Roque de los Muchachos Observatory

Isaac Newton Telescope

USERS' MANUAL

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The Isaac Newton Group of telescopes on La Palma is owned by the UK Science and Engineering Research Council and operated by the Royal Greenwich Observatory for the SERC in partnership with the Nederlandse Organisatie voor Wetenschappelijk Onderzoek (NWO) of the Netherlands, the Irish National Board for Science and Technology and the Dublin Institute for Advanced Studies.

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1 INTRODUCTION

1.1 Scope of this manual

This manual describes the operation of the Isaac Newton Telescope and its acquisition and guiding system from the user's point of view. Procedures for planning observations, opening up and closing down, controlling the telescope and dome, locating and tracking objects and using the integrating television system are presented.

The manual is divided into three parts. Part I covers sources of information, gives a general description of the telescope (section 2), and provides the information needed for advance planning of observations (section 3). Aspects of the telescope control and television systems at a conceptual level are discussed, which, although not strictly necessary for basic operation, should help in optimising, acquisition and detection of faint objects.

Part II (section 4) describes normal observing procedures in summary or checklist form. It is intended for quick reference during the night.

Part III contains reference material. Most users will be concerned only with sections 8, 10 and 12.3, which describe the telescope control, television systems and autoguider control, respectively, in detail. The other material concerns the full startup and shutdown sequences, test and calibration procedures, data logging and some trouble-shooting, which should only be required infrequently (*e.g.* after a power failure). For safety reasons, some calibration procedures may require privileged access to a programmer's account on the Perkin-Elmer computers; consult with the La Palma software group if you need it. Most of the operations and procedures described in these sections are anyway normally taken care of by the Telescope Operator.

The appendices contain information about the Perkin-Elmer telescope and instrument computers, as well as a listing of the pointing grid catalogue.

New users are invited to read sections 2 and 3, before consulting the more detailed reference sections as necessary.

1.2 Obtaining copies of this manual

This manual has been prepared using LaTeX. Copies of the current source for:

- the manual (`INT_MANUAL.TEX`);
- the "User Beware" list (`INT_BEWARE.TEX`);
- the "News" sheet (`INT_NEWS.TEX`).

are held on the La Palma VAX 8300 in directory `[MANUALS.INT_USER]`, along with their associated rasterized files, `.DVI-CAN`. New copies of the manual may be printed out using the commands:

- `WHT_GLASE [MANUALS.INT_USER]INT_MANUAL.DVI-CAN` or
- `INT_GLASE [MANUALS.INT_USER]INT_MANUAL.DVI-CAN`,

to give output on the laser-printers in the WHT and INT buildings, respectively. Copies are also held on the STARLINK node at RGO, in the directory `CAVAD::DISK$USER1:[MANUALS.INT_USER]`, although they may not be updated as frequently as their equivalents on La Palma.

1.3 Recent information: INT_NEWS and INT_BEWARE

Recent modifications to the operating procedures for the telescope will be included in the "INT_NEWS" sheet and filed with the control-room copy of this manual. Known faults and warnings, especially those affecting safety, are included in the "INT_BEWARE" list, which should also be filed with this manual in the control room.

> Any departures from the normal operating procedures for the telescope (because of faults, temporary repairs or testing) should be included in the current "INT_BEWARE LIST", which must *always* be consulted before proceeding further.

1.4 Getting help

The present manual is designed to be the main reference for telescope operation. Additional background information may be found in the *Observers' Guide* (1988 edition). In case of difficulty, consult your Support Astronomer or the Duty Technician. If they cannot answer your query, they can probably find someone who can.

1.5 Notation

The following conventions for computerese have been used more-or-less consistently throughout:

- Examples of commands entered at the terminal are presented in typewriter font, *e.g.* `DEC 12 34 56.78` or `SNAFU`. Command names are shown in upper-case, parameters (by name) are shown in lower-case.
- $\boxed{\text{KEY}}$ denotes a function key or labeled press button.

1.6 Acknowledgements

The authors wish to acknowledge the contributions of many colleagues to this manual. In particular we wish to thank Ann Charles, Jose Norberto Gonzales, Robert Laing, Alfredo Sevilla, Alejandro Vazdekis and Roy Wallis for providing many details of the operational and calibration procedures, and Chris Benn for proof reading.

2 THE 2.5-M ISAAC NEWTON TELESCOPE (INT)

2.1 Introduction

The Isaac Newton Telescope (INT) is a conventional Cassegrain-type telescope, mounted on a polar-disk mounting. The telescope building is located on the Canary Island of La Palma at an altitude of 2336 meters above sea level (ground floor) near the highest peak of the Caldera de Taburiente, an extinct volcano. Its geographical position is at longitude $17^\circ\ 52'\ 39.5''$ (W) and latitude $28^\circ\ 45'\ 43.2''$ (N). The telescope stands on its own pillar, separate from the rest of the building, with its base about level with the second floor (see Figure 1); the axes intersect at 14 meters above ground level. The observing floor and control room are found on third floor. A general desciption of the INT and the observing site can be found in *Vistas in Astronomy*, **28**, 1985.

The INT has a 2.54-m diameter primary mirror with a focal ratio of f/2.94. There are three focal stations, of which the f/3.29 Prime focus (with focal corrector) and the f/15 Cassegrain focus have been fully commissioned. The third, f/50 Coude focus was never implemented. Both Prime and Cassegrain foci are equipped with instrument rotators and autoguiders. In addition, the Cassegrain acquisition and guidance (A&G) box contains an integrating TV camera for field viewing. A second camera is attached to the wide-field finder telescope. This is used for locating guide stars for the autoguider and, to a limited extent, for field verification.

The telescope, the dome and shutters are normally operated by means of the dedicated telescope computer, which resides in a temperature-controlled clean room on the INT building's second floor, to the west of the void, the so-called CLIP centre. There one also finds power amplifiers for the telescope drive and much of the telescope, TV and Autoguider electronics. The Control Desk and System Console are located in the control room on the third floor, together with the Engineering Rack, which can be used, if necessary, for manual operation of the telescope system. (First-time readers may read section 2.6 at the end of this chapter before continuing.)

A separate Instrument Computer is located in a small room on the third floor, adjacent to the control room.

2.2 Mechanical design and Performance

The telescope has a polar disc/fork-type equatorial mounting, as illustrated in Figure 2, which is supported by five axial and three radial hydrostatic oil-bearing pads. The tube, a conventional open Serrurier truss structure, supports the Prime-focus assembly or the Cassegrain secondary mirror.

The telescope is operated under computer control and can be pointed to between -6 and $+6$ hours in hour angle, and from $-30^\circ\ 9'\ 30''$ to $+90^\circ$ in declination, subject to a maximum zenith distance of 70°. Operation below the pole is possible in principle but has never been implemented in practice. Note that the lower windshield causes vignetting for zenith distances $> 55^\circ$ and has to be raised for such observations. Figure 3 shows the area of sky accessible to the INT.

2.2.1 Pointing and Tracking

The telescope's position is determined by (Ferranti) Moire-fringe grating encoders mounted on each axis. There are three reading heads per axis, moving over a ruled stainless-steel tape. Each head produces a sinusoidal signal which is converted to a pulse train by a receiver in the CLIP Centre. These pulses are counted up (or down) by the so-called Grubb Parsons modules, whose values are transferred to a CAMAC register on receipt of a clock pulse. The registers are in turn read (at 0.1 s intervals) by the drive program. One encoder bit corresponds to 0.3 arcsec in RA and 1.0 arcsec in Dec, although systematic errors are currently somewhat larger. These errors have been partially calibrated, but still limit the absolute pointing of the telescope. The pointing accuracy of the telescope under computer control, using a regularly updated pointing model, is about 5 arcsec rms. Note that the offset accuracy is unreliable in declination at a level of 1-2 arcsec.

Because the Ferranti encoders are of the incremental type, their zero points have to be determined.

Figure 1: The INT building viewed from the east; north-south cut through the Dome. The ground floor is 2336 metre above sea level.

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Figure 2: Schematic views of the INT from the east and north.

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Figure 3: The area of sky accessible to the INT. Lines of equal zenith distance are drawn on a plot of declination against hour angle.

This is done by means of two zeroset modules, one for each telescope axis. The modules contain proximity sensors which detect targets positioned at HA = 0 and Dec = Latitude (*i.e.* corresponding to the telescope pointing towards zenith). Once a target is detected, when moving the telescope for this purpose, the "ZEROSET" procedure (section 11.1), a pulse is produced which persuades the hardware to reset the counters to zero.

A pair of powerful motors driving though spur gearing are used for the quick motion, *slew*, of the telescope; they also provide the anti-backlash preload. The maximum slewing speeds for hour angle and declination are 0.5° s^{-1} and 1.3° s^{-1}, respectively.

The slow-motion drives on both telescope axes are provided by a pair of DC servo motors with integral tachogenerators. The RA axis is driven by a worm/wormwheel assembly and the Dec axis by a recirculating ball screw and nut. Because of its appearance the latter mechanism is known as the "Banjo". When the telescope is being driven by the slow-motion motors, *e.g.* when tracking, optical incremental (Baldwin) encoders, with resolutions of 0.01875 and 0.01 arcsec in HA and Dec, respectively, are used. These encoders are mounted on the slow-motion drive shafts, which are disconnected from the telescope during a slew in quick motion. Consequently, the Baldwin encoders are not used unless the slow-motion clamps have been engaged. The guided tracking accuracy (using the autoguider) is better than 0.3 arcsec. Unguided tracking is accurate to 1 arcsec over a time period of 3 minutes, and accurate to 2 arcsec over 10 minutes.

Table 1: Summary of Mechanical Performance

Telescope Limits	Hour Angle Declination Zenith Distance	from -6^h to $+6^h$ $> -30^{\circ}\,09'\,30''$ $< 70^{\circ}$; beware vignetting by windscreen for ZD $> 55^{\circ}$
Pointing Accuracy	Global Fit Offset in Dec	*rms* residual = 5 arcsec. unreliable at 1-2 arcsec level
Tracking Accuracy	*un*guided guided	$<$ 1 arcsec in 3 minutes $<$ 2 arcsec in 10 minutes $<$ 0.3 arcsec
Quick Motion	Right Ascension Declination	up to $0.5^{\circ}s^{-1}$ up to $1.3^{\circ}s^{-1}$

2.3 Optics and optical performance

The optical system of the INT is a conventional Cassegrain configuration with a paraboloid primary mirror and a hyperboloid secondary. The primary has a diameter of 2.54 m and a focal length of 7.475 m, giving a focal ratio of f/2.94 at the *uncorrected* primary focus. The mirror is made of Zerodur and has a negligible coefficient of expansion: $< \ 10^{-7}/^{\circ}K$. On axis, 80 percent of the light from a stellar image lies within a circle of 0.3 arcsec diameter, as shown in Figure 4 at the end of this chapter. Table 2 and table 3 summarize the optical characteristics of the INT.

Table 2: Summary of mirror characteristics for the INT

Element	Shape	Asphericity	Working Diameter (mm)	Focal length (mm)	Separation from primary (mm)	Material
Telescope						
Primary	Paraboloid	-1	2540	7475		Zerodur
Secondary	Hyperboloid	-2.214	531	-1813	6017	Fused Silica
Finder						
Primary	Paraboloid	-1	405	2104		Pyrex
Flat	Flat		135		1600	Low expansion glass

Table 3: Optical characteristics of INT foci

Focal Station	Focal Length (mm)	Focal Ratio	Field Diameter (arcmin)	Scale (arcsec mm^{-1})	Central Obstruction (mm)	Notes
Prime (uncorrected)	7475	f/2.94		27.6	914	
Prime (with corrector)	8357	f/3.29	40 (52)	24.7	914	1
Cassegrain	38130	f/15	20 (22)	5.41	914	1,2
TV finder	2104	f/16	15	98	139	

Notes to Table 3:
1) Numbers between parentheses indicate the field diameter for 50% vignetting.
2) A unit movement of the secondary mirror corresponds to a focal shift of 27 mm.

A focal corrector of the type described by Wynne (1974), but with a flat rear surface and increased back focal distance, is used at the Prime focus in order to enlarge the useful field, where the images should be < 0.5 arcsec over the unvignetted field. The corrected focal ratio is f/3.29. The three elements of the Prime-focus corrector are made of UBK7 glass, coated to minimize reflections and thus improve efficiency and reduce ghosts. The first two elements are not interchangeable and have a broad-band, single layer MgF_2 coating. The rear element of the corrector, however, is available in several coating options, summarized in Table 4 below.

Table 4: Coating options for rear element of INT prime focus corrector

Waveband	Coating	Useful Range (Å)
Broad Band/Blue	Single layer MgF_2 matching first two elements	3500-7400
UV	Single layer MgF_2	<5000
V and R	Three-layer $MgF_2 + ZrO_2 + Al_2O_3$	4300-8000
R and I	Three-layer $MgF_2 + ZrO_2 + Al_2O_3$	6000-11000

Single-layer coatings produce reflectivities smaller than 2 percent per refracting surface over the appropriate wavelength range. Three-layer coatings give reflectivities of less than 0.5 percent per surface, but the performance deteriorates very rapidly (to worse than for uncoated glass !) outside the useful wavelength range. Most observations are done using the broad band/blue corrector. Note that changing from one rear element to another is a major operation and a day-time job. Frequent changes are strongly discouraged.

The Cassegrain secondary mirror gives a focal ratio of f/15. Spot diagrams for this focus are shown in Figure 5 at the end of this chapter.

2.4 Telescope control

The INT is controlled by a Perkin-Elmer 3220 computer interfaced through CAMAC. The software drives the main HA and Dec axes, the Cassegrain Instrument Rotator, the Focus and the Dome and Shutters, and the computer provides an interface to the Autoguider.

The Telescope Operator interacts with the telescope via commands typed at the User Interface terminal, to be found in the control room, or by pushing buttons on the Control Desk or the handset, *e.g.* to make the telescope slew or adjust the tracking rate. These buttons are of a special design which ensures that, even when held down, the actions are only performed once, except for the guider buttons, which act continuously. Most of the buttons acknowledge that they have been pressed by lighting up.

Data can be entered into the control system via the User Interface. In particular, it is possible to set up a catalogue with position of up to 500 objects, which is held in memory. The coordinates may be entered with simple commands or loaded from disc files: catalogues of photometric, spectrophotometric, and astrometric standards are available. Further, one may enter telescope parameters such as offsets or tracking rates.

2.4.1 Control Tasks

The control software is written in FORTRAN (with a minimum of assembler) and is, in fact, applicable to both INT and JKT. The differences between these telescopes are handled by Control Files with system parameters, which are read in when the software is being initialized at the start of an observing session.

The system control is organized as Tasks, which may run simultaneously or separately. The principal task, "TNHZ", is, of course, the one that drives the telescope, and, therefore, is active throughout. Other tasks that control the Dome, the Cassegrain Instrument Rotator, or Focus are run only intermittently, obviously because they are not needed all the time, and even then these functions do not need to be controlled to the same accuracy as the telescope itself. Yet another task is run every two seconds or so and drives the Information Display, on which such parameters are shown as the source name and its sky position, aperture offsets, differential tracking rates, the current pointing and focus of the telescope, and the location of the dome aperture.

The main control task for the telescope drives (TNHZ) runs at 10 Hz. A cycle consists basically of three steps. First, the actual encoder positions are read and the time is obtained from the Time Service rack in the CLIP Centre. Subsequently, the desired encoder values (for that moment) are calculated: The program calculates the position of a virtual telescope, without pointing defects, taking into account non-sidereal tracking rates, offsets, handset demands, autoguider error signals, as well as precession, nutation, aberration and atmospheric refraction. All calculations are performed in the proper coordinate system, as specified by the observer (mean or geocentric apparent). Finally, a parameterized model of the telescope's pointing (Section 2.4.2) is applied in order to produce a desired position reading for the encoders, which is compared with the true reading. If necessary, velocity corrections are applied to the drive motors in order to zero the position errors.

For large errors the velocity correction will be proportional to the square root of the error, within the mechanical limits; if the error is small, the correction will be approximately proportional to its magnitude. When a slew to a new object is requested, the slow-motion clamps are initially released and the telescope is driven in quick motion until it is within a few hundred arcsec of the object. The clamps are then re-engaged and final acquisition is made in slow motion, using the high-resolution Baldwin encoders for smooth tracking.

The telescope RA, Dec and Zenith Distance, as well as the universal and sidereal times, are output to the dedicated Beckmann Display on the Control Desk at 0.1 s intervals.

2.4.2 Pointing Model

The pointing model for the INT has 17 terms, comprising the standard errors of an equatorially-mounted telescope (offsets in HA and Dec, collimation error in HA, misalignment of the polar axis and non-perpendicularity of axes), together with an empirical (Fourier series and polynomial) model of flexure in the telescope structure and large-scale errors in the Ferranti encoder readings. The (software) zero point of the pointing model is determined with the “SNAFU” procedure (section 11.1). If pointing tests are made sufficiently frequently in order to update the pointing model, the *rms* error in the absolute pointing of the INT should always be better than 5 arcsec: values between 2.8 and 4.5 arcsec have been measured. Short-term tracking errors are <0.25 arcsec (there is a small residual oscillation at about 1 Hz in HA). Longer-term drifts should be removed by engaging the autoguiders.

2.4.3 Engineering Mode

The Engineering mode serves to move the telescope hardware without using the computer. This is done by technical staff to move the telescope for such jobs as top end changes or by the Telescope Operator for the initial setting up at the start of the night. Engineering Mode is the default mode on powering up the system; telescope control is from the Engineering Rack in the control room, placed conveniently close to a window from which the telescope can be seen. A blind is drawn over this window when the telescope is under computer control.

The telescope is protected from being driven outside a safe operating regime by the use of limit switches. When under computer control, the telescope is normally protected from running into these limit switches by the software. If, however, due to exceptional circumstances or faults (*e.g.* CAMAC or encoder failure), the telescope runs into a limit switch when under computer control, that control is lost completely. Then, the telescope can only be driven out of the switches by changing to the Engineering Mode and in all likelihood the zeropoint of the encoders will be lost. Therefore, the encoders will have to be re-initialized (section 11.1.1).

2.4.4 Alarms

There is a set of warning lights on the Control Desk which signal major changes of state and/or situations which could endanger the telescope hardware. Alarms can be of various types and upon no account should any be ignored. You will be unable to ignore an alarm anyway because, when an alarm occurs and a warning light comes on, the system also trips a relay which sounds a high-pitched, loud and very irritating whistle. A typical contingency (which we hope will never occur) would be a loss of oil pressure in the hydrostatic telescope bearing.

A failure of the air conditioning system will activate an alarm in the Air-Conditioning Plant room located outside the Control Room on the roof.

Normally, the Telescope Operator or Duty Technician will cope with these situations. Nevertheless, just in case, there is an emergency STOP button on the top-lefthand side of the Control Desk. Actually, certain fault conditions are best handled by using the emergency stop, such as encoder or CAMAC failures, which can cause a run away motion of the telescope.

2.5 Acquisition and Guiding

2.5.1 TV Cameras

Low-light-level, integrating television cameras are mounted on the finder and the Cassegrain focus of the main telescope. Picture integration is possible either on the camera target or in digital memory. A

Grinnell image display is used. The limiting magnitudes (in good seeing and transparancy) against a dark sky are fainter than V = 21.5 mag and V = 18.5 mag for the Cassegrain and finder cameras, respectively and approximate aperture photometry should be possible (in theory). Given that the INT points well, the most important use of the finder is the selection of guide stars for the Prime and Cassegrain autoguiders. The Cassegrain TV camera is used for acquisition and for guiding on light reflected from the spectrograph slit jaws (section 12.2.1). It is possible to archive a camera image on disc.

2.5.2 Autoguiders

Both the Prime and Cassegrain foci are equipped with autoguiders. The two systems are identical and have FW-130 image dissectors with S-20 photocathodes as detector. The autoguiders are controlled by a dedicated Micro Processor, which continuously analyses the image of a guide star, and provides small corrections to the telescope tracking (just two numbers) via the interface polled by the PE 3220. That is, of course, their main function, but they also monitor transparency and seeing. The guide-star image and seeing data can be displayed on a VDU in the Control Desk for inspection.

In order to acquire a guide star, a prism mounted on the end of a probe is moved to its position, which either can be measured in advance and entered via the User Interface, or it can be determined by using a cursor on the finder TV picture (see section 12.3).

Figure 4: Spot diagrams for the prime focus of the INT with the three-element corrector at different wavelengths and field radii. The scale is shown by a circle of radius 1.0 arcsec.

Figure 5: Spot diagrams for images at the f/15 Cassegrain focus of the INT, showing the dependence on field radius and the effects of defocussing.

2.6 A Guided Tour of Telescope Control Room and Environs

This section is intended as an introduction to the "geography" of the Telescope Control Room, in order to familiarize the reader with the location of various parts of the telescope control hardware and electronics.

For a start, the Telescope Control Room is located on the third floor of the INT buiding, on the North side of the observing floor and telescope. See Figure 6 for a ground plan. Access to the control room is via one of two staircases located on the East and West side. The staircase on the West side runs near the library on the first floor. When entering the control room through the West entrance, we encounter the following pieces of hardware (all on your right):

- **Instrument Desk and Data Monitor**
  These units are part of the instrument control hardware (*e.g.* for the IPCS) and the data acquisition system, and as such, do not function in the control of the INT itself. The "Data Monitor" consists of an ICS terminal of the PE 3210 Instrument Computer and a Lexidata display. The astronomer normally sits at this terminal with students sitting at the observer's feet and the support astronomer standing behind the chair. An important item at the top of the IPCS control desk is the instrument MIMIC display. A MOTOROLA EXORSET stands on a trolley to the right of the desk. It is not part of the regular instrument-control system, but is a valuable aid in diagnosing faults on the A&G box and Spectrographs.

- **Control Desk**
  This is the large panel with push buttons, TV monitors, keyboards, displays, *etc*, and has everything to do with the INT. It is the fiefdom of the Telescope Operator. A diagram of its layout is shown in Figure 7. There are, starting from the left, four sections, which each control a separate subsystem:

  1. The System Status Panel, which shows you everything about the system's health and holds the alarm lights. In the top left-hand corner is the emergency STOP. Here one also finds switches for telescope power, for the selection of computer or engineering mode, and the Dome lights. There is a monitor to which the Operator can route any of a selection of displays: the Information, Autoguider, or MIMIC display, or the digitized image from the Grinnell integrating TV system.
  2. The System Control Panel (SCP): A group of push buttons and a handset which enable function such as slew, offset, or tracking adjustments. The monitor here always carries the Information Display.
  3. Autoguider Panel: The autoguider is controlled by its own micro processor with the buttons in the lower part. Above those is the data-logging monitor, which is driven by the IBM PC standing on top of the desk, and interfaces with both the MIMIC display and the Information Display. Further, at the top of the desk are the Beckmann displays of RA, Dec, Zenith Distance, LST and UTC.
  4. Acquisition and Guidance Panel (AGP): A group of push buttons which control the movement of the TV camera and the Guide Probes in the A & G box. On top are four miniature monitors which carry the analogue TV pictures. Below them is the Grinnel digitising TV image display.

- **User Interface**
  The terminal used by the Telescope Operator to interact with telescope-control software. It consists of a VT320 terminal and currently lives on a trolley standing to the left of the Control Desk. Pointing instructions and Data input, *e.g.* catalogues, to the telescope-control program are via this terminal.

- **Engineering Rack**
  A tall blue rack standing on the east side near the observing floor window. It serves for manual control of telescope functions during start up or a top-end or instrument change. The monitor on

top is slaved to the one in the left-hand bay of the Control Desk. Standing right beside the Rack is the:

- **Weather Monitor**
  Which tells you all about how things are outside. Most annoying here are the humidity meter and the anemometer, which sometimes persuade the Telescope Operator to close the dome, *i.e.* when the relative humidity is more than 90 percent, and/or the wind speed rises above 80 km/h.

- **System Console**
  The VT 320 terminal used by the Telescope Operator to communicate with the PE 3220 telescope computer at the system level, *e.g.* to start up the telescope control software. The terminal currently stands on a desk on the far side of the Control Room window, as seen from the Control Desk.

- **VAX terminal and Instrument Computer terminal**
  Both stand on a desk at the far (east) end of the control room. The terminal to the PE 3210 Instrument Computer should *never* be used during observing, as using it can slow down, or even halt, the data taking. The VAX terminal has nothing to do with the INT. However, you can access the VAX 8300 with it, so that you can read your email during long exposures.

Further, notice against the wall opposite the Control Desk the bookcase with various manuals and other documentation, and the notice board (read it !). Please return the manuals tidily after use.

Apart from the Control Room one might familiarize oneself with:

- **Observing Floor**
  During observing, access to the observing floor is normally only needed to change optical components of the IDS. In order to keep those components at ambient temperature, they are stored in a steel cupboard standing against the SE wall. Unless observers are thoroughly familiar with the IDS, they should leave such changes to their support astronomer.

- **CLIP Centre**
  This is a temperature-controlled clean room on the floor below the console room, west of the void, near the west staircase, which houses the Perkin Elmer 3220 Telescope Computer (See section 7) and other telescope hardware and electronics, such as the power amplifiers for the telescope drive and the autoguider electronics. There is a second Local (System) Terminal for local control of Telescope Computer. The CLIP Centre also houses the Time Service.

- **The Instrument Computer Room** This is the room directly on your left when you enter the Control Room. It houses the Perkin Elmer 3210 Instrument Computer, which handles the data acquisition (section 9). The computer comes with two tape decks, an EGLE disk drive, a line printer and a system console. There is also a rack with a fresh supply of magnetic tapes, for you to take home with excellent data.

Figure 6: Ground plan of Observing Floor and INT Control Room

Figure 7: The Telescope Control Desk

3 PLANNING OBSERVATIONS

The observer will need to consider target coordinates, finding charts, guide stars, catalogue formats, and possibly blind offsets. The requirements are slightly different depending whether observations are made at Cassegrain or Prime focus.

3.1 Acquisition and Guiding at Cassegrain

- **Acquisition.** A Westinghouse extended S20 TV camera views a $1.8' \times 1.8'$ square of the $20'$ diameter unvignetted Cassegrain Field (on or off axis). The TV display includes labels giving orientation and scale. It is possible to store TV images, which is useful during good seeing for recording high spatial resolution images of the target. A filter wheel containing up to 4 circular filters is loaded. The filters currently available are green(BG28), blue(BG38), red(RG630) and clear (UBK7). The effective magnitude limit for the acquisition camera is 21.5 magnitude in integrating mode.
- **Slit Viewing.** A simple movement of the flip mirror allows viewing of the light reflected from the slit jaws using the acquisition TV. This allows visual confirmation of the positioning of the the target on the entrance aperture of the instrument, as well as an estimate of the seeing profile.
- **Autoguider.** The autoguider allows offset guiding using stars anywhere in a 90 square arcmin field (see Figure 3 for available area). Guide stars should have magnitudes in the range $7< m_v <14$, and should ideally be selected in advance of the observing run. Care must be taken to avoid selecting a guide star so positioned in the field that the autoguider probe obstructs the on-axis star-beam.

  Alternatively, an overlay showing the IDS slit and the area within which guide stars may be selected can be superposed on the TV image of the finder field. A guide star is then selected visually and the A&G unit autoguider probe directed to that position. There is a filter wheel in the autoguider beam allowing up to four circular filters green(BG28), blue(BG38), red(RG630) and clear (UBK7).

3.2 Acquisition and Guiding at Prime

This is mainly used with the prime focus CCD camera. The A&G unit is mounted on a rotator which allows the detector to be rotated to any position, although it is normally operated at one of the cardinal points. The default orientation is 180 degrees.

- **Acquisition.** No direct viewing of the field is available for the prime focus. The telescope points sufficiently accurately that any object with a reasonably accurate position can be acquired close to the centre of the CCD detector. This can be verified using a short CCD exposure.
- **Autoguider.** The prime focus autoguider is identical to that at Cassegrain. The detector is an FW-130 image dissector with an S-20 photocathode. There is a single filter, at present a broad-band green filter. Ideally guide stars should be selected in advance of the observing run, using Figure 15 which shows the area of sky within which guide stars may be selected.

  Alternatively they may be selected from the finder telescope and then acquired by scanning a $2.5' \times 2.5'$ area around the selected position. Stars with magnitudes in the range $7< m_v <14$ will probably be suitable. There is an overlay of the TV image which shows the area from which guide stars can be chosen. To get this overlay the TV camera must be on when we start ADAM. By default the system displays the Cassegrain overlay.
- **Important** At prime focus you must select the guide star before you start the exposure.

3.3 Finding charts, coordinates and blind offsets

The pointing accuracy of the INT is sufficiently high that acquisition onto the centre of the TV field (within $15''$ say) is usually possible. Positions should therefore be measured to better than 5 arcsec. A finding chart is necessary for all but the brightest targets. It should cover an area somewhat larger than the field of the acquisition TV, with orientation and scale clearly marked. A $10'$ square is about right.

Two coordinate systems are supported : mean pre-IAU76 and geocentric apparent at the time of observation. Neglect of the difference between pre- and post-IAU76 systems gives rise to a maximum error of about 1 arcsec in practical cases, which is small compared with the pointing error. Optional parameters are proper motions (often needed for white dwarfs used as spectrophotometric standards,) where the epoch is assumed to be the same as equinox, and differential tracking rates in RA and Dec, (needed for solar system objects). Conversion of target coordinates can be performed with the COCO package (Starlink User Note 56) beforehand in the UK, or on the VAX 8300 at La Palma.

If the target is fainter than about 20 magnitude, it will not be visible on the acquisition TV and a Blind Offset will have to be performed, (see Section 4.12 for details of indirect methods). The offset star should preferably be within an arcmin of the target, and should be in the magnitude range 9 to 16 mag. The difference in position between the target and blind offset must be measured to arcsecond accuracy before arriving at the telescope. Blind offsets by moving the telescope are not currently reliable in Dec (errors of $1 - 2$ arcsec are possible) on the INT. However subarcsecond accuracy is easily achieved by moving the probe of the autoguider.

3.4 Observation Catalogues

Target coordinates are normally supplied to the telescope computer by means of an observation catalogue. This must be typed in directly through the user interface or using an editor. If you have an extensive catalogue, this is best done in the afternoon before you start observing. Catalogues can of course be saved to disc, so they are available from night to night, but will normally be deleted at the end of an observing run. The telescope computer now has a tape drive and files can be transferred from the VAX 8300 on a scratch tape. This is a clumsy procedure and advance notice is necessary.

Positions of guide stars selected in advance of the observing run should be entered in the catalogue in the normal way.

3.4.1 Catalogue format

A catalogue for the telescope computer is a set of User Interface commands, (see chapter 8) exactly as typed in at a keyboard. Minimum matching is used, and portions of commands which may be omitted are given in brackets (*e.g.* the command SOURCE may be shortened to SO). Spaces or semi-colons may be used as separators, the latter being essential if the command is abbreviated (see RA and DECLINATION, below). Anything following an asterisk is treated as a comment and is ignored. The following user interface commands are relevant:

- **SO(URCE)** defines a new catalogue entry. The format is SOURCE name. A source name may have up to 20 alphanumeric characters. Embedded spaces are forbidden, unless the name is enclosed in double quotes.
- **R(A)** enters the Right Ascension. The format is R hours, minutes, seconds. The last two are optional, but the command must be terminated by a semi-colon if they are omitted. Spaces are not required between the hours, minutes and seconds but it doesn't matter if you put them in.

- **D(ECLINATION)** enters a declination. The format is D degrees, minutes, seconds. Again, the minutes and seconds may be omitted if the command is terminated by a semi-colon. Spaces are not required between the degrees, minutes and seconds but it doesn't matter if you put them in.
- **EQ(UINOX)** for mean positions, a leading letter indicates the coordinate system:
  B implies mean pre-IAU76 or FK4 (default)
  J implies mean post-IAU76 or FK5

  A number indicates the epoch of the mean equator and equinox of that system (*e.g.* B1950.0, J1987.5).

  The remaining option is APPARENT (abbreviable to A), for which no equinox is required.
- **P(ROPER-MOTION)** sets the proper motions. The corresponding epoch is assumed to be the same as the equinox.
- **/R(A)** proper motion in RA in sec yr^{-1}
- **/D(ECLINATION)** proper motion in Declination in arcsec yr^{-1}.
- or **/B(OTH)** both proper motions

A catalogue may be in free format. For legibility and neatness, however, it is worth adhering to a more rigid tabular format with one object per line of the file. The format should be as follows:-

- The file should consist of 80-byte records (*i.e.* maximum of 80 characters per line).
- The filename must consist of up to 8 alphanumeric characters, starting with a letter, and must have the extension '.CAT'.
- There should be no non-alphanumeric characters such as tabs anywhere in the file.
- A line specifying default parameters and the coordinate type should be given at the beginning of the file, for example:

  `.DEFAULT EQUINOX B1950 P/R 0.0 P/D 0.0`

  sets the default equinox to 1950 and the default proper motions to zero and specifies mean coordinates. If these parameters are not specified explicitly for objects in the file, then they will take these values. These are in fact the default values if DEFAULT is not included.
- The format should be:

  SO OBJECT R hh mm ss.ss D +dd mm ss.s P/R +s.sss P/D +s.sss EQ Byyyy.y

  with the coordinate type, proper motions and equinox omitted if they do not change from the default values.

3.5 System Catalogues

The catalogues currently available at the INT are:

- **PTGRID**: a grid of stars for pointing calibration.
- **SPECPHOT**: a catalogue of spectrophotometric standards with accurately known positions and proper motions.
- **UBVRIxxx**: a set of catalogues of photometric standards for imaging, based on the Landolt equatorial standards.

4 OBSERVING WITH THE INT: RECIPES

This section describes the basic operations of observing with the Isaac Newton Telescope in the the form of itemised "recipes". The recipes are necessarily presented as a checklist of things to do, and are primarily intended as reference for experienced users of the Isaac Newton Telescope. Many of the individual actions are described in full detail in the reference sections of this manual; some items themselves stand for another checklist in this section.

4.1 Starting up the INT

See for full details Chapter 5.

1. Confirm handover with Duty Technician.
2. Fill the cryostats.
3. If the dome temperature is higher than that of the outside air, then:
   (a) Move the dome to azimuth 90 degrees, and open up 1 metre.
   (b) Check that the EXTRACTOR fan by the telescope base is on, and that the INPUT fan on the ground floor is on.
4. Read the Telescope Logbook and check INT_BEWARE documentation for reported faults or hazards.
5. Check T/S DOME STOP is active.
6. Take ICONA Meteorological readings (optional).
7. Input files of standard stars and target objects into the PE 3220 Telescope Computer (see section 8.5.5.
8. EXTRACTOR fan ON, if not already done.
9. INPUT fan ON, if not already done.
10. Shut all doors and window blinds.
11. White lights out.
12. Remove dome fan covers, if not already done. Dome fans on.
13. Dome access doors closed.
14. Dome lights out.
15. Open Dome fully.
16. Finder cover open.
17. Do a ZEROSET (see section 11.1.1)
18. Primary mirror plug out (Cassegrain focus only).
19. Secondary and primary mirrors open.
20. Telescope in Computer Mode.

21. TV Camera(s) and Autoguider on.
22. Input SET, GUIDE and INCREMENT rates, if other than default values used.
23. Focus the Telescope (see section 4.9 or 11.2).
24. Do a SNAFU (see section 4.7 or 11.1.2)
25. Determine Finder Zero Point

4.2 Closing down the INT

See for full details Chapter 6.

1. TV Camera(s) and Autoguider OFF.
2. Press $\boxed{\text{ZP}}$ to move telescope to zenith.
3. Close PRIMARY and SECONDARY mirror covers IN THAT ORDER.
4. Switch over to Engineering Mode.
5. Close dome shutters.
6. Switch off dome fans; replace covers.
7. EXTRACTOR fan off.
8. INPUT fan off.
9. Close the Finder Cover.
10. Move Telescope to Park Access position.
11. (Cassegrain only) Replace Primary Mirror Plug.
12. (Cassegrain only) Move Telescope to Zenith under computer control.
13. Press the $\boxed{\text{EMERGENCY/STOP}}$ button.
14. Switch Oil Pump OFF.
15. Top up the Cryostat(s) with Liquid Nitrogen.
16. Check/close dome access doors.
17. Close down Telescope Control Software.
18. Shutdown ADAM (unless a flatfield is being taken).
19. Complete Log Books.

4.3 Startup and Shutdown of the PE 3220 Telescope Computer

- **Normal Startup:** Type at the Telescope Control System Console:

  `*D D`

  If MSMD: is OFF, then type:

  `*MA MSMD:,ON,,CD=ALL`

  When MSMD: is ON, then type:

  `*GO INT`

- **Shutdown:** Type at the Telescope Control System Console:

  `*FINISH`

  `*MA MSMD:,OFF`

- **Reboot after a power cut** Press INIT on CPU consolette

  Boot the computer by answering:

  ENTRY=`3`

  FILE=`MSMD3220.LPO`

  and wait for the message: "END OF ENVIRONMENT CONFIGURATION"

  To start the control system, type at the System Console:

  `*GO INT`

  If there has been a power failure initialize the CAMAC crates associated with the PE 3210 (see section 7.3.3).

