MULTIPLE MIRROR TELESCOPE OBSERVATORY

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MMTO TECHNICAL MEMORANDUM 89-1

Subject: Phased Geometry for the MMT

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On the night of December 18 we recovered a fully phased array for the first time since June. For the archive and for future phasing efforts I want to record the present geometry.

J.T. Williams used a surveyor's transit to measure the heights of the tertiary base plates above a reference level. I measured the distances from the same base plates to the surface of the primaries using a micrometer. In addition I measured the displacements of the ABC facets relative to the beam combiner flange.

The results are shown in the attached figure. The heights of each element (primary, tertiary, ABC facet) are given relative to three reference planes. Note that primary E is low with respect to the rest of the array, and over a quarter inch lower than its neighboring telescopes. This certainly contributed to the difficulty of finding its phased pathlength. The tertiary and ABC facet are also low to accommodate the position of the primary.

From this information we can calculate the relative focal lengths of the primaries provided we make the following assumptions: that the array has perfect radial geometry (i.e., the telescope axes are the same radial distance from center), and second, that the secondaries all have the same radius of curvature. The formula is simple:

1) $$dR = \{F-(P+T)\}/2$$

where dR is the difference in the primary radius
F is the facet height
P is the primary height
T is the tertiary height

A positive dR indicates a longer radius of curvature. Using E as the reference, the other telescopes' radii are:

	A(5)	B(2)	C(3)	D(4)	E(7)	F(6)
"F"	.42	.33	.49	.53	0	.33
"P"	.08	.17	.23	.30	0	.25
"T"	.14	.20	.25	.27	0	.24
dR	.10	-.02	.005	-.02	0	-.08

Compare these to the tabulated values of the telescope focal lengths given here relative to E:

	A(5)	B(2)	C(3)	D(4)	E(7)	F(6)
R	.098	-.06	-.02	-.098	0	-.099

Next I'd like to consider phasing the telescope with perfect f/9 and f/8.39 geometry. This implies that the quantities "F" and "T" from equation 1 must all be driven to zero. Rearranging equation 1 to the form:

2) $P = F - T - 2dR$

allows us to define a new primary height P′ to be:

3) $P' = F' - T' - 2dR$

Setting F′ and T′ equal to zero and solving for P′ gives:

4) $P' = P - F + T$ or $P' = -2dR$

Thus we can find a particular height P′ for each primary which will give a phased array with all the tertiaries and beam combiner facets level to one another. This would occur when the primaries are at the following relative heights (referenced to a level plane):

	A(5)	B(2)	C(3)	D(4)	E(7)	F(6)
P′	-.20	.04	-.01	.04	0	.16

In conclusion, the geometry of the array has apparently drifted over the years, with the result that the primary heights now vary as much as 0.3 inches. Since the tertiaries are set to the same nominal distance above the primaries, they closely follow the uneven piston of the primaries. This geometry means that each telescope beam arrives at focus from a slightly different angle. Thus neither the f/9 nor the f/8.39 geometries are "true." By returning the tertiaries to true level, we correct the f/9 focus. By displacing the primaries a specific distance above or below a plane, we can achieve perfect phased geometry for both f/9 and f/8.39.

MMT PHASED GEOMETRY AS OF DECEMBER, 1988

NUMBERS INDICATE HEIGHT IN INCHES ABOVE A LEVEL REFERENCE PLANE