UNIVERSITY OF CALIFORNIA

LICK OBSERVATORY TECHNICAL REPORTS

No. 23

24" ITS SPECTROGRAPH USER'S MANUAL

R. P. S. Stone

Santa Cruz, California

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PRELIMINARIES

Prospective users of the 24" ITS should read the general description of the system given by Robinson and Wampler (P.A.S.P. 84, 161), and Lick Observatory Technical Report #14, The Scanner Data Taking Program Users Manual. Much of the information presented there applies directly to the 24", but be aware that functions which require the multiplexer at the 120" are not available at the 24". Examples are the grating rocker, auto spectrograph setup and automatic slit changing.

Be sure to read the 24" ITS Spectrograph Users Log each time you come up to observe, in order to be aware of changes to the system which have been made since this manual was written.

Observers may not observe alone with the 24" ITS until they have obtained at least three nights experience with a Lick ITS system, either at the 24" or the 120". If you have not had the required prior experience with the Lick ITS, your initial time request must include an observing partner. Observing alone can be rather strenuous (because the computer is downstairs from the telescope) so many people prefer to observe in pairs anyway.

I especially thank Lloyd Robinson who knows everything (about everything) and who answered all my questions (about the ITS) with limitless patience. Thanks are also due to H.French, S.Grandi, E.Kemper, D.Lester, D.McKenna and D.Schroeder for their contributions to the lore.

I. Four Major Cautions

1. Because of the very long collimator on the 24" ITS, if driven to declinations greater than +60° it is possible for the collimator to strike the skirt of the telescope with consequent severe damage or destruction of both the spectrograph and drive components of the telescope. Thus it is essential that at the beginning of your run you compulsively verify that the 60° limit has been selected. See Section II A, Item 1.

2. Again because of the long collimator, there is a significant hazard of inadvertently striking objects on the dome floor. An orange circle has been painted on the floor, and every time you move the telescope, you should move ladders, chairs, etc. behind this line.

3. The spectrograph will not be harmed by exposure to room lights (but the afterglow may last an hour or two). But do not expose it to a daylight sky or shine a flashlight directly on the slit jaws.

4. The top of the image tube chain is held in place by a sleeve which is in turn held by two allen-head set screws and a red thumbscrew which screw radially in through the top of the image tube chain casing. If these screws are tight when cooling is initiated, as the chain contracts slightly the image tubes may be pulled apart. Conversely, if the chain is allowed to warm up with the set screws tight, the slight thermal expansion may result in a damaged image tube. Thus, it is essential that the red thumbscrew be loose during any cooling or warming of the image tube chain. The obvious corollary of this is that the tube must not be allowed to warm up inadvertently; that is, we cannot allow it to run out of ice or alcohol.

The observer will be fully responsible for maintaining the ice and alcohol in the system. If for any reason you will be unable to be certain of keeping the system iced, all you need do is loosen the red thumbscrew. It's a small matter to retighten it and reset sweeps. It is essential that this thumbscrew be loosened at the end of each nights observing as normal procedure.

II. At Start of Run

(The following will normally be performed by the Telescope Maintence crew before you arrive).

A. Setup

1. Check that the 60° declination limit is selected.

   The 60° limit switch is a key-operated one on the south end of the declination drive housing. The small cutout in the center ring should point to the labelled 60° limit position (see illustration in Appendix A). If the 60° limit is not selected, notify the dome crew and do not move the telescope in declination until it is!!

2. Thoroughly clean dewar of any residue. Neglect of this step will significantly degrade the cooling efficiency and lead to increased dark current.

3. Verify that the telescope is properly balanced. A 3x5 "24 -Inch Telescope Balance" book, bound in white plastic and composed of polaroid photos of proper weight distributions, may be found on the desk upstairs. If the telescope is not set up as illustrated for the ITS, do not move it until maintenance has correctly balanced it.

4. Check that the following cables and hoses are connected to the instrument:
   a. Dry nitrogen (N_2, surgical rubber hose)
   b. 110v. to amp/disc power supply, supply switched on
   c. Signal-out coaxial cable from amp/disc to memory (downstairs)
   d. Solid coax (signal) from dissector to amp/disc
   e. Dissector HV cable (with rectangular filter box)
   f. Sweep cable (grey 1/2" cable with three serrated rings on connector)
   g. Image tube HV; cleaned and plugged into top of voltage divider
   h. Four soft white cables and associated ground wire from voltage divider to back of dissector
   i. Alcohol cooling lines connected betwixt dewar and ITS.
5. Check that the two coax cables are connected to the small control box with the start and pause switches. This box is normally attached to the telescope to the left of and above the slit viewing eyepiece.
6. Remove small screw from brass outlet at bottom of dissector and purge tube with N_2 for 30 minutes or more before cooling, to flush out any moist air. Normally, it will only be necessary to open the black knob below the low-pressure regulator at the base of the telescope (just above the observing floor). Expect 2" to 5" H_2O pressure. Occasionally it may be necessary to open the valve at the N_2 tank and set the high pressure regulator at the tank to 10 psi. Also, there is a small valve on the ITS camera which should remain locked open. Check the brass outlet, at the bottom of the dissector, to be sure N_2 is flowing!

B. Checkout

While the tube is purging and before icing, performance of the following steps will detect any serious problems while the image tubes are warm and maintenance can still be performed expeditiously.

1. Check both dark slides closed.
2. Turn on telescope key.
3. Check both image tube and dissector power supplies off.
4. Turn on real time display oscilloscope. Move center display button out to observe sweep loading in Step 9 below. Check that every button marked with a black sticker is pushed in, and no others.
5. Turn on rate meter crate.
6. Turn on scanner memory. On the scanner memory box, press START, STOP, and ERASE, and check that traces can be seen on the oscilloscope. NOTE: Switching the scanner memory power off and on can wipe out the computer program. Always bootstrap after switching power on the scanner memory.
7. Load the Data Taking System (SDTS): Turn on the computer, set TTY to LINE, with ambient temperature <u>55° or higher</u> bootstrap the computer (procedure is posted on the front of the computer) with an SDTS tape on unit 8. If room temperature is too low, several minutes warm up may be needed before the bootstrap will work.
8. In preparation for step 9, Start Data Taking with switch 1, 1 and after answering the questions, set "More Goodies" switch to "Load Sweeps".

9. Turn on sweep power. Load sweeps (any sweeps will do) from tape immediately with the "More Goodies" switch to avoid possible overheating of sweep circuits. The SDTS tape nearly always has somebody's old sweeps stored on it as sweep #1. On the real time display, verify that the sweeps look reasonably flat; i.e. there should be no large discontinuities if they loaded properly.

10. On the real time display scope, push center display button in to display data from the scanner memory. Also on the center display module of the scope, push in the 10 mv vertical sensitivity button. This will enable you to see individual counts and verify the dissector is alive in the next step. On the scanner memory box, press start, check the counting light on and set the display scale to 2^8.

11. Turn on the dissector power supply, and slowly set it to the "best value" written near the 10-turn pot. The actual voltage is not important since it will be adjusted for best focus, and the knob value is more accurately resettable than the meter. At this point, if the cables are connected properly, you should occasionally see single counts in the display. After verifying this, reset real time scope to 100 mv vertical sensitivity for normal operation.

12. Next turn on the image tube power supply and set it slowly with reference to the dial, not the meter. Around 15 kv noticeable dark current should appear on the real time display. (If not, something is disconnected.) At about 20kv bright "ion spots" may appear in the display. If so, stop raising the voltage and let them cook for a while; temporarily exposing the tube to room

lights may speed the demise of the spots. Do not allow the dark current to exceed 20kHz on the rate meters as you set the voltage; if it exceeds this value without exposure to light, something is wrong. Finally, set to the recommended value written on the power supply panel (normally 24 kv).

13. As a final check of the system, set sweeps by mapping the tube. Use the neon lamps as a light source; set the diagonal mirror to the field viewing position, pull both dark slides, set the grating to 217.5 and try 40 counts per dot. The light may not illuminate the slits uniformly, so just establish that sweeps can be set and that the system responds to light. Observe the neon spectrum with a rough warm camera focus value ∿935 and verify that the focus is good enough to ensure that no major disaster has occurred. When you're satisfied, turn off the lamp and close dark slides.

14. Finally, if everything looks good, ice up. Be sure the red thumbscrew at the top of the image tube chain is loose, replace the small purging screw in the brass connector at the bottom of the dissector, and plug the alcohol pump into wall (not telescope) power with the extension cord provided on the west side of the telescope. Be sure there's enough isopropyl in the dewar to cover the copper tubes in the bottom when the telescope is vertical (about 1 1/2" of it) and that the pump reservoir is full of ethanol. Do not substitute one for the other. Fill up the dewar with dry ice, and mix it well with the isopropyl to make a good wet slurry.

III. Prepare to Observe

1. Read entries in both logs since your last visit.
2. Ensure a sufficient supply of Dectapes are on hand. Sign-out procedures are as follows:
   a. Formatted tapes should be signed out as needed by the 20 tape boxful from the 120" to the 24". They are stored in the wall lockers in the 120" electronics shop. In the sign-out book at the 120", just note 20 tapes removed and sign it 24".
   b. At the 24", sign out in the log attached to the end of the book-shelves on the ground floor for the tapes you've used. Do this nightly or at the end of your run, whichever is convenient for you.
   c. Each faculty observer is allowed an initial allotment of 100 tapes and/or floppy discs. After this sum is used, you will be recharged for any excess on a periodic basis by the Lick Business Office. All Dectapes are the property of Lick Observatory and eventually they must be either returned or paid for.
   d. When you return used tapes to the system, please put them in the appropriate wall locker in the 120" electronics shop and log them in the book there so they may be deducted from your running total. They will be erased, reformatted, freshly labelled and returned to the stock.
3. Check the N_2 supply at the tank (300 lbs. minimum for a night) and the pressure at the low pressure regulator at the southwest corner of the base of the telescope ($\sim$5 inches of water pressure).

