OPERATING MANUAL

THE OPTICAL PHOTOMETER ON THE ESO 1 m TELESCOPE

The Optical Photometer on the ESO 1m Telescope

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Chapter 1

The telescope control program

1.1   Starting up

The control electronics for telescope and photometer may be found in an inner room on the telescope floor. The HP 1000 telescope control computer together with its disk drive are also located in this room.

Switch on power for telescope motors, green and red buttons situated on top of the right rack. Check below in the same rack that the R.A. and Dec power supply/amplifiers are ON. The Sidereal Time (but not the coordinates) will now be displayed on the telescope coordinate panel in the dome.

Check that the main photometer shutter as well as the shutter on the photomultiplier housing are closed. Insert the field view mirror and the diaphragm view prism in the light-path. Check that the correct photomultiplier has been mounted and that the high voltage is set to its correct value. The power supply is mounted in the left-most rack in the inner room. The HV value is normally written on a label attached to the photomultiplier housing.

Check that the main mirror cover is closed. Open the dome. The switch for the dome slit is located on a control box at the southern wall of the dome. From the same control box the position of the two wind-screens may be adjusted.

The movable floor platform should be in its lowest position, controls are on a pole at the southern end of the platform and on a handset normally situated close to the photometer.

Open the main mirror cover; a pair of push-buttons are located in the centre of a control panel below the telescope coordinate display.

1.2   Telescope initialization

The telescope control system (TCS) is controlled from the left pair of HP terminals. The upper screen continuously displays the status of the telescope and the dome. The use of

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the TCS menus is illustrated below.

Start from the main menu:

CONSTANT HANDLING	CATALOGUE HANDLING	PRESETTING	AUTO-GUIDER
DOME/HATCH CONTR.	ADAPTER CONTROL	SPECIAL FEATURES	PREPARE OBSERV.

PREPARE OBSERVATIONS will show the following menu:

Initialize Telesc.	Set Instr.param.	Set date	Read CERME Clock
ABORT Init. proced.	—	—	MAIN MENU

If the bootstrap of the TCS computer has been made correctly, both the time and the date should automatically be correct. However, for added security they should be checked now and then: press Read CERME Clock, wait for synchronization and then Set date. Fill in the correct date (UT!) in the white windows and send the information to the computer by the ENTER key. The photometer may be specified by Set Instr.param.

Initialize the mechanical telescope zenith by Initialize Telesc., wait until the message 'Telescope initialized!' appears. The telescope coordinates are now displayed on the panel. The initialization procedure may be aborted by ABORT Init proced. The telescope can also be moved manually from the red buttons on the panel. The fast movement is selected by SLEW but the slower GUIDE and SET are also available. When the telescope is in SLEW mode the tracking is disabled. Two handsets provide the same functions.

Going back with MAIN MENU and pressing CONSTANT HANDLING will display the following:

Tracking speed	Guiding speed	Setting speed	Offset constant
Zen.dist.limit	1/cos(D)-correc.	Default values	MAIN MENU

The tracking, set, and guide speeds may be changed from this menu as well as the offset and maximum zenith-distance (normally less than 60°) values. Use the ENTER key to load the new values into the program. In addition to the software zenith-distance limit two hardware stops (in R.A. and Dec) exist which prevent the telescope from reaching hazardous positions.

In the OFFSET mode the telescope may be moved a number of arcseconds specified by the Offset constant command. The direction will be according to the R.A. and Dec button pressed. In R.A. a 1/cos(D) correction may be applied.

1.3 Dome control

The dome is controlled via the DOME/HATCH CONTROL menu:

Dome AUTOMATIC	Dome SEMI-AUTOMATIC	Dome MANUAL	Dome status
Rotate Dome —>	Rotate Dome <—	! Stop Dome !	MAIN MENU

Furthermore, the status of telescope and dome is continuously shown on the upper HP
screen:

```
Hour angle:    - 0  0  1 Hms  Zenith dist.:    .1 Deg  Airmass: 1.000
Parallc.angle:      -1.0 Deg  Dome Temp.:              Wind speed:        km/h


  Telescope  General Status          Auto-Guider          Cassegr.Adaptor
  Alpha: SLEW  Coord:
  Delta: SLEW  Instr:IR - Photom.


             Dome: SEMI-AUTOM.
    Drives   Whats going on:         Last preset to object:
  A                                  Identifier: HH57
  D                                  Alpha:162856.80 Delta:-444908.0


Hatches:
                                                           @-->
Altitude:        H [------------------------------------------] Z
Azimuth:    South           West           North           East           South
            ^---------------^---------------^---------------^---------------^

Dome-pos:     ] [
Tel.-pos:                                                             []


A  Tracking D  A  Guiding  D  A  Setting  D  A  Offset  D  Z-dist. Today
15.000  0.000    5.000  5.000  60.000 60.000   1.000  1.000  60.0    1991.14
```

When the dome is in AUTOMATIC, it will adjust itself with regular intervals to keep
up with the tracking of the telescope. To avoid possible spikes in the photometric signal
arising from disturbances from the dome motors, the SEMI-AUTOMATIC mode has been
implemented. In this mode the dome will move only at the moment the telescope is
sent to a new target. If very long integrations of an object are required one may correct
the position of the dome (between integrations) by temporarily putting the dome into
AUTOMATIC and then back to SEMI-AUTOMATIC (or MANUAL).

In the MANUAL mode all movements are initiated by hand. This may be done by using
the two soft-keys in the menu or from three places in the dome: with a special handset,
with a set of buttons located on the coordinate display panel, and from the control box
at the southern wall. As mentioned above, the windscreens and the opening and closing
of the dome have to be done from this control box.

Auto-guider and Cassegrain adapter controls are not implemented on the 1m telescope.

1.4   TCS catalog handling

The new TCS catalog handling program includes a number of features to make life easier for the observer. All catalogs used and created by the program are disk resident files which will remain available until they are explicitly purged. A large number of files may be entered containing up to 500 objects each. Some files meant to be permanently available, such as standard star catalogs, may be protected against change or deletion. It is possible to prepare catalogs in advance and outside the TCS environment by running the program module CATAL from the HP Command Interpreter (CI). The catalog files may, for example, be transported on cassettes. Since the same catalog handling program is running on several other La Silla telescopes, files may be interchanged between these systems.

At a given moment only one catalog is active and used by the system. This 'working catalog' may be selected from the ones already written on the disk or the user may create his own. This, in turn, can be done by entering new objects and/or merging existing files. Thus a customized catalog may easily be constructed containing both science objects and standard stars. A new working catalog may rapidly be selected at any time. Once a working catalog has been selected, all subsequent commands refer to this catalog.

As with the other TCS modules, the catalog handling is done from a set of soft-key menus. One may also use two-letter written commands followed by RETURN, see table at end of this section.

From the main menu | CATALOG HANDLING | key, the first of three catalog sub-menus are reached:

Coord Entry	List	Select Catalog	Display Catalogs
Delete Object	Edit Object	Search 1 Object	– ETC –

The name of the current working file and the number of objects it contains are written on the status line below this menu.

First select your working file by | Select Catalog |. The 'unselect' is used in connection with the Merge command. Fill in the catalog name in the white field and press ENTER. (To create new files see below).

The | Coord Entry | will add new objects to the working catalog. If this file is protected, the command will not work. Normally only the name, Alpha, Dec and Epoch have to be filled in, the other fields are optional. To simplify entering large catalogs where the information may be similar from one object to the next, all fields, except the name, for the current object are taken over from the previous one. Only the differing characters have to be entered. The TAB key may be used to jump to the next input field. To indicate that the end of the input list has been reached, the object name field should be left blank.

