Preface

This manual explains the basic operation of the NOT 2.5 m telescope. It shows how to start up the telescope, how to control the main telescope functions, such as tracking objects, and how to close down the telescope. When a guest observer uses the telescope for the first time, he or she will usually be assisted by a staff astronomer, in addition to these instructions. During most observing, however, staff astronomers will not be present.

These instructions concern only the telescope and its control system. You will also need instruction manuals for the instruments you will use, such as the CCD camera or the photopolarimeter. These manuals are available at the NOT.

The control system of the telescope was initially written by Ingvar Svärdh in 1985–89. It was further developed by Niklas Holsti in 1989–91. The system was ported to the current hardware configuration in 1990. As the work to improve the NOT continues, these instructions are changed frequently. This version describes the system as it was in December 1992.

Even if you have used the NOT before, please check chapter 2 to see if there are any changes. **And however familiar you are with the telescope, please read the precautions in chapter 1!**

The appendix contains some information that may be useful to those coming to La Palma for the first time.

Although we have tried to use English spelling consistently, some commands use the American form (center, catalog). We apologize for the confusion.

This manual is based on the previous version by Niklas Holsti. Some separate instructions by Per-Ivar Emanuelson and the Risø group have also been included in this manual. Errors are my own.

Santa Cruz de la Palma
December 26, 1992
Hannu Karttunen

Revision history

Ingvar Svärdh May 9, 1993

Simplified power up and close down. Several changes throughout the manual.

Contents

1 Important precautions

1.1 Weather precautions

- **Humidity precautions**
  - If humidity exceeds 90%, close mirror covers and hatches immediately. You may resume observations after the humidity has decreased below 85%.
  - If humidity is over 75% or increases rapidly, be prepared to close down.
- **Wind precautions; no dust in the air**
  - If the wind speed exceeds 12 m/s, don't open the lower hatch or sideports.
  - If the wind speed is more than 15 m/s, only downwind observations are allowed.
  - If the wind speed exceeds 20 m/s, stop observing and close the telescope immediately.
- **Wind precautions; dust in the air**
  - If the wind speed exceeds 10 m/s, sideports and lower hatch must be closed.
  - If the wind speed exceeds 12 m/s, stop observing and close the telescope immediately.
- Be careful when moving outside in heavy wind. The wind speed increases around the dome. When leaving the dome, open the door with caution.
- Sometimes the wind speed can exceed 30 m/s. In this case, lock the dome and service building and leave as soon as possible.
- In winter there can be ice on the road. Subzero rain and sleet are also common, making the road very slippery.

1.2 Telescope operation

- There are several emergency stop buttons. These are yellow boxes with a big red knob. In an emergency, push the button to stop the building, telescope and hatches.
- There are light cells at the lower end of the entrance staircase. If you hit the beam, the building will stop. This will cause an audible alarm in the control room. When leaving or entering the dome, be careful not to accidentally stop the building.
- Opening the trapdoor or the main door to the cellar will turn off the power. **Don't open them while the telescope power is on.**
- Remember to stop the telescope (including the rotator), when filling the CCD dewar with liquid nitrogen. The easiest way is to use the `zenith` command.
- If you have to work with the adapter or the CCD filter mechanism, disconnect their power first. Otherwise there is a danger of being hurt by moving parts.
- The guide tv camera is a very sensitive device. Don't ever point it towards bright objects or turn it on when there is light in the dome. Don't use the tv if the object is brighter than 1.5 magnitudes. Use a gray filter if it is brighter than 6 magnitudes.
- Most special keys of the observer terminal have special effects. The cursor keys move the telescope and the numeric keypad keys select menu items. Be careful not to touch these keys accidentally!
- Instruments are independent of the control system, and there are no safety interlocks between them. For example, the photopolarimeter can be damaged by pointing the telescope at a star that is too bright. See separate instrument manuals for details.
- You may need to fill CCD's with liquid nitrogen. See separate instructions about handling nitrogen.

2 Recent changes

The following list summarizes the most important changes since spring 1991.

- To operate the telescope, there is no more any need to go to the electronics room. Computer commands can be used to turn power on and off.
- The upper hatch has new hydraulic motors, which can be operated even during a total power failure.
- The safety interlock system has been completely changed. See sections 1.2 and 10.1.
- The CCD filter mechanism has been changed. Filters can now be easily loaded in a cassette, which takes up to nine filters.
- Magnitudes can be included in object catalogues.
- To boot the computer, it is no more necessary to turn off the power; just press the reset button of the master processor.
- Active optics has been installed. More information will appear in future revisions of this manual.

The following are changes since December 1992.

- The power up and power off procedures are simplified.
- A new iccd camera for the guide probe has been installed. It is some magnitudes more sensitive than the old one.

3 Technical information

3.1 Telescope

The following list gives some important figures of the telescope.

- Location $\lambda = 17^\circ\ 52'\ 59.7''$ W = 1 h 11 m 32.0 s, $\phi = +28^\circ\ 45'\ 20.5''$.
  Fig. 1 can be used to estimate the time of twilight and darkness, as well as the sidereal time.
- Time zone UTC + 0; during daylight savings time UTC + 1 hour.
- Minimum accessible declination -55°.
- Altitude from mean sea level 2382 m.
- Azimuthal mounting with a rotating observatory building. Rotating adapter in the Cassegrain focus compensates for field rotation. The zenith is a singularity, where tracking is impossible. Thus it is not recommended to make observations within a few degrees from the zenith.
- Minimum altitude 6°.
- Main mirror 2.56 m.
- Focal length 5.12 m.
- Focal ratio f/2.
- Secondary mirror 0.510 m.
- Effective focal length 28.160 m.
- Effective focal ratio F/11.
- Scale at focus $7.325''$/mm, 0.13652 mm/$''$.
- Total field of view $30'$ ($25'$ unvignetted).

The layout of the first floor of the dome is shown in Fig. 2.

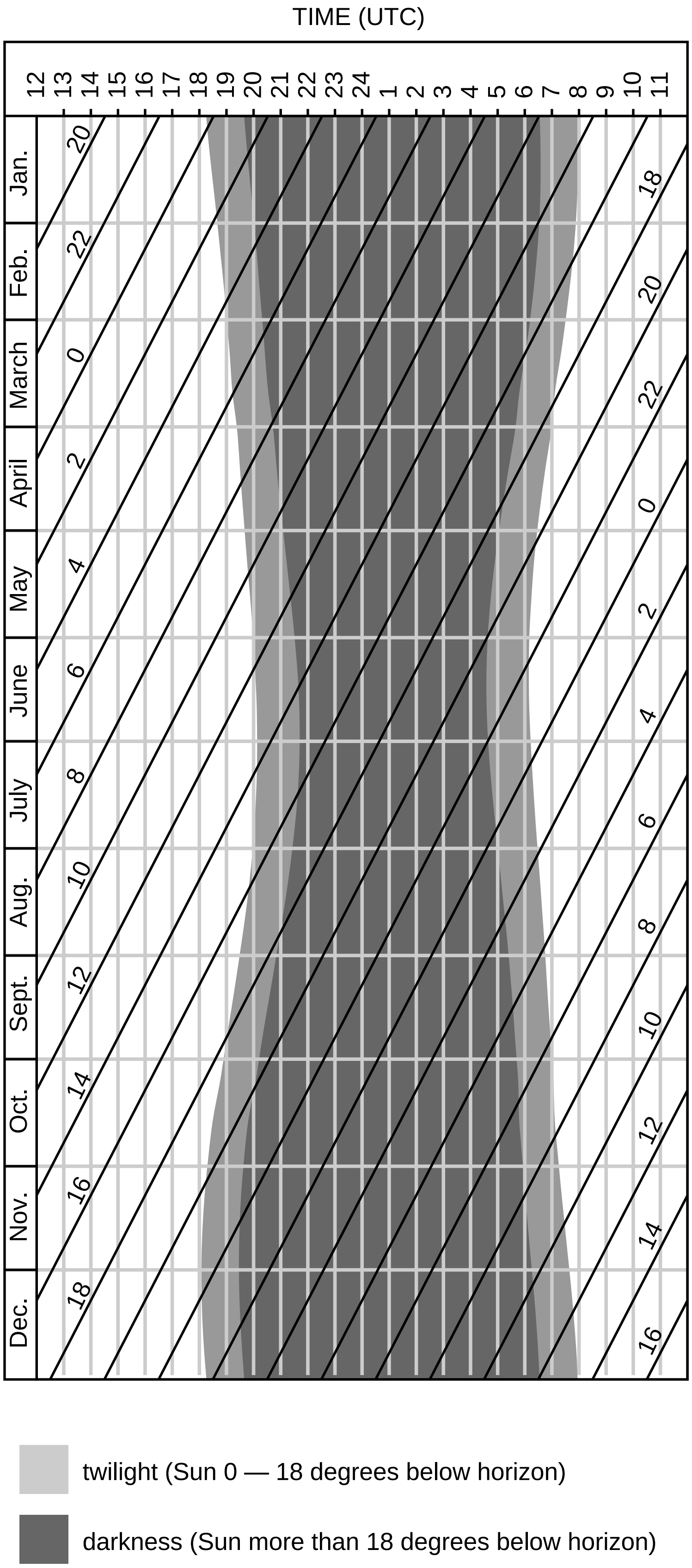

Fig 1: *Sidereal time, twilight and darkness on La Palma. The slanted lines correspond to different values of the sidereal time.*

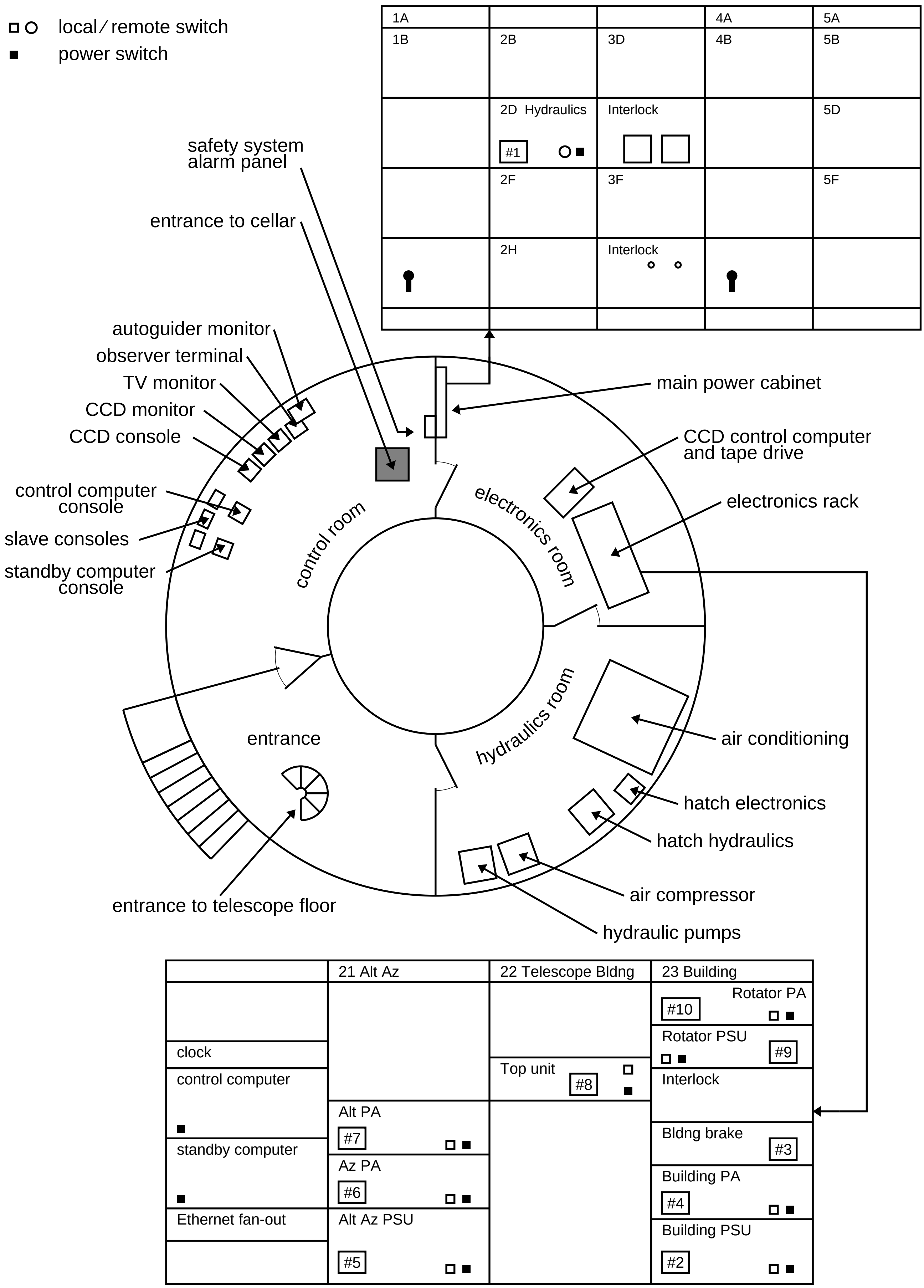

Fig 2: *Control floor layout.*

3.2 Adapter

The instrument adapter contains several instruments, including two movable probes, the *guide probe* and the *CCD probe*. There is also a *periscope mirror*, a *beamsplitter*, and *filter mechanisms* for the guide tv and CCD. The most important components and the possible light paths are shown in Fig. 3.