4. With the tube fully cooled (that is, ice plus two hours or more) tighten the red thumbscrew at the top of the image tube chain.
5. Top off the ice, ensure sufficient ethanol in the pump.
6. Turn on the real time data monitors, memoscope and TTY (check TTY on "LINE").
7. Check that the discriminator level is set as desired; usually this will be the value written on the unit near the knob. Recheck image tube HV set as desired.
8. Open the dark slide and set sweeps. Different sweeps will generally be required for each decker setting to be used. This is because the decker opens asymmetrically for each slit (see the illustrations of the slit assembly in the Appendix). Set the grating to ∿220, use the continuum lamp source at a low setting and use 1 or 2 counts per dot. Do not use the slit illuminator lights on the secondary spider to set sweeps!
9. Focus the spectrograph. Use a slit width of 80 units or less and set the grating to 217.5 units; the neon doublet at 6400 Å will be approximately centered. Use the focus program (self-explanatory), or you may prefer to do it manually. A quantitative focus parameter is F^4 (Famous Faber Focus Factor), which is the height of the valley between the two lines of the 6400 doublet when the right hand peak just reaches 40 units above the "continuum" just redward of the right hand peak, on the real time scope. Adjust the dissector voltage for the best split of the doublet, then adjust the camera focus knob on the spectrograph itself for the best split. Repeat this procedure with lines moved to one side of the spectrum. The best center and edge foci may not occur at the same values so compromise may be necessary.

10. Occasionally you may wish to check the left slit channel offset (usually rather stable). Use the line lamps to run a short scan and use option 1 of the peak finding routine to see if the current offset is satisfactory. If you find a new offset is better, change the value by using the set sweeps routine, and note the new value in the User's Log.

11. Determine the grating settings and filters to be used. Color filters will normally only be needed for order separation (to suppress second order blue contamination when observing in the first order red). See Section IV paragraph 3, and Appendix D.

12. Initialize data taking.

13. Do calibration ("quartz") scans for each decker setting, to be used later to remove small scale irregularities in the tube response. A possible scheme for these scans is to do two 8 minute scans on the continuum source at the beginning of the night, one at grating setting 190 and one at a setting of 250, and then repeat at the end of the night.

14. Use "load calibration buffer" on Special Functions switch to add, normalize and store the calibration scans in the calibration buffer.

15. Take short scans of the emission-line comparison lamp sources for wavelength calibration. Use neon for $\lambda \geq 5800$, helium-argon and/or mercury for shorter wavelengths. All three lamps contain <u>some</u> argon and will provide argon lines in the red and IR. Spectra of the lamps are shown in the Appendix. To avoid afterglow, don't expose the ITS to the comparison lamps longer than necessary. Because of the asymmetrical slit motion, a separate

calibration is required for each slit width to be used as well as for each grating setting. There may be some effect on the wavelength calibration when the decker is changed greatly. Shifts of 4 to 5 channels have been reported when the decker is changed from very small to very large (90 arc sec).

16. When ready to observe, remove the mirror and finder covers. Check to be certain the primary is still present. If not, anticipate lower counting rates.

IV. Observing Considerations

1. Do not plan to observe objects at declinations greater than 60° north. The reason for this limit is that the collimator tube will strike the skirt of the telescope at greater declinations. There is an interlock which is supposed to prevent driving north past 60°, but if it should fail to protect you and you prang the telescope (however inadvertently) you're still likely to be unpopular.

2. Only one tube chain is available at the 24". It corresponds to the "red" tube at the 120", but with much worse wings on spectral lines. Tube response extends roughly from λ3600 to λ8800.

3. Three gratings are available. They are all 600 line/mm; the "standard" one is blazed for 5000 Å in the first order. The others are blazed for 7500 Å and 1μ in first order. If you wish to use a grating other than the standard one, request it on your Time Request Form. Grating changes are not to be made by non-faculty users, and changes during an observing run are discouraged (but not forbidden). A rough calibration of grating readout versus central wavelength for the standard grating is given in Appendix B. Expect a bit less than 1.2 Å per channel or about 2400 Å in a first order spectrum. There is some degradation in quality near the ends, so try to keep important features in the middle 80% or so. There is a great deal of back-lash in the grating movement. The difference between setting clockwise or anticlockwise to a particular tilt value is about 75 channels in wavelength, so it is essential to set in a consistent sense: clockwise setting is assumed in

the tilt vs. wavelength chart. To reach a particular setting, always go past it by 10.0 dial units (or more) then come back to it in your consistent direction to eliminate backlash. With care, you can reset to ± 2 channels. Be sure to unlock the grating before moving and lock it afterward. Maximum channel shift due to flexure/position effects is also about ± 2 channels.

4. The decker and slit also have small amounts of backlash and should be set in a consistent direction. We suggest that everyone adopt the practice of setting from small to large so different users can communicate with each other meaningfully. Do not close the slit below 0.00. That means you have to know roughly what the dial is reading; you should not keep your eyes glued to the slit viewer and heedlessly spin the slit knob. In order to get light to the slit viewer, the slit assembly is tilted a few degrees toward the east side of the telescope. Both the slit and decker will open to about 90 arc sec.

5. Plan to use a neutral density filter for objects brighter than about 7th magnitude. Three densities of quartz substrate filter are available; 0.7 (1.75 mag), 1.0 (2.5 mag) and 2.0 (5 mag). The 0.7 is in the upper wheel and the other two are in the lower one so they offer a total of 5 attenuations: 1.75, 2.5, 4.25, 5 and 6.75 mags. (The contents of each location in the filter wheels is written on a card on the south side of the spectrograph body (below the filter access door)). The limiting factor for brightness is the paired-pulse correction due to deadtime in the amp/disc.

This correction is reasonably well known for counting rates up to one megahertz, but becomes increasingly uncertain for higher counting rates. Consideration of the number of channels to be counted (2048 per slit x 2 slits), the flyback time for the dissector (300 μsec) and the memory cycle clock rate (1 MHz) leads to the result that the peak count rate through the amp/disc is 4400 x peak channel counts sec^{-1}. If the peak rate is to be 10^6 then the peak channel should see no more than 227 counts sec^{-1}. At the telescope you may estimate this by setting the display scale to $2^8 = 256$ and looking for a peak channel folding time of about 1.1 seconds (or perhaps more realistically, a folding time of > 9 seconds on scale 2^{11}). If this rate is exceeded, use a neutral density filter for best results.

6. While you're thinking about bright objects, be aware that they will cause a lingering afterglow in the ITS, so don't plan to observe faint objects right after bright ones. It's hard to quantify this afterglow, but I would guess that a 7th mag star might leave some residual glow for half an hour and the room lights might last even longer.

The decay time depends on <u>how long</u> the ITS is exposed to the source, in addition to how bright the source is. You can check for afterglow by opening the gate on the memory box (that is, press START) and looking at the real time display with the gain all the way up and the dark slide closed. An absence of spectral features or continuum shape combined with a low count rate on the rate meters ($\lesssim$ 200 counts) will assure you the afterglow is gone. Prudence (that's Prudence Townsend of Hyannisport, the well-known ITS observer) would of course suggest that you plan your observing

program so you won't have to be concerned about this. In particular, do not do quartz calibration scans soon after wavelength calibration lamps or bright stars!

7. If the tracking oscillator rate is well set, and for objects at reasonable zenith distances, the telescope will track without guiding for a four minute scan. If guiding is needed, there is the possibility that the guide relays may introduce noise counts and you may wish to use the pause switch to stop counting momentarily. You may wish to check this for yourself by closing the dark slide and opening the memory gate with display gain at 2^8 and looking for excess counts in the real time display as the guide buttons are pressed. Also, be aware that it may take the computer a second or two to "see" that the pause switch is on.
8. An audio rate meter is available which is a great aid to guiding. It produces a tone whose pitch is proportional to the rate meter output, so a drop in the tone indicates a loss of light and the need for guiding. To use, adjust the rate meter scale switches to a range appropriate for the signal being detected. If the rate meter is allowed to saturate (too high a sensitivity selected) it will no longer trigger on each arriving pulse and the tone will be lower than expected and may deceive you.
9. From time to time during the night, check the oven temperature on the sweep box. The oven is to maintain stable sweeps, and the game is to find a combination of the temperature selector and fan (on/off) which will cause the oven to cycle on and off at the ambient temperature prevailing in the computer room. If the oven light on the panel is

cycling from time to time, you've hit it. On a summer night you may need to keep the room fan on, set the oven to a low temperature and leave the oven fan on. A cold winter's eve may require the room heater, oven heater on max and no fan. In any case, keep the room temperature as near 70° as you can to avoid problems with the computer.

10. The scanner produces about 3 counts for each incident photon. Since the accuracy of the observation depends on the number of photons counted, not counts, don't forget to divide by 3 when predicting signal/noise.

11. When the system is first iced, 1-2" of isopropyl should be in the dewar. Thereafter it is <u>not</u> ordinarily necessary to add alcohol to the dewar. In fact, too much alcohol will increase the sublimation temperature of the dry ice and lead to <u>less</u> efficient cooling. It is only necessary to mix the dry ice well with the alcohol already in the system.

12. Observers are requested <u>not</u> to adjust the memoscope. The reason is that the phosphor may be burned rather easily, and these large storage scopes are a rarity in the world of electronics in that they are getting more, rather than less, expensive as time goes on. It has been carefully adjusted for the best performance and a long phosphor life; please do not change it. A corollary consideration is to erase the display whenever it is no longer needed, and turn it off in the morning, even if the computer is left on.

