

# **POLARALIGN 0.10**

**A brief manual**

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## Brief description

Usually, one of the difficulties for an amateur astronomer is to align correctly the polar axis of the telescope mount with the real celestial pole in the sky. Often precise alignment is opposite to fast alignment and the mounts use a rough alignment. Some methods are more exacts to do it and some software too.

PolarAlign software has been developed using the idea described in the Sánchez-Valente method (<http://dastronomia.trainingpills.com/metodo-sanchez-valente/>), which some ideas are related to procedures appeared in old astronomical texts. PolarAlign contains two differences in relation to the software created by Sanchez-Valente (SV aligner).

One of them is the interface and visual design of the tool. It is not necessary to do anything by hand. The program can record the data and do the necessary calculations directly over pictures. The software is developed in a Java environment to run it on any software platform: Windows, Mac OS X, Linux, etc.

The other one is the mathematical calculation of the centre of the movement of stars. In PolarAlign the determination of the centre of rotation is made by an algorithm based on the Gauss solution to an over-determined equations system. Each equation of the system represents a straight orthogonal to the segment that joins the extremes of the curve drawn by a star (in the software interface this is clearly visible). This mathematical solution guarantees the best solution to calculate the centre where the lines join under criteria of mean squared error.

In theory this software can be used to align the mount when you do not have direct vision to the pole, but the error increases as the distance increase, especially due to the possible error of clicking in the points of stellar traces. A new version to do this with precision is under development.

## Requirements and Installation of the software

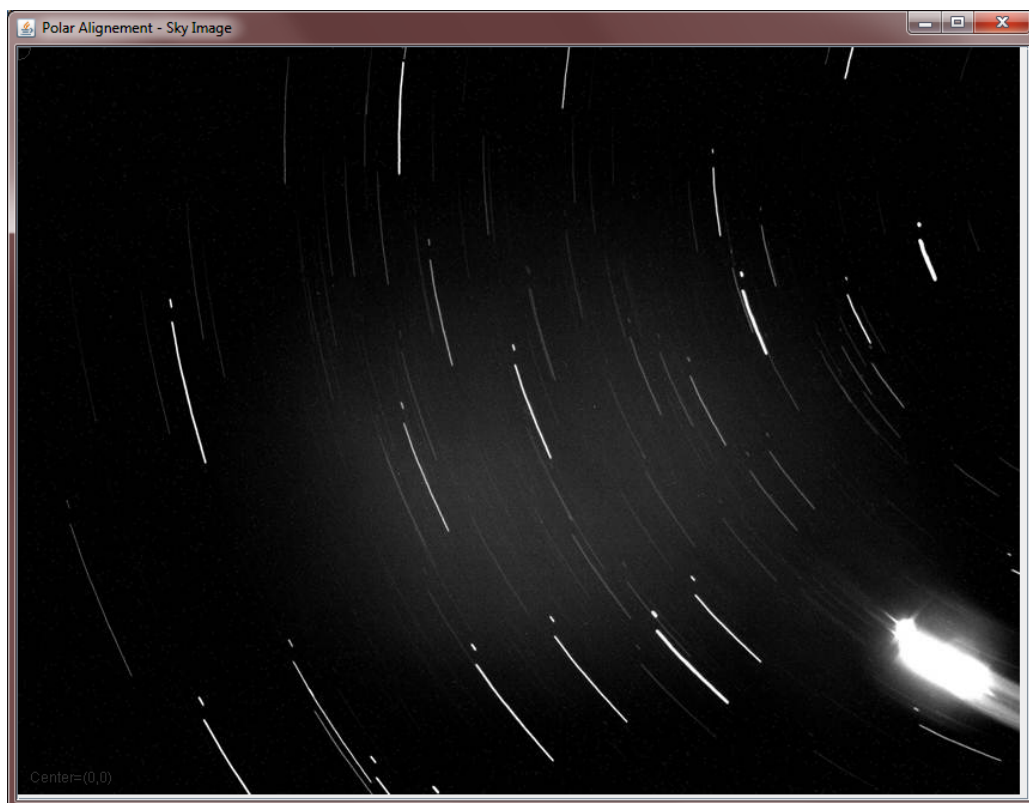
To execute PolarAlign is necessary Java runtime installed in your computer. No other requirements are necessary. PolarAlign is developed to run with Java JRE 1.6 or above. If you do not Java JRE installed pleased visit Oracle page to download it (free download).

