12 METER MILLIMETER WAVE TELESCOPE
MEMO No. 189

Correcting Template Sensor Readings Using Measurements of the Reference Jig

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August 27, 1982

1. Introduction

Memo #187 described our present "best" set of measurements of the positions of the dowels in the R/J. We now turn to the task of transforming these measurements into zero-point corrections to be applied to the T/P sensor readings.

In Figure 1 let (X_{cp}, Y_{cp}) be the measured coordinates of a dowel center in the reflector axis system (DAS). In Memo #187 X_{cp} and Y_{cp} are found from Equation (1), but with YY chosen to be the measured value, rather than the nominal value.

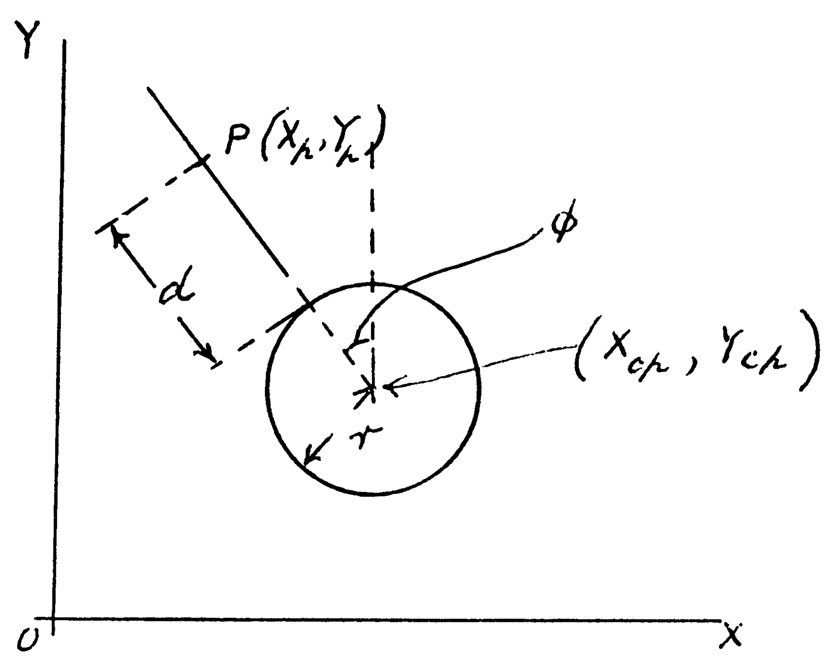

Figure 1

A Dowel in the Reflector Axis System

Let P be a point on the true reflector surface, with coordinates (X_p, Y_p).

Then:

$$X_p^2 = 4\,FY_p \tag{1}$$

and

$$\left.\begin{aligned} X_p &= X_{cp} - (d + r)\sin\phi \\ Y_p &= Y_{cp} + (d + r)\cos\phi \end{aligned}\right\}. \tag{2}$$

We require d, which follows from (1) and (2):

$$d = \frac{-B - \sqrt{B^2 - 4AC}}{2A} - r\ , \tag{3}$$

where

$$\left.\begin{aligned} A &= \sin^2\phi \\ B &= -2X_{cp}\sin\phi - 4F\cos\phi \\ C &= X_{cp}^2 - 4FY_{cp}\ , \end{aligned}\right\} \tag{4}$$

with F equal to the reflector focal length (F = 5080 mm nominally) and r equal to the dowel radius (9.525 mm).

2. Computation

Table 1 gives the computed values of d and shows the values adopted from Table 5 of Memo No. 187 for ΔX and ΔY. (Note that Table 5 used nominal values of $\Delta X = \Delta Y = 0$ at dowel No. 1, while here we have set $\Delta X = \Delta Y = 0$ at the origin.) We have checked Table 1 in two ways. First, if we set $\Delta X = \Delta Y = 0$ for all dowels we do, as we should, find $d = 0$ for all dowels. Second, we have used double precision (quite large numbers are differenced in (3)) and confirmed our results.

3. Application

We note that:

- A positive d means the sensor is extended beyond the true surface to reach the dowel.
- A longer d implies a lower voltage output from the sensor.
- Thus, if a given sensor reads V volts on a dowel with a positive d, it would read $(V + d/c)$ volts on the true surface. c is my sensor calibration constant which says that a sensor voltage change of dV volts corresponds to a movement of c x dV microns.

Dowel No.	ϕ degrees	Nominal Reference Jig X_c mm	Y_c - 647.7 mm	ΔX microns	ΔY microns	d microns
1	3.472	592.970	-171.694	-77	97	-74
2	6.572	1135.780	-295.615	-163	28	5
3	9.616	1684.445	-390.248	-176	27	-2
4	12.579	2237.303	-455.988	-204	125	-105
5	15.444	2792.773	-493.522	-224	198	-188
6	18.194	3349.396	-503.794	-220	245	-245
7	20.820	3905.867	-487.939	-215	241	-252
8	21.163	3980.326	-483.898	-170	287	-297
9	23.652	4537.792	-439.710	-190	85	-104
10	26.007	5092.870	-372.003	-175	75	-100
11	28.228	5644.780	-282.194	-182	52	-85
12	30.319	6192.901	-171.694	-179	97	-133

Table 1. The "d" values from the R/J measurements.

These rules then tell us to adjust the sensor zero point reading in volts (V(I) in my programs) so that

$$V(I) \rightarrow V(I) + d/c \tag{5}$$

4. Two Notes

(a) The RMS of the R/J profile.

Having measured the R/J and transferred the contact points on the dowels into telescope coordinates (DAS), it is interesting to put a best-fitted parabola through the measured points. We did this, adjusting only the focal length, and found:

Best fit focal length = 5079.3 ± 0.1 mm
RMS difference from best fit = 115 microns

(b) The edge-ball in telescope coordinates

We now repeat the calculation of paragraph 3(c) of Memo No. 187, using our "best" value for the coordinates of the center of the edge-ball dowel (No. 13) in the R/J axis system No. 2.

X = 6289.215 mm   X = -296.809 mm

and get

$$X_{pe} = 6076.413 \text{ mm} \quad Y_{pe} = 1639.575 \text{ mm} . \tag{6}$$

64.550"

The Y coordinate is the height at which all edge balls should be set above the top of the dish center ball.