Autoslew-Manual

Security

A telescope is able to cause injuries so please read the following page.

1) Never slew the telescope if you are not in the dome and if there are visitors or other people in the dome.
2) Always take care that people are standing away from the telescope if you begin to move the telescope.
3) Always be ready to push the emergency button to stop the telescope.
4) Remove all items like ladders from the dome which the telescope could hit.
5) Never point the telescope at the sun if the mirror covers are open. The secondary mirror and eyepieces could be damaged or burned. Of course you should never use the telescope to observe the sun. Your eye will be damaged. Use smaller telescopes with proper filters to observe the sun and keep the large telescope closed.
6) Always unplug computer and telescope control from the 220V if you stop your observation. This will not be a 100% security against damages from lightnings but it will reduce the risk significantly.
7) Always take care that the height (altitude) sensor is activated during normal usage. Please check this every time you begin with your observation. Deactivate the height sensor only if you hit the height limit and the telescope cannot be moved any more. After you moved it out of the height limit immediately activate the switch again.

Basic knowledge for working with Autoslew

Although the following 3 pages might be sufficient for the normal usage of a good calibrated telescope we recommend strongly to read the full manual. You will not have to read it then during the night if something fails.

A) Starting the telescope

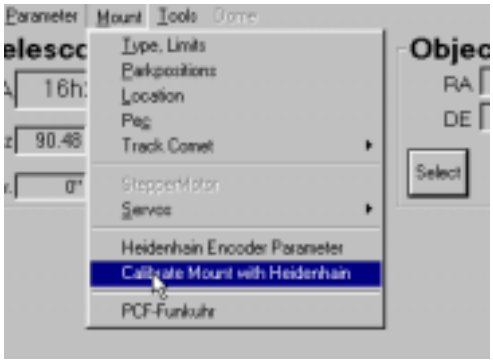
Please check that the Altitude sensor is activated (if you have one). Give voltage to the servocontrollers (control box) and the computer and start the computer. Check the computer time with an accurate clock. Every second error will cause 15 arc seconds error in RA. Start Autoslew.

B) Calibrating the telescopes position

Before you begin the slew the telescopes you should be sure that the telescope knows s current position. If the telescope thinks it points to Messier 13 but in reality it points to the orion-nebula it may try to slew below the horizon (that's why Altitude sensors make sense).

Autoslew checks if it is properly shutdown. If some system crash occurred in the last session there will be a warning in the message box (left picture). If this warning occurs some kind of calibration is necessary.

If Autoslew is terminated it always saves the last position on hard disc. If this user has properly used the telescope and left it in calibrated condition the telescope will know the right position for the next start (if the computer-time is set correctly). But since you do not know whether the former user has left it in calibrated position you should check the calibration. A rough check could be that the telescope is in park position (pointing to the zenith) and the altitude display in Autoslew shows about 90 degree. If Autoslew has crashed in the last session there will be an error message in the message-box.

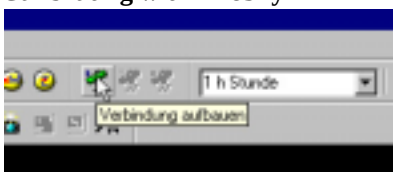


If this occurs or if there seems something wrong with the park position you should calibrate the telescope with the Heidenhain-Encoders (if you have them installed).

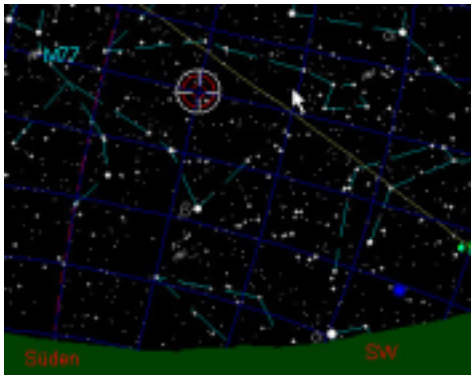
Point the telescope to the zenith (you can use the hand box or the mouse to do this) and click on Calibrate Mount in the Mount-Menu. The telescope will move about 10 degree in both directions and try to find the Heidenhain-reference marks. If calibration is finished the Heidenhain-window will close automatically. Please be patient and wait until this window closes.

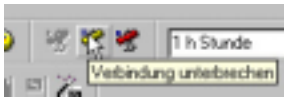
You can also calibrate Autoslew by pointing the telescope to a known star. This is even more accurate if you use an crosshair eyepiece or the center of your ccd. You can use Autoslew or TheSky to calibrate the telescope on a star.

Calibrating with TheSky



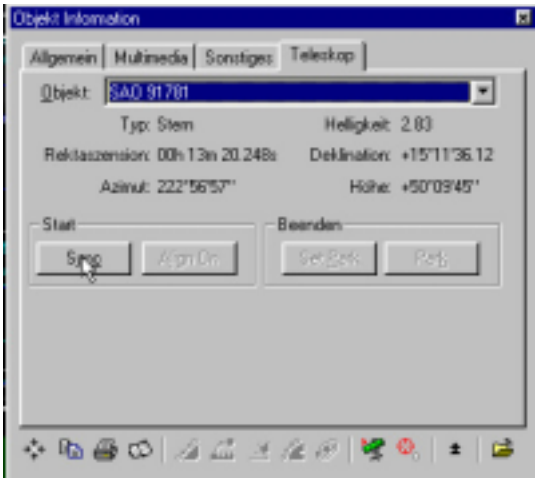
No matter whether you are running TheSky on the same computer as Autoslew or on a separate computer (Laptop) you will have to start TheSky and start the connection with Autoslew by clicking on the green telescope symbol. It will take some seconds until the connection is made and a white cross displays on the screen which shows the current telescope position. If you get an error message please try again.





One remark: The shown area of the sky is always centered on the actual telescope position. To display other objects you can put the connection on pause by clicking on the yellow symbol.

Please center a star in the telescope which you can clearly identify.

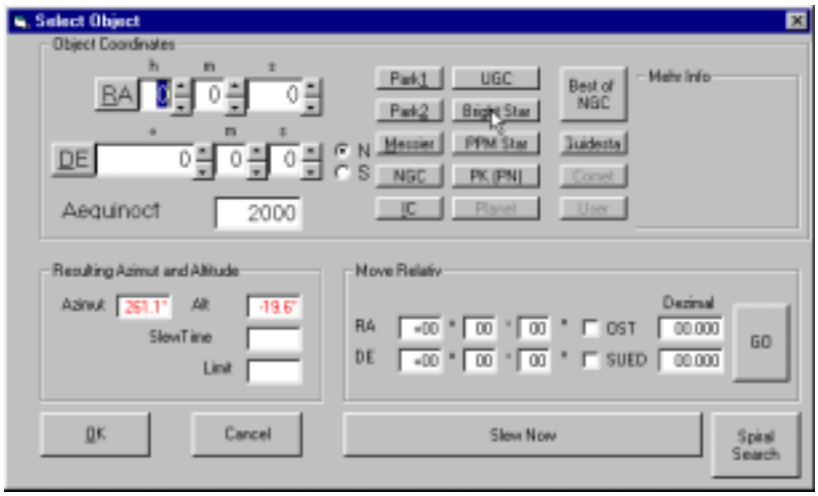


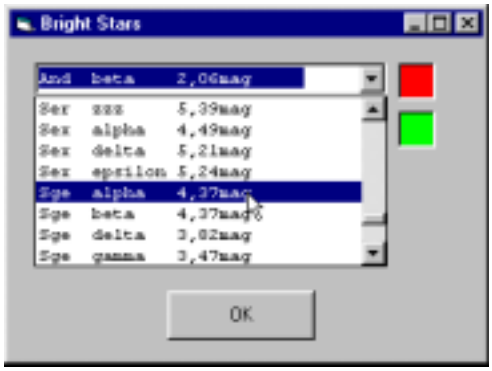
If you click with the mouse on this star a box will be opened with some object information. Check the red cross is really centered on this star and the magnitude shown in the object box of the star makes sense (sometimes a dimmer star near the star you wanted to use will be selected). Now click on [Telescope] and on [Synch] – the telescopes position will now be calibrated in Autoslew.

Calibrating with Autoslew

Click on the button [select] which you can find in the frame {Object}.

