Pine Bluff Observatory

Half-wave Spectropolarimeter
Observer's Manual

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April 4, 1989

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Summer, 1992

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Winter, 1993
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Introduction

This manual is intended for general users of the Half-wave spectropolarimeter mounted on the 36 inch telescope at Pine Bluff Observatory. It is intended to be an operation manual and not an instrument manual - very little information on the design or performance characteristics are included. It is hoped that this manual will provide any observer with the necessary information to complete a night of successful observing. The manual has six basic sections beyond this introduction as outlined in the Table of Contents:

Procedures is a section that details the set-up, telescope operation, observing, and close-down procedures. It is quite detailed and explains many aspects of the operation of the observatory from an observer's point of view. This document is the first place to look for general information on how to do something when observing. It is indispensable to the new observer and should be reviewed periodically by all observers.

The second section describes the display of the **STATUS window.** Every variable displayed in this window is defined and described in section two.

The third section contains a glossary of **commonly occurring Forth words** and **error messages** and is organized by the type of command. This organization is described further at the beginning of the section. Included as the fourth part of this section is a description of all words and variables that show up in the data header on the terminal.

The fourth section contains procedures for **malfunctions**. If something goes wrong during a night this section may be of some help.

The final section of this manual is an **abridged procedure.** This is a rough outline of the set-up, observing, and close-down procedures. *This final section is intended as a ready reference guide for the experienced observer.* It is very bare bones and is intended only as a checklist.

1. HPOL Observing Procedures

1.1 Setup Procedure

1. Arrive at about sunset, as it will require some time for preliminary setup and calibration runs. Close and lock the driveway gate after you drive in.

2. Turn the outside door alarm off, if necessary.

3. Turn the basement alarm off.

<u>In The Basement</u>

1. Turn on the power strip to the right of the terminal (this turns on the video monitors).

2. Start the observing session: Login to chad. In the <u>XTERM</u> window, enter:

> **observe yymmdd**   (note the closing "return" is understood for all commands)

This starts the FORTH, STATUS, and CCDVIEW windows. (Hereafter, all commands in the XTERM window will be underlined). It may take up to a minute for all the windows to appear, and it may be necessary to hit "Enter" in the FORTH window to get the "-ok->" prompt. All remaining observing commands are entered after the "-ok->" prompt in the FORTH window. By convention, <yyddmm> is the UT date (the date in Greenwich, England); if you are starting an observing session in the evening, it is <u>tomorrow</u>'s date, local time.

3. Load the FORTH software: In the FORTH window, enter

> **go ccd hpol**

The load takes about 10 seconds, and the name of each module is printed out as it loads.

4. Set up the observing log printer: hit "select" until the select light is off, hit "T.O.F.", line up the platen to just below the page fold, and hit "select" again.

5. Sign into the observer's log book.

On your way to the dome, turn on the red hallway and stair lights, and turn off the <u>outside</u> light on your way to the dome.

<u>In The Dome</u>

1. Plug in the beige power strip at the left of the crate to the black extension cord, and turn on the power strip.

2. Center the telescope at the zenith using the paddle and bubble levels (Dec, then RA) and stop it by hitting "STOP" on the telescope control panel.

3. Initialize the FORTH software: In the FORTH window of the dome Xterminal, enter

init

The following messages show the progress of the initialization:

DIRECTORY
      Current working directory: (should be /data/<n>/<observer>/<yymmdd>)
SESSION   (initializes "blocks.f" header file, if none)
SOFTWARE   (looks in block 0 of blocks.f for:
  image   1   (these are initial values; updated values are
  filter   0   kept in this block for future init's)
  color   0
  grating   0
  lampos   0
  adjtime   0
COMM   (serial devices, including telescope)
STATUS PAGE   (writes skeleton to DISPLAY window)
PRINTER LOG
  Current Printer log header:
  Enter new header (CR= keep):   (enter new name and date for printer log, or CR)
CCD
SPECTROGRAPH
  Loading spectrometer parameters for PBO, survey grating set
GRAPHICS   (clears STATUS (Tek) spectrum display)
MECHANISMS   (waveplate, lamp, grating, color filter)
TELESCOPE   (connects to TC12 telescope controller)
START DISPLAY   (starts once/2 secs STATUS display)

Most hardware problems will show up during the init step; go to Malfunction section for a description of error messages and recoveries.

4. On the instrument: First check on the STATUS window that TEC baseplate temperature is between -5 and -20 degrees; this indicates that the refrigerator is running. If so, turn on the Thermo-Electric Cooler (TEC) power by pulling the toggle switch on the bottom of the CCD controller <u>all the way out</u> (two clicks towards you). The CCD temperature on the STATUS display should immediately start dropping.

5. Initialize the time and the telescope controller. Check that the telescope is still at the zenith, then enter:

sclk

This command requires that the telescope be at the zenith (to within the accuracy of the bubble levels) and initializes the controller accordingly. The command will not have to be reentered unless you power

down the telescope controller. Therefore if you need to reload, you DO NOT need to do another **sclk.**

The Universal Time is obtained from the computer and updated using the NIST (National Institute of Standards and Technology) clock in Washington DC via the network. If the network does not respond, you will be asked to enter the UT date in the format yy.mmdd and the UT time in the format hh.mmss. If the UT clock is greater than 0 (*i.e.* 01 25 34) then enter tomorrow's date. If the UT clock is less than 0 (*i.e.* 23 05 25) then enter today's date. A message will give the resulting NIST time offset (called "adjtime"); it should be a small number of seconds.

Note: sometimes you will get a "NIST time not available" when chad has recently rebooted and the network has not properly established its "gateway". This may be fixed by typing

> **nistroute**

in the XTERM (Unix) window. Now try sclk again.

6. Open Dome, remove grounding clamps, and turn the dome power on.

7. Remove mirror covers, starting with the secondary mirror cover (do this after opening dome slit as snow or other substance may be on dome). Leave the primary baffle cover on, to keep stray light from entering the instrument during the dark calibration.

8. Turn on the reticle light of the 8 inch finder.

9. Open the spectrograph grating cover by pushing the slide in.

10. Turn off the dome lights.

11. When the CCD has cooled off and stabilized (about 20 min after turning on TEC; CCD temp should be < -50° C), perform "bias" (amplifier offset) and dark calibrations by

> **ccddark**

Enter "ccddark" as object name. Datataking will commence immediately: four very short exposures (biases") followed by four long (40-second) dark count exposures. (See §1.3.5).

12. Remove primary mirror baffle cover.

13. Telescope pointing is pretty good, but it is recommended that you locate a bright star such as a flux standard or one of the bright finder stars so that you can be sure of the pointing and fine tune it. See telescope operations below for details. For instance, a list of bright stars in the user star catalogue may be brought up by

> **usrsearch** (pattern: bright)

Choose a star near the zenith and enter

> **usrslew**

and the star name to slew the telescope there. After you have placed the bright star at the center of the slit-camera field of view enter the command:

urthere

This instructs the telescope controller to adopt the input coordinates that it has read in as corresponding to the current telescope position.

14. <u>Focus the telescope</u>. This is best done on your first object of the night. The focus controls are found on the NW or NE corners of the telescope - either set will work. The controls are the blue and yellow buttons marked UP and DOWN. Put the star very near the slit and use the buttons to focus the image to as close to a point as is possible.
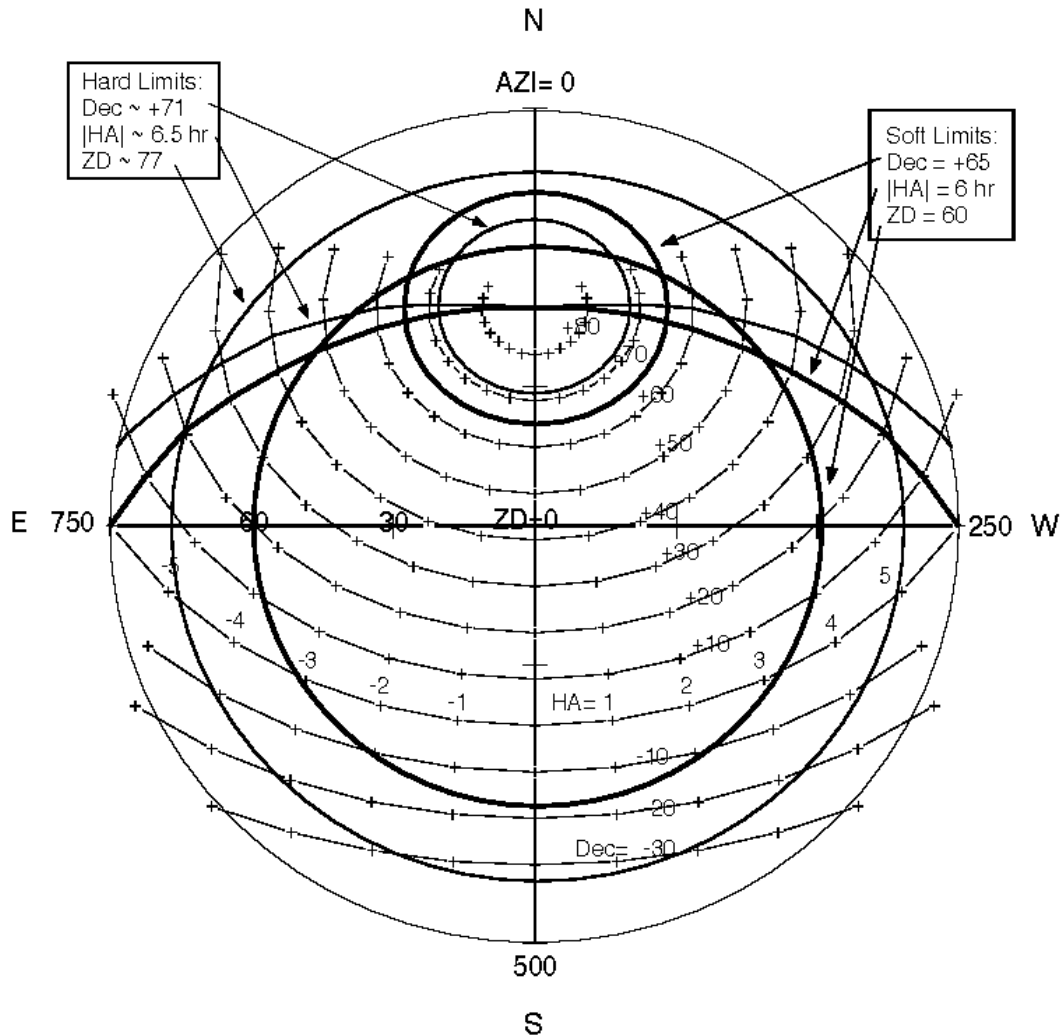
1.2 Telescope controls

Figure 1. PBO 36 inch telescope coordinates and limits.