This software does not require installation. All you need is extract the files contained in the zip file and executing ***polaralign.jar*** file.

The only limitation of the software is that it is necessary to use jpg, png or gif format in images.

## Procedure to use

The first step is to take two images, one with the mount stopped (that it is named sky image) and other moving it (that it is named mount image). The exposure of the sky image can be about half an hour or more but using shorter exposure times a first good approximation is possible. The exposure moving the mount can be as short as 5 or 10 seconds if your camera is enough sensitive, but if not you can reduce the mount speed and take an image of one or two minutes. The most important is having a couple of pictures with the stars showing their movement. Here there are an example of the sky image and the mount image. One image shows the rotation centre of the celestial objects and the other shows the rotation centre of the mount.



Sky image obtained with the mount stopped.



Mount image obtained with the mount in movement.

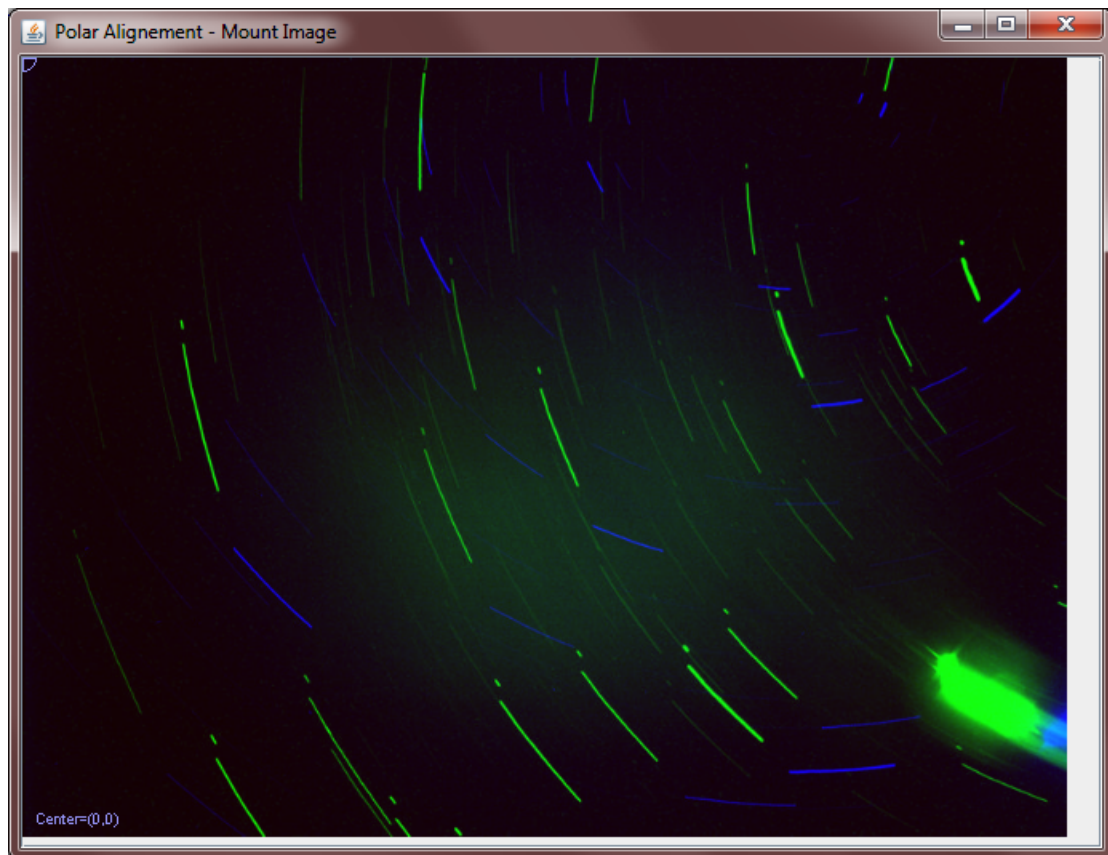
The next picture shows an alternative method of taking the sky image or the mount image. As it only is necessary to have the beginning and the end of stars' movement to mark it, it is possible to take 3 pictures at different times. For example, for the sky image, one-minute exposure or less in the minute 0, another in the minute 20 and another in the minute 40. Adding these three images it is possible to see where stars' path starts and ends. In theory two images would only be necessary but distinguishing the stars' movement would be confusing.



