12 METER MILLIMETER WAVE TELESCOPE

MEMO No. 220

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THE 12-METER TELESCOPE
PROFILE ERROR NEAR SENSOR 6
Comments on MEMO NO. 217

Memo 217 Section 4 "How did it happen?"

In trying to list any possible event or procedure which could cause a deformation of panels in the area of sensor No. 6 I come up with the following list in chronological order.

(A) Manufacturing error - Not all likely since if either the ESSCO mold and fabrication procedure or the ESSCO measuring machine were in error all inner panels would exhibit this error.

(B) Misfabricated Panels - This would require a deliberate action by ESSCO in furnishing a limited number of panels which their Coordinate Measuring Machine revealed were bad to NRAO. I don't think at all that this is what happened. ESSCO would have to much to lose and too many people aware of the action to risk such procedures and I think their ethics are above that type of action.

(C) Shipping and Handling - This is a candidate which I would call quite possible. Panels were shipped in a steel frame with all eight supports quite firmly bolted down. I removed some of the first panels installed from the frames of Kitt Peak and the grommets which were intended to shock mount the panels were very small and had been pulled down solid. It is highly unlikely that the frames were fabricated to the accuracies of the panels and panels were quite likely deformed in attachment. The vibration during transit could have caused a permanent set to occur in those panels which had the worst distortion. It probably can not be determined and is unlikely but it would be interesting to know if the distorted panels are ones which were removed in Green Bank and repackaged for shipment to Tucson.

(D) Storage at Kitt Peak - Possible but not likely. Panels were stored in a tarpaulin covered wooden enclosure at Kitt Peak for a period of some 8 weeks in August and September. These enclosures were quite uncomfortably hot and the difference in temperature expansion between the steel frame and the tightly bolted panels might possibly have distorted those panels which were most firmly attached.

(E) Rough Handling from Shipping Frame to Telescope - Had this happened to only one, two or three panels it might be considered but the panels were handled quite tenderly by the people involved and the number of panels involved makes this highly improbable.

(F) Installation on the Telescope - Possible but our installation procedure was one in which we tried to take precautions to prevent distorting the panel. The procedure followed was to loosely attach 6 bolts to the inner panel prior to lifting on the telescope ~ the inner two bolts were threaded into the tapped holes of the inner ring of the telescope. The panel was then inserted on the bolts of the inner ring first with the quarter inch bottom nut of the inner bolts at approximately the correct elevation. At this time only the top 3/8 inch nut and both top and bottom 1/4 inch nuts widely separated so as not to restrain the panel. The six outer adjusting bolts were then inserted into their matching holes on the antenna. The panel at this point was quite free to more as anyone on the installation group can verify. The first step taken was by use of the locating bar to locate the inner tooling hole to the correct distance, elevation and azimuth but only approximately as the top 1/4 inch nuts were left quite loose, in the usual case not even on the bolts. The second step involved positioning the outer tooling hole to the proper azimuth and approximate elevation by adjusting the top and bottom 3/8 inch nuts on the adjustment studs to attach the stud to the proper position. At this point the panel rests freely on the bottom 1/4 inch nuts of the 2 inner and 2 outer adjusting studs. The correct elevation (or what we intended to be the correct elevation) of the outer tooling hole and the outer panel corners was obtained by turning the bottom 1/4 inch nut which supports the panel making sure that azimuth of the tooling hole remains correct and the top 1/4 inch nut is free. The inner tooling hole is then checked for elevation, azimuth and distance with the tooling bar and theodite and the top 1/4 inch nut was tightened to secure the panel. Up to this point the four intermediate adjusting bolts are free in the supporting holes of the back-up structure and the bottom 1/4 inch nut is not supporting the panel. The bottom 3/8 inch nut and washer are then installed on the adjusting bolt and tightened making sure that both 1/4 inch nuts are free. The bottom 1/4 inch nut is then run-up against the panel (just barely) and the top 1/4 inch nut then down to restrain the panel. Note that the coupling nut (turnbuckle) was not used in the installation to adjust elevation and that the gravity deflection of the panel between the inner and outer support points would not be removed.

We work on the adjusting stud with the ¼ inch nuts

Since it is stated in Section 4 of Memo 217 that the data of figure 2 Memo 217 reveals that the outer panel was not bent much out of shape but that the inner panel was, however, badly bent I did a rather simple transformation of the data of figure 2 for comparison with figure 1(d). The data of the measurement of Oct. 13 of Radius 97 was transformed by rigid body translation and rotation as follows:

(1) The inner panel was translated up by adding to all readings the amount necessary to place Sensor 1 at the 0 error reading.