The | List | will display on the screen (if Lu is blank, 0 or 1) or on a paper printer (Lu 6) if any is connected to the TCS computer, the catalog objects with numbers between the limits given in the two first fields. If these fields are left blank the entire catalog is written. To interrupt an unwanted long display hit any key to get the CI prompt (CI >) and type

BR followed by the RETURN key. Object names may alternatively be given in the 'List from object' and 'to object' fields. In this case all objects in the working file found between these two names will be listed even if the second name happens to be located before the first one in the file. However, if the resulting list is very large, and if the search flag has been left blank or set to 0, only a message will be given informing the observer that the file is too long. If a list is wanted irrespective of length, the search flag should be set to 1.

Depending on the search mask given, the names of all (default) or the selected object catalogs may be displayed with | Display Catalogs |.

Objects specified by their names can be deleted from the working catalog by | Delete Object |. If All is entered the entire catalog content will be deleted after a prompt for confirmation of the request.

An edit facility is provided by | Edit Object |. Specify either the object name or number in the first field and press ENTER. A search will be made for the object and the currently available information will be displayed on the screen for editing. Finish editing with blank name.

A search for objects in the working catalog can be made by name or coordinates with the | Search 1 Object | key. Up to ten objects found closest to the specified position may be displayed if the search is made by R.A. and Dec.

The second sub-menu is reached by | - ETC - |:

Create Catalog	Change Protect.	Merge Catalogs	EXIT
Purge Catalog	Rename Catalog		- ETC -

The only information required in the | Create Catalog | command is the file name, the rest is optional. The Catalog Identifier may be used as a fuller description of the content of the file, the Comment field is available for any type of comments. Leave the Coord Format and Coord Frame fields blank, these parameters are unimportant when working with the 1m telescope. If the created catalog is going to be sorted according to alpha or delta, this may be announced by an AL or DE in the Sorting Mode field. This will considerably speed up later searches for a specific object in the catalogue. The sorting does not have to be perfect in order for the search algorithm to be faster. If the created file has no specific order, leave the mode window blank.

The file may be protected from changes with an R in the Protection window. Default is blank (or zero) for an unprotected catalogue. The | Change Protect. | command may be used to subsequently change the protection of the working file. This command will not work on some of the permanently installed catalogues, such as the SAO, the PERTH, the FK5 and FK2000, which always remain protected from all changes.

With the | Merge Catalogs | command, parts of different catalogs may be merged to create a new one. This new catalog must be defined in advance and should not be protected at the time the command is used. All selected input catalogs must of course exist. No working catalog may be active. Use the 'unselect' option in the | Select Catalog | command. If only one object is wanted from a catalogue, repeat the name (or number) a second time in the 'to object' window.

EXIT is a return to the main menu.

Purge Catalog will remove a catalog file from the disk. Remember that the Delete Object may be used to delete the entire content of a file without removing the file itself. Catalogs should be purged from the disk if they are not to be used further.

The Rename Catalog facility is not yet implemented.

Finally, in the last sub-menu catalogs may be written on and read from HP cassettes. The format is ASCII and identical to the one displayed with the List , except that the information preceding the actual coordinate list is skipped.

Instead of using the soft-keys it is possible to type two-letter commands followed by the RETURN key. These are the synonyms in use:

Soft-Key Label	Synonym
Coord Entry	CO
List	LI
Select Catalog	SC
Display Catalog	DI
Delete Object	DE
Edit Object	ED
Search 1 Object	SE
Create Catalog	CR
Change Protect.	CH
Merge Catalogs	MG
Read from casset	RE
Dump to cassette	WR
EXIT	FI,AB,EX
(Refresh screen)	ME

The ME command may be useful to refresh the TCS screens in case the keyboard suddenly appears 'locked' and no new commands can be entered. Press the black reset button located up to the left on the keyboard twice rapidly. With this the lower screen should be cleared. Typing ME followed by the RETURN key should refresh both TCS displays.

Return to the main menu by EXIT .

1.5   Telescope pointing

The telescope pointing is controlled from the PRESETTING menu:

Go to object	Go to coordinates	Correct coordinates	STOOOOOOP !!!
FIXED PRESETS		CATALOG HANDLING	MAIN MENU

Go to object accepts name or object catalog number.

If the target is not in the working catalog the $\boxed{\text{Go to coordinates}}$ may be used. The use of the proper motion and Apparent Coordinates (AP) are optional.

Since the mechanical zenith of the telescope differs from the true zenith, the zero-point of the coordinate system must be adjusted with the $\boxed{\text{Correct coordin.}}$ command. Choose a bright star and point the telescope with the $\boxed{\text{Go to object}}$ key. Center the star in the diaphragm (with the shutter of the photomultiplier box closed) and press $\boxed{\text{Correct coordin.}}$. Enter the name or catalog number of the object and press ENTER. As can be seen on the coordinate display panel, the R.A. and Dec values will change slightly as a result of the correction.

This is also a good moment to check the telescope focus. First make sure that the diaphragm edge is in focus, if not adjust the position of the diaphragm eyepiece. Focus the telescope with the help of the focusing handset until the image of the star appears as sharp as possible.

Any telescope preset may be aborted by $\boxed{\text{STOOOOOOP !!!}}$. An emergency stop is located on the coordinate display panel. Do not hesitate to use it if for some reason the telescope moves without control into a dangerous position. If there is time enough, one may also turn off the telescope power directly from the switch in the inner room or switch off the two motor current amplifiers.

The sub-menu $\boxed{\text{FIXED PRESETS}}$ provides easy pointing to the zenith, the south pole, and horizon as well as to an eastern or western position normally used if dry ice has to be filled into the photomultiplier cold-box:

Go to Zenith	Go to HA and DEC.	Go to South hori.	STOOOOOOP !!!
Go to Pole	5 hrs.West,-29 deg	5 hrs.East,-29 deg	– Return –

The $\boxed{\text{Go to zenith}}$ command moves the telescope to the zenith and leaves it in SLEW mode, i.e. with the tracking disabled. A preset may also be defined in terms of hour angle and declination. If not absolutely necessary do not move the telescope further 'south' than -89°, i.e. do not pass the pole. The soft- and hardware limit switches do not protect against collisions with the platform or objects located on it. Neither do they prevent cables from being stretched or broken.

The $\boxed{\text{SPECIAL FEATURES}}$ menu is the following:

Show time and date	Engineer. display	Special feature 3	HARDWARE DIAGNOST.
OFFSET STEP MONITOR	TEL. POS. MONITOR	POINTING BUSINESS	MAIN MENU

The only key of interest in this menu to the general observer may be the $\boxed{\text{Show time and date}}$, all other keys and sub-menus are for test purposes and should only be used by La Silla staff.

Chapter 2

The photometric acquisition program

2.1 Starting this up

The photometric acquisition program (PHOTO) runs in an HP 1000 computer located on the second floor of the 1m telescope building. The magnetic tape drive, used to store the photometric measurements, is mounted immediately below and to the right of the computer. A shelf contains seven magnetic tapes, one for each night of the week. Additional scratch tapes may be used if necessary.

Turn on power for the tape drive and check that the logical unit number is set to zero. Mount the appropriate tape with its write ring in place. A mount description may be found close to the tape drive head.

Press LOAD and then ON LINE. The tape will advance to its starting point.

Two consoles located in the dome are used by the acquisition program. The centre console accepts input commands via a set of soft-key menus or commands written directly by the observer. It also displays a number of measurement parameters. The right-hand terminal serves as a display of the measurements proper and provides information about star and sky filter sequences, diaphragm used, on-line magnitudes, etc. As described above, the left-most console is used for the Telescope Control System (TCS).

Also connected to the system is a paper printer normally located close to the terminals. As a rule, this printer should always be used as a further data backup in addition to the tape drive.

To start the program hit any key on the central acquisition console to get the Username prompt. Type PHOTO.

2.2 Program initialization

2.2.1 Time

After a display of the current PHOTO revision number, a request to check the Universal Time and date is made. The UT used in the acquisition program is obtained from the internal RTE clock of the HP computer and is written on the terminal together with the date. If these are not correct they have to be modified by overwriting the information after the colon-sign. Use the arrow keys to position the cursor and the RETURN key to send the updated time to the computer at the correct moment. Do not change the format. The date is the UT one.

