

# MANUAL

## Making Pointing Models with DDM85



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### What is a pointing model?

If you have an ideal telescope you would expect that by entering the real position of the object the telescope will hit the object without any error. However there is no ideal telescope and several errors can occur during slewing:

The main errors can be:

1. Polar alignment error in Azimuth
2. Polar alignment error in Altitude
3. Collimation error
4. Mount error (axes not perpendicular)
5. Tube flexure

And several gearing errors, mount flexure etc.

Autoslew can compensate all these errors as long as they are reproducible (same error every time telescope will point this position). To compensate these errors they first have to be measured. This is achieved by a pointing file.

A pointing file is a list of pointing observations specifying where the star really was and where the telescope readouts said the star was. Autoslew saves these files with the file extension .poi.

The simplest way to enhance the pointing would be make a table sorted by RA and Dec and put the error vectors there and if you point to the same area again correct the telescope coordinates by the error that has been measured. This method might work for really big pointing files with thousands of stars but if you want to have the maximum performance gain with as less as possible stars it is cleverer to make a model which models the telescope behavior with a set of error functions. This is also much more powerful in averaging out random noise in your pointing file.

Autoslew will work with a set of functions that describe the telescope pointing if the above listed errors (Polar alignment, Collimation, Mount error). All these functions have certain variables. These variables will be optimized so that the set of functions will optimally describe the telescopes pointing behavior that was measured with the pointing file. This set of variables that can be calculated from the pointing (\*.poi) files is called configuration. These files are saved with the extension cfg (\*.cfg).

It is important to understand that a pointing file is only a set of observations and a configuration file is a set of variables that are used to influence the telescope pointing.

### Why should you make pointing models?

The first reason of course is that you will achieve better pointing. However sometimes better pointing is not needed if you did a good polar alignment and your mount can hit the objects within your CCD field. But there is an even more important reason why you should use a pointing model in Autoslew and here comes the big difference to other pointing models that are not integrated into the mount control software but rather bought as external package.

Autoslew uses the pointing model configuration not only for correcting the pointing but also to change the tracking speeds in Right Ascension AND Declination in realtime during tracking. Please try to forget the old mount where a simple sidereal tracking rate was applied in RA and Dec was only moved in autoguiding by external commands.

If you start an exposure the telescope will move not in Right Ascension and Declination but in Hour Angle and Declination and thus move slowly through the Sky and also in areas where the pointing configuration indicate other pointing corrections compared to where the exposure started. Autoslew will update the drive rates several times per second in RA and Dec to keep the telescope on track. This can for example mean that the Dec speed is 0.1 arc seconds per Minute positive at the beginning of the exposure and turns negative 0.23 arc seconds per Minute at the end of the exposure.

It should be clear that old fashioned mounts with worm gears and a few arc seconds backlash will be without chance to correct these slight Dec speeds. If you tell these mounts to move 1.2 arc seconds in Declination it can be either 0 arc seconds or 2 arc seconds depending on which side of the backlash you currently are.

Only mounts with High Accuracy Encoders like the ASA DDM's and/or direct drive can convert these tiny speed commands in real sky movements and enable you to achieve pin point star images without autoguiding.

So the real gain if you try to make a good pointing model is not just in better pointing but especially in better tracking. You can easily expand your blind tracking time (without autoguiding) from 30secs without model to 10 minutes with a good pointing model.