See the Figure 1 for a diagram of the coordinate system and telescope motion limits described in this section:

<u>Observers horizon coordinates:</u>
Zenith Distance: angle measured in degrees down from the zenith (90 = horizon)
Azimuth (dome units): angular compass pointing, measured from North through West. North = 0;
          West = 250; South = 500.

<u>Celestial Coordinates:</u>
Declination: Celestial latitude, or angle from the projection of the Earth's equator (+90 = North
          Celestial Pole).
Right Ascension: Celestial longitude, or angle measured east from the position of the sun on the vernal
          equinox. Measured in time units 0 - 24 hr.

Hour Angle: = Local Sidereal Time - Right Ascension. The angle (in time units) of an object from the
          local meridian.

1.2.1 Slewing

WARNING:
ALL computer slews are to be done only while an observer is IN the dome. This rule shall NOT be transgressed.

It is good practice to hold the paddle during all slews so that the slew may be aborted if necessary. (See §4.2.1)

The telescope can be instructed by the following commands to go anywhere you would like, within the "software limits"

> Zenith distance < 60 degrees
> -6 hr < Hour Angle < +6 hr
> Declination < 65 degrees

(See "Manual Acquisition" below for slewing beyond these limits)

stow   tells the computer to stow the telescope at the zenith. Always check the STATUS window to be sure it is exactly there, if it isn't then reenter the command. The last portion of this command (FINE MOTION..) may take several minutes: observe the STATUS display to see the Hour Angle count up to 0.

urthere instructs the controller to adopt the celestial coordinates (RA, Dec) that it has been given as the correct ones for the current telescope position. <u>Be sure you are tracking and have the correct star centered when this command is entered as it resets the pointing!</u> It is not to be used after a stow, since the zenith does not have a fixed celestial coordinate.

manslew lets you enter coordinates at the terminal. These coordinates are not saved and must be reentered if you want to return to the object. The program prompts you for RA (hh.mmsss), Dec (ddd.mmss), and the Equinox year of the coordinates. This is not to be confused with

"manual acquisition" described below, which is not performed by the computer.

usrslew reads the coordinates from a stored star catalog. The user catalog is maintained to include stars in current observing programs. A sample catalog entry is

```
   Name        HD      SAO     RA(2000) Dec(2000) V      ID   Type    Sp
--------- ------- ------- --------- --------- ----- ---- ------- ----------
Zet-Peg    214923  108103  22.41274  10.4953  3.4   0610 Unpol   B8V
```

usrslew asks for the desired star name, which adheres to the naming rules of the HPOL observation summary. Coordinates are in the hh.mmsss format used on the STATUS window. A hard copy of the current user catalogue is kept in the manual binder at the observing station.

An on-line search of the user catalog may be made with the command

usrsearch lets you enter a search pattern, and lists up to 32 entries in usrcat.dat containing the pattern. This is especially useful for seeing a list of stars of the same type. For instance, the command **usrsearch** with pattern = "unpol" will produce a list that contains Zet-Peg. All user catalog searches are case-insensitive. Some common entry types are in the user catalog are:

Be   Be star program
Bright   Bright stars for telescope initialization
Flx-St   Flux standards
ISM   Interstellar polarization probes
IntBin   Interacting binaries
Jacoby Spectral atlas stars
LRV   Luminous Red Variables
Pol-St   Polarized standards
Unpol   Unpolarized standards
WR   Wolf-Rayet stars

Finally, if a star is not in the user catalogue but is in the SAO catalog (250,000 stars down to about magnitude 10), one may slew the telescope there via

saoslew   This asks for the SAO number and looks up the coordinates in the on-line SAO catalog.

With any of the slew-to-coordinate commands, the program computes the apparent coordinates of the desired star after correction for coordinate precession, aberration of light by the earth's motion, flexure of the telescope, and refraction by the atmosphere. It then checks the predicted zenith distance, declination, and hour angle against the software limits described above, and if these pass, requests confirmation from the observer. It then slews the telescope there. The observer should observe closely the motion of the telescope to see that some mechanical disaster is not immanent (see "Runaway Telescope" procedure, §4.2.1 below).

Paddle Operation:

Once at the approximate star position, go to the 8" finder telescope to verify the star field and center the star in the slit. The telescope may be moved at two speeds with the handpaddle, SET (slow) and

GUIDE (very slow). There are paddles in the dome and in the basement, both with a SET/GUIDE switch. To move the telescope at the SET rate with the paddle, **<u>BOTH</u>** paddles must be in the S (set) position. It is best to put the basement paddle in SET whenever you go from the basement to the dome to slew the telescope. Note that the telescope will go into track mode any time a paddle button is released; if you need the telescope to be stopped, hit the STOP button on the console.

1.2.2 Manual Acquisition

If you want to observe an object whose Zenith Distance (ZD) is more than $60°$, whose Declination (DEC) is more than about $65°$ N, or whose Hour Angle (HA) is more than $±6$ hours, the telescope will not automatically slew to these coordinates, as a safety measure against mechanical damage. However, it is possible to slew slightly farther by hand, up to the following "hard limits", which signal immanent damage as noted:

> Zenith distance $< 77°$ (mirror cell, cables)
> -6.5 hr $<$ Hour Angle $< +6.5$ hr   (cables)
> Declination $< 71°$ (spectrograph-pier collision)

In addition, it is possible to track an object you are observing past either the ZD or HA soft limits, although this is discouraged. Whenever you are in the area between the soft and hard limits, you should be extra aware of the telescope position. The ZD and Dec limits are protected by microswitches which disable the telescope (requiring embarrassing help from the resident to back off of), and the HA hard limit is not currently protected.

In order to perform a manual acquisition in this area, the following procedure can be used.

<div align="center">

*Please read these instructions *completely* before proceeding!*

</div>

NOTE: Especially when doing a manual acquisition, you must be in the dome and aware of the telescope position at all times! You are exceeding the normal operating limits of the telescope, so extra caution is required.

1. Enter the star's coordinates normally, using one of the **slew** commands. This causes the software to compute the precession and refraction corrections to the coordinates and produces the corrected apparent coordinates that you need to use to find the star. The command will then exit with the message that the star is beyond some limit.

2. There are now two ways to proceed, depending on your confidence level:

> a) Slew manually using the direction keys on the control panel:

For example, entering S 9 on the console will cause the telescope to slew rapidly to the south. To stop the telescope motion, hit the STOP button and then the TRACK button. This will stop the telescope motion and start it tracking at the current position.   Numbers smaller than 9 will slew at slower rates. **CAUTION:** Since the telescope will be moving rapidly if you use setting 9, **you must be very sure of what you are doing before starting the slew** and **watch carefully during the slew**. Overshooting toward the horizon or the fork can potentially cause damage to the telescope or the detector! Use a

slower rate (7 or 8) if you are concerned about speed.

        b) A more conservative approach, which lets the telescope do most of the work, is to slew the telescope to a position near the star of interest and then to maneuver the telescope the rest of the way manually:

In a **manslew**, enter coordinates close to the desired position, but within the soft limits. The telescope will automatically slew to these coordinates. From this point, you can slew the remaining (small) distance to the desired position of the star of interest using the handpaddle.

3. Once you get the telescope to the position you want, make sure it is tracking; hit the TRACK button on the control panel if you are not sure. At an extreme position it is quite likely the telescope pointing will be slightly off, so use the finder scope to bring the star into the slit in the usual way.

4. Start your observation. Remember that observing at extreme positions requires extra care to monitor the position of the telescope and to make sure that the cables are not caught in bad positions.

5. If you are at a large hour angle (HA) when you finish the observation, be sure to watch the telescope as you slew to the next object. Do not allow the telescope to try to slew under the pole, as the hoses and cables will be damaged. You may have to back the telescope off of its position, *i.e.* to a smaller HA, before slewing if this is a problem.

Once you are back to a more normal position at the next target, you may wish to reset the telescope coordinates with a **urthere**, as tracking at extreme positions sometimes causes slight slipping in the tracking, thus causing the coordinates to be a bit off.

1.3 Spectropolarimeter Controls

This section presents detailed explanations of the HPOL spectropolarimeter operation. Refer to Figure 2 for the optical elements of the instrument. Many HPOL mechanisms are automated and are operable singly by **go<mech>** commands. However, since it is easy to end up in an incorrect configuration in this way, it is usually advised to use the **setup/ nextobs** (§1.3.3) high level commands, which position all mechanisms for a particular observation. Use of these commands in the standard observing procedures is summarized in §1.4.

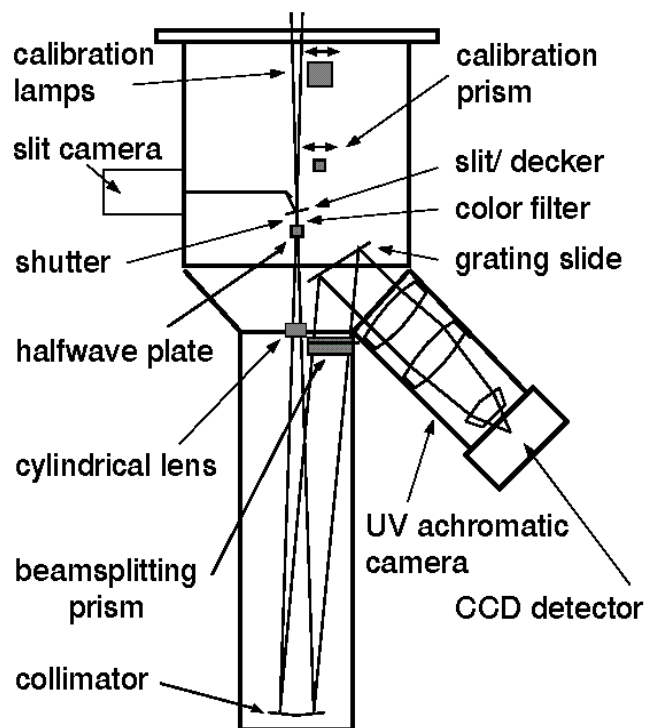**1.3.1 Spectrograph Slit, Decker, Slit Camera**

