

User's Manual for the
Large Cassegrain Spectrograph
and
Automated Telescope Offset Guider

October 29, 2002
DRAFT 3

1 Introduction

The Large Cassegrain Spectrograph (LCS) is a conventional long slit CCD spectrograph which operates in the spectral range from $0.3 - 1\mu\text{m}$. It is attached to the Automated Telescope Offset Guider (ATOG), which in turn is attached to the 2.7-m f/18 Cassegrain telescope focus. Many functions of the LCS are actually integral to the ATOG. The LCS cannot be operated without the ATOG. Therefore, in this manual, we will refer to the combination of the two as the LCS.

Figure 1 shows a schematic layout of the ATOG/LCS instrument with major parts labeled. First, we will describe all of the functions of these parts and then discuss the software which runs the instrument.

2 The Components of the LCS/ATOG

2.1 Diagonal Mirror

After the light passes through the Cassegrain hole, it first encounters the **DIAGONAL MIRROR**. This mirror is tilted at approximately a 45° angle to the sky. The mirror sits on a translation stage. If the mirror is in the LCSFIELD position, the light from the telescope cannot pass through to the instrument but is, instead, passed to the CCD guide camera.

The diagonal mirror has an approximately 2in hole in it. When the diagonal mirror is in the LCSSLIT position, the light from the telescope passes through this hole into the spectrograph. A lens assembly is mounted on the back side of the diagonal mirror so that a region of the slit of about 1 arcmin is imaged onto the guide camera. Thus, the light can pass into the spectrograph and the observer can still guide directly off of any light from their object which is reflected off the edges of the slit assembly.

In practice, some observers' targets are too faint, or their slit too wide, to have any light reflected off the slit to guide upon. In that case, the observer may either trust the tracking of the telescope and observe "blind" or may translate the guide camera so that it images the diagonal mirror away from the hole and another object is used as a guide object. This mode is known as OFFSET mode. The translation of the guide camera will be discussed in more detail in the next section.

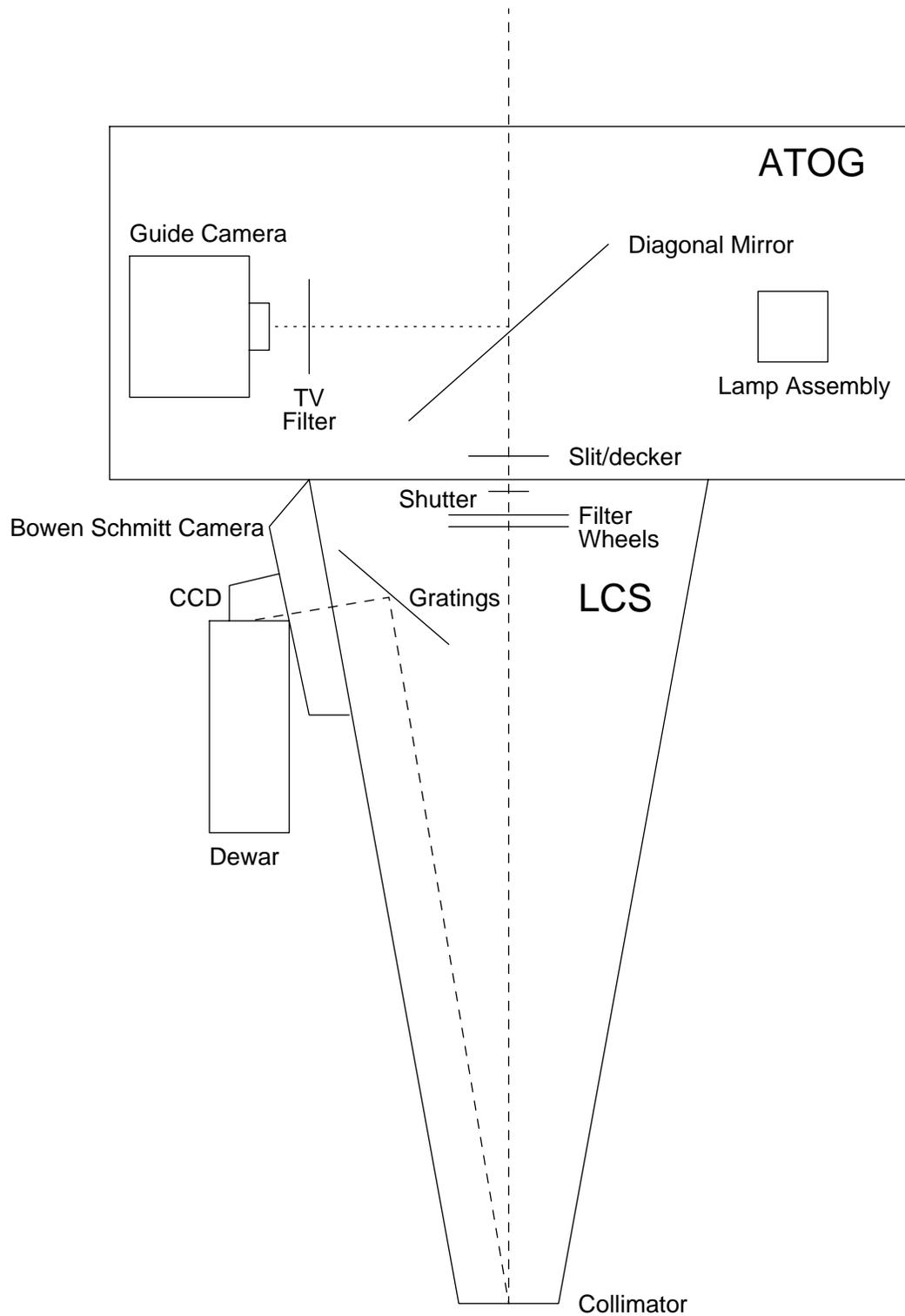


Figure 1: A schematic layout of the LCS and ATOG

2.2 Guide Camera Assembly

Guiding with the LCS is accomplished using a CCD guide camera. Currently the camera is an Apogee camera (the Star 1 camera is the backup setup). The camera is mounted in the ATOG, to the left in Figure 1. For instructions using either guide camera, the user should consult the appropriate manual for those cameras or ask the Observatory staff for instruction. The camera will have been placed in nominal focus for the instrument by the Observatory staff prior to the start of an observing run.

