Steward Observatory 2.3-m Boller and Chivens Spectrograph Manual

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Chapter 1

Introduction

This is an illustrated cookbook for the 2.3-m Boller and Chivens Spectrograph. It follows the light path from the telescope to the detector in discussing the internal elements and their access. It is not a substitute for experience in understanding either the optical design or any current idiosyncracies of the instrument, underscoring the requirement for the first-time user to be checked out before a solo run.

We will use a **boldface** font to denote commands and settings issued by the user. The abbreviations "CW" and "CCW" denote "clockwise" and "counterclockwise" respectively. Also, the letters appearing in square brackets [ ] correspond to identifications in the illustrations of Appendix A (see below).

1.1 Overview

The B&C Spectrograph is a somewhat evolved version of the classic reflection-optics spectrograph built by Boller & Chivens in the late 1960's. It is capable of moderate-resolution (~1–5Å) with good throughput from the atmospheric limit at ~3200Å to the near-IR. A provision was implemented in the mid-1970's for multi-order "echellette" spectroscopy with a cross-dispersion prism, providing 1–2Å resolution and complete coverage over $\lambda\lambda 3200 - 8000$ for a detector of sufficient size.

Light enters the spectrograph just behind the Cassegrain mounting plate through an aperture assembly which currently accepts one of two reflective slit plates (§3). The field around the slit is reflected to a CCD/intensified TV camera for acquisition and guiding (§5). Light which passes the slit encounters in order: an electronic shutter for controlling exposure, an order-separating/neutral density filter wheel (§7), a below-the-slit viewer for alignment/focusing purposes (§5), and then the $f/9$ off-axis paraboloidal collimator(§6). The primary disperser is a standard 102×102mm reflection grating (§2) chosen from a wide assortment of available options. Following the grating, the light can be cross-dispersed with a 60° quartz prism (§2.3) or sent directly through a manual camera shutter to the spectrograph camera. The camera (§10) is an on-axis, semi-solid Schmidt with the corrector element air-spaced from the sphere/secondary/field-flattener. Slit demagnification in the spatial direction is 5.44, for a resulting image scale of $54''$/mm on the detector ($1'' = 18\mu$m). A CCD dewar (§12 and a separate manual) with integral window follows the spectrograph. Calibration lamp illumination is provided via a small mirror inserted above the slit(§4).

Appendix A presents four color photographs illustrating the external components of the B&C Spectrograph. A new user should become familiar with these photos! The sides of the spectrograph will be referred to in this manual as being those corresponding to the photos. "Side 1" thus refers to the side closest to the control room, with Sides 2 – 4 corresponding to those seen when walking clockwise around the instrument. For the directionally-oriented, Side 1 refers to the west side, and Side 2 the south side, etc. The letters in square brackets appearing throughout the text refer to the same identifications marked in Appendix A.

1.2 Policy

The time between 10 AM and 3 PM is daily allocated to the Steward Observatory technical staff to make instrument changes, repairs, and updates. Hence it is advisable to always transfer data to tape and power-down before 10 AM. If additional time is needed, please make prior arrangements with the Operations staff.

1.3 Problems

The *Steward Observatory CCD Manual* contains the documentation on the CCD acquisition software, as well as other information on the computer operating system.

For technical problems with the spectrograph, CCD, and other hardware, first notify the Telescope Operator. If necessary, then proceed *in order* down the current calling list which is posted on the observer's console.

1.4 Observer's Responsibilities

Particularly delicate and vulnerable pieces of instrumentation on the spectrograph are the CCD camera, acquisition TV, and gratings. The observer must take special care to observe the following:

1. *NEVER tinker with the CCD dewar, CCD electronics box, or cabling.* See Chapter 11 for explicit precautions.
2. *NEVER blast the CCD or acquisition TV with excess light levels,* as *e.g.* from comparison lamps, dome lights, bright stars, etc. An excessively bright image on the CCD may require days to decay. Overillumination of the acquisition TV may be fatal to the intensified Vidicon. See CCD Manual for information on illumination limits of the CCD and Chapter 5 of this manual for further information regarding the acquisition TV camera.
3. *THUNDERSTORMS:* When thunder can be heard from the Bok walk, or the antenna on the Bok walk is ticking, turn **off** the CCD interface power supply, CCD controller, the Sun computer and all of its peripherals. Do not depend on the mountain crew to do this – they cannot be on site at all times.
4. *NEVER touch or attempt to clean a grating in any way.* Even air jets can be harmful, as shop-quality compressed air contains an oil mist and cans of "Dust-Off" occasionally squirt a stream of liquid propellant. Always close grating covers before removing them from the spectrograph and reopen covers only after locking them into the rotation mechanism.
5. *Treat the instrumentation with respect and care.* These are expensive pieces of facility hardware which are essential to the research programs of many scientists. No crank, knob, or lever should require excessive force for operation. If it does, something is wrong, and further damage will almost certainly result from additional elbow grease. Tell your telescope operator of the problem. If he/she cannot solve it, consult the appropriate calling list for that instrument.

Chapter 2

The Grating

Table 2.1 contains the current grating inventory and dispersion characteristics as used in the B&C Spectrograph. Note that these parameters were computed assuming a 1200×800 pixel CCD with $15\times15\mu$m pixels. Useful spectral range is limited by the smaller of the "Spec Coverage" or "Free Spec Range" (separation between orders) of the grating. Similarly, resolution for the high-dispersion gratings will be poorer than that indicated because of inadequate sampling of the slit at the detector. Absolute grating efficiencies are shown in Figures 2.1-2.3.

2.1 Changing the Grating

To change gratings, one must take care to protect the detector package if it is powered up. The Schmidt camera shutter (see below) should be closed and dome lighting minimized. Gratings are stored in two wooden boxes in the filter storage room. Refer to the illustrations in Appendix A for the bracketed letter identifications.

Use the following procedure to change gratings:

1. Protect the Schmidt camera by switching its shutter lever [W] closed (see Chapter 10).

2. On Side 3 of the spectrograph is a black port cover [Q] with a handle and three knurled knobs. Loosen the knobs and rotate the cover CCW and lift it off gently.