Mount image obtained with the mount in movement.

With these two taken images, the “sky image” and the “mount image” it is very easy to use the software. Only one menu is available. In the menu open the sky image or the mount image first, it is not important the order.

When the two images are opened the work begins. One additional feature in the menu is “*add images*”. This option calculates and shows another picture resulting of the addition of the two original pictures and it is possible to analyse roughly how far the mount of the ideal position is, showing the star traces of the two images in different colors.

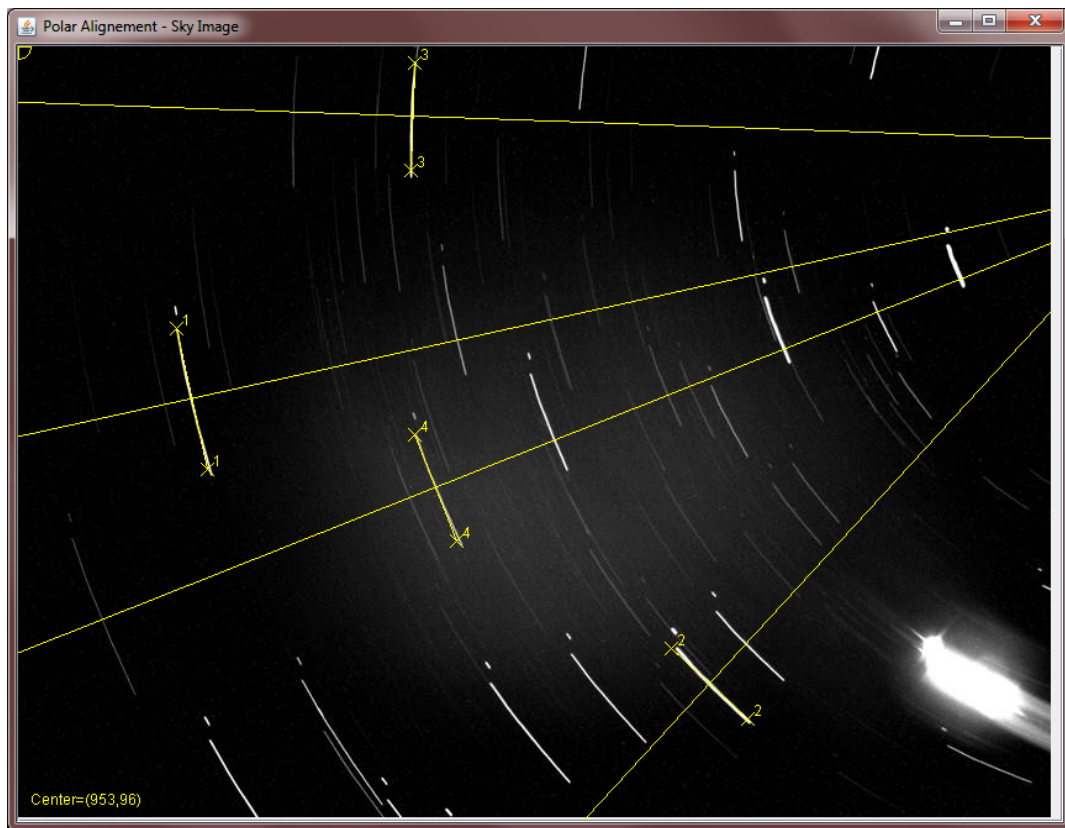


Added images obtained with the mount in movement.

