Enterprise Flight Manual
for the
MX Spectrometer

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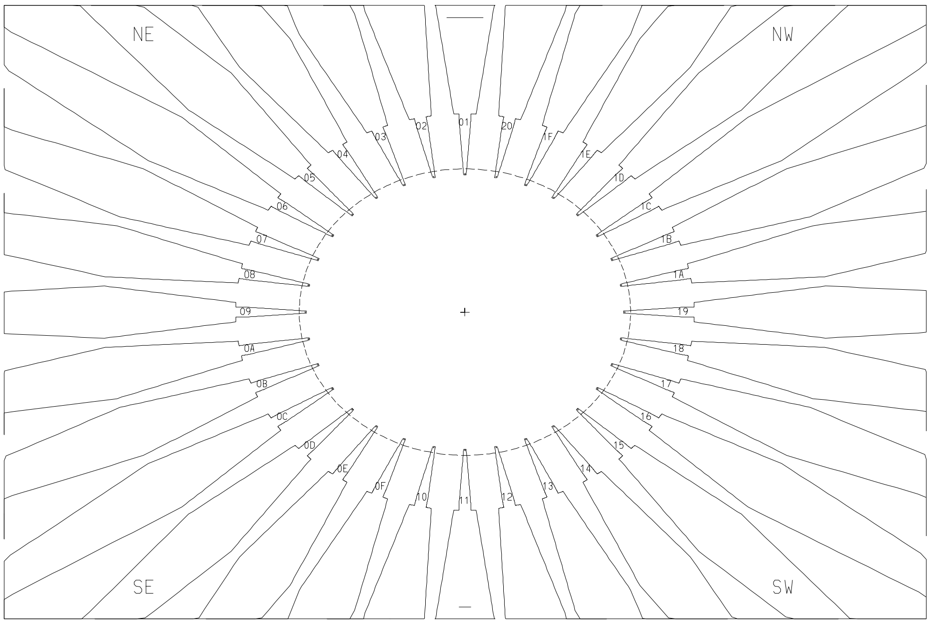
Abstract

The purpose of this manual is to explain to the observer how to operate the MX Spectrometer for the purpose of observing. The major tasks during observing are to transfer coordinates from the workstation in the control room into the Enterprise Z-80 on the telescope. After coordinates have been transferred, the Enterprise may be commanded to move the probes to the observing positions. MX-specific communications tasks are contained in the "mxpackage.mxobserve" package. All CCD functions are controlled separately from the "ccdacq" package on the Sun workstation. "ccdacq" also provides for remote control of the MX calibration lamps.



Contents

1 Typical Beginning of Night/Run Activities

- Setup MX Openwindows configuration and install "mxpackage" on the Sun.
- Make sure all instrument cabling is correctly connected.
- Power up CCD (see CCD manual)
- Power up MX and start Enterprise communications software (next chapter)
- Initialize Enterprise and exercise probes
- MX Probe Center Alignment with microscope
- B&C Spectrograph focus
- Take biases, darks and chip flats
- Ask Telescope Operator to acquire First Star
- Focus the telescope and initialize autoguider
- MX Guide Aperture Alignment
- Ask the telescope operator to acquire your MX alignment field
- MX Rotation Alignment
- MX Decenter Alignment
- Observing!

1.1 Workstation Configuration

MX observers use a slightly modified version of the standard Steward CCD observing environment on the observer's workstation. As of September 1996, the environment for Solaris / OpenWindows / IRAF / ICE is modified as follows:

1. Create .setenv.mxpackage
2. Create and edit loginlocal.cl in /home/bokobs/ (home directory for IRAF)
3. Get the pre-compiled mxpackage archive from John's directory on abell
4. Unpack the mxpackage archive
5. Copy some relevant files into the home directory:

To execute these steps in an almost completely automated fashion, say "cl < mxpackage.setup_bok", and then follow the instructions. You can find the script file at: "/net/abell/d1/hill/mx/mxpackage.setup_bok". More of the gory details are contained as comments in this IRAF script file.

2 Beginning of the Night Procedure

All communications with the Enterprise Z-80 which runs the MX probes occur over a serial link to the control room. A set of IRAF tasks from "mxpackage.mxobserve" manage commands and data sent to/from the Enterprise. Pre-run configuration of "mxpackage" on the workstation "bok.as.arizona.edu" is described in the script "mxpackage.setup_bok" (see previous chapter).

2.1 Procedure for Starting Enterprise Window

2.1.1 Condition before Startup

- Logged into IRAF "cl" on workstation
- "mxpackage" and "mxobserve" loaded
- Connected to IIS patch connector RS-3 from /dev/ttya (current loop)
- Enterprise Serial A connected via IIS connector RS-3

2.1.2 Procedure for Startup of Communication Program

- "listen &" to collect serial data from Enterprise in the background
- "subspace" to send keyboard input to Enterprise in the same window

If the Enterprise is already running, a carriage return should produce a prompt. Hitting the delete key is even better than a carriage return because it flushes the communications buffers. If the Enterprise is not running or does not respond, proceed to the next section.

"listen" is a cl script that runs task "ttarget" without all the cl overhead. It is normally run in the background, but could be in the foreground of a separate window.

Note that "listen" and "subspace" are permanently rather experimental and not particularly robust. Before you complain too loudly, remember that the alternative is a Z-80 with 8-inch floppy disks.

2.1.3 "listen" and "subspace" parameters

listen.par

```
      (port = "/dev/ttya")    serial port for enterprise
     (tfile = "")             stream file
     (necho = 1)              echo interval
      (verb = 4)              verbosity
   (version = "03 June 1992") Version date of this routine
      (mode = "ql")
```

"listen" also creates a temporary script file named ".listen_temp". "tmp$ttarget.txt" is a stream file that is only used for probe alignment. See "readcenters" below.

subspace.par

```
    (portname = "/dev/ttya")    Name of the serial port
  (instrument = "mxspect")      Instrument pset
   (verbosity = 4)              Output verbosity parameter
        (mode = "ql")
```

2.1.4 How to exit "listen" and "subspace"

"listen" exits whenever the Enterprise echoes a Cntrl-D. Type a Cntrl-D in "subspace" to exit gracefully. Then type a Cntrl-C to exit "subspace" or "readcenters".

If your window crashes and you have a rogue (dettached from the parent window) "listen" task, you will have to hunt it down with the Unix commands "!ps -efc" and destroy it with "!kill -9". There may be as many as three PIDs. Otherwise, the rogue task will continue to interact with the serial port producing very erratic communications. See the task "killer" to make the hunt easier. Sometimes "listen/ttarget" exits accidentally, if that occurs type a Cntrl-C to exit "subspace" and restart both of them as above.

2.2 Procedure for Starting the Enterprise

The Enterprise is the Z-80 microprocessor onboard the MX Spectrometer on the telescope which controls all of the motions of the 32 probes. It receives commands over a serial link from the workstation and the astronomer in the control room. The Enterprise moves the fibers probes with 32 intelligent stepper controller cards connected to an extension of the Z-80 STD bus. These controller cards are located in the 2 auxilliary Eurocard racks on the flanks of the MX.

2.2.1 Procedure for Power-up of Enterprise

- Turn ON the Enterprise Z-80 AC Power (white rocker switch on right side of card cage, behind some cables).

- Be Sure both the local and remote collision override switches (CXOVR) are set to NORMAL. (Yellow LED on the remote box will be off, or at least dim.)

- Press the Enterprise Reset, either the button on the Z-80 or the red button on the remote box. This should produce the Enterprise boot message and a $ prompt from the monitor on the terminal screen or Sun window. If you don't get a message from Enterprise, check all the power switches, check the serial cable from Enterprise Port A to /dev/ttya, restart the "listen" program.

- Turn on the MX Stepper Power Supply (+12 VDC), normally found hanging on the IIS ring above and to the right from Enterprise, ON is the toggle switch (on inside face) UP. **Do not turn on or leave on this power supply unless the Enterprise Z-80 is on.**

- Turn D'Arc Box AC toggle switch (right of center) to enable power to the arc lamps.
- Turn on B&C Lamp Controller Power Supply (in CCD rack in control room). Rebooting of the CCD VXWORKS computer is often required to get the communication with this lamp control interface working. (A buzzer on the remote box will complain if you forget to do this.)

2.2.2 Running the Enterprise Program

- When talking to Enterprise with a terminal, a carriage return should bring the $ prompt from the Enterprise monitor.
- If you are using a dumb terminal, press the Alpha Lock (caps) button on the terminal while talking to the Enterprise. ("subspace" converts to upper case automatically.)
- The executable code in the Enterprise is stored in battery-backed CMOS RAM. Normally it will not be necessary to download fresh code on power up. Typing an " `H` " will show you the monitor menu.
- To start the observing program in Enterprise, type " `G0100` ", this begins program execution at address 0100H. Note: that is " `G0100` " **not** " `GO100` ".

