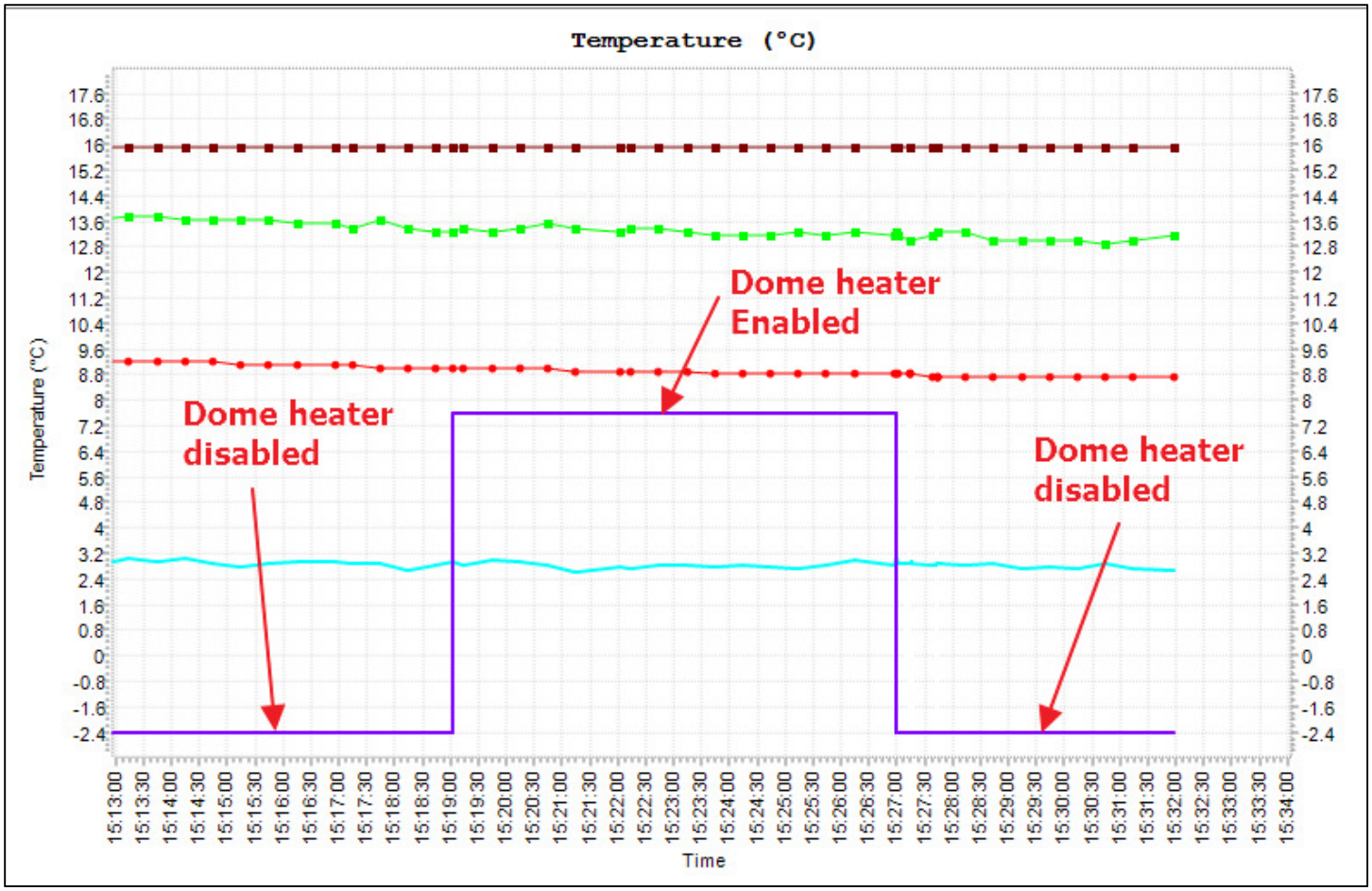


Fig. 81 *Heating plot (as purple) warning there is not unit bound to it*

The tab ***"% RH"*** provides access to humidity plot expressed as % RH (Relative Humidity). Outdoor temperature and humidity is measured by the external probe, and is used to trigger the dome heating.