13. Avoid anything which will change the balance of the telescope, such as adding or changing equipment on it. The reason is that the drive gears are made of a composition material which is prone to mechanical failure if subjected to excessive stress. This is also the reason why the position angle of the spectrograph is locked and cannot be changed; the weight distribution of the spectrograph is so asymmetrical that any rotation would

necessitate rebalancing the telescope. Also, the spectrograph is such a large load for the telescope already that it would not be possible to balance it for most other position angles!

14. Observers who work alone may choose not to keep a log on tape in order to avoid inconvenience with the teletype. Alternatively, you may move the teletype upstairs to enter the log on tape as you work. However, you must be aware that the teletype is rather delicate and unwieldy to move. In particular, it must not be tipped over, or parts fall out! If you don't feel confident you can move it safely, you may request the telescope maintenance crew to help you. At the end of your run, you must return it downstairs and check it to be sure it's still ok. It's safer not to use the log-on-tape option!

15. It is important to keep the ambient temperature of the computer within a reasonable range, preferably between 65°F and 80°F, by judicious use of the doors, windows, heater and blower. The blower switch is just above the light switches in the office. There is an arrangement of sliding doors high on the north side of the office so the blower can be used to pull air out of the office, out of the dome or both. The air is returned to the atmosphere on the other side of the brick watertank to the NE of the dome. Some observers feel that the seeing may be improved by using the blower to draw air in through the dome slit. During the day, please leave the office window and shade closed so as not to tempt passersby to appropriate our equipment; but otherwise arrange things so as to keep temperatures at a reasonable level.

16. It has been found that sky subtraction is markedly superior if, for observations totalling more than just a few minutes, the observations are made so as to obtain symmetry in the observations for both slits about a central time. For example, 2 minutes with the object in the left slit, 4 minutes right, then 2 minutes left will provide better sky subtraction than 4 left and then 4 right. Also, in general, it is better to switch the object between the slits at least every eight minutes.

17. Do not attempt to observe bright objects by defocussing them. We have found that for objects which are out of focus and off axis (to avoid the shadow of the secondary) the response of the system changes drastically and in a complex way. These difficulties may be avoided simply by keeping objects in focus and using the neutral density filters when necessary.

V. Shutdown at End of Night

1. Turn off telescope tracking oscillator.
2. Do wavelength/quartz calibrations as required. Wavelength calibrations may be slightly better if calibration spectra are taken at the position at which the object was observed.
3. Close both dark slides.
4. Cover mirror and finder.
5. Turn off the upstairs real time display scope.
6. Top off the ice and ethanol as required. The ice can usually be depended on to last only about 8 hours.
7. Loosen the red thumbscrew at the top of the tube. Once again, do not let the tube warm up inadvertently with that thumbscrew tight!
8. Store the telescope straight up and turn off telescope power.
9. Set dome to the stowage marks (slit ESE) and close and lock the shutter.
10. Downstairs, turn off the real time scope, memoscope and TTY. Leave everything else on during runs! Leave the room heater on during cold weather or the blower on if it's warm. If you remove all tapes from the tape drives, it will preclude any possibility of tape glitches in case of a power failure.
11. Sign out for Dectapes used.
12. At the end of your run, store all tapes properly on the shelves and clean up the computer room!!!
13. If no other observer is to follow you, please do the items listed in the next section.

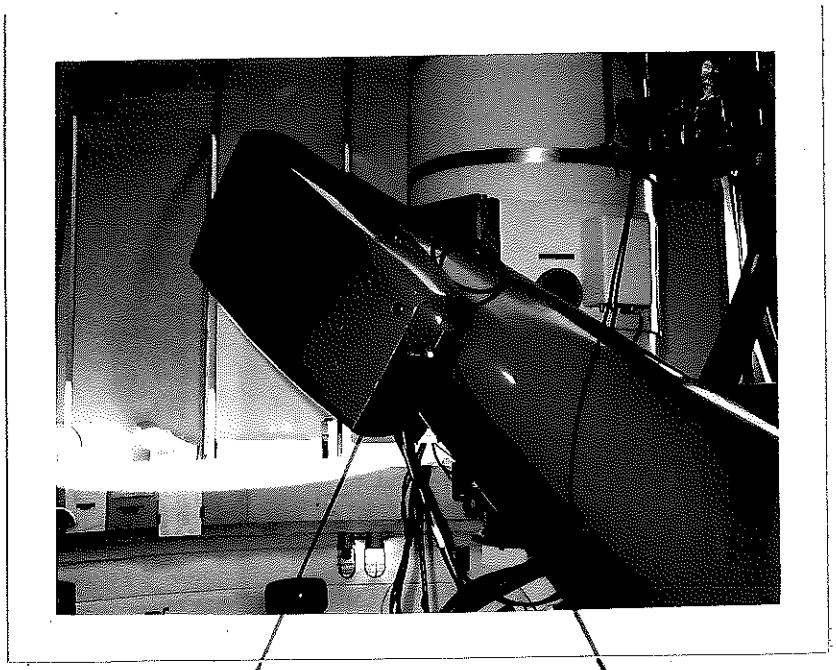
VI. At End of Run

(This section applies only if no one else is scheduled to observe on the night after your run ends.)

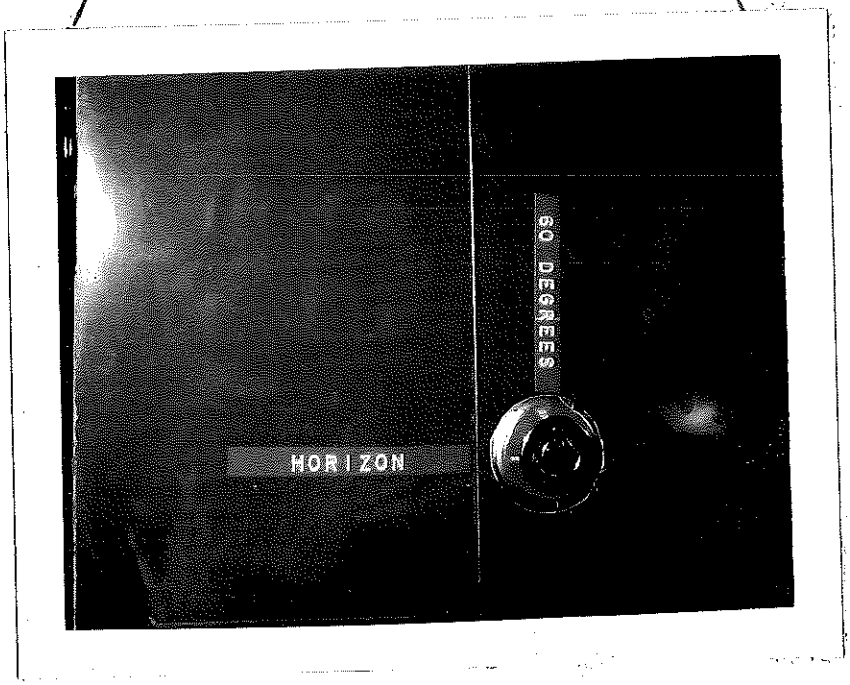
1. Gradually turn the image tube power supply to zero and turn off the power switch.
2. Do the same for the dissector supply.
3. Turn off the ratemeter bin, memory box and sweep box.
4. Turn off the computer (key switch in lower left corner of computer console).
5. Turn off the nitrogen with the black knob near the low-pressure regulator near the southwest corner of the base of the telescope.
6. Check again that the red thumbscrew at the top of the image tube chain is loose, and finally,
7. Pull the plug that runs the alcohol pump.

