



# MULTIPLE MIRROR TELESCOPE OBSERVATORY

Smithsonian Astrophysical Observatory and Steward Observatory, University of Arizona

Reply to: MMT Observatory  
University of Arizona  
Tucson, Arizona 85721  
(602) 621-1558

MMTO Internal Technical Memorandum 85-4

Subject: Autoguiding Tests, December 5th

From: D. Blanco, C. Janes, and J. Montgomery

Date: December 19, 1985

TCS autoguiding was tested during M&E time December 5th, 1985. The setup was identical to that used for the previous test in May 1985, as described in MMTO Internal Tech Memo 85-1: the I-CCD was used for the acquisition TV (with no rotation), and the Sony CCD TV was used to view the focal plane as folded by a dichroic. The purpose of the test was to determine if the image divergence reported in May had been corrected and to measure what other problems might exist with autoguiding.

The autoguiding routine was setup to hold the image positions, as relayed to the acquisition TV by the pupil wheel prisms, fixed on the Grinnell by moving the secondaries. The video from the Sony CCD was fed to the instrument Grinnell and the instrument computer was used to measure the image positions which were strung out in a line by the +MMT command issued by the TCS computer. The orientation of the instrument computer images was a 45 degree line sloping upward from the lower left hand corner of the instrument computer Grinnell monitor. The positions of the star images on the TCS monitor were:

B  
  
A            C  
  
F            D  
  
E

These images were to the left of center of the TCS monitor in order to get the star images on the instrument computer monitor.

The first scan (Scan 7) was for 256 data points. The last two scans were for 512 data points. The sample rate was one data point every two seconds. The change in ROT-PA was 11 degrees for scan 7, ?? for scan 8, and 12.8 degrees for scan 9. The dead time between scans was roughly 2-3 minutes or less.

We expected the measured position of each image on the instrument computer to lie on a straight line because we were holding the images fixed on the Grinnell to eliminate camera distortion. Also, we assumed that the instrument rotator was rotating smoothly and at the proper rate. We have tested the prisms and they appear to rotate correctly; however, we have yet to test for any eccentricity.

The results are shown in Figure 1. What was done was to superimpose the data for each telescope at the start of a scan, except for scan 7 where the data was superimposed when the cable was pulled (see below). The vertical units are in pixels, where 19.5 pixels is a second of arc. The horizontal units are in seconds of time. The results look "strange" at first but, with some thought, can be explained as follows:

1. For scan 7, ROT-PA information from the mount to the TCS computer was terminated roughly 200 seconds into the Scan by physically disconnecting the communication cable. Up until that time, TCS was rotating the boxes.

2. The sine curve which is present only on the AZ data and not on the EL data can be explained as follows:

- A. Both Grinnell's have stability problems. The instrument Grinnell has a known horizontal long term pixel wander of  $\pm 10$  pixels while the TCS Grinnell generally is stable to  $\pm 2$  or 3 pixels. However, if the computer room temperature is increasing/decreasing, all bets are off and wander can be as much as the Instrument Grinnell. Elevation wander on both systems has never been reported to be more than 2 pixels.

- B. With the above in mind, and the fact that the images were at a 45 degree angle on the Instrument Grinnell, we can say to first order:

- 1) The TCS Grinnell was probably stable to within 3 pixels; otherwise we would see a strong sine curve in the EL data.

- 2) The primary wander is in the Instrument Grinnell, and its period is roughly 16 minutes.

- 3) The one AZ curve that is "high" on Scan 8 is probably because the star image was on the edge of the Instrument Grinnell monitor. Supporting evidence is that for Scan 9, the image was further from the edge. We moved the images by offsetting the mount.

3. During the autoguiding tests in June (see MMT0 Internal Tech Memo 85-1), rotation of the centroiding boxes was introduced in software; however, the top box and pupil wheels were rotating during the tests so that the field was stationary. As a result, the images appeared to diverge at the focal plane. The software rotation was removed for the test in December (by disconnecting the cable that sends PA information from the mount to TCS), and the divergence disappeared.