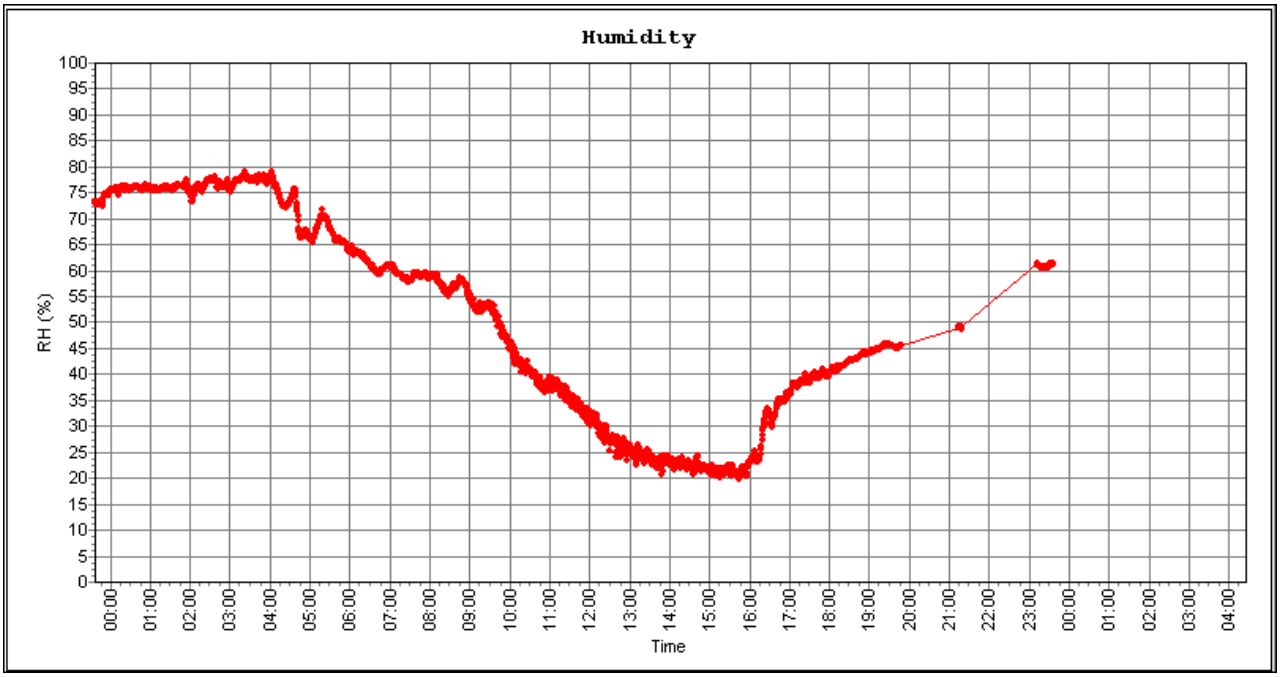


Fig. 82 *Relative humidity plot*

The next plot show as red the external camera humidity, and the marron plot is the internal caùera humidity. The internal humidity shall be kept under 20% RH. The camera embeds a desiccant (molecular sieve) inside it, to have the humidity as low as possible, to prevent dew from forming in the inner side of the dome. So do not dismount the backside of the camera if not needed, this would cancel out the effect of the desiccant, and humidity level would be higher than 20% RH.

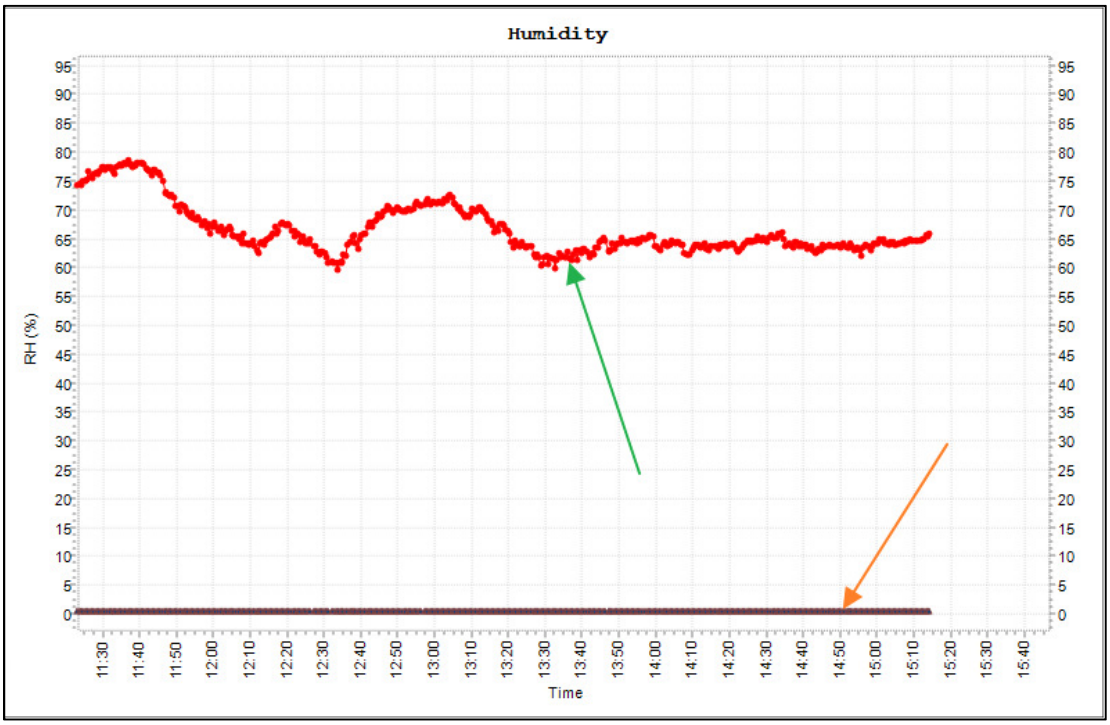


Fig. 83 *Relative humidity plot, the orange arrow shows the inner humidity level of the camera. Here close to zero on a brand new camera with fresh desiccant.*

The tab ***"Control/Setup***" sets the temperature and the humidity threshold levels that will trigger sphere heating start up. The power level to be used can also be set by user to get better efficiency. Once these parameters are set, do not forget that you need to send/write them to the camera.