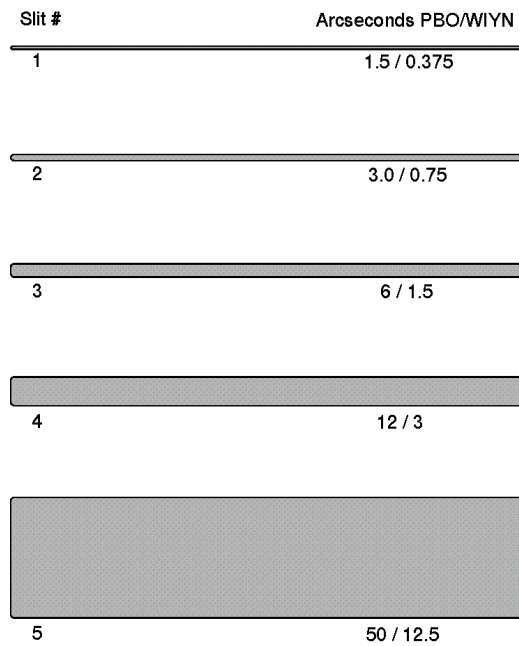
Figure 2. HPOL optical diagram.
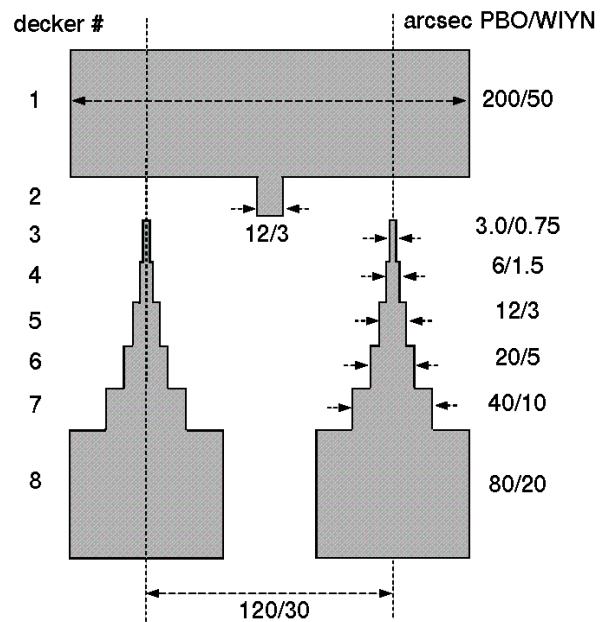
Figure 3. HPOL Slits

Figure 4. HPOL decker

The entrance aperture to the spectropolarimeter is defined by two superposed sliding aluminized plates which are visible in the slit-viewing camera when a calibration lamp is on (see Figure 3 and 4). The "slit" is the horizontal bar: there are 5 slits which may be centered by the knob below and to the right of the camera. The width and position of the slit affect the spectral resolution and the wavelength calibration, respectively.   The "decker" is a similar sliding plate with "shoulders" which limit the aperture along the slit. It is controlled by the knob on the left below the camera. Positioning the slit and decker is best done with the flat field lamp on so that you can see the aperture. Be sure that the slit is well-centered and away from the decker "shoulders." If the slit is near a large decker, one may get undesired extra light from the calibration lamps, which may cause saturation.

Standard stellar observations are done with slit 3 (6 arcsec at PBO/ 1.5 arcsec at WIYN) and decker 5 (the double-aperture 12/ 3 arcsec position). Special stellar or nebular observations may specify a different combination. The calibrations should always be done with the same slit/decker configuration as the observation. One should take special care not to move the slit during an observation / calibration, since this will alter the wavelength calibration. In the standard observation using the double-aperture decker, the star is place alternately on the right (aperture 0) and left (aperture 1) so that spectra are obtained of the star and sky background in each aperture.

A video CCD camera views the light reflected off the top of the slit/ decker combination for acquisition and guiding during an exposure. The camera has a sensitivity range of about 12 magnitudes (100,000×) which is adjusted by shuttering the camera electronically (low sensitivity mode, used for very bright objects), varying the video gain (medium brightness), and, finally, increasing the exposure time up to several seconds. This is controlled by a FORTH command:

m. slitmag

where "m." is the V magnitude of the object to be viewed. The magnitude must contain a decimal point (i.e. 7.6 slitmag or 7. slitmag). The current magnitude sensitivity of the slit camera may be seen on the "cammag" line of the STATUS display (§2).

1.3.2 Spectrograph halfwave filter, grating slide, and color filter

The polarimetric modulation is accomplished by a rotating waveplate, which is positioned at eight standard angles (0-7) separated by 11.25° in the sequence 0, 4, 2, 6, 1, 5, 3, 7 for a full polarimetric observation. Each pair of filter positions (eg 0, 4, corresponding to angle 0° and 45°) is obtained in a block referred to as a "filter-pair", and yields one component of the polarization. A filter-pair observation and its sky background obtained through each aperture is referred to as a "**dopol**". This is the basic polarimetric observing command. The halfwave filter is rarely moved by itself, but when this is necessary, the command is

$\qquad\qquad\qquad$ <n> **gofil** $\qquad$ (n is the desired halfwave filter position 0-7)

The spectrum is dispersed by one of two gratings which are mounted on a slide. One covers the spectrum from 3000 - 6200 Å. , and is referred to as the blue grating; the other, the "red" grating, covers 6100 - 10500 Å. The observing plan usually calls for observations with both gratings to cover the full visible spectrum, but this is not required; each grating observation stands on its own. The grating is usually moved via the **nextobs** high-level observation setup command, but it can be moved on its own by

$\qquad\qquad\qquad$ <n> **gograt** $\qquad$ (n = 0-1)

To eliminate unwanted diffracted or scattered light from the grating, three color filters on a slide are located just above the polarimeter waveplate. This must be positioned in particular combinations with the grating to obtain useful data, so in order to avoid incorrect configuration, one usually counts on the **nextobs** command to position the color filter. However, it too can be moved on its own by

Table **1**. Gratings and Filters

Grating	Color Filter
0 Blue	0 IR Block
	1 Clear
1 Red	2 Red

$\qquad\qquad\qquad$ <n> **goclr** $\qquad$ (n = 0 -2)

The grating/ color filter combinations are listed in Table 1. Use of the IR-block is called for on blue observations of specific objects (usually very red ones) in the observing program. Additional calibrations as noted below are required if a program star observation with IR-block filter is planned.

The positions of these mechanism may be seen as "HWAV" "GRAT", and "CLR" on the STATUS display (§2).

1.3.3 High-Level Commands: "setup" and "nextobs"

These commands are provided to ensure all the mechanisms are correctly placed for a planned observation. A data file "usrsetup.dat" is maintained by the target "hitlist" manager to contain the planned configuration for each object on the hitlist. To call up the configuration for an object, type

$\qquad\qquad$ **setup**

and respond with the object name (same spelling as in "usrslew"). This will load in all planned observations for this object and their configurations. For instance:

        -ok->setup

        ENTER STAR NAME: zet-peg
                   Name   Type   Cmd   Grat Mag Clr
                   --------- ------- ----------- ---- ---- ----
              1   Zet-Peg   Unpol   4 dopol   1   4   2
              2   Zet-Peg   Unpol   4 dopol   0   4   1
              3   Zet-Peg   Flx-St   2 dorun   1   4   2
              4   Zet-Peg   Flx-St   2 dorun   0   4   1
              5   Zet-Peg   Flx-St   2 dorun   0   4   0

         OK? <y/n> y

This loads in five planned observations for Zet-Peg, two polarimetric runs (4 dopol) with Zet-Peg as an unpolarized standard using red grating / red filter, and blue grating/ clear filter, and three (2 dorun) as flux standard using red grating/ red filter, blue grating/ clear filter, and blue grating/ IR-block filter. All are to be run with detector exposure times appropriate for a 4th magnitude normal star (see below). It is important to remember that this command does not actually position the mechanisms, it only clears all displays and buffers (the spectrum window will clear) and defines new observations 1-5 according to the usrsetup file.

To actually start one of the defined observations, type

                nextobs

and answer with the desired observation number (or take the computer's guess that you want the next one). For instance:

        -ok->nextobs
         NEXT OBSERVATION NUMBER: 1 (ENTER CR=OK, OR NEW NUMBER)

                   Name   Type   Cmd   Grat Mag Clr
                   --------- ------- ----------- ---- ---- ----
              1   Zet-Peg   Unpol   4 dopol   1   4   2

        OK? <y/n> y

This will position all mechanisms for observation 1 of Zet-Peg and start the 4 dopol.

1.3.4 Flat Field and Wavelength Calibrations

The "flat field" calibration is an observation of a tungsten lamp (continuous spectrum) which serves to define the relative pixel-to-pixel sensitivity of the detector and the position of the spectrum in the image. The wavelength calibration is an observation of a mercury-argon (Hg-Ar) "penray" gas discharge lamp whose spectrum consists entirely of narrow emission lines of known wavelength. It is

used to define the relationship between detector pixel number and wavelength. All of these can change slightly with time or telescope position due to motions of the slit and grating and flexure of the spectrograph.

Both flatfield and wavecal calibrations must be done with each observation, without moving the telescope, slit, decker, grating, or color filter. If you forget the calibrations, the observation may be very difficult to reduce.

The calibration lamps are mounted on a slide above the slit/decker. They may be operated singly by the command

<n> lampon   (n = 0-2)

where n=0 turns off the lamps and pulls out the lamp slide, and n=1 and 2 puts in the lamp slide and turns on the flatfield lamp (1) or the wavecal lamp (2). This is useful when one just wants to illuminate the slits to check the slit/decker configuration.

More frequently, the lamps are operated as part of a calibration run using the high-level command

docal

This command looks at the current observation configuration (you must have done this by hand or with a nextobs!), brings in the lamps, does a standard calibration sequence using both lamps, and removes the lamps. Since the most frequent type of observation set calls for observations on one target with both gratings, so that it is most convenient to do both sets of calibrations between the target observations, docal will do a calibration (flatfield, wavecal) on the current grating, then ask if you wish to go to the other grating, and if so, will go there and do calibrations on the other grating. For technical reasons having to do with warmup of the wavecal lamp, the calibrations on the second grating are done in reverse order (wavecal, flatfield). Note that for the red wavecal observation, the first few frames may saturate as the lamp warms up; you should be prepared to wait at the "ready?" step until the saturation indication on the STATUS display goes away.

The status of the lamp slide and lamps may be seen on the "LAMP" line of the STATUS display (§2).