The Enterprise Program will respond with:

```
EPROG3 -- Enterprise Control Program -- Version of 01-JAN-87
 -- Type H to get a menu of commands.
```

- The EPROG3 prompt is $< aa : b >$ where aa is the active probe number and b is the motor number.
- If you get gibberish on the screen, or if the Enterprise will not leave monitor mode (as indicated by the $ prompt); you need fresh software — see the next section.

2.2.3 Normal Startup Commands *(if software is already loaded)*

" `A/` " to reset all the motor controller

" `A?` " to verify that all probes are alive

" `A*` " to initialize the controllers and zeropoints by moving all probes back to their optical limits

Note that the " `A` " performs the following commands on all the probes. i.e. " `/` " resets the active probe while " `A/` " resets all probes.

See the Enterprise Menus section of this manual for a full list of commands.

2.3 Downloading Fresh Software to the Enterprise

The "listen" program should be running on the workstation and the Enterprise power should be ON. Remember this is NOT a normal observing procedure. Fresh software should only be needed when something has glitched the Enterprise memory, or when Enterprise has been turned off for a long time, or when the CMOS RAM batteries are dead. Typical symptoms of corrupted Enterprise software are "G0100" not producing a response or "#" hanging in a loop.

2.3.1 Download Software Procedure

1. Reset the Enterprise or return it to monitor mode with a " `!` " .

2. Load "mxpackage" and the "mxobserve" package in your cl window.

3. Run "loadcode" to send the program file "eprog3.hex".

   The hexadecimal address readout will update on the screen as the .HEX file is shipped across the serial link and loaded into Enterprise memory. The data area ends around $97C0_{16}$. (This file is an ascii hexadecimal representation of the Z-80 binary code.) Downloading takes about 70 seconds.

4. Run "loadcode" again to repeat the download procedure with "pivot.hex" if the probe geometry has been recently updated (**usually**). The pivot decenter offsets **must be reloaded** each time you reload the program code.

5. Run "loadcenters" if a center alignment has been performed at the beginning of the observing run (**always!**). Center coordinates are kept in a file usually named '*date*.set'. A center alignment is performed at the beginning of each observing run and should be repeated whenever MX is remounted on the telescope. The center coordinate offsets **must be reloaded** each time you reload the program code.

6. Run "makeitso". *After all information has been downloaded, return to communicating with Enterprise via the "subspace" program. You may now execute the new Enterprise program by typing " `G0100` " in the Enterprise window. There is a task to automatically send this and the following initialization commands (7,8,9) from the workstation. See "makeitso" below.*

7. After loading fresh software (eprog3.hex), reload the neutral coordinate buffer by typing " \ " . You must do this before trying to move the probes.

8. Apply any platescale or rotation alignment changes at this time. A rotation correction is determined from a star field each time the instrument is mounted on the telescope. The platescale should be stable with time.

9. You will also wish to create the standard circle patterns with the | command. (see below)

2.3.2 "loadcode" and "loadcenters" parameters

loadcode.par

```
     (hfile = "mxobserve$eprog3.hex") Name of the program (.hex) file
  (portname = "/dev/ttya")    Name of the serial port
     (delay = 20)             Output delay in milliseconds
(instrument = "mxspect")       Instrument pset
 (verbosity = 4)              Output verbosity parameter
      (mode = "ql")
```

loadcenters.par

```
      cfile =                 Name of the center calibration file
  (portname = "/dev/ttya")    Name of the serial port
     (delay = 50)             Output delay in milliseconds
(instrument = "mxspect")       Instrument pset
 (verbosity = 5)              Output verbosity parameter
      (mode = "ql")
```

2.3.3 Typical Circle Patterns

Operation of MX will be smoother if you use the first three or four coordinate buffers to store several standard circle patterns. You must reload these each time the software is reloaded. These patterns are not loaded automatically because they are sometimes different for engineering tests or special observing programs. See the section on how to create a circle pattern for more details.

- " B B000 " " | 00000000 00000000 " " # "
- " B B400 " " | 00008000 00000000 " " # "
- " B B800 " " | 00010000 00000000 " " # "
- " B BC00 " " | 00020000 FFFD0000 " " # "

2.3.4 Sample "makeitso" session

"mxobserve.makeitso" sends a series of initialization commands to the Enterprise after power up or reloading fresh software. The idea is to save the observer from a lot of typing in the Enterprise window with the Z-80 interface. "makeitso" does not handshake with the Enterprise, but simply sends the commands at pre-arranged intervals. Remember to set (epar) the current rotation angle before you run "makeitso".

```
MAKEITSO Program to Initialize the ENTERPRISE, SPP Version of 12-SEP-93
       Executed on: Sun 18:31:03 12-Sep-93
MAKEITSO:  G0100         Run Enterprise Program.
MAKEITSO:  \             Create Neutral Buffer.
MAKEITSO:  R 00000800    Using fangle 00000800.
MAKEITSO:  | 00000000 00000000 Creating circle.
MAKEITSO:  B B000        Using buffer B000.
MAKEITSO:  #             Conversion to steps.
MAKEITSO:  | 00010000 00000000 Creating circle.
MAKEITSO:  B B800        Using buffer B800.
MAKEITSO:  #             Conversion to steps.
MAKEITSO:  B C400        Using default buffer C400.
MAKEITSO:  B 0000        List buffers.
MAKEITSO:  A/            Reset controllers.
MAKEITSO:  A*            Initializing all probes.
MAKEITSO:  Please wait for probes to complete setup.

MAKEITSO is complete.
```

2.3.5 "makeitso" parameters

makeitso.par

```
(fangle =            00000800) Field rotation angle R
(portnam=           /dev/ttya) Name of the serial port
(circle =                 yes) Generate circle buffers?
(fix =                    yes) Replace broken fibers?
(move   =                 yes) Move the Probes?
(delay  =                  75) Serial delay in milliseconds
(instrum=             mxspect) Instrument pset
(verbosi=                   4) Output verbosity parameter
(mode   =                  ql)
```

3 End of Night Procedure

- " `A/` " to reset motor controllers.
- " `A~` " to retract the MX probes to the neutral position.
- " `!` " to shut down the motor controllers.
- Turn off calibration and flat field lamps.
- Close the Barn Doors above the focal plane – Autodoors=off and Remote Doors=closed.

3.1 When to turn the power off

If the possibility of thunderstorms exists, then you will want to power off MX, unplug D'ARC, unplug the B&C Interface Box, power off the CCD, and shutdown all computers. Be sure turn off the MX stepper power supply before turning off the Enterprise Z-80. Refer to the CCD manual for instructions on powering down the CCD and computers. Turn everything off if any significant work is to be done to the telescope or instrument.

Otherwise it is OK to continue taking biases, darks, lamps or flats while you sleep. The stability of both MX and the CCD seems to be better if they remain powered all the time.

4 Target File Processing

The Enterprise accepts X,Y position information from the workstation which stores .TRG files on disk. After the information for a set of probe targets has been downloaded, the Enterprise converts the coordinates into motor addresses for the two motors which move each probe.

4.1 Enterprise Coordinate Buffers

The Enterprise stores its coordinates (both types) in nine buffer locations in memory. Seven of these are available for observer use. To be consistent with convention in this manual, the first four buffers are assigned to patterns of probes in a circle. The next three are routinely used for storage of observing targets. The next to last one contains coordinates for the neutral position at the edge of the field. The last buffer always contains the last set of coordinates that were downloaded. Coordinates **must** be converted to motor steps after they are downloaded. To get a directory of the buffer contents type " `B 0000` ". After processing downloaded coordinates, the observer will give a command for the probes to move to the postions in the active buffer.

4.1.1 Example Buffer Listing

```
<01:1>B:0000
...Coordinates at: B000      CIRCLE        0
...Coordinates at: B400      CIRCLE    32768
...Coordinates at: B800      CIRCLE    65536
...Coordinates at: BC00      CIRCLE   131072
...Coordinates at: C000      m92obs1.trg
...Coordinates at: C400      a2089s5.trg
...Coordinates at: C800      a2666s3.trg
...Coordinates at: CC00      NEUTRL   133120
...Coordinates at: D000      m92obs1.trg

Active Buffer:     C000      m92obs1.trg
Probes Currently at:           NEUTRL    133120
<01:1>
```

B000 — Circle of zero radius, only one probe at a time please!

