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Oskar–Lühning–Telescope Operating Manual

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1 General

This manual provides observing guidelines for the 1.2m Oskar–Lühning–Telescope (OLT) equipped with the CCD camera. It describes the `oltcontrol` software to operate telescope and camera written by Hans-Jürgen Hagen.

The OLT is currently operated with an AP8 camera from Apogee Instruments for direct imaging. The camera is equipped with a SITE 1024x1024 CCD chip with a pixel size of 24μm, allowing imaging of a 5.4’x5.4’ field with a resolution of 0.32”/pixel. The CCD is cooled by thermoelectric cooler with forced air. Broad-band Johnson filter B, V, and R, and a narrow-band Hα filter are provided. Guiding of the telescope is done with a second CCD camera (Apogee KX260) mounted on a movable carriage. The CCD is a 512x512 pixel array with 20μm pixel size.

![OLT control window](image)

Figure 1: `OLT control main window`. Below the `main button bar` the window is divided into sections `main camera` (control of the main CCD-camera), `guiding camera` (control of the guiding camera), `dome` (dome control), `sky` (telescope pointing control), and `telescope` (with display and operations panels).
2 Getting started

2.1 Login into the telescope control computer

The PC (hspc55) controlling telescope and instrument is located in the observing room on the first floor of the OLT building. Currently, login into this PC is possible only at the console or from other PCs of the observatory. Ask for a user account and for the procedures to login.

2.2 Start telescope control software and make setups

Open an xterm on your PC.

Start telescope control software: Type oltremote.

After typing in your user account and password, the telescope control software oltcontrol is started. The OLT control main window of the telescope control software appears (Fig. 1).

Switch on the webcam: This allows you to control dome and telescope movements. Press button view in the main button bar (cf. Fig. 1)

Adjust the webcam and switch on the lights (if needed): Press lights to switch on the lights, and move the webcam by pressing the arrow buttons in the FOV (Fig. 2)

Directory to save data: If you wish to save your data it is advisable to define a directory for this purpose. Open a second xterm and type

mkdir my_data

If, you do not wish to save your data below your HOME-Directory you may wish to set a link to the appropriate directory

ln -s /data/hspc??/owner/my_data my_data

Don’t forget to create the directory first!

![Figure 2](image1.png)

Figure 2: Left: The webcam window, Right: The control panel in the telescope section.

Before you proceed, check that the humidity is within the limits allowed as given in Section 11.

2.3 Telescope controls

Switch on the main controls of the telescope in the control panel (Fig. 2) of the OLT control main window.
• Press operation on to switch on the main controls
• Press hydraulics on to switch on the oil pumps. Needs about 30 sec to start
• Press slit o(pen) to open the dome slit
• Press cover o(pen) to open the main mirror cover
• Press Camera systems on. On is the default
• Press Main camera cooling and Guide camera cooling. The cameras need about 20 min. to reach the operating temperature. Operating temperatures are \( \approx -40^\circ C \) for the main and \( \approx -20^\circ C \) for the guide camera

Now all control lamps (except for tracking) should show green lights.

![Image of camera display]

Figure 3: main camera display displaying a bias frame. Details of the image are given at the bottom of the display if image info is enabled in the pull-down menu misc. Below the display the color bar subwindow gives informations on the pixel below the mouse pointer position.

2.4 A first image

2.4.1 Bias image

Go to the main camera control buttons of the main camera section

Set exposure time: Press exptim and enter exposure time 0 seconds. The exposure time is set automatically to the minimum 0.02 sec.

Set binning: Press binni and choose 2, 2 (2x2 binning)

Expose: Press dark to obtain the bias image. The image is displayed in the main camera display. If you move the mouse over the image, the x,y-position and the intensity levels are displayed in the color bar subwindow at the bottom of the main camera display (Fig. 3). Intensity levels should be 2700-2800 counts. The bias level for 2x2 binning is 2750±20 counts (July 2001).
2.4.2 Science image of a bright star

**Tracking:** Now, switch on tracking on the control panel

**Dome tracking:** Switch on auto dome in the upper right corner of the OLT control main window. The dome now automatically tracks the movements of the telescope.

Go now to the position panel (Fig. 4) selecting pos.

**Select a bright star from the built-in catalog:** Press list and select the list brightstars. Select an appropriate star near the zenith by clicking on the star with the left mouse button.

Press exec to start positioning of the telescope. Wait until the message "positioning finished" is displayed.

![Image of position panel with pull-down menu opened and brightstar list opened.]

