MULTIPLE MIRROR TELESCOPE OBSERVATORY

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Subject: Abridged I-Ret Software Guide

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The purpose of this memorandum is to provide an abridged guide to the intensified Reticon (I-Ret) detector control software for the infrequent user. It is intended especially for all on the MMTO staff--day crew, instrument specialists, engineers, technicians, and telescope operators--who have the occasional need to start or stop exposures, store observers' data, or perform other simple tasks, but it can also serve as a "cookbook" for the observer who simply wants to gather and record data during his/her observing run.

The instrument computer is used to control the I-Ret detectors on both the MMT spectrograph and the MMT echelle. Each I-Ret has two parallel light-sensitive diode arrays adjacent to one another which record the spectrum of the object. The computer controls the acquisition and storage of spectroscopic data and has simple on-line and extensive off-line data analysis capabilities. The programs and associated overlays, representing several man-years of effort, are written in SAO FORTH. Complete software source code listings are available at the MMT. The on-line software is documented in the I-Ret software manual written by Bill Wyatt, and this manual is resident at several Tucson and Mt. Hopkins locations. SAO is responsible for incorporating changes in the control programs, and at irregular intervals Bill Wyatt will release new I-Ret control software and the appropriate updates to the software manual.

Data reduction and analysis packages are also available on the instrument computer, but except for the relatively simple routines described in the I-Ret

software manual, these programs must be used separately from the control software by booting the instrument computer with the floppy disc labeled "Data analysis boot disk". This software is described in the manual entitled "Z-machine software" written by John Tonry, and updates are incorporated at irregular intervals by Bill Wyatt, who also issues the appropriate documentation.

1. The Lexiscope Screen

In the normal operating mode, the top 3 lines of the instrument computer monitor (sometimes called the "Lexiscope") display information relevant to the detector status. Figure 1 is a copy of a typical Lexiscope header. Commands and responses use all of the screen except for these three lines which cannot be accessed in normal operation.

```
Object - INCANDS      0    Date - 02/14/83        Int.Time  - 00:19:54
Left   -    0             MST  - 00:20:11        Status    - INTEGRATE
Right  -    0             S.T. - 00:20:15        Time left - Forever!   4K
```

Figure 1: The Lexiscope Header

The word following the header "Object" displays the user-defined name for the current exposure. This is the name which appears next to the appropriate file number in the I-Ret log book which is kept by the observer for every exposure taken at the MMT. A flashing letter "C" will appear next to the object name if no comment header has been entered for the current exposure by the user. The number to the right of the object name (which appears as ø in Figure 1) is the number of the Trident directory onto which the present exposure is stored when terminated. (See section 2).

The numbers which follow the "Left" and "Right" labels indicate the total amount of light striking each of the two detector arrays in a given time interval. In normal operation, this interval is one second so these numbers will change every second when the detector is integrating.

The center three rows in the Lexiscope display shown in Figure 1 contain the current mountain standard date (Date), the mountain standard time (MST), and the local sidereal time (S.T.).

The right three rows give the integration time ("Int. Time") which is the elapsed time since the start of the current integration, the status ("Status") which indicates either "HALT" if no integration is in progress, or "INTEGRATE" if one is, and the "Time left" which gives the time remaining in the present exposure. If no exposure length has been entered by the observer, the "Time left" will be given as "Forever!", and the integration will continue indefinitely. An "*" appears after the "Time left" number if the data are to be automatically stored at the end of the integration. Finally, the symbol "4K" or "8K" appears to the right of the "Time left" field depending upon whether the observer has selected 1/2 or 1/4 diode resolution for data storage.

2. Selecting the Data Storage Medium

a) Recording data on the Trident

The data are automatically stored on the current Trident disc pack in the directory labelled **DATADIR**. Each directory has room for 31 data files, and a log sheet should be filled out by the observer for each exposure in the blue binder in the control room labelled "I-Ret data log book".

When the instrument computer is rebooted, the Lexiscope screen will prompt the user how to set the various start-up parameters. To prepare the Trident to access old data or to record new data, type

```
#       TLINK       <cr>                                    (1)
```

on the Visual 1Ø2 keyboard, where # is the number of the data directory from which old data are to be read or onto which new data are to be recorded. (The current data directory, onto which new data are to be stored, is the number which appears next to the number of the word "Disk" in the upper right hand corner of the most recent unfilled page in the I-Ret log book.) The <cr> indicates that the "Return" key is to be struck after typing the command TLINK. (All FORTH commands are executed only once a "Return" is struck, and from now on we will not indicate <cr> but assume it is understood.)

The message "If this is to be the data directory type ?DISK" will appear on the lexiscope screen. Obey this instruction if the "#" you typed was that of the current data directory. This will assure that the data are recorded in the proper directory on the Trident, and the current data directory number will appear next to the object name in the header as discussed above.

If the "#" you typed is <u>not</u> to be the directory in which new data are to be stored, as is the case when you want to read old data from the other than the current data directory, simply hit <cr> in answer to the Lexiscope prompt.

b) Recording data on magnetic tape

Many observers take their data from the mountain on magnetic tape, and the command

MAGTAPE (2)

will bring in an overlay containing all the commands necessary to implement the recording of data files on tape.