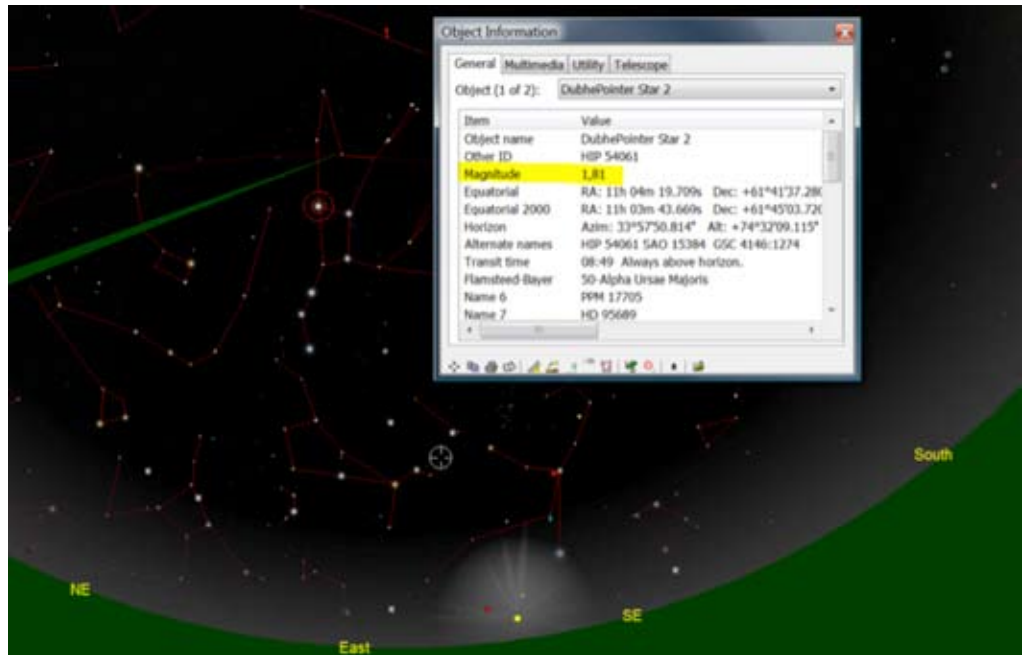
### Limitations of pointing models

You can only fit pointing errors if they are reproducible. This means that the pointing error must be the same at a certain location in the sky no matter if the telescope slews to this point coming from deep East or far West. You can test the repeatability of your scope by synching on a star and then slew again to the same star coming from different positions in the sky. If you are more than one arc minute off in this test, try to optimize your telescope (mirror cell, focuser etc.). Your final pointing will always be as good as your telescope. In 99% of all cases where people complain about bad pointing the problem is in the telescope and not the mount. We can build mounts with 5arc sec RMS pointing but with a Schmidt Cassegrain put on this mount with 1arcmin mirror shift you will never reach the mount performance! However, please accept that there is NO telescope in this world that has zero hysteresis. Especially reflectors will always have a little mirror shift and if you try to fix your mirrors until nothing moves you might have the mirror bent in its cell and have good pointing but bad image quality. Try to be realistic with your targets. If you can reach 5m unguided then it's often easier to stack more CCD frames than to try hard to get up to 20m unguided. I remember one 1m telescope from an Australian company where the mirror was GLUED to the mirror cell. This telescope reached 2arcsec RMS pointing but at the same time the image quality was a disaster. Since the telescope was only used photometric, there was no problem.

### DDM 85 Start your first pointing model and use it for polar alignment

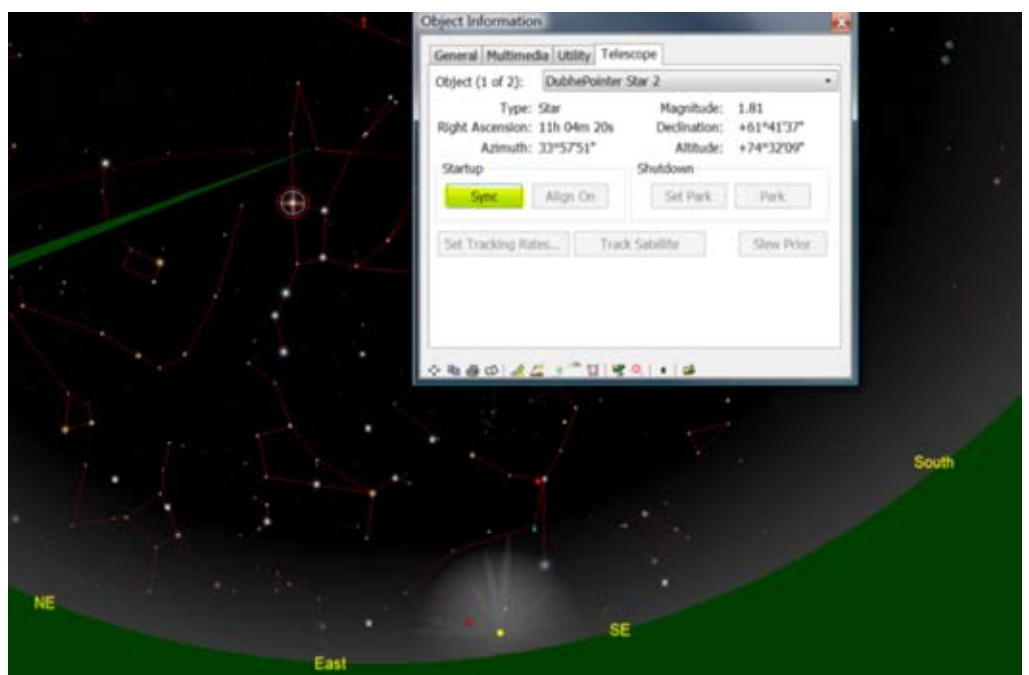
Let's assume you have roughly polar aligned your telescope with a viewfinder or a laser. (Later, if you have set your homefind position you can also make a homefind and then simply center a star to roughly align the telescope, there will be more on that in the Homefind section.)