1.3.5 Detector Operation

The CCD detector is operated by taking one or many successive exposures ("images" or "frames") of the same spectrum (this is called a "scan"). A sequence of "scans" may be taken with the star in each aperture (a "run"), or alternating between two halfwave filter positions of a filter pair: The length of each exposure ("FRMTIME") and the number of exposures ("FRAMES") in a scan are set by a parameter called "SPCMAG", which is (more or less) the astronomical magnitude of the star at the wavelengths covered by the

Table **2**. CCD exposure vs SPCMAG

PBO			WIYN
R/B	Exp (s)	Frames	R/ B
-1/ -2	.060	20	2/ 1
0/ -1	.160	20	3/ 2
1/ 0	.400	16	4/ 3
2/ 1	1	12	5/ 4
3/ 2	2.5	8	6/ 5
4/ 3	6	4	7/ 6
5/ 4	16	2	8/ 7
6/ 5	40	1	9/ 8
7/ 6	40	1	10/ 9
8/ 7	100	1	11/ 10
>	100	1	>

current grating. Table 2 gives the current exposure settings for PBO and WIYN for different SPECMAG's on the red and blue gratings ("R/ B"). For exposures of 40 seconds or less (above the dashed line in the table), the exposure is chosen to generate a signal which approaches the maximum signal ("saturation") that may be stored in the CCD, and the number of frames is chosen to take a total of 40 seconds, allowing for an overhead called the "readout time" which is 2 seconds/frame. It is advantageous to obtain the largest possible signal (without saturating) in a CCD frame because there is a minimum noise/frame called the "readout noise", which becomes significant if the signal obtained in one frame is very small. However, for fainter objects, when exposures exceed 40 seconds (below the dashed line), all scans are single 100-second frames, which is the maximum practical exposure for this system. The SPCMAG parameter is set in the setup/ nextobs observing commands based on the usrsetup file, and may be adjusted as described below.

When each of the observing commands runs a sequence of scans, it is done in a standard way by a template, called a "prompt block". A "skeleton" prompt block is shown in Figure 5:

```
prompt* ( hpol ccd spectropolarimetry )
  @IMAGE       0        @FRAME       1        @FILTER      0

  NAME : name of object                 ;    @LAMP        0
  @RA    00.0000      @DEC    00.0000        P.A.    :  90  ;
  @GRATING    0       @COLOR       0         #APER        0
  @SPCMAG     0       @FRMTIME   0.000       #FRAMES      0
  SLIT    : s  ;      DECKER : d  ;         @LENS        0
  COMMENTS :                                                ;

                        ( a,c,g )               [ ready? ]
  @HA    0.0000       @UT    0.0000         @LST   00.0000
  @THERM    0.0       @TSPC      0.0        @MJD  00000.00

                        ( p,r  c,q,a )          [ scanning ]
  @UT    0.0000       @NETMAG  00.00
```

Figure 5. Sample Data-Taking Prompt Block

The prompt block becomes the data header of the CCD images when they are stored; the data in the header is crucial to the later reduction of the data. When data is taken, a header block will be listed out with some values filled in by the computer (the items marked by "@" and "#"), and others which are to be filled in by the observer (those enclosed by a ": ;" pair). In this example, NAME, SLIT, DECKER, P.A., and COMMENTS are filled out by the observer. They are filled in by an editor in "typeover" mode, that is, entries replace whatever is beneath the cursor. "Enter" signifies that you are happy with the current entry. ("P.A." is the "position angle" of the spectrograph, which is "90" at PBO unless you have been required to physically rotate the spectrograph for a special observation.) The meaning of all the items in the prompt block is given in §3.4.

When the cursor gets to "ready?", the CCD will be run taking continuous frames without saving them, but only displaying them in the CCDVIEW window. This allows you to make sure the target is centered and (for short exposures) allows you to judge the exposure level of the frames. This mode is designated "LOOK" mode on the STATUS display. To exit LOOK mode, enter one of the three single-character commands

> a = abort (exit data-taking process)
> c = change (restart this scan, after allowing you to update the header items marked with a "#":
>   here APER and FRAMES)
> g = go

If you hit "go", you will proceed to "scanning", where CCD frames will be taken and saved on disk as data IMAGES. The STATUS display will indicate "SCAN" mode. In SCAN mode one may

> p = pause (stop taking data, waiting for clouds, etc;.STATUS display will indicate PAUS)
> r = resume (from pause)
> c = change (same as in LOOK mode)
> q = quit (exit, saving current frame)
> a = abort (exit, throwing away current frame)

The commands using this method of data taking are

> **ccddark**, **docal** (simple scans of CCD bias, dark, and cal lamps)
> <n> **dorun**   (do n scans, allowing a star to be placed in alternating apertures)
> <n> **dopol**   (do n dopols, each containing scans through two halfwave filters, with
>   the star placed in alternating apertures)

If you just wish to look at the spectrum, or need to adjust SPCMAG without taking data use the command

> **dolook**

This puts the detector into LOOK mode with the current spectrograph configuration (you need to have done a "nextobs"), displaying each frame on the CCDVIEW window. The following single character commands are accepted:

> > = increase SPCMAG by one (adjust FRMTIME as necessary)
> < = decrease SPCMAG by one
> q = exit

Whenever the detector is being run, each frame is displayed as an image in CCDVIEW. In the standard observing with the double-aperture decker, there will be four spectra within the image: aperture 0 and 1 for one sense of polarization (spectra A0 and A1), and aperture 0 and 1 for the other (B0 and B1). A graph of each spectrum is superposed on the image, and the STATUS display will show the peak signal of each expressed in percentage of saturation (%SAT), and the net astronomical magnitude "NETMAG" (star minus sky) in A and B. The NETMAG should be roughly comparable to the V-magnitude of the object. For FRMTIME 40 seconds or less, the %SAT should be between 15 and 65%; if not, you may need to abort out of the datataking and adjust SPCMAG via dolook. (for faint objects with 100 second exposures and small %SAT, you will have to take what you can get).

In a dorun or dopol, the online reduced spectrum display in the "Tek" window is updated periodically This can be used for checking star identification, (see spectrum cuesheet).

1.4 Standard Data-Taking

This section applies summarizes the techniques from §1.2 and 1.3 needed for standard data-taking.

1.4.1 Flux Standards

Flux calibration (reduction of detector counts/sec to absolute flux from the star) for each night is done by comparison with spectral scans of stars of known flux. Each flux standard must be done in each grating configuration that is to be used that night; the whole process takes about 15 minutes per star. Do at least three flux standards per night with good time coverage.

1. Slew the telescope to a flux standard with a **usrslew** (user catalogue type "flx-st"). Make sure the dome slit is centered (DOME = AZI ±DTOL).

2. Configure the slit camera with a <v.> slitmag, where "v." is the V magnitude of the star.

3. Find the star and put it in aperture 0 (right aperture). Verify in the finder that it is the correct star, if possible. Most flux standards are isolated bright stars, but some are doubles, and it is easy to get the wrong one.

4. Type **setup**, and give the star name. There will be three observations planned as a flux standard, each a 2 dorun.

5. **nextobs**. Obs 1 (Gr=1, red). In filling out the data header, put first in the NAME field the "HD" number of the star given in the usrcat listing. This is needed for recognition of the star by the reduction software later. At "scanning", check to see that the NETMAG is approximately = V (otherwise you have clouds, or the wrong star). The 2 dorun will have you do scans in the right aperture, followed by the left. Make sure you have the correct aperture (indicated by a * on the STATUS display, and listed as APER in the header. If you have the wrong aperture, the NETMAG will think you have a negative signal (sky - star) and NETMAG will be listed as 19.9.

6. **docal**. Do the flatfield and wavecal for the red grating, answer "Y" to "Go to other grating?", and do the wavecal and flatfield for the blue grating. For NAME, put something like "HD1234 red flatfield" so that you will recognize it in reductions.

7. **nextobs**. Obs 2 (Gr=0, blue; Clr=1, clear)

8. If the IR-block filter is called for on one of your program objects, do **nextobs** on Obs 3 (gr=0, blue; Clr=0, IR-block). It is not necessary to do another docal in this configuration.

9. Fill in the PBO targets log page with the NETMAG for each observation, plus the ZD and sky conditions.

1.4.2 Program Objects

Consult the hitlist if you are in doubt as to which object to observe. Be sure to note what has been

observed recently by other observers in order to optimize the number of hitlist objects that get observed. You can estimate how long an observation will take by looking at the number of dopols planned: the standard minimum full polarimetric run, 4 dopol, takes approximately 30 min if FRMTIME ≤ 40 seconds, and 1 hour if it is 100 seconds (see table 2).

The observation proceeds just as in the flux standard observation, except that the observation may need to be adjusted from the planned observation, especially if this is the first time the object has been observed. Also, it is important to check on the identity of the object if it is faint or in a crowded field.

1. Slew the telescope using **usrslew**, **manslew**, **saoslew**, or manual acquisition.

2. **< v. > slitmag.** For faint objects the camera update rate may become slow.

3. Verify star in finder, if possible, and put it in aperture 0.

4. **setup**. Check the hitlist for which planned observations are to be performed (these will be either dopols for polarimetry or doruns for spectrum-only observations). Usually, both a red and a blue observation are planned (assumed here)

5. **nextobs** on Obs 1. Enter name as it is on hitlist. As you start getting frames, check the NETMAG, and the spectrum against what you expect for this star. Especially if the star is variable or if it is the first time it has been observed, the SPCMAG may need to be adjusted: if %SAT < 15% and FRMTIME ≤ 40 secs, or if %SAT > 65%, update SPCMAG as follows;
> - abort out of the datataking with "**a**"
> - **dolook**
> - ">" or "<" until %SAT is within range, if possible
> - "**q**"
> - **new <n> dopol**, where <n> dopol is the planned observation command. The **new** is
>> important to cause FRAMES to be adjusted for the new FRMTIME
> - record the new SPCMAG in the log and note it for your end-of-night email

6. **docal**

7. **nextobs**, as required

8. record NETMAG, %SAT, and conditions in PBO targets log book.

1.5 Shutdown

<u>In The Dome</u>

1. Stow the telescope by entering:

> **stow**

2. Turn the TEC off by moving the switch on the CCD controller all the way towards the spectrograph

(two clicks).

3. Type
                    quit.

FORTH will issue a final message "FORTH Exits" and the FORTH and STATUS windows will become inactive.

4. Run the dome to location 500, close the telescope covers and the dome slit, turn the dome power off, and replace the grounding clamps.

5. Close the spectrograph grating cover (slide OUT)

6. Turn off the reticle light on the 8" finder.

7. Turn off the beige power strip to the left of the control panel, and unplug it from the extension cord.

8. Turn the dome and panel lights off.

9. Check that the dome and catwalk doors are closed tightly and locked. Turn on the outside light, <u>only</u> after making sure that no one is still observing at the 16" telescope or at the Space Physics telescope. Turn off the red hallway lights on the way to the basement.

<u>In The Basement</u>

1. In the <u>XTERM</u> window, enter

            <u>cleanup</u>

This closes down the windows and the observing session.

2. Get a blank DAT tape, label it with your login and yymmdd, put it in DAT machine.

3. In the XTERM window, enter

            <u>archstrip yymmdd &</u>.