The field-of-view (FOV) of the cameras is about 4×5 arcmin in the LCS-FIELD or OFFSET viewing positions described above. Note that this is defined by the optics and is slightly smaller than the FOV of the chip (thus not all of the guide CCD chip is in use). When the user is guiding directly off of the slit in the LCSSLIT mode described above, the unvignetted FOV is approximately 1 arcmin.

A **TV FILTER SLIDE** is located in front of the guide camera. This slide has three filters and an open position. These filters *only affect light coming to the guide camera and do not affect light to the spectrograph*. Many users will want to observe with the filter slide in the open position in order for the most light to be received by the guide camera. For viewing very bright objects, there is an ND2.0 filter which may be chosen. In addition, there are red and blue filters. A user might want to select these if they want to guide at a wavelength similar to their spectra to minimize guide errors resulting from atmospheric dispersion.

The guide camera is mounted on a stage which can be translated in both X and Y as seen on the guiding software screen. This allows the user to search around a wider area of the sky than can be viewed in the default positions. This is useful for initial setup, searching for an object without moving the telescope or for OFFSET mode.

The user can independently command the **TV X-AXIS** and **Y-AXIS**. At the start of a run, the user will want to locate an object in the LCSFIELD position and then move the diagonal mirror to LCSSLIT and view the object on the slit. The user may want to place the object in a particular location on the slit and it might be necessary to move in X and/or Y to view this location. When this location is set, the user will move the diagonal mirror back to the LCSFIELD position and move in X and Y so that the object can be seen on the guide camera. The user should mark what position in the LCSFIELD position they must place the object so that when they move

the diagonal mirror to LCSSLIT and return the TV X and Y axes to where they had set them in the LCSSLIT position, it will place the object on the slit in the desired location. Then, for subsequent objects the user will just have to locate the object in the LCSFIELD position, place it on the marked spot and change the diagonal mirror and the TV X and Y axes to LCSSLIT and the object should be placed on the slit.

In practice, there is some slop in the position of the TV X and Y axes and so the transfer between locations may not be perfect. However, the CCD guide camera chip is sufficiently large that it is possible to set up the TV X and Y axes so that they need not be moved between LCSSLIT and LCSFIELD, but only the diagonal mirror has to be moved. The default positions in the GUI (see below) should allow X and Y to not be moved between LCSSLIT and LCSFIELD.

If the target object is too faint to be viewed in reflection off the slit, or the slit is wide enough that no light is reflected, the user can use the OFFSET mode to guide. In this case, the diagonal mirror is set into the OFFSET position, so that the light passes into the spectrograph. The user then uses the TV X and Y axes to maneuver the guide camera so that it is looking at an object which is on a part of the diagonal mirror outside of the vignetted region around the hole. Note that, because of the slop in the X and Y axes mentioned above, the user should recheck their marks to move between LCSFIELD and LCSSLIT after using the camera in OFFSET mode.

2.3 Slit/Decker Assembly

The LCS may be used with a slit of ~ 2.5 arcmin length and a variety of widths or the slit can be slightly shorter or there can be two parallel apertures. These choices are accomplished with a combination of a slit and a decker to define the width and length respectively.

The **SLIT WIDTH** is continuously adjustable with a bi-lateral slit mechanism. The slit cannot be completely closed since its limit is at ~ 0.8 arcsec. To insure most accuracy, the slit position is always set with respect to this limit so that a change from 3 arcsec to 2 arcsec will actually cause the slit to be closed to the limit and stepped outward again.

The length of the slit is set with the slit decker mechanism. This is a plate which can be maneuvered in X and Y to position the decker so that it defines the endpoints of the slit. The user can define any **DECKER X AXIS** and **DECKER Y AXIS** positions they choose to position the decker on the

Table 1: LCS/ATOG Filters

Position	Wheel 1	Wheel 2
1	CLEAR	CLEAR
2	CuSO ₄ [†]	GG375
3	BG18	GG420
4	UG5	GG475
5	ND2.0	OG515
6	NA	OG550
7	NA	RG610
8	NA	RG645

[†] See Text

slit and chip. However, there are some predefined positions of use to the observer.

For the X Decker, the predefined positions include LONGSLIT, which defines a slit length of around 2.5 arcmin, LONGDECK, which defines a slit length of around 80 arcsec, and SMALL which defines a pair of small holes (useful for aligning the spectrum on the CCD during setup).

The Y Decker positions the decker along the chip. The only predefined position is CENTER.

2.4 Spectrograph Shutter

The spectrograph shutter controls whether light enters the spectrograph and reaches the CCD. It is opened at the start of integrations and closed at the end.

