MULTIPLE MIRROR TELESCOPE OBSERVATORY

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OPERATION OF THE MULTIPLE MIRROR TELESCOPE SPECTROGRAPH

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PREFACE

The MMT Spectrograph has proven itself to be an extremely powerful, versatile instrument. Unfortunately, when describing the spectrograph, the adjective 'user-friendly' does not jump into the mind of even the experienced user. The combination of hardware versatility (e.g. image stacker vs. direct mode), sophistication of the data-taking software, and destructibility of the image tube make it an intimidating instrument. Ray Weymann has performed an enormous service to the users of the MMT Spectrograph in his role as Instrument Scientist by preparing the lion's share of this manual. We believe that it will not only simplify the novice user's initiation into the use of the instrument, but also serve as a valuable reference for the experienced user.

The manual is not complete. It is an unfortunate fact of life that this manual may never be complete. The MMT Spectrograph has been evolving since it was first designed and will continue its evolution with the completion of the red channel, development of a two-dimensional detector for the blue channel, etc. As these developments proceed, we will make every effort to keep this documentation current. We welcome your comments and additions to this manual.

Craig B. Foltz
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MMT SPECTROGRAPH USERS MANUAL

TABLE OF CONTENTS

APPENDICES

1. INTRODUCTION AND GUIDE TO OTHER DOCUMENTATION

The MMT Spectrograph is a photon-counting spectrometer which provides resolution which runs from about 0.5 Å FWHM (with the echellete and stacker) to ~ 10 A and which is sensitive from 3200 A to about 7000 A with decreasing sensitivity further to the red. A future modification will provide a separate "Red Channel" spectrograph with a bare CCD detector for spectroscopy in the range 3700A - 1.0 micron.

The spectrograph is interfaced to the telescope via the general instrument interface called the Top Box. The Top Box contains the television acquisition and guider system as well as the comparison sources for use with the spectrograph. The current Top Box will be replaced in the Spring of 1985.

The current blue system uses a 3-stage magnetically-focussed ITT image tube fiber-coupled to a minifying boole followed by a microchannel plate and split boole. The split boole feeds two 1024 element Reticon diode arrays. Photon centroiding logic divides each physical 25-micron diode into 4 pixels, yielding 4096 pixels in each array. A portion of the diodes at both the red and blue ends of the two Reticon arrays are not illuminated by the image tube chain and therefore are "dead". A more detailed description of the optics is found in Appendix 10.

The image tube chain is extremely vulnerable to damage and USERS SHOULD READ SECTION 2 OF THIS MANUAL BEFORE ATTEMPTING TO USE THE SPECTROGRAPH. It is the responsibility of the user to be cognizant of the safety guidelines concerning the operation of Big Blue. Therefore, before consulting any other documentation, please become familiar with the material in Section 2 of this manual.

The telescope, data system and spectrograph form a complex system and first-time users are very strongly encouraged to spend at least the first half of a night with an experienced user rather than rely on manuals.

1.1 Additional Documentation

All of the documentation listed below as well as the most recent version of this manual are maintained in a documentation rack in the MMT Control Room. Modifications to this manual will be recorded in a section at the end of the manual called Recent Changes.

- First-time and infrequent users with fairly straightforward observing programs should consult MMT Technical Memorandum 84-10, "Abridged I-Ret Software Guide" for a cookbook describing the data-taking software. Sections 4 and 5 of this manual discuss this software somewhat more completely.

- A complete description of the software can be found in the current version of the I-RET Software Manual. Questions about details of SAO FORTH may be answered by consulting the SAO FORTH Manual.

- The KPNO IIDS Standard Star Manual contains finding charts and positions for bright (too bright?) standard stars. When using these stars, keep in mind the illumination guidelines for the image tube. A list of fainter stars which may be used as standards is contained in Appendix 15. Note that these stars have not yet been incorporated into the Steward data reduction system.

- The Reticon log sheets are contained in a blue binder ("Current Reticon Log Sheets")

- Users not familiar with the MMT mount commands may find it helpful to read Section ii of MMT Technical Memorandum No. 84-23 which summarizes the basic concepts and commands of the Mount Control system. This material is also contained in Appendix A-9.

Comments and suggestions concerning modifications, corrections or additions to the material in this manual are welcome. Please put them in writing and send them to C. B. Foltz, Multiple Mirror Telescope Observatory, Tucson, AZ 85721.

