



## MULTIPLE MIRROR TELESCOPE OBSERVATORY

Smithsonian Astrophysical Observatory and Steward Observatory, University of Arizona

MMTO Tech Memo 84-18

June 22, 1984

From: A. Poyner, J. Montgomery

Subject: Operational Periodic Error Corrections.

### A. Summary:

Correction of periodic errors in the telescope absolute encoders by computer-generated error tables underwent a second test on 18, 19-20 June 1984, and can now be considered to be an operational procedure.

### B. Clarification of Tech Memo 84-17 "best" and "worst" cases:

There has been some confusion about the examples of "best" and "worst case" tracking with the new error corrections, shown in Tech Memo 84-17. The data, taken June 8th., was collected under the following conditions.

When the error tables had been filled, we turned on the correction and continued to track the same star as we had used to fill the tables in the first place. Therefore in this first instance we were covering sky in a different position to that where the tables were generated. At a later point, we found another star in about the same area as we had generated the table and tracked it.

In both cases, we found the tracking errors to be similar. As the plot of error progresses in time, it expands and contracts more or less cyclicly, with a period that looks like 8 times the basic fine encoder cycle.

It was for this reason that we said that building the table should extend over at least 8 cycles, to average out the effect of any 8 cycle periodicity.

The examples shown in figures 3 and 4 of Tech Memo 84-17 are the largest and smallest areas of this 8 cycle effect. They are taken at a point beyond the sky where the table was generated, but proved to be similar in size to the remaining errors in the table-building area, when we covered it later.

### C. Operational Technique:

The mount program now includes two tables, one for each axis, containing 64 error values each. These error values have been measured at specific encoder readings - 64 readings for each cycle of the fine transducer. In use, each time the encoder is read, the corresponding error is found in the table and is subtracted from the encoder reading.

The error tables are kept on the Small Stars Catalog/Constants disk, and they are automatically loaded into the mount program when the initial

**strut-your-stuff**

command is entered. The error tables are used in place of the earlier sinewave corrections, which used amplitude and phase coefficients a512, a1024, a2048, p512, p1024 and p2048. However, for the moment the sine correction still exists in the mount program, so all of these coefficients must be zero. As with the new error tables, the sine coefficients are read from disk at the beginning of observing and should all be zero. The command

**ppec**

will verify this. If any coefficient is not zero, set it using the commands

```
e1 0 !a512      az 0 !a1024
e1 0.0 !p512    e1 0.0 !p2048  etc.
```

The mount program will start up with the new error corrections enabled. If for some reason the correction must be stopped, the command

**Ope**

will stop using the corrections and will zero the tables in memory. The tables on disk will not be changed, and will come into use again if the program is reloaded. To restart corrections without reloading, the commands

```
latest-ones - will reload the tables from disk, and
e1 remove-pe
az remove-pe - will use the corrections.
```

Note - it is assumed that the commands given above will be used very rarely, and so they have not been included in the commands that the parser will permit. Therefore, type

**sleep-parser**

before using them. This also applies when building the tables, as detailed in the next section.

D. Building New Tables:

a) On the TCS Computer

1. Select a suitable bright star - low elevation, approximately 35°, with velocities in both az and el about 10 arc-sec per sec. Note that too fast is as bad as too slow. Too slow means you have to take data forever to cover enough encoder cycles; too fast causes erratic data collection.

2. Align az and el such that positive el is "up" and positive az is "to the right" using the instrument rotator.

3. Do a point stack so that the TCS computer can calculate the scale, i.e. the number of pixels per second of arc on the sky.

4. Use one telescope (B) and move the others out of the way.

5. Box the star using the following commands:

pb - position boxes routine  
b - select box for telescope B  
A - add the box to the screen (note capital A)  
Move box over star using arrow keys (shift-H, -J, -K, -L)  
ESC - to get out of pb routine

6. Set the Grinnell parameters:

20 !it set the sample spacing time to once every 2 secs.  
5 !sd set the "leaky memory" shift down to 5 (2 secs.)

7. Start sending the position errors to the mount computer:

te - tune encoders

8. To stop sending error information to the mount computer:

qq - quit quickly

b) On the Mount Computer

1. One command will set up the initial conditions and start filling the error tables. The error signals will be output on d/a channels 0 (el) and 1 (az) and can be monitored on the strip chart recorder, if required.

fill-error-tables - setup and start the data flowing

2. Error data must now be collected for several cycles of the fine transducer. As we have noticed a component at 1/64th of a circle, at least 8 cycles should be covered. The minimum time for filling the error tables can be calculated as approximately 340/v minutes, where v is the smallest of the az and el velocities.

Data collection can be monitored by:

el ?errors - shows the error table  
az ?errors

el ?samples - shows the number of data points collected for  
az ?samples each table element

The tables should fill reasonably "smoothly". Discrepancies in the number of samples collected should be a maximum of less than 2 to 1 ratio - if there is more scatter, the star is probably too fast in this axis.

3. When error data collection is complete:

error-tables-full will stop filling the tables, will write them to the Constants disk, and will start to use the new corrections.

4. Print a copy of the error tables. In the computer room, turn the printer to the mount computer, and type

```
fprint az ?errors  
fprint az ?samples  
fprint el ?errors  
fprint el ?samples
```

File a copy of the error tables in the operations log, and send a copy to Tony Poyner for analysis.

#### E. Frequency of Updating the Tables:

Updating should be performed approximately monthly, (or when the astronomer requests it), normally during M&E time, unless some emergency condition exists. By picking a star with appropriate velocities, the procedure should take about 45 minutes, and it can be done on a bright star very early in the night or last thing in the morning.