3.2.1 CCD probe

The CCD probe carries a diagonal mirror for feeding the standby CCD camera (Brocam 1 or 2). It has three positions, *Park*, *CCD*, and *Split*. In the CCD position, the light from the centre of the field is directed into the CCD camera. In the park position, the probe is out of the field, and the CCD doesn't receive light. The name of the split position has historical reasons. Earlier there was a beamsplitter, but it has been replaced by a mirror that directs light to the wavefront sensor. Thus, the split position cannot be used for observing.

The filter mechanism of the CCD contains a cassette that can take up to nine filters. These filters can be changed easily.

3.2.2 Guide probe

The guide probe carries the guide tv camera. The tv camera is an intensified frame-rate (non-integrating) CCD that is used both as a finder and for manual or automatic guiding. The camera is equipped with a filter wheel, which contains four filters: *B*, *V*, *R*, *gray*. The filter can also be *closed* or *open*.

The guide probe also carries a periscope mirror that, when activated, allows the guide tv camera to look through the instrument diaphragm (if the instrument has been so designed).

The guide probe is continuously movable in x and y coordinates. One unit in x or y is approximately $0.0073''$. Two guide probe positions are predefined: a *park position*, where the probe is out of the field, and a *centre position*, where the probe is in the centre of the field.

Note that the tv camera can be damaged by too strong light, such as bright stars, the Moon, or dome lights. When moving to a new object, the program automatically turns the filter wheel to the closed position to protect the camera. When the new object is reached and the telescope is tracking, the program automatically selects a gray filter for a first look at the field.

Maximum recommended brightnesses:

- Object brighter than 1.5 mag: don't use the tv!
- Object between 1.5 and 6 mag: use the gray filter.
- Object fainter than 6 mag: use any filter.
- Morning or evening sky half an hour before sunrise or after sunset.

3.2.3 Interaction of the probes and other instruments

The light coming into the adapter first meets the CCD probe plane, then the guide probe plane, and then the light passes into centrally mounted instruments such as the photopolarimeter.

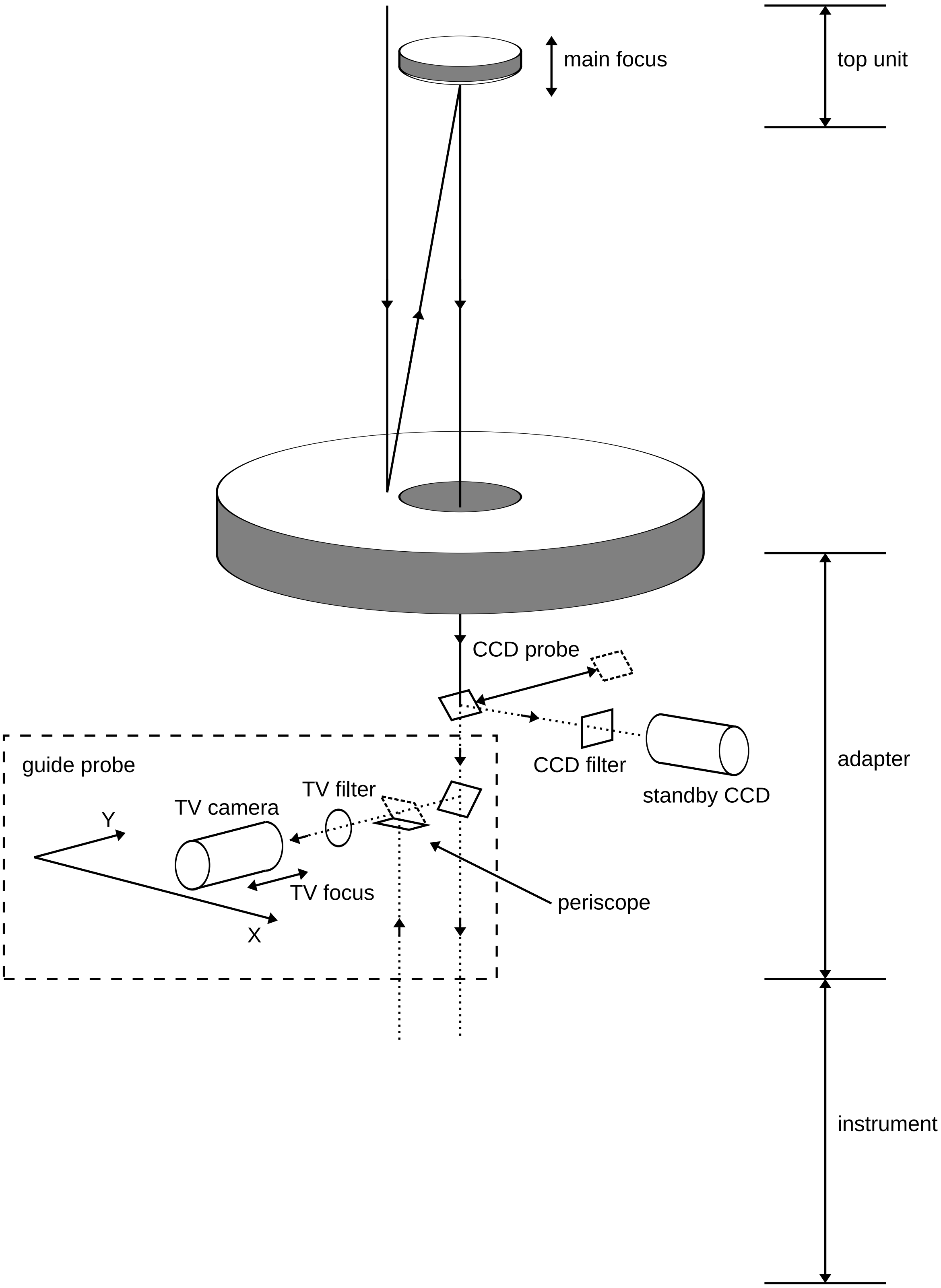

Fig 3: *Light paths in the telescope.*

When the CCD probe is in the CCD position, it obscures the centre of the field for the guide tv and centrally mounted instruments. Thus, the guide tv will show nothing, if the guide probe is also in its centre position. Analogously, with the guide probe in the centre position, no light reaches the centrally mounted instrument.

To use a centrally mounted instrument, the CCD probe must be in its park position, and the guide probe must be away from the centre position. Fig. 4 shows the area where the guide probe does not prevent light from entering the instrument. This is the area, where you should usually find your guide stars. There is an offline program running on a PC that you can use to find appropriate guide stars.

If you are using only the standby CCD, you can move the guide probe anywhere where you still can see something on the guide tv.

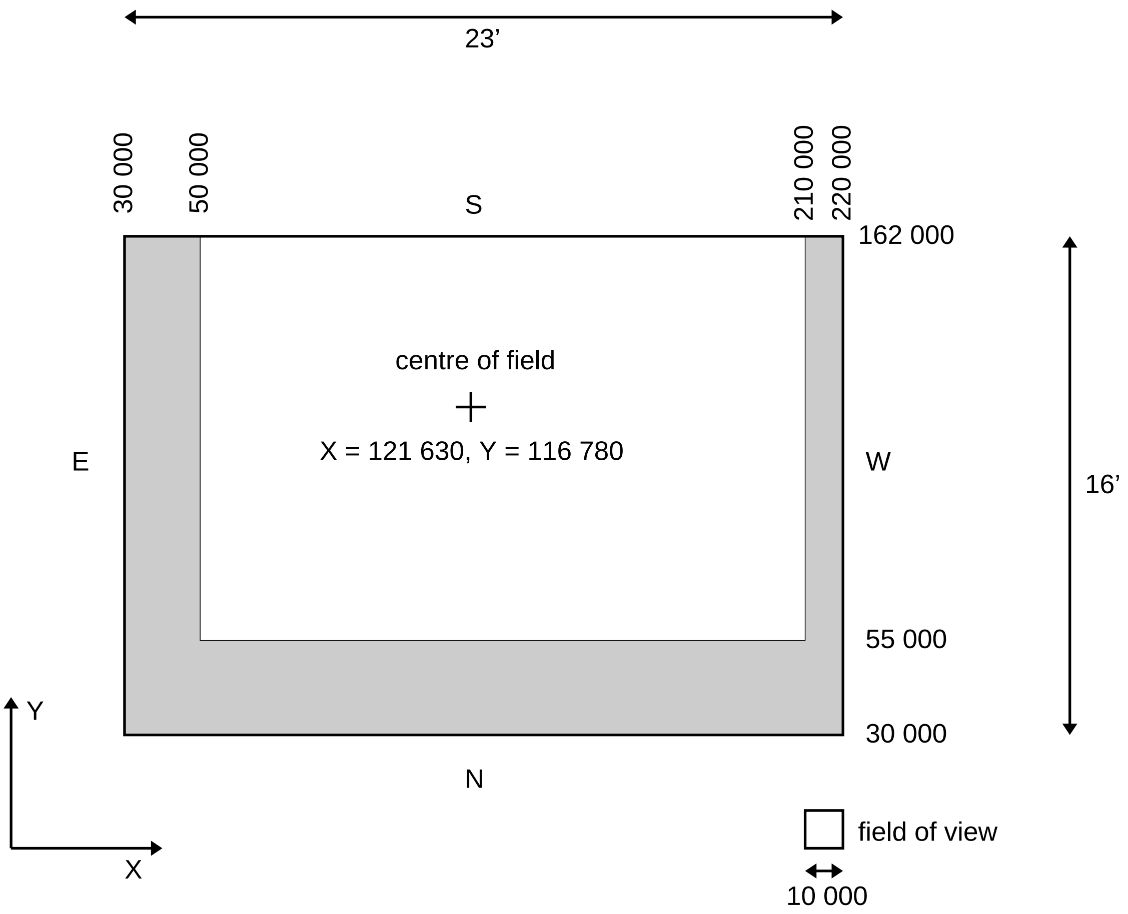

Fig 4: *Allowed guide probe range. In the gray region the probe does not prevent light from entering other instruments. Guide probe park coordinates are X=1100, Y=50000.*

4 User interface

The control system is run from the *Observer Terminal*. If nothing else is stated, everything is done from this terminal. The most often used commands can be selected from menus. Most commands can also be typed directly, which is usually faster after you have become familiar with the system.

4.1 Terminal screen

Dashed lines divide the screen in four main areas: status info, listing area, command and message area, and menu. Fig. 5 shows a typical display.

At the top is shown *status* information such as the sidereal time (ST), coordinates, hatches, mirror cover, etc.

```
Date   91-09-01       IDLE                Focus      2699     Upper Hatch   Closed
ST     12:30:00                           TV focus    414     Lower Hatch   Closed
RA     11:17:37.50  Azimuth   116.6004    TV         Off      Mirror Cover  Closed
DEC    38:07:27.9   Altitude   45.0000    CCD probe  Park        Guide-  X    1103
Z      45.00        Rotator   -89.98      CCD filter R           probe   Y    1154
--------------------------------------------------------------------------------
 2         WeathStat Temp.Air                  15.5 degr. C   { from }    8 ^
                     Temp.Check                19.5 degr. C   { from }
                     Pressure                 772.6 hPa       { from }
                     Wind Speed                 2.5 m/s       { from }
                     Wind Direction           248.3 degr      { from }
                     Humidity                  53.3 %         { from }
                     Light                     49.6 Lux       { from }
                     Rain                    false            { from }
                     Dust                     true            { set  }
           Autog.    Seeing                     3.8 "         { from }
           Watchdog - data above are            5.0 seconds old           9 v
--------------------------------------------------------------------------------

Command:

----------------------  MAIN MENU 1 commands  ---------------------------------
0 OTHERS 1 START/  2 PRESET  3 CATA-     4 GUIDE    5 ROTATOR 6 CCD      7 AUTO-
           STOP              LOGUE         PROBE              CAMERA     GUIDER
```

Fig 5: *Observer terminal display*

In the middle there is a *listing area* that is used for error and help messages, object catalogue listings, extended status displays, and output from more special commands. Entering certain menus will fill the listing area with corresponding information. For example, entering the `catalogue` menu displays the object catalogue.

Below the listing area is the *command line* that holds the commands you type and the prompts displayed by the program. *Warning* messages are displayed on the line just above the command, and *status* messages that result from command execution are displayed on the line just below. Warning and status messages remain on the display for 10 seconds and are then erased.

The current *menu functions* are displayed at the bottom of the screen. Many menu functions are just entries to other menus. Such functions are displayed in capital letters. Many menus have a function `OTHERS` that enters a second set of functions of this menu.

Note that the menu functions show the commands that are available at the current moment, not the current status. For example, if the mirror cover menu shows the function `open`, it means that the covers are currently closed, and thus can be opened. If the covers were currently open, the menu would show that `close` is possible.

