



## MULTIPLE MIRROR TELESCOPE OBSERVATORY

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### MMTO Internal Technical Memorandum 86-2

Subject: Notes on Tracking and Flexure Coefficients from Engineering Nights  
December 19, 1985 and January 2 and 6, 1986

From: C. Janes

Date: January 17, 1986

### TRACKING

Tracking data taken December 19-20, 1985, (Figures 1-8), were taken by tracking open loop (flexure coefficients, pointing coefficients, and encoder coefficients applied) and measuring star position on the TCS Grinnell. These data show the following:

1. At low tracking velocities, the star image appears to wander back and forth  $0.5\pi$  p-p with a frequency of 0.35 to 0.4 Hz (Figures 1 and 2).
2. At higher tracking velocities, the 1/1024 cycle component sometimes dominates. Figures 3 and 6 show a  $1\pi$  p-p error resulting entirely from the 1/1024 component. Figures 4 and 5, on the other hand, show comparatively little 1/1024 component though the velocities are the same as Figures 3 and 6, respectively. An "envelope" of 1/1024 modulation is also shown in Figure 8.
3. Position error (difference between calculated position and encoder output) increases with tracking velocity. The tracking data in Figure 1 has a position error of  $0.03\pi$  RMS ( $1.5 \times 0.02\pi$ /encoder bit) while the position error in Figure 6, though not available in RMS because of limitations in the mount routine, was occasionally as high as  $0.8\pi$ .

Theories abound on the causes of these tracking anomalies, but basically we don't know yet what causes these problems or what to do about them.

### FLEXURE COEFFICIENTS

The flexure coefficients were unable to correct for movement of mirror "D" after its installation in November. Figure 9 shows that the image from mirror D would fall out of the stack by  $5\pi$  after moving the telescope  $15^\circ$ . A tuneable member supporting the "D" cell was stiffened and the mirror moved in the cell to compensate for the optical center being 3 mm off axis (see December Monthly Summary). Figure 10 shows that the problem with holding "D" in the stack seems to be corrected as a result. Note: The difference in sizes of the stack in Figure 10 are due more to intensifier settings on the acquisition camera than differences in the size of the stack.

Figure 11 shows the number of steps issued to each secondary in each axis as a result of the application of the flexure coefficients.

