ProjectSoft ®

Astronomical institute of the Czech Republic

Control of Danish 1.54m telescope

USER MANUAL

date:	**24. 1. 2014**
visualization:	**TomPack 2.10**
version:	**1.2.1**

INVESTOR IN PEOPLE

CONTENT

1   INTRODUCTION

These OPERATING INSTRUCTIONS provide basic information necessary to operate the control and visualization system of the telescope. Before starting any operation, the personnel assigned to operate the system must be trained and familiar with these INSTRUCTIONS.

2   DESCRIPTION OF THE VISUALISATION SYSTEM

A control computer equipped with the visualization software is used for operation of the controlled technological unit. Using this control computer, operators have visual information on the condition of the technology and control the technological process by running individual program sequences, setting parameters (such as required set values of controlled variables, minimum and maximum values of two-stage controls etc.) or simply controlling individual actuating devices in manual mode. The visualization software has been designed on the TomPack platform by company ProjectSoft.

The controlling of the technological unit is performed by a PLC that processes data collected by sensors located on the unit, and executes necessary interventions to the process via actuating devices (relays, drives and motors) according the control program.

3   OPERATION OF THE CONTROL COMPUTER

The visualization software is installed on the control (PC) computer. The monitor of the control computer displays the actual condition of the controlled process to operators.

3.1 Putting the system into operation

Conditions for turning on of the telescope motion servo drives:
- Control voltage is on.
- Safety Stop button circuit is not activated.
- Hardware blocking circuit is not activated. This circuit includes following safety switches: wire safety system, PLC output contact, that is activated in the case of serious alarm, checked by the software. If any of these elements is active, the safety circuit is activated.
- On the front panel of the monitor press the main switch; green light indicates power on.
- On the front panel of the computer, press the main switch; green light indicates power on.
- After the monitor and computer have been switched on, procedures necessary to start the TomPack visualization software will start.

When these procedures are completed, the **Main control screen (CONTROLS)** will appear on the monitor.

3.2 System controls

Use the keyboard or mouse to control the system. The monitor shows information of the controlled process.

If you want to be able to print from the system, a local printer must be connected to the computer or the computer must be connected to a computer network and have an access to the network printer.

To start operation, log in to the system first!

3.2.1 Departments

Departments are groups of users. Only one group can operate the telescope at one time to prevent chaos during sharing of the telescope across the world.

Currently there are seven departments – La Silla (LS), Prague (P1), Copenjagen (C1), Ondrejov NEOS (O1), Ondrejov Gaia (O2), Brno (B1) and ProjectSoft (PS). Each department has its unique sign which is always part of the user name from the department. For example user "O1_Operator" is operator from department Ondrejov NEOS.

Only one department can be logged to the system at one time and only users from currently logged department can log in. When no department is logged in, the user can log in to the system and its department is automatically logged in too. After finishing work, some of the users from the currently logged department have to log off the department. Than the system will be ready for the next user/department. Only administrators from each department have the right to log off other departments. Currently logged department is also logged off approximately at noon (UT).

This is possible for users out off the currently logged department to log in the system, but they can not operate the telescope.

3.2.2 Logging on and off

Only authorized persons, logged on using their user name and password can access the software. Follow these steps to log on:

Logon/off button

- select and press the "Logon/Logoff button" on the right on the upper bar
- the "Logon/off" panel will appear

- click inside the **User** field and type in the user name
- then click inside the **Password** field, type in the required password and press Enter or click OK to confirm. If the procedure was successful, the name of the logged user will appear in the upper bar. If the procedure was not successful, click to the Password field again and re-enter the password.
- **to log off**, press the **"Logoff"** button at this panel

Individual authorized persons have the following access levels and corresponding restrictions to activities within the software (this can be modified on-site according to specific needs of the customers):

- **PROJECTSOFT**   no restrictions

- **TECHNOLOGIST**   authorized to change selected set values and parameters

- **OPERATOR**   the basic level of operation, no authorization to change the above-mentioned parameters

After job completion, the operator must log off to prevent an unauthorized usage !

3.2.3 Screens – overview

There are several groups, each group consists of one or more screen.

Group **CONTROLS**:
        Screen **CONTROLS**
        Screen **TECHNOLOGIES**
Group **ALARMS**:
        Screen **CURRENT ALARMS**
        Screen **ALARM HISTORY**
Group **TRENDS**:
        Screen **TRENDS**
Group **PARAMETERS**:
        Screen **PARAMETERS1**
        Screen **PARAMETERS2**
        Screen **PARAMETERS3**
        Screen **POINTING MODEL**
        Screen **POINTING RESTRICTIONS**
Group **SERVICE**:
        Screen **SERVICE**

3.2.4 Description of the upper and bottom bar

Each screen contains the appropriate drawing or scheme and the upper and bottom bar containing set of control buttons and displayed information.

Upper bar

The following information can be found on the **upper bar**:

- the name of the screen

- the field showing the **name of the logged on department and operator**

- the field showing type of control – **LOCAL/REMOTE**

- the field showing server **date and time** (should be UTC)

- the field showing client **date and time**

- the lower red line displays information about the last active alarm

Buttons from the left:

- the **SHOW** button shows the application frame
- the **HIDE** button hides the application frame
- the **DAY/NIGHT** button reduces the brightness of a screen
- the **LANGUAGE** button switches between English and Czech language
- the **HELP** button opens this document
- the **USER LIST** button opens a dialog where user can edit user accounts
- the **USER LOGON** button
- the **DEPARTMENT LOGOUT** button logs out the user and its department

Bottom bar

Groups

The following items can be found on the **bottom bar**:

Buttons on the left side from the left:

- the **CONTROLS** button to move to the control screen
- the **TECHNOLOGIES** button to move to the technologies screen

Buttons on the right side from the left:

- the **CONTROLS** button to move to control screens with the control elements
- the **ALARMS** button to display the screens with current and historical alarms
  - This button also servers as an indicator signaling an alarm in the system. In case if no alarm is active, the indicator is blue. If it is orange-flashing, there is a non-acknowledged (non-confirmed) alarm in the system. If it is solid orange, there is an acknowledged (confirmed) alarm in the system.
- the **TREND** button to display the screen with the graph of the selected technological variables
- the **PARAMETERS** button to display the screens with technical parameters
- the **SERVICE** button to display the screen used to reach the documentation/ manual files and job termination

3.2.5 Changing the value

- **only the authorized users with specified access levels can change** parameter values, alarm limits etc.
- use navigation buttons or mouse to move the pointer to the **field of the variable value (light blue)**

7200"/s   the field will be highlighted

- press **ENTER** or **click the left mouse button** to display the **"Value"** input window

- use the keyboard to enter value and press **ENTER** to confirm
- the value entered must be within the range set by the Min and Max values; values outside this range shall not be entered

3.3 Alarm messages

Alarm messages notify the operator of the control system of existing non-standard conditions in the controlled technology such as drive failures, monitored variables outside working limits, operation stopped due to exceeding of set parameters etc.

- in case a new alarm occurs in the controlled technology, it is indicated by the **flashing indicator** in the Upper bar

3.3.1 Actual alarms

- select the **ALARM** button in the upper bar and click to open the "**Actual alarms**" screen
- **actual alarms (i.e. new or persisting alarms) and so-called events** are displayed on this screen

individual columns of the table have the following meaning:

- date and time of the fault activation
- alarm status (A - active, + alarm activation, - alarm end)
- description of the fault
- location in the technology where the fault occurred
- value of the alarm variable

lines are color coded according to their status:

- active non-acknowledged alarms: red
- active acknowledged alarms: orange
- inactive non-acknowledged alarms: yellow

In case a new alarm is generated, operators are obliged to check the reason and acknowledge (confirm) it.

There are two possibilities how to acknowledge alarms:

1. acknowledge **all alarms in the system at one time** - click on the **"Acknowledge all"** button located on bottom bar. The upper bar indicator stops flashing, but turns red, to indicate that acknowledged faults (operators are aware of them) are persisting in the system

Remark: if the fault is resolved/removed indicator turns from red to blue

2. **acknowledge only selected alarms** - click to the appropriate alarm line

- **UP ARROW** and **DOWN ARROW** buttons in the middle of the bottom bar are used for navigation through the alarm list
- **LEFT** ARROW on the left of the lower bar is used to move back to the previous screen
- **RIGHT** ARROW on the left of the lower bar is used to move to the screen of alarm history

3.3.2 Alarm history

- in the alarm history screen all alarms and events can be displayed along with current alarms
- **event** is an issue that **does not have the character of a fault** (change of operator, change of important parameters etc.), however, it is advisable to monitor it

Note: acknowledging is not possible in alarm history.

Time setting from ... to...   List for last 24 hours   Turn on/off alarms showing   Turn on/off events showing

lines are color coded according to their status:

- active non-acknowledged alarms: red
- active acknowledged alarms: orange
- inactive non-acknowledged alarms: yellow
- events: blue

3.4 Historical trends

The system of historical trends is used to archive measured technological values and present them in the chart.

There are two ways of displaying historical trends in TomPack:

- to display the **trend of a specific measured variable**, click on the symbol of the controlled value (the left black section of the box).