(2) The inner panel is rotated down about sensor #1 by an angle (0.22886°) to make Sensor #7 read Zero. Proportional change of Sensors #2 thru #6 is calculated and applied to those readings.

(3) The outer panel is translated down by subtracting from all readings an amount necessary to make Sensor #8 read zero error.

(4) The outer panel is rotated up about Sensor 8 to make Sensor 12 reading Zero through angle of 0.015719° and changes in Sensors 9, 10 and 11 calculated.

Figure 1 following shows figure 1(d) of Memo 217 with the transformed error readings of radius 97 superimposed in dotted line.

Figure 1(d)

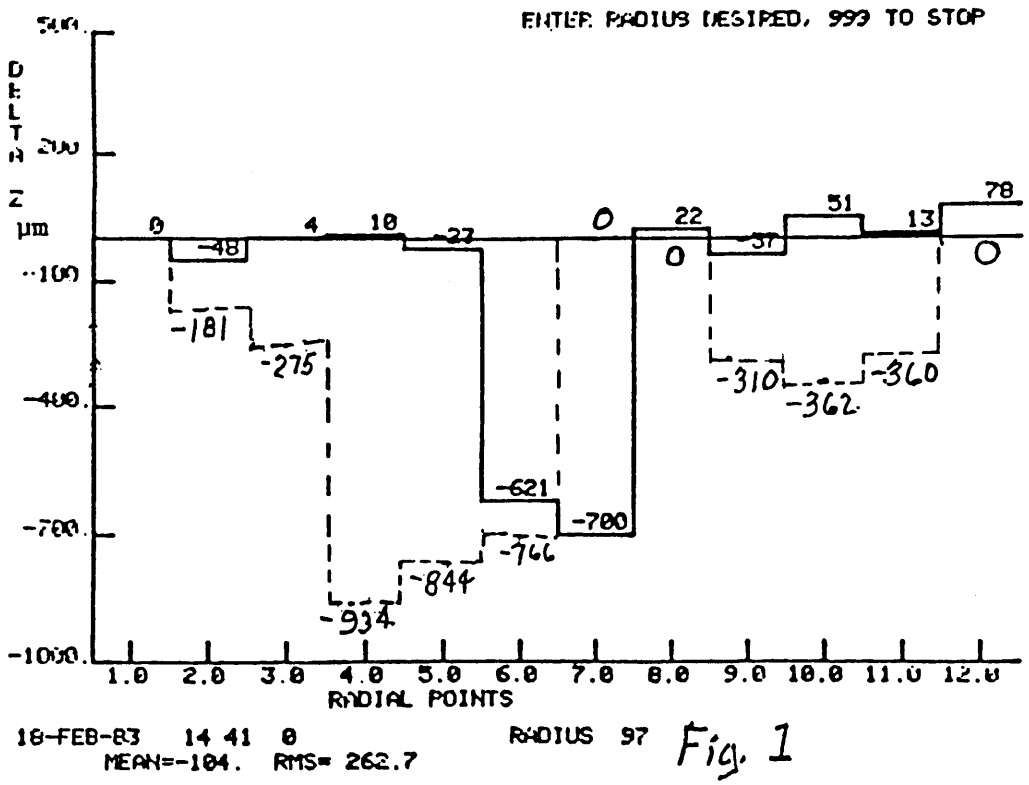


Fig. 1

It would appear to me that the data on radius #97 taken Oct. 13, 1982 does not show a badly bent panel but does show an effect due to the supports at sensors 3, 5 and 10 not being adjusted at installation to take the gravity deflection out of the panel when it is supported at the end supports.

