Wise Observatory Manual

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Updated: March 18, 1999

(first version: Wise Observatory Technical Report 95/6)

ABSTRACT

The Wise Observatory's 40 inch telescope of Tel-Aviv University has been operating since 1971. In the last few years a vast upgrading of the observing equipment and the operating systems has been conducted. The most frequent used observing systems which can be mounted on the telescope are:

1) Camera.

2) Faint Object Spectrographic Camera (FOSC).

3) Two Star Photometer.

The operating systems include programs to set the telescope to objects, automated guider, automated observations, operation of the CCD, and various other tasks.

The purpose of this manual is to describe the use of the above instruments as well as other instruments, programs and facilities at the Wise Observatory. The aim is to help the observer to operate the instruments properly and to avoid mistakes so that the observing time will be fully and properly used.

Since the Wise Observatory is in constant development this manual will hopefully be updated according to the developments. This document and time request forms are available via the WWW at http://wise-obs.tau.ac.il/~shai/wise_man/

Some general information about the Wise Observatory (and photos) is available at http://wise–obs.tau.ac.il/

Information about the Department of Astronomy and Astrophysics of Tel-Aviv University is available at http://wise–obs.tau.ac.il/~benny/Astrophys/

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Chapter 1

Introduction

The Wise Observatory, named in honor of Florence and George Wise, the first president of Tel-Aviv University and his lady, was dedicated in October 1971. The observatory is owned and operated by Tel-Aviv University (TAU), Israel, and is dedicated to research in observational optical astronomy. It is located on a high plateau in the central part of the Negev desert (longitude 34°45′48″ E, latitude 30°35′45″ N, altitude 875 m, time zone is –2 hours relative to Universal Time). The site is about 5 km west of the town of Mitzpe Ramon. 200 km south of Tel-Aviv and 86 km south of Beersheva. The town of Mitzpe Ramon has a population of about 6000 and offers facilities in housing, schools and medical services. The town management had cooperated with the observatory in controlling and shielding street lights and outside illumination to minimize the additional light background, but in the last few years together with a large development of the town, the light pollution from the town has increased considerably.

The characteristics of the site, prior to the establishing of an astronomical observatory on it, were described by Vidal and Feldman (1974). The number of clear nights (zero cloudiness) is about 170 a year. The number of useful nights is about 240. The best season, when practically no clouds are observed, is June to August, while the highest chance for clouds are in the period January to April. Winds are usually moderate mainly from NE and N. Storm wind velocities (greater than 40 km/h) occur, but rarely. The wind speed tends to decrease during the night. Temperature gradients are small and fairly moderate. After 23:00 LT, the gradient is usually 0.2°C/h the year round. The average relative humidity is quite high with a tendency to decline during the night from April to August. The average seeing is about 2–3 seconds of arc. A few good nights have seeing of 1″ or less while some show seeing larger than 5″. Typical extinction coefficients, in mag/airmass, are: $k_V = 0.24$, $k_{U-B} = 0.22$, $k_{B-V} = 0.14$, $k_{V-R} = 0.05$, and $k_{R-I} = 0.07$. These are median values for the last decade. A review of the observing conditions at the Wise Observatory (Brosch 1992) is given in appendix A.

The Boller and Chivens telescope is a wide field Ritchey-Chretien Reflector mounted on a rigid, off-axis equatorial mount. The optics are a *Mount Wilson/Palomar Observatories* design, consisting a 40 inches diameter clear aperture f/4 primary mirror, a 20.1 inches diameter f/7 Cassegrain secondary mirror, and a corrector quartz lens located 4 inches below the surface of the primary mirror, provides a field of up to 2.5 degrees in diameter. A f/13.5 secondary mirror is also available. The secondary mirror can be slightly inclined with a stepping motor. The telescope is controlled by a control system, located in the telescope room.

The present most frequent used observing instruments are the CCD Camera (for imaging and photometry) and the Faint Object Spectrographic Camera - FOSC (for spectroscopy, polarimetry, and very rarely for imaging). Both of them use a Tektronics 1024×1024 CCD as their detector. Each one of them can be mounted at the f/7 of the telescope, together with an acquisition and offset guider which is connected to an automatic guider. A rarely used instrument is the two star photometer that operates at f/13.5 and was designed by Ed Nather. This system is suitable for fast photometry. A forth instrument which is no longer in use but can be operated is the Boller and Chivens spectrograph (the "old spectrograph") which is mounted on the f/7. This instrument was used with the old RCA CCD as its detector and no adjustment have been made to connect it with the new Tek CCD.

Research activities include: imaging and photometry of planets, moons and comets, photometric and spectroscopic studies of novae, symbiotic stars and other cataclysmic variables, spectrophotometric studies of quasars and active galactic nuclei, photometry and spectroscopy of x-ray binaries, multi-color photometry of galaxies, studies of spectroscopic binary stars, participation in the international research project The Whole Earth Telescope.

The Wise 1 meter telescope took part in a number of international collaborations, particularly of simultaneous and nearly simultaneous observations of ground based and orbiting telescopes, such as IUE, GINGA, EXOSAT and others.

A few of the major astronomical discoveries made at the Wise Observatory are:

1. First detection of water molecules in comets.
2. One of the first identification of an X-ray binary with an optical star - Her X-1 = HZ Her.
3. Measurements of the size of the line emitting region in Seyfert galaxies and quasars.

The Wise Observatory E-mail address is: navon@wise.tau.ac.il . The FAX number is: (3)-6408179 and the phone numbers of the Tel-Aviv headquarters, on the campus of TAU, are (3)-6408729 or (3)-6409279. The phone number of the Mitzpe Ramon site is (7)-6588133 or (7)-6588303. The country code of Israel is 972. The observatory site is equipped with a modem-fax (9600 MNP Level 5). This allows access from the site to the TAU main

computer and through this to the INTERNET. There is also a possibility of phoning into the site computer modem. However, to use the modem one needs some special arrangements at TAU computing center - this can be coordinate with the help of the observatory staff.

The purpose of this manual is to describe the use of the above instruments as well as other instruments, programs and facilities at the Wise Observatory. The aim is to help the observer to operate the instruments properly and to avoid mistakes so that the observing time will be fully and properly used.

1.1 Observing Time Policy and Procedure

Policy

The equipment and facilities of the Wise Observatory are constructed and maintained for the use of the scientific community in general. Available observing time on the Wise Observatory telescope will be shared between staff members and visitors, and will be allotted on the basis of scientific merit and suitability of instruments. The final responsibility for all allocation of time shall be the director's.

Procedure

1. Requests for observing time are submitted to the observatory office using the standard Observing Time Request Form. Electronic mail applications will be accepted, provided they are detailed as required on the forms. A tex and postscript files of this form can be retrieved via the WWW at http://wise-obs.tau.ac.il/~shai/wise_man/ .

2. Requests for observing time should be made for the six month periods October 1 - March 31 or April 1 - September 30, and should be submitted prior to the preceding July 1 and January 1 respectively. Late requests will be granted only in exceptional cases at the discretion of the director.

3. Graduate students must submit an endorsement from their faculty advisor along with the form. The endorsement must contain statements concerning the student's academic standing, the acceptability of the proposed research to the department, and the capability of the student to perform the proposed work.

4. Requests will be reviewed by a scheduling committee appointed by the director.

5. Any applicant who feels that the decision on the telescope allocation has been unfair may appeal directly to the observatory director for reconsideration.

6. Once telescope allocations have been made, revisions in schedules must be negotiated through the director.

1.2 Guidelines for Visiting Astronomers

The Observatory staff have put together a few guidelines with a view to making your stay a more efficient and pleasant one. If there are any questions or we can help in any way, please do not hesitate to contact us.

Our headquarters are situated on the university campus in Ramat-Aviv, a suburb of Tel-Aviv north of the city center. The Observatory site itself is about 200 km south of Tel-Aviv.

Prior to departing for the site, the astronomer is encouraged to visit the TAU office for briefing and discussions with the Observatory staff. It is therefore advisable to plan to be in Tel-Aviv at least one day earlier than the commencement date of the observing run.

Likewise, if the observer should need some assistance in transferring data or reduction, a day or two in Tel-Aviv will be required at the end of the run.

N.B. The visitor must take into consideration that Tel-Aviv University is closed on Friday, Saturday and religious or national holidays. Sunday is a working day.

1.2.1 Transportation

a. To and from Ben-Gurion International Airport:

Ben-Gurion International Airport is about 20 km from Tel-Aviv North. The cost of a taxicab directly from the airport to Tel-Aviv is around $15 (+25% after 9 p.m.).

One can also take an El-Al bus to the Tel-Aviv Airport Terminal and from there a taxicab to the hotel.

b. To and from Mitzpe Ramon:

The Wise Observatory is situated 5 km west of the township of Mitzpe Ramon. Buses run regularly every 15-20 minutes from the Central Bus Station of Tel-Aviv, or every 30 minutes from Tel-Aviv North Railway Station, to Beersheva (roughly 3/5 of the way to Mitzpe Ramon), and then somewhat less frequently (about every hour, depending on the time of day) from Beersheva to Mitzpe Ramon. The trip takes all in all three and a half to four hours.

N.B. Buses do not run on the Sabbath, from Friday afternoon to Saturday evening and the same applies from the afternoon before until the evening after official holidays.

Cars can be hired at the airport or in Tel-Aviv. At peak seasons it might be advisable to reserve in advance.

The observer should coordinate his arrival in Mitzpe Ramon with the Observatory staff in regard to time and meeting place.

c. At site:

At Mitzpe Ramon there is a utility van, driven by the technical assistant, for traveling to and from the site. The utility van may not be used outside Mitzpe Ramon and the site, except in cases of emergency.

When permission has been given to observe without a night assistant, the van may be driven by the astronomer. In such circumstances, TAU regulations require that a photocopy of the observer's driving license be received in advance.

1.2.2 Accommodation

a. In Tel-Aviv:

It is advisable to reserve accommodation in Tel-Aviv a few weeks in advance through a reliable travel agency. We shall be glad to assist in making reservations for accommodation in Tel-Aviv (at the visiting astronomer's expense) if the following details are provided a few weeks in advance: arrival date and time, airline and flight number, room requirements (single or double accommodation) and duration of stay.

Likewise accommodation can be arranged for the end of the run, if we are advised of the visitor's requirements.

b. In Mitzpe Ramon:

Observers may stay at one of the Observatory's furnished flats for the duration of the observing run.

Accommodation fees of $15 per person per night are charged to the visiting astronomer.

Meals are obtainable at one of the few restaurants in the township, but can also be self-prepared in the flats where cooking facilities and utensils are available. It must be noted that no restaurants or shops are open in Mitzpe Ramon from Friday afternoon to Sunday morning. However, the local hotel restaurant is always open. The same applies to official holidays.

Observers who wish to be accompanied by members of their families, students or other guests, should first obtain the consent of the director.

There are sets of keys for the observatory and the apartments in Mitzpe. They are available in the observatory office in TAU. The keys are to be picked up when you go to the observatory for a run, and MUST BE RETURNED TO THE OFFICE IN TAU.

1.2.3 The Observatory: Operating Procedures & Briefings

As in every scientific laboratory, the basic rules are "if you are not sure, then don't" and "if something unexpected occurs, stop everything and call for help". For safety reasons no one is allowed to work at night alone.

1. Whenever a night assistant is assigned to an observer, the responsibility of the Observatory and the operation of the telescope rests with the night assistant.
2. Astronomers who receive permission from the director to work at the site without a night assistant must be thoroughly instructed by the station manager before the beginning of the observing run. It is the responsibility of the observer to see to it that he is properly instructed. Astronomers must strictly follow the local staff instructions and adhere to any written instructions that are supplied.
3. First-time visitors or astronomers who have not been at the Observatory for more than 6 months should plan to be at the site at least 8 hours before the actual run starts, in order to familiarize themselves with the Observatory and the instruments.
4. Instruments will be changed only during the daytime shift, excluding Saturdays and official holidays.
5. Astronomers who plan to take away their data, should bring their own media. We currently use 3.5" and 5.25" diskettes on MS DOS platforms, DAT tapes to record CCD images as tar files on a Sun UNIX platform, and writable CDroms recorded on a PC platform.
6. The telephone (07) 6588133 - a bell set in the office with extensions in the library and the dome room- is to be used for work only, as every call outside Mitzpe Ramon is billed as a long distance call. No international calls are permitted, unless authorized by the director.

1.2.4 Security at the Observatory Site

1. A list of emergency telephone numbers is posted in the office of the station manager and in the dome room. The observer should familiarize himself with the location of this list.
2. The station manager, or, in his absence, the day/night assistant is in charge of all security measures, and observers are expressly requested to comply with his instructions.
3. The gate of the compound and the door of the building must be kept locked.
4. During observation, every person in the dome room must be equipped with at least a red flash-light.

1.2.5 Publications and Acknowledgment

It is expected that visiting astronomers will utilize the observations they obtain at the Wise Observatory for the preparation of publications describing their research activity.

Publications by non-staff astronomers of such research should carry the following credit lines: an asterisk by the author(s) name to refer to a footnote stating, "Visiting astronomer, the Florence & George Wise Observatory, Raymond and Beverly Sackler Faculty of Exact Sciences, Tel-Aviv University, Israel".

Notification of any papers published for which the Wise Observatory is given a credit line would help keep the Observatory publication records accurate and current.

We would appreciate receiving 3 copies each of all preprints and reprints resulting from observations at Mitzpe Ramon.

1.2.6 Import of Own Equipment

1. *As accompanied or unaccompanied luggage:* From past experience it has been found that the clearing of such luggage is greatly facilitated by the use of a "Carnet de Passage" (obtainable at local, state or national Chambers of Commerce) with the addition of a detailed packing list for each packing.

2. *As separate shipment* (if too bulky or heavy for accompanied luggage): The Carnet de Passage and packing list as stated above is imperative. Due to delays in clearing customs, such shipments must reach Israel at least a week to 10 days before start of run.

   The shipment should be sent "door to door", to the Wise Observatory, Mitzpe Ramon. It might be convenient to use the services of the Tel-Aviv University customs brokers, but not necessarily so.

   N.B. When filling in the Carnet, "Represented by" should stipulate the visiting astronomer's name, the name of a member of the Wise Observatory staff and "all authorized representatives".

3. All expenses such as air freight, clearing incoming and outgoing shipments, and inland transportation must be borne by the astronomer.

1.3 Safety Instructions

1. When inside the dome, never slew the telescope without light in the dome.

2. When moving the telescope, you must ensure that it does not run into the platform or any other obstruction. When operating from the library, the platform must be in its lowest position.

3. Never move the telescope, the dome, or the platform from two different posts.

4. Check the humidity in the dome at least once every 2 hours, and more frequently when humidity is higher than 90%. You must close the dome if water condensation begins to form on the dome or the instruments.

5. Do not attempt to make any repair whatsoever to the telescope measuring instruments, platform or dome on your own. Call a member of the staff in any event or breakdown.

6. Always lock the doors of the building and turn the alarm system on (in the library room).

7. Always use a torch when moving in darkness.

8. Make sure you know the telephone numbers of the emergency services in Mitzpe-Ramon and those of the local staff members.

Telephone Numbers:

Dan Maoz, Director	W:03-6408538 or H:03-6425830
Ezra Mashal, Technical Director	H:03-5400633
Peter Ibbetson, Electronics Engineer	H:02-6781388
Sami Ben-Gigi, Technician	H:07-6588829 or 052-703382
Tel-Aviv Office	03-6408729 or 6409279
Site numbers	07-6588133 or 6588303
Emergency radio-telephone*	050-652032

*This telephone is in the site office and is to be used ONLY for emergency, when none of the regular lines is available, since the call units of this radio-telephone are very expensive.

Emergency Services:

Police	**100**
Red Magen David (ambulance & medical service)	**6588569**
Civil Guard	**6588333**

Chapter 2

Computers

The observatory is equipped with several computers which are connected in a network (see Fig. 2.1), control all observing main functions, and enable the observing process to be as fully automated as possible. There are two computer posts: the main one is in a glass/control room in the dome and the secondary is in the library. The two main computers are: 1) a computer to control the telescope movements and the autoguiding (§ 2.3) 2) a computer to control the instruments which are mounted at the telescope focus (CCD camera, FOSC, etc. § 2.2). The whole observing procedure during the night can be controlled from those two computers, which are posted in the dome. For convenient use, each of those two computers has a PC Companion in the library room so the observer can operate them from the library giving up the "pleasure" of sitting in the dark, cold dome. The two main computers control the FOSC mover computer (§ 2.5) and the dome mover computer (§ 2.4), which are the ones which move the FOSC wheels, the dome, and the telescope through the relays box.

At the library, in addition to the two PC companion, there is a PC (§ 2.6) with a printer, a CD-Rom writer, and a modem connection, and a Sun Sparc workstation (§ 2.1). The two PC companion and the library PC are switched on and off from consoles buttons in the relay/fuse box above them.

The four computers: the Sun, the library PC and the two main computers in the dome are connected via local Ethernet link which is used for files and images transferring.

IMPORTANT: Observers and accompanying persons are NOT ENTITLED to make any alteration to the settings of the computers at the Observatory, especially to the PC sitting in the library, not even making screen savers active, since they are harmful when one attempts to produce a CDROM backup; otherwise, we will be forced to block its access with a password (a nasty one).

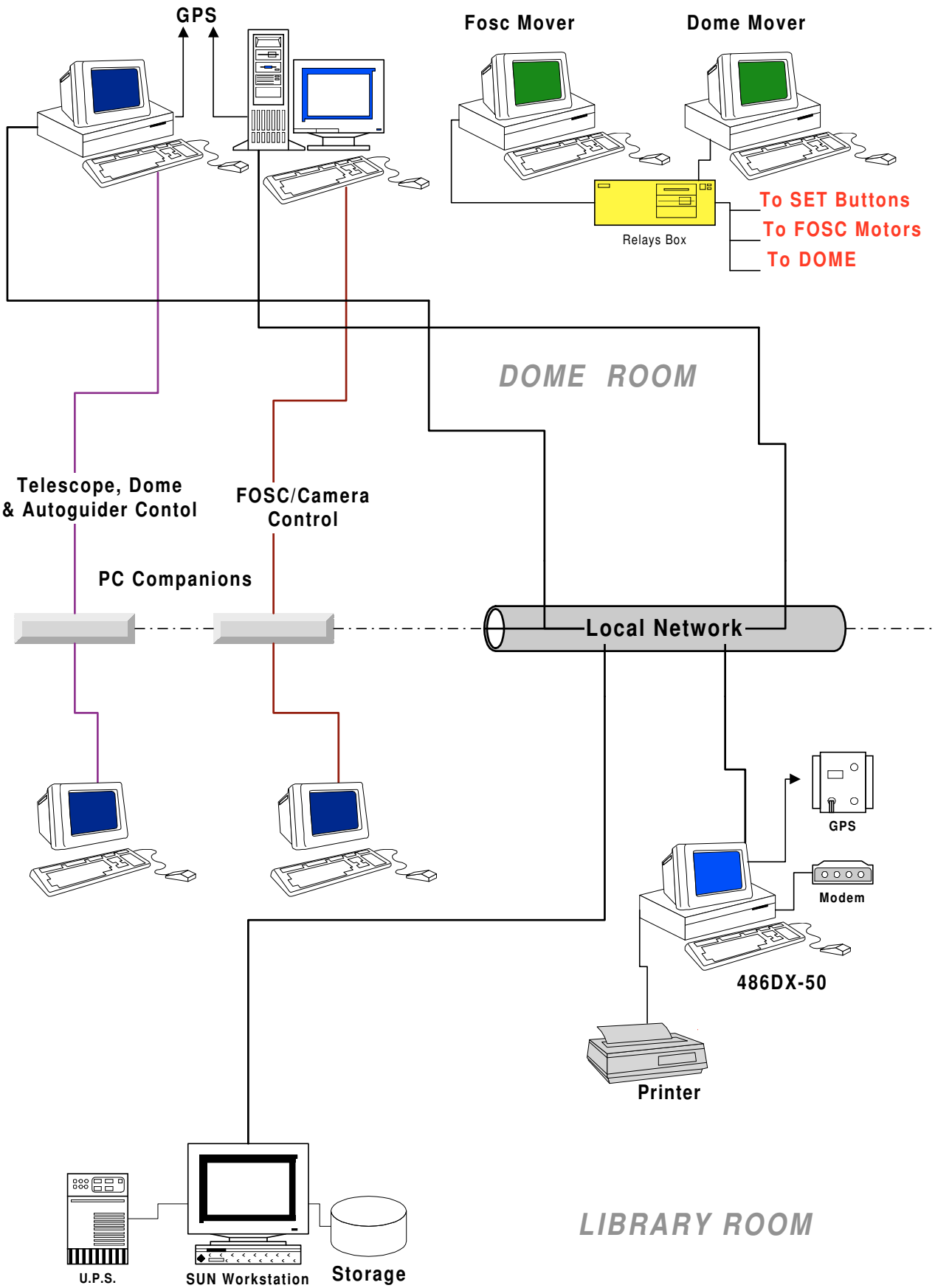

Figure 2.1: Computers network.

2.1 Sun Workstation

A Sun workstation (SPARC station *IPC*) called "wise10" is in the observatory library. It is used to backup the images taken with the CCD on a dat tape for transferring to other sites, and has various facilities in it for image reduction (namely VISTA and IRAF reduction packages).

To open *Sun OpenWindows* working environment type: openwin <cr>, to open *SunView* working environment type: sunview <cr>. Logging out from the workstation is by typing: logout <cr> .

The workstation is like all other workstation that are in the astrophysics department in TAU. It can be used in openwindows, in sunview windows, or just as a big screen. It is capable of doing almost everything that can be done in TAU. It has IRAF, VISTA, mongo, supermongo, xvgr, latex, tex, etc.

Be aware of the amount of disk space you have there. It's about 700 Mb, which can hold up to about 350 full frame (1K×1K) CCD images. Be careful not to lose any frames due to lack of space. You can check the amount of disk space you have by using the UNIX command "df" and looking at the available space under /home/wise10 section (where the home of the mizpe account is).

If you need to stop processes on the Sun workstation you can make a terminal connection from the Camera and FOSC controller PC (section 2.2):
Select LAN WorkPlace in the program manager.
Start up Host-Presenter.
Enter as Host Name 132.66.142.6 and press OPEN.
login as mizpe with wise as the password.
Now you can kill the process that is disturbing you. Just issue the command "ps -uxg" to find the process number and then "kill -9 number" to kill it. When done do "logout".

2.1.1 Transferring Files to Dat Tape

The CCD images are transferred to the Sun workstation using ftp from the Camera and FOSC controller PC (see section 2.2.6). As a convention they are transferred and kept in the /home/wise10/mizpe/ccd/ directory in subdirectories named as yymmdd (where yy is the year number, mm is the month number, and dd is the day number, e.g., January 17 1997 is 970117). Currently they are then transferred on from the Sun to the library PC for backup on CD-ROM (see section 2.6). However, if observers wish to continue collecting data on DAT tapes, they will be obliged to bring their own DAT tapes (No DAT tapes will be kept at the observatory), there are two procedures:

1. The "dat" procedure that was written specially for the Wise Observatory:
First make sure to copy the file from the subdirectory yymmdd to the upper directory (/home/wise10/mizpe/ccd).
Then type: dat <cr>
You'll be asked where to write the images: type 0 for the beginning of the dat, -1 for end of information, or the number of the tar file that you want to write after it. If you type 0, or the number of a file, you will be prompt to confirm this.

The dat will skip to the place you asked for. Next you will be asked which date files to transfer to the dat. You need to type the date, where date is the date name of the files from that night — for example: 11apr94 <cr> .
You'll get a list of all the files from that date, and you'll be asked to confirm the list, so type: y <cr> . All files from that date will be copied to the dat tape. Note that only one date can be copied each time on a different tar file.

2. The "tapio" procedure that all Wise users in TAU know:
Change directory to ccd/yymmdd by typing: cd ccd/yymmdd <cr>
Type: tapio <cr>
The program will then prompt you for what you want to do. Type in: c <cr> in order to copy files. then you'll be asked from where you want to copy, and you should answer: d <cr> for disk .
The next question will be: To where you want to transfer them. Answer: 4 <cr> which is the dat drive connected to the Sun station.
The program will check the tape drive status and will report it to you. Then you will be prompted for cassette identification. Just type in any string you like, something like: datjunk <cr>, will do.
Then you will be asked where to write the images: type 0 for the beginning of the dat or -1 for end of information. If you type 0 then you will be prompted to confirm this. The dat will skip to the place you asked for.
Next you will be asked for a comment. Just answer with <cr>. Then you will be asked to confirm the current directory. If it is /home/wise10/mizpe/ccd/ just answer: n <cr> to the question about changing directory, if not then change to that directory.
Next you'll be asked which files to transfer to the dat. If you cleaned the directory before you started transferring files to it you can answer <cr> for all files. If there already have been files there from previous nights and you want only the files from the last night to be copied to the dat you should type : date.* <cr> , where date is your date - for example 11apr94.* <cr>. You'll get a list of all the files you have specified and you'll be asked to confirm the list by typing: y <cr> .

Then all the files will be copied to the dat.

The end of the two procedures is the same:
Note that after the files have been copied, the program uses the verify option to check that the files were copied correctly. Be alert for any error message. When copying is completed the program will ask if you want to backup more files. Answer with: n <cr> .
The last question will be what to do with the dat cassette. Answer: u <cr> to unload it from the dat drive.
To logout from the workstation type: logout <cr> .