3. If there is a grating in place, <u>close</u> its cover by pushing the red cover slide in until it hits a hard stop.

g/mm	Order	Blaze Ang(°)	Blaze λ(Å)	Dispers (Å/pix)	Spec coverage (Å)	Free Spec Range (Å)	Resol (Å)	Peak Eff (%)
180	5	23.90	8022	1.32	1586	1459	2.04*	50
	6		6685					
	7		5730					
	8		5014	0.83	990	590	1.28*	
	9		4457					
	10		4011					
	11		3646					
	12		3342	0.55	660	267	0.85*	
300	1	3.63	3761	3.64	4373	2507	8.36	70
300	1	6.47	6693	3.72	4460	4462	8.11	75
	2		3347	1.86	2231	1339	4.05	
400	1	6.30	4889	2.78	3342	3259	6.09	
400	1	9.70	7506	2.84	3411	5004	5.85	62
	2		3753	1.42	1706	1501	2.92	
600	1	6.90	3568	1.86	2237	2379	4.03	
600	1	13.00	6681	1.93	2310	4454	3.72*	58
	2		3341	0.96	1155	1336	1.86*	
600	1	8.63	4458	1.88	2261	2972	3.95	
832	1	20.57	7524	1.42	1707	5016	2.37*	55
	2		3762	0.71	854	1505	1.18*	52
1200	1	21.10	5346	0.99	1185	3564	1.62*	
1200	1	31.90	7847	0.99	1187	5232	1.26*	46
	2		3924	0.49	593	1569	0.63*	41
1200	2	46.07	5347	0.47	563	2139	0.35*	

Table 2.1: B & C Spectrograph Grating Inventory. Parameters computed assuming 2″ slit and 1200×800 CCD with 15×15 μm pixels. At tilt angles > 20°, the beam from the collimator is progressively vignetted by the undersized grating (see Figure 2.5). The above calculations used camera-collimator angle = 54°, and camera focal length = 4.96 in. Note also that one will be limited by the smaller of either the spectral coverage or free spectral range.

*These configurations are undersampled (< 2 pix/res element), hence the quoted resolution will not be achieved.

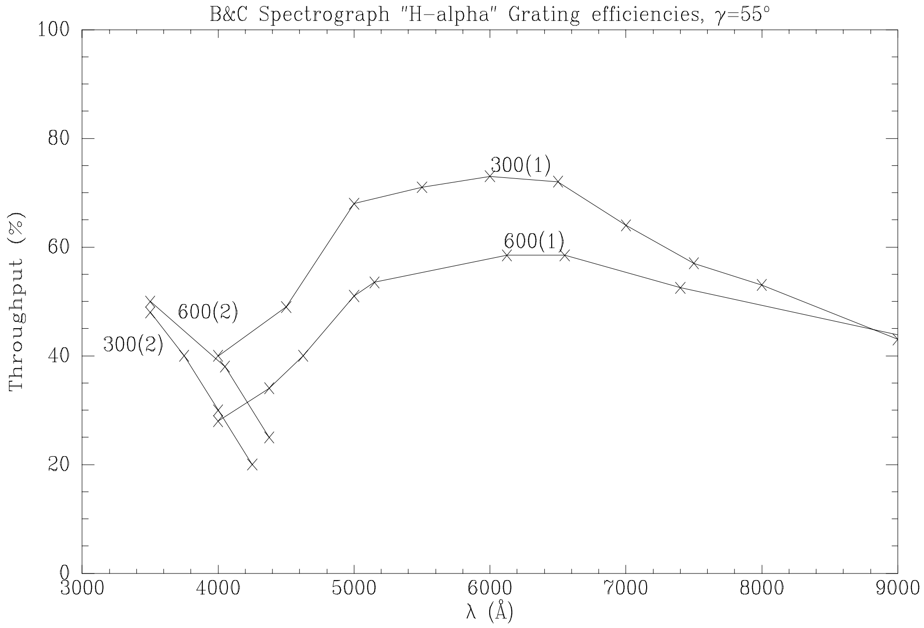

Figure 2.1: Efficiencies for gratings 300(1)/6693Å, 300(2)/3347Å, 600(1)/6681Å, and 600(2)/3341Å.

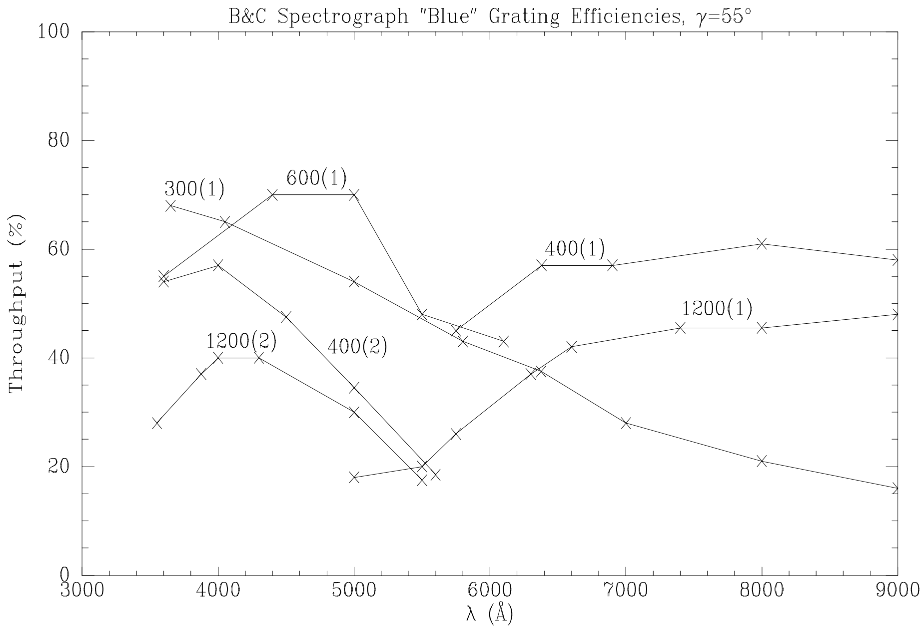

Figure 2.2: Efficiencies for gratings 300(1)/3761Å, 600(1)/4458Å, 400(1)/7506Å, 400(2)/3753Å, 1200(1)/7847Å, and 1200(2)/3924Å.

