Direct Drive Equatorial Mount
NOVA 120

Pointing model user manual

Changes history

Version 1.1	**12/05/2014**	Initial release

Here is a list of Acronym used in this document

Acronym	**Meaning**
RA	Right ascension
DEC	Declination
TPOINT	This is a standard formalism used for achieving pointing model, see here for more information http://www.tpsoft.demon.co.uk/pointing.htm
MA or HA	Hour angle, or meridian angle http://en.wikipedia.org/wiki/Hour_angle

Contents

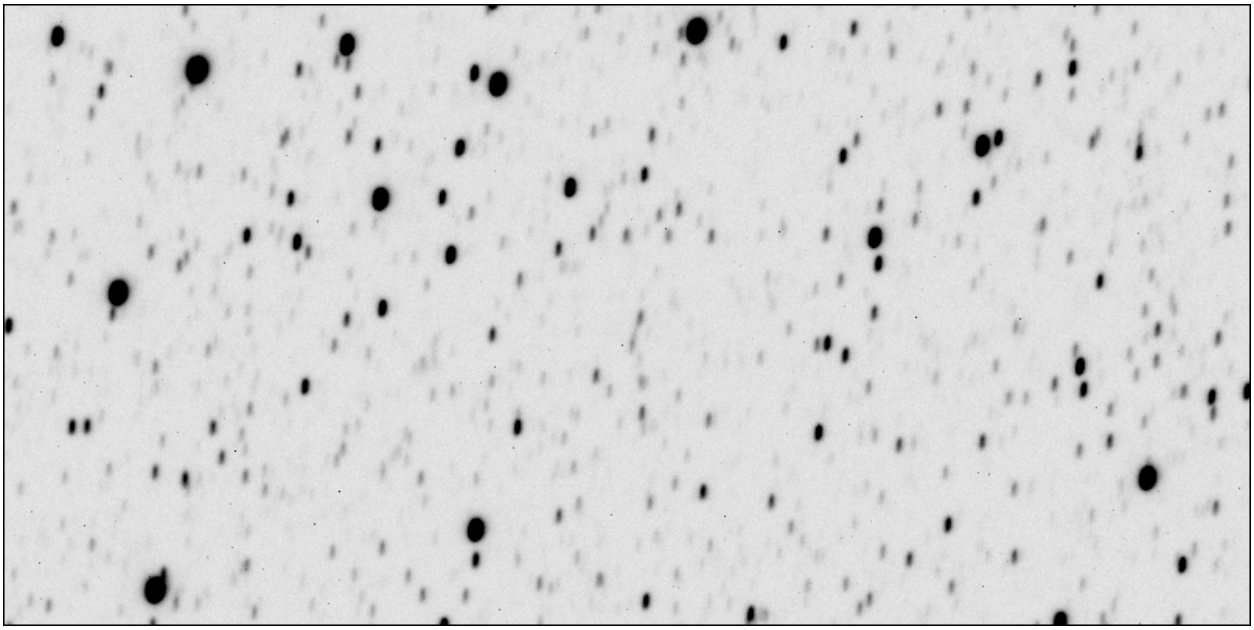
1. Introduction

A Pointing model is supported by the NOVA mounts family. It is essential to achieve it properly to create the best from your mount. Pointing model improves pointing accuracy, but also mount tracking accuracy, because the mount software can use the pointing model to get a speed model and also compensate for mount polar alignment errors, or any other errors that are supported by the model.

Left is an image with no pointing model, where the user tried to center the right star (field of view is 15x15 arcmin) but no star is present. Right is an image that demonstrates the effect of the pointing model: the star is at the image's center.

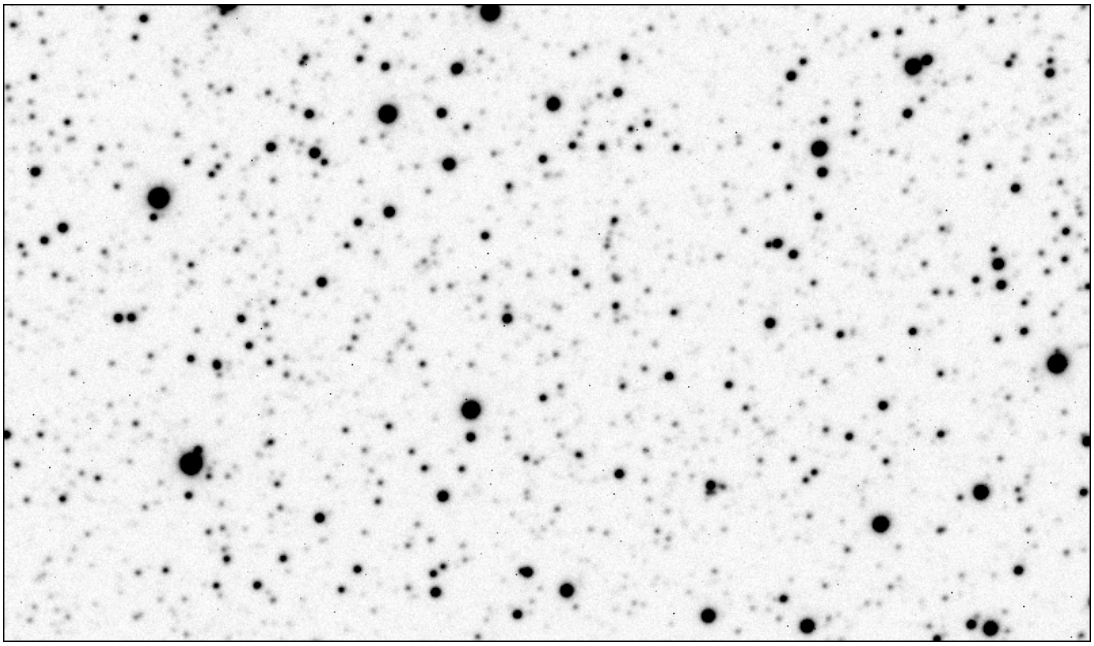
Working without a pointing model can allow dramatic errors with a German mount. Meridian flip and optical axis non perpendicularity error with the DEC axis can lead to pointing errors more than ½ of a degree! This causes most of the time, the target to be outside the field of view of the camera. A Pointing model can overcome this easily, allowing better use of your telescope, and not wasting time acquiring your target.

The next picture shows what happens with a poorly polar mount alignment (18 arcmin error from the pole) and a 600s unguided exposure.



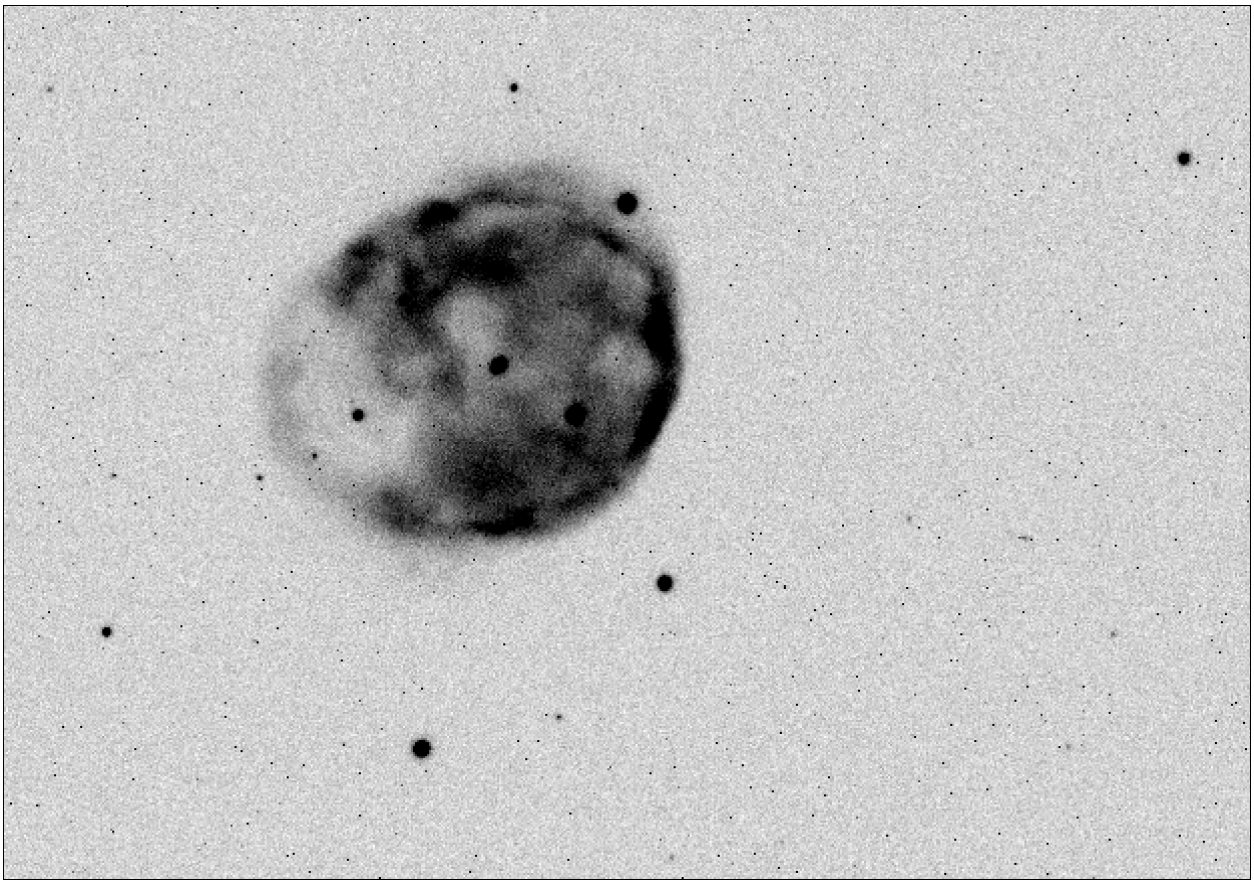
The image quality is weak and shows a vertical trailing in DEC direction. This is quite normal with badly polar aligned mounts.

If the pointing model has been previously created, and injected into the mount software, the speed model will be calculated and applied.



Despite the poor polar alignment, the 600s unguided exposure is perfect, because the mount software could compensate for this error automatically based on the pointing model. Since the mount can never be perfectly polar aligned, the speed model is a real asset for your mount.

Even, more the next picture shows a raw single 900s unguided exposure that would be impossible to achieve without the speed model and refraction speeds compensations.



2. Achieving Pointing model files

2.1. Data coming from any software (except PRISM software)

In this document, the pointing model will be demonstrated using the PRISM software package. Nevertheless, this is not a mandatory step, because other software in the market can use TPOINT and provide valid data that can be used with the mount NOVA software. The purpose of this document is not to demonstrate how to achieve a pointing model with all the software available in the market. We will do it using PRISM, because this is very easy to achieve.

An important point, for German mounts, there are two pointing models required, one for the tube located at the east side of pier, and another for the west side of pier. These models had turned out not to be the same, by experience.

The type of file format to provide to the NOVA mount software is a simple "***.cor**" file, which is indeed a simple text file.

Here is a ".cor" file sample; always starting with 789955491 as a magic number. Then pointing model coefficients expressed in radians are listed after:

```
789955491
 1.28873174669791E-0003
-1.01213383676195E-0003
-6.63990193728120E-0004
 4.39074860709788E-0004
-3.73858799270869E-0005
 1.58008143060133E-0003
 7.43329643913604E-0004
 2.46848043582684E-0004
-1.16523424111638E-0003
-5.05908232673203E-0005
 0.00000000000000E+0000
 0.00000000000000E+0000
-3.60434309820003E-0004
-2.61141145462940E-0004
 0.00000000000000E+0000
```

These coefficients translate into this table with famous TPOINT standard coefficients (CH, NP, , ME, MA) for equatorial mounts:

Raw figure as radians into the file	TPOINT Acron.	Meaning	Converted in arcmin
1.28873174669791E-0003	CH	Optical axis and DEC axis perpendicularity error	+4.4
-1.01213383676195E-0003	NP	RA/DEC axis perpendicularity error	-3.5
-6.63990193728120E-0004	ME	Elevation polar axis error (polar alignment)	-2.3
4.39074860709788E-0004	MA	Azimuth polar axis error (polar alignment)	+1.5
-3.73858799270869E-0005	ID	DEC offset	-0.1
1.58008143060133E-0003	IH	RA offset	+5.4
7.43329643913604E-0004	TF	Tube flexure error	+2.6
2.46848043582684E-0004	FO	Fork axis flexure error	+0.84
-1.16523424111638E-0003	DAF	DEC axis cantilever error	-3.98
-5.05908232673203E-0005	DAB	DEC axis flexure error	-0.174
0.00000000000000E+0000	DNP	Dynamic non perpendicularity error	0.0
0.00000000000000E+0000	HCEC	RA encoder error (cosine)	0.0
-3.60434309820003E-0004	HCES	RA encoder error (sine)	-1.2
-2.61141145462940E-0004	DCEC	DEC encoder error (cosine)	-0.89
0.00000000000000E+0000	DCES	DEC encoder error (sine)	0

All figures coming from third party software shall be all multiplied by -1 into this file to be used with the NOVA mount software (for historical reasons). Do tests to check all these step by step.

It is up to the user to arrange parameters in the same order as it is described above. In case of unknown parameters leave them simply to zero and do a test and see if it improves pointing accuracy.

When performing the pointing model with other software than PRISM, do not forget to disable any pointing model at the NOVA mount software level.

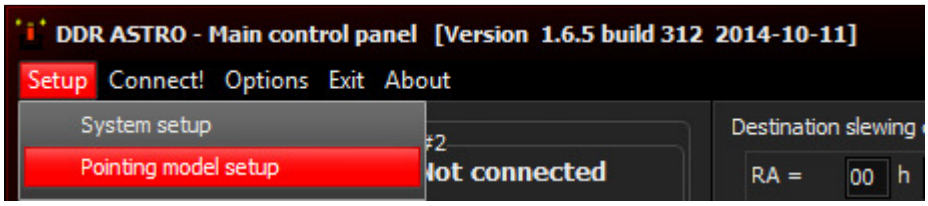
Finally keep in mind that the NOVA mount software sends to the ASCOM client software “Observed coordinates” that are corrected from refraction and not “Topocentric place” coordinates.

2.2. Using PRISM software to get pointing model coefficients

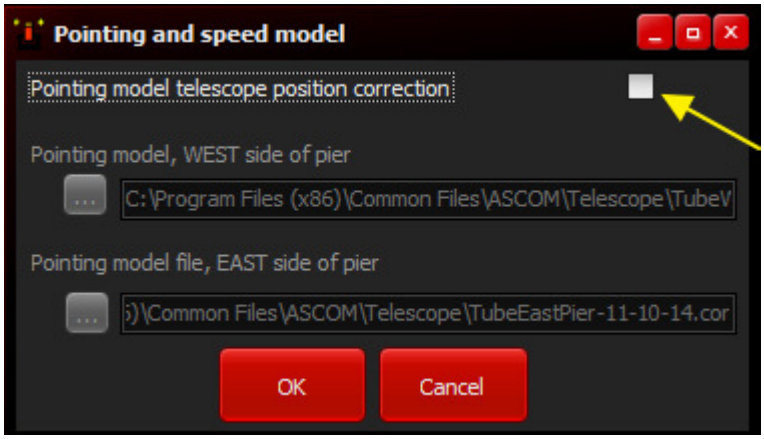
2.2.1. Prerequisites

Before starting the NOVA mount software, please ensure that any pointing model is already enabled, if so disable it.

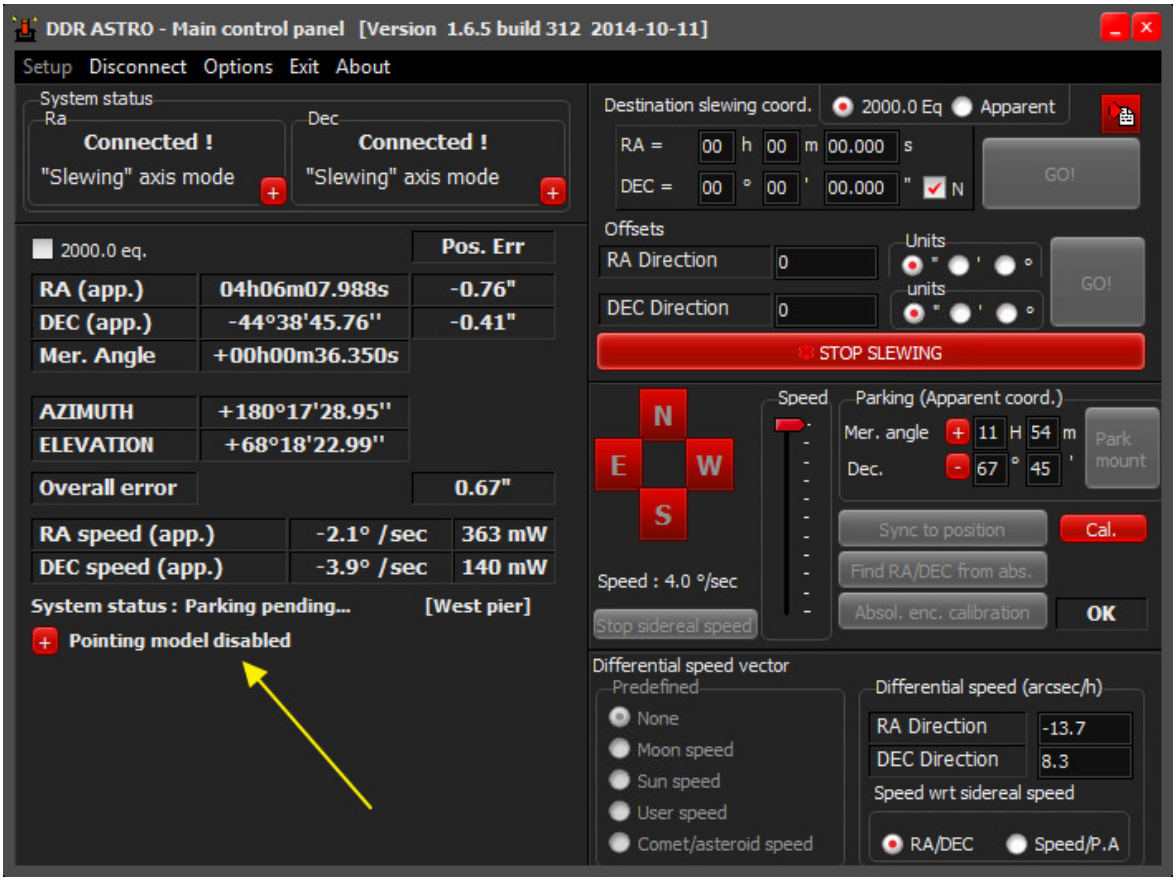
Go here:



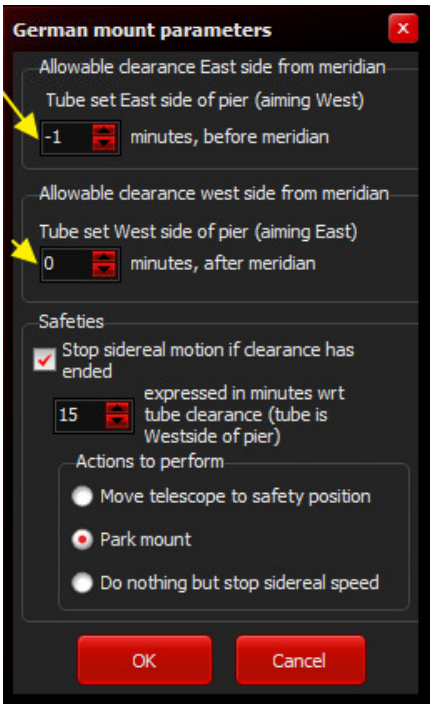
Uncheck this checkbox, if checked:



When the mount is running and connected to the software, it will mention that the pointing model is disabled, as shown hereafter:



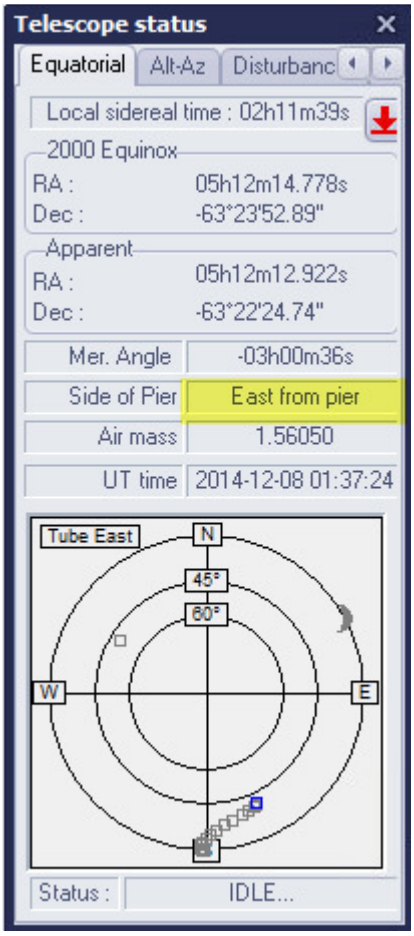
Go to "***Setup***" then "***System setup***", press "***German mount setup***" and change as follows the allowable mount clearance.



This step is achieved to avoid unwanted meridian flip, because two pointing models are required for German mounts, **one for the tube located at the east side of pier, and another for the west side of pier.** Since pointing models are created by slewing to areas only in one side of the pier, these settings forbids the mount from meridian flipping when located close to the meridian.