You will see the box which is shown to the right side. Now you can either enter the coordinates of the star in the RA and Dec field or you can select the object by clicking on [Messier], [NGC] etc.
You will see the altitude and azimuth of this object being updated. They will be green if the object is within the limits of the telescope (i.e. above the horizon).
For calibrating, stars are better used than deep-sky objects like galaxies. You can select a star if you click on [bright star].





If you then click on the above list (down arrow) you can select a star which are sorted depending on the name of the constellation. You can also type in the first letter of the constellation and the list will scroll to the right place.
You can also click on the button [sort to distance] and the list will be sorted according to the distance of the actual telescope position [quite useful if the calibration is already quite good].
Please confirm the selection by clicking [OK] for closing the star selection box and again [OK] for closing the Object selection box. Now you can synch the telescope by hitting the [synch] button.

Problems to reach a star with a non-calibrated telescope:

Sometimes it will happen that you will try to move the telescope by means of the hand paddle to a certain position but the telescope will slow down and stop before you reach this position. In this case the telescope thinks it hits a mechanical or altitude limit and thus stops the motor (which would make sense if the telescope would be calibrated correctly). In this case, synch the telescope on the park position (although you are not in the park-position) or some other object clearly above the horizon just to be able to move on to the desired star and synch on the star.

Synch and slew with a German type mount

With a German Mount you can reach stars on the meridian (south) with 2 different mount sides. In one case the counter weight axis will point towards the west, in the other case it will point towards the east.
In the west-side the mount will be able to follow the star until it reaches the horizon, in the east side it will hit some limit sooner or later.
This double meaning can lead to some problems. Imagine you have centered a star in the telescope. How can Autoslew know whether you have the mount in West or East side ? Also Autoslew does not know whether you want to slew to a star near the meridian in West or East side. So you will have to tell that to Autoslew.
There is a checkbox you can select in the menu <Parameter>+<TheSky/Guide>. It is named Auto-Synch. If you have checked this box Autoslew assumes that the telescope is roughly calibrated and will guess whether the telescope is in West or East side. If the box is left unchecked you will be asked every time you want to synch the telescope. The box should be unchecked in case Autoslew hang up or the side is completely lost.
If you are calibrating the telescope through TheSky software you have to change to Autoslew and answer the request about the telescope side. Autoslew waits until it gets an answer so after a while TheSky will stop the communication.
If you see a red button with „east limit“ or „west limit“ down in the status line you probably have made a wrong calibration.

For slewing to objects you can also select different options of how Autoslew decides whether to take the East or the West-side in the case both sides are within the limits. These options can be selected in the menu <Mount>+<Type,Limits> by hitting the button [Parameters]:
[Always ask]
If you select this option Autoslew will always ask you for stars near the meridian whether it should take the West or East side.
[Prefer West side (Photomode]:
You should select this option if you make imaging with long exposure times because if the mount is on the West side you will not have to switch due to a mechanical limit so soon.
[stay with current side but only it is possible to stay longer than]
This makes sense if you plan only short exposures or observations because you save time for slewing.

C) Slewing to Objects

As soon as the telescope is calibrated correctly and the mechanical limits are set you can start slewing to objects. You can set the acceleration and the slewing speed in <Parameter>+<Slewing Speed>. Select slow slewing speeds until you know the telescope.

Slewing with TheSky software

Once you have selected an object TheSky you can slew to the object by clicking on the little green telescope.

Slewing with Autoslew

You can select an object by the same procedure as you would synch. Instead of synch, click on <slew>.

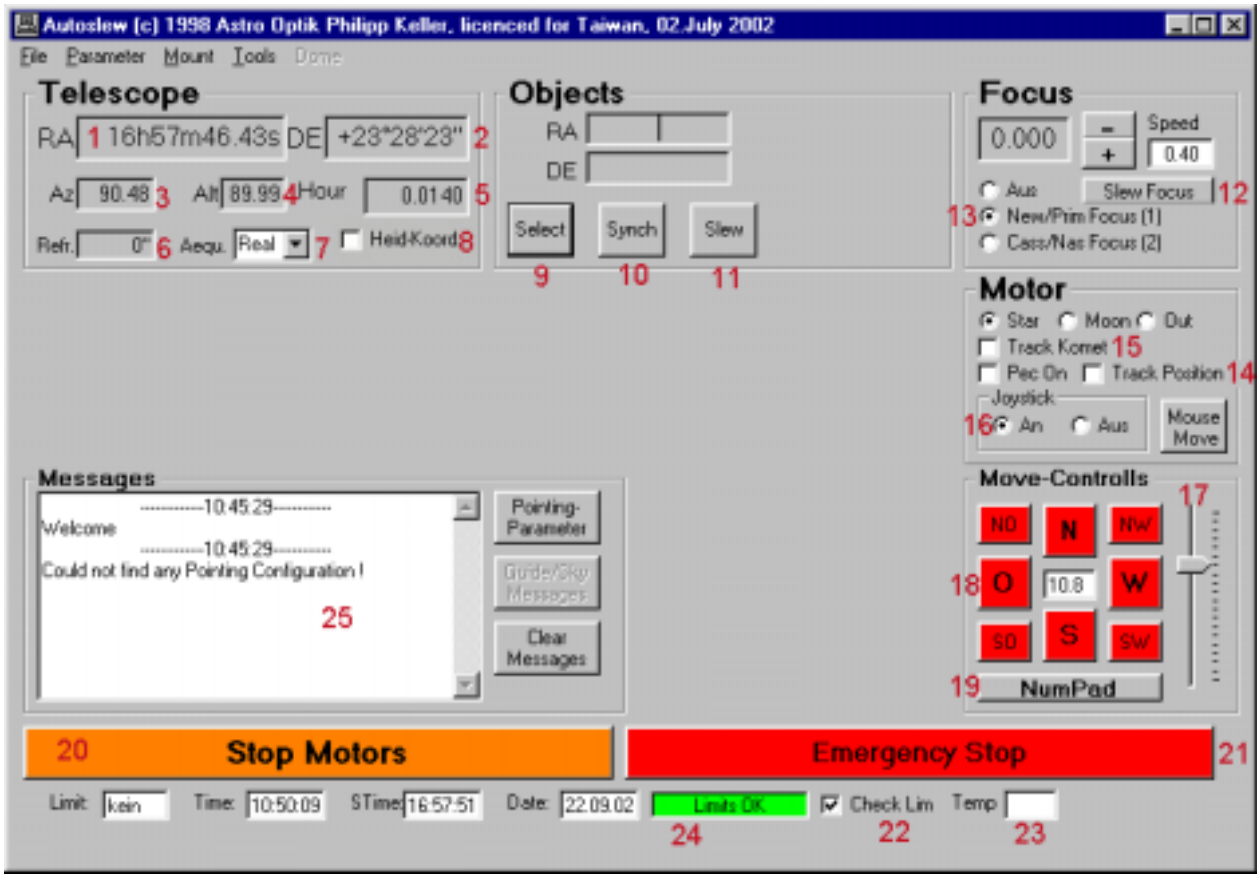
Interrupting the slewing

If you want to cancel the slewing progress you can use the cancel button in Autoslew or TheSky. Also pressing a button on the Handbox will stop the slewing. The motors will be stopped with a ramp.
If there is a dangerous situation you can also use the red button <emergency stop>. In this case the motors are stopped immediately without any ramp. This should be avoided in normal usage because it is bad for the mechanics. If the telescope does not stop after hitting the software emergency button please hit the hardware emergency button located at the telescope or control room.

Detailed Description

This description will be sorted mainly according to the menus of Autoslew.