Suppose that you open the sky image first. The same procedure is applied to the mount image. You only have to mark the extreme of the chosen stellar traces, that is, situating the cursor on one extreme of the trace and do click, go to the other extreme and do click too. As you will see, after marking every pair of points a straight line is plotted between the two points and the orthogonal straight line is plotted too. This second line crosses more or less near the rotation centre of the image. It is important to select stars the most separated possible because this guarantees the least error in the solution.

To mark these points it is possible to use a zoom function moving forward and backward the wheel of the mouse over the image.





Lines are drawn on the sky image.



Lines are drawn on the mount image.



If you observe that any of the plotted lines is far from the centre where the other lines converge, more or less, it is possible to deselect it by unchecking the checkbox in the column "OK" corresponding to this line and these data will not be used in the calculation of the rotation centre of the image. In the example shown the star number 5 of the mount image is bad selected and in the table ok box is unchecked to not use this star to calculate the centre.

When enough lines are ok (at least two in an image) it is only necessary to push the button "Calculate Centre" (sky or mount). Then you will see the calculated centre overlapped on the image and the value of its coordinates.

With the two centres calculated, in the sky image and in the mount image, you can push the button "Calculate displacement" and the value of the displacement between the two centres will appear and the correction that you have to do. You only have to take a picture of a star near the centre, and move the amount indicate on the image using the mount adjustments. That is all.

**Sky points table**

| STAR | OK                                  | X1  | Y1  | X2  | Y2  |
|------|-------------------------------------|-----|-----|-----|-----|
| 1    | <input checked="" type="checkbox"/> | 128 | 228 | 153 | 342 |
| 2    | <input checked="" type="checkbox"/> | 529 | 487 | 591 | 544 |
| 3    | <input checked="" type="checkbox"/> | 321 | 13  | 318 | 100 |
| 4    | <input checked="" type="checkbox"/> | 321 | 314 | 355 | 400 |
| 5    | <input type="checkbox"/>            |     |     |     |     |
| 6    | <input type="checkbox"/>            |     |     |     |     |
| 7    | <input type="checkbox"/>            |     |     |     |     |
| 8    | <input type="checkbox"/>            |     |     |     |     |
| 9    | <input type="checkbox"/>            |     |     |     |     |
| 10   | <input type="checkbox"/>            |     |     |     |     |
| 11   | <input type="checkbox"/>            |     |     |     |     |
| 12   | <input type="checkbox"/>            |     |     |     |     |
| 13   | <input type="checkbox"/>            |     |     |     |     |
| 14   | <input type="checkbox"/>            |     |     |     |     |
| 15   | <input type="checkbox"/>            |     |     |     |     |

**Mount points table**

| STAR | OK                                  | X1  | Y1  | X2  | Y2  |
|------|-------------------------------------|-----|-----|-----|-----|
| 1    | <input checked="" type="checkbox"/> | 319 | 144 | 342 | 186 |
| 2    | <input checked="" type="checkbox"/> | 634 | 278 | 669 | 273 |
| 3    | <input checked="" type="checkbox"/> | 171 | 391 | 231 | 450 |
| 4    | <input checked="" type="checkbox"/> | 531 | 588 | 614 | 595 |
| 5    | <input type="checkbox"/>            | 371 | 440 | 430 | 473 |
| 6    | <input type="checkbox"/>            |     |     |     |     |
| 7    | <input type="checkbox"/>            |     |     |     |     |
| 8    | <input type="checkbox"/>            |     |     |     |     |
| 9    | <input type="checkbox"/>            |     |     |     |     |
| 10   | <input type="checkbox"/>            |     |     |     |     |
| 11   | <input type="checkbox"/>            |     |     |     |     |
| 12   | <input type="checkbox"/>            |     |     |     |     |
| 13   | <input type="checkbox"/>            |     |     |     |     |
| 14   | <input type="checkbox"/>            |     |     |     |     |
| 15   | <input type="checkbox"/>            |     |     |     |     |

Buttons: Calculate Sky Center, Calculate Mount Center, Clear sky table, Clear mount table, Calculate displacement, Night, Day