B400 — Circle of 32,000 micron radius

B800 — Circle of 65,000 micron radius

BC00 — Large angle circle

C000 — Observation 1

C400 — Observation 2

C800 — Observation 3

CC00 — Neutral Circle at edge of field

D000 — Recent Download Storage

4.2 Downloading Target Files to Enterprise

4.2.1 Condition of the System

- "mxpackage" and "mxobserve" loaded
- "listen" task running on workstation
- Enterprise: Powered Up
- User: Sitting Calmly at Workstation, Shoes tied.

4.2.2 To Download .TRG File to Enterprise

- "starget a1795s5.trg"
- If Enterprise prompt is $, type " `G0100` "

If you have trouble, you may be sending data too fast, or there may have been a stray character in the input buffer. The Enterprise will echo Q's from the EPROG3 program. Communication is safer when Enterprise is in monitor mode.

Bug: Due to a problem with buffer overflow, it is expedient to type a "DEL" character to Enterprise before sending a target file from another window.

See the tasks "atarget" and "sensors" below for a *more automated procedure* which is **highly recommended**.

4.2.3 "starget" parameters

starget.par

```
       tfile =                    Name of the target file
   (portname = "/dev/ttya")       Name of the serial port
      (delay = 75)                Serial delay in milliseconds
 (instrument = "mxspect")         Instrument pset
  (verbosity = 4)                 Output verbosity parameter
       (mode = "ql")
```

4.3 Processing Targets Inside Enterprise

4.3.1 Generate Coordinates in Enterprise Buffers

- " `B 0000` " to show selection of Enterprise buffers
  - The neutral position buffer is always $CC00_{16}$.
  - The most recent download is at $D000_{16}$.
- " `B C000` " to select new active buffer $C000_{16}$
- " `#` " to CONVERT download coordinates into selected active buffer
- After this step, wait until you are ready to move the probes (integration done).

4.3.2 Lazy Man's Way Move Probes to Next Coordinates

- " `DEL` " key to clear buffer (temporary)
- " `B C000` " to select new active buffer $C000_{16}$
- " `A/` " to reset all motor controllers
- " `AM` " to move all probes to neutral position and then to next coordinates
- In about 60 seconds, you will get "Photon Torpedos Armed and Ready" message.
- Check the collision LED
- " `DEL` " key to clear buffer (temporary)
- " `A:` " to verify all probes at proper coordinates
- " `DEL` " key to clear buffer (temporary)

4.3.3 Educational Method to Move Probes to Specified Coordinates

- " `DEL` " key to clear buffer (temporary)
- " `B C000` " to select new active buffer $C000_{16}$
- " `A/` " to reset all motor controllers
- " `A~` " to move all probes to neutral position
- Repeat " `A?` " until all probes have arrived at neutral
- " `DEL` " key to clear buffer (temporary)
- " `A@` " to move probes to coordinates in new active buffer

- Wait about 50 seconds or repeat " `A?` "
- Check the collision LED on the remote box (it always has a faint glow)
- " `DEL` " key to clear buffer (temporary)
- " `A:` " to verify all probes at proper coordinates
- " `DEL` " key to clear buffer (temporary)

4.4 Automatic Processing in Enterprise

These tasks provide an automated high level interface for downloading a target file, processing targets and moving the probes.

4.4.1 Condition of the System

- "mxpackage" and "mxobserve" loaded
- "listen" task running on workstation
- Enterprise: Powered Up
- User: Sitting Calmly at Workstation, Shoes tied.

4.4.2 To Download and Process Targets

- If Enterprise prompt is $, type " `G0100` "
- "atarget a1795s5.trg"

The Enterprise will echo Q's from the EPROG3 program during the download process. Then, after a short pause, commands will be sent to automatically convert the coordinates inside the Enterprise. This may overwrite your previous coordinates. If you use "move=yes" or "move+", "atarget" will also send the commands to move the probes immediately.

4.4.3 "atarget" parameters

atarget.par

```
        tfile =                     Name of the target file
      (buffer = "C000")             Address of the conversion buffer
    (portname = "/dev/ttya")        Name of the serial port
        (move = no)                 Move the Probes?
       (delay = 75)                 Serial delay in milliseconds
  (instrument = "mxspect")          Instrument pset
   (verbosity = 4)                  Output verbosity parameter
        (mode = "ql")
```

4.4.4 Sample "atarget" Interaction

On the workstation

```
mx> atarget m92obs1.trg move+
ATARGET Program, SPP Version of 22-JUL-93
       Executed on: Sat 10:16:37 11-Sep-93
READ_TARGET:  Reading target file: m92obs1.trg
ATARGET:  Sent target file: m92obs1.trg
ATARGET:  B C000        Using buffer C000.
ATARGET:  #             Conversion to steps.
ATARGET:  A/            Reset controllers.
ATARGET:  AM            Moving all probes.

ATARGET is complete.
```

On the Enterprise

```
<01:1>#...Converting... m92obs1.trg
...Coordinates at: C000      m92obs1.trg

<01:1>AM Loading all probes, buffer = NEUTRL    133120
<20:1> Loading all probes, buffer = m92obs1.trg
<20:1> target: 1DEB target: 183A
Photon Torpedos Armed and Ready!
```

4.4.5 "sensors" parameters

sensors.par

```
      (buffer = "C000")             Buffer address
    (portname = "/dev/ttya")        Name of the serial port
       (delay = 120)                Serial delay in milliseconds
```

```
  (instrument = "mxspect")      Instrument pset
   (verbosity = 4)              Output verbosity parameter
```

4.4.6 Sample "sensors" Interaction

On the workstation

```
mx> sensors
SENSORS Program to Check the ENTERPRISE Probes, SPP Version of 14-SEP-93
       Executed on: Fri 23:26:28 08-Jul-94
SENSORS:  B C000        Checking against buffer C000.

SENSORS is complete.
mx>
```

On the Enterprise

```
<01:1>B:C000
Active Buffer:     C000       a2022s2.trg
Probes Currently at:            a2022s2.trg
<01:1>: 1=2752 1=2752   AOK     2=18EE 2=18EE   AOK
<02:1>: 1=2C33 1=2C33   AOK     2=17F0 2=17F0   AOK
<03:1>: 1=22CC 1=22CC   AOK     2=1810 2=1810   AOK
................................
<1E:1>: 1=277B 1=277B   AOK     2=1821 2=1821   AOK
<1F:1>: 1=13C9 1=13C9   AOK     2=1A1A 2=1A1A   AOK
<20:1>: 1=276E 1=276E   AOK     2=18E3 2=18E3   AOK
<01:1>B:0000                    a2022s2.trg
...Coordinates at: B000       CIRCLE        0
...Coordinates at: B400       CIRCLE    32768
...Coordinates at: B800       CIRCLE   131072
...Coordinates at: BC00       CIRCLE   131072
...Coordinates at: C000       a2022s2.trg
...Coordinates at: C400       ................
...Coordinates at: C800       ................
...Coordinates at: CC00       NEUTRL   133120
...Coordinates at: D000       a2022s2.trg

Active Buffer:     C000       a2022s2.trg
Probes Currently at:            a2022s2.trg
```

4.5 How to Create a Circle Target Pattern

Sometimes you may wish to move the probes into a tight circular pattern. For example, you may wish to take a fiber flat field with similar illumination on all the fibers. 32000 microns (00008000_{16}) radius is the smallest radius circle which will hold all the probes comfortably. 65000 microns (00010000_{16}) is the smallest circle which will allow a single probe to proceed to the center of the field. Enterprise has a special command to generate a circular target pattern without downloading a target file. The | command generates x-y coordinates in the download buffer ($D000_{16}$) just as if you had a circle target file (and destroys previously downloaded coordinates). The arguments to this command are the radius of the circle in microns and the rotation of the pattern in microradians (0 rotation orients the probes radially towards the center.). Both arguments are given in hexadecimal format (you must supply all 8 digits in legitimate hex characters).

- " `|`<u>`xxxxxxxx yyyyyyyy`</u> " to enter radius and rotation
- " `AF 01` " to select fiber 1
- " `B`<u>`zzzz`</u> " to select coordinate buffer
- " `#` " to convert coordinates to motor steps
- " `AM` " or " `A@` " to move the probes

5 Calibration and Alignment Procedures

5.1 Single Star Flux Calibration

Light from a single star is often used as a flux standard. In multiple fiber spectroscopy it is desirable to collect light from this single object through most or all of the individual fibers. It is possible to move either the telescope or the fiber probes so that the calibration star is placed in one after the other of the fiber entrance apertures. Usually these are quite short exposures.

For this reason, we have implemented a sequential move command in the Enterprise. This command, called by " `A(` ", moves each probe in order to its current buffer position, waits there for a predetermined dwell time, and then retracts the probe to neutral while moving the next probe into place. The operational procedure follows:

- " `B B800` " — select buffer for a 65K micron radius circle.
- " `AM` " — move probes to the indicated pattern.
- " `B B000` " — change the buffer to a zero radius circle. Make sure the zero radius circle has the correct fiber aperture.
- " `T 1000` " — set the dwell time.