The Main Frame:

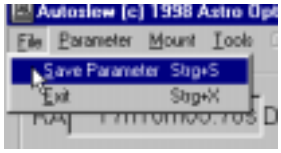


1. Display of the current telescope position right ascension
2. Display of the current telescope position declination
3. Display of the azimuth of the telescope. 0 is according to south, 90 = West, 180 = North and 270 = East
4. Current Altitude including refraction
5. Hour angle of the telescope. The hour angle is 0 at the meridian and upcounting towards the West
6. Refraction caused by atmosphere
7. Equinox which is used for the display of the current telescope position. TheSky and some other programs use the current equinox (real time) including nutation etc., therefore „Real“ is preselected if you start the program. You should select equinox 2000 if you want to have the same coordinates displayed that are often used in ephemerides of comets and asteroids.
8. If this box is checked the telescope determines its position from the readout values of the Heidenhainencoders. These encoders display the position at the axis of the telescope without any gearing errors and are thus more accurate as the positions of the servo-motors. If the box is left unchecked the position is determined from the position of the servo-motors. This can be used if the Heidenhainencoders are not working properly for some reason.
9. Here you get into the objectmenue where you can select objects or stars for slewing or synch.
10. If you have selected an object you can synch the telescope here.
11. If you have selected an object you can slew to the object here.
12. With <Slew Focus> you get into a more detailed focus menu
13. Here you can select from different focus positions.
14. This is an important check box. If it is checked the telescope will try to freeze the position and will also use the modelled pointing errors determined by a pointing file. If you have selected the Heidenhainencoders for position it will also correct every gearing error in real time. You should select this if you do unguided imaging.
15. Track Comet will allow you to track to comets or other moving objects. It will only be active if Track Position (see the last point) is activated. You can set the speed in the menu <Mount> + <Track Comet> in arc seconds per minute.

16. You can also use a joystick to move the telescope.
17. You can move the telescope around with the mouse of your computer. With the slide bar you can determine the speed of the telescope. The selected speed is displayed in the center (in units of sidereal speed which is 15arc seconds per second).
18. These are the different directions where you can move the telescope (N,S,E,W,NE...)
19. If you click on this button you can move the telescope with the numpad of your keyboard.
20. The motors will be stopped with a ramp.
21. The motors will be stopped immediately without a ramp. Only use this or the hardware limit switch in emergency or if you think the telescope will not stop before some mechanical resistance if you would use a ramp.
22. Check Limits should be activated all the time and only be unchecked if you want to observe at some forbidden position. Please note, that the telescope should not point below the horizon at no times.
23. Temperature at the telescope tube (measured at the truss tubes)

File

Save Parameters: Parameter which you may have changed in the menus, will only be permanently changed if you click this button (or press Strg+S). There are also some parameter where you will have to save and restart Autoslew like comports, gearing reduction.

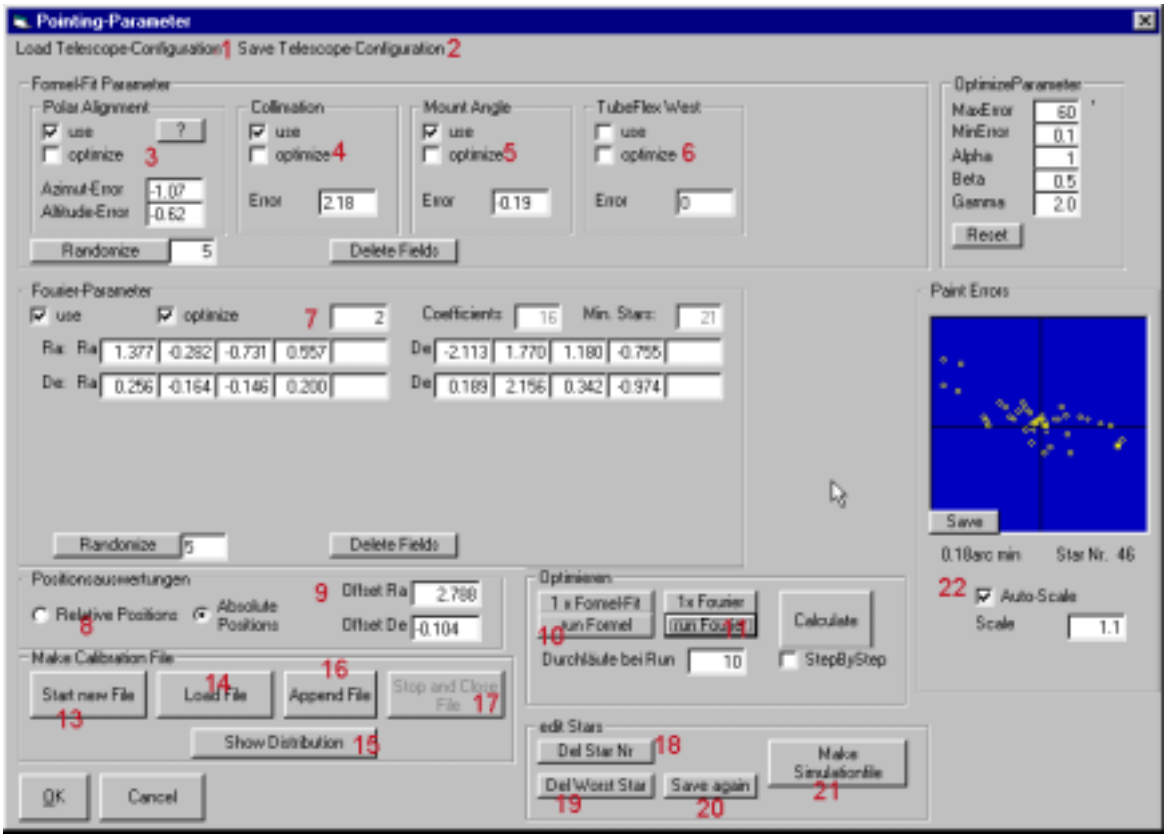


Parameter

Pointing: Here you get into the pointing menu
SlewSpeed: Here you can set the slewing speed and the acceleration (ramp)
Focus: All focus parameters can be set here
Joystick: Joystickparameter
Handbox: Here you can chose which speeds will be set at the handbox. You have 4 different slewing speeds and 2 focus speeds. The lowest speed should be set that it is suitable for guiding which is usually between 0.2 and 0.7 sidereal speed.
Refraction: Enter the temperature and air pressure here (air pressure at see level, not at your height).
Comports: Select the comport for the communication with other computers (TheSky) here.
TheSky/Guide: You can select whether to use Guide or TheSky.
Trackposition – Aggressiveness: If Track Position is activated the telescope tries to freeze the position. When a difference between this position and the real telescope position is observed Autoslew will move the telescope back to the freezed position. This value determines how fast it will try to bring it back to the freezed position. High values are good for bad gearing when the telescope has to react fast to errors whereas lower values should be used for good mounts to average through some Heidenhain readout cycles. Very high values can cause the telescope to overshoot.
Trackposition – Maxspeed: If you move the telescope by more than this speed track position will be deactivated. The units are sidereal speed.

Parameter in Detail

Pointing



1. Here you can load a telescope configuration. This means a set formal fit or Fourier parameters that have been optimised with a pointing file. Usually you will only use one configuration but for heavy instruments at the focuser you may want to take another pointing file and save the optimised values. If you want a configuration file to be loaded automatically after Autoslew starts you have to go to the main screen and select <File> +<Save Parameter>.
2. Here you can save a configuration.
3. In the frame **Formal Fit Parameter** you will find the values for the **polar alignment**. The checkbox „use“ means that a value is really used in the calculation of the telescope position. If you have checked the checkbox „optimize“ this value will be optimised in the next optimisation run.
4. **Collimation error:** The optic can be collimated but the optical axis not aligned with the tube. In a fork mount the critical error is that the optical axis has some angle in West/East direction. North/South is uncritical because this is just an offset in Declination. On a German Mount the critical error is the telescope to have an angle on the cradle plate. This error can be directly measured at a German Mount by slewing a star at the meridian from West side and then from east side. The difference in right ascension will be twice the value of this collimation error. You can correct this mechanically.
5. **Mount angle:** At a fork mount this error is a difference in the length of the forks, at a German Mount this error means that RA and Dec axis are not perpendicular.
6. **Tubeflex:** This parameter determines the amount of flex in the tube which depends on the altitude of the telescope
7. **Fourier-Parameter:** Another method to optimize a pointing file is to try to fit the pointing file by means of a Fourier development which means to fit it by a set of sinus and cosinus functions. The order defines the number of variables which is 8 if the order is 1 and 16 if the order is 2. You should always have much more stars in your pointing file compared to the number of variables you want to optimize. Often the results if you use Fourier Fit are better than with Formal Fit, but sometimes it makes sense to first optimize some Formal Fit variables like Polar Alignment and Collimation Error and leave this values checked (Check Use but uncheck Optimize) and add a Fourier optimisation.
8. Here you can select between **relative** and **absolute** position. If you select relative, only the difference between 2 stars will be evaluated whereas in absolute mode the absolute position of each star counts. Relative positions make sense if you use friction drive without Heidenhainencoders or stepper motors where

in both cases some errors can accumulate. If you have Heidenhainencoders always make a calibration on Heidenhainencoders before you measure a pointing file and make sure the time is set correctly. Then you should use absolute position. You can also merge the pointing file from several files in an editor but then change the number of stars that you find in the beginning of the file.

