

MEASUREMENT OF PANELS FOR BIMA ANTENNAS

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SUMMARY

The panels for the BIMA array are aluminum castings. There are 4 rows of panels with all panels less than 1 m. in size. The panels are machined leaving a scalloped surface equivalent to a 0.8 micron rms surface accuracy. Four test panels have been machined and independently measured. The measured fit to the a-priori parabolic surface varied from 6 microns rms for the inner panel to 41 microns for the outer panel. The increased rms in the outer panel is attributed to the rib structure which becomes increasingly parallel in the outer panels and allow the panel to be easily warped about its diagonal. The warp is clearly evident in the residual errors. Since the panel is mounted on the antenna backup structure by four mounting points at the corners of each panel, this warp will be removed when the panel is mounted on the antenna. Fitting a hyperbolic warp at 45 degrees to the panel axis reduces the rms residual to less than 6 microns for all four panels.

PANEL MEASUREMENTS

The panels were measured on a Mitutoyo coordinate measuring machine with a Renishaw touch trigger probe. The measurements were taken at the bottom of the scallop pattern so that the residuals reflect only the machining accuracy. The measurements have an absolute measuring accuracy of 0.00015 inches (3.8 micron) in all coordinates. The maximum dimensions of the measured surface is 28 x 24 x 18 inches.

The measurements are in a coordinate frame determined with respect to the machined edges of each panel. The surface accuracy is determined from a least squares fit to the parabola:

$$x^{**2} + y^{**2} = 4az , \text{ where } a=100.8 \text{ inches is the focal length.}$$

Measurements are made in the coordinate system (xm,ym,zm), where ym is measured along the panel axis, and zm is the measured surface depth. The parameters fitted are the offset in z and rotations rotations about the x and y axes. The offsets in (x,y), and the rotation about the z axis are constrained to their calculated values since the panels must be mounted in fixed locations on the parabolic surface.

RESULTS

The results for the three parameter fit described above are summarized in Table 1. The fitted values for the offset in z, and rotations about the x and y axes are close to their nominal values. The offsets in x and y and the rotation about the z axis are set at their constrained values. The rms residual is given in the last column. A histogram of the residual errors is shown in Figure 1. Plots of the residuals are shown in Figure 2.

WARP

A warp is clearly evident in the residual errors for the outer panels. The warp is attributed to the rib structure which becomes increasingly parallel in the outer panels and allow the panel to be easily warped about its diagonal. Since the panel is mounted on the antenna backup structure by four mounting points at the corners of each panel, this warp will be removed when the panel is mounted on the antenna. A hyperbolic warp was added to the parameters fitted. Fitting a hyperbolic warp at 45 degrees to the panel axis reduces the rms residual to less than 6 microns for all four panels. The results are shown in Table 2 and Figure 3. After fitting a warp the largest errors are in the inner panels, possibly because they are stiffer and suffer more from distortion in the machining process.



Table 1. - 3 parameter fit.

Parameters are axis rotations(degrees) and offsets(inches)							
panel	xrot	yrot	zrot	zoff	xoff	yoff	Rms
1	-0.0027	0.0270	0.0000	0.3572	0.0000	12.0250	0.000219
2	-0.1760	0.0004	0.0000	4.5859	0.0000	43.0250	0.000232
3	1.4135	-0.0054	0.0000	11.4718	0.0000	68.0250	0.000434
4	0.0364	-0.0267	0.0000	21.2545	0.0000	93.0250	0.001649

Table 2. - 3 parameter fit + hyperbolic warp.

Parameters are axis rotations(degrees), offsets(inches) and warp.							
panel	xrot	yrot	zoff	warp	angle	yoff	Rms
2	-0.1761	-0.0026	4.5859	0.0014	45.0000	43.0250	0.000208
3	1.4131	-0.0128	11.4720	0.0022	45.0000	68.0250	0.000204
4	0.0364	-0.0520	21.2545	0.0042	45.0000	93.0250	0.000159

FIGURE 1.

Fit to Parabolic Panel (version 30-Oct-90 mchw)
 Data file: data1-1.05mar91 Output file: fit1-1.05mar91

+++ PANEL 1-1. +++
 +++ (X, Z) = (12.025, .3586) SET TO (0, 0). +++
 +++ PANEL ANGLE SET TO 7.7678 AND PROBE-COMPENSATED. +++

Parameters are axis rotations(degrees) and offsets(inches)
 Fitting the first 3 parameters

final answers:	xrot	yrot	zrot	zoff	xoff	yoff
	-0.0027	0.0270	0.0000	0.3572	0.0000	12.0250

Mean -1.895418E-12, Rms 2.199089E-04, over 119 points
 Maximum value 6.661039E-04 at 107
 Minimum value -5.530614E-04 at 84

	Underflow	
1	-5.530614E-04	1 **
2	-4.768636E-04	2 ****
3	-4.006657E-04	5 *****
4	-3.244679E-04	6 *****
5	-2.482701E-04	7 *****
6	-1.720723E-04	20 *****
7	-9.587445E-05	19 *****
8	-1.967662E-05	18 *****
9	5.652121E-05	11 *****
10	1.327190E-04	9 *****
11	2.089169E-04	10 *****
12	2.851147E-04	4 *****
13	3.613126E-04	3 *****
14	4.375104E-04	0 *
15	5.137082E-04	2 ****
16	5.899061E-04	2 ****
	Overflow	0

rms= 0.0002
 Maximum deviation at point 107 is: 0.000666

FIGURE 2.