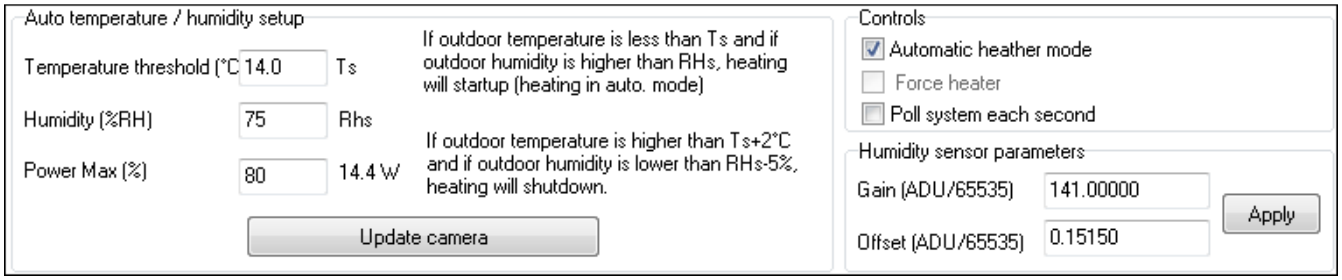


Fig. 84 *Setup and control panel*

This controls allow the heater to switch to automatic mode ***("Automatic heater mode»*** stand-alone or PC-free mode) or ***"Force Heater'' as*** manual mode in this case uncheck the ***"Automatic heater mode "***.

Humidity sensor calibration is also possible (gain/offset).

When the sphere heating runs, a small red LED will light up.

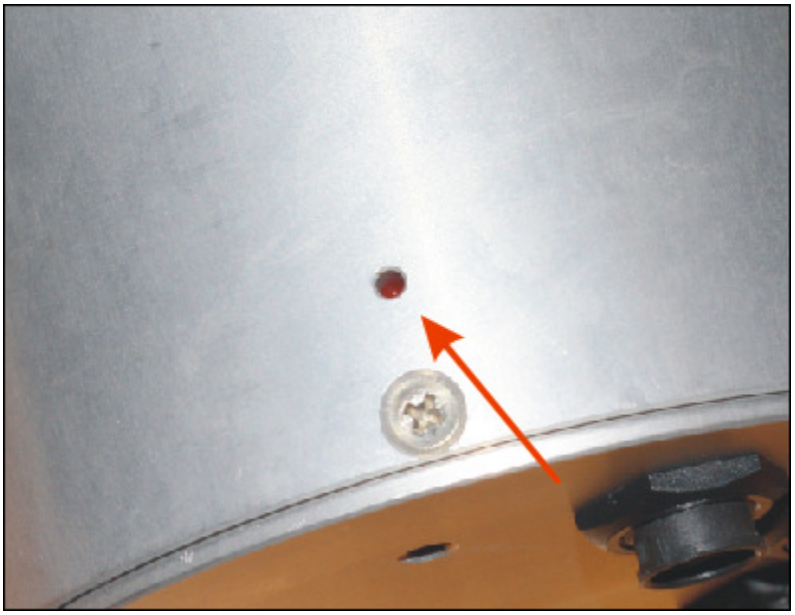


Fig. 85 *LED indicating that sphere heating is enabled*

Finally, it is possible to transfer these plots to website for remote control.

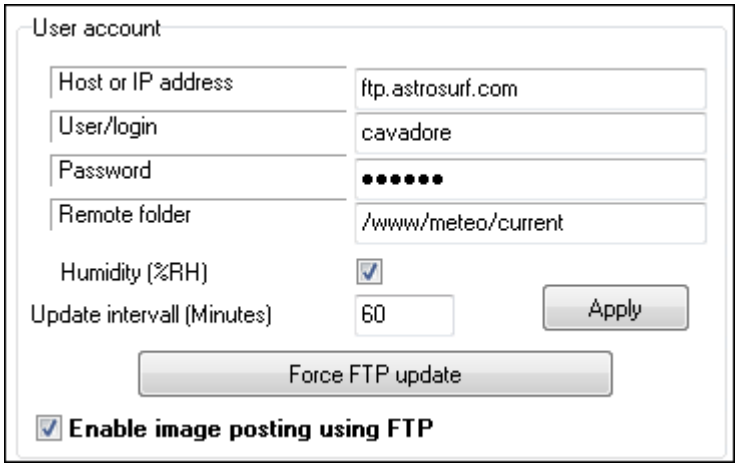


Fig. 86 *Website setting for temperature and humidity plot posting*

5 Weather measurement module

A weather module can be attached to the camera (optional). It consist in an external box that is attached to the camera and includes:

- Measurement of the ambient temperature
- Measurement of the ambient relative humidity
- Measurement of the Pressure (Mbar)
- Measurement of the wind speed
- Measurement of the wind direction

Fig. 87 *Wind speed – Wind direction sensor*

The next picture shows different part of the weather module:

- Relative Humidity and temperature module
- Cable going to the ALL-SKY camera
- 25m cable going to the wind speed and wind direction sensors

The 4 screws (green arrows), holding the top cover of the box can be unscrewed. The hole underneath them, allow using other screws in order to attach the box to a support. Then put back, the cover again. Important, despite this is a water tight box, the box must be always oriented with the vertical direction as depicted below otherwise water may ingress into the box and damage the electronic board inside. There is a small hole underneath the box to sense the atmospheric pressure. It is better to put the box and the RH/Temp sensor in permanent shadow, protected from direct SUN rays.