9. This is the **Offset in RA** and **Dec.** These values only make sense if you use absolute positions. A large error means that you did not calibrate the mount correctly.
10. If you click this button, the variables for Formal Fit will be optimised. If you click <run Formal>, the optimisation routine will run 10 times from different starting points and will select the best solution. Use this with a fast computer.
11. Here the Fourier-variables will be optimised. <**run Fourier**> will run the routine 10 times and select the best solution.
12. **<Calculate>:** In the picture to the right the errors will be displayed and the RMS and PV value calculated, another window will also open where the star distribution and error vectors will be displayed.
13. If you want to make a pointing file (slewing and center several stars) you can start a new measurement here.
14. With **<Load File>** you will load an existing pointing file for the optimisation of the parameters. Please note that after you ended and saved a file you have to load it to start optimisation routines.
15. Here you can take a look at the **Stardistribution**. You should try to cover the complete sky but with more stars at regions where you will mostly observe, like the meridian to the zenith. Do not center any stars at places where you will hardly ever observe like close to the horizon or deep north. In addition to the star distribution also some error vectors will be displayed (with RA left/right and Dec up/down). This makes only sense if you have Heidenhainencoders and selected absolute position instead of relative positions.
16. With **<Append File>**, you can add more stars to an already existing pointing file
17. <**Stop and Close File>**: Here you can stop and save a pointing file
18. With **Del Star Nr** you can delete a certain star. Check the number of the star first by checking the box „Step by Step“ and click on paint errors every time.
19. With **Del Worst Star** you will delete the star with the largest position error. It makes sense if you have some stars which have unlikely large position errors (maybe you centered a wrong star).
20. If you have deleted some stars and thus changed the pointing file you can save the new file with **<Save again>**.
21. Here you can create a Simulation File to try the optimisation.
22. In this picture box the position errors of the stars (with RA horizontal and Dec vertical) will be plotted. The average position error will be calculated. The maximum position error will be half the size of this box (size in arc minutes is displayed).

Making 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 flex

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.

Starting a pointing file:

Click on the button <**start new file**>. Now start slewing to stars either with TheSky software or the bright star selection in Autoslew. Do not use deep sky objects since the position is not very accurate. After the telescope has reached the position and stops you have to use the handbox or mouse control to center the star. Use a cross hair eyepiece or a video camera with some position mark on the screen. After it is centered please click the button in the main frame <please click here if the star is centered>. This button is only visible if you have started a pointing file and Autoslew waits for this confirmation. Please do not slew to a next star without centering the star and confirm that with this button ! **Also never use the synch command during a measurement !**

With every slewing and centering Autoslew will both save the coordinates before centering and the coordinates after centering. The difference is the position error at this position and is used to make a pointing model. The sense of the pointing model is to use this error if you later point the telescope to the same position (or near).

Please only read this if you want to understand what a pointing model is:

From a mathematical standpoint you can describe common telescope errors by a function with variables. For example the error in the hour angle caused by a polar misalignment will be $d_H = \tan(Dek) * (d_{Alt} * \sin(StW) - d_{Azi} * \cos(StW))$*, with* d_{alt} *is the variable for the polar height error and* d_{azi} *the variable for the azimut error. During optimisation of a pointing file Autoslew will calculate the average pointing error and fit the variables to minimize this error.*

Please note that if you want to fit a function to several measuring points (in our case stars) you can fit even an elephant if you optimize enough variables. This means for our case that you should try to have as much stars as possible and only optimize 1 parameter for about 3-4 stars. So to optimize the polar alignment, the collimation and the mount error (4 variables) you should at least make a pointing file with 12-16 stars distributed all over the sky.

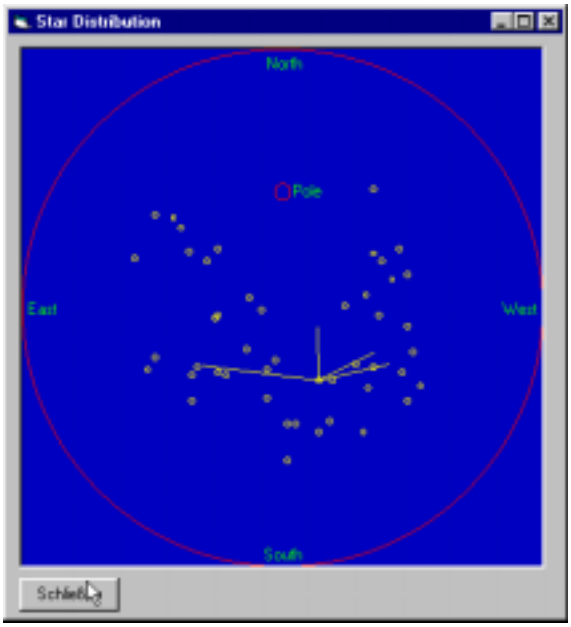
Example of a real pointing file and its optimisation

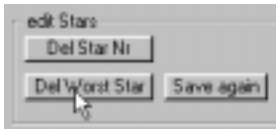
This is a typical pointing file for a telescope with Heidenhainencoders after a rough polar alignment:

1. Load an existing pointing file.

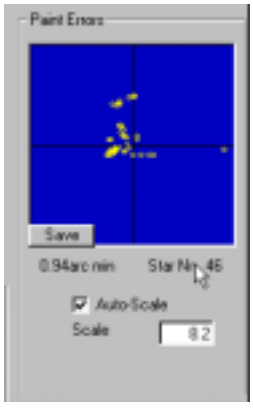
Please note that even if you have just made a pointing file it is not in memory so you will have to load it again before starting to optimize.

Set the values in all the fields to zero. Select the option absolute positions and click on <**calculate**> to take a look at this pointing file. You will notice, that not only the errors will be painted in the little box in the left side of the screen but also the star distribution with an error-vector will be painted. For example if there is a line from the little circle pointing upwards means that there was a large error in Declination. You will notice furthermore, that some of the stars have large errors compared to the average error. Maybe something went wrong during this measurement and you may want to delete this star(s).

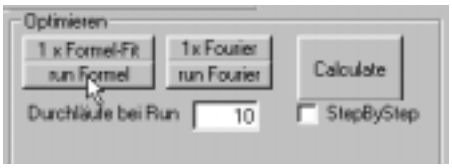


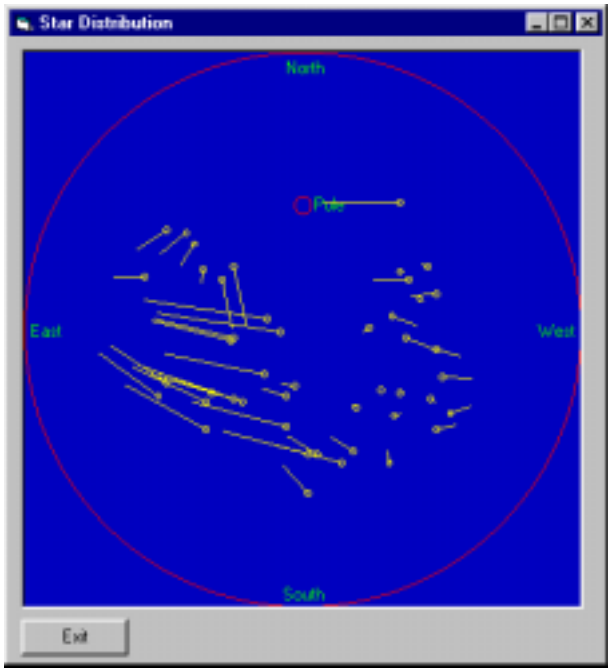


You can do that if you click on **Del Worst Star**. This will remove the worst measurement from the database. Please note that the errors are always scaled according to the maximum error. You can check the RMS-error below the picture box with the pointing errors. In the left you can see an example how the file looks like after you have removed the worst stars. The average pointing error is 0.94 arc minutes, the maximum error 4 arc minutes (since the scale of the picturebox is 8.2 arc minutes.