Open the trend screen

- to display the **summary trend of multiple measured inter-related variables**, click on the **TRENDS** button located on the bottom bar

Open the trend screen

- when first opening the trend screen, the **real-time trend** is always displayed, i.e. the course of the measured variable is continuously updated in real-time

3.4.1 Reading out of graph

- on the **right** side, next to the graph, **trend variables values are listed**; value of each trend variable is updated according to the slide ruler position

- how to **read out values from the graph using the slide ruler**: position the pointer to the "Y" axis, press the left mouse button, hold it and drag to the left (back in time)

- date and time is displayed above the ruler and listed variable values are displayed on the right, as it was already mentioned
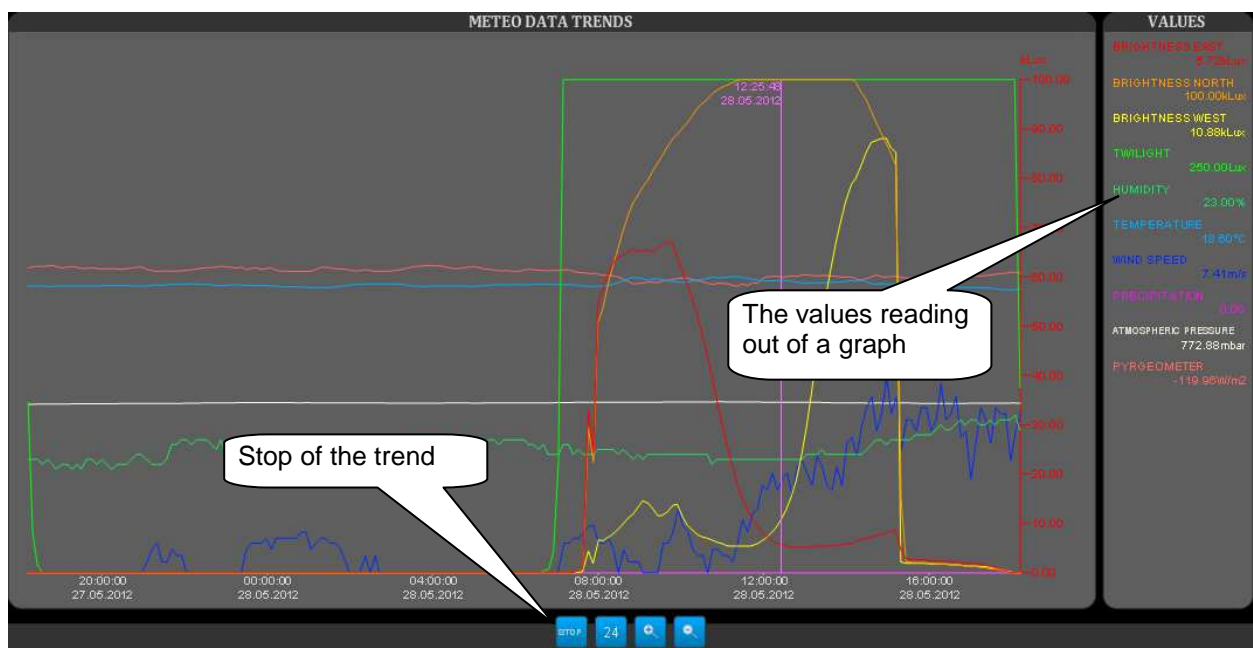
3.4.2 Movements in time

1. viewing of real-time course

   ▪ if you want to change the time range of the displayed variable in real time, you can use the following buttons located on the right of the graph:

   ▪ the **ZOOM+**, button used to enlarge the time range

   ▪ the **ZOOM-**, button used to reduce the time range

   ▪ the **24h** button to display last 24 hours

   ▪ the **STOP OF TREND** button is used to stop updating of the graph

   ▪ alternatively, the following steps can be used:

   ▪ click on the "X" axis, as shown on the picture, to open the **"Time from setting"** control panel for the time shift

   ▪ in this control panel, set the start time of the course either directly by filling in the date and time or by usage of the buttons for shifting the time

   ▪ in this way, the graph will be extended from the current time to the past

2. viewing the course in past

   ▪ use **STOP OF TREND** button to stop updating of the graph

   ▪ as previously, click on the "X" axis, as shown on the picture, to open the **"Time from setting"** control panel for the time shift and set the start time of the course

   ▪ in this way, the graph will be extended to the past

   ▪ however, if you want to shift the course back in time while maintaining the same width of the graph, the **"Retain width"** box should be checked

   ▪ similarly, if the course has already been shifted to the past and you want to adjust its end, click on the "X" axis to open the **"Time to setting"** control panel for the time shift and set the end time of the course
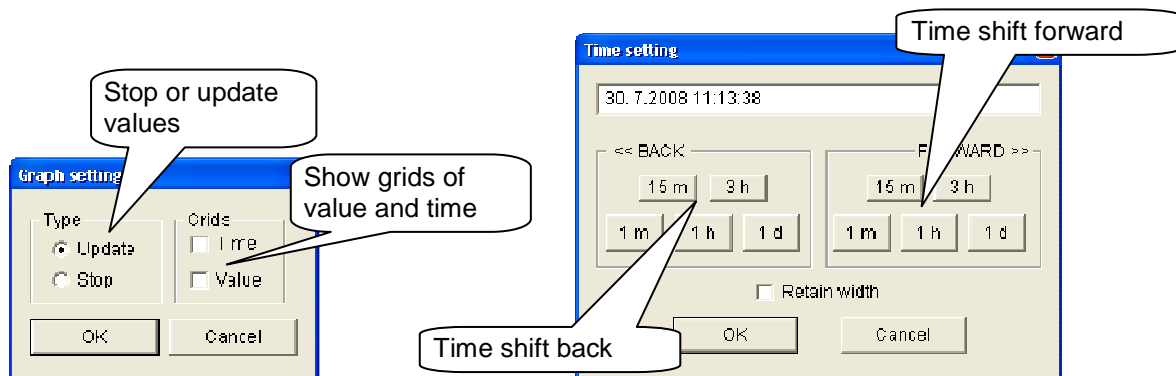
3.4.3 Setting graph properties

   ▪ click on the "X" axis, as shown on the picture, to open the "**Graph setting**" control panel for changing of graph properties

   ▪ in the left part "**Type**", graph updating can be stopped (the same function as the **STOP OF TREND** button)

   ▪ in the right part "**Grid**", an auxiliary grid can be displayed for both axes by marking the appropriate checkbox

3.5 Service screen

- use this screen to close the application or open "The User Manual" or "The Electrical Design Manual"
- to open the screen, click to the **SERVICE** button located on the bottom bar

Open the Service screen

4 CONTROL

4.1 Telescope

4.1.1 Telescope states

Off

Oil system and servo-amplifiers are switched off in this state. The motors stands and they are not electrically braked. The position sensors are working, so the automaton always knows the current position.

Switching on

Oil system is started. The servo-amplifiers are switched on and the system waits for about 2 sec to their initialization.

Switching off

The telescope is halted and the servo-amplifiers are still switched on for about 10 sec. The telescope is in the state of possible braking at this time period.

Ready

Oil system and servo-amplifiers are switched on. The motors stands, but they are "held" in their actual position by regulators of control system. The axes can be rotated by using of the manual telescope movement function.

Condition for turning on:

- serious alarm is not activated
- serious alarm is activated, but safety bypass (SA1) is on

Tracking

The control system uses actual right ascension and declination as required position values and it calculates appropriate mechanical coordinates. This calculation is rectified by aberration, precession, nutation, refraction and error model. The regulators maintain the telescope position in this requested position. It is possible to rotate the axes by manual control.

Sky Slew

This mode is used for slewing to the new coordinates – right ascension and declination. The appropriate mechanical coordinates of the target position are calculated before the slewing and they are rectified by aberration, precession, nutation, refraction and error model. The speeds in both axes are calculated so that both axes arrived to the target destination at the same time. A minimum altitude above the horizon is checked during the slewing. In the case of moving close to the horizon limit the alternative path is calculated.

After the slewing to the target position the telescope control system is switched to the **Tracking** mode.

After setting of the RA and DEC coordinates, click on **SLEW** button and the telescope automatically slew to the set position.

Condition for slew:

- the target must be above the horizon limit

- H.A. and D.A. axes must be calibrated
- less serious alarm is not activated
- safety bypass must be switched off
- hand movement of the telescope is not activated

It is possible to break slewing to the target position by **STOP** button.

Mechanic Slew

This mode is used for the slewing to the new mechanical coordinates. Before the slewing the target position is checked. The speeds in both axes are calculated so that both axes arrived to the target destination at the same time. A minimum altitude above the horizon is checked during the slewing. In the case of moving close to the horizon limit the alternative path is calculated.

The telescope control system is switched to the **Ready** mode after slewing.

After setting of mechanical coordinates, click on **SLEW** button and telescope automatically slew to the set position.

Condition for slew:

- target must be above horizontal limit
- H.A. and D.A. axes must be calibrated
- less serious alarm is not activated
- safety bypass (SA1) must be switched off
- hand movement of the telescope is not active

It is possible to break slewing to the target position by **STOP** button.

Mechanic Flip

This mode is similar to the **Mechanic Slew** mode. Telescope moves to reverse position.

The telescope control system is switched to the **Ready** mode after slewing.

Sky Flip

This mode is similar to the **Sky Slew** mode . Telescope moves to reverse position; after the movement the rectascension and declination remain the same.

Initializing

The short movement of the telescope is performed, with the aim to cross calibration points of incremental position sensors, installed on both the hour and declination axis. In the calibration point the corresponding source coordinates are set, according to the absolute sensor. This calibration must be done after every power off of the control switchboard. Mode of calibration is shown on the screen **CONTROL**.

Condition for initialize:

- less serious alarm is not activated
- safety bypass must be switched off
- hand movement of the telescope is not active
- telescope must not exceed the horizon boundary 0

Parking

This mode is similar to the Mechanic Slew mode. Telescope goes on the position given in the parameters. The telescope control system is switched to the **Off** mode after slewing.

4.1.2 Description of controls
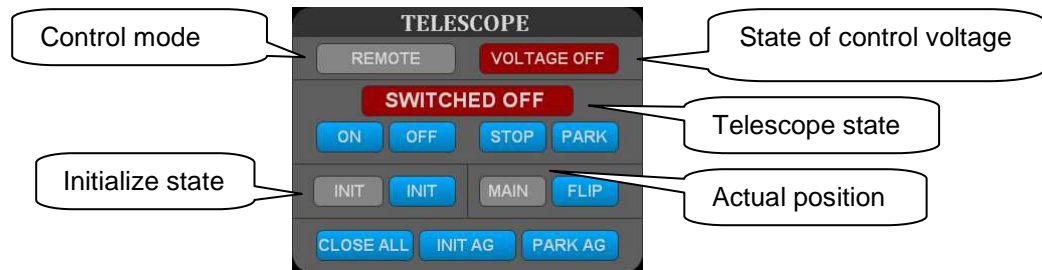
- **ON** button turns the telescope to the mode **Ready**. It works for the state **Switched off**.

- **OFF** button turns the telescope to the state **Switched Off.** It works for all modes.

- **STOP** button stops the movement of the telescope and the telescope turns to the mode **Ready**.

- **PARK** button parks the telescope to the parking position defined in parameters and switches the telescope off.

- **INIT** button turns on the state **Initializing** where the main encoders are initialized. It works for the state **Ready**.

- **FLIP** button turns on the state **Mechanic Flip** or **Sky Flip**, depending on whether the current state is **Ready** or **Tracking**.

- **CLOSE ALL** button closes all what is possible to close, parks the telescope and switches it off.