Figure 4: *Upper left:* The position panel with the pull-down menu to select an object catalog opened. *Upper right:* The object catalog brightstars.lst opened. *Lower center:* The position panel after selection of a star from the catalog.

**Expose:** Choose an exposure time (try 10 sec. to start with), a binning (leave 2x2 to start with) and expose by pressing exposure. The status of the camera is displayed in a bar in the upper part of the display window (Fig. 5)

![Image of main camera display with exposure settings and status bar.]  

Figure 5: Part of the main camera display with the main camera control buttons and the status bar, giving the integrating time left (left) and the read-out time left (right).
2.4.3 Adjusting the image display

After readout of the CCD the image is displayed in the main camera display. The cuts are automatically set according to the minimum and maximum intensity levels found in the image. Moving the mouse into the main camera display switches the color bar subwindow into a display showing the x,y-position (in pixel) and the intensity level under the mouse position. Values in parentheses give the x,y-position in arcsec relative to the center of the image.

Adjusting the cuts:

- Press the pull-down menu misc and select cuts (Fig. 3 and 11). You may enter new values. Auto sets the cuts to optimized values.
- Alternatively, move the mouse into the color bar subwindow and click on the left mouse button. The current cuts are displayed and they are changed by moving the mouse holding the left mouse button pressed. Dependent on the position of the mouse in the color bar subwindow the lower or the upper limit is modified.

If you are satisfied with your observation, you may proceed now with focusing the telescope and the guiding camera.

3 Focusing telescope and guiding camera

3.1 Focusing the telescope

Obtain an image of a bright star with binning 4x4: To focus the telescope point the telescope to a bright star (V≤6 mag). Go to the main camera control buttons of the main camera section, select a binning of 4x4 and an exposure time of 5 sec (Fig. 11). Press exposure to obtain an image. The large binning is selected only to speed up read-out of the CCD.

![Image of camera operating in focusing mode](image)

Figure 6: The camera operating in “focusing mode”.
Set the camera into “focusing” mode: Select now a binning 1x1. Move the mouse pointer to the center of the star in the main camera display, press the right mouse button, and select fit frame with the left mouse button. Press the button misc and select focusing with the left mouse button (Fig. 11 and 13).

The camera now makes continuously exposures and displays a subwindow (the fit frame) centered on the star in the main camera display (Fig. 6). A two-dimensional Gauss-Fit is applied to the brightness distribution of the star and is displayed as ellipse in the main camera display. The Gauss-Fit parameters are displayed in a Gauss fit parameter display at the top of the main camera display. Given are background and amplitude, x-position and full width half maximum (FWHM) in x-direction in arcsec, y-position and y-FWHM in arcsec, and offsets from the center position of the first exposure in arcsec.

Set a starting focus value: The focus is set in the control panel of the Telescope section. The focus is changed by moving the sliding button in the set focus section (Fig. 2) with the left mouse button. While the focus motor is operating the background of the slider turns to red. The values are in arbitrary units. Start with focus 235.

Make a focus imaging sequence: Change the focus stepwise, while the camera is in “focusing mode” and record the FWHMs displayed. The best focus is the one where the FWHMs are minimized. You may choose step sizes of four. A reasonable FWHM for a well focused telescope is <3” depending on the seeing. With good seeing, you may now fine-tune the focus with step sizes of two.

3.2 Focusing the guiding camera

Now shift to the guiding camera section and select an exposure time of 1 second. Press exposing to obtain continuous read-outs from the guiding camera (Fig. 7).

Select a guide field: To focus the guiding camera shift a reasonably bright star into the guiding camera field of view (GFOV). Press buttons + or – of the guiding field control unit to move the GFOV. The GFOV is displayed as the small square in the Sky Graphics Window (Fig. 14 and 15).

Set guiding camera into “focusing mode”: Press misc and select focusing with the left mouse button. Proceed as in the Section 3.1 before to obtain Gauss-Fits to the brightness distribution of your star.

Set a starting focus value: The focus is set in the guiding camera focus control unit of the guiding camera section (Fig. 14). The focus is changed by pressing the buttons + or –. A good starting value for the guiding camera focus is 19.0. The values are in arbitrary units.

Make a guide focus imaging sequence: Change the focus stepwise, while the guide camera is in “focusing mode” and record the FWHMs displayed. The best focus is the one where the FWHMs are minimized. Again, you may choose step sizes of four. A reasonable FWHM for a well focused guiding camera should be similar to the FWHM obtained for the main camera.