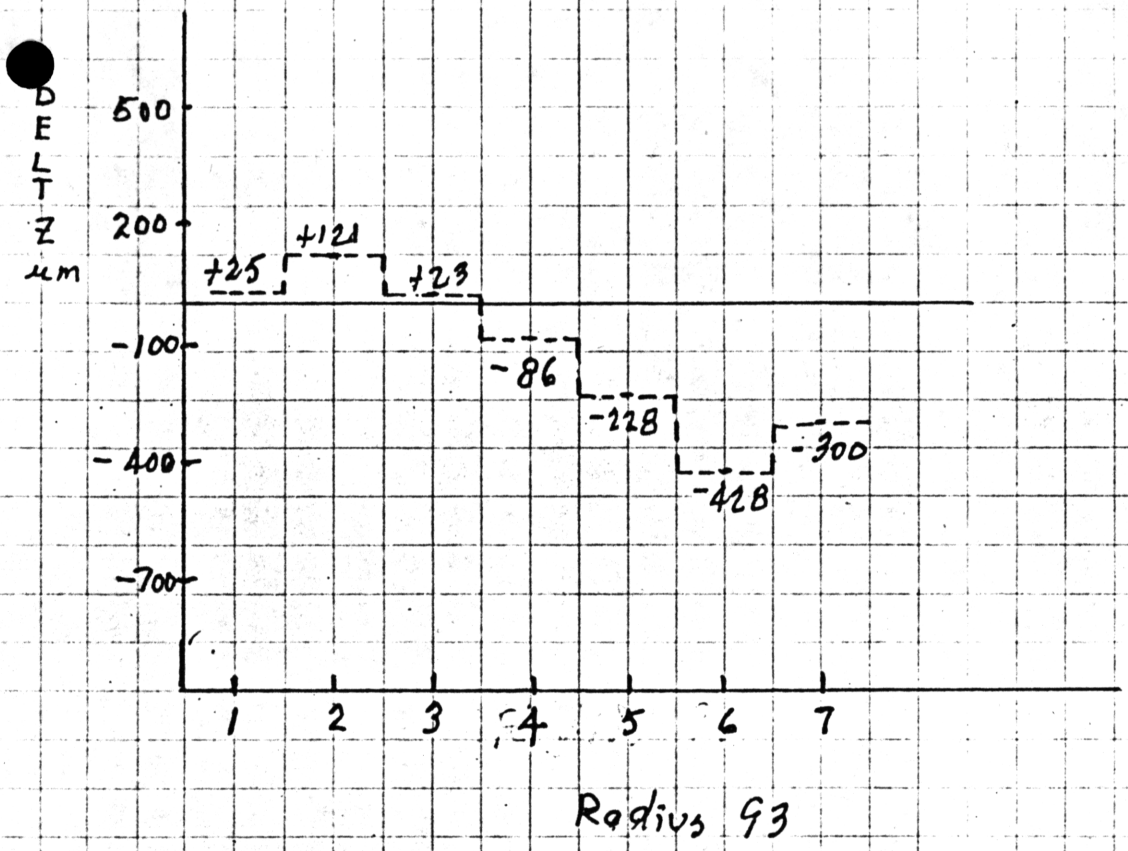
In an attempt to get a clearer picture of the panel as a whole I called Lee King and got the following error readings for radii 93, 94, 95, 96, 97 and 98 which were taken in Oct. 1982 (exact date I didn't get. Since the inner panel was the one I was interested in I only used those.

Sensor No.	#93	#94	#95	#96	#97	#98
1	-2006μm	-1955μm	-1955μm	-1880μm	-2083μm	-2311μm
2	-381	-406	-533M	-610	-660	-737
3	+1041	+1066	+1092	+1041	+915	+787
4	+2438	+2438	+2514	+2515	+2438	+2540
5	+3785	+3912	+4013	+4064	+4216	+4089
6	+5054	+5182	+5385	+5359	+5537	+5690
7	+6629	+6756	+6908	+6934	+7612	+7188

Since I wanted to transform the panel as a rigid body I took an average of the Sensor 1 readings and an average of the sensor 7 readings to calculate the amount of translation (+2031M) and the amount of rotation (0.158101°) and then calculated the Sensor error value for each sensor in each radii. The transformation was only done in the longitudinal direction. I was later informed by Lee King that the radii numbering might have been changed but since Memo 217 indicates that Radii 97 of Oct. 13 is the same as Radii 97 of 18 Feb. I have used the radii as being the same. Following is a plot on Figures 1 (a) through 1 (e) of the transformed data of Oct. 1982 plotted in dotted line on Radii 94 through 98 of Feb 19, 1983. I have included a plot of Radius 93 since it was not included in Memo 217. Again I am not sure that these reading clearly indicate that a badly bent panel existed in Oct of 1982.