4.2 Typing commands

In addition to the menu functions, most commands can also be typed. Commands can be in upper or lower case. Commands usually consist of words connected with hyphens, such as `tracking-limit`. The words can be abbreviated, and trailing words left out, as long as the abbreviation is unique. For `tracking-limit`, some valid abbreviations are `tracking-li`, `t-limit`, and `t-li`. If the command is ambiguous, the control program will list all matching commands. Since the number of commands tends to grow, don't be surprised if once valid abbreviations have become ambiguous.

Hit the `cr` key to end and execute each command. If more parameters are required, the program prompts for them. Use the `del` (or `bs`) key to correct typing mistakes. The `quit` key (key `-` on the numeric keypad) erases all of a command (and all stacked commands, see section 4.4).

Warning: The cursor (arrow) keys cannot be used to edit commands. They move the telescope.

Another warning: Don't use the numeric keypad keys to enter numeric parameters. A keypad key selects a menu item and executes the corresponding command.

If a command is very long, the command line will scroll horizontally, left or right, as needed.

The `Help` key (`PF1`) can be used at any time during the entry of a command. If used immediately after the command name, the syntax of the command is displayed. If used at a prompt for a parameter, the current value and the allowed range of that parameter are displayed.

The set of commands can be explored by typing the first letter of a command (`A`, say) followed by the `Help` key. All commands beginning with this letter will be listed on the screen (if there is only one such command, its help information is listed).

Some commands are valid only in the *engineering mode*. The engineering mode prompt is `Command/Eng:`, while the normal mode prompt is `Command:`. The command `engineering` enters engineering mode, and the command `quit-engineering` or simply `quit` returns to normal mode. Guest observers should not use engineering mode, except after consulting a staff member.

4.3 Menu selection

A menu selection is indicated below by the name of the menu function in a box, for example `TV On`.

Menu functions are numbered 0 to 7. The number appears highlighted to the left of the name of the function on the screen. To select a function, type its number **on the numeric keypad** (the group of numeric keys on the extreme right end of the keyboard). If there is a function name `OTHERS`, it gives access to a second set of functions in the same menu.

The keys `PF1`, . . . , `PF4` always have the meanings:

`PF1` help,

`PF2` enter and display the `MAIN MENU`,

`PF3` enter and display the `PRESET MENU`,

`PF4` abort a preset.

The commonly used menus are the following:

`MAIN MENU`	The top level menu. Access to other menus.
`START/STOP`	Open/close hatches, mirror cover, etc.
`PRESET`	Enter new objects, preset to them, etc.
`CATALOGUE`	Catalogue list, load, store, preset, etc.
`GUIDE PROBE`	Guide probe position, tv focus & filter.
`ROTATOR`	Rotator mode and position.
`CCD CAMERA`	CCD probe position, CCD camera filter.
`AUTOGUIDER`	Start/stop autoguiding, set parameters, etc.
`OTHERS`	Switch to another menu selection.
`SPECIAL FUNCTIONS`	Needed mainly to enter the status display.
`STATUS RECORD`	Weather conditions and other status info.

4.4 Command stacking

Menu functions can be selected even while typing a command. If the menu function needs no parameters, it is just executed with no effect on the command line. If the menu function does need parameters, the incomplete command is erased from the screen, but is saved internally (stacked). The command line is used to prompt for the menu function parameters in the usual way. When the menu function is completed, the saved, incomplete command is redisplayed, and can be completed or edited.

Up to 20 incomplete commands can be stacked in this way. A colon (:) is added to the `Command` prompt for each stack level. For example, if the prompt is `Command:::` there are two incomplete commands stacked.

The `quit` key (numeric keypad `-`) erases all commands, clearing the stack. To erase just the most recent, currently displayed command, backspace to the start of the command line and press the `cr` key.

4.5 Status record display

The *status record* contains information on the current state of the control system and the devices it controls. Most of this information is very technical and intended mainly to help in system maintenance. However, there are also some data that are useful for the observer.

To see the status record, use menu commands

`MAIN MENU`
 `OTHERS`
  `SPECIAL FUNCTIONS`
   `STATUS RECORD`

Use the menu key `Page listing` to see what is available. Particularly page 2 (Weather report) is important for the observer. Note that the page numbers may change when the system evolves.

In the case of problems, you may find it useful to find an appropriate status record page to see what is going on. Some of the entries are marked with `to`. They are usually commands sent by the control system to devices. Other items are marked with `from`, showing information sent by the devices back to the control system. A few items are `set`. These are parameters that usually remain constant, although some of them can be changed with a command.

5 Starting up

As described below in more detail, before observations you have to

1) check that the computers and control programs are running,
2) turn on the telescope power supplies,
3) open the dome and mirror covers,
4) check the configuration (pointing-model, focusing etc.).

5.1 Computer

The NOT is controlled by a VME-based Motorola computer with a master processor and three subunit or "slave" processors, in the same VME cabinet. This cabinet alaso contains a ScanBeam processor used by the autoguider. The operating system is OS-9, which resembles a simplified Unix. Some commands have different names (instead of `cd` you have to say `chd` and so on).

1) **Check that the control system is running.**
The computers and the control programs are usually running. If the computer does not respond at all, you have to reboot it, as explained in section 10.3.

   Look at the *Observer Terminal* in the Control Room. If an `hour:minute:second` display is running in the top left corner, the main control programs and user interface programs are running, and you can proceed to item 2). Otherwise you have to boot the computer (see 10.3).

   If you get an error message after trying to start the user interface, boot the computer (see 10.3).

2) **Restore display.**
Although the control program is usually left on between nights, the observer terminal screen may have been erased. In this case the screen is blank except some numbers at the upper left corner. To restore the normal display, type the command

   `refresh` $\boxed{\text{CR}}$

   (or abbreviated `re`).

5.2 Telescope power

At present the electronics and hydraulics for the telescope and building motions are usually turned off, when they are not needed. The power supplies are remotely controlled, and can usually be turned on and off from the observer's terminal. If you encounter any problems, see section 10.4, which explains how to check the local/remote switches and turn the power on manually.

1) **Check the telescope floor.**
Go up to the telescope floor and check that there is nothing the telescope or the instrument mounted on the rotator might hit. Make sure that the altitude lock-pin is in its outer position. This is a black oval handle near the right end of the altitude axis. Then return to the control room.

2) **Reset the safety system.**
If the safety system has been activated, it is not possible to turn on power. Therefore, check the safety system before continuing. Go to the main power cabinet

in the electronics room, push the two reset buttons on the interlock panels, and turn the two interlock keys. If the red lights don't go off, or if you hear a continuous clicking sound while turning the keys, you have to find the reason for the alarm, see 10.1.

3) **Turn on power.**
Turn on hydraulics and electronics with the command

`power-on` `CR`

When the programs asks you to confirm this, type `y` `CR`.

Don't continue before you see the message `Telescope power is ON`. Some of the power sources come on rather slowly; thus the power-on sequence will take about 60 seconds. If you want, you can see page 3 of the status record to check that all power sources are on. If you get an error message during the power-on procedure, the safety system may have been activated. In that case turn off power, check the safety system (see 10.1), and try again.

5.3 Opening the dome

Before opening hatches, sideports etc., take a look at the weather status on page 2 of the status record:

```
MAIN MENU
  OTHERS
    SPECIAL FUNCTIONS
      STATUS RECORD
        Page Number  2  CR
```

Please take note of the weather precautions listed in section 1.1. Weather conditions permitting, proceed as follows.

1) **Open sideports, if needed.**
To stabilize the temperature, it is often useful to open the sideports already in the late afternoon. Do not open the one towards the Sun. To open the sideports, go to the telescope floor, release the latches of the ports, turn the handles up, and slide the ports open. If you do this when power is on, remember what was said in 1.2 about the safety system!

2) **Open upper hatch.**
NOTE! Never move hatches with mirror cover open. Dust, ice, or other objects may fall on the mirror and damage it.

One should also take care when opening the dome in daylight. If the mirror covers are opened, the sunlight could be focused either on the instrument, or on the dome interior, with damage resulting in either case.

If, for any reason, the hatch refuses to move, it may help if you give the command `stop-u-h`. After that, you can try to open the hatch again.

You can open the upper hatch by

```
MAIN MENU
  START/STOP
    Open Upper H.
```

Or, you can just type the command `open-u-h`. Answer `yes` when the program asks you to confirm.

Wait until Upper Hatch is open ($\approx$ 5 min). A message will appear on the terminal, and `Open` will be displayed instead of `Undefined` or `Closed` in the upper right corner of the screen.

3) **Open lower hatch.**
If the altitude of your object is less than 35°, you have to open also the lower hatch. But notice that, due to the weak mechanism, the lower hatch must not be opened in heavy wind.

The lower hatch is opened by

```
MAIN MENU
  START/STOP
    Open Lower H.
```

or by typing `open-l-h`. To open the lower hatch, the upper hatch must be at least partly open; when closed, it engages the edge of the lower hatch and prevents it from opening.

The lower hatch can be stopped by

```
stop-lower-hatch
```

or, briefly, `s-l-h`. As with the upper hatch, the stop command may help if the hatch refuses to obey other commands.

4) **Open mirror cover**.

```
MAIN MENU
  START/STOP
    Open Mirror Cover
```

or `open-m-c`.

5.4 System and adapter setup

Finally, you have to set some parameters and turn on the auxiliary instruments you may need.

1) **Adjust the rotator.**
Enter the following commands to set the field rotator in automatic mode:

```
rot-auto
field 0
```

You can use other values, too, if you want a special field-orientation. If you do not want it to rotate with the field rotation then instead do:

```
rot-man
rot-pos 0
```

The rotator tries to stay within 90″ of the correct orientation. If the rotator exceeds this tracking limit, a warning is given and it will try to catch up as soon as possible. You can change this limit by e.g.

```
rot-tr-limit 120
```

which changes the rotator tracking limit to 120″. You should not decrease the limit, since the default is only four encoder units, and a stricter limit may make it impossible for the rotator servo program to maintain the required orientation.

2) **Turn on the guide tv.**
Turn on the guide tv monitor and the autoguider monitor (if you intend to autoguide).

N.B! The intensified CCD camera is delicate and will be damaged by excess light. Keep the dome as dark as possible while the camera is on. Keep `tv-filter` `closed` when you do not need the camera. The camera must not be turned on if daylight enters the dome.

In an emergency
To turn off the camera
TV-OFF $\boxed{\texttt{CR}}$

Before turning on the camera, close the filter:

```
tv-filter closed
```

Check that the dome is dark. Turn on the guide tv by

$\boxed{\texttt{MAIN MENU}}$
  $\boxed{\texttt{START/STOP}}$
    $\boxed{\texttt{TV On}}$

or simply

```
tv-on
```

If the tv does not turn on, first make sure that it is off by

```
tv-off
```

then go to the telescope floor and check that the mains voltage to the tv power supply is on. This is a red pushbutton on the adapter electronics box, marked *ICCD Power*. Remember to turn off the dome lights. When this is ok, try again with `tv-on`.

6 Controlling the telescope

After the start-up procedure the telescope should be standing still in idle mode and pointing to the zenith. To start tracking an object, use one of the commands described below in section 6.12. However, you should first understand the functions of the two movable probes in the instrument adapter. If you are not familiar with them, read section 3.2.

6.1 CCD probe

The CCD probe has three positions, *Park*, *CCD*, and *Split*). These positions are selected from the `CCD CAMERA` menu or by the following commands:

- `ccd-probe-park` or `c-p-p` moves the CCD mirror away from the optical axis. In this position the camera probe does not prevent light from entering other instruments.
- `ccd-probe-ccd` or `c-p-c` moves the CCD mirror to the optical axis. This position is used for CCD imaging. It will block the light from entering other instruments mounted at the optical axis. Also, it limits the region of the sky seen by the guide tv.
- `ccd-probe-split` or `c-p-s` moves another mirror to the optical axis. In this position, the light is reflected to the wavefront sensor.

The command `instrument-choice` allows more automatic control over the CCD probe. See section 6.7 on tv configurations.

6.2 CCD filters

The CCD camera has a filter mechanism with a cassette that can take up to nine filters. The filter can be selected by the command `ccd-filter`, or the menu function

```
MAIN MENU
  CCD CAMERA
    CCD Filter
```

followed by the name of the filter. Press the `Help` key after `CCD Filter` to see the list of possible filters. If you enter `off` as the filter name, the currently used filter is returned to the filter cassette, which can then be removed.

Changing the filter takes several seconds. Before starting your exposure, wait till the name of the selected filter is displayed in the status field of the Observer terminal.

If new filters are inserted in the filter cassette, they should be identified with the command `name-ccd-filter` which takes as parameters the filter number (the position in the filter cassette, 1–9) and the filter name. The name should start with a letter and should not contain blanks, colons, commas or other special characters. The names stay in effect even if the computer is rebooted.

Please make sure that `ccd-filter off` has been given before trying to take out the filter casette! When going to zenith this is done automatically.

6.3 Guide probe

The guide probe carries the guide tv camera, which is an intensified CCD camera. **Note that the tv camera can be damaged by too strong light. See the precautions given in chapter 1.**

The guide probe is continuously movable in x and y coordinates. Each coordinate can be set separately with the commands

`X` *value*
`Y` *value*

One unit in x or y is approximately $0.0073''$.