Using PRISM software from ALCOR-SYSTEM, please, connect the mount to PRISM, and keep eye on side of pier information that is sent by the NOVA mount software to PRISM.

This panel helps doing so:



Say, that the pointing model will be built for the telescope located on the east side of the pier, aiming at targets that are on the west side of the Sky.

A CCD camera attached to the telescope is mandatory. There is no way doing visually with an eyepiece; it will never reach to the required accuracy. The larger the field of view is the better to allow a fast pointing model to be built. But also a sampling of 3 arcsec per pixel is the maximum sampling rate required.

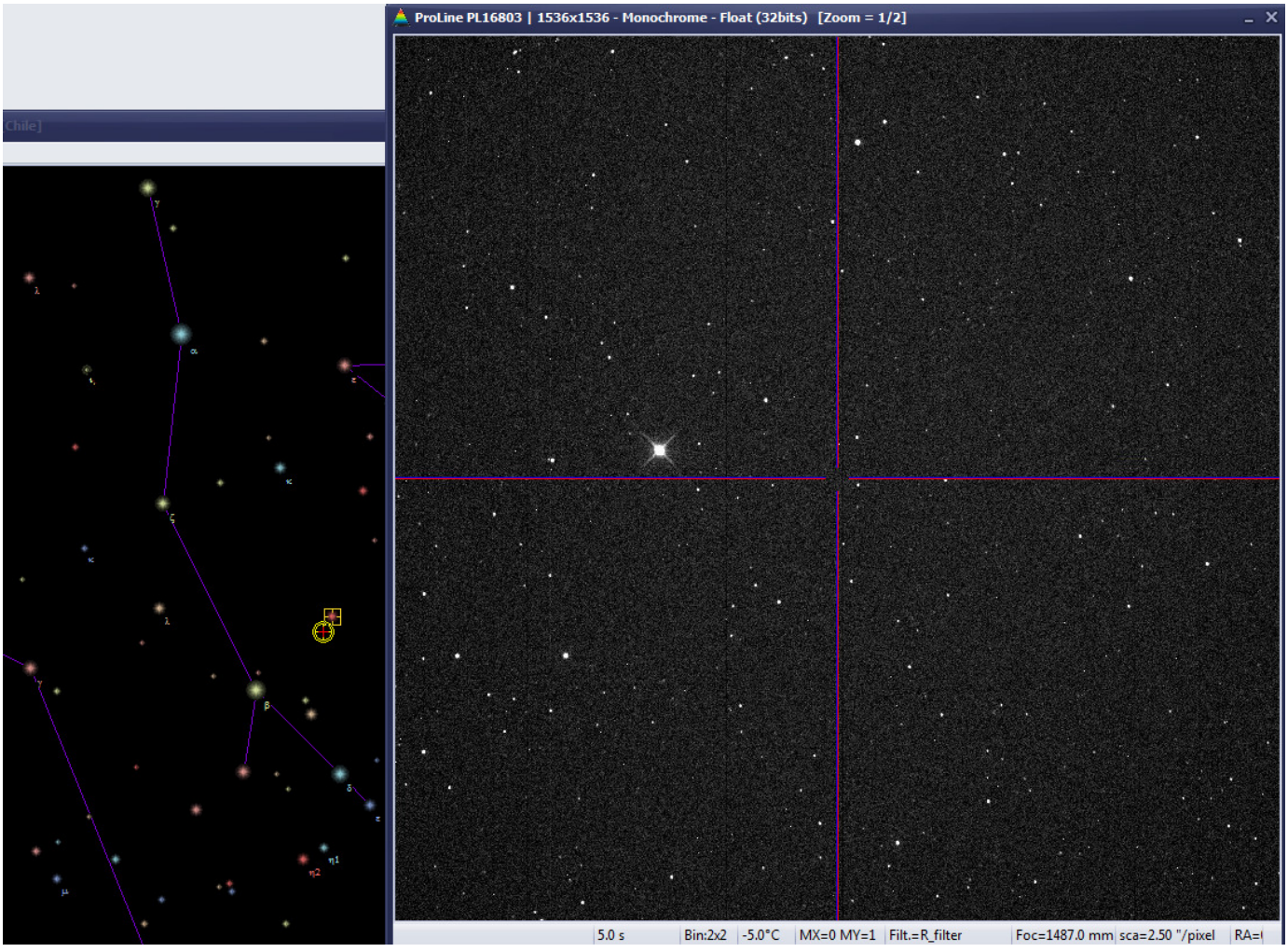
2.2.2. Plate solving checking

Plate solving, that is having each pixels X and Y image's coordinates to be translated into RA and DEC coordinates, is a fundamental step and must work.

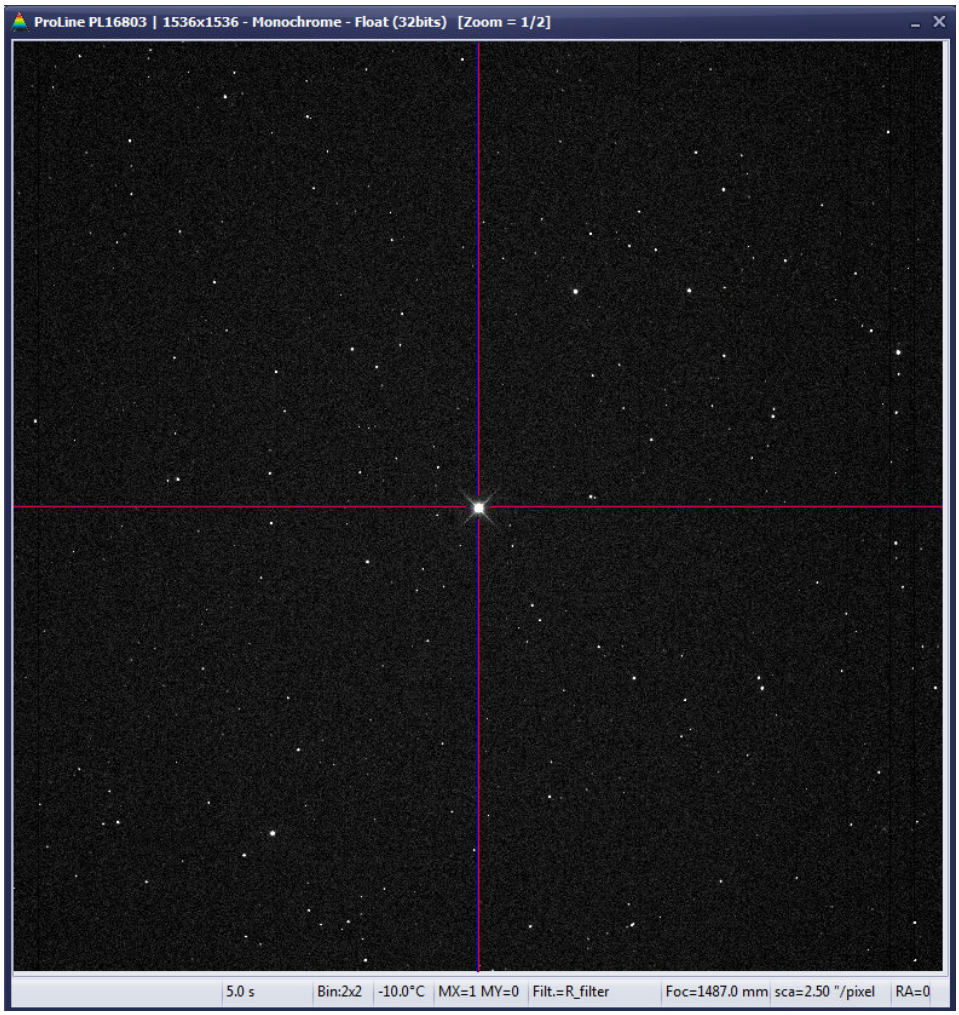
PRISM embeds this step automatically by matching the star of the image with a catalog. Nevertheless, this feature shall be checked and shall work; **otherwise no pointing model can be build.**

Slew to a star that can be identified with the sky map, which is not too bright, and be sure this star is located into the camera's field of view.

The next image shows the star and the sky map that matches to it.

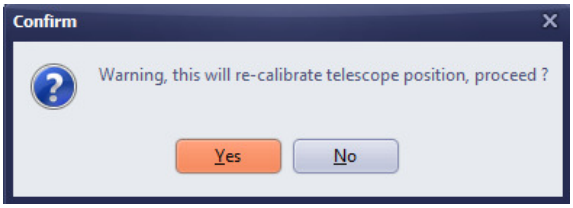


Then re-center the star so that it is located at the image's center.

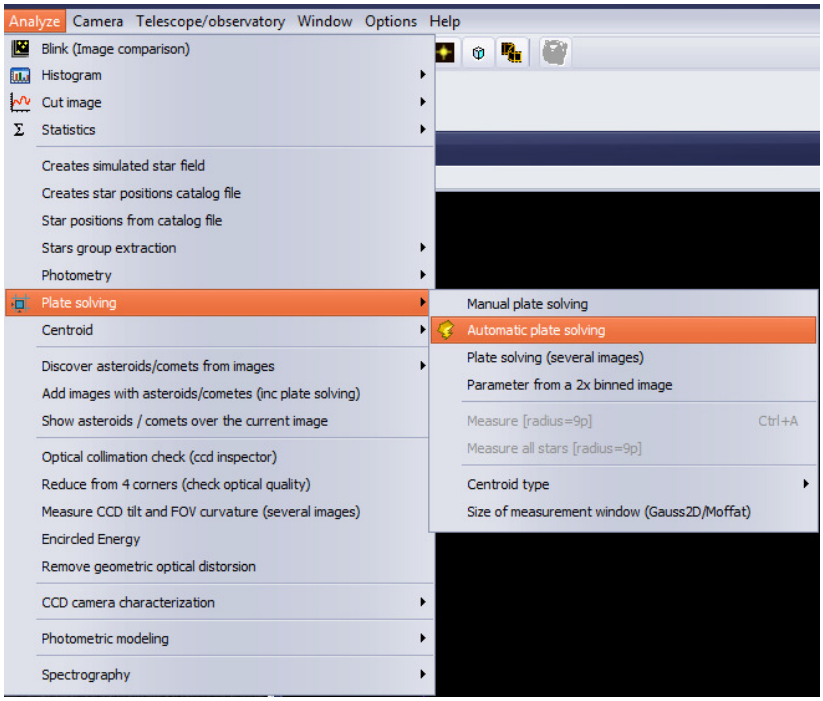


Once achieved, click on the star in the sky map that matches to this star (ensuring that the mouse is set to identification mode), and this window appears, click to the "***calibrate with***" button. Then the Sky map and the telescope are now synchronized.

Then now acquire another image, this image will have the proper rough RA/DEC coordinates that will be used for plate solving. Be sure to be focused as best as possible.



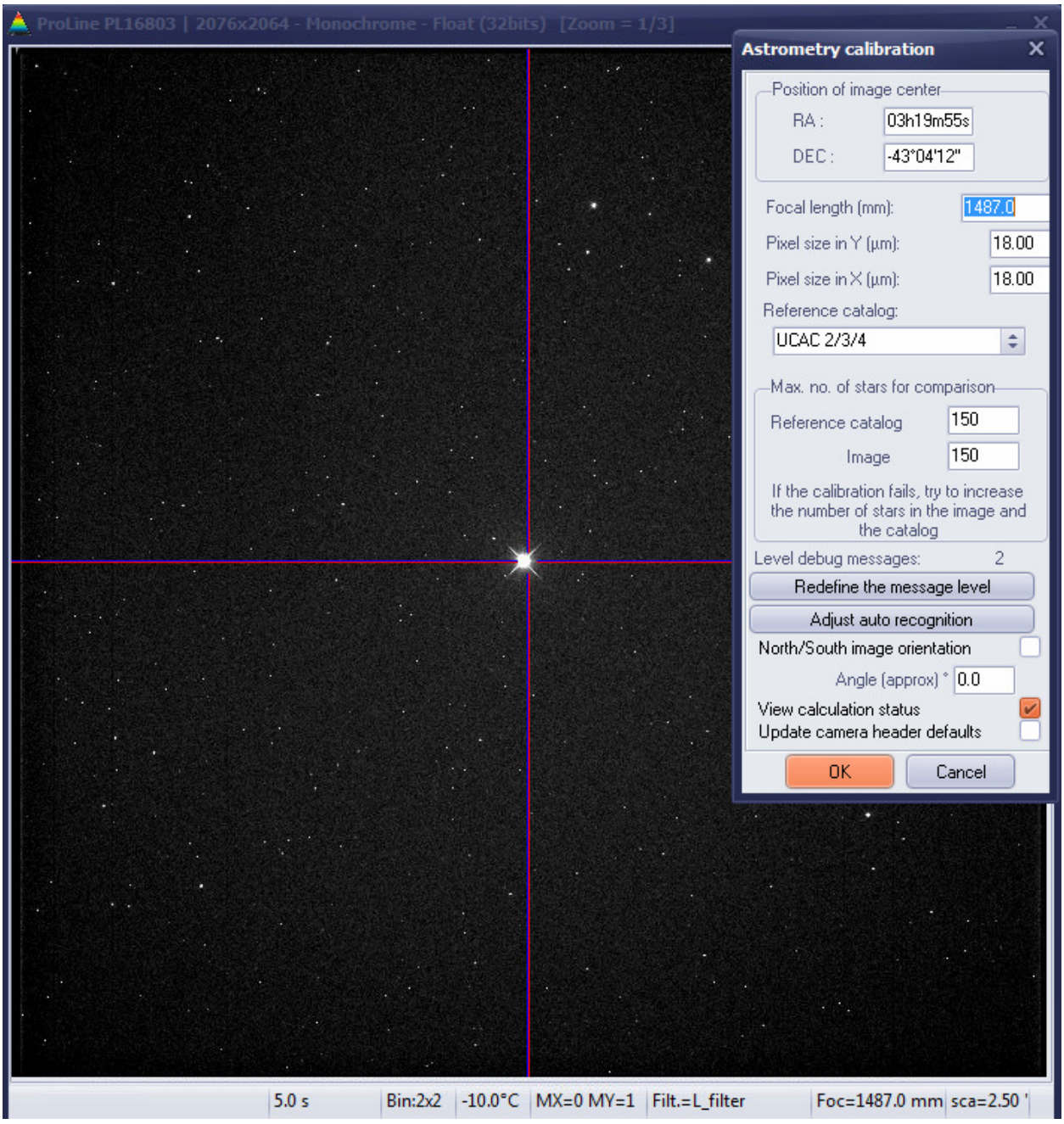
Then now select this menu:



This form sets the parameters to be used for automatic plate solving.

The RA/DEC comes from the telescope system and is embedded into the image's header. As well binned (or not) pixel size is included. The focal length comes from either from a previous plate solving or from the user when camera was set up.

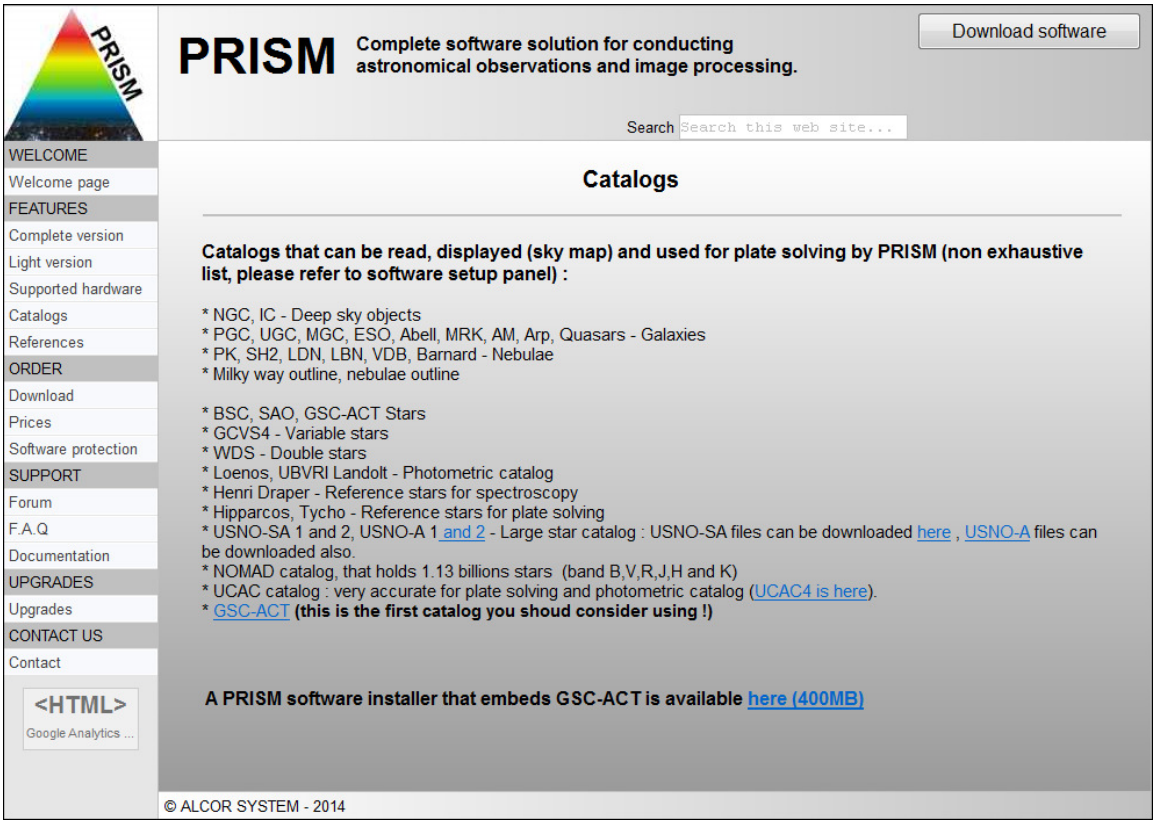
Do put a valid focal length (10% error is allowed). The catalog used for plate solving is important, use either GSC-ACT star catalog or UCAC 2/3/4 catalog.



These star catalogs are available for free on download here:

http://www.prism-astro.com/us/catalogs.html

UCAC 4 is recommended, but it works also well with GSC-ACT catalog.



When the "***OK***" button is pressed the software matches the star catalog and stars from the image and after some seconds the next form is displayed, saying that plate solving went fine.

104 stars have been found in this case. This is just a 10s exposure from a 400 mm F/3.5 telescope binned 2x2 image and turned out to be sufficient. In this case field of view is 1°25'

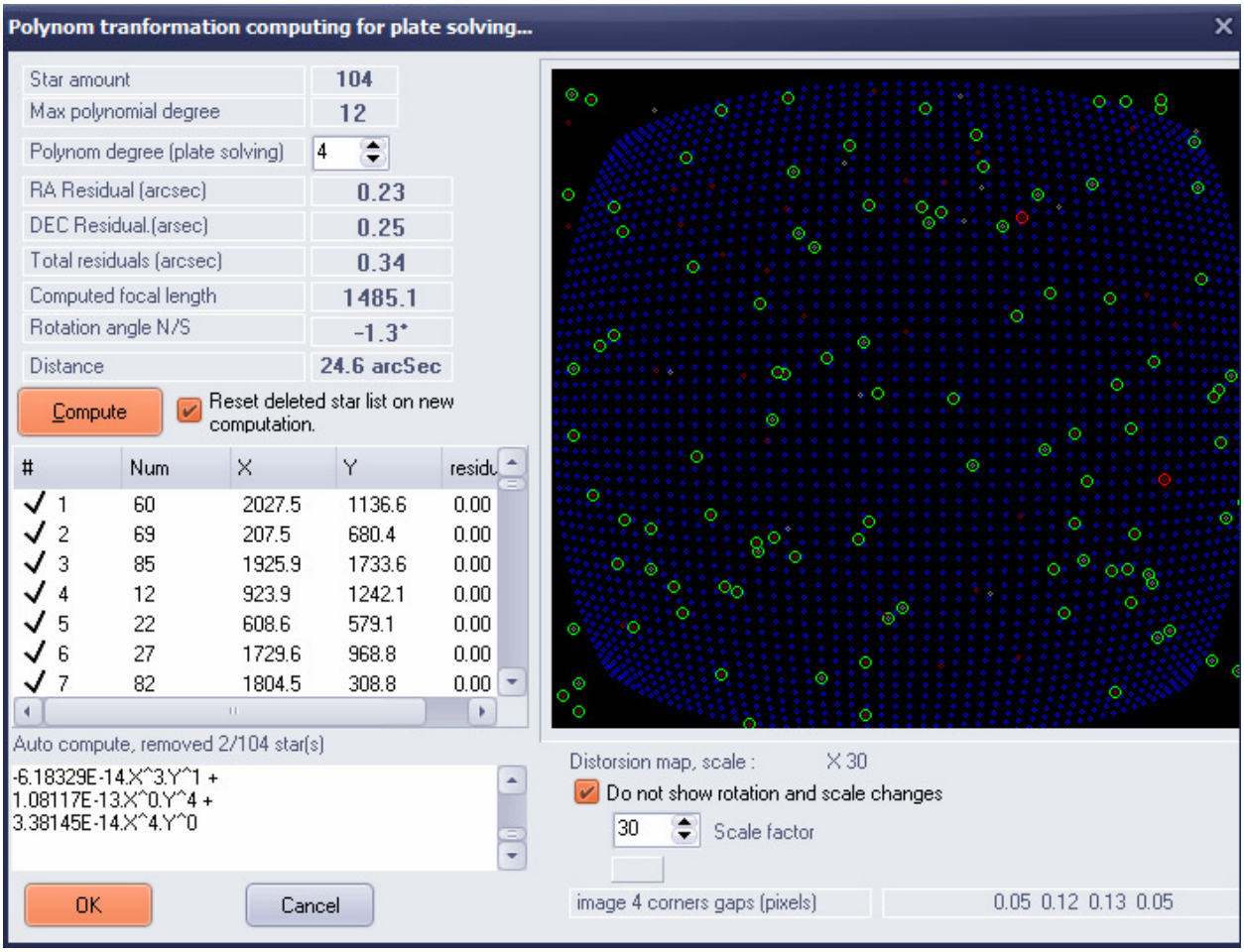
Select "***Polynomial degree (plate solving)***" from 2 to 4. Then click "***compute***". The image is calibrated and this has worked out fine in this case.