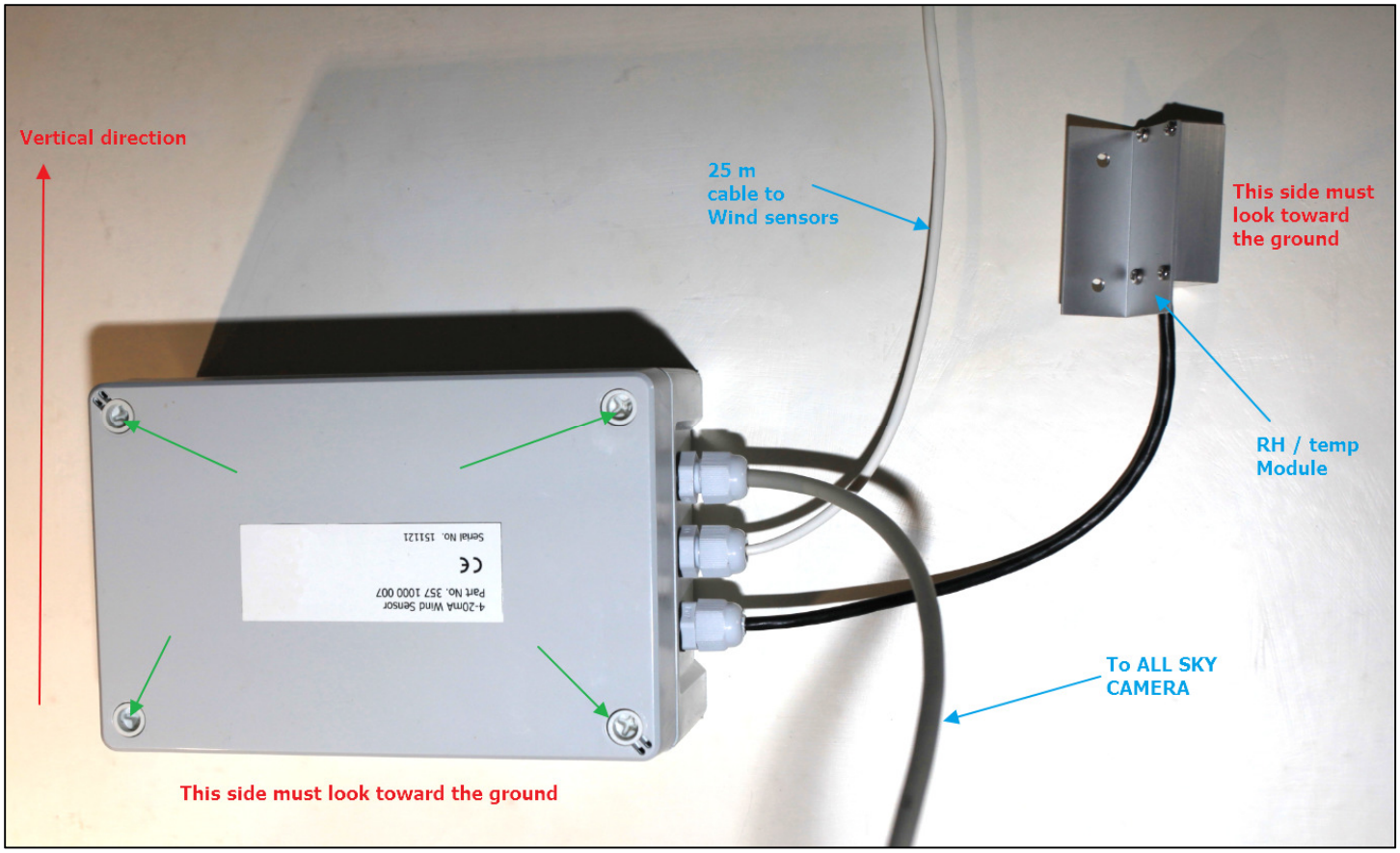


Fig. 88 *Sensors control box*

The wind sensor must be installed into a mast that is at least 5 m from the ground (10m is better). A system to clamp the wind sensors to the mast is provided. Orientate the wind direction to the north, and put the sensor horizontally.

