THE 12-METER TELESCOPE
A PERSISTENT PROFILE ERROR NEAR SENSOR #6

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1. Introduction

We have noted for some time the odd behavior of the readings from Sensor #6 when it is being used to measure or set the telescope surface. The measurements made on the surface during February 14th (1358 - 1552 local time) and the subsequent re-adjust of some radii on February 16th have now shown that the phenomenon is truly an error in the plate profile. We will briefly review the evidence for this, then suggest a reason for it and finally outline some possible courses of action.

2. Sensor #6

This sensor measures the elevation of the surface at a point 3339 mms radially from the dish vertex. Surface adjustment points are below Sensors #5 and #7, with #7 being the outermost adjustment point on an inner panel. This radial distance is important for the telescope performance, since it is both strongly illuminated and it provides a considerable area of surface for a given radial increment. We have naturally studied the sensor itself with care; it has been recalibrated, checked for free motion and watched when it is on the Reference Jig. No anomalies have been seen, except when it rests on the telescope surface. We thought at first that it might by chance be landing on one of the panel saw-cuts, but inspection showed this was not the case.

3. An example of bad surface

Figure 1 shows the profiles of five radii on one inner panel. These plots are from the Stobie programs in the PDP 11/40. As we measure the surface the raw voltage data from the 12 sensors is read via a 16-bit A/D converter to the PDP*. Betty Stobie then corrects this data for gravity, edge-ball heights and the measured shape of the R/J and the voltages read when the template is mated with the R/J. It seems certain that the measurements in Figure 1 show a badly deformed panel. All the data from the present surface have been sent to Lee King and he will soon produce a map of the deviations from the best-fit surface. All these numbers are available to me from the Stobie print-out, so I have examined the readings from sensor #6 all around the surface. I took as a test value the criterion that I would "star" any panel where #6 was 100 μm low, or lower, on one or more radii. I put

*Graham Moorey set up this system. I assume he has written a brief description of it somewhere.

a "star" against 46 radii, spread over 14 inner panels. We shall wait for the map, but we clearly have a most unpleasant low zone around the dish. And a look at Figure 1 suggests that it is not going to be easy to "best-fit" our way around this one.

4. How did it happen?

Of several possible causes, I have naturally rejected at once any manufacturing error. All panels were measured at ESSCO; all measurements are in the Charlottesville computer and a contour map has been drawn for each panel. My first candidate is that the panels were so deformed when first placed on the telescope that they took a permanent set. Look at Figure 2, which shows Radius #97 when we measured it on October 13th. This pattern occurred to a greater or less extent all around the dish. I wrote my Memo #196 on October 16th 1982 to show the setting errors for Radius #86. Since I showed it in Figure 1, I have called back from the Apple II Radius #97 for Figure 2.

One sees at once that on this radius the outer panel was not bent much out of shape. It was set uniformly almost 1 cm too high, but not bent. The inner panel was, however, badly bent. Sensor #1 is 3 mm too low, while #7 is almost 1 cm too high. I suggest that this stress caused the panel to take a set from which it did not recover. The shape error supports this theory; the magnitude of the set has only to be about 10% of the actual bend imposed to explain what we find.

5. A simple test

We tried briefly to release the panel shown in Figure 1, to see if it would recover, but it showed no desire to do so. I therefore suggest that we remove the whole panel, replace it with a spare, and send it back to ESSCO for them to re-measure. Depending on the result, we should know what to do next.

6. The Future

This difficulty is one of three outstanding tasks we need to work on before we try to improve the telescope further. The other two are to improve our edge-ball numbers and to study possible errors in the R/J and template mating and measuring. The possible actions on the plate errors could be listed (in a random order) as:

(a) Ask ESSCO if it might be possible to repair the bad panels.

(b) Buy and install about 12 new panels.

(c) Add further adjusting screws behind the panels and try to screw them into a better shape.

(d) Repair the phase errors at the sub-reflector. (I don't think much of this one.)