4 Calibration exposures

4.1 Dark current calibration

Dark current exposures are required to correct for the thermal release of electrons, which are accumulated during the exposure. The dark current is linear in time but the amount is varying from pixel to pixel. It is therefore necessary to obtain a dark current image for every exposure time and every binning used during observations. Dark current exposures can be made during daytime. As the
long term behaviour of the dark current is unknown it is recommended to make dark current images after each observing night. A dark current image with zero exposure time is also known as bias frame.

Switch on telescope electronics: Press operation on in the control panel to switch on the main controls. Hydraulics can be left ‘off’, but the main camera is to be cooled to operating temperature.

Go to the main camera section:

Setup of the main camera: Choose an exposure time and binning. Recall that you need dark current images for any combination of these settings used during observations.

Make a sequence of dark current exposures: Select exposing/save in the misc pull-down menu. Record at least 3 exposures to allow filtering of cosmic ray hits.

The master dark current image is obtained during the reduction process by averaging (use the median!) of the sequence of dark current exposures.

4.2 Flat-fielding

Flat-fields are required to correct for the pixel-to-pixel sensitivity variations of the CCD. Sky-flats taken after sunset or before sunrise are recommended. To obtain optimal results, flat-fields should be taken during each observing night. Go to the main camera section:

Setup of the main camera: Choose a filter and the binning. Recall that you need flats for any combination of these settings used during observations.

Switch off tracking: This is recommended to avoid remaining star light to be recorded always by the same section of the CCD. If remaining stars drift through the field, affected pixels can be removed later by median filtering.

Choose appropriate exposure time: Adjust the exposure time to obtain an intensity level of several ten thousand counts (but below saturation (≈60000 counts)!).

Make a sequence of flat-field exposures: Select exposing/save in the misc pull-down menu. Record at least 11 exposures to obtain reasonable statistics. You may adjust the varying intensity level due to the changing sky brightness by changing the exposure time on-line. The new exposure time setting gets active as soon as the next exposure is started.

The master flat-field is obtained during the reduction process by scaling and averaging the sequence of flat-field exposures. The quality of the master flat-field increases with the number of flat-field exposures.

5 Guiding the telescope

Verify that tracking is enabled. Shift to the guiding camera section and select an exposure time of 1 second. Press exposing to obtain continuous read-outs from the guiding camera. The field of view images now by the guiding camera is indicated as the small square in the Sky Graphics Window (Fig. 15).

Select a guide field: Search for a reasonably bright star by moving the guiding camera field of view (GFOV). Press buttons + or – of the guiding field control unit to move the GFOV (Fig. 14 and 15).

Set the camera into “guiding” mode: Move the mouse pointer to the center of the star in the guiding camera display, press the right mouse button, and select fit frame with the left mouse button. A small section around the star is now displayed (Fig. 7). If you are not satisfied, switch back to the full frame by pressing the right mouse button in the guiding camera display and by selecting total.
image. You may search now for another guide star. If satisfied, select an exposure time from 3 to 7 seconds (with button `exptime`), and press `guiding`.

**Judging the guide quality:** A two-dimensional Gauss-Fit is applied to the brightness distribution of the star and is displayed as ellipse in the *guiding camera display*. The Gauss-Fit parameters are displayed in a *Gauss fit parameter display* at the top of the *guiding camera display*. Given are background and amplitude, x-position and full width half maximum (FWHM) in x-direction in arcsec, y-position and y-FWHM in arcsec, and offsets from the center position of the first exposure in arcsec. Make sure that the intensity (amplitude) of your guide star has a level higher than 100. Offsets from the center position of the first exposure should be <2 arcsec, unless the seeing is much greater.

### 6 A typical observing night

#### 6.1 Preparing the observing night

**Source list:** You may prepare a source list to avoid typing in the coordinates manually. The source list must have the following format:

```
23 57 45.5 +25 08 29.0 (2000) 'Peg Psi-84 ' Comments
```

The *Comments* part is optional. Place the list into the directory in which you will start the telescope control software later on.

**Standards:** You may include a suitable number of standards in your source list.

**Sun and Moon:** Use the program *aurora* to obtain a printout of times related to sun- and moon-rise and the corresponding settings (Fig. 8). The coordinates of the observatory are \( \lambda=10.25 \) and \( \beta=+53.4833 \). If requested, the output is written to the file “drucken.txt” in the directory, in which *aurora* was called.
6.2 Setup and flat fields

**Setup:** You may setup the telescope during day-time as described in Section 2, but leaving the slit and the main mirror cover closed.