The prism wheel was inserted during the December test so that the images would be forced apart for easier centroiding and to test the rotation of the prism wheel; however, to use the prism wheel with the images spread out in a line and with the top box rotating would require each centroiding box to track its respective image in a circle around separate origins (see Figures 2 and

3). The tests should have been done with no rotation. The slight curve in E1 may result from this error.

4. The new data (Figure 4) shows that autoguiding corrects for long term tracking and flexure errors when compared to open-loop tracking (Figure 5). The problem with the short term (10 seconds) common mode tracking errors, noted in Internal Tech Memo 85-1, are still present at the same amplitude (0.5 arcseconds p-p).

5. Note what appears to be regular bursts of  $1/4096$  component errors in open loop tracking. This effect has not been previously noted and is unexplained at this writing (az  $197^{\circ}$  and el  $67^{\circ}$ ).

## CONCLUSIONS

1. The Instrument Grinnell can not be used for our testing purposes until its VCO problems are fixed and tested.

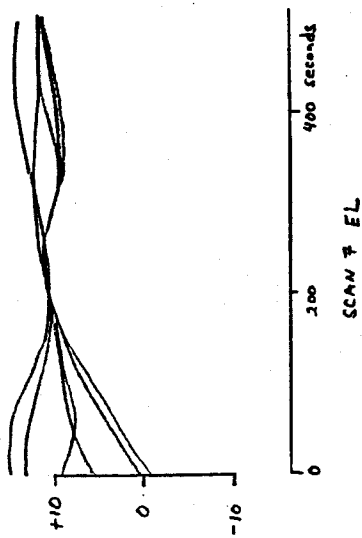
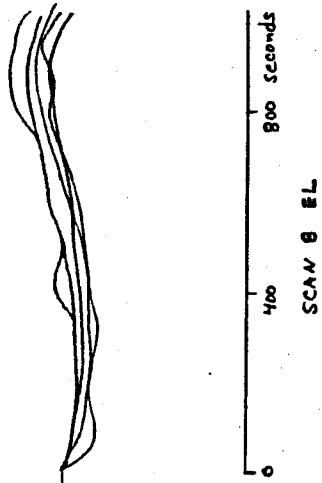
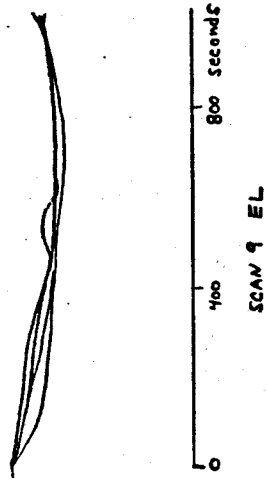
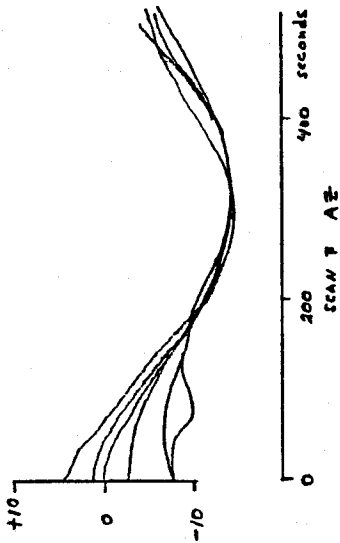
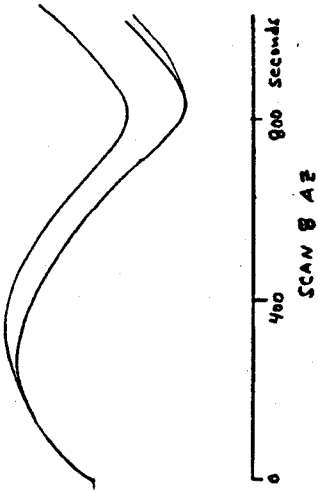
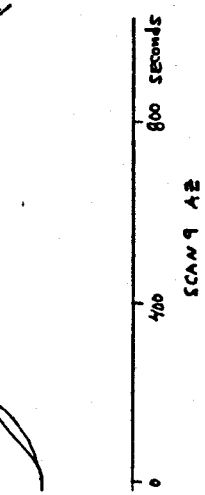
2. The TCS Grinnell is better, but it has sync problems if the room temperature changes. It needs to be fixed and tested like the Instrument Grinnell.