Figure 1(a)

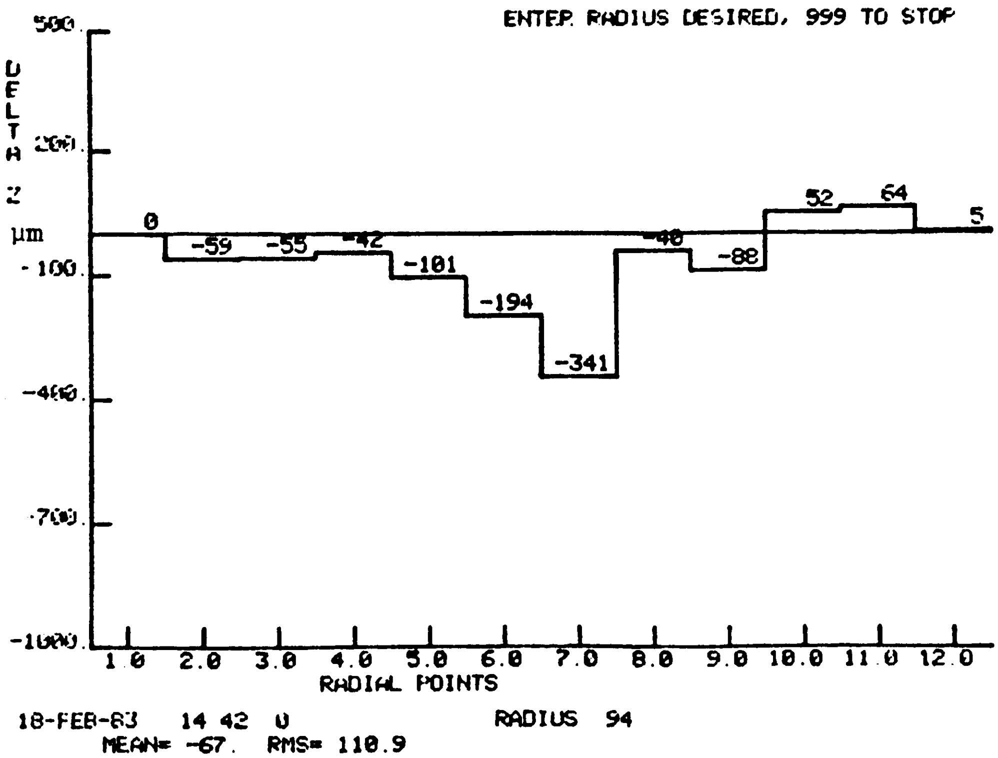


Figure 1(b)