2.2 Camera and FOSC controller

This computer is used to operate the observing instruments on the telescope, namely the camera, the FOSC, and the CCD. The working environment in it is Windows 3.1. To open windows used in observations you can choose their icons in the "CCD progs" icon in the window "Program manager". When the PC is booted the PC pauses waiting for the user to hit any key. When this is done the windows environment is started automatically.

2.2.1 PMIS Window

The PC will continue its initialization procedure and the PMIS window will appear. The Photometrics Image Processing Software (PMIS) is the software which operates the CCD. It will prompt you for your name, and then for the instrument you are about to use, so either answer "0" for the CAMERA, or "1" for the FOSC. Then you will be prompted for a list of objects (see the "takelist" and "ifiltseq" macros, if you don't have a list then just hit <cr>). If you chose the "camera" you will be also prompted for the filter wheel you are about to use: the manual one (four positions) or the automated one (8 positions). If you choose the automated filter wheel you will be also prompted for its current position. Then windows will initialize according to the instrument you specified.

The operation of the CCD is controlled by various macros - different for the FOSC and for the CAMERA (see sections 4.2 and 5.2). You choose the macros from the "user" menu in this window, or in the "initialdisplay" window which is a sub-window of the PMIS where the images are displayed. The default operation of the macros involves voice statements which are declared by the computer when operating something. You can disable this by writing in the PMIS main window: voiceoff . You can enable it again by writing: voiceon .

An important window is the "Abort" timer window which appears whenever the exposure time exceeds 25 seconds, and enables you to abort the exposure. After aborting, most macros

(except "takearc" and "takelamp" of the FOSC) give a chance to read the image acquired so far and to record this exposure to the disk. Note that the information which is recorded might be wrong since the parameters of GAIN and RDNOISE might set differently when the image is aborted. To get the CCD set back for regular work there is need to set its parameters right again. This is dome by taking an exposure of about 15 sec. The parameters of this exposure will be wrong but the images taken after this action will be O.K.. This action of taking a dummy exposure after aborting an image is performed automatically by almost all macros (except "takearc" and "takelamp" of the FOSC).

There are other sub-windows, like the "Wise-Obs" window which is a text window with information about the current observation, and various questions and pause windows which appear during the execution of the macros.

In the "initialdisplay" window you can use the "display" menu to scale the grayscale of your image by choosing the scaling option, you can also zoom in the image or squeeze it. From the "plot" menu you can choose to plot a line, a row, or a column of the displayed image. This will open a new sub window "PR_initialdisplay" with the plot in it. It is advisable to close the plot window after inspecting it because it often causes the PMIS program to crash.

When PMIS is executing a command or a macro do not attempt to enter other program windows. (an exception is the FOSC mover window, see 2.2.5). Only when an exposure exceeds 25 seconds and the "abort" window is displayed can one work in other windows (like the Norton commander or games), but at such a time nothing else within any of the PMIS windows can be operated. Be sure to finish everything in the other windows before the exposure is ended, otherwise you are risking crashing the PC and loosing the current exposure. However, note that if during a long exposure the "Abort" window is active (its top bar is blue highlighted) then hitting spacebar, enter, clicking the mouse etc. cause it to abort the exposure. Therefore it is recommended that during a long exposure another window will be active, e.g., a game window.

If PMIS crashes you can restore it from the "CCD progs" icon that is in the "Program manager" window.

There are two ways to change lists for the "takelist" or "ifiltseq" macros. One is to close the PMIS program and start it again with the new list name. The second is to run the "startup" macro from the command line of the PMIS and to enter the new list name.

2.2.2 Focus Window

The focus window opens automatically when starting PMIS. If this instance of the focus programme is closed and it has to be restarted there is to be found in the "CCD progs"

in the programme manager window a little camera icon marked telescope focus. The focus window may be started by double clicking on this icon.

For the present the following procedure is suggested when focusing. After PMIS has started and its introductory question list has been appropriately answered, the iareab macro is used to define the initial display. After the mtake macro has been used to take a stellar image, start the focusit macro, move the cursor into the displayed image onto a suitable focus star and click the left hand mouse button. When the continue focusing question box appears move the cursor into the focus window beneath the question box and click the left hand mouse button. The focus programme frame will turn from grey to blue and the focus programme can now be controlled from the keyboard.

If it is necessary to move the focus by a large amount for example after the instruments have been changed or when the telescope's f-ratio has been changed then press enter a numerical value to which the focus is to be moved and press the "move" key. Allow the focusing to proceed to completion before continuing. If the telescope is being focused with the same instrument and the same filter as on the previous night then use the + or - keys to single step the focus position. After the desired focus position has been attained click within the continue focusing question box and index the yes button. Note the quality of the focus and the degree of improvement or deterioration and repeat the process between the focus window and the focusing question box until the required focus for the particular filter has been achieved. Return to PMIS by answering No in the continue focusing question box.

Return to the User menu and run the mtake macro again either to check the final image quality or to select another filter. If it is necessary to check the focus on another filter run the focusit macro again.

Since it is generally unnecessary to recheck the focus in the course of the night provided the focus on all filters in use is the same the focus window may now be closed. If there is a significant difference in the required focus for two or more of the filters which are in use on a particular night minimize the focus window and bring it up each time a focus adjustment is required as the result of a filter change. Make the adjustment and once again iconize the focus window.

The focus window always displays the current focus setting.

It is not desirable to use the console focus buttons.

Every time the PMIS is started the focus window is appearing. It is not desirable to have several such windows so the observer needs to close the extra windows when they appear – always have only one focus window.

A Possible problem and its solution:

For the focus setting programme on the 486 to work the encoder readings must be

available to the computer. If the computer is unable to read the encoder and the focus motor is started it can only be stopped by the stop button. In the meantime the focus shaft may well have turned through the encoder zero position at which point the turns counter should have been incremented or decremented. However, the new turns counter reading will not have been noted. So when the encoder finally is powered the displayed reading may be out by 128 or a multiple of 128.

The encoder is only powered if the 386 setting guiding computer is switched on. This situation arises because the focus encoder is connected to the 486 through one of the 32 bit I/O boards. These in turn are connected through the brown box to the telescope setting encoders. For utility reasons all the encoders take their 5 volt power from the 386. So if the 386 is off the focus encoder is not working.

The encoder box is arranged so that its dial is visible beneath the old console beside the relay box. Each division represents one rotation of the focus encoder and the division numbers correspond to the turns count.

If the focus setting appears to be a long way out take a look at the coarse focus indicator on the box beneath the console and note the number of the region the pointer is in.

Be sure that the 386 setting guiding computer is turned on.

Click on Turns in the Files menu of the focus window and set the turns to correspond to the focus region which the pointer was in.

All being well that should bring the focus reading to where it belongs.

It is possible to move the focus motor when the 386 is off. However, it is now only possible to move it by a small amount. This cannot ensure that the turns will not get out of step but at least it reduces the probability.

2.2.3 Filter Wheel Window

This window is used to control the automated filter wheel position (sec. 4.1). When it first appears one need to reset it to the current filter position by looking on the filter wheel on the telescope and marking the current filter on the window and pressing reset. To move to a certain filter just mark it and then press the "move" button. Usually the programs and macro you're choosing for observation are taking care for moving the filter wheel and the observer does not need to deal with this window any more.

2.2.4 Observation Control Programme Window

The observation control programme aims to ease still further the observing sequence. It works in conjunction with the filter wheel control and the PMIS image processing software. It is appearing when one chooses the camera option in the PMIS startup procedure and

also can be invoked from the icon marked "Observation Control" in the "CCD progs" of the programme manager window.

It should be noted that it has not yet been thoroughly tested.

There are two modes of operation List Entry and User Entry. The ListEntry/UserEntry button serves to toggle between the two.

The programme comes up in UserEntry mode. The object name and exposure time should be keyed in in the spaces provided and the desired filter selected from the list either with the mouse or with the arrow keys. If the repeat box is checked then the observation will be repeated until the repeat box is cleared. Push the start button to observe.

Note that an area should have been defined prior to starting an observation.

Load a list file from the C:\misc\ directory and toggle to list entry. The object number in the list can be selected along with the exposure number in the sequence which has been prepared for the particular object. By checking the appropriate boxes either a specific observation in one filter may be repeated or the full sequence may be run through once or many times. Clearing the boxes prior to the end of a specific observation brings the repetition, the sequence or the repeating sequence to an end at the conclusion of that observation.

A new list file may be loaded at any time.

In user entry mode the particulars for the next observation may be entered whilst the current observation is progressing.

If the filter names in the lists are not identical to those specified for the filter wheel itself the filter names may be edited either in the observation control programme or in the filter wheel programme.

Incidentally the programme will deal with lists in their present format. It can also accept lists without coordinate details but there should be a running number associated with each and every object or observation sequence.

The repeat check box is associated with a spin wheel which may be set between 0 and 9. When the spin wheel is set to zero and the repeat box is checked the exposure will be repeated continuously. A counter indicates how many exposures remain. For a preset number of exposures between 1 and 9 the spin wheel will count down from the entered value to 1 and then stop exposing. If either or both of the repeat box and the sequence box is checked prior to starting an exposure recording is automatic. Thus if it is required to take a single exposure and record it automatically check the repeat box and set the spin wheel to 1 before starting.

If an exposure is aborted it is not necessary to uncheck either of the boxes it will occur automatically when the abort process completes. During an exposure whilst the exposure thermometer is displaying the check boxes can be cleared bringing the sequence or repeat

series to a halt at the termination of the current exposure.

In the list entry mode a sequence may be selected a repeat sequence may be selected or a repeat series of any entry in the sequence list.

Please note the abort does not function correctly for entered exposure times under 20 seconds.

2.2.5 FOSC Control Window

When you choose the FOSC option in the PMIS startup procedure, a window called "Faint Object Spectrographic Camera Control" will appear on the right-bottom corner of the screen, with the FOSC wheels menus and one button. This window is used to move the three wheels of the FOSC and in fact it is interfaced from the Camera and FOSC controller PC to the "FOSC Mover PC" (see section 2.5). This window can be also invoked from the "CCD progs" icon which is in the "Program manager" window.

When the FOSC is set and stationary the current positions of the three wheels are indicated at the top of each of the three wheel button groups and by the position of the highlighted button in each group. These positions should correspond to those indicated on the FOSC computer in the dome.

To move the FOSC wheels click the 'select' button and then click on the three menus for the positions you want. Black dots will appear near the positions you have clicked on. Then click on the "send" button. The computer will send the information to the "FOSC Mover PC". You may continue to work while the "FOSC Mover PC" will turn the wheels and the collimator will be moved to the right position according to the setup you have chosen. The wheel which is currently moving is indicated alongside the Send button and the time remaining for the motion of this wheel is indicated on the Send button. The Send button and all three wheel button groups are disabled whilst the FOSC is in motion. When the FOSC's wheel turning is complete all the controls are enabled and the current wheel positions are updated at the head of the three wheel groups.

The observer should monitor this window during the motion of the FOSC wheel's to ensure that all the wheels which ought to move do move. Should it be noticed that one of the wheels which ought to move does not move then when the indicator window reads READY the move wheels button in the FOSC mover should be pressed again reissuing the wheels selection command to the FOSC computer. The failure probably occurred because the FOSC computer misunderstood the first wheels selection command. The indicator window should now show motion of the wheels which previously failed to move.

If, as the result of an exposure, the wheels appear to be miscorrectly set, turn to the "FOSC Mover PC" (see section 2.5) and initialize the wheels positions according to the

instructions there If repeating initialization does not help try to turn off the FOSC, and the computers, and then turn them on again, it might solve your problems.

A motion of any wheel between two adjacent positions takes between 20 and 25 seconds. For example, if a motion of the filter wheel was selected, which involved moving 4 stages, it should take between 80 and 90 seconds. If the counter goes up to 100 and continues more likely than not the FOSC has failed. Take a look at the FOSC computer where it may be found that one of the numerical wheel position indicators is showing -1. This is the failure indication showing that the wheel position has not be read correctly. It is strongly suggested that the observer should throw up their hands in despair and abandon the FOSC for the current run. An alternative can be to proceed as described in sec 2.5.

2.2.6 File Transfer to the Sun Using FTP

In the Sun workstation the images are kept in the /home/wise10/mizpe/ccd/ directory in subdirectories named in the Japanese format date of yymmdd (where yy is the year number, mm is the month number, and dd is the day number, e.g., July 20 1991 is 910720). This way the list of sub-directories runs sequentially from earlier to later dates. There should be a directory named for the date of the files that have just been observed. If there is not such a directory create it.

There are two methods available for transferring your images from the PC to the Sun workstation. Both use ftp protocol.

1. DOS FTP Running Under Windows

The old and tried method for file transfer is the DOS ftp running under windows. This program is invoked from the "CCD progs" in the "Program manager" window:
Double click on the Program Manager icon on the windows' desktop.
Double click on the CCD Progs program group icon.
Double click on the FTP paper dart program icon.

When the ftp window comes up it prompts you for username and password. Your dialog with the PC should look like this:

```
FTP - Copyright <c> 1992,Novell, Inc.
220 wise10 FTP server <SunOS 4.1> ready.
Remote UserName: mizpe  <cr>
Remote Password: wise <cr>    (!!the word ''wise'' won't appear on screen)
ftp> cd ccd <cr>
ftp> mkdir yymmdd <cr>  (!!where yymmdd is your date of observation)
```

```
ftp> cd yymmdd <cr>
ftp> binary <cr>
ftp> prompt <cr>
DO not prompt for multiple commands.
ftp> verbose <cr>
Show FTP server's responses.
ftp>
```

The above insures that the files you'll transfer will be in the:
/home/wise10/mizpe/ccd/yymmdd directory on the Sun (where yy is the year number, mm is the month number, and dd is the day number). Note that when transferring FITS format files it has to be in the binary mode.

During the run minimize the "ftp" window into icon. Restore it whenever you want to transfer the images.

In order to transfer images one uses the command:

```
ftp> mput filenames <cr>
```

The images' file names are composed from the date of the observation and a running number. If the date is 11th April 1994 then the images name will be 11apr94.nnn , where nnn is 001, 002, 003, etc. In order to transfer all files the command is: mput 11apr94.* <cr>. In order to transfer them in groups of tens the command for the first group is: mput 11apr94.00* <cr>. For the second group: mput 11apr94.01* <cr>. For the third group 11apr94.02* <cr>. etc.

It is advisable to transfer them during an exposure in groups of tens since it will save time at the end of the run (i.e. in the morning). To transfer 10 images of 1024×1024 you need about 3 min. To transfer 10 images of 1024×200 you need about 0.5 min. Note that you need to have a long enough exposure, to allow ftp to end transferring the files before the exposure will end, otherwise an exposure may be lost. Always finish transferring and minimize the "ftp" window to an icon before the exposure will end.

When files are transfered one can monitor the screen to see which files are transferred and if they are transfered in a binary mode. If not then the files have to be transferred again after writing the binary command.

The last file to be transfer in the morning is the file date.lis (e.g. 11apr94.lis) which is an automatically generated observation log. It contain a list of all the images files created in the night and a description line on each image (the comment line from the image header, see section 3.1).

After transferring all files it is VITAL to check that all files were transfered OK. This can be done using the command dir in the ftp window:

```
ftp> dir <cr>
```

This will list all the files that were transfered with their sizes. All sizes of images with same CCD area have to be the same. If the sizes different from one another it means that the files were corrupted during the transfer. Usually this happens when files are not transferred in binary mode - so one have to write the binary command again and transfer the files once again and recheck their sizes until everything looks fine.

```
ftp> bye <cr>
```

closes the ftp connection, and the window will disappear.

Another check can be by logging into wise10, going to the directory where the files are and executing the command:

```
wise10% ls -l dd*.* <cr>
```

where dd is the date of the current day. This will list all files with their sizes that have to be the same for all images with the same CCD area. An extra check is the command:

```
wise10% ls dd*.* | wc  <cr>
```

where dd is the date of the current day. This will count the files in the current directory and will report them. One need to check if the number of files correspond to the number of images observed that night + the *.lis file.

2. Rapid Filer

The Rapid Filer icon appears in the "CCD progs" in the "Program manager" window. Double clicking on this icon brings up a the program window and it is logging into the sun - wise10 to the ccd directory.

In the upper window (the Sun) click on Create Directory. Type in the directory name you need in the form yymmdd (where yy is the year number, mm is the month number, and dd is the day number, e.g., January 1 2000 is 000101) and press the Create button. Then click on the directory you just created to enter it.

Click in the lower file box to bring this section of Rapid Filer into focus. Click on the first file of the group of files you wish to transfer. Hold down the Shift key and click on the last file of the group of files you wish to transfer. The group of files to be transferred is now highlighted in black. Click on the Copy button to proceed with the transfer of the selected group of files.

When transfer is complete it is VITAL to check that all files were transfered OK. This can be done bye clicking in the upper file box to bring this section of Rapid Filer into focus.

Click on the first file of the group. Hold down the Shift key and click on the last file of the group. The group of files is now highlighted in black. Now click on the Info button on the right side. This will open a window with information about the files including their sizes. All sizes of images with same CCD area have to be the same. If the sizes different from one another it means that the files were corrupted during the transfer. Usually this happens when files are not transferred in binary mode - so one have to make sure the binary mode is on and transfer the files once again and recheck their sizes until everything looks fine.

Close Rapid Filer from Exit on its File menu or by the Close entry on the menu brought down by clicking on the top left button of its window.

The Rapid Filer setup is arranged to ease the job of file transfer. it transfer the files in binary mode and opens up in the right directories.

However, if more images are observed after the program is running one need to select "Refresh File List" to update the screen with the new files.

2.2.7 Norton Commander Window

In order to see the images files and to keep track of files on the computer's disk you can use the "Norton commander". This window is invoked from the "CCD progs" group in the "Program manager". The icon is called "nc".

The Norton commander window will come up. It usually comes up already in the c:\PMIS\IMAGES\ directory where you have the recorded images from the TEK CCD. If the Norton commander didn't come up in this directory then move there. If you find there images from previous nights you should delete them (by pointing to them with the cursor and hitting F8 for delete) so that you'll have enough disk space for your images. Also if there are any images from the date you are working on (because Peter ran some tests during the day), you should delete them and also the list file (date.lis), in order to get your log properly made and numbered. When finished minimize the "nc" window into icon.

Remember that when you'll restore this icon it will be exactly as you left it, so don't be alarmed if you don't find there files which you have written to the disk. In order to get the nc updated you need to go one directory up and then back to the images directory.

2.2.8 Temperature Window

This window warns you when the temperature of the CCD begins to go high. It is opened when PMIS is initializing. It can also be invoked from the "CCD progs" group in the "Program manager". When the CCD temperature is around -90 degrees this window indicates "OK". When the CCD temperature is increasing the window indicates "FILL" and a warning message appears on the screen. Clear the message and fill the CCD dewar with LN2.

Once the temperature is decreased again the window will indicate "OK".

2.2.9 Visual Finding Charts

A facility for displaying a visual finding chart alongside the CCD's display window is now available. It is particularly useful for locating objects when centering an image, for checking the telescope's ccd field after positioning, and for the final precise setting of an object into the FOSC's slit.

First you need to prepare JPEG format finding chart files (e.g., ones which were created by the dss script of IRAF at TAU, or by using the Image Magic program to convert the standard astronomical FITS format files into highly compressed JPEG format). Then these files need to be transferred to the observatory, either by ftp using the modem (with the help of the observatory staff), or by writing them to diskette and bringing it to the observatory.

The JPEG files are to be stored on the c: drive of the computer in a directory called findstar. It is suggested that observers place their JPEG finding chart files in a subdirectory of the findstar directory. It is the responsibility of each observer to name this subdirectory and to name and maintain their finding chart files in it. If there are a large number of finding charts a numbered list starting with 001.jpg is a convenient method of maintaining an ordered list of files in the subdirectory. Moreover if these numbers correspond to a person's setting and observing lists a simple order for a whole series of observations can be arranged.

The programme for viewing the finding charts on the CCD control computer is to be found in the CCD progs window. To operate the viewer double click on the icon called "FindStar Editor". From the "File" menu choose "Open". This opens a 'file manager' in the c:\findstar directory. Entering the subdirectory where your images are brings up a list of *.jpg finding chart files. Clicking twice on a file name brings up the image in a display window within the Viewer window.

The display may be maximized in the window by hitting the appropriate button in the top right hand corner of the star chart display window. Then adjust the Viewer window to the size of the finding chart and place it in the lower right side of the screen.

You can close the star chart display window before bringing up the next finding chart, by double clicking on the left hand button of the display window, or by choosing "Close" from the "File" menu. Minimize the viewer window after the object has been positioned.

It may be necessary to click in the ccd image window after a ccd observation is made in order for the ccd image to be seen in its window when the finding chart is also displayed.

The ccd display status window can be hidden in order to see both displays side by side. Select the "Display" menu and "Hide status". Select the "Display" menu and "Show status" to restore the display status window.

Sometimes the images have to be rotated. It is suggested that the programme photostyler be used. Usually The size of the finding charts is 350×350 pixels. Read in the image. Zoom in on the object and the comparison star. Use the cursor to find the xy pixel locations of the object and the comparison star. Find the angle by which the image must be rotated either clockwise or counter clockwise. Perform the rotation. Select image cropping and enter a cropped area of 350 by 350 pixels. Select resampling to 350 by 350. Crop the image. Save the image. By this means both the original finding charts and the rotated finding charts occupy the same display window on the CCD control computer.

2.2.10 Miscellaneous Windows

In the "CCD progs" window of the file manager there are several more windows which can help the observation:

1. Sidereal Clock - Which gives the computer time, Universal time, and date, once you press its button to scroll between them.

2. Area Observation - A special program that allow the observer to move through an area of observation on the sky. Once the telescope is positioned right in the middle of a field it enables to move to a next field right next to the original field and so on in order to cover an area of observation that is 9 times larger then the area the CCD is capable to.

3. Wise Observatory - This window indicate the time taken from the GPS. Once the GPS is disabled in this window it shows the observatory coordinates on earth.

4. Telescope coordinates - Shows the RA and Dec that the telescope is pointing to. By clicking on its button it shows the HA and Dec.

5. Calculator - A calculator for doing arithmetics.

6. Telescope buttons - is used to move the telescope by pressing the buttons in the computer - this allows to manually point to a coordinate without using actual buttons on the console.

7. Set PC with GPS - Set the time of the PC to the GPS's one.

2.3 Telescope Control Computer

The telescope control computer is used for running several programs which serve the telescope. The programs work on windows environment and one can switch from one program to the other by pressing simultaneously the <ctrl>+<esc> button. This brings up a menu and one can choose the program he wants from the menu. When to computer is booted it comes up with the two program that are used:
Settings - the program to move the telescope.

Guider - the program for autoguiding the telescope.

Those programs can be invoked one at a time and they'll continue at the stage they were left earlier.

If one of the programs is accidently exited, one can start the program again from the "Program Manager" in the icon "telescope".

To have the autoguider work properly, its power switch (on the telescope) needs to be turned on prior to switching on the telescope control computer.

The Norton Commander program can be invoked in this computer from the "Program Manager" in the icon "telescope"

To transfer data to this computer one can use the ftp program. In order to operate ftp one needs to exit the Guider program. Then to execute ftp one needs to be in the C:\dosftp\ directory. This can be done by choosing from the "Program Manager" the /File/Run option then on the window that appearing choose 'Browse' and then to choose C:\dosftp\ and then ftp, or the shortcut of sun.bat or loral.bat.

2.3.1 Settings

The setting coordinates program controls the direction of the telescope and sets its position towards coordinates in the sky, using optical encoders on both axes and suitable A/D converters. Also, the telescope can be moved using the arrows keys of the key board. The current telescope direction (with an accuracy of $\sim 10''$) and information, that appears on screen, consists of:

Right Ascension
Declination
Hour Angle
sidereal time
Universal time
Air mass

...and... Dome position corresponding to telescope position on right-bottom corner of the screen.

This program operates in two modes, that are toggled using the Alt<t> key stroke:

1. Right Ascension tracking OFF

This mode should be active when the Right Ascension tracking of the telescope is off. The operations available in this mode are:

Key stroke	Operation
h	Move telescope to an hour angle
d	Move telescope to a declination
u	Get Universal Time from the GPS
l	Load a list of objects' coordinates
Alt<p>	Moves telescope to park (upright) position
Alt<o>	Sets telescope to dome flat-field position
Alt<c>	Positions the telescope to remove the cover (horizontal)
Alt<x>	Exit the setting program

Alt<o> sets the telescope to HA= 1^h36^mE, DEC= $+42°$. In that position the dome's screen should be positioned in front of the telescope by rotating the dome so that the marks on its rail will be in front of the dome's staircase. In that position dome flat-field are taken.

2. Right Ascension tracking ON

This mode should be active when the Right Ascension tracking of the telescope is on. The operations available in this mode are:

Key stroke	Operation
c	Move telescope to a bright star for coordinates calibration
l	Move telescope to a star from a list
s	Move telescope to a certain coordinate
u	Get Universal Time from the GPS
m	Toggle the Dome Mover/Follower on/off
Alt<r>	Enable/register right ascension correction
Alt<d>	Enable/register declination correction

In this mode whenever the telescope is sent to a position, first the program sends instructions to the Dome Mover PC (see section 2.4) to move the dome to the final telescope position and then it moves the telescope. This enables moving the dome and the telescope at the same time. After the telescope is positioned the observer can press "m" so that periodically the computer will send instructions to the Dome Mover PC so that the dome will follow the tracking-telescope automatically. There is an indication on the right-bottom corner of the setting screen of the dome status: "Dome Off" means that the dome is NOT following the telescope, "Dome On" means that the dome IS following the telescope.