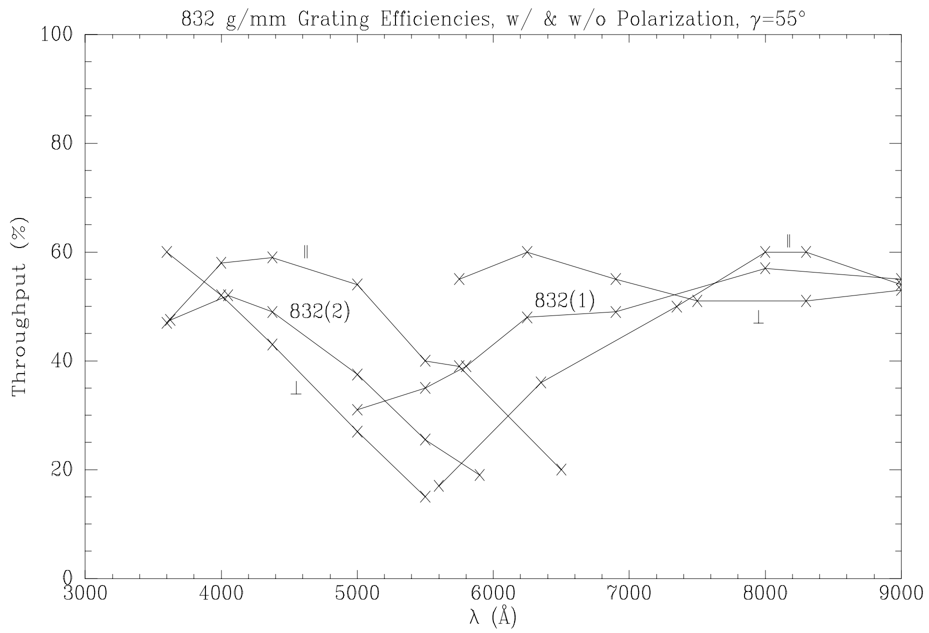

Figure 2.3: Efficiencies for 832 g/mm gratings, for unpolarized light as well as light polarized perpendicular and parallel to the grating.

4. Unlock the grating by turning the half moon handle CCW 90 degrees, *i.e.* until its flat surface is parallel with the grating holder. Gently pull the grating holder out, pulling on its black handle. If there was no grating, just make sure the half-moon handle is fully CCW.

5. Insert the new grating with its red cover slide closed.

6. Lock the grating in place by turning the half-moon handle fully CW (flat surface perpendicular to the grating holder), then open the grating cover by pulling out the red cover handle, extending the cover slide fully until it hits a hard stop.

7. Put the black port cover back over the port hole, twist it CW, and tighten the knobs.

8. Reopen the Schmidt camera shutter.

2.2 Grating Tilt Adjustment

On the corner between Sides 1 and 2 of the spectrograph is a square box containing a dial indicator of the grating tilt [F]. To change the tilt, first turn fully CCW the large, gold, grating rotation clamp knob [E] on Side 1 of the spectrograph to the right and up from the indicator box. This

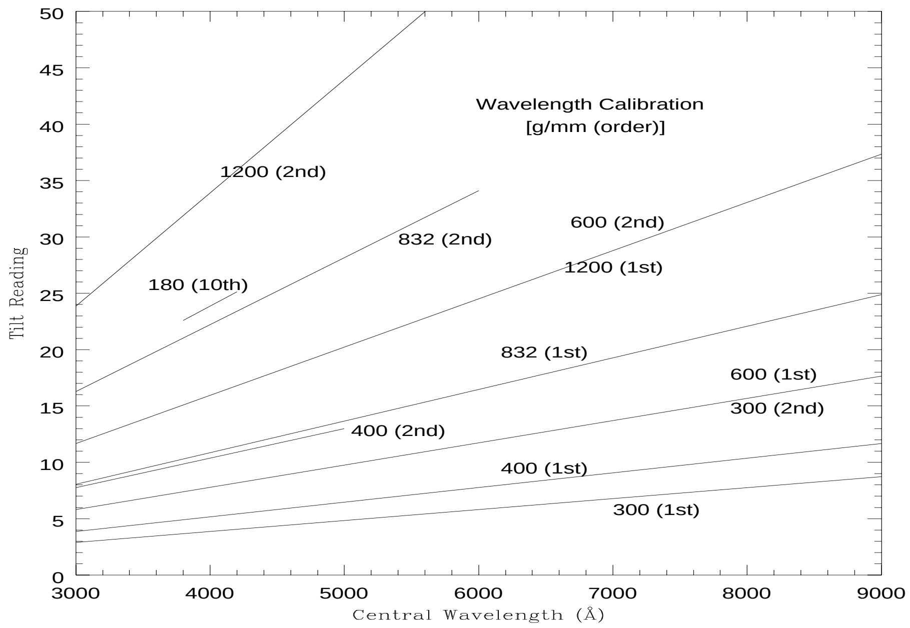

Figure 2.4: Grating tilt.

unlocks the grating. On the side of the indicator box is a knob with crank handle (folded within) which changes the tilt. The indicator displays units of tilt angle, with the fine wheel divided into divisions of 0.01 units. Always approach from lower values to higher ones to ensure repeatability. Finally, lock in the new grating position by turning the gold clamp knob.

Note: The tilt adjustment clamp is fully adequate to freeze the grating rotation against normal torques encountered while observing, but can be easily overwhelmed by the high gear ratio of the manual drive. Always release the clamp before rotating to a new position. Failure to do so will result in premature wearing of the clamp and eventual slippage!

When zeroed such that a tilt reading of 0.00 places the 0th-order slit image in the middle of the detector, tilt reading (in degrees) is related to the central wavelength of a grating by the following equation:

$$\text{tilt setting} = \sin^{-1}\Big(5.62 \times 10^{-8}\,\lambda\, m\, r\Big) \quad ,$$

where λ is the central wavelength (in Å), m is the order number, and r is the ruled grooves/mm of the grating. Appropriate tilt settings can also be estimated from the plot in Figure 2.4. Appendix B provides an atlas of the emission lines seen in the comparison lamps (see Chapter 4).