3. Until the Grinnells are fixed, all autoguiding test results are suspect.

4. Spilled light autoguiding will not be possible unless the computer room temperature can be maintained at a constant temperature.

5. Three point secondary fitting and all sky mount pointing coefficient determination are affected by the TCS VCO drift.

6. We still have no tests that truly verify autoguiding operation, though all indications are that the procedure will work as long as the TCS Grinnell doesn't drift. Further testing is necessary to find the causes of the various short term effects described above.



pixds

time →

Figure I

AUTO GUIDE, ROTATING TOP BOX

focal plane  
(stationary)

pupil wheel  
(follows top box rotation)

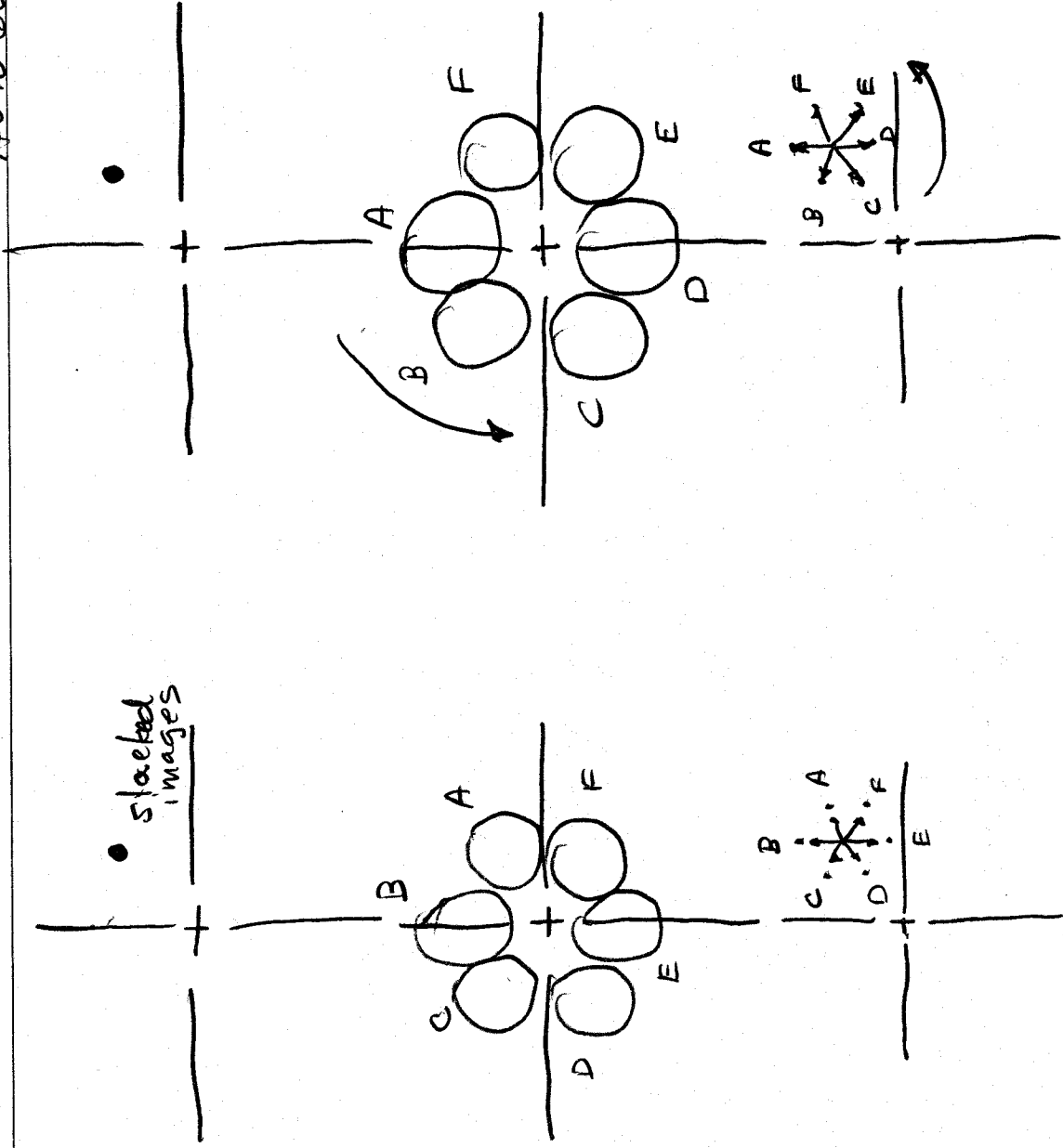
acquisition camera  
(translation about common center, follows prism wheel)