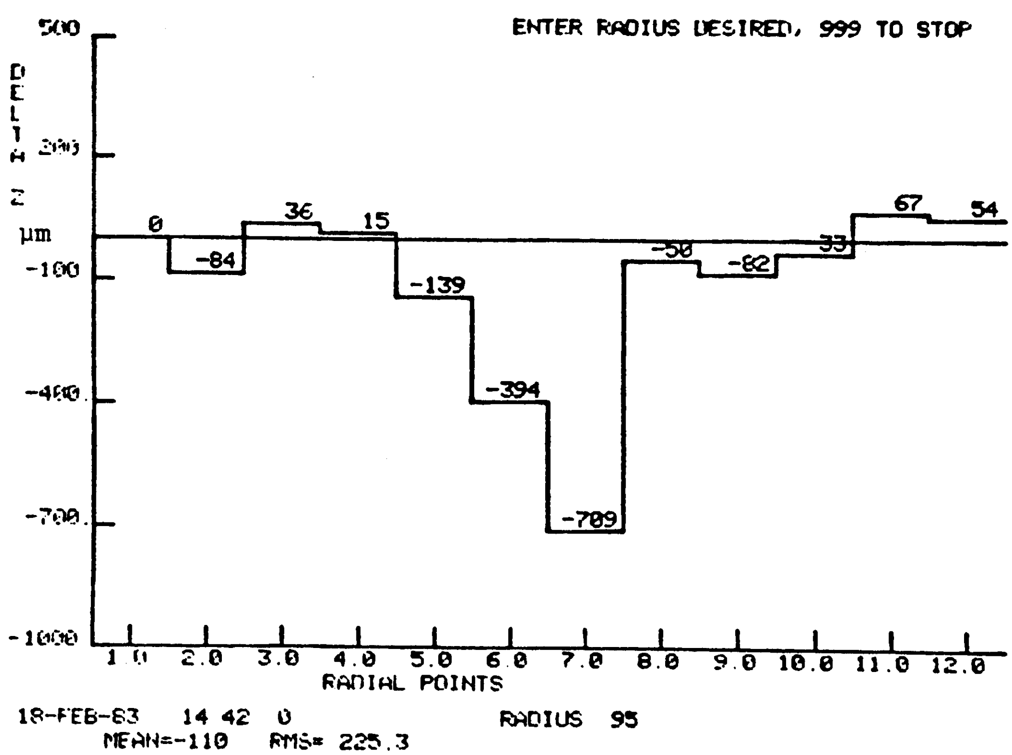


Figure 1(c)

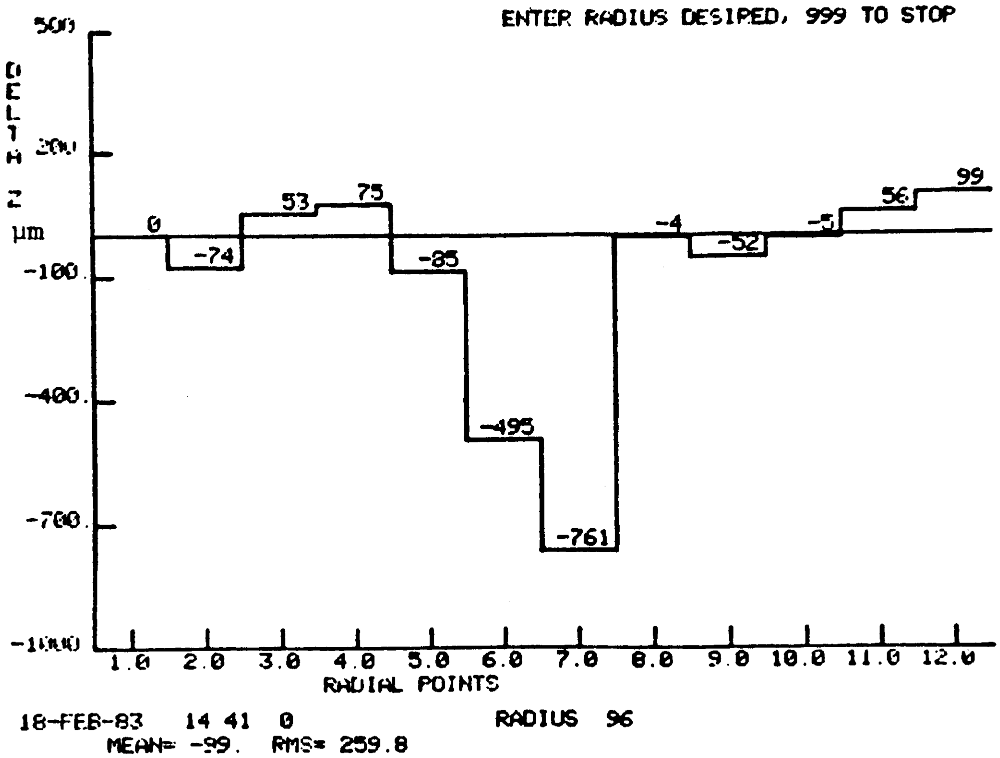


Figure 1(d)