When using the "c" option the program will choose a suitable bright star from its list and will present the coordinate on screen. You need to confirm its choice by pressing <cr>. The telescope will move to the bright star. Use "iacquire" to see the bright star and then the "imove" to position it in the center of the CCD. When done, press Alt<c> on the telescope control computer. Next you'll be asked whether to register the corrections, answering Shift<R> (capital R) will register the corrections, any other key will terminate the calibration program.

An alternative (older) way is to calibrate the telescope according to a bright star from

the almanac. If the coordinates on screen needs to be re-calibrated then: Alt<r>/Alt<d> enable adjustment of the RA/Dec display using the <+> and <–> keys on the right keypad. A second Alt<r>/Alt<d> is needed to register the new adjustments.

When using the "s" option you do not need to precess your coordinates, just enter coordinates and their epoch – the program will precess them for the current date and set the telescope automatically.

An alternative way to point the telescope to an object is by using the "l" option. One needs to prepare a list of one's objects in a five columns format: running number (starting with one, and with no gaps between numbers), Right ascension, Declination, epoch, and object name. For example:

```
1   0:07:59.40   17:07:38.00  1950.0  PKS0008+171
2   0:14:04.10   81:18:28.00  1950.0  S50014+81
3   0:52:11.10   25:09:24.00  1950.0  PG0052+252
4   0:56:31.80   -0:09:18.00  1950.0  PHL923
5   1:12:43.90   -1:42:56.00  1950.0  PKS0112-017
```

(Note: no blank rows are allowed, and no <cr> at the end of the file.) This list must be placed in the C:\misc\ directory of the telescope control computer, and must named with the extension: .lst . When starting to work, load the list using the "l" option in the "Right Ascension tracking OFF" mode (just enter the file name without the .lst extension). When you want to point to a star use the "l" option in the "Right Ascension tracking ON" mode, and just put in the object number in the list followed by <cr>.

All numbers entries in this mode should be done from the number key-pad on the right side of the key board.

NOTE: *Moving the telescope automatically is very risky since the telescope can run very easily into the platform. Always make sure that the platform is not in the way prior to moving the telescope. If for any reason you want* **to stop the telescope – press <ESC> few times**.

CAUTION: *Do not move the telescope from the setting computer while moving it from the camera computer or from the console buttons. This will severely damage the telescope.*

2.3.2 Automatic Guider

The automatic guider program is used to guide the telescope on long exposures. The auto-guider is an ST-7 CCD camera (from Santa Barbara Instruments Group — SBIG) and is operated via CCDOPS software (provided by SBIG). It is mounted on the periscope of the

offset guider. This provides automatic guiding of observations acquired at f/7. This option has not been implemented for observations at f/13.5.

The image is directed from the telescope using a 45° mirror through a lens (35 mm, focal length of 9 cm) to the CCD. The CCD is connected to the periscope by a motorized focuser which enable quick and accurate focusing of the guide star on the CCD. The ST-7 is a rectangular CCD of 765×510 pixel with each pixel is a square of 9×9 micron. With the current setup this gives a plate scale of 0.474±0.011 ″/pixel and hence a field of 6′×4′. The ST-7 current operating mode is binned×2 with a pixel size of 0.948″ on the actual images.

A ring connected to the periscope which is divided into 360° enables quick positioning of the CCD when rotating the instrument on the telescope. One just needs to make sure that the mark on the periscope will point to the angle on the ring that is the same as the angle of the rotator. In order to rotate the periscope one needs to loss the brass screw on the side of the periscope.

When using the camera and the rotator angle is 71° the two marks on the periscope on either side of the ring should coincide and with the telescope upright the wires of the ST-7 should point south – any other direction will mess up the guiding (with the FOSC is on the telescope and the angle is 173° the wires should point upright).

Running the ST-7

There are a lot of options in the software however only the following need be considered by the Wise Observatory Observer.

Switching on the camera: The program will only work if the camera has been switched on. The switch is in the power cable of the camera power supply. It is to be found quite close to the camera. Once the camera is on the programme will automatically connect to it.

IMPORTANT: Temperature regulation should be switched off BEFORE the camera is switched off.

Temperature Regulation and Switching off the camera: The Temperature regulation must be switched on after the camera has been switched on. This is done by choosing Camera from the program menu and then Setup. There one needs to set the "Temperature Regulation" to "Active" and by pressing Enter the cooling start.

To switch off the temperature regulation enter the Camera menu and choose setup, then set "Temperature Regulation" to "off" and press enter. Wait to see the cooling regulator display drop to zero percent (this is to be seen in the lower left of the ST-7 programme screen). Now chose "sHutdown" from the Camera menu and "eXit" from the file menu. after this the power switch in the camera power supply power cable may be switched off.

Focusing: Having focused the main CCD and decided upon a suitable mean focus value

for the night, set the telescope to this value and then go to the guider CCD focusing:
— Choose "Focus" from the Camera menu.
— Set the "Exposure time" to something between 1 and 5 seconds and "Frame size" should be set to Full.
— Start the focus sequence. The full image will be continuously refreshed this allows the observer to move the telescope about a bit to find a suitable star to focus on.
— Escape the focusing display and return to Camera - Focus.
— Select an exposure time suited to the selected star or stars and set the Frame size to Planet.
— Restart the focusing routine. This time it will stop after the first frame allowing the observer to select the part of the frame it is desired to focus on. Make a selection and continue the routine.
— The focus motor button power box must be plugged in and the focus can now be accurately and carefully set. Please unplug the box after you have set the focus. Do not leave it draping on its cable from the plug.

Guiding: When the telescope is positioned to a field and the ST-7 is rotated to the right angle as the rotator and everything is ready for guiding:
— Choose "Track and accumulate" from the "Track" menu.
— Enter the Declination value (which the telescope is pointing at) in degrees between zero and seventy. A positive value should also be entered for southern declinations. The "Snapshot time" should be set to something around 40 seconds. Make sure that "Track mode" is set to "Relays".
— Pressing enter starts the procedure. The first time round the programme will take a dark frame followed by a tracking frame and display the image.
— Move the cursor onto one of the brighter stars in the field. The selected star should have a brightness value of a thousand or more.
— If there are no suitable stars in the field move the guiding head a little and try again.
— Once the cursor has been placed on a suitable star press enter to go to the guide menu and enter again to say that the star has been located.
— That is all there is to it now the observer is free to go and have a cup of coffee or any other desirable beverage.

Note that on the "Track and accumulate" mode tracking continues for 64 images only. Hence, choosing "Snapshot time" of 50 seconds will track for about an hour (when accounting the readout and displaying time).

Inspecting a field: It may sometimes be quicker to use Camera - Grab which can be set for a 1 second exposure without a dark frame. However, it is to be born in mind that Track

followed by track and accumulate will then take an additional 40 seconds to capture a new dark frame before it goes on to take the light frame. Hence, observers are advised to stick with Track and Track and accumulate and not to use Camera followed by Grab. Whatever way you leave the programme when you finish work is the way the next person will start it up.

2.4 Dome Mover PC

Another PC is dedicated for moving the dome. It is connected to a potentiometer mounted with a gear reduction head and a pressure wheel in contact with the rotation track of the dome (Fig. 2.2) which enables to encode the dome position.

After booting this PC, one needs to choose from the Norton Commander menu (pops up when hitting the F2 key) the program "Dome". On the screen will appear the current position of the dome and several options. One is <S>et, i.e., after pressing "s" the computer will move the dome to the position asked by the number entered. Another option is <Esc>. Pressing <Esc> when the dome in motion will stop the motion, Pressing <Esc> when the dome not moving will exit the program. For the other options see below (Hot keys).

If when moving the dome no motion of it is found in 10 seconds, i.e., the dome is stuck, then the program and the dome will halt, so please pay attention that the dome won't stuck and ruin your image.

Usually this PC is interfaced from the telescope control computer and the user doesn't need to bother with the dome mover PC except for starting the program at the beginning of the night.

Hot keys:

1.) Pressing <SpaceBar> when the dome is in motion will stop the motion and the dome will start moving to the opposite direction and then back again. This is useful when the motors of the dome are working but the dome is not moving since it slips on its wheels. Pressing <SpaceBar> in this situation will move the wheels to the opposite direction – which should make the dome to move and get out of its stuck situation – and then it will move back to the initial direction it wanted to move, and to the required position.

2.) Pressing <R>, <+> or <L>, <–> on the right key-pad will move the dome a little to the right/left without changing the numbers on the screen. This enables to enter some fine adjustment to the positioning table of the program. This should not be used unless the dome positioning relative to the telescope is really bad, and should be performed by an experienced user.

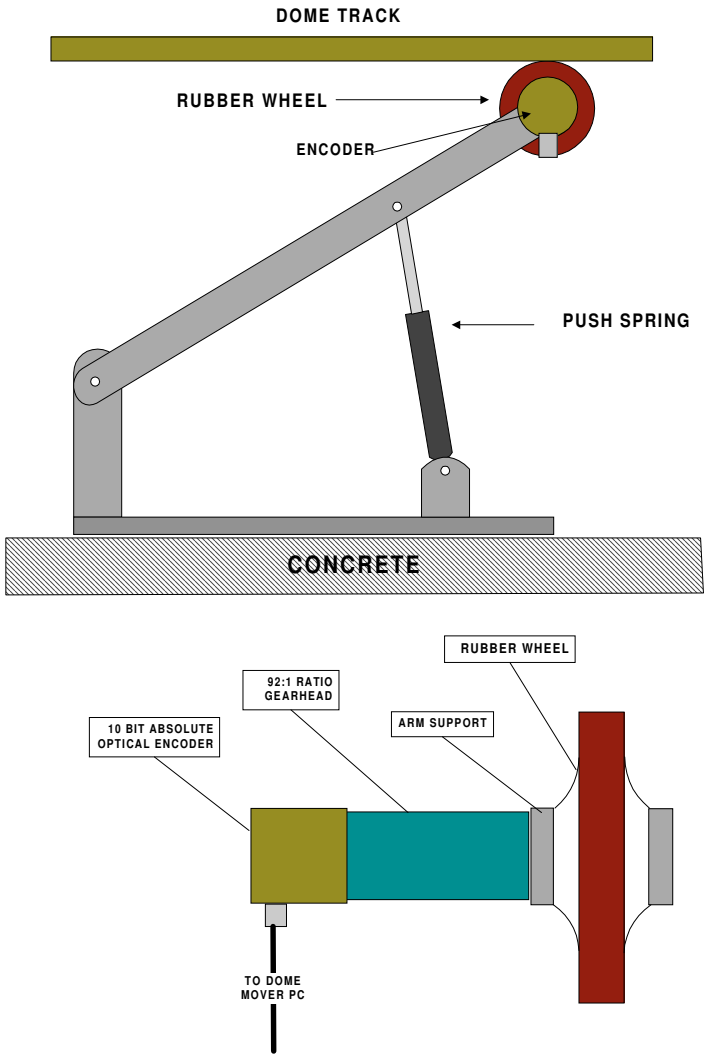

Figure 2.2: Mechanical wheel for dome positioning.

3.) Another way to calibrate the dome position is by pressing <C>. Before doing this turn off the relay box and then move the dome so its opening will be right in front of the telescope. At that position press <C> and you'll be asked for the dome position written on the setting screen of the telescope control computer (on the right-bottom corner). Entering this value will reset the dome computer for the position of the telescope. Don't forget to turn the relay box on again after the above action was done.

4.) The <O> key toggles the sound of this PC between the OFF and ON modes.

2.5 FOSC Mover PC

A PC is dedicated for moving the FOSC wheels and collimator. After booting one need to choose from the Norton Commander menu (pops up when hitting the F2 key) the program "FOSC". This will result with a three column menu corresponding to the FOSC's three

wheels. Also, it reports the last positions where the FOSC was left. After booting, the computer is zeroing the FOSC collimator. Then the user needs to initialize the wheels positions. This is done by putting "i" as an entry in the position number prompt, and pressing <cr>. This should be done for each of the three wheels.

In fact this PC is interfaced from the Camera and FOSC controller PC through the "FOSC Control window" (section 2.2.5) and the user does not need to deal with that PC except for turning it on at the beginning of the night and initializing the wheels positions. Advanced users might want to use it for its special abilities described below, however they should **note** that if the wheels are not moved from the "FOSC Control window" then the key words in the image's FITS-header referring to the wheels positions, will be incorrect.

For advanced users:

To move the wheels, enter a desired wheel position-number. Use the Left/Right arrows to move between wheels menus. After specifying all positions you want, press <cr>. The program will move the wheels one by one, position the collimator for the setup been asked, and will report when ready.

There are four hot-keys to ease the work of obtaining spectra:

Hot key	Wheel		
	Aperture	Upper	Lower
Alt-n	none	none	none
Alt-g	none	Wedge3	600 grism
Alt-a	Aperture last used	none	none
Alt-s	Aperture last used	Wedge3	600 grism

To initialize (check) a wheel position put "i" instead of a position number as an entry, and press <cr>.

To leave the wheels program, into the Norton commander, press Alt-x and then "x" to confirm your request. To operate the wheels program again, choose it from the Norton commander menu – "F2" key.

For more advanced users:

To change the collimator position, press "c" and then the desired collimator position (ranges from 0 to 540 in multiples of 10) and <cr>. Another <cr> will return the collimator position to the one corresponding to the wheels setup. To zero the collimator enter "i" instead of a position number.

By using the lampobs, arcon, and foccam macros, and moving the collimator, one can find the best collimator position for his setup. To make a collimator position the default for the system there is need to edit the file c:\misc\foscfile . This file consist of four columns: (1) capital letter describing the wheel (A - Aperture, U - Upper, L - lower), (2) number of

wheel position (0 – 9), (3) information number, and (4) position name. The information number in the aperture wheel rows is the wheel offset when positioning it. The information number in the upper wheel rows is the default collimator position when this row is chosen and this number should be edited to make another default. Default collimator positions for some setups are:

Table 2.1: FOSC collimator position

FOSC Wheel			Camera	collimator-
Aperture	Upper	Lower	wheel	position
10″ slitR	Wedge3	600 grism	none	530
5″ slit	Wedge3	600 grism	none	530
none	R filter	none	Clear	400
none	Fos/none	none	Clear	470
none	Cam/none	none	U filter	0
none	Cam/none	none	B filter	300
none	Cam/none	none	V filter	380
none	Cam/none	none	R filter	320
none	Cam/none	none	I-old filter	100
none	Cam/none	none	I-new filter	200

2.6 Library PC

This PC is in the library room and is used for archiving observations from the Wise Observatory on CD-ROMs (instead of DAT tapes as was in the past).

For this purpose the observer should transfer the images at the end of the night to the Sun workstation (see section 2.2.6). Once there, they should be left there until it is removed by the undaunted Wise Observatory staff.

After transferring to the Sun, the observer need to transfer the images on from the Sun to the library PC. The files are kept in the library PC in the D:\CCD\ directory in subdirectories named named in the Japanese format date of yymmdd (where yy is the year number, mm is the month number, and dd is the day number, e.g., December 31 1999 is 991231). This way the list of sub-directories runs sequentially from earlier to later dates. There should be a directory named for the date of the files that have just been observed. If there is not such a directory create it. Within the Norton Commander this can be done using the F7 function key as indicated on the bottom line of the Norton Commander display.

This procedure of transferring the files, by ftp, is similar to that used from the 'Camera and FOSC controller' PC to the Sun but here one uses an interactive window to do this:
— Go to the library PC and turn it on. It will boot up into Norton Commander which need

to be quit by pressing F10, then the computer will continue to the WINDOWS-95 workspace.
— Choose the "FTP SUN" icon from the workspace by clicking twice on it. An WS_FTP window will be opened and on it a "Session Profile" sub-window.
— From the "Profile Name" button menu choose "_wise10" and click on the "OK" button. A connection will be established to the Sun.
— On the left side of the WS_FTP window it displays the contest of the D:\ccd directory in the local system - the library PC (directories on the upper window and files in the lower window). Use the "MkDir" button to crate a directory correspond to your date (yymmdd).
— Change to the directory you have just created by clicking on it twice.
— On the right side of the window it displays the contest of the /home/wise10/mizpe/ccd/ directory in the remote system - the SUN workstation wise10 (directories on the upper window and files in the lower window).
— Change into the directory that correspond to your date by clicking on it twice (yymmdd).
— Mark the files to be transferred by pressing the left mouse button on the first one and dragging the mouse up to the last file (the yymmdd.lis file).
— Make sure the binary transfer mode is marked (with a black dot) in the bottom of the WS_FTP window.
— Press the button in the middle of the WS_FTP window marked as "<−" to transffer the files from the remote system to the local system.
— Check that the files were transferred correctly. The simple check is to check that their sizes are identical to their original sizes on the Dome PC (the camera controller PC). This can be done by using the "DirInfo" bottun within the ftp window or by using the Norton Commander on both PCs (which their screens are right next to one another in the library). If some of the sizes are different then something was wrong during the transfer and the procedure of transferring should be repeated. If all files were transferred well, then they can be deleted from the Dome PC. One can also check that the number of images is the same in both computers using the option of info in the Norton Commander. — When done, exit the WS_FTP window by clicking on the "Exit" botton on the bottum-right corner of the window.

IMPORTANT: Before switching off the library-PC one needs to exit from Windows-95. This is done by clicking on the Start button, then clicking on Shut Down, and clicking on Yes. Turn off the computer when the message on the screen indicates you may do so.

This finishes the work of the observer (unless one wants to take a copy of the data on a DAT tape, then proceed as described in section 2.1.1).

The above procedure ensures that two copies of the data are kept (one on the Sun disk and one on the library PC disk) until a permanent backup is done on CD-ROMs. In order

not to delete files from the Sun it is vital that NO observer will do the 'cleanup'. The Observatory staff will clear those disks once the relevant CD-ROMs have been created.

When enough files have been accumulated on the library PC 2 CD-ROMs will be prepared by the Observatory staff. One will be retained at the Wise Observatory as a backup and the other will be sent to the University where observers can have immediate access to their files using the CD jukebox reader or any other CD-ROM reader attached to a PC or a workstation.

If observers wish to continue collecting data on DAT tapes they may do so. They will be obliged to bring their own DAT tapes. No DAT tapes will be kept at the observatory.

2.6.1 Recent Weather Map

A recent weather map can be downloaded to the library pc. The method is as follows:
— Open the modem directory on the desktop.
— Start TCP manager.
— On the Dialer menu double click on Login.
— After a connection is made and an address is assigned start Netscape Navigator on the Bookmarks menu call up CNN-satellite image for Middle East. If all goes well a recent weather map should appear.
— Place the mouse cursor within the image and click the right hand mouse button. A menu will appear, select save image. Save the image to the 'desktop' overwriting an existing image if necessary.
— Close Netscape.
— Return to Trumpet winsock and the Dialer menu click on Bye.
— Only when you have done so is the telephone line connection to the university closed.
— Double click on the mideast image on the desktop and you can take a close look at the cloud cover as seen from the satellite.

2.7 More About the Computers

Reading these is optional. Try it on a dark rainy night. It refers to Fig. 2.3

SWITCHS POSITIONS and SWITCHING EVERYTHING OFF

The following pieces of equipment should have been switched off.

The console: There are two switches. The key switch should be locked in and the lower bar on the two bar switch beside it should be pressed in.

The electrical box: It is in the large room beneath the telescope. There are four main circuit breakers in the upper left of the cabinet. The one on the left hand side should be up

on. The other three should be down off.

The autoguider: It is mounted beneath the telescope. The switch is on the cord of the power supply box.

The Photometrics CCD box: It is mounted beside the camera beneath the telescope. Its switch is on the back of the box. When the box is off there should be no lights and no temperature indication.

The filter wheel power supply: There is a black power switch in its power cable. When it is off the indicator lamp on the motor drive box should be off and the motor should be free to move.

All four computers in the dome control room are now powered through a trip switch box behind the door under the light switches. Also both the relay box behind the 'console' and the control screens and keyboards in the library are powered from this switch box.

The box may be used to switch on all the computers and the library controls together. The relay box behind the 'console' should only be switched on when the dome control programme is up and running.

When switching off the relay box behind the console should be switched off first. Then all running programmes on the computers should be shut down and finally all of them may be switched off together.

The FOSC control computer need only be switched on when the FOSC is in use. The PMIS FOSC programme on the CCD TEK computer should be fully initialized before the FOSC control box is switched on. This will ensure that the FOSC lamps are not inadvertently left on. The FOSC control programme on the FOSC computer should be started after the FOSC control box has been switched on.

In view of the above the following 5 items are not much relevant any more:

The camera and FOSC computer: The on off switch of the camera and FOSC computer is the lower round push button on its front panel. The indicator lamps on this computer should be off.

The telescope control computer: The on off switch of the telescope control computer is a square push button in the front of the computer. The indicator lamps on this computer should be off.

The dome mover computer: The on off switch of the dome mover computer is a rectangular push button in front of the computer. The indicator lamps on this computer should be off.

The FOSC mover computer: The on off switch of the FOSC mover computer is a square push button in the front of the computer. The indicator lamps on this computer should be off.

The relay box: The on off switch of the relay box is an up down switch towards the back on the right hand side. It should be down. Please note there are no indicator lamps on this box. The box is near the console on the platform.

EXTRA INFORMATION

Console relays: There is a hidden set of relays in the console. These relays are off when the console is off. Computer controlled relays: The relay box is connected to the dome and these relays are controlled by the dome mover computer. The relay box is connected to the four setting buttons. These relays are controlled by the camera and FOSC controller computer employed by the MOVEIT macro used for precise star positioning. The hidden console relays are connected to the five setting and slewing console buttons. These relays are controlled by the telescope control computer. The four setting guiding relays are connected to the autoguider box. The switch on the guider control should be set to guide. These relays are controlled by the telescope control computer through the autoguider box.

There is one basic rule. Any computer which controls relays should be switched on and booted up before those relays are powered. Hence:
The telescope control computer should be switched on and booted up before the console and telescope and before the autoguider box.
The dome mover computer should be switched on and booted up before the relay box is switched on.
The camera and FOSC computer should be switched on and booted up before the relay box is switched on.

Dome Mover: Thus switch on the Dome Mover computer and see that it is booted up. The dome mover programme need not be running but the Norton menu should be showing on the screen.

Setting and Guiding: Now switch on the telescope control computer and see that it is booted up. Enter the GUIDER programme. Turn on the AutoGuider box. Return to the guider computer hit a key to continue, bring down the Camera menu either by using the arrow keys and enter or by pressing C. Go to Establish ComLink. Once again either use the arrow keys and enter or press E. The following message should appear after about 5 seconds in the Status box in the lower half of the screen Communicating with camera at 57600 baud.

The autoguider is now ready to work but consult the Wise Observatory manual regarding its full setup procedure.

The Telescope and the Dome: Since the telescope control computer has been switched on, the console key switch may now be put on by releasing it so that it comes out, and the upper bar of the switch beside the keyswitch may be pushed in. The console should now be on. Descend to the electrical box in the large room beneath the telescope and push up

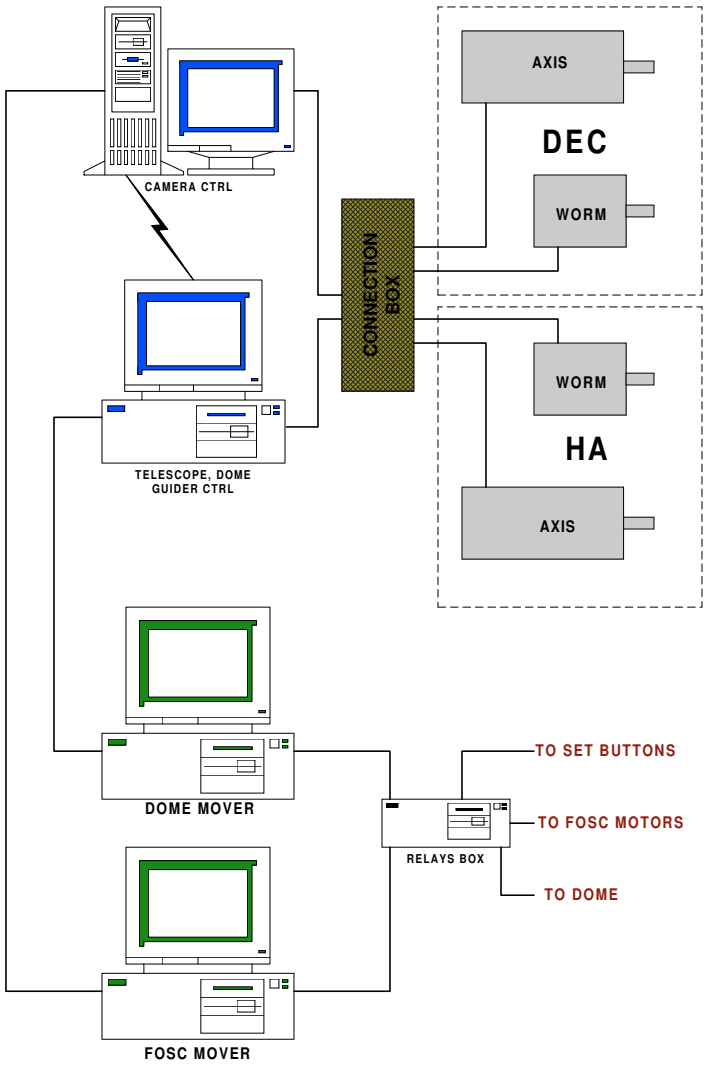

Figure 2.3: Computers and relays connections.

the three circuit breakers which are off in the upper left of the electrical box (CB2, CB3, CB4). Try from right to left. The first two will go on without any difficulty. Engage the third breaker slowly. There will be a big clunk from several heavy duty relays at which point it may disengage along with one of the other circuit breakers. It is sometimes necessary to press the RESET button on the lower right of the console before attempting to push up the three circuit breakers. All four circuit breakers must be up before the telescope will work.

