140-ft Memo
June 17, 1977

READADJUSTMENT OF THE 140-FT SURFACE ?

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ENGINEERING MEMO #113

For a proper decision about this question, we need two estimates. First, how much labour and telescope down-time would be needed for the measurement and adjustment; second, how much improvement would it yield. A first very rough time estimate gave about 6 weeks with about 1/3 of it as down-time, and John Ralston has agreed to work out a proper estimate. A rough performance estimate is given in the following, but a proper estimate would need the measurement of two more radii.

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On May 12, John Findlay measured one radius of the 140-ft with his stepping method, see Fig. 1, with the result:

$$\delta = 0.066 \text{ mm} = \text{rms measuring error}, \quad (1)$$

$$\Delta_o = 0.709 \text{ mm} = \text{rms deviation of surface from design parabola}. \quad (2)$$

.. seems that this radius is just a little better than the average telescope, for which we derived in 1975 from several astronomical efficiency measurements, at λ = 2.0 and 1.3 cm,

$$\Delta_a = 0.80 \text{ mm}, \quad (3)$$

where

$$\eta = 0.57 \ e^{-(4\pi\Delta/\lambda)^2}. \quad (4)$$

For finding the best adjustments for the panel corners along this measured radius, we draw in Fig. 1 the best-fitting straight line for each of the three panels. At the six panel corners, we read:

	inner	outer	corner
inner panel	- .55	- .33	Corner adjustment (mm) (5)
second panel	-1.06	+ .18	
outer panel	+ .75	-1.18	

In passing, we note that there is no obvious parabolic deviation in any of the ree panels, thus the focal length seems ok, at least along this radius.

After adjustment according to (5), the corrected deviations from the design paraboloid (= deviations from straight lines in Fig. 1) would be, if adjustment errors can be neglected,

$$\Delta_c = 0.466 \text{ mm.} \tag{6}$$

The measured radius was close to the radial edge of the panels. Radii close to the panel center would not be as well adjusted as (6). This difference is difficult to estimate, and we may adopt for the whole panel about

$$\Delta_p = 0.500 \text{ mm.} \tag{7}$$

Since the measured radius seems to be better than average, we normalize accordingly and obtain for the whole telescope, after readjustment,

$$\Delta = \frac{0.800}{0.709}\, 0.500 = 0.56 \text{ mm.} \tag{8}$$

Using this value, we calculate the efficiency, η , for several interesting wavelengths according to (4), before and after readjustment:

Δ \ λ	1.36 mm (H_2O)	0.97 cm (window)	0.73 cm (Si O)	
0.80 mm	0.330	0.195	0.086	efficiency η
0.56 mm	.436	.337	.225	

(9)

For comparison, we also calculate the equivalent diameter (after adjustment) of a telescope with equal gain but perfect surface:

$$D = 42.7 \text{ m} \sqrt{\eta/0.57} \tag{10}$$

and obtain

λ	1.36 cm	0.97 cm	0.73 cm
D	37.3 m	32.8 m	26.8 m

(11)

Results (9) and (11) look fairly promising. But for a proper estimate we would need two more radii measured: along the center and along the other edge of the same panels. This would also be useful for preparing the final job (if we decide to do it).