2.5 Filter Wheels

Located below the slit are two filter wheels. **FILTER WHEEL 1** has 5 filter holes while **FILTER WHEEL 2** has 8 filter holes, one of which is always clear for each. The user may use any combination of two clears, one filter from wheel 1 and clear, one filter from wheel 2 and clear, or one filter each from wheels 1 and 2. The permanently installed filters are listed in Table 1. It is possible that the CuSO₄ filter will have been removed at times. Check with David Doss if you need this filter to determine if it is installed.

Table 2: LCS Gratings

Num.	Grooves/ mm	Blaze (Å)	Effective Blaze (Å)	Resolving ^a Power
40	300	4200	3900	550
41	300	7500	6000	550
42	300	10000	9200	550
43	600	4000	3700	1100
44	600	7500	6900	1100
45	600	10000	9200	1100
46	1200	4000	3700	2200
47 ^b	1200	6000	5500	2200
48 ^b	1200	7500	6900	2200

^a $\lambda/\delta\lambda$ for TI 1; multiply by 15/12 for CC1

^b Cannot be used redward of ~ 7500 Å because of limit.

2.6 Collimator

The collimator sits at the bottom of the LCS. The spectrograph may be focused by moving the collimator up or down. The focus is controlled with the **COLLIMATOR FOCUS** commands.

2.7 Gratings

The LCS has a wide choice of gratings for observations. These are listed in Table 2. The observer should specify the gratings needed in their Request For Services and the Observatory staff will usually mount them for the observer.

Three gratings may be mounted in the spectrograph at any one time. They sit side-by-side in a holder. The user may choose between the three gratings using the **GRATING SLIDE** option. The options for this command are **LEFT**, **CENTER** and **RIGHT**, with the orientations being defined by a user standing in front of the grating access port. In general, any grating can be placed in any slot except that gratings 47 and 48 can only be used in the right position.

The wavelength range can be set with the **GRATING TILT**. The user should use “/opt/atlas/bin/lcswave” as a first guess to the proper tilt to set. In this program, the user can either request a central wavelength and the program will yield a tilt, or the user can input a tilt and the program will

predict the central wavelength. Figure 2 is an example of a typical use of the program. Note that the value predicted by LCSWAVE is just a first guess and the user should check the resultant wavelength range and tweak it appropriately. To move the grating to a bluer wavelength, increase the encoder value; to move the grating to a redder wavelength, decrease the encoder value.

There is an important stability problem with the LCS that the user should keep in mind. The mechanism which holds the grating at the proper tilt has a great deal of flexure problems and the grating position can change with telescope position. To combat this problem, the user is advised to clamp the grating into position once the proper bandpass is selected (note that this will shift the spectrum slightly blueward). This is achieved by removing the side of the LCS and inserting the grating clamp and tightening (but not overtightening). *Whenever the grating clamp is in use, the observer must either turn off power to the grating tilt motor via the breaker or uncable the grating tilt motor or both so that an accidental commanding of the tilt does not cause damage to the mechanism.*

There is only one predefined position for the **GRATING TILT**. That is the **ACCESS** position. When the grating tilt is ordered to this position, the gratings are set in a horizontal orientation. This is needed whenever the user wants to insert or remove a grating. After placing the gratings into this position and choosing the appropriate grating, the user may access the gratings by opening the hatch on the left side of the instrument (see Figure 1) just above the dewar. Be careful not to pull down on the door and bend it around the dewar. Then the gratings can be removed by flipping the latch from vertical to horizontal and sliding the gratings out. An experienced user or Observatory staff member can show users how to do this, although the user should probably not be changing gratings.

2.8 Camera

The camera for focusing the light from the grating onto the CCD is a Bowen Schmitt Camera. The camera lens is a part of the CCD cryocan. There is no external focus mechanism. The user can not do anything with this camera.

Figure 2: Example of LCSWAVE

```
[atlas] /opt/atlas/bin/lcswave
Wavelength or Slew (w/s)(w)?w
Enter wavelength: 4300

                <-300 mm-> <-600 mm-> <-1200 mm->
Grating? (Enter 40 41 42 43 44 45 46 47 48)(): 40

Order? 1
w 4300 40 1

Input values:
Wavelength = 4300  Grating = 40  Order = 1

Slew setting = 6809    One slew step = 3.9 Angstroms

Dispersion = 0.222 Angstroms/micron
  TI1: 3.38 Angstroms/pixel
  CC1: 2.66 Angstroms/pixel

Central wavelength = 4300.00 Angstroms
Coverage is approximately 2948 to 5652
```

2.9 CCD

Finally, the light enters the CCD. The front window is a field flattening lens. Two CCDs may be used with the LCS. These are the thinned, back-side illuminated TI 1 CCD. TI 1 has $15\mu\text{m}$ pixels and good UV/blue response. Because it is a thin chip, it suffers from fringing in the red, which starts at around 6500\AA and can be as large as 20% at 9500\AA . As the telescope position changes, the fringes change position on the sky, so if TI 1 is used in the red, great care must be taken to observe flat lamps at the positions of targets.

The other CCD is a thick, front-side illuminated Loral Fairchild CCD, designated CC 1, with $12\mu\text{m}$ pixels. This chip does not suffer from fringing in the red and so is the chip of choice for the red. It is coated with metachrome for improved blue response. However, the quantum efficiency of CC 1 is lower than that of TI 1 *at all wavelengths* so that users who do not need the higher resolution of CC 1 who wish to observe in the blue should always choose TI 1.

The nominal resolving power ($\lambda/\Delta\lambda$) for TI 1 in first order is 550 for 300 grooves/mm, 1100 for 600 grooves/mm and 2200 for 1200 grooves/mm. The nominal resolving power for CC 1 is 15/12 of that for TI 1. The nominal spatial resolution for TI1 is 0.64 arcsec/pixel if there is no binning in the spatial direction. CC 1 is 12/15 that of TI 1.