Select a bright star in TheSky or any other Skymap program. Be careful that your mouse really hit the bright star and not some other minor star or object nearby. This could cause massive errors in your pointing file. The best thing is to check name or magnitude of the selected star to avoid a mistake.

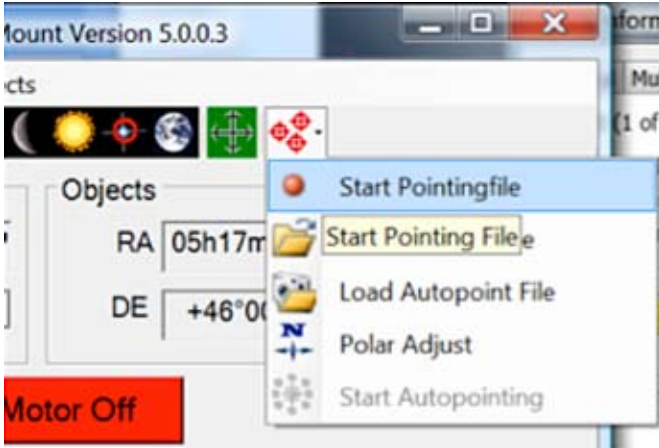


Now please slew to this star. Center the star and then use the synch function in TheSky to calibrate the telescope position.

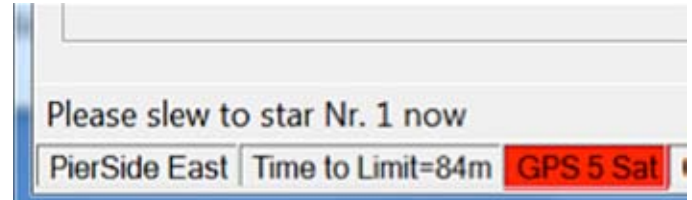
One remark here: If this is the first night with your ASA DDM mount try to keep it simple. Don't use a complicated setup with CCD camera or digital camera for centering the stars but rather use a crosshair eyepiece and a view finder for that purpose. A lot of times errors occurred in the pointing files because the people simply weren't able to find the right stars (they selected in TheSky) or center them. In some cases they used subframes and then centered the stars in the subframe only etc. And don't even go out in the dark if you are not familiar with your mount. Try motor tuning and slewing at day time until you have optimized your setup. The time you need to do that is a wise investment.



Now we are ready to start the pointing file.



When you click on the Start pointing File Toolstrip button a file dialog will be opened where you can enter the name of your pointing file. After you clicked OK you are prompted to slew to your first star:

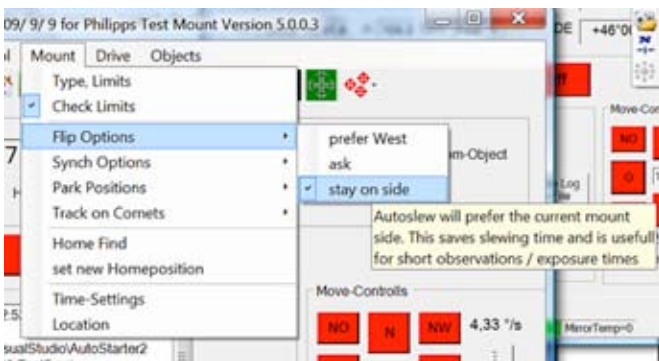


### Which stars and how many stars to choose ?

If you make a file for polar alignment with a German mount you should select stars either on the west side or on the east side but not use both sides at the same time. In theory, 2 stars would be sufficient for determining the polar misalignment. However the telescope may also have other errors like flexure and collimation

and if you select only 2 stars the pointing model will try to squeeze the observed errors in the polar alignment error only. So it is always better to use around 4 stars equally distributed on the East OR West side to separate the polar error from other errors.