Sometime plate solving might not work, and here it a list and proposed solutions

Cause of failure	**Solution**
Focal length no set correctly	Change focal length, do trial and tests
The center coordinates are not good	Refine them; be sure to get the right one. They do not need to be accurate. All sky plate solving can help retrieving these coordinates
Star size (FWHM) too big. When star FWHM exceeds 15 to 20 pixels, it might not work.	Use binning to reduce star FWHM size. Be sure to be properly focused
Too few stars	Increase exposure time, or/and binning

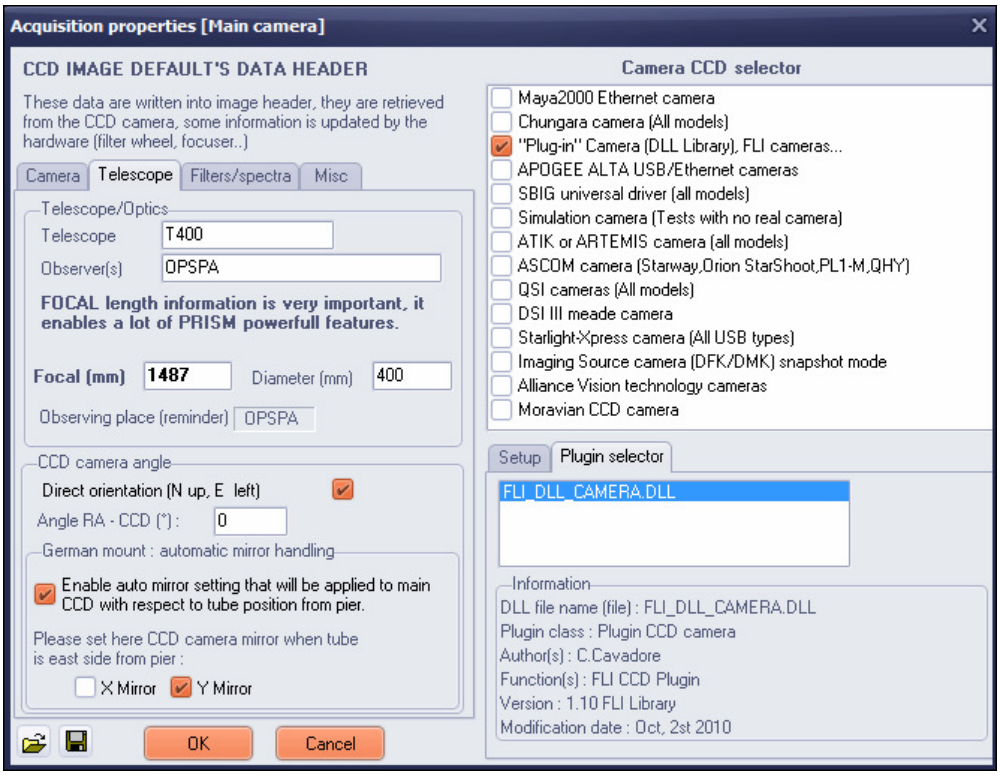
A combination of failures above will result in failure, they do not compensate, so go step by step.

Failure to achieve PRISM's plate solving will result in pointing model failure, so this is a mandatory step and need to work out!

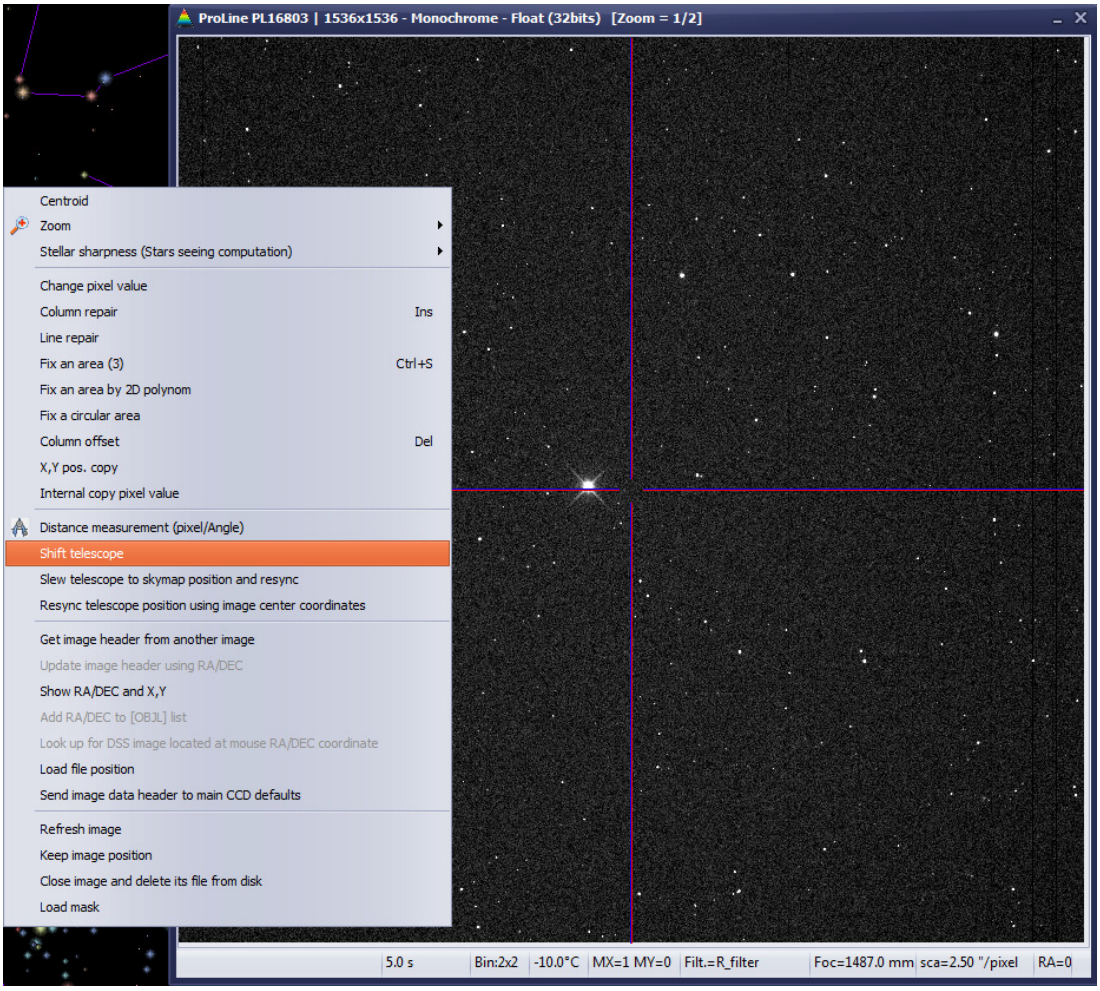


Focal length is being computed and is accurate to the mm.

If you go back into the camera setup form, the focal length can be updated. The camera orientation can be also been entered in this case, this has no function for achieving the pointing model, but can be convenient for other purposes.



This “other purpose” is to use telescope shift with the mouse. Left click over the image and then use “***Shift telescope***”



Then put the mouse where you want the star (or other object) to be inside the image, the telescope will slew so that the image is centered as you wish.

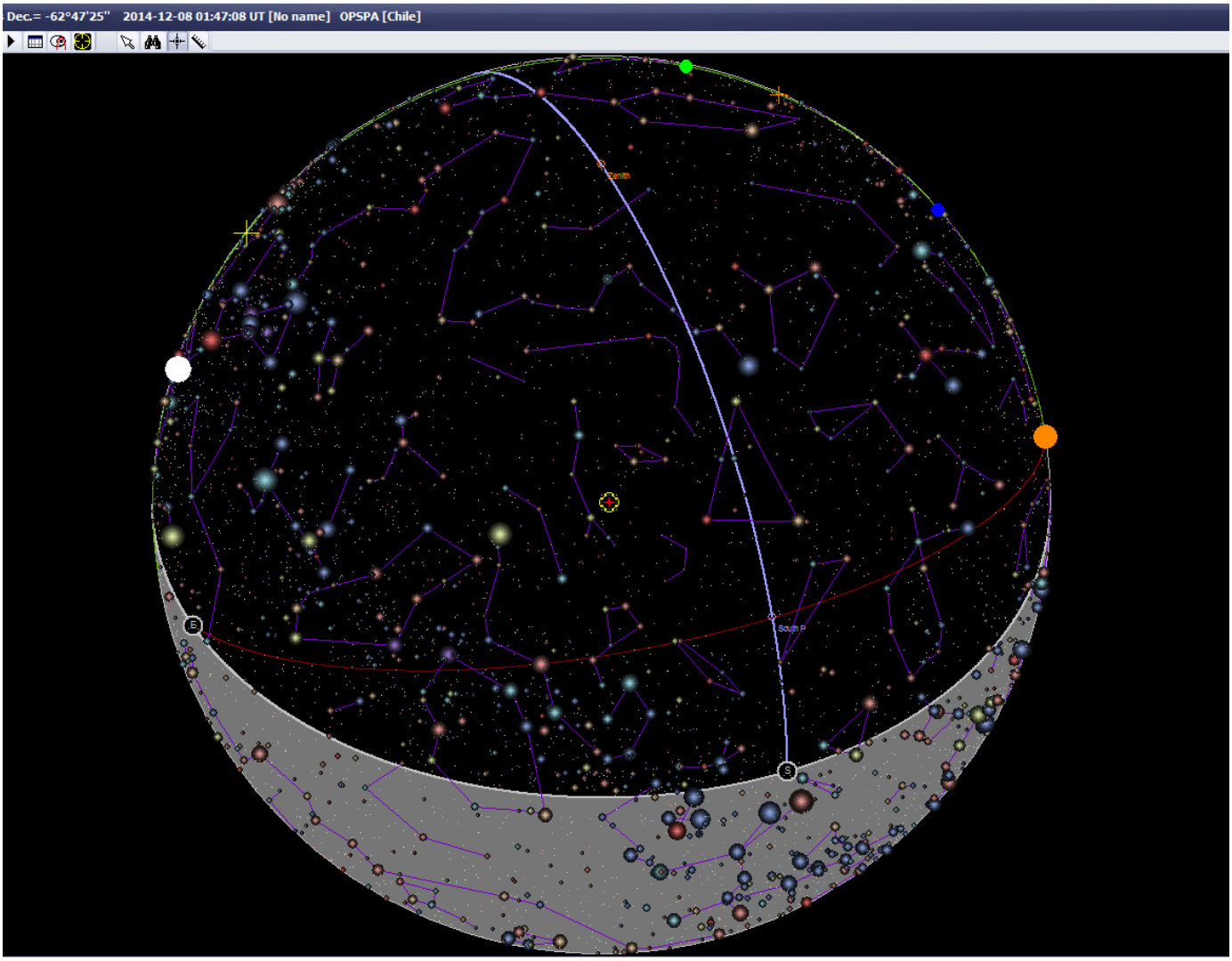
This not a mandatory step to make functional the pointing model, but is very useful.

Now, you are ready to create your first point model.

2.2.3. Calibrating the first field

2.3. Sweep the sky with fields, and build pointing model field list

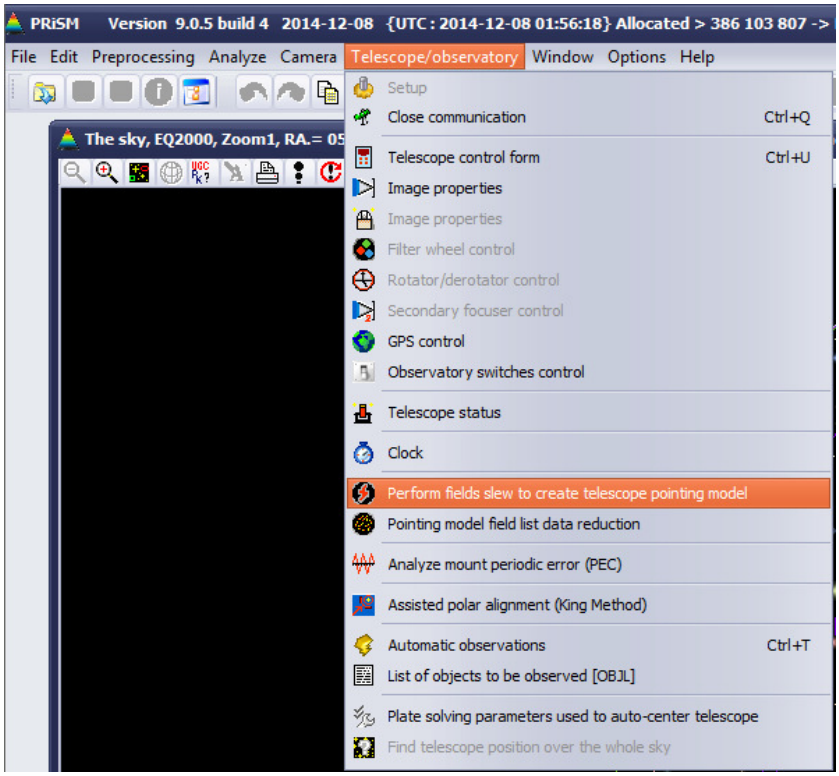
To build pointing model, the telescope needs to go throughout the sky. Instead of using a single star, the telescope moves to any field and computes plate solving with many stars present into this field. The amount of stars used can reach one hundred stars and leads to a far better positioning that he could be achieved with a single star. So there is no need to center to a single star used as reference and to select some.



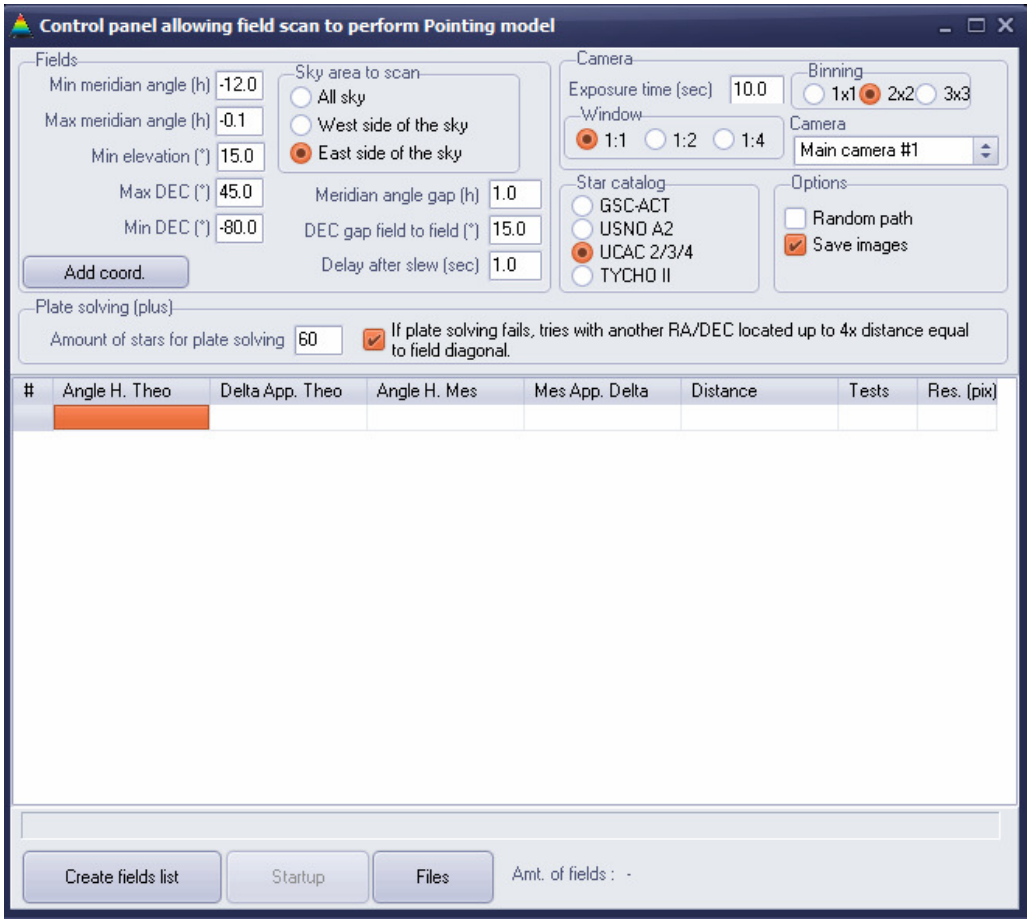
In this document a German mount will be assumed. The tube's side of pier is located Westside, meaning that the telescope is looking at the East side of the sky, thus meridian angle http://en.wikipedia.org/wiki/Hour_angle is from minus 12H to 0H.

PRISM embeds a feature that will allow sweeping across the sky, and allowing you to carry out the pointing model.

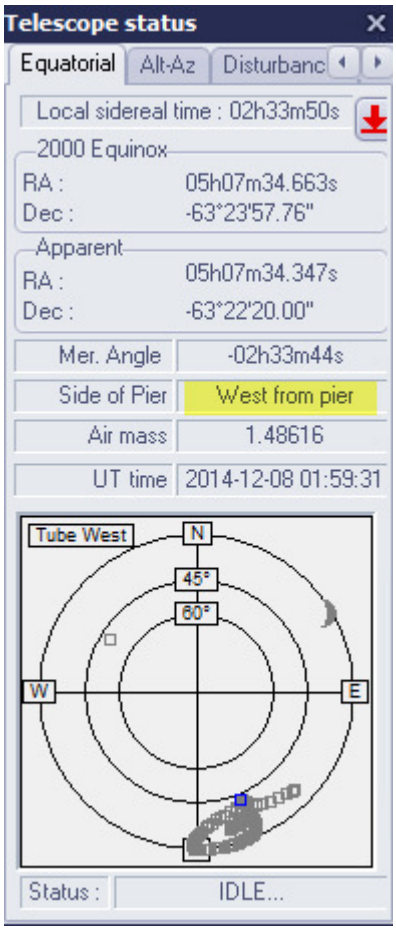
Click to this menu:



This form should appear, and is the control panel that will allow you to build the pointing model field list.



As said previously, the telescope is aiming to the east side of the sky, because telescope tube's is west from pier:



The idea is to have the telescope to scan this area with many fields, perform plate solving and create a list that contains the actual telescope position and theoretical (or expected) position. To obtain a good pointing model, this scan must have regularly sampled fields across the sky, and at least 20 fields (40 is better).

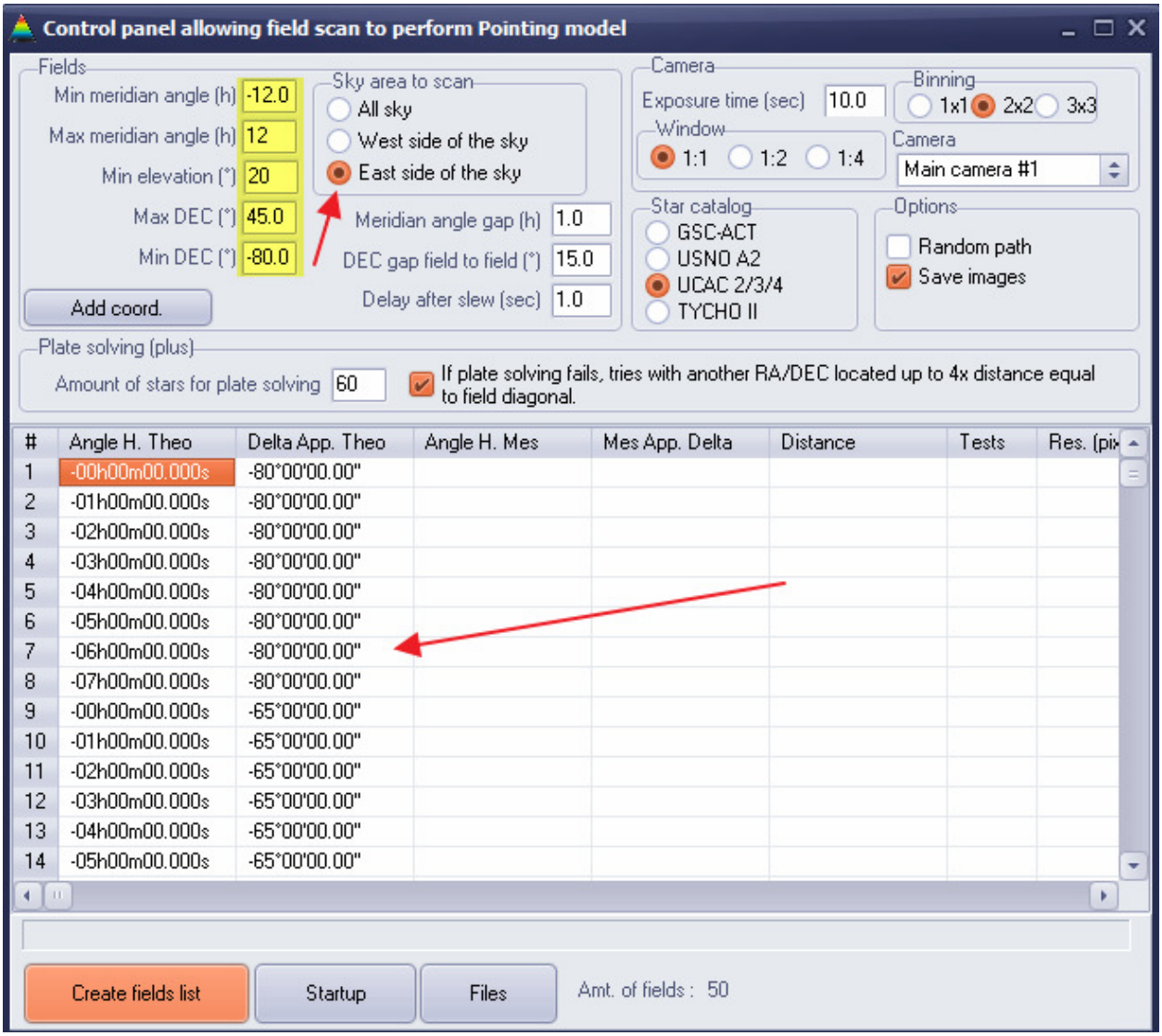
In the next sample, the fields are selected by PRISM so that meridian angle gap between fields will be set to 1h, the DEC gap to 15°. All fields shall be at least 20° elevation above horizon. Since in this sample, southern hemisphere location mount is used, the min DEC is set to -80° and max DEC to +45°. If northern hemisphere, say in the USA, theses figures would be from DEC=-20° to +80°.