ct 12/12/85

time 2  
figure 2

stacked images

time 1

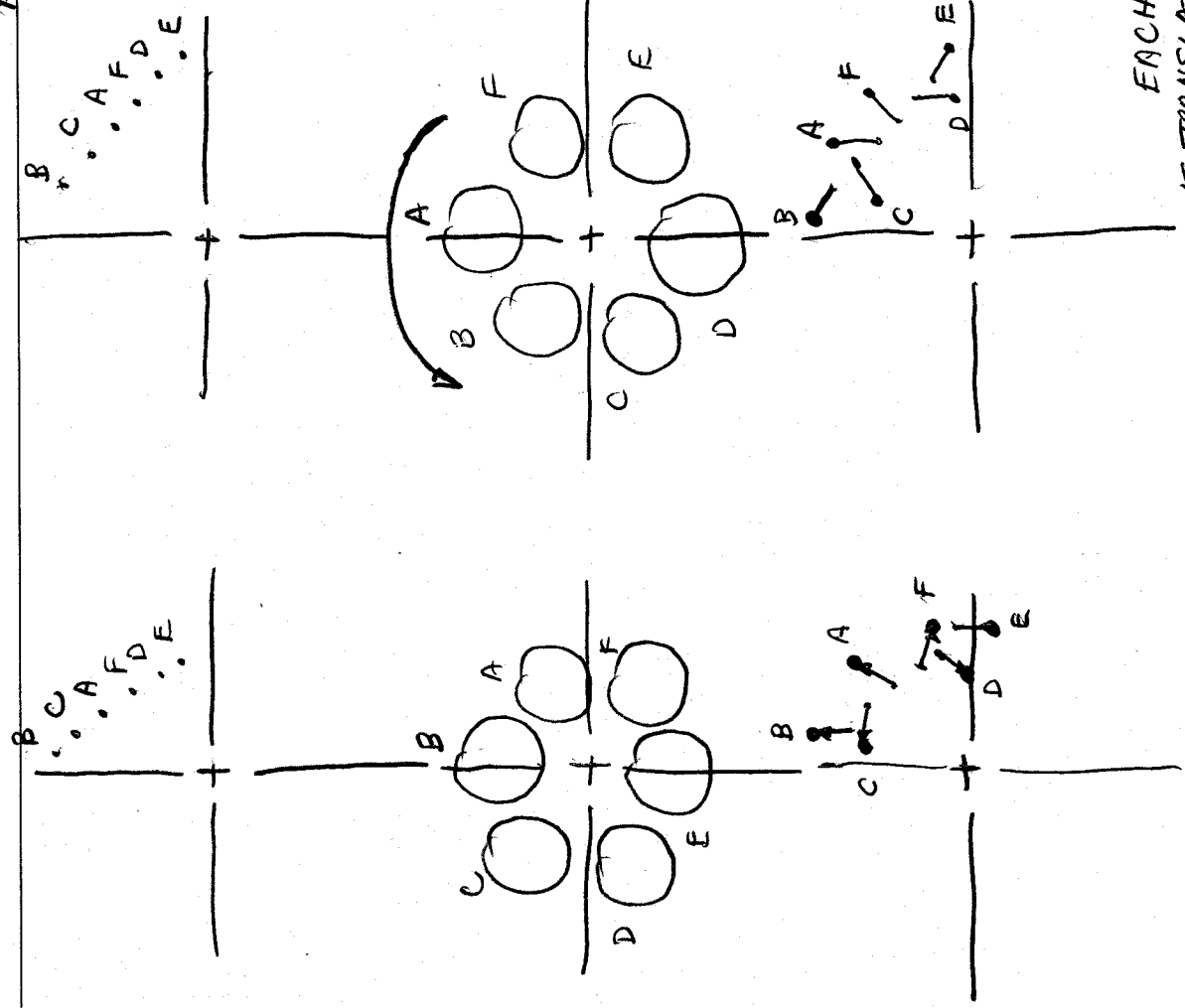


AUTOGUIDE, ROTATING TOP BOX

focal plane  
(field stationary)

pupil wheel  
(translates because  
top box rotates)

acq camera



EACH IMAGE  
IS TRANSLATED ABOUT ITS  
OWN CENTER; DEFLECTION  
FROM CENTER CAUSED BY  
PUPIL WEDGE PRISM.