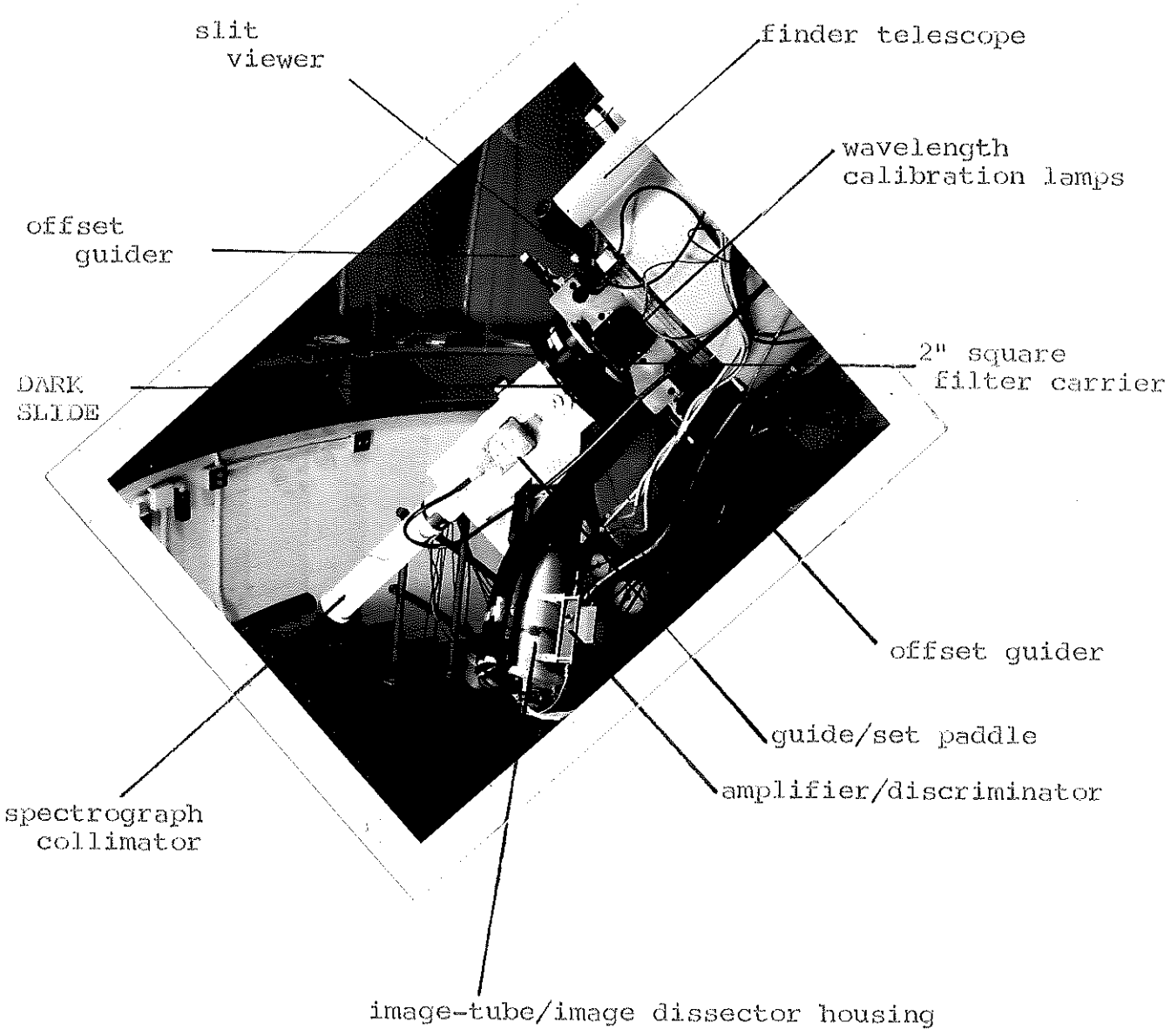
APPENDICES

The 60° limit switch is on the south end of the dec drive housing



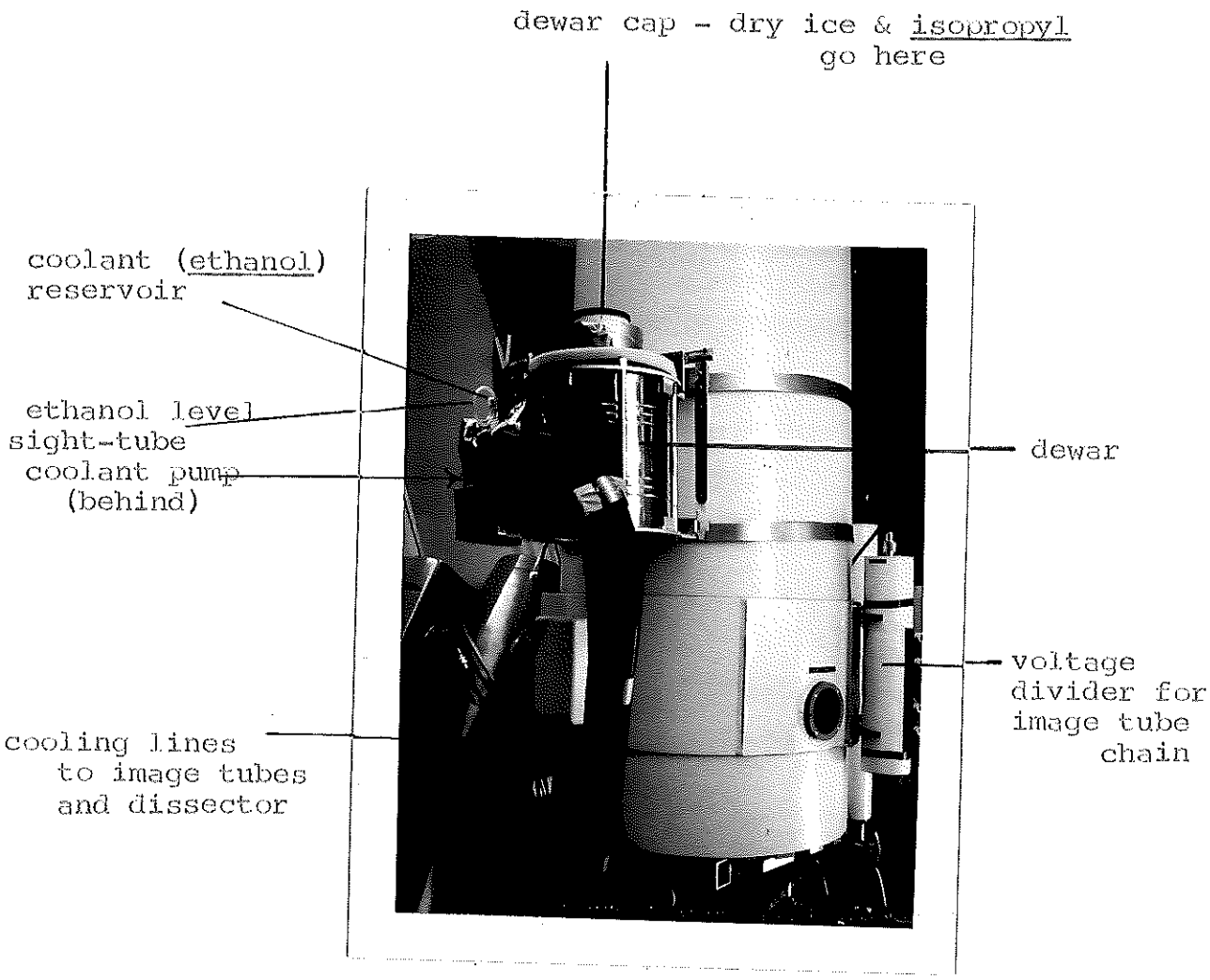
Each observer MUST verify that it is set to 60° before commencing observations. Notch in inside cylinder points to limit selected. Call maintenance to reset.