Camera computer: Now turn on the camera and FOSC computer. Wait for it to boot up. It is better not to turn this computer on until after 16:30 Israel Standard Time.

Computer clocks and the GPS: Incidentally, nobody does this, but it is worth watching the boot process of both the camera amd FOSC computer and the telescope control computer. Both computers should have their internal clocks set to the GPS UT clock transmitted from the black box on the right hand wall in the library.

This may fail for one of two reasons: The GPS box is not connected to the dome. The

dome library rotary switch should be set to dome. The GPS box is off. If it is off the green monitor lamp on the top of the GPS will be off. This can happen either due to an electrical surge or due to an electrical failure. Its switch is on the bottom of the box. It is a three position slide switch. It should currently be in the central position which is the on position even if the GPS green lamp is off. Push it to the left which is the off position. Wait 10 seconds. This is important since there is a solid state antisurge relay in the GPS which requires this time to reset. Now switch it back on by sliding it to the right to its central position. The red light will come on first then together with the yellow. The red light goes out and the yellow light flashes once. The yellow light is finally succeeded by the solid green light after a couple of minutes.

The signal from the GPS goes to the rotary switch through a blue connector box located near the rotary switch (on the library printer stand). The "power" red light of this box should be on and the box should be plugged to the electricity, otherwise, the GPS signal won't get through to the PCs.

The telescope control computer and the camera and FOSC control computer should both be booted when the green light is showing and the rotary switch in the library is set to dome. Failure to set the telescope control computer clock to the GPS may result in poor setting since the computer internal clock is far from being a perfect time piece. Failure to set the camera and FOSC computer clock to the GPS during its boot procedure can be more serious since the time and date registered in the camera files may be incorrect together with the sidereal time and the right ascension. Moreover the computer may collapse whilst attempting to write a file at some time during the night.

The relay box: Only when the dome mover computer and the camera and FOSC computer are up and running should the relay box be switched on.

Camera controller and filter wheel: The Photometrics camera controller and the filter wheel stepping motor controller may be turned on and off at any time without causing problems either with the operation of the telescope or the operation of the dome.

Problems with the telescope and dome: If the telescope fails to set and slew check that the console reset switch on the lower right is not glowing red. If it is, press it and reset the three main breakers downstairs.

If the telescope still fails to set and slew check that the right ascension and declination mesh pull rods are fully inserted. The right ascension mesh rod is on the left hand side of the telescope plinth. The declination mesh rod is a Tbar towards the top of the lower side of the telescope axis when the telescope is at zero hour angle.

If the telescope still fails to slew. Turn off the console. Turn off the three main breakers downstairs. Turn the console back on and turn the three main breakers back on. Try again.

Only now contact Sammy.

If the dome fails to rotate. It may be because it is stuck in which case the motors will be laboring in their attempt to turn it. It may be because one of the phases powering the motors has failed. In the first case try sending it to the right and then to the left in an attempt to unstick it. In the second case find your way to the observatory electrical and generator room. Check the barrage of trips. Turn the large rotary phase switches off and back on again. Generally this does the trick. Now and then one of the main fuses may have blown in which case Sammy is your only recourse.

Problems with the computers: If the telescope moves and the dome moves more often than not it is possible to get all the computers to function. Generally they fail because a connector has been knocked out. Check on the back that all the plugs seem to be plugged firmly in.

Sometimes the PC companions which link both the camera and the setting computers in the dome to the keyboards & consoles in the library may fail. These are powered by 9 volt battery type replacers plugged in beneath the table. Unplug and replug the 9 volt lead or leads which plug into the box or boxes between the displays in the library. These must be properly powered not only for the library end to work but also for the dome.

Chapter 3

The CCD

The CCD detector is a Tektronics 1024×1024 pixel CCD with pixel size (square section) of 24μm and it is used both by the camera and the FOSC. It is coated with METACHROME II which is used to increase the CCD sensitivity in blue-visible and ultraviolet wavelengths. It was purchase from Photometrics, Tucson Arizona, at the beginning of 1994. It is interfaced to a PC with an AT200 CCD camera system board supplied by Photometrics. Tests for Linearity, readout noise, gain, images tests and quantum efficiency were done by Photometrics in December 1993 and are reported in "The final test report" that was shipped with the CCD and is available at the Wise Observatory. The CCD dewar must be filled with liquid N_2 and the temperature control on its "control box" (see below) must be adjusted for its proper operation. The dewar filling tube is at its bottom and for filling it is connected by a rubber pipe of the lN_2 container. The dewar should be filled with low pressure from the container to insure that the dewar is really full. This is done by opening the container tap just a little bit so that the lN_2 pressure going out of it will be low. It takes about 3-5 minutes to fill the dewar when it is empty. When cooling the hot CCD it is advised to do it with the CCD power off so that the cooling will be much faster.

The operating temperature of the CCD is $\sim -90°$C, which is achieved by adjusting the temperature controller (a potentiometer) to the value of about 2.96. It is useful to know that the "control box" hanging near the CCD contains a temperature control for the CCD. Whenever the red LED is on, indicating *"HEATING"*, it means that there is enough lN_2 to cool the CCD and that the resistor mounted on the copper block which holds the CCD is powered. The positive temperature control is achieved by heating the copper block and the chip on it. If you see this LED going dim, or off altogether, after which the control box indicates *"COOLING"* by turning the green LED on, it is a sure sign that the lN_2 has evaporated. If the "control box" tells you that it is *COOLING* the CCD it means that you are working with a hot CCD. You'd better throw away the frames accumulated with the hot CCD and start again!

The potential well of the TEK CCD is deeper than the TI and the RCA CCDs (previously used in the Wise Observatory), and its dynamical range is wider. The full well capacity is 275 ke$^-$ and with Gain of 4.21 e$^-$/ADU this is converted to about 65320 ADUs in the CCD output to the computer. Due to technical problems with displaying the image in FITS format all DNs from the CCD are divided by two when read from the CCD. Hence the saturation level is 32767 ADUs and the Bias level is about 486 ADUs. At unity gain has a readout noise of 6.5 electrons=1.54 ADUs. At 4x gain the readout noise is 3 electrons=2.94 ADUs.

The QE of this chip peaks at 6500Å with a value of 0.80 and drops to 0.17 at 10000Å. In the blue, this is a very sensitive chip because of its special coating of METACHROME II by Photometrics, and the QE stays higher than 0.40 from 4500Å to 3200Å (table 3.1 and Fig. 3.1).

Table 3.1: TEK CCD quantum efficiency

nm	240	260	280	300	320	340	360	380	400	450	
QEccd	0.37	0.40	0.39	0.39	0.42	0.42	0.50	0.48	0.45	0.45	
nm	500	550	600	650	700	750	800	850	900	950	1000
QEccd	0.72	0.76	0.79	0.80	0.79	0.75	0.69	0.58	0.48	0.33	0.17

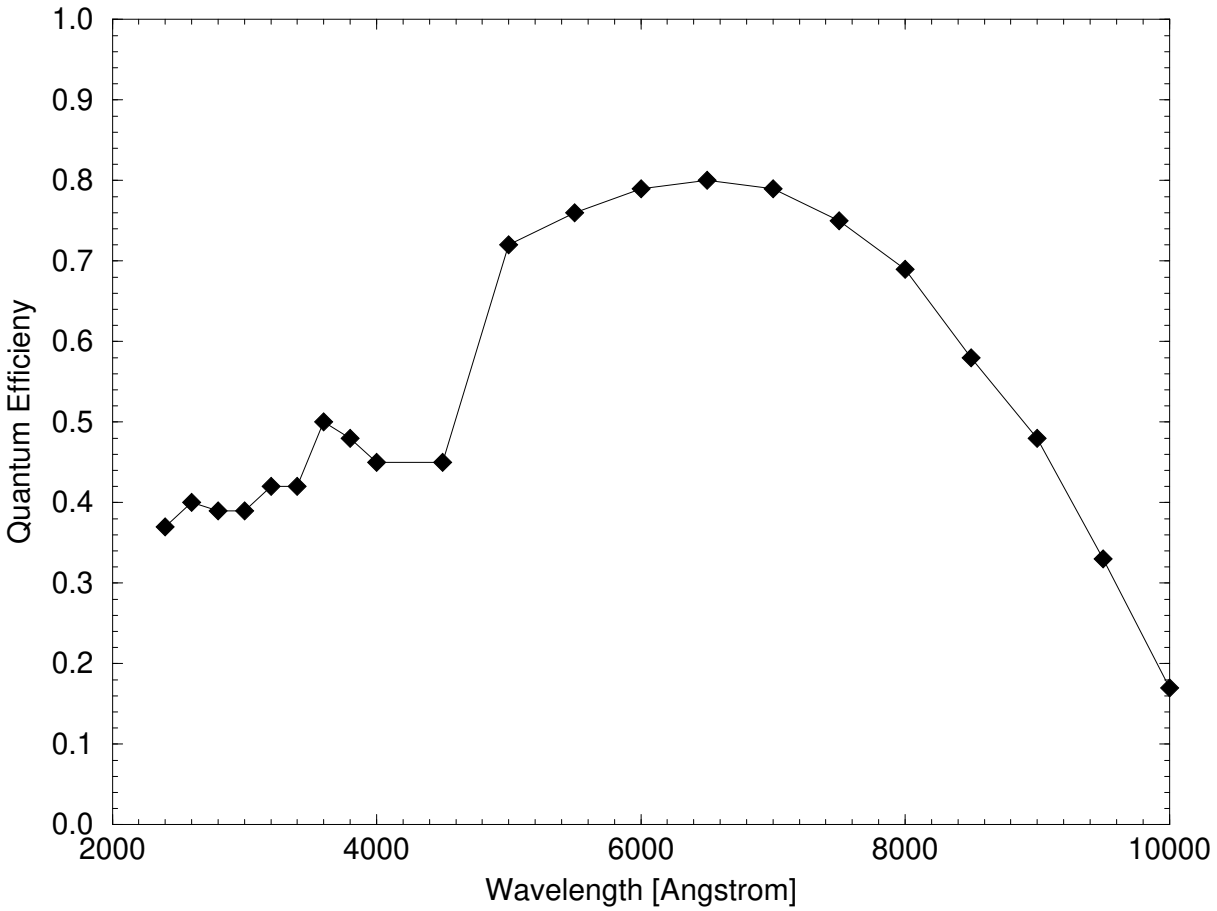

Figure 3.1: TEK CCD quantum efficiency.

The CCD is controlled by the camera and FOSC controller PC (see section 2.2)
NOTES:
— A misbehaviour of the CCD was observed when it was too cold, about -106 degrees. The bias at the was odd and showed oblique strikes. Such temperature occurs when cooling the CCD while the power of its control box is off, in order to get it cold faster. During the winter when the dome temperature is lower, it takes the ccd a longer time to stabilize.
— It was found that when read out is in progress one should not start operating any electric device in the dome (e.g., moving the dome, platform, telescope) since this is damaging the image being read. The observer should wait until the image is displayed on the screen before operating those devices.
—- The times it takes to read a specific image out of the CCD, to display it on the screen and to write it to the disk, are as specify in Table 3.2.

Table 3.2: CCD readout time

frame size	readout+display	write to disk
1024×1024	40 seconds	7 seconds
724×724	25 seconds	5 seconds
512×512	17 seconds	5 seconds

3.1 FITS Header

Images acquired with the CCD are written in FITS format onto the hard disk of the Camera and FOSC controller PC into the directory c:\pmis\images. The FITS header includes the following information:

```
SIMPLE  =                    T  / File conform to basic format?
BITPIX  =                   16  / Number of bits used for each pixel value
NAXIS   =                    2  / Number of Image Dimensions
NAXIS1  =                 1024  / Length of axis (fastest varying axis) columns
NAXIS2  =                  200  /     - " -  (second fastest varying axis) rows
DATATYPE= 'INTEGER'             / Type of data
OBSERVER= 'shai'                / Observer name
OBSERVAT= 'WISE'                / Data acquisition observatory
TELESCOP= '40 INCH'             / Data acquisition telescope
INSTRUM = 'fosc'                / Data acquisition instrument (FOSC,CAMERA,B&C)
INSTRUME= 'TK 1K'               / Sensor used to capture image (TI,RCA)
FILTERS = ' Wedge3'             / Filer used (V B R I etc.)
APERTURE= ' 10"SlitR'           / Aperture used (15"slit, CLEAR)
GRISM   = ' 600Grism'           / Grism used (600 grism, ClEAR, ECHELLE)
ROTNANGL=                104.80  / Rotating Angle of the instrument
SECPIX  =                  2.10  / Arc seconds of sky per pixel
OBJECT  = 'PG0052+252'          / Image name - observed object, bias, etc.
DATE-OBS= '31/08/94'            / Date of data acquisition  'dd/mm/yy'
UT      = '22:22:36'            / Universal Time - beginning of exposure
EXPTIME =             3600.000  / Exposure time in seconds
JD      =        2449596.43236  / Julian date - beginning of exposure
ST      = '23:21:05'            / Sidereal time - beginning of exposure
HA      = '-01:35'              / Hour Angle - beginning of exposure
ZD      = '21:33:00'            / Zenith Distance - beginning of exposure
RA      = '00:56:23'            / Right Ascension = telescope position
DEC     = '25:45:00'            / Declination = telescope position
EPOCH   =              1994.67  / epoch of RA and DEC = date of acquisition
AIRMASS =                1.075  / Air-mass at beginning of exposure
GAIN    =                 8.42  / Readout gain
RDNOISE =                 6.50  / Readout noise
ORIGIN  = 'WISE-OBSERVATORY'    / Tape writing institute
DISPAXIS=                    1  / Dispersion axis of spectra images
COMMENT = 'PG0052+2   Wedge3 3600s UT22:22 31/08/94 AM1.075 01:35E  '
END
```

All information is given for the beginning of the exposure. The DEC is rounded to a minute of a degree. The RA is rounded to a second of time.

Chapter 4

The CCD CAMERA

The camera consist of a filter wheel mounted directly on the telescope and the CCD mounted beneath it. The CCD is mounted at the f/7. The pixel scale is 0.696 ± 0.002 ″/pixel, which gives very good sampling of the imaged objects. The overall field of view of the CCD is 11.88×11.88 arcmin.

4.1 Camera Filter Wheel

The old manual-operated filter wheel has four positions for 2 inch round or square filters (for list of available filters table 4.1) and it is rarely used now. The new automated filter wheel (Fig. 4.1) has eight positions for 2 inch round or square filters (which their thickness is no more then 8 mm). The wheel is absolutely encoded and a filter change is very rapid (a few seconds) and it is the most commonly used now. If you change filters in the wheel, be sure to change the list on the Camera and FOSC controller PC at c:\pmis\filtfile . In order to move the automated wheel one can use the "Filter Wheel" window (sec. 2.2.3) from the "CCD progs" icon that is in the "Program manager" window; However, usually this is not required since the macros move it to the desired position.

Note that when the automated filter wheel is in a "right" position a small red light (in the brown control box behind the screens) is on. If this light is off then the filter wheel need to be adjusted; This is done by switching the wheel power supply off (using the black switch), moving the wheel by hand to the right positions according to the white marks, switching the power supply on again, and checking if the red lamp is on (if not repeat the above procedure until you will reach the goal of having the red light on).

Sometimes (usually when operating an electrical system in the dome - like moving the dome or the platform) the wheels gets out of its "right" place and the red light turns off. Be sure to look very frequently on the red light to see that it is lit.

Table 4.1: Available filters

Filter	$\lambda_{central}$	FWHM	Remarks
U	-	-	Johnson/Cousins
B	-	-	Johnson/Cousins
V	-	-	Johnson/Cousins
R	-	-	Cousins
I_{old}	-	-	Pseudo-Johnson
I_{new}	-	-	Cousins
Z	-	-	Blue cutoff + CCD response
H_β	4863	42	RGO 52
H_β	4856	10	RGO 40
$\sim H_\beta$	4883	32	RGO 53
Continuum	4919	38	RGO 54
Continuum	4960	30	RGO 55
[O III]	5010	40	RGO 56
Continuum	5077	40	RGO 58
Continuum	5107	29	RGO 59
Continuum	5295	88	IR
Continuum	5300	144	(WB16) Kris Davidson's Crab filter
Continuum	6447	54	(H_α1), Microcoatings, peak=64.4%
H_α v=0 km/sec	6562	50	(H_α2), Microcoatings, peak=67.5%
H_α v=1050	6586	48	(H_α3), Microcoatings, peak=66%
H_α v=2150	6610	55	(H_α4), Microcoatings, peak=69.7%
H_α v=4390	6659	60	RGO 67
H_α v=6240	6700	53	(H_α5), Microcoatings, peak=70%
[S II]	6736	75	BARR associates
He II, N III	4697	53	BARR associates
He I	5874	62	BARR associates

Notes:

(1) The six filters UBVRI$_{old}$Z have the same thickness, hence when setting the telescope focus for one of them it will be good for the others. However the I$_{new}$ filter is thinner then the above six, hence if the telescope focus was set with one of the above six it will not be in focus for the I$_{new}$, and vice versa. The same apply for using the H_α filters with the above six, but here the phenomenon is much less prominent. To overcome this problem it is advised to focus the telescope with one of the six filters, then with the I$_{new}$ filter, and then to set the telescope focus right between the two values, so that it will be close to focus for both.

(2) The broad-band UBVRI$_{old}$Z filters were designed at RGO to match the RCA CCD. Note that seeing test have shown that the seeing is better through red filters probably due to the fact that earth atmosphere scatters blue light better than red light.

(3) The filters are 2 inch round or square and their thickness is no more then 7 mm (in order to be used in the FOSC. For use in the CAMERA the limit is 8 mm).

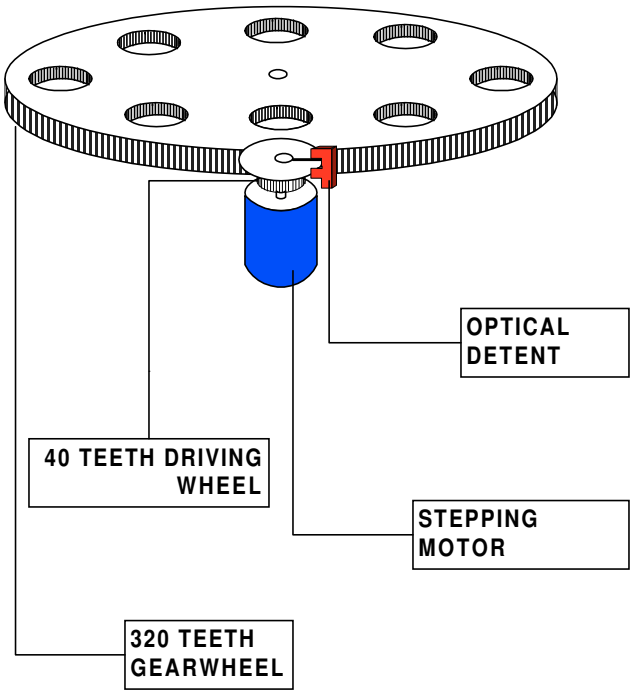

Figure 4.1: Camera filter wheel.

4.2 CAMERA User Macros

The operation of the CAMERA is controlled via user macros in the PMIS window (section 2.2.1). The following is Peter's help file available on line, about the CAMERA user macros. This file will be updated according to changes in the operating system of the CAMERA, so it is advisable to look at it occasionally:

Notes on the camera macro routines.

1. **iacquire**

Use to take and display a field for the purposes of acquisition.
INPUT (1) observation time #.# real value in seconds.
NOTE: A digit or 0 must be entered ahead of the decimal point.
A 10 second exposure with iacquire is equivalent to a 160 second exposure with mtake. After the iacquire is done it prompts for defining again the area of the CCD in order to get out of binned mode.

2. **iareab**

Defines an area in the center of the chip and creates an image display.
INPUT (1) ### integer value number of pixels 100 to 1024.
INPUT (2) # integer value desired binning parameter 1 to 4.

Note: The second parameter is optional and must be specifically entered if a binning value other than 1 is required. If the full chip binned by 2 is required specify as parameters 1024 2. The macro then automatically sets up the CCD as 512×512 pixels binned 2×2. The binning parameter is not entered into the FITS header.

3. **mtake**

This macro takes images. It prompts for:

INPUT (1) object name up to 18 characters but no spaces.

(2) observation time ###.# integer value up to 9999 seconds.

NOTE: A real value may be entered provided a digit or 0 is entered ahead of the decimal point.

It then asks for filter position in the filter wheel and takes an image, displays it and ask whether to records it as a fits file with Shai specified enhanced fits header.

The file is placed in the c:\pmis\images directory and is named according to the date followed by a three digit numeric extension.

The image display should first have been defined using iareab.

FLAT-FIELDS – if one specify "FF" as the object name, then after taking an image and recording it the macro will move the telescope by about 35″ in RA and will start another exposure.

4. **iseq**

The sequence input parameters are exactly the same as those for mtake or iftake.

Provided the observation time is 25 seconds or more an abort timer window appears during the exposure.

The time overhead for a 350 square box is something between 17 and 18 seconds.

To finish the sequence press the escape key immediately after the beep. "sequence concluded" is written to the main PMIS CLI window.

To abort a long exposure press the escape key whilst the abort thermometer is on screen and then press the escape key again immediately after the beep. "User abort." appears in the PMIS window before "sequence concluded".

5. **imbias**

Takes a bias, displays it and records it as a fits file with Shai specified enhanced fits header.

The file is placed in the c:\pmis\images directory and is named according to the date followed by a three digit numeric extension.

The image display should first have been defined using iareab.

If it is entered with a number other than 1 then a multiple bias is taken.

INPUT # integer value the number of biases to accumulate.

6. **camhelp**

Displays this help text. Either minimize or close after use.

7.**focusit**

This is a new focus macro for the camera which replace the foccam macro (which is still in use for the fosc and can be also invoked for the camera by writing "foccam" in the PMIS command line).

Precede a call to focusit by taking an image with mtake or iacquire. The exposure time selected here will define the exposure time used in focusit.

Invoke focusit, move the cursor into the image, select a star and press the LEFT mouse button.

The macro will close everything and will take an exposure.

When done, the image and a plot will be displayed together with an information window about the image.

Move the secondary mirror (using the + and − buttons on the console) and continue with the macro until best focus is achieved.

Use the peak value and the plot through the star's peak to optimize the focus.

Exit from the focus routine when the best focus has been determined.

8. **camamove**

This macro can be used either prior to taking sky flat fields or to move a program object to a desired position in a field.

It should be preceded by either IACQUIRE or the combination of IAREAB and ITAKE. After taking the preliminary exposure use DISPLAY SCALING to display the current field in a suitable fashion and check the SAVE AS DEFAULT box to hold that scaling throughout the subsequent CAMAMOVE sequence. A single press on either the ESCape key or the right mouse button cleanly aborts the CAMAMOVE macro and restores the status and cursor displays.

A 30 by 30 pixel box is displayed in the center of the image and the minimum and maximum found in this box are displayed in the main window for each exposure.

9. **takelist**

The input for this macro is a number corresponding to a number in a list the observer prepared in the C:\misc\ directory (with an extension .lst). The list should specify the exposure time of each filter and should look like this:

```
1   0:07:59.40   17:07:38.00  1950.0  PKS0008+171    U 300  R 400
2   0:14:04.10   81:18:28.00  1950.0  S5_0014+81     R 250  B 300  V 400
3   0:17:49.90   15:24:16.00  1950.0  3C9            B 300  I 400
4   0:26:38.10   12:59:30.00  1950.0  PG0026+129     R 120  V 180
5   0:42:22.70   10:10:30.00  1950.0  MC0042+101     R 300  B 400  I 30
```

(Note: no spaces are allowed after the last character at the end of a line, no blank rows are allowed, and no <cr> at the end of the file.) The macro will prompt you for the filter number in the filter wheel and then will find its name and the exposure time in the list and will start the exposure using the "mtake" macro. If this macro does not find the readings for the specified filter in the file, it prompts for the exposure time.

10. **ifiltseq**

The input for this macro is a number corresponding to a number in a list the observer prepared in the C:\misc\ directory (with an extension .lst). The list should specify the exposure time of each filter and if a filter is need to be observed twice then it should appear twice in the list, which should look like this:

```
1   0:07:59.40   17:07:38.00  1950.0  PKS0008+171    U 300  U 400
2   0:14:04.10   81:18:28.00  1950.0  S5_0014+81     R 250  B 300  B 400
3   0:17:49.90   15:24:16.00  1950.0  3C9            B 300  I 400  I 400
4   0:26:38.10   12:59:30.00  1950.0  PG0026+129     V 120  V 180
5   0:42:22.70   10:10:30.00  1950.0  MC0042+101     R 300  B 400  I 30
```

(Note: no spaces are allowed after the last character at the end of a line, no blank rows are allowed, and no <cr> at the end of the file.) First the macro asks if you want a repetitive sequence or just one, so answer according to your needs. Then it asks you for the number in the list. Next, the macro will move the automated filter wheel to the first filter specified in this list for the numbered object, take the exposure, write it to the disk, and then will move to the next specified filter and will take its exposure and so on. Hence if someone wants two exposures with the same filter and same exposure time he should specify this filter twice (e.g. the above line 3).

NOTE: The lists for the takelist and ifiltseq macros can be used in the setting program (see section 2.3.1), there is no need to make two separate lists.

11. **moveit**

This macro moves the point marked by the cursor to the middle of the field. When starting this macro it will prompt for the rotator angle. Then point the mouse cursor to the point you want to move to the middle of the field. The macro will then move the telescope.