This archives your data onto the tape and starts the data extraction process. When finished, it will transmit the extracted spectra and engineering data from your run back to SAL. (The "&" is necessary to put this very lengthy process "into the background" and give you control back. If you should happen to forget it, you will be left without a prompt. You may remedy this by typing "^Z" (control-Z) to stop the job, then "bg" to put it in background manually)

4. Send a summary e-mail of the night to reducers by entering

            <u>mail reducers@jerry</u>

Note what you observed, any problems you might have had, and the total number of images.

5. Logout from the XTERM window on michael, and quit the Xsession by double-clicking on the Session Manager Icon, clicking on "Session" and pulling the popup menu down to "Quit".

6. Turn off the power strip to the left of the terminal.

7. Complete filling out observer's log book.

8. Bring in the observing log and any telescope problem sheets (i.e. the "green sheet").

7. Turn off all lights, and lock all doors

8. Turn on the alarm in the basement, and <u>only if the resident is not home</u>, turn on the outside alarm.

9. Always close and lock the driveway gate on your way out.

2. Status Display

The STATUS window displays useful information concerning the telescope and dome, calibration lamps, mechanisms, detector, and data acquisition. The following is a display of the STATUS window with semi-descriptive entries where variables will appear when observing. A description of each entry follows the display.

```
        RA    hh.mmsss DEC +dd.mmss   DS ?
        HA    hh.mmss  ZD   dd.d       TL ?
                       AZI  xxx
        LST   hh.mmss  DOME xxx   DTOL xxx
        UT    hh.mmss  CAMMAG xx.x  LO  ?
        MJD ddddd.dd
                       LAMP   x eee   ON  n
        CCD +tt.t   HWAV   p eee
        TEC +tt.t   GRAT   g eee       CURR
        SPC +tt.t   CLR    p eee       x.x

        SPCMAG mm   FRMTIME  ss.sss  ????
        APERTURE    a1? ?a0    b1? ?b0
        %/FR        xx.x xx.x   xx.x xx.x
        NETMAG      xx.xx       xx.xx
         ?????  BN0 CTS xxxxxxx  FR xx ?
         nn nn  BN1 CTS xxxxxxx  FR xx ?
```

The text in **bold face** is fixed text; the rest is overwritten by the display software when it is running.

DS ?

      The "display toggle" indicator at the upper right refers to the entire display. When the display is updating, it will alternate between a "*" (this is called a "bug" in NASA parlance) and a blank every two seconds. If it stops updating after an error or an abort, the information on the display is "stale" and it will need to be restarted with an **init**.

2.1 Telescope and Dome Status

The telescope status is read from the controller and if the telescope was not properly initialized or has become confused in some way all of the following telescope displays may not be correct.

TL ?

      This displays a "*" when the telescope controller is responding to information requests; otherwise it is a blank. The "bug" will go out during some controller-intensive slews and when you are using the controller console buttons for manual acquisitions. During these periods the telescope information on the display is "stale".

RA   hh.mmsss

This is the right ascension to which the telescope is (or believes it is) pointing, in units of time. The format is indicated as two places for the hour followed by a period and then two places for the minutes and three places for the seconds for an accuracy of 0.1 seconds of time.

DEC   ±dd.mmss
This is the declination to which the telescope believes it is pointing in units of arc degrees, minutes and seconds.

HA   hh.mmss
This is the hour angle in units of time: hours, minutes, and seconds. It will be negative for angles east of the meridian and positive for angles west of the meridian.

ZD   dd.d
This is the zenith distance of the current telescope position in decimal degrees.

AZI   xxx
This is the current azimuth of the telescope in dome encoder units. These units run from 000 to 999 with 000 being straight North, and 500 being straight South. The numbers increase from North through West to South.

DOME xxx
This is the current location of the dome in dome encoder units. It is not currently a valid reading- use the separate LED dome readouts. This number should be equal to the AZImuth to within the tolerance given by DTOL.

DTOL xxx
This is the tolerance in the dome setting. If the AZImuth and the DOME setting are different by more than the amount DTOL, then you are close to observing part of the dome. When outside out this tolerance, the value will be shown in inverse video as a warning.

2.2 Time

UT   hh.mmss
This is the current Universal Time (formerly called Greenwich Mean Time, or GMT) according to the computer, as updated by **sclk**.

LST   hh.mmss
This is the current Local Sidereal Time (the current RA that is crossing the meridian) in hours, minutes, and seconds. It is calculated from the current date and the UT.

MJD   ddddd.dd
This is the "Modified Julian Date", or Julian Date - 2,400,000. The Julian Date is the number of days since UT 12^h, 1 Jan 4713 BC. It is often used to time astronomical events. The current JD can be found in the Astronomical Almanac, and the hitlist shows the range of MJD's to which it applies.

2.3 Slit Camera/ Calibration Lamp Status

CAMMAG xx.x **LO** ?

This indicates the sensitivity of the slit camera. CAMMAG is the magnitude of a star which is well-exposed in the image, and LO * indicates whether the camera has been placed in "low-sensitivity" mode (an "electronic shutter" cuts down the light reaching the camera for magnitudes brighter than 3). These are controlled by the **slitmag** command.

LAMP x eee **ON** n

The "x" indicates the position of the calibration lamp slide: 0 = out; 1 = in (the "eee" is the encoder error, and should be small). The "n" after "ON" indicates which lamp is on (0 = off; 1 = tungsten flatfield lamp; 2 = mercury-argon wavecal lamp).

2.4 Temperature and Mechanism Status

CCD +tt.t

This is the temperature of the CCD detector, and should be < -50 when the TEC (Thermo-Electric Cooler) is on and stabilized. These values are in degrees C. The CCD will run warmer in the summer and colder in the winter.

TEC +tt.t

This is the temperature of the "baseplate" of the thermoelectric cooler, which is attached to a circulating ethylene glycol refrigerator beneath the dome floor. This value should be -15 to -20 when the TEC is off, and will rise to no higher than -5 when the TEC is dumping heat into it.

SPC   ±tt.t

This is the temperature of the spectrograph and should be a fair indication of the ambient dome temperature.

HWAV   p eee

The p indicates the current position of the waveplate filter. The allowed positions are 0 to 7.

GRAT g eee

Indicates which grating is in place (grating and color filter positions are numbered in order of wavelength).

1 = red
0 = blue

CLR c eee

Indicates which color filter is in place. This filter suppresses unwanted (wrong color) scattered or diffracted light from the grating.

2 = red
1 = clear
0 = IR-block

With all mechanisms (as with the lamp slide above), the "eee" will indicate an error in the position. This error is an integer and is used to determine if the filter is close to the position that it is supposed to be in. The software will give you a LAMPOS, WVPLATE, GRATING, or CLRFIL FAILS error if

this number is too large.

2.5 Data Acquisition Status

????
         The data acquisition mode is shown on the upper right of this portion of the display as a quick reference. It will show one of the following:

         IDLE   The detector is not running; the CCD display will shown the last obtained spectrum.

         LOOK The detector is doing single frames and displaying them on the CCD display, <u>but not saving the data</u>. This status is shown during a **dolook** and during the **?ready** step of data taking.

         SCAN   The detector is doing a multiple-frame scan and saving the data. The CCD display will show the accumulated frames in this scan for the current memory BANK.

         PAUS   You have temporarily suspended a SCAN using the p=pause control in **scanning**. New data is not being acquired but what has been accumulated so far is still there (shown on the CCD display).

         SATN   This will replace LOOK if the detector is saturating (and the monitor bell will ring).

SPCMAG mm   **FRMTIME** ss.sss
         This gives the current SPCMAG and should be between -1 and 12, inclusive. This sets the frame exposure time (FRMTIME) for optimal exposure of the CCD on a continuum object of magnitude mm. FRMTIME is given in seconds and will range from 0.160 to 100 based on a lookup table which is different for each grating (see table 2). The SPCMAG is set by the **nextobs** command based on the usrsetup file. It may be very different from the actual magnitude of the object if it has emission lines or a very red color.

APERTURE   a1? ?a0   b1? ?b0
         Tells which spectra should be getting star counts by a "*". For APER = 0, there will be bugs next to a0 and b0 (the polarized split spectra from the right-hand aperture 0), for APER = 1, next to a1 and b1, and for APER 2 or 3, all or none of the bugs will be on.

%/FR   xx.x xx.x xx.x xx.x
         This displays the percent of saturation xx.x detected by the CCD in each of the four spectra described above in the most recent FRMTIME (i.e during one Frame). %/FR should be between 15 and 65% for bright objects with FRMTIME ≤ 40 seconds, and may get as low as 6% for fainter objects with FRMTIME 100.

NETMAG   xx.xx   xx.xx
         This displays the approximate continuum magnitude of the spectrum detected in the two split spectra (the illuminated aperture minus the background aperture). It should be comparable to the "V"

magnitude listed in the hitlist. The constancy of this number is the best indication of the quality of your guiding and/or the weather.

BN0 CTS xxxxxx **FR** xx ?

  There are two data accumulation "banks", 0 and 1, and when doing polarimetry data, data will be written into both banks alternately as the filter changes.   One bank holds all the data taken through one filter during a scan, and the other bank holds all the data of the other filter. A "*" replaces the "?" on this line when bank 0 is accumulating data. The total mean counts/pixel "xxxxx", that have been accumulated in bank "0", and the number of frames "xx" is shown. When FR is equal to the total number of frames to be done the scan will have finished for this bank.

BN1 CTS xxxxxx **FR** xx ?

  This is identical to BN0 but it is the status of bank 1.

???? nn nn

  On the lower left of the display is listed the observation command (dorun or dopol) that is currently under way, the number of cycles that have been completed, and the total that have been requested. ie, when this reads **dopol** 7 8, you are working on the 7th out of a total of 8 dopols.

3. FORTH

The control language used for the HPOL instrument is SAL FORTH. FORTH is a computer language developed for astronomers for instrument control and data handling. It is quite different from many familiar computer languages like FORTRAN and "c". It consists of a compiled interpreter or "kernal" which recognizes a list (a "dictionary") of certain basic commands (called "words"). The SAL FORTH kernal is written in "c" and is started in the FORTH window by the **observe** Unix script. At this point, words in the basic dictionary can be executed and new words may be defined in a "user dictionary", using a high-level language consisting of all the words previously defined. The user dictionary for the HPOL system exists as a set of files (written in FORTH) which are "loaded" to form the full system. This section is simply a glossary of HPOL FORTH words and assumes the user has no knowledge of FORTH or the way in which FORTH works. If one is interested in learning FORTH or at least developing a better understanding of the language, I suggest reading the book *Starting FORTH* by Leo Brodie. There are several copies floating around SAL. A second reference is the "Kitt Peak FORTH Primer". A version of FORTH exists on the SAL computers and can be used with either of these references to get started in understanding FORTH.