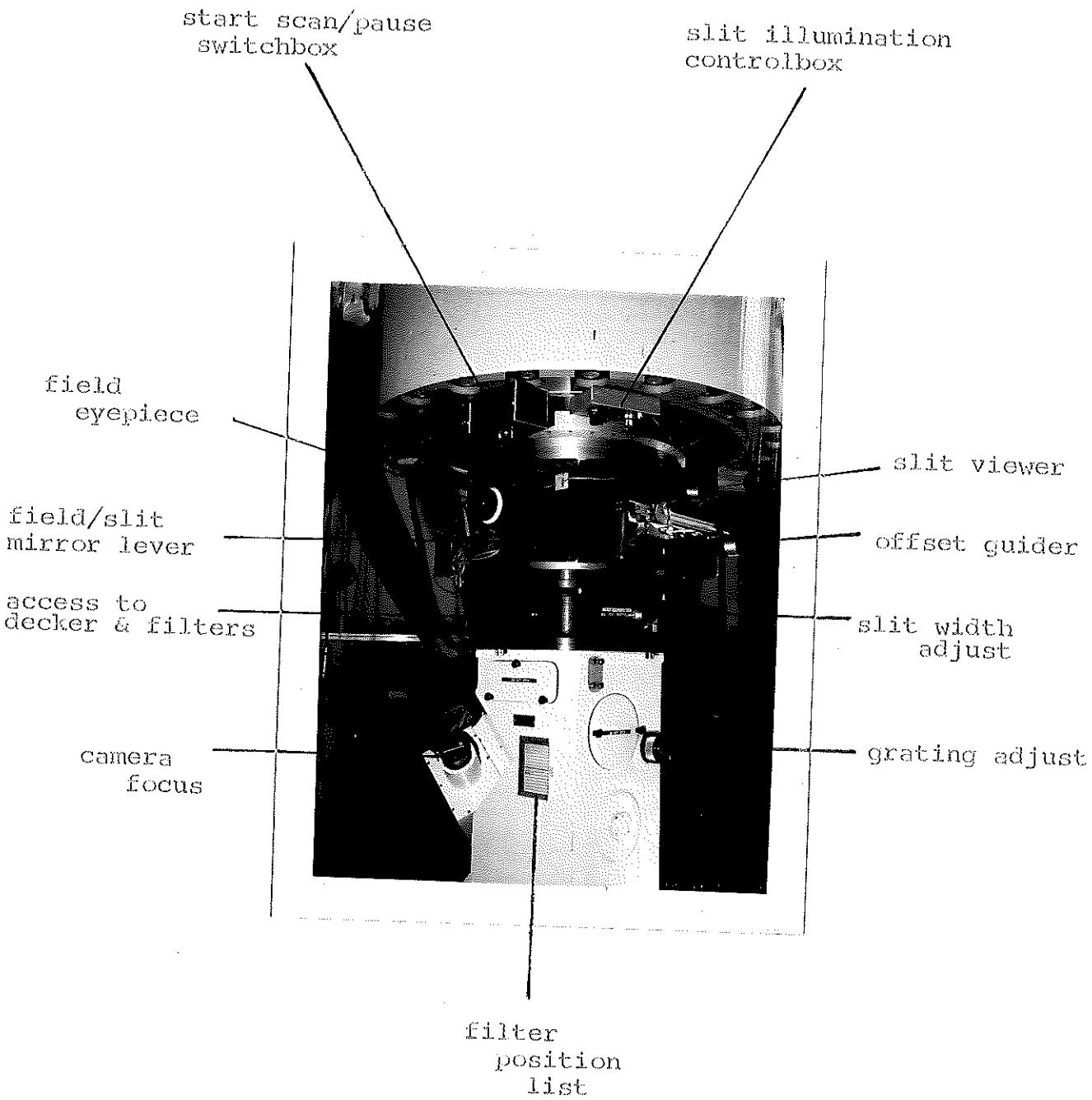




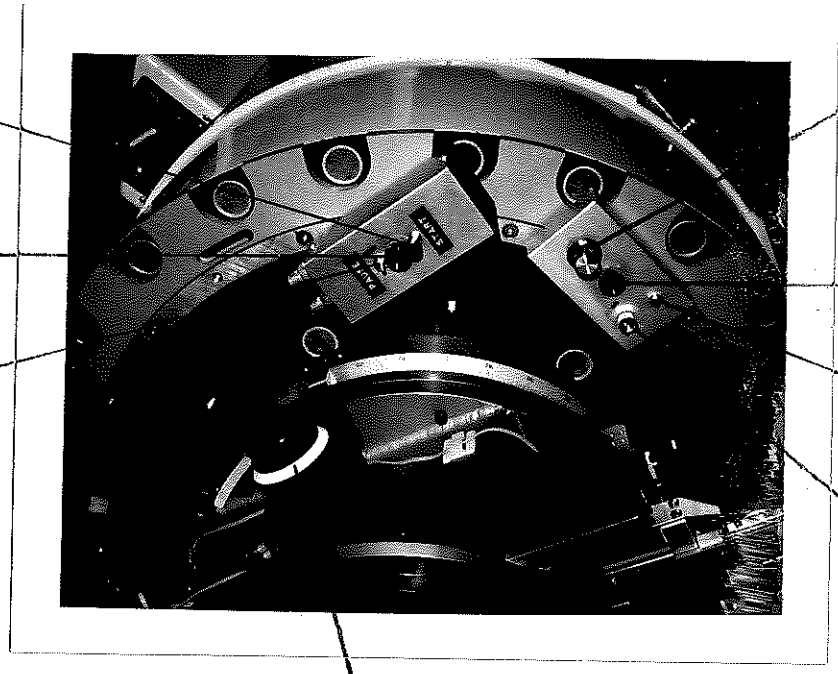
24" ITS SPECTROGRAPH -- GENERAL VIEW

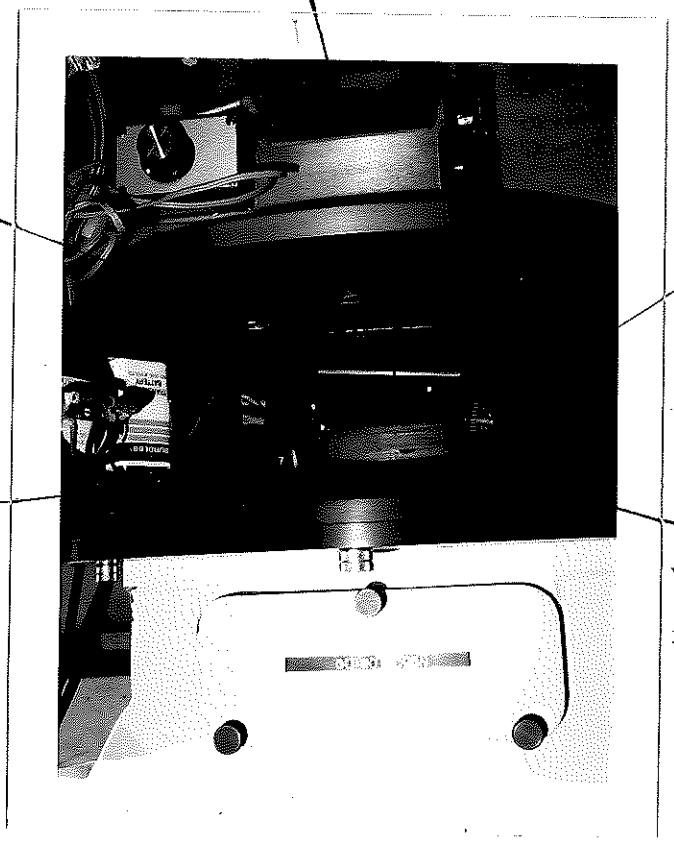
Note: A second dark slide is located below the right-hand (west) offset guider.


dewar cap - dry ice & isopropyl go here
coolant (ethanol) reservoir
ethanol level sight-tube
coolant pump (behind)
dewar
voltage divider for image tube chain
cooling lines to image tubes and dissector