Two guide probe positions are predefined: a park position, where the probe is out of the way, and a centre position, where the probe is in the centre of the field. These predefined positions can be reached from the `GUIDE PROBE` menu or by commands:

- `guide-probe-park` or `g-p-p` moves the guide probe away; thus it will not block light from entering other instruments in the Cassegrain focus. Use this position only if you don't intend to use autoguiding.
- `guide-probe-center` or `g-p-c` moves the guide probe to the optical axis so that you can check the pointing of the telescope.

The guide probe can be stepped in x or y with the menu functions

`GUIDE PROBE`
  `OTHERS`
    `X-`
    `X+`
    `Y-`
    `Y+`

The step size can be set with the command

`probe-step-size` or `p-s-s`

followed by the x and y step sizes. One unit is 1/1024 mm in the focal plane.

The x and y coordinates of a guide star for your object can easily be found by using the offline guide star program running on a PC at the NOT. You can, of course, also scan the allowed guide probe region.

6.4 Focusing the telescope

The image you see on the guide tv monitor is influenced both by the telescope focus (changed by moving the secondary) and the guide tv focus (changed by moving the tv camera on the guide probe). The telescope focus setting affects all other instruments, too. Therefore, you should first set the main focus.

The main focus is very sensitive to the position of the secondary mirror. If any work has been made in the top unit, you'll find that the focus values may be quite different from what they were during your previous visit. Also, the focus depends on the temperature. Therefore, you may have to adjust the focus during the night.

To set the main focus, type the command

`focus` *value*

where *value* is an integer.

The CCD control system has a command **focimage**, which can be used to make multiple exposures. Move the telescope and change the focus between the exposures, and find the smallest image to determine the proper focus value.

6.5 Focusing the tv

The guide tv focus setting affects only the guide tv.

The guide tv focus can be stepped up or down with the menu functions

```
MAIN MENU
  GUIDE PROBE
    OTHERS
      TV focus +
      TV focus -
```

The step size for the movement can be set by

`tv-step-focus` *value*

The tv focus can also be set with the command

`tv-focus` *value*

6.6 TV filters

To select a tv filter, use the command **tv-filter** or the corresponding function in the `GUIDE PROBE` menu. When you are asked to name the filter, remember that the `Help` key will show you which filters are available. Usually, the filters are `B`, `V`, `R`, **gray**, **open**, and **closed**. When you move the telescope to a new object, the gray filter is selected automatically. If the object looks very faint, open the filter by

`tv-fi open`

Note: only **closed** is allowed if the telescope is slewing, in order to prevent light of bright objects from entering the tv. If the system complains that the filter is unknown, wait till the telescope is in the tracking mode.

6.7 Tv configurations

The guide tv is used for three main tasks:

- **center** configuration: Look at the object to be observed, in the centre of the field.
- **guide** configuration: Look at a guide star, for autoguiding.
- **periscope** configuration: Look through the periscope, to check the position of the object in the diaphragm.

The program maintains a separate *tv configuration* for each task. A tv configuration specifies several things:

- position of the guide probe (x and y)
- tv focus
- tv filter
- tv integration parameters (see section 7.3)

To define a tv configuration, move the guide probe to the desired position and set the tv filter, tv focus, and tv integration to the desired values, then give the command

`adopt-tv-configuration`	or `ad`

This command takes one parameter which is the name of the configuration: `center`, `guide`, or `periscope`. The current state is recorded as that tv configuration.

To change to a defined tv configuration, use one of the commands

`center-tv-configuration`	or `ce-t`
`guide-tv-configuration`	or `gu-t`
`periscope-tv-configuration`	or `pe-t`

These commands change the guide probe position and the tv filter, tv focus, and tv integration to the states stored previously for the configuration. (Note that the guide probe position of the centre configuration may differ from the one given by [GUIDE PROBE] [Center Position]).

6.8 Periscope

To activate the periscope, use the command

`periscope-activate`

You will also need to set x, y, and tv focus values according to the instrument you are using. To fold back (inactivate) the periscope mirror, use the command

`periscope-fold`

These commands are are also available in the menu

- [MAIN MENU]
  - [OTHERS]
    - [PERISCOPE BEAMSPLITTER]
      - [Periscope Activate]
      - [Periscope Fold]

6.9 Offset-mode and set-mode

The telescope can track either in *offset-mode* or *set-mode*. The cursor control keys are interpreted differently in these modes.

In the offset-mode the arrow keys [$\leftarrow$], [$\rightarrow$] step α, and [$\uparrow$], [$\downarrow$] step δ. This mode is normally used to centre the telescope on a fixed object.

In the set-mode the arrow keys change the α and δ rates. This mode is used in the rather rare occasions when you want to scan the sky, or to track a moving object (planet, comet, UFO, ...)

Offset-mode is the default. The mode is changed with the commands

`offset-mode`	or `of-m`	enter offset mode
`set-mode`	or `s-m`	enter set mode

The step size in the offset mode can be changed by the command

`offset-size` or `o-s`

to define the coordinate step per keypress, in seconds of arc. In order to see the current value, hit [Help] after typing `o-s`. For example,

```
o-s 10 10
```

sets the step size to $10''$ in both directions; this is a convenient value when exposing a focusing sequence.

If you want the same movement on the screen for offset-steps in α as in δ the cosine compensation should be on. This is the default, but if it has been turned off, use the commands

```
MAIN MENU
  OTHERS
    CONSTANTS
      Cos-Del comp on
```

to turn it on. Turn the compensation off, if, for some reason, you want the right ascension step to correspond to coordinate differences.

In the set-mode you may want to use the commands

- `set-step` defines the rate step per keypress.
- `set-rate` defines the precise α and δ rates without using the cursor keys.

The unit used for α and δ rates is seconds of arc per second of sidereal time.

If you move the telescope abruptly with very large step sizes, it may be necessary to increase the value of the tracking error limit, which specifies when the telescope is considered to have lost tracking. To set the limit to 1 arcminute, type

`tracking-limit 60` or `tr-li 60`

6.10 Clock adjustment

The current sidereal time clock cannot be set very precisely, and seems to drift a little. To correct for these problems, the following procedure can be used.

First, preset to an object with precise coordinates. Next, using offset-mode, move the telescope until the object is where you want your objects to be (e.g. on the diaphragm). Finally, give the command

`clock-adjustment adopt` or `clock ad`

This will deduce an Θ correction (from the amount you moved in α). The correction is applied for all future objects until you repeat the procedure or reset (zero) the correction with

`clock-adjustment reset` or `clock re`

6.11 Field rotator

The instrument adapter sits on a field rotator that can turn the mounted instruments (including the guide tv and the CCD camera) around the optical axis in the range $-199°$ to $+203°$. The rotator can hold a fixed angle relative to the telescope (manual mode), or it can hold a given orientation relative to the equatorial system on the sky (automatic mode).

When the rotator is at position $0°$ relative to the telescope, the guide-probe tv image shows altitude in the vertical direction, increasing downwards, and azimuth horizontal with west to the right. When the rotator moves to positive angles, the image rotates counterclockwise.

To keep a fixed angle relative to the telescope, give the command

```
rotator-manual
```

This stops the rotator at its current position

To hold a given orientation on the sky type

```
rotator-automatic
```

The rotator now starts to track the field rotation due to the azimuthal mounting.

The rotator position can be set either with respect to the telescope, or with respect to the equatorial system, in both the manual and automatic (tracking) modes. The mode is not changed by these commands.

The command

`rotator-position` *value*

moves the rotator to *value* degrees relative to the telescope.

The command

`field-rotation` *value*

moves the rotator to put the α axis on the guide tv image at *value* degrees counterclockwise from the left-to-right direction.

The most common case is the automatic mode at zero degrees field rotation:

```
rot-auto
field 0
```

Note that the rotator cannot rotate indefinitely in the same direction, as the telescope and building can. To avoid running into the limits during tracking, select a suitable sign for the angle you give in the `rotator-position` or `field-rotation` commands. Although `rot-pos 180` and `rot-pos -180` give the same orientation of the field, they give different ranges of rotator tracking.

If the rotator threatens to reach the end of its range, the control system emits a warning (once only). If the absolute value of the rotator position exceeds 180 degrees, give the following commands to turn the rotator one whole turn:

`rot-man`
`rotator-turn-360` or `ro-tu`

When the rotator has reached the proper position, give again the commands `rot-auto` and `field 0`.

If passing the 180 degree limits and you do not take any actions, then you should be aware of that when the rotator reaches the end limit in automatic mode it will be turned 360 degrees and then continue tracking.

There is also a tracking error limit for the rotator, which can be set with `rotator-tracking-limit` (default 90 arc sec). If you get the message

```
Rotator tracking lost!
```

you must enter both `rot-auto` and a `field` command to restart the rotator. `rot-auto` by itself is not enough. Also, if you were autoguiding, you must start the guiding again.

To stop rotator tracking, use `rotator-manual`. **N.B. The rotator MUST BE STOPPED when filling the CCD with liquid nitrogen!** `rot-pos -90` is a good position for this. We recommend that you **turn off the telescope power while working on the telescope floor.**

6.12 Tracking and slewing

In the *tracking* mode the control system tries to keep the telescope pointed towards an object. In the *slewing* mode it moves fast to a new object.

When you go to a catalogue object (section 8.2), the telescope will automatically start tracking the object. You can also start tracking from the current position by giving the command

`track-on`

Also, the `Abort preset` key (`PF4`) will start tracking from the current position. (The main purpose of this key is to cancel the slewing of the telescope towards a catalogue object.)

While tracking, you can use the cursor keys to adjust the pointing of the telescope. If the telescope is tracking in the offset-mode, as it usually is, the keys $\boxed{\uparrow}$ and $\boxed{\downarrow}$ change the declination and the keys $\boxed{\leftarrow}$ and $\boxed{\rightarrow}$ change the right ascension. Note that after you have pressed a cursor key, the telescope will go to the slewing mode for a while.

To stop tracking, use the command `idle-mode`, which stops the telescope at its current position, or `zenith`, which stops the azimuth and goes to altitude nearly 90 degrees (there is a small random component to avoid gear wear). The command `zenith` automatically sets the rotator in manual mode and turns it to $-90°$. When going to the next object, remember `rot-auto` and `field`.

To move the telescope manually in idle-mode use the cursor keys $\boxed{\uparrow}$ and $\boxed{\downarrow}$ to change the altitude and the keys $\boxed{\leftarrow}$ and $\boxed{\rightarrow}$ to change the azimuth.

To move to a known altitude and/or azimuth use the commands

`altitude-position` or `alt`
`azimuth-position` or `az`

followed by the position in degrees. A movement started with these commands can be stopped by pressing a cursor key: to stop motion in altitude press $\boxed{\uparrow}$ or $\boxed{\downarrow}$, to stop motion in azimuth press $\boxed{\leftarrow}$ or $\boxed{\rightarrow}$.

There are two predefined azimuth directions, accessed with the menu keys

```
MAIN MENU
   START/STOP
      PARK BUILDING
      HOIST POSITION
```

The former turns the building to the default parking position. The latter is convenient, if you want to use the crane to lift heavy things from the unloading area to the telescope floor.

6.13 Guide probe tracking

The guide probe operates in one of two modes: manual mode or tracking mode. In the default manual mode, the probe is moved only on command, and otherwise stays at the given x, y coordinates. In tracking mode, the probe tracks a position on the sky given in equatorial coordinates. This can be used for guiding while tracking a moving object (see 7.6), and also for moving the probe to a guide star (7.5).

Manual mode is set with the command

`probe-manual`

or any of the position-setting commands mentioned earlier. Tracking mode is set with the command

`probe-preset-to-this` or `pro-pres`

which makes the probe track the current selected catalogue object (e.g. the one just entered with `app-eq` or `mean-eq`). If the probe is subsequently put in manual mode, tracking mode can be re-entered for the same object with the command

```
probe-track
```

When the probe is tracking, moving the telescope with the cursor keys will not move the image on the guide tv monitor, since the probe compensates for the telescope motion. (The pointing precision of `probe-preset` is not yet determined.)

7 Autoguiding

The autoguider works by grabbing frames from the guide tv and correcting the telescope position to keep a star at a fixed position in the frame (fixed pixel numbers). The position of the star is measured by summing pixel rows and columns of a square aperture placed on the star image. The autoguider tries to keep the star centered in the aperture. A separate square aperture measures the background intensity. These apertures are drawn in red on the autoguider monitor—the background aperture is a plain box, and the star aperture is a box with a hollow cross. The autoguider screen is shown in Fig. 6.

7.1 Guiding modes

The autoguider has three modes of operation: *autobox*, *autoprobe*, and *autoguide*. In the autobox and autoprobe modes the autoguider corrections are not applied to move the telescope; instead they move the star box on the autoguider screen or the guideprobe, respectively. The mode is shown on the second line of the Observer's terminal.

Furthermore, the autoguider can be in a *single-frame mode* or *integrating mode*. In the single-frame mode, guide tv frames are grabbed one at a time, and the position of the star is measured from each frame. Exactly 12.5 frames per second are processed. Thus, of the 25 frames per second produced by the guide tv, half are lost.