To make sure the mount will stay on the current side and not flip to the other side if you selected stars near the meridian, you may select this option in Autoslew first:



The above example is what I selected for this pointing file. It uses a star near zenith, one star on the meridian at around 60 degree (you can use you status bar options in the sky to display the current Alt and Azimuth of your cursor position), one star near the meridian at around 25 degree and the finally a star down East. It

does not make sense to measure stars that are too close to the North pole. You should also not use stars that are close to the horizon. I never select stars below 25 degree for my pointing files (you will also never make images there!).

### Making the pointing file

OK, back to our pointing file...

The first star I slew to is nearly always the star which I used to synch the mount because it will be at or close to the center of course.

Select the green telescope to slew to this star now.

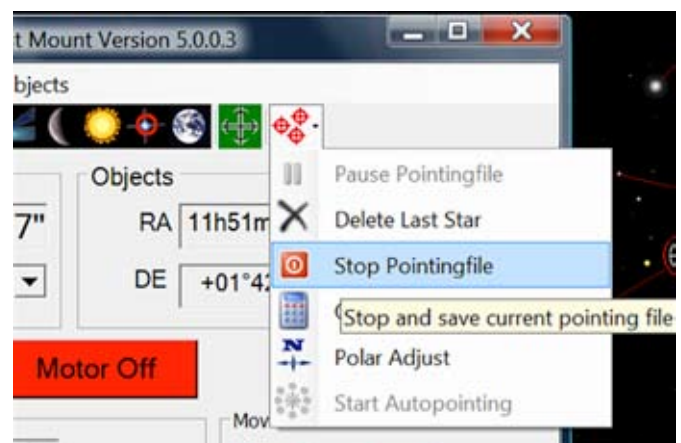
After the telescope finished slewing you will see a new symbol in the toolbar menu:



This is the button you have to click AFTER you have centered the star in your crosshair eyepiece or CCD. To center the star you can either use the Move-Controls or the joystick. To tell Autoslew that you have successfully centered the star you can also use the special function button 1 of your joystick or gamepad (you can configure your buttons in Control/Joystick). At the moment you press this button or the confirm center toolbar button, 2 positions will be saved in your pointing file (\*.poi). The first position is the catalog position of the star, the second position is the position where you really found the star after making the manual pointing corrections. Later Autoslew will use the difference to calculate the polar alignment errors.

For the first star, don't expect much pointing error because this was the star you synched on.

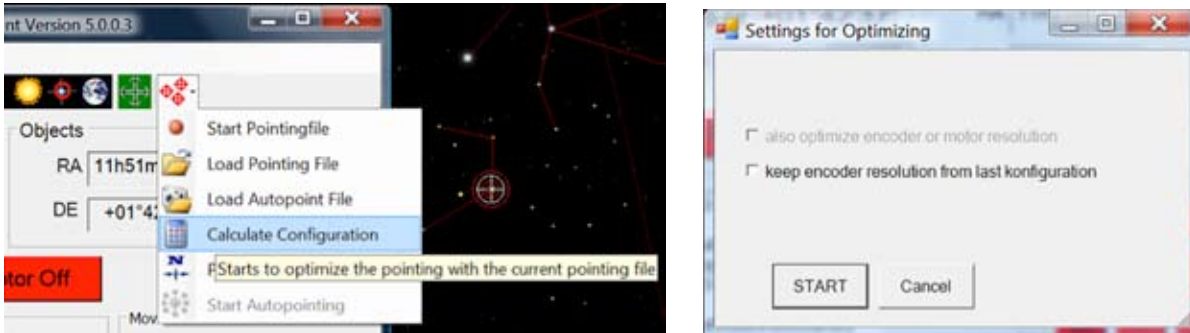
Now continue that procedure for the next 3 stars. So slew to the stars, center them and then confirm the centering to Autoslew. After you are done, click on the ToolStrip button Stop Pointingfile.



The pointing file has now been saved with the file name you have selected when you started the file. You can load and examine this file anytime with the ToolStrip button Load Pointing File.