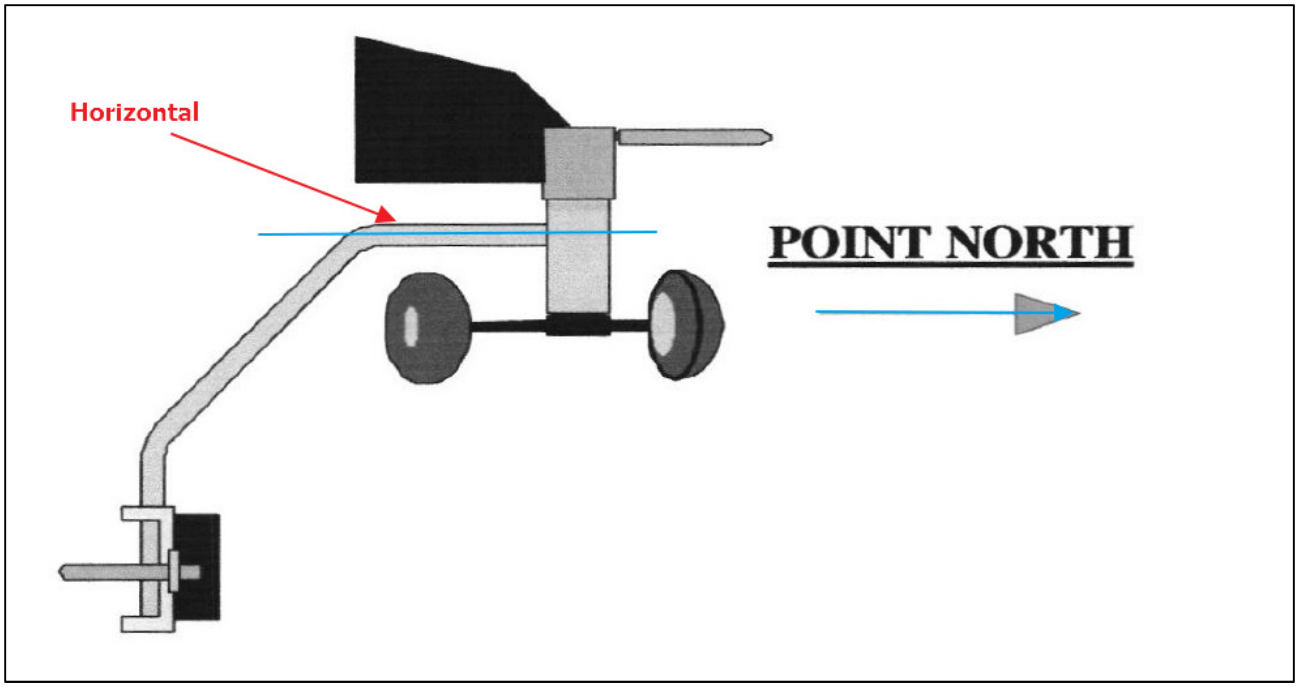


Fig. 89 *Wind-sensor orientation*

5.1 Sensors software management

Click "***Options/Dome Heating control/ CCD cooling / Weather cond.***" It will bring up the usual sensor panels with plots. Select the appropriate COM port.