Coordinates and Displacement:

- (X,Y) coordinate of point: (355,400)
- (X,Y) coordinate of point: (430,473)
- (X,Y) of the sky center: (953,96)
- (X,Y) of the mount center: (618,22)
- MOVE X= -335 MOVE y= -74
- Error value (pixels / arcsec): 343 / 343.0
- Arcsec/pixels: 1.00

Atmospheric refraction section:

The value obtained of the atmospheric refraction is an approximate correction in altitude to obtain the true pole. To correct it it is necessary to decrease the altitude of the polar axis the number of arcseconds (pixels) indicated. The new center is drawn

☐ Atmospheric Refraction

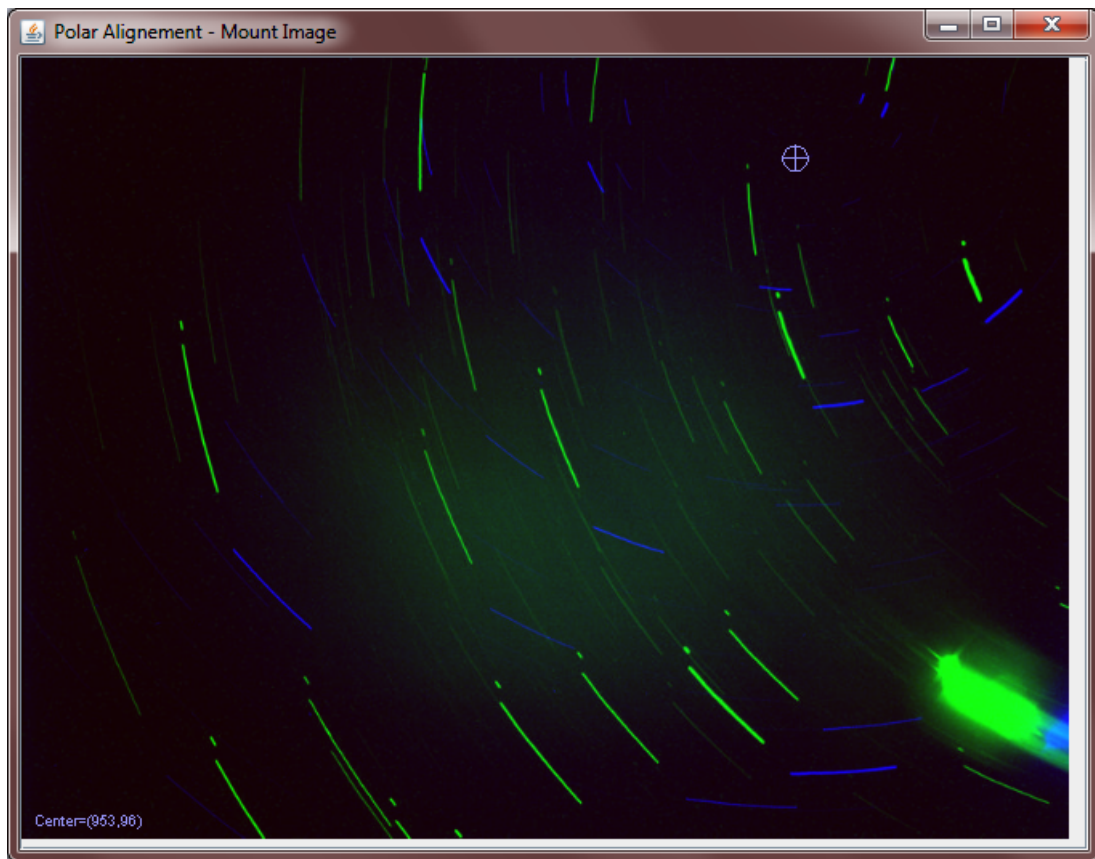
Atmospheric Refraction arcsec:

Atmospheric Refraction pixels:

Input Latitude value degrees:

Image scale (arcsec/pixel):

Diagram: A small diagram showing a blue dot (center) and a yellow dot (star) with a line connecting them.