Now check the boxes „optimize“ in the formal fit parameters at the polar alignment, Collimation and mount angle error like is shown on the next page.

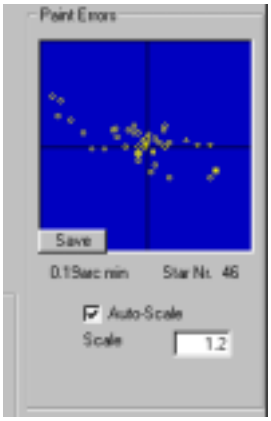




Click on <**run Formal**> now. Autoslew will now try to optimize the parameters that you have allowed for optimisation. This is done by simulating the measured pointing procedure with the new formulas and minimize the RMS pointing error. Please note, that the RMS error is reduced, not the maximum pointing error. 10 optimisation runs will be calculated and the best result will be displayed in the end.
Now the RMS pointing error has been reduced to 0.38 arc minutes and 2.1 arc minutes maximum error.

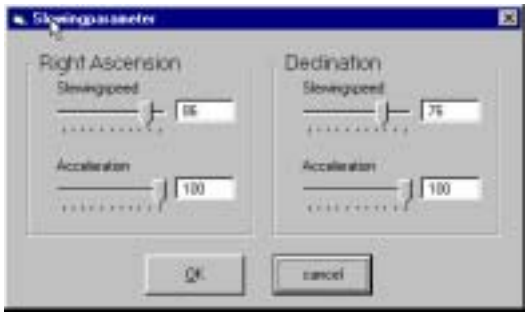
Activate now the check box „optimize“ in the Fourierparameter frame. Please note, that the optimize boxes in all the formal fit parameter will be automatically unchecked. This means that if you optimize the Fourierparameter the values of the formal-parameter will be used but not optimised together with the Fourier-parameter in one run.
For the number of coefficients you can enter 2 since we have a quite large pointing file with 46 stars. If you have less stars, enter a 1 here.

Now click on <**run Fourier**>. After the 10 optimisation runs the best solution will be displayed. You can click several times and watch the solutions. The best solutions are those that have the smallest pointing error but also the smallest values of the optimised variables. As final result you will get a pointing error of around 0.2 arc minutes (11 arc seconds) and a maximum error of 30 arc seconds.



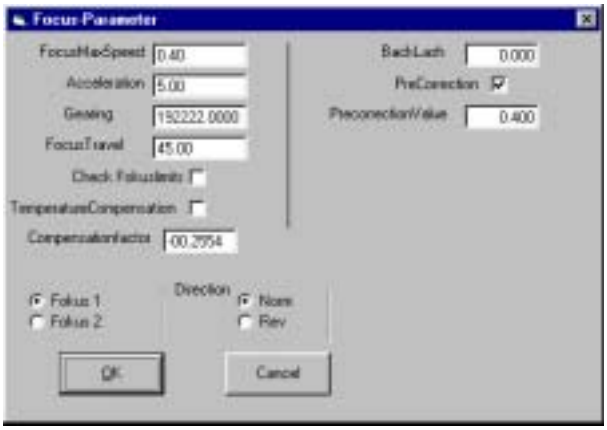
If you are satisfied, you can save all the variables in a configuration file (extension *.cfg) by clicking on <Save Telescope Configuration>. If you want that this configuration is automatically loaded in the next program-start you have to click on <Save Parameter> in the main Autoslew window.
As a final step, please run Autoslew again,. Check that the configuration file is loaded (it will show up in the message box). Make a calibration run, center a star in the zenith and synch. Then, calibrate the Heidenhainencoders again. This usually gives the best accuracy.

Parameter / Slewspeed



Here you can input the slewingspeed and the acceleration that is used during slewing of the telescope. If you have position errors during slewing, please reduce the slewing speed and maybe the acceleration. Also in public use you may want to reduce the speed due to safety reasons. In most cases, the dome will be the limiting factor anyway.

Parameter / Focus



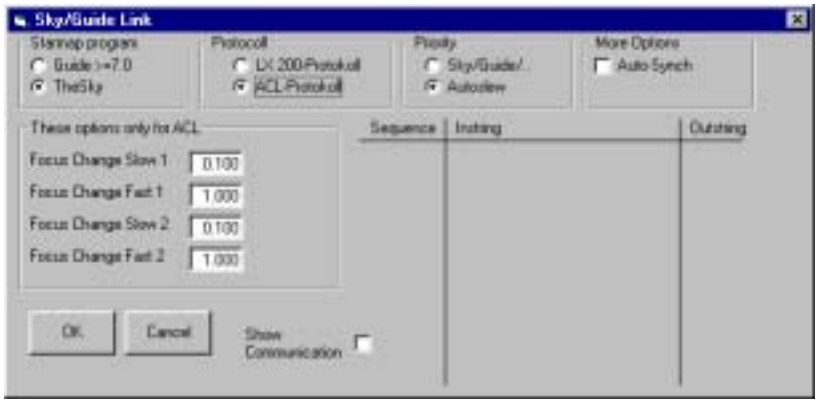
FocusMaxSpeed: Focusspeed during slewing and maximum speed for manual focusing.
Gearing: You have to change that parameter until the real movement of the focuser and the displayed value is in synch.
FocusTravel: This is the difference between the fully racked in focuser and the fully racked out focuser.
Check Focuslimits: If you have checked this box, the focuser will not travel below 0 and beyond the FocusTravel. You can use that to prevent the focuser from hitting the mechanical limit.
TemperatureCompensation: If this box is checked, the temperature is measured (you need a detector of course) and the focuser is moved if the temperature falls. Please note, that the position display of the focuser is not changed during this move because the internal position calculation is corrected by this shift.

Compensationsfactor: This is the focus-movement per degree centigrade. The value can be determined by measuring it or it can be calculated from the distance between the mirrors and the expansion coefficient of the tube. Positive values mean that the focus position is increasing with increasing temperature. For cassegrains, the value is usually negative because an increasing distance between the mirrors mean a decreasing value of the focus.
BackLash: If you have mechanical backlash in your system you can input that here. However it is nearly always better to use Precorrection and set this value to zero.
PreCorrection: Precorrection will force the focuser only to reach the final focus from one direction. So if you slew to a certain focus position that is further out, it will move a little more than needed and go back by the amount determined by the PrecorrectionValue. In this case, all back-lash is compensated in any case.
PreCorrectionValue: This is the value the focuser will moved further out before the wanted focus is reached. If the value is negative, the focuser will focus further in before reaching the final value.

Parameter / Handbox

You can select 4 different speeds at the handbox. The values of these speeds can be set here. You can also set the focus-speed and switch the buttons of the handbox. If you click on Init ComBox the Handbox will be reset if there was some communication problem.

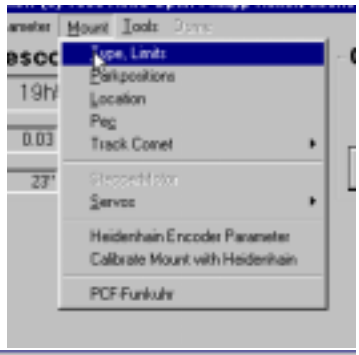
Parameter / TheSkyGuide



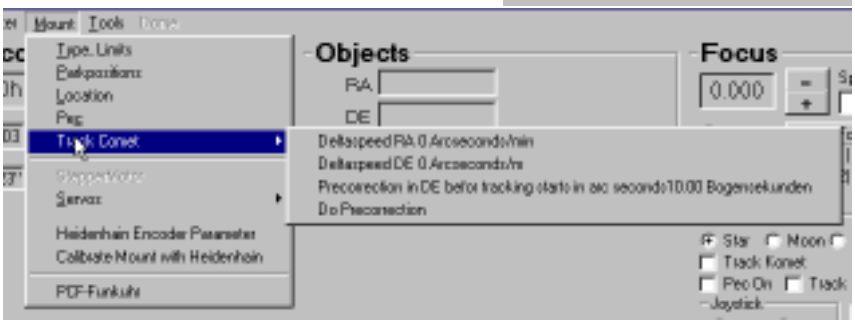
Here you can input some parameters that influence the communication between Autoslew and the server like TheSky or other programs. If possible, select the ACL protocol since it is far more accurate. If you have checked <**Show Communication**>, all incoming and outgoing messages will be shown. This is useful if you are writing your own code to communicate with Autoslew.