4.4 Startup and Shutdown of the PE 3210 Instrument Computer

- **Normal Startup:** Type at the ADAM terminal:

  `*SI ABC, n, DEF`

- **Warm Restart** (after a controlled shutdown):

  Power up the EGLE: disc (On with 3 lights)

  `*D D` at System Console

  `*MA EGLE:,ON,,CD=ALL`

  `*STARTUP` to give END OF ENVIRONMENT CONFIGURATATION

  `*SI ABC, n, DEF` at the ADAM terminal

- **Cold Restart (after power failure)**

  Mains supply ON.

  Power up the EGLE: disc (On with 3 lights).

  Press the INIT switch on the PE3210 consolette.

  Answer `DSC2` and `EGLE3210.LPO` to prompts at system terminal.

  Await END OF ENVIRONMENT CONFIGURATION

  `*SI ABC, n, DEF` at ADAM terminal

- **Stopping** the PE 3210:

  *`SIGNOFF` at all terminals

  *`STOPALL` at System Terminal

  *`OFF`

  *`MA EGLE:,OFF`

4.5 ZEROSET

For full details see chapter 11.1.1.

1. Position the telescope at zenith.
2. Drive the telescope a few degrees away from zenith by pressing the **positive** direction buttons $\boxed{+}$ on the handset, in both Right Ascention and Declination.
3. At the User Interface do:

   UI–> `ZEROSET`

   The two red encoder/zeroset lights on the Control should light up. If not, go back to step 2 and move the telescope a bit further from zenith (consult section 11.1.1).
4. Set the speed controls on the Engineering Rack to the marked positions.
5. Drive the telescope back through the zenith by pressing the **negative** direction handset buttons $\boxed{-}$ until the lights on the Control Desk go out and a message appears on the User Interface to the effect that the ZEROSET has completed.

4.6 Acquiring an object

4.6.1 Slewing to an object

If not done before, enter the coordinates of the object, equinox and proper motions via the User Interface (see section 8.5.3):

UI–> `SO(URCE) source-name`

UI–> `R hh mm ss.ss`

UI–> `D dd mm ss.s`

UI–> `EQ Byyyy or Jyyyy`

UI–> `P/R s.sss` (optional)

UI–> `P/D s.sss` (optional)

When the coordinates of your object are stored in the catalogue do:

UI–> `NEXT source-name`

UI–> `GO` , or press the $\boxed{\text{SRCE}}$ button on the Control Desk.

If the object is within the software limits, then the green **go** lamp will light up and the telescope will commence slewing. If the object is beyond the limits, then the **go** lamp will only flash briefly and the red **stop** lamp will be lit. Appropriate messages will also be output to the Information Display (see section 8.7).

4.6.2 Using the Handset and Guide Buttons

The guide buttons on the handset and the 'arrow' buttons at the top left-hand corner of the SCP have identical functions. Those on the handset are ostensibly dual-pressure, but the first pressure has been disabled on grounds of unreliability.

Selection between the SET, GUIDE and INCREMENT modes is made with the buttons at the bottom left-hand side of the Control Desk. The $\boxed{\text{SET}}$ and $\boxed{\text{GUIDE}}$ modes give continuous motion while $\boxed{\text{INC}}$ moves the telescope in steps.

The set and guide rates and incremental step size can be defined at the User Interface withe the HANDSET command (see chapter 8). Enter new values with:

UI–> `HA/S set-rate` ($''$ /sec)

UI–> `HA/G guide-rate` ($''$ /sec)

UI–> `HA/I increment` ($''$)

However the new value will only become active **after** the $\boxed{\text{SET}}$, $\boxed{\text{GUIDE}}$ or $\boxed{\text{INC}}$ button is pressed.

4.6.3 RA/Dec Offsets

The telescope may be offset from its current position with an RA/Dec offset, for example to move an object with known offset position onto the reference point or spectrograph slit. The offset is made in the same coordinate system as specified for the input source and is currently implemented as an offset in arcseconds East and North in a tangent plane projection centred on the current tracking centre. The value of the offset is entered via the User Interface by typing:

UI–> `OFFSET/RA value`

UI–> `OFFSET/DEC value`

The values are specified in arcseconds. They are introduced into the telescope tracking when the $\boxed{\text{OFFSET}}$ button on the Control Desk is pressed. The OFFSET lamp will then be lit and the value of the offset will be shown on the Information Display. Offsets are **not** cumulative, *i.e.* pushing the offset button again will not cause a further offset.

Offsets in Declination are notoriously inaccurate. Therefore, some adjustment afterwards to the position of the translated object may be required; this implies that that object should be visible on the TV probe. If you want to do an offset on an object too weak to be seen on the TV probe, then it is better to use the autoguider probe for a blind offset, as described in section 4.12.

4.7 Single-Star SNAFU at Cassegrain

Perform a Single star SNAFU in order to determine a software zeropoint for the Pointing Model (see section 11.1 for a full description). It is recommended to use a star within 2 degrees from the zenith if afterwards the finder zeropoint has to be determined (using the same star).

The SNAFU at the **Cassegrain** Focus is done as follows:

1. Move the telescope to the SNAFU star.
2. Wait until the telescope is tracking accurately.
3. Type at User Interface:-

   UI–> `SNAFU`
4. Turn up the gain of the Cassegrain TV until the star is clearly visible and use the handset to place the star at the reference position on the spectrograph slit.
5. Press the $\boxed{\text{ACK}}$ button.

4.8 Single-Star SNAFU at Prime

See section 11.1.4 for full details:

1. If not yet done startup ADAM.
2. Move the rotator to position angle 180° with the ADAM command `ROTPOS 180`.
3. Slew the telescope to the SNAFU star, as for Cassegrain mode.
4. Take a test GLANCE exposure of the field (1-5 seconds; use filters if the star is very bright). The CCD image will appear on the LEXIDATA and the star should be visible near the centre of the chip.
5. Use the Grinnell MOVESTAR command, and locate the star with the cursor. The telescope will move and the star will move on the Finder TV image.
6. Mark the position of the star now on the Finder TV screen with a felt pen or similar marker.
7. Move the telescope again to the original position by pushing the $\boxed{\text{SCRE}}$ button.
8. Type at the User Interface:

   UI–> `SNAFU`

   and move the telescope with the handset such that the star image on the finder coincides with the position marker put in step 6.
9. Press the $\boxed{\text{ACK}}$.

4.9 Focusing the telescope

4.9.1 Using the Handset

The simplest way of focusing the telescope is to use the focus $\boxed{+}$ and $\boxed{-}$ buttons on the handset. These are actually dual-pressure buttons, designed to give slow and fast focus for first and second pressure, respectively. The fast focus drive is currently disabled in computer mode, so the handset gives slow drive for either pressure.

4.9.2 Via the User Interface

Set the telescope focus to a known value as follows.

1. Type at the User Interface:

   UI–> `FOCUS value`

   where the focus `value` is in `mm` (as on the Information Display; note that the units on the engineering display are 0.01 `mm`).

2. Press the FOCUS $\boxed{\text{NOM}}$ button on the Control Desk. The focus will then drive to the value defined before, and the red **focus stop** light will come on when it is in position.

4.9.3 From the Engineering Rack

This is recommended when the focus is grossly out of position, because it provides the only way of driving quickly.

1. Either (a) depress the FOCUS $\boxed{\text{SELECT/MANUAL}}$ button (the button must be illuminated), or (b) select Engineering Mode by pressing the $\boxed{\text{ENG/COMP}}$ button.

2. Select FOCUS $\boxed{\text{FAST}}$ or $\boxed{\text{SLOW}}$ motion as appropriate and move the focus using the $\boxed{+}$ or $\boxed{-}$ button. All buttons are found on the Engineering rack.

4.9.4 Finding the best Focus at Cassegrain

At Cassegrain, the telescope is focused by eye, using an **unsaturated** stellar image on the TV. Run through focus a few times, noting the value for the smallest image each time and averaging the results. Further:

- Check that the TV camera itself is focused on the slit (see section 11.6.2).

- The telescope focus is altered by the insertion of an ABOVE SLIT filter. For the neutral density filters currently in use with FOS or IDS, the focus is increased by 0.04 `mm` when the filter is put in. Correct the focus to the by entering the new value (after changing to a filter) via the User Interface.

4.9.5 Finding the best focus at Prime

There is no TV camera at Prime, so interactive focussing is not possible. The telescope is focussed by making a multiple exposure on the CCD (for a full description see section 11.2), stepping both focus and telescope between exposures.

1. If not done already, startup ADAM

2. Move the rotator to a cardinal point, preferably 180°, with

   ADAM: > `ROTPOS 180`

3. Move to a not very bright star and take a GLANCE exposure of between 5 and 10 seconds. After the image appears on the LEXIDATA display go into PHOTOM and make sure that the star image is not saturated. If it is, select another object and repeat.

4. Check whether the star is in the correct position on the chip: with the rotator at 180° the orientation on the LEXIDATA display is: North up, and East to the right. The telescope will step with $20''$ between exposures with a double step between the first and second exposure. Is there enough space on the chip for your intended number of steps and stepping direction? If not, move the star to a position where it is and confirm with another GLANCE.

5. Start the multiple focus exposure with:

   ADAM: > `FOCUS`

   and follow the prompts. Use 7 exposures for a first setup, 5 for subsequent fine-tuning; provide a negative number of exposures if you want to use a negative increment; use an exposure time between 5 and 10 seconds. The focus is stepped by $\pm$ 0.1 mm between exposures; the current focus is in the middle of the range.

6. After the FOCUS procedure has finished, the multiple image will appear on the LEXIDATA display. It will normally be obvious which images are closest to focus and these should be measured using the PROFILE option of PHOTOM and the seeing determinated. If you find yourself far from focus, then make an educated guess about its approximate value and move the focus to that value via the User Interface, followed by a repeat of the FOCUS procedure.

7. Log the current value of the Seeing.

Beware of starting an observation until the focus has stopped driving and the red **focus stop** lamp on the Control Desk is lit.

4.9.6 Using automatic Focus Adjustment at Prime

The Prime focus CCD software allows automatic compensation for the changes in focus due to different filter thicknesses. This option must be explicitly enabled with the SETFOCUS command.

1. Use the ADAM command WHEEL to set up a table with filter thicknesses (see the Prime Focus manual section 3.1).

2. Make sure that the same filter is used for which the focus was determined. Alternatively, determine the focus now for the current filter.

3. To enable the focus adjustment, type, **before changing filter**:

   ADAM: > `SETFOCUS value`

   Here, `value` is your best estimate of the focus, in `mm`. The focus will be driven automatically to the correct position on change of filter.

4. To disable the focus adjustment, type:

   ADAM: > `SETFOCUS DISABLE`

Beware of starting an observation until the focus has stopped driving and the red **focus stop** lamp on the Control Desk is lit.

4.9.7 Autoguider Focus at Prime

It is most unlikely that the autoguider will be detectably out of focus if the system has been set up correctly. However, if the images look very extended and in particular if they have holes in their middles, then the focus should be adjusted. For a full description, see section 11.5.2:

1. Focus the telescope without using a filter.
2. Acquire a star on the autoguider.
3. Step the focus through a range of values around the nominal focus position (the current one, most likely) using the command:

   ADAM: > `GDFOCPOS value`

   After each step, press FIELD, then WAIT on the Autoguider Panel. Do not leave the autoguider integrating, as the images will get mixed up. Inspect the star image and measure its width with the Grinnell PROFILE function; find the `value` for which the image is narrowest.

4. When you have discovered the correct focus, type:

   ADAM: > `SETGDFOCUS value`

   where value is your best focus in `mm`.

4.10 Acquiring a Guide Star

For a full description refer to section 12.3. The acquisition of guide stars proceeds in two steps: (1) location a suitable guide star on the Finder and moving the probe to the corresponding position, and (2) locking the probe onto the guide star and closing the guide loop.

4.10.1 Locating guide stars at Prime Focus

A star will be bright enough for autoguiding if it is visible on the finder with 4 frames of integration at full TV gain. Avoid very bright (m_v <6) stars. Proceed as follows:

1. Move the rotator to your required position angle with *e.g.*:

   ADAM: > `ROTPOS 180`

2. Slew the telescope to your object to be observed; confirm with a GLANCE exposure.

3. Press the $\boxed{\text{FINDER}}$ button on the Grinnell panel.

4. Press the $\boxed{\text{DIRECT}}$ button on the Grinnell panel.

5. Press the BEAMSWITCH $\boxed{\text{A}}$ button on the Control Desk.

   The guide probe field will now become visible on the finder; stars should appear to move along the major axis of the chip as the beamswitch takes effect.

   If nothing happens, check at the User Interface (with `AD/T`) that the aperture A position is correctly defined: it should be 0,-590. If it is not, then type:

   UI–> `AP/A 0 -590`

   in order to define the aperture position, and press $\boxed{\text{A}}$ again.

6. Select the Grinnell function GET GUIDE STAR. A display of the field accessible to the probe will appear on the screen.

7. Move the cursor to your chosen guide star in the permitted area and press $\boxed{\text{ENTER}}$ on the Grinnell joystick control box.

8. Finally press the BEAMSWITCH $\boxed{\text{NOM}}$ button on the Control Desk and press $\boxed{\text{DIRECT}}$ on the Grinnell panel.

The telescope is now pointing to your object, which should be positioned close to the centre of the CCD detector, while the guide probe is positioned such that the guide star is at the centre of the acquisition area. Subsequently, the guide star will have to be acquired with the guide probe, by going through the **field - acquire - guide - loop/enable** sequence described below in section 4.10.4.

4.10.2 Locating guide stars at the Cassegrain focus

1. Move the object to be observed onto the slit using the Cassegrain TV camera.

2. Press the $\boxed{\text{FINDER}}$ button on the Grinnell Panel.

3. Press the $\boxed{\text{DIRECT}}$ button on the Grinnell Panel.

4. Select the Grinnell menu function GET GUIDE STAR: a horseshoe-shaped acquisition field will appear on the Grinnell TV monitor.

5. Choose a star within the permitted area which is visible without integration (otherwise it will be too faint for the autoguider).

6. Move the Grinnell cursor to the desired guide star and press $\boxed{\text{ACCEPT}}$ on the joystick.

7. If you have been operating the autoguider in Telescope Mode, or just to be sure, switch to Probe Mode by typing at the User Interface:

   UI–> `AC/PR`

8. Acquire the guide star by going through the **field - acquire - guide - loop/enable** sequence described below in section 4.10.4.

4.10.3 Using guide stars of known RA and Dec (either focus)

Enter the object `name` and its guide star `guidename` at the User Interface in the usual way and associate the two entries by:

UI–> `name`

UI–> `GUIDE guidename`

In order to move the guide probe to the correct position, point the telescope to your object and press the GUIDE/STAR button on the A&G panel. Subsequently acquire the guide star.

4.10.4 Acquiring a guide star

This procedure discribes the acquisition of a guide star with the guide probe after a guide star is positioned near the centre of the probe field. A full description is given in section 12.3.8.

- If not yet done, switch on the autoguider. If no 'idle' message appears press the SHUTDOWN button on the Autoguider Panel.
- Select the autoguider probe image on one of the TV monitors (there is also a dedicated mini-monitor).
- Press the FIELD button on the Autoguider Panel. An image will appear in the autoguider sub-display.
- If you are happy with the selected guide star, press ACQUIRE. Either the probe or the telescope is moved, depending on the chosen acquisition mode, in order to position the star at the centre of the autoguider field. On the monitor a message 'pulling-in' will appear after a while.
- When the error drops below a preset threshold, scanning ceases and a message 'OK to Guide?' will appear on the monitor. If you are satisfied with the image press GUIDE.
- Wait until the autoguider display is completely redrawn and then press the LOOP/ENABLE button which should turn green.

  When the cross (the measured star position) is centred in the circle you are ready to observe.

On source change, press WAIT (the guide probe is automatically switched to LOOP DISABLE).

4.11 Beamswitching and Aperture Offsets

An APERTURE offset is made in a coordinate system fixed in the instrument rotator, so its value in RA and Dec changes as a function of rotator angle. This is done to facilitate moving an object between points on the detector itself, rather than defining offsets on the sky for which OFFSET should be used.

There are three apertures: NOMINAL, A and B:

- The NOMINAL aperture is defined to be the position of the reference point used for SNAFU: the Grinnell crosswire or spectrograph slit for the Cassegrain focus, or the centre of the CCD chip at Prime focus.

The reference point need not coincide with the axis of the instrument rotator, and the system knows the displacement between them, if the software is setup correctly. Thus, an image placed on the reference point will remain stationary when the rotator is turned.

- Apertures A and B may be used for other positions on the detector, TV or autoguider. At Cassegrain a preference has developed to put the nominal position on the slit, and use A and B for separate offsets, but if the crosswire were used as SNAFU reference point, it would be useful, for example, to define either A or B to be the centre of the slit. The default value of aperture A at Prime focus is defined to bring the guide star acquisition field into the finder display.

Aperture offsets are applied as *pointing corrections*: the displayed position of the source does not change when they are introduced (except briefly, as the telescope moves). This is because aperture offsets are used to move the same object to a different place on the detector, rather than a different object to the same place on the detector (for which operation, an RA/Dec OFFSET should be used). There is no reason why both kinds of displacement should not be used simultaneously. For example, if the crosswire is used as reference point for SNAFU, the following sequence can be useful: (1) slew to a bright reference star, (2) centre it on the reference point, (3) RA/Dec OFFSET to a faint galaxy, and (4) beamswitch A to move that galaxy onto the spectrograph slit.

4.11.1 Using known aperture offsets

1. To define the offset(s) type at the User Interface:

   UI–> `AP(ERTURE)/A x-value y-value`

   or

   UI–> `AP(ERTURE)/B x-value y-value`

   The `x` and `y` values are given in arcsec.

2. In order to introduce the offset, press the BEAMSWITCH $\boxed{\text{A}}$ or $\boxed{\text{B}}$ button on the Control Desk; to return to the reference position, press the $\boxed{\text{NOM}}$ button. The offsets are displayed on the Information Display.

4.11.2 Setting apertures interactively

The commands SNAFU/A and SNAFU/B are used to determine the positions of apertures A and B interactively. For example, when an object has been located on a particular detector pixel, one might want to keep the offset for future use.

1. Position the object on the SNAFU reference point.

2. Type at the User Interface:

   UI–> `SNAFU/A`

3. Move the object to the intended position of aperture A using the handset or guide buttons.

4. Press the $\boxed{\text{ACK}}$ button (acknowledge) on the telescope Control Desk.

5. Press the BEAMSWITCH $\boxed{\text{NOM}}$ button to return the star to the reference point.

6. If wanted, repeat the procedure for aperture B.

Hereafter, pressing the BEAMSWITCH $\boxed{\text{A}}$ or $\boxed{\text{B}}$ button will cause the offset to be made. If you want to record the offsets for future reference, inquire their values by typing at the User Interface:

UI–> `AD(VISE)/TEL(ESCOPE)`

4.12 Blind Offsets at Cassegrain

It frequently happens that an observer working with the FOS wants to take a spectrum of an object too faint to be seen. Such objects should be measured astrometrically before leaving for La Palma relative to a comparatively bright reference star close to the object. An accuracy substantially better than an arcsecond is recommended. Blind offsets are made with the autoguider, because it is more accurate than simple offsetting the telescope especially in Declination.

At the telescope, proceed as follows:

1. Place the reference star on the slit of the spectrograph.
2. Acquire an autoguide star in the ordinary way with the guide probe.
3. Switch over to ACQUIRE/TELESCOPE mode.
4. Enter the offset values at the User Interface console with:

   UI–> `AU/B RA-offset,Dec-offset`

   where both offsets are in arcseconds. The telescope will be offset by the appropriate amount to put the invisible object (approximately) on the slit, while the guide probe is moved to the precise position where the autoguide star (step 2) should be after the telescope offset.

The autoguider will now lock onto the guide star at the offset position to centre it on the probe. When the measured star position is centred in the circle, the invisible object will be on the slit. On big offsets the autoguider may lose the guide star because the telescope moves faster than the probe. However, you can always re-acquire the guide star (with the probe still fixed).

One important drawback to blind offsetting is that when the autoguider probe is offset it may actually be carried into an area where it either vignettes the spectrograph slit or is itself vignetted by the iron-mongery of the A&G box. For this reason one should try to find a reference star as close to the invisible object as possible. If no suitable reference star is found, one has to fall back on the simple telescope offset/beamswitch method referred to in section 4.11, which is inherently less accurate.

4.13 Rotating the Cassegrain turntable

4.13.1 Under Computer Control

1. Enter the desired position angle on the user interface:

   UI–> `TU(RNTABLE) position-angle`

   where the angle is in degrees.

2. Press the TURNTABLE $\boxed{\text{NOM}}$ button on the Control Desk.

   The turntable will move in the correct direction to avoid the limit switch at Position Angle 140°.

3. If the table stops an arcminute or two away from the correct position, press the $\boxed{\text{NOM}}$ button again.

If you end up in a turntable limit (this should never occur when operating in this way), then you will have to escape from it in manual mode (see the section immediately below).

4.13.2 Under Manual Control

1. Either (a) Depress the TURNTABLE $\boxed{\text{SELECT/MANUAL}}$ control button on the Control Desk (the button must be illuminated),
   or (b) Switch over to Engineering Mode by pressing the $\boxed{\text{ENG/COMP}}$ button.
2. Select fast or slow motion on the Engineering Rack.
3. Press the rotation $\boxed{+}$ or $\boxed{-}$ buttons as appropriate. Note that the motion as indicated on the Engineering Rack is counter to the change of position angle! The correct value of the position angle on the sky is shown on the Information Display; the value on the Engineering desk equals $360°-\text{PA}$ and in addition includes a small encoder zero-point correction.

Beware: do not drive through angle 220° on the Engineering Rack, *i.e.* Position Angle 140° on the sky (and Information Display), because the turntable will hit a limit switch and you will have to go all the way round in the opposite direction. If you do hit the limit switch somehow, signalled with the red light on the Engineering Rack below the "position angle" display, back out of it in **slow** motion.

4.14 Making a Hard Copy of a Grinnell TV image

1. Select TV monitor 1 or 2 on the Control Desk.
2. Freeze and Fill the image (essential for a star field).
3. Push the button on the copy machine.
4. **Wait** untill the copying is completed before switching back to the Grinnell.

4.15 Archiving a Grinnell TV image

1. Freeze and Fill the image.
2. Push the Archive button on the Grinnel Panel.
3. Fingers crossed while a '.BDF' file is created which can be displayed on the LEXIDATA and output with FITSOUT.

5 STARTING UP THE INT

Unless there are strong operational reasons, the observers should expect to have access to the Telescope and its Instrumentation from 1600 Local Time onwards. The Duty Technician (DT) will have made a series of tests on the Telescope, the Dome, the Computers and the Instrumentation before the INT is handed over to the Telescope Operator and the Support Astronomer. (There should be a DT checklist available in the Control Room.) The telescope will always be left by the DT in one of the park positions, *i.e.* Zenith for Cassegrain, and "Access" for Prime Focus configuration. Before the observers can start with preparing for the night, the Telescope Operator will carry out several checks.

5.1 Initial action by Telescope Operator

1. Handover the telescope to the Telescope Operator (TO) normally takes place at 1600 Local Time. By then the TO will have read the white board in the coffee room (first floor) to find out who is the Support Astronomer (SA), and who the observers are. He should find out whether the SA will be present on the mountain that night, and in any case contact him, perhaps at dinner, to discuss any particular problems which are to be expected.
2. The telescope should be found in the following state after the DT checks:
   (a) Power to both Telescope and Dome on. (Section 16)
   (b) Telescope Control program running. (Section 7.2)
   (c) Oil pump and air compressor on. (Section 16)
   (d) Encoder Zeroset complete.(Section 11.1.1)
   (e) Emergency Stop activated.
3. Inspect the telescope logbook (on the Control Desk) for the most recent information about the condition of the telescope. Further information may be found in the INT_BEWARE leaflet, which must be kept with this manual in the Control Room.
4. Note that the T/S DOME STOP button is illuminated, indicating a stationary telescope.
5. Make the ICONA Meteorological Station readings (Section 14.2), but only if this does not interfere with observing or the taking of calibration data during twilight. Further, read the rain gauge if there has been any precipitation during the last 24 hours.

5.2 Preparation for observing by the Telescope Operator

The following checklist is for normal operation in good weather conditions. However, some of the following actions should be done also in bad weather. Remember that the dome may **not** be opened in adverse weather conditions, *i.e.* with strong winds over 80 km/h, with more than 90 percent humidity, with ice on the dome (which can fall in), and with high outside dust levels. Note that, if at night the humidity drops quickly from 100 percent (after rain or dense fog), the dome will be opened only at below 80 percent, in order to give the dome structure time to dry up.

1. When convenient, *e.g.* in the afternoon, input any long catalogue files that the observer may require, such as seeing standards or target lists for the observer, by typing at the user interface console:

   UI–> `INPUT filename`

   where `filename` is the name of the catalogue (Section 8.5). If a file extension is not specified, it is assumed to be '.CAT'. A maximum of 500 objects can be entered.

2. During or after dinner discuss with the observer(s) any special requirements they may have, and determined at what time they want to open up. Good communication between the TO and SA and the observer(s) is essential for a smooth operation of the telescope.

3. With the telescope at Zenith (Cassegrain) or Access Park (Prime) position, fill the CCD dewar(s) with liquid Nitrogen. This is normally the first thing the Telescope Operator does after dinner. Note that the dewars have to be topped up whatever the outside weather conditions.

4. Check that the INPUT fan on the ground floor and the EXTRACTOR fan on the second floor near the telescope base are both on. The latter fan can be reached via the small Coude room, opposite the CLIP Centre (beware oil on the floor!). If the fan is not working, switch it on by pressing the green start button. This will also start the INPUT fan on the ground floor. Both fans are essential in the control of the dome temperature and hence the dome seeing.

   Obviously, when the dome may not be opened because of adverse weather conditions, these fans must be or remain switched off.

5. Close all doors and pull down the blinds in the library and the restroom.

6. Switch off all unnecessary white lights. Safety lights will automatically come on at various points in the building.

7. In the afternoon, as soon as the outside temperature becomes lower than the inside temperature, open the dome as follows, in order to thoroughly ventilate the dome interior: Turn the dome slit position to the East (azimuth = 90 degrees) and raise the Upper Shutter to an aperture of about 1 metre. Press the $\boxed{\text{RAISE/MICRO}}$ on the Engineering Rack until the MAIN OVER TRAVEL indicator light switches off, and then press the $\boxed{\text{RAISE/MAIN}}$ button until the required aperture is made.

8. Remove lids from the fan ducts (if necessary) and start the dome fans, subject to current practice. Replace fan covers if it clouds up.

9. Open the dome fully by pressing again the $\boxed{\text{RAISE/MAIN}}$ for about 10 seconds; the MAIN OVER TRAVEL light should now be on again. Further, the dome lights should be extinguished to avoid throwing unwanted light in the direction of the other telescopes when the dome is rotated.

10. Execute the encoder ZEROSET procedure, in order to obtain the hardware zeropoints of the Ferranti Encoders. This procedure consists of carefully moving the telescope in engineering mode through zenith in both RA and Dec, and is described in detail in section 11.1.1.

11. Open the cover of the Finder by pulling the cord, and attach the ring to a rivet located on the mirror cell nearby.

12. If working at Cassegrain remove the Primary Mirror Plug as follows:

    (a) Change over to engineering mode by pressing the $\boxed{\text{ENG/COMP}}$ button on the Telescope Control Desk.

    (b) Move the telescope to the North Horizon Limit; use an Hour Angle of exactly 24.00 hours, so that the telescope needs to be moved in Declination only.

    (c) Press the Declination $\boxed{\text{QM}}$ (Quick Motion) button on the Engeneering Rack until the green light comes on to signal that the mode is engaged. The corresponding light of the $\boxed{\text{SM}}$ (Slow Motion) button must be off. If wanted, one can adjust the quick motion speed by turning the QM RATE dial just above these buttons.

(d) Press the Declination $\boxed{+}$ button, which actually moves the telescope, until the alarm sounds as sign that the telescope has run into a limit. Now press the $\boxed{\text{ACCEPT}}$ button on the Control Desk to switch the alarm off.

(e) Turn the key-operated LIMIT switch on the Engineering Rack to the O/R position (limit override). The key no. 6 must be inserted before the switch can be operated. (If the Key is not in the switch, it will be in the Key Press, which in its turn can only be opened by the Duty Officer!)

(f) Repeat steps d) and e). This time there will be no alarm, but the telescope will halt in horizontal position when it runs into a second limit switch.

(g) Use the ladder on the observing floor to get at the primary-mirror plug. Place the ladder such that it fits within the two brackets on the bottom half of the cube. Climb into the cube and remove the plug. Put the ladder in a safe place on the dome floor.

(h) Press the Declination $\boxed{-}$ button to move the Telescope back to the the pole position at declination 90°.

(i) Turn the LIMIT switch to the NULL position and push the Declination $\boxed{\text{SM}}$ button.

(j) Change over to computer mode by turning the spring-loaded key on the Control Desk against the spring for a moment. Subsequently, press the $\boxed{\text{ZP}}$ on the System Control panel on the Control Desk in order to park the telescope at zenith.

Beware! If no ZEROSET was done previously, or if there are problems with the encoders, the telescope can move to an incorrect position when sent to zenith in computer mode. Therefore, keep an eye on the RA and Dec gauges or check the telescopes behaviour through the control room window. Alternatively, move to zenith in engineering mode.

13. If not yet done before, change over to Computer Mode by turning the key on the Control Desk to the right against the spring. The COMP light should come on and the key will spring back to its original position. If the COMP light does not come on check that:

    (a) both RA and Dec slow motion (SM) clamps are engaged (indicator lamps on Engineering Rack, bay 5).

    (b) the $\boxed{\text{RESET}}$ button has been pressed after an emergency stop.

    (c) No alarms are active.

14. If it is dark enough, switch on the TV cameras and their corresponding monitors (Finder and, if appropriate, Cassegrain) and the Autoguider, using the buttons on the control desk (see figure 7).

15. Open the secondary-mirror cover and primary-mirror cover IN THAT ORDER (something might drop from the Top End!), by operating the PRIMARY MIRROR COVER and SECONDARY MIRROR COVER $\boxed{\text{OPEN}}$ buttons on the Engineering Rack. The secondary-mirror cover button needs to be pressed only once but the primary mirror cover button must be kept depressed until the OPEN light is illuminated. Further, note that the secondary-mirror cover must also be opened when operating at Prime Focus.

16. If SET, GUIDE or INCREMENT rates other than the defaults are to be used, enter these via the User Interface (see Section 8.4) and press the corresponding buttons on the Telescope Control Desk to 'activate' the new values.

17. Focus the telescope (section 11.2). In Cassegrain mode, this is done by visual inspection of the image of a bright star on the Cassegrain TV (which is accurate enough). The focussing procedure for Prime Focus work uses a sequence of 7 short exposures on the CCD (under ADAM control) of a star for different focal positions to determine the best focus setting. The FOCUS procedure is described in detail in section 11.2.

18. Perform a Single star SNAFU on a star near the zenith in order to determine a software zeropoint for the Pointing Model (see Section 11.1.2). The Telescope Operator will normally take a star from the SAO Catalogue within 2 degrees from zenith with an eye on the ensueing determination of the finder zeropoint (very important for Prime Focus work).

    The SNAFU at the **Cassegrain** Focus is done as follows:

    (a) Enter the coordinates of the star at the User Interface (see section 8.5.3): use the SOURCE command and use object name *e.g.* SS.
    (b) Drive the telescope to the object: make the SNAFU star the next object with the command `NEXT SS` and press the $\boxed{\text{SRCE}}$ button on the Telescope Control Desk.
    (c) Wait until the telescope is tracking accurately.
    (d) Type at User Interface:-
    UI–> `SNAFU`
    (e) Turn up the gain of the Cassegrain TV until the star is clearly visible and use the handset to place the star at the required reference point (usually the Grinnell crosswires).
    (f) When satisfied with the SNAFU star's position, press the $\boxed{\text{ACK}}$ button on the Control Desk (Bay 2, Rack 3) to reset the collimation corrections in the pointing model.

    The SNAFU at **Prime** Focus is done completely differently by means of a test GLANCE exposure on the prime focus CCD, under ADAM control (see section 11.1.4 for more details):

    (a) Startup ADAM (See the Prime Focus User Guide)
    (b) Move the rotator to position angle 180° with the ADAM command ROTPOS 180.
    (c) Slew the telescope to the SNAFU star, as for Cassegrain mode.
    (d) Take a test GLANCE exposure of the field (1-5 seconds; use filters if the star is very bright). The CCD image will appear on the LEXIDATA and the star should be obviously visible near the centre of the chip.
    (e) Use the MOVESTAR command, and locate the star with the cursor. ADAM wil now calculate a position correction and send those via the link to the Telescope Control Computer. The telescope will move to the corrected position: the star will move on the Finder TV image.
    (f) Mark the position of the star now on the Finder TV screen with a felt pen or similar marker.
    (g) Now send the telescope again to the original position by pushing the $\boxed{\text{SCRE}}$ button.
    (h) Type at the User Interface:
    UI–> `SNAFU`
    and move the telescope with the handset such that the star image on the finder will coincide with the position marker.
    (i) Press the $\boxed{\text{ACK}}$

    The reason behind the last three steps is that allthough ADAM sends the corrections to the Telescope Control Program, this does not update the pointing model zeropoint. That is done in the same way as for Cassegrain mode during the last three steps.

19. Finally, determine the Finder Zero Point with the telescope still pointing to the SNAFU star:

    (a) Select the Finder on the TV monitor on the Control Desk.
    (b) The SNAFU star must now be visible at, or very close to, the centre of the finder field. It's position corresponds to the centre of the Cassegrain field.
    (c) Press the $\boxed{\text{MENU}}$ button and select "SET FINDER ZERO POINT".
    (d) Put the cross upon the star with the Grinnell joystick (on the Control Desk).
    (e) Press the $\boxed{\text{ENTER}}$ button; this sometimes has to be repeated.

5.3 Summary

1. Confirm handover with Duty Technician.
2. Fill the cryostats.
3. Check to see if the dome temperature is higher than that of the outside air. If it is then:
   (a) Move the dome to azimuth 90 degrees, and open up 1 metre.
   (b) Check that the EXTRACTOR fan by the telescope base is on, and that the INPUT fan on the ground floor is on.
4. Read the Telescope Logbook and check INT_BEWARE documentation for reported faults or hazards.
5. Check T/S DOME STOP is active.
6. Take ICONA Meteorological readings (when the TO has some free time).
7. Input files of standard stars and target objects into the PE 3220 Telescope Computer.
8. EXTRACTOR fan ON, if not already done.
9. INPUT fan ON, if not already done.
10. Shut all doors and window blinds.
11. White lights out.
12. Remove dome fan covers, if not already done. Dome fans on.
13. Dome access doors closed.
14. Dome lights out.
15. Open Dome fully.
16. Finder cover open.
17. ZEROSET
18. Primary mirror plug out (Cassegrain focus only).
19. Secondary and primary mirrors open.
20. Telescope in Computer Mode.
21. TV Camera(s) and Autoguider on.
22. Input SET, GUIDE and INCREMENT rates, if other than default values used.
23. Focus the Telescope.
24. SNAFU.
25. Finder Zero Point

6 CLOSING DOWN THE INT

At the end of an observing night, the Telescope Operator will shut down the Dome, the Telescope Control Computer, and the Telescope itself, after moving it to a park position, *i.e.* the Zenith when in Cassegrain Mode or the Access Park position when in Prime Focus Mode, with the telescope in a nearly horizontal position leaning towards the North. The Instrument Control Software should be closed down, but may be left running if a dump from Disk to Tape or a Flatfield exposure is in progress.

The process of closing down the INT is broadly the reverse of the starting up described in the previous section 5.

6.1 Closing down Telescope and Dome

1. Before moving the telescope to the park position, switch off the Cassegrain (if in use) and Finder TV cameras, and switch off the Autoguider. It is important that this is done before slewing the telescope, in order to avoid accidental damage to the cameras by a possible bright object appearing in the camera field. The TV cameras are controlled from small racks near the top of right-most panel of the Control Desk, to the left of the Autoguider Control. Switch the cameras off by turning the gain controls anti-clockwise until they click, followed by pressing the small red OFF button. The autoguider is switched off by pressing the $\boxed{\text{ON/OFF}}$ button on the rack to the right.

2. Move the telescope to zenith by pressing $\boxed{\text{ZP}}$ on the Control Desk (Bay 2, Rack 3). This also disables the dome tracking.

3. Close the PRIMARY and SECONDARY mirror covers IN THAT ORDER by operating the MIRROR COVER $\boxed{\text{CLOSE}}$ on the Engineering Rack. This must be done before closing the dome shutters for safety reasons.