As described below, it is also possible to display and correct both time and date later during the measurements.

2.2.2 Filter and diaphragm table

The PHOTO program uses a special disk file named SPHOTB.TBL as a working file to identify the filters and diaphragms with names and wheels positions. The contents of this working table is written on the screen after the time check has been made. The observer must check that the information in the file corresponds to what is actually mounted in the photometer. To see the different parts of the file use the ROLL UP and ROLL DOWN keys. The set-up form for the 1m photometer provides information about the installation at the start of the observing run.

There are two pre-prepared standard wheel tables meant to be used with the red- and the blue-sensitive tubes respectively. These are named SPHTB1.TBL and SPHTB2.TBL and should have the following content:

Table SPHTB1 for red-sensitive tubes (UBVRI):

```
*C=======================================
*C        1.0 M ESO PHOTOMETER TABLE #01
*C=======================================
*C        UPDATE:1991 APR 15
*C        AUTHOR:H.LINDGREN
*C--------------------------------------
*C        FILTERS ( FIL,AA  INF,TA,,LI )
*C--------------------------------------
*C NAME   CODE     NUMBER     TYPE      CENTER   WIDTH      COMMENTS
*C                                      (ANGSTROMS)
    B      0        0        ESO 284    4353     985        ------------
    U      1        1        ESO 283    3529     752        UG2+CuSO4
    DA     2        2        CLOSED     ----     ---        ------------
    DA     3        3        CLOSED     ----     ---        ------------
    DA     4        4        CLOSED     ----     ---        ------------
    DA     5        5        CLOSED     ----     ---        ------------
```

```
      DA        6        6      CLOSED        ----       ---        ------------
      DA        7        7      CLOSED        ----       ---        ------------
      DA        8        8      CLOSED        ----       ---        ------------
      I         9        9      ESO 287       8797:      3064       RG9 --------
      R        10       10      ESO 286       6282       1219       ------------
      V        11       11      ESO 285       5398       1048       ------------
*C
*C---------------------------------------------
*C        DIAPHRAGMS (DIA)
*C---------------------------------------------
*C NAME    CODE      NUMBER    APERTURE   SEPARATION
*2                                        (ARC SECONDS)
      D0        0        0      86.6          ---
      D1        1        1       4.1          ---
      D2        2        2       5.5          ---
      D3        3        3       7.5          ---
      D4        4        4      10.9          ---
      D5        5        5      15.5          ---
      D6        6        6      22.9          ---
      D7        7        7      31.2          ---
      D8        8        8      43.4          ---
      D9        9        9      60.8          ---
      --        0       10      ----          ---
      --        0       11      ----          ---
**
**------------------------------------------------
**        END
**
```

Table SPHTB2 for blue-sensitive tubes (UBV and uvby-Hβ):

```
*C=======================================
*C        1.0 M ESO PHOTOMETER TABLE #02
*C=======================================
*C        UPDATE:1991 APR 15
*C        AUTHOR:H.LINDGREN
*C---------------------------------------------
*C        FILTERS ( FIL,AA  INF,TA,,LI )
*C---------------------------------------------
*C NAME    CODE    NUMBER    TYPE      CENTER   WIDTH    COMMENTS
*C                                     (ANGSTROMS)
      BN        0        0   ESO 326    4867      28     Hbeta narrow
      BW        1        1   ESO 327    4871     145     Hbeta wide
      SU        2        2   ESO 322    3501     321     Stands for u
      SV        3        3   ESO 323    4123     193     Stands for v
      SB        4        4   ESO 324    4676     167     Stands for b
```

```
SY          5          5      ESO 325      5477     213     Stands for y
DA          6          6      CLOSED       ----     ---     ------------
DA          7          7      CLOSED       ----     ---     ------------
DA          8          8      CLOSED       ----     ---     ------------
U           9          9      ESO 113      3554     591     W. read-leak
V          10         10      ESO 111      5216     LWP     Lo.wave.pass
B          11         11      ESO 112      4393    1079     W. read-leak
*C
*C-------------------------------------------
*C         DIAPHRAGMS (DIA)
*C-------------------------------------------
*C NAME   CODE      NUMBER     APERTURE  SEPARATION
*2                                       (ARC SECONDS)
     D0     0          0        86.6        ---
     D1     1          1         4.1        ---
     D2     2          2         5.5        ---
     D3     3          3         7.5        ---
     D4     4          4        10.9        ---
     D5     5          5        15.5        ---
     D6     6          6        22.9        ---
     D7     7          7        31.2        ---
     D8     8          8        43.4        ---
     D9     9          9        60.8        ---
     --     0         10        ----        ---
     --     0         11        ----        ---
**
**-----------------------------------------
**          END
**
```

As can be seen the two wheels contain the standard filter-sets, mounted in their standard filter slots, for the Cousins' UBV(RI)$_c$ and the Johnson UBV as well as the Strömgren $uvby$ and Hβ photometric systems. Note that the $uvby$ filters are called SU, SV, SB and SY to avoid confusion with the Johnson set! All filters in a wheel should have unique names. Even if PHOTO allows the use of lower case characters it is generally safer to use upper case only. PHOTO uses only the filter name, the code and slot number, the additional information in the tables is redundant but useful for the observer.

The diaphragm information should not be changed. Ignore the SEPARATION heading.

If no changes are required in the table continue the PHOTO session by soft-key $\boxed{\text{f1}}$ or press the RETURN key. To load table 1 or 2 use $\boxed{\text{f3}}$ (UBVRI) or $\boxed{\text{f4}}$ (UBV+$uvby$Hβ). $\boxed{\text{f5}}$ will print a copy of the current working table. Hit $\boxed{\text{f2}}$ if you wish to modify the table. This will put the Editor into the screen mode described below. Start from point 4. It is also possible to work directly from the normal HP Command Interpreter CI. At this moment in the initialization process it is in fact active as can be seen from the Photo.12> prompt. Later on in the execution of the PHOTO program it can be started by RU,CI.

Exit by EX. To load one of the two standard tables into the working file use the CI transfer command files TR,#4/LOTA1.CMD or TR,#4/LOTA2.CMD for table 1 and 2 respectively. The table will automatically be printed as well.

Changes in the working table may be done using the EDIT program. Type:

1. RU,EDIT

2. and after the / prompt type FI,#4/SPHOTB.TBL

3. and again after the / type 2,22,S

4. You are now in the Screen Edit mode. Use the arrow keys on the right-hand side of the keyboard to move the screen cursor. Overwrite the existing information with your new data without changing the format.

5. Read the modifications by simultaneously pressing CTRL and Q followed by the RETURN key. The updated screen will be scanned by the EDIT program.

6. Update the disk file by ER (End Replace) followed by RETURN. If for some reason you wish to abort the editor without changing the original working file, exit by A (Abort) and RETURN.

To list an extra copy of the working wheel table on the printer type:

CO,#4/SPHOTB.TBL 6 N (copy to printer).

The Editor may also be used in line mode, see HP manual.

2.2.3   PHOTO environment

The PHOTO program is designed to run with different photometers and telescopes. The initialization section will now display the default configuration under which the program will work. At the 1m telescope the combination should be: Telescope = 1, Photometer = 2.

Table 2.1 shows the different telescopes and photometers which may be used together with the PHOTO program.

Table 2.1: Acquisition environment

Telescope	Photometer
1=ESO 1.0m tel.	1=ESO Standard Photometer
2=Danish 1.5m tel.	2=One channel at 1m tel.
3=ESO 3.6m tel.	

2.2.4 Magnetic tape unit check

After displaying the currently used telescope-photometer combination the program will check whether the magnetic tape unit is ready to receive data, i.e.:

1. Logical unit number set to zero

2. Magnetic tape drive on line

3. Write enable ring mounted

If an error is detected, a message will be displayed until the problem is solved by the observer.