Note: At high grating tilts ($\gtrsim 20°$), the beam projects to an eccentric ellipse which overfills the grating. The amount of light lost by this vignetting is related to tilt angle as depicted in Figure 2.5.

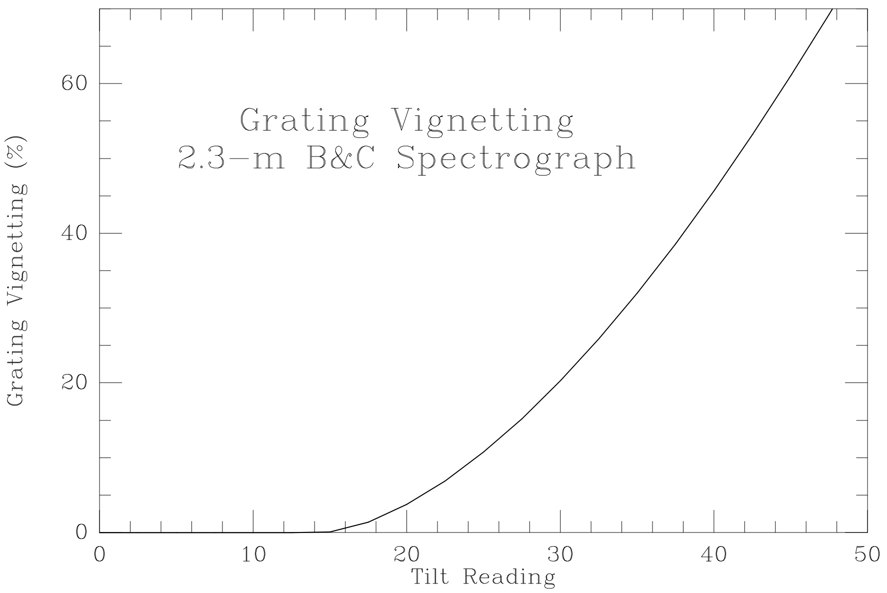

Figure 2.5: Grating vignetting.

2.3 The Echellette Grating

The echellette mode of the spectrograph uses a rather coarse (180 l/mm) grating ruled at a high blaze angle (23.90°) to yield 1–2Å resolution for multi-order spectroscopy. A sketch of the optical path is contained as Figure 2.6 (from Carswell et al. 1975, ApJ, 196, 351). With the 60° quartz cross-dispersion prism and a 1200×800 pixel CCD, 8 spectral orders provide continuous coverage from the atmospheric limit to approximately 8800Å in the format shown in Figure 2.7. Maximum slit length depends on the spectral region of interest, reaching a minimum between orders 4 and 5. Thus, a special decker is generally substituted for the standard slit plate for echellette spectroscopy, providing for slits of 16″ in length with a wide selection of widths. See chapter 3.1 for details regarding the echellette decker.

Conversion to or from the echellette mode requires considerable mechanical adjustments to the spectrograph and therefore can only be carried out by qualified technical staff during the day. Should you wish to take advantage of the substantial benefits of this mode of observing, you <u>must</u> notify the technical staff well in advance of this request!

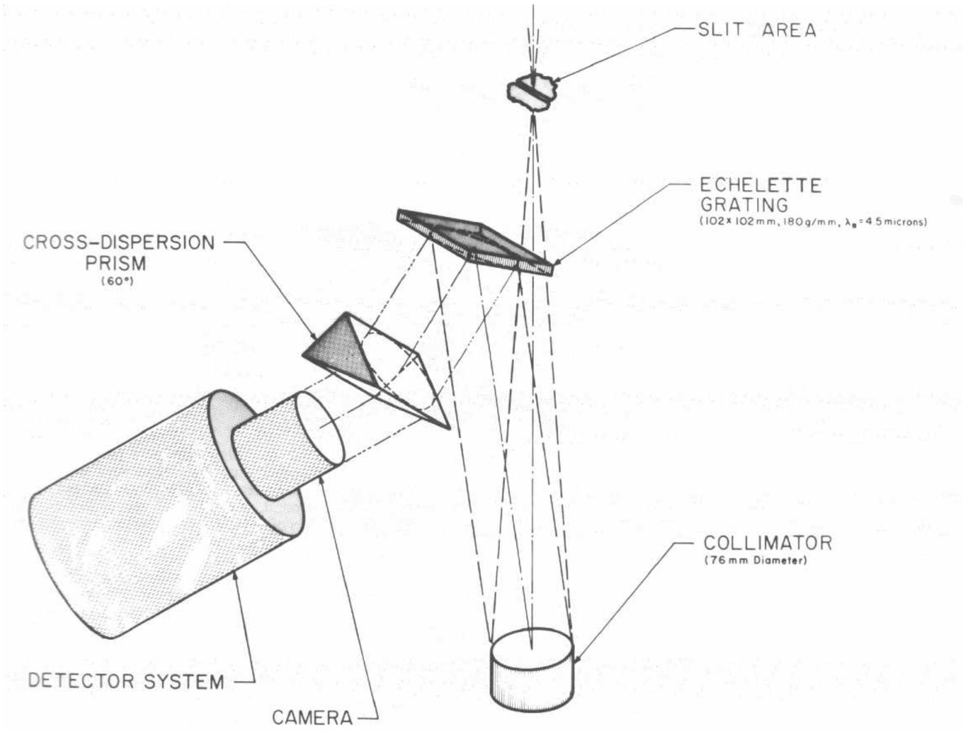

Figure 2.6: Schematic of echellette mode.