4. Switch to Engineering mode by pressing the $\boxed{\text{ENG/COMP}}$ on the Telescope Control Desk.

5. Close the dome shutter(s) by pressing $\boxed{\text{LOWER/MICRO}}$ button on the Engineering Rack until the MAIN OVER TRAVEL light is out, followed by pressing the $\boxed{\text{LOWER/MAIN}}$ button until that light comes on again, and then finishing with pressing anew $\boxed{\text{LOWER/MICRO}}$ for about 10 seconds. This procedure has to be done for BOTH shutters, starting with the Lower Shutter (buttons on the right), but only if that shutter happens to be raised, which will not often be the case. The control buttons for the Upper Shutter are found on the left-hand side of the Rack.

   The main (upper) shutter should be at a zenith distance of 71.9 degrees when fully closed. This value is listed on the Information Display (section 8.7) as 'Upper Shutter ZD'. Take care: if only "*"s are displayed, this normally means that the Dome is fully open. Thus, a visual inspection is the best way to ensure that the Dome is properly closed. Note, that the MAIN OVER TRAVEL indicator light for the Upper Shutter will be on when the dome is closed; this is a necessary condition, but **not** a sufficient one.

6. Switch off the dome fans and (if necessary, it is rarely done) replace fan covers.

7. Switch off the EXTRACTOR and INPUT ventilators, on the second and the ground floor, respectively, by pressing the red stop button on the control panel near the telescope base, which can be reached via the small Coude room opposite the CLIP Centre (beware oil on the floor!).

8. Close the Finder Cover.

9. When working at Cassegrain, the Primary Mirror Plug will have to be replaced; when in Prime Focus Mode, the telescope has to be parked in the Access Park position. In both cases, move the telescope to the park position (manually; the PARK ACCESS button does not work!) by following the procedure described in item 12 of the previous section 12:

   (a) Move the telescope to the North Horizon Limit; use an Hour Angle of exactly 24.00 hours, so that the telescope needs to be moved in Declination only. If the Hour Angle is not exactly 24 hours, the telescope will hit the platform.
   (b) Press the Declination $\boxed{\text{QM}}$ (Quick Motion) button on the Engineering Rack until the green light comes on to signal that the mode is engaged. The corresponding light of the $\boxed{\text{SM}}$ (Slow Motion) button must be off.
   (c) Press the Declination $\boxed{+}$ button, which actually moves the telescope, until the alarm sounds as sign that the telescope has run into a limit. Now press the $\boxed{\text{ACCEPT}}$ button on the Control Desk to switch the alarm off.
   (d) Turn the key-operated LIMIT switch on the Engineering Rack to the O/R position (limit override).
   (e) Repeat steps b) and c). This time there will be no alarm, but the telescope will halt in Park Access position when it runs into a second limit switch.
   In **Prime Focus** mode, leave the telescope in this position.

   In **Cassegrain** mode, replace the mirror plug, and move the telescope via the pole position back to zenith, as follows:
   (f) Press the Declination $\boxed{-}$ button to move the Telescope back to the the pole position at declination 90°.
   (g) Turn the LIMIT switch to the NULL position.
   (h) Press the $\boxed{\text{SM}}$ button on the Engineering Rack.
   (i) Switch to computer mode by turning the key on the Control Desk.
   (j) Press the $\boxed{\text{ZP}}$ button on the Control Desk to move the telescope to the 'zenith park' position.

10. Press the $\boxed{\text{EMERGENCY/STOP}}$ button in order to disable any subsequent motion of the telescope. This is not essential, but good practice. One has to remember, however, to press the $\boxed{\text{RESET}}$ button before starting up in the following afternoon.

11. Switch off the oil pump, by pressing the OIL PUMP switch on the Engineering Rack.

12. But DO NOT SWITCH OFF POWER to either Dome or Telescope.

13. Top up the Cryostats with Liquid Nitrogen.

14. Check that the access doors to the dome are closed.

6.2 Control Software and Instrument shut down

1. The PE 3220 Telescope Computer will be shut down. However, before stopping the Telescope Control Software, save, if so wanted, the observer's object catalogue on a disk file (see section 8.4) with the SAVE command.

   Terminate the Telescope Control Program by typing on the PE 3220 System Console (on the desk to the left of the Engineering Rack):

*FINISH

and shut down the Telescope Computer with:

*MA MSMD:,OFF

This command shuts down the Telescope Computer to a known state, and leaves the disk protected.

2. The PE 3210 Instrument Computer is normally left running. Nevertheless, it is good practice to shut down the ADAM control software, unless the observer is going to take flatfield exposures or do a tape dump of his data. The PE 3210 is frequently used during daytime for development work.

   If the observer leaves a flatfield or other calibration exposure running at the end of the night, it is very important that special warning signs are placed on BOTH doors leading into the dome as well as on the console in the Control Room. It is the responsibility of the Telescope Operator to put up these signs, who therefore has to be properly informed by the observer(s). Further, the observer should make sure that, when using a CCD detector, the TO has filled the cryostats with Liquid Nitrogen before starting calibration exposures. The interval between dawn and 09:15 Local Time is reserved for the taking of flat field exposures.

3. When observing or other data taking has finished, ensure that the spectrograph's camera shutters are closed (on both 235 and 500 cameras; use IDS CLOSE), and, if the IPCS was used, that, most importantly, the EHT switch on the IPCS rack below the telescope mirror cell is switched to STANDBY. After a long morning flatfield, the day crew will safely shut down the IPCS after an exposure has finished, and shut down the Instrument Control Software.

4. If it is necessary to completely close down the PE 3210 Instrument Computer, for instance because a power cut is expected, proceed as follows:

   (a) **ADAM:** > SHUTDOWN

   (b) Sign Off at the User Terminal(s) with:

   *SO

   (c) Type at the System Terminal in the Computer Room:

   *STOPALL

   *OFF

   *MA EGLE:,OFF

   (d) On the EGLE disc drive switch WRITE PROTECT to ON, and POWER to OFF.

6.3 Logbooks and Magnetic Tapes

The following logbooks and forms should be completed:-

1. Telescope Operators Log and Telescope Log.

2. Nightly Report Sheet, to be completed by the Telescope Operator and left in the tray on top of the book shelves in the Control Room.

3. Fault Sheets and SER forms, to be left in the same tray.

4. The Telescope Operator will complete the printing of the Observing Log and place the sheets in the ring-backed binder. A second copy should be given to the observer. The printer, the PC and its VDU should be switched off.

5. Magnetic Tape Copying Requests. Leave both the D-Tape and the completed Request form in the grey tray in the Control room. If a tape dump is done at the end of the night, complete the form and ask the day crew to remove the tape after the dump has completed correctly.

Observers should keep their tape copying up to date as far as possible. Otherwise there may be not sufficient time at the end of an observing run to copy all the D-tapes (1600 BPI) to C-tapes (6250 BPI) before the observer leaves. It is **strictly forbidden** to take D-tapes from the mountain, and it can take ages for a C-tape to reach your home institution by post.

Normally, the C-tape(s) will be left in the pigeon-hole marked "Copied Tapes" in the East-West Corridor on the first floor of the INT building. If they aren't there, inquire in the software office at the East end of the same corridor; if no-one who knows can be found, try the WHT computer room. Observers having little time before leaving after the end of their run are well-advised to inform the person doing the copying by a note to that effect on the Tape Copy Request Form. If you are blessed with a Support Astronomer of an especially big-hearted and generous nature he/she might copy your tapes in an emergency.

7 THE PE 3220 TELESCOPE COMPUTER

7.1 Introduction

The INT is controlled by a Perkin-Elmer 3220 computer interfaced through CAMAC. The computer system is found in the CLIP Centre, a temperature-controled clean room on the second floor of the INT building, west of the central void. The machine stands in the south-west corner. Both computer and its AMPEX disk drive are powered via the Buffer Set.

Control of the computer is via one of two terminals: either from the System Console in the Telescope Control Room, on the third floor, standing on the far left-hand side of the Control Desk, or from the Local Console in the CLIP Centre, a standard VT220 terminal on the desk next to the PE 3220. The two-position switch for selecting either Control Room or CLIP Centre normally stands right beside the Local Console.

The PE 3220 software is controlled by the Telescope Operator via the User Interface, which is the VDU currently standing on a small table to the left of the Control Desk in the Telescope Control Room. The computer drives the "Information Display", which is a monitor showing the Date, Time and Positions of the current or next sky object. The Operator can move this Information Display to any of a selection of different monitors by pressing the appropriate button(s) on the Control Desk. Such is also the case for the MIMIC display (both Cassegrain and Prime Focus), and for the Autoguider Display. The PE 3220 also takes care of some of the Control Desk hardware, in particular the Beckmann Displays, which display the UTC, LST, RA, Dec and Zenith Distance in red illuminated numerals.

7.2 Checking the state of the telescope computer

This section covers the ways of finding out the state in which the telescope computer has been left. The possibilities are:-

1. **Control system loaded and running.**

   If the Telescope Control System is running, the Beckmann Display of UTC and LST on the Control Desk in the telescope control room will be updating.
   If such is the case, you are in business and need not read further in this Chapter.

2. Closed down deliberately, with the disc write-protected (Section 7.2.3).

3. Running, but with the disc protected in hardware and/or software (Section 7.2.2).

4. Running, with the disc write-enabled, but no telescope software working (Section 7.3.1).

5. In some strange condition, which will require a system reboot. (Section 7.4).

7.2.1 Control system not working.

1. Press RETURN on the System Console. If you do not get the "*" prompt, the system is dead. Continue at section 7.2.3.

2. Probe the current state of the computer by attempting to type on the System Console:-

   `*D(ISPLAY) D(EVICES)`

   If you get no response, then either the computer needs to be initialised or the terminal is not connected. See Section 7.2.3 in both cases.

   Otherwise, you will see a list of devices.

7.2.2 Running but with disc write-protected

1. Go to the CLIP Centre and check that the hardware write-protect switch on the AMPEX disk drive front panel is OFF (*i.e.* not protected). The tumbler switch should be pressed/positioned to the left; the "Read Only" light should be off.

2. Go back to the control room and execute the DISPLAY DEVICES command. Check in the output listing that the fixed disc with physical name **MSMD:** is software enabled. That is, the line commencing MSMD: should read:-

   `MSMD FC 0000 SYS CDIR`

   If, instead you find:-

   `MSMD FC 0000 OFF`

   you will need to enable the device in software by typing:-

   `MA MSMD:,ON,,CD=ALL`

3. Type:

   `*FINISH`

   to remove any running software and reduce the system to a known state.

4. Proceed with Normal Startup (Section 7.3.1).

7.2.3 No response on the System Console

1. Proceed to the CLIP Centre.

2. Check that the correct System Console is selected (Section 7.1) or set the switch to Control Room, so that the computer can be addressed from the telescope control room. Return to the control room and try DISPLAY DEVICES again.

3. Otherwise check the computer hardware in the CLIP Centre:

   (a) Set the switch to CLIP Centre, for local control.

   (b) Check that the disc drive is powered up and is up to speed, and that the computer is powered up (both should have the green "ready" lights on their front panels illuminated).

   (c) Make sure that the write-protect switch on the disc drive is set to OFF (*i.e.* unprotected). The switch should be positioned/pressed to the left, and the "Read Only" light should be off.

   (d) On top of the left-hand module of the PE 3220 is a long grey box. On this box press the INIT spring-loaded switch. This will 'cold' start the computer. If the machine refuses to start, check that the little plastic key is turned to ON and not to STANDBY.

(e) Reboot the computer by answering the questions at the Local Console.
ENTRY=3
FILENAME=MSMD3220.LPO (Beware "0" and "O")
and wait for the message saying:-
END OF ENVIRONMENT CONFIGURATION

(f) Reset the switch to Control Room, to transfer control to the INT control room.

(g) Now return to the telescope control room and proceed with Normal Startup (Section 7.3.1).

7.3 Loading and starting the control software

7.3.1 Normal startup

If the system is running, with the disk write-enabled, the normal procedure to start the telescope software is to type on the System Console:

```
*GO INT
```

Once the startup is completed a message including the name of the telescope appears on the User Interface terminal.

7.3.2 Startup using COMPILE option

The normal startup will not work correctly on change of focal station or if system parameters like pointing coefficients have been altered. In these cases use the COMPILE option.

The control software is initialised from two text files, one containing quantities which do not depend on the focal station or instrument (e.g. servo constants and CAMAC addresses), the other containing focus-specific data such as pointing coefficients. The files currently available are:-

INT.STD	Telescope File	
INTCASS.STD	Focus File	(Cassegrain)
INTPFRCA.STD		(Prime focus with RCA CCD)
INTPFGEC.STD		(Prime focus with GEC CCD)

If one of these files has been changed, or if there has been a change of focal station (involving a top-end change), the control software MUST be loaded by typing:-

`*GO INT, CASS, COMPILE`	for the INT Cassegrain focus
`*GO INT, PFRCA, COMPILE`	for the INT with Prime focus with RCA CCD
`*GO INT, PFGEC, COMPILE`	for the INT with Prime focus with GEC CCD

The process takes about 2 minutes, and prints various messages on the System Console.
(The COMPILE option generates a pair of binary files INPSCF.SYM and INPSCF.VAL from the .STD files, which can be read in more quickly when the normal startup GO INT is used on subsequent occasions.)

7.3.3 Potential problems

1. **Incorrect startup**

   The GO command objects if you type a command of illegal format, or if one of the requested input files does not exist, so it should not be possible to initialise the system with *e.g.* the pointing coefficients missing. Beware of using the wrong files, and especially of trying to run the INT with the JKT software and vice versa! Check for the absence of error messages on the System Console and the reassuring presence of the proper telescope name in the startup message on the User Terminal.

2. **CAMAC**

   Amongst the messages which are output during startup are a group which refer to the initialisation of the CAMAC crates. These all begin with INITIAL: (the name of the task). Check that there are no messages of the form

   INITIAL: ∗ ∗ ∗ ERROR: Branch **x** Crate **y** off-line

   If there are, check that every CAMAC crate is powered up and/or reset it. There is one branch crate in the telescope control room at the left-hand end of the Control Desk behind a blue door. The system crate and another branch crate are found in the CLIP Centre. Reset a crate as follows: Turn the crate off-line, press the C/Z switch first to C and then to Z, and finally switch the crate back on-line. If you still have problems, call the Duty Technician.

   If there are any other suspicious messages (*e.g.* containing the words PAUSE, ARITH-ERR, LOAD-ERR or indeed any other -ERR), consult Section 7.4 to bootstrap the computer and, please, note any such errors accurately on an Software Enhancement Report. If even rebooting fails, call the Duty Technician.

7.4 Rebooting the computer after a power failure or crash

After a power failure or system crash the telescope computer has to be rebooted, and the telescope control program has to be restarted (from scratch). Note, that after a power break it can take some time before the power supply to the PE 3220 is restored. Wait for a message from the Duty Officer to restart the Buffer Set. This will normally be done by the Duty Technician or the Telescope Operator. Once the power supply is restored, reboot as follows:

1. Go to the CLIP Centre.
2. Check that the computer and disc drive are powered up, *i.e.* some lights on the front panels should be illuminated. If there is no power, check the mains isolator, a rotary switch on the wall behind the machine, and, if off, switch it on.
3. Make sure that the disc drive is up to operational speed, and that the Write-protect rocker switch on the disc drive is set to OFF (*i.e.* unprotected). The switch should be positioned to the left, and the "Read Only" light should be off.
4. Make sure that the control switch is set to CLIP Centre (section 7.1), for local access.
5. Press the INIT button at the top of the front panel of the PE 3220 (See section 7.2.3).
6. Boot the computer by answering the questions at the Local Console:

   ENTRY=`3`

   FILENAME=`MSMD3220.LPO`   (Beware "`O`" and "`0`")

   and wait for the message saying:-

   END OF ENVIRONMENT CONFIGURATION

7. Initialise the CAMAC crates associated with the PE 3220 (Section 7.3.3). This is most important after a power failure.

8. Reset the control switch to Control Room.

9. Return to the telescope control room and proceed with Normal Startup by typing:-

   `*GO INT`

   Do not worry about messages saying POTENTIAL LOST DATA, which are generated everytime an open file is closed. However, if you get messages about BAD SECTORS, ask for technical support, as there has probably been a disc crash.

7.5 Regular Shutdown

In order to stop the Telescope Control Program type at the System Console:

`*FINISH`

Wait for the message explaining how to close down computer or restart the control system. Nothing needs to be done at the User Interface. Notice, however, that only under computer control the telescope can parked at zenith, by pushing the ZENITH button on the Control Desk. That, therefore, has to be done before stopping the control program.

Further, to shut down the computer itself, after observing or as a precaution before an anticipated power cut, type, again at the System Console:

`*MA MSMD:,OFF`

7.6 Tasks and miscellaneous problems

7.6.1 Control system tasks

The control system contains the following tasks:

LIBRARY	Library subroutines
TSKCOM	Task common (global variables shared by the whole system)
MESSAGES	Initiation of operations (e.g. slew to source)
USER	User Interface
AGBX	Acquisition and guiding panel
AUTOGUID	Autoguider control
CONTROL	System control panel buttons
TNHZ	10Hz loop controlling pointing, tracking and fast displays
INFODISP	Information display
IPL	Interprocessor link between telescope and instrumentation computers
SERVICE	Interprocessor link service task
UTILITY	Dome, shutters, focus and Cassegrain turntable

In addition, three tasks run as part of the startup procedure but are not normally resident:

INPSCF	Reads system configuration files and initialises task common
INITIAL	Clears and checks CAMAC and initialises lamps and displays
LOADER	Controls loading and starting of other tasks.

The INPSCF task deals with the setting of constants used by the telescope control software, in particular those which must be updated regularly, such as coefficients for the pointing model. A "guide to the use of INPSCF" is given in La Palma Technical Note 39 (Laing & Wood, 1986).

A number of tasks may run alongside the control system. These are:

INPSCF	see above
POINT	Logs pointing data
ENCODERS	Displays INT encoder readings on SC
FERRDIFF	continually logs differences between Ferranti encoders
CAMTST	Tests CAMAC
EDIT32	Text editor

7.6.2 Checking for tasks

In order to find out what tasks are running, type on the System Console:

`*D(ISPLAY) M(EMORY)`

During normal operation, all tasks should be active (A), except for LIBRARY and TSKCOM, which should be dormant (D). If one of these tasks is paused (P) and this has not been done deliberately, there will be problems, as described below.

7.6.3 Problems due to tasks

1. **The control software has stopped and the displays are not updating.**

   The likeliest problem is that the 10 Hz task has paused. There may be a message like TNHZ: ARITH-ERR AE5A on the System Console. Type

   `*D(ISPLAY) M(EMORY)`

   on the System Console and look at the line beginning TNHZ. If the task is paused (P) rather than active (A), try continuing it:

   `*T(ASK) TNHZ; CO(NTINUE)`

   If this doesn't work, restart it:-

   `*RESTART TNHZ`

   If ARITH-ERR's occur on every cycle, then TNHZ is probably being fed rubbish by the time service or the encoders. Call the Duty Technician.

2. **There is a continuous stream of LOGQ-ERR's on the System Console.**

   If TNHZ is the task responsible, you will not be able to recover control without either removing the 10 Hz interrupt line from the box on the wall in the CLIP Centre (it may be labelled) or rebooting the computer. The latter is preferred.

3. **The Autoguider Panel on the Control Desk is not working.**

   Check that the task AUTOGUID is alive. If not:-

`*RESTART AUTOGUID`

4. **The Acquisition & Guiding Panel on the Controle Desk is not working.**

   Check that the task AGBX is active. If not:-

   `*RESTART AGBX`

5. **The Beckmann Displays are working, but the Information Display is not updating.**

   In this case, the 10-Hz synchronous task (TNHZ) is running, but the Information Display task (INFODISP) is not. If the latter is paused, try to continue it:

   `*T(ASK) INFODISP; CO(NTINUE)`

   and if this fails:

   `*RESTART INFODISP`

6. **The User Interface terminal hangs up and gives no response.**

   Check on the System Console whether Task USER (or any other) has failed with an error message. Type on the System Console:-

   `*RESTART USER` (or whichever task it was)

   If the User Interface does not now restart, try stopping and restarting the telescope control system with `*FINISH` and `*GO INT`.

7.7 Enquiring and Defining parameter values with INPSCF

The INPSCF task deals with the definition of constants used by the telescope control software. A comprehensive "Guide to the use of INPSCF" is given in La Palma Technical Note 39 (Laing & Wood, 1986). Here is only briefly outlined how to enquire and (re)define parameter values. Details about restrictions on newly entered values are given in the aforementioned Technical Note.

Run INPSCF by typing at the TCS terminal:

`*INPSCF`

This will start the INPSCF task. It can run alongside other tasks of the telescope control software (see previous section). However, it can **not** run simultaneously with POINT.

You may now query the values of various control constants by typing:

INPSCF > `@PARAMETER`

where `PARAMETER` is the name of the constant, *e.g.* HATERM, AOXNOM, TDATA(11), *etc.* (see LPTN 39 for full details). Its current value will appear on the terminal.

If you don't like a value and want to change it, only if you are very sure of what you are doing!, type:

INPSCF > `PARAMETER new-value` , for instance: `HATERM 2`

Notice the absence of an 'equals' symbol. The control software will immediately use the new value, but it will be lost as soon as you shut down the INT. Notice, that some parameters, and in particular the software limits on the telescope pointing, can only be modified by someone who has a detailed knowledge of the telescope drive software; a password has to be provided. Thus, if a soft limit has to be altered, consult a qualified member of the La Palma staff.

Get out of INPSCF by typing: INPSCF > `END`

7.8 Summary of startup and shutdown

7.8.1 Normal Startup

1. Type at System Console:-
   `*D D`
2. If MSMD: is OFF, type:-
   `*MA MSMD:,ON,,CD=ALL`
3. When MSMD: is ON, type:-
   `*GO INT`

7.8.2 Shutdown

Type at the System Console:-	`*FINISH`	to terminate the telescope control program.
	`*MA MSMD:,OFF`	to shut down the PE 3220.

7.8.3 Reboot after a power cut or INIT pressed

1. Press INIT on CPU.
2. Boot the computer by answering:-
   ENTRY=3
   FILE=MSMD3220.LPO
   and wait for the message saying:-
   END OF ENVIRONMENT CONFIGURATION
3. To start the control system, type:-
   `*GO INT`
4. If there has been a power failure check the CAMAC crates (Section 7.3.3)

7.8.4 After a change of focal station

Once the system is running with the disk marked ON (write-enabled), type at the SC:-

`*GO INT, CASS, COMPILE`	For Cassegrain Focus
`*GO INT, PFRCA, COMPILE`	For Prime Focus
`*GO INT, PFGEC, COMPILE`	For Prime Focus

8 THE TELESCOPE USER INTERFACE

8.1 Introduction

On the INT the User Interface is operated by the Telescope Operator so most observers will not require a detailed knowledge of it. The telescope user interface, of which many features are common to the JKT and INT, is used for two main purposes:

- the **ENTRY OF DATA** which are then transferred to the on-line part of the control system by the action of pressing a button on the system control panel and
- **the CHANGING OF OPERATING MODES**.

At present, the philosophy is that no action occurs until a button is pressed, except for the two most commonly used commands (GO and STOP) which can be issued either from the user interface or from the control panel. It is likely that all of the button functions will eventually be duplicated within the user interface, but a clear distinction between data input and action will remain. For example, the operations of entering the RA and Dec of an object and slewing to it are separate. An operating mode determines the way in which the control system responds to a command, for instance whether the telescope or guide probe is moved during autoguider acquisition or whether an object is to be observed with the JKT, East or West of its pier.

8.1.1 Starting the program

Section 7 describes the commands needed to start the telescope control software. A successful start-up results in the User Interface displaying the name of the telescope (check that it is the correct one!) and a short set of instructions on the usage of the LIST and GO commands: The user interface program is ready to accept input when the terminal prompts with:

UI–>

In what follows, prompts issued by the computer will be in boldface and words in capital letters represent commands. In the text, commands are given in full, but the permissible abbreviations are listed in section 8.3.

8.1.2 How the program deals with input

Character strings separated by spaces are entered at the User Console and sent to the program USER by pressing RETURN. USER's command processor first attempts to identify the first string as a command name by comparing it with its internal dictionary of such names. If it is successful in making a match, one of two things may happen: (1) a command which does not take any arguments (*e.g.* GO) is executed immediately, or (2), if the command takes arguments (*e.g.* RA), the command interpreter will go on processing the input line until the requisite number of acceptable arguments have been analysed, after which the command is executed. If the input line is not exhausted the next character string is interpreted as a new command and processed in the same manner. Thus, commands can be staggered; delimiters are 'space' and semicolon ';'. When the command processor is not able to match a character string with a command name, the program outputs a message and ignores the rest of the input line. Commands may have up to 7 qualifiers and 5 parameters. Most require a button on the Control Desk to be pushed for any action to occur, *i.e.* to 'activate' the command. The full specification of an action can therefore be of the form:

UI–> `COMMAND/QUALIFIER1/QUALIFIER2/... PARAMETER1 PARAMETER2 ...`

possibly followed by pressing a control panel button. Note that occasionally parameters are associated with only one qualifier. Section 8.4 gives a complete list of commands, their qualifiers, parameters and any required control panel interaction. The *default* qualifier for all commands which take qualifiers is the first one given. If the user interface requires a parameter which has not been specified it will request it with the prompt:

UI–Parm>

If you have changed your mind and don't want to give a value, just press RETURN and the command is ignored, *i.e.* the old value is retained.

8.1.3 Catalogue entries

There is an internal catalogue containing the names, positions and guide star references for up to 500 objects. ADV/CAT will give the source names of all targets in the current catalogue, while LIST/CAT will give the full details. Stored system cataloges are listed in section 8.6.2. There are 3 special entries:

- the 'EDIT source' is the catalogue entry whose parameters (RA, Dec, equinox, proper motions, guide object) are presently being modified;
- the 'CURRENT source' is the object being observed, and
- the 'NEXT source' is the object that will be observed when the GO command is typed, or the 'Telescope-Dome Source' button SRCE on the Control Desk is pressed, at which point the object also becomes the CURRENT source. The said button is found under the label T/S DOME at the top centre of the 'System Control' panel, which occupies the lower section of bay 2 (from left).

Modifications to the CURRENT source's parameters do not affect the operation of the telescope directly. This is only altered when a button is pressed or GO is typed, in which case the parameters of the NEXT source are always picked up. When a new catalogue entry is defined using the SOURCE command, it automatically becomes the EDIT source, except if SOURCE/MARK is used. The edit pointer is also changed if an existing source name is input. Thus any data input will always be associated with the edit source until the pointer is changed by a SOURCE or an already defined source name. Any source parameters which are not specifically entered will be picked up from the first entry in the catalogue .D(EFAULT). At STARTUP all three pointers point to .D(EFAULT). It is therefore, possible to observe by merely entering R and D commands (each new entry going into .D) and pressing GO at the end of the observation. By this means the pointers are never reset and no source entries are accumulated in the catalogue.

When the same objects are to be observed on different nights SA(VE) will store the current internally held catalogue and this can then be recalled from disc with I(NPUT) on any subsequent occasion. The contents of the catalogue are stored as commands so that restoring the catalogue allows objects in it to be acquired immediately without resort to any other commands apart from GO.

8.2 HELP

The on-line help facility displays information on User Interface commands and is usually quicker than looking in the manual itself. It is invoked by typing:

UI–> `HELP command-name`

There are four single-character commands which can be entered in response to a prompt from the HELP system:

'?'	list all topics below the current level
' '	move one level up the hierarchy - terminates HELP at level 0
'!'	terminate the HELP command immediately

8.3 Summary of User Interface commands

COMMAND	QUALIFIERS	PARAMETER	CONSOLE BUTTON
*			None
AC(QUIRE)	/PR(OBE) /TE(LESCOPE)	None	AUTOGUIDER $\boxed{\text{ACQ}}$
AD(VISE)	/S(OURCE) /E(DIT) /N(EXT) /CU(RRENT) /T(EL) /CAT /UI	Source name None None None None None	None None None None None None None
AP(ERTURE)	/A /B	x y offsets for A x y offsets for B	BEAMSWITCH $\boxed{\text{A}}$ $\boxed{\text{NOM}}$ $\boxed{\text{B}}$
AU(TOFFSET)	/B(OTH) /R(A) /D(EC)	RA & Dec Offsets RA Offset Dec Offset	None
B(EAMSWITCH)	/A /B	x y offsets for A x y offsets for B	BEAMSWITCH $\boxed{\text{A}}$ $\boxed{\text{NOM}}$ $\boxed{\text{B}}$
D(EC)	None	+/− dd mm ss.s	None
DEL(ETE)	/F(ROM) /A(LL) /S(EQ)	source1 source2 seq.no 1 seq.no 2	None
DIF(F_RATES)	/B(OTH) /R(A) .... /D(EC)...........	RA & Dec Rates RA tracking rate Dec tracking rate	$\boxed{\text{DIFF/RATE}}$
E(DIT)		source name	None
EQ(UINOX)	None	B/J date in years or A(pparent)	None

EXPLANATIONS OF

COMMANDS	PARAMETERS AND QUALIFIERS
Marks comment line in catalogue or at terminal	
Acquire star by (Beware change from historical use)	moving guide probe moving telescope
Give parameters at a given time of the Lists Gives summary of the	named source edit source next source to be observed source currently being observed telescope names in catalogue User Interface parameters
Set up collimation offsets	offsets for aperture A ($''$) offsets for aperture B ($''$)
Moves telescope by required offset and guide probes in reverse	 RA offset ($''$) Dec offset ($''$)
Set up collimation offsets (Synonym for APERTURE)	offsets for aperture A ($''$) offsets for aperture B ($''$)
Declination of edit source is	
Delete Catalogue entries	- from source1 to source2 (if source2 omitted, then only source1) - whole catalogue (except .DEF .GUIDE .LINK) - from sequence number 1 to sequence number 2
Non-sidereal tracking rate (Switched off on source change)	 RA rate in seconds/sec Dec rate in $''$/sec
Selects given source as the	Edit source
The equinox for coordinates is	Byear or Jyear (Mean) or A=(apparent) (B, J, or A *must* be defined)

COMMAND	QUALIFIERS	PARAMETER	CONSOLE BUTTON
F(OCUS)	None	focus position	FOCUS $\boxed{\text{NOM}}$ $\boxed{\text{STOP}}$
GO(TO)	/N(EXT) /SO(URCE)	none source name	T/S DOME $\boxed{\text{SRCE}}$ $\boxed{\text{STOP}}$ none
GU(IDE_OBJECT)	None	object name	GUIDE PROBE $\boxed{\text{GUIDE/STAR}}$
HA(NDSET)	/A(LL) /S(ET) .... /G(UIDE) .... /I(NCREMENT) ...	set rate, guide rate, increment step set rate guide rate increment step	Handset and $\boxed{\uparrow}$ $\boxed{\leftarrow}$ $\boxed{\rightarrow}$ $\boxed{\downarrow}$ XY AXES $\boxed{\text{SET}}$ $\boxed{\text{GUIDE}}$ $\boxed{\text{INC}}$
H(ELP)	None	command name /qualifier	None
I(NPUT)	/N(ORMAL) /P(ROMPT)	file name device name	None
L(IST)	/A(LL) /F(ROM) .... /PR(INTER)	 source1 source2	None
N(EXT)	/NA(ME) .... /SEQ(UENCE)	source name sequence number	T/S DOME $\boxed{\text{SRCE}}$
O(FFSET)	/B(OTH) /R(A) /D(EC)	RA Dec Offsets RA offset Dec offset	OFFSET $\boxed{\text{NOM}}$ $\boxed{\text{OFFSET}}$
P(ROPER_MOTION)	/B(OTH) /R(A) /D(EC)	proper motion RA & Dec proper motion in RA proper motion in Dec	None

EXPLANATIONS OF

COMMANDS	PARAMETERS AND QUALIFIERS
Define requested focus setting Goto requested position with $\boxed{\text{NOM}}$	Focus Position in `mm` of motion of secundary
Slew telescope and dome to the NEXT object GO to source name	*Either* type 'GO' *or* press $\boxed{\text{SRCE}}$ Abort a slew by pressing $\boxed{\text{STOP}}$!! Beware: *not yet debugged*
Define guide-star name as 'edit source'.	Object Name must be a name in an existing Catalogue
Handset buttons are equivalent to 'arrowed' XY AXES buttons. 'set' mode for continuous motion; 'increment' mode for steps.	all values can be defined in one instruction setting rate in ($''$/sec) guiding rate in ($''$/sec) increment in ($''$)
Provide information about a command or qualifier	
Input from file or device	without **UI**–> prompt with **UI**–> prompt
List catalogue entries	for whole catalogue from source1 to source2 on screen to the line printer
Define Next Source	Source Name must be catalogue name Don't press $\boxed{\text{SRCE}}$ until ready to go Sequence Number in current catalogue
Define Offsets in RA and/or Dec; Pushing $\boxed{\text{NOM}}$ cancels offsets.	both can be defined in one instruction offset in RA ($''$) offset in Dec ($''$)
Proper motion	both can be defined in one instruction proper motion in RA (seconds/yr) proper motion in Dec ($''$/yr)

COMMAND	QUALIFIERS	PARAMETER	CONSOLE BUTTON
R(A)	None	hh mm ss.s	None
ROTATOR	see TURNTABLE		
SA(VE)	None	file name	None
SE(T)	/LST /UT /NOW	hh mm ss hh mm ss	
SN(AFU)	/N(OMINAL) /A /B	None	Handset buttons GUIDER buttons ACK
SO(URCE)	/I(NPUT) /MA(RK)	source name source name	None None
STOP	None	None	T/S DOME STOP
T(ELESCOPE)	/O(VER-POLE) /U(NDER-POLE) [/E(AST)] [/W(EST)]	None	None
TI(TLE)	None	text	
TR(AIL)	/ALL /D(URATION) ..... /L(ENGTH) ..... /A(NGLE)	 duration of trail length of trail position angle	SCAN/TRAIL START/CONT HOLD BACK ABORT
TU(RNTABLE)		position angle	TURNTABLE NOM STOP
Z(EROSET)	/A(UTO) /M(ANUAL)		

EXPLANATIONS OF

COMMANDS	PARAMETERS AND QUALIFIERS
Right ascension of edit source is	
See TURNTABLE	
Save current catalogue to disc	
Sets which system and time to be used by ADVISE	set up sidereal time used by ADVISE set up UT for ADVISE ADVISE will use current time
Sets pointing corrections	collimation errors in HA and Dec aperture offset for aperture A aperture offset for aperture B
Define a new catalogue entry	makes new entry in catalogue from terminal takes RA and Dec from telescope position
Stop the telescope and dome	*Either* type 'STOP' at the User Interface *or* press $\boxed{\text{STOP}}$ on the Control Desk
Sets mode of Telescope operation	above the Pole (INT - default) below the Pole (INT - not enabled) East of the pier (JKT - default) West of the pier (JKT)
Types initial USER Interface message to screen	
Define a Trail on the sky.	All values can be defined in one instruction Trail duration in seconds length of trail on sky in $''$. position angle in degrees
Define required rotator setting. Execute rotation with $\boxed{\text{NOM}}$	Position Angle in degrees
Zeroset encoders under computer control Manual ZEROSET	See section 11.1.1 !! Beware: *not yet debugged*

8.4 Details of individual commands in alphabetical order

∗ (text)

In a line of input to the user interface, all characters following an asterisk are ignored by the command processor. In prepared or SAVEd files it is often useful to indicate the purpose or significance of the commands that follow, to flag and date amendments or to indicate the source of the data values appearing as arguments of commands. Comments may be in blocks of lines, each with an asterisk in column 1, or as in-line comments following a command and its argument.

At the console the text is ignored and the user is prompted for further input; in a file the command processor ignores the text and moves on to interpret the next line. There are no qualifiers.

AC(QUIRE)

defines the autoguider acquisition mode and is used to tell the system whether to move the guide-probes or the telescope when acquiring a guide star. Veteran observers should beware the reversal of definitions compared with the historical case.

AC(QUIRE)/PR(OBE) moves the guide probes until the guide-star is centred while the telescope remains fixed (tracking). It is used when the object of interest is already positioned in the TV or on the CCD chip and should stay where it has been put. The position of the guide star will probably not be known very accurately and moving the telescope rather than the probe would cause the target to move.

AC(QUIRE)/TE(LESCOPE) moves the telescope to acquire the star while the guide-probe remains fixed in the focal plane of the telescope. It is used when the guide star position is known precisely *a priori* ; either because it has been observed before and the probe position is known or because the offset between it and the target has been measured in advance.

ADVISE

gives details of a source, telescope or UI parameters, or lists the source-names in the resident catalogue.

AD(VISE)/S(OURCE) source-name

gives details of source-name and times to rise and set from a given time. The output is in LST and an example is given in Figure 8. The desired time is input using SET/LST or SET/UT. If no time has been set, the current time is used.