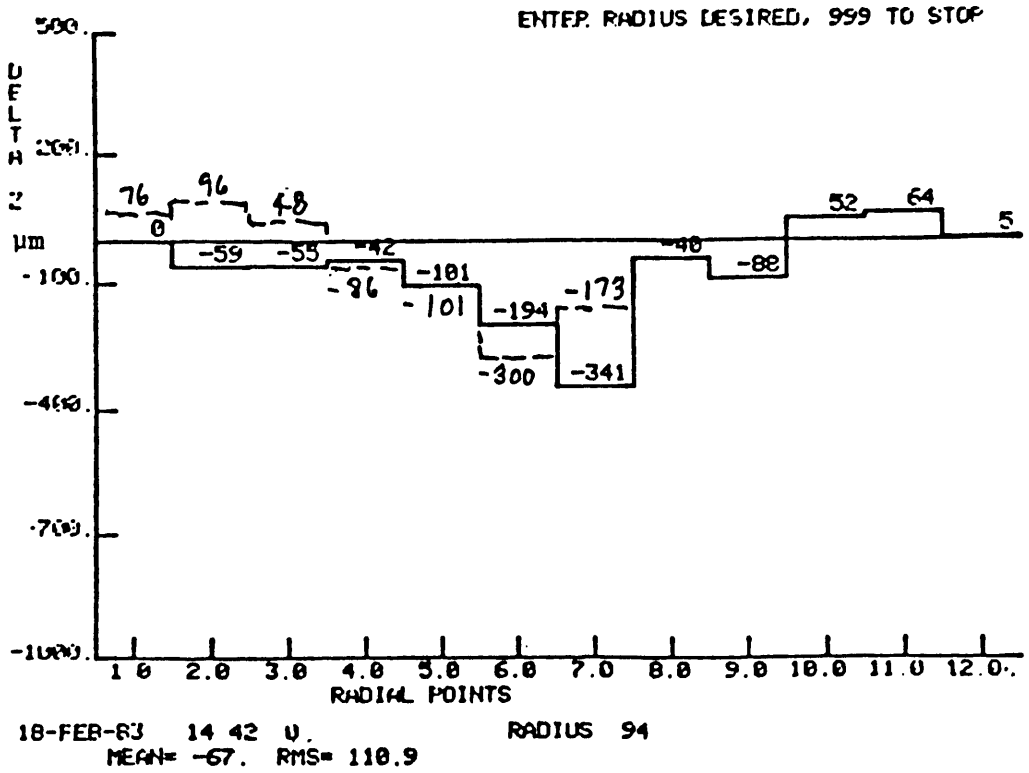
WH/bmg

Figure 1(f)



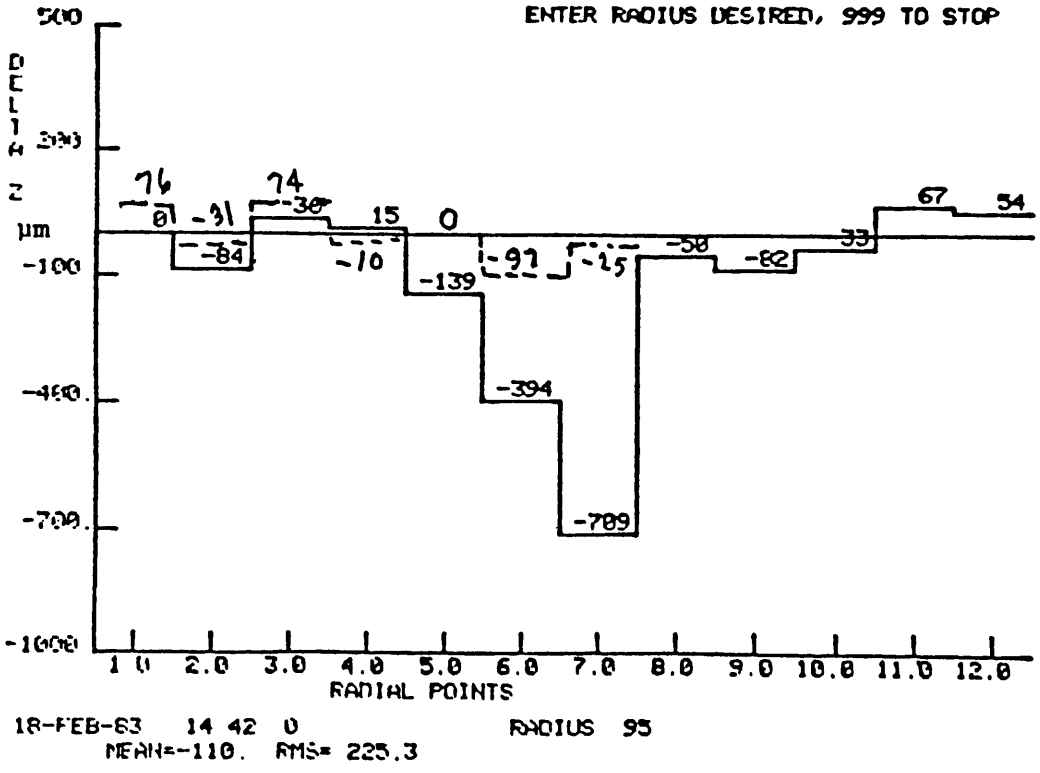
Radius 93

Figure 1(a)