CAUTION: *Do not use this macro while moving the telescope from the telescope control computer or from the console buttons. This will severely damage the telescope.*

12. **seeing**

Allows the user to select a star in any displayed field. It plots a line through the most intense point in the star and displays this value. It also displays the standard deviation of the points in the region of interest which contains the star. This region of interest is rescaled to clearly display the center of the star as in the focus routine. After the macro pauses the image is restored to its original scaling parameters.

13. **impndis**

Import and Display. It takes as a command line parameter the full name of a FITS image file with its complete path. The image is displayed. In general it will be correctly scaled in dimension and intensity.

ADDITIONAL USEFUL MACROS

These may be typed directly into the Command Line Interpreter 'CLI' window.

voiceon and voiceoff

Control Peter's voice and do precisely what their names would suggest.

savelast

Save the last image observed to the hard disk (see sec. C.1).

chnglist

Change the list name for the ifiltseq and takelist macros.

4.3 CAMERA Operation

A suggested procedure for operating the telescope with the CAMERA is outlined here. It is suggested to come to the observatory about an hour before sunset (if the CCD is warm you need to come 2 hours before sunset, so that you'll have enough time to cool it).

In the library:

— Check the GPS in the library. Its green light should be glowing, and the power red light of the small blue connection box bellow it should be on.

— Switch on the console box that powers the PCs of the library.

In the dome:

— Turn on the CCD control box and the autoguider (the ST-7). The working temperature of the TEK CCD is about -90 degrees, the red lamp indicating "heating" should be on when the CCD is operational. If the green lamp indicating "cooling" is on then the CCD is warm and needs to be cooled down.

— Note that the rotator angle is 71. On that position the wires outlet of the CCD dewar should point eastwards. Any other direction will mess up your work.
— Turn on the filter wheel power supply and make sure it is on a right filter position (see section 4.1).
— Turn On all computers in the dome by pushing the red bottun of the switch box behind the door under the light switch.
— Continue booting the setting and guiding computer. Select DOS and note that it brings up both the guiding and setting programmes running under windows. To switch between programs use <ctrl>+<esc> and choose from the menu.
— Switch to the guider program and switch on the ST-7 temperature regulation (set '/Camera/Setup/Temperature regulation' to Active, and check that '/Track/Track and accumulate/Track mode' is set to "Relays" – see section 2.3.2).
— Continue booting the camera and FOSC computer. The PC will start its initialization procedure and one should choose the Windows 3.1 working enviroment so that the PMIS window will appear and prompt you for your name, and then for the instrument your are about to use, so answer "0" for the CAMERA. Then you will be prompted for a list of objects (see the "takelist" and "ifiltseq" macros, if you don't have a list then just hit <cr>). Afterwards you will be prompted for the filter wheel you are about to use: the manual one (four positions) or the automated one (8 positions). If you will choose the automated filter wheel you will be also prompted for its current position to be reset in the "Filter Wheel" window (sec. 2.2.3). Also a "FOCUS" window (sec. 2.2.2), a "Temperature" window (sec. 2.2.8), and the "Observation Control Program" window (sec. 2.2.4) will appear on screen.

— Bring up the Norton commander window. Delete any images that are left there and are not needed. See section 2.2.7 for details. Minimize "nc" window.
— Define the area of the CCD you want to use, with the "iareab" macro.

— Start the dome programme on the dome mover PC, and if needed calibrate it according to section 2.4.
— Turn on the relay box.
— Turn on the console. Pay attention that the R.A. track speed dial is on 0 and the source button (near the R.A. track button) is positioned on VARIABLE.

— Go to the electric box in the room below the telescope and lift the three circuit breakers (CB2, CB3, CB4, they are jumping to off positions once the console is turned on).

— About 15 minutes before sunset, you should take a bias sequence by choosing the macro "imbias" from the "user" menu. Usually we sum 10 biases, but this might be over cautious,

you can sum less. The macro will add the bias frames, average them, and will write the multiple bias to the disk.
NOTE: Take the bias in complete darkness in the dome in order to prevent light leaks to the camera. The average of the bias level should be around 486 (in the little statistics window next to the image display).
— Turn OFF the dome air condition using its remote control (section C.8).
— Open the dome using the console buttons and the shutters around it using their remote control (section C.9).
— Take off the telescope cover (alt-C in the telescope control program), and raise it back with alt-P.
— fill the CCD with nitrogen for about 3 minutes (lasts for about 6 hours work). Don't open the tap of the nitrogen fully open with a strong stream of nitrogen. Use weak stream and the filling of the dewar will be better (see chapter 3), Provided the CCD is at its working temperature of -90 degree.
— Disconnect the nitrogen filling pipe.
— Turn on R.A. tracking on the console, verify it's on Variable.
— If you have a list of objects in the computers load it into the setting computer by pressing "l" on the "tracking off" mode of the setting program.
— On the setting program change into the "tracking on" mode using alt-T, and press "m" on the setting screen so that the dome will follow the telescope.
— Right after sunset start taking sky flats using the macro "mtake" which accepts at the parameter line the object name and the exposure time. It is advised to move the telescope a bit between flat-field exposures so that in case there will be a star in one flat-field it won't appear in the same position in the next flat-field (this enable to get a good median flat-field later in the reduction procedure). Hence, Enter "FF" as the object name so that the telescope will move between exposures. Take 4-5 exposures of about 5 sec each with each filter you are about to use during the night. Check the number of counts, the maximum should be around 30000. Remember that the TEK saturates at about 32000 counts and the bias level is around 486.

— On the setting screen of the telescope control computer (in the "tracking on" mode) press "c". The telescope will move to an appropriate bright star from its list.
— Take a 0.5 sec exposures with the "mtake" macro.
— Center the star in the middle of the screen by moving the telescope using the "moveit" macro.
— Calibrate the telescope coordinates on the telescope control computer by pressing Alt<c> and Shift<R> (don't perform this unless the star in the right position).

— Move the telescope a bit and take a short exposure (∼3 sec) using the "mtake" macro.
— Focus the telescope by choosing the "focusit" macro. Click on the left mouse button while pointing to a star in the field. The focus loop will start and you should focus the telescope to get the smallest image for the star as describe in sec. 2.2.2 (typical focus is about 1000).

— The telescope is now ready for work.

— Just point the telescope to an object, and use the "mtake" macro to set the filter wheel to the right filter and observe.
— If your exposure is long then make sure that on the setting screen appears "Dome ON" so that the dome will follow the telescope, and start the autoguider according to section 2.3.2.

— The last exposure of the night should not continue beyond the time when the sun is 12 degrees below the horizon.
— If you have time take a final bias sequence using the "imbias" macro.
— If sky flats were not taken at the beginning of the night, take them at dawn, as described above.
— Turn OFF the R.A. tracking on the console.
— Cover the telescope and position it upright.
— Close the dome using the console buttons and the shutters around it using their remote control (section C.9).
— If no instrument-change is scheduled today then fill up the CCD with nitrogen.

— Bring up the Rapid-Filer window in the Camera and FOSC controller PC. Initialize it as described in section 2.2.6 and transfer your files to the Sun workstation.
— It is VITAL at this stage to check the sizes of the transferred images - see section 2.2.6 for details.
— Continue and transfer your files from the Sun workstation to the Library PC as described in section 2.6. They should be left on the Sun and on the library PC until the observatory staff will attend to them.
— If you want to transfer the images from the Sun workstation to the dat tape see section 2.1.1 for details.

— On the telescope control computer switch off the ST-7 temperature regulation (set /Camera/Setup/Temperature regulation to OFF) and when the temperature indicator (bottom right) is 0 shut the ST-7 down (/Camera/SHutdown – see section 2.3.2). To exit the guider program choose /File/EXit.
— Exit the setting program using Alt-x on the right-ascesntion OFF mode screen. Then exit from the windows 3.1 using the "Window manager" menu.

— Before switching off the computers switch off the power supplies of the filter wheel, the CCD, the autoguider and the relay box.
— In the Camera and FOSC controller PC you should exit gracefully from all the programs and windows. In the "Rapid-Filer" window use /File/Exit. In the "nc" window press F10 to quit. In the "PMIS" window choose "close" from the window menu. You'll be prompted to save the PMIS state which usually you would like to answer with no. Then exit from the windows 3.1 using the "Window manager" menu.
— In the dome mover PC exit the program using Alt-x and then x to confirm.
— Switch off the computers using the black bottun of the switch box behind the door under the light switch.
— Turn ON the dome air condition using the remote control (see section C.8).
— On the way down switch off the three circuit breakers (CB2, CB3, CB4).
— Switch off the console box that powers the PCs of the library
— Fill the log in the office.
— Before leaving the site, please check that all the books are back at their place, the kitchen is clean and all lights are off.
— Lock the observatory and go to sleep.

Chapter 5

The FOSC

The Faint Object Spectrographic Camera (FOSC) is a general purpose instrument that permits imaging of a ~17' diameter field through different filters and rapid change to an operation mode of spectroscopy of point-like or extended objects, within a few minutes and without refocusing the instrument.

The FOSC is patterned after the EFOSC instrument built by ESO (Dekker and D'Odorico, 1985), but realized on a "shoestring" budget. Thus, it may not be so versatile as the EFOSC, or so efficient, and we certainly compromised on the quality of images in order to be able to afford it. A description of the FOSC *as delivered* can be found in the "User's Manual" (Hilliard, 1989).

The optics and mechanics of the FOSC were contracted out to Optomechanics Research, Inc. of Tucson, AZ (*i.e.* Dr. Ron Hilliard), with whom the Wise Observatory has had a connection since they supplied us with an intensified TV camera. The detector mounted on the FOSC is the Tek CCD chip (see chapter 3).

The FOSC is controlled by the Camera and FOSC controller PC and the FOSC Mover PC (see sections 2.2 and 2.5). After its acquisition and delivery, the FOSC was modified at the Wise Observatory by incorporating simple absolute encoders for three main functions and adding a He-Ar and Th-Ar spectral lamps. The encoders will be described below.

5.1 FOSC Optics

The FOSC is designed as a transmission optics instrument in which all elements are colinear and on the telescope optical axis. In particular, the spectral dispersion is by grisms, that is prisms with transmission gratings replicated onto their faces. This ensures that the first order of the dispersion is directed along the optical axis. A schematic diagram of the FOSC optics is shown in figure 5.1. Figs. 5.2 and 5.3 show two views of the instrument with various parts identified.

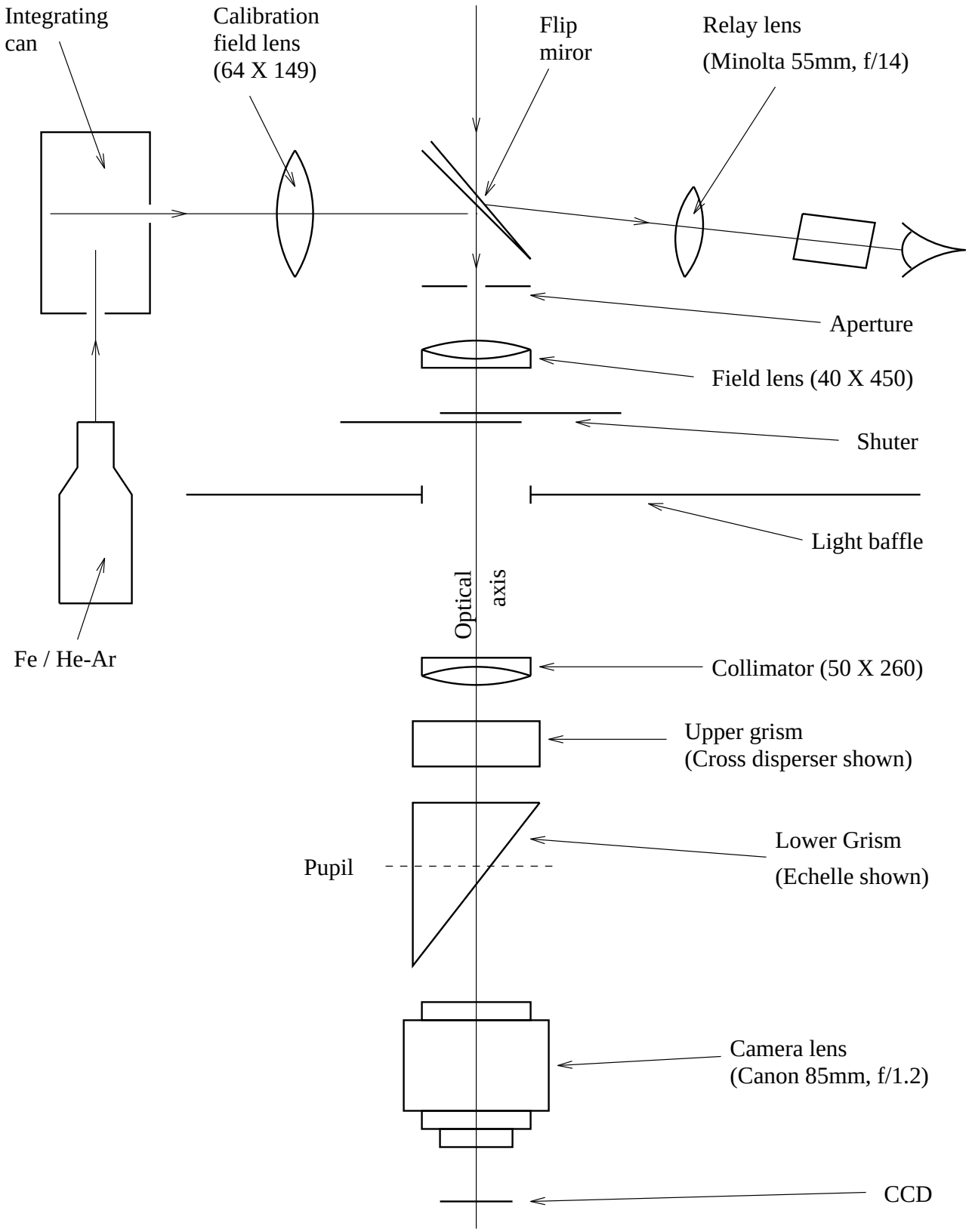

Figure 5.1: Schematic description of the FOSC optics.

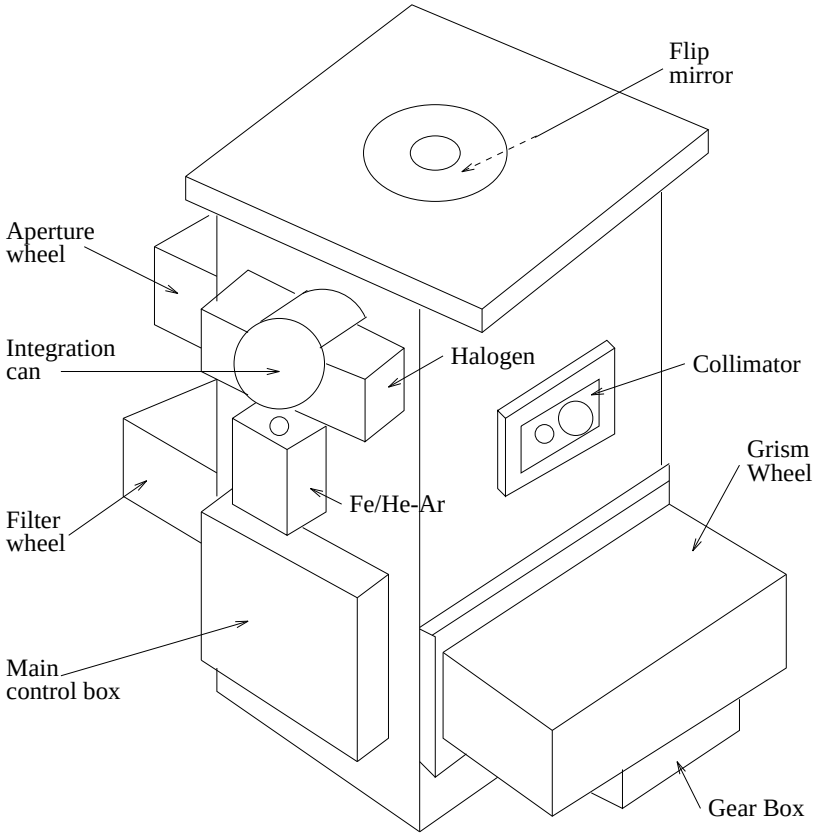

Figure 5.2: FOSC mechanical layout - top view.

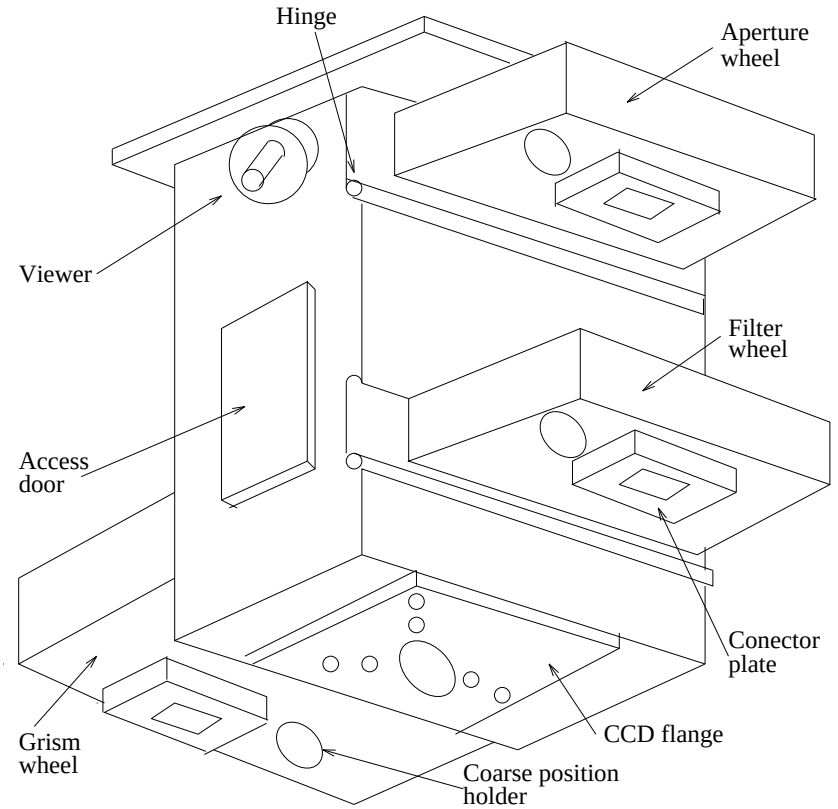

Figure 5.3: FOSC mechanical layout - bottom view.

The internal parts of the FOSC are not visible, and should not be accessed by regular users. If there is need for special filters, grisms, or other elements to be mounted, these should be handed to the day/night assistant preferably well *before* the beginning of the observing run, and he should be instructed in which location should these elements be inserted. Note that the operating program must be told about the modification - this is not a trivial task as one of the files must be modified. Also, the wheel where a new element has been installed needs, sometimes, to be balanced, otherwise it will not rotate properly.

The FOSC is mounted on the Cassegrain Camera (CAM) mounting box at f/7, and the offset guider (using the autoguider - section 2.3.2) is available for guiding.The plate scale on the focal plane is $\sim$30 $''$/mm. However, this is a focal reducing instrument, producing an f/3 beam, which is collimated prior to being re-imaged. The projected pixel size of the FOSC was about $0.9''$ with its original CCD, but with the TEK CCD it is now 2.081 ± 0.003 $''$/pixel (plans are being made to buy a new lens or a CCD that will resume the former pixel size).

The field imaged by the FOSC is $\sim 17'$ in diameter (this limit is due to the collimator lens). There is considerable vignetting at the outer $2'$ of the field, or central field intensity flare in the innermost $15'$. This, however, is removed by flat fielding. There are also various distortions of the images at the outer field; the most prominent being coma. Also, various optical elements may produce ghost images when bright sources are in the field.

A viewing eyepiece is provided on the FOSC, that looks at the center of the field reflected off a 45° mirror. The visible part of the field is $\sim 1'$ in diameter and is well centered onto the chip. An illuminated cross-hair is provided. The cross-hair LEDs should be turned off after using this periscope. The lens itself should be covered with the black cap provided, to minimize external light entry into the FOSC. The 45° mirror can be inserted in the optical axis for visual inspection of the field, or can be removed from the field, on command from the PC. Note that the field looked at with the viewing eyepiece is *before* the apertures.

5.1.1 The Integrating Can and Lamps

Whenever the viewer is IN, the FOSC can be fed light by an "integrating can", a cylindrical box mounted on its side and painted with Lambertian reflecting white paint. The can may be illuminated by an incandescent filament halogen lamp (for flat-fielding), by a He-Ar arc, or by a Th-Ar arc. The Th-Ar lamp can be replaced with a Fe-Ar lamp, however, this lamp is VERY weak, and only a long exposure will show lines.

In addition, a β light can be inserted manually into the extended cylinder that contains the He-Ar arc and may be used to test the instrument's linearity. The β light produces light from the radioactive decay of (probably) Tritium (^{3}H), whose positrons activate a phosphor. The light output is supposed to be constant, apart from long-term effects of half-life and

possibly a temperature dependence of phosphor efficiency. The insertion of the β light in the integrating can should be done by the night assistant. Table 5.1 shows the available light sources that may feed the integrating can.

Table 5.1: Available light sources

Lamp	Consists of	Remarks
1	He-Ar arc	Low and intermediate dispersion
2	Th-Ar arc	High dispersion
3	Fe-Ar arc	High dispersion (weak source)
4	Halogen	Flat-fielding
5	β light	For tests

The can projects a beam with the same shape as the telescope beam, *i.e.* a converging f/7 beam, with a central obscuration similar to that produced by the secondary mirror. The light that enters the can from any lamp is diffused by multiple lambertian scattering along the sides of the can before reaching the viewer mirror. Extraneous light may enter the FOSC through the entrance holes of the integrating can. We recommend keeping the inside of the dome dark while calibrating, for this reason.

5.1.2 The Apertures

Below the mirror, at the focal plane of the telescope, are the entrance apertures of the FOSC. These are mounted into the aperture wheel (AP) with 10 positions. The AP wheel has the apertures mounted at 9.45 cm from the center of rotation of the wheel. With the present optical train, a 10 step move corresponds approximately to one pixel on the detector.

The original FOSC apertures are two round apertures of $2''$ and $6''$ diameter (pinholes from Melles-Griot), and three slits, of $2''$, $5''$ and $15''$ width, all $\sim 15'$ long. Two new "flexible" slits were assembled at TAU workshop. The width and the position of those slits can be changed in order to get an optimal slit for specific observation. Both of them are $\sim 10'$long, and Currently are of about $11''$. One centered on the blue side of the spectrum and the other on the red side. The different apertures of the AP wheel are detailed in the table 5.2.

The shutter of the instrument is located immediately below the apertures. This is a fairly large electro-mechanical shutter (three-blade, solenoid driven), that may take a while to fully open, so the observer should be careful with short exposures. Timed exposures as short as 0.1 sec are possible, though due to the way the shutter opens, vignetting of the field edges will certainly occur. The shutter is *normally open*, thus it requires current to close and stay closed, but not while exposing. This is done to minimize heat dissipation inside the FOSC while observing.

TIP: it is possible to know the amount of light from the object passing through the slit by taking two images, one with the full aperture and no grism and another with the slit and without the grism.

Table 5.2: FOSC's Apertures

Name	Width/Diameter
$2''$ hole	75μm pinhole=$2.2''$
$5''$ hole	200μm pinhole=$5.8''$
$2''$ slit	$15'$ long and 69μm=$2''$ wide
$5''$ slit	$15'$ long and 172μm=$5''$ wide
$15''$ slit	$15'$ long and 516μm=$15''$ wide
$10''$B slit	$\sim 11'$ long and $\sim 400\mu$m=$11.6''$ wide
$10''$R slit	$\sim 11'$ long and $\sim 400\mu$m=$11.6''$ wide

5.1.3 The Field Lens and the Collimator

A field lens is mounted below the shutter. This is a 40 mm diameter coated achromat. The field lens forms a system pupil near the location of the lower grism wheel (see below). Below the field lens is the collimator lens, that can be moved by computer control along the optical axis. It creates a (hopefully) collimated bundle of light, that is further manipulated by the optical elements in the upper filter wheel and the lower grism wheel (FI and GR). The collimator is a 50 mm diameter coated achromat.

The collimator position is relative to a single encoded location near its lowest point of travel. The position is actually the number of steps of the motor moving the eccentric cam, and is in the range 0 to 550 steps. Note that the collimator is initialized at startup of the control program. If the power to the FOSC is lost, the collimator position might change. We suggest to zero its position and initialize the wheels position using the FOSC Mover PC (see section 2.5).

Although the collimator should not require refocusing when the optical elements in the light path between the collimator and the CCD camera lens are changed, in practice it turns out that it does need refocusing. This, no doubt, is the result of the lack of auto-collimation of the FOSC. Hence when ever the setup of the elements in the light path is changed it moves automatically to the its right position for that setup.

5.1.4 The Filter Wheel

The FI wheel (named also the Upper wheel) has 10 positions (for 2 inch round or square filter with thickness no more then 7 mm) and is used mainly for filters, but also for wedged

windows, that steer the beam of the 300 gr/mm and 600 gr/mm grisms in the GR wheel, and for the 150 g/mm "cross-disperser" grism, that serves as the cross-disperser for the echelle grism.

The wedged windows may also be used for imaging, to shift the image of a star off a bad column. As these are essentially prisms, they will cause the images of stars to become enlarged, by dispersing the light along the columns.