AD(VISE)/E(DIT)

gives details of the edit source and times to rise and set from a given time. This time is input using SET/LST or SET/UT. If no time has been set, the current time is used.

AD(VISE)/N(EXT)

gives details of the next source and times to rise and set from a given time. This time is input using SET/LST or SET/UT. If no time has been set, the current time is used.

AD(VISE)/CU(RRENT)

gives details of the current source and times to rise and set from a given time. This time is input using SET/LST or SET/UT. If no time has been set, the current time is used.

AD(VISE)/T(EL)

gives all telescope parameters such as SET/GUIDE/INCREMENT rates, offsets, focus position and the like. Sample output Figure 8.

AD(VISE)/CAT

gives a list of only the source-names and sequence-numbers in the resident catalogue. This is a useful command to inspect object names in a large catalogue. Its output, however, is formatted to fill the line accross the VDU screen.

AD(VISE)/UI

gives coordinates of the edit, current and next sources, acquisition and telescope modes and the time set by SET.

AP(ERTURE)

AP(ERTURE)/A x y (arcsecs)	sets aperture A
AP(ERTURE)/B x y (arcsecs)	sets aperture B

sets up aperture offsets defined in an X-Y coordinate system fixed in the instrument rotator. These can be used, for example, to locate an object within a particular aperture or detector pixel. An aperture offset is executed by pushing one of the beamswitch buttons on the control desk.

If it is required to beam-switch (for example on a two channel photometer), then the apertures can be set up using the qualifiers /A and /B with X-Y offsets in arcsecs as input parameters. The control panel BEAMSWITCH buttons $\boxed{\text{A}}$, $\boxed{\text{NOM}}$ and $\boxed{\text{B}}$ (near the centre of the 'System Control' Panel) are then used to select between either aperture or the nominal position. If the required aperture offsets are not known *a priori* then the /A and /B qualifiers for SNAFU may be used to set them up interactively.

APERTURE is applied as a pointing correction, so it is not reflected in the displayed telescope position: conceptually, applying an aperture offset causes the SAME object to be observed using a DIFFERENT area of the instrument whereas an RA/Dec offset causes a DIFFERENT object to be observed on the SAME part of the detector and therefore causes the displayed position to change. The RA & DEC displacements corresponding to a particular aperture offset will vary with the turntable rotator position angle (unlike that for an RA/Dec offset, of course), but the displacement on anything attached to the rotator (TV, CCD, IPCS) will remain constant. All of the aperture offsets are calculated relative to a nominal aperture position which is specified in the system startup (.STD) file and corresponds to an easily visible reference position (the Grinnell crosswires or the centre pixel of an imaging CCD). This is because the reference position does not usually coincide with the rotator axis (which defines the origin of coordinates). The displacement between the reference position and the rotator axis (the base aperture offset) must be calibrated from time to time. For the INT at prime focus, the reference point is in the centre of the CCD chip (10 arcmin off-axis), but for the Cassegrain systems on both telescopes, SNAFU is usually done on the Grinnell cross wires so the reference aperture offset is set up to be the (small) difference between the turntable centre of rotation and the Grinnell cross-wires with the TV in the centre/acquisition position.

AUTOFFSET

is a method of doing precise blind offsets which gets round errors in the declination encoder. The telescope and guide probe are offset by equal and opposite amounts whilst autoguiding, and the guide star is kept at the centre of the autoguider field. This exploits the fact that the probe encoding is more accurate than that of the telescope. It is recommended for blind ofsetting and for 2D spectroscopy when the slit is moved by small increments to cover the field.

AU(TOFFSET)/B(OTH)	RA & Dec
AU(TOFFSET)/R(A)	RA $''$
AU(TOFFSET)/D(EC)	Dec $''$

sets up the telescope offsets in arcsecs in RA, Dec or both according to the qualifier. These are defined in a tangent plane projection centred on the current position of the telescope. The telescope begins to move as soon as $\boxed{\text{RETURN}}$ key is pressed. As the telescope moves to the OFFSET the autoguider automatically follows the reverse vector so that it does not lose the guide star. Be careful: there is always the danger that the autoguider probe may move to a position where it cannot see the guide star. Further, if you press the OFFSET $\boxed{\text{NOM}}$ button after an AUTOFFSET then the telescope returns to its previous position but **not** the autoguider probe.

BEAMSWITCH

is synonymous with APERTURE

D(EC)

D(EC) dd mm ss.s

enters the declination for the current edit source. The format is: degrees minutes seconds. The seconds and minutes may be omitted but then the command must be terminated explicitly either by a carriage return or by a semicolon ';'. There are no qualifiers.

DELETE

deletes sources from the catalogue according to the qualifier.

DEL(ETE)/F(ROM) source-name source-name

deletes the sources in the resident catalogue between and including the given source-names. If only one source name is given, only that source will be deleted.

DEL(ETE)/A(LL)

deletes all sources in the resident catalogue except the first three, since .DEFAULT, .GUIDE and .LINK are protected sources (for *e.g.* input from the autoguider or via the interprocessor link).

DEL(ETE)/S(EQ) sequence-number sequence-number

deletes sources in the resident catalogue between and including the given sequence numbers. If only one sequence number is given, only that source will be deleted.

DIFF_RATES

DIF(F_RATES)/B(OTH)	RA-rate (secnds/sec) Dec-rate ($''$/sec)
DIF(F_RATES)/R(A)	rate(sec/sec)
DIF(F_RATES)D(EC)	rate($''$/sec)

sets up differential tracking rates in RA,Dec or both (according to the qualifier). This will be actioned by pressing the 'differential track' button $\boxed{\text{DIFF/RATE}}$ in the right-hand lower corner of the System Control Panel. Note that this mode is switched off upon source change.

EDIT

E(DIT) Source-name

selects the given source as the edit source. There are no qualifiers. If you define a new source name with the SO command, it will become the current 'EDIT source'.

EQUINOX

EQ(UINOX) Byear
EQ(UINOX) Jyear
EQ(UINOX) A(pparent)

sets up the mean coordinate system (B for Besselian or J for Julian) and the equinox (year) for the edit source. The equinox for apparent coordinates is assumed to correspond to the current date. FK4(B1950.0) and FK5(J2000.0) will eventually be supported, but at the moment only FK4 is implemented. Note that B, J or A *must* be specified.

FOCUS

F(OCUS) position (mm)

Sets the required focus position. The telescope focus will be driven to this value when the FOCUS NOM button on the control desk (right-hand side of System Control Panel) is pressed. Pressing the FOCUS STOP button halts a focus drive. Once the focus drive has been set it will track to follow any change in tube temperature. There are no qualifiers. The position value is `mm` of motion of either the secondary mirror (Gassegrain mode) or the instrument at Prime. Increasing values mean that the secondary or primary instrument is moving further from the main mirror.

GOTO

GO(TO)

slews the telescope to the NEXT or given source and initiates tracking.

GO(TO)/N(EXT)

is equivalent to pushing the T/S DOME SRCE button on the control panel. It will move the telescope to the NEXT source and initiates tracking. If the source is within the software limits, then the green **go** lamp will light up and the telescope will commence slewing. If the object is beyond any (soft) limit, then the **go** lamp will only flash briefly and the red **stop** lamp will be lit. Appropriate messages will also be output to the Information Display (see section 8.7).

If you changed your mind while the telescope is moving push the STOP button to halt the slew.

GO(TO)/SO(URCE) source-name

slews the telescope to the named source and initiates tracking. Beware, *this option has not yet been tested*!

GUIDE_OBJECT

GU(IDE_OBJECT) guide-name

defines a guide object for the edit source by linkage to an existing entry in the catalogue containing the coordinates of the object which you want to be the guide star. After the telescope is pointed to a new source and the GUIDE PROBE button $\boxed{\text{GUIDE/STAR}}$ is pressed on the Acquisition and Guidance panel (A&G, the right-hand panel in bay 3, *NOT* to be confused with the Autoguider Panel), the probes will drive to the position of the guide object, but only if it is at a legal position, *i.e.* within its physical limits. This procedure can be used when the coordinates of a guide star are known in advance. There are no qualifiers.

HANDSET

HA(NDSET)/A(LL)	set-rate guide-rate increment	
HA(NDSET)/S(ET)	set-rate	[0 - 75] ″/sec
HA(NDSET)/G(UIDE)	guide-rate	[0 - 75] ″/sec
HA(NDSET)/I(NCREMENT)	increment	[0 - 6000] ″

This command inputs the set and guide rates and the increment step to be actioned by the handset and/or the 'arrow' buttons on the System Control panel, and the XY AXES buttons $\boxed{\text{SET}}$, $\boxed{\text{GUIDE}}$ and $\boxed{\text{INC}}$, which are found in the lower-left corner of the System Control panel. When in SET or GUIDE mode, the motion is continuous; when in INCREMENT mode, the motion is stepped everytime the button is pressed. If you change a HANDSET parameter the control software will not adopt the new value **until** the appropriate button has been pressed.

H(ELP)

H(ELP) Command

provides on-line help information about a specific command. There are no qualifiers.

INPUT

I(NPUT)

inputs a catalogue from a specified disc file.

I(NPUT)/N(ORMAL) file-name

If no extension of the file-name is given then .CAT is assumed. A maximum of 500 entries in the catalogue is allowed.

I(NPUT)/PROMPT device name:

This is used on startup of the user-interface to select input from this terminal interactively, and is rarely needed.

LIST

L(IST)

will list the source names and coordinates from the resident catalogue.

L(IST)/A(LL)

will list the whole resident catalogue to the screen, pausing after each page to ask whether more output is wanted.

L(IST)/F(ROM) source1 source2

will list from source1 to source2 on the screen.

L(IST)/PR(INTER)

will list the whole resident catalogue to the line printer.

NEXT

N(EXT)/NA(ME) source-name
N(EXT)/SEQ(UENCE) sequence-number

defines the next source to be observed, selected by name or sequence number according to the qualifier used. .DEFAULT is number 1, .GUIDE is number 2 and so on through the catalogue.

OFFSET

O(FFSET)/B(OTH)	RA-Offset	Dec-Offset
O(FFSET)/R(A)	RA-Offset	($''$)
O(FFSET)/D(EC)		Dec-Offset ($''$)

Sets up the telescope offsets in arcsec in RA, Dec or both (according to the qualifier). These are defined in a tangent-plane projection centred on the current position of the telescope. They are actioned by the control panel OFFSET buttons. Pressing $\boxed{\text{OFFSET}}$ will action the offset; pushing the $\boxed{\text{NOM}}$ button will return the telescope to the original position. The current offset values are displayed on the information display. Beware: If you use the FOCUS or MULTEXP commands from the ADAM terminal then you will find that any values you have previously entered for OFFSET have been overwritten.

PROPER_MOTION

P(ROPER_MOTION)/B(OTH) RA Dec	
P(ROPER_MOTION)/R(A) RA	(secs/year)
P(ROPER_MOTION)/D(EC) Dec	($''$/year)

sets the proper motion of the edit source in RA,Dec or both. The corresponding epoch is assumed to be the same as the equinox. Note the *different units*!

RA

R(A) hh mm ss.s

sets up the Right Ascension for the edit source. This format is hours minutes seconds. As with D(EC) the last two are optional but the command must be terminated with a semi-colon if they are omitted. There are no qualifiers.

ROTATOR

RO(TATOR) position (deg)

synonym for TURNTABLE (q.v)

SAVE

SA(VE) Filename

saves the catalogue in memory to a user-specified disk file, which will have a .CAT extension, whatever extension was defined at the User Interface; if you were to specify another extension, a warning would appear: 'File type is forced to .CAT'. There are no qualifiers.

SET

Sets up various UI parameters for the ADVISE (*q.v.*) command according to the qualifier:

SET/LST hh mm ss

sets up the Local Sidereal Time for use by the ADVISE command.

SET/UT hh mm ss

sets up the UT for use by the ADVISE command

SET/NOW

ADVISE will use the current time (this is the default on startup)

SNAFU

sets up the telescope collimation and index errors or the aperture offsets.

SNAFU/NOMINAL

sets the collimation and index errors.

The sequence of events for a ONE-STAR SNAFU is as follows:

1. slew the telescope to an accurately-known source position;
2. Type SN(AFU) and follow the instructions on the terminal *i.e.* press RETURN and ....
3. use the set/guide/increment functions to position the object on the defined reference mark (either the Grinnell cross-wires or the centre of a CCD chip) – see APERTURE
4. press the 'acknowledge button' ACK in the right-hand lower corner of the System Control panel.

SNAFU/A and SNAFU/B

The qualifiers /A and /B enable the different aperture positions to be recorded by the system for use by the BEAMSWITCH buttons A and B. The procedure is:

1. set an object on the reference mark (see above) using the guide buttons or the handset;
2. type SNAFU/A on the user interface console;
3. move the object to the desired aperture position, again using the handset or desk buttons;
4. press the ACK button and then BEAMSWITCH NOM to restore the object to the reference position.

SOURCE

SO(URCE)

defines a new entry in the source catalogue. Note that the first three entries, .DEFAULT, .GUIDE and .LINK, cannot be deleted nor redefined, because they have a dedicated function in data transfer via the CAMAC interfaces. For instance, .LINK is used to transfer source data from the PE 3210 instrument computer over the interprocessor link, and enables the sending of a pointing command to the telescope control software from the ADAM environment.

A newly defined entry automatically becomes the current 'edit' source, so its parameters (RA, Dec *etc.*) can be entered immediately. Note that, until a new SOURCE command is issued, all commands which specify source parameters (*e.g.* RA, Dec, P, *etc.*) will update the values associated with the 'source-name' last entered.

SO(URCE)/I(INPUT) source-name

This command provides the source with default values for RA, DEC, EQUINOX, coordinate type (MEAN or APPARENT) and PROPER_MOTION in both coordinates. The default values for all these quantities are copied from the source which is called .DEFAULT . This is the first entry in the catalogue and has its parameters set on start up.

SO(URCE)/M(ARK) Source-Name

This command reads values for RA,DEC, EQUINOX and coordinate type from the current position of the telescope: proper motions are set to zero. Thus, it provides a means to record the positions of objects with poor or unknown coordinates, as measured at the telescope. Again, the new entry in the catalogue becomes the 'edit' source.

Error checks are made to see if the source-name is already in the catalogue; whether the maximum number of catalogue entries has been exceeded; whether the storage allocated to the dictionary of source-names has been filled; or whether the name of the source is too long. If the source name does already exist the entry is simply overwritten without error message. Otherwise, appropriate messages are displayed in each case and no catalogue entry is made.

STOP

STOP

is the equivalent of the T/S Dome STOP button on the control panel. It stops both the telescope and the dome. There are no qualifiers.

TELESCOPE

T(ELESCOPE)/O(VER_POLE)	*(INT default)*
T(ELESCOPE)/U(NDER_POLE)	*(INT not enabled)*
T(ELESCOPE)/E(AST)	*(JKT)*
T(ELESCOPE)/W(EST)	*(JKT)*

is used to set the mode of telescope operation according to the qualifier; *i.e.* working either East or West of the pier on JKT with E(AST) as default. On the INT, OVER is the default and UNDER_POLE is *NOT* enabled.

TITLE

TI(TLE)

is only used for input from files. The text following the command is printed on the terminal. It is used for instance to output the initial messages for the user interface. There are no qualifiers.

TRAIL

TR(AIL)/ALL	duration length angle
TR(AIL)/D(URATION)	duration (secs)
TR(AIL)/L(ENGTH)	length (arcsecs)
TR(AIL)/A(NGLE)	position-angle (degrees)

sets up the parameters for a trail on the sky to be followed by the telescope. The trailing is activated by pushing the associated buttons under SCAN/TRAIL near the centre of the System Control panel (see below). The starting position is where the telescope happens to be at the time the TRAIL begins; thus, its definition is relative to the starting point; there is no offset to a central position.

Note that the default mode is TRAIL, with the $\boxed{\text{SCAN/TRAIL}}$ button *un*lit. (SCAN is a command very similar to TRAIL; if the SCAN mode is selected this button lights up. In SCAN mode you are supposed to be able to make a series of parallel trails, in order to scan an area of sky; this command has, however, not yet been commissioned.)

A TRAIL is performed as follows:-

To start a trail	press: $\boxed{\text{START/CONT}}$
To pause a trail	press: $\boxed{\text{HOLD}}$
To reverse a trail direction	press: $\boxed{\text{BACK}}$
To stop a trail and return to the start position	press: $\boxed{\text{ABORT}}$

TURNTABLE

TU(RNTABLE) position angle (degrees)

sets the required rotator position at Cassegrain. The turntable will be driven to this position when the TURNTABLE $\boxed{\text{NOM}}$ button on the control desk is pressed. There are no qualifiers. Note that it has a synonym, ROTATOR.

ZEROSET

is used to zeroset the incremental encoders.

Z(EROSET)/A(UTO)

sets the incremental encoder readings to zero when the telescope slews past a hardware marker. The sequence of operations is:

1. Move telescope to within a few degrees of the zero set position;
2. Press $\boxed{\text{RETURN}}$ when ready to continue the green handset lamps on the control panel will light up
3. Use the engineering-mode telescope control buttons to move the telescope through the zeroset position at the speed marked on the control potentiometers (about 1°/sec) in each of the coordinates successively. As each axis is zero-set the appropriate console light will go out indicating successful completion for that axis.

To get out of this procedure at any time, press $\boxed{\text{ACK}}$ on the control desk.

Z(EROSET)/M(ANUAL)

Warning: this command is not yet fully debugged. It can be used when the hardware zeroset is broken. In this case, move the telescope to the zeroset position at the zenith (HA = 0; Dec = latitude) as indicated by the synchros (INT) (or setting circles at the JKT) and enter Z(EROSET)/M(ANUAL). This effectively does a SNAFU operation assuming that the telescope is at the zeroset position. The result will be significantly less accurate than the standard hardware zeroset. See section 11.1.5 for more information.

8.5 Examples of working with Catalogues

Suppose it is desired to observe three objects, as follows:

1. A star called HD 1234 at RA $07^h\ 08^m\ 09.32^s$, Dec $+17°\ 14'\ 44.1''$ at equinox B 1950.0 (Besselian). This has annual proper motions of $+0.034$ secs of time in RA and $-0.127''$ in Dec.

2. A galaxy called NGC 3456 at RA $10^h\ 11^m\ 12.3^s$, Dec $-3°\ 7'\ 14''$ at equinox B 1900.0.

3. A nearby star, to be used as a standard, HD 2345 at RA $10^h\ 13^m\ 15.7^s$ Dec $-4°\ 5'\ 6''$ at equinox J 2000.0 (Julian).

HD 1234 is to be observed first and then the main object will be NGC 3456 with HD 2345 as the standard.

8.5.1 Adding sources to a Catalogue

The UI commands may be used to enter an object name and details in the following way (minimum abbreviations are used):

Command	Comment
UI–> `SO HD1234`	∗ Object name
UI–> `R 07 08 09.34`	∗ RA
UI–> `D 17 14 44.1`	∗ Dec
UI–> `EQ B1950`	∗ Equinox (Besselian)
UI–> `P/R +0.034`	∗ RA Proper Motion (sec/year)
UI–> `P/D −0.0127`	∗ Dec Proper Motion (″/year)

Source names may be defined with any letters inside brackets used as optional descriptors, *e.g.* AL(VIN) may be recalled as ALVI, ALV or AL.

An alternative way of entering commands is to put all of them on a single line leaving spaces between each trailing field and the next command word. NGC 3456 may be input, using minimum abbreviations, as follows:

UI–> `SO NGC3456 R 10 11 12.3 D -03 07 14 EQ B1950`

The semicolon may be used as an alternative to $\boxed{\text{RETURN}}$ as a command terminator. For example, each of the commands RA and DEC expect one sexagesimal argument with 3 fields (hrs mins secs or degs mins secs), but right ascension 1^h, declination $+30°$ and equinox 1950 is abbreviable to:

UI–> `R 1; D 30; E B1950`

The command processor ceases looking for further arguments for R and D on detecting the semicolon and begins processing afresh at the next character.

8.5.2 To inspect catalogue contents

To check that the coordinates have been typed in correctly, we can LIST the target objects and their positions on the screen:

UI–> `LIST`

which results in:

Name	RA	Declination	Equinox	PM-RA	PM-Dec	Guide-Object
NGC3456	10:11:12.300	−03:07:14.000	B1950.0	0.000	0.000	.GUIDE
HD2345	10:13:15.700	−04:05:06.000	J2000.0	0.000	0.000	Not specified
HD1234	07:08:09.340	17:44:44.100	B1950.0	0.034	−0.127	.GUIDE

The catalogue information for individual sources may be displayed by:

UI−> `AD/E`	for the entry now being edited
UI−> `AD/N`	for the next source to be observed
UI−> `AD/CU`	for the source currently being observed

The command AD/CAT lists just the source names in the resident catalogue.

8.5.3 To enter a parameter for several catalogue entries

Parameters which are not entered specifically for a new source are taken from the previously entered source (or from .DEFAULT). This allows one to specify parameters which are then valid for all subsequently entered sources. For instance, in order to enter a list of stars with J1900.0 coordinates, one would only have to type:

UI−> `EQ J1900`
UI−> `SO STAR R 12 34 56 D 12 34 56`

and the equinox of all following entries will be J1900 until changed.

8.5.4 To save the catalogue in a Disc File

UI−> `SA(VE) STAR`

Will save the current catalogue in file STAR.CAT. All SAVE files are given the extension '.CAT'.

8.5.5 To restore a catalogue from disc file

Use the INPUT command to load a catalogue from disk:

UI−> `I(NPUT) STAR.CAT`

The catalogue could have been typed in during a previous session and SAVE, or the catalogue may have been created outside the User Interface software by using the Perkin Elmer EDITOR (see section B.2 for details).

8.5.6 To LIST the resident catalogue on line printer

The line printer is found in the Instrument Computer room, beside the PE 3210 System Console. There is a black box with a switch, most likely resting on the floor beside the printer. Ensure that this selector switch is switched to *Telescope* Computer, *i.e.* not to Instrument Computer. (It is intended to replace it by a device without switch.) Go back to the control room and type at the UI console:

UI−> `L(IST)/PRI(NTER)`

Wait for a few seconds. If nothing happens, type (on the PE 3220 Telescope System Console):

∗D(isplay) M(emory)

in order to check that the Spooler task, '.SPL', is not Paused. (See section B.1 for more details about the Perkin Elmer operating system.) If the Spooler task is paused, type on System Console:

∗T(ask) .SPL
∗CO(ntinue)

and try again LI/PRI at the User Interface. If .SPL was not loaded, then type on System Console:

∗STARTSPL

and try `LI/PRI` again.

8.5.7 To remove objects from a Catalogue

Use the DEL command, but do it carefully:

UI–> `DEL/F HD1234 HD2345`

This removes *all* the objects in the catalogue with entry numbers between those of HD 1234 and HD 2345.

8.5.8 To move the telescope

Indicate which source is to be observed by using the NEXT command, followed by pressing SRCE or typing GO:

UI–> `NEXT NGC3456`	: Select NGC3456 as your 'next' object
UI–> `GO`	: Move telescope to this object

If you change your mind, or whatever, the telescope is halted by pressing T/S DOME STOP on the System Control panel.

8.5.9 To use a catalogue entry as guide star

The standard HD 2345 can be set up as the guide star for target HD1234 by using the GUIDE command:

UI–> `SO HD2345 R 10 13 15.7 D -04 05 06 EQ J2000`
UI–> `GU HD2345`
UI–> `NE HD1234`
UI–> `GO/NEXT`

This sequence moves the telescope to HD 1234 and specifies the object HD 2345 as guide star. Now, push the GUIDE/STAR button in right-hand upper corner of the Acquisition & Guidance panel (bay 3). This causes the guide probe to be driven to the correct offset to pick up HD 2345, if within range. It will assume that the guide star and target source coordinates have the same equinox and makes no allowance for proper motions.

8.6 Standard catalogues on disc

8.6.1 Catalogue format

A catalogue for the telescope computer is a set of user interface commands and as such can be in free format. For legibility and neatness, however, it is worth adhering to a more rigid tabular format with one object per line of the file. The guidelines for generating catalogues may be divided into essential rules (disregard of which will cause the interface to be unable to read in the file) and conventions (which are guidelines for producing catalogues which may be read in as quickly as possible and are easy to maintain).

Essential rules

The following rules MUST be followed.

1. The file should consist of 80-byte records. Consequently, no more than 80 characters per line are allowed.
2. There should be no non-alphanumeric characters (carriage returns, line feeds, *etc.*) anywhere in the file.
3. The filename must consist of 8 alphanumeric characters or less, starting with a letter, and must have the extension '.CAT'.
4. There should be no more than 500 objects in the file, as this is the maximum number that can be held in memory at once.

Conventions

1. Every standard catalogue should start with a comment line giving its contents and giving the name of the originator.
2. If all of the objects in the catalogue have the same equinox, and coordinate type (ie J B or A(pparent)) then this should be given at the beginning of the file, not repeated for every object.
3. The format should be as given in the examples below, *i.e.*:
   `SO OBJECT R hh mm ss.ss D +dd mm ss.s P/R +s.ssss P/D +s.sss EQ Jyyyy.y`
   with the equinox omitted if it does not change from line to line.
4. It is expected that each catalogue file will have an associated documentation file with the same name but with the extension '.DOC'.
5. Catalogues should be split by Right Ascension in order to minimise the number of records to be read in - there is no point storing objects if they are unobservable..

Coordinate Systems

The restrictions on coordinate types are as follows:

1. Coordinates may be either mean or geocentric apparent. B1950 (FK4) and J2000 coordinates are supported at present.
2. Geocentric Apparent coordinates refer to the current date and time.
3. The epoch for the proper motions must be equal to the equinox for mean coordinates. (Conversions can be made using the COCO program on the VAX 8300, if necessary.)

8.6.2 List of standard catalogues

Astrometric standards

PTGRID (see listing in Appendix A) contains a grid of stars with accurately-known positions for pointing tests. The following four catalogues are subsets of PTGRID and contain stars which pass through the zenith. They are to be used for setting the encoder zeropoints of the telescope (SNAFU) (section 11.1.2 and for measuring the seeing (section 14.4).

PTGRID	0 hr < RA < 24 hr
SEE0006	0 hr < RA < 6 hr
SEE0612	6 hr < RA < 12 hr
SEE1218	12 hr < RA < 18 hr
SEE1824	18 hr < RA < 24 hr

Spectrophotometric Flux Standards

SPECPHOT Spectrophotometric flux standards

A description of this data is given in La Palma Technical Note 65. There is a blue loose-leaf binder on the control-room shelf entitled: 'Spectral Flux Standards' which includes LPTN 65, and further standards from Oke, J.B. 1990 (A. J., **99**, 1621) and Massey, P. et al. 1988 (Ap. J., **328**, 315).

Photometric standards

The following six catalogues contain stars from Landolt's list of equatorial standards for UBVRI photometry. There are two overlapping sets, one with photometry by D.H.P. Jones & J.E. Sinclair (from SAAO) and the other with photometry by Landolt (from KPNO; see INT Prime Focus manual for details). Users should be warned that there are differences between the two datasets in the U and B bands, as is discussed further in the .DOC files. All of the positions have, however, been checked and/or remeasured. There is a further division between stars suitable for CCD's (V > 10) and those which should only be used with photoelectric photometers.

UBVRIRG	Jones & Sinclair photometry; no magnitude restriction
UBVRIRGB	Jones & Sinclair photometry; V < 10
UBVRIRGF	Jones & Sinclair photometry; V > 10
UBVRIKP	Landolt photometry; no magnitude restriction
UBVRIKPB	Landolt photometry; V < 10
UBVRIKPF	Landolt photometry; V > 10

8.7 The Information Display

The Control System's TNHZ task regularly updates (roughly once a second) the Beckmann Displays at the top of the Control Desk and the Information Display, which can be routed by the Telescope Operator to a selection of up to three monitors in the Control Room; the monitor on the System Control Panel (Control Desk, Bay 2) always carries the Information Display. A sample output is shown in Figure 8; some additional comments are given here:

- The top line gives the Date, the Universal Time and the geocentric Julian Date.
- The block labelled INPUT echoes details of the current source as supplied to the User Interface:
  1. The RA and Dec will be either Mean coordinates, in which case the associated Equinox is also displayed, or Geocentric Apparent, as defined when entering the position data. This display will not change when the telescope is tracking or guiding.
  2. The proper motion values shown are as given to the User Interface.
  3. Offsets in RA and Dec are updated when one of the buttons $\boxed{\text{OFFSET}}$ or $\boxed{\text{NOM}}$ on the Control Desk is pressed (and the offset increments used by the Telescope Control Software are not equal zero). On source change the offset values are reset.
  4. The differential tracking rate display reflects the values passed on with the DIF command. The displayed values are updated (and the telescope acts upon those values) whenever the differential track button $\boxed{\text{DIFF/RATE}}$ on the console is pressed. Note that the value is reset to its normal value (usually zero) on change of source.
  5. The aperture display shows which aperture position is being used. The RA and Dec position values are calculated from the X,Y rotator coordinates to indicate where on the sky the current aperture is positioned. Note that the offset is executed by pushing the BEAMSWITCH buttons on the System Control Panel. The NOMINAL position usually has non-zero X and Y because the reference point used for the SNAFU procedure is not on the rotator axis.
- The TELESCOPE block of the Information Display gives details of the *current* telescope parameters:
  1. For the INT is indicated whether the telescope is OVER (above) or below the pole (or, equivalently, for the JKT, whether the telescope is East or West of the mounting).
  2. The status of the telescope drive is indicated with the display of FAST SLEWING, SLOW SLEWING, TRACKING or STOPPED, according to the velocity demand. Note that TRACKING only indicates that the slow-motion drive is turned on, *not* that it is tracking within any particular error. If the Telescope is in fact tracking but the Dome is still out of position, then the Information Display reads SLOW SLEWING.
  3. The two positions displayed are, firstly, on top, the telescope position (mean or apparent) as entered via the User Interface, and secondly, below, the Geocentric Apparent coordinates.

     For the purists among the readers it is noted that the latter position is strictly only accurate if the telescope is tracking with a negligible position error. This is because the apparent position is calculated by adding the demanded position to the known position error; the position error, however, is determined in the encoder coordinate system, which is skewed with respect to the telescope mean or geocentric apparent systems. Therefore, this calculation is not accurate for large position errors.
  4. The position error represents the telescope's (momentary) distance from the the correct tracking position. These values should be zero (or at most $\pm$ 2 in the least significant digit) under normal operations.

Figure 8: Sample Output on the Information Display

5. The Local Sidereal Time and Hour Angle displays are accompanied by details of the current source's visibility:
   (a) If the source is visible its Local Sidereal Time of Rising and remaining time above the horizon are given. The number of hours left for observation is calculated as the time to lapse before the source goes below one of the telescope (software) limits. This will be either the Hour Angle, Zenith Distance or, for the INT, the Southern Declination limit.
   (b) If the source has not yet risen the rise time and possible observing time are given.
   (c) If the requested source either never rises or is circumpolar then appropriate messages are displayed.
6. The three azimuth position angles displayed, refer to the telescope, the demanded dome position, and the actual dome position. (The demanded dome position will be different from the telescope azimuth for an offset-mounted mounted telescope, such as the JKT or the finder.) The actual dome azimuth value is read directly from the encoder, and its alignment should be checked daily because the encoder gearing occasionally slips.
7. The Zenith Distance (software) limit is set at 70°. The airmasses are simply relative to zenith, but *no* allowance is made for the altitude above sea-level.
8. For the INT the zenith distances of the edges of the wind shields are also given. These are the actual zenith distances, not when the telescope begins to be obscured! With the lower shutter *down* the telescope starts to vignette at a zenith distance of 58°; with the lower shutter fully *up*, the telescope is vignetted at a zenith distance of 49°and *lower*. Further, when the shutter is fully open the lower edge of the shutter is beyond the zenith, its zenith distance is without meaning and a row of asterisks ("$*$") is displayed.
9. The Parallactic Angle and Instrument Rotator positions are very useful information when doing spectroscopy at large zenith distances. The Telescope Operator can rotate the A&G box to align the spectrograph slit vertically so that atmospheric dispersion spreads starlight along the slit and not across it.
10. The control software includes a model of the Telescope Focus as a function of the ambient temperature. Once the focus has been determined at the beginning of a night, the telescope will remain in focus, even when the temperature changes. The displayed values allow on-line inspection of this little miracle.

- The last line displays the selected NEXT object to observe. The telescope will move to this object either by typing `GO/NEXT` on the User Interface or pressing the $\boxed{\text{SRCE}}$ button on the Control Desk. Typing `GO` is sufficient to go to the NEXT source.

9 THE PE 3210 INSTRUMENT COMPUTER

9.1 Introduction

Common-User instruments on the INT are provided with their own software packages, which run under ADAM on the dedicated PE 3210 Instrument Computer. This machine is found in the air-conditioned Instrument Computer Room, adjacent to the Telescope Control Room, together with two Magnetic Tape Units, an EGLE disk drive, a Line Printer, and the System Console. The system is powered via the Buffer Set (Chapter 16). Two user terminals are located in the Telescope Control Room: one acts as the interface to the instrumentation computer software, and is more commonly called the ADAM terminal (see Section 2.6), whilst the other one stands on a desk at the East end of the Control Room and is for general use during daytime only, when the PE 3210 is frequently used for software development.
Beware! Never use the latter terminal to work on the computer during observing: its use will substantially slow down the ADAM control software, and may even cause data to be lost.

A full discussion of the PE 3210 is somewhat outside the scope of this INT User Manual. This section only deals with starting (*e.g.* after a power failure) and stopping the computer. However, because the Instrument Computer is also available to observers with private (non common-user) instrumentation (in consultation with the La Palma staff), additional information about the PE's Operating System, its text Editor and PE-specific Tape Handling, is provided in the appendices. Those notes are intended to assist with such private use, and indeed may also be of interest to observers who require a more detailed knowledge of the Instrument and Telescope Computers. More extensive information can be found in the documentation bays in room D102 (to be reached via the software room, D101) on the first floor of the INT building. Tape handling under ADAM, in particular the initialisation and writing of FITS formatted D-Tapes during or after observing, is described in detail in the relevant instrument manuals.

The normal practice is to leave the PE 3210 Instrument Computer up and running during daytime for development work. At the end of the night, after data taking and tape dumps have finished, the instrument control software is shut down as described in chapter 6.

9.2 Normal Startup and Sign On

1. Check that the PE 3210 is alive by pressing the RETURN key on any terminal. An asterisk "*" response indicates that all is well. If there is no response you will have to bootstrap the computer: divert to Section 9.3.1.

2. Go to the System Terminal in the side room and type:

   `*D(ISPLAY) D(EVICES)` (or `D D`)

   A listing of devices known to the system and their status will appear on the terminal. Check that the EGLE disk is on-line and write enabled. If not, divert to section 9.3.1.

3. Sign on to the computer via the ADAM terminal in the Control Room: There are eight account numbers (1-8) reserved for visiting astronomers, of which normally 2 or 3 are already in use by someone else (staff and/or the previous observers). The accounts currently in use will be listed on the information board above the book shelves. Choose a vacant account number, say n, and enter your initials to the information board as well as the date interval during which you reserve the account for your exclusive use. This interval is usually from the current date until about three days after the end of your run. Accounts that have expired are considered to be vacant. If you are desperately short of disc space ask your Support Astronomer or one of the software staff to delete all the files they may contain. Then sign on by typing:

```
*SI(GNON) AXZ, n, n
```

where AXZ are the initials of, or used by, the observer, n is the account number, and the second n is provided as a password (currently the same as the account number). The initials provided are used in combination with the name of the detector or instrument to be employed to compose the names of your data files, *e.g.* CCDAXZ.003; more than 4 initials will be truncated.
Note: It would be appreciated if observers use the initials of the Principal Investigator of the PATT or CAT proposal under which the observing time was granted. This is because the PI is the official owner of the data during the proprietary period of one year, and the initials are included in the La Palma Data Archive descriptors.

4. If your sign-on is accepted, a number of system messages will be generated and you will be ready to run the instrument control software. However, that is another story altogether ... , and the reader is here referred to the ADAM and appropriate Instrument Manuals.