- **INIT AG** button initializes all axes of the autoguider

- **PARK AG** button parks all axes of the autoguider

-
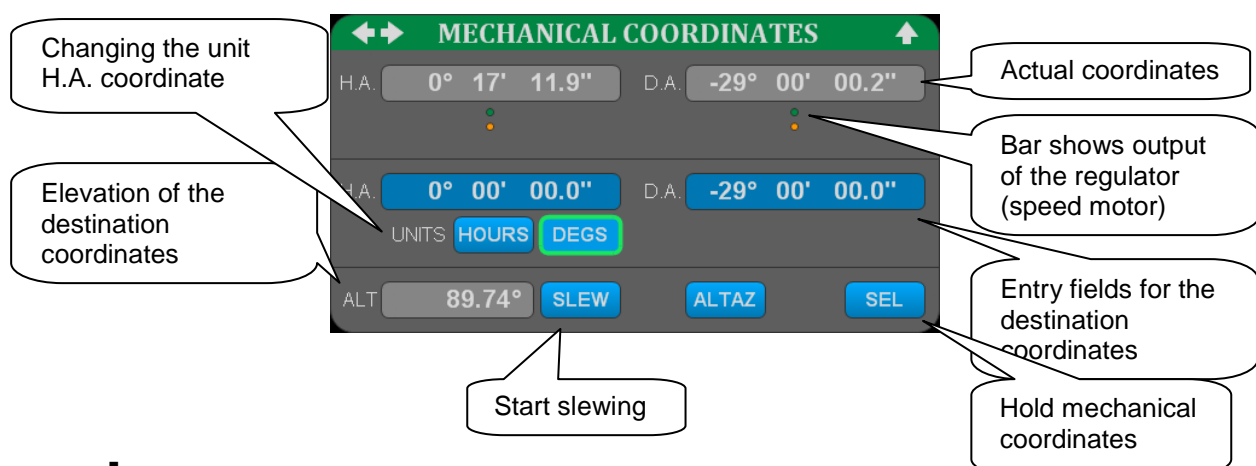
- **SLEW** button starts the slew to the new target position (Mechanic Slew), given in mechanical coordinates setting box.

- **SEL** button turn back to **Ready** mode from **Tracking**.

- **ALT** data field shows the height of the telescope above the horizon for the assigned target coordinates. If the assigned target location of the telescope is below the horizon, the field will have an orange background and **Mechanic Slew** mode will be disabled.
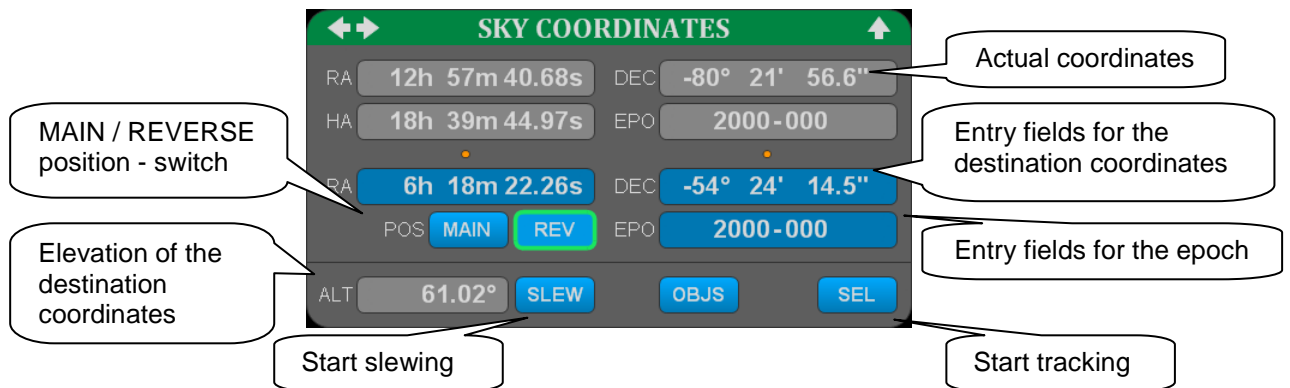
- **SLEW** button starts the slew to the new target position (**Sky slew**), given in topocentric coordinates setting box.
- **SEL** button starts **Tracking** mode.
- **MAIN / REV** button switches the required position of the telescope mount.
- **ALT** data field shows the height of the telescope above the horizon for the assigned target coordinates. If the assigned target location of the telescope is below the horizon, the field will have an orange background and **Sky Slew** mode will be disabled.
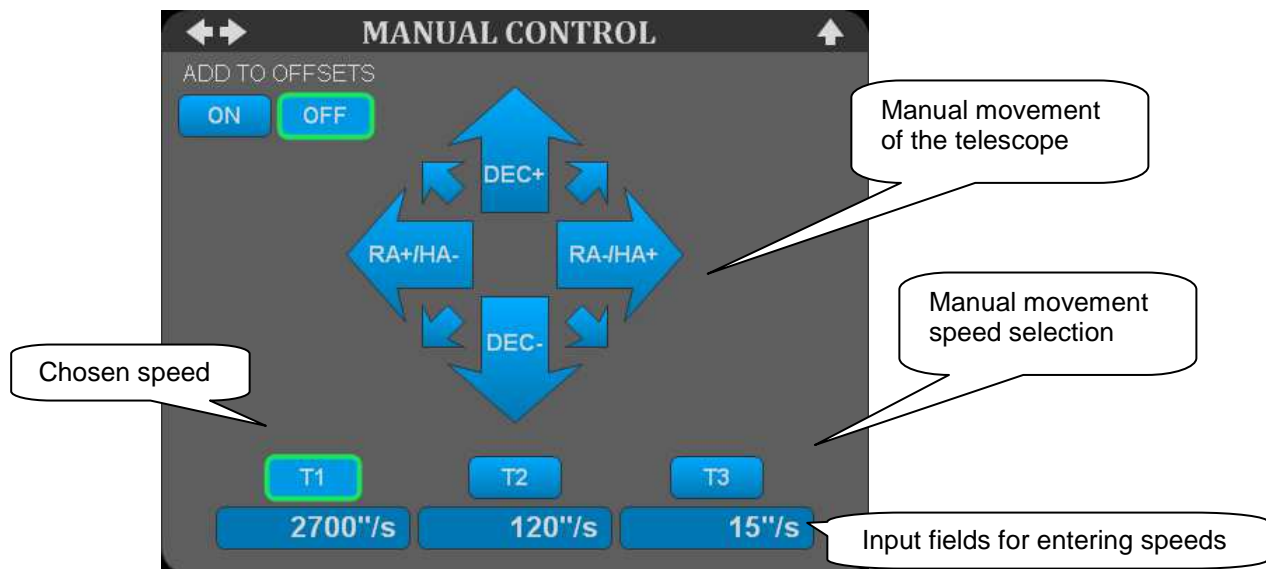
- **RA+/HA-, RA-/HA+, DEC+, DEC-** buttons are used for manual movement of the telescope in modes **Ready** and **Tracking**.
- **T1, T2, T3** buttons are used to the selection of hand movement speed.
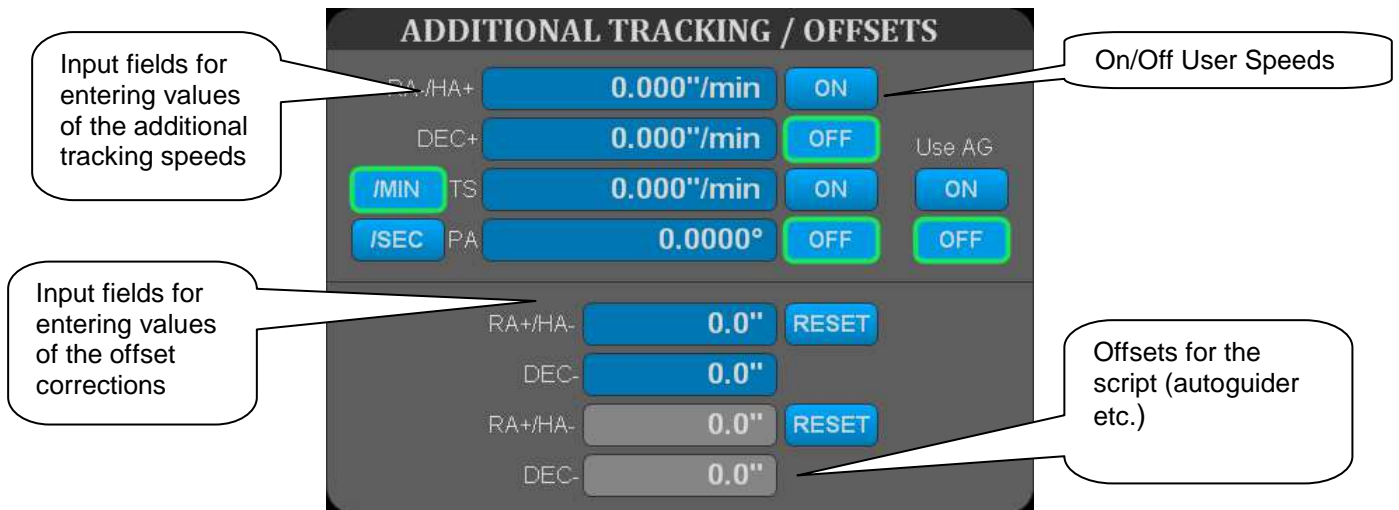
- User Speed **ON** / **OFF** buttons turns on / off the user speeds.
- Use AG **ON / OFF** buttons turns on / off .
- Correction **RESET** button sets the zero correction.