The two wedged windows currently in use has a 50 mm diameter. The older (wedge 2) has a 2° wedge angle, and the newer (wedge 3) has a 3° wedge angle. A small wedged window is also exist. It has a circular aperture of 37 mm diameter and a wedge angle of 4°. It is made of fused silica and is **not** anti-reflection coated. The deflection angle of a wedged window is approximately half the wedge angle. The various combinations of spectral coverage and dispersion are detailed in table 5.3.

Note that, as the beam through elements in the FI wheel is almost collimated, incidence effects on narrow band filters should be negligible! On the other hand, the filters mounted in the beam should be of **image** quality. The elements mounted in the FI wheel are changed quite often, according to the requests of the observers, except for the cross-disperser grism and the wedged windows. Table 4.1 shows the filters that can be mounted into the FI wheel. The U filter is available in principle, but due to the quality of the UV images of the FOSC, it is not recommended to use it.

Care should be taken when mounting slightly undersized filters in the FI wheel. No clear unblocked areas should remain beyond the filter edges. This may cause light leakage out of the filter band, internal reflections, and other unwanted effects. Changing of filters in the FI wheel should be left to the night assistant or the day technician.

5.1.5 The Grisms

The GR wheel (named also the Lower wheel) has 10 positions. Three are taken by the 300 g/mm, 600 g/mm grism, and the echelle grism. It is possible to mount other elements in this wheel, if required. Because of the large mass of the grisms, it is recommended **not** to change their positions as this may destabilize the GR wheel with catastrophic positioning results. New elements should be mounted in symmetric positions in this wheel, that should be rebalanced afterwards. Therefore, we recommend not changing elements in the FI or GR wheels at night. This means that the observing program should be well thought of in advance and the requests from the day/night assistants be also made in advance.

All three grisms are mounted in the same orientation and will produce spectra with blue at the right, on the display in the dome of the Wise Observatory. The echelle with the cross-disperser in the FI wheel will produce lower orders of dispersion with shorter wavelengths

higher on the display.

The echelle grism has a 79 g/mm grating replicated onto the prism. This provides the highest resolution available at the Wise Observatory, of ~2Å /pixel at 5345Å in the 11th order of diffraction, allowing a resolution of about 5ÅThe blazing angle of the echelle is 63.5°, and for the grisms: 150, 300, and 600, is 8.6°, 14.6°, and 34°, respectably.

5.1.6 FOSC Wavelength Ranges

Details about the different available setups and the wavelength coverage and dispersion are given in tables 5.3 and 5.4. Those wavelength ranges are from a test (which took place on October 8, 1994) in which the telescope was upright. It should be noted that the numbers can vary up to 10 pixels due to flexture in the instrument, when the telescope is tilted to any direction.

The setup of the 2″slit with the 300 grism and no wedge has in its spectra the 0th order of dispersion. Also a possible setup can be with a slit and the 150 grism. Such setup gives dispersion of about 17 Å/ Pixel and covers the whole wavelength range (from 0 to about 15000Å.)

The FOSC has poor blue response as the optics is not adjusted and optimized for this spectral region. Hence, the spectral response does not extend below about 4000Å and there is no use in using spectral ranges below that limit.

An example of the He-Ar arc spectrum with the setup of 2″slit, Wedge3 and the 600 grism, on the Tek CCD, including line identification, is shown in Fig. 5.4.

5.1.7 The Camera

The beam from the optical elements is imaged by a camera lens. In order to save costs, this was chosen to be a stock camera lens, a Canon 85 mm f/1.2 lens. The lens images the field/spectrum onto the CCD detector. Because this is a stock lens, that is not designed specially for astronomy, it will not image well in the near UV and in the IR. It is also fairly certain that some chromatic effects will be apparent at intermediate λs. The FOSC is designed to operate properly from about 3900Å longward up to about 8000Å . The images near the end of this spectral range will certainly be out-of-focus. Nominally, the FOSC should provide images that are 25μm or smaller in diameter.

The effective f/number of the FOSC is ~2.5, much faster than the f/7 beam normally used for imaging with the 40" reflector. This implies that the plate scale is also changed, in such a manner that the Tek CCD pixels, would undersample the seeing disk. The current plate scale of the FOSC is 2.081 ± 0.003 ″/pix.

Table 5.3: Wavelength ranges for different FOSC setups.

Slit name	Wedge (number)	Grism line/mm	Coverage Å	Dispersion Å/Pixel
2″	Wedge 3	600	3493 – 7263	3.68
2″	Wedge 2	600	3403 – 7156	3.67
2″		600	3201 – 6948	3.66
2″		300	783 – 9130	8.16
2″	Wedge 3	300	1511 – 9874	8.18
2″	Wedge 2	300	1183 – 9623	8.25
10″R	Wedge 2	300	2089 – 10905	8.62
10″R	Wedge 3	300	2267 – 11161	8.69
10″R		300	1361 – 10458	8.62
10″R		600	3681 – 7515	3.75
10″R	Wedge 3	600	3980 – 7821	3.76
10″R	Wedge 2	600	3878 – 7717	3.75
10″B	Wedge 2	600	3619 – 7433	3.73
10″B	Wedge 3	600	3725 – 7544	3.73
10″B		600	3425 – 7222	3.71
10″B		300	859 – 9787	8.73
10″B	Wedge 3	300	1657 – 10524	8.67
10″B	Wedge 2	300	1459 – 10263	8.61

Although most optical surfaces of the FOSC are anti-reflection coated, ghost reflections are almost certain to occur when a bright star is in the field. These are most prominent in narrow-band imaging. Finally, expect some image distortion near the edges of the field. The full 17′ field is unvignetted only in its inner ∼15′. The vignetting is normally taken out by the flat field compensation, but the S/N will always be lower in the outer one arcmin ring.

Table 5.4: Wavelength ranges for the cross disperser (150 grism) + echelle.

line number	Coverage Å	Dispersion Å/pixel
1	8604 – 11192	2.59
2	7408 – 9636	2.23
3	6515 – 8453	1.94
4	5823 – 7538	1.72
5	5272 – 6803	1.54
6	4829 – 6203	1.38

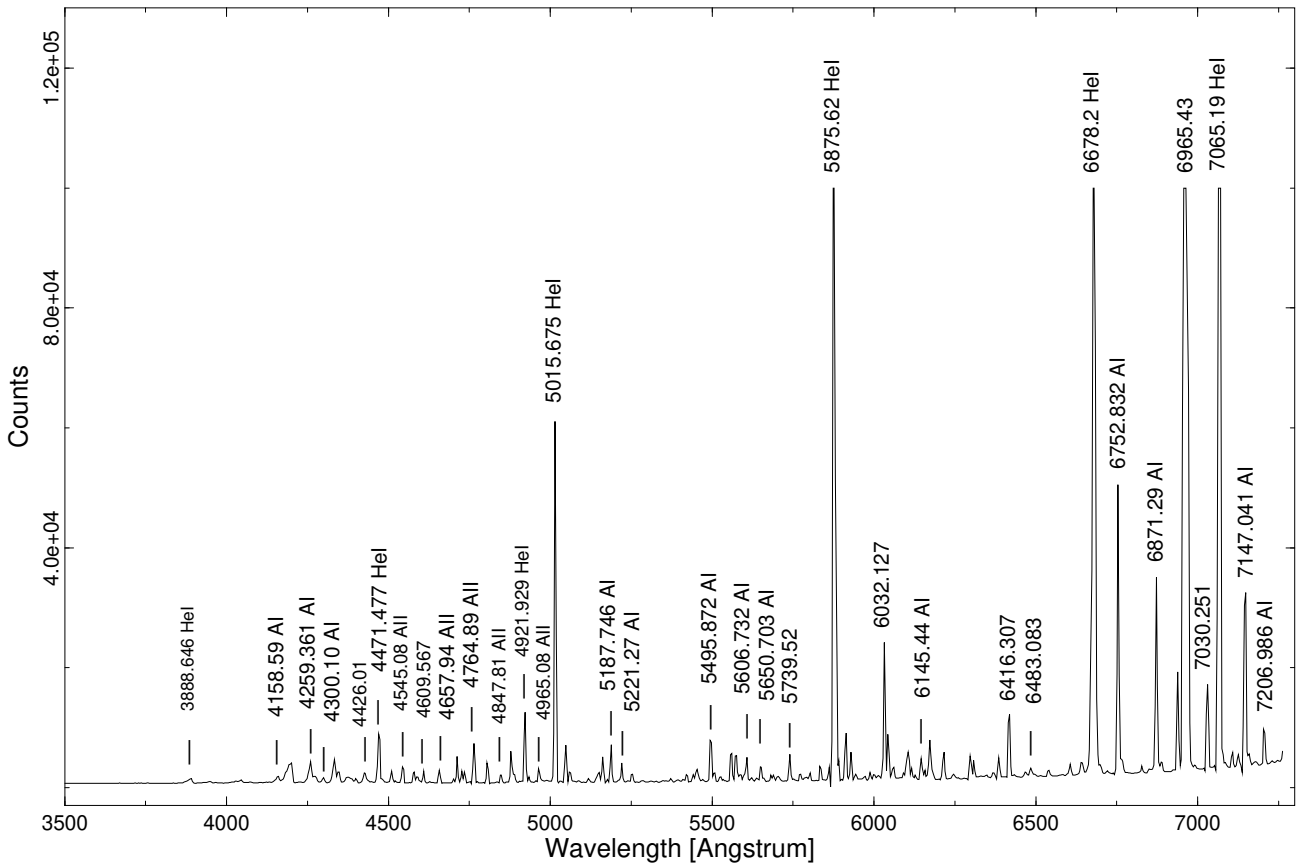

Figure 5.4: The He-Ar spectrum with the 600 g/mm grism and wedge3

5.1.8 The Wheels

The entire internal surface of the FOSC is covered by black felt-like fabric to reduce scattered light. Baffles are provided between the wheels for the same purpose. The scattered light problem, as well as that of the internally-produced light, were demonstrated when an unexplained dark-count enhancement was traced to the LEDs mounted in the position detectors of the "absolute encoders" of the AP, FI and GR wheels. These were emitting very faint light, in a location far from the optical axis, that was nevertheless detected by the CCD. This problem was solved by disabling the encoders and the drive motors whenever observing. This turns the illumination off except when moving the wheels.

FOSC functions are controlled by the Camera and FOSC controller PC and the FOSC mover PC. The position of the AP, FI and GR wheels, as well as that of the collimator, are read and can be modified by the software. The position of the wheels can be read to within a few arcsec, because of "absolute encoders" that are mounted near the centers of the apertures. These encoders are essentially slits of different widths fixed to the wheels, that are sensed by optical switches connected to Schmitt triggers that respond within a few

steps. One rotation of any wheel corresponds to 72,000 steps of the driving motor. The repeatability of any position is from 2 to 8 steps, depending on the position of the telescope and on the balancing of the respective wheel.

The software used for moving the wheels is described in sections 2.5 and 2.2.5.

5.1.9 Unorthodox Users

Being a flexible instrument, the FOSC is allowing modes of operation that can hardly be found elsewhere. It is possible, in principle, to have a narrow-band filter as pre-disperser in the FI wheel to work in conjunction with the echelle grism in the GR wheel. In this case, the idea would be to use a long and narrow slit in the AP wheel and to image possibly a single emission line. A possible observing project with such a setup would be rotation curves of galaxies, by setting the spectral range to H_α. Another would be a study of the kinematics of emission line nebula. This observational setup has not been tested, but we believe it should work.

Another possibility which is already in use is to insert polaroid filters, with the polarizing axes at 120° spacings, in the AP wheel and use the FOSC for imaging polarimetry, either with broad or with narrow-band filters. Such three polaroid filters are available at the site and studies using this setup were already published.

5.2 FOSC User Macros

The operation of the FOSC is controlled via user macros in the PMIS window (section 2.2.1). The following is Peter's help file available on line, about the FOSC user macros. This file will be updated according to changes in the FOSC operating system, so it is advisable to look at it occasionally:

User macros

When FOSC is invoked in the startup macro the FOSC User menu is automatically installed.
To load another User menu or reload the FOSC User menu:
In the PMIS command line window bring up the Macros menu and go to the Load List.. command. The desired list may then be loaded from the file display window.

The following are the macros in the FOSC USER MENU.

1. **iftake**

Takes an image, displays it and records it as a fits file with Shai specified enhanced fits header.

The data in the file is normalized to 15 bits.
The file is placed in the c:\pmis\images directory and is named according to the date followed by a three digit numeric extension.
The image display should first have been defined using ispectra (or foscarea).
INPUT (1) object name up to 18 characters but no spaces.
(2) observation time #### integer value up to 9999 seconds.
NOTE: A real value may be entered provided a digit or 0 precedes the decimal point.

2. **foscarea**

Defines an area in the center of the chip and creates an image display.
PARAMETERS

#1 x offset for box

#2 y offset for box

Use these to adjust the box position by up to + or - 10 pixels.
Select a CCD AREA of 300 or less when trimming these parameters.
IFTAKE then leaves the correct aperture box displayed on top of the observed aperture.

PROMPT — SELECTED SLIT — APERTURES

1	CLEAR	
2	10 RED	
3	10 BLUE	
4	15 micron	
5		2 micron HOLE
6	2/5 micron	

Enter the number corresponding to the desired aperture.
PROMPT - CCD AREA

Enter the number of pixels for the desired area on the chip.
A value of 530 matches the viewing region of the FOSC.
A value of 370 allows positioning on any of the apertures and provides a large enough field for identification.

3. **ispectra**

Defines a strip for a spectrum in the middle of the chip and creates an image display.
INPUT ### integer value height in pixels

4. **imbias**

Takes a bias, displays it and records it as a fits file with Shai specified enhanced fits header.
The file is placed in the c:\pmis\images directory and is named according to the date followed by a three digit numeric extension.

The image display should first have been defined using foscarea or ispectra.
If it is entered with a number other than 1 then a multiple bias is taken.
The data in the file is normalized to 15 bits and is divided by the number of biases specified.
INPUT # integer value the number of biases to accumulate.

5. **foccam**
is a focus routine.
Precede a call to foccam by taking an image with iftake. The exposure time selected here will define the exposure time used in foccam.
Invoke foccam and input the parameter that specify the orientation of plotted line. '1' is vertical line (useful for grisms spectra), '2' is horizontal line (useful for echelle spectra), '0' is diagonal line (useful for star image).
Move the cursor into the image, select a star and press the LEFT mouse button.
Use the peak value displayed in the PMIS main window to the right of the image the standard deviation and the star's appearance to optimize the focus.
Exit from the focus routine when the best focus has been determined.
When using the FOSC to take spectra, display a slitless bright star spectrum on the screen using iftake and then use foccam to focus the spectrum for minimum width.

6. **takearc**
takes an arc spectrum.
A fits file is recorded with Shai specified enhanced fits header.
The data in the file is normalized to 15 bits.
ispectra should be used before the exposure to specify the spectral height.
The fosc wheels program has to be used to set up the FOSC.
INPUT (1) # of seconds the exposure is to take.

7. **takelamp**
takes a lamp flat field spectrum.
A fits file is recorded with Shai specified enhanced fits header.
The data in the file is normalized to 15 bits.
ispectra should be used before the exposure to specify the spectral height.
The fosc wheels program has to be used to set up the FOSC.
INPUT (1) # of seconds the exposure is to take.

8. **foschelp**
Displays a version of this help text. Either minimize or close after use.

9. **rotnangl**

Used to input the angle of the telescope rotating equipment mount if this is altered from the standard FOSC value of 173. The new value will then be entered in the Shai specified enhanced fits header.

INPUT (1) ### angle of rotating equipment mount on the telescope.

10. **ifmove**

Use to take and display an image repetitively.

First specify the correct aperture with foscarea.

Use the paddle buttons in set mode to move the desired star into the aperture area.

When the mouse cursor is in the display area use the <ESC> key to escape from the ifmove routine.

Use the "FOSC control" window to move the desired aperture into position.

Enter ifmove again and use the paddle buttons in guide mode to center the star in the aperture.

INPUT (1) # exposure in seconds.

NOTE: A real value may be entered provided a digit or 0 is entered ahead of the decimal point.

(2) # 0, 1 or 2 image display scaling mode.

0 - scaling determined from a previous iftake.

1 - optimal suitable for placing a star in the field display.

2 - gamma 0.4 suitable for placing a star in the slit.

This option also zooms the image centered on the slit.

{(3) - optional parameter which may be used with scaling option 2 to specify the gamma value - 1 to 9 specifies 0.1 to 0.9.}

You may leave the ifmove macro running and move the slit into place. The ifmove macro will continue where it was left off.

The macro is plotting a line along the brightest pixel in the slit to aid guiding extended objects (e.g., galaxies) into the slit.

11. **iech3**

formats the ccd and sets up an image display for the second and third order echelle spectrum.

12. **takelist**

The input for this macro is a number corresponding to a number in a list the observer prepared in the C:\misc\ directory (with an extension .lst). The list should specify the exposure time of each filter and should look like this:

```
1   0:07:59.40   17:07:38.00  1950.0  PKS0008+171    U 300  R 400
2   0:14:04.10   81:18:28.00  1950.0  S5_0014+81     R 250  B 300  V 400
3   0:17:49.90   15:24:16.00  1950.0  3C9            B 300  I 400
4   0:26:38.10   12:59:30.00  1950.0  PG0026+129     R 120  V 180
5   0:42:22.70   10:10:30.00  1950.0  MC0042+101     R 300  B 400  I 30
```

(Note: no spaces are allowed after the last character at the end of a line, no blank rows are allowed, and no <cr> at the end of the file.) The macro will prompt you for the filter number in the filter wheel and then will find its name and the exposure time in the list and will start the exposure using the "mtake" macro.

13. **moveit**

This macro moves the point marked by the cursor to the aperture position. When starting this macro it will prompt for the rotator angle. Then point the mouse cursor to the point you want to move to the aperture position previously selected in the "foscarea" macro. The macro will then move the telescope.

CAUTION: *Do not use this macro while moving the telescope from the telescope control computer or from the console buttons. This will severely damage the telescope.*

ADDITIONAL USEFUL MACROS

These macros may be executed directly by typing the name in the command line window. If the macro has parameters default values will be used. Parameters in the correct order may be entered on the command line.

Macros which control the operation of the FOSC directly:

ffon and ffoff

Control the flat field comparison lamp.

arcon and arcoff

control the arc lamp.

starobs and lampobs

control the viewing prism.

oshut and cshut

open and close the shutter.

voiceon and voiceoff

control Peter's voice.

savelast

Save the last image observed to the hard disk (see sec. C.1).

chnglist

Change the list name for the ifiltseq and takelist macros.

5.3 FOSC Operation

A suggested procedure for operating the telescope with the FOSC is outlined here. It is suggested to come to the observatory about an hour before sunset (if the CCD is warm you need to come 2 hours before sunset, so that you'll have enough time to cool it).

Systems Startup

In the library:

— Check the GPS in the library. Its green light should be glowing, and the power red light of the small blue connection box bellow it should be on.

— Switch on the console box that powers the PCs of the library.

In the dome:

— Turn on the FOSC power supply and the CCD control box. The working temperature of the TEK CCD is about -90 degrees, the red lamp indicating "heating" should be on when the CCD is operational. If the green lamp indicating "cooling" is on then the CCD is warm and needs to be cool down.

— Note that the rotator angle is 173. On that position the wires outlet of the CCD dewar should point westwards. Any other direction will mess up your work.

— Turn on the autoguider (the ST-7). Note its angle is on 173.

— Turn On all computers in the dome by pushing the red bottun of the switch box behind the door under the light switch. If one/some of the 4 computers are off then switch them on using their switchs.

— Continue booting the telescope control computer. Select DOS and note that it brings up both the guiding and setting programmes running under windows. To switch between programs use <ctrl>+<esc> and choose from the menu.

— Switch to the guider program and switch on the ST-7 temperature regulation (set '/Camera/Setup/Temperature regulation' to Active, and check that '/Track/Track and accumulate/Track mode' is set to "Relays" – see section 2.3.2).

— Start the "FOSC" program on the "FOSC Mover PC". It will initialize and zero the collimator.

— Continue booting the camera and FOSC controller computer. The PC will start its initialization procedure and one should choose the Windows 3.1 working enviroment so that the PMIS window will appear and prompt you for your name, and then for the instrument you are about to use, so answer "1" for the FOSC. Then you will be prompted for a list of objects (see the "takelist" and "ifiltseq" macros, if you don't have a list then just hit <cr>).

— At this stage a window called "FOSC control" will appear on the right-bottom corner of the screen. Also a "FOCUS" window (sec. 2.2.2) and a "Temperature" window (sec. 2.2.8)

will appear near it.
— Use the "FOSC control" window to Position the FOSC wheels on the setup you are about to work during the night in order to take flat-fields at twilight (sec. 2.2.5).
— Define the area of the CCD you want to use, with the "ispectra" macro – for spectroscopy, or with the "foscarea" macro for imaging.
— Bring up the Norton commander window. if there isn't enough disk space for your work, delete images that are left there and are not needed. See section 2.2.7 for details. Minimize "nc" window.
— Start the dome programme on the dome mover computer, and if needed calibrate it according to section 2.4.

— Turn on the relay box.
— Turn on the console. Pay attention that the R.A. track speed dial is on 0 and the source button (near the R.A. track button) is positioned on VARIABLE.

— Go to the electric box in the room below the telescope and lift the three circuit breakers (CB2, CB3, CB4, they are jumping to off positions once the console is turned on).

— About 15 minutes before sunset, you should take a bias sequence by choosing the macro "imbias" from the "user" menu. Usually we sum 10 biases, but this might be over cautious, you can sum less. The macro will add the bias frames, average them, and will write the multiple bias to the disk.
NOTE: Take the bias in complete darkness in the dome in order to prevent light leaks to the camera. The average of the bias level should be around 486 (in the little statistics window next to the image display).
— Turn OFF the dome air condition using the remote control (section C.8).
— Open the dome using the console buttons and the shutters around it using their remote control (section C.9).
— Take off the telescope cover (alt-C in the telescope control program), and raise it back with alt-P.
— fill the CCD with nitrogen for about 3 minutes (lasts for about 6 hours work). Don't open the tap of the nitrogen fully open with a strong stream of nitrogen. Use weak stream and the filling of the dewar will be better (see chapter 3), Provided the CCD is at its working temperature of -90 degree.
— Disconnect the nitrogen filling pipe.
— Turn on R.A. tracking on the console, verify it's on Variable.
— If you have a list of objects in the computers load it into the setting computer by pressing "l" on the "tracking off" mode of the setting program.

— On the setting program change into the "tracking on" mode using alt-T, and press "m" on the setting screen so that the dome will follow the telescope.
— Right after sunset start taking sky flats using the macro "iftake" which accepts at the parameter line the object name and the exposure time. It is advised to move the telescope a little between taking the images, especially when using imaging mode, so that if stars appear in the flat-field frames you will be able to take them out by combining the images using the median option (in the reduction procedure). Hence, Enter "ff" as the object name so that the telescope will move between exposures. Take 3-4 exposures of about 5 sec each at each setup you are about to use during the night. Check the number of counts in the sky flat, the maximum should be around 30000. Remember that the TEK saturates at 32767 counts and the bias level is around 486.
— After taking sky flats, put all wheels in "none" positions closest to the positions used before.
— On the setting screen of the telescope control computer (in the "tracking on" mode) press "c". The telescope will move to an appropriate bright star from its list.
— Define new region for the display with the "foscarea". This macro will prompt for the shift in the aperture you are going to use - two numbers in pixel units (+ or –, form 1 to 10) for the x and y shifts. Then it prompts for the required aperture – at this stage put "1" for "clear" position, and forwards it will prompt for the number of pixels to define the region size, about 370 pixels should be enough.
— Take a 0.5 sec exposures with the "iftake" macro.
— Center the star in the middle of the image using the "moveit" macro.
— Calibrate the telescope coordinates on the telescope control computer by pressing Alt<c> and Shift<R> (don't perform this unless the star in the right position).

From here we divide the procedure for spectroscopy or imaging:

Spectroscopy

— Define new region for the display with the "foscarea". This time enter the aperture you want to use during the night.
— Take a 0.5 sec exposures with the "iftake" macro.
— Move the bright star to the aperture position using the "moveit" macro.
— Move in the dispersing elements you need (i.e. wedge and grism) using the "FOSC control" window. (no aperture is necessary at this stage).
— take a spectrum of the bright star using "iftake". If you see nothing on the display then you should adjust the gray scale by choosing the option "scaling" from the "display" menu. In the window that will appear you need to choose your favorite gray-scale option, usually

the first option - optimal non-linear - is the best to see all details.
— Focus on the spectra by choosing the "foccam" macro, entering a parameter ("1" for grisms spectra, or "2" for echelle spectra), and clicking on the left mouse button while pointing to the middle of the spectrum. The focus loop will start and you should focus the telescope to get the narrowest spectrum possible as describe in sec. 2.2.2 (typical focus is about 1060).

— The telescope is now ready to work.