9.3 Starting the Instrument Computer

9.3.1 Cold Start

A 'cold' (*i.e.* from the very beginning) startup of the PE 3210 will be needed if there has been a power failure or system crash, or if the computer has been closed down deliberately or accidentally (*e.g.* the pressing of the INIT key as described in item 4). After a power break it can take some time before the power supply is restored. Wait for a message from the Duty Officer for the Buffer Set to be restarted. This will normally be done by the Duty Technician or the Telescope Operator. If the power supply to the INT building is in order, reboot as follows:

1. Check that the Instrument Computer and peripherals are powered up. If not, see that the mains switch (high on the wall) is turned to position '1'. This switches on everything except the CPU and the Line Printer, which are powered via an additional red socket on the wall behind the computer.
2. The 400 Mbyte EGLE disk is located below Magnetic Tape Drive number 1. Make sure that:
   - The **protect** switch is at OFF, *i.e.* in the position opposite ON.
   - The **start** ON/OFF switch is at ON. If the EGLE was OFF it will take about a minute for the disk to reach operational speed after being switched on. The disk is powered up when:
   - The three red lights (Start, Power On and Ready) on the front panel are all lit.
3. Go to the computer rack with the 'Perkin Elmer 3210' label. Press down two finger catches at the top so that the front panel comes away in your hands to reveal the consolette at the top inside. Check that the ENABLE/DISABLE switch on the consolette above the computer is in the DISABLE position.
4. Press the INIT button on the PE 3210 consolette. This initialises the computer. If the machine refuses to cold start when the INIT button is pressed, check that the little plastic key is turned to ON and not to STANDBY.
5. Replace the front panel.
6. The boot loading sequence will have started and you will be asked two questions at the System Console. Answer as follows:

***DEV:**	`DSC2`	
***VOL=SYS FILE=**	`EGLE3210.LPO`	(Beware '`O`' and '`0`')

The system will now be loaded and configured for your use, a process taking approximately three minutes. Several messages will be generated about discs being checked, and (after a previous power failure or crash) warnings can appear about possibly lost data, which can safely be ignored (they are generated when the system closes files that are found to be open).

The punch line you are looking for is:

END OF ENVIRONMENT CONFIGURATION

If the line printer is off-line, an additional message will appear:

.SPL: I/O error A009 on LP1 - Please correct

This is just a warning and can again be ignored until you wish to use the printer.

7. The system is now up and running and you can proceed with the normal Sign-on procedure at the ADAM terminal as described in the previous Section 9.2.

9.3.2 Warm Start

If the computer was shut down in a controlled manner, *e.g.* in anticipation of a power failure, then it can be 'warm' restarted as follows:

1. Check that the EGLE disc is ready:
   - **protect** switch OFF, *i.e.* in position opposite ON
   - **start** switch ON.
   - Start, Power On and Ready lights all lit.
2. Go to the system console, and check that the EGLE disc is ON with:

   `*D D`

   If the device EGLE is OFF, then do:

   `*MA EGLE:,ON,,CD=ALL`
3. Subsequently, type:

   `*STARTUP`

   When the system is ready for use it will display the message:

   END OF ENVIRONMENT CONFIGURATION

9.4 Stopping the Instrument Computer

A controlled shut down of the PE 3210 (*e.g.* in anticipation of a Power Failure) is done as follows:

1. Sign off all (three) terminals, if not yet done, by typing on each terminal:
   - `*SO`
2. Go to the System Terminal in the computer room and type:
   - `*STOPALL`

- *OFF

Wait for the message about the EGLE disc still being marked ON; then type:

- *MA EGLE:,OFF

3. Go to the EGLE disc and:

   - Switch the **write protect** switch to ON
   - Switch the **start** swith to OFF, *i.e.* the position opposite ON.

   After a successful controlled shutdown, the Instrument Computer can be restarted following the Warm Start procedure described in the previous Section 9.3.2.

9.5 Problems with the EGLE disc

9.5.1 Shortage of Disc Space

During a Cold Start (see Section 9.3.1) initialisation sequence one of the tests done by the operating system is to determine the amount of free space on the EGLE disc. Normally there should be several 100000 blocks available, but on occasion the disc may be nearly full. Ask your Support Astronomer to delete files (if any) from expired accounts.

Within the ADAM data acquisition software environment one can check how much disc space is left with the commands CCDSPACE or DSPACE; use these commands occasionally to keep track of the available disc space. If you do run out of space then ADAM will write the next image (observation) into file R0 (normally used for GLANCEs) and will display a warning that it has done so, and why. Thus, if you are low on disc space be on the lookout for such a message.

Inside ADAM you can create more space by purging some of your files that you have already written to the D-tape. Use the PURGE command, answer SYS to the first prompt, and take it from there. If you try to PURGE a file that has *not* been written to tape previously, you will get an error message to the effect:

'FILE PROTECTED, ARE YOU SURE YOU WANT TO DELETE Y/N'

Reflect on this question, before answering! Pessimists don't purge before their files have been copied to 1600 BPI D-Tape and then recopied to 6250 BPI C-Tape. The copying program alerts the operator to possibly corrupted files on the D-Tape. Therefore, it is a good idea to use the **verify** option of the FITSOUT programme when saving data files on the D-Tape. Writing a file to D-Tape unprotects the disc file.

As an alternative to PURGE you can use the DELETE command to delete files m to n:

*DELETE Rm−Rn

The DELETE command will ignore protected files (and not prompt for a decision). If you are very sure, you can unprotect a data file with:

*REPROTECT/WKEY=0,189 Rm−Rn

Finally, if the cleanup of disc space was prompted by ADAM writing an observation into R0, don't forget to KEEP that data file!

9.5.2 "Funny Images": DMA Transfer Problems and Bad Disc Sectors

Occasionally, you will get a funny looking image which looks as if one part has slipped relative to the other, or has bars across it or some equally obvious fault. The most likely cause is a fault occurring during the transfer of the image from detector to disc. In order to check this, look a few lines back on the ADAM screen for a line to the effect:

'Time-out during DMA transfer'

If you do find this message then the image is hopelessly corrupted and cannot be recovered. The observation is unfortunately lost; you may as well PURGE the file at once, and use the NEXTRUN command to reset the run number if you do not want an hiatus in the numbering of your observations. After a failed DMA transfer the next observation usually transfers without difficulty. You can do a CCDINIT, but there is no clear evidence that this makes subsequent transfers any more reliable.

However, **if you do NOT find** an error message about DMA transfer problems, then your image has probably been written on to an irrecoverably corrupt sector of the EGLE disc. In this case do NOT purge or delete the file! Instead, leave the file as it is, but don't copy it to tape, because the image is corrupted forever and you cannot do anything about it, except repeat the observation. Further, leave a note to the software group to the effect that file Rn on account m is written on a corrupt sector of the EGLE. They will then rename the file to a hidden account, leaving the data on the disc, which effectively prevents ADAM from trying to use that part of the disc again. Therefore, whatever you do, DO NOT DELETE the file, as the software group won't be able to find the corrupted area again until some unfortunate following observer, or indeed you yourself, succeeds in putting a (necessarily corrupted) image on it. By following this policy quite a number of bad sectors on the disc are now protected from being used by ADAM, and faults of this nature are now rarely encountered.

The worst variation of the aforementioned problem is that your GLANCE files are written on a bad sector: doing a new GLANCE simply will write on the same bad sector. The only way out is to KEEP the glance file with the faulty image, which is then renamed to Rn, and inform the software staff as before about the corrupted file. Subsequent GLANCEs will be directed to a different part of the disc.

10 THE TV ACQUISITION CAMERA

10.1 Introduction and Safety

The acquisition and guide box (A&G) on the INT features a rotating flip mirror which directs the telescope beam to a high-gain Westinghouse TV camera, thus providing field or slit viewing at the Cassegrain Focus; there is **no** camera at Prime. The Westinghouse is a high (3000) gain video camera with a Grinnell digital integrating store. It is a very sensitive system and care must be taken in its use. There is an identical Westinghouse camera on the finder which can be directed to the Grinnell when wanted. This section is intended as a guide to the safe use of the TV Cameras, and how to get the most out of their facilities.

The very high-gain TV cameras can be quickly and
PERMANENTLY DAMAGED BY OVER-ILLUMINATION
by BRIGHT stars or BRIGHT lights.

Do not, therefore, operate the TV until you have read all of this Section and preferably have also been shown how to use it. If you suspect overillumination you should immediately press the $\boxed{\text{FREEZE}}$ button and turn the gain down.

Some simple **precautions** to ensure a long life for the TV Camera:

1. Check that all dome lights, including torches, are turned off before turning on the camera.
2. Always view a field in **DIRECT** mode first, NEVER in **AVERAGE** or **SUM**.
3. Turn the gain up SLOWLY. The system time constant is about 3 seconds.
4. Never do a long integration with a bright star in the field.
5. Always turn the camera gain off BEFORE MOVING the telescope.
6. DO NOT TWIDDLE knobs at random.
7. If in doubt, press the $\boxed{\text{FREEZE}}$ button and turn the gain down.

10.2 Camera Control

The controls for the two Westinghouse TV's , Cassegrain and Finder are located in Bay 4, Rack 1 directly beneath the small TV monitors at the top which all act as raw video displays. The Grinnell monitor itself is located directly underneath the monitors in Bay 4, Rack 2. Its picture can also be routed to a monitor in Bay 1. The selector switches which allow TV pictures from all focal stations and the finder to be sent to the monitor are located directly below, alongside an array of feature-selection buttons which are described in more detail further on. The final piece of hardware in the TV system is a joystick controller box which normally resides on the telescope Control Desk. Figure 9 shows the location of the TV camera controls on the INT Control Desk (bay 4).

Control of the flipmirror as part of the A&G box is made through both the ADAM instrument control software environment and the telescope User Interface, from which Guide and TV probe move requests can be made. The TV flip mirror should be in place when it is necessary to view a new field or when ready to guide. Note the possibility to use colour filters with the camera: the finder filters numbered 1, 2, 3 and 4 are respectively CLEAR, B, V and R.

Figure 9: TV Acquisition Camera controls

The Grinnell Camera is controlled with several groups of switches and push buttons: A group of three rotary switches serve to define the setup of image integration and contrast. The main Grinnell functions are controlled with a 3×3 block of buttons just above the rotatary switches. Note the facilities to archive the camera image and to obtain a hard copy. A further set of push buttons serve to select functions from a menu which enable on-line image analysis.

The three rotary switches below the panel buttons act as follows:

- **INTEGRATION**

  The absolute position of this switch determines the number of frames of integration $N=2^n$.

- **BACKGROUND**

  Makes the background blacker or whiter. There is no absolute position, the effect is determined by the direction and number of steps moved. However, after a complete $\boxed{\text{RESET}}$ of the TV control System, the background always has the value 2048.

- **CONTRAST**

  As for the BACKGROUND switch but it controls the contrast *i.e.* softens or enhances.

The main 3×3 block of the main Grinnell controls have the following functions, from top to bottom and left to right:

- **AVERAGE**

  Recursively filters on-target integrations to increase signal-to-noise ratio. The number of on-target integrations ($N=2^n$) are selected by the **INTEGRATION** rotary switch. The filtering is done in the TV system microprocessor; the image is effectively smoothed over 2^S frames, where S equals 2 or 3. The signal-to-noise ratio is proportional to $(2^S - 1)^{1/2} N^{1/2}$ and the effective time constant is 40(2^SN) milliseconds. Note that when using **AVERAGE**, for a given S/N ratio a smaller number of on-target integrations is required than with **SUM**, and less charge on the cathode is accumulated. Because **AVERAGE** gives a higher S/N ratio, at the expense of a longer effective time constant, it should be used in preference to **SUM** except for quick looks with short integrations, *e.g.* acquisition of an object just below the **DIRECT** mode limit.

- **SUM**

  ON-target summation of N=2^n frames (each of 40 msec), selected via the **INTEGRATION** rotary switch. The signal-to-noise (neglecting dark current) is proportional to $N^{1/2}$. On-target integration is potentially dangerous because the photocathode may be damaged by excessive build-up of charge, so care is needed. In all but special cases **AVERAGE** is to be prefered: it is usually better to use moderate on-target integrations with filtering rather than very long integrations.

- **DIRECT**

  Real time digitisation at normal frame rates. Normal Frame integration time is 40ms.

- **FILL**

  Fills in the alternate lines of a stationary (**FROZEN**) picture. Considerably improves the appearance of faint, extended objects.

- **FREEZE**

  Freezes the current picture.

- **ARCHIVE**

  Saves TV frames in the memory of the 3210 Instrument Computer.

- **OVERLAY-ONE**

  Enables/disables the first graphics overlay plane (*i.e.* the boundary, the orientation and the scale).

- **OVERLAY-TWO**

  Enables/disables the second graphics overlay plane (*i.e.* the integration, tau, background and contrast information).

- **CROSS HAIR**

  This puts a crosswire on the screen.

To the left of the rotary switches are three more push buttons: MENU , SELECT and RESET. Pressing MENU will freeze the image and cause the first of a two-page image processing Menu to be displayed. A description of the available menu functions is given in Section 10.5 towards the end of this chapter. A cursor will appear, which can be positioned on a selected Menu item by repeated depressions of the SELECT button. Alternatively, the joystick may be used for the selection of a Menu function. The joystick controller box also contains the buttons to enable/disable the movement of any displayed cursor. Press the ENTER button on the joystick controller to enter the menu selection. Pressing the RESET button will completely reset the system: all overlays *etc.* will be lost.

10.3 Powering up the TV system

To operate the system follow these steps:

1. Make sure all lights, including torches, are out in the dome.
2. Turn on the power of the Finder (and if necessary, Cass) monitors in Rack 1 and let them warm up so that you can see if there is any image on the TV cameras.
3. Ensure that the gain controls for Cass and Finder are turned fully OFF (turned anti-clockwise until they click).
4. Press the black $\boxed{\text{ON}}$ button on both control boxes. The lights marked DELAY and RESET will come on. Wait about 15 seconds until they go out and the green ON light comes on in each case. If RESET does not go out, press $\boxed{\text{OFF}}$, check step (3) and try again.
5. Each TV control box has two scan reverse toggle switches (which allow the orientation of the TV display to be changed to match finding charts for example). Initially, however they can be used to check the status of the system. When the monitors are powered up, and adjusted in brightness to give a visible background, switching the toggle switches will, if the system is OK, result in the bright edge of the TV cathode traversing the screen. If this is not seen then check the monitor brightness settings. If there is still no response then call for help.
6. To use the TV system, you will need to have:-
   (a) TV probe centred.
   (b) Flip Mirror viewing field or slit as desired.
   (c) Comparison Mirror out of the way.
   (d) Autoguider Probe out of the way.
7. To remove flickering of picture and white screen at start-up press $\boxed{\text{FINDER/SEL'D}}$ and then the $\boxed{\text{DIRECT}}$ button.
8. The bias has been selected to give a black picture when the camera is started up otherwise the light level on the monitor would be very high in a bright sky. Decrease the BACKGROUND control (Section 10.2) until you begin to see white noise on the screen.

10.4 Normal operation

1. Before viewing a source, select the $\boxed{\text{DIRECT}}$ viewing mode on the Grinnell buttons.
2. When pointing at a field, even if you know that it only contains 18th magnitude objects, turn up the gain SLOWLY whilst observing the effects on the direct (raw video) TV camera monitor. There is a lag of about 3 seconds between operating the gain control and the full effect being seen.
3. As the object or field of interest appears on the direct screen adjust the gain control to give a sensible picture on the Grinnell monitor.
4. If the gain control reaches maximum without ill-effects on the direct screen and further gain is required, then select $\boxed{\text{AVERAGE}}$ mode on the Grinnell and adjust the number of frames of integration ONE step at a time waiting between steps to see the resultant image. When the Grinnell is in the average mode, the direct monitor will flash the integrated signal with a period equal to the integration time.

5. If in doubt, press the $\boxed{\text{FREEZE}}$ button and turn down the gain. This ensures that the TV read beam is not blanked and therefore any over-illumination is discharged. Hitting the red $\boxed{\text{OFF}}$ button does not guarantee this and should be avoided. It is always safer to turn the **GAIN** control to its clicked-off position than to operate the $\boxed{\text{OFF}}$ button.
6. Always turn the gain off before moving the telescope. You never know which first magnitude star is lurking round the corner!

10.5 The Grinnell MENU

When the menu is displayed on the Grinnell TV monitor, move the cursor to the function required and press the $\boxed{\text{ENTER}}$ button on the joystick controller to process the selection; *nota bene*: the $\boxed{\text{TRACK}}$ switch, No. 3 in the bottom row, should always be up, *i.e.* ON). When the function selected requires further positional information, up to 4 cursors can be enabled on the screen depending on the function. When they appear they may well be overlaid and so only appear as one. On the joystick controller the cursor switches determine which cursor(s) the joystick will control at any one time (for these switches, UP is equivalent to ON). Once the cursors have been positioned as desired, ensure that at least switch $\boxed{1}$ is on, and then press $\boxed{\text{ENTER}}$ again to initiate the processing. A quick guide to the menu is given in the following sections.

Grinnell Menu Functions: Page 1

- **DRAW RESTRICTED PROFILE**

  Requires TWO cursors to be positioned in either the X or Y plane and draws the profile of the data contained in displayed image between the two cursor points on Overlay Plane 2. At the start the cursors are overlaid. This function is used for seeing estimates as it gives the FWHM of a star image in arcsecs. The PROFILE is automatically erased when **DIRECT** is pressed.

- **SET FINDER ZERO POINT**

  Define centre of Cassegrain or Prime field as viewed on the finder TV.

- **GET GUIDE STAR**

  Plots on the Grinnell view of the finder field the 'catchment area' for possible guide stars at **Cass** in the form of a circle which represents the autoguider probe range and an enclosed square in which the probe can vignette the field. The area between the two thus represents the available area in which guide stars may be acquired. The slit is also marked. At **Prime** the catchment area is a rectangle which will rotate with the rotation of the prime focus assembly. Gives a cursor for guide star selection.

- **CALCULATE MAGNITUDE** Requires one cursor to be positioned over the object and displays the integrated magnitude of the object. There is an arbitrary zero point for the magnitude scale.

- **MOVE STAR TO SLIT**

  Requires two cursors, one to select the star and one to place on the slit or desired new position.

- **CALCULATE DISTANCE**

  Calculates the distance (x and y and total) in arcsecs between two cursor positions, on Overlay Plane 2.

- **INITIALISE**

  Initialises the TV system. No cursors. Like pressing the $\boxed{\text{RESET}}$ button, it resets display parameters.

- **ERASE ALPHANUMERICS**

  Clears the areas of the overlay planes used for displaying information (*i.e.* the MENU)

- **ERASE OVERLAY**

  Erases overlay plane number 2.

- **ERASE IMAGE**

  Erases the image plane.

- **ERASE PROFILE**

  Erases Overlay Plane 2 used to display profiles.

- **NEXT PAGE..**

  Displays the second page of the menu.

Grinnell Menu Functions: Page 2

- **TEST PATTERN 0, 1, 2, 3**

  Displays the Grinnell test pattern.

- **ERASE TEST PATTERNS**

  Erases a test pattern.

- **INTEGRATION PARAMETERS**

  Displays the current integration parameters on Overlay Plane 2 (*i.e.* the current status of the rotary switches).

- **DRAW SLIT**

  Requires all four cursors to be positioned independently and then joins them up on Overlay Plane 1. Intended to be used for marking slits, but can be used to draw any quadrilateral.

- **DRAW CIRCLE**

  Requires two cursors to be positioned to define the diameter of a circle which is then drawn on Overlay Plane 1. Useful for defining the position of photometer apertures.

- **DRAW BOX**

  Two cursors are enabled which are used to define the sides of a rhombus on Overlay Plane 1. The line joining the two points must have a positive gradient in the X-Y plane of the screen. If the two cursors have the same Y position, they will define the top side of a square. If they have the same X position, they define the left hand side of a square.

- **ZOOM**

  Zoom factors are determined by the state of the function switches **FUN A** and **FUN B** on the cursor controller. Setting one or both of these switches followed by $\boxed{\text{ENTER}}$ causes a new zoom factor to become operational. The factors are: A for a factor 4, B for a factor 2, and A+B for a zoom factor 8. The zoomed image can be panned via the joystick. To exit from **ZOOM**, turn both function switches off (down) and press $\boxed{\text{ENTER}}$. The facility requires the **TRACK** switch to be up (ON).

- **ARCHIVE FULL IMAGE**

  Creates a '.BDF' file of the currently displayed Grinnell image on the EGLE disk.

- **SET ROTATOR PA**

  Gives two cursors to select rotator orientation. Use $\boxed{\text{ENTER}}$ to select and exit.

10.6 Complete restart of the TV control system

If the TV system has been completely shut down, then check that the following units in the Clip Centre (Bay 8) are ON.

1. The large Grinnell systems unit (power switch bottom left).
2. The Westinghouse camera control units below it (front switches).

The camera control software is now held in ROM and the startup/reset procedure consists of pressing the $\boxed{\text{RESET}}$ button on the Grinnell control panel.

11 CALIBRATION TESTS AND QUALITY CONTROL

This section is intended primarily for La Palma staff. It describes several calibration procedures and quality control tests in detail. Some of these tests must be done every night (by the Telescope Operator), others only on occasion. Several procedures require the inspection and/or redefinition of global Task Common parameters, others are just detailed recipes which can also be of use to experienced observers. It is recommended to read the La Palma Technical Note No. 39: "Telescope Control Software: Global Variables and Configuration Files", before having a go at those procedures dealing with Task Common variables (see also section 7.7).

11.1 Telescope Pointing

In order to achieve the best performance of the Telescope Pointing Model, the following zeropoint determinations have to be carried out daily, as part of the start-up procedure for the INT:

- A hardware zeropoint, determined by the initialization of the Ferranti Encoders with the ZEROSET procedure (section 11.1.1), which involves carefully moving the telescope across hardware markers on both axes.
- A software zeropoint, which has to be determined by pointing the telescope to a star with known position, and use a SNAFU procedure to find a correction to the pointing-model's zeropoint. SNAFU comes in two versions: a long one, the 2-Star SNAFU (section 11.1.3), which has to be performed after an instrument change-over, and a short one, the 1-Star SNAFU (section 11.1.2), which can be used on subsequent nights. The recommended procedure is to do a 1-Star SNAFU at the beginning of the night. With the improvement in performance of the telescope the longer version is rarely used. However, failure to do a SNAFU at the beginning of the night, will seriously impair the pointing of the telescope. A SNAFU at Prime Focus (section 11.1.4) is different from one at Cassegrain because at prime there is no TV camera for field viewing.

Further, the parameters of the Pointing Model itself have to be determined at regular intervals of several months (see section 11.1.7).

In order to achieve the maximum accuracy and consistency in the determination of zeropoints it is essential that these ZEROSET and SNAFU procedures are adhered to and that variations are not introduced for purposes of expediency or personal preference.

11.1.1 Encoder Zeropoints: ZEROSET

To be done daily, as part of the start-up procedure for the INT.

1. In engineering mode, position the telescope roughly at zenith, *i.e.* position Hour Angle 0^h and Declination $28°46'$ on the synchros.
2. Now drive the telescope in slow motion a few degrees away from the zenith in both Hour Angle and Declination by pressing the **positive** direction buttons $\boxed{+}$.
3. Type ZEROSET on the User Interface and press $\boxed{\text{RETURN}}$, but only if you have successfully performed action (2).

4. Check that the two red encoder/zeroset-in-progress lights on the Control Desk are **both** lit. If they are not, it means that the telescope is not far enough away from the zeroset markers, so cancel zeroset by pressing the $\boxed{\text{ACK}}$ button on the control console and start again.

5. Set the engineering-mode speed controls (on the Engineering Rack) to the position markers, and make sure the **slow**-motion drive is selected. It is worth to move the telescope in slow motion to see that the zeroset is triggered. The accuracy of the result is now independent of speed to good approximation.

6. Drive the telescope through the zeroset position (*i.e.* zenith) by pressing the **negative** direction buttons $\boxed{-}$. The indicator lights on the Control Desk should go out and a message:

   "Zeroset completed"

   should appear at the User Interface.

If for any reason, the procedure does not work, or if you feel it is giving inconsistent results, report it on a Fault Report Card; in order to escape from the zeroset procedure at any stage, press the $\boxed{\text{ACK}}$ button.

If the above described zeroset fails, it is still possible to observe by doing a rough zeroset, as follows:

1. Position the telescope at zenith, as before, and set the telescope as accurately as possible on the centre of the position range where the yellow-green lights are on.

2. Type at the User Interface terminal:

   UI–> `ZEROSET/MANUAL`

The zeropoint determined in this way is far less accurate than when using the regular procedure, and it is necessary to do a 1-star SNAFU in order to adjust the software zeropoint.

11.1.2 Software Zeropoint: 1-star SNAFU

A single star SNAFU is done as follows:

1. At the Telescope Computer system terminal, run INPSCF and check (see section 7.7) that the value of parameter HATERM equals 2 (inquire its value by typing: @HATERM). It is **essential** to do this because if it has accidentally been left with a value of 1, the following actions will completely invalidate the pointing.

2. Check that PCCH has the correct value from the last 2-star SNAFU (check the log sheet). If it does not, then enter the appropriate value.

3. Slew to a star with $0° <$ Dec $< 40°$; the choice between North ($\delta > 28°46'$) and South ($delta < 28°46'$) should be made to minimize dome rotation.

4. Type SNAFU at the User Interface.

5. Centre the star on the reference point (see end of Section 11.1.5).

6. Press the $\boxed{\text{ACK}}$ button until it goes out.

7. Determine and record the values of PCIH and PCID.

8. Type END at Telescope Control System Console to exit from INPSCF.

If the pointing after a 1-Star SNAFU is unsatisfactory, then it is good practice to first check if the encoders are performing correctly, before doing anything else, by running the ENCODERS test programme (see section 11.1.6). If necessary disable a bad encoder and do again a ZEROSET and 1-Star SNAFU. If all else fails try a 2-Star SNAFU, but it is more likely that such failure indicates a serious problem: call the Duty Technician.

11.1.3 Software Zeropoint and Collimation Error: 2-star SNAFU

To be done at the beginning of a run, but definitely after an instrument change.

1. At the Telescope Computer System Terminal, enter INPSCF and set HATERM 1 (section 7.7).
2. Select slit view mode and enable the TV crosswires.
3. Select a star with Hour Angle $<$ 3 hours and Declination $> 85°$.
4. Slew to that object.
5. Type SNAFU at the User Interface.
6. Move the object to the SNAFU reference position (see end of Section 11.1.5) using the handset.
7. Press the $\boxed{\text{ACK}}$ button on the Control Desk **until it goes out**.
8. Select a new star at $30° <$ Dec $< 40°$and $|\text{HA}| < 3^h$.
9. Slew to that object.
10. On Telescope Computer System Terminal change HATERM to 2.
11. Type SNAFU again on the User Interface.
12. Position the object as before on the TV monitor.
13. Press $\boxed{\text{ACK}}$ button until extinguished.
14. If, in action (6) and (12), the corrections to the telescope positions were large ($>$ 10 arcsecs) then repeat the process from (1) (INPSCF will already be running).
15. Record the values of the variables PCIH, PCID and PCCH on the form provided. (Get their values by typing @PCIH *etc.* within INPSCF).
16. Type END at the Telescope Control System Console to exit from INPSCF.

11.1.4 SNAFU at Prime Focus

The SNAFU at **Prime** Focus is done completely differently, because there is no TV camera for field viewing, and involves the taking of a test GLANCE exposure on the prime focus CCD, under ADAM control. One approach would be to simply follow the procedures for Cassegrain focus (sections 11.1.3 and 11.1.2), and move the star iteratively to the SNAFU reference point on the CCD by means of repeated GLANCE exposures on which the star's position is determined by using the LIST option of PHOTOM. The reference point is obviously the centre of the chip. However, the following procedure is more convenient, since it requires only one GLANCE to be taken, and makes use of standard ADAM functions:

1. Move the rotator to position angle 180° with the ADAM command ROTPOS 180.
2. Select the finder on the TV monitor at the Control Desk.
3. Slew the telescope to the SNAFU star, as for Cassegrain mode.
4. Startup ADAM (See the Prime Focus User Guide).
5. Take a test GLANCE exposure of the field (1-5 seconds; use filters if the star is very bright). The CCD image will appear on the LEXIDATA and the star should be obviously visible near the centre of the chip. If it is not, either the top-end change over has gone catastrophically wrong (is the telescope control software configured for Prime?), or you have done something silly, such as mis-typing the SNAFU star coordinates.
6. Use the MOVESTAR command, and locate the star with the cursor. ADAM wil now calculate a position correction and send those via the inter-processor link to the Telescope Control Computer. The telescope will move to the corrected position: the star will move on the Finder TV image.
7. Mark the position of the star now on the Finder TV screen with a felt pen or similar marker. This position corresponds to the centre of the CCD detector.
8. Now send the telescope again to the original position by pushing the $\boxed{\text{SRCE}}$ button.
9. Type at the User Interface console:

   UI–> `SNAFU`

   and move the telescope with the handset such that the star image on the finder will coincide with the position marker put on the screen with action 7.
10. Press the $\boxed{\text{ACK}}$ button on the Control Desk.

The reason behind the last three steps is that although ADAM sends the corrections to the Telescope Control Software, this does not update the pointing model zeropoint. That is done in the same way as for Cassegrain mode during the last three steps.

11.1.5 Reasons behind the ZEROSET and SNAFU procedures

ZEROSET

ZEROSET is the procedure that must be run when the telescope control system has been started up, or if for some reason the encoders have become corrupted during operation. It is a technique for initialising the Ferranti encoders. These are incremental devices and must be given an absolute reference from which to work. The ZEROSET process involves sweeping the telescope across hardware markers on both axes. When these markers are detected, the encoders are zeroed by the hardware, if this mode is enabled by having typed ZEROSET. The hardware detector is positioned so that the "zeroset position" is at the zenith.

There are errors inherent in this process, but these can be minimised by the correct operational procedures.

1. The angle within which the telescope is "detected" on each axis has a finite size of a few arcsec. This is why it is possible to position the telescope and keep it stationary "in the zeroset position" with the green zeroset lights above the RA and Dec dials lit. However, the encoders will be initialized by the hardware if the telescope is anywhere within this region and this leads to zeroset errors comparable to the extent of the zeroset region. For this reason, the technique of setting the telescope at this position and **then** running ZEROSET is unsatisfactorily crude. The technique capable of giving the highest accuracy and the most repeatable results is to 1) ZEROSET at the User Interface, and then 2) move the telescope slowly through the zenith in both axes, but always going in the same direction. In this way the leading edge of the detector area will be used as the reference, and this is clearly much better determined than any random point within the region.

2. The speed with which the telescope is driven past the detectors is now not very important. Although the detection/encoder-reset is done by the hardware, and there is some small error associated with this process, tests indicate that the error is practically independent of speed, but depends on direction. Markers have been placed on the speed control potentiometers to indicate a recommended speed at which the ZEROSET triggering can easily be observed.

SNAFU

The SNAFU procedure is designed to perform a somewhat similar task to ZEROSET. It does however have various subtleties which should be appreciated if it is to be used properly.

Originally SNAFU was used to update only the encoder index errors (ID and IH) of the telescope pointing model, which are simple zeropoint offsets of the encoder readings. These are deduced by pointing the telescope at an object whose position is precisely known. More recently, it was considered desirable to introduce the possibility of updating the collimation error of the telescope as well. This error (CH term in the pointing model) is the offset between the mechanical and optical axes of the telescope and ideally should not change if the telescope configuration is stable. The collimation error is indistinguishable from the index error in Declination, being a constant angular offset. But in Right Ascension a Cos(Dec) term is introduced by the projection onto the sky. The error in RA as seen on the sky is given by:

E(RA) = Index Error $\times$ Cos(Dec) + Collimation error

As the Declination increases, the effect of the index error diminishes and it is a good approximation to ascribe the pointing error solely to the collimation error. Note though, that cos $85°\sim0.09$, but cos $70°\sim0.34$. The SNAFU process can therefore be split into two separate operations.

1. The telescope is set on a star at **high** Declination and the correction observed is attributed to the collimation error in RA and the index error in Dec. The hour angle of the star observed is

not critical (it can be +3 hrs before other effects become important) but it is essential that the Declination be greater than 85°, or else the approximation that cos(Dec)$\sim$0 implicit in the method is invalid.

2. An object at **low** declination is observed, and only the index errors in both axes are updated.

The SNAFU software therefore has two modes of operation, and depending on which mode it is in, the coefficients of the pointing model that are updated are either (ID and IH) **or** (ID and CH). The mode of SNAFU is set by the Task Common variable HATERM. At the moment, access to this variable is somewhat cumbersome and only possible through the use of INPSCF on the telescope control system terminal. The default (*e.g.* startup) value for HATERM is 2, which means it is in the mode where the index errors ID and IH are corrected. The consequence of this is that it is safe to perform a single star SNAFU at any Declination ($< 45°$) at any time without changing the value of HATERM. In fact, with improvements in the performance of the telescope, serious problems with collimation do now rarely occur, and most of the time doing a single-star SNAFU is sufficient. We have more problems with the encoders than with collimation. However, after an instrument change, a full 2-star SNAFU should be performed. This involves changing HATERM to value 1, and then SNAFUing on a star with Dec $>85°$. Again, the star used for this need not be on the meridian, but it is important to get high declination. The value of HATERM should be returned to 2 before any SNAFU is repeated at a lower declination. Since the high-declination SNAFU is only an approximate solution, if the corrections needed to bring the stars onto the reference point are large ($>$10 arcsec) when performing a 2-star SNAFU, then the whole procedure should be repeated at least once. In this case the declinations chosen for the two stars should be (HATERM=1 , Dec $> 85°$), (HATERM=2 , $30° <$Dec $< 40°$). This avoids a 180° rotation of the dome between SNAFUs.

Reference Point for SNAFU

It is equally important to be precise and consistent about what reference point is used for SNAFU. At Cassegrain, some point on the A&G box TV is used. It should NOT be an arbitrary point, since the software assumes that the SNAFU position is fixed relative to the rotator axis and uses this information to perform aperture offsets and corrections for rotator angle changes. A preference has emerged for SNAFUing on the spectrograph slit. The position along the slit must be defined, and this is the intersection of the slit and the single aperture dekker. This convention must be strictly adhered to, because the rotator axes will be determined relative to this point. It also has the inherent advantage of ensuring that the slit mirror, as opposed to the field mirror, is used to view the object. If this position is not optimum for placement of the object on the detector, then use an aperture offset to move to the required position afterwards (*i.e.* define an offset using SNAFU/A and thereafter use the BEAMSWITCH $\boxed{\text{A}}$ button to move to that point). A change of reference point requires a 2-star SNAFU to be performed, since it implies a collimation shift.

11.1.6 Testing the Encoders

Problems with the telescope pointing are nowadays more often than not due to problems with the encoders. If encoder problems are suspected, *e.g.* because even after a repeated 1-Star SNAFU the pointing remains poor, test the encoder readings, as follows:

1. Be sure that the slow-motion drive is engaged, *e.g.* the telescope is tracking (to ensure that the Baldwin encoders are engaged).

2. Stop the telescope and switch to Engineering mode (for safety).

3. Run the task ENCODERS from the Telescope Control System terminal. Type:

   `*ENCODERS`

   This produces a status report of the readings from the 4 independent encoders (3 Ferranti, 1 Baldwin) on each axis. Firstly, look at the Ferranti readings. If one of these is grossly different from other two on the same axis and is not already disabled, then that individual encoder is baulking. Confirm this by looking at the counters in the CLIP Centre. Correct any obvious problems (such as disconnected electronics).

   If the problem persists run the INPSCF task (see section 7.7) and disable the faulty encoder by resetting the appropriate encoder weight to zero with variables WHAFEn and WDCFEn for Hour Angle and Declination Ferranti head n, respectively. Thus, to disable Hour Angle Ferranti Encoder number 2, do:

   `*INPSCF`

   INPSCF> `WHAFE2 0.0`

   INPSCF> `END`

   Note that this procedure only affects the running system - if, for any reason, the TCS is stopped and then restarted you will have to reset again the appropriate weights to zero. A long-term fix is to ask software support staff to update the initialization files.

4. If all of the Ferranti readings appear to be sensible, compare the Baldwin+Ferranti values with those for the Ferrantis alone. If they are more than a few arcseconds different, then the Baldwin encoder has probably broken. It is easy to switch over to using Ferrantis only in Declination (just set Task Common parameter JDCBW to zero using INPSCF). However, if the problem is with the Hour Angle encoder, better call out the Duty Technician in order to check out the encoder and adjust the servo constants.

11.1.7 Pointing Tests using POINT and AUTOPNT

The pointing model for the INT has 17 terms, comprising the standard errors of an equatorially-mounted telescope (offsets in HA and Dec, collimation error in HA, misalignment of the polar axis and non-perpendicularity of axes), together with an empirical (Fourier series and polynomial) model of flexure in the telescope structure and large-scale errors in the Ferranti encoder readings. If pointing tests are made sufficiently frequently in order to update the pointing model, the *rms* error in the absolute pointing of the INT should always be better than 5 arcsec: values between 2.8 and 4.5 arcsec have been measured; a small residual oscillation at about 1 Hz persists in Hour Angle.