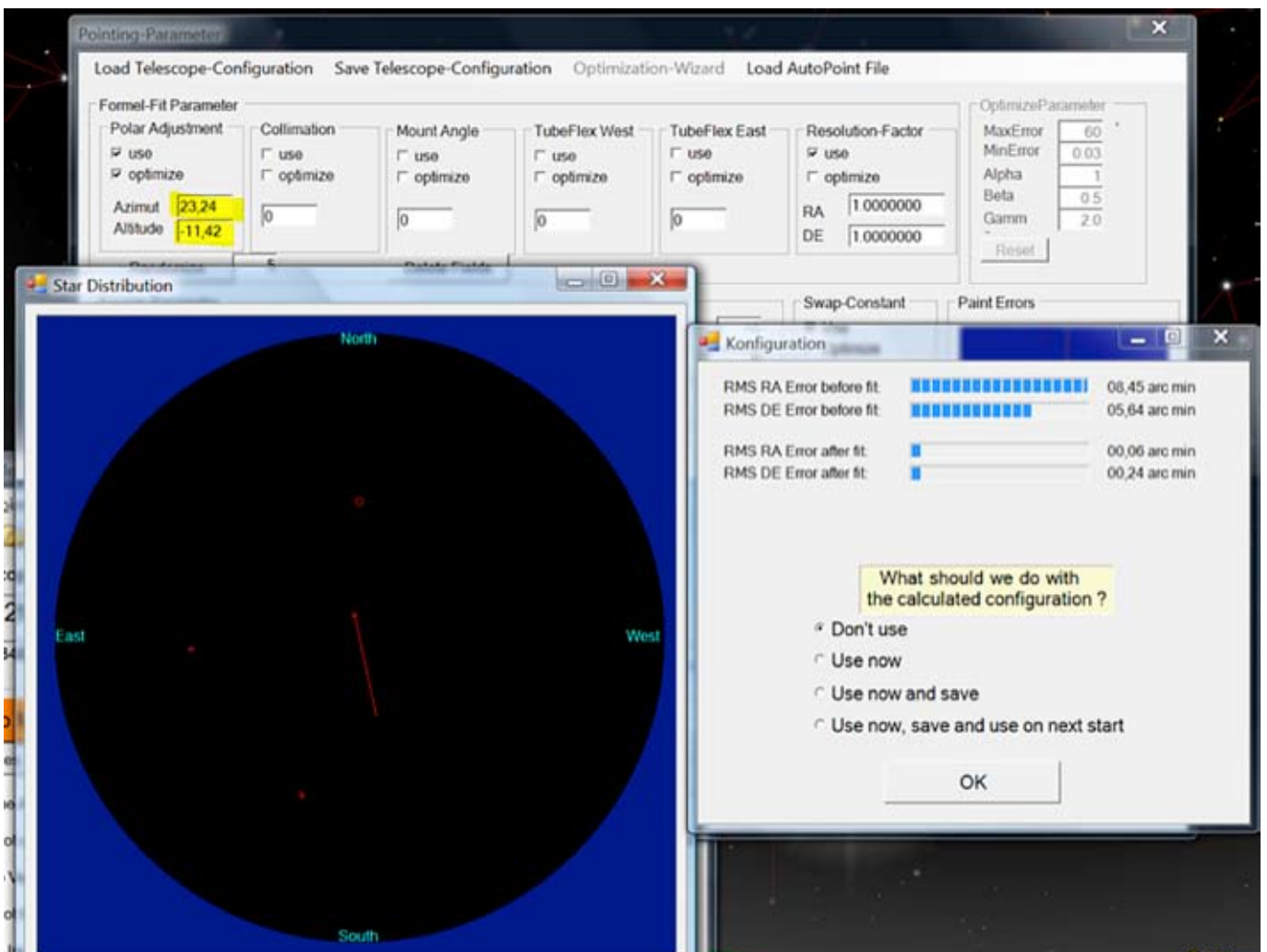
### Calculating a Configuration

After you have made a pointing file or loaded an old pointing file you can now use the Toolstrip button Calculate Configuration.



Just click Start on the next request and DON'T check any of the check boxes with the DDM85 (these boxes only make sense on mounts with unknown encoder resolution but the DDM85 uses an encoder ring with exactly specified encoder specifications).