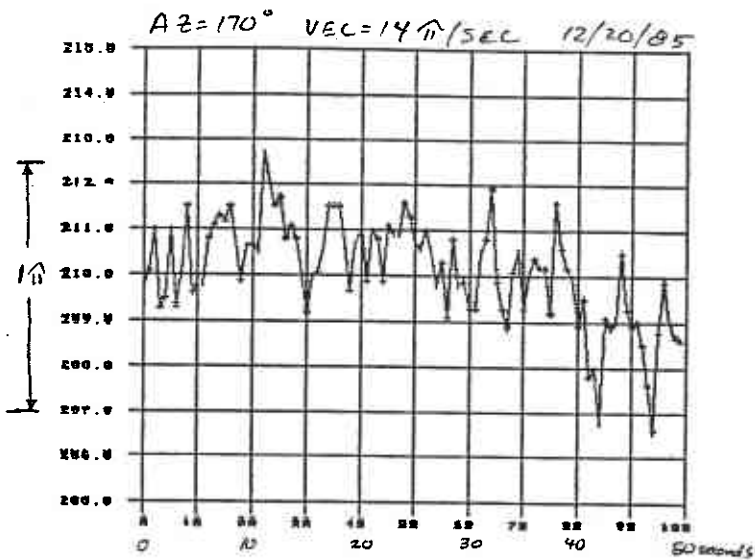


FIGURE 1

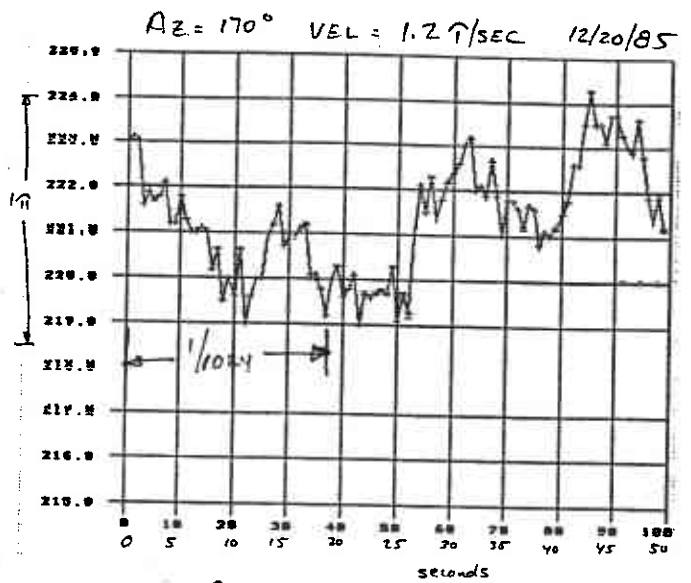


FIGURE 4

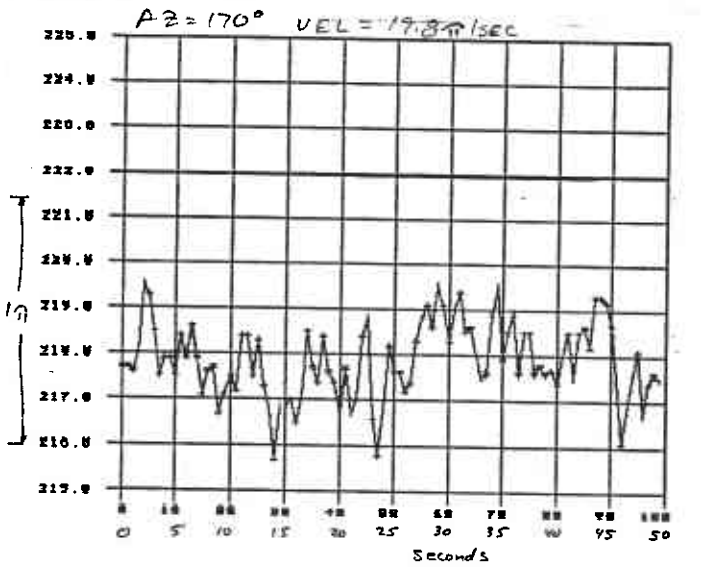


FIGURE 2

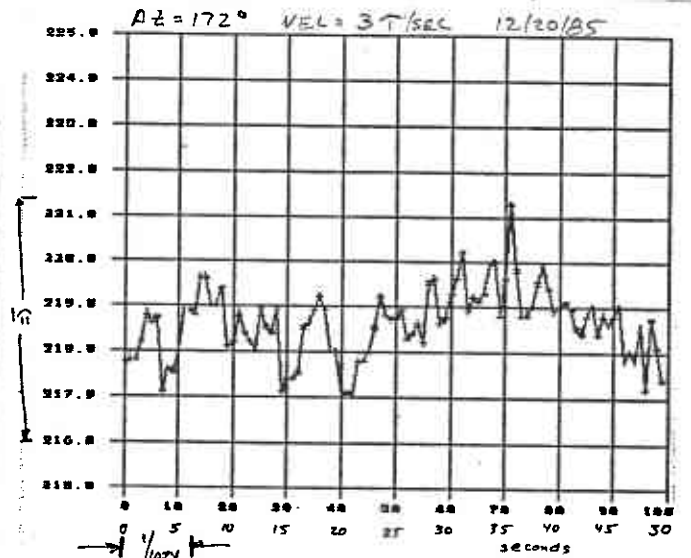


FIGURE 5

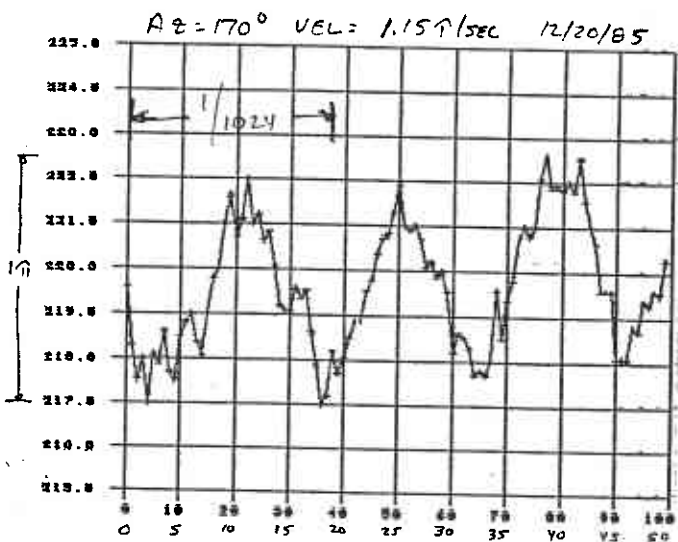


FIGURE 3