The rules for entering FORTH commands are simple:

- The "prompt" for user input is "-ok->". If there is no prompt, some word is still executing. Some HPOL words accept their own input, as described in the glossary. A running word may be aborted by hitting "Ctrl-X".

- Words may be "stacked" on the command line by separating them by any number of blanks (FORTH has "free field" input). A carriage return causes the command line to be executed from left to right.

- Spelling of words is important, except that no distinction is made between upper and lower case. A nonexistent or misspelled word will result in the error message "Error: Undefined word."

- You may use the mouse to cut and paste into and out of the FORTH window, but for safety, you must hold down the "Enter" key while doing mouse operations within it.

The following is a glossary of FORTH words (i.e. commands) that are often used by the observer or that the observer must respond to. This glossary will be organized into five sections as follows:

1. FORTH system control
2. Telescope and instrument initialization words
3. Basic operating words and commonly used observing commands
4. Items that appear in the scan header displayed on the terminal
5. Error messages

3.1 FORTH System Control

go

This command loads a small list of basic words, including the user dictionary loading words below.

ccd

This loads the software that controls the operation of the ccd and how data from it is handled.

hpol

This loads the software that will allow the operator to take polarimetric data using the half-wave spectropolarimeter.

zap

This causes operations to cease, and all of the user dictionary (starting with **go**) to be forgotten. The FORTH banner is printed out:

***** SAL C-Forth Version HPOL (date of version) *****

followed by the "-ok->" prompt. FORTH is still operational, but the user dictionary will have to be reloaded, and the system re-initialized.

quit

This causes operations to cease, and the FORTH program to be terminated. The message "FORTH Exits" will be printed out.

3.2 Initialization Words

init

This initializes many software and hardware related things (see §1.1) .

sclk

This initializes the telescope controller. *THE TELESCOPE MUST BE AT THE ZENITH* when this command is issued. The current UT date and time are updated and sent to the telescope controller.

ccddark

This takes four zero-exposure ccd frames, then four 40-second dark frames for calibration purposes.

3.3 Operation Words

These words are also described in §1.3.

v. slitmag
> Set the slit camera sensitivity for an object of astronomical magnitude v. (decimal point required).

n gofil
> This sends the half-wave filter to position **n**. It is useful if you have aborted a **dopol** operation and want to go to another star or do a calibration where you should start with filter 0. Other applications can arise.

n gograt
> This sends the grating slide to position 0 (blue grating) or 1 (red grating).

n goclr
> This sends the color filter to position 0 (IR-block), 1 (clear), or 2 (red). See §1.3.2 for details.

dolook
> This does single exposures of one FRMTIME. The data is displayed in the CCDVIEW window, but no data is stored. This is simply a quick look procedure to see what the spectrum of the object looks like and allows you to adjust the exposure so that a reasonable signal is received in each FRAME. During a **dolook** you can do several things by entering single characters from the terminal (also programmed into the function keys along the top of the keyboard). The possible commands are <, >, or Q.

> > <,> - Adjust the SPCMAG (i.e. the length of a single exposure). > increases the FRMTIME and hence increases the length of the exposure by roughly a factor of 2 for each key stroke. < decreases the FRMTIME and exposure in a like fashion. See §1.3.5

> > q - Quit the **dolook** (i.e. get out of this loop). Enter a "q" and the **dolook** will end. Again no data is being stored, so nothing is saved.

n dorun
> This takes n scans of spectroscopic data (eg, for flux calibrations). Generally **n** should be divisible by 2, so that at least one background and one object scan is obtained for each aperture. For each aperture a scan header is displayed to be filled out, and data is acquired in two steps, denoted by **ready?** (verify spectrum) and **scanning** (take data). The header information and controls for **ready?** and **scanning** are described below.

n dopol
> This takes n filter pair sets of polarization data. This procedure will handle all half-wave filter rotations and log all the data properly. Each filter-pair is 8 scans: four scans for each of two halfwave positions, done in the order aperture 0, 1, 1, 0. A full set of polarimetric data requires 4 filter pairs: 4 **dopol** will do 32 scans. The dopol will start with the current filter-pair; do a **n gofil** (see below) to start with a different one. As with **dorun**, for each scan a scan header is displayed to be filled out, and

data is acquired in two steps, denoted by **ready?** (verify spectrum) and **scanning** (take data). The header information and controls for **ready?** and **scanning** are described below.

ready?

The computer is all set to take data and it wants to know if you are ready. This is your chance to check the header and be sure that it has all the proper values and that you have the star in the proper position. Your possible responses are g, c, or a:

g - GO, yes you're ready so go ahead and take the data.

c - CHANGE the header info.

a - ABORT the scan. This returns you to the FORTH -ok-> prompt.

scanning

After you enter a g in **ready?** the terminal cursor will advance to just after a **scanning**, and begin data-taking. During data-taking you can enter p, r, c, q, or a:

p - PAUSE, hold the data taking process for a bit while you wait for clouds to clear or to move the dome, etc...

r - RESUME, issued to resume the data taking after a P has been entered.

c - CHANGE, which allows you to stop the scan and change header information if you like. The computer displays certain control items in the header and allows you to change them (or to hit RETURN to accept them as is), then re-displays the header annotation items before returning to **ready?**. This is useful whenever something happens where you want to restart the scan, and do NOT want to save the data that has been collected in that particular scan, but neither do you want to exit out to FORTH: For instance, if in the middle of a scan with the object centered you discover that the scan should be a background, or that you wish to decrease the number of FRAMES to be taken, hit a c, change the header information if desired, reposition the telescope, and enter "g" at **ready?**.

q - QUIT says save the data you have accumulated in this scan and exit the **dorun** or **dopol** to get back to the FORTH -ok-> prompt.

a - ABORT says don't bother with the data you have accumulated in this scan; simply get out of this **dorun** or **dopol** and return to FORTH.

You can, of course, let the scan end normally on its own.

new

This is used before either an **n dorun** or **n dopol** command when you are going to a new source. This clears the on-line reduction buffers and recomputes the number of frames to be done for each scan.

docal

This is a high level word which brings in the calibration lamps, performs a flatfield and a

wavecal observation appropriate for the current grating, then offers to go to the other grataing, where it will perform a wavecal and flatfield observation. Finally it pulls the lamps out to allow for continued observations.

setup
>Calls in the planned observation configurations for a star in the usrsetup file.

nextobs
>Starts a preplanned observation by positioning all the mechanisms, setting SPCMAG, and executing a (new) <n> dorun or (new) <n> dopol.

3.4 Header Items

During execution of a **dorun** or **dopol**, the scan header for each scan is displayed for information and modification. The header contains FORTH control items (preceded by a "#" character), FORTH status variables (preceded by "@"), and annotation items (between ":" and ";"). You may change control items with the "c" option as described above, and the annotation items during header display at the beginning of a run or after a "c". Updating control items is usually unnecessary since they are handled by the datataking software. The annotation items usually require updating at the beginning of each run. Status variables cannot be updated.

Control Items:

APER
>This designates the aperture through which the light is shining.
The convention is:

>>0 - Source light through right-hand aperture
>>1 - Source light through left-hand aperture
>>2 - Source light through both apertures
>>3 - Source light through neither (i.e. background counts).

FRAMES
>This is the number of individual exposures, or frames, that will be added together to form a complete scan.

Annotation Items

NAME
>Used in the logging and reduction software. For flux standards, use the HD number. For unknowns, use the user catalog name. For calibrations, indicate which object the calibration goes with.

P.A.
>This is the "position angle" of the spectrograph. Normally PA = 90 (detector on South side) - only if you are told differently will you need to change this value. REDUCE does read this number in reducing the polarimetric data, so be sure it is correct.

SLIT
> This is the integer designation of the current slit width. Five slits are currently available and are labeled 1 to 5.   See figure 3.

DECKER
> The decker position. The decker controls the length of the slit being used. Each decker is referred to by an integer from 1 to 9. See figure 4.

COMMENTS
> Enter here any information which might be useful for reduction, like "intermittent clouds", or "near bright moon".

Status Variables

IMAGE
> This is the number of the first CCD image in the current scan. The image number is seen updated in the CCDVIEW window as each frame completes.

FRAME
> The number of frames actually taken (less than frames if scan was "Quit").

FILTER, RA, DEC, GRATING, COLOR, SPCMAG, FRMTIME, HA, UT, LST, THERM=CCD TEMP, TSPC=SPC TEMP, MJD,
> Copied into the header from the STATUS window.

UT0
> UT at beginning of scan ("UT" is for end).

NETMAG
> The mean astronomical magnitude, averaged over both arrays and the whole scan.

3.5 Common FORTH Error Messages

Error messages from SAL FORTH have the format

> Error: "**error message text**"
> Current word is "word"
> Return stack = "stuff" User stack = "stuff"
>
> Restart 1 (terminal beep)

Below are a number of commonly-encountered error message texts (**bold face**) in order of severity, along with suggestions of their cause:

Procedural error:

User interrupt
> This message is given whenever you abort a word with "Ctrl-X".

Undefined word
> Word not found in FORTH dictionary. Probably misspelled.

User stack underflow
> Variables are passed to words on a "user stack". You may have neglected to enter a number required by a word like **dorun** or **dopol**.

Initialization/ Hardware errors

COMM Error <message>
> One of the serial devices (log printer, telescope controller, mechanism controller) is not responding correctly. This may be a transient error, in which case you may just continue operations (it may be necessary to restart the STATUS display with a "startops"; see below). If it is persistent, you may have forgotten to turn something on, or there may be a cabling problem.

FORTH Abort
> These are aborts from the HPOL words. It will be followed by one of several further messages:

> **WVPLATE/ GRATING/ CLRFIL/ LAMPOS FAIL**
> > One of the mechanisms is inoperative or jammed (see §4.6).

> **COMM not yet initialized**
> > You forgot to do an **init:** not ready to talk to RS-232 systems

> **COMM: no response from comm_server**
> > The process that talks to the serial devices, "comm_server" has died. You will need to restart the observing session (§4.1.4).

> **CCD CMD GIVEN DURING READOUT/EXPOSURE**
> > The FORTH software has gotten out of synch with the CCD controller. Retry the command; if it fails try **init-ccd** and retry; if this fails go to the software recovery procedure (§4.1).

> **ILLEGAL OBSERVATION NUMBER**
> > In **nextobs** you have requested an observation not defined in **setup**

Telescope Control aborts:

> **STAR NOT FOUND**
> > In **usrslew** you have not spelled the star name exactly the same as the first entry in the user catalogue (do a "usrsearch" to find the entry). In **saoslew** you have not entered an existing SAO number.