Click [START]



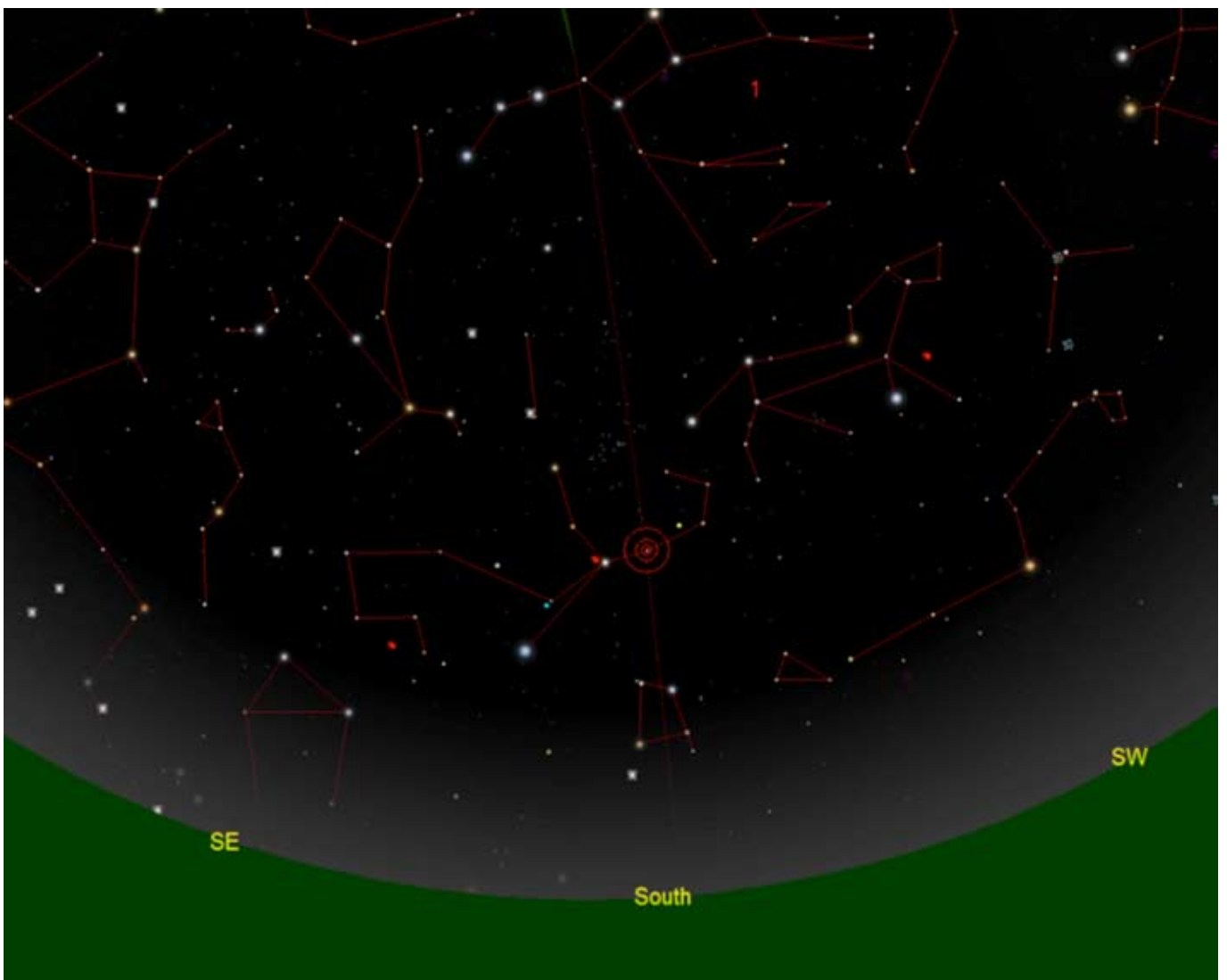
Several windows will pop open and the pointing model will be calculated.

The first window shows how the stars were distributed through the Sky and what error vectors have been measured. This serves only as additional information. You can also see the advanced pointing window in the background, where Autoslew has already inserted the measured Azimuth and Altitude pointing error. The window where you have to take some action now is the request window what to do with the calculated pointing model (we call this configuration). The window displays the pointing error that was measured in your pointing file and the pointing errors with the new calculated pointing configuration. If you click "Don't use", the model will not be used and erased. If you click "Use now" it will be used until Autoslew is stopped but not saved. If you select the option "Use now and save", the configuration will be used and a file dialog will open where you can save your

configuration for later use. But it will only be loaded on the next program start if you select the last option "Use now, save and use on next start". This last option only makes sense on final pointing models and not for our first polar alignment model so we will select the "Use now" option.

The configuration which also contains information about your polar alignment error is now in memory and use. We will now use it to correct the polar axis direction of the mount.