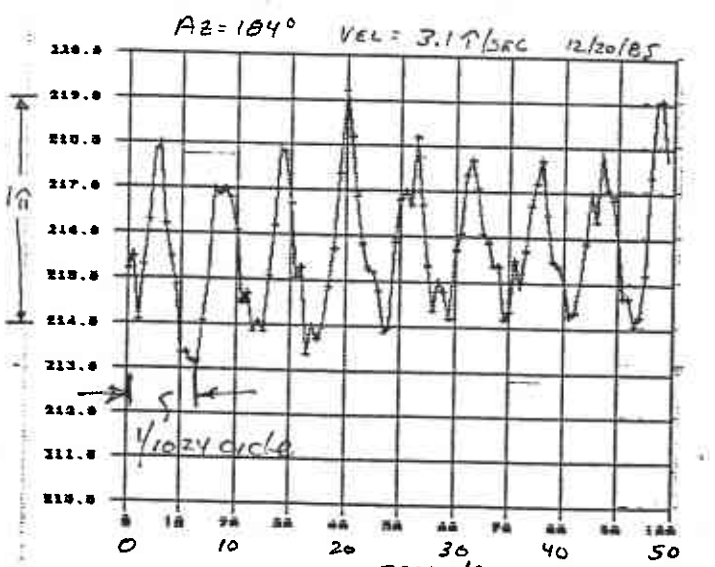


FIGURE 6

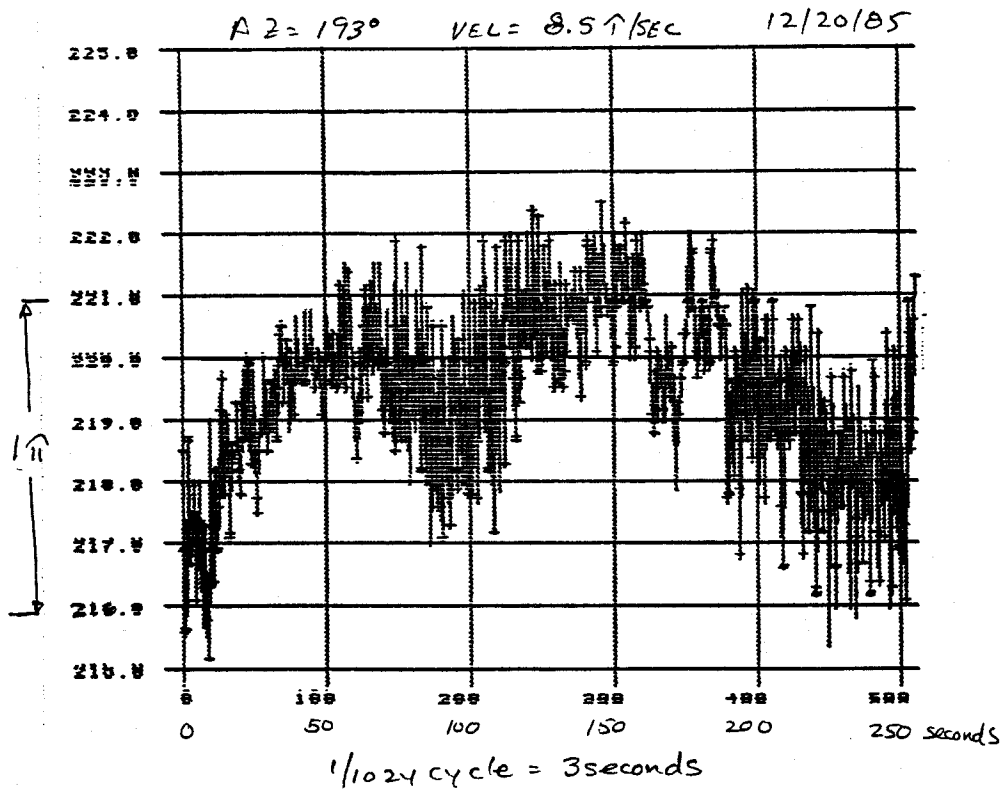


FIGURE 7

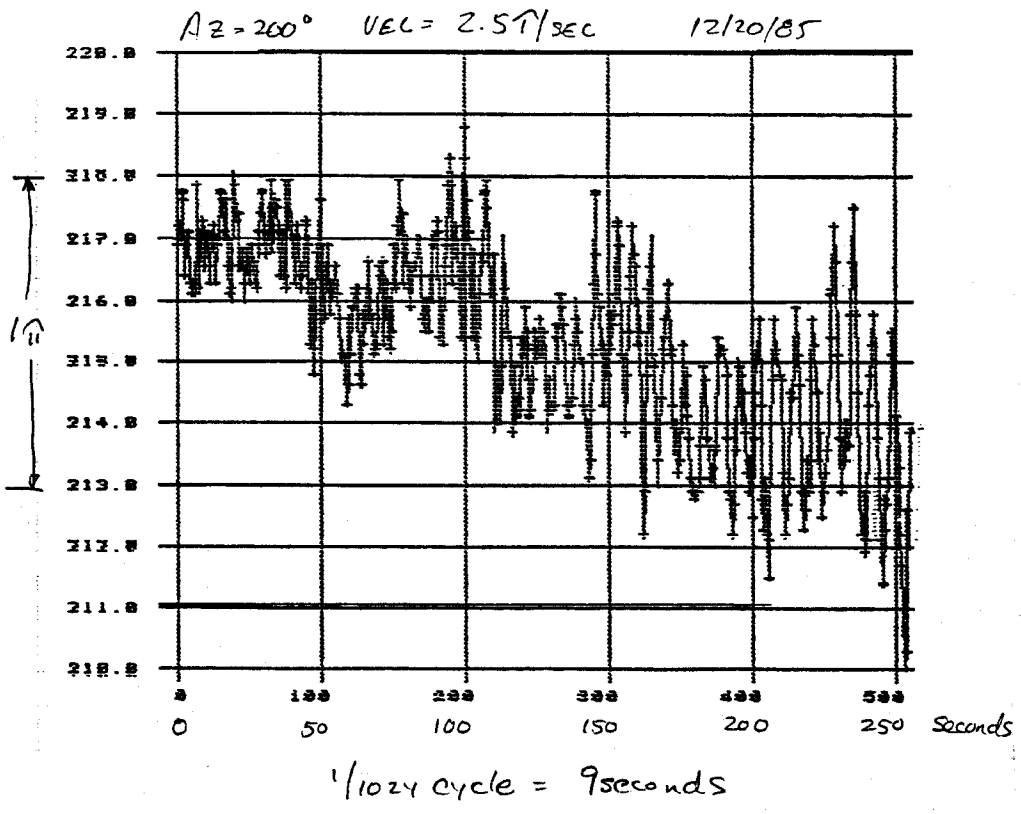


FIGURE 8

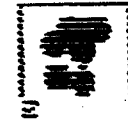
COMPARISON OF STACK: OPEN LOOP VS IDLE (EAST)

878

OPEN LOOP  
(FLEXURE COEFFICIENTS  
APPLIED)

IDLE  
(NO FLEXURE COEFFICIENTS)

66.5° EL  
(DIS OUT)



66° EL  
(DIS IN UPPER  
MIDDLE)

53° EL  
(POINT STACK)



53° EL  
(POINT STACK)

35.7° EL  
(DIS OUT)



5 1/3"



38° EL  
(DIS IN  
MIDDLE)

NOTE: FLEXURE COEFFICIENTS  
TAKEN IMMEDIATELY BEFORE  
THIS DATA TAKEN.