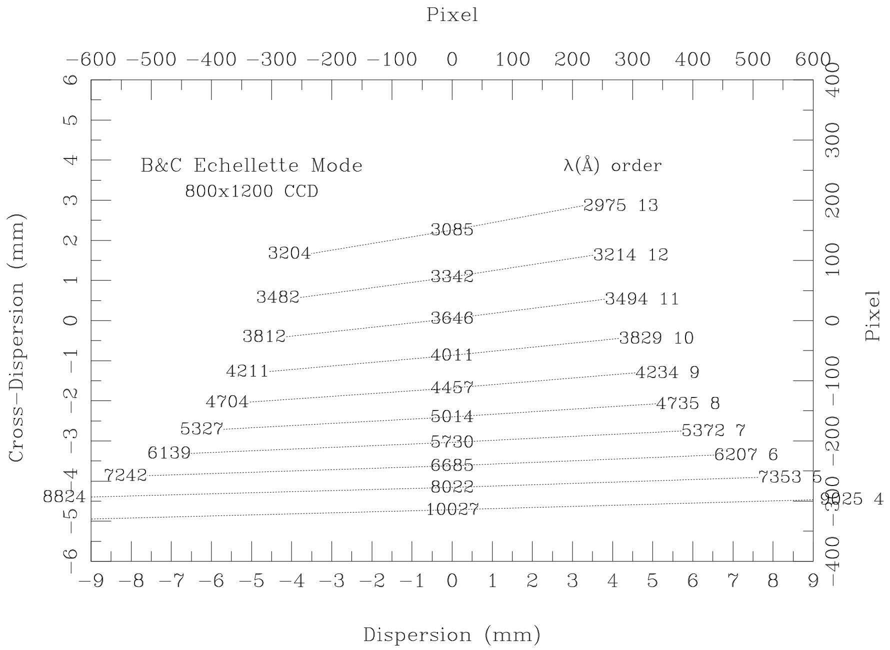

Figure 2.7: Cross-dispersed formats.

Chapter 3

Aperture and Shutter Assembly

3.1 Slit Position

Three slit widths are available for spectrograph+CCD imaging, which are positioned with the silver crank handle [R] on Side 3 of the spectrograph. To change the slit, first release the little rectangular lever on the bottom left of the slit assembly, that engages and disengages the handle from the mirror. The lever must be pushed all the way in, *i.e.* flush with the base of the assembly to properly release the slide assembly. Turning the crank handle will now pull the assembly in or out, moving to different slit widths as follows:

Standard Slit Plate

1. 4.5 arcsec width: Turn the handle fully CW, then turn it back 0.75 of a turn CCW.

2. 2.5 arcsec width: Turn the handle fully CW, then turn it back 3.75 turns CCW.

3. 1.5 arcsec width: Turn the handle fully CCW, then turn back 0.75 of a turn CW.

Make sure to lock in the new slit by pulling out the clutch lever again.

Each slit has a roughly 4 arcmin length. Unfortunately, the edges of the apertures have some irregularities, which will be noticeable in the resulting spectra. It is therefore crucial that the slit not be moved between the flat

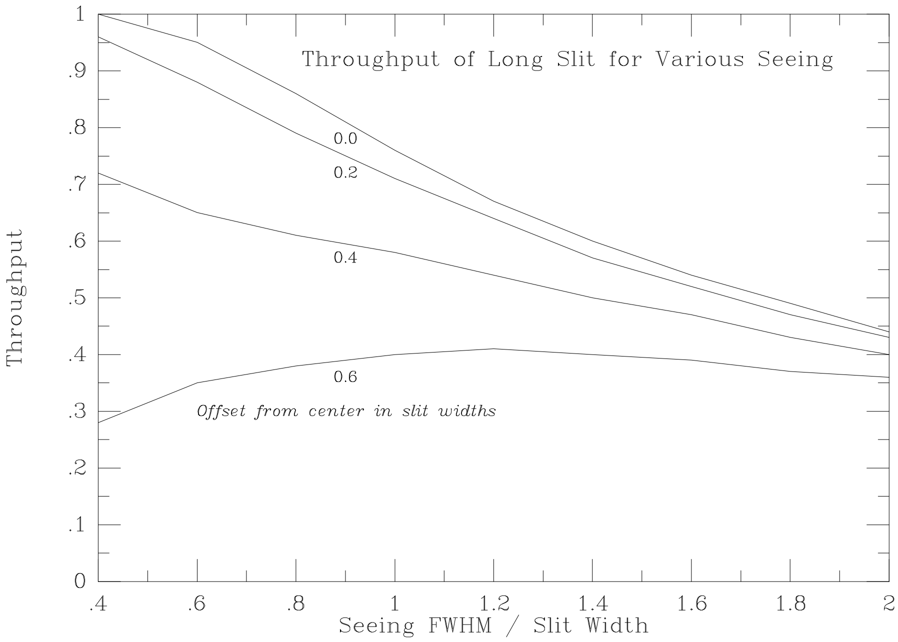

Figure 3.1: Efficiency as a function of slit width and seeing.

field and target observations. The throughput of the slits for various seeing conditions is analyzed in Figure 3.1.

Echellette Decker

The echellette decker is an alternate slit plate for the aperture assembly which contains 2 combinations of holes and 6 short slits, labelled A–H in the table below. Successive decker locations are separated by exactly one turn of the aperture plate lead screw (motor axis). It is suggested that the rather delicate adjustment necessary for proper selection and setting of the echellette decker be verified visually with the guiding TV.

Echellette Decker

Opening	Width×Length (arcsec)	Width×Length (mm)	Shape
A	1″ diam, 8″ sep	.15 diam, .81 sep	Dual circular holes
B	5″ diam	.51 diam	Single hole
C	1.25×16	.13×1.63	Slit
D	1.5×16	.15×1.63	Slit
E	2.0×16	.20×1.63	Slit
F	3.0×16	.31×1.63	Slit
G	4.5×16	.46×1.63	Slit
H	5.9×16	.61×1.63	Slit

3.2 Aperture Assembly Removal

The entire aperture-shutter assembly can be removed by unplugging the shutter cables, removing the three hex head screws that fasten the assembly to the spectrograph body and sliding the assembly out. Because of extremely tight clearance, fragile wires, and delicate optics, *it is requested that only qualified instrument/telescope technicians and the cognizant observers remove the aperture assembly.*

Chapter 4

Calibration Lamps

A continuum lamp, He-Ar lamp, and Fe-Ne source are available for spectral calibration [X]. They can be controlled either manually or remotely by computer. In order to adjust the intensity to safe levels and to spectrally compensate a lamp's output, each lamp housing contains a filter access which can hold up to two 2×2–in. filters (neutral density or otherwise) in standard Steward filter holders (see Chapter 7). Make sure the acquisition TV (Chapter 5.1) is turned down when using the calibration lamps!