— Put all wheels in "none" position close to the positions of the elements you need to use.
— Point the telescope to the object.
— If your exposures time is long remember to press "m" on the setting screen so that the dome will follow the telescope.
— Take a short exposure with "iftake", to identify the field. Adjust the gray-scale, usually optimal non-linear is the best.
— Use "moveit" macro to move the object into the aperture.
— Use "ifmove" macro from the user menu in order to take a sequence of repeated exposures, and position your object where the aperture place is (using the hand paddle). The "ifmove" takes in its parameter line two parameters: the first one is the exposure time in seconds (2 is recommanded) and the second one is the gray scale (0 is recomanded to keep the previous gray scale).
— After you'll move the object to the center of the position marked on the screen, you can move the aperture (using the FOSC control window) into its place.
— After the aperture was positioned, take a short exposure usin 'iftake'

— Adjust the gray-scale, usually gamma with around 0.5 is good enough to see all the details in the aperture.
— Zoom into the image by choosing "zoom" from the "display" menu and clicking the mouse left button right in the middle between the two objects. Repeat this several times until you'll get a satisfactory zoom. If you have zoomed too much you can zoom out by choosing "squeeze" from the "display" menu, and clicking the left mouse button on the spot you want to zoom out from.
— Now choose again the "ifmove" macro. Move the telescope slightly using the hand paddle until the object is centered in the slit.
— If your exposures time is long make sure that on the setting screen appear "Dome ON" so that the dome will follow the telescope.
— If you want to use the autoguider, then while the "ifmove" loop is still working find a star for the autoguider and have it start guiding (see section 2.3.2 for details).

— Exit the "ifmove" macro (see above).
— Move in the dispersing elements you want to use with the FOSC control window.
— Define the spectral height you want to use (usually 100 pixels are enough for a one star spectrum) using the "ispectra" macro.
— Use the "iftake" macro, specifying the correct object name and the exposure time, to take an exposure.
— If you want to record it don't forget to fill in the log with the information in the "text" window.
— When the exposure ends take a He-Ar (ARC) exposure (about 5sec – depending on the aperture you are using) with the "takearc" macro,(don't forget to fill the log), and record it to the disk.
— Take exposure of lampflats with the "takelamp". Depending on your aperture you might want to take more than one such exposure to have enough S/N. The exposure time should be such that brings the CCD to high counts but not saturated.
— Now you can take another spectra of the same object — or move the telescope to another object and repeat the previous sequence.

Imaging

— Move into the light path the filters you want to image with.
— Take an image using "iftake".
— Focus on the telescope by choosing the "foccam" macro and enter "0" in the parameter line. Click on the left mouse button while pointing to a star in the field. The focus loop will start and you should focus the telescope to get the smallest image for the star as describe in sec. 2.2.2 (typical focus is about 1060).

— The telescope is now ready to work.

— Just point the telescope to an object, set the wheels to the right filters and use the "iftake" macro to observe.
— If your exposure is long then make sure that on the setting screen appears "Dome ON" so that the dome will follow the telescope, and start the autoguider according to section 2.3.2.

Imaging with the CAMERA filter wheel

Since the wheels of the FOSC are much slower than the CAMERA wheel, a new operation mode was implanted on June 1996. The CAMERA wheel is placed in its place above the FOSC with the required filters, and the FOSC wheels beneath it are placed in "none" places

so the imaging is done through the FOSC and the filter wheel can move fast from one position to the other.

For that purpose the macros "mtake" and "ifiltseq" were added to the FOSC macro list and can be operate, and operate the automatic CAMERA filter wheel, from the FOSC operating environment.

When executing a combined observing program of imaging and spectra this is probably the best set up. However, note should be made that when taking spectra no filter is present in the filter wheel, and that when imaging the collimator is placed in the right position (Table 2.1) for the filters (usually this is achieved by placing the middle FOSC wheel – the filters wheel – on the Cam/none position).

Closing down

— It is recommended that the last exposure of the night should not continue beyond the time when the sun is 12 degrees below the horizon.
— If you have time take a final bias sequence using the "imbias" macro.
— If sky flats were not taken at the beginning of the night, take them at dawn as described above.
— Turn OFF the R.A. tracking on the console.
— Cover the telescope and position it upright.
— Close the dome using the console buttons and the shutters around it using their remote control (section C.9).
— If no instrument-change is scheduled today then fill up the CCD with nitrogen.

— Bring up the Rapid-filer window in the Camera and FOSC controller PC. Initialize it as described in section 2.2.6 and transfer your files to the Sun workstation.
— It is VITAL at this stage to check the sizes of the transferred images - see section 2.2.6 for details.
— Continue and transfer your files from the Sun workstation to the Library PC as described in section 2.6. They should be left on the Sun and on the library PC until the observatory staff will attend to them.
— If you want to transfer the images from the Sun workstation to the dat tape see section 2.1.1 for details.
— On the telescope control computer switch off the ST-7 temperature regulation (set /Camera/Setup/Temperature regulation to OFF) and when the temperature indicator (bottom right) is 0 shut the ST-7 down (/Camera/SHutdown – see section 2.3.2). To exit the guider program choose /File/EXit.
— Exit the setting program using Alt-x on the right-ascesntion OFF mode screen. Then

exit from the windows 3.1 using the "Window manager" menu.
— Before switching off the computers switch off the power supplies of the FOSC, the CCD, the autoguider and the relay box.
— In the Camera and FOSC controller PC you should exit gracefully from all the programs and windows. In the "Rapid-Filer" window use /File/Exit. In the "nc" window press F10 to quit. In the "PMIS" window choose "close" from the window menu. You'll be prompted to save the PMIS state which usually you would like to answer with no. Then exit from the windows 3.1 using the "Window manager" menu.
— In the FOSC mover computer and in the dome mover PC exit the programs using Alt-x and then x to confirm.
— Switch off the computers using the black bottun of the switch box behind the door under the light switch.
— Switch off the console and lights in the dome.
— Turn ON the dome air condition using the remote control (see section C.8).
— On the way down switch off the three circuit breakers (CB2, CB3, CB4).
— Switch off the console box that powers the PCs of the library
— Fill the log in the office.
— Before leaving the site, please check that all the books are back at their place, the kitchen is clean and all lights are off.
— Lock the observatory and go to sleep.

Chapter 6

The Two Star Photometer

This chapter describes the two star photometer which was designed and built by Ed Nather for use at f/13.5. It is similar to instruments used widely at observatories throughout United States and elsewhere. Acquisition and guiding is performed by a viewing system which is constructed as an integral part of the photometer. The system, controlled by a PC computer, is suitable for fast photometry.

6.1 Optical Design

The two star photometer is used at the f/13 Cassegrain focus. It consists of two separate assemblies of photomultiplier + apertures + filters. One, called "channel 1", is on the telescope optical axis. The other, "channel 2", can be offset from ch. 1 to measure a nearby star. See Fig. 6.1 for details.

The diaphragm slide is equipped with 6 apertures of 0.5, 0.75, 1.0, 1.5, 2.0 and 4.0 mm corresponding to 7.5, 11, 15, 22, 30 and 60 seconds of arc in diameter. Diaphragm illumination for ch. 1 is provided by red light emitting diodes, which can only be lit when the centering eyepiece is fully inserted.

The standard filter wheel of ch. 1 has seven stations in which normally UBVRI Hα wide and Hα narrow-band filters are placed. The filter wheel may be rotated manually or under computer control. Other filter wheels and filters, in particular a set of Stromgren filters and Hβ, wide and narrow, are available. Also a set of "comet" filters, acquired for the *Halley Watch* program, is available.

The standard photomultiplier tube is a GaAs RCA C31034 although other tubes may be available. The tube housing incorporates a manual shutter and a fabry lens.

The guiding eyepiece of ch.2 can either view the object by inserting the offset guiding mirror, or the field, by withdrawing the mirror from the light path and offsetting the eyepiece position.

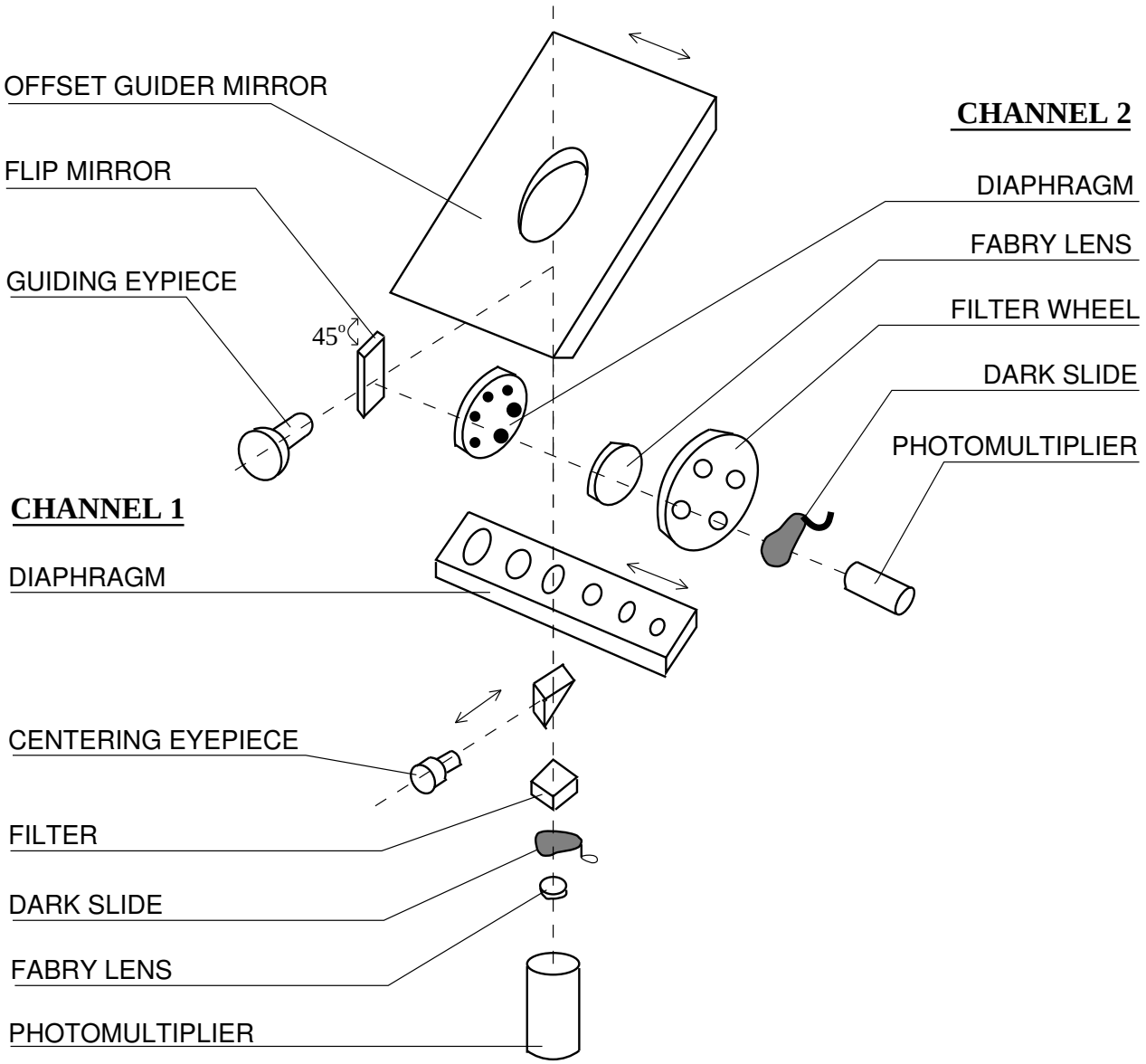

Figure 6.1: Optical parts in the two star photometer

Light is directed to the second channel by a 40:60 beamsplitter mounted at 45° in front of the guiding eyepiece. Light enters a permanently mounted RCA 4516 tube (S11) through a diaphragm wheel equipped with the same set of apertures as the first channel, a fabry lens, and a four position filter wheel holding UBV filters and having an open position. A dark slide protects the tube. The filter wheel may be rotated manually but the UBV filters cannot be changed and the apertures cannot be viewed by the user.

6.2 Photomultiplier Tubes and Housings

At present, two photomultiplier tubes may be mounted as ch. 1:

S11: The standard tube is a RCA 8850 operated uncooled. The dark count is typically between 30 and 120 per second depending upon the ambient temperature. UBV glass filters

do not require IR blocking since the tube's long wavelength cutoff is completely effective in this regard. The UBV filters are part of the complement developed for the **GaAs** tube (see below), and may not match exactly the Johnson response with the bi-alkali tube.

GaAs: An RCA C31034 tube mounted in a water-cooled Products for Research thermoelectric cooler is available. The circulating water is itself refrigerated to between 5 and 15°C depending upon the ambient temperature, and the thermoelectric housing lowers the temperature of the tube a further 30 degrees. Under favorable conditions the tube is cooled to −30°C. Under such conditions, the dark current is less than 10 counts per second. However, the cold box is particularly prone to electrical pickup, thus great care must be taken as to which pieces of electrical equipment are used in the dome when observing with this tube. This tube has a flat response to beyond 900 nanometres.

6.3 Computer Programs to Operate the Photometer

PHOT: This is a photometry program written in Pascal. It can easily be modified to meet the requirements of different observers. The standard program allows up to seven filters. In addition it outputs the mean and standard deviation in each color and operates the secondary mirror stepping motor for immediate sky background subtraction. Data are recorded, at the end of measurement, onto standard $5\frac{1}{4}$" or 3.5" diskettes. Computer programs are available for transferring the data directly to the observatory's Sun workstations. It is also possible to transfer data files through INTERNET, via a modem connected to the data acquisition PC. This cannot be done whilst observing.

The standard PHOT program allows an integration time longer than ∼1 second. For fast photometry, a suite of programs has been developed, allowing integration times as short as 2 msec, albeit with some restrictions (1 byte wide numbers, single filter, no secondary mirror rocking).

QUILT 9: A version of photometry with two channels, filter change, but without mirror rocking, is available with only S11 photomultiplier. It is called QUILT 9, has been written by Ed Nather, and is implemented on a PC/AT through a dedicated interface card. This version will display graphically the counts of both channels on the VGA screen of the PC while being accumulated. The data is automatically written to the 20 MB hard disk of the PC.

Time services: The time-keeping service of the Wise Observatory is based on a GPS receiver connected to one of the PC computers. The computer displays UT(C) with an accuracy of 50 nsec. At present there is no option of synchronizing the data acquisition with the GPS time standard.

Chapter 7

Other instruments

This chapter will describe few other instruments that exist in the Wise Observatory. Those instruments are now rarely used, but probably can be operated if they will be required.

7.1 The Cassegrain Camera

The Cassegrain camera was constructed in the workshop of Tel Aviv University and is designed for use with 14 x 14 inch plates which cover a field of 3 degrees in diameter. The camera is mounted at f/7 and is equipped with an offset guider which uses light from the main beam, with a set of gelatin Kodak filters and with a knife-edge for accurate focusing. Special adaptors permit use of smaller plates. When 14 x 14 inch or 16 x 16 cm plates are used, a simultaneous exposure on one corner of the plate can be obtained by a step wedge, for sensitometric calibration. When 8 x 8 cm plates are used, a similar spot sensitometric device located in the darkroom can be used to calibrate 6 x 9 cm plates from the same batch.

N.B. Please note that the Wise Observatory **no longer** *stocks photographic plates and fresh chemicals. Users wishing to avail themselves of this facility should provide new plates and chemicals prior to their observing run.*

7.2 The Cassegrain Spectrograph

This spectrograph is used at the f/7 focus. The image scale at the slit is $\sim 30''$/mm and the Schmitt camera reduction factor is 4.5. This camera has a curved focal plane. In order to use it with photographic plates it is necessary to insert a field flattener lens. This must be done by the site manager. A Wynne camera with longer focus and flat focal plane is available as well. The spectrograph is mounted on an acquisition and offset guide box similar to that of the CCD camera, which has an offset guider. It may be possible to mount the SBIG guiding CCD at this position for automatic guiding, although this has not been tested.

The slit width is adjustable between 30 and 1200 microns. A withdrawing mirror selects between a comparison lamp source and the star light. Rotating the mirror in the inserted position selects between two lamps. A helium–argon arc and a high temperature miniature quartz iodide lamp, as comparison and calibration source, are available. A periscope views the slit from above, seeing the reflected sky, and it may be moved to view the slit from below, though this facility is almost never used. The periscope can be equipped with an 18mm first generation 3 stage ITT F- 4710 image tube for viewing fainter sources. This device has not been operated for more than five years and its behavior cannot be predicted.

Gratings are available providing spectral coverage from the ultraviolet into the near infrared with dispersions between 30 and 220Å/mm. Suitable order-separation filters are inserted below the slit.

The Bowen Schmitt camera (f/1.4) can be used only in direct photography. The Wynne Maksutov camera (f/2.2) has a 28mm flat focal plane. It is used with the CCD chip of the, with the addition of an optical spacer inside the Maksutov camera to push the focal plane onto the chip surface. In this configuration, a $\sim 5'$ long slit is available.

7.3 The IR Spectro-Photometer

The Wise Observatory is developing an IR capability, based on an Infrared Laboratories InSb detector mounted in a lN_2 dewar. The dewar is equipped with a semi-circular CVF for the 2-4 μm range and with J, H and K standard filters. The available apertures are $30''$ and $1'$ in diameter. A dichroic mirror will split the optical band off into a viewing eyepiece/single channel photometer. This instrument is controlled by a PC/AT and has not yet been released for general use.

7.4 Old CCDs

The two old CCD detectors can be available for mounting on the camera, the spectrograph, or the FOSC:

1. The RCA SID 501 EX CCD chip in a lN_2 dewar is a 512×320 pixel detector, with 30 micron square pixels, which are $0.89''$ at f/7. The full field is slightly larger than $7' \times 4'$. The CCD chip is thinned and back-illuminated, providing suitable response in B and even at the U band. This detector is sensitive to cosmic rays, and about 100 can be seen in a 30 min exposure. Exposures at spectral bands affected by strong sky lines (V & R broad bands) show noticeable fringing on about 30% of the chip area.

The readout noise is 52 electrons and the A/D conversion is done as 15.5 electrons = 1 ADU. Saturation is reached near 16000 ADUs. Linearity of response above 12000 ADUs

should not be taken for granted. The observatory is equipped with a set of standard, imaging UBVRIZ filters for this chip, and other, more specialized filters. Prospective users are urged to consult with observatory staff to obtain the most recent filter list.

2. It is also possible to mount the TI CCD (originally used for the FOSC) as a direct camera, although this is not very efficient. This sensor has 1024x1000 pixels of 12 μm side, that translate into less than $0.5''$ at the f/7 focus. The field covered with the TI CCD is about $5'$ square. The q.e. of the TI is noticeably lower than that of the RCA at V, very much lower at B, and virtually nil at U.

Both CCDs are operated through the Heurikon computer and the data are acquired by it and stored on 1600 bpi magnetic tapes, in a binary format. This equipment is old and causes many problems, so it is not advised to use those CCDs any more.

7.5 Summary and Future Developments

By no means the programs described in this manual are "astronomer-proof", but they are certainly workable. A keen attempt was made to prevent foolish mistakes from ruining an observation, so the programs will warn you if you have blundered some how. It is *certain* that there are operator mistakes that have not been covered. We shall attempt to modify the programs further, to make it more flexible and less attention-requiring.

We would like to emphasize that changes in the operation of the Wise Observatory, as a result of further developments, are imminent. New and updated editions of this manual will be issued as required.

Current developments are acquiring a new CCD (2048×2048) and a re-imager lens so that a field of about 1 degree would be imaged with the new CCD.

Appendix A

Observing Conditions at the Wise Observatory

This appendix is part of a paper with the same title (Brosch 1992).

The quality of the nights at the Wise Observatory, in terms of cloudiness and fraction of useful time, has been collected from the interim observing reports filled by the astronomers at the end of each observing night for 17 consecutive years. This report is based on 11 years of operating the observatory that were processed manually and six years when the interim reports were processed by computer. The fraction of nights when no clouds were reported is typically about 70%. The best season, when practically no clouds are observed, is June to August, while the highest chance for clouds are in the period January to April. The actual breakdown of cloudiness percentage for individual months is given in Table A.1.

Table A.1: Clear nights 1972 to 1983

Month	Percent clear
January	52 [10]
February	56 [17]
March	55 [12]
April	51 [10]
May	77 [10]
June	89 [10]
July	92 [06]
August	90 [05]
September	76 [16]
October	67 [19]
November	60 [12]
December	64 [13]
Yearly mean	69 [15]

Note: The standard deviation of the mean is given in square brackets.

A.1 Extinction

Since 1975 extinction coefficients are measured at the Wise Observatory on a fairly regular basis. Their collection gives an idea about the character of the site and may be useful to observers if no measurement of the extinction was obtained for a certain observation. The results presented here combine about 100 observing nights when at least UBV standard photometry with adequate standards was done. We include among them results presented by Vidal *et al.* (1978) from the preliminary test of the photometric qualities of the site. The photoelectric system used at the Wise Observatory is based on Landolt (1973) UBV standards with the RI extension based on stars from Moffett and Barnes (1979). Table A.2 shows the median value of the extinction coefficients for different years and the number of different nights from which the median values were derived.

Table A.2: Median extinction coefficients for the Wise Observatory

Period	k_V	k_{B-V}	k_{U-B}	k_{V-R}	k_{R-I}	$N_{measurements}$
1975-80	0.26	0.15	0.33	-	-	5
1981-82	0.26	0.17	0.31	-	-	20
1984	0.45	0.07	0.14	0.01	0.02	9
1986-87	0.24	0.14	0.23	0.05	0.06	23
1988	0.24	0.14	0.22	0.05	0.07	26
1989	0.22	0.14	0.24	0.08	0.04	14

Notes: The measurements before 1984 used the bi-alkali photomultiplier and were limited to the UBV bands. We find no ready explanation for the anomalous extinction coefficients measured in 1984.

The typical extinction at zenith, taken as the median value over all the measurements, is 0.24 at V. The color-dependent terms are k_{B-V}=0.14, k_{U-B}=0.22, k_{V-R}=0.05 and k_{R-I}=0.07. For comparison, the typical extinction at La Silla, as given in the ESO User's Manual, is 0.11 at V and the color-dependent terms are k_{B-V}=0.09, k_{U-B}=0.26, k_{V-R}=0.08 and k_{R-I}=0.02. Similar values can be derived for the CFHT. At Mauna Kea Krisciunas *et al.* (1987) measured k_V=0.113 and k_{B-V}=0.082 at the mountain peak and k_V=0.149, k_{B-V}=0.158 at 2800 m altitude. The extinction at Wise is slightly worse than at ESO or at the CFHT, by about 0.13 mag at zenith. This is to be expected, considering the altitude difference between Wise Observatory and ESO/La Silla (2400m) or the CFHT (4204m).

A.2 Sky Brightness

The sky brightness is measured on a star-free sky patch one arcminute in diameter. In 1976 November-December the zenith sky brightness toward the Perseus cluster of galaxies yielded "U"=23.0 (see note about the definition of the U-band in Vidal *et al.*, 1978), B=22.7 and

V=21.6 mag/square arcsec. In 1979 July the sky brightness during a dark night was measured at U=21.7, B=22.2 and V=21.6 mag./square arcsec. In March 1989 the measurement was repeated towards the Coma region with a different photomultiplier and filter combination. The results are comparable with those of 1979, implying no worsening of the sky conditions.

Table A.3: Sky brightness in mag/square arcsec

Period/Band	U	B	V	R	I	Notes
Nov-Dec 1976	23.0	22.7	21.6	-	-	from Vidal *et al.* (1978)
July 1979	21.7	22.2	21.6	-	-	Bi-li tube
Mar 1989	21.5	22.2	21.7	21.2	20.4	Ga-As tube
AAT	-	22.5	21.5	20.8	19.3	AAO Newsletter
CFHT	21.6	22.3	21.1	20.3	19.2	User's manual
ESO	22.0	23.0	21.9	21.1	20.2	User's manual
KPNO	-	22.9	21.9	-	-	Garstang
CTIO	-	22.5	21.6	-	-	Garstang
DDO	-	19.9	19.2	-	-	Garstang
Palomar	-	22.9	21.5	-	-	Garstang

A summary of sky brightness measurements is given in Table A.3, together with representative values for CFHT (CFHT User's manual, 1990 edition, p. 5-2), for ESO (ESO User's manual), and for the AAT (AAO Newsletter No. 56, 1991). A location in California, with dark skies, was reported to have a typical sky brightness of B=22.3 – 23.1 and V=21.2 – 22.1, depending on solar activity (Walker, 1988). From all these we conclude that Wise Observatory has a similar sky brightness as other observatories.

A.3 Seeing

The typical seeing reported by various observers at the Wise Observatory ranges from 2″ to 3″. Rare nights exhibit 1″ seeing or less; these are only a few per year and occur mainly in winter, after the passage of a storm front. This determination is based on individual, visual estimates of various observers, sometimes by observing double stars with known separation, and is confirmed by measurements of stellar integrated profiles obtained with the photometer and a large aperture, while the star is drifting at the sidereal rate through the field of view.

The seeing evaluation is also based on many hundreds of CCD exposures obtained since 1986 that were analyzed at the Wise Observatory. The average FWHM of stellar images is 3.5″. Bad seeing produces images of 7″ FWHM; worse images are not recorded. In general, the seeing improves after midnight, following the reduced wind speed mentioned by Vidal and Feldman (1974).

Appendix B

The Automation of The Observatory

A presentation given by Peter Ibbetson at the first joint astrophysical workshop: The National Research Institute of Astronomy and Geophysics (Helwan, Cairo, Egypt) and The Wise Observatory of Tel-Aviv University (Tel-Aviv, Israel), which took place at Taba, Egypt, February 27-29 1996. Refers to Fig. B.1.

Written by:
Peter Ibbetson - Electronics Engineer.
Ezra Mashal - Technical Director.

ABSTRACT

The successive stages in automation of the observatory are discussed. The automatic setting of the telescope is described. The insertion of positional information into image files follows. It is shown how the precise positionning of an object is achieved. A description of the motorized filter wheel is given followed by a description of the automation of the dome. Automatic guiding is touched on. Finally further items which may need automating are listed.

The automation of the Wise Observatory has proceeded over a number of years. Each stage has been accompanied by an experimental period followed by a shake down period. During the shake down period each system has been exhaustively used by the observing astronomers. Their comments and requests have been heeded by the electronic, computing and technical staff.