0001_{16} = 3 milliseconds

1000_{16} = 13 seconds

$F000_{16}$ = 2:50 minutes

0000_{16} is not a valid dwell. There is presently a bug that offsets from zero.

- Start the CCD Exposure (6 minute minimum).
- Center the object at the center mark on the acquisition TV
- " `A(` " — Execute the sequence move command.

5.2 Single Galaxy Observations

Light from a single bright galaxy is often used as a velocity standard. In multiple fiber spectroscopy it is desirable to collect light from this single object through several of the individual fibers. Typically we might put the galaxy nucleus in the center of the field (guide star position) and put several probes on it during the course of a CCD exposure. A typical operational procedure follows (see Single Star Flux Calibration if you have short exposures):

- " `B B800` " — select buffer for a 65K micron radius circle.
- " `AM` " — move probes to the indicated pattern.

- “ `B B000` ” — change the buffer to a zero radius circle. Make sure the zero radius circle has the correct fiber aperture.
- Center the object at the center mark on the acquisition TV
- Start the CCD Exposure
- Move probe 01 to the center of the field.
  “ + `or` − ” to select probe 1, expect prompt: $< 01 : 1 >$ or $< 01 : 2 >$
  “ `@` ” to move the probe in.
- After the appropriate time retract probe 01 with “ ∼ ” .
- Guide the telescope when you can see the galaxy.
- Repeat for another probe.
- After the exposure is complete, “ `A∼` ” to retract all probes.

If your exposure in each fiber is more than a few minutes long, you may want to retract the probe momentarily to check on the telescope tracking.

- “ `N 0100` ” — set the cursor step size (at the beginning)
- “ `A^` ” — reload motor program parameters (at the beginning)
- Hit the ↓ key (1–) once to pull the probe back.
- Adjust the guiding.
- “ `@` ” to move the probe back in.

5.3 MX Telescope Focus Instructions

Probe 01 in the MX focal plane has a tiny knife-edge screwed to the tip. By defocussing the acquisition television with a lens that lets you view the pupil, this knife-edge may be used to focus the telescope.

5.3.1 Knife Edge Focus Procedure

- Acquire a bright (3 – 6 mag) focus star on the TV. The first star will do just fine.
- Figure out where the knife edge is on the probe. (optional — You can use the known coordinates of the knife edge listed below.)
  - Run the star out of focus with the telescope focus buttons.
  - Move probe 01 to the center of the field. (Instructions below)

  - Position the knife edge just off the center of the image using the cursor keys. (You can see the shadow of the probe.)
  - Note the probe coordinates.
  - Retract probe 1 to neutral with " `A~` ".
  - Roughly focus the telescope.

- Turn down the television gain. (optional)
- Pull the defocus knob on the side of MX. (It moves about 1.5 inches.)
- Turn up the television gain to acquire the defocussed star image on the TV. (Now fills whole screen)
- Move probe 01 to the center of the field. (Tricky: pay careful attention.)
  - " `G0100` " to start Enterprise program if needed
  - " `+ or -` " to select probe 1, expect prompt: < 01 : 1 > or < 01 : 2 >
  - " `'` " to set radial motor active (#1) with a single quote
  - " `P 34E1` " — moves probe 1 in radius
  - " `"` " to set azimuthal motor active (#2) with a double quote
  - " `P 1A59` " — moves probe 1 in azimuth
  - " `?` " to see when probe is done moving
- Move probe with keypad cursor keys until knife edge cuts the star. Probe 01 cuts left (2-) from motor coordinates 1=34E1, 2=1A59.
- Scan knife edge through image using cursor keys or by moving telescope (E–W).
- Adjust focus for uniform obscuration of pupil. (± 1 unit on the focus readout is possible in good seeing.)
- Turn down television gain. **Very Important**
- Retract probe 01 with " $\sim$ ".
- Push in defocus knob to restore normal star image.
- Restore TV gain and position guide star at center of MX field.
- Image should now appear in focus on TV screen. It is very rare to need to adjust the MX TV Focus.

5.4 MX Guide Aperture Alignment

This section describes the procedure for marking the position of the MX field center on the acquisition TV screen so that you may guide the center star on this mark. Yes, there probably is a better way, but either we haven't thought of it yet, or we can't afford it. Position should be stable for the duration of the run, but its good to check now and then.

- Close Schmidt Camera Shutter (to avoid over-illuminating the CCD).
- Put Behind-the-Slit Viewing Mirror In with the rotating disk. (View detente, or Thru away)
- Set Bending Mirror in B&C to Viewer.
- Follow Telescope Focus Procedure Above.
- Use switches on monitor or TV camera to orient the field the way you like it for guiding. (The best advice here is don't mess with it or let the operator select the orientation.)
- Check to be sure you have an appropriate TV filter in place. This filter controls the guide wavelength of the acquisition TV. (Typically we use B460, and it is already in place.)
- Open Slit Shutter by taking a long dummy picture with CCD. (test)
- Setup Probes from their home positions — Give " `A*` " command to Enterprise.
- Move Probe 05 to the center position — buffer $B000_{16}$, by selecting the probe and then giving the " `@` " command. The single probe at the center will block the star image on the TV. (Alternately, you could move the probes to an alignment cluster of stars.)
- Set Photomultiplier Amplifier Voltage to +5.5 Volts DC.
- Set Photomultiplier Counter to "RATE 0.6 SEC" or "FREQUENCY 0.1 SEC".
- Set Photomultiplier Voltage to –800V or less. (Current $\sim$ 1 mA)
- Center Star on Probe by Guiding Telescope and Peaking the PMT readout counter.
- Retract Probe " $\sim$ " and Mark Star Position with a Grease Pencil. This **WILL** be your guiding mark! Also mark TV defects on screen to avoid monitor drift and parallax.
- Try this on a couple of the probes. Centers should repeat to within the seeing disk size.
- Move all probes to Neutral Position " `A~` " .
- ABORT the CCD exposure.

- Remove Behind-the-Slit Viewing Mirror.
- Open Schmidt Camera Shutter.

5.5 MX Rotation Alignment on the Sky

Since the neither the MX bolt pattern nor the IIS rotation pointer is precise at the sub-arcsecond level, it is important to set the absolute instrument rotation each time the MX is mounted on the telescope. You will also want to check the rotation if you have coordinates which are not accurate with respect to the absolute reference frame of the sky.

The IIS (instrument rotator) ring should be clamped with the index pointer on the chisel mark. The adjustment and the pointer are on the west side. The C-clamp location is on the east side. Once the IIS is clamped, you can make the final rotation alignment with the fudge factors in the Enterprise software. The key parameter is the variable FANG which is the absolute field rotation in microradians. Typically, the range of adjustment from the chisel mark is 0 to 2000 microradians. In typical MX style, FANG is stored as an I*4 variable. The memory location of FANG is at 8000_{16}. To check the current setting, say " `D 8000` " while talking to the Enterprise. The first line of the response will read `8000 4C 04 00 00 00 00 00 00 00 00 00 .....` Naturally the values are displayed as hexadecimal bytes in reverse order. The value of FANG here is $0000044C_{16}$ or 1100_{10}. See the sample listing below. The typical range of rotation angles is from 00000000_{16} to 00001800_{16}.

Optimum rotation is defined as maximum signal from a cluster of alignment stars. Be careful to avoid a single bright star which dominates all the others and gives one probe undue influence on the signal. Always be sure to guide carefully on the center star while checking the rotation.

5.5.1 Changing the rotation parameter

To change the rotation value from the command line use the task mxobserve.radjust and type " `radjust 0000044C` " or whatever angle you wish to change to.

To change the rotation value directly in Enterprise type " `R0000044C` " or whatever angle you wish to change to. The " `R` " command automatically reconverts the coordinates in buffer $D000_{16}$ into the current buffer. After you haved changed the rotation angle, " `A@` " will move the probes to the rotated position. This allows you to quickly iterate the PMT counts because the probes only take a few seconds to move.

5.5.2 Changing the platescale parameter

To change the platescale value from the command line use the task mxobserve.sadjust and type " `sadjust 000001F4` " or whatever scale factor you wish to change to. This updates the variable DSCL at location 8010_{16} which modifies the platescale by parts per million. The platescale rarely needs to be adjusted.

5.5.3 Example Memory Listing

```
<01:1>D8000
8000 4C 04 00 00 00 00 00 00 00 00 00 00 00 00 00 00  L...............
8010 F4 01 00 00 00 00 00 00 00 00 00 00 00 00 00 00  ................
8020 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00  ................
8030 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00  ................
```

Once you've gone this far, we can tell you where other important variables are stored. Details are given in the source code files ESUBS.FOR, EPROG3.MAC and EPCOM3.MAC.