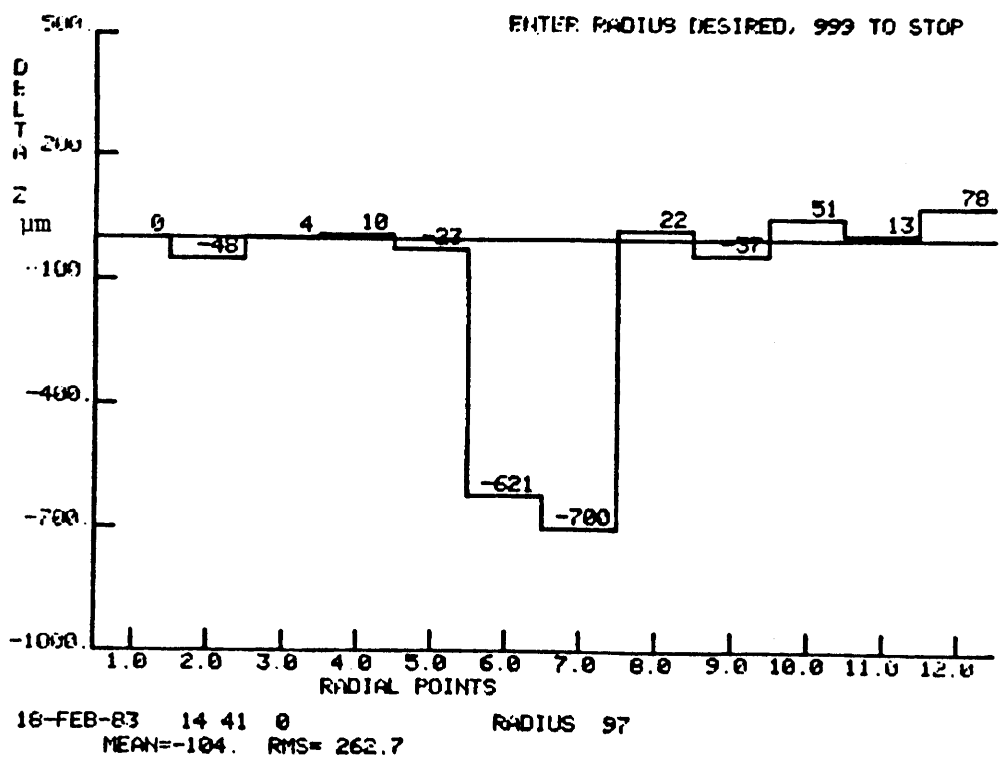


Figure 1(e)