2.2.5 ST time comparison and selection

The PHOTO program now displays the computer and the TCS Sidereal time. The difference should be a few seconds at most, if not, the computer time has to be reset. This can be done later in the session with the $\boxed{\text{TIME CHANGE}}$ command. See below.

Normally ST is preferred in the photometric output file. For example, the SNOPY reduction program assumes that the time is ST. However, for some type of measurements (rapidly varying stars, eclipses etc) it may be more interesting to use UT. A program is available at the La Silla computer centre which converts from UT to ST. After this conversion the SNOPY package may be used as normal for reductions. A RETURN will assume the default ST, otherwise UT has to be entered.

2.2.6 Hardware tests

PHOTO automatically performs a number of different tests on the photometer itself (filter and diaphragm wheels) as well as of the controlling electronics (quad scaler). If all is found to be normal PHOTO proceeds to the header section.

2.2.7 Header

The header serves mainly as a log for the observer and the computer operators who do the data saving. Fill in the information you find relevant, a RETURN will leave the item blank. The header may be omitted in case of a PHOTO restart during the night.

2.2.8 The main soft-key menu

The first soft-key menu together with a display of a number of measurement parameters will appear next:

Init Acquisition	Tests	Set Sequences	Set Parameters

Acquisition Mode	PHOTometric sys.	Information	New Frames

STD-PHOTOMETRY

```
IDEN: TEST         ALPHA: 01:07:16.1  DELTA: -29:24:34  AIRMASS: 1.000
SMODE:Automatic    LMODE:ABsolute     TMOVE:  MAnual    DELAY T:   1 sec
TBASE:    .2 sec   TINTr:  1.0 sec    TIME :Sidereal    MAGTAPE: On
OFFSE: 15.0, 15.0  FLMOD:AUtomatic         :            PRINTER: On
PHOT.SY:UBVRI      PHMULT.QUANTACON   EXTIN:La Silla Me. Z-POINT: On
```

2.2.9 Tests

The sub-menu |Tests| contains the following commands:

TESt Cnt:sum/dif	CAMAC	TIME	SET UP

TESt single read	INFO,TABLES	TIME CHANGE	MENU

Two counters are used to alternatively read the photometric signal. The sample time is specified by the value of TBASE (normally 0.2 seconds), i.e. PHOTO counts the signal coming from counter one during TBASE seconds and then switches to counter two and adds the new counts coming from this counter to the previous, and so on until the specified full integration time has been reached. Dividing by the total integration time gives, of course, the counts per second. Each counter uses two 16 bit registers (numbered 0, 1, 2 and 3) in series to be able to handle 32 bit numbers.

The |TESt single read| displays the individual counts per TBASE and per second in the following way: counts are collected by counter 1 (called 'Up' and using registers 0 and 1) during TBASE (0.2) seconds. This value is written on the screen together with the accumulated sum. The same is done for counter 2 (called 'Lo' and using registers 2 and 3), the accumulated sum will now be the total counts collected during 2 x 0.2 sec. This procedure goes on for a total time of 1 sec thus giving 5 measurements, 3 from counter 1 and 2 from counter 2. The final value of the accumulated sum is of course the total counts per second. This command is useful to compare the behaviour of the two sets of 32 bit counters.

The |TESt Cnt:sum/dif| may also be employed. The actual measurements done are the same as for |TESt single read| but in addition to the normal counts per second the percentage difference between the values from the two counters is calculated and displayed. For a 'normal' stellar signal, this difference should be smaller than approximately ± 5%. The test is not appropriate for very low signals such as dark counts.

The |CAMAC| key is for La Silla staff only. The date, Julian date, ST and UT may be shown with |TIME| and reset with |TIME CHANGE|. The |SET UP| was meant to save or

reload the full status of the PHOTO program i.e. all the values of the various measurement parameters used by a particular observer. This useful command is unfortunately not yet implemented. The ⬚INFO,TABLES⬚ will write the working table for the filter and diaphragm wheels on the screen.

2.2.10 Information

With the ⬚MENu⬚ the first main set of soft-keys are called up again. From this the ⬚Information⬚ menu is reached:

HELp	Standard Catalo.	Photomultipliers	Zero Points

Wheel table	Object Catalogue	Phot.OLMAG Syst.	MENu

The ⬚HELp⬚ will give a short summary of the different commands used in PHOTO which may be directly typed or invoked from a soft-key. The ⬚Wheel table⬚ will again display the current filter and diaphragm set-up. Not yet fully implemented are the catalogue handling commands for the object and standard star lists. Thus, even though ⬚Standard Catalo.⬚ and ⬚Object Catalogue⬚ will list test catalogues these are not accessible in any other way.

The photomultiplier in use should be specified with a numerical code in ⬚Photomultipliers⬚. This will ensure that the correct transformation coefficient matrix and dead time constant used in the calculation of the on-line magnitudes are selected.

The ⬚Phot.OLMAG Syst⬚ will show the working matrices for the currently defined system.

The current zero points values for the on-line magnitudes are displayed with ⬚Zero Points⬚.

2.2.11 Define measurement sequences

The definitions of the various measurement sequences are made from the sub-menu reached with ⬚Set Sequences⬚:

StartAcquisition	STar Sequence	LIMit STar	Set Telescope

LIMit,INforma.	SKy Sequence	LIMit SKy	MENu

The star filter sequence is defined by ⬚STar Sequence⬚. This key will write STS, on the screen. It is of course also possible to directly type STS, without using the soft-key. The filter sequence has to be entered next. Filters may be measured in any order, for example

STS,SU,SV,SB,SY,SY,SB,SV,SU,HW,HN

In order to save time, it is however recommended to do the measurements in the same order as the filters are mounted in the wheel (backwards or forwards) to minimize the amount of wheel movement. Instead of filter names, the corresponding filter wheel slot numbers may be used but for clarity reasons the names are to be preferred.

The definition of the sky filter sequence SKS, is completely analogous.

Sometimes it may be of interest to move the filter wheel without using the measurement sequence commands. This may be done by typing NEX to select the filter following the current one or PRE for the previous one. More generally FIL,FN, where FN is the filter name, may be used to position any filter in the wheel. However, at the moment an integration is started, the wheel will position itself to the first filter defined with the STS, or SKS, commands.

2.2.12 Integration limits

Each filter measurement is described by four parameters:

MIN : Minimum total integration time in seconds
MAX : Maximum total integration time in seconds
IT   : Sampling time in seconds (normally 1 sec)
%ER : Standard deviation error limit expressed in percent

The integration will stop either at the moment the standard deviation drops below the %ER limit or when the MAX integration time has been reached. If the percent %ER limit is reached before MIN seconds, the integration will of course continue for a total of MIN seconds.

The general command to set the integration limits is the following:

```
        (STar)
LIMit,(      ),(FIlter,P1),MIN,MAX,IT,%ER
        (SKy )
```

The parameters within parenthesis are optional. It is thus possible to define the same limits for star and sky and for all filters with, for example, the command LIM,30,50,1,0.5. Here the MIN time is 30 sec, the MAX 50 sec, the basic sampling time 1 sec (other values for this basic integration time should only be used for special applications) and the standard deviation limit is 0.5%. These values and the previously selected filter sequence are displayed on the right-hand HP terminal screen. More commonly, different limits are used for star and sky: LIM,ST,30,50,1,0.2 and LIM,SK,10,20,1,0.5. To modify the values for one filter only use: LIM,ST,FI,3,20,30,1,0.3. Note that we here use the number of the filter in the sequence (not the filter wheel slot number). Thus it is possible to have different limits for two occurrences of the same filter in a sequence. On the other hand, if the filter name is used, the limits for all occurrences of that filter will be identical.

The only function of the soft-keys LIMit STar and LIMit SKy is to write LIM,ST and LIM,SK on the command line.