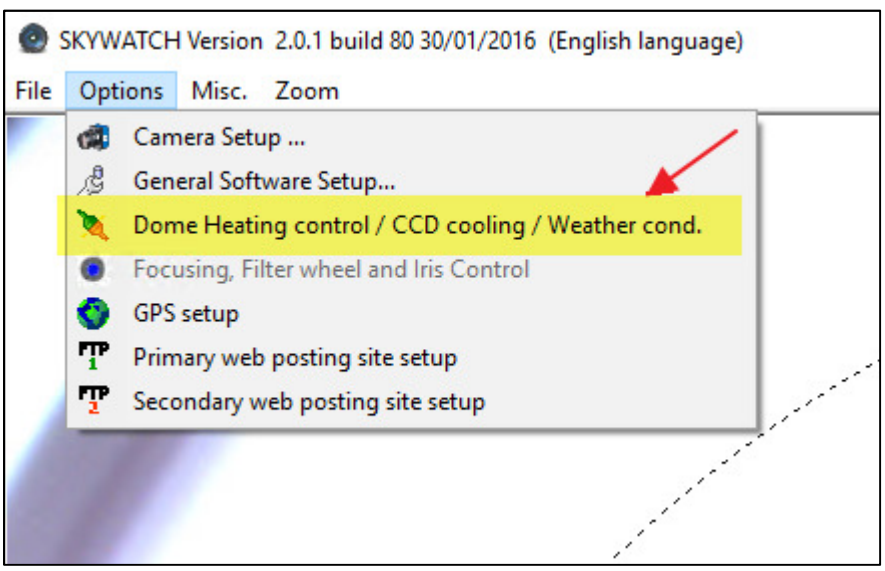


Fig. 90 *Menu*

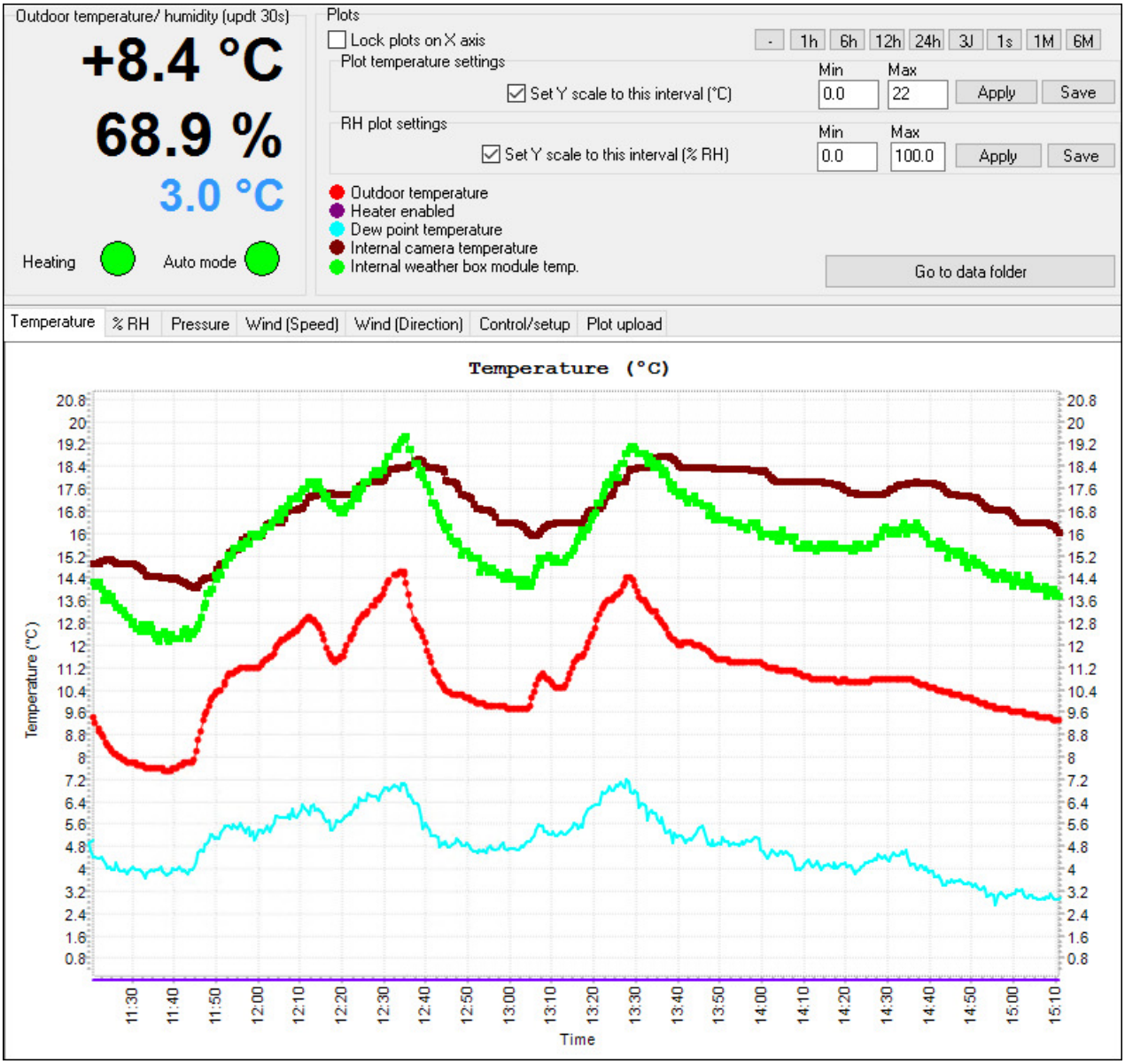


Fig. 91 *Temperature from the different sensor of the camera. Red is external temperature, brown is internal camera temperature, green is weather box internal temperature, and cyan is the dew point temperature.*