4.1.3 Corrections
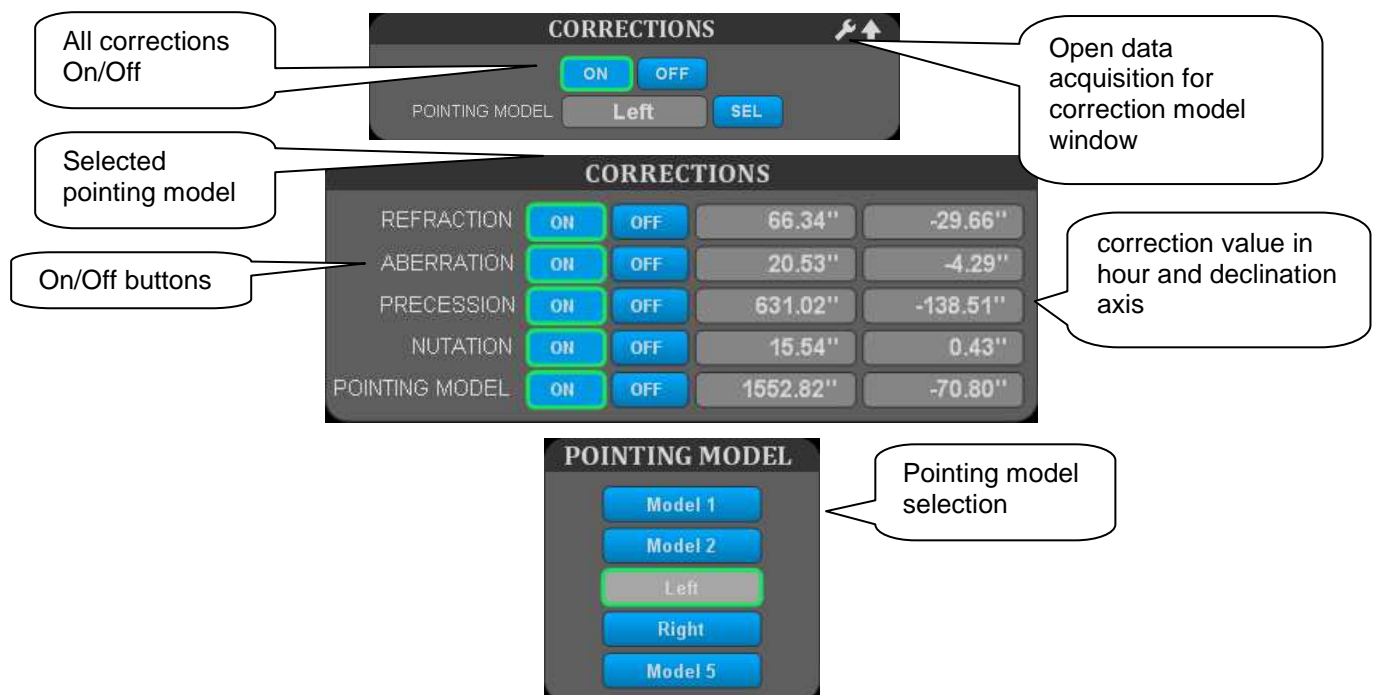
Any correction is possible to turn on/off by the appropriate button. The calculated value is displayed for both axis.

Turning on the corrections (aberration, precession and nutation, refraction and corrections model) and selecting index of corrections model is only possible when the control is in **Ready** state.

4.1.4 User Corrections

This corrections are used for compensation of error, which is not removed by the error model and which must by corrected by the observer. He must slightly manually move the telescope to the exact target position. It is possible to make by a small hand change of RA and DEC. The offset correction is a pair of values, which are added to the other corrections and only

these corrections are changed during the final precise manual setting. RA and DEC values remain correct and moreover, it is possible to determine the value of mistake.

4.1.5 User Speeds

The user's speeds serve for moving of the telescope with selected speed in **Track** mode. This function is useful for tracking of comets and objects moving in the sky.

This function is switched on and off by buttons **ON** and **OFF** on the screen **CONTROL**. The speeds of movement are set in the setting box.

4.2 Correction model

4.2.1 Introduction

A couple of astronomical corrections are implemented in the PLC software. It is mainly annual aberration, precession and nutation, when sky coordinates are used. Actual precession correction values depend on the epoch of coordinates entered.

The actual local apparent sideral time is computed from actual UTC time. To be able to use the UT1 time for more precise sideral time, manually entered DUT1 correction is necessary regularly update.

Refraction correction is computed from measured outside temperature and pressure.

Inaccuracies of the mount are corrected using these steps:

1. Measuring of the inaccuracies

The user has to create a measurement database. It is accomplished by pointing telescope to stars, fixing telescope to reference point of the camera and storing the actual difference to text file. Both Main and Reverse position should be used, but they will result in only one set of coefficients. To speed-up data collection, part of the delivery is a star database, which includes uniformly selected stars of equal magnitude with lowest amount of neighborhood's stars. There is also screen where user can enter X/Y coordinates of measured star on the CCD camera and control system computes required correction.

2. Computation of the coefficients

Next step is computation of the coefficients, using command line program TeleModel. It uses the least square fit of the measured data to compute values of the coefficients. User can choose text file with measured data and set of computed coefficients. Selection of the coefficients is important for the correct and effective computation.

3. Transfer coefficient values into control system

The next step is simple - the user fills in the parameter screen with computed coefficients values. It is possible to use 5 sets of parameters. The selection can be done by "1-5 Selection index" buttons. During obtaining the coefficients all other corrections must be switched on.

4. Test of the model

The last step should prove the validity of the data. The method is the same as step 1, but the necessary correction to reach reference point of camera should be in expected range of the model.

There is possible to merge data from different measurements, but all conditions must be the same! Even the small change of the full optical or mechanical part disallows data merging.

The different measurement and coefficients computation has to be done for different optical configuration of the telescope. It is also common that different optical configurations have different set of coefficients, not only different values.

It is suitable to perform the preliminary setting of error model at first step, so that the deviations are measured for twenty objects only and the error model is used with these preliminary coefficients. The entire process is then repeated, as described in the preceding paragraph, with the preliminary error model turned on.

The following terms could be currently used:

1. Inaccurate setting of zero position of hour axis in respect of south, HS

2. Inaccurate setting of zero position of declination axis in respect of equator, DS

3. Non-perpendicularity of declination and optical axis, TD

4. Non-perpendicularity of hour and declination axis, DH

5. The inclination of polar axis to the east-west direction (in respect to the equator), EW

6. The inclination of polar axis to the south direction, NS

7. Deflection of the tube (deflection of polar axis respectively), TF

8. Deflection of the fork, FF

9. Deflection of declination axis, DF

Name	Hour axis influence	Declination axis influence
HS (IH)	HS	0
DS (ID)	0	DS
TD (CH)	TD*1/cos(da)	0
DH (NP)	DH*tan(da)	0
EW (MA)	-EW*cos(ha)*tan(da)	EW*sin(ha)
NS (ME)	NS*sin(ha)*tan(da)	NS*cos(ha)
TF (TF)	TF*cos(lat)*sin(ha)/cos(da)	TF*[cos(lat)*cos(ha)*sin(da)-sin(lat)*cos(da)]
FF (FO)	0	FF*cos(ha)
DF (DAF)	-DF*[cos(lat)*cos(ha)-sin(lat)*tan(da)]	0

4.2.2 The procedure for calculating of the coefficients

Step1 - Measuring of the inaccuracies, collecting data

The coordinates can be entered manually on the screen **CONTROL,** or the selected objects can be loaded from a text file, prepared in advance. The pathname of the file can be entered in the correction model window, usually c:\model\stars.dat

Example of the line data format:

The first six characters represent the identification number

RA (hours, minutes, seconds, degrees, arc minutes, arc seconds)

Dec

RA proper motions (seconds and arc seconds per year)

Dec proper motions

equinox

The file is terminated by the word "END".

Example:

000001 01 33 13.030 -79 55 35.70   +.0126 +.011 2000.0
END

The procedure for data acquisition is following:

1. Switch telescope to READY mode.

Check or update the DUT1 value in parameters 1 screen. Source of this value is in IERS BULLETIN - A, for example here: http://maia.usno.navy.mil/ser7/ser7.dat, section COMBINED EARTH ORIENTATION PARAMETERS, column UT1-UTC, value from the most recent date. The value can be also negative. Check also data acquisition parameters (on the parameters 3 screen) for fast centering of the star.

2. Select the position of the telescope (for example MAIN), enter Epoch 2000-000.

SKY COORDINATES

RA	8h 57m 54.25s	DEC	-28° 56' 42.1"
HA	0h 01m 40.31s	EPO	2000-000
RA	4h 00m 00.00s	DEC	-151° 00' 00.0"
POS	MAIN REV	EPO	2000-000
ALT	2.41° SLEW		OBJS SEL

3. Open Corrections dialog. Turn on all corrections and select appropriate correction model if there is any. Check the focus setting for selected configuration.

Turn On all corrections

CORRECTIONS

ON   OFF

POINTING MODEL   Left   SEL

4. Reset user and script corrections.

RA+/HA-	0.0"	RESET
DEC+	0.0"	
RA-/HA+	0.0"	RESET
DEC+	0.0"	
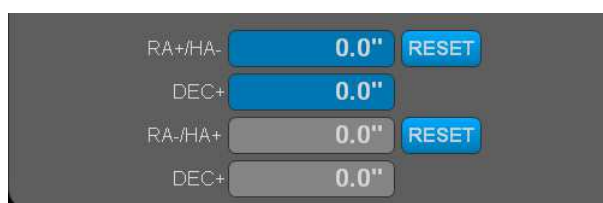
5. Open Correction model dialog.
6.

CORRECTIONS

Open

ON   OFF

POINTING MODEL   Left   SEL

- Enter the path to the file with TeleModel database of stars (c:\model\stars.dat).
- Start with line 1 (enter 1 to the box LINE).
- To read data from the selected line click on READ ACTUAL button.
- To read data from the next line click on READ NEXT button. The line number will increase automatically.
- If the line is read successfully (green) than the coordinates and epoch of the star are transferred to Sky coordinates.

- If the coordinates of the star are above horizon (ELEV. is not yellow) and are not covered be the shutter, click on SLEW button.
- If the telescope is at the desired position, exposure.

CENTERING

ACTUAL X POS. **1055** CENT

ACTUAL Y POS. **3070**

- If the star is not at reference pixel, enter the actual pixel position and click on button CENT. Calculated corrections will be added to actual User corrections and telescope will immediately change its position. Another possibility is manual entry of the desired correction into CORRECTION values or movement of the telescope using T3 speed and correction mode of the movement.
- Exposure an image.
- Repeat this procedure until the actual position of the star will correspond with the reference pixel. Sufficient accuracy is reached when star is closer then approximately 1-2 arcs to the reference pixel.

MODEL CORRECTION

OBSERVED H.A. **359° 33' 21.4"** READ

ENCODER H.A. **180° 00' 00.3"**

OBSERVED D.A. **-18° 44' 32.9"**

ENCODER D.A. **-161° 13' 43.8"**

- If the actual position of the star corresponds with the reference pixel click on READ button.

OUTPUT TO FILE

FILE C:\\model\\model_2012_05_29.dat

WRITE

- If system is ready (grey) click on WRITE RECORD button to write data to output file. The name of the file is generated automatically in format model_YYYY_MM_DD.dat. Check if data were successfully written to the file.
- Repeat this procedure by pressing button READ NEXT until all visible stars from database are measured

Repeat the whole procedure (using the same stars) for reverse position of the telescope

2. Computation of the coefficients

Command line program TeleModel.exe should be used for coefficients computation. Its first parameter is name of text file with measured data, next parameters are coefficient names to compute.