Images with drawn lines are saved in the same directory where the program is working in jpg format.

Additional options are the possibility of to add the effect of the atmospheric refraction (based on Sæmundsson formula of 1986). When this option is selected, it is mandatory to introduce the latitude of the place and the scale of the image in arc seconds per pixel. If you are operating in a dark environment you can select "Night" to see the background in red colour.

| Sky points table |                                     |     |     |     |     | Mount points table |    |    |    |    |    |  |  |
|------------------|-------------------------------------|-----|-----|-----|-----|--------------------|----|----|----|----|----|--|--|
| STAR             | OK                                  | X1  | Y1  | X2  | Y2  | STAR               | OK | X1 | Y1 | X2 | Y2 |  |  |
| 1                | <input checked="" type="checkbox"/> | 128 | 228 | 153 | 342 |                    |    |    |    |    |    |  |  |
| 2                | <input checked="" type="checkbox"/> | 529 | 487 | 591 | 544 |                    |    |    |    |    |    |  |  |
| 3                | <input checked="" type="checkbox"/> | 321 | 13  | 318 | 100 |                    |    |    |    |    |    |  |  |
| 4                | <input checked="" type="checkbox"/> | 321 | 314 | 355 | 400 |                    |    |    |    |    |    |  |  |
| 5                | <input type="checkbox"/>            |     |     |     |     |                    |    |    |    |    |    |  |  |
| 6                | <input type="checkbox"/>            |     |     |     |     |                    |    |    |    |    |    |  |  |
| 7                | <input type="checkbox"/>            |     |     |     |     |                    |    |    |    |    |    |  |  |
| 8                | <input type="checkbox"/>            |     |     |     |     |                    |    |    |    |    |    |  |  |
| 9                | <input type="checkbox"/>            |     |     |     |     |                    |    |    |    |    |    |  |  |
| 10               | <input type="checkbox"/>            |     |     |     |     |                    |    |    |    |    |    |  |  |
| 11               | <input type="checkbox"/>            |     |     |     |     |                    |    |    |    |    |    |  |  |
| 12               | <input type="checkbox"/>            |     |     |     |     |                    |    |    |    |    |    |  |  |
| 13               | <input type="checkbox"/>            |     |     |     |     |                    |    |    |    |    |    |  |  |
| 14               | <input type="checkbox"/>            |     |     |     |     |                    |    |    |    |    |    |  |  |
| 15               | <input type="checkbox"/>            |     |     |     |     |                    |    |    |    |    |    |  |  |

| Atmospheric Refraction   |  |                                  |  |  |  |
|--|--|----------------------------------|--|--|--|
| The value obtained of the atmospheric refraction is an approximate correction in altitude to obtain the true pole. To correct it it is necessary to decrease the altitude of the polar axis the number of arcseconds (pixels) indicated. The new center is drawn |  |                                  |  |  |  |
| <input checked="" type="checkbox"/> Atmospheric Refraction   |  |                                  |  |  |  |
| Atmospheric Refraction arcsec  |  | <input type="text" value="69"/>  |  |  |  |
| Atmospheric Refraction pixels  |  | <input type="text" value="58"/>  |  |  |  |
| Input Latitude value degrees   |  | <input type="text" value="41"/>  |  |  |  |
| Image scale (arcsec/pixel)   |  | <input type="text" value="1.2"/> |  |  |  |

| Buttons                |     |
|------------------------|-----|
| Calculate Sky Center   |     |
| Calculate Mount Center |     |
| Clear sky table        |     |
| Clear mount table      |     |
| Calculate displacement |     |
| Night                  | Day |

| Coordinates and Movement                   |                                   |
|--|-----------------------------------|
| (X,Y) coordinate of point. (355,400)       |                                   |
| (X,Y) coordinate of point. (430,473)       |                                   |
| (X,Y) of the sky center. (953,96)          |                                   |
| (X,Y) of the mount center. (518,80)        |                                   |
| MOVE X=-335 MOVE y=-16                     |                                   |
| Error value (pixels / arcsec): 335 / 335.0 |                                   |
| Arcsec/pixels                              | <input type="text" value="1.00"/> |