CCJ & CH  
12/20/85

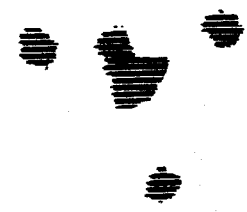
FIGURE 9

COMPARISON OF STACKED IMAGES: OPEN LOOP VS IDLE (EAST)

OPEN LOOP  
(FLEXURE COEFFICIENTS  
APPLIED)

IDLE  
(NO FLEXURE COEFFICIENTS)

Az = 171°  
EL = 79°



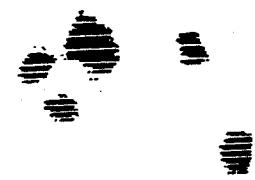
Az = 184°  
EL = 79°

Az = 176°  
EL = 57°  
(point stack)



Az = 176°  
EL = 57°  
(POINT STACK)

Az = 156°  
EL = 30°



Az = 158°  
EL = 31°

FIG 10

SCALE  
↔  
5 μ

FIGURE 10

CCJ & JMc  
1/7/86

# Flexure Corrections

Object: zeta tau	MMT COALIGNMENT SYSTEM STATUS Open Loop					7 JAN 1986 East Pointing	
	Az	E1	UT	Pa	Rot-Pa	Temp(F)	
True:	170:34:07.5	<u>79:19:02.1</u>	5:46:54	0.0	0.0	24	
Zero:	175:31:03.5	<u>57:01:16.1</u>	5:43:19	0.0	0.0	27	
Delta:	-4:56:56.0	22:17:46.0	0:03:35	0.0	0.0	-3	
Telescope:	A	B	C	D	E	F	Z
Fwhm Az("):	1.9	2.0	1.5	1.7	2.2	2.2	0.0
Fwhm E1("):	1.9	2.0	2.1	1.7	1.9	2.3	0.0
Intensity:	18334	23167	13901	14366	9314	11296	0
Limit:							
Control:	AE	AE	AE	AE	AE	AE	
Home:							
Sky: 14584	Star: 50769	Threshold: 0			Pa-offset: 0.0		
Mount Corrections: Az("):	0.0	E1("): 0.0			(Flexure corrections)		
	Issued Steps From Zero Position						
Az:	50	1	30	143	55	-80	0
E1:	-34	80	-68	-120	-104	-132	0
Focus:	0	0	0	0	0	0	0

*Flexure Corrections for stack at E1 79°*

Object: omicron 2 cma	MMT COALIGNMENT SYSTEM STATUS Open Loop					7 JAN 1986 East Pointing	
	Az	E1	UT	Pa	Rot-Pa	Temp(F)	
True:	155:50:44.3	<u>30:24:31.6</u>	5:49:14	0.0	0.0	22	
Zero:	175:31:03.5	<u>57:01:16.1</u>	5:43:19	0.0	0.0	27	
Delta:	-19:40:19.2	-26:35:55.6	0:05:55	0.0	0.0	-4	
Telescope:	A	B	C	D	E	F	Z
Fwhm Az("):	1.9	2.0	1.5	1.7	2.2	2.2	0.0
Fwhm E1("):	1.9	2.0	2.1	1.7	1.9	2.3	0.0
Intensity:	18334	23167	13901	14366	9314	11296	0
Limit:							
Control:	AE	AE	AE	AE	AE	AE	
Home:							
Sky: 14584	Star: 50769	Threshold: 0			Pa-offset: 0.0		
Mount Corrections: Az("):	0.0	E1("): 0.0			(Flexure Corrections)		
	Issued Steps From Zero Position						
Az:	148	73	-50	-112	43	106	0
E1:	-80	-116	-99	61	-81	-26	0
Focus:	0	0	0	0	0	0	0

*Flexure Corrections for stack at E1 30°*

NOTE: FLEXURE CORRECTIONS FOR POINT STACK IMAGE AT EL 57° (SEE FIGURE 10) WERE ALL "0."