18-FEB-83 14 42 0. RADIUS 94
MEAN= -67. RMS= 110.9

Figure 1(b)



18-FEB-83 14 42 0 RADIUS 95
MEAN=-110. RMS= 225.3

Figure 1(c)

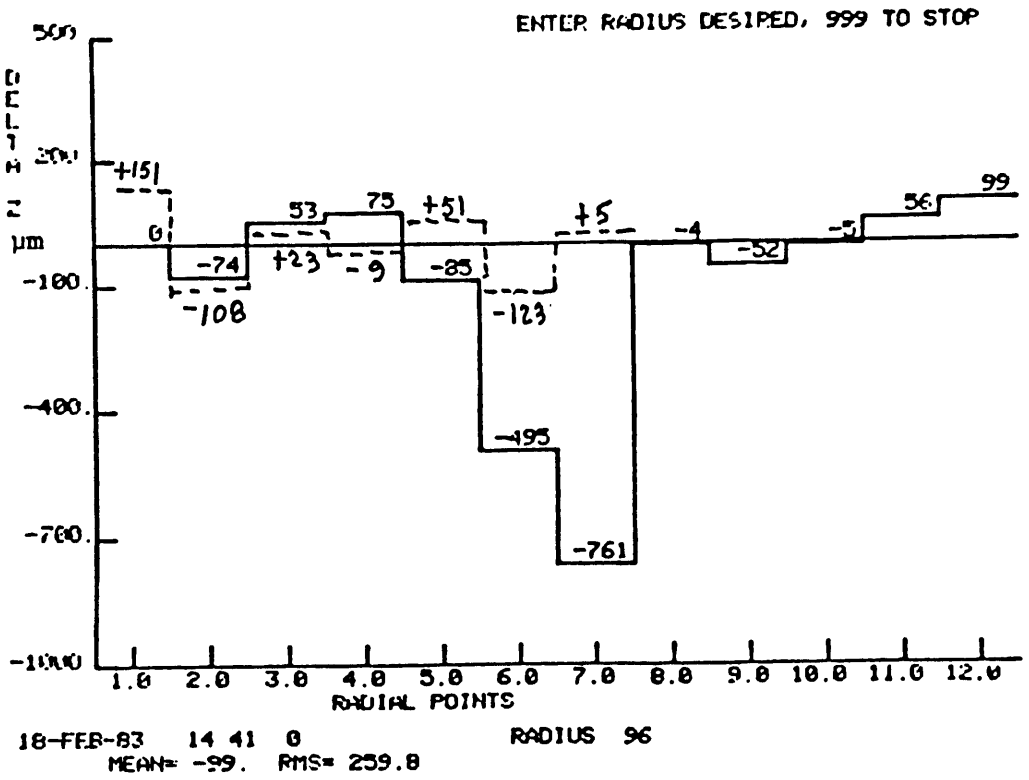


Figure 1(d)