**Dark current:** You may wish to make dark exposures with a range of exposure times to obtain corrections for the dark current (cf. Section 4.1).

**Ventilation:** You may open the slit and the doors of the dome after sunset to allow adjustment of temperatures inside the dome to the ambient temperature. **Keep the doors to the lower floors strictly closed.**

**Flat-fields:** Open slit and the main mirror cover and proceed with flat-field observations (cf. Section 4.2).

6.3 Observations

A typical sequence of observations could be:

- **Bias frame** – to check the performance of the CCD
- **Flux-Standard(s)** – flux calibration
- **Extinction-Standard** – choose an arbitrary bright star (preferably one of the flux standards to save observing time), which can be followed during the night between telescope heights 30°–80°(90°). Measure the Extinction-Standard frequently at low telescope heights!
- **Science frames** – Select objects from your prepared source list. The source list can be loaded by pressing list and open in the position panel. Check that the predicted telescope height is >27° before moving the telescope. The telescope will not move if the requested telescope height is <10°.
- **Flux- and Extinction Standards** – measure them ≈ every hour during photometric nights.
- **Bias frame** – to check the performance of the CCD at the end of the observations
- You may use the time until sunrise to obtain additional flat fields

6.4 Logs

A variety of logs are provided to recall the actions performed during the observing session and to document your data. For example, it is mandatory to control the humidity level regularly during the observing night.
The *environ*ment *panel* in the *telescope section* provides temperature and humidity outside and inside the dome and at the Cassegrain focus of the telescope (Fig. 17). Additionally a relative brightness level at the Cassegrain focus is given.

The *protocol* *panel* in the *telescope section* displays messages from the different tasks operating telescope and instrument (Fig. 17).

In your home directory an *observation log file* is created (f.e. olt_2002_Mar_22_12_37.prot) containing all messages displayed by the *protocol* *panel* during the observing session.

The data are stored in *fits-format* and several observing parameters (cf. Fig. 9) are permanently written to the header.

You may wish to write an observing log by hand. The most important information will be your notes about the weather conditions during the observations! A standardized form is available: /data/hspc55/mira/observing_log.ps
7 Shutting down camera and telescope

**Placing telescope into the zenith:** Select the *position panel* and toggle the *right ascension* button. The button displays now *hour angle* meaning that the coordinates are interpreted as hour angle and the window labeled *equinox* changes into a button *zenith*. *Tracking* is automatically switched off. Press *zenith* to move the telescope into the parking position (Fig. 10).

![Position panel](image)

Figure 10: Position panel in hour-angle-mode. The *zenith* button moves the telescope into the parking position.

**Closing the dome:** Select the *control panel* (Fig. 2) and press *slit c(lose).* The dome rotates into its parking position before the slit closes.

**Switch off the main controls of the telescope** in the *control panel* of the *OLT control main window*.

- Press *cover c(lose)* to close the main mirror cover
- Press *hydraulics on* to switch off the oil pumps
- Wait until dome slit and main mirror cover have finished closing operation. Then, press *operation on* to switch off the main controls.
- Press *guide camera cooling* and *main camera cooling* to switch off cooling.

Now all control lamps (except for *Camera systems on*) should show red lights. The control lamps for the camera cooling may still blink.

**Stop telescope control software:** Press *quit* in the *main button bar* of the *OLT control main window* to leave *oltcontrol*.

**Backup:** If you do not trust the integrity of your hard-disc, you may consider making a back-up. The easiest way is a copy of your data directory to another directory located on a different hard-disc.

**Logout from the computer.**
8 Oltcontrol Manual

This Section provides a detailed description of the oltcontrol capabilities.

8.1 Main button bar

quit  This button merely finishes the oltcontrol telescope software. Telescope, dome, and cameras remain in operation. Do not leave oltcontrol without closing the dome and stop telescope tracking. Note that the quit button is disabled while the telescope is tracking.
start  The button opens a pull-down menu displaying the different tasks making up oltcontrol. During regular telescope operations all tasks should be 'on' (default setting after start of oltcontrol; Fig. 11).
view  Button toggling the webcam 'on' and 'off'. Press control in the webcam window, press lights to switch on the lights in the dome, and move the webcam by pressing the arrow buttons in the FOV (Fig. 2).
sound  Button toggling the microphone in the dome 'on' and 'off'.