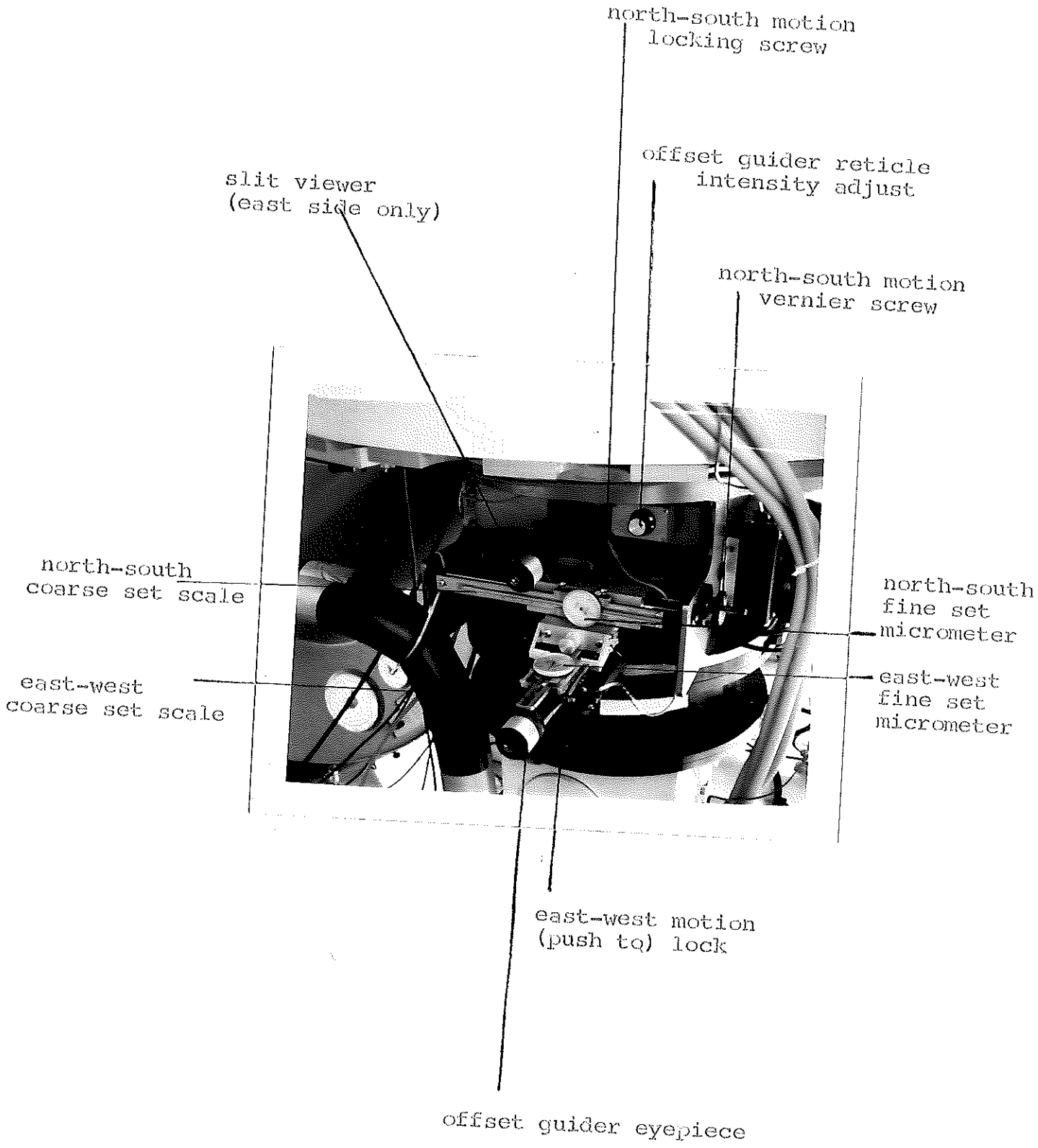


SOUTHEAST SIDE

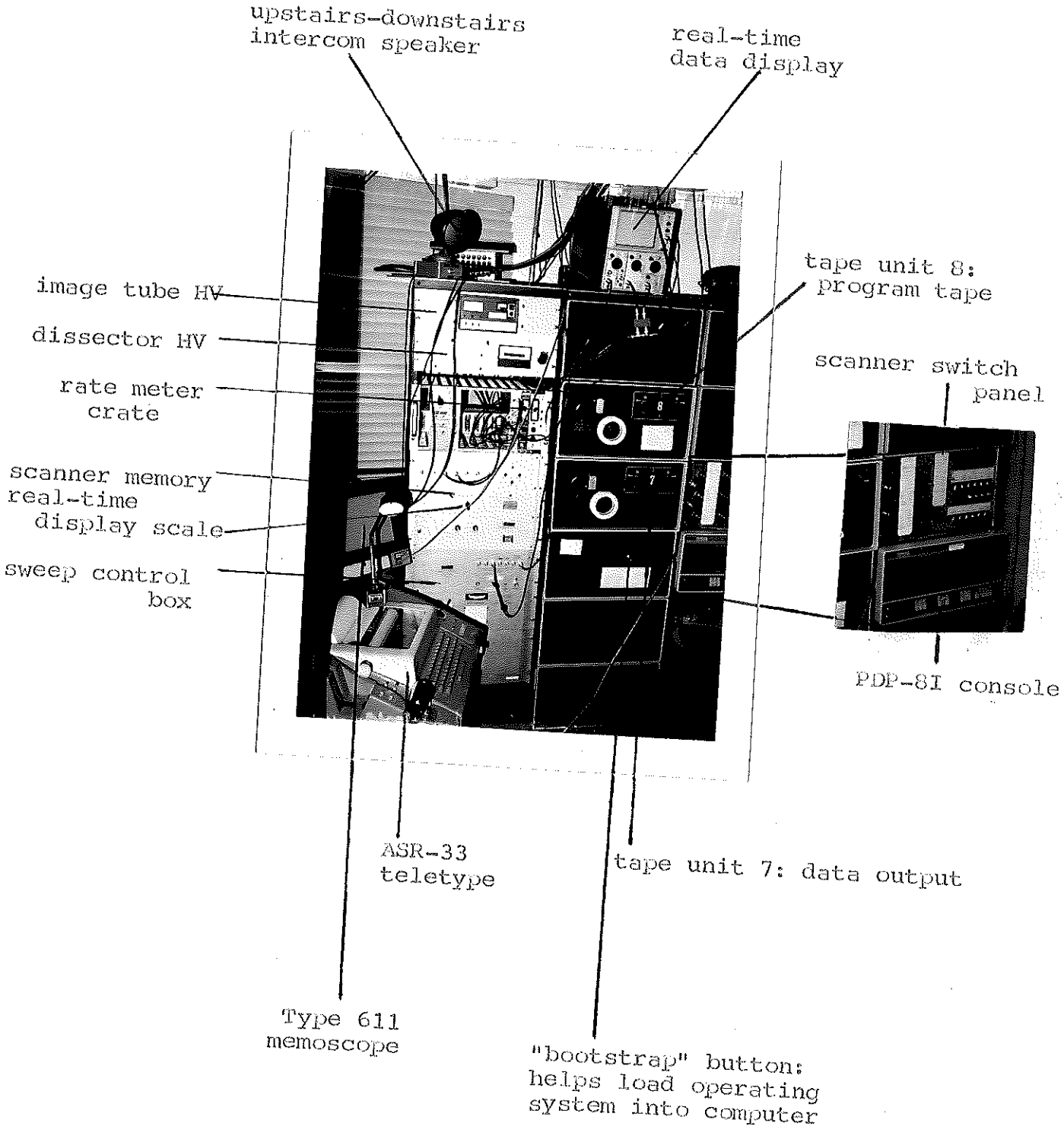




Note: Filter wheels inside access door are 1" square or round and may be added/changed with difficulty and prior notice. The 2" square filter holder is higher in the beam and easily accessible to users.

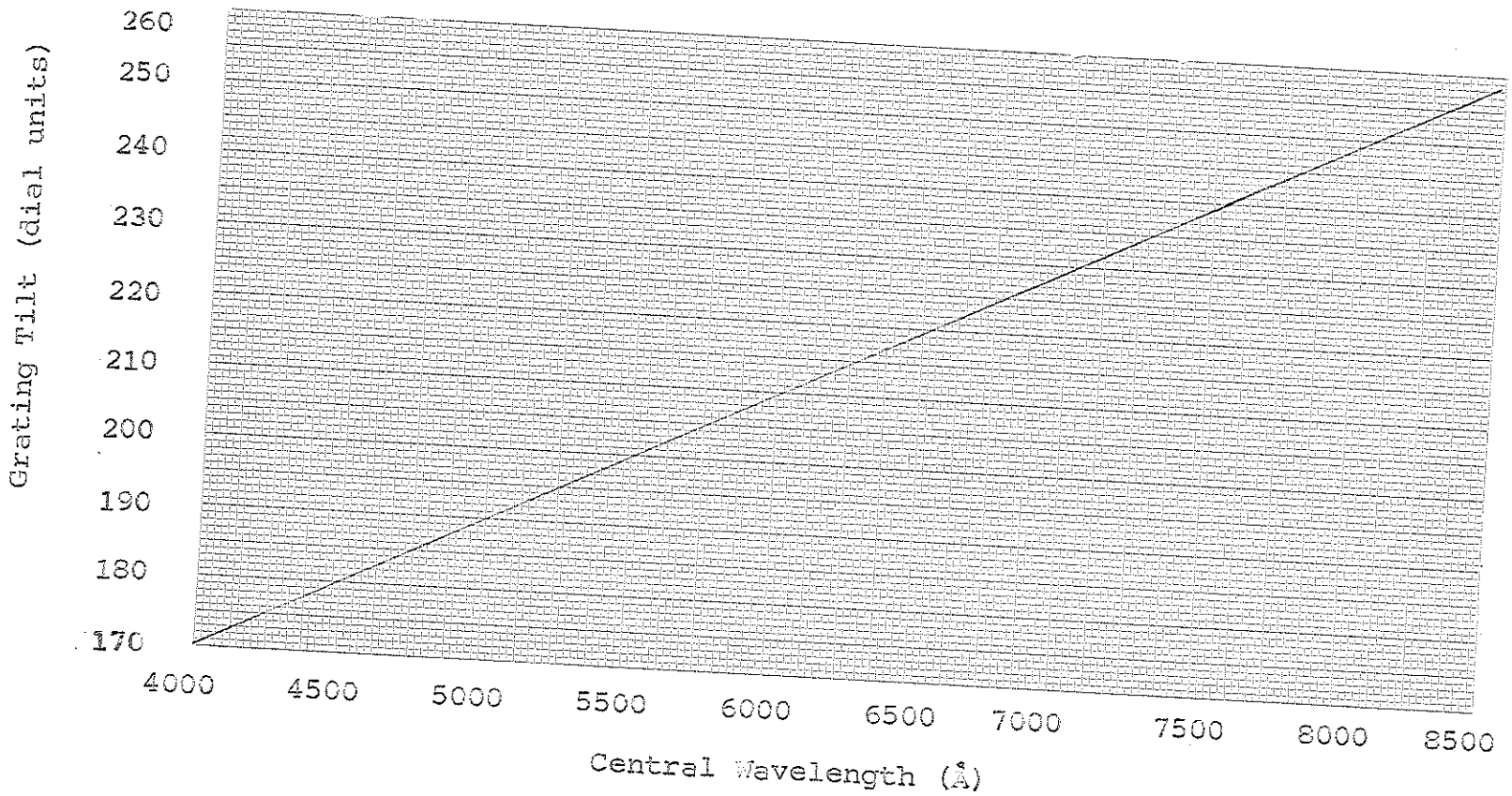


Note: East side (shown) and west side offset guiders are identical

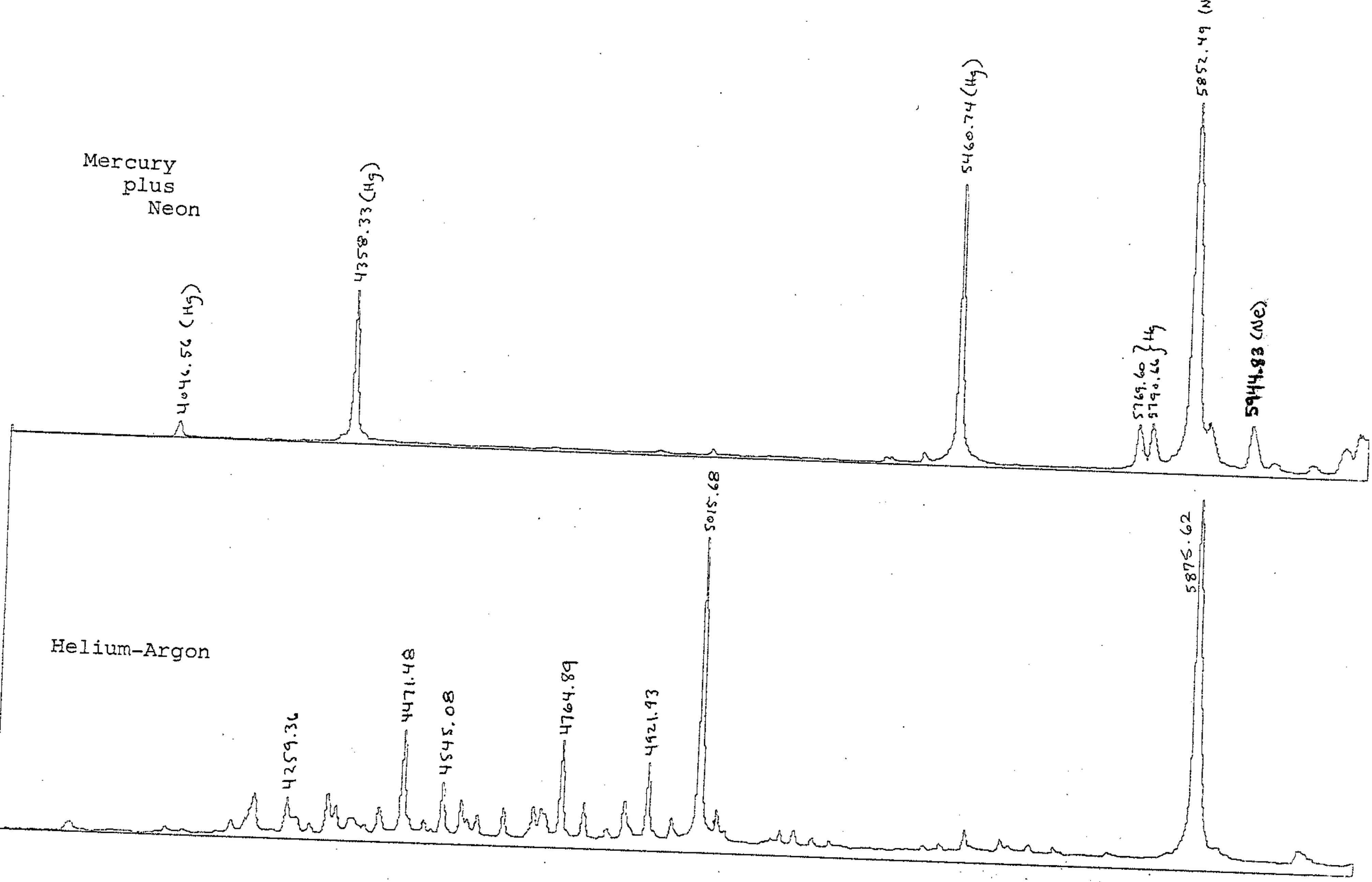

upstairs-downstairs intercom speaker
real-time data display
image tube HV
dissector HV
rate meter crate
scanner memory real-time display scale
sweep control box
tape unit 8: program tape
scanner switch panel
PDP-8I console
ASR-33 teletype
tape unit 7: data output
Type 611 memoscope
"bootstrap" button: helps load operating system into computer