5.6 MX Probe Center Alignment

This section describes the procedure for calibrating the coordinates of each of the 32 MX probes at the beginning of an observing run. This normally occurs in the afternoon after the instrument has been mounted. Only J. Hill, the instrument specialist, or the most experienced observers should ever need to do this. Make sure the MX support struts were installed and adjusted correctly before you start.

- Make sure Schmidt Camera Shutter is closed (to avoid over-illuminating the CCD).
- Illuminate the spectrograph (slit) end of the fiber bundle — The best method for this seems to be the work light on the platform.
- Move workstation terminal to the Platform. See the section on terminal / computer / network setup below.
- Move Erfle Mirror Out (if it was in).
- Take off Launch Pad Port Cover on NE side.
- Install Alignment Microscope in Launch Pad Port.
- Open Slit Shutter by taking a dummy object picture with CCD. (tests)
- Start Up Enterprise.
- Load the nominal center coordinates (23oct97.set) with "loadcenters" to provide a starting position.
- Open a Setup File.
  - "listen &" with a stream file name specified in the parameters
  - "readcenters" instead of "subspace" to capture data from the stream file
- Setup the probes with " `A*` ", then exercise the probes in all parts of their travel (see Exercise section). Exercise makes for a well aligned MX.

- Move probes into a tighter circle (65K) — “ `B` <u>`B800`</u> ” “ `AM` ”
- Select Buffer for Center of the field — “ `B` <u>`B000`</u> ”
- Move first probe into center — “ `@` ”
- Adjust microscope to center probe (fiber core) on the crosshairs. Tighten screws. This procedure relies on bootstrapping the center location from where it was on previous runs. (Usually I take the mean position from several fibers.)
- Center the fiber with the cursor keys. Verify with “ `.` ”
- Store these coordinates — “ `I` ”
- Retract this probe — “ ~ ”
- Move in the next one — “ ++ `@` ” (doing alternate probes)
- Center it and repeat the procedure:

$$. \quad I \quad \sim \quad ++ \quad @ \quad \uparrow\downarrow\leftarrow\rightarrow$$

  or if using IC2400 terminal:

$$. \quad I \quad F7 \quad \uparrow\downarrow\leftarrow\rightarrow$$

  or if using em4010 on a PC:

$$. \quad Cntrl - F7 \quad \uparrow\downarrow\leftarrow\rightarrow$$

  or if using X-terminal:

$$. \quad I \quad PageUp \quad \uparrow\downarrow\leftarrow\rightarrow$$

- Repeat for all probes, odd then even numbers.
- Exit “readcenters” with a “Cntrl-C”, restart “subspace”.
- Send the center setup file to Enterprise after each program download using “loadcenters”.
- Restore MX to observing condition.
  - probably you should restart “listen &” with no stream file name specified

5.6.1 "listen" and "readcenters" parameters

listen.par

```
        (port = "/dev/ttya")    serial port for enterprise
       (tfile = "tmp$ttarget.txt") stream file
       (necho = 1)              echo interval
        (verb = 4)              verbosity
     (version = "03 June 1992") Version date of this routine
        (mode = "ql")
```

readcenters.par

```
       (cfile = )               Name of the center calibration file
     (apndset = yes)             Append to output file
     (clobset = no)             Clobber output file
      (stream = "tmp$ttarget.txt") Name of the enterprise stream file
    (portname = "/dev/ttya")    Name of the serial port
  (instrument = "mxspect")       Instrument pset
   (verbosity = 4)              Output verbosity parameter
        (mode = "ql")
```

5.6.2 Remote Terminal / Computer and Network Setup

What you need for probe alignment is:

- IRAF login capability to workstation while standing on the platform beside the instrument.
- epar capabilities for several IRAF tasks.
- arrow keys with the appropriate codes

```
^[[D  ^[[C  ^[[B  ^[[A
```

- at least one programmable function key (optional) or a "Page Up" key

Recently we have been using the Exceed xwindows program running on "bokpc1" connected via a long 10baseT network cable. The xterminal "ncdxtb22" can also be used on the same long network cable. Ask the instrument specialist if you are uncertain about moving the auxiliary PC or the xterminal out to the platform. The 40-foot 10baseT cable lives behind the partition at the South end of the control room.

em4010 settings

- VT100, 7-bit
- baud rate for serial port (access main menu by Alt-F1)
  or network settings
- IBM keypad = arrows (access in keyboard submenu by F3)
- Softkey 7: $I < P : 2 > \sim + + @ < P : 4 > ?$ (access in softkey submenu by Shift-F2)

5.6.3 Probe Exercise Procedure

- “ `A*` ” to setup probes.
- “ `B BC00` ” to select large angle circle. (option: use 2=1C00)
- “ `AM` ” to move probes to targets in buffer.
- “ `B B800` ” to select compact circle.
- “ `AM` ” to move probes to targets in buffer.
- “ `B B000` ” to select center buffer.
- “ `A(` ” to execute sequence move (takes 10 minutes).
- “ `A*` ” to setup probes.

5.6.4 Special Alignment for Broken Object Fibers

We replaced the bad fibers in October 1997, so this procedure is not needed.

Several of the probes may have broken or damaged object fibers. The target selection programs are able to make use of these probes by assigning targets to the sky fibers. Unfortunately, the center alignment procedure does not deal well with aligning the sky fibers onto the field center. The following procedure allows a manual workaround to this shortcoming. When the center file has a fiber number other than 01, "loadcenters" corrects the offset. It reduces the motor 1 coordinates by $016F_{16}$ for each probe where you centered on fiber 05 instead of fiber 01. The scale factor is the fiber index times 1016 microns times 0.090229 steps per micron.

- " | `00000000 00000000` " to create zero radius circle in download buffer
- " ± " " `F 05` " to change relevant fibers from 01 to 05
- " `B B000` " " `#` " to convert into a circle buffer
- Proceed with normal centering procedure described above.
- Download center coordinates as usual.

The two historically broken fibers in position 01 are on probes 03_{16} and 12_{16}. As of July 96, these two fibers are corrected in the manner described above if you do "makeitso circle=yes fix=yes".

6 How to Recover from a Probe Collision

If the red collision LED comes on brighter than its usual faint glow, or if you get the message "No controller present", you have had a probe collision. This is not a fatal problem, but it could put a halt to your observing program for a while. The electronic collision detector resets all the motor controllers to stop further probe motion whenever two probes make contact. A collision may be caused by a bad command such as moving all probes to the center simultaneously. A collision may also result if there is an electronic or mechanical failure that prevents a probe from moving. Sometimes static can scramble the brains of the stepper controller, causing it to move erratically.

1. Identify that there was a collision (as per above paragraph).
2. Turn Collision Override Switch (CXOVR) ON → Yellow LED will come On.
3. Press Enterprise Reset Button.
4. " `G0100` " — To Restart Enterprise Program
5. " `A?` " — To see if all probe controllers are alive. If not, call for help.
6. " `A^` " — to reload motor controllers if power was interrupted.
7. " `A<` " — to retract all probes radially (fixes 99% of collisions)
8. Wait 5 seconds and Turn OFF CXOVR switch. The probes should have moved away from the collision. If the red collision LED comes on again, go back to step 1.
9. Wait 30 seconds for probes to retract radially.
10. " `A?` " should show all probes at the negative radial (1–) limit.
11. " `A>` " to retract all probes azimuthally.
12. Wait 30 seconds for probes to retract azimuthally.
13. " `A?` " should show all probes at the negative azimuthal (2–) limit.
14. " `AZ` " to zero all probes at this position.
15. " `A*` " — to reinitialize all probes at limits. It is usually best to do this *twice*.
16. Ready to Go again after "Setup Done" message from Enterprise.

6.1 Things That Make Probe Collisions

- Astronomer Error
- Problematic Probe Targets
- Corrupted Coordinate Buffer
- Electrical Glitch of Stepper Controller
- Stepper Motor Loses Track of Steps
- Electronic Failure
- Power Outage

7 MX Calibration Lamps

7.1 General Description of Lamps

Five emission arc lamps (Hg, Ar, He, Kr and Ne) and one continuum lamp are located inside the main housing of MX beneath the focal plane. These lamps provide calibration light to the fibers by reflecting off closed doors above the focal plane. These lamps may be turned on by any of three circuits. First, a set of manual toggle switches located directly on the "D'Arc II Lamp Control Box" located on the IIS — the box was refurbished in 1995 by R. Ganguly and J. Hill. Second, a set of manual switches on the Enterprise Remote Box located in the control room. The Enterprise Remote Box also handles remote reset and collision override switches for the Enterprise as well as lamp control. Third, a set of computer commands sent through the CCD VxWorks computer from the "ccdacq" software. These computer signals travel via a serial current loop cable to the B&C Interface Box. Unlike the original version of MX lamp control, any of these three sources can turn on a lamp regardless of the state of the other two sources — they are connected as a wire-OR. Any number of lamps may be turned on simultaneously.