During the actual integration (see below) it is possible to override to some extent the limits set with the LIM command. The whole integration may of course be stopped but a STop-Cont. (0) soft-key also exists which allows the observer to shorten the integration

for the current measurement and automatically move on to the next filter in the sequence. This may be very useful for bright stars or for sky measurements for bright stars. The observer may change limits at any time during the night to suit the objects under study. Different limits may be appropriate for stars of widely differing brightness. However, one may also keep a set of limits suitable for an object of intermediate brightness and simply repeat this sequence a number of times for fainter objects until the measurement is considered finished.

The ⎢LIMit,INforma.⎢ shows the current sequences and limits on the right-hand screen.

Currently, the only available option for the LMOde is ABsolute.

2.2.13 Flip parameters for sky pointing

Various parameters associated with star/sky pointing are defined from the ⎢Set Telescope⎢ sub-menu:

DIAphragm	IDentifier	OFFset,al,de	Sequence MOdes

OFfset Definit.	TElescope Move.	DELay tel.	MENU

First select the diaphragm by name or number: DIA,5 for example. Check on right-hand screen that the command was executed. The identifier may be specified later.

The telescope may be moved to the sky position manually or automatically with the FLIP command (see below). The mode is specified by the ⎢TElescope Move.⎢ key TMO,P1, were P1 may be:

MA = Manual, no telescope movement at FLIp command
AL = Alpha, telescope moves in Right Ascension only at FLIp command
DE = Delta, telescope moves in declination only at FLIp command
AU = Automatic, telescope moves both in Right Ascension and declination at FLIp command)

The size and direction of the telescope movement is defined by the OFFset parameters. These are continuously displayed on the middle screen. Positive values of alpha and delta will generate a movement to the North-East when the sequence is changed from Star to Sky and the movement will be to the South-West when the Sky to Star change is executed. Negative values will cause the reverse situation, i.e. movement to the South-West at Star to Sky flip, etc. The signs may also be different to produce combinations of the previous cases.

To change the offset values, use the command OFF,AL,DE (soft-key ⎢OFFset,al,de⎢), where AL is the Right Ascension offset and DE is the declination offset. Both values are in arc seconds.

The program also provides a command to create new offset values with the help of the telescope. To use it type OFD (or use ⎢OFfset Definit.⎢) and manually move the telescope to the new selected sky position. At this position, press the RETURN key on the terminal and the program will calculate the difference between the two positions and send the telescope to the starting position (the star). The differences will be the new offset values.

However, since these values can not be saved and used for individual objects, this facility is of limited value.

To ensure that the telescope has time to settle after an offset movement, a time delay has been incorporated. The value of this is also written on the central screen. It is calculated from the formula:

$$DEL = MAX(\text{Off}alp, \text{Off}del) * 5/900 + 1 \qquad \text{(seconds)}$$

If really necessary this value may be changed with DEL,SE where SE is the settling time in seconds.

If the TMOVE is not in Manual, a flip command will always produce a movement of the telescope. The direction of this will depend on the previous sequence; if this was a star or sky measurement. To override this situation the flip command may be used with an additional parameter; FLIP,P1 where P1 can be:

ST or 1 : Force SKY to STAR movement
SK or 2 : Force STAR to SKY movement
DU   : Change sequence without movement

The flip mode FLMod may be MAnual or AUtomatic. AUtomatic will automatically flip the white star/sky window at the end of a measurement sequence; to sky if the previous sequence was a stellar one, and vice versa. If in MAnual, the change has to be done by pressing the $\boxed{\text{FLIp}}$ (see below).

2.2.14 Measurement sequence modes

Once the limits and sequences have been defined, various ways of executing these sequences may be employed. The $\boxed{\text{Sequence MOdes}}$ key gives access to the the following sub-menu:

MANual	REPeat,st,sk	PRInt,(ON/OF)	On-line Mag.Calc
AUTomatic	GLObal,st,st,rep	MAGta,(ON/OF/AL)	MENu

The current sequence mode SMODE is displayed on the centre screen. In the MANual mode all integrations have to be started manually after each filter positioning. In the AUTomatic mode the filters advance automatically according to the star (STS) or sky (SKS) sequences.

As mentioned above the sequences for star and sky may be repeated any number of times. This can be done by manually restarting every sequence or the command REPeat,NST,NSK may be used. After a STArt (see below) the star sequence will be repeated automatically NST times and the sky sequence NSK times. A FLIP has to be done in between.

A more general repeat mode may be invoked with GREpeat,NST,NSK,NAL. This command is similar to the previous one except that the NAL parameter specifies how many times the full star/sky sequence will be repeated; (NST star sequences, NSK sky sequences) all

repeated NAL times. This command works only when the TMOVE is in Automatic since also the FLIP is made automatically. Example: GRE,2,1,2 will generate a measurement as STS STS FLIP SKS FLIP STS STS FLIP SKS END.

When an automatic flip is made back to the star position it is essential that the telescope movement is working with some degree of precision. This has to be checked by the observer at the time of measurement.

The output modes of the printer and magnetic tape can also be selected from the current menu with PRI,ON and OFF and MAG,ON and OFF. Default is ON for both devices. Check on center display. The paper printer should always be used. A TOP will generate a paper top of form. Normally only the mean values after every integrating are saved on paper and magnetic tape but sometimes it may be of interest to save every single integration (of duration IT seconds) on magnetic tape. For example, if external electric disturbances are uncommonly frequent giving rise to spikes in the signal, the measurements may be saved by removing the individual erroneous values. Select the all integrating mode by MAG,AL.

2.3 On-line magnitude preparation

2.3.1 Standard on-line system selection

The on-line magnitude calculations should be regarded as a help for the observer to check the system performance and to get a first quick look at the data. For these reasons it is recommended to activate it. It is also recommended to fully reduce the observations from the previous night the following day to have an additional check of the behaviour of the system.

Go to the │ PHOtometric sys. │ menu to define your photometric system:

UBV	VRI	uvby	UBVRI
HBETA	Define New Sys.	PHotoMultip.,n	MENU

The general command for photometric system definition is PHO,P1 where P1 is the system name:

System	P1
UBV	UBV
VRI	VRI
uvby	UVBY
UBVRI	UBVRI
H-beta	H-BETA
User defined	GENERAL

Check on the centre screen (PHOT.SY:) that it has been read.

Within the PHOTO program the photometric systems are defined with the help of so called structure matrices which describe how magnitudes and colours are formed. These

matrices are given in the following sections. Mean La Silla first order extinction coefficients are assumed and applied as well as second order ones. Finally, the transformations from the instrumental to the standard systems are given by the transformation matrices. The values in these have been derived from earlier, fully reduced, observations in the various systems. The system zero-points have to be determined (normally every night), by observations of suitable standard stars (see below).

2.3.2   Program tables for the UBV system

	U	B	V
V	0	0	1
B-V	0	1	-1
U-B	1	-1	0

UBV structure matrix

V	0.125
B-V	0.087
U-B	0.247

UBV mean extinction for La Silla

	V	B-V	U-B
V	0.0	0.0	0.0
B-V	0.0	-0.035	0.0
U-B	0.0	0.0	0.012

UBV second order extinction

	V	B-V	U-B
V	1.0	0.005	0.0
B-V	0.0	0.985	0.0
U-B	0.0	0.0	1.045

UBV transformation coefficients (EMI 6256)

2.3.3   Program tables for the VRI system

	V	R	I
V	1	0	0
V-R	1	-1	0
V-I	1	0	-1

VRI structure matrix

V	0.125
V-R	0.034
V-I	0.074

VRI mean extinction for La Silla

	V	V-R	V-I
V	0.0	0.0	0.0
V-R	0.0	0.0	0.0
V-I	0.0	0.0	0.0

VRI second order extinction

	V	V-R	V-I
V	1.0	0.0	0.0
V-R	0.0	1.147	0.0
V-I	0.0	0.0	0.997

VRI transformation coefficients (Quantacon)