Filling the CCD dewars with LN_2 is the responsibility of the observers. The dewars should be capable of remaining cold for 24 hours. However, it is suggested that observers fill the dewar at the start and end of the night for reliability.

The CCD dewar is held onto the LCS with a circular ring. The user may wish to align the spectrum with the rows and columns of the CCD. To do this, the user rotates the CCD to align it with the grating. Each grating may require a slightly different rotation. The CCD is rotated by loosening the four bolts on the ring about 1/4 to 1/2 turn, rotating the whole dewar (there is a micrometer for positioning) and then clamping the four bolts. The bolts should be loosened and tightened by first loosening the upper left screw, then the lower right screw, the upper right screw and finally the lower left screw.

If one is using the “small” XDECKER and the length of the chip to determine the rotation, one needs to move the micrometer to smaller numbers if the blue end is to the left (lower pixel numbers) of the red end. A 1 pixel difference is approximately 0.25 mm on the micrometer.

When displaying the spectral image within a tool such as ximtool, the

spectrum will run from blue at top to red at bottom in the default orientation for ximtool (e.g. no flipped axes). Spatial will be left to right.

2.10 Calibration Lamps

The user will want to calibrate their spectra for dispersion as well as flat fields.

For flat fielding, the observer should image a dome flat through the telescope. Point the telescope to the dome plaque (coordinates are known to TCS), position the dome so the telescope is looking at the plaque and the curtains are not in the way, open the mirror cover of the telescope, put the diagonal mirror in the LCSSLIT position and turn on the dome flat lights.

Users who want to observe a flat lamp at some random telescope position (e.g. if needing a lamp at a target position for fringe removal) can look at the dome lamp reflected off the dome curtains. The UV reflectivity of the curtains is substantially reduced from that of the plaque, which has a special paint, so users working in the blue should always use the plaque. If observing lamps off the curtain in the middle of the night, the user *must close the dome* to minimize disturbing observers on other telescopes.

For dispersion curves, the LCS has internal hollow cathode calibration lamps. These are located in the ATOG on the right side of Figure 1. The LCS contains both argon and neon lamps which are each useful at different bandpasses. The light is projected into the instrument from the lamps by reflection off of a mirror which is attached to the back side of the diagonal mirror. Thus, to observe a hollow cathode lamp, the user must place the diagonal mirror into the LCSFIELD position. Then the user selects which lamp they want and the power for that lamp with the **COMPLAMP** command. It is suggested that the user use a narrow slit for these observations to minimize the blending and to improve centroiding.

The intensity of the lamp spectra may be controlled in two ways. The user can set the intensity of the lamp itself in the COMPLAMP command. However, sometimes the lamp cannot be set to a low enough level and still have enough power to light. Then the user can use the **COMPLAMP FILTER WHEEL** to attenuate the light. The filters which exist are ND0.3, ND0.5, ND1.0 and ND2.0. Most users will use no filter.

3 Position Angle of the Instrument

When the instrument is mounted on the telescope, the TV guider and the CCD are normally on the north side of the telescope and the ATOG control electronics are on the south. This results in the slit being positioned east/west ($PA = 90^\circ$). The complete instrument can be rotated on the back of the telescope. This might be done to align along the parallactic angle or to align with a particular feature. The position angle of the instrument cannot be controlled by the computer.

To rotate the instrument, the user must cable the external position angle rotation box to the underside of the ATOG. This can be done at the start of a run and the control box can be left on the dome floor. However, it is suggested that the control box only be plugged in when needed. There is a position angle scale marked on the side of the ATOG near where it mates with the telescope. An arrow points to the position angle of the slit (so in the nominal position it points to “90”). To rotate the instrument, the control box is plugged in and a direction is selected (clockwise or counter-clockwise). Then, the power level knob is turned up to control the speed of rotation. The user stops rotation when the desired position angle is being pointed to by the arrow.

The instrument can be rotated at any telescope position but it may be difficult to read the scale in some positions. Care should be taken when the telescope is pointed to the southeast since the bottom of the LCS is near the floor then and the cables can get trapped underneath the instrument in some orientations.

Users who do not anticipate a need for rotating the instrument do not need to hook up the external box at all.

4 Software for Instrument Control

All of the hardware except the position angle are controlled with software which runs on the Sun computers in the control room. With the exception of the CCDs, all of the functions may be controlled with a stand-alone GUI or from within the ICEX package of IRAF. The science CCDs can only be controlled via ICEX.

Most of the functions of the LCS are executed with stepper motors which can be controlled via software. The positions of the various functions are

generally determined with 10-turn potentiometers (pots) which are only approximately absolute (they can drift). The GRATING TILT position is an absolutely encoded motor. In what follows we will differentiate commanding the various pots and encoders in STEPS and COUNTS. STEPS refer to actual motor steps. COUNTS refer to pot or encoder values. For most devices, positions may be located in either of these units.

4.1 Stand-alone GUI

The GUI is run from an Atlas window and is invoked with the command “/opt/atlas/bin/atog”. When the program is first invoked, the user will get a screen that looks like Figure 3.

On the leftmost side of the GUI is listed the command names. The first column to the right of the command names (column 2) has a heading of “L”. When this box is “L” and red it indicates that the device is at a limit. Column 3 (“Encoder”) gives the present location of any device. Column 4 (“Position”) indicates if the encoder location given in column 3 is near any of the predefined positions. Column 5 (“Next”) is a box that the user can use to enter values to move a device. Column 6 shows an arrow. This indicates that there is a pull-down menu from which the user can select predefined locations. Column 7 has a button marked “Go”. This is used to send a device to the selected location. If go is pushed but no “Next” position was given, the device does not move. The user can move each device individually or can select several devices to move and can move them with one click on the “Go All” button described below.