Meridian angle (or hour angle) can be from -12H to +12H, and since the "***East side of the Sky***" checkbox is checked, the software will only select fields that are in this location and nowhere else, so that meridian flip of the mount will not occur during this step.

Then click "***Create field list***", the software will then build a list of field to be scanned.

In this case, 50 fields have been selected, not randomly but using a regular pattern of 15° in DEC direction and 1h in RA direction.
Then select 10s of exposure, full frame, using 2x2 binning (here this is a 4096x4096 CCD used).

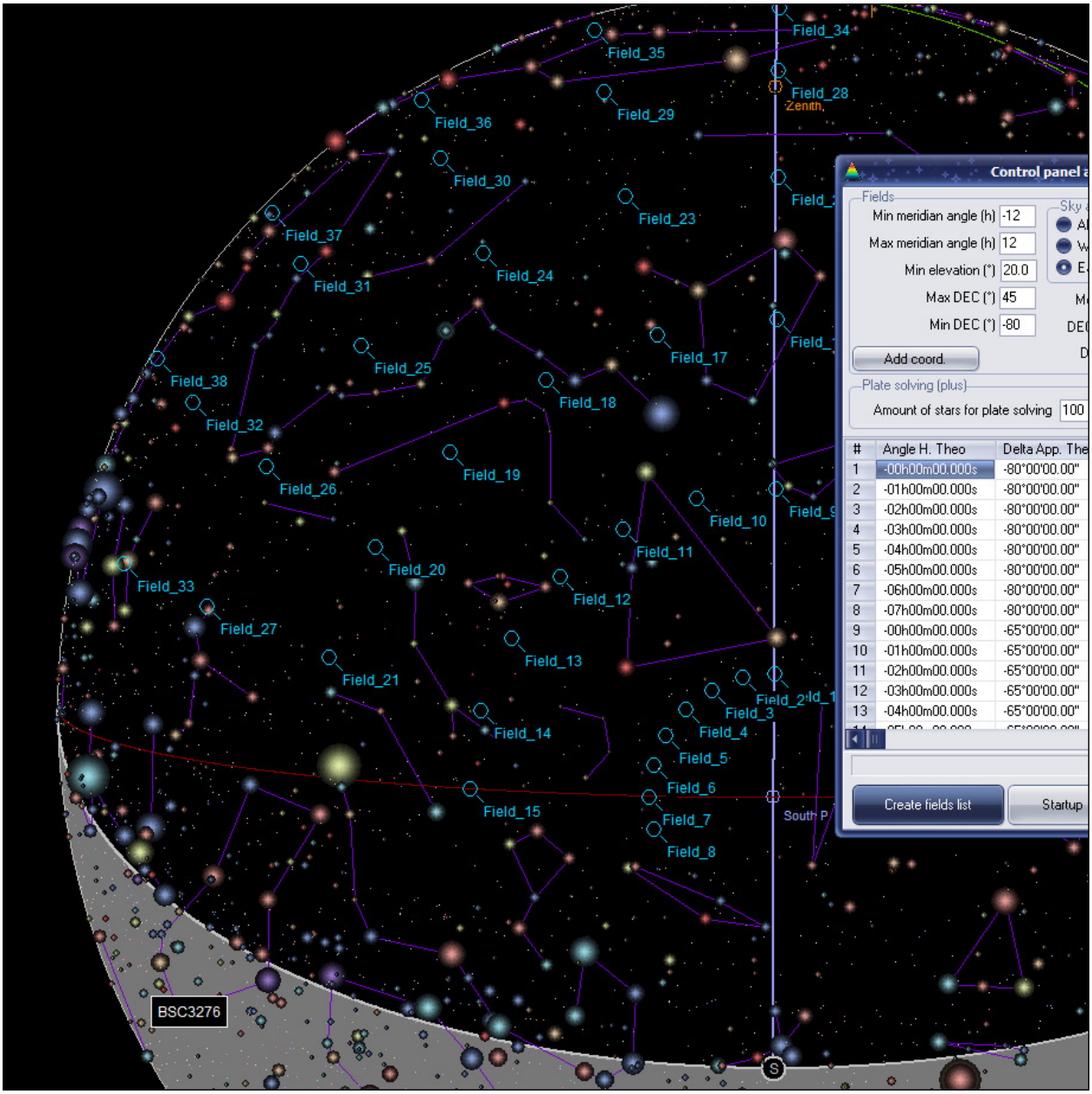
Check also "***If plate solving fails, tries ….***" This will allow the software to perform plate solving into neighborhood locations in case it would fail in the center field. This can happen when the mount is really not well polar aligned or optical axis and DEC axis errors exceeds more than 30' (indeed has poor pointing performance).



If full moon is present (or near to be full) use a red filter, this will help a lot and will avoid getting plate solving failures when located near to the Moon.

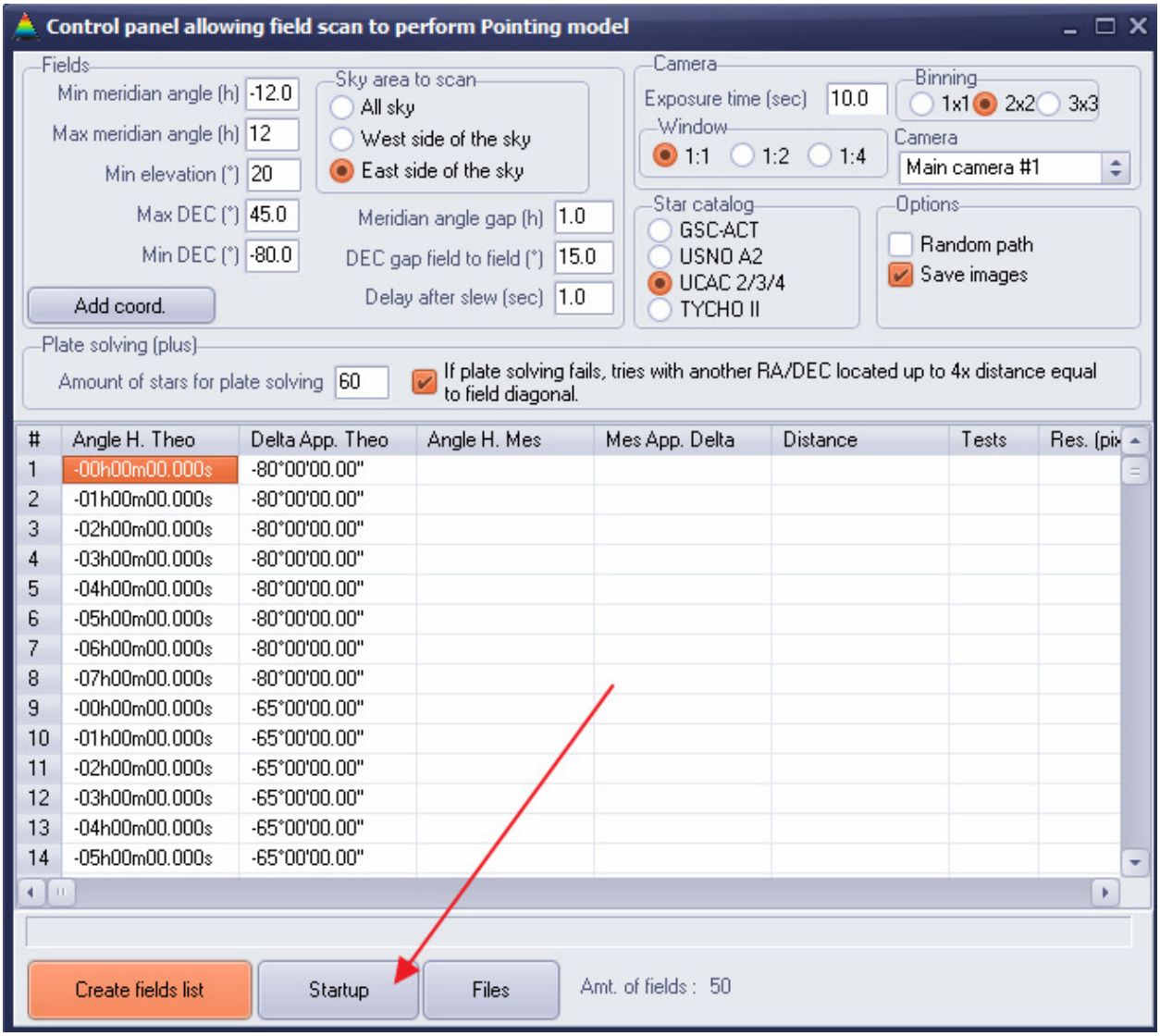
The sky map is populated with blue dots, with corresponding field's number.

There are many more fields nearby the pole because meridian lines distances are getting closer (because distance is divided by cosine of DEC).

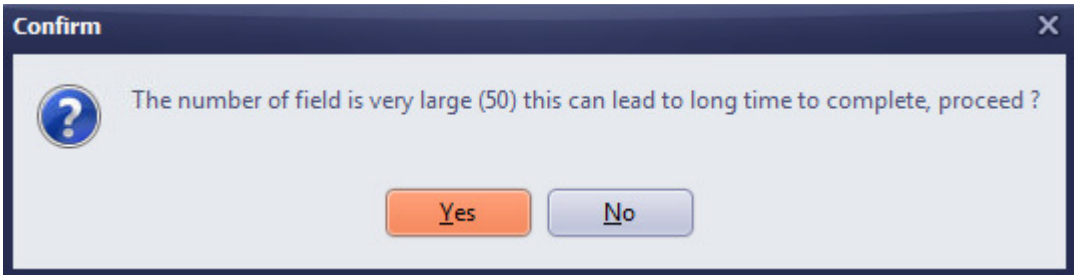


Ensure that the half of the sky is well populated with fields, and distribution is uniform. In case of fork mount a single all sky sweep is sufficient, since those kind of mount does not perform any meridian flip.

Then press "***Startup***", and the telescope will slew toward all the 50 fields, one after the other, and will perform plate solving for each.



This message may appear, click "***Yes***". When using a direct drive mount such as NOVA mount, it will take around 25 to 35 minutes to complete this process (using I-Core I7 PC).

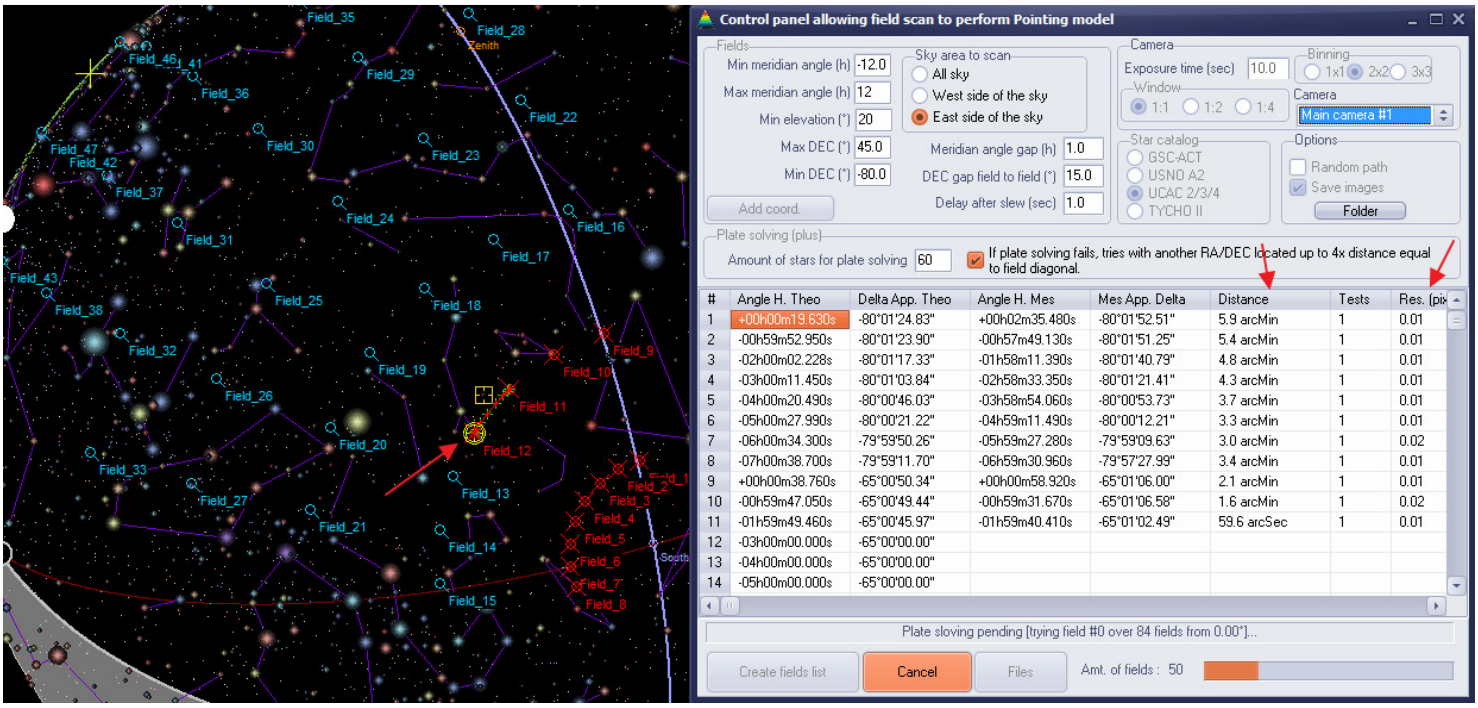


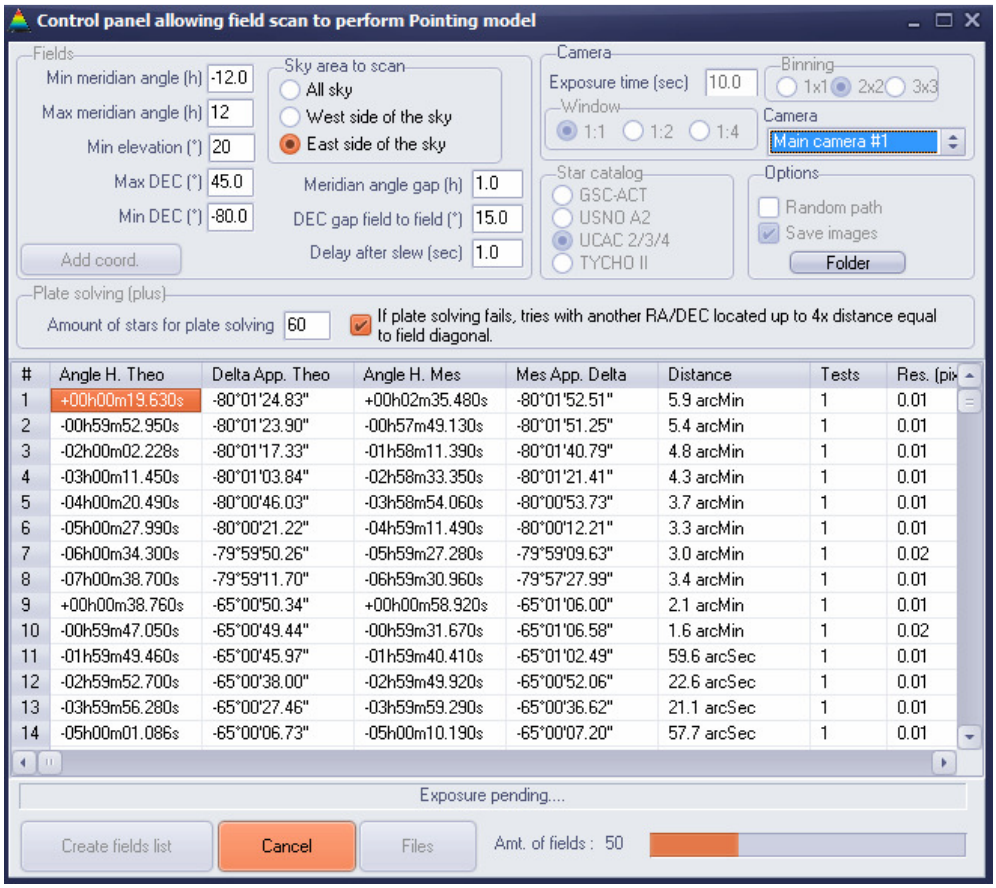
When a field is completed, the sky map label turns into red, actual and expected coordinates are filled, as well as distance from actual to expected position.

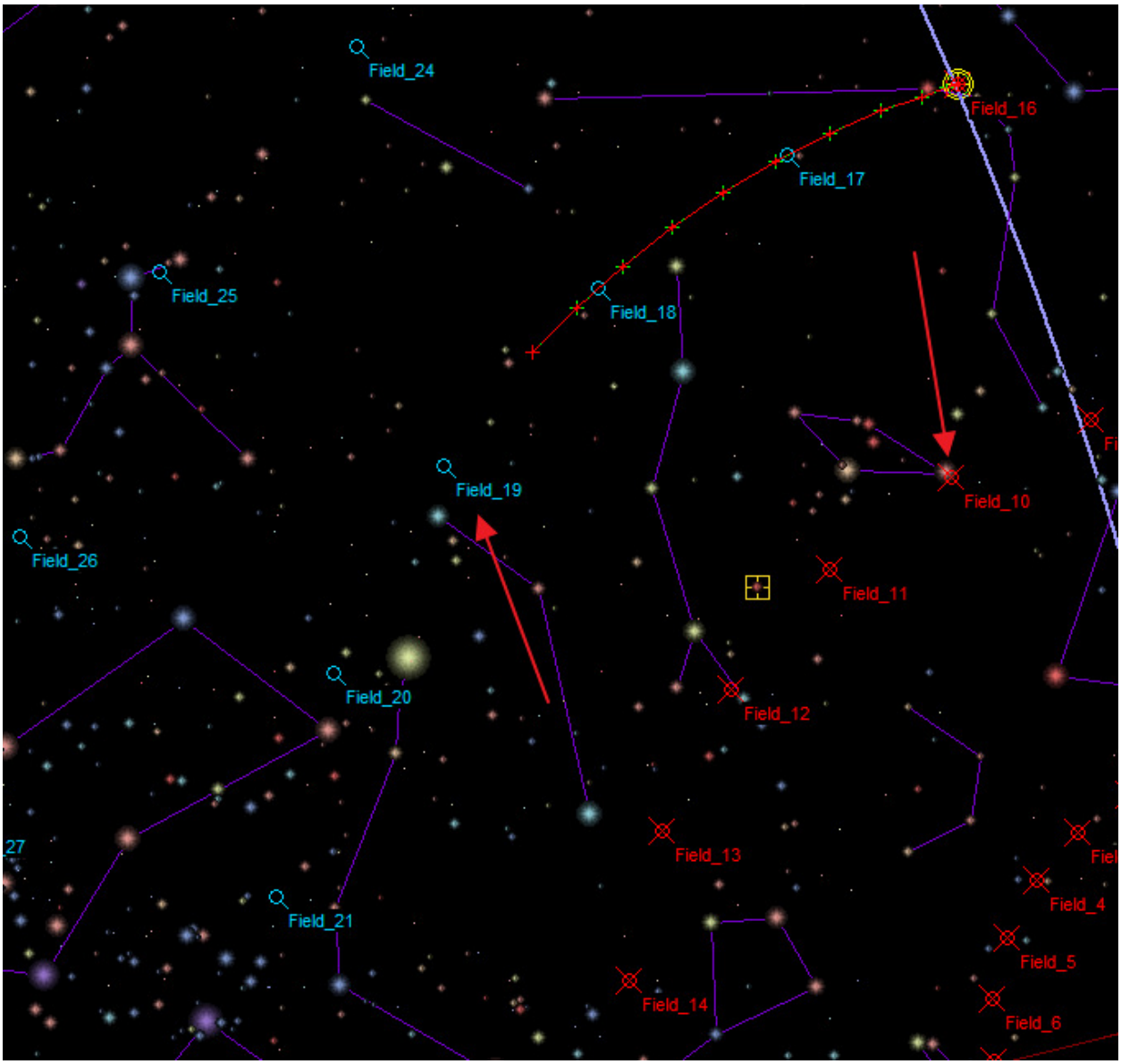
For instance, field #1, error distance is 5.9 arcmin, it found plate solving after 1 trial (***Tests*** column), and plate solving residual are just 0.01 pixel.

