

MEMO TO: Engineering Staff
FROM: D. Bianco and C. Foltz
RE: Flexures
DATE: July 30, 1985

MMTO Internal Tech memo 85-2

Summary:

Small image motions (~4 arcseconds across 85 degrees elevation) were seen in the MMTSG aperture plates as viewed by both the Vidicon and I-CCD cameras. This may account for the image motion during auto-guiding reported in MMT Internal Memo one.

On July 23 several tests were done to determine the effects of telescope flexure on the telescope guiding systems. The tests were done in daytime using light reflected from the dome from the incandescent lamps mounted on top of the secondary packages. The Top Box and MMT Spectrograph were in place. Two optical modes were tested;

Mode 1) The MMT Spectrograph aperture plates were viewed with the I-CCD camera and 200 mm lens, and with the Vidicon camera and both 200mm and 85mm lenses, while the telescope moved from zenith pointing to 5 degrees elevation (service position).

Mode 2) The pupil images formed in the top box pupil plane were viewed with the I-CCD camera and pupil imaging optics (28mm lens with a Fresnel field lens and pupil mask in the pupil wheel).

In addition, the optics inside the topbox were moved by hand to empirically determine which is most compliant, and the flexure of the spectrograph was measured with respect to the OSS with a dial indicator.

Results:

Mode 1: The apertures moved about four arc seconds full excursion tracing an arc from left to right across the television screen as the telescope moved from zenith to service. The motion was very repeatable; the apertures returned to their starting positions with no discernable hysteresis. This test was repeated for the derotator positioned at 0 and -60 degrees ROTPA. This is shown in figure 1. We also noticed a focus change; a sharp aperture image at zenith went out of focus at service and came back in at zenith again. This effect was clearly visible with the Vidicon and 85mm lens, less noticeable with the 200mm, and was not noticed at all with the I-CCD camera.

Mode 2: For this test a pupil mask was placed in the pupil wheel consisting of a thin aluminum plate with six holes in a hexagonal pattern. The holes are oversized to allow for the difference in the pupils cast by the f/9 and f/8.39 beamcombiners, and to allow for assymetry caused by telescope miscollimation. Assymetry was evident; the oversized mask partially vignetted two of the pupils. There was a noticeable shift in the six pupils with change in elevation. These moved together horizontally across the screen about 5 inches (judged from the 72 inch size of an individual pupil) moving from right to left as the telescope moved from zenith to service. This flexure was very repeatable with no discernable hysteresis.

Moving optics by hand clearly showed that the 200mm lens is the single most compliant element in the chain.

The dial indicator revealed a repeatable flexure of 0.043 inch measured between the OSS and the MMTSG collimator housing.

Discussion:

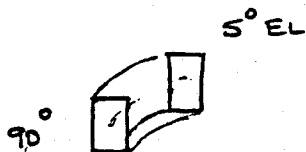
To state the obvious, any flexure noted is the result of the combined flexures of all elements in the measured path. One would like to ascribe the observed flexure to the most compliant element, the camera lens. There is a field rotation in the light arriving at the camera, so this would be consistent with the observed flexure in the horizontal (az) direction with a change in telescope elevation. Lens flexure is also consistent with the pupils moving together instead of seperately. However, if the observed flexure was due only to the camera lens, why do the slit images move in an arc, while the pupils move in a line? Moreover, why do the slits move from left to right, while the pupils move right to left? Are the mode one and two flexures even related?

These flexures are small enough to cause little or no trouble in normal operation, though they certainly contributed to and may account for the star image motion observed during auto-guiding and reported in Internal Technical Memo one.

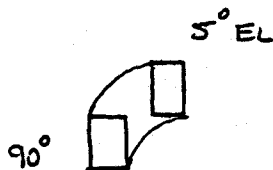
Recommendations:

From the questions raised above it is clear that further tests are needed. These should include clamping the camera lens rigidly in place to see if any improvement results. We intend to continue these tests as soon as the control console is finished and the telescope can be moved again. If, as we suspect, the image motion is mostly due to lens flexure, then we can correct this to some extent by fortifying the lenses and lens turrets. The remaining flexure could be modeled by a simple trig function of elevation angle and derotator position angle.

SCALE : $\rightarrow \leftarrow$ 1 ARCSEC



1 - CCD, 200 MM LENS
0° ROTPA



1 - VIDICON, 200 MM LENS
0° ROTPA



1 - VIDICON, 200 MM LENS
-60° ROTPA

FIGURE 1 : OBSERVED FLEXURE OF THE
2x3 " APERTURE PLATE WITH
ELEVATION CHANGE FROM ZENITH
TO SERVICE.