Figure 11: Left: Pull-down menu of the start button, Middle and right: Pull-down menus of the binning and misc buttons in the main camera display

8.2 Main camera section

The CCD section consists of the row of main camera control buttons, of the main camera display, and of the row of filter selection buttons (cf. Fig. 1).

8.2.1 Main camera control buttons

exposure  Starts an exposure with the integration time set in exptim. The status of the exposure is displayed in a status bar at the top of the image display.
dark  As exposure, but without opening the shutter
binni  Set the binning of the pixels (Fig. 11). Values 1x1 – 8x8 are possible. Depending on the setting the image sizes are 1024x1024 – 12x12 pixels and the read-out times vary between 25 and 2 seconds.
exptim  Setting the exposure time. Minimum is 0.02 seconds. Enter enters the value displayed, cancel leaves the current setting.
misc  Contains a variety of settings and operation modes (Fig. 11)
focus  Switches Gauss fitting on
cuts  
Sets the limits of the image intensity levels currently loaded in the display. Setting appropriate cuts is described in Section 2.4.3.

exposing  
Starts continuous exposures of expitn duration without saving. Toggle to stop.

save image  
Save last exposure to disk. Before the first image is saved you are asked to provide the appropriate directory.

simulating  
For test use only

exposing/save  
Starts continuous exposures of expitn duration with automatic data saving. Toggle to stop.

darkening/save  
Starts continuous exposures with closed shutter of expitn duration with automatic data saving. Toggle to stop.

temperature  
Choose between display of cooling temperature of the camera or ambient temperature taken outside the dome. You may fix the cooling temperature of the camera with set temp (Fig. 12). See also Section 9.4

reset camera  
Resets camera settings to default values

image info  
Displays a bar at the bottom of the display, giving size, binning, exposure time, total range of intensity levels, and cuts for the image currently displayed (Fig. 3). Toggle to close.

LUT  
Selects color coding of the image display (Fig. 12). Deflut is default.

![Pull-down menus of the misc/temp and misc/LUT buttons.](image)

Figure 12: Pull-down menus of the misc/temp and misc/LUT buttons.

### 8.2.2 Main camera display

The main camera display displays either the full image or part of it. If only a part of the image is displayed, the display has a red border (Figs. 6 and 7). During exposures a status bar pops up in the upper left part of the display. The CCD cooling temperature is displayed in the upper right corner of the display.

The color bar subwindow at the bottom of the main camera display can be used to set the cuts of the image display or to show information about the pixel currently located below the mouse pointer.

To change the cuts move the mouse into the color bar subwindow and click on the left mouse button. The current cuts are displayed and they are changed by moving the mouse holding the left mouse button pressed. Dependent on the position of the mouse in the color bar subwindow the lower or the upper limit is modified.

If the mouse pointer is within the display the x,y-position (in pixel) and the intensity level under the mouse position is given. Values in parentheses give the x,y-position in arcsec relative to the center of the image.

Several operations are possible using the mouse within the display (Fig. 13).
8.2.2.1 **Defining a subimage**  You may need the information of only part of the full CCD. To define a subimage click on the *left mouse button* and draw a rectangular subarea by holding the *left mouse button* pressed. Click then on the *sub image* message. The subimage chosen will be shown by red borders. After the next exposure only this part of the CCD is read out and displayed. To go back to the full image, click on the *right mouse button* and choose *total image* and make a new exposure.

8.2.2.2 **Moving the telescope by mouse drag**  To position an object conveniently on a particular point of the display the telescope can be moved by mouse drag. Set the mouse pointer on the object. Press the *middle mouse button* and drag the mouse to the position desired. With release of the button the message *move telescope* appears (Figure 13). Click on the message with the *left mouse button* to start telescope positioning. At the end of the operation the message “positioning finished” appears.

If tracking is enabled, tracking is temporarily disabled during positioning and restarted again automatically. If this operation is made while the telescope is in “guide” mode, guiding is automatically stopped. Adjust the guide field and restart guiding manually (Section 5).

8.2.2.3 **Set the “fit frame” for gauss fitting**  Set the mouse pointer to a particular point of the display. Press the *right mouse button* and select *fit frame*. A subwindow will be defined in which Gauss fitting will be made. Needed for focusing and guiding.

8.2.2.4 **Centering the “fit frame”** If you are not satisfied with the position of the subwindow, you may recenter it by pointing to the center wished, pressing the *right mouse button* and selecting *new center*. The new center will be active for the next exposure.
8.2.3 Filter selection buttons

Currently Johnson B, V, and R broadband filters are available. Hα is a narrowband filter centered on \( \lambda = 6565 \) Å. Button free contains no filter.