2.3.4 Program tables for the *uvby* system

	u	v	b	y
y	0	0	0	1
b-y	0	0	1	-1
m1	0	1	-2	1
c1	1	-2	1	0

uvby structure matrix

y	0.128
b-y	0.055
m1	0.061
c1	0.158

uvby mean extinction for La Silla

	y	b-y	m1	c1
y	0.0	0.0	0.0	0.0
b-y	0.0	0.0	0.0	0.0
m1	0.0	0.0	0.0	0.0
c1	0.0	0.0	0.0	0.0

uvby second order extinction

	y	b-y	m1	c1
y	1.0	0.062	0.0	0.0
b-y	0.0	1.075	0.0	0.0
m1	0.0	-0.145	1.107	0.0
c1	0.0	-0.098	0.0	0.992

uvby transformation coefficients (EMI 6256)

2.3.5 Program tables for the UBVRI system

	U	B	V	R	I
V	0	0	1	0	0
B-V	0	1	-1	0	0
U-B	1	-1	0	0	0
V-R	0	0	1	-1	0
V-I	0	0	1	0	-1

UBVRI structure matrix

V	0.130
B-V	0.090
U-B	0.247
V-R	0.034
V-I	0.074

UBVRI mean extinction for La Silla

	V	B-V	U-B	V-R	V-I
V	0.0	0.0	0.0	0.0	0.0
B-V	0.0	-0.035	0.0	0.0	0.0
U-B	0.0	0.0	0.012	0.0	0.0
V-R	0.0	0.0	0.0	0.0	0.0
V-I	0.0	0.0	0.0	0.0	0.0

UBVRI second order extinction

	V	B-V	U-B	V-R	V-I
V	1.0	-0.050	0.0	0.0	0.0
B-V	0.0	1.015	0.0	0.0	0.0
U-B	0.0	-0.010	0.990	0.0	0.0
V-R	0.0	0.0	0.0	1.040	0.0
V-I	0.0	0.0	0.0	0.0	0.950

UBVRI transformation coefficients (Quantacon)

2.3.6 User defined on-line systems

In addition to the standard systems described above, PHOTO allows the user to define her/his own photometric system. This is done by first naming the system:

`PHD,SYNAME,NFILT`

where SYNAME is the name of the new system (up to six characters) and NFILT its dimension, i.e. the number of filters it contains (between 2 and 6). The command will automatically ask for the new FILTER names (two characters) and the new COLOUR names (4 characters). These names must be in correspondence with the names given in the filter table and the structure matrix of the system. Define the system as GENERAL.

To define or modify the structure matrix use the following command:

`STR,ROW,v1,v2,v3,v4,v5,v6`

where ROW is the row number inside the matrix, and v1 to v6 are the different parameter values of each column in that line. Default values may be used which will not change the existing data. For example, `STR,3,,1,,,,`, will only alter the value in the second column of the third line of the structure matrix. If ROW is omitted the program will prompt automatically for the parameters of the matrix.

New mean extinction data may be entered with

`EXT,CH,v1,v2,v3,v4,v5,v6`

where v1 to v6 are the new values. The second order extinction coefficients are entered with

`EX2,LINE,v1,v2,v3,v4,v5,v6`

where LINE is the line number of the second order extinction matrix, and v1 to v6 are the new values. These second order extinction values are in practice of limited importance and may be set to zero.

Finally, to modify the transformation coefficient matrix use

`COL,LINE,v1,v2,v3,v4,v5,v6`

To check what on-line magnitude tables are currently active use the command `INF,PH,,LI`. In case the third parameter, L1, is given, the program will list a copy of the display on the printer.

The menu reached from ⟦ OLM System Def. ⟧ contains soft-keys for the commands discussed above:

PHDefin,nam,dim	EXTin,CH,v1..	COLor,n1,c1,..	PONd,ZP,(0=M/1=L
STRucture,n1,i1.	EXT.2nd,n1,e2,.	INFormation syst	MENu

2.4 Measurements

The main measurement menu is reached via the [Acquisition Mode] sub-menu:

STD.PHOTOMETRY	2 CHA. STAR/SKY	N CHANNEL PHOT.	CHOPPING PHOT.
DIAPHRAGM PHOT.			MENU

The only key in use in this sub-menu at the 1m telescope is the one producing the measurement menu [STD.PHOTOMETRY]:

STArt	IDEntifier	COMment	FLIp
AGAin		DIAphragm	MENu

2.4.1 Identifier

Before starting any integration an identifier must be given. This is done by IDE,Identifier (soft-key [IDEntifier]), where the name may be any set of up to 12 alpha-numeric characters. Check on centre screen that the name has been accepted correctly. If the object is to be repeated after the END command (see below) has been given, the AGAin may be used. This will copy the previous name into the current identifier. To modify the identifier in case of a typing error use MID,Identifier.

2.4.2 Start of acquisition

Once the object is centered in the diaphragm and all shutters open, the integration is started by [STArt] or by typing STA. During the integration a new menu will appear:

STArt	STop-Cont. (0)	End-DElete-ob(4)	FLIp
STOp (1)	REpeat-Filter(3)	DElete-Filter(5)	END

After the start of the integration it will proceed according to the sequences and limits defined previously. The counts are displayed on the right-hand screen together with some statistical parameters meant to describe the stability of the signal. The filter name, the accumulated integration time, the individual counts collected during IT seconds (see LIMit command), a running mean value of the signal as well as its standard deviation are continuously written on this screen.

The first statistical parameter describes the atmospheric scintillation. The second parameter should be around 1, if it is much larger than 1 oscillations are present in the signal and values much less than 1 indicate drifts or slow changes. If the third parameter is not close to zero the reason may be spikes in the measured signal. For a more detailed description of how these tests are calculated see Bartoldi et al. (1984).

Once the star sequence has been finished the sky is normally measured. A [FLIp] command will tell the PHOTO program that the following measurements are of the sky. An inverse

video field will move from the Star Seq. to the Sky Seq. text on the right-hand screen. Another FLIp will move it back. If TMOve is set to automatic, the telescope will move according to the OFFset values. An $\boxed{\text{END}}$ will indicate that the measurement of the current object has been finished. As mentioned above, any number and any mixture of star and sky sequences can be made before an END is given. Everything between STArt and END will be averaged and considered as one measurement by the SNOPY program.

On the right-hand screen is furthermore shown the status of the filter and diaphragm wheels and the photometer shutter. A small log is kept of the previous counts for the star and sky sequences. On-line magnitude calculations and associated parameters are also listed on this screen.

An integration in progress may be stopped by STOp. This will simply interrupt the ongoing integration and further action has to be initiated by the observer. The STop-Cont. (STC) will stop the measurements of the current filter and automatically move on to the next in the sequence. Both commands will of course register the counts collected up to the moment the command was given. Measurements in a filter may be repeated at any time during the integration by REpeat-Filter (REF). At the moment the command is given a '3' code (see Output format) will be written in the output file and the measurements will start all over for the filter in question. The two commands End-DElete-ob (EDE) and DElete-Filter (DEF) will write a special code in the output list instructing the SNOPY program to ignore the whole current object or the measurement of the last filter. Since the data are not actually removed from the file it may be better to make a note of the mistake and later edit the file before the reductions are made.

An END will mark the termination of an object and the measurement menu will reappear. The FLIp will automatically be set for a subsequent star sequence. On-line magnitudes will be calculated and displayed.