The data necessary to produce pointing models for the telescope are logged by the PE 3220 running the task POINT. Data are logged by this task when the LOG button on the control console is pressed. Note that this button lights up while the logging task is active and the telescope should not be moved until the light goes out. The pointing program creates four data files on the PE 3220 system disc. The first one is called POINT.DAT and must not exist when the program is started. Either delete them or rename them if they are to be kept. The extra three files created at the INT are called POINT1, POINT2 and POINT3 (all .DAT file extension). They contain details of the individual Ferranti encoder readings alone so that checks can be made for any systematic drifts in the Baldwin encoders and also to provide data from which it may be possible at a later stage to model the individual Ferranti encoder errors and separate them from global pointing effects such as a polar axis misalignment. The main data file, POINT.DAT, contains the name of the observed source, the Baldwin and Ferranti encoder readings of RA and Dec and the Local Siderial Time of the observation. A grid of objects suitable for use in the pointing test is contained in the file PTGRID.CAT (see Appendix A), which resides permanently on the system disc.

To run a pointing test with POINT:

1. Load the PTGRID Catalogue by typing at the User Interface:

   UI–> `I(NPUT) ptgrid`

2. Run POINT by typing at the TCS terminal:

   `*POINT INT`

   If the computer responds with a message to the effect that file POINT.DAT already exists, and that therefore the task can not be started, rename that file with:

   `*RENAME POINT.DAT, POLD.DAT`

   and similarly for the other three data files:

   `*RENAME POINT1.DAT, P1OLD.DAT` , *etc.*

   Do **not** delete the files, since they may still be of interest. Further, report this action to the Software Manager.

3. Select a grid star from the catalogue with:

   UI–> `NEXT sourcename`

4. Move the telescope to the grid star by pressing the $\boxed{\text{SRCE}}$ button. Centre the star on the SNAFU reference point (see section 11.1.5).

5. Press the $\boxed{\text{LOG}}$ button on the Control Desk - wait until the light goes out (it should light up for a brief moment).

6. Repeat steps 3 through 5 until sufficient stars have been observed. Choose your objects all over the sky.

7. Stop the POINT program by typing at the TCS terminal:

   `*ENDPOINT`

   This will stop the program and print out the data files. Subsequently, press the **on-line** button in order to re-initialise the terminal.

8. Ask the software group to transfer the file POINT.DAT to the POINTING account on the VAX 8300.

Having transferred the POINT.DAT file to the VAX 8300 it is necessary to add two lines (with the editor) at the beginning with the date and observer's name, and the temperature and atmospheric pressure at the time the measurements were made. The data can then be analysed with the TPOINT software (SUN 100.7, a Starlink User Note by P. Wallace, 1989) in order to determine the pointing model coefficients. These can then be entered in the relevant .STD file (by qualified La Palma staff!).

AUTOPNT

The pointing procedure has now been completely automated and the procedure AUTOPNT should be used at Cassegrain. The acquisition of pointing stars is made with the autoguider probe; the stars are put at the SNAFU reference position. Therefore, the guide probe has to be told where the reference position is by placing a star on the reference point and acquiring it with the autoguider in 'probe' mode. The procedure is now as follows:

1. Place a star on the SNAFU reference position, *i.e.* the slit or the Grinnell crosswire (press $\boxed{\text{CROSS/HAIR}}$).
2. Acquire this star with the autoguider using the ACQUIRE/PROBE option.

   (Alternative to steps 1 and 2: drive the probe to the centre position. The idea is just to put the probe at the reference point.)
3. At the user interface select ACQUIRE/TELESCOPE.
4. At the Telescope Control System Console type:

   `*AUTOPNT INT`

The telescope will work its way through every available star from PTGRID.CAT from North to South and then back again. When it has acquired each star it will guide for a few seconds and then log that position before moving on to the next star.

At Prime focus the situation is more complicated because it is impossible to move the autoguider to the rotator axis of the telescope. The Prime Focus geometry is set up such that if a star is on the optical axis of the telescope pressing BEAMSWITCH $\boxed{\text{B}}$ will move the telescope so that the star is centred on the autoguider in its parked position. Thus, when using AUTOPNT at Prime you have to press BEAMSWITCH $\boxed{\text{B}}$ so that the stars fall within the field of the autoguider. Unfortunately the Telescope Drive Software has a feature that at the beginning of every slew the BEAMSWITCH automatically reverts to the NOMINAL aperture. Therefore, when running AUTOPNT at Prime it would be necessary to press BEAMSWITCH $\boxed{\text{B}}$ every time the telescope begins a slew to the next star! This would be a cumbersome exercise, but a simple way around it is to change the NOMINAL aperture position before starting AUTOPNT as follows:

1. Inquire the current BEAMSWITCH B aperture co-ordinates at the User Interface console:

   UI–> `ADV/TEL`

   The aperture position is given in arcseconds.
2. Transform the co-ordinates to radians through division by 206265.
3. Inquire the current NOMINAL aperture co-ordinates at the TCS console:

   `*INPSCF`
   INPSCF > `@AOXNOM`
   INPSCF > `@AOYNOM`

   Important: make a note of the current values.
4. Replace the NOMINAL offset values by adding the beamswitch offsets to their current values:

   INPSCF > `AOXNOM new-aoxnom`
   INPSCF > `AOYNOM new-aoynom`

where: `new-aoxnom` = current aoxnom + beamswitch B.x
`new-aoynom` = current aoynom + beamswitch B.y

Important: do not forget to reset AOXNOM and AOYNOM to their original values after AUTOPNT has finished!

Some NOTES:

- At any time the contents of the data file(s) being created can be inspected by typing at the TCS terminal:

  `*PRINT filename`

  It is worth checking that the program is working by printing the POINT.DAT file after the first 5 observations have been made with:

  `*PRINT POINT.DAT`

  A listing should then be output to the lineprinter standing in the Instrument Computer Room, adjacent to the Control Room. Check that it is switched on-line. If there does not appear any output, go to the TCS console and try:

  `*TASK SPOOLER`

  `*CO(NTINUE)`

  If that doesn't work, type

  `*STARTSPL`

  If this still doesn't work write a 'Software Error Report' (SER).

- It is **not** possible to run the task INPSCF or the ENCODERS test program simultaneously with POINT.

- If you have renamed an existing POINT.DAT file, report this action to the Software Manager so that he can archive or delete the file as he sees fit. Don't forget to do this, or the disk will get littered with old pointing files. Do NOT delete the file yourself unless you are positive that it is of no further interest.

- The POINT program can be used to keep a record of the directions to which the telescope was pointed throughout an observing night. This can be particularly useful for analysing the geometrical errors of the mounting (see for instance RGO/La Palma Technical Note No. 32). POINT is started at the beginning of the as for a normal run with PTGRID, but now your own objects are the test points. Thus, press the LOG button on the console every time you centre a star. At the end of the night type ENDPOINT at the TCS terminal, press the **on-line** button and issue a request to transfer the file to the VAX 8300.

11.2 Telescope Focus

11.2.1 Focus Drive

The focus drive has two drive speeds. The point at which the change from fast to slow takes place when moving the focus position to a new value is determined by the Task Common (TSKCOM) variable FOCS2F, while the stopping window for the focus is defined by the variable FOCSTP. These parameters may need to be adjusted at times (see section 7.7) , especially if any of the encoders is faulty (*e.g.* losing bits), because this is liable to cause oscillation of the focus mechanism, in particular if the limits are too finely set. Adjustment is exclusively done by La Palma support staff; the mechanism has proved to be reliable.

11.2.2 Focus and Temperature

The telescope focus varies with temperature, primarily as a result of thermal expansion in the Serrurier trusses. This dependence has been determined empirically by fitting a simple linear model to the focus position as function of temperature, and the focus on the INT is now temperature compensated. Temperature sensors are positioned on the steel work of the tube; their analogue output is digitised in order to be read by the PE 3220. The temperature of the structure is calculated by assuming a linear relation between the ADC output value and the temperature:

Temperature = ATEL + BTEL $\times$ ADC reading.

The calibration constants ATEL and BTEL should be checked occasionally.

The assumed focus-temperature relation is of the form:

Focus position = FOCT0 + TEMP2F $\times$ temperature

The constants are TSKCOM variables. For Cassegrain mode, FOCT0=0.5 and TEMP2F=0.07335; for Prime TEMP2F=$-$0.0854. The coefficients for the two focii have opposite sign because the encoders are mounted in opposite directions. Their values merely reflect the coefficient of expansion of the steel work, and once determined should never again have to be measured.

The system checks that the focus is within a margin FOCERR of its demanded value, **provided** that the parameter FTRACK is set to either 1 or 2; if FTRACK is set to 0, the temperature compensation is disabled. FOCERR approximately equals the value of the stopping window FOCSTP. Similarly, the maximum allowed change of temperature before the focus is moved is set by a parameter TERR (currently 0.5°).

11.2.3 Focusing at Prime

At Prime Focus the telescope is focused by making a multiple exposure of a star on the CCD detector, stepping both the focus and the telescope pointing between exposures, and only reading out the chip at the end of the operation. Subsequently, the multiple image is examined to establish the best focus (accurate to about 0.05 mm).

The exposure is controlled from ADAM by an automatic procedure on the Instrumentation Computer. Select a faint star with no bright star near it on the TV and move it to the appropriate side of the chip. Saturated images should not be used for focusing. The idea is to make exposures of at least 5 seconds duration in order to smooth out seeing fluctuations.

If you are going to use several filters during the night, you must first run the WHEEL command (see INT Prime Focus Manual section 3.2.4) to tell the software the names and thicknesses of the filters in the filter wheel. This is vital if the automatic focus adjustment for different filters is to be used.

To start the focus procedure, type at the ADAM terminal:

ADAM: > `FOCUS`

The software will prompt for three parameters to set up the focus procedure:

- The number of exposures, including sign, + or −, to indicate positive or negative focus increments, respectively.
- The exposure time in seconds per 'shot'.
- The direction of motion of the image on the chip (N, S, E or W).

The focus is stepped by ±0.1 mm between exposures, depending on the sign specified with the first parameter, and starts at position:

Current focus postion ±0.05(n - 1) mm,

so that the current focus is in the middle of the range. The telescope is offset by 20 arcsec between shots: make sure that there is enough space on the chip by looking at a GLANCE run or on the finder display before you select the direction in which the telescope has to move between exposures. It helps if the rotator is at a cardinal point and the CCD's orientation is indicated on the LEXIDATA display. Check the exposure time by using PHOTOM on the results of the GLANCE. At the beginning of the night, try seven exposures (±0.3 mm around the nominal value). Fine-tuning during the night can be done with 5 exposures: differences in focus of 0.1 mm are easily distinguishable under good conditions.

The telescope will be returned to its starting position at the end of the run but the focus **remains at its final value**. A double step between the first and second image will help you to establishes which image corresponds to which focus position. It will normally be obvious which images are closest to focus and these should be measured using STARFIT option of PHOTOM in order to determine the seeing. If the calculated focus is out of the range covered by the exposure, you will have to extrapolate and repeat the procedure at another focus position.

The focus setting is effectively determined by the temperature (variation), for which a reliable correction procedure is now implemented (see previous section). In principle only one focus determination at the beginning of each prime focus observing run is necessary. You can carry the focus setting from night to night if you adjust for temperature. In practice, one focus run per night is usually done.

11.2.4 Prime Focus Adjustment when using Filters

The filters in front of the CCD have different optical thicknesses and the software compensates for these by refocusing the telescope when a filter is changed. The thickness values are communicated to the instrumentation computer by the ADAM command WHEEL (see section 3.2.4 of the INT Prime Focus Manual). WHEEL is run at the beginning of each Prime Focus run or whenever a filter wheel is changed.

Therefore, after a focus exposure (previous section) and **before** changing filter, type:

ADAM: > `SETFOCUS value`

where `value` is your best estimate for the focus in `mm` as determined by FOCUS. This command enables the automatic focal adjustment, and the specified focus position value will now be use as a reference position by the software. The focus will from now on be driven automatically to the correct position, and adjusted as you change filters in future, and as the temperature changes.

The automatic focus adjustment can be disabled by simply typing:

ADAM: > `SETFOCUS DISABLE`

11.3 Finder Flop Zeropoint

The finder flexes with respect to the main telescope by ±110 arcsec in Right Ascension and ±75 arcsec in Declination. The flex in RA is very reproducible and can be modelled accurately, whereas the effect in Declination is less reproducible and can be modelled only to a (maximum) uncertainty of ±45 arcsec.

The finder flex must be calibrated whenever guide stars are to be located using the finder display. A simple linear model of the finder flop as function of zenith distance is implemented in order to compensate for the flop in the finder mounting and allows guide stars to be located all over the sky. The zeropoint of the relation must be determined at the beginning of the night with the telescope very close to zenith; thereafter adjustment is automatic.

The finder flop zeropoint determination is done by positioning a calibration star at a reference position on the Cassegrain TV camera (normally the SNAFU position) or on the autoguider probe at Prime. Subsequently, the same test star is located on the finder display and its position as measured there is used to calculate a zeropoint (offset) between the main telescope and the finder. Because the test star is practically at zenith, the zeropoint can be derived directly, without invoking an approximate flop model.

The values of the zeropoint derived each night should be logged by the Telescope Operator. However, note the effect of the reference position used as implied by the procedures described below.

11.3.1 Finder Zeropoint in Cassegrain Mode

This is most conveniently done after a SNAFU zeropoint determination, with the telescope still pointing to the SNAFU star, provided that star is close to the zenith. If it is not, then track a star within 2° of the zenith.

1. If not already done, select Cassegrain on the TV monitor on the Control Desk.
2. If not already there, move the telescope in order to place the test star at the reference (SNAFU) position, (the centre of the CROSS HAIR).
3. The test star must now be visible at, or very close to, the centre of the finder field. Its current position in the finder field corresponds to the reference position the the Cassegrain field.
4. Press the MENU button on the Grinnell TV Control Panel and select the 'SET FINDER ZEROPOINT' option from the Grinnell Menu (see Section 10.5).
5. Put the cursor cross upon the test star with the Grinnell joystick (on the Control Desk).
6. Press the ENTER button; this sometimes has to be repeated.

The finder zeropoint is now defined, and subsequently positions indicated on the Finder TV can be translated into autoguider GDXY co-ordinates.

11.3.2 Zeroing the finder at Prime

Zeroing the finder at prime is best done by acquiring the test star with the autoguider probe. It is best to use the SNAFU star following the SNAFU. Proceed as follows:

1. Move the guide probe to its park position: press the guide probe PARK button on the A&G GUIDE PROBE panel, don't confuse it with the TV PARK , or type at the ADAM terminal:
   ADAM: > `GDXY 550 900`
2. Move the rotator to position angle 180° with:
   ADAM: > `ROTPOS 180`
3. Track a test star within about 2° of the zenith. This will usually be the SNAFU star.
4. Select the Finder TV on the Grinnell display.
5. Enable cursor 1, select SET FINDER zeropoint on the Grinnell MENU, and press the ENTER button twice. This puts up a cursor at the reference point used before. (If you have an ink mark from the previous night move the cursor to that position and press ENTER again; but this isn't essential.)
6. Select DIRECT mode to unfreeze the display. Press the BEAMSWITCH B button and the star will begin to move to the left of the screen. Wait until the star is apparently stationary and the telescope is tracking.
7. Turn on the autoguider high voltage (with the red-white button below the mini-monitor at the top right-hand corner of the control desk) and select the autoguider display (A&G) on one of the TV channels.
8. Do a FIELD integration (section 12.3.8). The test star should now be visible on the autoguider display. If it is not, do a spiral search around the position, moving the telescope (NOT THE PROBE) by 60 arcsec increments until you find it.
9. When you have located the star, type AC/TEL on the User Interface terminal and use the autoguider to ACQUIRE the star (again, see section 12.3.8). You are moving the telescope so that the star is at the centre of the autoguider probe when at its PARK position.
10. Select SET FINDER ZEROPOINT on the Grinnell again, but this time move the cursor to the star's position on the Finder and press the ENTER button.
11. Put the autoguider into WAIT state and type AC/PR on the User Interface console for later use.

The purpose of this elaborate procedure is to mark the position corresponding to a reference point fixed with respect to the main telescope (the guide probe centre) on the finder field at a known position on the sky (the zenith). From now on, the software will recompute the position of the CCD chip and guide probe field overlays on source change and will always show them in their correct place on the finder display.

11.4 A&G Box Geometry

Some aspects of the A&G box geometry should be tested or measured occasionally in order to ensure the optimum performance of the INT.

- The position of the axis of rotation of the A&G box turntable (the rotator centre position) in the coordinate system of the TV camera or guide probe. They serve to inter-relate the coordinate systems of various A&G box components.
- The offset from the rotator centre of the reference position used for the SNAFU, the nominal aperture, which is usually defined as some point on the instrument or detector. This reference position does not coincide with the rotator centre and its offset must be known to the system, so that the position of an object placed on the reference position is invariant with rotator position angle.

Different techniques are required for measuring these quantities at Cassegrain and Prime. At Cassegrain the probes can reach the on-axis position but at Prime they cannot, and furthermore at Prime the detector itself is mounted off-axis.

A simple quick-look test to check if the geometry is set up correctly consists of placing a star on the reference position and rotating the turntable. The star should remain stationary on the TV probe (at Cassegrain) or the CCD (at Prime) during the process.

11.4.1 Geometry at Cassegrain

Rotator Centre

The relevant Task Common parameters are TVXCTR, TVYCTR, GDXCTR and GDYCTR, which represent the position of the rotator centre in the TV probe coordinates, where the TV cross-wires define the probe position, and in guide probe units, where the tracking centre defines the probe position, respectively.

These four quantities can be measured as follows:

1. Set the nominal aperture offset parameters AOXNOM and AOYNOM to zero.
2. Centre a star on the probe (either the TV or the autoguider).
3. Rotate the turntable to the cardinal points in turn ($0°$, $90°$, $180°$, $270°$) and at each position angle move the probe so that the object is centred on the probe position (as defined above).
4. At each position note the (x,y) probe position as shown on the MIMIC display.

The rotator centre position in probe coordinates is now the centre of the circle on which the measured points lie, *i.e.* the mean of x and y measurements if the cardinal points have been used.

Nominal Aperture Offset

The parameters of concern here are AOXNOM and AOYNOM, which are used to allow for the fact that the reference position is off-axis on the rotator. Their values must be redetermined if the A&G box is somehow shifted. Define the relevant reference point as follows:

1. For the IDS and FOS, use the intersection of the slit and the dekker. All dekker apertures, in the IPCS setup dekker at least, are concentric apart from the comb dekker.
2. For other instruments and non common-user instruments, which do not have any easy reference positions, use the TV crosswires (with the TV probe centred) with the flip mirror in the field position, or use the centre of the detector.

Measure AOXNOM and AOYNOM as follows:

1. Set up the system so that the values of AOXNOM and AOYNOM are roughly correct, *i.e.* so that a star image stays in the field of the probe when the turntable is rotated. In fact, at Cassegrain it is good enough to set these parameters to zero.
2. Point the telescope to a star near zenith (and track, of course).
3. Rotate the turntable to the cardinal points and measure or mark the position of the star on the TV probe with Grinnell cursors (see chapter 10).
4. Determine the centre of rotation from the measured positions.
5. The **corrections** to the values of AOXNOM and AOYNOM already in the system are the distances between the reference position and the apparent centre of rotation. To determine this, put the star on the calculated position of the centre of rotation and use SNAFU/A to determine the offset to the reference position. Using the BEAMSWITCH $\boxed{\text{NOM}}$ and $\boxed{\text{A}}$ buttons, it should now be possible to offset and switch back and forth between the two positions (circle centre and reference point). The required values of AOXNOM and AOYNOM will then be displayed on the information display.
6. Enter the correct values for the parameters and test their validity by centering an object on the reference position and seeing whether its position alters as the turntable is rotated.

11.4.2 Geometry at Prime

The Prime Focus Camera Unit is now mounted and dismounted with the probe 'park' position defined by a mechanical template, which ensures a very reproducible geometry from one run to another. It is therefore very unlikely that the geometry parameters at Prime will have to be modified: In other words, **be sure to have a very good reason for changing any parameters.** If you find something odd with the geometry try first to attribute it to some other cause. In particular, check that the telescope was initialized with the correct configuration file for the CCD chip mounted: either with `*GO INT, PFRCA, COMPILE` or `*GO INT, PFGEC, COMPILE` (see section 7.3.2).

The relevant geometry parameters at Prime, as shown in figure 10, are:

AOXNOM	x-distance of chip centre below rotator axis	in radians
AOYNOM	y-distance of chip centre from rotator axis	in radians
TDATA(13)	x-distance of chip centre below GD PARK	in arcseconds
TDATA(14)	y-distance of chip centre from GD PARK	in arcseconds

for the centre of the CCD chip. The GD PARK position is at the top right-hand corner of autoguider field. Further, for the position of the rotator axis, we have:

TDATA(11)	x-distance of rotator axis below GD PARK	in arcseconds
TDATA(12)	y-distance of rotator axis from GD PARK	in arcseconds
GDXCTR	the rotator axis x-coordinate on the guide probe	in μm
GDYCTR	the rotator axis y-coordinate on the guide probe	in μm

The current values of these parameters can be inquired at the TCS terminal with the INPSCF task (see section 7.7). Note that figure 10 refers to a rotator position of 180°. The sign convention is such that distances measured in x below GD PARK (as shown in the diagram) are positive, and distances measured in y towards the left from GD PARK are positive. This means that AOYNOM and TDATA(12) are normally negative. The x measures are close to zero, and therefore unpredictable.

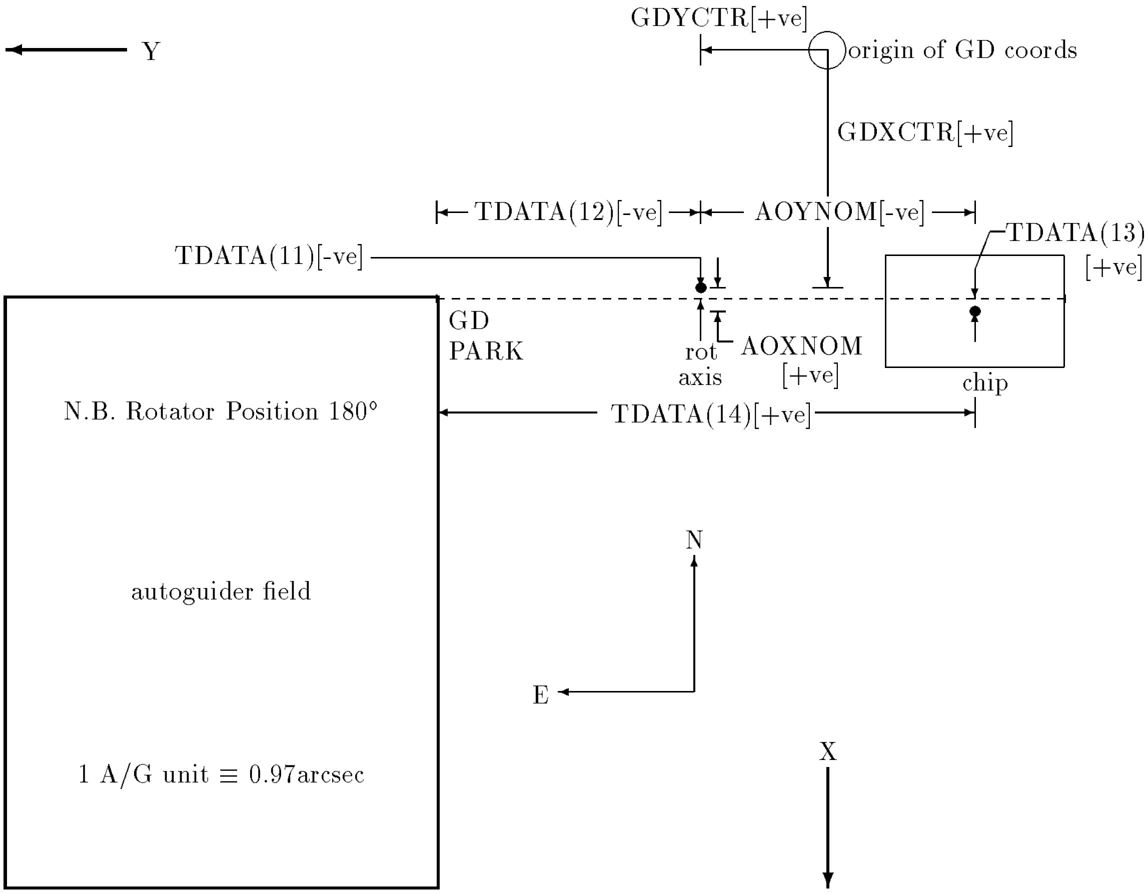

Figure 10: Prime Focus geometry parameters

Because at prime focus both the detector and the autoguider probe are positioned off-axis, the default beamswitch apertures A and B are defined such as to enable viewing of the autoguider field with the Finder TV camera and the CCD detector itself:

- The aperture A (offset) coordinates represent the offsets of the rotator axis from the GD PARK position (*i.e.* the top right-hand corner of the autoguider field) with the same sign convention as before, and equals the amount the telescope will move **North** and **West** in order to view the autoguider field on the Finder TV. The offset values are (must be) the same as TDATA(11), TDATA(12).
- The aperture B coordinates are the offsets of the GD PARK position from the centre of the chip, and equal the amount the telescope will move **North** and **West** in order to transfer a star at the chip centre to the **parked** autoguider probe. The offset values are (must be) the same as {AOXNOM + TDATA(11)} , –{AOYNOM + TDATA(12)} (the sign of the x coordinate is due to the sign convention).

The current values of the aperture offsets can be queried via the User Interface by typing:

UI–> `AD(VISE)/T(ELESCOPE)`

In order to test and re-determine the geometry parameters, proceed as follows:

1. - Perform a GLANCE to display a brightish star at about the centre of the chip.
   - Do a STARFIT to measure on which pixel the star is centred.
   - Park the autoguider probe by typing GDXY 550 900 at the ADAM terminal.
   - Type AC/TEL at the User Interface terminal.
   - Press the BEAMSWITCH $\boxed{\text{B}}$ button and acquire the star with the autoguider.
   - Press the $\boxed{\text{ACQ}}$ button on the Autoguider Panel, and when the small circle on the monitor has disappeared, stop the autoguider and press the BEAMSWITCH $\boxed{\text{NOM}}$ button.
   - Do a STARFIT to find on which pixel the star is centred, and subtract from the measured coordinates those of the chip centre.
   - Change the sign of the x coordinate (because the detector x coordinate runs against the autoguider x coordinate.
   - Convert the offset values thus obtained into arcseconds by multiplication with 0.74 (RCA) or 0.54 (GEC).

   We now have determined corrections to the APERTURE B offset coordinates.

2. In order to correct the rotator centre coordinates, continue:

   - Rotate the rotator through 180°. The telescope will move in an attempt to keep the star centred on the chip, using the current (approximately correct) values of AOXNOM and AOYNOM.
   - Perform another GLANCE and do a STARFIT to find which pixel the star is now on.

   The mean of the two sets of measured pixel coordinates gives the coordinates of the *apparent* rotator centre. The differences between these and the pixel coordinates of the chip centre, converted to arcseconds as in the preceeding paragraph, and converted to radians by dividing by 206264.8, result in the corrections to the current values of AOXNOM and AOYNOM. Update these parameters in the sense that, if the apparent rotation centre is above the chip centre, ADD the difference to AOXNOM, and, if the apparent rotation centre is to the right of the chip centre, ADD the difference to AOYNOM.

3. Calculate the new APERTURE A coordinates by subtracting the new AOXNOM from the new APERTURE B x coordinate, and by adding the new AOYNOM and the new APERTURE B y coordinate and changing the sign.

4. Calculate the new rotator axis coordinates from the following expressions:

   GDXCTR = 39.3 × (550 + TDATA(11)/0.97)
   GDYCTR = 39.3 × (900 + TDATA(12)/0.97)

5. Enter the new geometry parameters into the Telescope Controle Software with the INPSCF task. Subsequently, inquire the new aperture offset values by typing at the User Interface terminal:

   UI–> `AD/T`

   and check that:

   AP/A equals TDATA(11) , TDATA(12)
   AP/B equals TDATA(13) , TDATA(14)

6. Finally, communicate the new geometry to the ADAM data acquisition software by typing at the ADAM terminal:

   ADAM: > `TV_OFFSETS`

   and follow the prompts (Beware: defaults are not accepted; you must enter values, even if they are unchanged):

- On "offsets (arcsecs) from rotator centre to parked probes": Take the Aperture A coordinatess and enter them as $-$Ap.Ay Ap.Ax.
- On "offsets (arcsecs) from rotator centre to CCD centre": Enter $-$AOYNOM +AOXNOM.
- Chip size in arcseconds: Enter 237 379 for the RCA chip or 208 312 for the GEC chip.
- Finally, the angle offset in milliradians between TV axes and RA, Dec is currently 10.

You should now be able to find guide stars in any orientation of the rotator. If you can't, report it to the Astronomy Group.

All default values are loaded automatically at startup. If you are sure the new geometry is correct, inform the Software Group, who will enter the new values as defaults in the proper '.STD' configuration file. Figure 15 shows the current geometry of the INT Prime Focus Unit.

11.4.3 Rotator Mechanics

Rotator Drive

The rotator drive has two drive speeds. The point at which the drive changes form fast to slow, when driving to a new position, is determined by the Task Common variable TTS2F. This parameter may need to be adjusted occasionally. In order to ensure that the turntable does not spontaneously rotate when the telescope is moved (until now this has never been observed), the system also checks that its position angle is within an error TTERR of the requested one.

Encoder Zeropoint

For the IDS/FOS check that with the rotator nominally at 90° or 270° a star trailed in RA moves accurately along the slit. A misalignment of 1° is easily detectable. In general, the rotator offset is defined so that East$-$West (*i.e.* PA 90° or 270°) is along one of the detector axes, in particular the IDS slit. An allowance can subsequently be made for any offset/rotation between this and the A&G box coordinate system (see section 11.4.4). Note that any gross change in the rotator zeropoint requires a change in the software limits. (If the zeropoint changes, the limits appear to be at a different Position Angle.)

11.4.4 A&G box coordinate system

In theory, the A&G box coordinate system could be misaligned with the slit, although such an effect has not been observed until now. To check the alignment proceed as follows:

1. Set the turntable to a known position angle with respect to the slit.
2. Move the guide probe (and/or TV - both systems should be checked) to centre on stars of accurately known position (*e.g.* SA57 or Pleiades field) whilst guiding on the other probe.
3. Record all the star positions in guide probe coordinates and go away and do an astrometric analysis to get the scale, rotation and any field distortions.

NB: at present none of this is catered for in the control software, but at least a rotation between the A&G box and the detector should be allowed for so that Cassegrain imaging can be set up correctly.

11.5 The Autoguiders

11.5.1 The Autoguider Focus at Cassegrain

The Cassegrain autoguider focus should be checked occasionally. The autoguider is focussed manually, which involves the removal of the cover of the A&G box on the autoguider side, unclamping the autoguider assembly, screwing the camera head in and out until the profiles (of a point source) produced by the autoguider software are as narrow as possible, reclamping the device and replacing the cover. All the TV filters, including 'clear' are parfocal.

11.5.2 The Autoguider Focus at Prime

The autoguider focus at Prime appears to be stable, but should be checked occasionally. There are no autoguider (colour) filters at Prime, and also the autoguider does not look through the same filter as the CCD. However, it is most unlikely that the autoguider will be detectably out of focus, provided that it is initially set up at the nominal value for the (CCD) filter in use. Nevertheless, if the images look very extended and in particular if they have holes in their middles, then the focus should be adjusted.

The Prime autoguider focus is determined by performing an interactive 'focus run' under ADAM control. To do this, first focus the telescope with **no** filter. Subsequently, acquire a star on the autoguider and step the autoguider focus through a range of values around the nominal one using the GDFOCPOS command:

ADAM: > `GDFOCPOS value`

where `value` is the test focus position in `mm`. Recommended values are from -3.3 to +3.3 `mm`. The autoguider focus drives much more quickly than the telescope focus, so you need not worry about starting an exposure with it out of position. After each step, press the FIELD button followed by WAIT on the Autoguider Panel and inspect the image. Select the focus position where the profiles produced (of a point source) are narrowest. Do **not** leave the autoguider integrating, otherwise the images will get mixed up. When you have discovered the correct focus position type:

ADAM: > `SETGDFOCUS value`

where `value` is your best focus position in `mm`. This command enables the automatic focus compensation, such that the autoguider focus is changed automatically on change of (CCD) filter. (If you do not type this command at the beginning of an observing session, the software will assume that the autoguider focus in the absence of a filter is +2.7 `mm`).

11.5.3 Autoguider Gain

The autoguider runs on its own cycle time of approximately one second duration and presents its error signals to the PE 3220 TCS computer via the CAMAC interface. The TNHZ task on the PE 3220 samples these errors ten times a second; the errors are multiplied by the "open loop" gains AGGRA and AGGDEC in order to scale the autoguider errors to the encoder errors to which they are then added. The gains AGGRA and AGGDEC are derived from the expression:

Gain = (sample time)/(autoguider update time)

Autoguider gains only need to be changed if there is a substantial alteration in the telescope response to small offsets.

11.6 TV cameras

11.6.1 TV scale

The TV system has nominal scales for various focal setups. The actual scale is defined by a multiplicative correction factor, which is downloaded by the Instrument Control Software on startup. An incorrect scale of the Finder TV will cause difficulties with the location of guide stars.

1. To check a TV scale, observe 2 stars of known position (so that both are in the field of view of the TV in question) and use the CALCULATE DISTANCE option of the Grinnell TV system menu to compare the measured separation with the true value (in both coordinates). Alternatively offset the telescope in order to displace the same star over a known distance on the TV screen.
2. To redetermine the scales, set the scale factor to 1.0 and measure the separation as above. The scale factor is the ratio between the true and measured values in each coordinate.

11.6.2 TV Focus

The focus should be checked regularly for all the TV cameras. Inspect the profiles of unsaturated images for any unusual broadening. If a broadening is suspected, the camera focus should be adjusted, which is done manually.

- Focussing the Finder TV camera is a delicate and sometimes very cumbersome operation in which the camera head is positioned by hand. Care should be taken not to displace the field centre. If in the process the finder is moved, it must be returned to a position so that the (prime) CCD chip and guide star overlay can be seen. The most important requirement is that the autoguider reference point (550,900) in guide coordinates is on the screen. Thus, take care that:
  1. **For Cassegrain** - with TV centred, a star centred on the Cassegrain TV appears near the centre of the Finder TV screen.
  2. **For Prime** - a star recorded on the centre of the CCD chip appears near the middle of the right-hand side.
- The Cassegrain TV camera should be focussed on the spectrograph slit, which should be done under low illumination. It involves the removal of the cover of the A&G box on the TV side, unclamping the TV camera, screwing the head in and out until the optimum focus is obtained, followed by reclamping the camera and replacing the cover.

11.7 Dome Encoder Zeropoints

The dome encoders tend to come loose and are checked daily by Duty Technicians.

1. Dome (AZOFF). Should be monitored daily by setting dome to known azimuth (AP position on INT) and check against information display value. The easiest way to check for vignetting when on the sky is to observe a grossly out of focus bright star.
2. Shutters (TOPOFF and BOTOFF). As above, use out-of-focus star to check for and to define onset of vignetting and thus compare with telescope zenith distance (ZD). The dome shutter encoders seem to give sensible answers now. The shutters are usually positioned at their extreme positions, where the precise encoder values are not very relevant anyway.

11.8 Servo Constants

The servo velocity demands for the telescope drive depend on the distance of the telescope to the source it has to go to. There are three regimes of velocity control ensuring that for small position error (PE) the correction is critically damped, whereas for larger distances the velocity increases with increasing distance (but within the physical specification of the drive):

$\lvert PE \rvert > a$	velocity proportional to $\frac{PE}{\sqrt{\lvert PE \rvert}}$
$a > \lvert PE \rvert > b$	velocity proportional to PE (linear regime)
$b > \lvert PE \rvert > 0$	velocity = $k_1.PE + k_2 \int PE\,dt + k_3(v_d - v_a)$

where k_1 and k_2 are linear gains and k_3 is the integrator gain. The relevant Task Common variables are TGLH, TGLD, HGI and DGI. These are likely to need resetting after any alteration to the telescope drives. The objective is to obtain parameter values for which a critically damped offset with minimal fluctuations is realised when tracking. There is a certain art involved in assessing the correct values, the telescope performance being judged from the TV, position error displays and the velocity demand display. A basic requirement is, of course, that the telescope should track with approximately zero position error. The autoguider errors are logged by the Telescope Control Software and the servo constants are adjusted until the guiding errors are minimised. If any of the DACs on the axes get changed, then the parameters HDAC and/or DDAC will need to be checked.

12 ACQUISITION AND (AUTO)GUIDING

12.1 Finder telescope

A finder telescope is available on the INT. A TV camera can be used to view a field $33' \times 25'$ in size. The finder is in particular useful for the location of guide stars: the TCS software will generate overlays on the TV image of the finder field, at either focus, indicating the areas of sky where guide stars may be selected. It is therefore important that the zeropoint of the finder coordinate system is properly determined (see section 11.3.1), in order to allow accurate mapping of the autoguider acquisition areas and detector/slit positions onto the finder field.

12.2 The Acquisition and Guider Units

A&G units are provided at both the Cassegrain and prime foci of the INT.

