MULTIPLE MIRROR TELESCOPE OBSERVATORY

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MMTO Technical Memorandum 85-6
Subject: Alignment Requirements for Autoguiding
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Summary:

Tests performed during M&E time June 12 showed that the focal plane flat is a critical element when obtaining the alignment necessary for autoguiding. A small tilt of the focal plane flat results in a dramatic change in the position of the pupil plane in the top box without changing the position of the star image on the acquisition TV.

Procedure:

1. The alignment of the telescope was carefully checked on June 12 for two reasons:

A. The new f/9 beam combiner was installed. The new beam combiner has improved optical surfaces to better match the improvements being made to the figure of the primary mirrors.

The new beam combiner mounting fixture was found to have a tilt of 0.013" in 3" which was corrected by re-machining the combiner mount. The telescope was then collimated following the usual procedure. Inspection of the pupil plane showed that this collimation produced a nearly symmetrical hexagonal array of pupils at the pupil plane. This inspection was performed using a 28 mm closeup lens on the acquisition camera and a Fresnel field lens in the pupil wheel to permit a focused image of the pupil plane on the acquisition TV video. Previous tests showed that the hexagon defined by the 6 pupils will be asymmetrical if the telescope is not properly collimated.

B. Previous tests had indicated that the alignment required for autoguiding is more stringent than that required for open-loop tracking. Autoguiding requires that the pupils of the individual telescopes align with their respective wedge prisms in the top box without introducing vignetting of the images to the acquisition TV and without disturbing the coaxial alignment of the apertures in the spectrograph slit jaws, the telescope optical axis, and the center of the acquisition TV video monitor.

Previously, the Wazel (steering) mirror in the top box had been adjusted in an attempt to steer the beams through the center of the aperture defined by the pupil wheel and as close to parallel as possible with the optical bench in the top box. With the existing alignment of the top box, and with the new collimation of the telescope, the acquisition camera (the intensified CCD or I-CCD) was moved so that the center of rotation of the acquisition camera was coaxial with the center of rotation of the instrument derotator (telescope optical axis).

2. The focal plane mirror (a flat mounted on the bottom of the top box with three standoffs usually referred to as the "engineering mirror") was tilted to study the effect on the star image and on the pupils at the pupil plane. Placing a 0.03" shim under one standoff tilted the mirror about 10 arcminutes. This moved the pupils away from the center of the pupil wheel aperture so that two pupils were totally vignetted and two were partially

vignetted. At the same time the star image on the acquisition TV showed no change in position. Then the focal plane mirror adjusted to align the center of the circle defined by the 6 telescope pupils with the center defined by the pupil wheel. This alignment was performed by shimming the posts on the engineering mirror until the two centers were coaxial. The shimming of the posts required for alignment indicates the criticality of focal plane positioning:

.020" SW post
.006" NW post
.002" E post

3. Alignment of the pupils with the wedge prisms was verified by "nodding" each of the secondaries in turn, and carefully examining the acquisition TV video (using the 200 mm lens) to see that only one image moved. Motion in more than one image would indicate that the pupil was overlapping more than one prism. A small amount of overlapping appeared to be present, but is thought to be caused by light scattering from the prism facets rather than from misalignment.

4. The aperture plates on the MMT spectrograph were tested to see how each effected the pupil plane. Estimates were made of the required adjustments to the tilt of each plate :

	Aperture	Adjustment reqd in az	Adjustment reqd in el
1.	3 arcsecond single aperture	-5 arcminutes	none
2.	1 arcsecond double aperture	none	+5 arcminutes
3.	1.4 arcsecond double aperture	-5 arcminutes	+5 arcminutes
4.	2 x 3 arcsecond aperture	none	none
5.	5 arcsecond aperture	-5 arcminutes	none
6.	1 x 3 arcsecond aperture	-5 arcminutes	-5 arcminutes
7.	image stacker	-5 arcminutes	+5 arcminutes

The tests were repeated with similar results indicating the aperture plate positions are repeatable. Autoguiding tests were successfully accomplished using the 2 x 3 aperture plate.

Discussion:

The alignment procedure dramatically demonstrated that adjustment of the focal plane flat moves the pupil plane but does not move the star image as seen by the acquisition TV. Hence, the images could be moved about the field without moving the pupil plane by guiding the telescope pointing or by adjusting the primary mirrors. Adjustments to secondaries, tertiaries, the beam combiner, or the Wazel mirror will move both the images and the pupil plane proportional to the proximity of that set of optics with the primary mirrors and the focal plane, respectively. For example, it is futile to adjust the Wazel mirror in an effort to simultaneously align images at the focal plane and align the pupil plane with the prisms.

Conclusions:

Where autoguiding is required, there must be provisions for adjusting the focal plane reflecting flat to permit alignment of the pupils with the prism wheel. This feature must be added to both facilities spectrographs and any PI instruments planned for use with the top box before autoguiding can become routinely available with those instruments. For example, six of the seven aperture plates on the MMT spectrograph need adjustment of a few

thousandths to provide the pupil plane alignment required for autoguiding. The repeatability of the aperture plates suggests that once made, these adjustments need only be changed when significant adjustments are made to the top box or telescope optics, making the routine use of auto-guiding a more promising prospect.