2. PROTECTION OF THE BIG BLUE DETECTOR: OBSERVER'S RESPONSIBILITIES

The blue image-tube chain driving the Reticon on the MMT Spectrograph is a very valuable, very vulnerable, and virtually irreplaceable piece of equipment. Its loss would severely curtail the research of many astronomers. Therefore, all users of the MMT Spectrograph are requested to read this chapter with care: it spells out important safety procedures and precautions. It is the OBSERVER'S responsibilty to see that these are carried out.

(1) Whenever the high voltage is on and the CAMERA SHUTTER (NOT the dark position in the lower filter wheel; see spectrograph schematic) is OPEN the flashing warning lights should be on, WHETHER OR NOT DATA IS BEING TAKEN. (The switch for the warning light is located on the wall behind the observer's workstation). Flashlights should be used in the telescope chamber when the warning lights are flashing unless the count rates are being monitored. Count rates above 2000 /side/second mean too much illumination -- close the camera shutter.

NOTE: When the comparison mirror is "out" and the camera shutter is open, high count rates may result even for very low levels of dome illumination, due to light reflected off the beam combiner.

(2) Always leave the spectrograph in a "safe" configuration unless you need to have the camera shutter open and you have turned on the flashing warning lights. The "safe" configuration is obtained by:

a) Closing the camera shutter

b) Setting the lower filter wheel to the "dark" position (ccw limit switch)

NOTE: In the SCCS [See section 3.4] this is done by SAFE <cr>

In this "safe" condition the fluorescent and incandescent lights in the chamber may be used. The building shutters and mirror covers may be opened NO EARLIER THAN ONE HOUR BEFORE SUNSET PROVIDED THE BUILDING IS TURNED AWAY FROM THE SUN. Monitor the counts CAREFULLY as the shutters are opening.

(3) Neither the solenoid power supply nor the solenoid cooling should be turned off during the run, except for a real emergency; in this case turn off the solenoid power before you turn off the solenoid cooling, but do so only after the image tubes are powered-down. See Appendix 13 and Section 3.1.1.

(4) If it should be necessary to turn off the high voltage ("Spellman") power supplies, or if a power failure has occurred, follow carefully the instructions attached to the power supply and contained in Appendix 13. In particular, if there has been a power failure, or the over-illumination sensor described in (6) below has turned off the power, DO NOT turn the supplies back on UNTIL the voltage control knobs have been turned BACK TO ZERO. BE CAREFUL NOT TO EXCEED THE SPECIFIED VOLTAGES WHEN TURNING UP THE SUPPLIES!!

(5) NEVER illuminate the detector with a uniform continuum source yielding more than 3000 counts/side/sec. Be especially careful of the illumination level with emission line lamps. Do not exceed 4 counts/half diode/sec or 2 counts/quarter diode/sec [see Section 4.1 for an explanation of '1/4 diode' and '1/2 diode' displays] for the strongest emission line.

(6) An over-illumination sensor has been installed as an extra measure of protection against damage by bright stars. (Note that "bright" for the 300 g/mm grating is about m=15 !) Whenever either of the two arrays senses a count rate of 6000/sec or greater a high-pitched alarm will sound. HIT THE PANIC BUTTON NEAR THE ALARM. (Take time to locate this button while you are reading this.) After 2 seconds the lower filter wheel will be moved to 'dark' Automatically. After 5 more seconds the high-voltage power supplies will be turned off if the counts are still high. Observers MUST NOT BE LULLED INTO A SENSE OF SECURITY BY THIS DEVICE BUT MUST CONTINUE TO OBSERVE GREAT CAUTION, and follow the procedures in (7) below. There are two reasons for this:

i) Count rates VERY VERY MUCH higher than 6000 counts/sec can result from, for example SAO stars. This could destroy the tube in less than 2 seconds and may saturate the Reticon electronics so such count rates may not even be detected.

ii) Turning off the power supply to the high-voltage abruptly is itself a risky operation and is to be avoided!!

(7) When slewing to a new position or offsetting to an allignment star brighter than about 14, SET THE BOTTOM FILTER WHEEL to the DARK position by running the wheel to the CW limit.* When you have returned to your object and the TV has been turned up and you have confirmed that there is no brght object in the aperture the wheel may be set to CLEAR by running the wheel to the CCW limit. The 'dark slide' is a closed position in the bottom filter wheel. It is activated either manually by the panic button (no matter what the spectrograph settings are) or by the overillumination sensor.