7.2 Automated Control of Lamps

To use the B&C Spectrograph lamp control for MX, set "instrpars.instrname=bcspeclamps". "instrpars.complamp" or "comp.complamp" determines which lamp or lamps will turn on. Leaving the "complamp" parameter blank turns all lamps off. Comparison lamps will only be turned on by the "ccdacq.observe" command when "imagetype=comp" (requiring a little trickery when using the MX lamps to take fiber flats or chip flats). You may turn the lamps on or off under computer control without taking an exposure by using the command "instrument comp=lampname".

To assist in taking fiber flat and top comparison arc lamps between MX integrations, we have written the script "mxobserve.mxlamps.cl". All you need to do is turn down the TV gain, close the barn doors, and type "mxlamps" — assuming that you preset the parameters with "epar". Automation of the barn doors using the D'Arc lamp control box is described below.

7.2.1 "mxlamps" parameters

mxlamps.par

```
cluster =                       Object title
(nexpoz =                     0) Number of zero exposures
(exptiz =                    0.) Exposure time, zeros (seconds)
(zerotit=                  zero) Object title for zeros
(nexpof =                     1) Number of flat exposures
(exptif =                   15.) Exposure time, flats (seconds)
(flatlam=               mxcont0) Lamp for flats
(flattit=            fiber flat) Object title for flats
(nexpoc =                     1) Number of comp exposures
(exptic =                   80.) Exposure time, comps (seconds)
(complam=        mxar mxhe mxne) Lamp for comps
(comptit=                  comp) Object title for comps
(verbose=                   yes)
(version=             21-OCT-95) Version date of script
(mode   =                     h)
```

7.2.2 names of MX lamps

B&C Bit ID	J5 Pin#	complamp Designation	Lamp Description	CCD Type
MX1	1	mxcont0	actual continuum lamp	flat
MX2	2	mxcont1	spare continuum lamp	flat
MX3	3	mxhg	mercury lamp	comp
MX4	4	mxar	argon lamp	comp
MX5	5	mxhe	helium lamp	comp

`MX6`	`6`	`mxkr`	`krypton lamp`	`comp`
`MX7`	`7`	`mxne`	`neon lamp`	`comp`
`MX8`	`8`	`mxsp`	`(spare bit + buzzer)`	`comp`

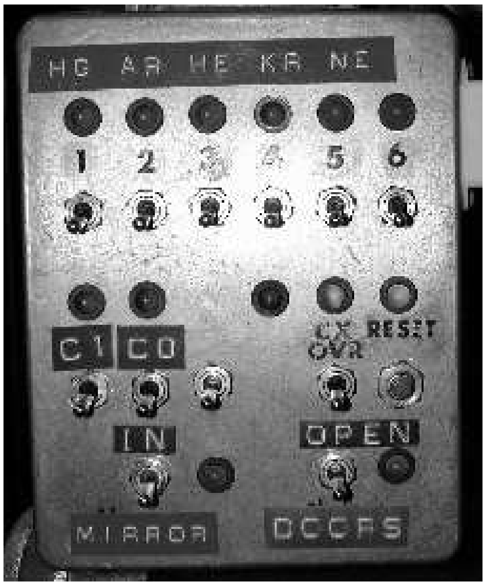
Note that all the lamps in MX begin with "mx" to distiguish them from the normal lamps in the B&C Spectrograph with similar names ("quartz", "hear", "fene").

7.2.3 automatic barn doors

As of July 1996, the new improved D'Arc lamp box has an automatic door closing circuit. With this feature enabled, the barn doors will automatically close whenever a lamp is turned on by the computer or manually. To enable the automatic door closing, set the Remote Box Doors Switch to "closed" and set the Autodoors Switch on the D'Arc Box to "on". For manual remote operation of the doors as before, set the Autodoors Switch to "off". Please turn the Autodoors Switch "off" at the end of the night to keep dust out of the instrument.

7.2.4 lamp alarm

If Enterprise and the D'Arc lamp box are powered up while the B&C Lamp Controller is off, **all the lamps will be turned on**. To prevent the bulbs from burning out or something else from getting fried, we have installed a buzzer on the Enterprise remote box that beeps when this condition occurs. To stop the beeping, turn on the B&C Lamp Controller power supply above the CCD controller, or turn off the Enterprise power. (The buzzer really goes off anytime the non-existent #6 arc lamp — "mxsp" — is turned on.)



8 Observation Troubleshooting Guide

These lists are intended to give you hints about what might be wrong when things aren't going as you expected.

8.1 No Guide Star Image

- Barn Doors Closed
- TV Gain Down
- TV Shutter Closed
- TV Shutter Unplugged
- Defocus Lens In
- Probe at center of field blocking Guide Star
- Mirror covers closed
- Clouds
- Dome or Windscreen

8.2 No Photomultiplier Counts

- Slit Shutter Closed
- PMT Amplifier Voltage Off
- PMT High Voltage Off
- Wrong Probe Calibration Loaded
- Probes at Wrong Target File
- Behind the Slit Mirror in Wrong Position
- Wrong Slit Selected
- Coax Cables Connected Incorrectly
- Black Tape over PMT Aperture

8.3 No Spectra of Any Kind

- Filter Wheel in Wrong Position
- Grating at Wrong Angle
- Grating Cover Closed
- Schmidt Camera Shutter Closed
- CCD (slit) Shutter Closed
- Interface Box Shutter Switch in Wrong Position
- Slit Shutter Cable Unplugged or Broken

8.4 Only Sky Spectra

- Wrong Probe Center Calibration Loaded
- Probes at Wrong Target File
- Probe Collision
- Telescope Set on Wrong Center Star
- Behind the Slit Mirror in Wrong Position
- Wrong Fiber Slit Selected
- Wrong Rotation or Scale Factor
- Bad Line in the Center Calibration File

8.5 No Arc Lamp Spectra

- Lamp controller on local instead of remote
- Barn Doors Open
- Lamp AC Power Off
- Remote Switch Cable not connected
- Wrong instrument name specified

8.6 All Arc Lamps Stuck On or Buzzer Beeping

- B&C Lamp Controller Power Supply is off or disconnected

8.7 MX Won't Talk to You

- Serial Cable disconnected
- Current Loop Converter unplugged
- Enterprise Turned Off
- ttarget/listen/subspace not running
- Wrong Serial Port specified in parameter file(s)
- Buffer Overflow (cured with DEL key or reset)
- multiple copies of ttarget/listen/subspace running
- "instrument error: bad reply from instrument computer" — is a problem with the B&C Lamp Controller Box and has nothing to do with MX.

8.8 MX Babbles Uncontrollably

- Buffer Loopback — multiple copies of ttarget/listen/subspace running

9 Instrument Setup

9.1 MX and B&C Filter Locations

Filters to be used with MX can be inserted in four places. The filters installed in the first two locations cannot be removed or replaced during the night except by J. Hill. The B&C lamp and acquisition television filters can be changed any time. Do NOT remove the Acquisition TV to change the filters.

1. B&C filter wheel below the fiber slit (6 positions, # 5 is open)
2. MX Top Comparison Quartz Lamp (stack of 2, Hoya LB120)
3. B&C lamp filters (stacks of 2, normally blank)
4. Acquisition TV filter (1 thin holder, normally Hoya B460)

The ring of filters available above the B&C in long slit mode is not available with MX for obvious reasons.

9.2 MX Shutter Locations

1. Dome Shutters (telescope operator)
2. Primary Mirror Covers (telescope operator)
3. Barn Doors above focal plane (MX toggle switches)
4. Erfle Mirror above focal plane (MX toggle switches)
5. Below-the-Slit Shutter (CCD Controller)
6. Behind-the-Slit Viewer Mirror (manual on B&C)
7. Grating Cover (manual inside B&C)
8. Schmidt Camera Shutter (manual on B&C)

10 ENTERPRISE MENUS

10.1 ENTERPRISE MENU page 1

These are the normal observing commands.

- A/ reset motor controllers on all probes (stops motion)
- A? read current probe positions in hex steps
- A* retract to limits and setup probes at neutral
- A@ move probes to XY coordinates in active buffer
- A: check probe positions against active buffer
- A∼ move probes to neutral position at edge of field
- # convert XY coords in buffer to polar coords in steps
- Bnnnn set active coordinate buffer to nnnn, 0000 gives an index
- $ perform collision check in active coordinate buffer
- AM move probes back to neutral and then to active buffer

Hit $< CR >$ to quit, any key to see more detailed commands

10.2 ENTERPRISE MENU page 2

These are other commands you might find useful.