The user's tape should be mounted on the Cipher tape drive in the instrument computer, the density level selected, and the tape advanced to the load point via the push-buttons on the Cipher panel. If the data are to be recorded at the start of the tape, the command

Ø INITIALIZE-TAPE nnnnnnn (3)

should be executed where nnnnnnn is the seven letter name the user wishes to give the tape.

If the user wishes to record the present data contiguously with data that are already written on his tape, the command

Ø MOUNT-TAPE (4)

should be used instead of (3). The Lexiscope will prompt the user with the message "Tape name nnnnnnn", listing the user-given name, nnnnnnn, from whenever the tape was last initialized.

Once (3) or (4) has been carried out, the MAGTAPE overlay should be discarded by typing

DISCARD (5)

Then the command

AUTOTAPE (6)

will assure that the data will be written on tape as well as on the Trident after every exposure. In the AUTOTAPE mode, a "T" appears to the right of the "Time left" field in the Lexiscope header shown in Figure 1.

3. Object Exposures and the Comment Block

Once TLINK and AUTOTAPE (if desired) have been executed, the instrument computer is ready to take data, and the following is a typical command sequence:

ZABORT ZGO (fill in comments and exit with ctl x) (7)

s TOTAL (8)

ZGO clears the integration buffer, 8192 words of memory located on the I-Ret interface board in the instrument computer where incoming data are accumulated, begins a new integration, and displays the comment block for editing. The integration buffer is the most "sacred" area of memory, and very few commands

are allowed to modify it in any way. ZABORT is one of the commands which allows ZGO to be executed--it is a safety valve to assure that the user really wants to clear the integration buffer. If the previous integration hasn't been stored on the Trident and ZGO is typed without being preceeded by ZABORT, the message "NO ERASE!" will be flashed on the Lexiscope screen, and ZGO will not be executed.

The comment block, which is automatically accessed by ZGO or by typing either RCOMMENT or COMMENT, is stored with the data at the end of the integration and contains vital information about the data--the object's name, its right ascension and declination, (RCOMMENT automatically enters the mount coordinates in the header whereas COMMENT does not), the observer's name, the program being worked on, any observer comments, and status information about the spectrograph-grating settings, filters being used, etc.

The comment editor programs certain keys on the Visual 1Ø2 to allow the cursor to be moved around the comment block quickly to fill in the relevant information: 1. <cr> moves the cursor to the beginning of the current line or to the next line if the cursor is already all the way to the left; 2. <esc> moves the cursor to the right one word at a time; 3. <del> moves the cursor one space to the left; 4. <line feed> moves the cursor up one line; 5. ctl K (the "control" key and the "K" key struck simultaneously) will erase the line the cursor is currently on.

Once the cursor is positioned at the proper place, the appropriate entry is made via the keyboard, and once all comments have been entered, ctl X exits from the comment editor. The message "Comments ready!" flashes on the Lexiscope screen and this comment block will be stored with the data at the end of the integration. At the same time the first 7 letters of the object name in the comment block will be inserted after the word "Object" in the Lexiscope header (Figure 1) if *no id* is in the object field prior to editing comments.

The command "s TOTAL" sets the length of the exposure to be s seconds. The "Time Left" in the Lexiscope header will change from "Forever!" to s minus the integration time, and an "*" will appear to the right of the time left indicating that the data will be automatically stored when "Time left" is less than or equal to zero.

To interrupt an ongoing integration (for clouds, for example), simply type

STOP (9)

and the integration will pause until

GO (10)

is typed to resume it.

4. Comparison Exposures

Comparison lamp exposures should be taken at regular intervals, the time between such exposures depending on the particular program being pursued. The command

ZABORT CEX (11)

will begin an exposure, change the object name to that of the appropriate lamp (TH-AR, HE-AR, etc.), and set the integration time to 90 seconds. Frequently, no comments are recorded with the comparison exposure since they are assumed to be the same as that for the object exposure which preceeded or will follow it.

5. Displaying the Data

Observers will frequently want to plot their data as they are being accumulated to judge their quality, decide when to store them, and so on. A typical command string to do this is:

DMOVE ERASE p1 p2 PLOT (12)

DMOVE moves the data from the "sacred" integration buffer to a 4096 word long scratch buffer in the Point 4 memory, leaving the integration buffer

unchanged and allowing the exposure to continue to accumulate. In normal operation, words 0 through 2047 in the scratch buffer contain the data from the 2048 pixels of the left I-Ret array and words 2048 through 4095 contain these from the right array. From the scratch buffer the data can then be plotted.

ERASE erases the graphics screen, and p1 p2 PLOT plots the data between pixels p1 and p2 where p1 and p2 must be real numbers(where $0 \leq p1,p2 \leq 4095$) and are entered by the user. For convenience there are two FORTH constants named LCO (for "left cutoff") and RCO (for "right cutoff") which are core-resident and whose default values are 20 and 2000 which can be used instead of entering numbers each time. Thus

```
ERASE   LCO   RCO   PLOT                                    (13)
```

will plot the contents of the scratch buffer between pixels 20 and 2000.