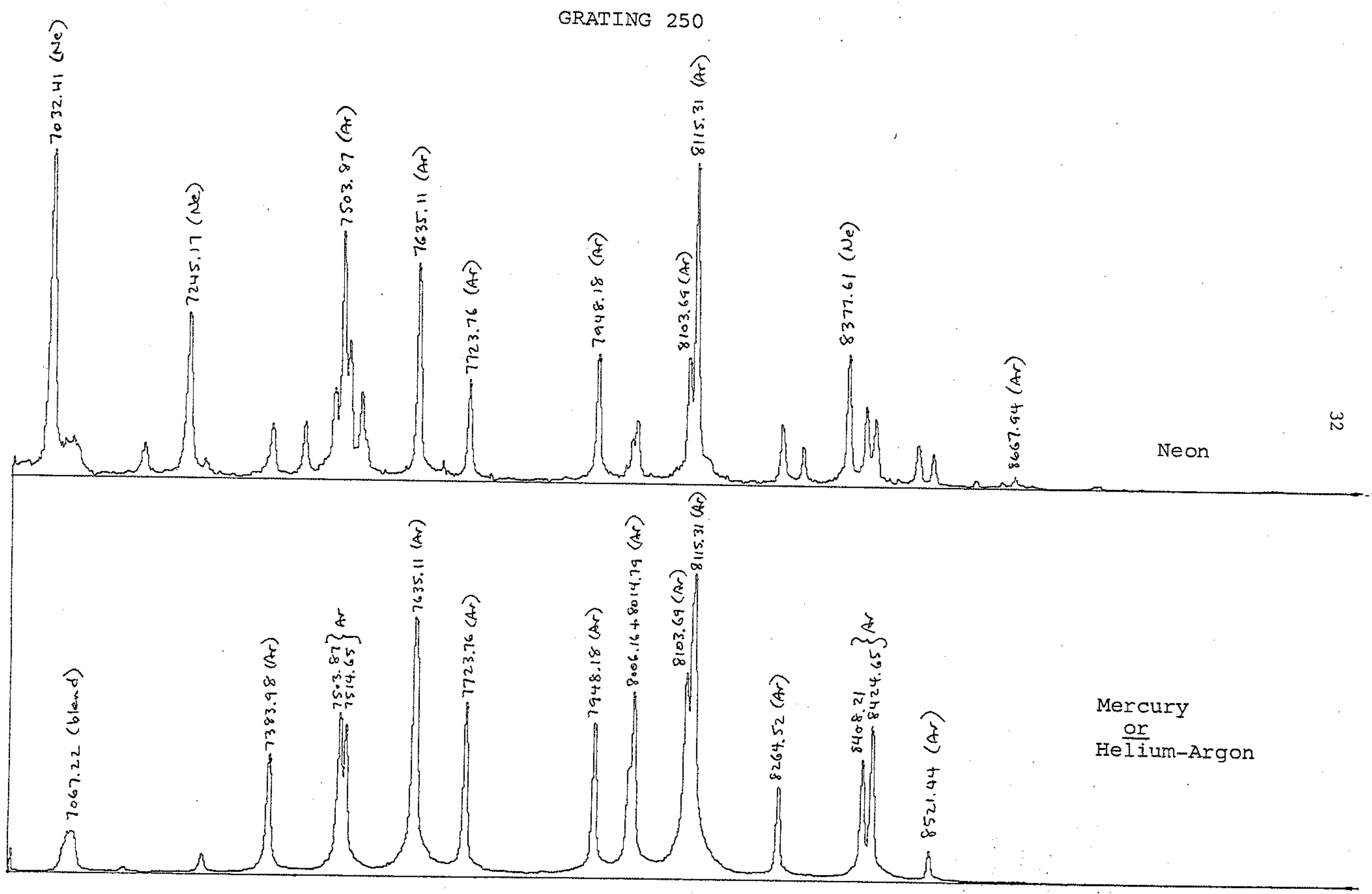
Appendix B: Grating Tilt versus Central Wavelength for "STANDARD" grating (5000 Å blaze).

This chart assumes all grating settings are clockwise; that is, lower to higher.

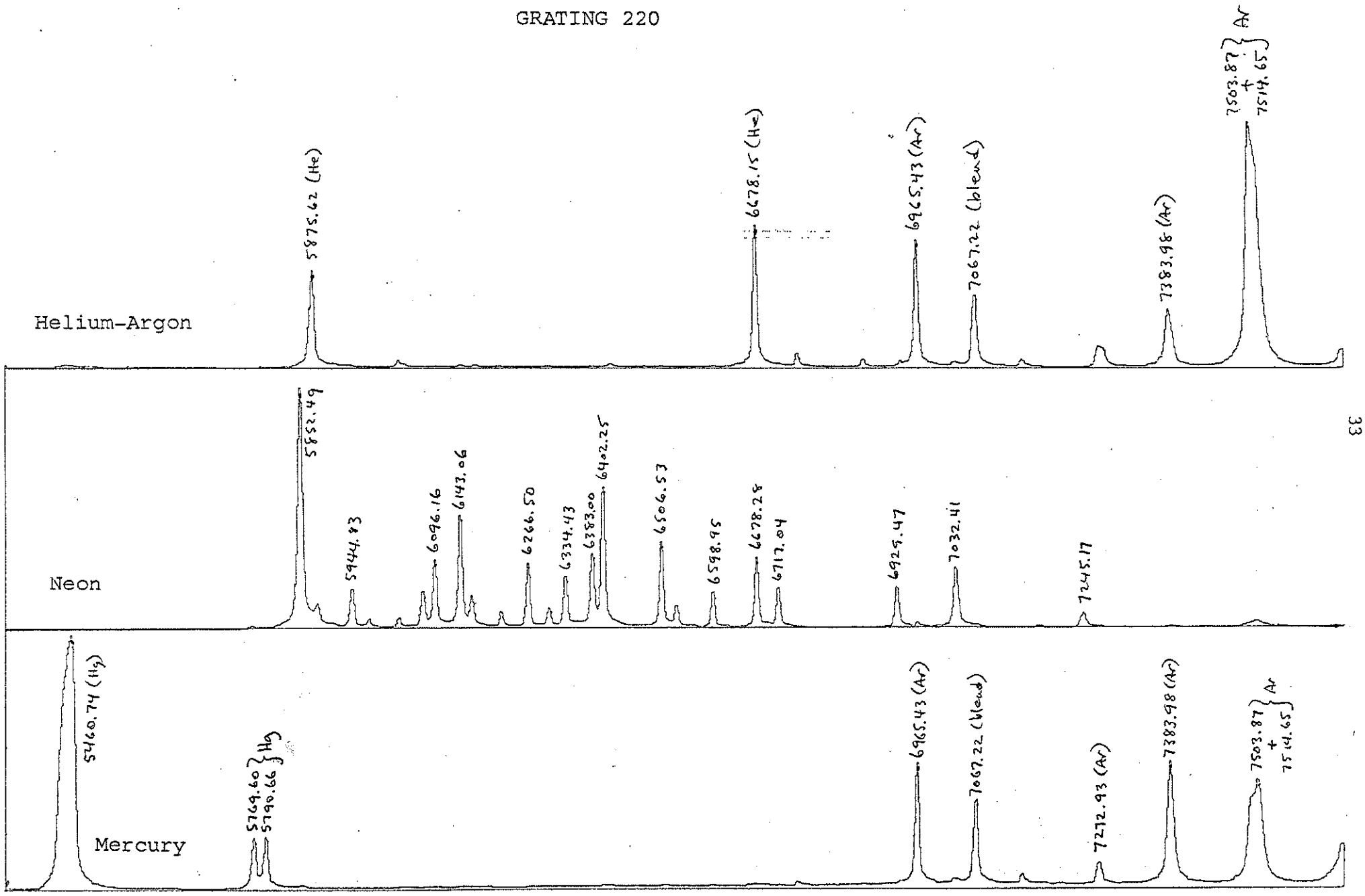


GRATING 190


Mercury plus Neon
4046.56 (Hg)
4358.33 (Hg)
5460.74 (Hg)
5769.60
5790.66 Hg
5852.49 (Ne)
5944.83 (Ne)
Helium-Argon
4259.36
4471.48
4545.08
4764.89
4921.93
5015.68
5875.62


GRATING 250
7032.41 (Ne)
7245.17 (Ne)
7503.87 (Ar)
7635.11 (Ar)
7723.76 (Ar)
7948.18 (Ar)
8103.69 (Ar)
8115.31 (Ar)
8377.61 (Ne)
8667.94 (Ar)
Neon
7067.22 (blend)
7383.98 (Ar)
7503.87
7514.65 Ar
7635.11 (Ar)
7723.76 (Ar)
7948.18 (Ar)
8006.16 + 8014.79 (Ar)
8103.69 (Ar)
8115.31 (Ar)
8264.52 (Ar)
8408.21
8424.65 Ar
8521.44 (Ar)
Mercury
or
Helium-Argon

GRATING 220


Helium-Argon
5875.62 (He)
6678.15 (He)
6965.43 (Ar)
7067.22 (blend)
7383.98 (Ar)
7503.87 + 7514.65 Ar
Neon
5852.49
5944.83
6096.16
6143.06
6266.50
6334.43
6383.00
6402.25
6506.53
6598.95
6678.28
6717.04
6929.47
7032.41
7245.17
Mercury
5460.74 (Hg)
5769.60 } Hg
5790.66 }
6965.43 (Ar)
7067.22 (blend)
7272.93 (Ar)
7383.98 (Ar)
7503.87 + 7514.65 Ar

Appendix D: Filters

The filters and positions shown here are as of mid-1977. The most likely change is just to add filters not listed here. However, there's nothing sacred about these lists and the actual contents of the filter wheels at any time will be found on the filter position list, on the spectrograph below the filter access door.