ZD > 60
DEC > 65
|HA| > 6   ACTION ABORTED
In **usrslew**, **manslew**, or **saoslew** you have requested a motion that will take you beyond the "soft limits". You may go beyond these limits, up to the "hard limits" with a "manual acquisition" (§1.2.2).

TC12 TIME WRONG: SCLK REQUIRED ACTION ABORTED
You have requested a **usrslew**, **manslew**, or **saoslew** either without doing an **sclk** to initialize the telescope controller, or there has been a spurious telescope controller reset. Slew the telescope to the zenith *WITH THE CONSOLE BUTTONS* (not with the "**stow**" command); center the bubble levels, and do an **sclk**.

Software Crash

The following errors indicate a serious software problem. Please document fully the information after the error message and follow the procedures in §4.1:

Bus trap
Segmentation trap
Arithmetic trap
User stack overflow
Return stack overflow

4. Malfunction Procedures

This section describes possible solutions to problems that have occurred sometime in the past. This section is updated whenever a new problem occurs for which a work-around must be developed.

The major divisions of this section are listed below. The first one is the most vague: it is always easy to "blame the computer", but you can often save a lot of time by first considering whether there might be some easy hardware answer: i.e. consider some of the other subsections first.

Index

In General:

If you have tried all the appropriate malfunction procedures and are still have difficulties, <u>do not hesitate</u> to call:

> PBO Resident
> Geoff (anytime)
> Ken (before 11 pm, unless an emergency)

4.1 Computer Control Problems

Suspected computer control problems might be broken down roughly by symptom as follows

a) Unexpected FORTH error message or "abort"
b) Executed FORTH commands do not give expected results
c) FORTH window "hangs" or does not accept input
d) All windows freeze up

When the problem first happens, note down carefully any error message. If it is a particularly complicated one, do a screen-dump (see below) of the window. Next, look carefully at the STATUS window (see §3 above), check to see if it is updating, and note the status of the telescope, TEC, filter, and detector subsystems. Again, if something seems wrong, get a screen-dump.

General recovery procedures, in order of severity, can be classified also:

1) Retry command
2) Re-initialize FORTH, and retry
3) Reload the FORTH observing software, then (2)
4) Restart the observing session, then (3)
5) Reboot, then (4). **Do this only if some procedure specifically calls for it.**

Detailed procedures for 2-5 are given below.

In the case of symptoms (a) and (b), try the procedures in order until the problem is resolved.

In the case of a FORTH "hang", first attempt a "Ctrl-X" user abort to get control back. If this gives you an abort followed by an -ok-> prompt, continue as for symptoms (a) and (b). If you don't get control back, you will need to do a session restart ((4) above).
If all windows are frozen, you may need to reboot.

4.1.1 Screen-dump

In chad's XTERM window, type

                    xdump

When requested, click the cross-hair cursor in the desired window. The output will come out on the laser-printer. Annotate it with time and comments.

4.1.2 Re-initialize FORTH and Recover Observing

This puts all the software subsystems into a known configuration and restarts the STATUS display. Nothing is forgotten by the program, so observing continues normally. In the FORTH window, type

            init   (you should not need to re-enter the printer header)

If you interrupted a dopol, you should restart it with the last filter pair (set of eight scans). Suppose, for instance:

> The last **dopol** command was **new 8 dopol**, and **dopol** was terminated during filter pair 6. (This can be seen on the lower left of the STATUS display) You will need to restart filter pair 6, and do filter pair 7 and 8: 3 filter pairs

> > **3 dopol**   (the "new" is not required since this is still the same object).

> You should not have to move the halfwave filter, which will be left on the last filter pair.

4.1.3 Reload FORTH Observing Software

Without restarting the FORTH program, we can get a fresh copy of the high-level software. This causes the program to forget many things, but the most important, like the last image number, mechanism positions and time are kept in BLOCK 0 of your data blocks file, and are recovered automatically in the "initialize software" step of **init**. In the FORTH window, type

	zap	
then	**go ccd hpol**	
	init	(again, the printer header should be intact)
	ccddark	(only necessary to display the netmag correctly)
(WIYN)	**init-rotator**	(answer "Y" to "Just set init flag?")

Now recover observing:

setup	(reloads observing parameters for current object)
nextobs	(sets up mechanisms; abort when you get to "ready?")
x gofil	(x is first filter of the filter-pair you interrupted)
new <n> dopol	(the "new" is required because of computer amnesia)

4.1.4 Restart Observing Session

This procedure is the next to most severe of the recovery procedures. It will kill and restart all the observing processes, including FORTH and the STATUS display processes. In the FORTH window, type

> **quit**

The message "FORTH Exits" should appear, and the window will become inactive.

Now, on chad's <u>XTERM</u> window, shut down the observing session by typing

> **<u>cleanup</u>**

Observe the resulting messages.

If you will get the message:

> THE FOLLOWING PROCESSES WILL NOT DIE:
> (a list of rogue processes - please write these down)
> REBOOT SUGGESTED

As it says, in this case you will have to perform a reboot (§4.1.5 below) before proceeding.

Finally, on the XTERM window, enter

observe yymmdd

And on the resulting FORTH window, recover as in §4.1.3:

	go ccd hpol	
	init	(you <u>will</u> need to re-enter your printer header)
	ccddark	
(WIYN)	**init-rotator**	(answer "Y" to "Just set init flag?")
	setup	
	nextobs	(abort when you get to "ready?")
	x gofil	
	new <n> dopol (if required)	

You are now hopefully back in action. If not, call for help!

4.1.5 Rebooting chad

This is a last resort to be used if "restart observing session" does not work for some reason. There are two versions, "soft" reboot (from a terminal window) and "hard" reboot, (using a button on the back of the computer)

<u>a) Soft reboot</u>. Always try this first. In an <u>XTERM</u> window (either on chad or on an xterm window created by a login to chad from another machine, like michael) type

shutdwn

There will be a warning message, then rebooting will commence.

<u>b) Hard reboot</u>. Do this only as a last resort, since it is possible to corrupt disk files with a hard reboot. Go around in back of chad, being very careful not to trip over the numerous cables back there. On the bottom left of chad's CPU (the box beneath the monitor), there is a cable with a metal connector. Hidden beneath this is a small square button. Depress this button, hold it for a second, and release.

In a reboot, the screen will shut down, and a black area will appear at the bottom. After about 3-15 minutes of system-type gobbledegook (which may initially not even be in the roman alphabet!) the login window and the PBO logo will be repainted. The reboot will take a long time if you did a hard reboot,

or if there has not been a reboot in a while, and it decides to check the big data disk; be patient. But do watch for ominous messages, like "xxx failed", followed by a ">>" prompt, which would indicate that a systems person would need to intervene. Now login, and restart, starting with **observe**, as illustrated above.

After a reboot if the "sclk" gives you a "Network Time not available", the reboot has not restarted the network correctly: enter

> **nistroute**

in the <u>XTERM</u> window, and retry.

4.2 Telescope Problems

 Slewing problems can take four forms.

> HOW TO STOP A RUN-AWAY TELESCOPE
> Telescope slew binding at high Dec and/or HA
> Telescope is very slow at finding its target
> Telescope is lost

4.2.1 HOW TO STOP A RUN-AWAY TELESCOPE (Know this by memory!)

UNDER NORMAL CIRCUMSTANCES:

> 1) Type a CTRL-X on the terminal, <u>and</u>

> 2) Push any paddle button. If this doesn't work, then

> 3) Push STOP on the controller panel

When the telescope is slewing, hitting any button on the paddle should stop it momentarily. You can then repeat the operation or start a new one after hitting the reset button on the telescope and entering a CTRL-X on the terminal.

Otherwise:

> Hold in the STOP button on the console, and then push the RESET
> button. Then call the resident: the telescope is seriously confused.

EMERGENCY STOP:

If things are DISASTROUS simply push the RESET button.
This is the very last resort as it stops the slew WITHOUT RAMPING DOWN the motors.

<div align="center">

SOME DISASTROUS CIRCUMSTANCES:

</div>

Spectrograph about to slew into the pier, no time to ramp down
Telescope is horizontal and headed to negative altitudes.
Cables about to be ripped out.
The first two procedures have not worked after 2 or 3 tries.

4.2.2 Telescope slew binding at high Dec and/or HA

This problem occurs at certain temperatures and is caused by binding in the drive gear. The symptoms include a noticeable "bumping" sound and a lack of ability to move the telescope northward, yet the coordinates will change and claim to have gone North.

This problem can occur at any drive rate but shows up most frequently at the guide rate. If it happens while you are trying to center a star in the finder, simply back the telescope off to the South and get a little run at it. This will often work. If it doesn't, again back off to the South, get into Set rate and drive a little past the star to the North and then bring it into position using the South button. This almost always works. When leaving this position to go to a new object be sure that you first do a **stow** and **sclk** to reset the proper coordinates in the controller. In addition, be aware that the telescope may really be stuck at this position if you have sat there quite long. In this case, as the telescope ramps up to go North to different object (if it has to go North), you will hear a very loud BUMPING sound as the motor tries to drive North but can't overcome the binding. Quickly stop the slew by hitting any paddle button, type a **CTRL-X**, and push **STOP** on the controller panel. Now move the telescope in RA to the meridian, and then manually drive the telescope to the zenith using the levels on the sides of the telescope. Then do an **sclk** to reset the controller.

4.2.3 Telescope is very slow at finding its target

Generally this occurs for one axis but not the other, and usually means the controller is confused. The quickest way to get to the desired position is to let the good axis finish its slew and then **push a paddle button**, type **CTRL-X**, push **STOP** on the controller panel and then position the telescope using the paddle or control panel.

Ultimately the way to fix the problem is to **stow the telescope** at the zenith, push the **red reset button** on the telescope controller panel and enter another **sclk** in an effort to reset the controller.

4.2.4 Telescope is lost

<u>1) Telescope doesn't know where it is when going from one target to another</u>
Bring the telescope back to Zenith using the console buttons. Hit "Stop" if necessary to stop tracking. Check the **levels** on the North and West sides of the telescope to make sure that the bubbles are between the lines. If resetting levels (fine tuning) with the paddle, hit STOP as soon as you have finished with the paddle. Now do **sclk** to reset the controller coordinates to the zenith. After slew to the next target or a bright star, fine-tune the coordinates with a **urthere**.

2) Telescope doesn't know where it is while tracking a known object.

Enter one of the **slew** commands (**manslew**, **usrslew**, or **saoslew**) to slew to the object you are already on, and enter "**n**" when asked if the telescope should slew to these coordinates. (This ensures that the controller has the correct target coordinates). Then do a **urthere** to set the current coordinates to the target coordinates.