time 1  
time 2

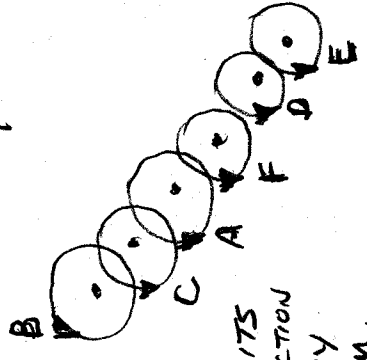


figure 3 CT 12/12/85

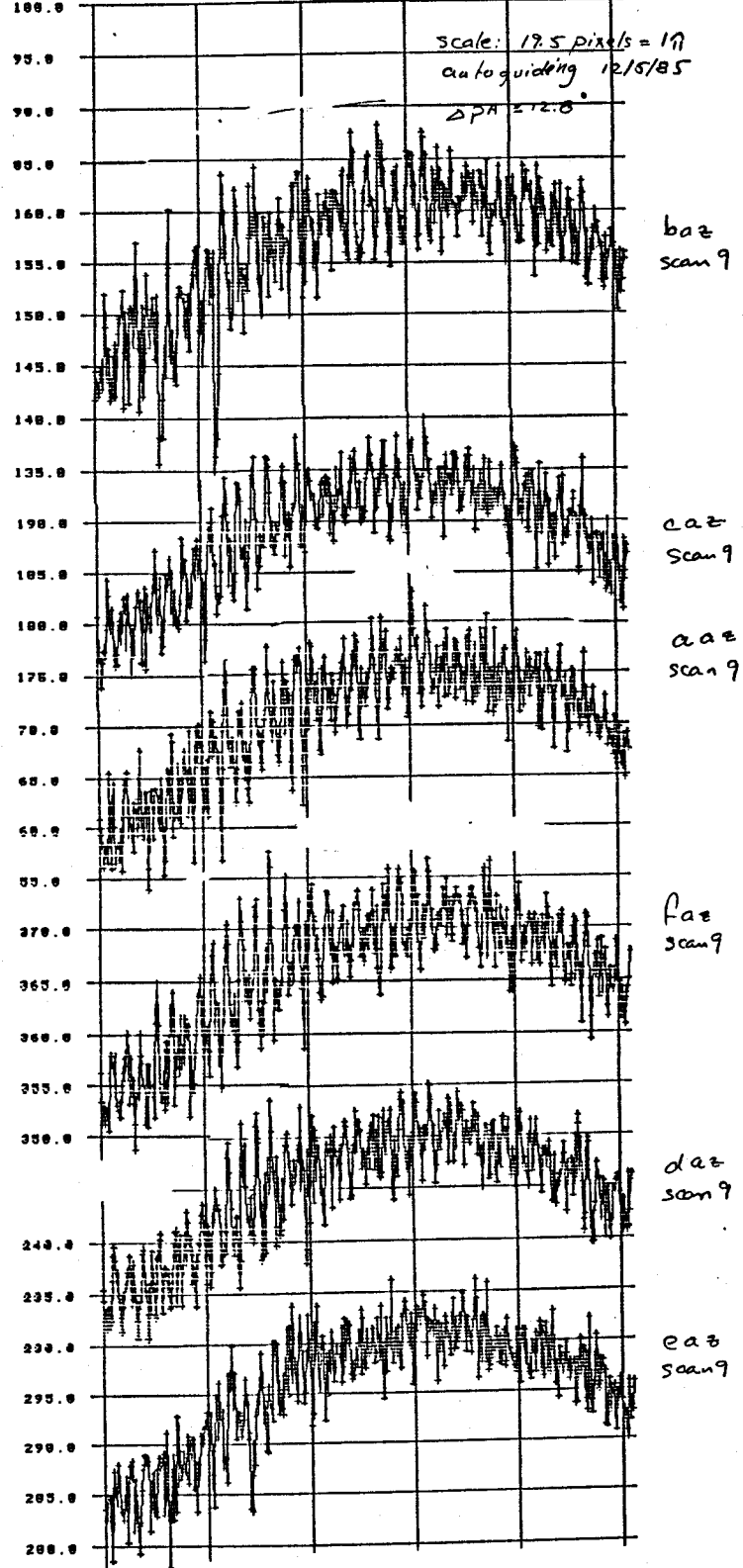
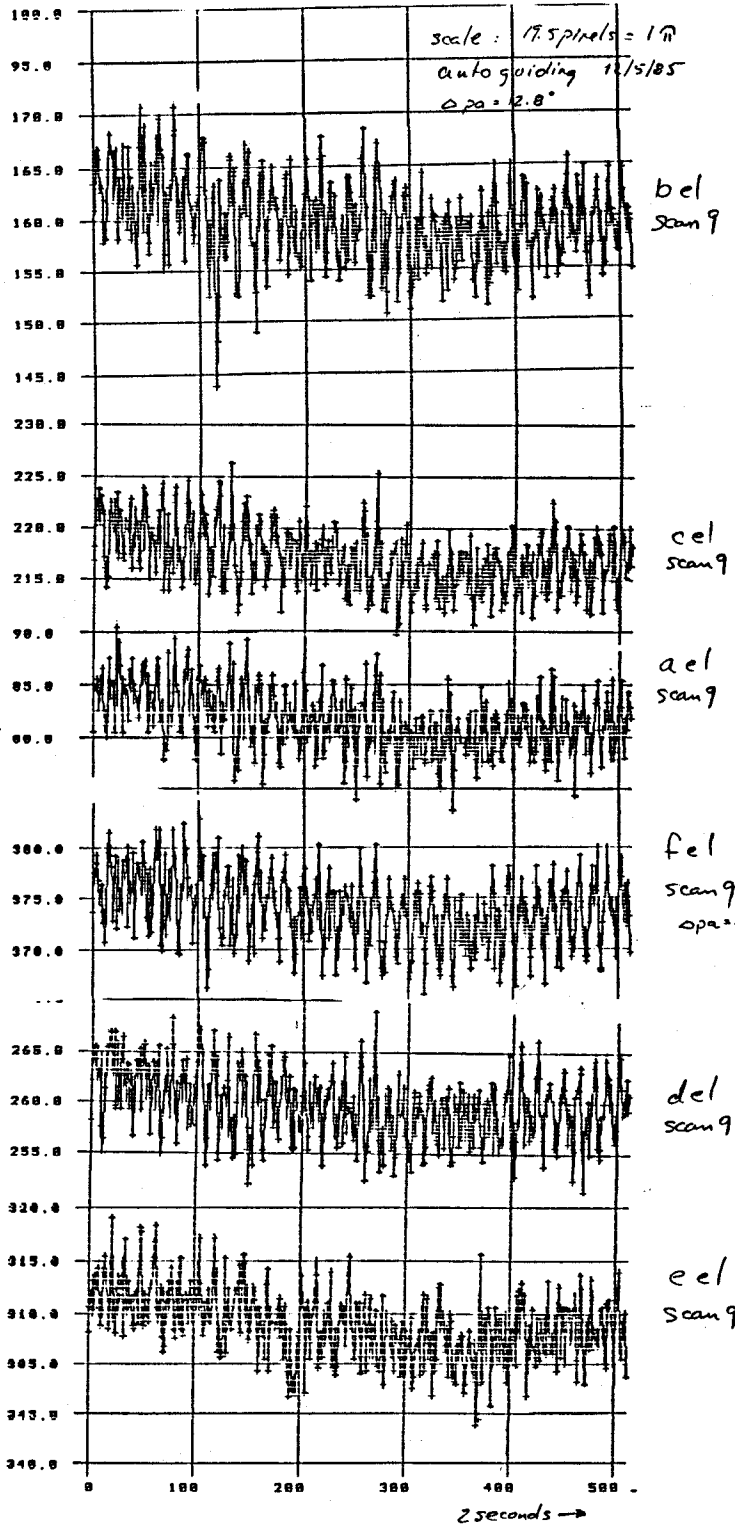