Auto-Synch: This is only for German Mounts. Please read the explanation in the beginning of this manual at **Synch and slew with a German type mount**. If this checkbox is selected Autoslew will guess from the last position whether the mount is on the West or East side. You should uncheck this box if the position of the mount is completely unclear before calibrating.

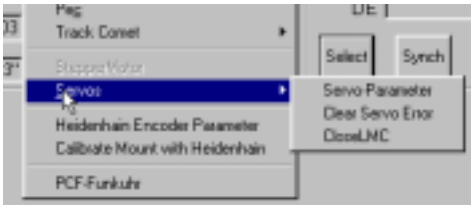
Mount



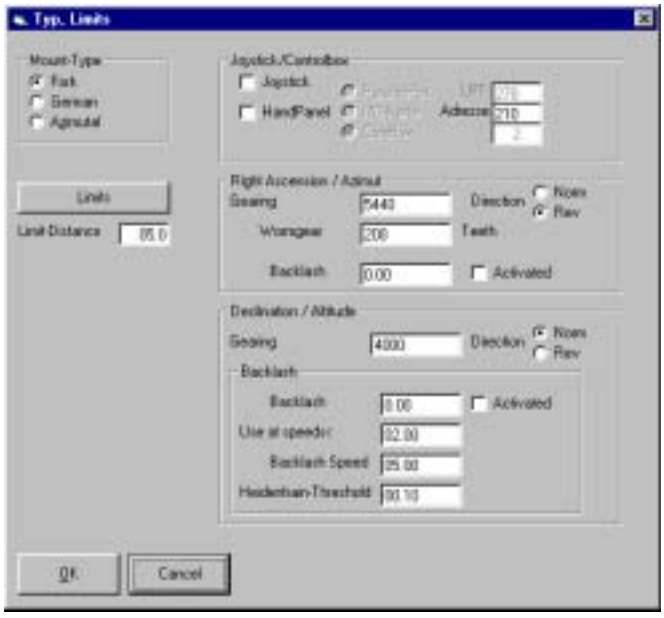
Typ, Limits: Select type of mount, gearing reduction, limits etc. here
Parkpositions: Define here your park-positions that you can select for slewing in the Object-Menu.
Location: Define here the location of the telescope
Pec: Here you can measure the PEC file for later usage. Do not use PEC with Heidenhainencoders. Use PEC only if you have a Worm-Gear and no Heidenhainencoders installed.
Track Comet: You can input here the speed that is used to track on moving objects. It is the difference to sidereal speed. To activate the speed you have to check <**Track Position**> and <**Track Comet**>. A precorrection makes sense to get rid of any backlash especially if you do not have any Heidenhainencoders.



Servo-Parameter: You get into a large Servo-Menu that will be described later.
Clear Servo Error: No meaning right now.
CloseLMC: No meaning right now.
Heidenhain Encoder Parameter: You get into the Menu where you can input some more parameters for these encoders. You can also synch the Heidenhainencoders here.
Calibrate Mount with Heidenhain: If you have installed Heidenhainencoders you can calibrate the mount on the reference marks of the encoders. Bring the telescope roughly in Park-position and start the reference drive. The telescope will move by appr. 10 degree until it has hit 2 reference marks. The calibration run is finished if the Heidenhain-frame is closed. If the telescope moves more than 10 degree there may be a problem to detect the reference marks. Stop the reference drive then and try again.



Mount / Type,Limits

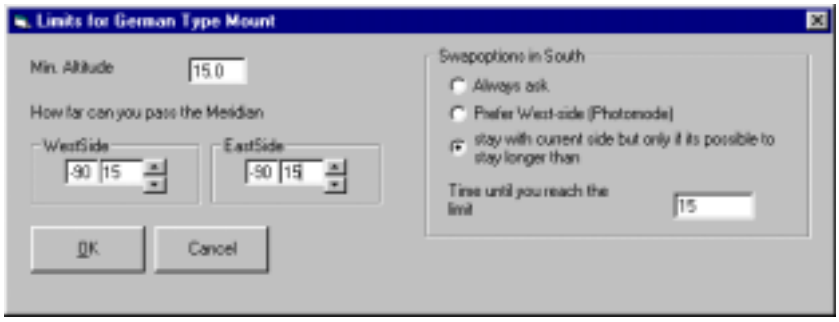


Mount-Type: Select here the type of mount you are using. Restart the program if you changed this option.
Controlbox: Input here which kind of handbox you are using. Select the comport if you are using a LCD-Combox.
Gearing: If you are using a frictiondrive you should hand-fit this value according to your slewing results.
Wormgear: Input the number of tooth here. This number is needed for the PEC control.
Backlash: Use this only in Declination.
Use at speed < : The Backlash is only corrected if you are moving at slow speed, for example during guiding.. Input the limit in units of sidereal speed.
Backlash Speed: This is the speed that is applied during the back-lash correction. Try the best values where it is correcting fast but not overshooting.
Heidenhain-Threshold: If you are using Heidenhainencoders backlash can be realtime corrected. If you change direction, the mount will move with the Backlash Speed until it recognises that the measured position at the Heidenhainencoders is changed. Since the measured Heidenhainposition is always influenced by some noise in the readout of the Heidenhainencoders you have to determine a Heidenhain-Threshold. It should be below the seeing but larger than the typical readoutnoise of the encoders. Typical values are between 0.1 and 0.3 arc seconds.
Limitdistance: If you come closer than this value to a Limit (for example the Altitude Limit) the telescope will be slowed down. The value should be large enough to be able to be slowed down before reaching the limit. If you have a fast acceleration this value can be smaller and it should be large with fast slewing speeds and slow acceleration.

Limits at Fork-Mounts

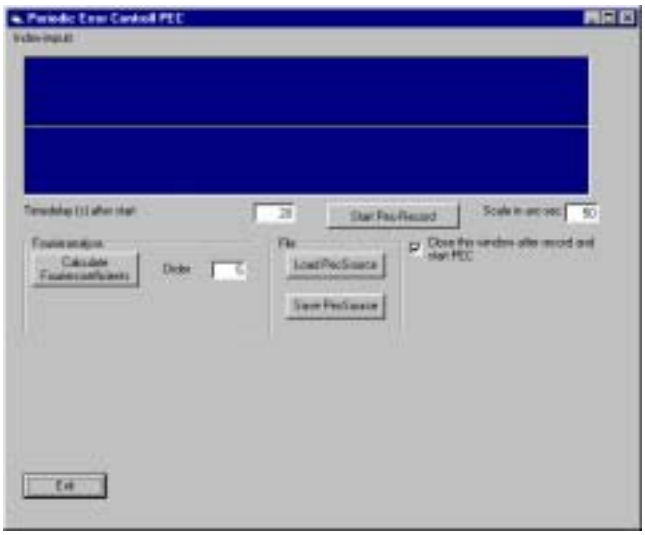
The first limit at the fork-mount is the Altitude-Limit. The telescope will not move below this Altitude. You can also input the limits for the hour angle and if it is allowed to swap the telescope through the fork. It is usually better not to slew the telescope through the fork and better input 180 degree for the hour angle limit.

Limits at a German Mount



You can input here not only the Altitude limit but also how far the telescope can be slewed over the meridian.
You can input different values for every declination but in most cases you will input the same number for every declination.
You can find out this value if you synch on a star with the mount in West-position and then move the telescope to the East until you hit the mount. The Swapoptions have already been described in the beginning of this manual.