4.3 Dome won't move

1) The tires are slipping on the rail.

If they are, they need air and that will solve the problem. There is a portable air compressor/ tank on a cart in the dome to remedy this situation: wheel the cart next to an AC outlet and plug it in. The compressor motor will come on and will pressurize the tank; when the tank pressure dial reaches 80 psi, unplug the AC, wheel the cart to the tire and fill it up.

2) Tires are full; no motor noise:

Check the circuit breaker in the right most circuit box under the stairwell in the basement (i.e. where you turn off the alarm).

3) Tires are full; motors are nice and loud, but no dome motion:

Check the differential on both drive mechanisms; they should rotate when you push the dome motion button. If one of them does not, tighten the allen bolts on the slip ring between the motor and the differential.

4.4 Cooling Problems

1) TEC baseplate temperature > -5 deg.

The refrigerator that circulates cold fluid past the TEC to absorb the heat it generates is off or broken. **If the TEC is on turn it off immediately**, so that it does not overheat, and call for help.

2) The CCD temp does not drop.

The STATUS display may not be updating, or the TEC power switch may not be pulled all the way out. Otherwise, there is some kind of TEC failure - call for help..

4.5 Mechanism Problems

1) HALFWAVE FILTER FAILURE abort

These messages occur while taking data and indicate that the halfwave filter drive has not positioned the polarimetric filter to within +/- 11 position units. At this point the system is not taking data. Try entering **hwmtr mtrzero** to zero the filter position. If this does not work lift the cover on the halfwave filter driver, hold out the small plastic knob which releases the detenting solenoid and try to run the steel rod next to it back and forth. (Both of these fixtures are below the color filter slide) This may work out any contamination that may have got into the mechanism. Then try again. If this doesn't work, call for help.

2) ZEROING-FILTER message
This message is not a true error message - it requires no action on the observer's part. The computer
is simply trying to reset the filter position within the allowed tolerance, and indicates that the position
readout potentiometer may have drifted. Note down which filter position it occurred on and the
position error for later correction.

3) GRATING FAIL
The grating has not reached its commanded position. If this happens at an extreme telescope position,
try again with the telescope near the zenith, then return to the star. If the grating does not correctly
position after several tries, call for help.

4.6 No light getting through to the detector

1) Can't see anything on the TV monitor
Make sure that the TV camera is on (red light on back) and the CAMMAG is reasonable. If still
nothing:

a) If you are looking at a comparison lamp, check (on the STATUS display) that
                    the correct lamp is in position
                    the lamp is on
                    There is a possibility that the lamp is burnt out. In this case the resident can change it
                         if it is the flat field lamp.

b) If you are looking at a star, check that
                    it isn't cloudy
                    the dome isn't in the way
                    the mirror and baffle covers are off
                    the lamp slide is not in
                    the star is centered in the slit

2) Light on the slit camera but no spectrum (detector status LOOK or SCAN). Check

                    the grating cover on the east side of the spectrograph is open (in)
                    the observation configuration is correct (did you do a **nextobs**?)

5. Abridged PBO Observing Procedures

for only the experienced observer!

5.1 Setup Procedure

In The Basement

1. Turn on the power strip to the right of the terminal.
2. Login to chad. Type **observe yymmdd**.
3. In the FORTH window, enter **go ccd hpol**.
4. Set up the observing log printer.
5. Sign into observer's log book.

In The Dome

1. Plug in the beige power strip at the left of the crate to the black extension cord, and turn on the power strip.
2. Center the telescope at the zenith and hit "STOP" on the telescope control panel.
3. **init**
4. Turn on TEC (verify TEC baseplate temp OK first)
5. **sclk**
6. Open Dome, remove grounding clamps, and turn the dome power on.
7. Remove mirror covers, except baffle cover.
8. Turn on the reticle light of the 8 inch finder.
9. Open spectrograph grating cover.
10. Turn off the dome lights.
11. When the TEC has cooled off enter **ccddark.**
12. Remove baffle cover.
13. Fine tune the telescope pointing with a **usrslew** and **urthere** on a bright star, and focus the telescope.

5.2 Observing Procedures

<u>Calibration Summary</u>

Calibration	Grating	Slit	Decker	Clrfil	Spcmag	Frames	Cmd
Flatfield	0=blue	3	5	1=clear	2	8	doscan
(lamp=1)	1=red	3	5	2=red	2	12	
Wavecal	0=blue	3	5	1=clear	1	12	doscan
(lamp=2)	1=red	3	5	2=red	2	12	
Fluxcal	0=blue	3	5	1=clear 0=IR-blk	B		2 dorun
	1=red	3	5	2=red	R		

Calibration

To be done on every observation or flux calibration (for each grating):

docal. Does **flatfield**, **wavecal**, on current grating, then (optionally) **wavecal**, **flatfield** on

other. Special instructions:

- red wavecal: wait at ready? until not saturating

Flux Standards

Do at least three flux standards per night with good time coverage; if the program stars require

it, IR-block with blue grating.

1. **usrslew** or **manslew**

2. **< v. > slitmag.** (Set slit camera sensitivity; decimal required).

3. Put star in aperture 0 (right aperture).

4. **setup** (Bring in observation parameters).

5. **nextobs**. Obs 1 (Gr=1, red). Update SPCMAG with change if necessary.

6. **docal** (red flat, wavecal; blue wavecal, flat)

7. **nextobs** Obs 2 (Gr=0, blue). Update SPCMAG with change if necessary.

8. If IR-Blk standard required: **nextobs** (Gr=0, Clr=0, IR-blk)

9. Fill in PBO targets log page.

Program Objects

Same as flux standard steps 1-7. **nextobs** command will be an **n dopol** as required in **setup**.

5.3 Shutdown

In The Dome

1. **stow**

2. TEC off.

3. **quit**

4. Dome to location 500, close telescope covers and dome slit, dome power off, and
     replace the grounding clamps.

5. Spectrograph grating cover on.

6. Reticle light on 8" scope off.

7. Turn off the beige power strip, and unplug it from the extension cord.

8. Turn the dome and panel lights off.

9. Check that dome and catwalk doors are locked. Turn on the outside light, turn off the red hallway
     lights.

In The Basement

1. In the XTERM window, enter **cleanup**.

2. Get a blank DAT tape, label it with your login and yymmdd, put it in DAT machine.

3. Enter **archstrip yymmdd &**.

4. Send a summary e-mail of the night to reducers

5. Logout from the XTERM window on chad, and quit the Xsession.

6. Turn off the power strip to the left of the terminal.

7. Complete filling out observer's log book.

8. Bring in observing log, and leave telescope problem sheets on computer for resident.

9. Turn off all lights, and lock all doors.

10. Turn on basement alarm, and only if the resident is not home, turn on outside alarm.

11. Close and lock the driveway gate on your way out.

6. Abridged WIYN Observing Procedures

6.1 Setup for Run (at least 6 hours before start)

<u>In The Dome</u>

Turn up two nitrogen flow meters on South side of instrument to 1.5

<u>In the Cone Room</u>

1. Plug in two AC cords on top of HPOL power box into AC outlet above

2. Turn on chiller.

6.2 Setup for Night

<u>In The Control Room</u>

1. (Operator) on bone, wiyn_router: **enable chad.kpno.noao.edu**

                   mpg_router: **enableHost chad.kpno.noao.edu**

2. Login to chad. Type **observe yymmdd**.

3. In the FORTH window, enter **go ccd hpol**.

4. Set up the observing log printer.

<u>In the Cone Room</u>

1. Turn on AC strip (powers instrument)

<u>In The Dome</u>

1. Open spectrograph grating cover.

2. Turn on TEC (switch all the way out)

<u>In The Control Room</u>

1. **init**

2. Verify CCD temp dropping

3. **init-rotator**

3. When the TEC has cooled off (CCD < -50, 20 minutes) enter **ccddark.**

4. (Operator) Fold tertiary

5.   " Put in mount offsets:

Azi: -1' 10"   El: -1' 57"   Focus: -1775 microns

6.3 Observing Procedures

Calibration Summary

Calibration	Grating	Slit	Decker	Clrfil	Spcmag	Frames	Cmd
Flatfield	0=blue	3	5	1=clear	5	8	doscan
(lamp=1)	1=red	3	5	2=red	5	12	
Wavecal	0=blue	3	5	1=clear	4	12	doscan
(lamp=2)	1=red	3	5	2=red	5	12	
Fluxcal	0=blue	3	5	1=clear 0=IR-blk	B		2 dorun
	1=red	3	5	2=red	R		

Calibration

To be done on every observation or flux calibration (for each grating):

docal. Does **flatfield**, **wavecal**, on current grating, then (optionally) **wavecal**, **flatfield** on

other. Special instructions:

- red wavecal: wait at ready? until not saturating

- blue flatfield: at ready? do "change", FRAMES 2 -> 8

Flux Standards

Do at least three flux standards per night with good time coverage; if the program stars require

it, IR-block with blue grating.

1. **usrslew**. Take default rotator track PA (90 or 270)

2. **< v. > slitmag**. (Set slit camera sensitivity)

3. Put star in between apertures.

4. **setup**. (Bring in observation parameters)

5. **nextobs**. Obs 1 (Gr=1, red). Update SPCMAG with change if necessary.

6. **docal** (red flat, wavecal; blue wavecal, flat)

7. **nextobs** Obs 2 (Gr=0, blue). Update SPCMAG with change if necessary.

8. If IR-Blk standard required: **nextobs** Obs 3 (Gr=0, Clr=0, IR-blk)

Program Objects

Same as flux standard steps 1-7. **nextobs** command will be an **n dopol** as required in **setup**.

6.4 Shutdown

<u>In The Control Room</u>

1. In FORTH window: **0. rot-move** (stows rotator)
2. **quit**

<u>In The Dome</u>

1. TEC Off (switch all the way in)
2. Spectrograph grating cover on.

<u>In the Cone Room</u>

1. Turn off AC strip

<u>In The Control Room</u>

1. In the XTERM window, enter **cleanup**.
2. Get a blank DAT tape, label it with your login and yymmdd, put it in DAT machine.
3. Enter **archstrip yymmdd &**.
4. Send a summary e-mail of the night to reducers@sal.wisc.edu
5. Logout from the XTERM window on chad, and quit the Xsession.

6.5 At End of Run

<u>In the Cone Room</u>

1. Turn off chiller
2. Unplug two AC cords on top of HPOL power box from AC outlet above.

<u>In The Dome</u> (> 6 hrs after above step)

Turn down two nitrogen flow meters on South side of instrument to 0