This method has lead to the current system. It cannot be said to be flawless but it does work consistently. Furthermore it has been designed to make the pattern of observing as simple as possible. Thought has also been given to assisting the astronomers in their subsequent reduction by ensuring that all peripheral data required in the reduction is recorded in an accessible form at the time of observation without the intervention of the astronomer. It should be noted that this can only be achieved consequent upon each stage of automation.

Automation is an open ended process. With the accomplishment of each stage the as-

tronomer's life becomes easier. Then there follow, from those who are never satisfied, suggestions as to what must be the next step.

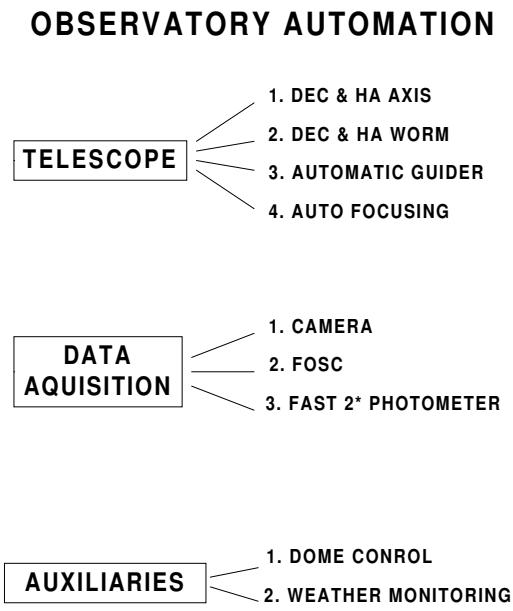

Figure B.1: Automation Scheme.

DETAILED DISCUSSION

The automation of the dome was to have been the last piece of the puzzle. Naturally it has not turned out to be this way. A policy of automating the observing routines at the Wise Observatory was initiated in earnest some two years ago. There had been an expensive but half hearted attempt in the early days of the observatory back in the middle seventies. This was abandonned because the electrical noise in the dome spelt doom for the incremental encoders and consequently the telescope when the first attempt was made to set it automatically. It was clear from these early efforts that incremental encoders would never work with the large currents powering the heavy motors used in this somewhat vintage observatory. Unfortunately having already spent a lot of money unwisely there was a natural unwillingness to spend a great deal more in order to do it right.

As the years passed and the equipment used for observations with the telescope was itself computerized and to some extent automated there became increasing pressure to automate the telescope itself. Many of the current observations are repeated on a monthly routine basis. They are often of a short duration and each observation is in a different filter. Moreover the series of observations can cover a large number of stars spread all over the sky. Because of this it was found that a great deal of the time was spent each night setting the telescope, moving the dome, finding and positioning the star and rotating the filter wheel.

The second attempt to add a digital indicator for the telescope's position followed a

suggestion by the first electronic's engineer employed in the observatory. He observed that the synchros used for the dial setting could be electronically digitised. This was done with the three synchros associated with each axis some thirteen years ago. The system worked as an indicator but the locking points between two of the three synchros associated with a given axis was not wholly reliable. Moreover, because of all the computation involved the time taken to make any given reading precluded the possibility of making the whole scheme automatic and reliable.

Meanwhile computers became cheaper, smaller, more powerful and more reliable.

The next attempt involved placing potentiometers as inexpensive encoders directly on the telescope axes and on the worm wheels. The cost of a single absolute encoder with sufficient resolution on a given axis was seen to be prohibitively expensive. This system proved a great deal more reliable than the triple synchro system previously employed. It was now felt that an attempt ought to be made to automate the telescope setting. A PC AT computer was more than man enough for the job and now readily available so the first real automatic setting was undertaken. It proved immediately ninety five per cent successful. It was very popular.

This attempt showed the way forward to the next step. Two absolute optical digital encoders would be used for each pair of axis and worm. The cost of these items had also dropped as the years had passed. Having already placed potentiometer encoders on the axes, replacing these with the optical variety was a straightforward task. The setting programme developed for the potentiometers was easily adapted to the new encoders. It was immediately found to work more reliably with them.

That would seem to be the end of the road but of course it was not. Resettability to any given position over the whole sky was within perhaps 10 or 15 seconds of arc but due to various telescope errors that did not necessarily correspond to the required stellar position. A star position mapping programme over the whole sky was undertaken and correction values found. These were added into the setting programme which was then found to achieve an accuracy of better than one minute of arc over the whole sky.

The widely embraced optical video medium adopted by the astronomical community was now the CCD. PC's had grown in stature to nurture the new devices. The file interface transfer system originally proposed by astronomers some years ago for archived storage of astronomical images on magnetic tape had become ubiquitous. There was an increasing demand that a whole set of fields be correctly defined and entered into each file header. A number of these were associated with the telescope setting but the computer used for setting and guiding could not also be used for image acquisition. Frequently from the point of view of time considerations telescope setting had to be undertaken whilst the CCD image was

being read out. A simple and elegant solution was found - let the CCD PC read the encoders. Everything is digital and the encoders can easily drive a number of reading devices. There are rather a lot of lines but that difficulty was overcome.

There was a specific demand for precise telescope positionning to within plus or minus five seconds of arc in one particular application. This was in connection with long slit spectroscopy of two objects observed simultaneously with the faint object spectrographic camera used on the Wise 40" telescope. In order to accommodate a star and a quasar in the slit at the same time the instrument on the telescope has to be rotated. Subsequently the two objects have to be moved onto the slit. A manual setting method using repeated imaging was first employed. Because of the curious orientation of the instrument on the telescope this could sometimes take rather a long time. It was clear that the CCD ought to be made into its own positionning device. The pair of objects could be found on the CCD. The position of the slit onto which these objects had to be moved was known. Unfortunately the rotation of the telescope has to be made manually and this orientation must be entered manually into the CCD PC. The field scale and pixel dimensions are known so the CCD PC can compute the exact motions required in right ascension and declination to move the stellar object pair onto the slit. It simply has to make the correct pushes on the settings buttons. This sort of task is well adapted to the capacity of a PC. A procedure which used to take between 10 and 15 minutes was reduced to 30 seconds.

Naturally once the CCD PC could accurately position the telescope a variety of other applications for this ability were found. Small telescope motion between sky flat fields was automated. Precise positioning on a given pixel can be achieved. On occasions telescope rotation is used with the direct camera in which case positionning the object correctly is greatly simplified.

A filter wheel which holds eight two inch filters was constructed. It is rotated by a stepping motor with a direct mesh gear. One rotation of the stepping motor corresponds to the motion required to move between any pair of adjacent filters. A disk with a single slit was mounted on the motor shaft together with the gear. The disk passes through an optical switch. The precise detent position for each filter can thus be checked. The system does not depend entirely on motor step counting. It is known that stepping motors sometimes get out of step in the harsh electrical environment of an observatory. If the motor positionning fails the observer is warned and the automated procedure halts until the error has been corrected. With this filter wheel serial observations in several filters can be smoothly undertaken and if required automated.

Precise positionning of an archaic American telescope was not the simplest task but it was achieved. Positionning a particularly recalcitrant and awkward Israeli dome both to a

given telescope setting and to follow the telescope tracking had yet to be implemented. Now following a wise Egyptian suggestion two Israel residents of Iraqui and English origin have achieved this too.

A potentiometer once used on the telescope axis was mounted with a gear reduction head and a pressure wheel in contact with the rotation track of the dome. The reduction gear was chosen so that a single rotation of the dome would correspond to a single rotation of the potentiometer. It was a matter of half a day to have a computer settable dome once the encoding device was mounted. But there were weak spots the potentiometer has a three degree dead region. Having tasted this particular mouthful of vinegar before, once having shown the feasibility, no attempt was made to pursue the matter until an absolute optical encoder was available. A very reasonably priced 10 bit encoder of Swedish manufacture was purchased. It proved to use a grey code rather than a binary coded decimal scheme so a fast conversion array had to be created. A collection of unused PC AT's were lying around the observatory. One of these was pressed into service. Sufficiently accurate dome positioning over the full revolution of the dome was quickly accomplished. A connection had now to be made between the telescope setting PC and the dome positioning PC. A dome mapping array returning a dome position for any combination of hour angle and declination was found experimentally. The main problem here was craning ones neck in seldom used telescope configurations and then bumping ones head. A hard hat was worn.

The setting PC tells the dome PC ahead of making a setting where the dome must go. Whilst the telescope is setting the dome is also in motion. The setting PC doubles as the guiding PC but continues to send out the current required dome setting every five minutes whilst the telescope is tracking. The dome PC then determines whether it should update the dome's position or not dependent upon the amount of the required correction.

The automation of almost everything required for remote operation has now been implemented. It is now possible for an observer to keep his cool whilst he keeps himself warm in the observatory's library during a winter observing run. What are the remaining items. Telescope focusing has yet to be encoded. In principle encoding is not required for remote focusing. In practice if an observer requires filters of different thickness these will have different focii. These must be determined at the beginning of the night and the telescope refocused each time the filter is changed. For this an encoded focus indicator is required.

The automatic guider requires observer intervention. The observer must find a guide star and set the guider's focus according to the telescope focus. It is hoped to bring a new guider based on a more sensitive larger CCD chip into operation with which it should be possible to acquire and focus a suitable guide star remotely.

It is open to speculation what will be the final chapter in the tale.

Appendix C

Additional Information

C.1 Notes, Tips, Warnings, and Troubleshooting

— When the telescope approaches a horizontal position, a red light will turn on the "HORIZONTAL LIMIT" indicator on the right side of the console, and a buzzer will sound; to stop the buzzer, just press the push-switch above the indicator.
— If for some reason you did not saved an image to the disk and then changed your mind, you can still save it (provided you didn't do anything bad to it – like taking another exposure) by executing the command 'savelast' in the PMIS window command line. The savelast command macro has been modified so that it will work even if for some reason the take macro fails either after the array has been read out or during an attempt to write the file. The failure generally occurs because the pmis global variable list becomes corrupted. savelast does not actually require any pmis global variables and has now been modified so that it does not call any. So you should now bring up the pmis command line window after the take macro fails type in "savelast" and then close pmis and restart it. The file will be correctly saved in order with its full fits header. An anomaly was found that sometimes it does not save the right UT time of the exposure but rather the time of the previous file. Please note this when you're using savelast.
— When using a guidestar, take care that the periscope stays at the edge of the field so as not to get into the main field of view.
— Make sure the temperature on the cooling box is about -90.0 degrees (the potentiometer on it should be on about 2.96).
— If you couldn't take sky flats at dusk or dawn (e.g. it's raining, or you missed the twilight due to some malfunction), take a dome flat instead in the same way.
— If there is a PMIS crash with a message that it needs to be closed you can restart the "PMIS" program from the "CCD progs" in the "Window manager".
— If the system crashes and nothing respond on the screen to the keyboard or the mouse

action, then reset everything and start from a softboot – alt+ctrl+del , and the whole starting procedure of the computer. Sometimes a hardboot is needed (press the reset button in the CCD controller PC or turn it off and on again).

— Nitrogen should be filled every 6 hours for about 3 min. So fill it before sunset, and in the middle of the night.

— You can use the Norton commander window to erase the last file you wrote or to look in the observing list. Remember that if you minimize it and then restore it from an icon it does not update automatically. You need to do something in it so that it will get updated (like going a directory up and than back to the images directory).

— Keep the door to dome (from staircase) closed. This will improve seeing by reducing influx of hot air in the dome.

— Remember to take enough arc spectra to calibrate your observations! Although the attempt was made to make the FOSC very rigid, flexture at various telescope positions and small motions of the various elements are still possible. The only way to guard against these is to take your calibration spectra at the same telescope orientation as the actual observations.

— In spectrophotometry, beware of differential refraction effects.

— The FOSC shutter is fairly large and may take a while to fully open. As it is mounted just below of the field lens, behind the apertures, this opening delay may cause extra vignetting. Such an effect will **not** flat-field well. Exposure times should probably be longer than one second to minimize this effect.

— If on the right-bottom corner of the console the small orange button is light, it indicates that an electricity break down took place.

— The "DEC track" button on the console should be always on "off" position.

— If the telescope run below the horizon-limit, a buzzer starts and a red light appears on the lower-right side of the console. Press the red-light button to stop the buzzer and move the telescope above the horizon limit in order to turn-off the red light.

— If the telescope does not move look at the right-bottom corner of the console: if the lights indicating "mash" are on than the mashes were probably forgotten in out position and they need to be pushed back to their positions.

— When observing objects which are far to the west it is helpful to put the "R.A. track" dial of the console on about "3" with the little switch beside it pointing to "E".

C.2 Exposure Time and Limiting Magnitude

No thorough study was done on the limiting magnitude and exposure times required by the different instruments. Based on our experience we can estimate the above quantities.

CAMERA

— Typical exposure time with the camera are:

∼V Magnitude (point source)	Exposure Time (sec) R filter	B filter
~ 13	50	80
$\sim 14-15$	120	180
$\sim 15-16$	180	240
$\sim 16-17$	250	300
$\sim 17-18$	300	400

FOSC

— Exposure time of 1 hour is considered to be the highest exposure time due to the many cosmic ray that are gathered in that time, hence spectra for point-like objects with magnitude above ~ 15.5 magnitude.

— The resolution of the 2″slit wedge3 and 600 grism can fully separate two lines that their separation is 15Å. This means that separation of peaks can be done for peaks with separation of 8Å. Also this means that the echelle with 2″ aperture can fully separate lines with separation of 7Å, and can separate only peaks of about 4Å.

— Using the 10″slit Wedge3 and 600 grism the typical exposure times to get spectra from point-like objects are:

∼V Magnitude (point source)	Exposure Time (sec)
$\sim 10-11$	400
$\sim 12-13$	900
$\sim 13-14$	1800
$\sim 14-15$	3600

C.3 Rotating the Instruments on the Telescope

All instruments are mounted under the telescope on a disk that can be rotated relative to the telescope. Rotating the instrument is easy: unscrew the two holding screws, and rotate the handle near the rotator dial to the angle you want.

The rotating facility makes the use of the telescope much more flexible and convenient. For example this enables to rotate the FOSC in order to have two (or more) objects aligned

in the spectrograph's slit to get simultaneously spectra. For this purpose there is also the "rotnangl" macro for the FOSC, where one can edit the rotator angle value in the image header. Another use for the rotator is when doing deep-imaging and some CCD pixels become saturated and start to pour electrons along the rows. If your object is on such row your in troubles, however, rotating the instrument in 90° will cause the saturation not to pour on the desired object.

EXTRA CAUTION should be paid when rotating the instrument so that its many wires won't be caught and ripped.

When rotating the instrument pay attention that north as appear in the focal plane is not in the direction it usually is, i.e., the image on the screen will not have north at the top and east to the left, but it will be rotated, so be careful to rotate your finding chart as well. Also for the same reason the autoguider CCD needs to be rotated to about to the same angle that the rotator was rotate. This is done by unscrewing the brass screw, and rotating the periscope by hand to the appropriate angle. This angle is read on the aluminum ring of the periscope housing, and it should be positioned so that the angle that correspond to the rotator dial should be pointing to the mark on the periscope.

Two rules of thumb for aligning the objects in the FOSC slit:
1) If the line between them is tilted to the right (west) and you want to turn it to the left (east) you need to enlarge the rotator angle. If the line between them is tilted to the left (east) and you want to turn it to the right (west) you need to make the rotator angle smaller.
2) If you want the image to be aligned to a specific Position_Angle (measured from north through east), then: $Rotator_Angle = Instrument_Angle - Position_Angle$, where Instrument_Angle is the angle when the instrument is aligned to the north (i.e., 173 for the FOSC, and 71 for the CAMERA).

C.4 Emergency Power Generator

The Wise Observatory is equipped with a Peugeot generator (Fig. C.1) to allow working ability during electricity breakdowns. Here we outlined the operating instruction of the generator.

Starting up the system

1. Open the external door of the generator room (it must be so as long as the generator is in operation);
2. Check oil in engine and water in its radiator and fill up if necessary;
3. Check fuel and fill up if necessary (see Fig. C.1);

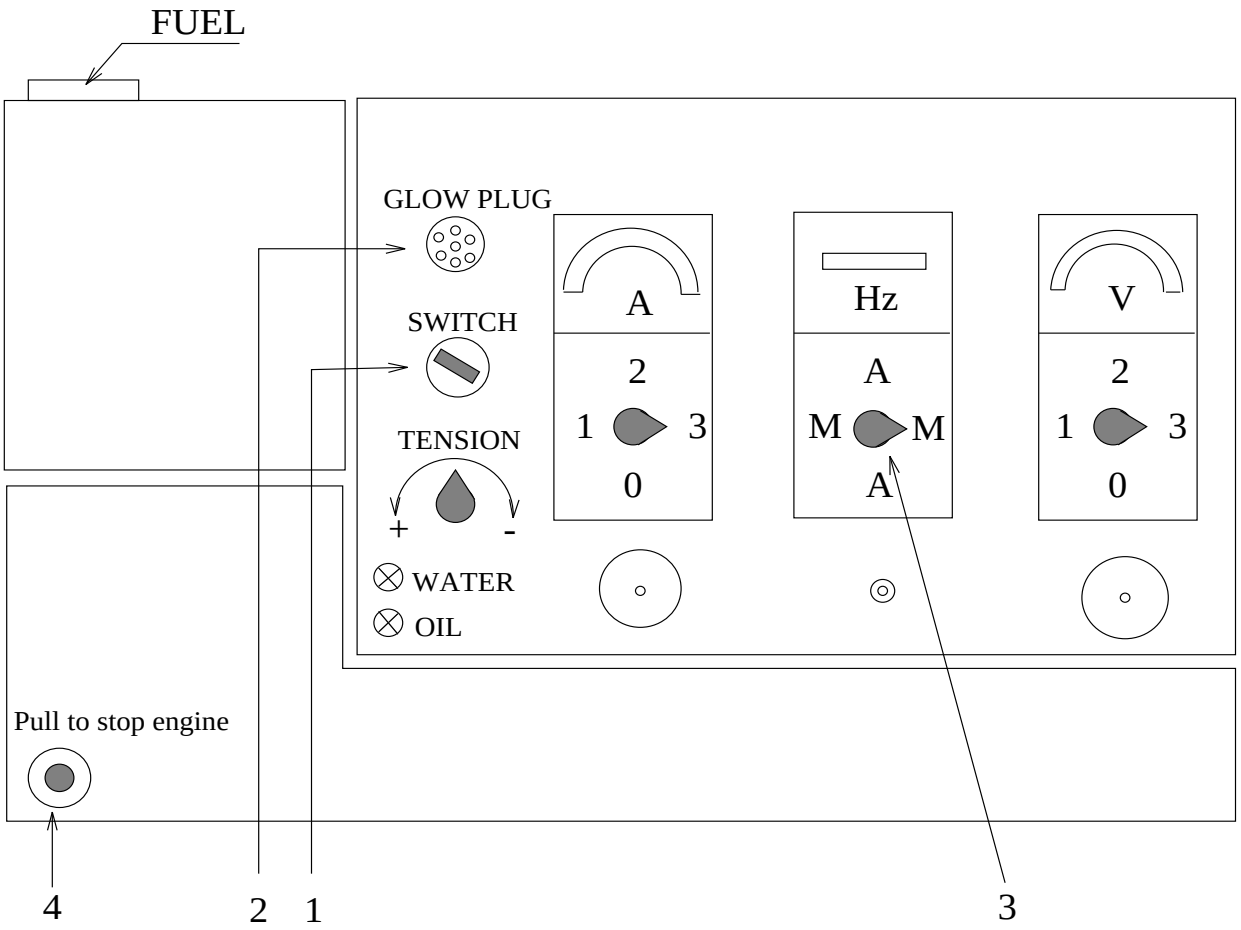

Figure C.1: Generator's console schematic diagram.

4. Make sure that the main connector of the generator (3) is in the **A** position (OFF);

5. Turn keyswitch (1) clocwise and hold it like that until pilot light (2) turns on red;

6. Release keyswitch (1) and immediately press and turn clocwise again until engine starts;

7. Wait 5 minutes until engine warms up (the red warning lights **WATER** and **OIL** should turn off);

8. Turn the main connector (3) to position **M** (ON);

9. Rotate the three connectors on the main electrical panels to the positions marked **GENERATOR** to make the link between the generator and the building.

To turn off the system

1. Rotate the three connectors on the main electrical panels to the positions marked **LINE**;

2. Turn the main connector of the generator (3) to position **A** (OFF);

3. Pull handle (4) until engine stops;

4. Turn off keyswitch (1) anticlocwise.

C.5 Data Reduction

Images from the CCD camera or from the FOSC can be reduced with the IRAF or VISTA image reduction packages installed on the Sun workstation network at the Tel-Aviv headquarters (and in the Sun workstation at the observatory). The image reduction center has several Postscript laser printers, One streamer magtape drive set at 1600 bpi, a cartridge tape drive of 150 MB capacity, an HEXBYE tape drive, several CD-ROM drives, and several DAT cartridge tape drive. Hence, visitors can choose which is the best media for them to export/import their data.

Eleven Sun workstations are networked into an integrated image reduction and astronomical data processing system. The disk space available at present totals $\sim$15 GB. AIPS is available on a single workstation.

Standard UBVRI photometry (and spectroscopy) is done in a semi-automatic mode. The pre-requisite for this option is choosing the standard stars from an approved standard list based on Landolt equatorial stars.

C.6 Standard Stars

Photometry: The observatory is equipped with the three Landolt standard stars catalogs: Landolt (1973), Landolt (1983), and Landolt (1992). They are placed in a green folder on the telescope console, and can be used for Standard UBVRI photometry.

Spectrophotometry: In order to transform the spectroscopic observations to absolute fluxes, at lest one, and preferably more, spectrophotometric standard stars should be observed. There are few lists of such stars in the observatory (in a red file on the telescope console). Those lists include the IRS standard star manual (1984), and the IIDS standard star manual (1977), both of Kitt Peak National Observatory, which are included in the spectrophotometry routines within IRAF and VISTA. Also there are some private lists based on information from IRAF. The spectral energy distributions can be found also in Stone (1977) or Oke (1974).

C.7 Computing Zenith Distance

To compute the angle of an object from the zenith (zenith distance) one uses the formula:

$$\cos Z = \sin\phi \sin\delta + \cos\phi \cos\delta \cos H, \qquad \text{where:}$$

Z = the Zenith Distance; $90° - Z$ above the horizon.

H = the hour angle of the object (HA = RA — ST).

ϕ = the latitude of the observatory; at Wise $\phi = 30.5°$.

δ = the Declination of the object.

Air Mass $= \sec Z - 0.0018167(\sec Z - 1) - 0.002875(\sec Z - 1)^2 - 0.0008083(\sec Z - 1)^3 \approx \frac{1}{\cos Z}$ (Hardie's formulae) where, $\sec Z \equiv \frac{1}{\cos Z}$.

C.8 Dome air conditioners

The dome has been fitted with two air-conditioners. Their purpose is to keep the day time dome temperature as low as possible so as to maintain the mirror throughout any 24 hour period at a temperature lower than or about equal to the lowest night time temperature. In practice this cannot be achieved and in any case it might cause dewing on the mirror but this is nevertheless the aim.

The air conditioners should be turned on just after the dome is closed in the morning and they should be turned off just after the dome is openned in the evening.

They should always be operated in a mode to achieve maximum cooling.

They are controlled remotely with the Electra remote panel.

The red button turns the air conditioners on and off.

Point the remote panel at each air conditioner in turn and press the red button.

The remote panel should indicate the following:

— There are six grey buttons.

— Left hand top grey button controls the fan speed. The lower right hand display indicates the fan speed setting. This should be set to six horizontal bars. This is the maximum fan speed setting.

— The center top grey button controls the air conditioner mode. The top left display indicates the mode. The mode should be set for maximum cooling. This is indicated by the six pointed frilly star. This is in position two of the five selectable modes.

— The two right hand grey buttons inscribed + and − select the desired temperature. The lower right display indicates the selected temperature. This should always be set to the minimum setting of 16 degrees. Press the minus button repeatedly until 16 degrees is indicated.

C.9 Dome ventilations openings

In order to improve the dome seeing openings were cut on the dome sides. Those opennings are open/close using a remote control that is places on the old telescope console. A common problem with operation of the opennings is that their power supply switch is often turns off - and the green lights on the power box on the dome goes off. In order to turn it on again the dome needs to be rotated so that the power box is near the stairs inside the dome, where it will be reachable. Then the green bottun needs to be pressed. Only then the remote control will be able to operate the sutters of the opennings.

References

Brosch, N. 1992, Q.J.R.astr.Soc. **33**, 27–32.

Dekker, H. and D'Odorico, S. 1985 *The ESO Faint Object Spectrograph and Camera*, ESO Operating Manual no. 4

Hilliard, R. 1989, *The FOSC User's Manual*

Krisciunas, K. *et al.* 1987, Pub. Astr.Soc.Pacific **99**, 887.

Landolt, A.U. 1973, A.J. **78**, 959.

Landolt, A.U. 1983, A.J. **88**, 439.

Landolt, A.U. 1992, A.J. **104**, 340.

Moffett, T.J. and Barnes, T.G., III 1979, A.J. **84**, 627.

Oke, J.B. 1974, Ap.J.Suppl. **27**, 21.

Stone, R.P.S. 1974, Ap.J. **218**, 767.

Vidal, N.V., Brosch, N. and Livio, M. 1978 The Observatory **98**, 60.

Vidal, N.V. and Feldman, U. 1974, Q.J.R.astr.Soc. **15**, 462.