8.3 Guiding camera section

The guiding camera section consists of the row of guide camera control buttons, of the guiding camera display, and of the guiding field control and guiding camera focus control units (cf. Fig. 1).

8.3.1 guiding camera control buttons

- **exposing** Starts continuous exposures of exptim duration. Toggle to stop.
- **guiding** Switches telescope guiding on. Requires presence of a guide star (cf. Section 5)
- **exptim** Setting the exposure time. Minimum is 0.02 seconds. Enter enters the value displayed, cancel leaves the current setting.
- **misc** Contains a variety of settings and operation modes.

- **focusing** Switches Gauss fitting on
- **cuts** Sets the limits of the image intensity levels currently loaded in the display
- **binni** Set the binning of the pixels. Values 1x1 - 8x8 are possible. Leave on auto for normal operations.
- **exposure** Not used. (Starts a single exposure of exptim duration).
- **save image** Not used. (Save last guiding camera exposure to disk).
- **simulating** Not used. (For test use only)
- **exposing/save** Not used. (Starts continuous exposures of exptim duration with automatic data saving. Toggle to stop.)
- **temperature** Choose between display of cooling temperature of the camera or ambient temperature taken outside the dome. You may fix the cooling temperature of the camera with set temp (Fig. 12).
- **reset camera** Resets camera settings to default values
- **image info** Displays a bar at the bottom of the display, giving size, binning, exposure time, total range of intensity levels, and cuts for the image currently displayed (Fig. 3). Toggle to close.
- **LUT** Selects color coding of the camera image display (Fig. 12).

8.3.2 Guiding camera display

The guiding camera display displays either the full image or part of it. If only a part of the image is displayed, the display has a red border (Figs. 6 and 7). The CCD cooling temperature is displayed in the upper right corner of the display.

The color bar subwindow at the bottom of the guiding camera display can be used to set the cuts of the image display or to show information about the pixel currently located below the mouse pointer.

To change the cuts move the mouse into the color bar subwindow and click on the left mouse button. The current cuts are displayed and they are changed by moving the mouse holding the left mouse button pressed. Dependent on the position of the mouse in the color bar subwindow the lower or the upper limit is modified.

If the mouse pointer is within the display the x,y-position (in pixel) and the intensity level under the
mouse position is given. Values in parentheses give the x,y-position in arcsec relative to the center of the image.

Several operations are possible using the mouse within the display. The operations are identical to those described for the main camera display (Section 8.2.2). The most important operation is the setting of the fit frame around the guide star.

8.3.2.1 Set the “fit frame” for guiding Set the mouse pointer to the guide star chosen. Press the right mouse button and select fit frame. A subwindow will be defined in which Gauss fitting will be made (Fig. 7). Offsets of the center of the fit to the center of the very first image will be communicated to the telescope for correction.

8.3.2.2 Centering the “fit frame” If the guide star moves uncomfortably close to the guiding camera display borders you may recenter the fit frame by pointing to the guide star, pressing the right mouse button and selecting new center.

8.3.3 Guiding field control

The field-of-view of the guiding camera (GFOV) can be changed along declination by ±15 arcmin with respect to the coordinates at which the telescope points. In rectascension the guide field is offset 8.77 arcmin to the west. The GFOV is moved by pressing ”+” or ”−” in the guiding field control unit. Two velocities are provided (Fig. 14).

8.3.4 Guiding camera focus control

The focus of the guiding camera can be changed by pressing ”+” or ”−” in the guiding camera focus control unit. Two velocities are provided. The focus is not very sensitive to changes. Step in units of at least 2 (Fig. 14).

![Guiding field and Guiding camera focus control](image)

Figure 14: Guiding field and Guiding camera focus control

8.4 Dome section

The Dome section (Fig. 15) allows to switch on and off (button Auto Dome) the automatic tracking of the movements of the telescope by the dome. A graphic sketch indicates the position of the slit (in green) and the pointing direction of the telescope (red circle). South is up and east is left (Fig. 15).
8.5 Sky section

The Sky section (Fig. 15) contains a graphic display (Sky Graphics Window), which shows the sky as it is projected onto the focal plane. If, tracking is disabled, the stars drift through the window. The FOV of the main camera (large box) and of the guiding camera are indicated. The stars are taken from the Guide Star Catalogue and have a limiting magnitude V<15 mag.