12.2.1 Cassegrain A&G Unit

The A&G Unit at Cassegrain is mounted on the turntable at the rear of the INT primary mirror cell. The turntable can be rotated through 365 degrees. The Cassegrain A&G Unit has been designed primarily for use with the Cassegrain Intermediate Dispersion Spectrograph (IDS) and Faint Object Spectrograph (FOS). Nevertheless, the overall philosophy of the design has been to incorporate a range of facilities which would be required by most instruments operating at the Cassegrain focus. Figures 11 through 14 show the layout of the A&G unit. The following functions are provided:

- **Acquisition:** A TV camera views a $1.8' \times 1.8'$ element of the $20'$ diameter unvignetted Cassegrain field (on or off axis) via a flip mirror in the field-viewing position. There are four TV colour filters available: BG28 (blue), BG38 (green), RG630 (red) and clear (UBK7).
- **Slit Viewing:** A simple movement of the flip mirror facilitates viewing of the light reflected from the spectrograph slit jaws by the acquisition TV.
- **Autoguiding:** An autoguider based on an FW-130 image dissector scanner with S-20 photocathode is available, which allows offset guiding using stars anywhere in a $90'$ square field, apart from an area near the centre where the probe obscures the spectrograph slit. Guide stars should have magnitudes in the range $7 < m_v < 14$. There are four colour filters available for the autoguider beam: BG28, BG38, RG630 and clear (UBK7).

Further, a selection of spectroscopic and photometric calibration lamps and a selection of neutral density and colour filters are available for use with the attached instrument. The comparison lamps and filters are only useful over a more restricted field of $4'$ diameter, matching that of the IDS.

12.2.2 Prime Focus A&G Unit

At Prime focus the A&G unit is mainly used with the prime focus CCD camera. The unit is mounted on a rotator, which allows the detector to be rotated to any position angle, although it is normally operated at one of the cardinal points. The default orientation is 180°, for which position angle spillage of Liquid Nitrogen is lowest.

Figure 11: The Cassegrain Acquisition and Guider Unit (side view), showing the autoguider, TV camera, comparison system and filters.

Figure 12: The Cassegrain Acquisition and Guider Unit (side view).

Figure 13: The Cassegrain Acquisition and Guider Unit (viewed from above).

Figure 14: The relationship between probe positions and encoder readings for the Cassegrain A&G Unit. The IDS slit lies parallel to the x co-ordinate: for Position Angle 0° the slit orientation is North-South. Units in this diagram are microns.

Note that **no direct viewing** facility exists at prime. The telescope points sufficiently accurately that any object with known position can be acquired close to the centre of the CCD detector. Further, there are no calibration lamps provided, but there is a filter wheel which can carry up to 6 filters, for use with the CCD detector.

The prime focus autoguider is identical to the one at Cassegrain focus. However, because there is insufficient space to accommodate a filter wheel or slide, a single fixed broad-band green filter is used. The choice of this filter is a compromise between a match to the FW-130 response and to the spectral response of the CCD detectors used at prime focus. Note that the autoguider at prime does not look through the same colour filter as the CCD, which has implications for focal adjustments, in particular on changing (CCD) filter (see section 11.5.2).

An important feature of the geometry at Prime is that both the guide probe and the CCD detector are mounted off-axis. This means that guide stars can only be selected in an area located about 30$'$ away from the field viewed by the CCD, on the opposite side of the rotator axis. This feature makes some special procedures necessary for the set up of geometry parameters at prime (see section 11.4.2) to enable easy acquisition of guide stars. Figure 15 shows the geometry and the area in which guide stars can be selected. As for Cassegrain, stars with magnitudes in the range 7< m_v <14 are suitable.

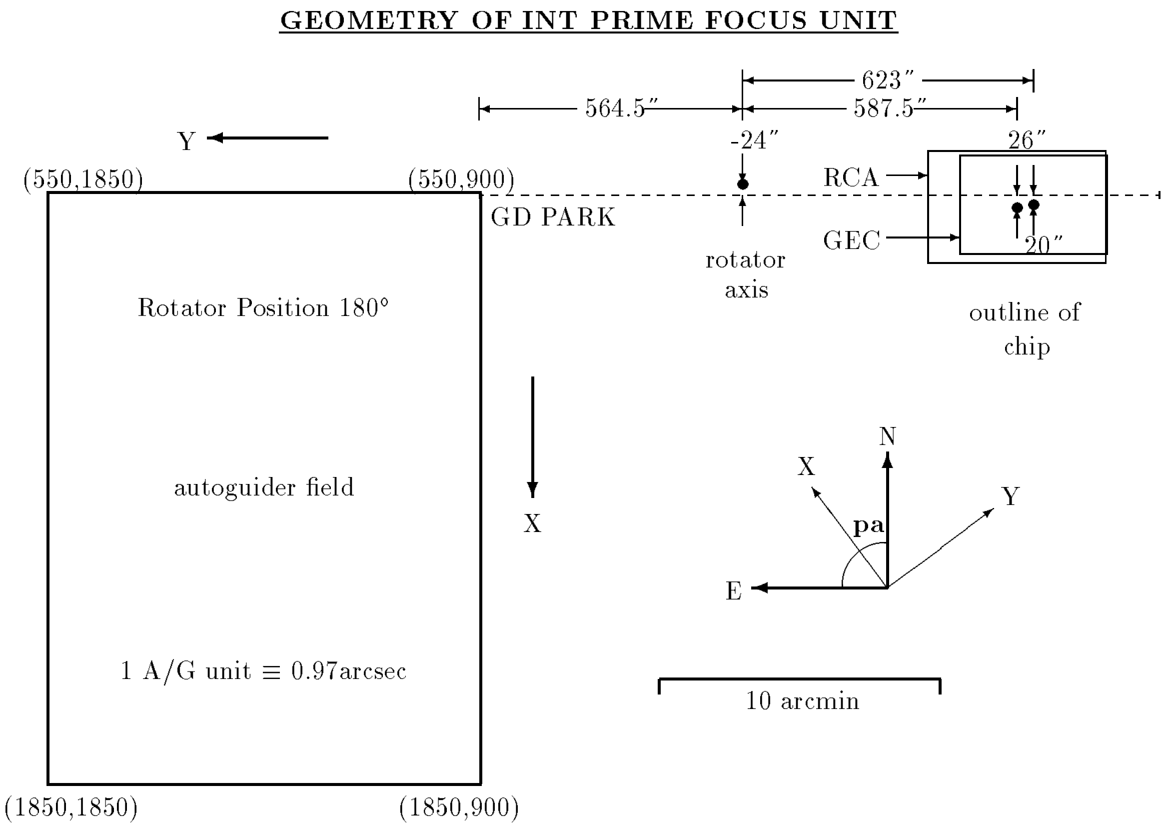

Figure 15: Scale drawing of locations of chip, rotator axis and guide-star acquisition field, showing probe-coordinate limits. The probe's park position is at the top right-hand corner (550,900). The orientation indicated is for position angle 180°; the 'compass' shows the general relation between guide probe coordinates for any Position Angle on the sky.

12.3 Using the Autoguiders

12.3.1 Introduction

Both the Cassegrain and Prime Focus A&G units are equiped with identical autoguiders. The autoguiders are controlled by a dedicated micro processor, which continuously analyses the image of a guide star at the centre of the guide probe and determines its position in the frame of the autoguider. Position errors, offsets from the probe centre due to tracking errors, are communicated to the Telescope Control software which can then make a pointing correction. Before the autoguider can lock onto a guide star, that star has to be positioned on the guide probe near the probe centre, by moving either the probe or the telescope. If the guide star is within the field of the probe, the autoguider will locate it in the 'field' mode; once the star is detected, the probe (or telescope) can be moved to centre it, and the guider-telescope combination can lock onto the guide star in a closed guide loop. The tracking errors are sent to the Telescope Control computer (the PE 3220) in order to effectuate pointing or tracking corrections.

The control of the probe position (for moving the probe around to acquire a guide star) is via the Instrument Computer (the PE 3210, because that one controls the A&G Unit functions). Therefore, one can centre a guide star on the probe in two different ways: (1) by moving the probe with the ADAM GDXY command (Instrument Computer) while the telescope is tracking, or (2) by moving the telescope (handset or User Interface) with a fixed probe position. Each possibility has its own advantages and disadvantages which are discussed in section 12.3.2 below. The GET GUIDE STAR command of the Grinnell menu has the effect of moving the probe.

The standard way of acquiring guide stars is by locating them on the Finder TV probe (at either focus). The telescope control software knows how to map positions on the Finder TV onto the autoguider acquisition field provided that (1) the finder zeropoint is determined correctly (see section 11.3.1), and (2) the geometry parameters for the focus used are set up correctly (see section 11.4). Although guide stars can be located on the finder TV, it is desirable to select guide stars in advance of an observing run on survey plates and measure their coordinates, in particular if there are restrictions on the rotator Position Angle (see section 12.3.3). If a guide star position is known, the coordinates can be entered directly via the User Interface and the TCS will position the guide probe straightaway. At Cassegrain, care must be taken to avoid selecting a guide star so positioned that the autoguider probe obstructs the spectrograph slit.

12.3.2 Acquisition modes: Probe or Telescope?

When the 'acquire' button on the autoguider control panel is pressed there are two ways of moving the guide star into the centre of the autoguider field so that the guiding loop may be locked: by offsetting the telescope, leaving the probe stationary, or by moving the probe whilst the telescope tracks undisturbed. Their advantages and disadvantages are:

- Move the probe (after `AC/PR` at the User Interface): Location of a guide star is normally much less accurate than the positioning of the main telescope, because of the finder flop error. Therefore, this is the default mode, because by moving the probe any residual error in the mapping will be compensated for. (Of course, when the guide loop is closed, the probe will be kept stationary.) Since the probe is moved from the Instrument Computer, but the position errors are sampled by the Telescope Computer, this mode requires data to be transfered via the interprocessor link. It will not work if the link is broken.
- Move telescope (after `AC/TE` at the User Interface): If the guide star position is known precisely, either in RA and Dec by accurate measurement or in probe x,y coordinates from a previous observa-

tion, then this mode can be used to make an accurate blind offset. This is not very important with an imaging detector, *i.e.* the Prime focus CCD, but does help with the IDS and FOS; acquisition is also significantly faster than when the probes are moved and the process is independent of the interprocessor link.

Thus, in general it is best to move the probe. If, however, you have an accurate probe position for the guide star (from a previous run), or if the interprocesor link is broken, then move the telescope.

In order to switch modes, type at the User Interface terminal:

UI–> `AC/PR` to move the probe (with fixed telescope).

UI–> `AC/TEL` to move the telescope (with fixed probe).

12.3.3 Locating guide stars on Sky Survey plates

Although there is no strict need for the observer to select guide stars in advance, since locating them on the finder field is simple and quick, it is desirable to measure guide star coordinates before going to the telescope, and at Prime Focus in particular it is worth checking that there is a suitable guide star in the field accessible to the probe, especially if there are constraints on the exact position angle of the CCD chip on the sky.

A scale diagram of the Prime Focus detector and guide-probe fields is shown in figure 15; the diagram for Cassegrain is show in figure 16. In order to check that there is a suitable guide star, place a scaled version of the overlay on the POSS with the chip outline centred on the object to be observed. Rotate the overlay to your chosen position angle. If you do not care, use 0° at Cassegrain, and 180° at Prime, because this avoids unnecessary loss of liquid nitrogen at large zenith distances in the North. Check that there is a star with $7 < m_v < 14$ in the probe field. If there is not, try again with the overlay rotated by 180° (if you care about the orientation) or any angle (if you don't, but remember that cardinal points give better displays). Make a note of the approximate PA to be used; at the telescope you can locate the star on the Finder TV, or, if you happen to know its coordinates, then these can be entered at the User Interface console.

12.3.4 Locating guide stars at Prime Focus

The standard method of finding guide stars for the Prime focus CCD Camera is to locate them on the wide-field Finder display. Having reassured yourself in advance that a suitable star exists (see 12.3.3 above) and having zeroed the finder model at the beginning of the night (section 11.3.1), proceed as follows:

1. Move the rotator to your required position angle with the ADAM command ROTPOS. The default angle on startup is at 180°.
2. Point the telescope to your object to be observed; take a GLANCE to check its position.
3. Select $\boxed{\text{FINDER}}$ and $\boxed{\text{DIRECT}}$ on the Grinnell panel to route the raw finder image to the monitor.
4. Offset the telescope so that the guide probe field becomes visible on the finder. This done by pressing the BEAMSWITCH $\boxed{\text{A}}$ button on the Control Desk. The offset is made in a coordinate system fixed to the Prime Focus Unit; its value on the sky depends therefore on the rotator Position Angle.

5. As a result of pressing $\boxed{\text{A}}$, stars should appear to move along the major axis of the chip as the beamswitch takes effect and this will be visible on the finder image. If they move otherwise, or if nothing happens, perhaps the default aperture offset values have been overwritten. The correct offset values are set up on startup of the control software; to check the values, type at the User Interface console:

   UI–> `AD(VISE)/T(ELESCOPE)`

   Aperture A should be set to 0,−590 arcsec. If you have accidentally overwritten these values, type:

   UI–> `AP(ERTURE)/A 0 -590`

   and press $\boxed{\text{A}}$ again. The aperture in use is shown on the Information Display with the offsets converted to RA and Dec.

6. Select the Grinnell function GET GUIDE STAR. A display of the field accessible to the probe will appear on the screen. Move the cursor to your chosen guide star in the permitted area and press $\boxed{\text{ENTER}}$ on the Grinnell joystick control box. The coordinates of the star will be transmitted to the instrumentation computer which will then move the guide probe to the correct position.

   A star will be bright enough for autoguiding if it is visible on the finder with 4 frames of integration at full TV gain. Avoid very bright (m_v <6) stars.

7. Finally press the BEAMSWITCH $\boxed{\text{NOM}}$ button on the Control Desk to return the telescope to your object and press $\boxed{\text{DIRECT}}$ on the Grinnell panel to unfreeze the TV display.

The telescope is now pointing to your object, which should be positioned close to the centre of the CCD detector, while the guide probe is positioned such that the guide star is at the centre of the acquisition area. The guide star must now be acquired with the guide probe, and the guide loop enabled as described in section 12.3.8 below.

Note: if the acquisition of a guide star fails, the most likely cause is that the mapping of the autoguider acquisition field onto the finder has gone wrong. This will occur if the TV scales are more than about 5 percent off the correct values, and these should be checked/redefined with the ADAM command TV_SETSCALE. Nominal values at Prime are 3.38 arcsec/pixel in x and 2.75 arcsec/pixel in y (see section 3.1.8 of the INT Prime Focus User Guide).

12.3.5 Locating guide stars at the Cassegrain focus

The best way to find guide stars is by using the Finder TV probe. The Grinnell menu function GET GUIDE STAR draws an overlay on the display of the Finder field which shows the locations of the spectrograph slit and the area in which guide stars may be selected (Figure 16). It is very important that the zeropoint of the finder be determined beforehand, in order to enable the TCS to map the guide probe acquisition area accurately onto the finder field.

1. Slew the telescope to the object to be observed and move it onto the spectrograph slit using the Cassegrain TV camera.

2. Press the $\boxed{\text{FINDER}}$ button followed by the $\boxed{\text{DIRECT}}$ button on the Grinnell Panel.

3. Select the Grinnell menu function GET GUIDE STAR: a horseshoe-shaped acquisition field will appear on the Grinnell TV monitor (figure 16). Any stars which appear within the permitted area of sky can be reached by the guide probe without obscuring the spectrograph slit. Choose a star which is visible without integration (otherwise it will be too faint for the autoguider).

Figure 16: The area in which guide stars may be chosen at the Cassegrain focus of the INT. The orientation on the sky is given for Position Angle 0°; at other angles, the diagram must be rotated anticlockwise by the angle. Stars may be selected in the shaded area. If the autoguider probe is moved closed to the centre of the field, then the slit is obscured; partial obscuration occurs in the area shaded with dashed lines. The field outside the circle is heavily vignetted, but bright stars may be usable.

4. Move the grinnell cursor to the desired guide star position and press the ACCEPT button on the joystick. The probe will now move to this star.
5. Select probe mode by typing at the User Interface:

   UI–> `AC/PR`

You are now ready to set up the autoguider and acquire the guide star as described in section 12.3.8 furtheron.

12.3.6 Using guide stars of known RA and Dec

If you happen to know the coordinates of a suitable guide star, you can enter them directly in the object catalogue. Enter the object `name` and its guide star `guidename` at the User Interface in the usual way and associate the two entries by typing:

UI–> `name`

(This selects `name` as the edit source), followed by:

UI–> `GUIDE guidename`

This information can, of course, be entered from a prepared disc file. Note that the coordinate systems used for an object and its guide star must be the same (both Apparent or Mean with the same Equinox).

In order to move the guide probe to the correct position, press the GUIDE/STAR button on the A&G panel.

12.3.7 Using guide stars with known probe coordinates

If you know the probe coordinates from a previous observation (these should have been noted in the observations log), type at the ADAM terminal:

ADAM:> `GDXY(POS) x y`

where `x` and `y` are the probe coordinates. These values are returned by the PFSTATUS command (for the Prime focus) or the Mimic Display (at Cassegrain focus). Units are 40 microns at Prime (despite PFSTATUS's allegation that they are in `mm`) and microns at Cassegrain.

In this case, you may well wish to acquire the guide star by moving the telescope rather than the guide probe (section 12.3.2), as this ensures that your field is in exactly the same position on the detector (or slit) as it was on an earlier run.

12.3.8 Acquiring a guide star

This procedure is the same whether the telescope or the probe is to be moved. Route the autoguider probe image to one of the TV monitors. If the autoguider has not been turned on (resulting in a blank screen) press the button below the fourth mini-monitor on the extreme top right of the Control Desk (red = on; white = off). This switches the High Tension power supply on. The HT supply is interlocked with the main dome lights: if the latter are switched on, the HT is disabled in order to protect the guide probe; conversely, it is not possible to power the guide probe with the dome illumination on. The autoguider display should come up with a frame and an 'idle' message (Figure 17). If it does not, press the $\boxed{\text{SHUTDOWN}}$ button on the Autoguider Panel. If there are still no signs of life and the autoguider panel appears to be active, call the Duty Technician.

If the autoguider is alive, press the $\boxed{\text{FIELD}}$ button on the autoguider panel. This causes the autoguider to scan a field of about $2' \times 2'$ and to lock onto the brightest pixel (in software; the probe does not move), which in all likelihood is the intended guide star (if the proper procedure was followed to move the probe to the guide star position). Note that the outer parts of the scanned area are heavily vignetted at Prime, but not so at Cassegrain. An image will appear on the 32×32, 3-bit (gray-scale) autoguider sub-display (figure 17), with the position of the brightest pixel marked with a cross in the diagram below.

If the image occupies a single pixel, the intended guide star is probably very weak or strongly vignetted. In such a case, first press $\boxed{\text{WAIT}}$ to stop the integration, and subsequently repeat the $\boxed{\text{FIELD}}$ integration. Random events look very similar to faint stars. If, however, an image is found consistently in the same place, then it is probably real.

The "magnitude" of the star indicated on the autoguider display is alleged to be roughly m_v. A magnitude m_v <14 is acceptable for guiding.

If you are happy with the guide star selection, press $\boxed{\text{ACQUIRE}}$; if not, press $\boxed{\text{WAIT}}$ and pause for thought (see section 12.3.9, furtheron).

Pressing $\boxed{\text{ACQUIRE}}$ passes the coordinates of the guide star measured by the probe to the TCS computer and requests that now either the probe or the telescope be moved, depending on the acquisition mode selected, such as to position the star at the centre of the autoguider field. This is done either by sending a message over the interprocessor link to the Instrumentation Computer (for probe movements) or directly by moving the telescope. When the positioning of the probe/telescope is completed, the autoguider will do another field integration. It then switches from raster to cross scan and starts to measure the position of the star with greater accuracy. This is the "pulling-in" phase, as is indicated on the monitor. Messages are sent to the telescope computer, which attempts to move the probe/telescope to minimise the error. When the error drops below a preset threshold, scanning ceases and the x and y profiles of the star are displayed with a message 'OK to Guide?'.

At this point, press $\boxed{\text{GUIDE}}$ unless the profile is double-peaked, indicating a narrow double star or out of focus image, or if the object is very weak. Wait until the autoguider display is completely redrawn and then press the $\boxed{\text{LOOP/ENABLE}}$ button on the A&G panel which should turn green. Note that the loop is locked by the action of switching from LOOP DISABLE to LOOP ENABLE. Wait until the cross (the measured star position) is centred in the 2 arcsecond diameter circle. You are now ready to observe.

The coordinates of the guide star will be recorded in the automatic observing log and displayed on the MIMIC display. If the same star is observed later, the probe can be sent to the guide star following section 12.3.7.

The autoguider signal should be monitored during observing in case the signal becomes weak (indicated by the message: CLOUDY). On the right-hand side of the autoguider display (figure 17) are histograms of the last 128 guiding errors in x and y On the left-hand side are the current state (GUIDING), warnings (*e.g.* CLOUDY), an approximate visual magnitude, a measure of the relative transparency (RT, relative to the measurement of the first scan) and a measure of seeing estimated from the profiles (**beware:** not equal to or linearly related to the true seeing! It is a function of both seeing and brightness of the guide star).

The cross should always remain within the circle. If it consistently strays, you have probably lost the

Figure 17: The Autoguider Display

guide star. Check whether there is any signal.

On source change press $\boxed{\text{WAIT}}$; the autoguider is automatically switched to the LOOP DISABLE status. If you need light in the dome (also with tungstens, unless these are very dim), turn off the HT.

12.3.9 Problems with guide-star acquisition

- There is no star in the autoguider field. Is the beam obscured? Can you see anything through the telescope? Are mirror covers, dome and shutters open. Did you provide the correct sky- or probe-coordinates of the guide star, and are they within the limits (otherwise the probe will not have been moved)? Is the probe in a sensible place? Has it moved? (Use PFSTATUS to check this at Prime; Mimic display at Cassegrain). Is the star visible on the finder in direct mode? If not, then it may be too faint for the autoguider.

  At Prime: Was the star close to the boundary of the box on the finder? If so, it might actually be over the limits. Have you gone back to BEAMSWITCH $\boxed{\text{NOM}}$? It sometimes happens that, because of hysteresis in the finder, the guide star is out of position in Declination. Try moving the probe by $\pm 50''$ in an appropriate direction.

  At Cassegrain: Is the probe within the unvignetted field of the telescope?

- The autoguider selects the wrong star (*e.g.* a close double) when there is an alternative and acceptable guide star in the field. Provide a better position.

- Double-peaked or other non-Gaussian profiles. Is the star double? (look on the finder!). If so, you probably cannot guide on it. If both profiles are double-peaked or if a field integration results in images with holes in their centres, then the autoguider and/or the telescope itself is probably out of focus:

  Ensure that the telescope is focused.

  At Prime, refocus the guider using the ADAM commands GDFOCPOS and SETGDFOCUS. Refer to section 11.5.2.

  At Cassegrain, call for help.

  Asymmetries in the profiles often result when the autoguider does a scan before an acquisition movement has quite finished. This is nothing to worry about; guiding should not be affected.

- The autoguider seizes up whilst guiding. Press $\boxed{\text{SHUTDOWN}}$ to re-initialise the autoguider, and repeat the acquisition sequence, but make sure that the telescope, not the probe, is moved during acquisition by first typing at the User Interface console:

  UI–> `AC/TEL`

  Assuming that the telescope has not drifted by more than a few arcseconds, the object should be returned to exactly the same position on the detector and observing can continue.

- The autoguider refuses to acquire by moving the probes. Have you asked the probe to go somewhere illegal (is it close to a limit)? Is the interprocessor link active on both computers? If not, try reloading it (see chapter 13.4).

- The autoguider or A&G panels do not respond. Refer to chapter 13.4.

- At Prime: the Grinnell is re-initialised during normal operation, *e.g.* by pressing the $\boxed{\text{RESET}}$ button by accident. In this case, the Prime-Focus overlay may not appear because the Grinnell thinks that the Cassegrain system is required. To fix this, type:

  ADAM: > `RESETTV`

- At prime: if acquisition of a guide star fails while everything seems to work properly, check whether the TV finder scale has been altered (*e.g.* by replacement of the TV camera). Nominal values are 3.38 arcsec/pixel in x and 2.75 arcsec/pixel in y. In order to alter the TV scale values type at the ADAM terminal:

  ADAM: > `TV_SETSCALE`

  and follow the prompts. Alternatively, it may be necessary to measure the scale anew: refer to section 11.6.1.

13 TROUBLE SHOOTING

13.1 Checking the Light Beam

If the telescope is operating normally but you can't see any images on the Finder TV, The Cassegrain TV or the CCD (at Prime), check the following possible causes:

- Is it cloudy? Go outside and look for yourself.
- Is the dome closed or is the lower shutter vignetting the beam?
- Is the dome open but pointing in the wrong direction. This can happen if the dome is switched to MANUAL or if there is a malfunction of the dome rotation or the dome rotation encoder.
- Are the primary or secondary mirrors still closed?
- Is the finder cover closed?
- On the Cassegrain A&G box check that the autoguider probe isn't close to the centre and thus vignetting the beam.
- Is the telescope somewhere near its nominal focus? It sometimes happens that on startup the focus runs away to 62 `mm`. At this setting the image is so far out of focus that it is very difficult to see stars on the TV.
- Are the TV cameras running normally with the gain fully up and no warning lights showing?

13.2 The telescope is tracking but pointing badly

- Have you zeroset correctly and done a SNAFU?
- Check the coordinates (including proper motions) and the equinox. If you are observing a star with a high proper motion (several of the white dwarf spectrophotometric standards fall into this category), it is vital to include the proper motions and to beware of old finding charts. Has the proper motion in Right Ascension A been entered in $''$/year (which is wrong) rather than seconds-of-time/year (which is correct)?
- Has the telescope control software been initialised with the correct focus file?
- Are the encoders working correctly? Do a systematic check as follows:
  1. Stop the telescope and switch to Engineering mode
  2. Check the position roughly on the synchros. Is there a big pointing error: more than 2^m in RA or $30'$ in Dec? If so, shut down the Telescope Control System and start again. If the error persists call the Duty Technician.
  3. Test the performance of the encoders by running the task ENCODERS from the Telescope Control System terminal. Type:

     ```
     *ENCODERS
     ```

     This runs a program which compares the readings from the 4 independent encoders (3 Ferranti, 1 Baldwin) on each axis. Firstly, look at the Ferranti readings. If one of these is grossly different from other two on the same axis (and from the the synchro), then that individual encoder is baulking. Confirm this by looking at the counters in the CLIP Centre. Correct any obvious problems (disconnected electronics). If the problem persists run the INPSCF task (see section 7.7) and reset the appropriate encoder weight to zero with variables WHAFEn and WDCFEn for Hour Angle and Declination Ferranti head n, respectively. Thus, to disable Hour Angle Ferranti Encoder number 2, do:

`*INPSCF`

INPSCF > `WHAFE2 0.0`

INPSCF > `END`

Note that this procedure only affects the running system - if, for any reason, the TCS is stopped and then restarted you will have to reset again the appropriate weights to zero.

4. Now repeat the ZEROSET and SNAFU and try again.

5. If all of the Ferranti readings appear to be sensible, compare the Baldwin+Ferranti values with those for the Ferrantis alone. If they are more than a few arcseconds different, then the Baldwin encoder has probably broken. It is easy to switch over to using Ferrantis only in Declination (just set Task Common parameter JDCBW to zero using INPSCF). If the problem is with the Hour Angle encoder, better call out the Duty Technician in order to check out the encoder and adjust the servo constants.

13.3 The telescope runs away

Do the following *in this order very quickly*, whilst watching the synchros:

1. IF THE TELESCOPE IS NEAR A LIMIT, PRESS EMERGENCY STOP.
2. Else press the T/S DOME STOP button on the Control Desk. If this does not stop the telescope, then
3. Select ENGINEERING MODE and if everything else fails,
4. PRESS EMERGENCY STOP.

If pressing the T/S DOME STOP worked, then none of the main control software tasks have stopped, and the control system seems to be in order. Thus, check the following possible causes:

- Did you slew to the right place? Check on the Information Display.
- Were you using the handset when the runaway occurred? If so, the the cause may be a stuck contact.
- Did the runaway occur in quick or slow-motion drive? If it happened in quick motion, a stuck Baldwin encoder is a likely candidate. Check this by running the ENCODERS test task several times whilst moving the telescope slowly in Engineering Mode with the Slow Motion clamps on. If one of the Baldwin encoders is not updating, then remove it from operation as decribed in the previous section.

- Are the encoders reading correctly? Do the tests given in the previous section. If none of the encoders appears to be working, and especially if they all show values very close to zero and do not increment when the telescope is moved, yet all of the control software is operational, the most likely faults are:

  1. Catastrophic CAMAC failure. In this case **none** of the Information Display readouts give sensible values. However, if for example the focus is reading correctly, but none of the HA and Dec encoders works, then it is quite likely that:
  2. No clock pulses are reaching the encoder modules. Call the Duty Technician.

13.4 Autoguider Problems

- **Autoguider Panel does not respond.**

  Check TCS tasks AGBX and AUTOGUIDE. Type at the TCS console:

  `*D(ISPLAY) M(EMORY)`

  Are tasks AGBX and AUTOGUIDE present and active (A)? If not, cancel and restart the relevant task with:

  `*CA(NCEL) AGBX`

  `*RESTART AGBX`

  and similarly for AUTOGUIDE. Further, restart the task from the ADAM terminal with:

  ADAM: > `AGBXINIT`

- **Interprocessor Link down?**

  Call the Duty Technician, or check TCS task IPL with:

  `*D(ISPLAY) M(EMORY)`

  If task IPL is not active (A) or absent, cancel and restart with:

  `*CA(NCEL) IPL`

  `*RESTART IPL`

  Further, the link should be re-initialised from the ADAM terminal with:

  ADAM: > `IPLINIT`

14 LOGGING DATA

14.1 Logging Observations

All observations taken at prime Focus or with the IDS/FOS spectrographs are logged by an automatic system based on an IBM PC. This system is interfaced to the MIMIC display and the Information Display from which it takes all the information relevant relevant to the status of instrumentation and telescope at the time of observation. Among the items logged are the UT, exposure time, RA, Dec, Autoguider Probe position, filters and central wavelength of spectroscopic observations. The log is currently kept on the hard disk of the PC and written to a dedicated line printer. It is intended to send the data to the VAX as well, and from there to the UK. A print copy of the log is collected in a binder which remains in the INT Control Room. The observer will get another print copy to take home.

14.2 Reading the ICONA Meteorological Instruments

The Stevenson screen containing 4 thermometers and a thermo- hygrograph is located about 100 metres east of the INT Dome. The rain gauge is a few metres to the north-east of the screen and is normally kept locked. The replacement charts for the thermohygrograph are kept in the cupboard in the TO Office and are changed every Monday morning by the TOs.

On rare occasions it may be necessary to read the rain gauge. This is usually done on the first day of the month.

Open the bottom flap of the rain gauge using the Yale key. Take care because the measuring cylinder is only resting inside and is not fixed in any way. Remove the cork from the nozzle and operate the valve to let the accumulated rainwater run out. Quite often, the volume will be greater that the capacity of the measuring cylinder so the valve must be closed before the level of the water reaches the 10.0 mm mark. NOTE THAT THE MAXIMUM READING IS 10 AND NOT 100 MM. Record the reading each time until a pink, viscous liquid comes out. This liquid is intended to prevent evaporation and it is less dense than water. Wait until it has settled out on top of the water and take the reading at the bottom of the liquid mensicus. Note the reading, adding it to the others (if any), empty the cylinder and cork the nozzle. Replace the cylinder, lock the gauge and record all readings along with the time of observation on the ICONA form.

14.3 Telescope Focus

Now that the dome-induced seeing is under control, the largest contribution to the image size in the telescope focal plane seems to be the telescope focus. In 1.0 arc second seeing, with a 1.0 arc second slit, a deterioration of telescope focus by 0.05 mm decreases the efficiency of the telescope by 10-20 per cent; in 0.6 arc second seeing, it would cost 30 per cent.

Focus in the direct TV mode. First adjust the TV gain to give an image which is easy to see but not saturated. Telescope operators should determine focus by taking an average of at least 3 and preferably 5 independent measurements. Take the mean and write down the result in the TO's log. Once set the telescope tracks with temperature. However if the seeing improves it is wise to focus again later in the night.

14.4 Seeing Measurements

To ensure that we have a method which enables us to compare one night with another at the Cassegrain focus please adopt the following. One of the seeing measurements must be taken at the zenith around midnight - or after the dome has been open for several hours.

1. Choose a star which appears in or near the field being observed.
2. Focus the telescope (see Section 12.2).
3. Integrate for 128 frames in SUM mode using the slit viewing Grinnell TV.
4. Adjust the TV gain to give an unsaturated image. (The profile of a saturated image shows a flat top).
5. Select MENU (RESTRICTED PROFILE) using the joystick or the SELECT button on the Grinnell control box.
6. Make the Grinnell seeing measure in RA. If the turntable has been rotated use the RA guide button to see where RA lies.
7. Repeat twice more and carry out the whole procedure 4 or 5 times per night. Record in the NA logbook.
8. Note the zenith distance and focus for the measurement in the TOs log.

14.5 Windspeed Measurements

The INT Dome should not be left open if the windspeed exceeds:

22 metres/sec = 80 km/hour = 50 mph

The wind speed measurements and direction indicators on the Meteorological Console are taken from the mast 100 metres to the East of the building. They are reliable except when the instruments are frozen solid.

14.6 Telescope Operation Logbook

This log is used to provide information with regard to the telescope operational activities. It is kept in a standard Stationery Office hard-covered manuscript book.

The following notes describe the way in which the log is to be used.

1. Start each day in the log on the right hand page and head it with the date in the following format: 1985 August 22/23
2. Note in the Log any action or occurrence concerning the T/S, Dome, Instruments or Computer Systems.

   Notes should be brief and to the point, thus:

   2100 - Dome opened JNG

   2130 - IPCS Failure, fault under investigation DJI

Any detailed information should be put in the appropriate log with the reference to it recorded in this log.

NB EACH LOG ENTRY SHOULD BE INITIALLED

3. Fault cards should be filled in in the usual way and a brief note of the fault also made in this log:

   2200 - Telescope tracking problems. Fault card submitted VR

4. The log begins at the start of each day and ends when observing finishes the next morning.

   The following notes give an example of what a day's log may look like:

Time	1985 Mon/Tue Sept 15/16	
0930	Flat field terminated	DXC
1030	A and G Box fault investigation started	RDA
1040	telescope control software modified	ACC
1115	A and G Box fault repaired - OK	RDA
1300	Telescope access parked for work at Prime	KGM
1345	Prime focus work complete. T/S zenith parked	KGM
1440	Duty Technician checks OK	EJM
1700	FOS CCD filled	VR
2100	Dome opened	VR
0300	Noisy dome motor, fault card submitted	VR
0700	Dome closed, T/S Closed down. Flat field running	VR

15 USER-SUPPLIED INSTRUMENTS

The Acquisition and Guidance Unit at Cassegrain includes an instrument mounting plate to which user-supplied instruments can be attached. The overall dimensions of the A&G Unit are 2.26m×1.38m×0.50m; the maximum loading is 500 kg on the outer columns and 200 kg on the circular central pattern of holes (see figure 18). Test carried out with a 500 kg load showed that the maximum shift (flexure) produced at the Cassegrain focus when moving the telescope through 90°, from a horizontal to a vertical position, is 20 μm.

Figure 15 shows the maximum dimensions possible for instruments to be attached to the A&G Unit.

The optimum focal position is 150 mm below the back surface of the instrument mounting plate. The total movement of the focus about this position, determined by the the maximum travel of the telescope top end, is ±729 mm. The aberrations in the image resulting from a focal shift are shown in figure 5 (chapter 2). Note, however, that the A&G Unit TV camera and autoguider are set to be in focus at the optimum focal position. Instruments requiring a different focal distance can be accomodated by inserting an appropriate lens in the holder of the TV probe (where no lens is required at the nominal focus) and by substituting the reducing lens in the autoguider probe. Observers requiring this flexibility must provide their own lenses and arrange for their use well in advance of an observing run.

User-supplied instruments may be controlled from the PE 3210 Instrument Computer (see section 9).

Figure 18: The Cassegrain A&G Unit: Instrument Mounting Holes

Figure 19: The Cassegrain A&G Unit: Space Restrictions for Instruments

16 POWER SUPPLY AND UTILITIES

The INT has some major engineering systems where minor faults may be cured by the Support Astronomer or Telescope Operator if they have the required experience. Most faults, however, will require the intervention of the the Duty Technician. On no account should a visiting observer tamper with any of these systems:

- **The Buffer Set**
- **Oil Pump and Hydrostatic Bearing System**
- **Air-Conditioning to the PE 3210 Instrument Computer**
- **Air-Conditioning to the PE 3220 Telescope Computer and CLIP Centre**
- **Gaseous Nitrogen Distribution System**

A The Pointing Grid Catalogue

Table 5 lists the pointing grid catalogue currently installed on the PE 3220 disc. Some notes to the table are given at the end.