The result is splitted to two parts. First part shows the measured data with following columns:

HA   Hour axis angle of measured star

DA   Declination axis angle of measured star

Input d_ha   Measured difference in hour axis

Input d_da   Measured difference in declination axis

Input sqr   Total measured difference (magnitude of the error)

Result d_ha   Resulted difference in hour axis

Result d_da   Resulted difference in declination axis

Result sqr   Total result difference (the expected remaining error)

Second part includes coefficients:

Input RMS	Root mean square of input data
Coeff	Coefficient name
Value	Computed coefficient value
Sigma	Deviation of coefficient value
Result RMS	Root mean square of resulted remaining error

HA values are in hours, minutes and seconds, DA in degrees, arcminutes and arcseconds. The rest are in arcseconds.

example:

```
C:\WINDOWS\system32\cmd.exe                                              _ □ ×

D:\!work\Akce\Tenerife\model_act>telemodel model_2010_07_19.dat hs ds td dh ew n
s tf df hsh dsd dcd dsh dch hch2 dch2 hcd
TeleModel v1.2 (c) ProjectSoft 2010

                                    Input                     Result
           HA               DA      d_ha      d_da      sqr   d_ha      d_da      sqr
    0: 21 10 12.00  -034 58 54.7   1369.8    1427.8   1816.1   -3.2      -2.0     3.30
    1: 22 17 02.14  -033 57 51.1   1356.1    1423.9   1814.5   -4.7       5.2     6.53
    2: 00 58 22.32  -042 46 31.1   1342.2    1438.4   1743.4    4.7      -2.6     4.32
    3: 19 34 23.27  -017 29 32.7   1431.3    1423.2   1972.1    4.3      -1.3     4.29
    4: 21 20 32.00  -016 23 17.8   1393.3    1422.6   1952.1   -3.7       2.9     4.62
    5: 22 34 31.70  -015 12 21.4   1374.6    1427.3   1948.5   -0.5       1.4     1.50
    6: 23 38 00.24  -014 02 27.3   1371.1    1431.0   1953.7    2.8       0.2     2.72
    7: 01 10 54.83  -023 06 00.6   1387.5    1436.1   1921.3    0.8      -1.7     1.81
    8: 02 39 21.78  -027 04 04.1   1426.2    1438.9   1919.2    1.3      -3.3     3.52
    9: 03 07 12.72  -025 38 28.7   1443.1    1430.5   1933.6    2.6       5.1     5.58
   10: 19 12 10.09  -002 53 40.6   1448.5    1423.2   2029.4    3.4      -0.7     3.46
   11: 20 30 27.10  +004 24 23.5   1414.2    1423.2   2003.4   -2.2       0.7     2.25
   12: 21 59 41.83  +006 26 16.4   1383.0    1426.5   1980.8   -0.4       0.0     0.41
   13: 02 12 58.28  -005 08 19.1   1424.8    1435.4   2018.5   -2.2      -0.9     2.39
   14: 03 00 40.38  -006 42 21.7   1447.8    1437.2   2033.0    0.3      -2.0     2.03
   15: 04 30 20.30  -003 25 13.9   1504.6    1435.2   2077.4   -2.6       1.2     2.88
   16: 19 21 26.83  +022 17 44.2   1423.0    1420.2   1936.6    4.7       4.5     6.28
   17: 03 29 38.83  +021 40 14.6   1438.1    1435.3   1961.2    2.9       1.2     2.90
   18: 04 47 56.99  +014 27 09.2   1498.7    1437.6   2042.8   -1.7       0.5     1.75
   19: 05 47 13.67  +033 59 22.8   1495.0    1440.5   1900.4   -7.4       2.6     6.62
   20: 18 27 20.38  +044 16 25.8   1388.3    1428.0   1739.9    2.7       1.1     2.21
   21: 20 10 31.57  +041 57 13.3   1357.0    1431.1   1751.1   -1.4      -5.0     5.07
   22: 04 03 47.62  +043 22 42.4   1388.7    1440.3   1758.8    8.6      -0.9     6.33
   23: 15 04 36.65  +066 25 49.0   1220.2    1450.5   1530.4    7.1      -1.1     3.04
   24: 17 23 33.93  +055 53 29.4   1347.1    1436.5   1623.0   -7.6      -1.6     4.56
   25: 19 18 22.94  +052 52 16.5   1321.2    1431.5   1638.7   -4.1      -3.3     4.09
   26: 21 21 07.62  +060 48 48.4   1205.3    1425.3   1541.7   -2.0       2.6     2.75
   27: 14 53 19.76  +086 08 26.5  -1888.7    1452.2   1457.7    4.3       1.0     1.04
   28: 20 23 55.00  +084 08 29.0   -357.4    1434.3   1434.8   -0.4      -4.3     4.25
   29: 22 54 23.70  -004 15 29.0   1382.0    1429.8   1985.9   -5.4      -0.8     5.44
   30: 23 24 01.61  -000 19 32.5   1376.1    1431.4   1985.5    0.2      -1.5     1.48
   31: 22 24 09.81  +024 04 16.7   1363.4    1423.9   1891.3   -1.1       3.5     3.60
   32: 23 54 36.36  +018 32 39.2   1363.6    1435.1   1931.5    4.0      -4.7     6.02
   33: 00 40 55.10  +020 11 16.6   1372.8    1434.9   1928.6    0.7      -3.1     3.16
   34: 21 02 03.54  +034 12 45.9   1361.8    1422.6   1814.4    0.1       3.2     3.18
   35: 22 41 41.76  +038 52 00.0   1327.3    1430.3   1764.6    0.3      -2.1     2.10
   36: 01 47 06.22  +037 36 44.9   1356.1    1439.6   1796.3    1.3      -5.5     5.61
   37: 23 44 54.73  +060 29 10.2   1197.6    1419.7   1537.4   -2.8      11.4    11.48

Input RMS:    1851.988

Coeff     Value[''] Sigma['']

   HS      1709.9      15.214
   DS      1439.4       6.728
   TD      -171.8       7.108
   DH        39.9       4.531
   EW       -25.8       4.080
   NS        12.2       2.966
   TF       -11.7       7.309
   DF       152.7      13.090
  HSH       -22.2       7.086
 HCH2        -5.1       4.364
  HCD       -19.0      12.118
  DSD         7.6       5.533
  DCD       -10.9       5.149
  DSH        18.4       4.236
  DCH       -18.0       5.953
 DCH2         3.0       2.213

Result RMS:     4.327

D:\!work\Akce\Tenerife\model_act>
```
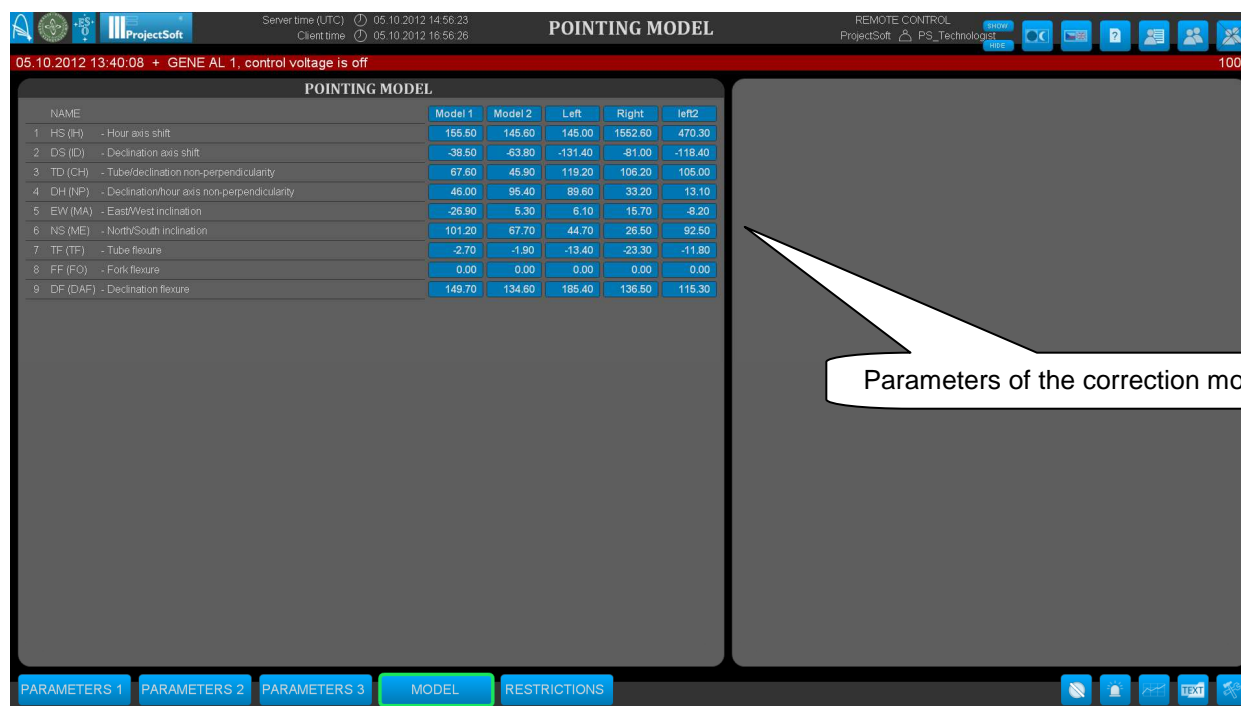
3. Transfer coefficient values into control system

The resulted values should be then typed into corresponding boxes on the parameter screen. Unused coefficients have to be zeroed.

Parameters of the correction models

4. Test of the model

The last step should prove the validity of the data. User should repeat the same method as in case of collection data for model. However, the measured corrections should be approximately in the expected range of the model resulted RMS. The new created database could be then also used for new computation of the coefficients.

4.3 Main focus

4.3.1 Main focus states

Focus states are visible in the indication field on the right and has following meaning :

STOPPED

Focus drive is off.

MANUAL +, MANUAL -

Manual focusing**.**

POSITIONING

Automatic movement to a preset position.