SvH:vlt
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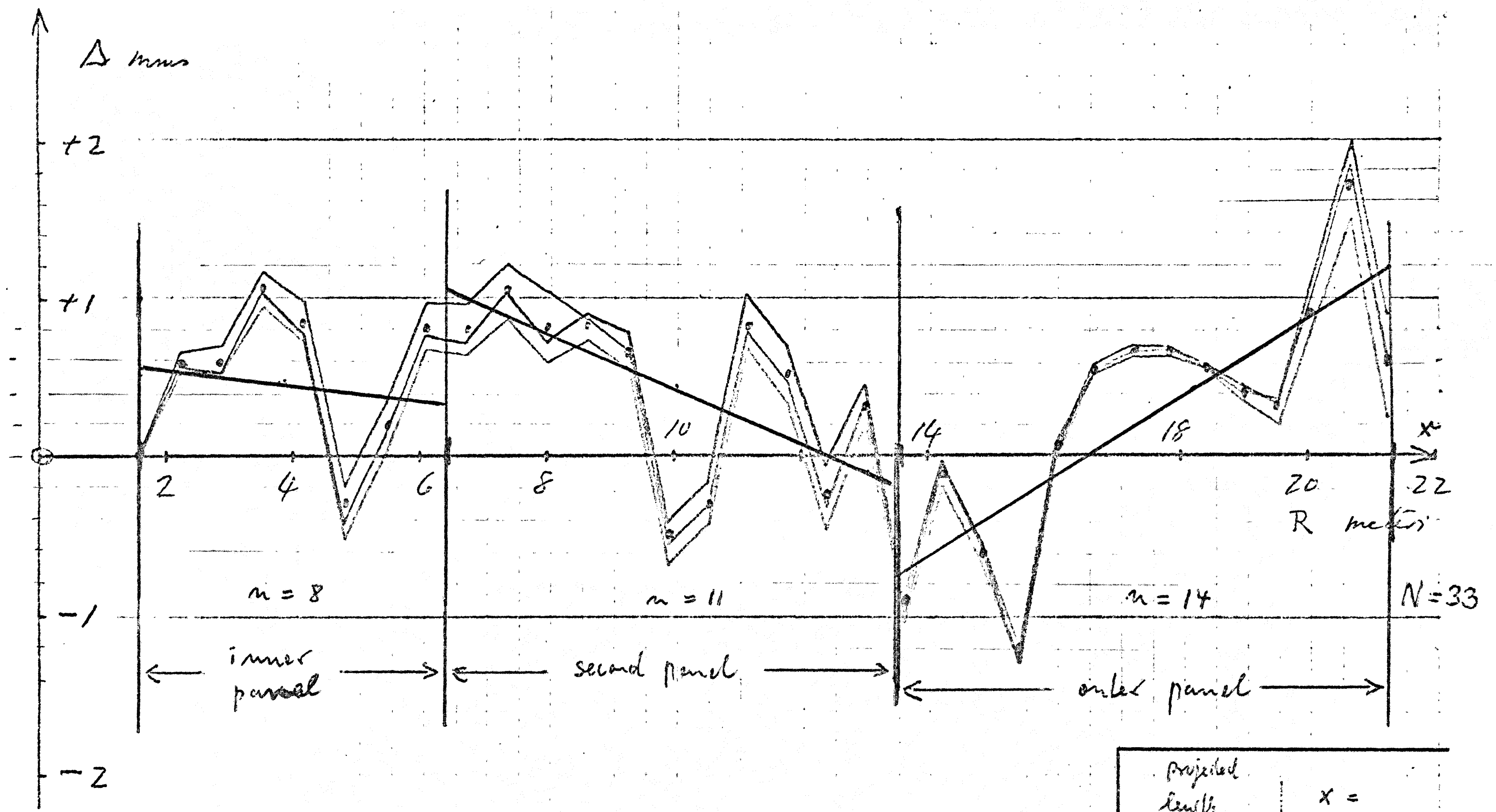

Projected length	x =
	21.34 m
− 7.85 =	13.49
− 7.11 =	6.38
− 4.86 =	1.52

__Fig. 1.__ Measuring one radius of the 140-ft telescope three times, with __Stepping Method__ (John Findlay, May 12, 1977).

0.709 mm = rms deviation of surface from design parabola

0.066 mm = rms measuring error

140-Ft. Memo
June 16, 1977

J. Ralston

SCHEDULE
For Measuring 140' Surface
Using J. Findlay Stepping Bar Method

I. Prepare for measurements:

A. New drill tape dimensions — 12 hrs.
B. Dimensional layout, drill and install bushings — 18 hrs. - 2 men

30 hrs.

∴ 30 ÷ 6 = 5 days with no telescope down time.

II. Preparing surface for measurement by drilling:

A. Layout 72 radial lines (vertex to perimeter) — 18 hrs. - 2 men
B. Drill 2232 pilot holes on 72 radial lines — 36 hrs. - 2 men
C. Countersink 2232 holes with centering drill bit — 18 hrs. - 2 men

72 hrs.

∴ 72 ÷ 6 = 12 days with 1/3 time telescope down time.

III. Measuring surface using stepping bar:

A. Measure 72 radii — 36 hrs. - 4 men
B. Remeasure 4 radii (day to day reference) — 12 hrs. - 4 men

48 hrs.

∴ 48 ÷ 6 = 8 days with 1/3 time telescope down time.

IV. Adjust surface:

A. Assuming all 228 points to be adjusted — 56 hrs. - 4 men
B. Plus time for climbing, breaks, weather, etc. — 28 hrs. - 4 men

84 hrs.

∴ 84 ÷ 6 = 14 days with 1/3 time telescope down time.

C. Error budget for adjustment using dial indicators should be between 5×10^{-3} and 10×10^{-3} inch.

V. Total time:

A. Duration = 8 weeks.
B. Down time = [illegible] hours.
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cc: R. Brown
K. Kellermann
Horton
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S. [illegible]