Ac perform command c on all probes, indicated by -A

/ reset motor controllers on active probe (stops motion) -A

? read current probe position in hex steps -A

$*$ retract to limits and setup probe at neutral -A

@ move probe to XY coordinates in active buffer -A

; read status bits of active probe (no reset) -A

: check probe position against active buffer -A

$\sim$ move probe to neutral position at edge of field -A

M move probe to neutral and then to active buffer -A

Nxxxx set xxxx steps for relative motor moves

R load field rotation constant

| load a CIRCLE TaRGet pattern into download buffer

! sleep probes and jump to monitor

Hit $< CR >$ to quit, any key to see more

10.3 ENTERPRISE MENU page 3

These commands are rarely used.

+ increment active probe number

- decrement active probe number

' set radial motor active (#1)

" set azimuthal motor active (#2)

. put probe in current position (absorbs backlash)

Xnnnn store nnnn as XTARGET in hex microns for active probe -A

Ynnnn store nnnn as YTARGET in hex microns for active probe -A

Fnn store nn as FIBER number for active probe -A

) sleep limits on all probes = turn LEDs off

(sequence move probe from buffer -A

% move probe in preprogrammed raster pattern -A

^ set the CY512 motor rates on active probe -A

\ setup the neutral position coordinate buffer

Hit $< CR >$ to quit, any key to see more

10.4 ENTERPRISE MENU page 4

Txxxx set xxxx as the dwell time

I read and send probe coordinates and HP data

= read and show the program buffer of active CY512

These commands are extremely dangerous - use with caution.

& draw sequential move from buffer for single probe

Z set probe home position to current position -A

Pnnnn move active motor to position nnnn -A

‘ move probe to home position -A

$<$ retract radial motor 4000 steps -A

$>$ retract azimuthal motor 4000 steps -A

_ move single active axis of active probe from buffer -A

Hit $< CR >$ to quit, any key to see more

10.5 ENTERPRISE MENU page 5

These commands call the Enterprise Monitor functions.

Cnnnn XXyy modify memory at nnnn from xx to yy

$< - >$ to back up, $< space >$ to skip, $< CR >$ to end

Dnnnn display block of memory contents at nnnn

S display next consecutive block of memory

Lnnnnxxyyzz.... load the following bytes into memory

Qnnnnxxyyzz.... load bytes with no echo to screen

Gnnnn execute program at memory location nnnn

G0100 execute or restart normal Enterprise program

H type this help menu of commands

[or] test commands - infinite loop - no escape

Delete will terminate most command lines and prompts.

Commands a b d h i n s also available in lower case.

End of Enterprise Menu.........Good Luck Captain!

10.6 Enterprise Monitor Menu

```
$ ?
 ENTERPRISE MONITOR MENU  Version 2.6
   Cxxxx       modify memory at xxxxH
   Dxxxx       display block at xxxxH
   Gxxxx       execute from xxxxH
   H or ?      print this menu
   Lxxxxzzzz...load zzzz into memory at xxxxH
                 (terminate load with ^D)
   P           show the EPROM ID message
   Qxxxxzzzz...same as load but no echo
   S           display next block of memory
```

11 MX Hardware/Software Configuration

11.1 Probe Status Bytes

The Enterprise communicates with each of the 64 CY512 intelligent stepper controllers through three I/O ports. Ports for each motor controller are mapped to different addresses on the extended Z-80 bus. Port A is the "data" port and is used to send and receive data from the CY512. Port B is the "status" port and is used to read the controller status lines and limit switches. Port C is the "control" port and is used to send control signals to the CY512. The bit values read from ports A and B indicate to the operator the status of the probe control system. This information is displayed as two hex digits with the ";" and "?" commands in EPROG3. You may give these commands anytime the Enterprise is ready for a command. To view the status of all the probes say "A;" or "A?".

11.1.1 Example Status Queries

A;

```
<01:1> B=DD A=00
<02:1> B=DD A=00
<03:1> B=DD A=00
<04:1> B=DD A=00
<05:1> B=DD A=00
<06:1> B=DD A=00
................
```

A?

```
<01:1> B=DD A=00 1=1F6B   2=188E
<02:1> B=DD A=00 1=2109   2=1BF1
<03:1> B=DD A=00 1=276C   2=1947
<04:1> B=DD A=00 1=24AF   2=17A8
<05:1> B=DD A=00 1=23E5   2=19A3
<06:1> B=DD A=00 1=26D4   2=17B0
................
```

or if some probes are still moving

```
<01:1> B=DD A=02 1=0345   2=195E
<02:1> B=DD A=02 1=0327   2=1912
<03:1> B=D5 A=02 1=Move   2=1930
<04:1> B=DD A=02 1=0363   2=1858
<05:1> B=DD A=02 1=0315   2=18B5
<06:1> B=D1 A=02 1=Exec   2=183E
................
```

A:

```
<01:1> 1=1F6B 1=1F6B   AOK     2=188E 2=188E   AOK
<02:1> 1=2109 1=2109   AOK     2=1BF1 2=1BF1   AOK
<03:1> 1=276C 1=276C   AOK     2=1947 2=1947   AOK
<04:1> 1=24AF 1=24AF   AOK     2=17A8 2=17A8   AOK
<05:1> 1=23E5 1=23E5   AOK     2=19A3 2=19A3   AOK
<06:1> 1=26D4 1=26D4   AOK     2=17B0 2=17B0   AOK
................
```

or

```
<01:1> 1=1F6B 1=0345   Wrong!! 2=188E 2=195E   Wrong!!
<02:1> 1=2109 1=0327   Wrong!! 2=1BF1 2=1912   Wrong!!
<03:1> 1=276C 1=0325   Wrong!! 2=1947 2=1930   Wrong!!
<04:1> 1=24AF 1=0363   Wrong!! 2=17A8 2=1858   Wrong!!
<05:1> 1=23E5 1=0315   Wrong!! 2=19A3 2=18B5   Wrong!!
<06:1> 1=26D4 1=035F   Wrong!! 2=17B0 2=183E   Wrong!!
................
```

11.1.2 Port A

The following combinations are seen in Port A:

00 — ready, after a reset or a direct command

02 — ready, after program execution

78 — the motor controller is disconnected

FF — the collision detector is tripped, take evasive action

11.1.3 Port B

The following combinations are seen in Port B:

DD — both motor controllers ready

FF — limit switches are turned off or disconnected

57 — motor 2 is moving and motor 1 is at a limit

71 — motor 2 is at a limit and motor 1 is executing a CY512 program

The first digit or high nibble in Ports B and C refers to motor 2 (azimuth). The second digit refers to motor 1 (radial). The individual nibble codes are as follows:

1 — CY512 program executing

5 — motor is moving (RUN)

7 — limit encountered (INH)

9 — motion complete

D — ready

F — limits off or disconnected

These are the individual bit functions in Port B:

B0 == $\overline{Busy}/Ready$ for controller 1

B1 == $Inhibit\ Motion$ for controller 1

B2 == $\overline{Motion\ Complete}$ for controller 1

B3 == $\overline{Run}$ for controller 1

B4 == $\overline{Busy}/Ready$ for controller 2

B5 == $Inhibit\ Motion$ for controller 2

B6 == $\overline{Motion\ Complete}$ for controller 2

B7 == $\overline{Run}$ for controller 2

11.2 HEX Download File Format

The code that executes in the Enterprise is downloaded from a Z80 Hex file (ASCII representation of binary code) into Enterprise Memory. The same text file format can be used to download center offsets or other parameters you wish to place in Enterprise memory. The Hex file format has line of text of the form:

$$:NNAAAA00HHIIJJKK........00$$

where NN is the Hex number of bytes to be loaded (two ASCII characters per byte, AAAA is the Hex address to start loading the memory, HHIIJJKK........... are the bytes to be loaded and 00 are two extra bytes at the beginning/end.

11.3 Enterprise Buffer Contents

The following example shows the contents of a target buffer in the Enterprise. Each line is displayed with a Hex address, followed by 16 bytes displayed in Hex format (Two ASCII characters per byte), followed by the same 16 bytes displayed as ASCII characters (where possible).