In the integrating mode, a portion of the tv image is integrated by summing a given number of frames, pixel by pixel. A typical integration time is one second (25 frames). A portion about 120×120 pixels in size can be integrated while using all frames. The position of the star is measured from the integrated image, which is also displayed on the autoguider monitor.

Use single-frame mode when the guide star is fairly bright and seeing is good. Use integrating mode when the guide star is faint, or to smooth out bad seeing. Single-frame mode is the default when the control system is started (total start-up).

A tv configuration (section 6.7) includes the tv integration mode and integration parameters.

7.2 Single-frame mode

Single-frame mode is the default. To enter the single-frame mode after integration mode, use the command

```
integrate-frames 0
```

i.e. specify zero frames to be integrated.

In the single-frame mode, the full width of the tv image is displayed on the autoguider monitor. In addition to the apertures drawn in red, yellow corners outline the aperture that would be used in the integration mode.

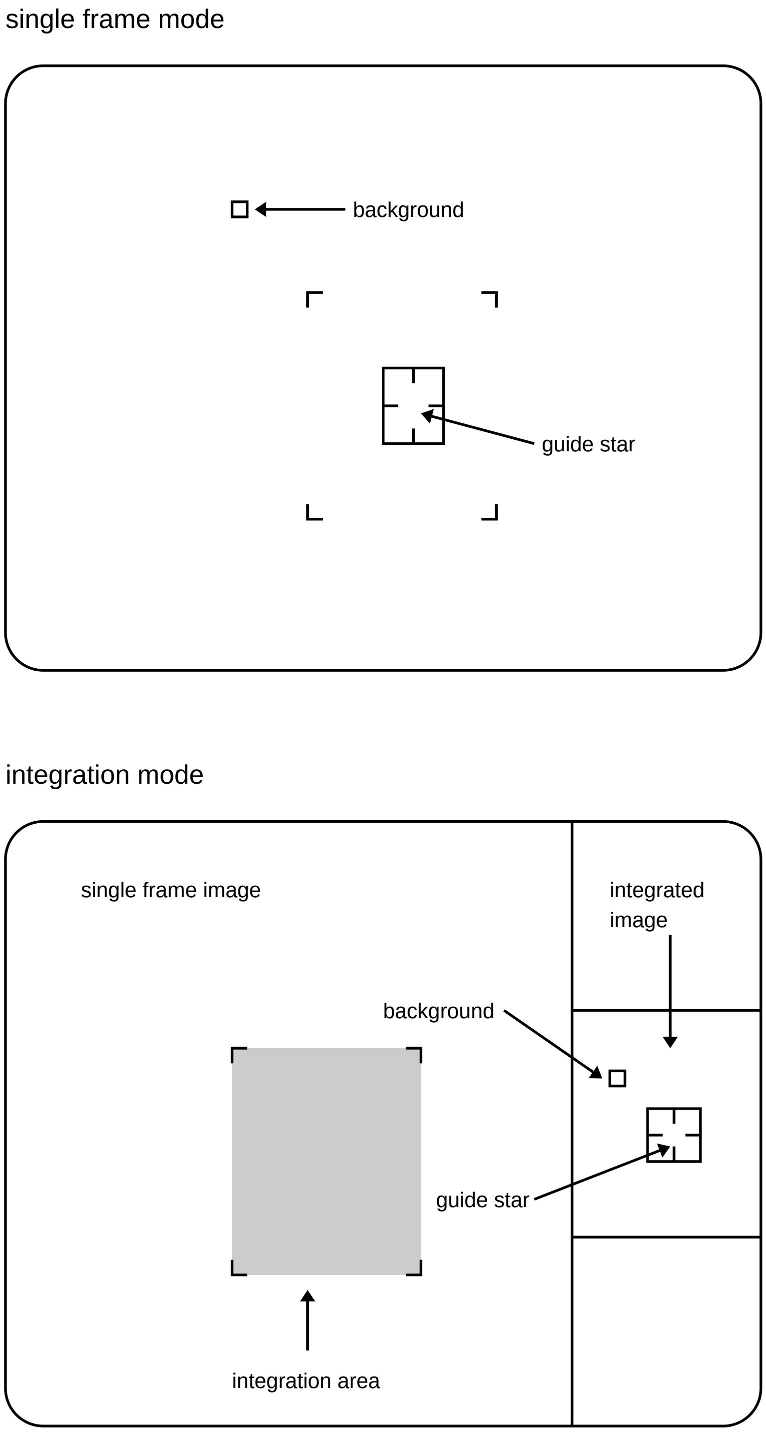

Fig 6: *The autoguider screen.*

7.3 Integration mode

To select integration mode, use the command

`integrate-frames` or **`i-f`**

to set the integration time, specified as the number of frames; 25 frames is one second. This command, and the other tv integration controls discussed below, can also be found in the `TV INTEGR.` menu.

In integrating mode, the autoguider monitor screen is divided vertically into two parts. The left part shows the real-time tv image. The portion or aperture being integrated is outlined with yellow corners. The right part of the screen shows the integrated image, outlined in the same way.

The brightness of the integrated image usually needs to be adjusted with the command

`integrate-scale` or **`i-s`**

This command takes two integer parameters, a multiplier and a divisor. The summed image is scaled by the ratio multiplier/divisor when displayed. Normally, the divisor is set to the number of frames being integrated (this is, in fact, automatically done by the command **`integrate-frames`**). Then, the multiplier is just the factor by which the integrated image is enhanced. For example, if the multiplier is 2, the stars in the integrated image appear twice as bright.

If the integrated image is enhanced too much, the pixel values will overflow the 8-bit range per pixel, and the star image will seem to have a hole in the centre, or be contoured with nested dark and bright circles. If this happens, reduce the multiplier.

The best values of the integration parameters must be found by experimenting. You could begin, for example, with 10 frames, divisor 10 and multiplier 2.

The size of the integration aperture can be changed with the command **`integrate-box-size`**, which needs both an x and a y size, given as half the number of pixels in the aperture. Normally, the size does not need to be changed.

The position of the integration aperture is usually set with the mouse, as will be explained below. Alternatively, the command **`integrate-box-position`** sets the pixel coordinates of the center of the aperture.

7.4 Positioning and sizing apertures

The star, background, and integration apertures can be moved with the mouse. The mouse cursor is a yellow arrow and is moved by rolling the mouse along the table (the cursor may not be visible until the mouse is moved). The mouse has three buttons: left, middle, and right.

To move an aperture, move the mouse cursor to the position desired for the center of the aperture and click the appropriate mouse button:

- background aperture — left button
- star aperture — middle button
- integration aperture — right button

In the integration mode, the star and background apertures can be placed either on the integrated image (right part of screen), or on the real-time image (left part of screen). Normally the integrated image is used. If the real-time image is used, the star position will be measured from single frames, but only at integration time intervals, thus less often than in single-frame mode.

The star aperture can be positioned with the command **`box-position`**. The position defined as the center of field is $x = 390$, $y = 296$. (Note that the (x, y) pixel coordinates are not the same as the guide probe (x, y) coordinates). The current position can be displayed by `b-p` `Help`. The integration aperture can be placed in a similar way with the command `integrate-box-position`.

The aperture sizes can be set in pixel units with the commands

`background-box-size`	or `b-b-s`	background aperture
`box-size`	or `b-s`	star aperture
`integrate-box-size`	or `i-b-s`	integration aperture

One pixel is 0.14 arc seconds. The star aperture should be large enough to include some background sky. The star and background apertures can be of different sizes.

The commands `box-position` and `box-size` are also available in the `AUTOGUIDER` menu, and the corresponding commands for the integration aperture can be found in the `TV INTEGR.` menu.

7.5 Using the autoguider

To use the autoguider, first center the object you want to observe on your instrument in tracking mode. Next, find a suitable guide star by moving the guide probe, without changing the telescope coordinates (i.e. do not touch the cursor keys).

N.B. if there are bright stars nearby, set `tv-filter closed` before moving the guide probe, and then take a first look with `tv-filter gray`.

If you know the equatorial coordinates of a guide star, enter them in the catalogue using `app-eq` or `mean-eq`. The command

```
probe-preset
```

should move the guide probe to the guide star (6.13). This, however, will leave the probe in automatic mode, and its motions will eventually heat the power amplifiers. To prevent this, give the command

```
probe-manual
```

after the preset command.

If you must scan the field for a guide star, this is most conveniently done by stepping the guide probe x and y in steps corresponding to the guide tv field of view, about 9000 units. An easier way to find a guide star is to use the Space Telescope guide star catalogue, available on a PC. There is a program that will find the brightest guide star in the allowed guide probe region.

Fig. 4 shows the permitted region in the xy space. If the guide probe is moved closer to the centre, it may obstruct the light path to instruments mounted centrally, below the adapter. When using the CCD camera with the diagonal mirror, all xy coordinates are allowed, but near the center the CCD probe will shadow the guide tv, and no guide stars will be found.

Put the guide star in a suitable position in the tv image, not very near an edge or corner. In integration mode, put the guide star in the integration aperture, or move the integration aperture to the guide star. Make sure that the background aperture is on empty sky, and move the star aperture onto the guide star.

At this point, you may like to record the tv configuration by

`adopt guide` or `ad g`

You can now start autoguiding. Autoguiding is started and stopped with the menu functions

```
MAIN MENU
  AUTOGUIDER
```

`Autoguide telescope`
`Stop guiding`

or with the equivalent commands

```
auto-guide
auto-stop
```

The cursor keys are disabled while autoguiding. The telescope can be moved (e.g. to center the observed object in a diaphragm) by moving the guide probe — if the guide probe motion is slow enough, the autoguider moves the telescope. Thus, set **probe-step-size** to some fairly small value (50–100) and use the `X+-` and `Y+-` menu functions in `GUIDE PROBE` `OTHERS`.

There is an alarm if the autoguider fails, or if the guide star is too faint (e.g. because of worsening seeing). The current confidence value is displayed after the guide mode on the Observer's terminal. This value is given by $(I - I_b)/I_l imit$, where I is the total intensity in the star box, and I_b is the background. The confidence limit is set by **guide-doubt**. The default value is 0.4; smaller values permit fainter stars, but are not recommended for single-frame mode.

7.6 Tracking a moving object

The NOT has NOT been designed for tracking moving objects (asteroids, comets, birds). To a certain extent that, however, is possible. The idea is to move the guide probe while autoguiding, thus cheating the telescope to follow an object that moves with respect to the guide star.

First, find your object and a proper guide star. Store the coordinates of the guide star into your catalogue by

`MAIN MENU`
  `CATALOG`
    `OTHERS`
      `Probe coord.`

You will use the telescope in the set mode (maybe some ethymologist could explain the origin of this funny name). You then have to give the probe correction speeds by

set-mode
set-rate x y

where $x[''/s]$ and $y[''/s]$ are the speeds in right ascension and declination, respectively. Both are in arc seconds per second of sidereal time. The telescope will move with the defined set rate as long as set-mode is used.

If doing

set-step *value*

then during set-mode hitting a cursor key will now make the telescope drift at the defined rate and track your object. This is in addition to the set rate used.

Next, start tracking the guide star with the guide probe by

`MAIN MENU`
  `CATALOG`
    `Probe preset`

Now you can start autoguiding the usual way.

This method will soon overheat the power amplifiers of the xy servos. After maybe 15 minutes you will get a warning. Then you should stop guiding, set the probe into manual mode by

```
probe-man
```

and let the amplifiers cool for some time, perhaps half an hour.

After finishing your observations you have to remember to set the probe in the manual mode and reset the correction speeds by

```
probe-man
set-rate 0 0
offset-mode
```

8 Object catalogues

The program keeps a catalogue of objects. An object in the catalogue can be specified with mean coordinates of some epoch, or apparent coordinates of date. An object specified with mean coordinates can also have a proper motion. Objects can be entered into the catalogue on-line.

Under the `CATALOGUE` menu, the objects in the catalogue are listed on the screen. The listing can be scrolled back and forth. An object can be selected with menu keys, or by giving the name of the object. The selected object is displayed with white background in the listing. Then, the telescope (or the guide probe) can be told to track (preset to) the selected object. Many of these commands are also available in the `PRESET` menu.

8.1 Adding objects

To enter an object with mean coordinates:

Type the command `mean-equatorial` or select it from the menu. Then type the following items:

- Name of the object (a string). If the object name starts with a non-alphabetic character, or contains spaces, commas, or colons, it must be enclosed in single or double quotes, for example `'123M'` or `"U Her"`.
- Right Ascension; hours, minutes, and seconds, separated by spaces, colons or commas; hours and minutes must be integers, seconds can contain also a decimal part.
- Declination (possible sign, degrees, minutes, seconds).
- Epoch (1900 – 2100; the year can also contain decimals).
- Proper motion in α (seconds of arc / year).
- Proper motion in δ (seconds of arc / year).
- Magnitude.
- `CR`.

For example, the command

```
mean-eq obj1 1 0 1.5  -10 1 1  1950.0 0 0 18.5
```

adds an object `obj1`, whose $\alpha = 1\,\mathrm{h}\,0\,\mathrm{min}\,1.5\,\mathrm{s}$, $\delta = -10°1'1''$, epoch is 1950.0, proper motion is zero and magnitude 18.5.