Mount / PEC

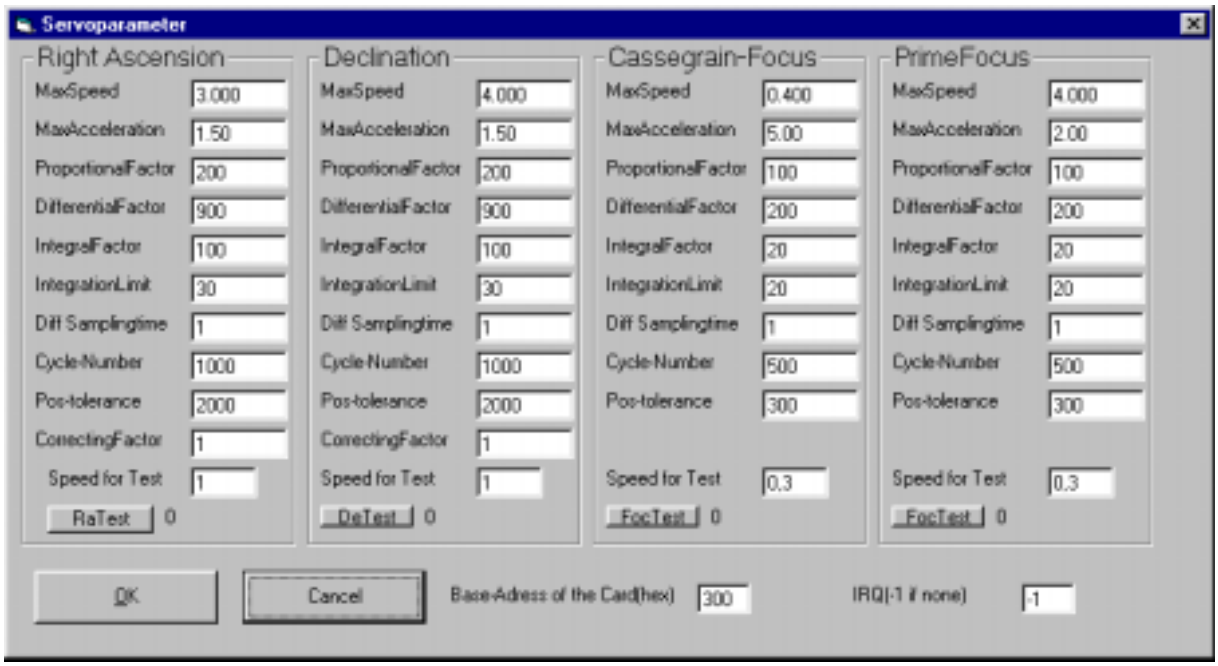


To activate PEC you have to record a PEC file first. For a correct file you need to set the tooth-number correctly in the menu <Mount>, <Type,Limits>. Guide a star with a tracking CCD or with an eyepiece at high magnification, click on <**Start Pec-Record**> and guide for one complete revolution. You don't have to touch the declination, concentrate on a good guiding in RA.

After you recorded the PEC function you can average the function by a Fourier-transformation. The original function is displayed red, the averaged function is displayed yellow. You can also input the order of the Fouriertransform. A high order fits the function closely but you may want to choose an order number below 10 to average out seeing and random effects. A order of 1 fits only the main sinus.

Mount / Servos

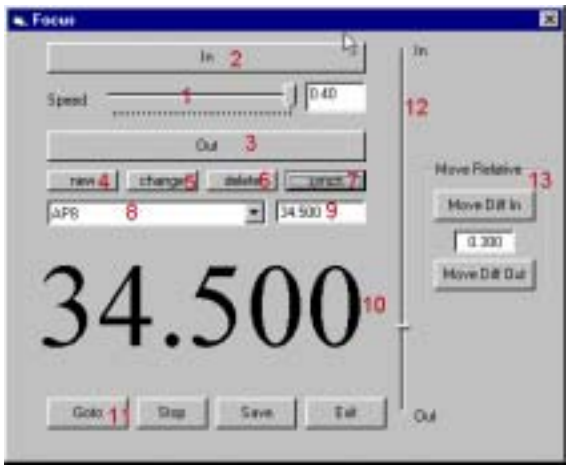
These parameters should not be changed unless you have installed the telescope or some changes have been made to motor/gearing or electronics. Entering the wrong numbers here can damage the telescope. Before you change the values please make a copy of the Autoslew.ini file and save it on disc or some other directory.
Maxspeed: This is the absolute maximum allowed speed in degree per second. If this value is to high it will result in some position errors and warnings during usage.
MaxAcceleration: Maximum allowed acceleration in Degree/s^2.
Proportionalfactor: For the control of the servomotor a PID-controller is used. The proportional factor determines how strong the current is increased if some difference from the wanted position is measured to get the motor back to the wanted position. Large proportional factors result in a very "hard" drive but may cause oscillations whereas to small factors result in a weak and not accurate drive. You can check the quality of the servo by checking the RA-display in Autoslew.
Differentialfactor: This is the counterpart of the proportionalfactor and is set to dampen the oscillations. To large but also to small factors here will make the drive noisy or will start oscillations. A good starting point for the differential factor is to set it to about the same value as the proportionalfactor.
Integralfactor: If the drive is constantly moved in one direction usually the drive will hang on the opposite side. The integral factor integrates through these position errors and forcing the drive to the right position. A good starting point is about 1/10 of the differential factor
Integrationlimit: This is the limit for the integrationfactor.
Diff. Samplingtime: Don't touch this. It should be set to 1.
Cycle-Number: Number of lines on the encoder. The true resolution will be 4x this value because you have 2 tracks (A and B)
Pos-tolerance : The drive is constantly comparing the measured position (from the encoder readout) with the wanted position. If the difference gets larger than this Position tolerance value, the drive is stopped. A reason for large position errors that may stop the motors can be a bad balanced telescope, emergency stop, some limit hit, or some over/under voltage at the servo-amplifiers. If this value is small the telescope till stop immediately if some problem occurs like hitting a mechanical limit but on the other hand it will then react to sensitive against a small in-balance of the scope.
Correctingfactor: set to 1 every time !



Mount / Heidenhainencoder

The only point that should be touched by the customer is the command <Functions>+<calibrate Heidenhainencoder> in the above menu. This is used to calibrate the reference marks of the Heidenhainencoders. After a calibration run is made the telescope knows its position relative to the encoder-bands. But to tell Autoslew the position relative to the sky (the position of the encoder bands in the mount) the Heidenhainencoders itself have to be calibrated.
To do this you have to start Autoslew, check the computer time and make a calibration run in the main frame (telescope moves 10 degree in both directions). It may happen that the telescope is now completely out of synch. Then center a star and synch on this star. After that, open the Heidenhain-Menu, select <Functions>+<calibrate Heidenhainencoder>. Now the telescope is completely calibrated and know its position after starting Autoslew and calibrating on the Heidenhainencoders.

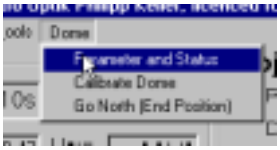
Tools / Focus



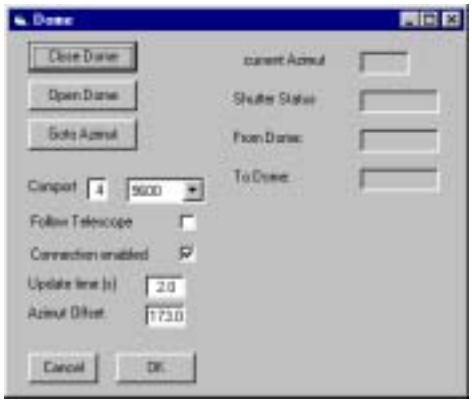
If you click on Tools, Focus, you get into a focusmenu. It can be used to focus ccd-cameras. With the

1. Here you can select the speed that is used to drive the focuser as long as you are in this frame
2. Focus in here
3. Focus out here
4. New: Here you can enter a new focus-name and input a focus position
5. Change: You can change a selected focus-name here
6. delete: Delete a focus name
7. Synch: Synch the focuser at the selected focus name
8. Here the selected focus name is displayed.
10. the current focus position is displayed here
11. With Goto the selected focus name and focus position will be slewed.
12. This slide bar shows the position relative to the focus-travel (you can input this value in Parameter/Focus)
13. If you focus a CCD it makes sense to make an initial guess of the focus position and then focus in and out by the same value. Then the in and out-focused images can be compared to estimate whether the initial focus was correct. Unsharp images are often better compared than images near the focus.

Dome



We have up to now implemented a dome protocol for Baader domes but we can of course add some other protocols here if good suggestions will made.
Baader uses a reference mark that sets the dome position to zero. But as long as the power is not turned off the dome does not loose its position and so it is not necessary to make a reference run every time.
Calibrate Dome: The com-connection to the dome will be opened and the dome moved 5 degrees to left and then 10 degrees to right. So if the dome is close to the reference mark the position will be reseted.
Go North: Since the reference mark is in the north of the Baader dome this is used to park the dome in north direction so a following calibration run will be near to the reference switch. However Baader told me that the normal position of the reference switch is South and it was only north at the dome we tested this protocol.