In the example in Figure 3 none of the devices are at their limits (no Ls in column 2) but the Diagonal Mirror, TV X-Axis and TV Y-Axis are all in the LCSFIELD position, the TV Filter is RED, both science filters are in their CLEAR positions, there is a ARGON lamp on with an ND2.0 filter. The decker is CENTERed and is a long slit. The Grating tilt is not at the access but is at an encoder value given in column 3 and the collimator focus is at 4069.

At the bottom of the GUI are 3 buttons. The “Go All” button will move all of the devices for which locations have been chosen. It moves the devices one at a time. The order the devices is moved in is defined by the way the devices are wired on the ATOG and *they are not executed in the order the locations were chosen nor on their order top-to-bottom on the screen*. The “Clear All” button clears any locations which have been selected for motion.

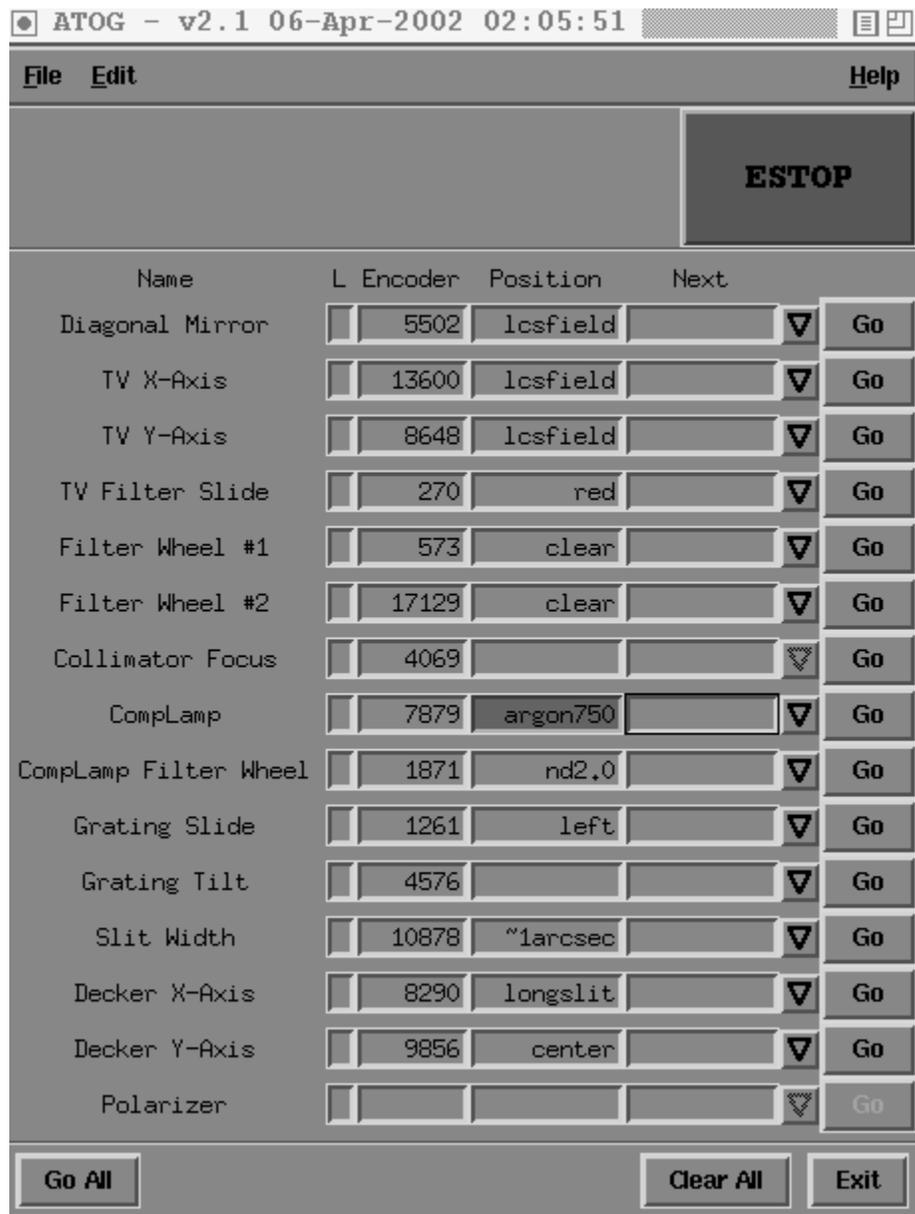


Figure 3: The ATOG/LCS GUI

The “Exit” button is used to exit the program. A dialogue box will open to confirm you really wanted to exit. A “shift” while clicking on exit will exit the program without confirmation.

Near the top of the gui is a big, red, button marked “EStop”. Clicking on this button will halt immediately any motors which are running and abort any moves which were selected but not executed as part of a “Go All”.

At the top of the GUI are two pull-down menus, FILE and HELP (the edit button shown in the figure has been removed). Only FILE is currently operational. It includes an “Exit” which duplicates the function of the exit button and “Save”, which is used to save the current definitions of the predefined positions to the “.atogrc” file *in the directory from which you started the atog gui* (see next paragraph – the old “.atogrc” file will be move to “.atogrc~” in the same directory).