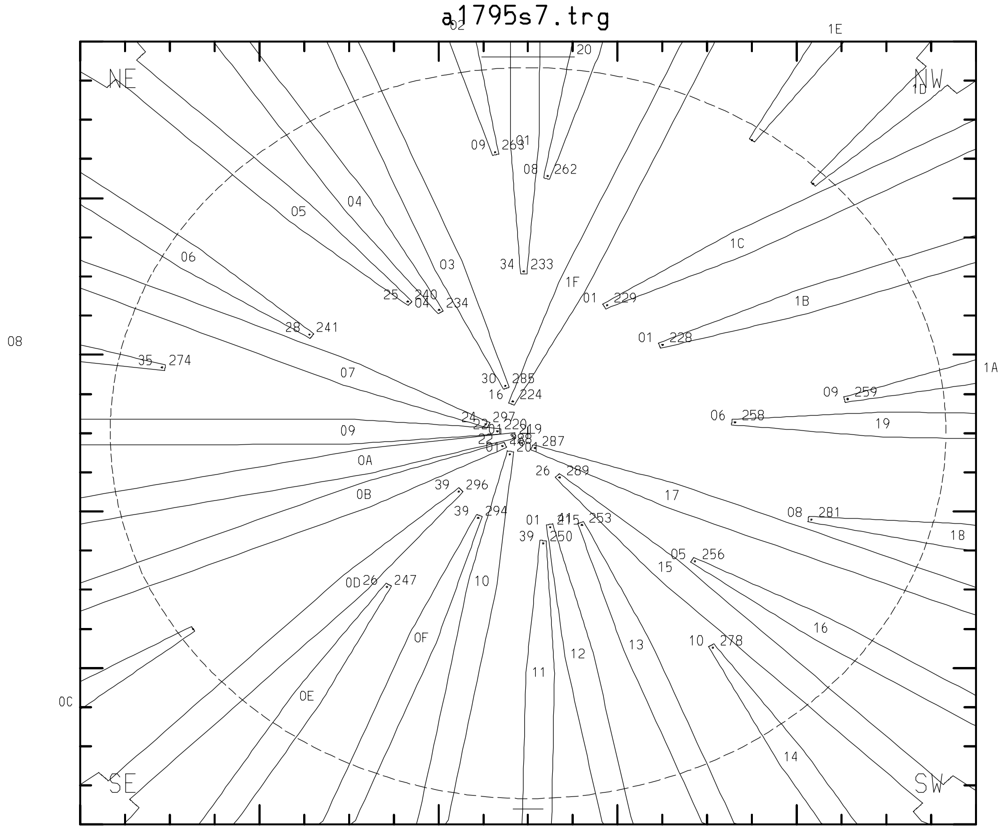
The first line of the buffer shows a 16 byte string containing the title of the target file. The next 32 lines contain coordinates for each probe. The address for the beginning of each line is the buffer address plus 16 times the probe number. Within the 16 bytes allocated for each probe we find the information listed below. The multi-byte integers are stored low byte first as Z-80s are wont to do. All of these numbers are downloaded from the target file except for the motor steps which are calculated locally in the Enterprise with the "#" command.

```
Byte 0 Probe Number (1-20)
Byte 1 Fiber Number (1,3,5)
Bytes 2,3 Object Number (I*2)
Bytes 4,5 RSTEPS (I*2) radial motor steps
Bytes 6,7 TSTEPS (I*2) azimuthal motor steps
Bytes 8 - B X (I*4) focal plane position (microns)
Bytes C - F Y (I*4) focal plane position (microns)
```

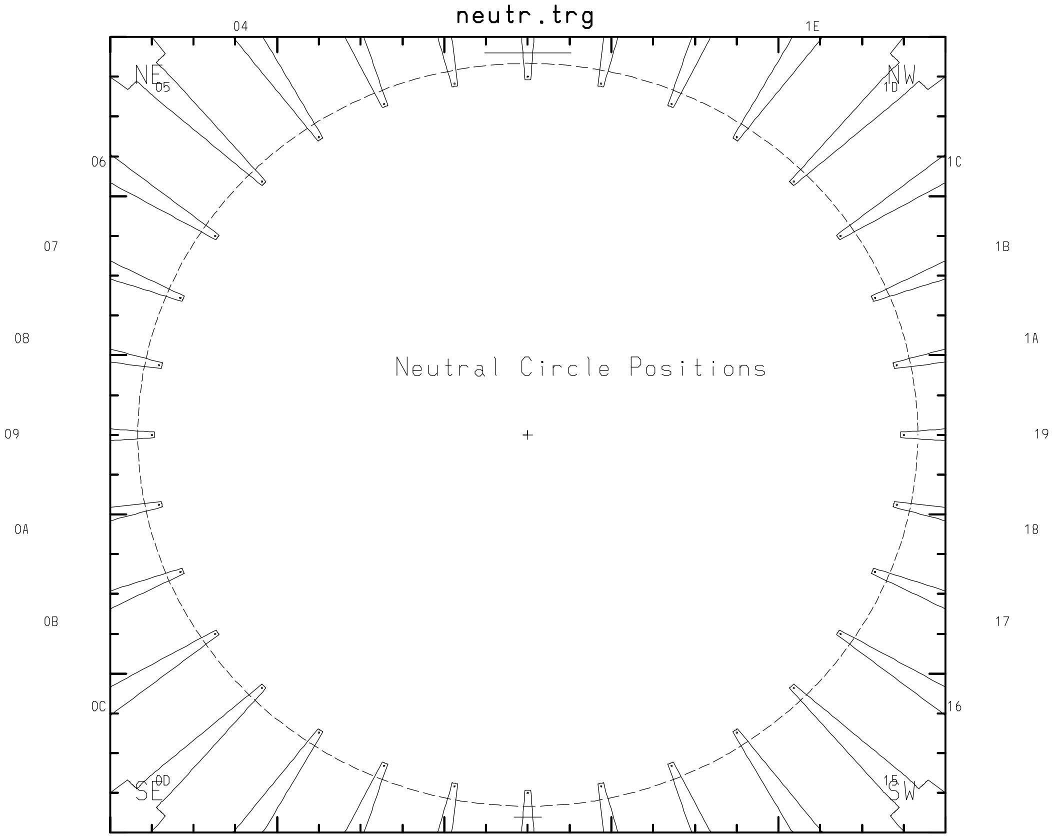
11.3.1 Sample Target Buffer

```
<01:1>DC000
C000 6D 39 32 6F 62 73 31 2E 74 72 67 20 20 20 20 20  m92obs1.trg
C010 01 01 1D 00 6B 1F 8E 18 89 FB FF FF FD CF 00 00  ....k...........
C020 02 01 1E 00 09 21 F1 1B 24 F3 FF FF 95 BF 00 00  .....!..$.......
C030 03 05 83 00 6C 27 47 19 E3 CD FF FF 7D 7C 00 00  ....l'G.....}|..
C040 04 01 8A 00 AF 24 A8 17 69 A8 FF FF 72 7C 00 00  .....$..i...r|..
C050 05 01 8C 00 E5 23 A3 19 7C 97 FF FF C4 75 00 00  .....#..|....u..
C060 06 01 72 00 D4 26 B0 17 90 93 FF FF B4 44 00 00  ..r..&.......D..
C070 07 01 70 00 C9 26 8C 18 FE 8C FF FF BC 34 00 00  ..p..&.......4..
C080 08 01 69 00 B4 29 3D 1A 55 A2 FF FF D2 1D 00 00  ..i..)=.U.......
C090 09 01 AD 00 5C 24 0F 19 1E 65 FF FF DE 01 00 00  ....\$...e......
C0A0 0A 00 00 00 76 19 F3 17 0D F3 FE FF 81 CA FF FF  ....v...........
C0B0 0B 01 63 00 50 28 2E 1B 30 8F FF FF F2 EC FF FF  ..c.P(..0.......
........
C1F0 1F 01 2E 00 D4 28 DF 11 F8 ED FF FF 7D 74 00 00  .....(......}t..
C200 20 00 00 00 D0 0A FD 18 5C 54 00 00 1C A8 01 00   .......
```

a1795s7.trg



neutr.trg



12 Slit Identification Files

```
23OCT97.SLIT2.ID.MARS
02 SA19       33 SA06
03 SC12       34 SA1F
04 SA1E       35 SA07
05 SC1E       36 SA0E
06 SC07       37 SA12
07 SC08       38 SC16
08 SC14       39 SC0D
09 SC1F       40 SC0A
10 SA14       41 SA18
11 SC0E       42 SC0C
12 SA02       43 SC0F
13 SC1D       44 SA08
14 SA15       45 SA16
15 SA0D       46 SA0F
16 SA0B       47 SC02
17 SC1A       48 SC1B
18 SC15       49 SA1C
19 SC1C       50 SA09
20 SA1B       51 SC05
21 SA04       52 SC0B
22 SC06       53 SC01
23 SA20       54 SC18
24 SA01       55 SA03
25 SA10       56 SA0A
26 SC09       57 SA05
27 SC17       58 SC19
28 SA1D       59 SA1A
29 SA17       60 SC10
30 SA13       61 SC04
31 SA0C       62 SC11
32 SA11       63 SC20
```