4.3.2 Description of control panel
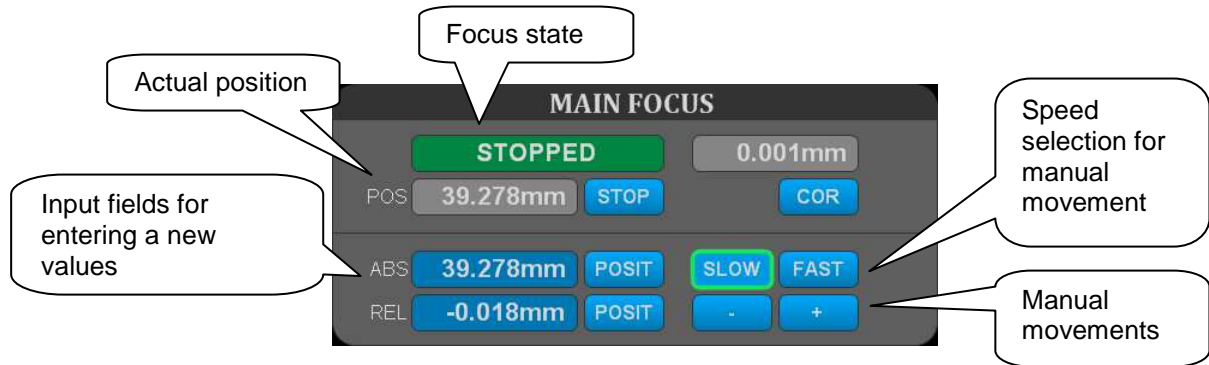
Buttons and input fields meaning :

- **+ , -** - manual focusing
- **STOP** – stop the focusing movement.
- **SLOW / FAST** – switching between slow/fast focusing movement.
- ABS **POSIT** - Automatic focusing movement to an absolute preset position
- REL **POSIT** - Automatic focusing movement - shift from the current position by the entered value

4.4 Flaps

4.4.1 Flap states

States are visible in the indication field on the right and has following meaning :

STOPPED

> Flap position is not defined (the end position signal is not received).

OPENING, CLOSING

> Flap opening/closing is in progress.

OPENED, CLOSED

> Flap is in the Opened/Closed position.

4.4.2 Description of controls
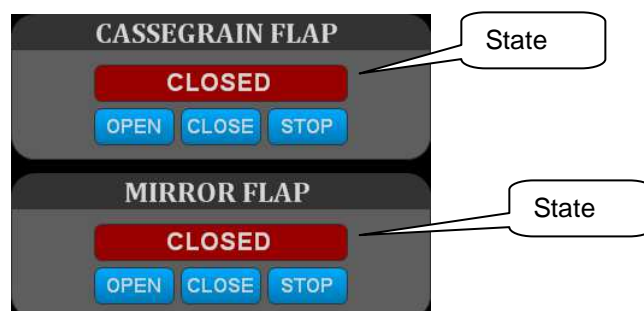
- **STOP -** stop flap movement.
- **OPEN, CLOSE -** open/close flap.

4.5 Dome

4.5.1 Dome states

STOPPED

The dome is stopped and ready to operate.

AUTO

The automatic movement of the dome. Slit of the dome follows the telescope position. This regime can be terminated by the STOP button..

AUTO +, AUTO -

The automatic movement to a new position is in progress. Slit of the dome follows the telescope position with a certain tolerance, which is specified by the parameters.

SLEW +, SLEW -

The automatic movement to a new position , determined by the azimuth, set by the operator is in progress.

PARKING, PARKING +, PARKING -

Dome is parking to the predefined parking position. After parking is finished, the slit is closed.

4.5.2 Description of control buttons

Actual position

Input field for entering a new position of the dome

DOME

STOPPED

POS 180.16° STOP

POS 0.00° SLEW

AUTO PARK

Dome state

- **STOP** – stops AUTO, SLEW or PARKING regime
- **SLEW** – turning on SLEW regime.
- **AUTO** - turning on AUTO regime
- **PARK** – turning on PARKING regime

4.6 Slit

4.6.1 Slit states

STOPPED

Slit position is not defined (the end position signal is not received).

OPENING, CLOSING

Slit opening/closing is in progress.

OPEND, CLOSED

Slit is in the Opened/Closed position.

.

4.6.2 Description of controls

- **STOP -** stop slit movement.
- **OPEN, CLOSE -** open/close slit.

5 MAINTENANCE AND SERVICE OF THE CONTROL COMPUTER

5.1 Fail-safe operation policy

To ensure fail-safe operation of the control computer, the following rules must be observed:
- only duly trained and instructed personnel can operate the control computer
- smoking is forbidden in the computer room
- carefully protect the computer and keyboard against contamination
- if not necessary, do not move the computer
- if you need to move it, store it in a clean, dust-free room with constant room temperature without excessive humidity and vibrations
- if you are planning not to use the computer for longer time, properly close the application first (see the Service screen) and then turn off the computer and monitor

5.2 Modifications of hardware and software of the control computer

- any modifications of the control computer hardware and software, even after the warranty period, are recommended to be consulted with our technicians first
- our company is not responsible for potential functional problems of the control computer caused by non-consulted modifications
- in case of any non-consulted hardware or software modifications during warranty period, the warranty is void
- from this point of view, replacing the keyboard, mouse or monitor is not considered as the hardware modification

5.3 Maintenance and back-up

- no maintenance is necessary on the control computer, with the exception of cleaning the keyboard, mouse and monitor screen
- in case the computer is equipped with a back-up source (UPS), the battery must be replaced or recalibrated in intervals set by the manufacturer (see the supplier instructions)
- if you require archiving of alarm message and historical trend files for future purpose such as for inspection authorities, back up files regularly as described in chapters Alarm messages and Historical trends
- in all these cases, contact your IT department or administrator and discuss specific solutions

6 PARAMETERS

6.1 Telescope parameters

TELESCOPE PARAMETERS		
1 ABSOLUTE SENSOR, POSITION CORRECTION	-1726.80"	1087.50"
2 INCREMENTAL SENSOR, REFERENCE SHIFT	-1006.80"	2167.50"
3 MAX. DIFFERENCE BETWEEN ABS. AND INC. SENSOR	2000.00"	2000.00"
4 MAX. SPEED	3500"/s	3500"/s
5 MAX. SYSTEM SPEED (POSITION LOOP LIMIT)	3960"/s	3960"/s
6 MAX. ACCELERATION / DECCELERATION	720"/s2	720"/s2
7 MAX. CHANGE OF ACCELERATION / DECCELERATION	0"/s3	0"/s3
8 PROPORTIONAL GAIN OF CONTROLER	3.000-/s	3.000-/s
9 INTEGRATION TIME OF CONTROLER	0.000-/s	0.000-/s
10 MAX. INTEGRATION COMPONENT (PERCENTAGE OF OUTPUT)	0.00%	0.00%
11 MAX. CONTROL DEVIATION	45000.00"	45000.00"
12 MAX. POINTING OFFSET	3600.0"	3600.0"
13 MAX. AUTOGUIDER OFFSET	300.0"	300.0"
14 PARKING POSITION	0.0000°	-29.2630°

15 LONGITUDE EAST	-70.7403°	24 HAND PADDLE (CONT. ROOM)	ON	OFF
16 LATITUDE NORTH	-29.2630°	25 HAND PADDLE (DOME)	ON	OFF
17 DUT1	-40ms	26 DISABLE CASSEGRAIN FLAP	ON	OFF
18 SLEW SPEED	3500"/s	27 DISABLED CASS. FLAP STATE		3
19 LIMITED SPEED	900"/s			
20 INITIALIZATION SPEED	360"/s			
21 INITIALIZATION TIMEOUT	10s			
22 MAX. INCLINATION DIF.	14.00°			
23 CAN COMM. WITH SERVO DRV.	ON OFF			

0 - stopped
1 - opening
2 - closing
3 - open
4 - closed

6.2 Dome parameters

DOME PARAMETERS	▲
1 SENSOR SICK 1	ON OFF
2 SENSOR SICK 2	ON OFF
3 SICK 1, POSITION COR.	-1.90°
4 SICK 2, POSITION COR.	-2.07°
5 SLEW POSITION TOLERANCE	1.00°
6 AUTO POSITION TOLERANCE	1.50°
7 SPEED	100.00%
8 INITIALIZATION SPEED	50.00%
9 PARKING POSITION, MIN.	179.50°
10 PARKING POSITION, MAX.	180.50°
11 PARK DELAY	5s
12 TIMEOUT	100s
13 INITIALIZATION TIMEOUT	80s
14 NORTH CALIBRATION POINT	0.00°
15 EAST CALIBRATION POINT	89.80°
16 SOUTH CALIBRATION POINT	180.30°
17 WEST CALIBRATION POINT	270.30°
18 RADIUS	5.25m
19 X SHIFT	0.00m
20 Y SHIFT	0.00m
21 Z SHIFT	-1.20m
22 DEC SHIFT	1.85m

6.3 Slit parameters

SLIT PARAMETERS	▲
1 MIN. TIMEOUT	40s
2 MAX. TIMEOUT	65s
3 MIN. BATTERY VOLTAGE	23.00V
4 MIN. BAT. VOLTAGE TIMEOUT	1.0m

6.4 Flaps parameters

FLAPS PARAMETERS	▲
1 C. FLAP, TIMEOUT	14s
2 M. FLAP, TIMEOUT	12s

6.5 Vents parameters

VENTS PARAMETERS	▲
1 OPEN POSITION	17.0s
2 CLOSING TIMEOUT	18s

6.6 Oil parameters

OIL PARAMETERS	
1 MAX. TEMPERATURE	50.00°C
2 MIN. LEVEL	80.00%
3 LEVEL	85.00%
4 LEVEL HYSTERESIS	0.50%
5 MIN. PRESSURE	3.00bar
6 MAX. PRESSURE	6.00bar
7 STARTING TIMEOUT (LEVEL)	10m
8 STARTING TIMEOUT (PRES.)	30s
9 SUCKING DELAY	5m
10 SUCKING TIME	3.0m

6.7 Main focus parameters

MAIN FOCUS PARAMETERS	
1 POSITION CORRECTION	25.300mm
2 MIN. POSITION	0.300mm
3 MAX. POSITION	49.300mm
4 POSITION SHIFT	0.000mm
5 POSITION TOLERANCE	0.005mm
6 POSITION NEAR	0.100mm
7 SLOW SPEED	11.00%
8 FAST SPEED	100.00%
9 POSITIONING TIMEOUT	450s
10 TEMPERATURE CORRECTION	0.045mm/°C
11 AUTOMATIC TEMP. COR.	ON OFF
12 AUTO. TEMP. COR. HYST.	0.4°C
13 XY, SPEED	50.00%
14 XY, NUMBER OF COUNTS	300