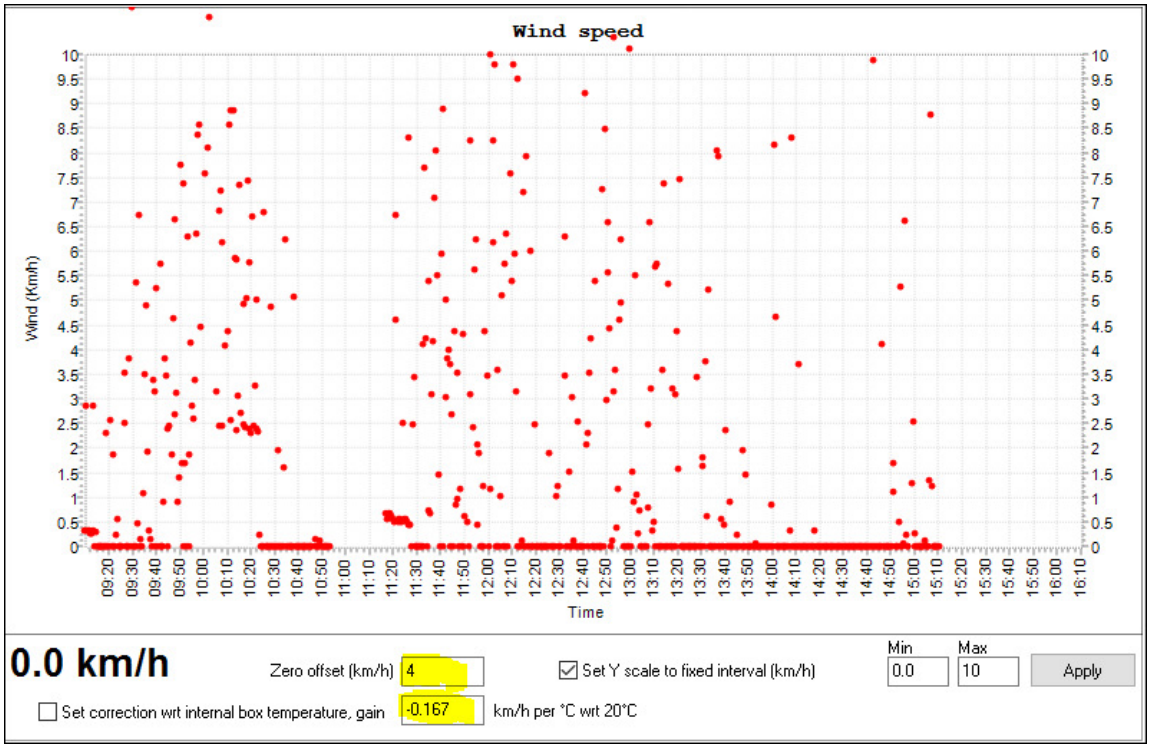


Fig. 92 *Wind speed plot*

The wind speed raw data can be offset by some figure, because the electronic has a small offset when the wind speed is zero. Also, the measurement can be corrected from some drift induced by temperature changes inside the weather box. The formula used is:

*Wind_speed= (Raw_wind_speed - (InternalBoxTemperature - 20.0)*Correction_factor) - Offset*