If plate solving fails, the error is reported in the list, this field will not be used to build the pointing model file and telescope slews to the next field.

This can happen if the field is too close to the moon or if clouds are present in this location.



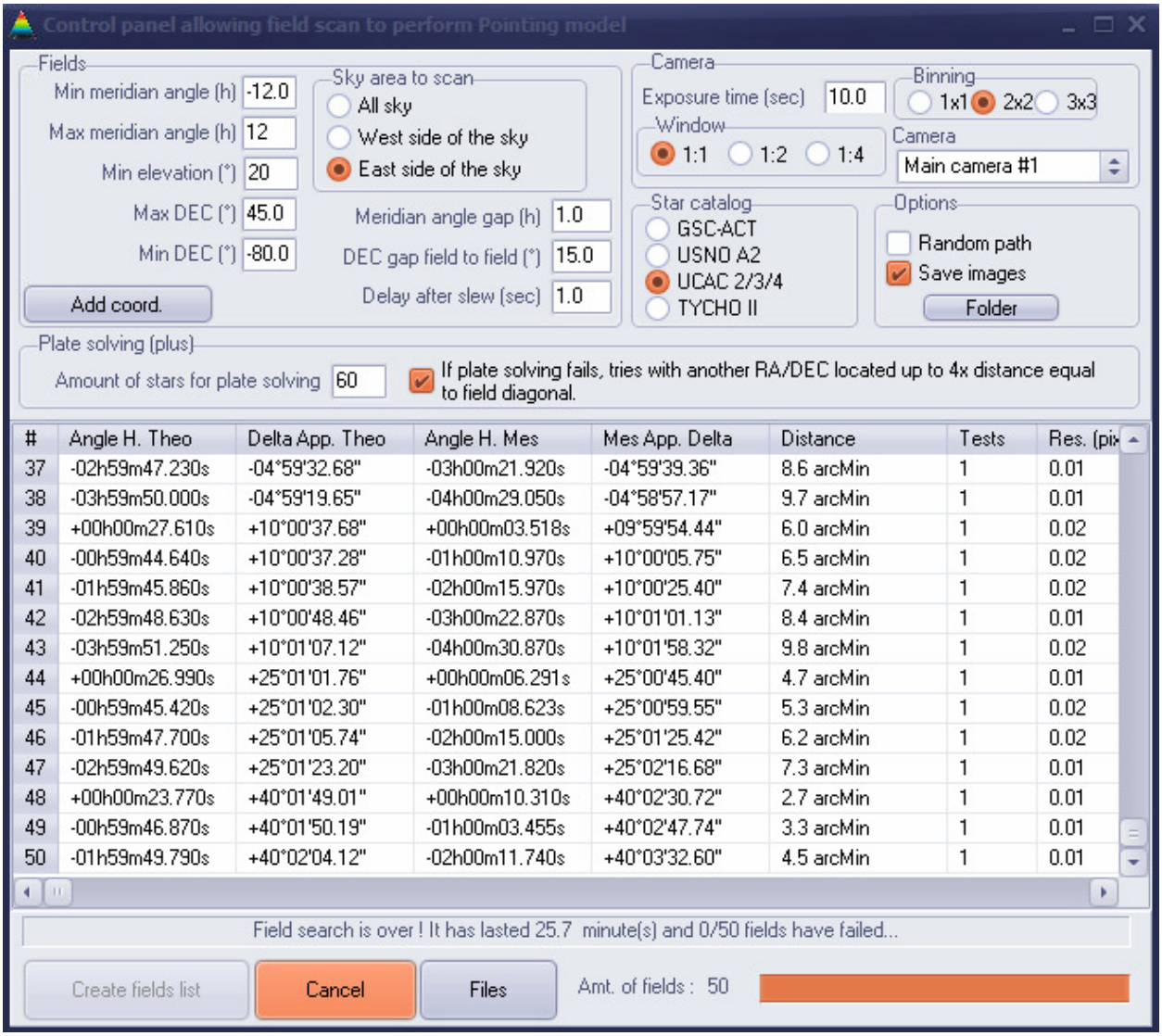




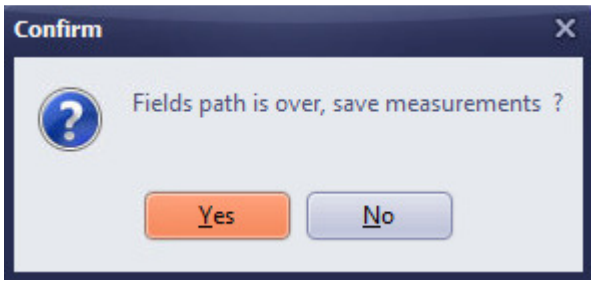
The picture above shows that 15 fields have been completed and the telescope is slewing to the 16th.

Important: mount meridian flip should never occur during this process! Otherwise pointing model will not be valid.

Just watch from time to time that the process goes well, and during it you can have a cup of coffee, and let it running.



When the whole process has completed (50 fields swept), this message appears:



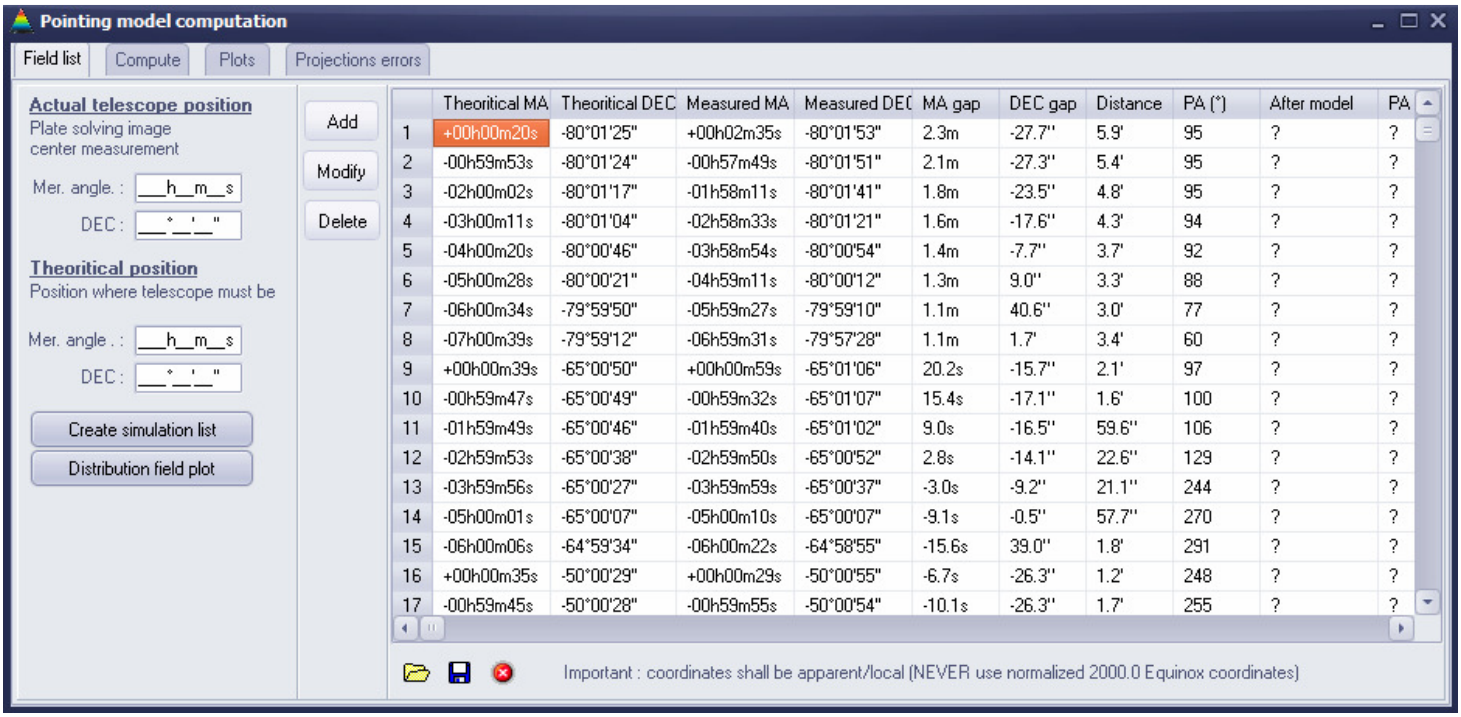
Click "***Yes***" and a save dialog form will show up. The list of actual and expected coordinates has to be save into a text file

Save the file as for instance as "***StarFieldWest_sideofPier***"

Note that, in this case, none of the fields returned plate solving failed, if you have 5% to 10% field failed, in random fashion, this will little impact. Nevertheless, it those failed fields are located at the same place of the sky; this is not good and can lead to poor pointing model.
Investigate the cause of these failures and try to solve them.

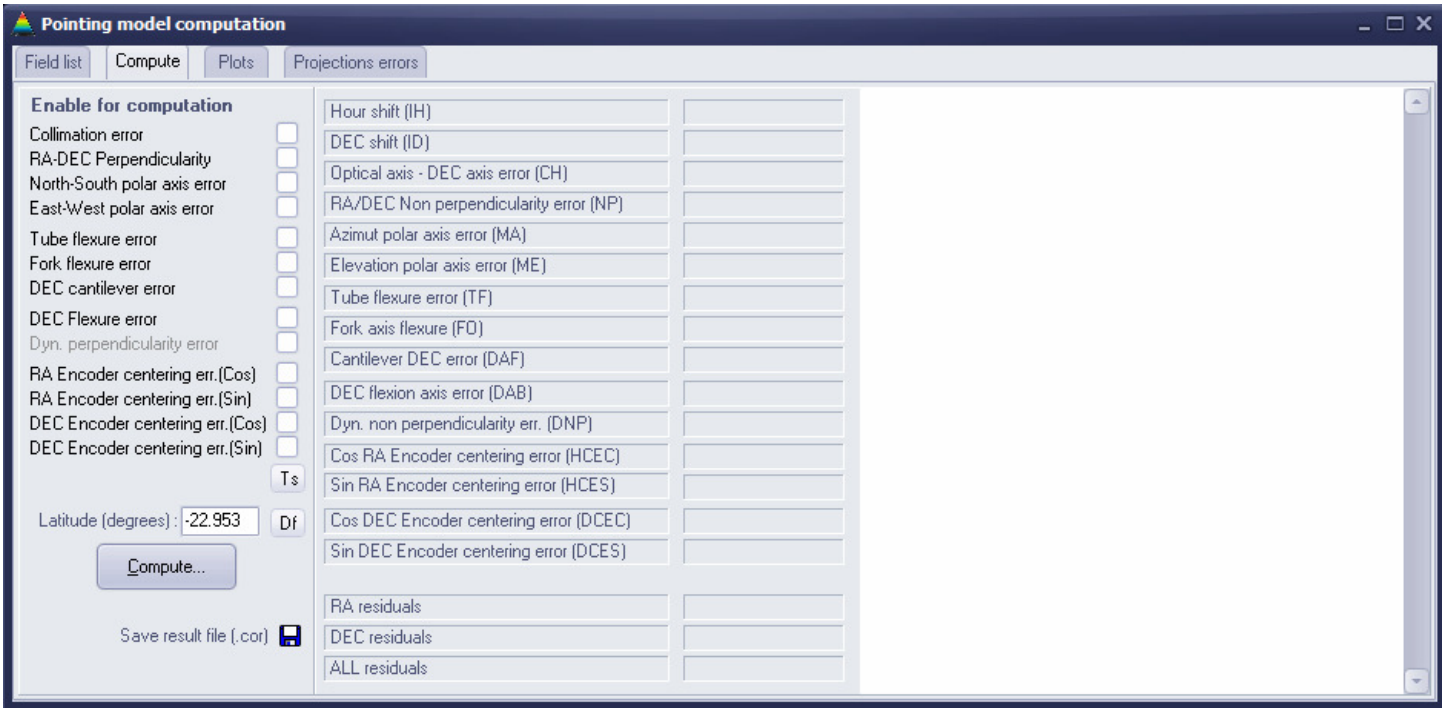
Since all the images of the different field have been saved, the images can be inspected later to understand the cause of failure.

After field list coordinates have been saved, this form appears, and will allow you to build the pointing model file.



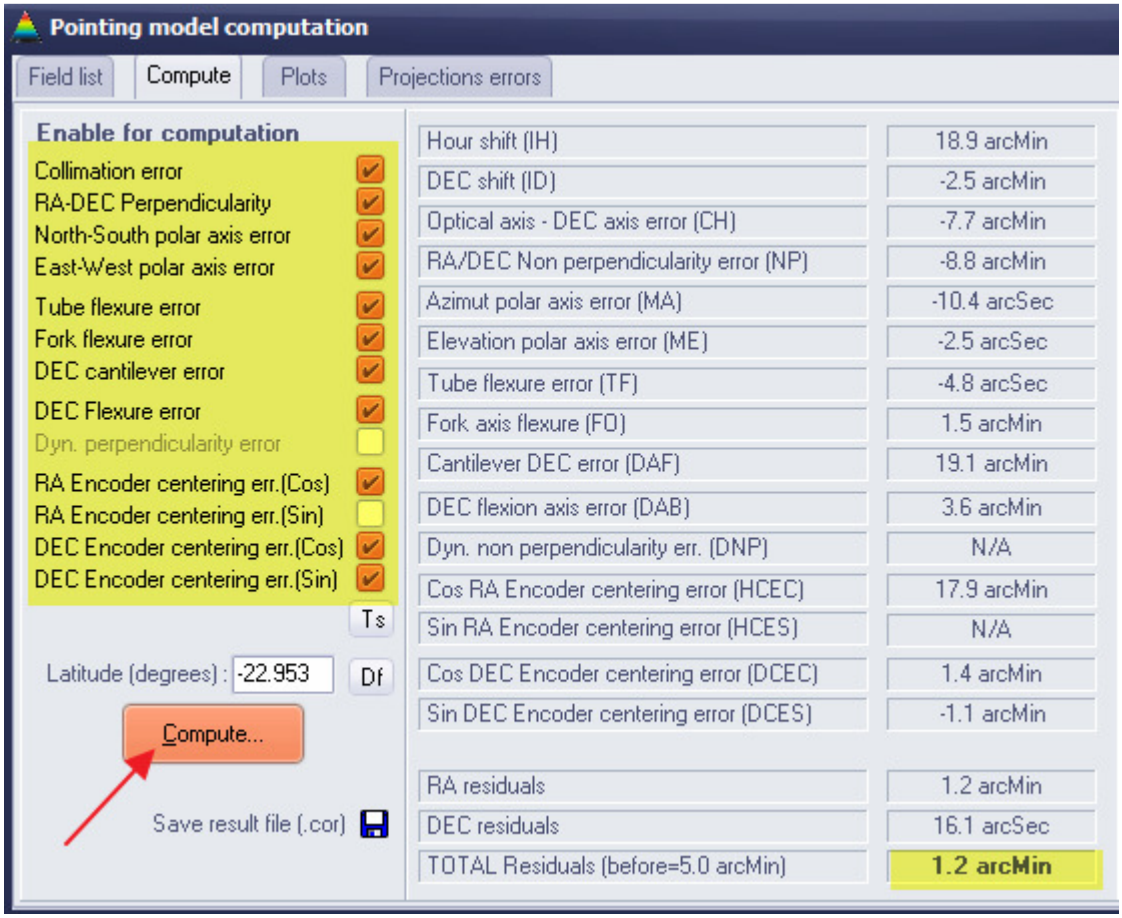
The same list is displayed: expected/theoretical positions and actual/measured positions.

This is “observed place” coordinates system. Then click to “***Compute***” tab.



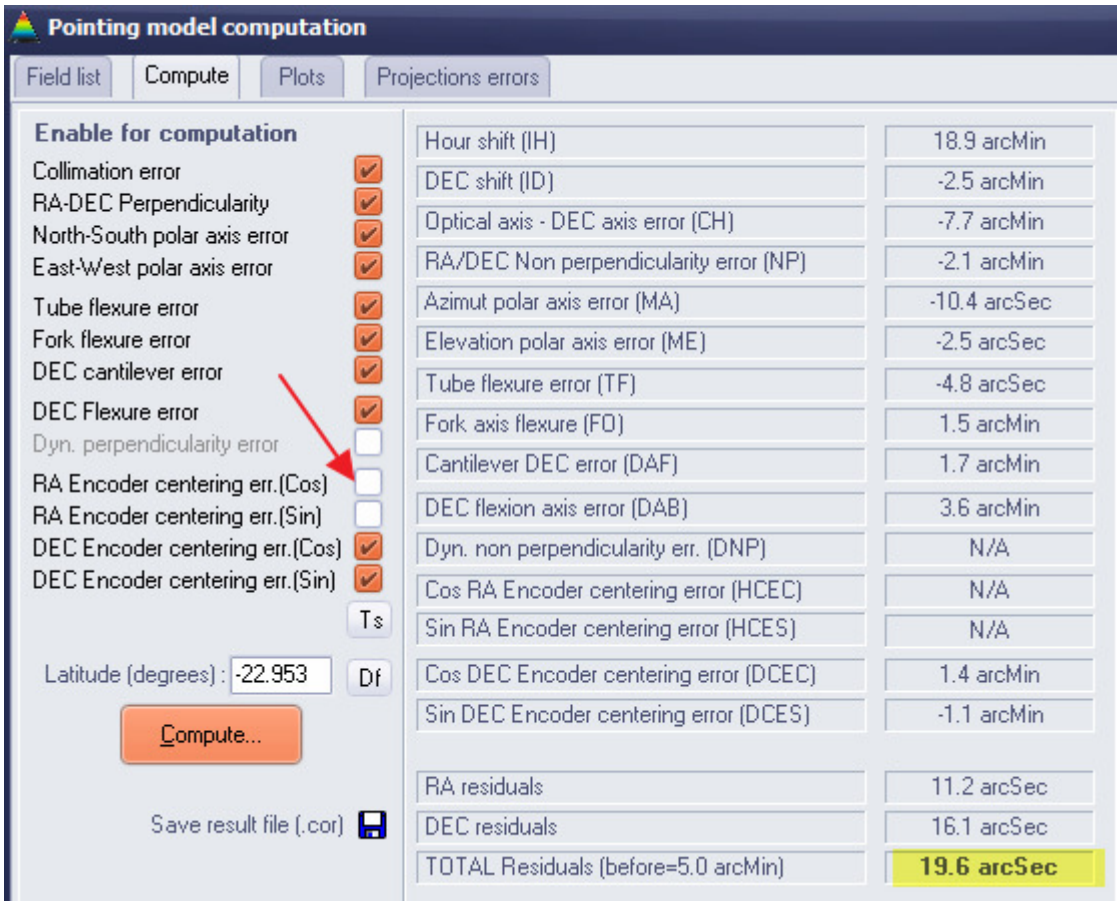
Then enable all mount errors, and click "***Compute***" The fit error is displayed right bottom and shows that 1.2 arcmin error is achieved by fitting to all fields. The previous RMS error with no pointing model is 5.0 arcmin.

There is some improvement, but better can be obtained.

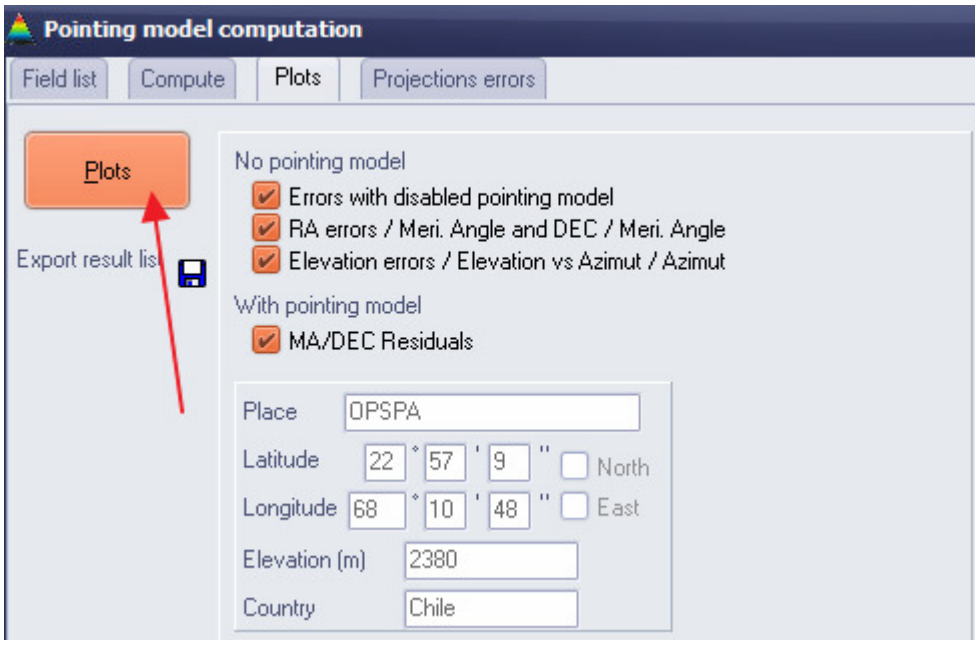


Do some try and test by checking and unchecking mount errors (checkboxes), and the press "***Compute***" to evaluate the result.