![Dome section and Sky section](image)

Figure 15: Left: Dome section, Right: Sky section containing the Sky Graphics Window

8.6 Telescope section

The telescope section contains the telescope control display and a set of panels to operate the telescope and to monitor its status.

8.6.1 The telescope operating display

The telescope operating display (Fig. 16) gives the sky coordinates (current equinox!), at which the telescope actually points. Below the coordinates sidereal and universal time are given. Telescope positioning can be controlled by hour angle and telescope height. Telescope and dome azimuth, and telescope focus are given in the bottom windows of the display. Azimuth 0° is the direction towards the south. The parking position of the dome is at azimuth 340°.

![Telescope operating display](image)

Figure 16: Operating Display in the telescope section.
8.6.2 The control panel

In the control panel (Fig. 2) telescope, dome and camera operations are controlled. Additionally, telescope and dome can be moved "manually", and the telescope focus can be adjusted.

The switches have the following purposes

- **operation on** switches on and off the main controls
- **hydraulics on** controls the oil pumps. Need about 30 sec to start
- **slit open** (close) opens (closes) the dome slit. On closing the dome rotates automatically in its parking position
- **cover open** (close) opens (closes) the main mirror cover. Either operation requires \( \approx 60 \text{ sec} \).
- **camera systems on**. Off cuts the power supply to the PC controlling the cameras. The default status is **on** also during telescope shut-down periods.
- **main camera cooling** and **guide camera cooling**. The cameras need about 20 min. to reach the operating temperature. Operating temperatures are \( < -40^\circ \text{C} \) for the main and \( < -19^\circ \text{C} \) for the guiding camera

8.6.2.1 Moving the telescope "manually" You may move the telescope "manually" by selecting first a movement modus stepwise or continuously (slow, fast). Click then with the left mouse button on one of the directional buttons labeled east, south, west, north. The telescope starts moving stepwise, slow or fast according to your selection. Click on the directional buttons again to stop the movement. Be careful: Use this option only with the webcam switched on, so that you can visually control the movements of the telescope!

8.6.2.2 Moving the dome "manually" You may move the telescope "manually" by clicking with the left mouse button on one of the buttons labeled east, home, or west in the dome field. By clicking on home the dome moves into its parking position. Only in this position the slit can be closed.

8.6.2.3 Adjusting the telescope focus The focus is changed by moving the sliding button in the set focus section with the left mouse button. While the focus motor is operating the background of the slider turns to red. The values are in arbitrary units. Start with focus 235.

8.6.3 The position panel

The position panel (Fig. 4) serves as input for object coordinates and automatic positioning of the telescope. Type in object name, its coordinates and equinox, and press enter. The coordinates are precessed to the current equinox and written to a buffer displayed in the lower part of the panel. The predicted telescope position (azimuth, height) is given, as well as the distance \( (\Delta \alpha, \Delta \delta) \) the telescope will have to move to reach the requested position.

8.6.3.1 Starting telescope movement Press exec to start positioning of the telescope. Press abort to stop the operation. Avoid telescope heights \(< 27^\circ \) because of vignetting by the surrounding vegetation. Movement of the telescope is blocked by the software, if a telescope height \(< 10^\circ \) is requested. Wait until the message "positioning finished" is displayed, before you start further actions.
8.6.3.2 Using object catalogs Instead of typing in coordinates manually, you may select the coordinates from prepared catalogs or lists. The button list offers the following options:

- **main → guide:** Offset the telescope to place a star centered in the main camera display into the GFOV of the guiding camera. The offset is done in rectascension. You may have to move the GFOV in declination to pick up the star (cf. Section 8.3.3).

- **guide → main:** Reverse

- **open:** Allows you to enter your own catalog. Once selected this catalog is offered every time you press open. To close the catalog press close while the catalog is opened.

- **bright stars:** Provides a catalog of bright stars (V<7 mag).

- **moving targets:** Provides a catalog of Solar system targets

To select a star from a catalog and to position the telescope you have to press list and select the appropriate catalog. Browse through the catalog using the arrow keys (or the left mouse button and the scroll bar) and click with the left mouse button on the star selected. The coordinates of the star are entered into the buffer. Press exec to start moving the telescope.

8.6.3.3 Moving telescope into the zenith To move the telescope into its parking position (zenith) toggle the right ascension button and press zenith (Fig. 10).