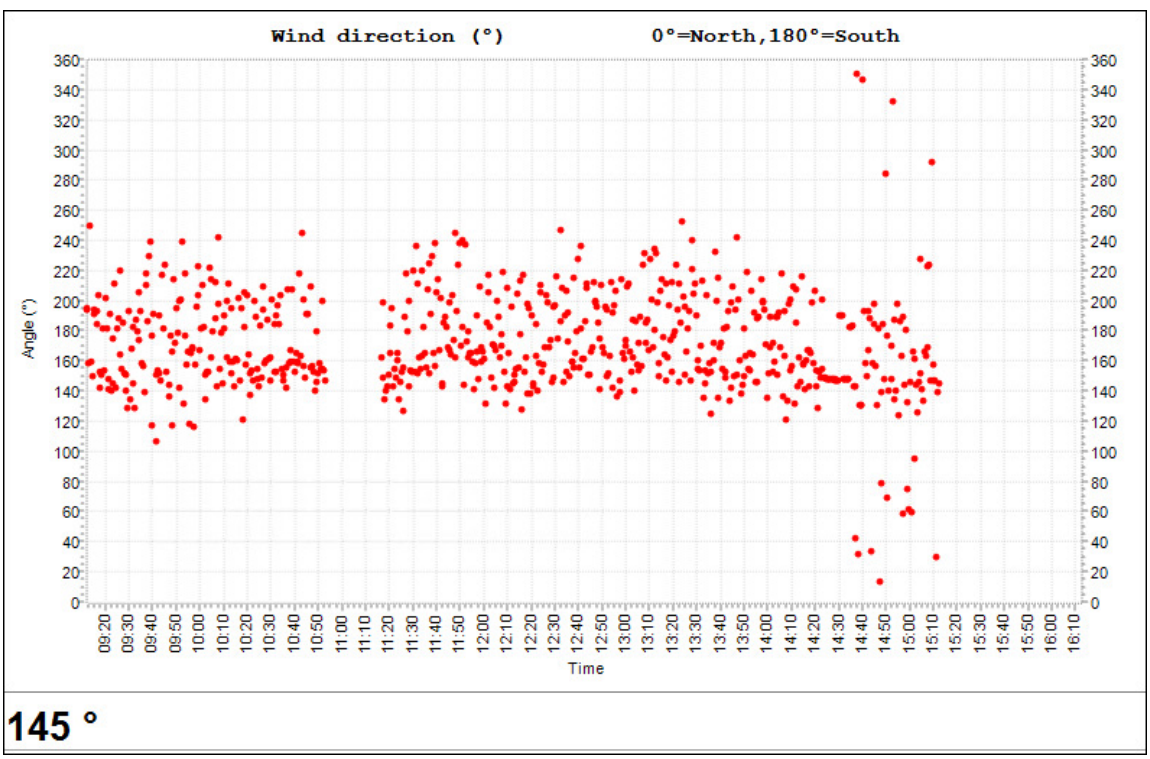


Fig. 93 *Wind direction plot*

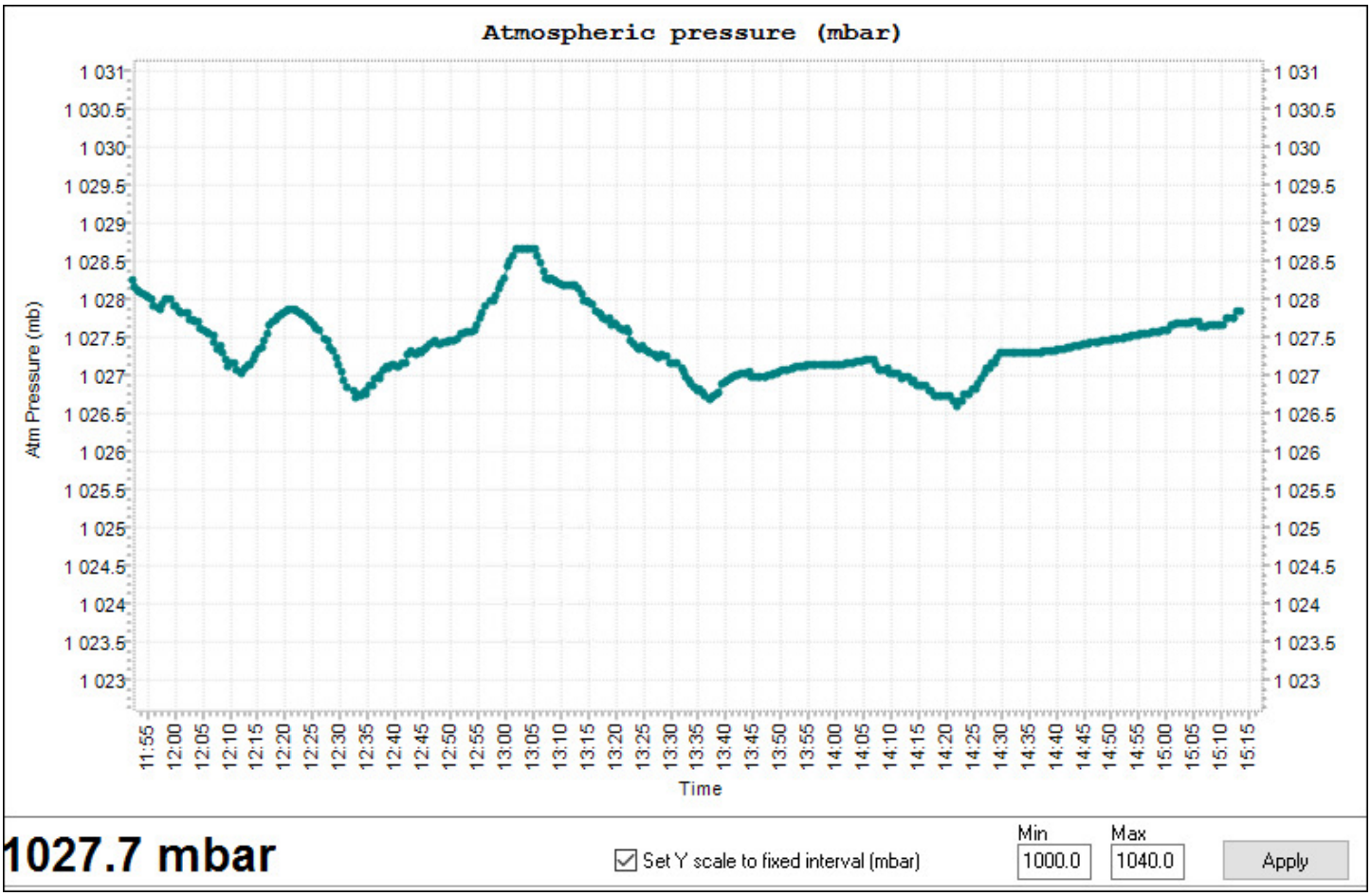


Fig. 94 *Atmospheric Pressure*

The pressure is corrected to the sea-level, because the software knows all the parameters to carry out the computation.

6 Camera maintenance

6.1 Sphere cleaning

Sphere cleaning must be achieved on regular basis. Rains can bring dust that is deposited on the sphere surface; it reduces the optical transmission and image quality.
The acrylic sphere outer and inner surface can be cleaned with water, then with a Kleenex moistened with washer fluid dedicated for window cleaning. The 8 screws can be removed to detach the sphere from the rest of the camera. Attention must be paid on these topics:

- The cable bringing power to the heaters should not be pinched during reassembly
- O-rings properly positioned in their grooves
- The distance between the sphere support and the camera body must be at least 0.7mm and constant around the perimeter.
- 8 screws must be put together with their washer and all tightened the same way.

Incorrect reassembly can cause loss of sealing, allowing rain to enter and de facto guarantees no longer apply. If you feel confident with dismounting sphere, please do not do it.

6.2 Camera internal desiccant replacement

Inside the camera, a small desiccant bag has been installed. This is molecular sieve that can set the level of humidity down to zero. Replacement of this bag, may happen once every 3 years.

7 Trouble shooting

This section aims at providing hints to solve issues.

7.1 Camera does not deliver images

On I3 to I7 PC, or modern PC, the CPU put idle the USB channel where the images are coming from. The consequence, is that images are not been delivered to the software anymore. Install this tool here

http://www.theimagingsource.com/support/downloads-for-windows/software-tools/procidlestateman/

Download Processor Idle State Manager

This will solve the issue.
If it does not, the USB port driver might be outdated, please update USB port driver. Also change USB port, sometime some are slightly damaged with the course of the time.

If the issue persists please contact us, the long 20 m cable can be also damaged, check that no damage has occurred on this cable (no small animal has started to eat the USB cable for instance).

7.2 Dew inside the dome

This may happen after several year of operation, if the internal desiccant is exhausted. Please check the internal humidity figure. It should be less than 20%, above 60% dew can form easily. To replace the internal desiccant, please contact us to get the procedure.

8 Product terms of use

The use of this product is solely for monitoring the sky, night and day, entertaining, educational or scientific purposes.
Use of this product involving people's lives is the responsibility of the user and in no way ALCOR SYSTEM will be held liable for injuries to persons or property theft as the use of this camera described in this manual.

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