Table 5: The Pointing Grid Catalogue PTGRID.CAT (Equinox 1950.0)

Object Name	Mag	Type	Catalogue name	Right Ascension	Declination	Proper Motion RA	Proper Motion Dec
PERTH 18406	8.4	K0	00−30	23 55 59.305	−29 29 19.13	+0.0028	−0.021
SAO 165994	8.6	G5	00−15	23 57 50.305	−14 46 07.95	+0.0108	+0.006
AGK3 −0 3013	9.2	K0	00+00	23 58 05.203	−00 03 19.65	+0.0025	+0.011
AGK3 +14 2660	8.7	G5	00+15	23 59 04.195	+14 21 13.70	+0.0021	+0.009
AGK3 +30 2685	9.3	K2	00+30	23 56 14.320	+30 32 32.98	+0.0022	+0.013
AGK3 +44 2265	9.1	K2	00+45	23 59 33.188	+44 15 14.34	+0.0031	−0.003
AGK3 +60 1609	8.9	K2	00+60	23 55 58.234	+60 24 32.28	+0.0018	−0.011
AGK3 +74 703	8.9	K0	00+75	23 52 48.266	+74 35 44.38	−0.0036	+0.016
AGK3 +88 99	9.2	K0	00+90	18 58 29.008	+88 46 55.47	−0.0695	+0.019
SAO 166759	8.0	K0	01−22	00 59 44.241	−21 52 39.70	−0.0003	+0.010
PERTH 3528	7.4	K2	01−07	00 59 02.560	−07 04 05.54	+0.0025	−0.013
AGK3 +6 107	9.4	K2	01+07	01 01 34.209	+06 56 23.74	+0.0011	+0.003
AGK3 +23 91	9.2	K0	01+22	00 57 23.779	+23 09 00.44	+0.0028	−0.043
AGK3 +38 107	9.3	K2	01+37	01 02 20.972	+38 12 32.23	+0.0001	−0.002
AGK3 +53 93	8.9	K0	01+52	01 05 05.167	+53 01 09.63	+0.0019	−0.003
AGK3 +68 56	8.8	G5	01+67	00 58 47.242	+68 24 37.70	−0.0005	−0.007
AGK3 +81 15	8.9	G5	01+82	00 45 54.147	+81 41 42.41	−0.0028	+0.004
SAO 167494	8.4	G5	02−30	01 59 03.846	−29 44 40.70	+0.0029	−0.012
SAO 148174	9.0	G5	02−15	02 05 33.485	−14 29 17.05	+0.0041	+0.009
AGK3 −0 204	9.4	K0	02+00	01 54 22.845	−00 29 04.67	+0.0003	−0.025
AGK3 +15 170	8.7	K0	02+15	01 59 46.049	+15 15 18.39	+0.0002	+0.005
AGK3 +30 212	9.5	G5	02+30	02 03 22.556	+30 45 21.38	+0.0004	−0.053
AGK3 +44 216	9.0	K0	02+45	02 03 59.901	+44 31 30.41	−0.0001	−0.018
AGK3 +60 248	8.9	K0	02+60	02 07 48.917	+60 58 15.34	+0.0053	+0.009
AGK3 +76 63	8.7	G5	02+75	01 53 18.592	+76 07 37.91	+0.0232	−0.034
SAO 168252	7.7	K5	03−22	03 00 32.105	−22 43 48.63	−0.0007	+0.013
SAO 130259	8.7	G5	03−07	03 00 42.062	−08 13 38.32	−0.0009	+0.012
AGK3 +7 330	8.8	G5	03+07	03 03 54.759	+08 01 48.45	+0.0009	+0.010
AGK3 +21 278	9.2	K2	03+22	03 00 08.714	+21 47 30.65	−0.0011	−0.004
AGK3 +37 371	9.4	K5	03+37	03 02 51.375	+37 23 55.69	+0.0040	−0.014
AGK3 +52 315	8.5	K0	03+52	02 53 47.539	+52 18 03.05	+0.0016	−0.014
AGK3 +67 165	9.3	G5	03+67	02 54 41.738	+67 41 57.06	+0.0019	+0.035
AGK3 +81 91	9.2	G5	03+82	03 26 35.339	+81 37 36.78	+0.0007	+0.017

The Pointing Grid Catalogue PTGRID.CAT (Equinox 1950.0)

Object Name	Mag	Type	Catalogue name	Right Ascension	Declination	Proper Motion RA	Proper Motion Dec
SAO 169102	8.5	K0	04−30	04 02 50.346	−29 03 27.27	+0.0020	+0.026
PERTH 5510	8.2	K2	04−15	04 03 41.953	−14 51 40.44	+0.0031	+0.010
AGK3 +0 349	9.5	K5	04+00	04 03 02.658	+00 02 54.30	+0.0023	−0.043
AGK3 +15 341	9.1	K0	04+15	04 02 52.065	+15 36 13.31	+0.0018	−0.032
AGK3 +31 381	8.8	K5	04+30	04 02 23.989	+31 21 44.51	+0.0009	−0.033
AGK3 +44 397	9.6	K0	04+45	03 58 33.653	+44 36 13.31	+0.0005	−0.007
AGK3 +60 411	9.4	G5	04+60	04 06 28.018	+60 14 10.41	−0.0005	−0.015
AGK3 +74 96	9.6	K5	04+75	04 06 01.809	+74 15 02.63	+0.0031	−0.009
PERTH 6114	9.4	K0	05−22	04 59 37.320	−22 05 47.79	+0.0016	+0.005
PERTH 6090	8.2	K5	05−07	04 56 53.176	−07 51 20.15	−0.0012	−0.010
AGK3 +8 545	8.8	G5	05+07	05 01 38.299	+08 08 11.78	+0.0006	−0.008
AGK3 +23 476	9.4	K5	05+22	05 01 19.070	+23 27 30.16	+0.0007	−0.001
AGK3 +37 562	9.0	G5	05+37	05 09 29.246	+37 41 05.69	+0.0010	+0.000
AGK3 +53 446	9.1	K2	05+52	05 03 50.936	+53 08 48.59	+0.0025	−0.036
AGK3 +67 262	9.5	K0	05+67	05 07 29.703	+67 17 14.16	+0.0014	+0.011
AGK3 +83 122	9.3	K2	05+82	04 54 06.305	+83 24 20.78	+0.0033	+0.006
SAO 171088	7.5	K0	06−30	05 56 18.061	−29 06 47.21	−0.0019	+0.002
SAO 151096	8.5	K0	06−15	06 02 52.936	−14 18 16.17	+0.0021	+0.011
AGK3 −0 731	9.3	K0	06+00	06 01 29.273	−00 13 14.20	−0.0007	+0.013
AGK3 +15 553	8.8	K0	06+15	05 57 23.211	+15 07 46.54	+0.0007	+0.004
AGK3 +30 640	9.1	G5	06+30	06 05 04.438	+30 15 33.60	−0.0008	+0.002
AGK3 +44 624	8.7	K2	06+45	06 02 08.602	+44 41 41.19	−0.0002	−0.029
AGK3 +60 497	8.5	K0	06+60	05 59 20.508	+60 27 18.05	−0.0018	+0.011
AGK3 +75 258	9.5	K2	06+75	05 46 09.910	+75 51 23.38	+0.0005	−0.017
SAO 172842	8.3	K0	07−22	07 01 00.266	−22 44 31.99	−0.0024	+0.001
SAO 134078	8.7	K0	07−07	06 59 33.641	−06 52 45.64	−0.0010	+0.004
AGK3 +7 921	9.3	G5	07+07	07 01 04.924	+07 39 13.85	−0.0011	−0.015
AGK3 +22 801	9.4	K2	07+22	06 56 31.289	+22 18 59.63	−0.0015	−0.030
AGK3 +37 807	9.2	K2	07+37	07 01 25.758	+37 01 11.98	+0.0015	−0.067
AGK3 +51 597	9.1	G5	07+52	06 57 31.303	+51 49 35.92	−0.0010	−0.020
AGK3 +68 320	8.8	K0	07+67	06 52 48.646	+68 25 55.20	+0.0046	−0.006
AGK3 +82 199	9.1	K5	07+82	07 05 24.695	+82 31 30.38	+0.0004	+0.008
SAO 175134	7.9	K5	08−30	08 02 59.479	−29 48 12.78	−0.0020	−0.003
SAO 153730	8.0	K5	08−15	07 59 19.627	−14 37 14.86	−0.0031	−0.026
AGK3 +0 1074	9.6	K2	08+00	08 01 34.205	+00 09 58.67	+0.0003	+0.011
AGK3 +15 871	9.1	K0	08+15	07 56 32.998	+15 30 09.68	−0.0012	−0.017
AGK3 +29 922	9.5	K0	08+30	07 54 47.088	+29 39 07.72	−0.0001	−0.012
AGK3 +44 790	9.2	K0	08+45	08 00 53.963	+44 44 50.70	+0.0003	+0.000
AGK3 +60 619	9.6	G5	08+60	08 04 48.652	+60 28 26.56	−0.0012	−0.020
AGK3 +75 385	6.5	G5	08+75	07 56 20.035	+74 22 35.88	+0.0069	+0.040

The Pointing Grid Catalogue PTGRID.CAT (Equinox 1950.0)

Object Name	Mag	Type	Catalogue name	Right Ascension	Declination	Proper Motion RA	Proper Motion Dec
SAO 176767	8.4	K0	09−22	08 56 21.471	−22 45 14.49	−0.0027	+0.006
SAO 136544	8.5	K0	09−07	09 01 17.889	−08 23 02.93	+0.0001	−0.035
AGK3 +7 1285	9.5	K0	09+07	08 57 19.338	+07 50 28.40	−0.0004	−0.017
AGK3 +22 1057	8.8	G5	09+22	09 00 30.988	+22 48 35.83	+0.0012	−0.012
AGK3 +37 971	9.2	G5	09+37	08 58 12.307	+37 05 14.91	−0.0002	−0.035
AGK3 +53 674	9.1	G5	09+52	08 52 35.025	+53 15 02.28	−0.0019	−0.005
AGK3 +68 405	9.1	K0	09+67	08 51 07.402	+68 39 39.44	+0.0028	+0.007
AGK3 +83 233	9.0	G5	09+82	09 24 21.566	+83 57 42.19	−0.0030	−0.004
SAO 178244	8.3	K0	10−30	09 55 53.832	−29 22 55.84	−0.0045	−0.033
PERTH 9420	8.6	G5	10−15	10 00 03.395	−14 53 24.91	−0.0005	−0.033
AGK3 +0 1354	9.3	G5	10+00	09 56 24.391	+00 43 08.41	−0.0056	−0.029
AGK3 +14 1070	9.3	K0	10+15	09 57 17.688	+14 30 12.02	+0.0004	−0.013
AGK3 +29 1098	8.5	G5	10+30	10 04 23.109	+29 28 54.94	−0.0010	+0.017
AGK3 +45 878	9.4	K5	10+45	10 01 45.410	+45 35 04.03	+0.0001	−0.017
AGK3 +59 743	9.1	K0	10+60	10 00 53.199	+59 26 47.55	−0.0022	−0.038
AGK3 +74 264	9.1	G5	10+75	10 01 48.094	+74 33 15.19	+0.0048	−0.006
PERTH 10102	8.9	K0	11−22	11 01 42.789	−22 01 49.35	−0.0021	−0.022
SAO 137917	8.8	K0	11−07	10 55 58.441	−06 47 13.03	−0.0019	−0.014
AGK3 +7 1513	9.5	K0	11+07	11 04 46.215	+07 47 04.77	−0.0032	−0.061
AGK3 +22 1203	9.0	G5	11+22	10 55 55.758	+22 08 14.02	−0.0004	−0.005
AGK3 +36 1042	8.9	G5	11+37	10 59 52.102	+36 36 21.17	−0.0027	−0.007
AGK3 +51 834	9.2	G5	11+52	11 04 07.684	+51 32 04.81	+0.0015	−0.036
AGK3 +68 469	9.3	K0	11+67	11 09 00.172	+68 08 15.55	+0.0022	−0.008
AGK3 +81 331	9.4	K0	11+82	11 15 16.602	+81 14 54.69	−0.0139	−0.015
SAO 180360	8.4	K5	12−30	11 57 11.461	−29 13 22.02	−0.0016	−0.069
PERTH 10756	8.3	K2	12−15	12 02 27.961	−14 15 08.67	+0.0018	−0.001
AGK3 +0 1534	8.9	K2	12+00	11 59 47.559	+00 50 31.76	−0.0005	−0.026
AGK3 +13 1201	8.5	K5	12+15	12 02 36.234	+13 45 04.74	−0.0017	−0.004
AGK3 +28 1216	9.4	K0	12+30	12 02 57.504	+28 47 01.91	+0.0001	−0.018
AGK3 +44 1046	9.1	K0	12+45	12 01 40.297	+44 43 42.98	−0.0014	−0.005
AGK3 +59 825	9.1	K0	12+60	11 51 21.719	+59 57 31.22	−0.0004	−0.007
AGK3 +75 543	9.0	K0	12+75	12 24 08.227	+75 59 44.22	−0.0028	+0.001
PERTH 11403	8.0	K0	13−07	12 56 45.977	−21 51 31.10	+0.0008	−0.000
PERTH 11341	8.0	K2	13−22	13 02 10.594	−08 18 11.00	−0.0017	−0.015
AGK3 +8 1610	9.0	K0	13+07	12 56 38.004	+08 10 12.64	−0.0032	−0.004
AGK3 +23 1282	9.0	K0	13+22	13 00 08.797	+23 12 54.98	+0.0014	+0.009
AGK3 +37 1237	8.6	G5	13+37	13 04 56.410	+37 31 58.84	−0.0037	−0.016
AGK3 +53 878	9.3	K0	13+52	12 53 29.957	+53 00 47.58	−0.0023	−0.024
AGK3 +68 533	8.4	G5	13+67	12 56 19.863	+68 58 31.86	+0.0021	−0.020
AGK3 +83 314	9.0	K0	13+82	12 18 18.598	+83 39 04.56	+0.0071	+0.021

The Pointing Grid Catalogue PTGRID.CAT (Equinox 1950.0)

Object Name	Mag	Type	Catalogue name	Right Ascension	Declination	Proper Motion RA	Proper Motion Dec
PERTH 12069	8.2	K5	14−30	14 04 05.586	−30 51 48.19	−0.0023	−0.014
PERTH 11995	8.3	K0	14−15	13 57 45.797	−14 42 36.73	−0.0013	−0.024
AGK3 − 0 1895	9.0	K0	14+00	14 05 33.156	−00 48 41.35	−0.0008	−0.025
AGK3 +15 1417	9.3	K0	14+15	13 58 19.961	+15 37 03.91	+0.0000	+0.003
AGK3 +31 1247	9.5	K2	14+30	14 05 22.719	+31 12 53.52	−0.0001	−0.005
AGK3 +45 1086	9.2	K0	14+45	13 59 10.957	+45 31 36.41	+0.0012	−0.023
AGK3 +58 916	9.4	K0	14+60	13 54 46.035	+58 44 30.92	+0.0000	+0.003
AGK3 +75 597	8.8	K0	14+75	14 18 33.027	+75 53 53.06	+0.0008	−0.014
SAO 183083	8.1	G5	15−22	14 58 07.141	−22 58 59.39	−0.0002	−0.007
PERTH 12636	8.5	K0	15−07	14 55 57.910	−06 13 42.90	+0.0015	+0.012
AGK3 +6 1764	9.4	K2	15+07	14 58 12.176	+06 13 44.53	−0.0006	−0.001
AGK3 +22 1491	9.4	G5	15+22	15 03 38.320	+22 52 52.01	+0.0000	+0.006
AGK3 +38 1375	8.8	G5	15+37	14 56 44.035	+38 43 05.06	−0.0052	+0.004
AGK3 +53 982	9.3	G5	15+52	14 56 14.598	+53 50 44.02	−0.0050	+0.041
AGK3 +66 666	9.4	K0	15+67	14 55 19.242	+66 49 08.20	−0.0033	−0.015
AGK3 +82 431	9.4	G5	15+82	14 39 48.906	+82 40 48.53	+0.0018	+0.010
SAO 207271	8.3	K5	16−30	15 59 55.098	−30 07 30.23	−0.0025	+0.041
PERTH 13340	9.0	K2	16−15	16 01 53.035	−14 46 28.09	−0.0026	−0.001
AGK3 − 0 2061	8.7	G5	16+00	16 00 09.168	−00 16 29.46	−0.0023	−0.005
AGK3 +15 1610	8.8	K2	16+15	16 05 28.078	+15 50 33.55	+0.0007	−0.021
AGK3 +29 1533	9.4	K0	16+30	15 58 10.961	+29 46 24.83	−0.0009	+0.008
AGK3 +44 1282	9.3	K0	16+45	15 55 48.871	+44 16 42.73	+0.0001	−0.003
AGK3 +60 996	9.0	K0	16+60	16 02 06.910	+60 35 32.23	−0.0016	+0.018
AGK3 +74 449	9.2	K0	16+75	16 01 33.684	+74 26 48.13	−0.0065	−0.034
PERTH 13957	7.5	K5	17−22	17 00 20.215	−23 04 54.06	−0.0006	+0.000
PERTH 13940	7.5	K2	17−07	16 58 31.836	−06 57 21.49	−0.0009	−0.002
AGK3 +8 2040	9.4	K2	17+07	16 57 10.625	+08 06 01.88	−0.0019	+0.008
AGK3 +21 1658	9.5	K2	17+22	17 02 12.516	+21 45 58.82	+0.0000	−0.007
AGK3 +36 1481	8.9	K2	17+37	17 02 30.156	+36 49 16.16	−0.0018	−0.014
AGK3 +51 1112	9.3	G5	17+52	16 56 54.176	+51 52 10.80	−0.0001	−0.017
AGK3 +67 735	9.5	G0	17+67	17 07 40.176	+67 19 38.77	+0.0000	+0.013
AGK3 +82 504	9.3	K0	17+82	17 20 17.621	+82 22 55.16	−0.0013	−0.008
SAO 186186	7.6	G5	18−30	18 00 24.211	−29 51 50.46	−0.0001	−0.050
PERTH 14568	8.1	K0	18−15	17 57 29.746	−14 12 23.48	+0.0017	−0.012
AGK3 +0 2145	9.5	K5	18+00	17 57 41.660	+00 10 18.50	−0.0004	−0.007
AGK3 +14 1822	9.4	K0	18+15	18 01 27.770	+14 33 01.63	−0.0008	+0.010
AGK3 +31 1570	9.2	K0	18+30	17 53 13.953	+31 20 01.39	−0.0005	−0.017
AGK3 +44 1445	8.7	G5	18+45	17 58 00.531	+44 43 10.58	−0.0025	+0.009
AGK3 +60 1105	9.1	K5	18+60	18 02 56.375	+60 07 39.69	+0.0001	+0.002
AGK3 +75 727	9.4	K0	18+75	17 40 37.352	+75 56 21.69	−0.0101	−0.028

The Pointing Grid Catalogue PTGRID.CAT (Equinox 1950.0)

Object Name	Mag	Type	Catalogue name	Right Ascension	Declination	Proper Motion RA	Proper Motion Dec
PERTH 15200	8.0	K0	19−22	18 56 36.266	−21 53 53.09	+0.0006	+0.003
SAO 142975	8.0	K2	19−07	19 01 25.961	−08 14 09.68	−0.0001	−0.010
AGK3 +8 2453	9.5	K0	19+07	19 02 05.406	+08 13 14.58	−0.0005	−0.023
AGK3 +21 1916	8.6	K0	19+22	18 54 32.820	+21 18 44.20	−0.0005	+0.004
AGK3 +37 1726	8.7	K0	19+37	19 00 26.438	+37 44 17.94	+0.0008	+0.002
AGK3 +52 1233	8.9	K0	19+52	18 57 21.609	+52 06 31.86	−0.0023	+0.002
AGK3 +66 883	9.0	K0	19+67	19 11 11.891	+66 55 50.66	+0.0022	+0.004
AGK3 +83 470	8.7	G5	19+82	18 14 03.141	+83 40 15.28	−0.0152	−0.042
PERTH 15895	7.6	K2	20−30	20 01 16.977	−30 18 28.73	+0.0043	−0.028
SAO 163252	9.0	G5	20−15	20 02 37.367	−15 13 48.62	−0.0027	+0.007
AGK3 − 0 2562	9.4	K0	20+00	20 00 10.445	−00 44 49.93	+0.0000	−0.021
AGK3 +14 2126	8.5	K2	20+15	19 58 50.242	+14 39 44.59	−0.0013	+0.010
AGK3 +29 2217	8.9	G0	20+30	19 59 53.922	+29 45 13.29	−0.0007	−0.004
AGK3 +44 1701	9.5	K0	20+45	19 58 10.594	+44 24 01.52	+0.0021	+0.024
AGK3 +60 1242	8.6	K0	20+60	19 55 44.922	+60 08 36.72	+0.0000	−0.003
AGK3 +75 821	8.6	K5	20+75	19 58 12.078	+75 34 39.41	−0.0032	−0.041
SAO 189965	8.5	K0	21−22	21 00 09.219	−22 09 59.16	+0.0044	−0.010
SAO 145068	8.4	K0	21−07	21 01 45.016	−07 14 52.56	+0.0007	−0.011
AGK3 +8 2905	9.5	K2	21+07	20 58 12.398	+08 00 52.94	+0.0002	+0.015
AGK3 +22 2268	9.2	G0	21+22	21 02 14.367	+22 53 00.10	−0.0007	−0.042
AGK3 +37 2061	8.7	G5	21+37	20 58 55.844	+37 27 22.73	+0.0014	+0.014
AGK3 +51 1515	8.6	K2	21+52	20 59 36.336	+51 56 23.31	−0.0034	+0.005
AGK3 +67 923	8.8	K5	21+67	20 57 12.414	+67 34 07.94	−0.0017	+0.008
AGK3 +81 666	8.8	K0	21+82	21 20 27.586	+81 48 22.84	+0.0063	+0.003
SAO 213556	8.2	K2	22−30	22 04 08.117	−31 10 39.18	+0.0015	−0.054
PERTH 17205	9.0	G5	22−15	22 03 46.469	−14 19 53.56	+0.0006	−0.007
AGK3 +0 2769	9.1	K0	22+00	21 59 14.484	+00 05 35.80	−0.0002	−0.035
AGK3 +15 2480	9.6	K0	22+15	21 57 01.031	+15 08 38.86	−0.0003	−0.021
AGK3 +29 2705	9.2	K5	22+30	22 01 05.172	+29 30 25.04	+0.0009	+0.005
AGK3 +44 2024	8.8	K5	22+45	22 03 51.922	+44 02 37.34	−0.0013	−0.023
AGK3 +59 1492	9.2	G5	22+60	22 05 34.734	+59 57 41.50	+0.0048	+0.023
AGK3 +75 929	9.0	K2	22+75	21 57 40.195	+75 50 58.59	+0.0054	+0.040
SAO 191618	7.5	K0	23−22	23 01 22.828	−22 58 47.61	+0.0030	+0.013
PERTH 17787	7.8	K0	23−07	22 59 09.938	−07 13 45.21	+0.0011	−0.022
AGK3 +7 3335	9.1	K2	23+07	23 00 20.734	+07 21 37.41	−0.0001	+0.009
AGK3 +23 2381	9.5	G5	23+22	22 58 48.727	+23 05 58.01	+0.0013	+0.013
AGK3 +37 2302	8.8	G5	23+37	23 04 33.477	+37 44 43.88	+0.0084	+0.022
AGK3 +52 1715	8.9	K2	23+52	23 00 34.703	+52 58 37.06	+0.0020	−0.007
AGK3 +67 1052	8.9	K0	23+67	23 03 08.875	+67 02 47.59	+0.0102	+0.042
AGK3 +82 700	8.5	K0	23+82	23 16 39.070	+82 02 53.09	+0.0130	+0.024

Notes to Table 5:

This grid of pointing stars was compiled by Roger Wood and Janet Sinclair and covers the whole sky north of declination $-30°$. The aim has been to locate stars close to grid points on meridians separated by 1 hour in right ascension and separated by $15°$ in declination. Thus, for even hours of Right Ascension grid points were taken at Declinations $-30°$, $-15°$, $0°$, $+15°$, $+30°$, $+45°$, $+60°$, $+75°$, and for odd hours of Right Ascension at Declinations $-22.5°$, $-7.5°$, $+7.5°$, $+22.5°$, $+37.5°$, $+52.5°$, $+67.5°$, $+82.5°$, supplemented by a single point at $+90°$, a total of 193 points. Each star is identified by a catalogue name indicating the position of its nearest grid point in the format RA$\pm$DD.

For the best astrometric accuracy the AGK3 catalogue has been used north of the equator and, since there is no comparable catalogue in the south, the Perth 70 catalogue where suitable stars exist or the SAO catalogue where they do not. In order to create a grid of stars with uniform properties the following selection criteria were adopted:

- Photographic magnitude between 8.5 and 9.5
- Spectral type between G5 and K5
- Small proper motion
- No double stars, clusters or crowded fields

It was not always possible to apply these criteria rigidly. In difficult cases, the star which seemed to fulfil most of them has been chosen. An overlay was also produced for each field so that the star images could be examined on the Palomar survey prints. For AGK3 stars, the photographic magnitudes given are taken straight from that catalogue. The Perth 70 and SAO catalogues give only visual magnitudes: in consequence the magnitudes given here have been adjusted by applying a nominal B-V derived from the spectral type of the star.

B Advanced use of the PE 3210 and PE 3220 Computers

B.1 The Perkin Elmer Operating System (MTM)

This section contains a brief introduction to some commands of the Perkin Elmer MTM Operating System. For full details, the reader is referred to the PE OS/32 documentation on the bay in room D102 (to be reached via room D101) on the first floor of the INT building. A listing of some useful commands is given in Table 6. Here follow some additional comments, and a short desciption of the use of Perkin Elmer Fortran.

Miscellaneous Notes

- **Sign on/off**

  Before you can do anything at all, you have to sign on to the (presumably) Perkin Elmer 3210 with:

  `*SI(GNON) INITIALS,ACCOUNT,PASSWORD` *e.g.* `SI ABZ,4,4`

  where the *initials* are your up to three initials, and the *password* on observer accounts is at present the same as the *account* number.

  At the end of your trials and tribulations, sign off with:

  `*SO`

- **File Descriptors**

  The full description of a file is:

  DISK:FILENAME.EXTENSION/ACCOUNT *e.g.* SYS:PHOCDP.001/8

  The *filename* consists of up to 8 characters. The disk volume name 'SYS:' is unique to the System Disk from which the operating system executes system-type 'CCS' files and tasks, such as FORT, LINK and EDIT. Therefore, it is not a good idea to rename the System Volume, unless you know precisely what you are doing.

- **Display**

  Below are given some examples with the DISPLAY command; notice the use of the wild-card symbols '–' and '∗' (not the MTM prompt, of course):

`*D F,-.-/*`	displays all files on that disk
`*D F,-.FTN`	displays all '.FTN' files; similarly for other extensions
`*D F,DONKEY.-`	displays all 'DONKEY' files whatever their extension
`*D F,DONKEY.FTN/-`	displays all 'DONKEY.FTN' files for whatever account

- **Rename & Copy**

  To rename a file (can only be done on the same disk) do:

  `*RENAME FILE.EXT/ACC , NEWFILE.NEWEXT/NEWACC`

  Copy, however, also works from disk to disk:

  `*COPY FILEDESCRIPTOR , NEWFILEDESCRIPTOR`

  When copying on the same disk, leave out the volume specification. Take care to delete unwanted copies of files, to maximize available disk space.

Table 6: Summary of Operating System Commands

COMMAND	COMMENT	TERMINAL
CA taskname	CAncel to abandon a task which *e.g.* has paused with an error condition	any
CO taskname	COntinue a task which has paused	any
D D	Display Devices	any
D F	Display Files	any
D L	Display Logical Units	any
D M	Display Memory	any
D T	Display Time	any
D V,VOLname	Display Volume – shows how much left	from SC
DE FILENAME	DElete file	any
MA EGLE:,OFF	Mark EGLE: disc off	from SC
MA EGLE:,ON,,CD=ALL	Mark EGLE: disc on	from SC
OFF	Mark off all discs except SYS	from SC
ON	mark on discs ON and OFF are potentially dangerous ! They may not function correctly	from SC
PRINT FILE.EXT	Prints file on the Line Printer	any
.MTM REM VDU3:	Remove VDU from .MTM	from SC
.MTM REN VDU3:,TEK1:	Rename VDU on .MTM	from SC
.MTM ADD VDU3:	Add a third VDU to .MTM	from SC
SE TI DD/MM/YY,HH:MM:SS	Set computer time	from SC
SE PRI n	Set the private account number (not available on observer accounts)	
STARTUP	A macro to set up the environment configuration	from SC
STARTALL	restarts .MTM and other essential tasks	from SC
STOPALL	Stops all activity in Computer	from SC
V	tells you what volume is loaded	any
V OBS	loads VOLUME OBS as current disk volume NOT to be done from the System Console because it would reset the System Volume	*NOT* from SC

B.1.1 Compile, Link and Run a FORTRAN program

- A Perkin Elmer FORTRAN VII reference manual and user guide can be found in the documentation bay in room D102 on the first floor of the INT building.
- To Compile a FORTRAN program use:

  `*FORT FILE,DEV:` or

  `*FORTOPT FILE,DEV:` for the optimized version

  Here, FILE is the filename of the source code. It MUST have file extension '.FTN', but this specification does NOT appear in the FORT or FORTOPT commands. The 'DEV:' specification refers to the output device for the process. It can be omitted, for no output if you are very confident, or be either:

CON:	for output to your terminal
LP:	for output to the lineprinter in the Instrument Computer Room

- Similarly, after successful compilation, you link a program with:

  `*LINK FILE,DEV:`

  If you have several files to LINK you can put them in a LINKFILE.LNK file and when linking this file, the LINK task will properly find all files specified.
- After a successful link then have fun with:

  ```
  *LO(AD) FILE
  *ST(ART)
  ```

B.2 The Perkin Elmer text EDITOR

This section is intended as a very brief introduction to the PE text editor, just to get you started. For full details of commands the reader is referred to section 3 of the Perkin Elmer OS/32 EDIT User Guide, which can be found in the documentation bay in room D102 (to be reached via room D101) on the first floor of the INT building.

To enter edit mode, type on the operating system prompt:-

`*EDIT FILE.EXT` (extension '.FTN' is assumed if none is specified)

EDIT is essentially a line editor and puts you into 'insert' mode upon entry. Hit twice RETURN to get out of it.

Table 7 lists a number of useful commands and their function. In the commands '*range*' is of form '*n*-*m*' for line *n* through *m*; if no lines are specified, the current line is taken; '*range n*-' stands for line *n* to end of file.

Miscellaneous Notes

- **To terminate:**

  Use `SAVE` to store an edited file on disk (but stay in EDIT).

  Use `END` to leave EDIT. Beware: do SAVE first, if not done before.

  Use `DONE` to SAVE and EXIT.

- **On-line help:**

  `HELP` * gives a list of edit commands.

  `HELP MNEMONIC` gives short description command MNEMONIC.

- **Merging files:**

  To CONCATENATE files A,B,C using the editor (see table 7):

`*EDIT A`	Edit file A
`>BO`	Move to bottom of file A
`>INC,B,1-`	Include all of file B before current line
`>INC,C,1-`	Include all of file C before current line
`>DO`	Saves edited file and exits

- **BIOC mode:**

  BIOC mode (see OS/32 EDIT User Guide, section D-1) enables editing with a cursor. One may, or may not, find this more convenient than simple line editing in NOBIOC mode. Default mode is BIOC, *i.e.* cursor editing.

- **ADAM:**

  If you 'break' out of ADAM, you can only type single line commands, so you *cannot* use EDIT while running ADAM. The only way to edit while running ADAM is to sign on to another System Console, using another account.

Table 7: Summary of Line Edit Commands

COMMAND	**Description**
AF/string/newstring/range	Insert *newstring* AFter *string*
AGAIN	Repeat previous command
AL (non-BIOC mode)	ALters a line in (default) line mode:
@	Deletes the current character
%	Inserts space preceeding current position
%/string/	Inserts string preceeding current position
AL (BIOC mode)	Alters a line in BIOC (cursor) mode:
Ctrl Z	move cursor to end of line
Ctrl B	move cursor left
Ctrl F	move cursor right
Ctrl ^	toggles (switches on/off) insert mode
Ctrl _	deletes character at cursor position
Ctrl C	forget last edit / restore line
AP	APpends new line at end
BE/string/newstring/range	Inserts *newstring* BEfore *string*
BO	BOttom of File (go to last line)
CH/string/,/newstring/,range	CHange *string* by *newstring*
CO n,/string/,range	Replace data from COlumn n onwards by *string*
CO n,/*/,range	Put a $*$ at COlumn n
DE n-m	DElete line n through m
DO(NE)	Output edits DONE to File *and* exits
END	ENDs edit session
FI/string/,range	FInds all occurrences of *string*
HELP mnemonic	Information about command *mnemonic*
INC [n],file,range	INCludes *range* from *file* after line n; default current line
INC ,,n-m	copies lines n through m of current file after current line
INS n	INSert new lines of data after line n; default current line
	To exit insert mode, type Return *twice*
−n	go backward n lines; default preceeding line
MO n,l-m	MOve line l through m to after line n
n	display line n
n data	replace existing line n by, or insert new line with, *data*
O(PTION) BIOC	select BIOC editing (with cursor; the default mode)
O(PTION) NOBIOC	select no-BIOC line editing mode
O(PTION) MODE=H (or A)	Select list mode HEXADECIMAL (or ASCII)
+n	go forward n lines; default next line
RU	generate a RUler with column numbers
SA file, n-m	SAve line n through m on *file*
SA *	SAve all data on current file (*i.e.* renumber and no exit)
SC [S or C]	generate SCreen of data starting/centered at current line
SU/string/newstring/range	SUbstitute first occurrence of *string* by *newstring*
TO(P)	go to the first line of file
T(YPE) range	display line(s); *e.g.* 'T 1-' types the whole file

B.3 Magnetic Tape Handling on the Perkin Elmer

B.3.1 Tape Backup using FASTBACK

FASTBACK is a quick and efficient method of backing up disks and transporting data. It is very economic of tape but the tapes can be read only by other Perkin-Elmer machines with OS/32. Therefore, observers can use FASTBACK only if they are going to read their tape on a Perkin Elmer back home. As Murphy's law dictates, STARLINK does not support any PE hardware, nor does RGO have any PEs at Cambridge.

FASTBACK works disk-to-tape or *vice-versa*. FASTBACK does not work from disk to disk; you will have to use BACKUP instead. If you intend to work tape-to-disk, remove the "write-enable" ring from your tape, or a moment's lapse in concentration may corrupt an irreplaceable tape.

FASTBACK can be run on the PE 3210 Instrument Computer from any of its three terminals:

`*LO(AD) FASTBACK`	
`*T(ASK) FASTBACK`	
`*ST(ART)`	and answer at the prompts:
>`BA(CKUP)`	for disc-to-tape backup (tape write-enabled ?)
or `RES(TORE)`	for tape-to-disc (write-ring removed ?)
>Copy from unprotected disc?	`Y(ES)`
>Vol or DEVN:	*e.g.* `SYS:`
>Tape	`MAG1:` or `MAG2:`

You can now work through all the options available, but the odds are that you will just want the defaults. Therefore, you can skip further input at any time, and start the data transfer, by typing:

>`!GO`

which will initiate the transfer (and verify) of files files to the tape or disk. If you only want to transfer specific files, then type:

>@

which allows you to select files interactively: Run through the questions giving the default option at every line until you are prompted for a list of files. You can either type in a list of files followed by period-slash, './', or use wild cards such as '–.FTN', 'HSP.–', or '–.–/60' followed by './'. Further tricks that may be useful are *e.g.*: 'REN(AME) = –.–/60', which allows you to change account number, or '!–.OBJ/–' to omit all '–.OBJ' files from your current file selection.

If you want to FASTBACK files created since a certain date, go through the questions, until you get the AGE prompt:

>DEFAULT AGE	`Y(ES)`
>SI(NCE) =	`01/APR/90`
>`!GO`	

If you wish to abandon at any stage, send STOP.

B.3.2 Reading non Perkin-Elmer Tapes

Strange Magnetic Tapes can be analyzed with the MTANAL System procedure:

`*MTANAL MAG1:` (or `MAG2:`)

To copy files to disk from a magnetic tape which you have just 'MTANAL-ed':

`*COPY MAG1: , FILE.EXT , RECL=xx , NF=1 , SKIP=yy`

The default skip is `yy`=0, but specifying `SKIP=0` will result in an error status. In order to copy the whole tape, specify `NF=ALL`.