**Polar Alignment**

File About

### Sky points table

| STAR | OK                                  | X1  | Y1  | X2  | Y2  |
|------|-------------------------------------|-----|-----|-----|-----|
| 1    | <input checked="" type="checkbox"/> | 129 | 228 | 153 | 342 |
| 2    | <input checked="" type="checkbox"/> | 529 | 487 | 591 | 544 |
| 3    | <input checked="" type="checkbox"/> | 321 | 13  | 318 | 100 |
| 4    | <input checked="" type="checkbox"/> | 321 | 314 | 355 | 400 |
| 5    | <input type="checkbox"/>            |     |     |     |     |
| 6    | <input type="checkbox"/>            |     |     |     |     |
| 7    | <input type="checkbox"/>            |     |     |     |     |
| 8    | <input type="checkbox"/>            |     |     |     |     |
| 9    | <input type="checkbox"/>            |     |     |     |     |
| 10   | <input type="checkbox"/>            |     |     |     |     |
| 11   | <input type="checkbox"/>            |     |     |     |     |
| 12   | <input type="checkbox"/>            |     |     |     |     |
| 13   | <input type="checkbox"/>            |     |     |     |     |
| 14   | <input type="checkbox"/>            |     |     |     |     |
| 15   | <input type="checkbox"/>            |     |     |     |     |

### Mount points table

| STAR | OK                                  | X1  | Y1  | X2  | Y2  |
|------|-------------------------------------|-----|-----|-----|-----|
| 1    | <input checked="" type="checkbox"/> | 318 | 144 | 342 | 189 |
| 2    | <input checked="" type="checkbox"/> | 834 | 278 | 889 | 273 |
| 3    | <input checked="" type="checkbox"/> | 171 | 391 | 231 | 450 |
| 4    | <input checked="" type="checkbox"/> | 531 | 588 | 614 | 595 |
| 5    | <input type="checkbox"/>            | 371 | 440 | 430 | 473 |
| 6    | <input type="checkbox"/>            |     |     |     |     |
| 7    | <input type="checkbox"/>            |     |     |     |     |
| 8    | <input type="checkbox"/>            |     |     |     |     |
| 9    | <input type="checkbox"/>            |     |     |     |     |
| 10   | <input type="checkbox"/>            |     |     |     |     |
| 11   | <input type="checkbox"/>            |     |     |     |     |
| 12   | <input type="checkbox"/>            |     |     |     |     |
| 13   | <input type="checkbox"/>            |     |     |     |     |
| 14   | <input type="checkbox"/>            |     |     |     |     |
| 15   | <input type="checkbox"/>            |     |     |     |     |

Calculate Sky Center

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Calculate Mount Center

---

Clear sky table

---

Clear mount table

---

Calculate displacement

---

Night
Day

(X,Y) coordinate of point: (355,400)

(X,Y) coordinate of point: (430,473)

(X,Y) of the sky center: (953,96)

(X,Y) of the mount center: (618,80)

MOVE X= -335 MOVE y= -16

Error value (pixels / arcsec): 335 / 335.0

Arcsec/pixels 1.00

**Atmospheric refraction**

The value obtained of the atmospheric refraction is an approximate correction in altitude to obtain the true pole. To correct it it is necessary to decrease the altitude of the polar axis the number of arcseconds (pixels) indicated. The new center is drawn

☐ Atmospheric Refraction

Atmospheric Refraction arcsec

Atmospheric Refraction pixels

Input Latitude value degrees 41

Image scale (arcsec/pixel) 1.2

Enjoy this software and obtain good pictures of the sky. If you detect some bug or you have suggestions to correct this manual or the software please send me an e-mail to: [toniarda\(at\)gmail.com](mailto:toniarda(at)gmail.com)

Toni Ardanuy

Notes:

Jama is a library developed by NASA to operate with matrices in Java.

Sanchez-Valente Method is described by authors in Internet.

Java is a language developed by Sun Microsystems and continued by Oracle.