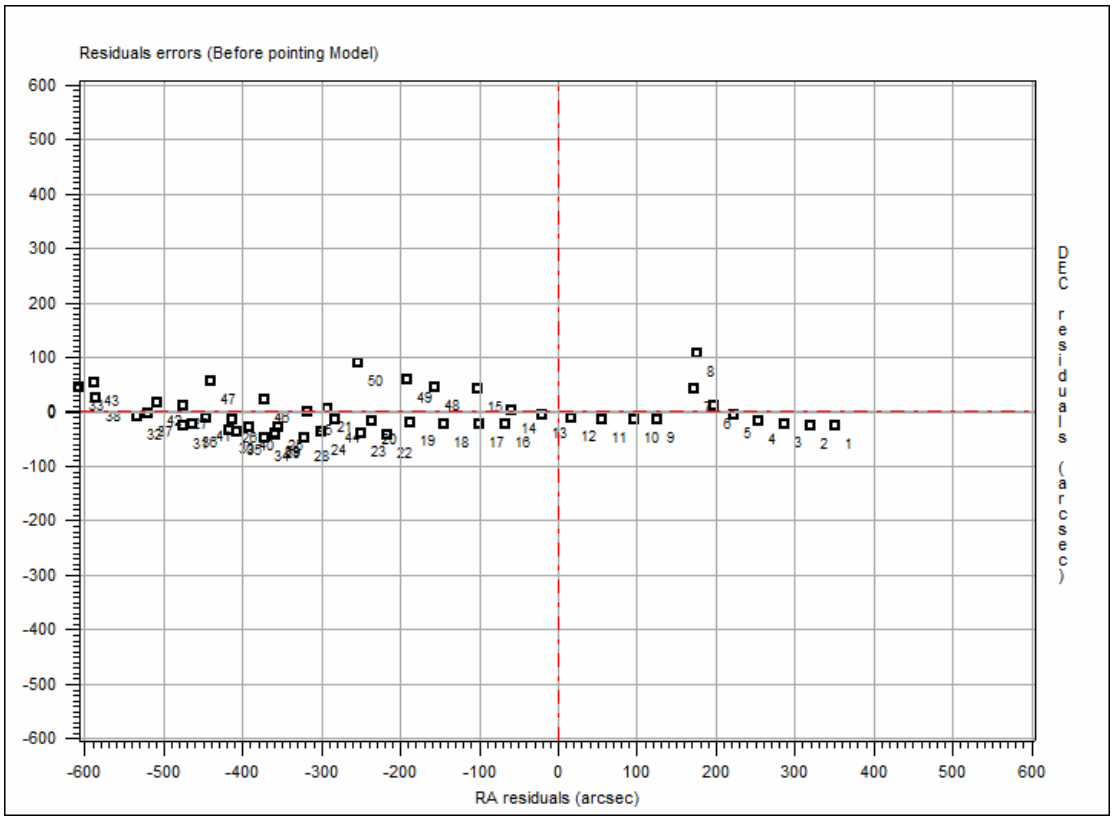
19.6 arcsec RMS error is been now achieved, using this set of enables / disables. This is a very good performance, because the RMS pointing error has been reduced from 5 arcmin (600 arcsec) down to 19.6 arcsec which is a ratio of **30.6** fold!



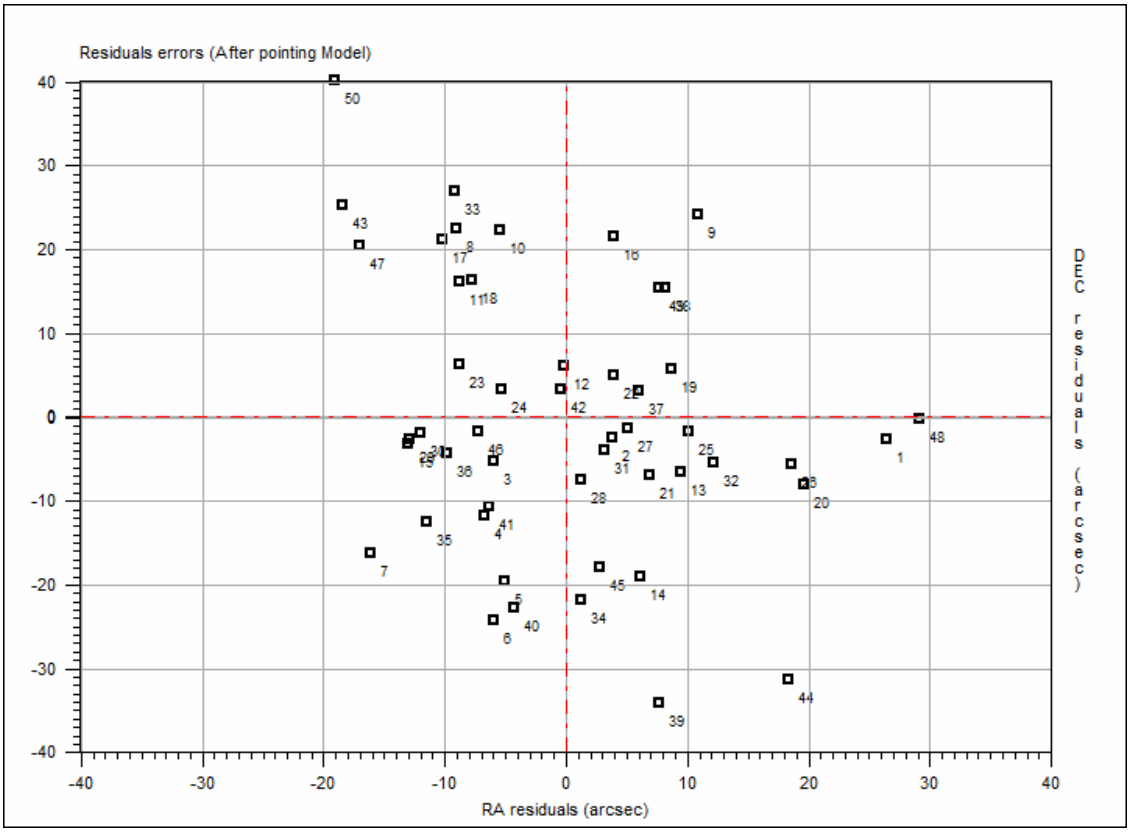
In the "***Plots***" tab, various errors can be plotted.



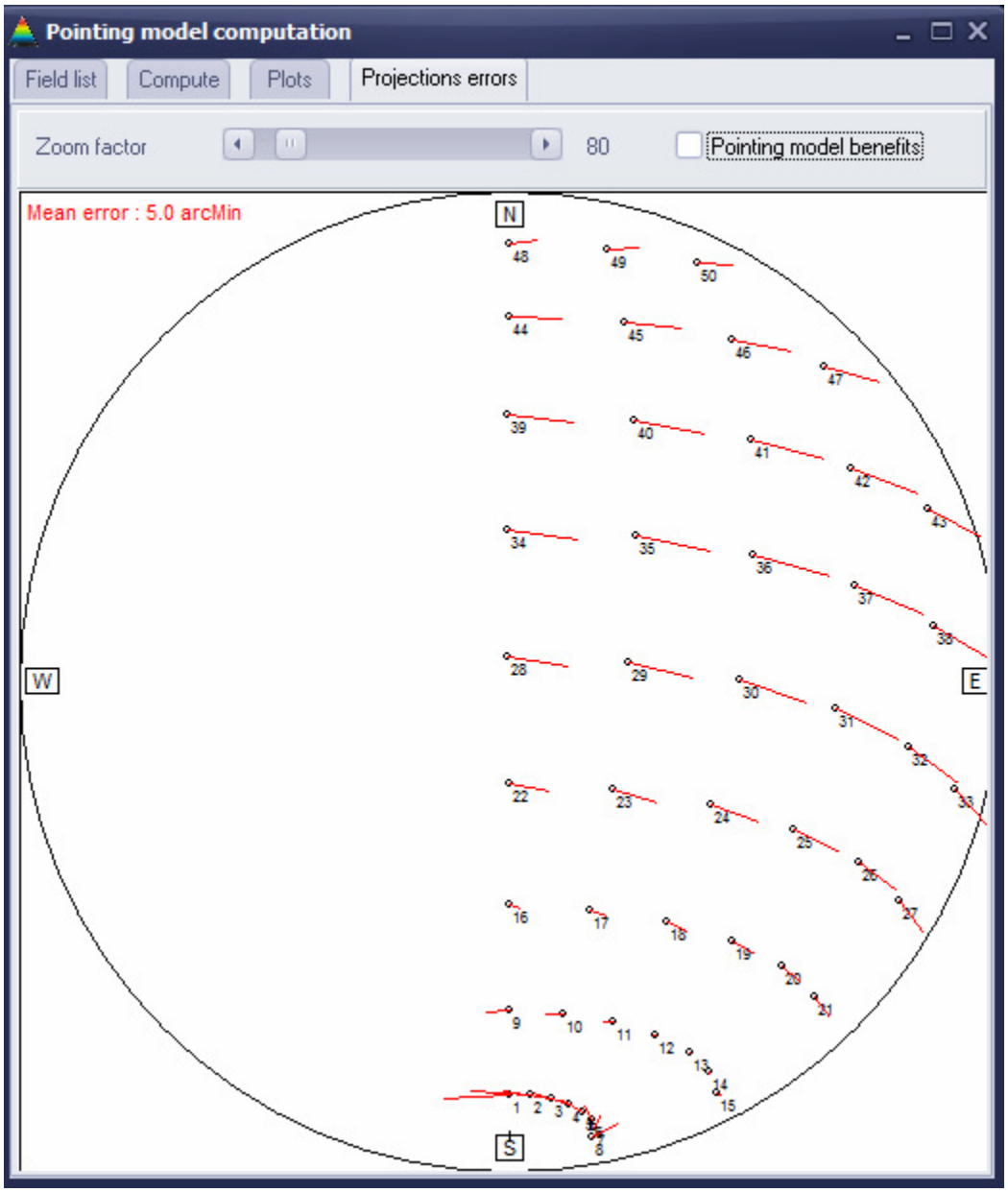
The residuals point errors before and after the pointing model is really interesting. Here is after before, where point are really spread.



The “after pointing model” residual shows that the position error for each field is random. It has been reduced by 30x and can fit a RA -20 / +20 arcsec and DEC -40 / +40 arcsec box!

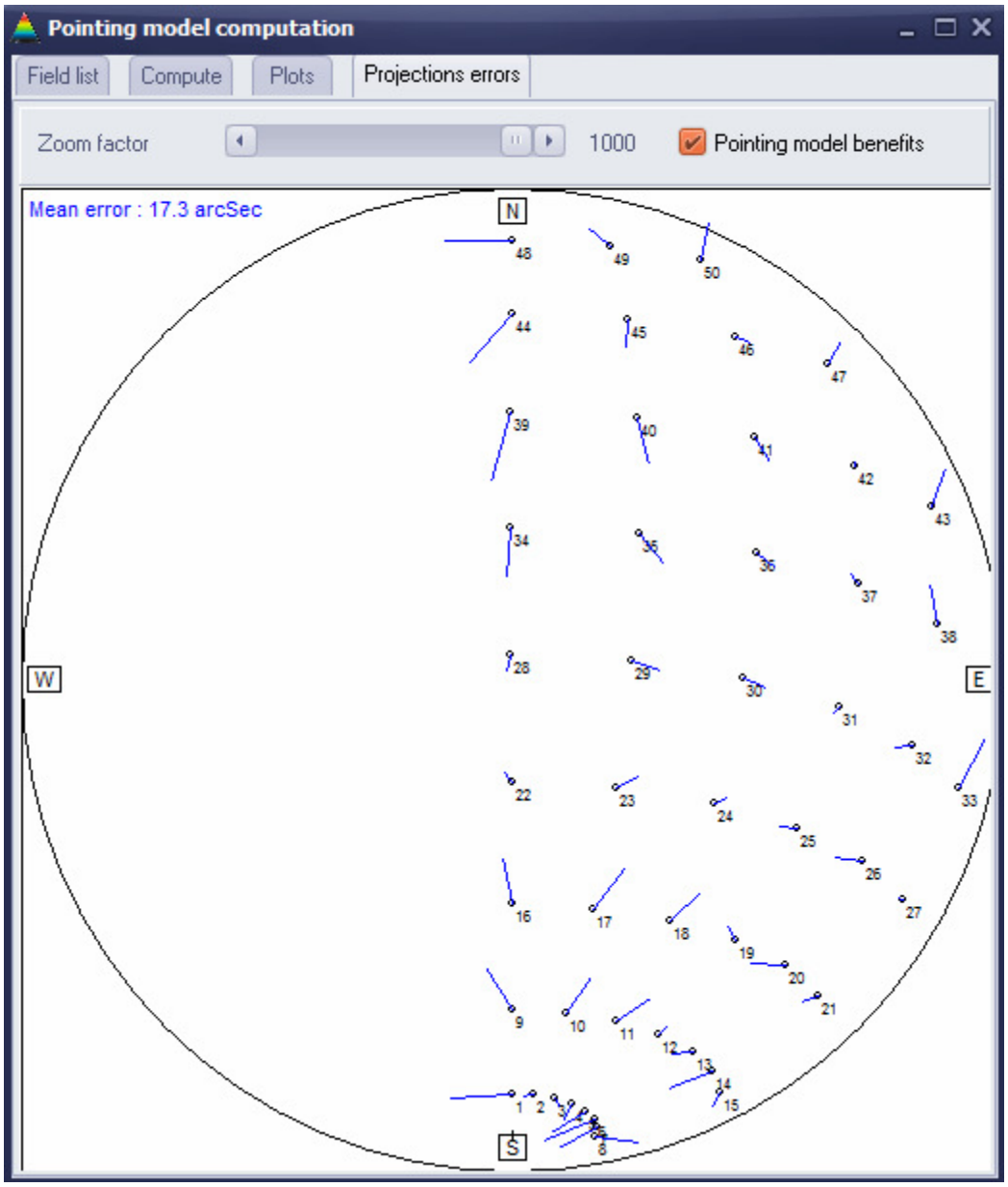


Even more impressive is the “***Projection errors***” tab showing errors before and after pointing model



Use horizontal slide bar to zoom into error for each field, and check/uncheck "***Pointing model benefits***".

In this example, the improvement is rather impressive. Also the error vector is random, meaning that the pointing model fitting is rather suitable.



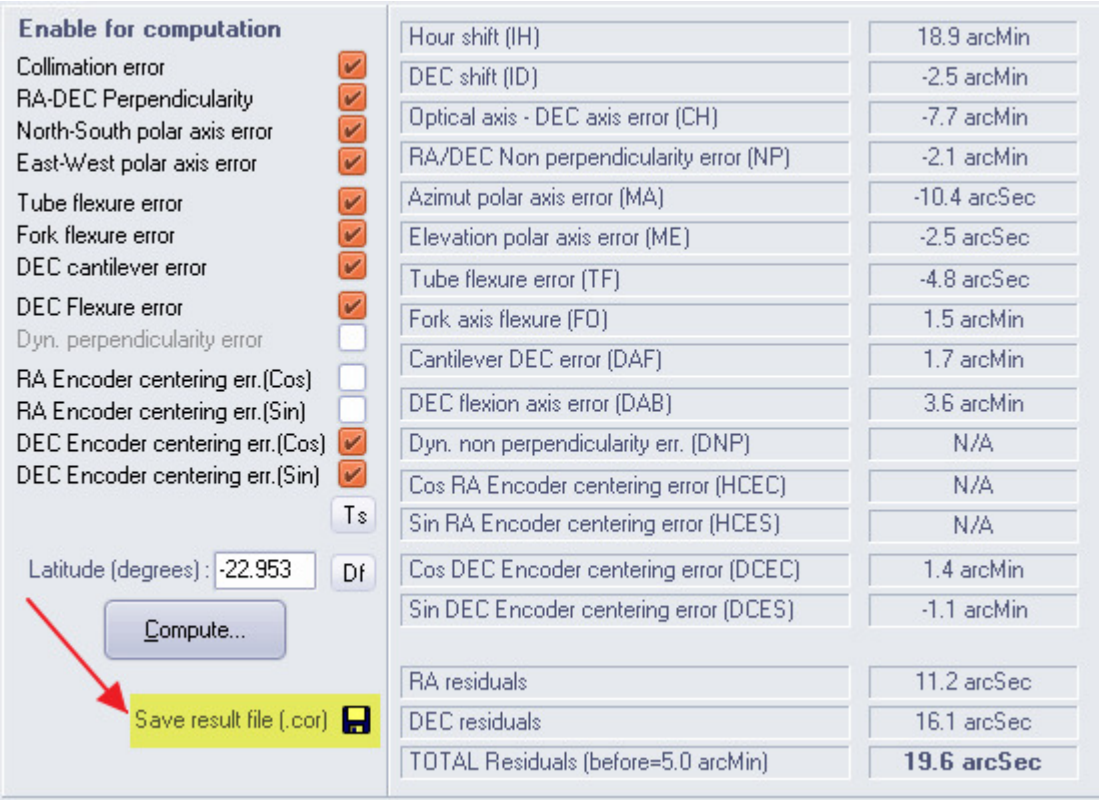
The pointing model can be regarded as valid and will be saved in to a text file (that internal description is given into §1)

Click "***Save result file (.cor)***", a save dialog appears.

Any name can be used, but a meaningful name is recommended such as:

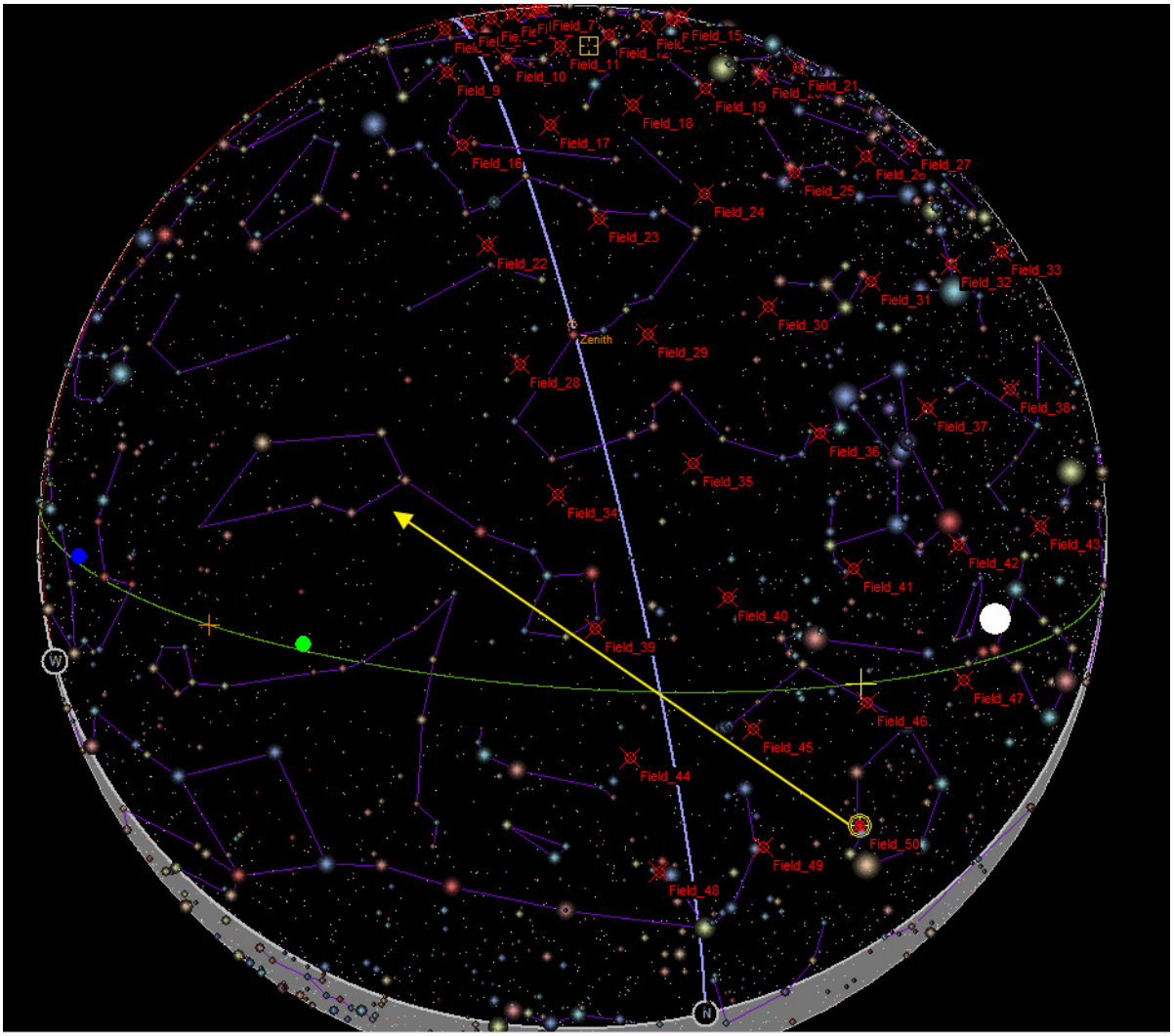
TubeWestPier-10-10-14.cor

We recommend putting into the file name the side of the tube used for building this model. Later, the explanation of this trick will be described.