Note that the Fe-Ne lamp may take a good fraction of a minute to warm up, depending on ambient temperature. Exercise caution and use a neutral density filter or filters in front of this lamp to obtain a proper exposure.

An atlas of comparison lamp spectra is provided as Appendix B.

4.1 Local Operation

The lamp control box [D] is located on Side 1 of the spectrograph. Switch the **display** switch to **on** and the **local/remote** switch to **local**. Place the **shutter** toggle to **open** and choose the lamp(s) using the toggle switches on the right of the lamp control box. Use the **observe** command as in normal observations to take a picture. Switch the lamp toggles **off** when finished.

4.2 Remote Operation

Set the lamp control box to **remote**, shutter to **close**. The command **comps** will activate the appropriate lamps. (Refer to CCD Manual for details.)

Chapter 5

Telescope Focus and Aperture Viewing Optics

Proper focus of the spectrograph optics requires three adjustments be made: the TV acquisition camera, telescope's secondary mirror, and the collimator (see Chapter 6). The aperture plate can be viewed visually from both above and below.

5.1 Acquisition TV

The acquisition TV [B] is a very sensitive instrument which will be destroyed by excessive light levels. *DO NOT allow any extraneous light to fall anywhere around the TV while the high voltage is up*, and remember to bring it down before *any* lamp exposures are taken.

The TV has both zoom and focus adjustments. The zoom may be set by turning on the TV (with the operator's help) and turning the plastic gear on top of the TV periscope [J] until the picture fills the screen as desired. To focus the TV, *make sure* the mirror covers are closed and dome lights are off. Then put in the 2.5 arcsec slit (see Chapter 3) and turn the high voltage all the way up. Have someone watch the monitor while another person turns the knurled ring that encircles the TV periscope until the slit is focused on the monitor. Make sure to turn the high voltage back down again! Note that if the zoom is changed during observation, the TV must be refocused.

Since the acquisition TV is more sensitive to red wavelengths, there is a blue filter available for viewing the TV field at shorter wavelengths. This is put in place with a switch [K] at the top of the TV tube. Please leave the switch in the default **out** position at the end of your run.

5.2 Telescope Secondary Focus

One can now bring the telescope into a near focus by watching the TV image while adjusting the secondary position (done by the telescope operator), although a behind the slit "knife edge" test is a little more exact. One may also perform a "knife edge" focus from above the slit using the eyepiece on the side of the TV. This is slightly less awkward to carry out. Finally, using the method described in Chapter 6, use a row/column plot to make the final collimator focus adjustment on a star.

5.3 Above-the-Slit Viewing

Viewing the aperture plate from above yields about a 2.5×3.5 arcmin field ($\sim$ 15mm$\times$20mm). Normally, the acquisition TV camera [B] views the aperture plate from above. To see the same picture visually, a relay mirror directly above the TV must be rotated by turning the selector knob [P] so that the handle indicator aligns to horizontal. Uncap the viewing eyepiece by pulling off the captive cover [J] and focus by twisting the threaded eyepiece holder.

5.4 Below-the-Slit Viewing

Viewing the aperture plate from below the slit is accomplished by positioning a flat mirror on a rotating arm into the beam below the slit. This arm is stowed safely out of the beam in a detent, and the detent itself is moved for the arm to seat in viewing mode. The detent is moved by a black knurled wheel [I] on Side 1 of the spectrograph, in the black cylindrical housing. The word **thru** should be visible on the black knob. Turn it clockwise past **chop** until it settles at **view**. Then turn the double-handled brass crank a half-turn counterclockwise until the arm is seated in the new detent position. Make sure the Schmidt camera shutter is closed (see Chapter 10) and open the slit shutter to view with the eyepiece [H] the field transmitted through the aperture. *This beam is affected by both the upper and lower filter wheels (see Chapter 7), and the procedure must be reversed to assure that the spectrograph is illuminated by an unvignetted beam.*

Chapter 6

The Collimator

The collimator located at the bottom of the spectrograph is a 3.5 inch diameter, f/9 off-axis parabolic mirror. Because the beam at this point is only 3.0 inches in diameter, the beam is unvignetted by this element over the nearly 1-inch ($240''$) length of the spectrograph slit.

6.1 Collimator Focus

A counter is provided on the side of the collimator tube which indicates the position of the collimator [G]. The little lever when pulled out unlocks the dial, and should be pressed up and in again when the change is completed. To focus the camera, the knurled knob moves the collimating mirror vertically and turns the dial counter. Always approach values from the same direction to insure repeatability. A typical focus reading with the standard aperture plate is ∼010, while the total range of the counter is from 000 to 050.

Using the He-Ar lamp (see Chapter 4), take a series of exposures of consistent duration (*e.g.* 10 seconds each), using the narrowest slit ($1.5''$, see Chapter 3). Take a column plot through each exposure to measure the pixel width at FWHM for a single spectral line. The only difference between exposures should be the collimator setting. The smallest width at FWHM is the approximate collimator focus, which is close to 2-3 pixels FWHM at its optimum setting. A similar procedure should be done on a star after the TV and telescope are focused (see Chapter 5).

Chapter 7

Filters

There are 5 locations where filters may lurk, and it would be to one's advantage to check them each time a run is started. Details on the filter wheels themselves are outlined in the following sections of this chapter.

1. Above-the-slit filter wheels [O]: These are on top of the spectrograph and below the base of the telescope. One is accessed from the Side 2, the other from Side 4. Each wheel has six filter slots.

2. Below-the-slit filter wheel: This wheel is internal to the spectrograph and has 6 positions. The filters and positions are noted [T] over the adjusting knob [S], which is located on Side 3 of the spectrograph. Affects both lamps and sky.

3. Lamp filters: In front of each of the comparison lamps [X] is a place for two slides (neutral density). The Fe-Ne usually has a cardboard piece in one, which should be replaced before leaving the mountain, as this lamp is dangerous for another detector using this spectrograph (Reticon).