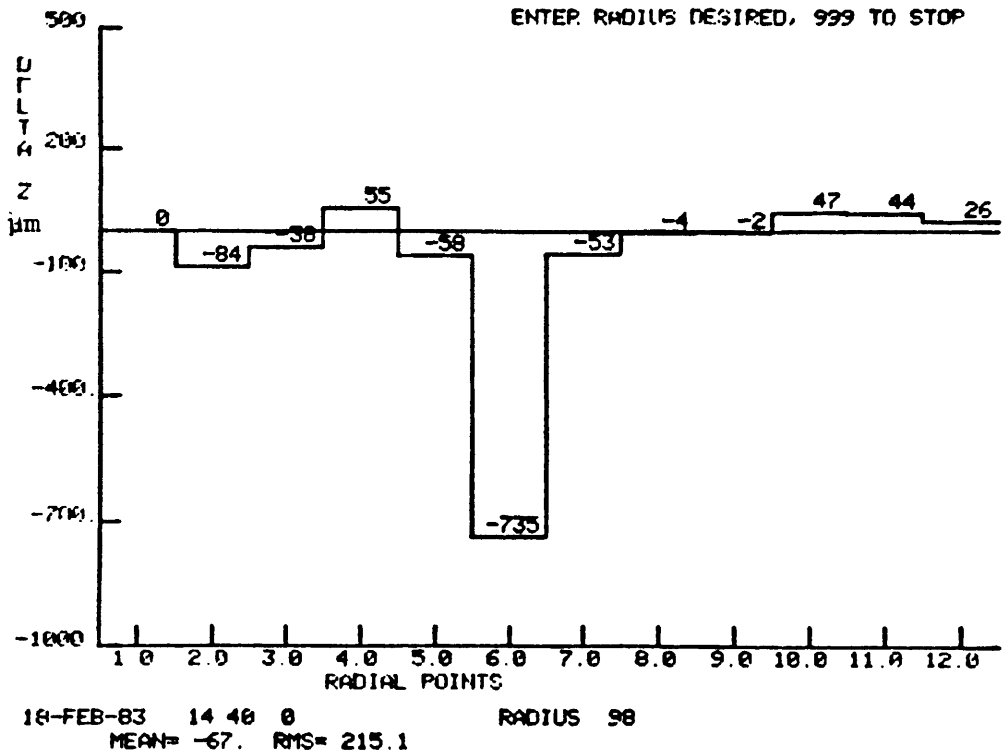
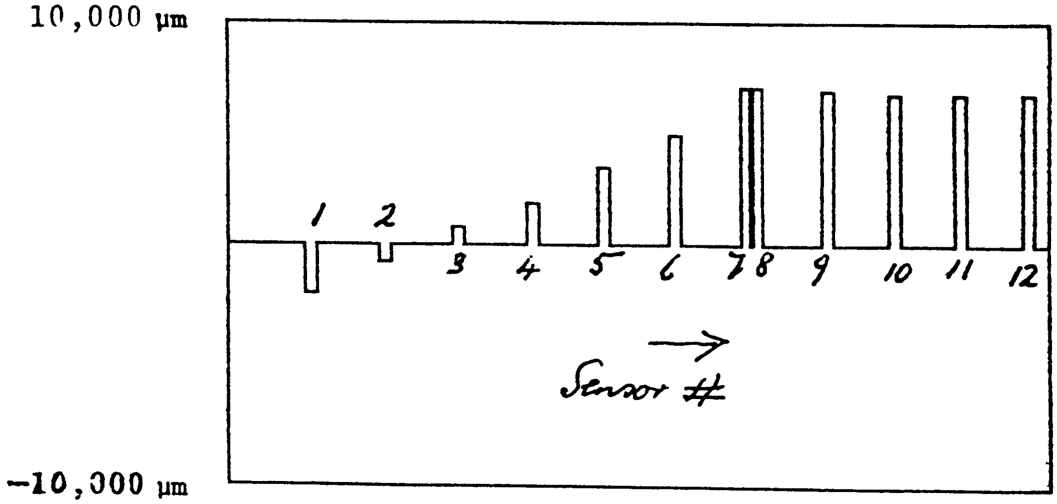


FIGURE 1

Profiles taken on Radii #94 through #98. Radius #93 is a full panel edge, with a mean elevation of 8µm and an RMS of 56µm . The profiles show the differences between the "desired" profile and the measured profile. When the display which gives the differences between the measured and the "best-fit" is called, the errors become somewhat less. Had the Delta Z in 1(e) above been zero at Sensor #6, the RMS would have dropped to 47µm. Radius #98 is the other full panel edge.

Radius # 97. Measured 1430 October 13th 1982



THE ERROR =	-3153	MICRONS
THE ERROR =	-1121	MICRONS
THE ERROR =	985	MICRONS
THE ERROR =	2506	MICRONS
THE ERROR =	4752	MICRONS
THE ERROR =	6797	MICRONS
THE ERROR =	9817	MICRONS
THE ERROR =	9822	MICRONS
THE ERROR =	9370	MICRONS
THE ERROR =	9179	MICRONS
THE ERROR =	9089	MICRONS
THE ERROR =	9271	MICRONS

MEAN ERROR=5610 MICRONS

RMS = 7192 MICRONS

FIGURE 2

The shape to which Radius #97 was first set. The errors are the differences between the measured shape and the design shape. A positive error is a high panel.