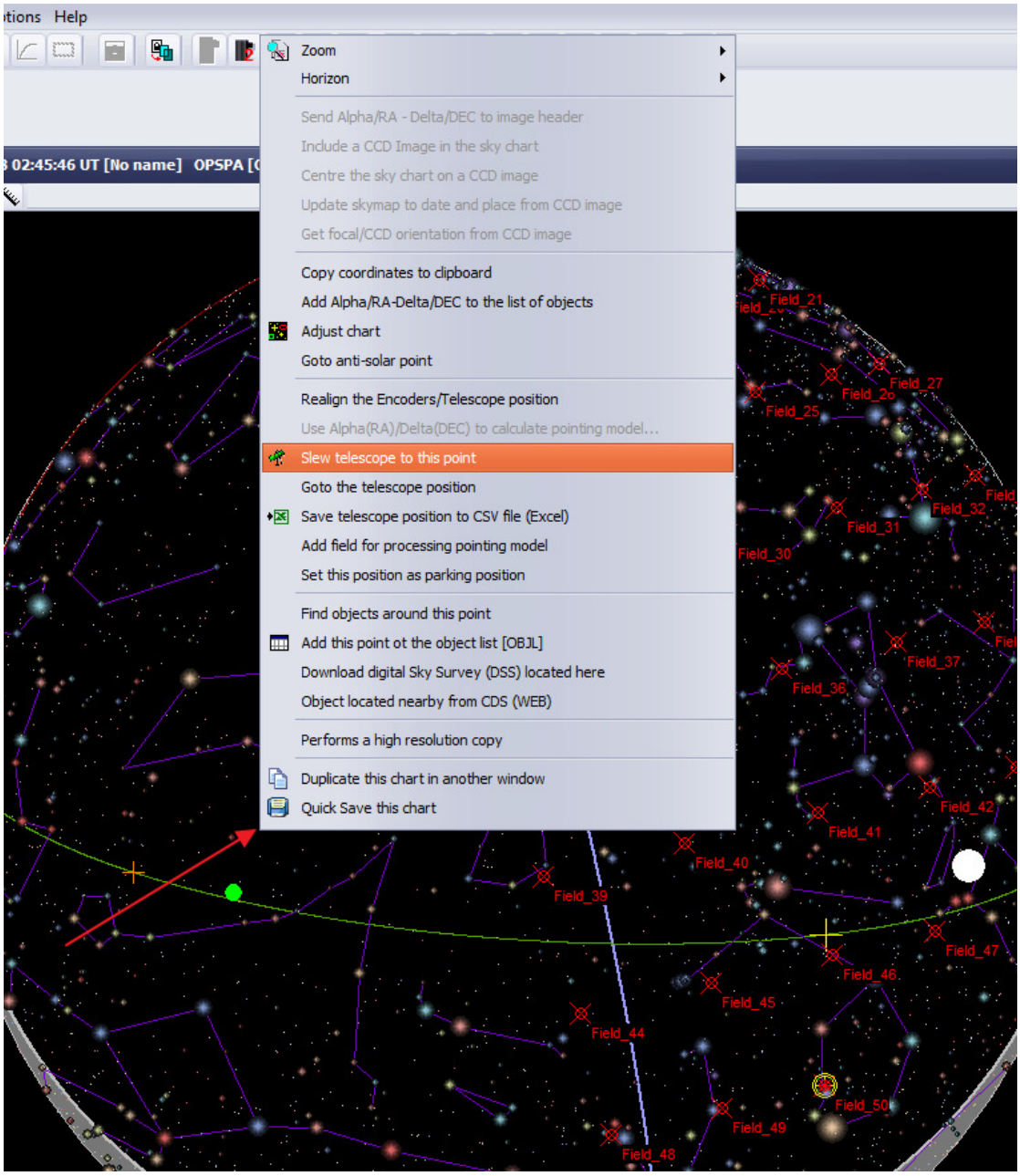


Then this form can be closed. Do not close the form that controls the recording / sweeping of fields.

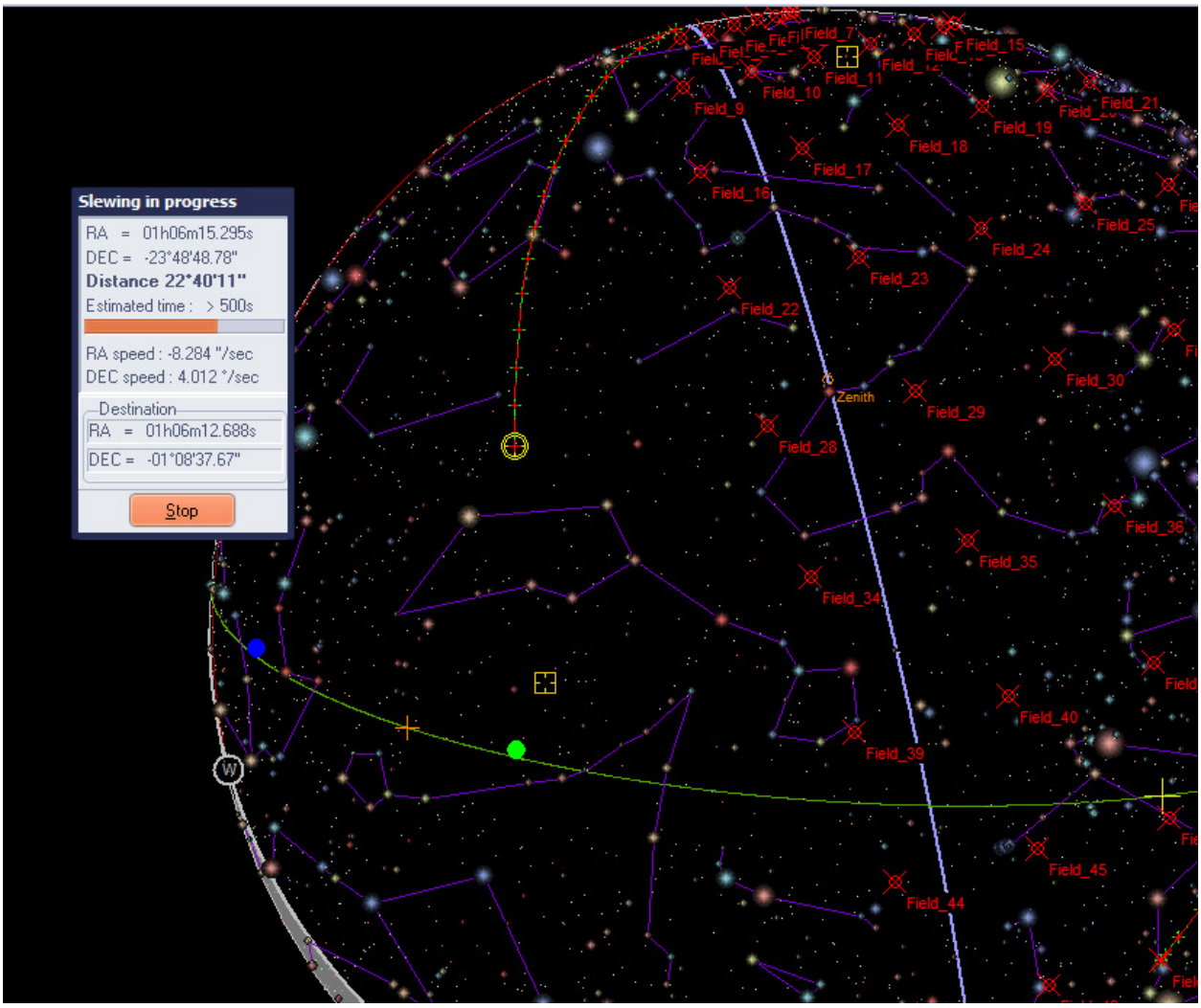
For German mounts, the same procedure shall be applied onto the other side of the sky. **Do not synchronize the mount**; just perform a slewing to the next side of the sky. The mount will then perform mount flip.



This can be carried out by left click of the mouse where the telescope is going to be at end slewing (red arrow on next screen capture).

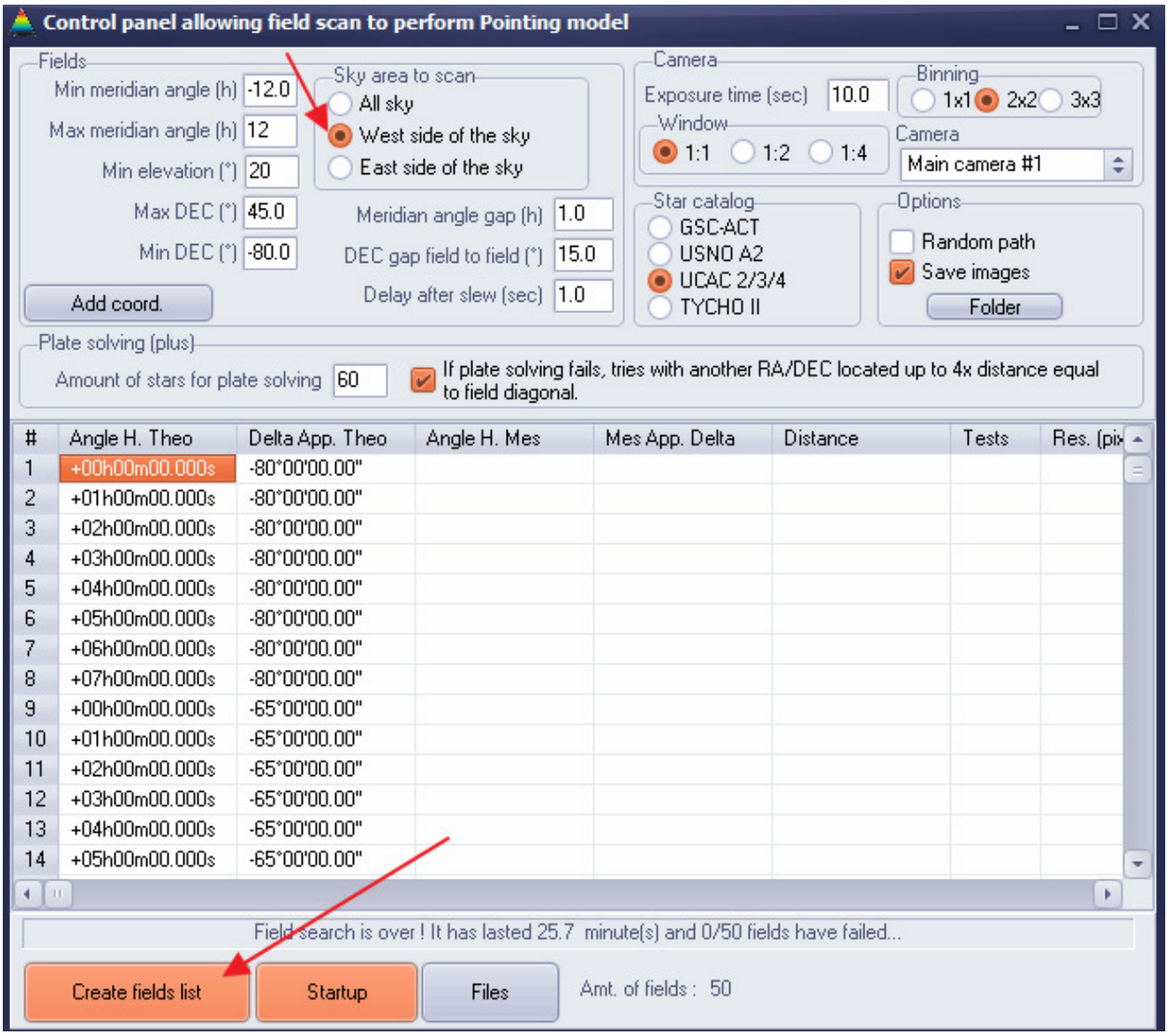


The mount will slew and perform a meridian flip to the destination coordinates.
On slew ending, the telescope's side of pier will report "East side"



Now go back to the control panel, and click "***West side of the Sky***". Then click "***Create field list***", this will erase and overwrite the previous field list.

The blue dots that are representing the fields to be scanned, will change position to the other side of the Sky.

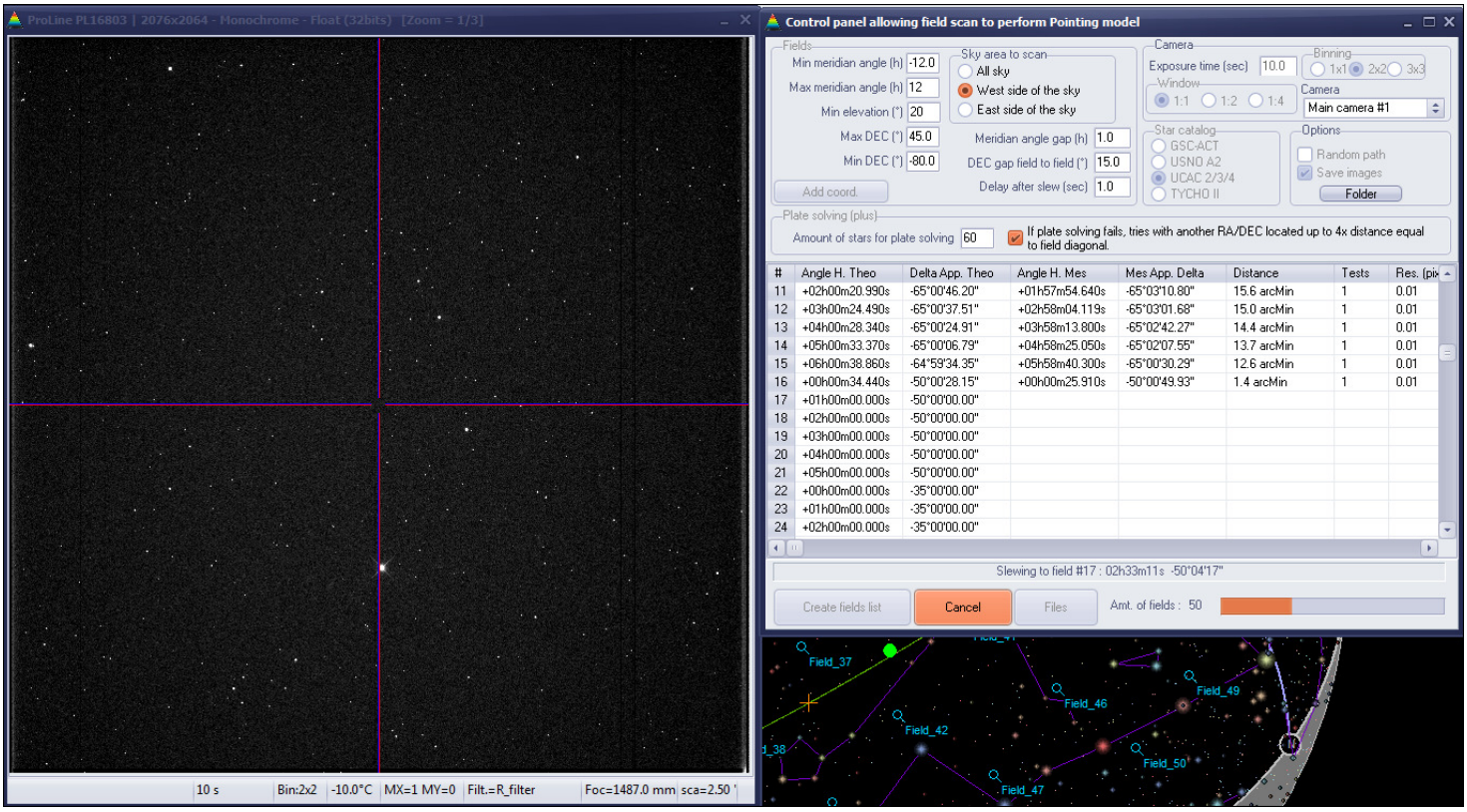


Then just click "***Startup***", and the process will commence.

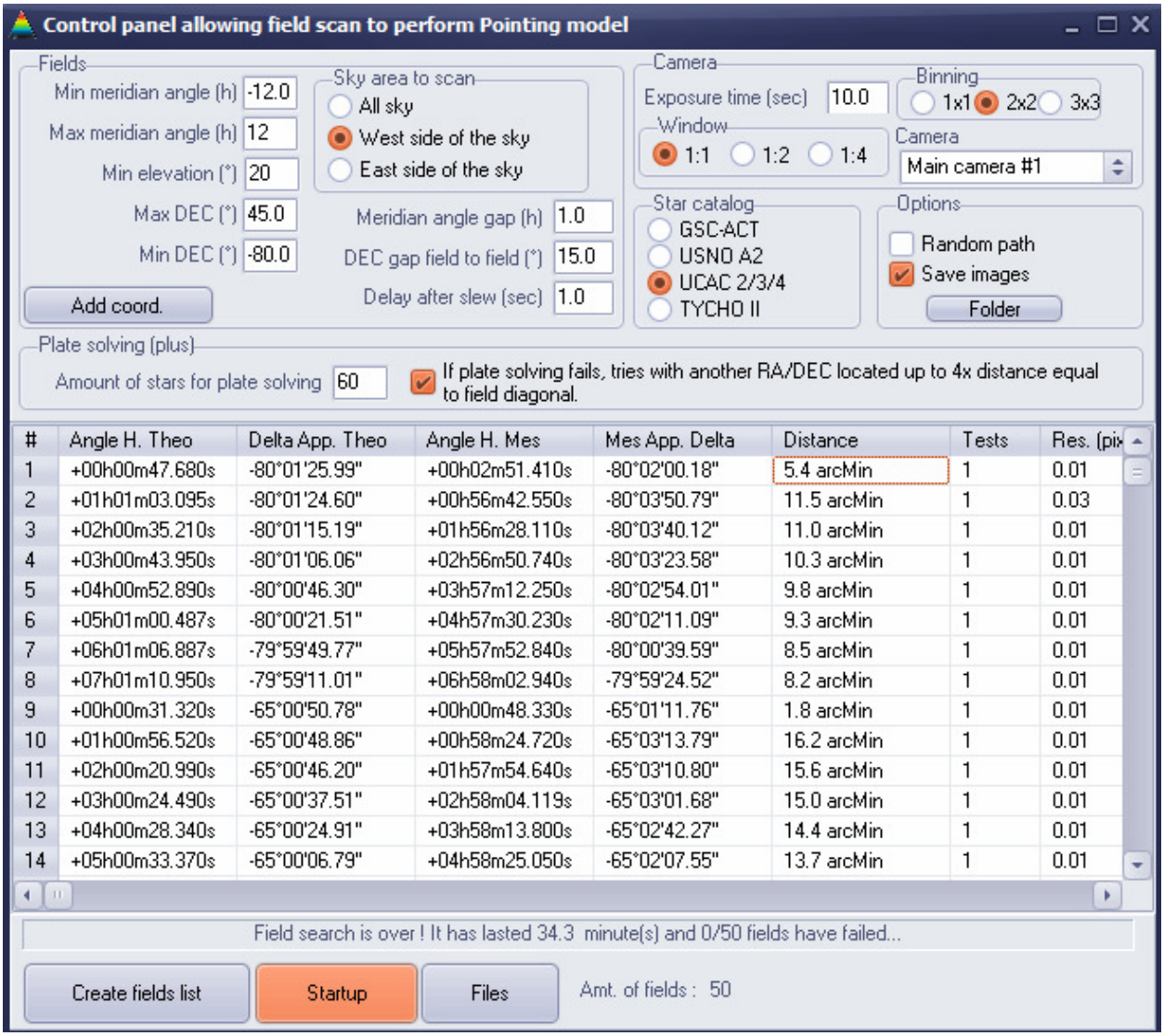
Important: the mount should not flip to the other side of the pier! If so, CANCEL the process and:

- **Avoid fields to be too close to the meridian**
- **Be sure about the NOVA mount setting and what cause the meridian flip; go above into this documentation on how to overcome this.**

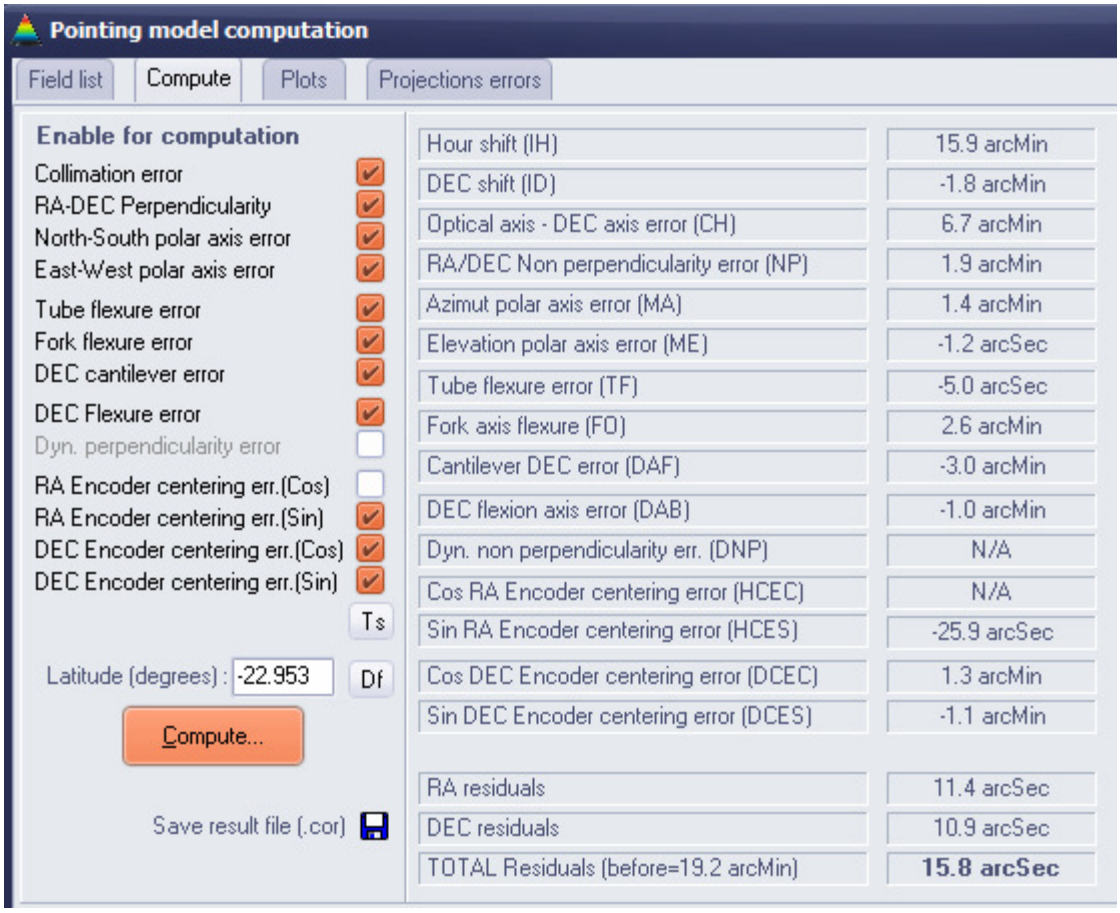
The process lasts some minutes, if you have a dome, ensure that the dome is "slaved" to the telescope, otherwise plate solving error will arise (obscured and missing stars).