(8) If a thunderstorm is nearby, the high voltage should be turned off (Appendix 13) as should the instrument computer. The telescope operator should do this.

If any users have any questions about the foregoing instructions they should contact Craig Foltz [621-1269 (O)/790-8640 (H)] or Dave Ouellette [326-6129(H)] before attempting to operate the spectrograph.

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*In SCCS, type DARK <cr>

3. OPERATING THE SPECTROGRAPH HARDWARE

Caution: Before proceeding, please make sure you have read section 2. of this manual on the safety of BIG BLUE.

3.1 Big Blue Detector System

This section describes the Big Blue detector system and a check-list that the observer should go through upon arriving or if there are indications of trouble. In appendix 13 will be found detailed instructions for turning on and off the detector system.

The operation of the spectrograph itself as (distinct from the detector system) is described in sections 3.2 through 3.4. Section 3.3 is superceded by section 3.4 (Computer Control of the Spectrograph) but is left in the manual since the system described in that section is the manual back-up to the Spectrograph Control Computer. The operation of the data-taking computer system is described in section 4.

3.1.1 Detector System Components and their Locations

3.1.1.1 Image Tube/Reticon/Solenoid Package

The image tube chains consists of a 3-stage image tube with fiber-optic coupling to a microchannel plate, which in turn is coupled to a V-shaped fiber bundle to which is attached the dual channel Reticon. This entire package is enclosed in a large cylinder which contains the solenoid cooling lines and windings. This solenoid-detector package is mounted at the focal plane of the camera on the spectrograph.

3.1.1.2 Cooling System

There are two separate cooling systems for Big Blue, one for the solenoid and the other for the image tube photocathode. The solenoid cooling system consists of a chiller, reservoir, and pump located in the yoke room. The cooling lines run through the cable wrap and into the solenoid. The image tube cooling system is a refrigeration unit ("Neslab") mounted with a gimbal on the telescope structure. The cooling lines from this refrigerator do not go through the image rotator and are too short to accommodate the full range of the image rotator. Use great caution and watch these lines if you use the image rotator.

3.1.1.3 Dry Nitrogen System

Dry nitrogen must always flow through the detector when the spectrograph is in use or frost will form, ruining the spectra. On the ground floor are a series of dry nitrogen tanks with an automatic switching system which will switch to spare tanks when necessary. A very loud alarm bell near these tanks will sound when the system switches over to the last spare tank. If this occurs, notify the telescope operator or day crew to make sure new tanks are installed.

On the telescope floor on the back wall inside the chamber (opposite the building shutters) is a small green panel on which are mounted two valves and two flow meters for "low" and "medium" flow rates. The red hose should be attached to either one and goes through the cable wrap. The left scale on either of the flow meters reads liters/minute (SLPM).

3.1.1.4 Reticon Head Power Supply and Electronics Package

These are two small (8x6x10) boxes mounted on the spectrograph. The power supply has an on/off switch and red light.

3.1.1.5 Reticon Discriminator Electronics Box

There are actually two such boxes, one mounted above the other, in the 2nd rack from the left in the floor directly above the control room where the computers are housed. One of the units is used for the Echelle Reticon and serves as a spare for the Big Blue discrminator box. There are two led displays on this box which display the count rate from the detector whether or not the instrument computer is on.

3.1.1.6 Solenoid Current Meter and Power Supply

These are located at the top of the right-most rack in the computer room as you stand with the instrument computer on your left. The meter unit also contains the solenoid overheating protect light and reset button.

3.1.1.7 Image Tube High Voltage Power Supplies

There are two separate supplies: The microchannel plate supply is the top most and is located beneath the solenoid power supply. Underneath the microchannel plate supply is the 3-stage tube supply. WARNING:DO NOT MAKE ANY ADJUSTMENT WHATSOEVER ON THESE SUPPLIES WITHOUT FOLLOWING EXACTLY THE INSTRUCTIONS FOR TURNING ON AND OFF THE HIGH VOLTAGE CONTAINED IN APPENDIX 13 AND POSTED ALONGSIDE THE POWER SUPPLIES.

3.1.2 Detector System Checklist for Observers

Normally, the MMT Instrument Specialist will be responsible for seeing that the entire system has been properly hooked up and turned on. However, there may be special circumstances when this is not the case or when a