6.8 Filter wheels parameters

FILTER WHEEL A PARAMETERS	↟		FILTER WHEEL B PARAMETERS	↟
1 SPEED	70.00%	1 SPEED	70.00%
2 POSITIONING TIMEOUT	13s	2 POSITIONING TIMEOUT	18s
3 FOCUS CORRECTION	ON OFF	3 FOCUS CORRECTION	ON OFF
4 0. POS. FOCUS CORRECTION	0.000mm	4 0. POS. FOCUS CORRECTION	0.230mm
5 1. POS. FOCUS CORRECTION	0.100mm	5 1. POS. FOCUS CORRECTION	-0.190mm
6 2. POS. FOCUS CORRECTION	0.000mm	6 2. POS. FOCUS CORRECTION	0.000mm
7 3. POS. FOCUS CORRECTION	0.000mm	7 3. POS. FOCUS CORRECTION	0.000mm
8 4. POS. FOCUS CORRECTION	0.000mm	8 4. POS. FOCUS CORRECTION	0.000mm
9 5. POS. FOCUS CORRECTION	0.000mm	9 5. POS. FOCUS CORRECTION	0.150mm
10 6. POS. FOCUS CORRECTION	0.000mm	10 6. POS. FOCUS CORRECTION	-0.120mm
11 7. POS. FOCUS CORRECTION	0.000mm	11 AG FOCUS COR. FACTOR	0.5000
11 7. POS. FOCUS CORRECTION	0.000mm	12 0. POS. NAME	empty
12 AG FOCUS COR. FACTOR	0.5000	13 1. POS. NAME	U
13 0. POS. NAME	empty	14 2. POS. NAME	B
14 1. POS. NAME	Stromgr u	15 3. POS. NAME	V
15 2. POS. NAME	Stromgr v	16 4. POS. NAME	R
16 3. POS. NAME	Stromgr b	17 5. POS. NAME	I
17 4. POS. NAME	Stromgr y	18 6. POS. NAME	H-alpha n?
18 5. POS. NAME	H-beta		
19 6. POS. NAME	H-beta narr		
20 7. POS. NAME	Gunn z		

6.9 Autoguider parameters

AG FOCUS PARAMETERS	↟
1 POSITION CORRECTION	20.000mm
2 MIN. POSITION	4.000mm
3 MAX. POSITION	34.000mm
4 POSITION TOLERANCE	0.010mm
5 POSITION NEAR	1.000mm
6 SLOW SPEED	50.00%
7 FAST SPEED	100.00%
8 INITIALIZATION SPEED	50.00%
9 PARKING POSITION	6.000mm
10 POSITIONING TIMEOUT	60s
11 INITIALIZATION TIMEOUT	80s

AG X AXIS PARAMETERS

#	Parameter	Value
1	POSITION CORRECTION	210.000mm
2	MIN. POSITION	12.000mm
3	MAX. POSITION	226.000mm
4	POSITION TOLERANCE	0.030mm
5	POSITION NEAR	0.100mm
6	SLOW SPEED	20.00%
7	FAST SPEED	100.00%
8	INITIALIZATION SPEED	50.00%
9	PARKING POSITION	14.000mm
10	POSITIONING TIMEOUT	75s
11	INITIALIZATION TIMEOUT	120s
12	PROP. GAIN OF CONTROLER	50
13	FIELD OF VIEW MIN. POSITION	12.500mm
14	FIELD OF VIEW MAX. POSITION	24.000mm

AG Y AXIS PARAMETERS

#	Parameter	Value
1	POSITION CORRECTION	20.000mm
2	MIN. POSITION	12.000mm
3	MAX. POSITION	144.000mm
4	POSITION TOLERANCE	0.020mm
5	POSITION NEAR	1.000mm
6	SLOW SPEED	20.00%
7	FAST SPEED	100.00%
8	INITIALIZATION SPEED	50.00%
9	PARKING POSITION	14.000mm
10	POSITIONING TIMEOUT	70s
11	INITIALIZATION TIMEOUT	100s
12	PROP. GAIN OF CONTROLER	50
13	FIELD OF VIEW MIN. POSITION	12.500mm
14	FIELD OF VIEW MAX. POSITION	143.000mm

AG FILTER WHEEL PARAMETERS

#	Parameter	Value
1	POSITION CORRECTION	-192.2°
2	POSITION TOLERANCE	1.0°
3	SPEED	80.00%
4	POSITIONING TIMEOUT	6s
5	0. POSITION NAME	empty
6	1. POSITION NAME	pos 1
7	2. POSITION NAME	pos 2
8	3. POSITION NAME	pos 3
9	4. POSITION NAME	pos 4
10	5. POSITION NAME	pos 5

MOVABLE CARRIAGE PARAMETERS ⬆	
1 POSITION CORRECTION	40.00mm
2 MIN. POSITION	10.00mm
3 MAX. POSITION	306.00mm
4 POSITION TOLERANCE	0.10mm
5 POSITION NEAR	2.00mm
6 SLOW SPEED	15.00%
7 FAST SPEED	100.00%
8 INITIALIZATION SPEED	50.00%
9 PARKING POSITION	304.00mm
10 POSITIONING TIMEOUT	240s
11 INITIALIZATION TIMEOUT	260s

6.10 Meteo parameters

METEO PARAMETERS ⬆		
1 PRECIPITATION CHECK	ON	OFF
2 BRIGHTNESS CHECK	ON	OFF
3 BRIGHTNESS, HIGH LIMIT	11.0kLux	
4 BRIGHTNESS, LOW LIMIT	1.0kLux	
5 HUMIDITY CHECK	ON	OFF
6 MAX. HUMIDITY 1	80%	
7 MAX. HUMIDITY 2	85%	
8 WIND SPEED CHECK	ON	OFF
9 MAX. WIND SPEED (SLIT)	18.0m/s	
10 MAX. WIND SPEED (VENT.)	14.0m/s	
11 PYRGEOMETER VALUE CHECK	ON	OFF
12 MAX. PYRGEOMETER VALUE	-60.01W/m2	

6.11 Correction model 1...5

HS - Hour axis shift
The constant shift between true hour axis direction and hour axis sensor direction.

DS - Declination axis shift

The constant shift between true declination axis direction and declination axis sensor direction

TD - Tube/declination non-perpendicularity
Non-perpendicularity of declination and optical axis.

DH - Declination/hour axis non-perpendicularity
Non-perpendicularity of hour and declination axis.

EW - East/West inclination
The inclination of hour axis to the east-west direction (in respect to the equator).

NS - North/Southe inclination
The inclination of hour axis to the south direction.

TF - Tube flexure

Linear flexure of the tube

FF - Fork flexure

Linear flexure of the fork (for form mount)

DF - Declination flexure

Flexure of the declination axis. (for german equatorial mount)

6.12 Pointing restrictions

Main

This is a list of fifty mechanical coordinates (hour / declination axis), which define the boundary of telescope horizon. This is the horizon limitation, below which the automatic modes of the telescope are switched off.

Reverse

This is the list of fifty mechanical coordinates (hour / declination axis), which define the boundary of telescope horizon. This is the horizon limitation, below which the automatic modes of the telescope are switched off.

HA MIN

The end of the horizon boundary on the hour axis.

HA MAX

The end of the horizon boundary on the hour axis.

DA MIN

The end of the horizon boundary on the declination axis.

DA MAX

The end of the horizon boundary on the declination axis.

GREEN DISTANCE

Below this inward distance from the blue line the telescope speed is limited.

RED DISTANCE

Beyond this outside distance from the blue line the telescope is switched off and can be only switched on again using safety bypass.

7 ALARMS

7.1 Types of the alarms

There are three types of the alarms:

- Serious failures that lead to the turning off of the servo-amplifiers power (all main checks of the telescope location and servo-amplifiers failures).

- Less serious failures that lead to the shutdown of automatic modes of the telescope. Only manual movement by limited speed is possible (pointing restrictions, inclination check).

- Failures intended for information purposes only, not directly related with the telescope and restricted its operation (measuring loop of meteorological data for example).

It is possible to switch on the **ON** button on the **CONTROL** screen of the visualization if no serious failure exists. This turns on power of servo-amplifiers and the telescope is ready for operation. The warning message **Active alarm** appears if the alarm is activated and operator presses the **ON** button.

The operator must to use the key to switch on the safety bypass, if there the serious alarm is activated and he need to get the telescope from the accident position. **The safety bypass do not inhibit the safety loop.** The **ON** button is possible to switch on then and it is possible manually move the telescope on the responsibility of the operator.

7.2 List of alarms

Analog Inputs
AINPUTS AL 1, L1_L2 error (voltage between phases L1-L2 - error of analog input)
AINPUTS AL 2, L2_L3 error (voltage between phases L2-L3 - error of analog input)
AINPUTS AL 3, L1_L3 error (voltage between phases L1-L3 - error of analog input)
AINPUTS AL 4, PI1 error (atmospheric pressure - error of analog input)
AINPUTS AL 5, TI2 error (indoor temperature - error of analog input)
AINPUTS AL 6, TI3 error (oil temperature - error of analog input)
AINPUTS AL 7, GU1 error (current - error of analog input)
AINPUTS AL 8, GU2 error (current - error of analog input)
AINPUTS AL 9, PI2 error (oil pressure - error of analog input)
AINPUTS AL 10, LI1 error (oil level - error of analog input)
AINPUTS AL 11, TI4 error (telescope temperature - error of analog input)
AINPUTS AL 12, GI1_X error (inclinometer - error of analog input)
General
GENE AL 2, KA1 error (safety relay is open)
GENE AL 3, Q7 error (circuit breaker open)
GENE AL 4, Q12 error (circuit breaker open)
GENE AL 5, Q13 error (circuit breaker open)
GENE AL 6, Q14 error (circuit breaker open)
GENE AL 7, Q15 error (circuit breaker open)
GENE AL 8, Q46 error (circuit breaker open)
GENE AL 9, Q8 error (circuit breaker open)
GENE AL 10, M15_M16 error (ventilator - feedback signal not corresponding with current state)
GENE AL 11, CRC error (control checksum of pameters not corresponding with previous one)

GENE AL 12, remote error (human presence detected)

GENE AL 13, power supply error (system is on UPS)

GENE AL 14, Q54 error (circuit breaker open)

Oil

OIL AL 1, F5 error (circuit breaker open)

OIL AL 2, F6 error (circuit breaker open)

OIL AL 3, F7 error (circuit breaker open)

OIL AL 4, M7 error (feed pump - feedback signal not corresponding with current state)

OIL AL 5, M8 error (suction pump 1 - feedback signal not corresponding with current state)

OIL AL 6, M9 error (suction pump 2 - feedback signal not corresponding with current state)

OIL AL 7, TI3 maximum (maximum oil temperature exceeded)

OIL AL 8, LI1 minimum (low oil level)

OIL AL 9, PI2 minimum (low oil pressure)

OIL AL 10, PI2 maximum (maximum oil pressure exceeded)

OIL AL 11, starting timeout (level) (desired oil level not reached)

OIL AL 12, starting timeout (pressure) (desired oil pressure not reached)

Telescope

TELE AL 1, HA absolute sensor error

TELE AL 2, DEC absolute sensor error

TELE AL 3, HA incremental sensor error

TELE AL 4, DEC incremental sensor error

TELE AL 5, HA abs. vs. inc. sensor error (maximum difference between sensors exceeded)

TELE AL 6, DEC abs. vs. inc. sensor error (maximum difference between sensors exceeded)