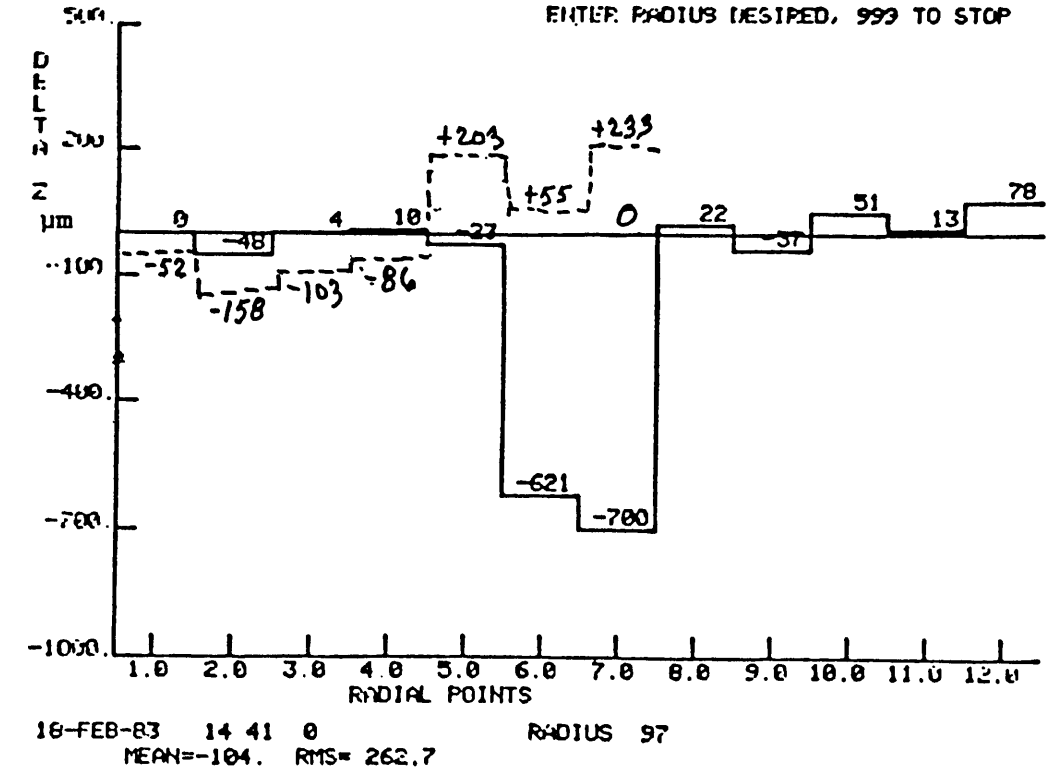


Figure 1(e)

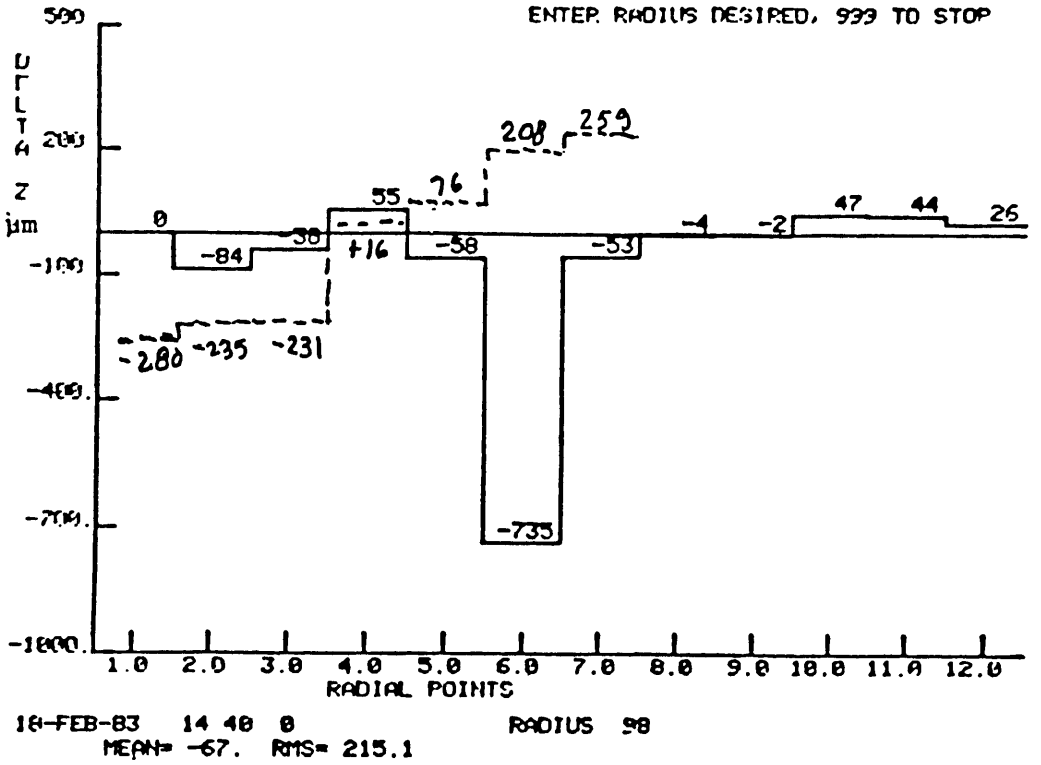


FIGURE 1

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.