![Figure 17: Left: Envi(ronment) panel, Right: Prot(ocol) panel](image)

8.6.4 The environment panel

The envi(ronment) panel (Fig. 17) displays temperature and relative humidity values measured outside and inside the dome, and at the Cassegrain focus of the telescope, where the CCD camera is attached. Additionally the relative brightness level (light pollution) is measured by a light sensor at the Cassegrain focus. For values <15% observing is possible. Above >40% the ambient light is too high for observations.

8.6.5 The protocol panel

The oltcontrol tasks regularly send control messages about the status of camera, dome and telescope. They are displayed in the prot(ocol) panel (Fig. 17). A copy of this messages is written to an observation log file (f.e. olt_2002_Mar_22_12_37.prot), which is located in the directory, where oltremote was started.
9 Troubleshooting

9.1 Resetting oltcontrol software

In case that oltcontrol was not terminated regularly, you will have to end non-terminated tasks started by oltcontrol first. Type
cleanoltcontrol
at the Linux shell prompt and start oltremote again.

9.2 Emergency stop of the telescope

In case that the connection to the running telescope via oltcontrol cannot be restored use the Emergency Stop (red button) in the observing room on the first floor of the OLT building besides the PC, which is controlling telescope and instrument.

9.3 Closing the dome by hand

In case that the dome slit cannot be closed remotely via oltcontrol you will have to close the slit from inside the dome.

- Connect the power cable located in the cupboard on the south-west side of the dome with the plugs in the cupboard and at the slit motor (Fig. 18). Turn the black switch to “I” (On) and press button “Zu” until the slit is closed.
- In case of a power failure use the crank (to be found in the same cupboard) and close the slit manually. A security lock has to be removed before the crank can be fixed on the slit motor axis.

![Image 1](image1.jpg) ![Image 2](image2.jpg)

Figure 18: Left: Dome control unit. Left is the plug for the power connection. Middle: Slit motor. Access to the motor axis is inhibited. Right: The crank is fixed after removal of the security stirrup.

9.4 Observing at high ambient temperatures

During summertime ambient temperatures during the night might be so high (T > 20°C) that the cooling temperatures of the CCDs do not reach their usual operating temperatures (cf. Section 10). In such cases, set the operating temperature to the minimum cooling temperature achieved. Use the camera control buttons misc and set temp.
10 Technical parameters

10.1 Telescope

- Mirror diameter: 120 cm
- Focal length: 15.6 m
- Slew velocity (fast): 1°/sec in $\alpha$; 2.5°/sec in $\delta$
- Slew velocity (slow): 1′/sec in $\alpha$; 25″/sec in $\delta$
- Step interval: 6″ in $\alpha$; 0.1″ in $\delta$

10.2 Main camera

- CCD size: 1024x1024 pixel (24.6x24.6 mm)
- Pixel size: 24$\mu$m
- Binning: 1x1-8x8 (image sizes: 1024x1024 - 128x128 pixel)
- Read-out times: 35 – 2 seconds
- Read noise (e$^-$): 15
- Gain: 4.25 e$^-$/ADU (Apogee) / 3.85 e$^-$/ADU (Hühn)
- Operating temperature: -40±2 C
- FOV Main camera: 324x324″ (5.4’x5.4’)
- Resolution: 0.32–2.5″/pixel dependent on binning
- Linearity: up to 60,000 counts

![Graph](image)

Figure 19: Linearity of the main camera CCD. Median count levels measured over the full frame are displayed as function of exposure time. Exposures were taken without filter. The scatter around the regression line is 140 counts.
10.3 Guiding camera

- CCD size: 512x512 pixel (10.2x10.2 mm)
- Pixel size: 20 μm
- Read noise (e−): 15
- Gain: 8 e−/ADU
- Operating temperature: -20±2 °C
- FOV Guide camera: 133x133” (2.2’x2.2’)

11 Weather limitations

11.1 Humidity

To avoid damage of telescope and instruments it is strictly forbidden to open the dome under high humidity conditions or danger of rain fall. Observations have to be stopped immediately, if a warning message from the rain detector is displayed or the limiting humidity in the Cassegrain focus is reached. Do not reopen the dome before the humidity at the cassegrain focus and the humidity outside the dome has fallen by at least 5%. Humidity values are displayed by the enviroment panel (Fig. 17) in the telescope section.

Humidity limit at Cass. focus <90%

12 Support

- Software: Hans-Jürgen Hagen, Tel. 040 428914136, e-mail: hhagen@hs.uni-hamburg.de
- Manual: Dieter Engels, Tel. 040 428914136, e-mail: dengels@hs.uni-hamburg.de