To enter an object with apparent coordinates of date use the command `apparent-equatorial` followed by

- Name of the object, as above.
- α and δ, as above.
- Magnitude.
- `CR`.

After either of these two commands, the new object is the selected one. Finally, a function is provided to enter the current telescope position as a catalogue object (with apparent coordinates of date). The command is `these-coordinates` followed by the object name.

8.2 Going to catalogue objects

To start tracking the selected object:

> `CATALOGUE`
> `Preset to this`

or type **`preset-to-this`** or **`pres`**.

Then type **`guide-star-recall`** or **`g-s-r`** to put the guide probe on the guide star. After the guide probe has moved to a proper position, use **`tv-filter red`** (**`tv-fi r`**) and after that, if needed, **`tv-filter open`** (**`tv-fi o`**) to select the most suitable filter for you. The last step is to click the autoguider mouse's center button on the star and after that enter command **`auto-guide`** or **`a-g`**.

There is also a command **`go-to-object`** (or **`go`**) that takes as parameter the name of the object to be selected and tracked.

For apparent coordinates, the program applies diurnal aberration, atmospheric refraction, and telescope pointing corrections.

For mean coordinates, the program applies precession, nutation, annual aberration and proper motion to compute the corresponding apparent coordinates of date, which are then treated as above.

If you change your mind, use the `Abort Preset` key (`PF4` key) to cancel the presetting. The telescope will start tracking from its current position. The command **`abort-preset`** is equivalent.

Analogously, to make the guide probe track the selected object, use `CATALOGUE` `probe preset` or **`probe-preset`**. See 7.5.

It is possible to preset to given apparent coordinates without adding the object to the catalogue. The command is

> **`new-object`** α δ `CR`

8.3 Listing and editing a catalogue

The `CATALOGUE` menu functions to control the catalogue listing are:

`Select next`	select next object (scroll if needed)
`Select previous`	select preceding object (scroll if needed)
`Select object`	select object identified by name
Numeric keypad `8`	scroll one page backward
Numeric keypad `9`	scroll one page forward

The catalogue listing remains on the screen even if you move away from the `CATALOGUE` menu. To get rid of it, enter the `START/STOP` menu temporarily (e.g. from the main menu).

The selected object can be deleted (erased) with the command **`delete-this-object`**. The entire catalogue can be erased with the command **`erase-catalogue`**.

At present, objects cannot be edited on-line in the control system computer.

To store or load the catalogue, use the menu functions or commands

> `CATALOGUE`
> `Store catalog`
> `Load catalog`

The program asks for a file name. File names should start with a letter and should not contain blanks, colons, commas, or hyphens. If the file already exists, `Store catalogue` overwrites it. The file is put in the directory `/dd/user/observer` (unless it contains an absolute path name, i.e. one that starts with slash /) as in '/catalog/mycat.cat' which stores it on the HP disc.

N.B. If you will need your catalogue next night, please store it. Otherwise, if the control program is stopped during the day for some reason, the catalogue will be lost.

8.4 Prerecorded catalogues

Catalogues are ordinary text files. You can write them using your favourite text editor, and bring them to the NOT on 3 inch PC diskettes (sorry, we cannot read Mac diskettes) or on tape. Then you can use the local network to copy them to the control computer, with help of the staff.

Each line of a catalogue contains one object. For each object the following information is needed:

1) Name of the object. Columns 1–9 are always interpreted as the name, and column 10 must be empty. Otherwise the input format is relatively free.

2) Right ascension in the form *hour:minute:second*; *hour* and *minute* must be integers and *second* can be a real number.

3) Declination, *degree:minute:second*; again *degree* and *minute* are integers and *second* a real number.

4) Type of coordinates. This can be `M` (mean coordinates) or `A` (apparent). If the type is `M`, you can also give the items 5)–8). If the type is `A`, you cannot specify epoch or proper motion, but you can still give the magnitude.

5) Epoch of the coordinates. For mean coordinates the default is 1950.0.

6) Proper motion in right ascension, seconds of arc per year.

7) Proper motion in declination, seconds of arc per year.

8) Magnitude. Default is 0.

Items 5)–8) are optional.

When you load a prerecorded catalogue, check that the display shows the correct number of objects. If there is anything wrong with an entry, it is omitted. This may happen if, e.g. minutes or seconds exceed 60, hour, degree or minute is not an integer etc. If there are any errors, they will be listed in the file `/dd/user/observer/errors`.

The offline guide star program can also read your catalogue. It will check that the catalogue is syntactically correct and that the values are reasonable, find the best guide stars (and add them to your catalogue if you want to), display the fields, and show the altitude as a function of time for each object.

8.5 Example

Assume the file `/dd/NOT/OBSERVER/test` contains the following lines:

```
qwerty    12:10:10.00 -10:10:10.0 M 2000.0  0.0003  0.0001  2.7
asdfg     12:06:18.76 -12:11:22.5 M
sdlkhkh   10:12:45.00  34:34:43.6 A  6.5
```

This catalogue can be loaded with the commands

```
MAIN MENU
   CATALOGUE
      load catalog
```

The program asks for the the file name. Enter `test`, and after a while the following display appears in the listing area:

```
   1 qwerty     12:10:10.00 -10:10:10.0 Mean 2000.0  0.0003  0.0001  2.7
   2 asdfg      12:06:18.76 -12:11:22.5 Mean 1950.0  0.0000  0.0000  0.0
   3 sdlkhkh    10:12:45.00  34:34:43.6 Apparent                      6.5
(   3 objects in test)
```

Initially the first object is selected, and displayed in inverse video (shown here inside the box).

You can now use the `Nearest FK5 star` menu key to ask the program to find the coordinates of the FK5 star nearest to the selected object. Its coordinates will be inserted after the selected object, and the display changes to

```
   1 qwerty     12:10:10.00 -10:10:10.0 Mean 2000.0  0.0003  0.0001  2.7
   2 FK5        12:06:18.76 -12:11:22.5 Mean 1990.5  0.0000  0.0000  0.0
   3 asdfg      12:06:18.76 -12:11:22.5 Mean 1950.0  0.0000  0.0000  0.0
   4 sdlkhkh    10:12:45.00  34:34:43.6 Apparent                      6.5
(   4 objects in test)
```

The FK5 star also becomes the selected object.

After finishing observations and having possibly added more objects you can save the catalogue with the commands

```
MAIN MENU
   CATALOGUE
      save catalog
```

The program asks again for a file name. If you give the name of your original catalogue, it will be overwritten. If you want to keep the original file, too, you must give another name to the modified catalogue. The file will appear in the directory `/dd/NOT/OBSERVER` (which is `R:/ASTRO/CATALOG` on PC), from which you can later rescue it to another computer with the help of `ftp`.

9 Closing down

The normal close-down procedure at present involves closing the mirror covers, hatches, and side ports. The guide tv must be turned off. The telescope is moved to the zenith position. (You may note that the zenith position varies a little. The position is given a small random variation to reduce wear on the altitude gears.)

The building is turned to put the entrance in a convenient position. The electronics and hydraulics are turned off. For safety, the servos are set to the minimum velocities. The computers and control programs are left running.

9.1 Turn off tv, and park the telescope

Do the following functions in the `MAIN MENU` `START/STOP` menu:

`TV Off`	Turn off guide tv camera
`Zenith Position`	Telescope to zenith
`Close Mirr-Cov`	Close mirror cover
`Park Building`	For convenient entry
`Close Lower H.`	Close lower hatch (if open)

Before continuing, you must wait until the mirror cover is closed to avoid loose stuff falling on the mirror (look at the upper right corner of the screen). Also, you have to wait until the lower hatch is closed, because before that the upper hatch cannot be closed.

If a timeout should occur on the lower hatch, then do like this:

`stop-lower`	wait 10 s
`open-lower`	wait 10 s
`stop-lower`	wait 10 s
`close-lower`	

Repeat this 5 times, if there is no success, tell the staff or try to do it manually (see section 10.6).

When the mirror cover and lower hatch are closed, close the upper hatch by

`Close Upper H.`

Please note that closing the upper hatch takes almost five minutes. Be patient.

If the hatches do not move, give the commands `stop-l-h` and/or `stop-u-h` and try again. If they still do not move, close them manually (see 10.6 for instructions).

9.2 Turn off power

Before doing this you should wait until the telescope and building have stopped. In the park position the azimuth is about 116°. Look at the Observer's terminal, and wait till the azimuth value remains constant.

Next, give the command

```
power-off
```

and wait till you see the message `Telescope power is off`. If the automatic power-off fails for any reason, turn power sources into local mode and turn them off manually (see 10.4.3 for instructions).

9.3 Finish

- If the sideports are open, go to the telescope floor and close them.
- If you will need your catalogue later, save it:

  `CATALOGUE`
    `Store catalogue`
- Turn down the brightness of the observer terminal.
- Switch off the guide tv, autoguider and CCD monitors.
- **Write in the logbook**

  Please use only the right hand side of each leaf. The logbook is periodically faxed to the NOT director. Use a pen that makes a strong line, and write fairly large letters. We welcome criticism and suggestions for improving the telescope.
- **CLEAN UP AFTER YOUR NIGHT SNACKS, BOTH IN THE DOME AND SERVICE BUILDING, PLEASE!!**
- Lock the doors (dome and service building).

9.4 After the last observing night

- After your last observing night, write an observing report. There are empty forms in a blue binder labelled *Observing reports* in the control room.
- Remove your snack leftovers from the fridge.
- Return the observatory key to the staff. Otherwise you will lose your deposit.

10 Troubleshooting

This chapter describes some problems you may meet when observing with the NOT. Also, some of the error and warning messages of the control system you can (and probably will) get, are discussed here. If the supporting astronomer is not available, you can try to solve these problems by yourself. Because of the small staff at NOT, there may be times when no support is available.

10.1 Emergency stops

The emergency switches turn off the power to the dome, telescope and hatch motors. If you cannot move the telescope or hatches, you should first check, if an emergency stop has been used to cut off the power.

If the telescope power is not on when an emergency stop is activated, it is relatively easy to reset the safety system (see 10.1.2). If the power was on, but nothing was moving, it may still be enough to reset the safety system, and turn on the power again. If the telescope was moving when the power was turned off by the safety system, you may also experience a building crash (see 10.5).

Most of the emergency stops are yellow boxes with red buttons. Pushing the button in will cut off the power. In addition, there are some other emergency stops, which you may very easily trigger inadvertently:

- The entrance to the cellar, as well as the exterior cellar door are connected to the safety system. **Don't open these doors while the telescope power is on.**
- Opening the door to the telescope floor will also turn off the power, unless you first take the yellow joystick looking thing to the right of the door, and keep the button pressed **halfway**. Since working while holding this device is almost impossible, you should turn off the power if you have to work on the telescope floor.
- At the lower end of the entrance staircase there are light cells, which stop the building, if something hits the beam. This will cause an audible alarm in the control room (see 10.1.4).

10.1.1 Indications

In the control room there is an indication panel on the wall to the left of the door to the electronics room. It should have one green light on. If any of the yellow lights is lit, an emergency stop has been activated, and you have to reset the security system, as described in 10.1.2.

In the electronics room there are two alarm panels in the main power rack (marked *Interlock* in Fig. 2). Both panels must have a green LED on, and none of the red LED's should be lit or flashing. Otherwise, reset the security system.

10.1.2 LED's lit in the control room indicator panel

If one or more LED's are lit on the indicator panel in the control room, proceed as follows:

1) **Identify the source of the problem.**
Go to the alarm panel in the electronics room (located in the main power rack to the left of the door) and identify the source of the problem, i.e. which red LED's are flashing. Go to the site of the problem and assure that everything is ok. Release the emergency stop, if it has been pushed in. Remember that someone might

have pressed an emergency button to prevent you from accidentally moving the telescope.

2) **Acknowledge alarm.**
Push the reset button of the alarmpanel. This will cause the flashing LED/LED's to go off and you can proceed to the next step. If the LED's change to constant light the problem prevails and you should go back and identify the source of the problem.

3) **Reset the security system.**
At this point you must be absolutely sure that nobody will be accidentally harmed when you reset the security system! Further, you must assure that the power-off sequence has been completed either automatically or manually. To reset the security system, turn the keys located below the alarm panels till a distinct click indicates that the reset was succesful. Repeatedly clicking noises indicate problems, in which case you have to go back to identify the problem or call a technician.

10.1.3 No LED's lit, but the telescope doesn't move

There is also a separate safety system for the hydraulics. In rack 23 there is a row of red lights and a yellow one (marked Interlock in Fig. 2). If the yellow light is not lit, do the following:

1) Turn off power, manually or automatically (it is probably already off).
2) Reset the hydraulics interlock by pushing the yellow button.
3) Reset the interlock system as in previous section.

10.1.4 Audible alarm in the control room

If the moving staircase hits something, the light cells will cut off the power to the building motion. If the telescope is tracking, it will still continue its motion. If you hear the alarm (and get a message that indicates problems with the building power), you have to quickly check, if it's a real accident. If not, reset the safety system by pushing the reset buttons and turning the keys. The building power will be turned on automatically. If you are not too close to the zenith, you may be able to continue tracking without an interrupt. If you are too slow, or if the telescope is moving fast, you'll end up with a genuine building crash, which you can solve as explained in 10.5.