2.5 On-line magnitude calculations

If the on-line magnitude system is to be used, the zero-point of the photometric system in question has to be determined by measurement of at least one star with known magnitude and colours. From the star and sky counts (STAR(i), SKY(i)) for the standard the corresponding raw magnitudes are calculated:

$$RMAG(i) = -2.5\log(VAL(i)/(1 - TO * VAL(i)))$$

where

$$VAL(i) = MAX(STAR(i) - SKY(i), 1)$$

Here i=1 to N (=number of filters in the system) and TO is the dead time. The MAX is introduced to avoid the situation where the sky counts are higher than the star counts. If RMAG is defined as the vector

$$RMAG = \begin{bmatrix} RMAG(1) \\ - \\ - \\ - \\ RMAG(N) \end{bmatrix}$$

then the first order colour matrix is obtained from

$$COL1 = STRU * RMAG$$

where STRU is the structure matrix of the system used to transform the measurements through single filters to colour values. As an example consider the VRI system:

$$RMAG = \begin{bmatrix} V \\ R \\ I \end{bmatrix} \qquad COL = \begin{bmatrix} V \\ V - R \\ V - I \end{bmatrix} \qquad STRU = \begin{bmatrix} 1 & 0 & 0 \\ 1 & -1 & 0 \\ 1 & 0 & -1 \end{bmatrix}$$

The second order extinction coefficients are taken into account with

$$COL2 = SECEXT * COL1$$

Assuming for the moment that the zero-point is known we may apply the main extinction as

$$COLO = COL1 - AIRM * (EXT + COL2) + ZEROP$$

EXT and SECEXT are of course the extinction matrices and AIRM the mean airmass for the measurement. If for some reason, no extinction corrections are desired, the calculation may be skipped by EXTI,OF. EXTI,ON will re-insert it. Finally, to convert into standard system magnitudes the transformation coefficients have to be applied to COLO:

$$OLMAG = INST * COLO$$

Thus on-line magnitudes (OLMAG) may be derived for any object. Considering again the measurement for the standard star we solve for the system zero-point:

$$LZP = INVINST * STD - COLO$$

INVINST is the inverse of INST and STD the vector with the known standard values for the standard star. Here we have called the zero-point LZP (Last Zero-Point) to distinguish it from the actually used one (ZEROP). If the currently used zero-point is called MZP

(Mean Zero-Point) a new measurement of a standard star may wholly or partially change the zero-point according to the formula:

$$ZEROP = POND * LZP + (1 - POND) * MZP$$

POND is the so called ponderation factor $(0 \leq POND \leq 1)$ determining the weight given to the new zero-point measurement. Normally POND is set to one, e.g. the new measurement will simply be the new zero-point. POND may be changed with PON,ZP,P1 where P1 (real) is the new value of POND. The commands LAZ and MEZ are also provided to set POND=1.0 and 0.0 respectively.

2.5.1   On-line zero-point determination

First check that the photometric system has been selected correctly and that the tube has been defined. Choose a suitable standard star, not too different in colour from the program stars. Make sure that the previous measurement has been terminated with an END. Enter the identifier. Give the standard values with the command STD,v1,v2...vN, where v1 to vN may be, for example V, B-V, U-B or y, b-y, m1, c1 or V, B-V, U-B, V-R, V-I etc. Check on the right-hand screen that the given identifier has been associated with the colour values. At least for the first determination it may be better to clear the previous zero-points entirely with the command CLZ,ZP. Later, a ponderation factor less than zero may be used. Measure the star and sky in the normal way and finish with END.

At this moment the new zero-points have still not been calculated. This is done by giving the command ZPO. All subsequent measurements of program stars will automatically have their on-line magnitudes calculated and displayed on the right-hand screen and written on the printer (but not on the magtape) at the moment the END command is given. Another command OLM can be given at any moment before a new identifier is entered, also before the END command, to give the on-line magnitudes for the current object. Of course, if some filters lack measurements the result for the related colours will be meaningless. In case no sky data are available for the object the sky measurements for the preceding star will be used.

The ZPO command can also be used to directly change or display zero-point values:

```
ZPO,CH,v1,...,vN
ZPO,IN,,LI
```

When the first parameter is CH, the program will read v1 to vN and save them as new zero-point values.

On the other hand, if the first parameter is IN the PHOTO program will display 3 sets of zero-points:

- Those actually used for the on-line magnitudes
- The last zero-points derived
- The mean value of all zero-points measured during the night

The soft-key ⎢On-line Mag.Calc⎥ will display a menu for help with the above:

OLM,On-line calc	Zero POint	RAW,(ON/OF)	OLM System Def.

STanDard star	REject Zero poi	Clear Zero poin	MENu

Before a new identifier is given, the observer has the possibility to reject the zero-point calculation with REZ if something seems wrong.

On-line magnitudes uncorrected for extinction and colour effects may be displayed by RAW,ON. Turn off with RAW,OF.

To get a check of the first zero point determination, it is recommended to measure at least one additional standard star without declaring it as standard, i.e. treating it as a program star. The on-line magnitudes calculated from this star should then be compared with the standard values. Typical on-line errors in UBV are 0.01 - 0.03 magnitudes for V and B-V and 0.02 - 0.05 for U-B. Similar values hold for the other photometric systems. Since the assumed colour transformation matrix is not the exact one valid for the night in question, program stars with colours much different from the standard star used to fix the zero point, may get on-line values with errors significantly larger than the ones cited above.

The standards used for the on-line zero point determination may of course be part of the standard set meant to establish the nightly extinction and colour transformation coefficients. Depending on the nature of the observing program and the range in colours of the program stars, the necessary number of standards for this purpose is normally between 10 and 20.

2.6 Output format

The output format is the ESO standard one for photometric measurements. The type of each output line is defined by a code at the beginning of the line:

```
8  Heading or comment
5  Object identifier
6  Telescope coordinates
7  Measurement number, Universal Time and Julian Day
0  Current filter measurement with:
   - Identifier
   - Integration time
   - Sidereal or Universal Time depending on TIM,ST or TIM,UT
   - Filter number
   - 0 not yet used
   - Star or sky measurement (0 or 1)
   - Mean value of integrations
   - Number of integrations
   - % standard deviation
   - Statistical parameters related to
```

```
            - Atmospheric scintillation
            - Slow signal variations (or oscillations)
            - Asymmetry, spikes or loss of signal
       1  Last integration results if MAGtape,All
       9  End of object
       4  Cancel last object
       3  Cancel last filter measurement
```

Example:

```
FRMT 1
1  1
8=  Observer(s):H. Lindgren              Date :23/24-11-1988
8=  Prog.Descr.:RR Lyrae
8=  Temp.:      Humid:      Wind:        Clouds:        Seeing:
8=  Tim.Out:SI  I.Day:328  Com.UT:20:31:19  Com.ST:20: 0:26  Tel.ST:20: 0:27  =
8===============================================================================
8
5  W TUC
6     0:57:44.7   -63:26:49
7     2  2447489.5         0:30: 7  23:59: 0
0  5  1.0   0: 0:26.6  0   0   0    3817.7  60.   .25  1.14  5.61   .12
0  5  1.0   0: 1:19.8  11  0   0    5429.3  40.   .20  1.26  10.08  .15
0  5  1.0   0: 2:11.9  10  0   0    4803.3  60.   .23  1.32  6.50   .11
0  5  1.0   0: 3:15.1  9   0   0    4098.1  60.   .21  1.04  6.05   .07
0  5  1.0   0: 4:29.3  9   0   1     662.8  10.  1.01  1.03  6.30   .39
0  5  1.0   0: 4:41.3  10  0   1     444.2  10.   .94   .91  3.95   .31
0  5  1.0   0: 4:53.4  11  0   1     511.0  10.  1.45  1.14  5.05  -.34
0  5  1.0   0: 5: 5.4  0   0   1     412.0  10.  1.53  1.36  3.35  -.42
0  5  1.0   0: 6:00.0  1   0   1     100.0  10.   .20  1.00  1.00   .50
9

5  HD5648
6     0:56:36.3   -63:19:38
7     3  2447489 5         0:39:30   0: 9: 0
0  5  1.0   0: 9:00.0  1   0   0    1000.0  60.   .20  1.00  1.00   .50
0  5  1.0   0: 9:27.1  0   0   0   24638.2  12.   .20  1.15  144.5  .36
0  5  1.0   0: 9:41.1  11  0   0   36606.7  12.   .20  2.32  105.1 -.16
0  5  1.0   0: 9:54.7  10  0   0   31880.6  11.   .19  1.62  153.9  .09
0  5  1.0   0:10:14.7  9   0   0   24320.7  25.   .20  1.47  53.16  .04
0  5  1.0   0:10:59.4  9   0   1     639.0  10.  1.66  1.36  5.03   .43
0  5  1.0   0:11:12.4  10  0   1     491.7  10.  1.47  1.36  3.13   .29
0  5  1.0   0:11:24.4  11  0   1     578.2  10.  1.52  2.34  4.35   .33
0  5  1.0   0:11:39.5  0   0   1     453.6  16.  1.96  2.08  1.68  1.24
9
```

2.7 Some observing advice

It is good practice to keep an eye, when possible, on the individual integrations (normally 1 sec) to check the performance of the system. Possible problems may often be detected at an early stage with this simple precaution. Stability and odd/even differences between the two counters should in particular be checked.