Upper Filter Wheel		Lower Filter Wheel	
Position	Filter	Position	Filter
1		9	QND 1.0 (2.5 mag)
2	GG 385	10	QND 2.0 (5 mag)
3	GG 455	11	
4	GG 495	12	
5		13	
6		14	
7	NG 5 (1.1 mag)	15	NG4 (2.3 mag)
8	QND 0.7 (1.75 mag)	16	

Note: Filters prefixed GG are Schott numbers for order separation. The three digits indicate the cutoff wavelengths; GG 455 cuts off at $\sim$ 4550 Å. QND means Quartz Neutral Density. NG signifies glass neutral density (more nonlinear at short wavelength than the quartz).

Appendix E: Eyepieces, Offset Guiders and Slit/Decker Assembly

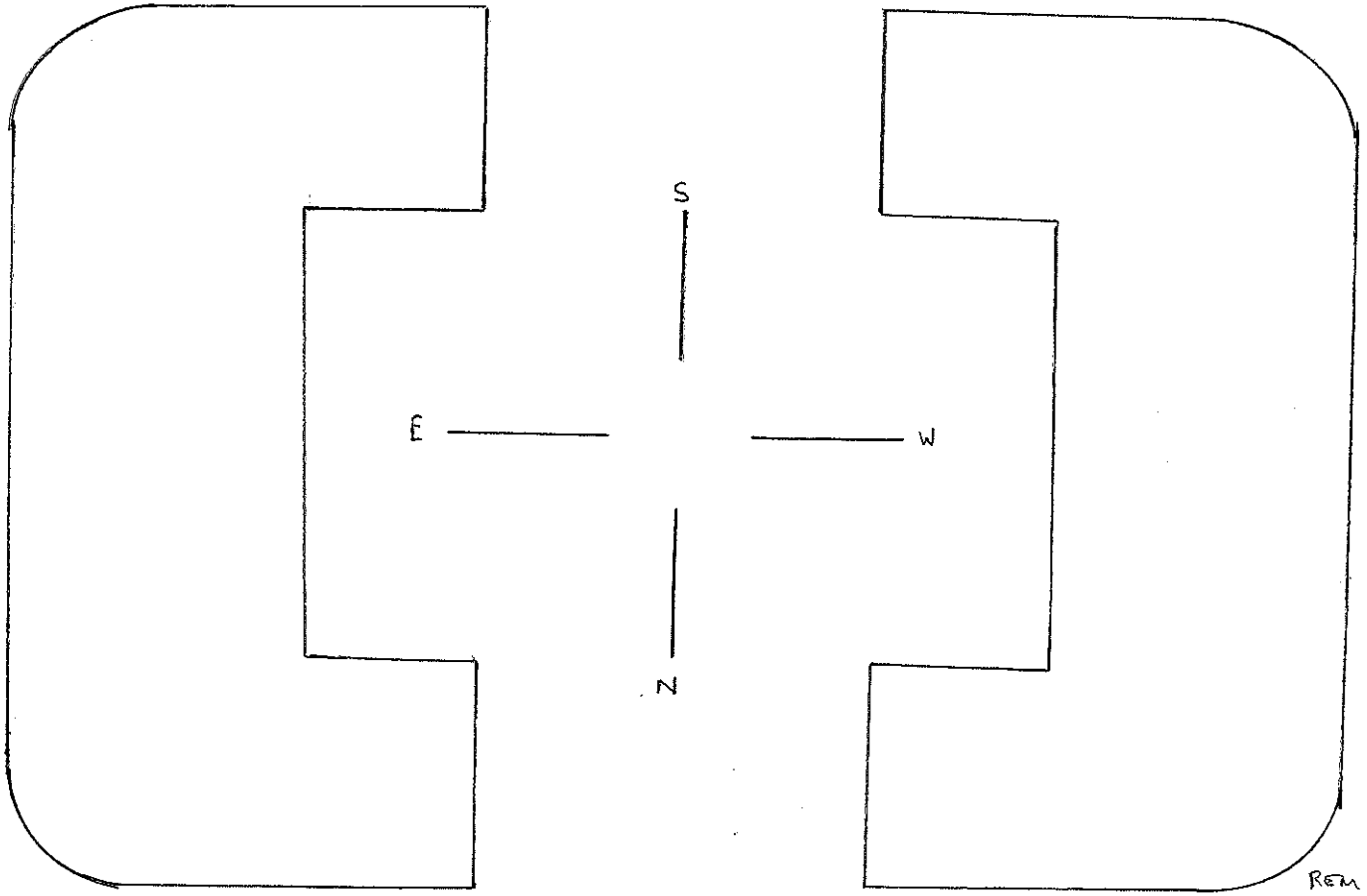
I. Eyepieces:

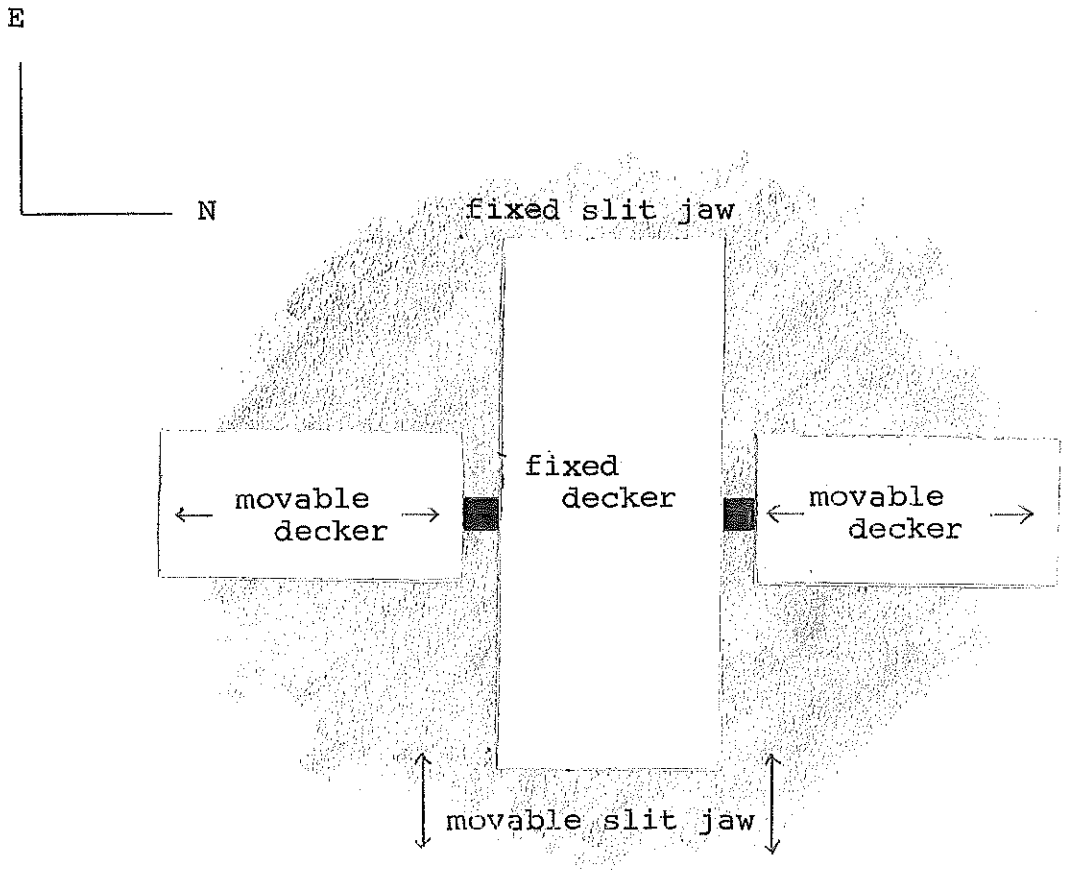
Eyepiece	Field Diameter (minutes of arc)	Orientation
Finder	97	(marked on reticle)
Field	13.75	E = left, N = down
Slit Viewer	(for small decker, slits are ∿ 100 arc sec apart)	N = right, E = up
Offset (East side)	3	N = right, E = down
(West side)	3	N = left, E = up

2. Offset guiders:

Note that the offset guider on the east side of the spectrograph observes a field to the west of an object on the slit, and vice versa. The cutouts from the inside of each offset field are due to blocks which prevent one from putting the offset guider in a position where the pickup prism will obstruct the slits. However, it is still possible for the east side guider (only) to come between the slit viewer and the slit, but don't panic because light on the optic axis will still reach the slits. There is a great deal of light lost in the optics of the offset guiders so that it is not easy to guide on stars fainter than about mag 10.

This drawing shows the finder reticle superimposed on the fields available to the offset guiders. The scale of the offset field drawings is 1:1. The scale of the telescope at the offset guiders is approximately 20"/mm.





24" ITS slit/decker assembly.

The slit jaws underlie the three sections of the decker. Only the bottom slit jaw and only the outside deckers are movable. The apertures are the black squares, and for small decker openings the center-to-center distance is about 100 arc-sec.

One complete rotation of the slit adjust knob is taken to be one unit, and 1/10 unit $\approx$ 1 arc-sec (max 90 arc-sec). The decker wheel is marked every 2/10 unit, and again 1/10 unit $\approx$ 1 arc-sec, max 90 arc-sec.

Appendix F: Telescope Limits

Wind: Close if steady at 35 or gusting over 40 mph. (Gauge is on NNW side of dome).

Humidity: Close if relative humidity exceeds 95%, or as necessary to exclude moisture. Listen for the sound of the 120" shutter closing, and if you hear it, check the weather and be especially alert.

Declination: +60°

Horizon Limit (declination $\leq$ 60°): $\sim$ 10°

Slit: Do not attempt to set below 0.0.