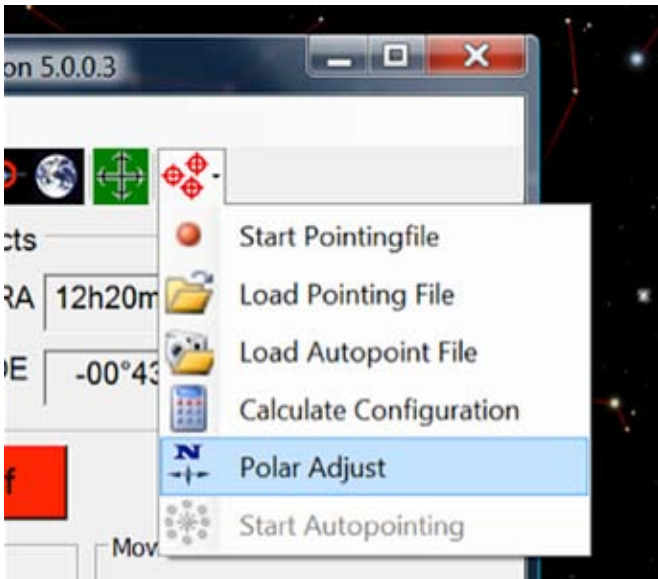
To do the polar alignment we have to slew to a star in the SOUTH now near the Meridian.



Please note, that I added the Meridian in TheSky/ Reference Lines.

Center this star in your eyepiece or CCD !

Click the Polar Adjust button now from the Toolstrip menu.



If you click the orange Move Star Now button, the telescope will move the star in Ra and Dec exactly by the amount that corresponds to the Azimuth and Altitude error but in the opposite direction.

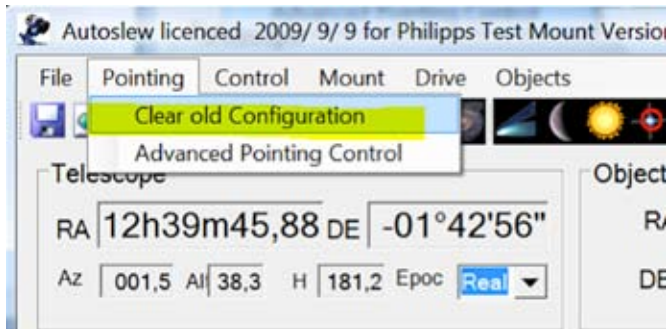
All you have to do now is use the Azimuth and Altitude adjustments of your mount to bring back the star in the field center. **Don't use Ra and Dec movements (Joystick or move controls !)** but only **Azimuth and Altitude adjustments !**

If you fix the screws of your mount after the adjustments you may note, that the star moved a few arc minutes. If it is too much, you should try to correct it again after the star is centered AFTER you have fixed the screws.

You can now repeat the process with the next pointing file to make sure your polar alignment is within the range you want to achieve. For permanent setups I would try to get the polar alignment to within 3 arc minutes, for transportable mounts like the DDM60 and small CCD fields 10 arc minutes is also sufficient.

Anyway, after making a polar adjustment you will ALWAYS have to make a new pointing file.

Since you have moved the mount and thus changed the configuration you should now clear the old configuration because it contains a model that was made before you moved the axis:



So click on Clear old Configuration and then make your new pointing file.

#### Suggestions for the pointing model after polar alignment

If you make a pointing file and measured, that your polar alignment is OK for your purpose and you want to make a bigger pointing file you don't need to clear the old configuration (as long as you did not move the polar axis). Instead you can use the calculated configuration of the old file to make your second pointing file. In this case, the pointing model will be used to enhance the pointing accuracy for the next file. It does not change the model but it will makes life easier for you because the stars will already be closer to the center. I am usually making a rough 4-7 star model, then calculate this configuration and then add my final pointing model (15-40 stars). Of course large pointing files only make sense in permanent setups!

With a German mount try to distribute the stars on both sides (West and East side). The pointing model will try to weight regions the most where you have selected the most stars. So it makes sense to use the most stars of your pointing file in regions where your most targets will be. In most cases this means that you don't need to select stars far down north or close to the horizon.

I should point out again that a 50 star pointing model is a complete waist of time if your telescope has problems with reproducibility.

#### Support:

In case you encounter a problem that you cannot solve on your own, ASA's technical staff can assist you through remotely accessing your Autoslew software. Should you encounter a problem, send us an email describing the nature of your problem (support@astro-systeme.at). We will then get in touch to arrange a remote session with you.