When the user starts the GUI program, the system default predefined positions will be loaded (these are located in /etc/atogrc). The program will then search for any user predefined positions in a “.atogrc” file. The program will first search for this file in the current directory and then in the user’s home directory. Figure 4 shows an example of a “.atogrc” file. The user defined positions will be loaded. If the user defines names that *are not* in the system file, the user’s names will be added to the predefined lists. However, the user may also replace the system predefined values by using a name *that is* in the system file with a different value. Note that the program *will not* report that you have changed a predefined value. If the user has a .atogrc file in the local directory and the home directory, the one in the local directory is the one which will be loaded. Note, however, that the “Save” function always saves to the directory from which ATOG was started, regardless of whether the original .atogrc file came from your home directory or from the directory from which you started atog.

The next positions to go to can be described in various ways. If not using predefined positions from the pull-down menu, the next position can be typed into the “Next” block. To do this, the user must first activate the desired device next block by clicking in it. The various notations which may be used are described in Table 3. When the user designates an encoder position, the program computes how many steps to tell the motor to move but it also checks for the value being returned from the pot or encoder. It stops when it gets within a certain tolerance of the value. The tolerances are preset in the program. When telling a device to move in motor steps, the device moves by an exact number of steps and at the end reports the value

Figure 4: Example .atogrc file. A version suitable for editing is available at “/etc/atogrc.tmpl”.

```
# ATOG/LCS Example Template File - 07 Mar 2002
#
# Sections are started with a [] type declaration. The [] brackets
# can contain either an old style two letter device name or the long
# form shown when the atog program is running with spaces replaced by
# underscores or, finally, the long form but with all the spaces
# simply removed. Commands are found only after a section declaration
# and they always follow the format ‘command=argument’. Comments can
# be found anywhere and they always start with the ‘#’ character.
# Blank lines are also allowed anywhere. Note that all strings (section
# names, commands, and arguments) can be in upper, lower, or mixed case.

[xt]                # Start TV X-Axis section (using short name)
location=newx1(@1234) # new location newx1 with spec @1234
location=lcsfield(@760) # replace current lcsfield with a new loc spec
# etc, etc, etc.

[tv_y-axis]        # Start TV Y-Axis section (using long name)
location=newy1(@999)

[deckerx-axis]     # Start Decker X-Axis section (long name w/out spaces)
location=xxx(@yyy)
```

Table 3: Ways to Designate Moves

Designation	Action
@n	move to encoder value n
@label	move to the predefined position “label”
±n	move the encoder value plus or minus n counts
#±n	move n motor steps positive or negative
]n	move to the upper limit and then move down by n steps
[n	move to the lower limit and then move up by n steps
]]n	move to the upper limit fast, then find the limit very accurately and slowly and then move down by n steps
[[n	move to the lower limit fast, then find the limit very accurately and slowly and then move up by n steps

returned from the pot or encoder. The user may want to go to a predefined position without worrying about its encoder value or the number of steps. This can be done by using the pull-down menus or by the command being typed into the “Next” column.

In Table 3 there are two different types of move n steps away from the limit. The difference is one of precision. Whenever a device encounters a limit, the controllers will automatically step the user off the limit. Because there is a finite time to sense that the device is no longer at the limit, the number of steps off the limit may be different at different times. For many devices, where the encoder value does not have to be precise to the nearest count, this mode is fine. However, some devices, like the slit width, need more precision setting. Thus, there is a mode that will first run to the limit quickly and the controller will move back off the limit by some unknown number of steps. Then the motor is single-stepped to the limit so that the program knows it is exactly one step off the limit. Then the move is completed by stepping away from this point. While this method is very precise, it is much slower, which is why it is not done by default for most devices. To move to either limit for a device use a “[0” or “]0”.

If using the pull-down menus, the user just needs to move to the arrow and hold down the left mouse button and select a position. Then click “Go” or select positions for other devices getting ready for “Go All”. If the user holds down the right mouse button, a table of the predefined values with labels and values will appear (see Figure 5). The user can highlight one of the labels. The label and its value will appear in a box at the bottom of



Figure 5: An example of a device value editing box

this screen. The value in this box can be edited to change it. If the label is changed, a new predefined location is created. At the top of this dialogue box is a box marked “Enabled”. If the user unselects this box, then the device will not respond to any commands while the gui is running. Unless “Save” is selected from the “File” menu, these changes are not saved when the program exits but will be in effect as long as the program is running.

When any device is moving, the device “Encoder” block on the GUI (column 3) will flash and the user will see the encoder values update. When the requested position is reached, the flashing will cease and the program will beep.

The program keeps a history which the user can access. A list of past commands may be accessed by right clicking the mouse while positioned on the “go” button. Figure 6 shows an example. To recall a command from the list, just click on that line. This will load the command into the next block to be executed the next time a “go” or “go all” is selected. Alternatively, a “shift” plus right button on the “go” will reissue the last command. This is most useful when stepping a device by a number of steps to repeat the same move.