Always check the dark current of the tube at the beginning of the night. The tracking of the telescope is normally good, but if long integrations are necessary, the position of the object in the diaphragm should be checked.

If observations are to be performed in a restricted area of the sky, the pointing may be much improved by a new CC command on an object within this area.

Keep the light inside the dome at a low level. The intensity of the screens may be adjusted with the help of potentiometers mounted on every terminal.

It is of course the responsibility of the observer to prepare suitable standard stars for extinction and colour-transformation determinations. A binder may be found in the dome containing some of the most used standard star lists. The range in colour and airmass of the program stars should be matched by the standards. A small drift during the night in the photometric system may be present. To keep track of this, measurements of some standards should be well spread in time.

Remember that the Quantacon and Hamamatsu tubes only allow moderate count-rates and that faint enough standard stars have to be prepared.

When the telescope is moved to another target the light-path must not be left opened, insert for example the field-view mirror.

If for some reason the observations are temporarily interrupted during the night, the telescope should be moved to the zenith with the $\boxed{\text{Go to Zenith}}$ command (which will also disable the tracking). The main mirror cover, the dome, and at least one of the shutters should be closed.

Chapter 3

Quick reference guide

In late afternoon:
- Turn on telescope power.
- Platform in lowest position.
- Read CERME clock, Set date, Initialize telescope.
- Set constants for telescope handling.
- Prepare your working coordinate catalog.
- All photometer shutters and main mirror cover **closed**.
- Check HV setting for photomultiplier.
- Open dome, slit towards south. Adjust wind-screen position.
- Mount magnetic tape, check printer paper.
- Start PHOTO.
- Check PHOTO time.
- Check information in filter wheel table and correspondence with set-up form.
- Check PHOTO ST.
- Enter header.
- Define filter sequences (STS,B,V,U and SKS,U,V,B).
- Define integration limits (LIM,ST,min,max,it,% and LIM,SK,min,max,it,% or LIM,ST,FI,#,min,max,it,%).
- Select diaphragm (DIA,n).
- Choose photometric system and define tube (PHO,UBV and PHM,n).
- Check system selection (PHO,IN).
- Choose sequence mode (normally AUTomatic).
- Choose output devices (MAG,ON and PRI,ON) and output modes.
- Choose integration limit mode (normally ABsolute).
- Choose telescope movement mode (normally MAnual).
- Check dark current (with cold-box shutter closed).

At beginning of night:
- Open main mirror cover.
- Open main photometer shutter. Cold-box shutter **closed**.
- Dome SEMI-AUTOMATIC.
- Point telescope towards a bright star.
- Focus field-viewer.

- Focus diaphragm with eyepiece. - Focus telescope.
- Correct coordinates.
- Point to standard star for on-line magnitude zero-point determination.
- Open cold-box shutter.
- Clear zero-points (CLZ,ZP).
- Give standard star identifier (ID,name).
- Give standard star magnitude and colours (STD,V,B-V,U-B).
- Measure standard star (STA, FLI, STA, END).
- Calculate new zero-points (ZPO).
- Check on-line magnitudes with another standard.
- Start with your observing programme.

At end of night:
- Do TERM or ADIOS to terminate the PHOTO program. This will write an End of File mark on the magnetic tape.
- Close shutter of photomultiplier box.
- Move platform down to the level of the dome floor.
- Move telescope to zenith.
- Insert eyepiece- and field-viewer into light-path.
- Close main photometer shutter.
- Close main mirror cover.
- Rotate dome towards south-west.
- Close dome.
- Turn off telescope power.
- Fill in the nightly Operation Report.
- Dismount the magnetic tape and fill in the label with the information needed for the La Silla data bank.
- Leave the Operation Report in the red mail-box at the hotel entrance and the magnetic tape in the software mail-box.

Chapter 4

Detected problems and software bugs

The problems described below are currently (August 1991) being remedied but they should nevertheless be checked by the observer.

- Some photomultiplier housings or cold-boxes have shown light-leaks especially around the shutter mounting. Check with a flashlight and cover with black tape.
- The mounting of some cold-box shutters has no well-defined 'open' position. An accidental push may partially close the shutter which will then partly obscure the light-path. During the night fix the shutter in the open position with black tape.
- The positioning of the diaphragm wheel is not perfectly repeatable. As a result, different diaphragms may have different centre positions. Even the centre position of a particular diaphragm may change slightly after a new wheel positioning.
- The dome positioning in Automatic and Semi-automatic mode is not perfect. Often the slit edge is found very close to obscuring the view of the telescope. Check and adjust the dome by hand.
- The photometer is sensitive to external electrical disturbances which may produce spikes in the signal. Do not switch on (or off) lamps and do not move the dome, platform etc. during an integration.

References

Bartoldi, P., Burnet, M., Rufener, F.: 1984, *Astron. Astrophys.* **134**, 290

Appendix A

Soft-key resume

Menu #0. Main menu:

Init Acquisition	Tests	Set Sequences	Set Parameters
Acquisition Mode	PHOTometric sys.	Information	New Frames

Menu # 1. Acquisition mode:

STD.PHOTOMETRY	2 CHA. STAR/SKY	N CHANNEL PHOT.	CHOPPING PHOT.
DIAPHRAGM PHOT.			MENU

Menu #2. Tests:

TESt Cnt:sum/dif	CAMAC	TIME	SET UP
TESt single read	INFO,TABLES	TIME CHANGE	MENU

Menu #3. Set sequences:

StartAcquisition	STar Sequence	LIMit STar	Set Telescope
LIMit,INforma.	SKy Sequence	LIMit SKy	MENu

Menu #4. Set telescope:

DIAphragm	IDentifier	OFFset,al,de	Sequence MOdes
OFfset Definit.	TElescope Move.	DELay tel.	MENU

Menu #5. Sequence modes:

MANual	REPeat,st,sk	PRInt,(ON/OF)	On-line Mag.Calc
AUTomatic	GLObal,st,st,rep	MAGta,(ON/OF/AL)	MENu

Menu #6. On-line magnitude calculations:

OLM,On-line calc	Zero POint	RAW,(ON/OF)	OLM System Def.
STanDard star	REject Zero poi	Clear Zero poin	MENu

Menu #7. On-line system definition:

PHDefin,nam,dim	EXTin,CH,v1..	COLor,n1,c1,..	PONd,ZP,(0=M/1=L
STRucture,n1,i1.	EXT.2nd,n1,e2,.	INFormation syst	MENu

Menu #8. Photometric systems:

UBV	VRI	uvby	UBVRI
HBETA	Define New Sys.	PHotoMultip.,n	MENU

Menu #9. Information:

HELp	Standard Catalo.	Photomultipliers .	Zero Points
Wheel table	Object Catalogue	Phot.OLMAG Syst.	MENu

Menu #10. Standard photometry:

STArt	IDEntifier	COMment	FLIp
AGAin	NExt Object	DIAphragm	MENu

Menu #11. During acquisition:

STArt	STop-Cont. (0)	End-DElete-ob(4)	FLIp
STOp (1)	REpeat-Filter(3)	DElete-Filter(5)	END