10.1.5 After resetting the safety system

After resetting the security system you may still have some problems in bringing the system up to full life.

1) Check power indications.
If the power is off, try to turn it on. Look at page 3 of the status record. If any of the entries keeps showing `Failure`, you'll probably have to boot the computer.

2) Check the slaves.
Look at the slave consoles. If there are any cryptic error messages, it is better to reboot the computer.

10.2 Terminal problems

The observer terminal does not respond.
Check if the computer is running. This you can see at the console. If that seems dead, too, boot the computer (see section 10.3). Otherwise, turn the power of the observer terminal off and on again, and use the `refresh` command to clean the display. If even this does not help, the terminal may have been broken. In this case you can try using the console to run the user interface, after the support staff has logged you in.

10.3 How to reboot the computer

The system may crash for many reasons:

- Only when the control system starts, does it check if the I/O cards are on. If they have later been turned off, an attempt to read device status or send a command will crash the programs. This happens mainly after repairs, during which the power has been turned off. This is intentional, since in such a case the system should be reset anyway. Sometimes, the I/O cards may seem absent without any obvious reason.
- Software error. Well ... the programmers are just human beings.
- Operating system bug. The OS-9 real-time operating system is widely used internationally but is is not free from bugs. Also, the Certified Software Pascal compiler is far from reliable.

Even if the control system has not crashed completely but behaves in a strange way, it may be wise to reboot the computer.

To boot the control computer you have to do the following things:

1) Check that the terminals marked *control computer console* and *observer terminal* are on; they are both in the Control room.
2) Go to the Electronics room and find the *master processor* in the leftmost electronics rack. (It has a sticker that says *master*). Push the red reset button.
3) Go to the *control computer console* in the Control room. The terminal displays various messages. Don't do anything before the prompt `$` is displayed on the last line; this takes about 20 seconds.
4) Start the subunit programs. On the console, type

   `startslaves` [Return]

   You can use either uppercase or lowercase letters. Typing mistakes can be corrected with the [BS] (backspace) or [DEL] key.

   The console terminal displays various messages. Wait until the prompt `$` again appears on the last line.
5) Wait till the slave processors have started. This takes about a minute. The three slave consoles on the shelf in the control room should all display a line

   `EVENTS  WARNINGS  ERRORS`

   Continuing before the slaves are running will probably crash the system, and you have to start from the beginning, this time slowly enough. Also, if the slave consoles display any error messages, go back to item 2) and reboot.
6) Log on to the master computer. On the *observer terminal*, press the [CLEAR] key, which is in the upper row of orange keys, a bit above and to the left of the [Return] key. Next, press the Return key ([CR]) until the prompt `User name?:` appears. Now log on by writing (in upper or lower case; it doesn't matter)

   `not 2.5` [CR]

   The system should bid you welcome, and the prompt `NOT:` should appear.
7) Start the master programs by typing

   `startcs` [CR]

   A number is displayed (for example, `+14`). If the autoguider monitor is on, it will go dark after some seconds, then display a colourful advertisement, and then (after about 10 seconds) a dark background with two small red boxes and a larger box outlined with yellow corners.

Wait until the prompt `NOT:` appears again on the observer terminal.

8) Start the user interface program. On the observer terminal, type

   `notcs` CR

   The program will display the user number assigned to this terminal, and then the usual display of telescope status should appear.

9) At the lower right corner of the message area there will be a message `Simulated`. This means that the master is not yet communicating with the slaves. So you have to start the subunits. Type

   `start-subunit all` CR

   and observe that the Sidereal Time (ST) displayed on the terminal now agrees with the large clock display above the terminal. You will get an error message, when the sidereal time clock is read for the first time. You don't have to worry about this.

10) Just to be sure, check once more the slave consoles. If they display any error messages, the system is not running as it should. In this case try once more to reset the system.

If anything goes wrong, start again from the beginning. If you don't manage to bring the system up after a few (3–5) trials, call for help.

10.4 Power-up

In the following, the items #1,...,#10 refer to the labels $\boxed{\#1}$,..., $\boxed{\#10}$ in Fig. 2. The switches on the two racks in the electronics room are also labeled with the same numbers.

10.4.1 Selecting local/remote mode

In order to use the automatic power-up sequence, the local/remote switches must be in the remote position. Most switches have a green lamp, which is off in the remote position. For automatic operation these switches must be in the remote position, the button **out**, and the green light off. In the local mode the button is **pushed in** and the green light is lit.

To check these switches, go to the electronics room, and find the following items:

1) Hydraulic pump switches. Find the switch labeled #1 (on wall to Control room), second section from left, fourth door from below (bay 2D). The local/remote switch is to the left of this.
2) Building power supply, switch #2, Rack 23, near the floor, Building PSU, second button from right.
3) Building power amplifier. Switch #4, Rack 23, Building PA, second button from right.
4) Az/Alt power supply. Az/Alt PSU, switch #5, rack 21, Az/Alt PSU, second button from right.
5) Azimuth power amplifier. Switch #6, Rack 21, Azimuth PA, second button from right.
6) Altitude power amplifier. Switch #7, Rack 21, Altitude PA, second button from right.
7) Top Unit $\pm$24 V. Switch #8, Rack 22, 1.2 m from floor, upper button.
8) Rotator power supply. Switch #9, Rack 23, high up, Rotator PSU, second button from right.
9) Rotator power amplifier. Switch #10, Rack 23, highest unit, Rotator PA, second button from right.

10.4.2 Manual power-up

If nothing else helps, you can turn the power on manually. In this case the local/remote switches must be in **local**. Do as described above, but set the switches in local (indicated by green lights). Then do the following operations:

1) Switch on hydraulic pumps. Find the switch #1 (on wall to Control room), second section from left, fourth door from below (bay 2D). Turn the switch on.
2) Start building power supply, switch #2, Rack 23, near the floor, Building PSU, rightmost button. If the yellow lamp on PSU is not lit, press "Interlock Reset" (Rack 23, Interlock Monitor).

   If the red lamp on Building PA does not turn off within a few seconds, call technician and stop.
3) Loosen building brakes. Switch #3, Rack 23, 1.2 m from floor, Building Brakes to position *Breaks released.*
4) Start building power amplifier. Switch #4, Rack 23, Building PA, rightmost button.

Note! If a red lamp is lit, switch off PA and PSU and go back to step 2 (Start building power supply).

5) Start Az/Alt power supply.

   First, find the 28V DC lamps on the Azimuth and Altitude power amplifiers in rack 21. You need to check these immediately after this step.

   Turn on Az/Alt PSU, switch #5, rack 21, Az/Alt PSU, rightmost button. Note! If the 28V DC lamps on the Azimuth PA and Altitude PA do not light up at once, switch off Az/Alt PSU immediately! Wait at least 10 seconds before trying to turn it on again.

   It is also important to wait (about 5-10 seconds) until 170V DC lamps are lit on Azimuth PA and Altitude PA.

   If the fuses burn out, switch off Az/Alt PSU, change fuses. Switchboard 1 in Electronics room, second section from left, second door from below (bay 2H), fuses marked *power amplifier*.

6) Start Azimuth power amplifier. Switch #6, Rack 21, Azimuth PA, rightmost button.

7) Start Altitude power amplifier. Switch #7, Rack 21, Altitude PA, rightmost button

   Note that when the power amplifiers are on, the telescope may "creep" slowly in altitude and azimuth, until the normal servo speeds are set.

8) Switch on Top Unit ± 24 V. Switch #8, Rack 22, 1.2 m from floor, lower button.

9) Start Rotator power supply. Switch #9, Rack 23, high up, Rotator PSU rightmost button. Wait for yellow lamp (28 V DC) to light up.

10) Switch on Rotator power amplifier. Switch #10, Rack 23, highest unit, Rotator PA, rightmost button.

11) Set servos to normal, and proceed to section 5.3.

10.4.3 Manual power-down

To turn power off manually, check first that the local/remote switches are set to local. Then do the following operations:

1) Switch off Rotator power amplifier. Switch #10, Rack 23, highest unit, Rotator PA, rightmost button.
2) Turn off Rotator power supply. Switch #9, Rack 23, high up, Rotator PSU, rightmost button.
3) Switch off Top Unit ±24 V. Switch #8, Rack 22, 1.2 m from floor.
4) Turn off Altitude power amplifier. Switch #7, Rack 21, Altitude PA, rightmost button
5) Turn off Azimuth power amplifier. Switch #6, Rack 21, Azimuth PA, rightmost button.
6) Turn off Az/Alt PSU, switch #5, rack 21, Az/Alt PSU, rightmost button.
7) Turn off building power amplifier. Switch #4, Rack 23, Building PA, rightmost button.
8) Turn on building brakes. Switch #3, Rack 23, 1.2 m from floor, Building Brakes to position *Breakes engaged*.
9) Turn off building power supply, switch #2, Rack 23, near the floor, Building PSU, rightmost button.
10) Switch off hydraulic pumps. Find the switch labeled #1 (on wall to Control room), second section from left, fourth door from below (bay 2D).
11) Set servos to slow.

10.5 Building crash

The building moves independently of the telescope but tries to follow the azimuth movement. Their collision will trigger the safety system. A collision can be caused by an observer stepping in the stair case light path.

In the case of a building crash, do the following:

1) Turn off power, unless it is already off.
2) Go to the electronics room and find bay 2D, item $\boxed{\texttt{\#1}}$ in Fig. 2. Set the hydraulics in local mode, and turn on the hydraulic pumps.
3) Go to the telescope floor. Opposite the entrance, there are strips of tape on the floor and the telescope base. They show the proper alignment of the telescope. Push the telescope, till the strips are aligned (about 1 cm to the right of tape). (Yes, it has a lot of inertia, but you can do it!)
4) Go down and turn off the hydraulics and set the hydraulics in remote mode.
5) Reset the safety system.
6) Turn on power.

10.6 Hatches

If the hatches do not move, try first to give the command `stop-u-h` or `stop-l-h`. This will clear a possible error state of the control program. If you still cannot move the hatches, check that they are in the remote mode. This can be seen on pages 37–38 of the status record. If they are remote, but still nothing happens, close them manually, as described below.

10.6.1 Manual and remote modes

To select the local/remote mode of the hatches, go to the air conditioner and hydraulics room. On the wall there is a big hatch electronics cabinet with a glass window. Open the door and find the switches marked *local/remote*. Turn them if necessary.

10.6.2 Manual operation of hatches

To move the hatches manually, turn the local/remote switches first to the local position. Then go to the dome and use the handset. This is a small box with four green buttons near the right edge of the lower hatch. The handset controls both upper and lower hatch. It will take a few seconds before the hatches start to move.

NOTE: give the commands `stop-upper` and `stop-lower` before manual move because otherwise when the hatches are set back to remote mode the control system might open them again due to the still valid last commands from the user terminal.

10.6.3 Closing upper hatch during power failure

The hydraulic pump controlling the upper hatch can be operated also with a small engine, which should be used during a total power failure. In this very rare event it is better to call somebody for help. However, if you cannot find anybody, and the weather conditions require immediate action, you have to do the following things.

1) **Set the hydraulic valves.**
   To operate the hatches with the motor pump, several valves must be in different positions. A valve is open, when the handle is parallel with the pipe, and closed, when the handle is perpendicular to the pipe.

   There are three sets of valves that you have to check. In each place there are instructions that tell in which position the valves must be.

   1.1) Go to the hydraulics room and find the blue hydraulic pump that operates the hatch. In the pump there are three valves. Open *K 1.1* and *K 1.2* and close valves *K 2.1* and *K 2.2*.

   1.2) Go to the telescope floor. On the wall, to the right of the entrance, there are four valves, labeled *K 4.1*, *K 4.2*, *K 5.1*, *K 5.2*. Open all these valves.

2) **Start the motor.**
   The motor is to the right of the hatch hydraulics in the hydraulics room.

   2.1) Open the fuel valve by moving it to the right.

   2.2) Move the choke to the left to the open position. Because of the high altitude, closing the choke makes the mixture too rich.

   2.3) Open the throttle a little by moving it to the left.

   2.4) Turn on the ignition switch.

2.5) Grasp the handle firmly, move it out until you feel some resistance, and give it a determined pull. Don't release the handle but return it slowly back.

2.6) When the motor runs, adjust the throttle.

On the wall there is a booklet that explains in more detail how to operate the motor.

The motor may cause a fire alarm to go off. You don't have to worry about this, since the alarm is not connected to the outside world. Open doors to ventilate the room.