Figure 4

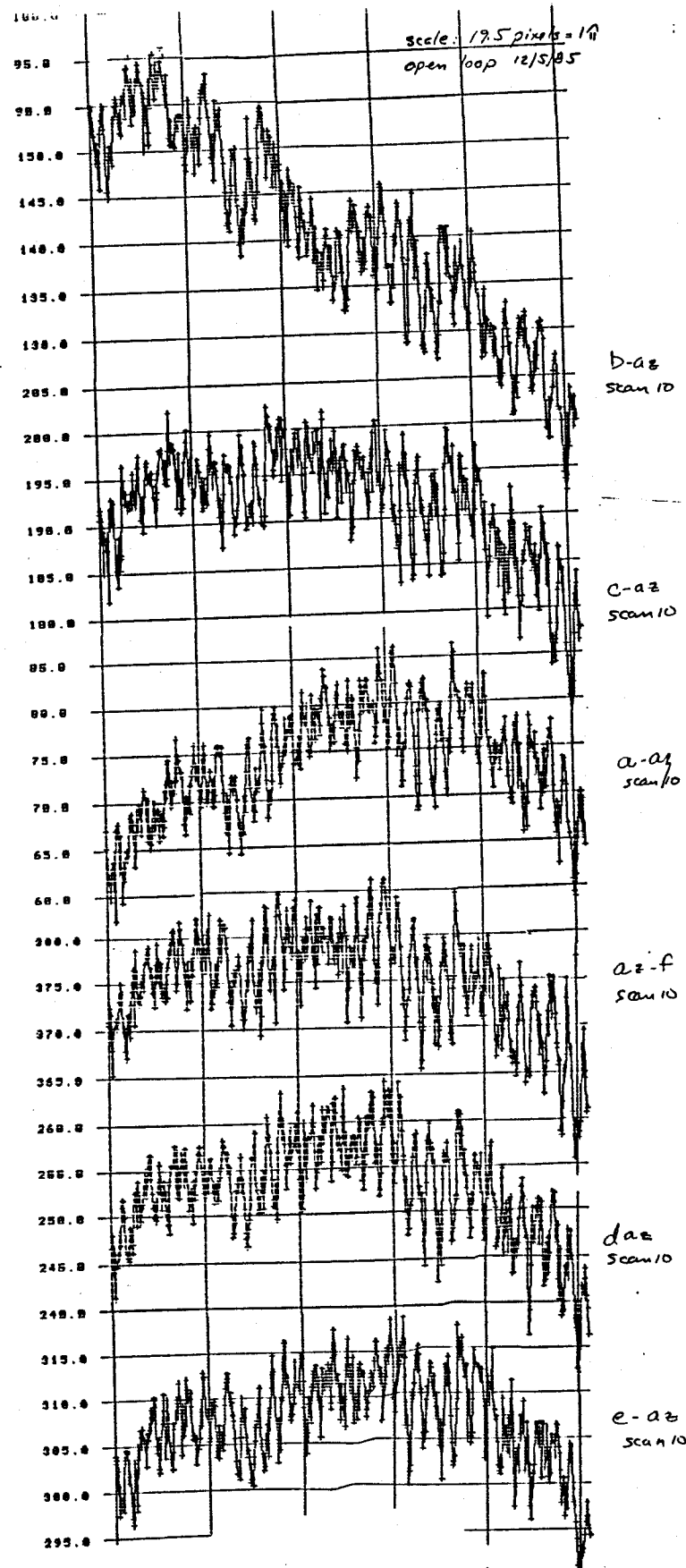