If you click on **Parameter and Status** another frame will be opened. Here you can open or close the dome cover.
The Azimuth offset should be such that the azimuth displayed in current Azimuth is the same as the Azimuth of the telescope.
Comport: Here you can input the comport and select the Baudrate (standard 9600)
Goto Azimuth: Here you can input a certain azimuth and let the dome slew there.
Follow Telescope: If you have activated this checkbox the dome is following the telescope as soon as it moves. With **Update time** you will determine how often the position will be refreshed. However we have now changed the software so the dome position will only be refreshed, if the difference between the dome azimuth and the telescope azimuth is larger than a azimuth tolerance that is initially set to 2 degree. This is used so the dome is moved much more seldom which is better for the dome motors. You can change the Azimuth Tolerance in [Dome] in the Autoslew.ini file. It is there saved in 1/10 degree (so 20 means 2 degree).

External control of Autoslew

TheSky

You can also use other programs like Guide. You can select the ACL protocol as well as the LX200 protocol. However we recommend to use the ACL protocol due to its higher accuracy.
You can run TheSky on the same computer as Autoslew if you connect to free serial ports. You have to connect the ports (also if you use another computer) will a crossed serial cable.
You need a cable with two female 9-pin SubD connectors and connect Pin 2 with Pin3, Pin 3 with Pin 2 and Pin 5 to Pin 5. So all you need is 3 cables. Of course you can also use another computer and serial connect this with the Autoslew computer. The cable length may be up to 20m if a high quality shielded cable is used.
Please read the manual of TheSky how to get a link to the telescope. Select the ACL protocol, uncheck all boxes with the exception of the crosshair update (set this to 1000ms) and set the baudrate to 19200 (or some other baudrate that is selected in Autoslew).

Custom-Software, Description

You can get the original description from the ACL protocol from Merlin Software. You can also get a copy from us. Furthermore we can give you an VB6 example of a DLL that sends commands to Autoslew via the ACL protocol. A lot of sources can be found at www.ascom-standards.org.
It should be noted that the ACL protocol inhibits not only a pure ASCII message like the LX200 protocol but also Checksums, Sequence Numbers etc. Please use the sources you find on the Ascom Page because otherwise you will really have a hard time to understand the methods of sequencing, byte stuffing etc. You will find complete functions at the Ascom-page that takes care of that stuff, so don't waist time by doing the coding by yourself.

Description	Message to Autoslew	Answer from Autoslew
Device	„device“	„ok Astro Optik Philipp Keller“
Status Status is a 16-Bit number, every bit is used to set a certain status. For example can the status be used to check whether the focuser has already reached the new position or is still moving etc. Here is what we support right now: Flag 0 (1 when tracking) Flag 5 (1 if the focuser is busy) Flag 6 (1 if the rotator is busy)	„status“	„ok 01“
Get flag Nr can be a byte between 0 and 256. Autoslew gives back some status quite similar to the status command above Nr=1: Autoslew will send back 1 if the telescope is slewing or 0 if the telescope has reached the target Nr=55: Autoslew will send back 1 if the focuser is slewing or 0 if the focuser as reached the target More numbers are not supported right now.	„get flag Nr“	„ok 0“ or „ok 1“
Get Right Ascension	„get ra“	„ok 02h32m54.1s“
Get Declination	„get dec“	„ok +16d23m11s“
Set Right Ascension	„set objectra 22.987563h“	„ok“

Set Declination	„set objectdec +86.87563d“	„ok“
Stop Telescope	„stop“	
Goto If you have set coordinates with Set Right Ascension and Set Declination the telescope will be moved to this Target.	„goto“	„ok“ or „error 101“ when Object is within a Limit
Synch If you have set coordinates with Set Right Ascension and Set Declination the telescope will be synched on these coordinates	„synch“	„ok“ or „error 102“ “ when Object is within a Limit
Slew to Park Position	„home park“	
Set Park 1 Define the position of Park 1	"home x_parkset"	„ok“
This command is used with TheSky. The focuser is moved in by a small focus value that can be set in Autoslew in Parameter / TheSky.	":F+#"	„ok“
This command is used with TheSky. The focuser is moved out by a small focus value that can be set in Autoslew in Parameter / TheSky.	":F-#"	„ok“
Set RA-Trackspeed (in degree per second) for moving objects like comets or asteroids. Please note, that this value is added to the sidereal speed	"set trackha +0.0023" The length of the sended string is not fixed. You may also send „set trackh –0.123332123“ sein	„ok“
Same as above but for DE	"set trackdec +0.0002334"	„ok“
Activate the tracking with the selected trackspeeds.	"offsettrack on"	„ok“
Deactivate the tracking on moving objects.	"offsettrack off"	„ok“
Trackposition should be activated before a ccd-exposure is started. Trackposition looks at the configuration file and real-time corrects the error like polar alignment etc. If the Heidenhainencoders are used also gearing errors are corrected in real time. Please note, that you have to activate trackposition after each slew because it is deactivated during slewing.	"trackposition on"	„ok“
Deactivate Trackposition	"trackposition off"	„ok“
Read selected focusnumber	"get focusnumber"	„ok 1“ or „ok 2“
Read out current focusposition	"get focuspos"	„ok +43567“ (this is a focus position of 43.567mm)
Set Focusposition in microns. So if you want the focus to 8.76mm , send 8760. The focus starts slewing after it got the focusposition.	"set focuspos +8760" The length of the sended string is not fixed	„ok“
Stop Focusslewing	"stop focus"	„ok“

Problems and Errormessages

Positionerror
This is the most common error and can have all different kind of reasons. The error happens if the difference between the measured position at the servomotor-encoder and the calculated position is larger than the position tolerance set in the servoparameters.

Reason	Solution
Servoamplifiers (the little black boxes) are shutdown (red LED is on). They probably got a voltage peak above 60V or a voltage drop below 10V.	Use the Emergency button (press and release again) to reset the servoamplifiers. You can also interrupt the connection between Pin 13 and Pin 14 on the servoamplifiers or just turn out the voltage on the servoamplifiers, wait some seconds and turn on the voltage again (this also resets the amplifiers) If this is happening to often you may want to use diodes like the 5KP48A to kill overvoltages on the servoamplifiers.
To big resistance in the gearing	If you have a worm gear maybe the distance between the worm and the wormwheel is to small.
To small motor current	At the servoamplifiers there is a little screw with which you can set the motor current. Please check with us about the maximum motor current that is allowed. If the voltage-supply cannot deliver sufficient current, please select a larger one.
To small position tolerance	You can set the threshold (how sensitive Autoslew causes a position error). You can set this parameter in the menu Mount/Servos/Servo-parameter.
Unbalanced telescope	Try to bring the telescope in balance. If for example the error occurs during slewing south you may need more weight at the front ring.
Cables defect	Check the cable between the motor and the Servoamplifier, the cable between the Servoamplifier and the PC and the cable between the PC and the Motor-Encoder
Wrong polarity at the motor	Try to change the polarity at the motor current.
Emergency button was hit	Check all emergency buttons and release them.
Altitude limit hit	Bridge the Altitude switch and bring out the telescope out of the limit. Measure the resistance of the cable between Pin13 and Pin14 at the servoamplifiers. It should be below 10Ohm. Please note, that the emergency buttons are all in row together with the altitude switch and other limit switches. If there is an interruption in this line, the servoamplifiers are without current. Sometimes the HG-switches in the Altitude switch get old and may have to be replaced. You can measure each HG switch if it is OK with a OHM-meter.

Errors with Heidenhainencoder

The telescope is not stopping the reference drive after 10 degree.	Check the cables of the Heidenhainencoders. If the adjustment of the optical heads of the Heidenhainencoders is bad, the reference-signal is not detected. Try to adjust the optical heads and try again. Activate the Heidenhainencoders and move the telescope. If the display in RA and DE is not moving, please deactivate the Heidenhainencoders and work

	with the servos until we have solved the problem.

More Problems

The telescope gets slower and it cannot be moved with the Handbox in a certain direction. The red limit warning in the status line is on.	Maybe you are near a software limit. If you are without doubt not near a limit, please check whether the telescope is correctly calibrated. If you want to center a star for synch but cannot get there, synch at the park position, center the star and synch then on the star.