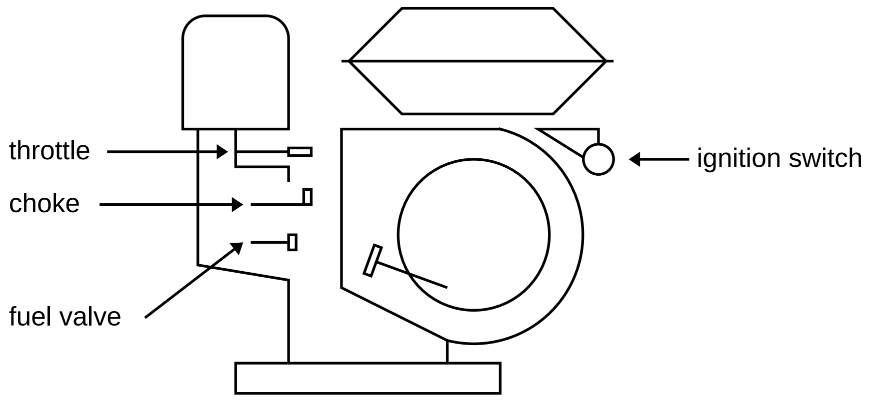

Fig 7: *Controls of the motor for the upper hatch hydraulics.*

3) **Close the hatch.**
When the motor runs smoothly, do the following things:

3.1) Close valve *K 1* slowly. If the motor slows down considerably, open the throttle a little more.

3.2) Go to the telescope floor.

3.3) The upper hatch is now controlled by the valve *K3*. When you push the handle down, the upper hatch should start closing. There is a reflecting strip on the hatch and another on the dome wall. When the strips are aligned, the hatch is in correct position, and you should stop it by releasing the handle. Use a flashlight to see the reflections from these strips.

4) **Turn off the motor.**
When the hatch is closed, go down to turn off the motor.

4.1) Move the throttle fully to the right.

4.2) Turn the ignition switch off.

4.3) Close the fuel valve by moving it to the left.

10.7 Tracking problems

Tracking Lost

You could try to preset to the object again, but if you are close to zenith, you are playing with a higher force. To be sure the rotator is moving, also do the actions for Rotator Tracking Lost.

Guide Star Lost or too Faint

Check the guiding significance. It should be greater than 0.4. If the significance is less than 0.4, you should do the following:

- Stop guiding.
- Move the telescope in small steps until the guidestar is in the box.
- Start guiding.

If the guidestar is too weak, you have to find a brighter one. You could also try the integration mode of the autoguider.

10.8 Rotator problems

Rotator Tracking Lost

Do the following commands:

```
rot-auto
field 0
```

In case you lose it again, you could try to increase the tracking limit by e.g:

```
rot-tr-limit 120
```

Rotator Nearing End of Range

This is not an error message, but a warning. This happens when the rotator is passing $-180°$ and decreasing or when passing $+180°$ and increasing. The rotator can only move between $-199°$ and $+203°$. If you see that this limit will be reached, you have to do the following commands:

- Stop guiding (if you are guiding).
- `rot-man`
- `rot-turn-360`
- Wait until the rotator is not moving anymore.
- `rot-auto`
- `field 0`
- Start guiding.

Remember, you must not do an exposure during this procedure.

10.9 When you cannot find your star

Nothing appears on the tv screen

Check the following things.

1) Is the guideprobe in the position you want it to be (center etc.)?
2) Is the CCD probe in the way?
3) Which tv-filter are you using?
4) Is the tv on (command `tv-on`)?
5) Is the telescope in the correct position?
6) Do you have correct coordinates and epoch? Usually you should not try to compute the apparent coordinates yourself, but let the control computer do the work.
6) Are the UTC and ST clocks correct? The UTC is not used by the program, but if it's wrong, it may indicate that the ST is also incorrect.
7) Perhaps the object is too weak to be seen.
8) There might be clouds in that part of the sky.
9) Try looking at an open cluster. If you can find some star images, check if they are symmetric when the image is out of focus. If there is a bad coma, there is something wrong with mirror support or alignment. Call the staff and close down.

No objects on CCD screen

The same as above applies, but the CCD probe must be in the CCD position.

10.10 Focus problems

Increasing focus does not work

This happens from time to time. Try to move focus down a bit (10 units for instance), and then up again. You may have to do this several times before reaching the desired focus.

10.11 Filter mechanism

You cannot remove the cassette

The filter mechanism does not tell, which filter is in position. After booting the computer, the system will think the cassette is in the off position, and the command `ccd-fi off` will not do anything. Select another filter, and try then again. See status record page 59, variable *InPos*. It should be true, when the filter is in position.

Before opening the door to the filter cassette holder, disconnect the power cord marked *Filtermechanism*. Otherwise there is a danger of being squeezed by moving parts.

10.12 User interface

Unknown command

If the system complains that a command is unknown, although you are sure that it is a legal command, check the following things:

1) Are you sure it is not an engineering mode command.

2) Remember that some strings are parameters to the command, and must not be preceded by hyphens.

2) Check the spelling e.g. by typing the first letter of the command and pressing the `Help` key.

Appendix 1: Computer facilities

In addition to the control computer there are several PC's, most of which are used to control instruments, a HP9000/835 workstation and a SparcStation 20 workstation. They are connected to the local Ethernet, and you can use `ftp` e.g. to transfer object catalogues from a PC to the control computer, or observations from some of the instrument computers to the workstation.

The local network is connected to the Internet, and you can use `ftp` also to copy files between your home institution and the NOT. The Internet name of the workstation is `notrmhp1.not.iac.es`.

When sending e-mail, it is enough to use the node name `not.iac.es`. You can send your inquiries to the address

`astro@not.iac.es`

A 1.1 Data storage

To save your data you'll need either ordinary tapes or DAT tapes. Because we can write only 1600 bpi tapes, you'll probably need quite a few of them for storing images. Since the standby CCD controller cannot be connected to the network, you have to either copy your images to your own 1600 bpi tapes, or use our tapes to move the files to the workstation, where you can store them to a DAT tape.

For storing your data, you have to bring your own tapes or diskettes. **Tapes and diskettes are not available at the NOT.** We can write 1.3Gb DAT tapes (60m, DDS quality only), 1600 bpi tapes (there is no 6250 bpi drive), and 5 and 3 inch PC diskettes (no Mac's, please).

A 1.2 Application programs

The available application programs on the workstation include

- IRAF and SAOimage for image processing.
- Midas.
- TEX for text processing (includes a previewer and a dvi to PostScript conversion program).
- Nag library for Fortran programmers.

On a PC we have a program for finding guide stars from the Space Telescope guide star catalogue. If you bring your object catalogue on a PC diskette, you can feed it to the program, which will also check the correctness of your catalogue.

Appendix 2: About La Palma

Here are some hints that you may find useful, if this is your first visit to La Palma.

To be sure to get accommodation and local flight tickets, it is important that you **arrange your travel as early as possible**, preferably immediately after your observing time application has been accepted. **As soon as you know your schedule, inform us.** Also, if there is anything you want to know about the instrument you'll use, ask us well in advance before coming here.

For arrangements, contact the administrator, Mr. Paco Armas, by fax (preferably) +34 22 405 501, or by E-mail to astro@not.iac.es

A 2.1 Traveling

There are very few direct flights from the continental Europe to La Palma. Usually you have to come first to Tenerife or Gran Canaria. Tenerife is closer to La Palma; the flight takes about half an hour - and is much more cheaper than a flight from Gran Canaria.

If you come to Tenerife, note that there are two airports. Most international flights come to the southern airport (Tenerife Sur or Reina Sofia, TFS). Flights to La Palma usually leave from the northern airport (Tenerife Norte or Los Rodeos, TFN). If you have to go from one airport to another, you will need about one hour for the trip, and the taxi will charge you 7000–8000 pesetas. There are no direct bus connections; you have to change bus in Santa Cruz de Tenerife. Anyway, a bus to Santa Cruz de Tenerife from the southern airport leaves almost hourly from the front of the airport.

If you use a regular flight, a good place to stay on Tenerife is Santa Cruz de Tenerife, since it has good connections to all other places and is close to the northern airport. Another convenient possibility is El Medano, which is very close to the southern airport.

If you use a charter flight, the available destinations may not include Santa Cruz de Tenerife. In that case Puerto de la Cruz is a good choice; it is close to Los Rodeos. If your flight to La Palma leaves from Tenerife Sur, Playa de las Americas is the best place.

When you buy your ticket, be sure it is to Santa Cruz de la Palma, **not** to Las Palmas or Santa Cruz de Tenerife. The abbreviation of the La Palma airport is SPC (Santa Palma de la Cruz, don't ask why). When you get your ticket, check it once more. Your travel agent probably wants to send you to a wrong island. Also, he may suggest a hotel that is very inconveniently located. The list at the end of this chapter gives some acceptable hotels.

If you have to change plane in Madrid, your baggage may follow you one day later. (Well, this is just my personal experience, there are people that have passed Madrid successfully.) Flights to Madrid are often delayed because of the crowded European airspace. If you have to change plane in Madrid, it will save your nerves, if you reserve about three hours for the change. International and domestic flights use separate terminals, and there is a very long corridor between them.

You can stay in hotel Residencia, close to the observatory, but the reservation must be made well in advance, since its capacity is very limited. So, once more, **please inform us early enough.**

We highly recommend that at least one in your team should have a driver's license, and that you rent a car; otherwise you will experience transportation problems. Sometimes a staff member can give you a ride, but you must not count on that. In the worst case you have to walk from Residencia to the NOT, which, of course, is rather healthy. The distance along the road is about 4 kilometers, and the height difference is about 250 meters.

We can also arrange a rental car for you in the airport. A taxi from the airport to the observatory will cost 4000–5000 pesetas.

The distance from Santa Cruz to the observatory is about 40 kilometers, and the road is a good wide asphalt road, but an ordinary driver will need at least some 50 minutes to negotiate it. If you are not used to winding mountain roads, you will probably need over an hour.

Drive along the main road through Santa Cruz. The road, Avenida Maritima, follows the seashore. When the road is about to turn away from the sea, there are traffic lights, and you can see a replica of Columbus' ship to the left. Take the right lane and go straight ahead. A little further you will see a sign *Observatorio Astrofísico.*

Go on for two kilometers, then turn left. Again there is a very clear sign pointing to the observatory. After another two kilometers turn right. This intersection is behind a cliff, and comes as a complete surprise. However, there is again a sign pointing to the observatory. When you are on this road, just keep going, and beware the slowly moving tourists and Englishmen that drive like crazy. Also, there are often some fallen rocks on the road. Sometimes (particularly in winter) the mountain is surrounded by dense clouds, and the visibility may fall down to a few meters. Higher on the mountain there may also be some ice in winter. In winter the road can sometimes be closed because of fallen boulders or impassable because of snow and ice. It is a good idea to call the observatory before leaving Santa Cruz and check if the road is open.

After reaching the summit you will finally see some buildings. The observatory area is to the left, and Hotel Residencia is the motel looking building that you will see immediately after turning off from the main road. Go there and ask for more details.

If you keep driving along the Observatory road, you'll soon come to an intersection. Go straight ahead; the road to the left goes to the other telescopes. Close to the highest point of the mountain there is an exit with a barrier on the left side of the road, and the NOT is a few hundred meters away along that road. Because of the sometimes too inquisitive tourists, the barrier may be closed, particularly during weekends. However, usually it is not locked, and you will easily find out how to open it.

To get a key to the NOT you have to pay a deposit of 5000 pesetas, which will be paid back upon return of the key.

A 2.2 Staying on La Palma

During your observing period, you will probably live in Hotel Residencia, about 4 kilometers from the NOT. Accommodation in a single room costs currently 5300 pesetas per night; a double room costs 9270 pesetas. These prices do not include any meals.

The restaurant serves breakfast from 7:30 to 9, lunch at 12:30 and dinner at 19:00 (in winter at 18:00 and 19:00, or 17:00 and 18:00). If you want to have a lunch or dinner, you have to order them in advance. You can also order a small snack or a more substantial supersnack that you can take with you. Ask the receptionist for more details.

The current prices of the meals are: hot breakfast 575 Ptas, cold breakfast 450 Ptas, snack 486 Ptas, lunch, dinner, supersnack 1420 Ptas and take-away meal 700 Ptas.

You may also want to spend an extra day driving around the island, which is not yet completely destroyed by tourists, although Germans are abundant. There are several reasonably priced hotels on the island.

A 2.3 Observing

If possible, come to the observatory the day before you will start observing. You can then discuss your problems with the staff. They have to mount your instrument, and they are happy to know in advance if you will need something specific.

If you need something really special, like some strange filters, you must contact the staff well before coming here.

During the first night you will have an assisting astronomer to help you. Use the first night to ask him/her everything you want to know about the NOT. Later you will have to work alone, although most of the time there will be somebody on the mountain, prepared to come and help, if needed.

A 2.4 Hotels

In Santa Cruz de la Palma:
Hotel Maritimo, phone +34 22 42 02 22.
Hotel Castillete, phone +34 22 42 08 40, fax +34 22 42 00 67.

In El Medano on Tenerife, near the Southern airport:
Hotel Medano, phone +34 22 70 40 00.
Hotel Playa Sur de Tenerife, phone +34 22 17 61 20.

In Santa Cruz de Tenerife:
Hotel Residencia Plaza, phone +34 22 24 58 62.

On Gran Canaria, close to the airport:
Hotel Bahia Mar, phone +34 28 13 08 08.

In Madrid there is a hotel close to the airport. They have free transportation a couple of times an hour; if you arrive very late, call the hotel to get a ride.

Hotel Diana, phone +34 1 747 13 55, fax +34 1 747 97 97.