TELE AL 7, M1 error (HA motor - feedback signal not corresponding with current state)

TELE AL 8, M2 error (DEC motor - feedback signal not corresponding with current state)

TELE AL 9, KA2 error (safety bypass in on)

TELE AL 10, safety switch

TELE AL 11, inclination error (max. diff. between inclinometer and elevation calculation exceeded)

TELE AL 12, HA control deviation error (maximum control deviation exceeded)

TELE AL 13, DEC control deviation error (maximum control deviation exceeded)

TELE AL 14, HA initialization timeout (time for initialization expired)

TELE AL 15, DEC initialization timeout (time for initialization expired)

TELE AL 16, pointing restrictions, abs slow (below green)

TELE AL 17, pointing restrictions, abs stop (below blue)

TELE AL 18, pointing restrictions, abs off (below green)

TELE AL 19, pointing restrictions, inc slow (below green)

TELE AL 20, pointing restrictions, inc stop (below blue)

TELE AL 21, pointing restrictions, inc off (below green)

Hand paddle

HAND AL 1, hand paddle 1 error (loss of communication with hand paddle in control room)

HAND AL 2, hand paddle 2 error (loss of communication with hand paddle in dome)

Pointing Restrictions

STG AL 1, pointing restrictions error (erroneous calculation of pointing restrictions)

Meteo Station

METEO AL 1, communication error (loss of communication with meteo station)

METEO AL 2, precipitation error

METEO AL 3, brightness error (brightness exceeded high limit)

METEO AL 4, humidity error (maximum humidity exceeded)

METEO AL 5, wind speed error (maximum wind speed for slit exceeded)

METEO AL 6, pyrgeometer error (maximum pyrgeometer value exceeded)

METEO AL 7, brightness error (brightness exceeded low limit)

METEO AL 8, wind speed error (maximum wind speed for ventilation exceeded)

Dome
DOME AL 1, sick 1 sensor error
DOME AL 2, sick 2 sensor error
DOME AL 3, absolute sensor error
DOME AL 4, M17_M19 error (motor - feedback signal not corresponding with current state)
DOME AL 5, moving timeout (time for moving expired)
DOME AL 6, initialization timeout (time for initialization expired)

Slit
SLIT AL 1, communication error (loss of communication with slit)
SLIT AL 2, TIRK1 error (temperature in control cabinet - error of analog input)
SLIT AL 3, BAT error (battery voltage - error of analog input)
SLIT AL 4, PG1 error (pyrgeometer - error of analog input)
SLIT AL 5, end switches error (both end switches triggered)
SLIT AL 6, open error (loss of end switches in open state)
SLIT AL 7, closed error (loss of end switches in closed state)
SLIT AL 8, moving timeout min error
SLIT AL 9, moving timeout max error (time for moving expired)
SLIT AL 10, meteo error (slit is open during bad meteo conditions)

Cassegrain Flap
CFLAP AL 1, F9 error (circuit breaker open)
CFLAP AL 2, M11 error (motor - feedback signal not corresponding with current state)
CFLAP AL 3, end switches error (both end switches triggered)
CFLAP AL 4, moving timeout (time for moving expired)
CFLAP AL 5, open error (loss of end switch in open state)
CFLAP AL 6, closed error (loss of end switch in closed state)

Mirror Flap
MFLAP AL 1, F8 error (circuit breaker open)
MFLAP AL 2, M10 error (motor - feedback signal not corresponding with current state)
MFLAP AL 3, end switches error (both end switches triggered)
MFLAP AL 4, moving timeout (time for moving expired)
MFLAP AL 5, open error (loss of end switch in open state)
MFLAP AL 6, closed error (loss of end switch in closed state)

Filter Wheel A
FWHEELA AL 1, moving timeout (time for moving expired)
FWHEELA AL 2, locked error (loss of current position)

Filter Wheel B
FWHEELB AL 1, position error (signals not corresponding with any position)
FWHEELB AL 2, moving timeout (time for moving expired)
FWHEELB AL 3, locked error (loss of current position)

Main Focus
FOCUS AL 1, sensor error
FOCUS AL 2, end switches error (both end switches triggered)
FOCUS AL 3, positioning timeout (time for positioning expired)
FOCUS_XY AL 1, x axis end switches error (both end switches triggered)
FOCUS_XY AL 2, y axis end switches error (both end switches triggered)

Movable Carriage
MCARRIAGE AL 1, sensor error
MCARRIAGE AL 2, end switches error (both end switches triggered)
MCARRIAGE AL 3, positioning timeout (time for positioning expired)
MCARRIAGE AL 4, initialization timeout (time for initialization expired)

Autoguider Focus
AGUIDER FOCUS AL 1, sensor error

AGUIDER FOCUS AL 2, end switches error (both end switches triggered)
AGUIDER FOCUS AL 3, positioning timeout (time for positioning expired)
AGUIDER FOCUS AL 4, initialization timeout (time for initialization expired)
Autoguider X axis
AGUIDER X AL 1, sensor error
AGUIDER X AL 2, end switches error (both end switches triggered)
AGUIDER X AL 3, positioning timeout (time for positioning expired)
AGUIDER X AL 4, initialization timeout (time for initialization expired)
Autoguider Y axis
AGUIDER Y AL 1, sensor error
AGUIDER Y AL 2, end switches error (both end switches triggered)
AGUIDER Y AL 3, positioning timeout (time for positioning expired)
AGUIDER Y AL 4, initialization timeout (time for initialization expired)
Autoguider Filter Wheel
AGUIDER FWHEEL AL 1, sensor error
AGUIDER FWHEEL AL 2, moving timeout (time for moving expired)
AGUIDER FWHEEL AL 3, locked error (loss of current position)
Shutter
SHUTTER AL 1, opening timeout (time for opening expired)
SHUTTER AL 2, power supply error
Ventilation
VENT N AL 1, closing timeout (time for closing expired)
VENT N AL 2, closed error (loss of end switches in closed state)
VENT NE AL 1, closing timeout (time for closing expired)
VENT NE AL 2, closed error (loss of end switches in closed state)
VENT E AL 1, closing timeout (time for closing expired)
VENT E AL 2, closed error (loss of end switches in closed state)
VENT SE AL 1, closing timeout (time for closing expired)
VENT SE AL 2, closed error (loss of end switches in closed state)
VENT S AL 1, closing timeout (time for closing expired)
VENT S AL 2, closed error (loss of end switches in closed state)
VENT SW AL 1, closing timeout (time for closing expired)
VENT SW AL 2, closed error (loss of end switches in closed state)
VENT W AL 1, closing timeout (time for closing expired)
VENT W AL 2, closed error (loss of end switches in closed state)
VENT NW AL 1, closing timeout (time for closing expired)
VENT NW AL 2, closed error (loss of end switches in closed state)
VE AL 1, meteo error (at least one ventilation window is open during bad meteo conditions)
VE AL 2, local error (ventilation windows are in local mode)

8 Upgrade from October 9, 2013

8.1 Cassegrain flap can be disabled

| 26 | DISABLE CASSEGRAIN FLAP | ON | OFF |
| 27 | DISABLED CASS. FLAP STATE | | 3 |

```
0 - stopped
1 - opening
2 - closing
3 - open
4 - closed
```

The cassegrain flap can be disabled in TELESCOPE PARAMETERS with parameter number 26. The TSC than behaves as if there was no cassegrain flap – no CFLAP alarms, no blocking of other subsystems, etc.

With parameter number 27, user can set the cassegrain flap state which is in disabled state returned by ASCOL commands FCRS and displayed in the TCS client.

9 Upgrade from October 28, 2013

9.1 Two brightness limits

2	BRIGHTNESS CHECK	ON	OFF
3	BRIGHTNESS, HIGH LIMIT		11.0kLux
4	BRIGHTNESS, LOW LIMIT		1.0kLux

There are two brightness limits (originally there was only one) in METEO PARAMETERS – HIGH and LOW.

If the HIGH limit is exceeded all the ventilation windows are closed, the dome is parked, both flaps are closed and the slit is closed. Any attempt to open the ventilation windows or the slit is than blocked.

If the LOW limit is exceeded (but not HIGH) than:
- Before noon - the ventilation windows NE, E and SE are closed and the slit is closed if the dome azimuth is in the range of 30 to 150 degrees.
- After noon - the ventilation windows NW, W and SW are closed and the slit is closed if the dome azimuth is in the range of 210 to 330 degrees.

Any attempt to open ventilation windows or the slit during mentioned conditions is than blocked.

Local noon time is set as 16 hours UTC.

9.2 Two wind speed limits

8	WIND SPEED CHECK	ON	OFF
9	MAX. WIND SPEED (SLIT)		18.0m/s
10	MAX. WIND SPEED (VENT.)		14.0m/s

There are two wind speed limits (originally there was only one) in METEO PARAMETERS – for the slit and for the ventilation windows.

If the limit is exceeded than the corresponding subsystem is closed and any attempt to open it is than blocked.

# 10 Upgrade from December 5, 2013

10.1 All Clear Dome Slit
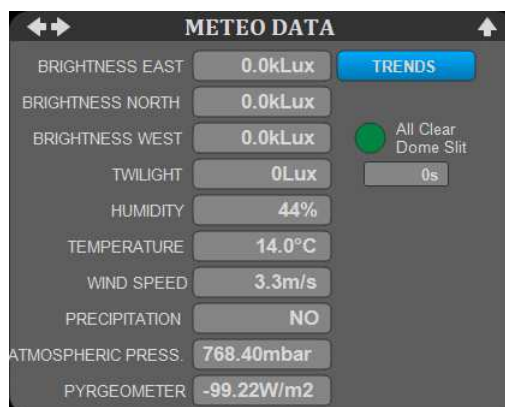
There is a new "LED" and a time value in METEO DATA panel.

If it is possible to open the slit the "LED" is green otherwise it is red.

The time value indicates the time that is necessary to wait until it will be possible to open the slit. But only if all meteo conditions are ok and it is only necessary to wait for running off-delays of meteo alarms.

10.2 Two humidity limits
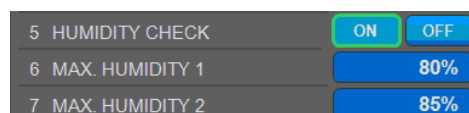
There are two humidity limits (originally there was only one) in METEO PARAMETERS – the first and the second.

Alarm occurs only when both limits are exceeded and disappears only when both limits are not exceeded. This alarm is evaluated without timers.

If the alarm is active all the ventilation windows are closed, the dome is parked, both flaps are closed and the slit is closed. Any attempt to open the ventilation windows or the slit is than blocked.