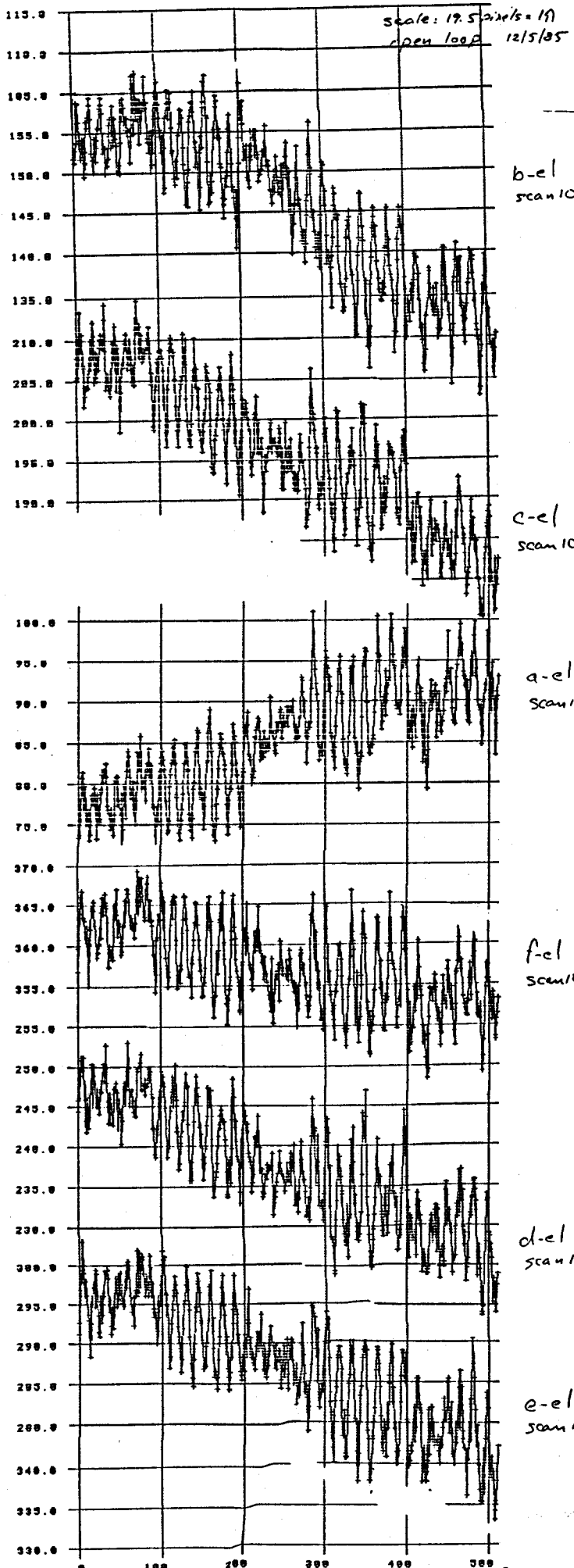


Figure 5