4. In front of the acquisition TV camera is a small lever [K] that either puts in or takes out a blue filter which only affects the TV. Normal position is out.

5. Directly in front of the continuum lamp bulb [in assembly X] is a small aluminum slide with an open aperture (when pulled half way out) and an aperture with a neutral density filter (pushed all the way in). This lamp is calibrated with the neutral density slide in, and should be left alone unless necessary, and certainly returned to its normal state if changed. We mention this slide primarily as a trouble-shooting area if counts are much higher or lower than normal.

7.1 Above-the-Slit Filter Wheels

Between the offset guider box and the spectrograph body is a half-inch spacer plate and a thick black anodized plate which contains two filter wheels [O], each containing up to six 2×2–in. filters, such as those used for broad and narrow-band imaging. The access slots are located on Sides 2 and 4 of the spectrograph, and are customarily sealed with strips of duct tape in case of light leaks. Each filter position accepts an individual filter holder, which slides out of the filter wheel assembly through a notch. The wheels turn manually with the aid of the individual filter holder handles, and will stop at a detent for each filter position. You must therefore count three stops for the filter you just inserted to be positioned in the beam. The colored-glass filters just sit on the lip within the trays, and do not require restraining clips. Quartz-substrate neutral density filters are also available, mounted in their own holders. Both sets of filters may be found in wooden boxes in the filter storage room. *You must remove your filters from the wheel at the end of your run and return them to the box;* it is also good practice to check that your predecessor has not forgotten to do the same. Note that these above-the-slit filters affect all the light from the telescope, but do not intercept the comparison lamps.

7.2 Below-the-Slit Filter Wheel

Below the slit is a six-position filter wheel containing several 2×2–in. blocking filters. These generally remain in place, and can be accessed only when the spectrograph is off the telescope. They are positioned by turning a knob on the mounting plate [S]; the corresponding position number becomes centered in the window when the filter is seated. The present filter complement (also listed [T] on Side 3 of the spectrograph) is:

1. Copper sulfate (transmits < 6000Å)
2. UV36 (transmits > 3600Å)
3. L38 (transmits > 3800Å)
4. L42 (transmits > 4200Å)
5. Open
6. Y48 (transmits > 4800Å)

Do not attempt to turn the filter wheel past 6 to 1 — it will break.
Figure 7.1 displays the transmissions of the blocking filters.

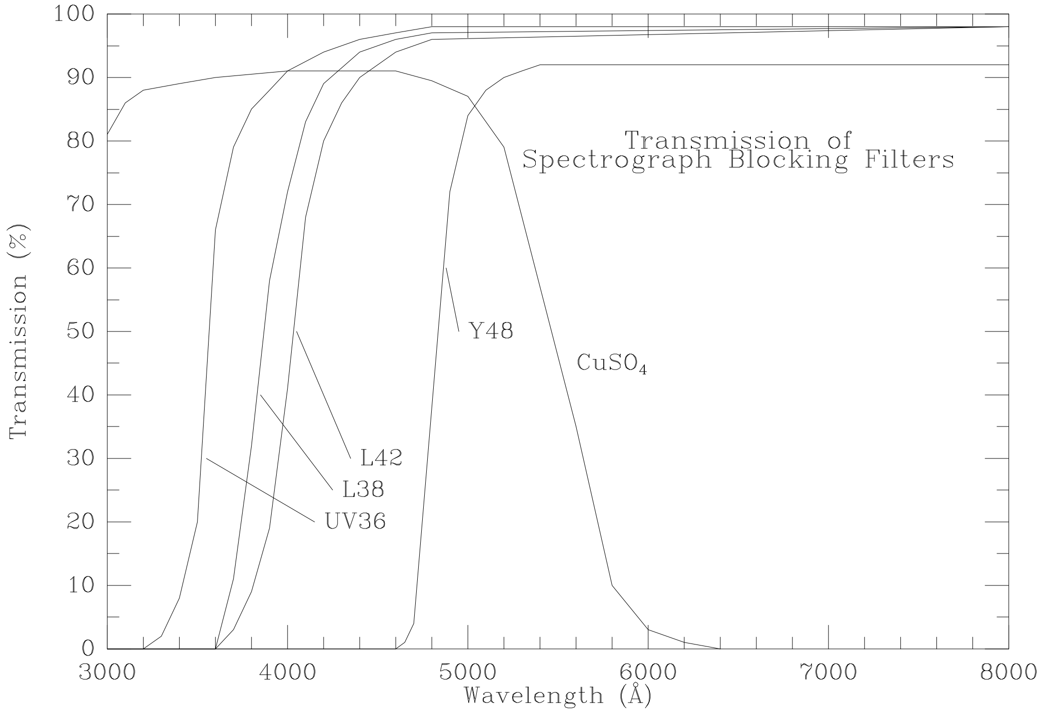

Figure 7.1: Available filters.

Chapter 8

Instrument Rotator

The position angle of the slit (and spectrograph) is controlled by the rotator, whose control box is located above Side 1 of the spectrograph, when at its default position angle (E–W). Turn **on** the power switch on the end of the control box, a second one on the front of the box, and lastly, the LED display. The position angle is changed by setting the **forward/reverse** switch, and turning up the motor's rheostat knob. Do not rotate the spectrograph too quickly — it can easily run away to a very awkward and potentially dangerous position.

Unfortunately, the displayed position angle is actually its supplement plus $\sim 3°$. In other words, the rotator should be set to $183 - PA$ for positive PA, and $-PA + 3$ for negative PA. This $\sim 3°$ offset can vary somewhat from night to night, and by as much as a few degrees between observing runs. A precision fiducial for the normal E–W (PA = 90°) orientation is provided in the form of a reference mark inscribed on the instrument rotator hub, which should be aligned with the mechanical pointer. Do not set the rotator to angles whose displayed values are beyond the limits written on the rotator control box or cables, etc. will be pulled loose!

After setting the rotator, you may wish to turn off the LED display while taking exposures.