Not listed in Table 3 is the syntax for selecting comparison lamps. Here, the user has the choice of argon or neon and also various lamp intensities, which are set in volts. To use the lamps, the diagonal mirror must be in the

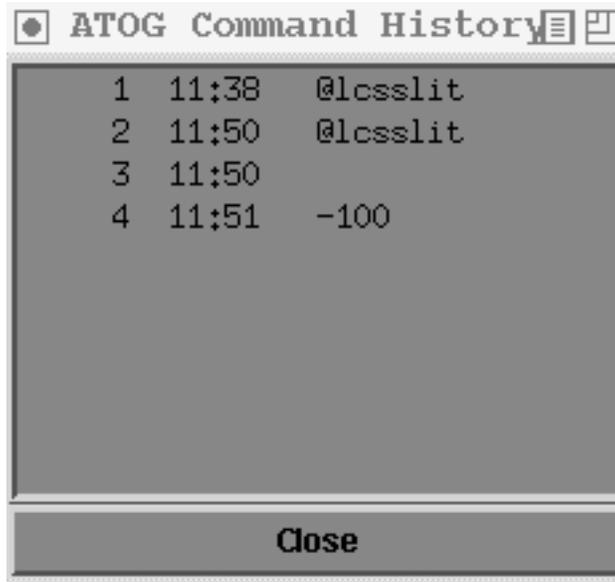


Figure 6: An example history file”

LCSFIELD position or the lamp will not fire. Then the lamp and intensity must be set in a composite command such as “@neon1.5” which means to fire neon with 1.5 volts. When neon is chosen, the position box will have a pink-red background. When the lamp is turned off, it will still say “neon” in the box. When argon is chosen, the position box will have a purplish background. Once a lamp type is chosen, the user need only specify the intensity to turn it on again. Thus, if “@neon1.5” was the last use of the lamp, “@2.5” would fire neon with 2.5 volts. Intensities may be specified in either volts or millivolts so 1.5 volts can be either can be either “@1.5” or “@1500”. A value of “@0” will turn off the designated lamp. A value of “@off” will make sure both lamps are off.

4.2 The ICEX interface

The science CCD is controlled with the IRAF package “ICEX”. Though the user will be logged in on the console of oberon, the CCD can only be run from atlas. Therefore, before starting IRAF and the ICEX package, the user should open an atlas window and “setenv DISPLAY oberon:0.n”, where n is 0, 1, or 2 for the different oberon screens. Be sure to execute an “xhost + atlas” on oberon prior to opening your display.. Then start ximtool or saomage (e.g. “ximtool &”). At this point IRAF can be started. See the Appendix for some information on parameter files needed to run the LCS.

All functions controlled by the ATOG stand-alone gui can also be controlled by the “instrument” parameter file within ICEX. However, users may

choose to only use the stand-alone gui and never control the ATOG from within ICEX. Control from within ICEX is useful for creating macros which move multiple devices and then obtain some spectra.

Before any ATOG commands can be issued by ICEX, the ATOG gui must be running since it is the ATOG gui program which executes the commands. When a device is being moved under ICEX control, the position in the “next” box will be highlighted in yellow.

All interactions between ICEX and the ATOG use the instrument command and the instrpars parameter file. For complete details check the manual at “www.as.utexas.edu/mcdonald/computer/lcs_ice_commands”.

Note that if you use the “comps” command in ICEX to run your comparison lamps (as opposed to using observe or object, etc.), then you will have to modify your comps par file to set the parameter “complamp” to a valid instrpars parameter such as “l@value”, where value is something like argon9000 or neon3000 (a blank is a valid instrpars value). See the web page mentioned above for other valid parameters. Failure to do so will result in an error message and the lamp will not be turned on if it is not already on. If the user turns on the lamp with the gui before issuing the comp command, then failure to have a valid instrpars value in the par file will just result in an error message, but will cause no other problems.

Regardless of whether or not the user issues commands to the ATOG program from ICEX, the ICEX package will communicate with the ATOG. At the start of every integration, the ICEX package will query the ATOG program for the status of all devices and put the status information into the fits headers.

4.3 Some Potentially Useful Notes

The predefined LCSFIELD and LCSSLIT positions were carefully chosen so that users should not have to move the TV X-Axis or Y-Axis to move from field to slit. This works because the guide cameras have a much larger FOV than the optics. This mode is desirable because of the slop in the TV X and Y axes. At the time the predefined positions were set up, an object just to the right of center in the field would be just to the left of center in the slit.

If you move the TV Y-axis, increased encoder values will move an object up on the screen. If you move the TV X-axis, increased encoder values will move an object to the right on the screen.

The hollow cathode lamp intensities are set in voltages with the maximum

voltage being 10 volts. The minimum voltage which will cause either lamp to fire is 0.75 volts.

There are many predefined slit widths. The user who needs another value than the predefined ones may calculate it as follows:

$$nsteps = (arcsecdesired - 0.84) * 0.237 * 400/0.5$$

where $nsteps$ is the number of steps to command the slit to move, $arcsecdesired$ is how wide the slit should be in arcsec, 0.84 is the minimum slit width in arcsec, 0.237 is the mm/arcsec, 400 is the number of steps in one motor revolution and 0.5 is the number of mm the slit opens in one revolution. Be sure to use the “]n” version of the move commands to specify the slit width move.

For focusing the collimator, steps of ~ 400 are a good size for finding the approximate focus.

When moving the grating tilt, increasing encoder values move the spectrum to the blue. You can use the LCSWAVE program to predict the number of Å/step for your grating.

The Decker X and Y-axes were defined when the LCS was sitting on its cradle off the telescope. Thus, their orientation on the TV is not very intuitive. Moving the Decker X-axis makes things appear to move in Y and vice versa.

There is a known flakiness with the ATOG program. Sometimes all of the encoder values will show as “0”. We don’t know why but this means the program has lost contact with the ATOG. If this happens, exit and restart the program. Log the number of occurrences in the night report.

5 Appendix: ICEX parameter files for the LCS

In order to run the LCS under icex, you will need to make sure that four ICEX parameter files have information necessary to run the instrument. These four parameter files are “instrpars”, “detpars”, “obsvars”, and “telpars”. Examples follow.