As you can notice, pointing errors are increased compared to the other side of the Sky. This is normal, because DEC mount axis and telescope optical axis are never perfectly perpendicular, and this error leads to large errors when mount is meridian flipped.



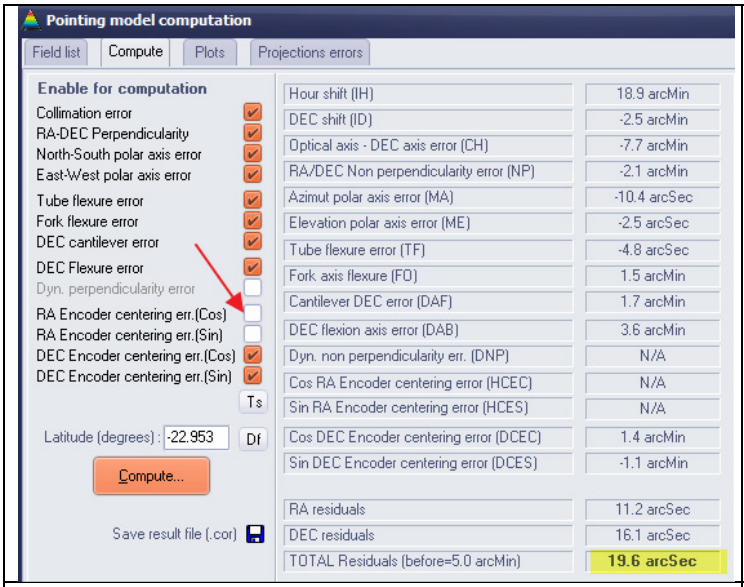
At the end of the process, the same form will appear, and you have to proceed the same way with.



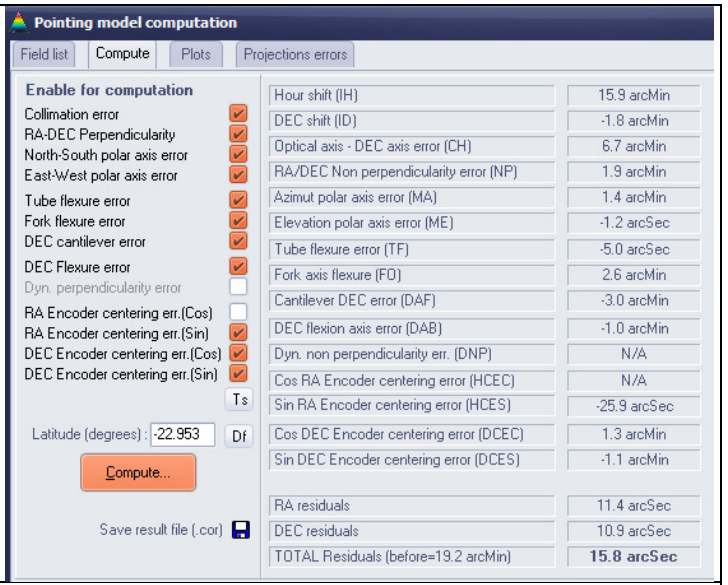
Do not forget to save the resulting "***.cor***" file as (for instance):

TubeEastPier-10-10-14.cor

This is interesting to look at differences between west and east side of pier models:



Side of pier : West



Side of pier : East

All the figures of IH, ID… DCES are not the same, but are close, or have opposite signs. MA and ME are directly related to polar alignment errors and must be the same. It must be noticed that polar alignment of the mount used to create the document is really excellent!

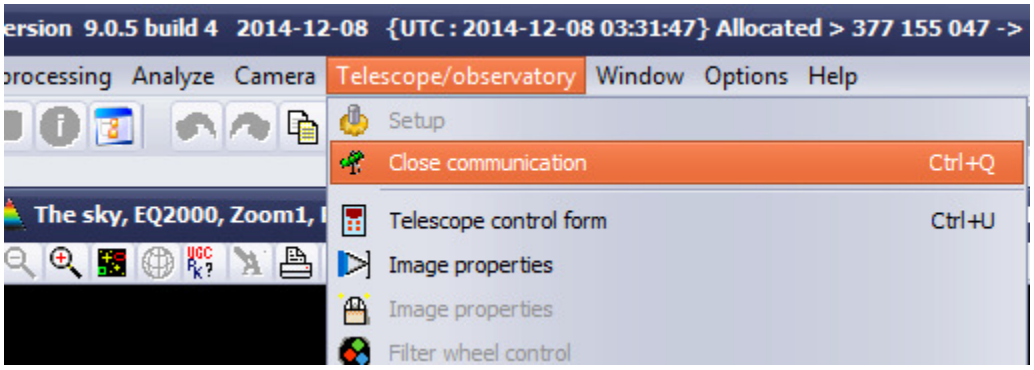
MA is jumping from -10.4 arcsec to 1.4 arcmin error, ME from -2.5 arcsec to -1.2 arcsec. This denotes a slight pillar flexure when tube is located at the West side of the pier and the East side. This is why for German mount, performing two models is always employed by professionals.

Pointing model is really powerful to extract what is happening to the whole setup (telescope + mount) and sometime can help to apply fixes: polar alignment being too bad, tube flexion and so on.

3. Applying the pointing model to the NOVA mount

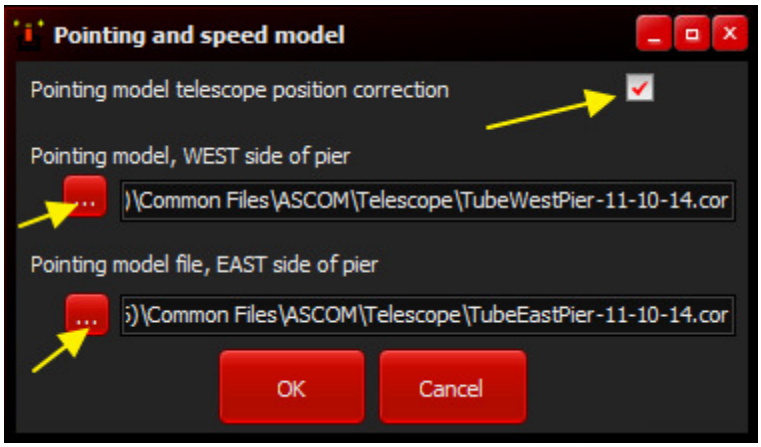
Once the two **.cor** files are generated by the process above, they need to be entered into the NOVA mount software.

First, close PRISM's connection to the NOVA mount software.



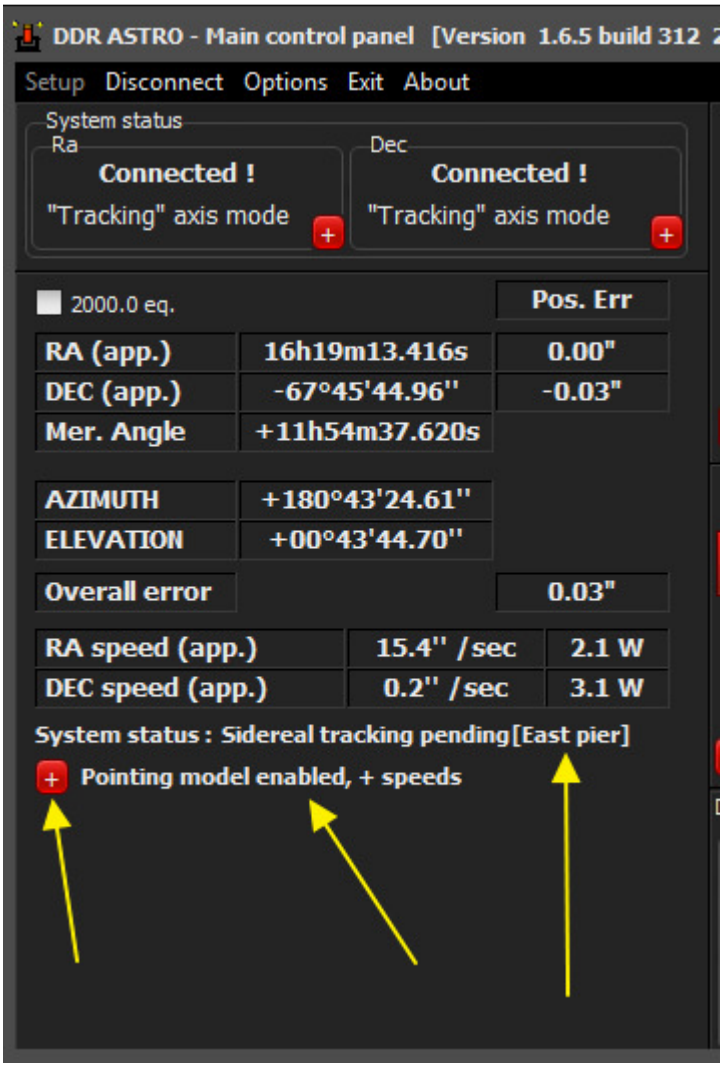
Then to the NOVA mount software, go to setup then open the pointing model setup form:

Enable pointing model and select the ***TubeWestPier-10-10-14.cor*** and ***TubeEastPier-10-10-14.cor*** accordingly. So having named the files this way is a good trick to avoid mixing up these files.



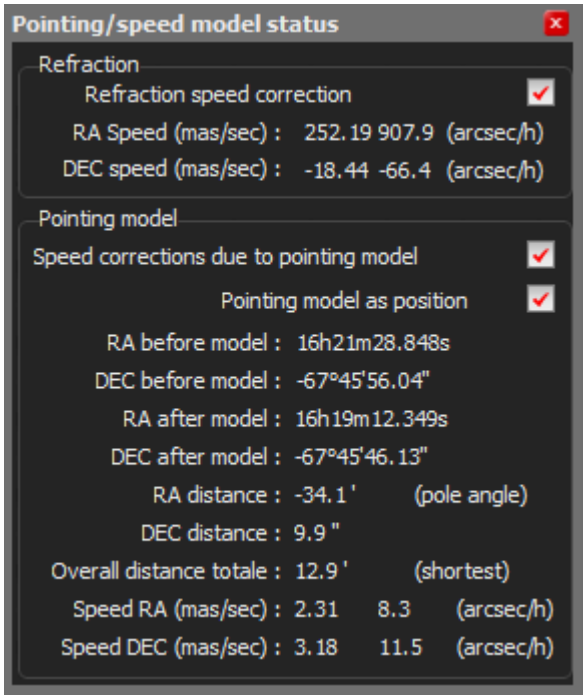
Never swap the files otherwise, the pointing model will produce twice the error of no pointing model!

Then connect to the mount hardware, and notice that pointing model is enabled, also speed model is enabled:



If the "*+*" button is clicked, a status window appears and shows the current status of pointing/speed model.

Each of these models can be enabled / disabled, even the mount been online to the NOVA mount software. This can be interesting for testing purposes. Also refraction speed can be set or unset, because refraction is causing pointing errors (compensated by the software, but also tracking speeds errors).



4. Final checks

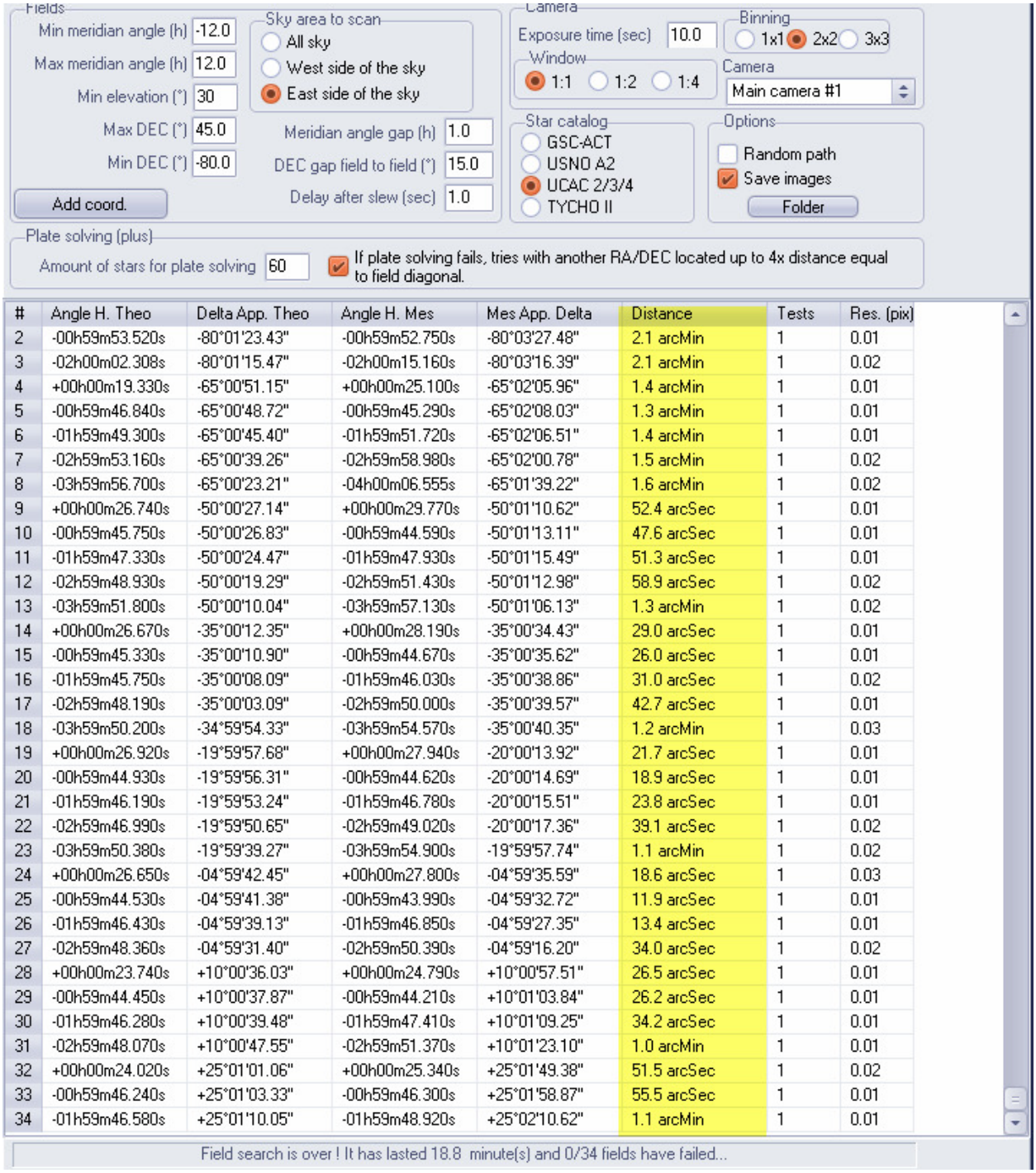
It can be interesting to check how this pointing model actually improves pointing accuracy of the telescope. This can be performed by manually pointing a field, or an object. At first pointing, synchronization with a bright star can be achieved and will not jeopardize point model performance.

Then the same procedure of field scans can be achieved in both sky hemispheres (before and after meridian) to check how the pointing model is actually improving the pointing accuracy.

The next screen capture is showing residual errors for each field that has been scanned. Some fields are exhibiting just 10 arcsec pointing error, other up to 2 arcmin, for instance. This is more than expected, but always the case because different fields have been used.

It means, in this sample, if the telescope focal length would be increased from 1.5 m to 63 m using the same CCD detector, in all cases, in all places over the Sky, targets will be inside the field of view of the camera.

Also same checking can be performed by long unguided exposures with speed model enabled.



#	Angle H. Theo	Delta App. Theo	Angle H. Mes	Mes App. Delta	Distance	Tests	Res. (pix)
2	-00h59m53.520s	-80°01'23.43"	-00h59m52.750s	-80°03'27.48"	2.1 arcMin	1	0.01
3	-02h00m02.308s	-80°01'15.47"	-02h00m15.160s	-80°03'16.39"	2.1 arcMin	1	0.02
4	+00h00m19.330s	-65°00'51.15"	+00h00m25.100s	-65°02'05.96"	1.4 arcMin	1	0.01
5	-00h59m46.840s	-65°00'48.72"	-00h59m45.290s	-65°02'08.03"	1.3 arcMin	1	0.01
6	-01h59m49.300s	-65°00'45.40"	-01h59m51.720s	-65°02'06.51"	1.4 arcMin	1	0.01
7	-02h59m53.160s	-65°00'39.26"	-02h59m58.980s	-65°02'00.78"	1.5 arcMin	1	0.02
8	-03h59m56.700s	-65°00'23.21"	-04h00m06.555s	-65°01'39.22"	1.6 arcMin	1	0.02
9	+00h00m26.740s	-50°00'27.14"	+00h00m29.770s	-50°01'10.62"	52.4 arcSec	1	0.01
10	-00h59m45.750s	-50°00'26.83"	-00h59m44.590s	-50°01'13.11"	47.6 arcSec	1	0.01
11	-01h59m47.330s	-50°00'24.47"	-01h59m47.930s	-50°01'15.49"	51.3 arcSec	1	0.01
12	-02h59m48.930s	-50°00'19.29"	-02h59m51.430s	-50°01'12.98"	58.9 arcSec	1	0.02
13	-03h59m51.800s	-50°00'10.04"	-03h59m57.130s	-50°01'06.13"	1.3 arcMin	1	0.02
14	+00h00m26.670s	-35°00'12.35"	+00h00m28.190s	-35°00'34.43"	29.0 arcSec	1	0.01
15	-00h59m45.330s	-35°00'10.90"	-00h59m44.670s	-35°00'35.62"	26.0 arcSec	1	0.01
16	-01h59m45.750s	-35°00'08.09"	-01h59m46.030s	-35°00'38.86"	31.0 arcSec	1	0.02
17	-02h59m48.190s	-35°00'03.09"	-02h59m50.000s	-35°00'39.57"	42.7 arcSec	1	0.01
18	-03h59m50.200s	-34°59'54.33"	-03h59m54.570s	-35°00'40.35"	1.2 arcMin	1	0.03
19	+00h00m26.920s	-19°59'57.68"	+00h00m27.940s	-20°00'13.92"	21.7 arcSec	1	0.01
20	-00h59m44.930s	-19°59'56.31"	-00h59m44.620s	-20°00'14.69"	18.9 arcSec	1	0.01
21	-01h59m46.190s	-19°59'53.24"	-01h59m46.780s	-20°00'15.51"	23.8 arcSec	1	0.01
22	-02h59m46.990s	-19°59'50.65"	-02h59m49.020s	-20°00'17.36"	39.1 arcSec	1	0.02
23	-03h59m50.380s	-19°59'39.27"	-03h59m54.900s	-19°59'57.74"	1.1 arcMin	1	0.02
24	+00h00m26.650s	-04°59'42.45"	+00h00m27.800s	-04°59'35.59"	18.6 arcSec	1	0.03
25	-00h59m44.530s	-04°59'41.38"	-00h59m43.990s	-04°59'32.72"	11.9 arcSec	1	0.01
26	-01h59m46.430s	-04°59'39.13"	-01h59m46.850s	-04°59'27.35"	13.4 arcSec	1	0.01
27	-02h59m48.360s	-04°59'31.40"	-02h59m50.390s	-04°59'16.20"	34.0 arcSec	1	0.02
28	+00h00m23.740s	+10°00'36.03"	+00h00m24.790s	+10°00'57.51"	26.5 arcSec	1	0.01
29	-00h59m44.450s	+10°00'37.87"	-00h59m44.210s	+10°01'03.84"	26.2 arcSec	1	0.01
30	-01h59m46.280s	+10°00'39.48"	-01h59m47.410s	+10°01'09.25"	34.2 arcSec	1	0.01
31	-02h59m48.070s	+10°00'47.55"	-02h59m51.370s	+10°01'23.10"	1.0 arcMin	1	0.01
32	+00h00m24.020s	+25°01'01.06"	+00h00m25.340s	+25°01'49.38"	51.5 arcSec	1	0.02
33	-00h59m46.240s	+25°01'03.33"	-00h59m46.300s	+25°01'58.87"	55.5 arcSec	1	0.01
34	-01h59m46.580s	+25°01'10.05"	-01h59m48.920s	+25°02'10.62"	1.1 arcMin	1	0.01

Creating a pointing model is provides a true added value, and can be achieved once every year or every two years for a fixed telescope. For a mobile telescope, this has to be performed each time the telescope is moved. In the latter case, it is not required, but mount performance will be degraded and since it just takes one hour to be achieved, it is worth the effort.

-o**O**o-