Chapter 9

Offset Guider Box

The B&C Spectrograph is mounted in the Cassegrain focal plane of the telescope at the offset guider box [L]. The guider box contains a guide probe [M] which deflects the light to a wide-field Erfle eyepiece [V] when the two-position, center-off toggle switch [U] for the Erfle flat mirror is momentarily switched into the **out** position. Movement in two coordinates is controlled by the motion toggle switch on the SCR control box [N]. In order for the beam to the spectrograph to be unobstructed, make sure that the guide probe is moved to one of the side limits of its travel.

Chapter 10

Schmidt Camera and Shutter

The Schmidt camera and subsequent detector can be protected from overillumination and falling material (*e.g.* when changing the grating) by closing a mechanical shutter in front of the first surface. Pulling the lever [W] on Side 4 up and to the left opens the shutter, and pushing it down with the end touching the lip of the spectrograph, closes the shutter.

Chapter 11

CCD Camera

The CCD camera is operated on the 90-inch telescope as a facility instrument for general use. It currently uses a 1200×800 thinned, back-illuminated chip manufactured by LORAL. See the CCD Documentation Notebook for chip characteristics. For information on the acquisition software, please refer to the CCD Manual.

The camera's instrument specialist normally installs the instrument and computer software before each observing run, and is the person to whom users should direct questions or problems. (See the calling list on the observer's console.)

11.1 Precautions

As most users know, CCD detectors are very fragile and expensive items. In fact, our TI chip cannot be replaced at any price. Fortunately, once the CCD is installed in a cryogenic dewar [A] it is relatively sturdy. The observer must follow the following precautions, or face both self-destruction and chip destruction:

1. *NEVER let air into the dewar! Never play with the valve on the rear of the dewar!* Explosive destruction (of chip and astronomer) will result!

2. *NEVER disassemble the dewar or the electronics box that is attached to it* (the camera head box). *NEVER* separate the camera head box from the dewar.

3. *NEVER* disconnect or jiggle any cables unless the CCD power supply and CCD controller are off. (Total of two toggle switches.)

Chapter 12

System Throughput

When observations are made through sufficiently large apertures, and proper account is taken for atmospheric absorption and telescope mirror reflectance, the photon throughput of the telescope, spectrograph, and TI CCD is as high as one could hope. Figure 12.1 shows the total throughput for the 600 g/mm (3568)Å and 300 g/mm (6690)Å gratings, peaking around 13%.

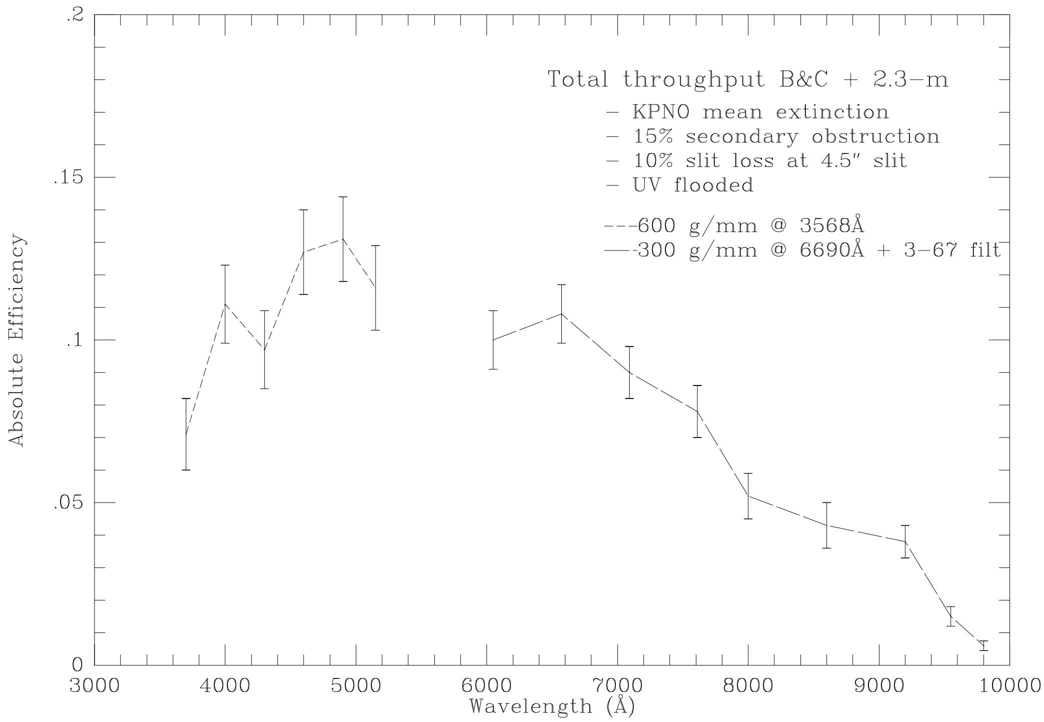

Figure 12.1: Total throughput.

Appendix A

Photos

The following color photographs identify the external mechanisms and attachments of the spectrograph. The four sides correspond to those referenced in the text, with Side 1 referring to the side nearest the control room (west side), and subsequent sides following as when viewing the spectrograph walking clockwise. The photographs are available online as side1.gif, side2.gif, side3.gif, and side4.gif in this directory; or simply click on their names in the Observer's Page.

A. CCD dewar and camera head box (leave alone!)
B. Acquisition TV camera
C. Manual control paddle for adjusting telescope pointing
D. Comparison lamp control box
E. Grating clamp
F. Grating tilt adjustment knob and readout
G. Collimator focus mechanism
H. Below-the-slit viewing eyepiece
I. Below-the-slit viewing selector
J. Above-the-slit/TV viewing eyepiece
K. Acquisition TV blue filter control lever
L. Offset guider box
M. Offset guider probe
N. SCR control box for offset guider motion
O. Above-the-slit filter wheels
P. TV-eyepiece selector knob for aperture viewing
Q. Grating housing port
R. Slit selector crank and locking lever
S. Below-the-slit filter wheel rotation knob
T. Below-the-slit filter wheel info card
U. Erfle eyepiece selector switch
V. Wide-field Erfle eyepiece

W. Schmidt camera shutter lever
X. Comparison lamp assembly