Figure 7 shows an example of the DETPARS file. This example is for the TI 1. Thus, “lastcol” and “lastrow” are set to 800. For CC 1, these should be 1024. In this example, we are binning 2 pixels in the spatial direction

Figure 7: The DETPARS file

(firstcol = 1)	First column of data (device coordinates)
(lastcol = 800)	Last column of data (device coordinates)
(firstrow = 1)	First row of data (device coordinates)
(lastrow = 800)	Last row of data (device coordinates)
(colbin = "2")	Column binning factor
(rowbin = 1)	Row binning factor
(preflash = 0)	Preflash time in seconds
(gain = 0)	Instrumental gain setting (0 for default)
(detinfo = "")	Optional image header info about detector
(detcap = "runlib\$detcap")	Detector capabilities file
(detname = "ti1")	Detector name
(detpix = "u")	Data type of detector pix (u=16-bit l=18-bit)
(integrator = "1")	Detector integrator (1=slow 2=medium 3=fast)
(amplifier = "1")	Detector amplifier
(nframes = "")	IRDetector sum/average nframes
(angle = 0)	Detector angle from nominal
(regions = "")	Selected regions of the detector to readout
(debug = no)	Debug the detector interface
(mode = "ql")	

("colbin"). The only other parameter which is not a default value is that "detname" is set to ti1. For CC 1, this should be set to cc1.

Figure 8 is an example of an OBSPARS file. Parameters such as "exposuretime", "imagetype", and "objecttitle" will be filled in by whatever observe task the user is using. The filename is constructed of a concatenation of the "rootname" and "sequence". The sequence number updates automatically with each image. The user may want to add things to parameters such as "observers", "comments", etc. "Command" is the command for post-processing. In this example, the data will be displayed at the end of the readout to buffer 1 of the image tool.

Figure 9 is the INSTRPARS file. The user must set "instrname" to "lcs".

Figure 8: The OBSPARS file

exposuretime =	Exposure time (seconds)
imagetype =	Image type
objecttitle =	Object title
nfexpo = 7	Number of focus exposures
shdtype = "detector"	Shift type
focmode = "manual"	Focus mode
fstart =	Starting focus value
fdelta = ""	Focus increment
nrrows = 25	Number of rows to reverse shift
(rootname = "lc0")	Image root name
(sequence = 5907)	Sequence number
(setfilters = no)	Query and set filters?
(setfocus = no)	Query and set focus?
(setscanrows = no)	Query and set nscanrows? (short scan mode)
(filtype = "telescope")	Type of filters to use
(foctype = "telescope")	Type of focus to use
(pixtype = "u")	Data type of IRAF pixels
(observers = "")	Observers
(comments = "")	Comments
(comfile = "")	Observer header comments file
(obsinfo = "")	Optional observing information for image header
(observatory = "MCDONALD")	Observatory name
(command = "display %s 1")	Postprocessing command
(preallocate = 60)	Preallocate image (0=no 1=yes N=if exptime > N)
(preprefix = "imdir\$_")	Preallocate image prefix
(longexpo = 300.)	Long exposure time (seconds)
(verbose = yes)	Type out image name?
(debug = no)	
(mode = "ql")	

The use of the other parameters is described in the section on using ICEX, above, and on the web page referenced in that section.

Figure 10 is an example of the TELPARS file. Most parameters are filled in automatically when an observe task is executed. The user must set the “telname” to “mcd107x”.

Figure 9: The INSTRPARS file

```
(instrfilters = "")      filter bolt positions
  (aperture = "")       aperture
  (tvfilt = "")        tv filter
  (complamp = "")      comparison lamp
  (probepos = "")     probe position file
  (disperser = "")    disperser
  (tiltpos = "")     tilt position
  (order = "")       spectral order (0 = most efficient)
  (decker = "")     decker
(instrfocus = "")    instrument focus
  (posangle = "")   position angle
  (dispaxis = "")  dispersion axis
  (fts = "")       filter translation
  (filtoffs = "")  filter offset values
  (gts = "")       grism translation
(slitunitoffs = "")  slit unit focus offset values
  (polarizer = "")  polarizer angle in degrees
  (instrinfo = "")  Optional image header info about instrument
  (instrcap = "runlib$instrcap") Instrument capabilities file
(instrname = "lcs")  Instrument name
  (debug = no)      Debug the instrument interface
  (mode = "ql")
```

Figure 10: The TELPARS file

(dateobs = "")	date (dd/mm/yy) of observation
(ut = "")	universal time (hh:mm:ss)
(st = "")	sidereal time (hh:mm:ss)
(ra = "")	right ascension (hh:mm:ss)
(dec = "")	declination (dd:mm:ss)
(epoch = "")	epoch of ra and dec
(ha = "")	hour angle (hh:mm:ss)
(zd = "")	zenith distance (dd:mm:ss)
(airmass = "")	airmass
(telfocus = "")	telescope focus
(telfilters = "")	filter bolt positions
(rotangle = "")	rotation angle
(pressure = "")	barometer
(teltemp = "")	telescope temperature
(windspeed = "")	wind speed
(winddirectio = "")	wind direction
(humidity = "")	humidity
(seeing = "")	seeing
(pointsrc = "")	point source info
(pointdir = "")	optional point source directory info
(pointtype = "mean")	point type header info
(aperture = 2.7)	telescope aperture size (m)
(focalratio = 18.)	telescope focal ratio
(tcscmd = "")	TCS motion command
(telinfo = "")	Optional image header info about telescope
(telcap = "runlib\$telcap")	Telescope capabilities file
(telname = "mcd107x")	Telescope name
(debug = no)	Debug the telescope interface
(mode = "ql")	