There is a FORTH word, EP, which is defined as

```
: EP ERASE PLOT ;                                           (14)
```

(FORTH words are defined by preceeding the word to be defined by a colon and a space, naming the new word, and giving the string of existing FORTH commands that the new word is to execute. A semi-colon indicates the end of the definition.) Thus the command string

```
DMOVE  p1 p2  EP                                            (15)
```

is equivalent to (12).

Analogously to (14), it is often convenient to define FORTH words to execute frequently used command strings:

```
: JANET DMOVE LCO RCO EP ;                                  (16)
```

will define JANET to copy the data from the integration buffer to the scratch buffer and plot them between pixels LCO and RCO. Then just typing JANET will execute the desired string from then on.

If the user wants to plot data other than the current data, he gets to the

appropriate directory using TLINK as described above and by typing

n RFILE

where n is the file number on the directory containing the data to be plotted. This reads the data from file n into the scratch buffer from where it can be plotted as in (13) above.

6. Flatfield exposures

During non-observing hours (usually at the end of the night) most observers take long "flatfield" exposures to allow systematic detector response variations to be removed from the night's data. These are simply exposures of the spectrum of an incandescent lamp residing in the top box.

ZABORT m FLATFIELD (17)

will begin an "m" minute flatfield exposure. (Note that the number preceeding FLATFIELD is in minutes, one of the few times an exposure-related number is not in seconds.) FLATFIELD will take and store "m" (observers usually use 3Ø to 9Ø) minute exposures ad infinitum until they are terminated by the string:

NOREPEAT HELP HALT (18)

NOREPEAT sets a software switch to cancel the automatic repeating of exposures; HELP cancels the automatic storing of the exposure in progress; and HALT stops the current exposure and changes the "Status" entry in the Lexiscope header to "HALT". (If HALT is not preceeded by HELP, the exposure will be automaticaly stored if an "*" appears next to the Time Left field in the Lexiscope header (Figure 1).

With the very limited FORTH vocabulary outlined above, most of the routine observing can be carried out with the spectrographs on the MMT. Of course, many more features exist, and the reader is referred to the extensive software manuals referred to above for their use.

5. A Typical Observing Sequence

A typical observing sequence might look as follows:

Setting up the data storage medium:

```
1ØØ TLINK
     ?DISK
     MAGTAPE
     Ø INITIALIZE-TAPE    QUASARS
     DISCARD
     AUTOTAPE
```

Starting, documenting, displaying, and storing object exposures

```
     ZABORT
     ZGO (fill in comments and exit with ctl x)
     DMOVE
     LCO RCO  EP
 9ØØ TOTAL
```

After 9ØØ seconds (when "Time left" has become zero and the data have been stored), comparison lamp exposures should be taken.

```
     ZABORT
     CEX
```

After the final comparison lamp exposure of the night has been stored, flatfield exposures are begun.

```
     ZABORT
     9Ø FLATFIELD
```

To terminate the continuous series of flatfield exposures,

```
     NOREPEAT HELP HALT
```

AUTOTAPE -- sets a software switch to automatically record I-Ret data on magnetic tape.

CEX -- clears integration buffer and carries out a 9Ø second Comparison EXposure.

COMMENT -- brings in the comment block to be stored with the present integration for editing (exit by ctl X).

DISCARD -- discards the most recently called overlay.

DMOVE -- copies data from integration buffer to scratch buffer.

p1 p2 EP -- erases graphics screen and plots data between pixels p1 and p2.

ERASE -- erases graphics screen.

FLATFIELD -- clears the integration buffer and carries out an "m" minute exposure, stores it, and repeats the process until terminated manually.

GO -- starts an integration without clearing the integration buffer or restarts an interrupted integration.

HALT -- stops the current exposure and stores the data on the disk.

HELP -- sets a software switch to cancel the auto-store feature of the HALT command.

Ø INITIALIZE-TAPE nnnnnnn -- initializes a tape on which the observer wishes to record his/her data and names it nnnnnnn. This command should not be used if the tape already contains data the observer wishes to save.

MAGTAPE -- calls the MAGTAPE overlay for recording data on tape.

Ø MOUNT-TAPE -- assures that a tape containing user data is mounted properly on the Cipher tape drive.

NOREPEAT -- sets a software switch to cancel the auto-repeat feature of such commands as FLATFIELD.

p1 p2 PLOT -- plots the data on the graphics screen between pixels p1 and p2.

RCOMMENT -- same as COMMENT, but automatically enters the mount coordinates in

the appropriate place in the comment header.

n RFILE -- copies file n from the current directory into the scratch buffer.

STOP -- stops an ongoing integration but does not store it.

TLINK -- moves the user to the subdirectory given by "#".

s TOTAL -- sets the exposure time to be "s" seconds, after which the current integration and its comment are stored in the next available location on the Trident.

ZABORT -- sets a software flag that allows the ingetration buffer to be cleared.

ZGO -- clears the integration buffer, starts an exposure, and performs an RCOMMENT.

?DISK -- links the current directory to DATADIR, puts that number next to the object name in the Lexiscope header, and assures that the data will be stored in that directory.