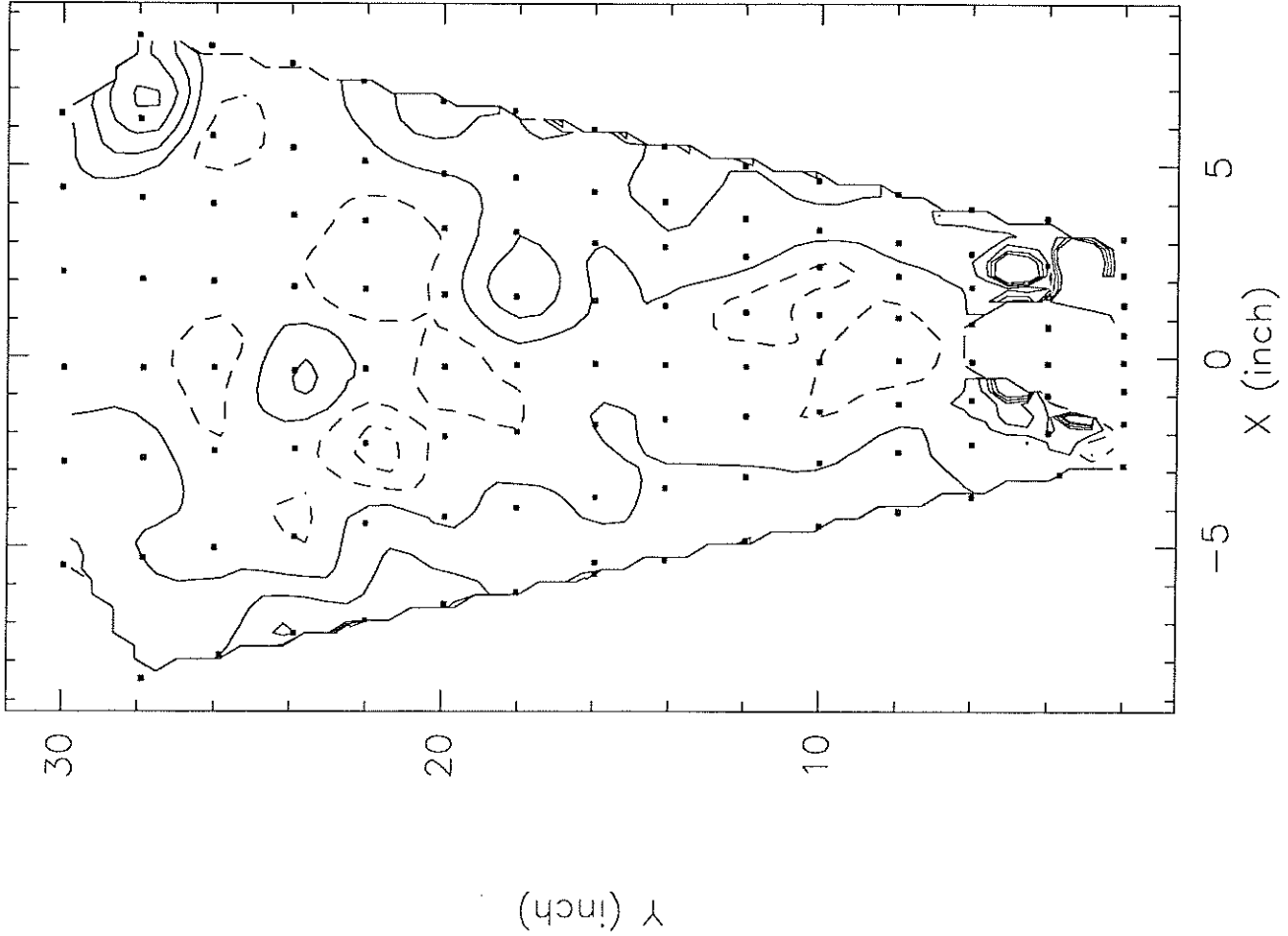
Plots of residual errors after a 3-parameter fit to a-priori parabolic surface.

FIGURE 3.

Plots of residual errors after fitting a hyperbolic warp in addition to a 3-parameter fit to a-priori parabolic surface.



panel1-1.05mar91 3-parameter fit (0.25 mil contour)

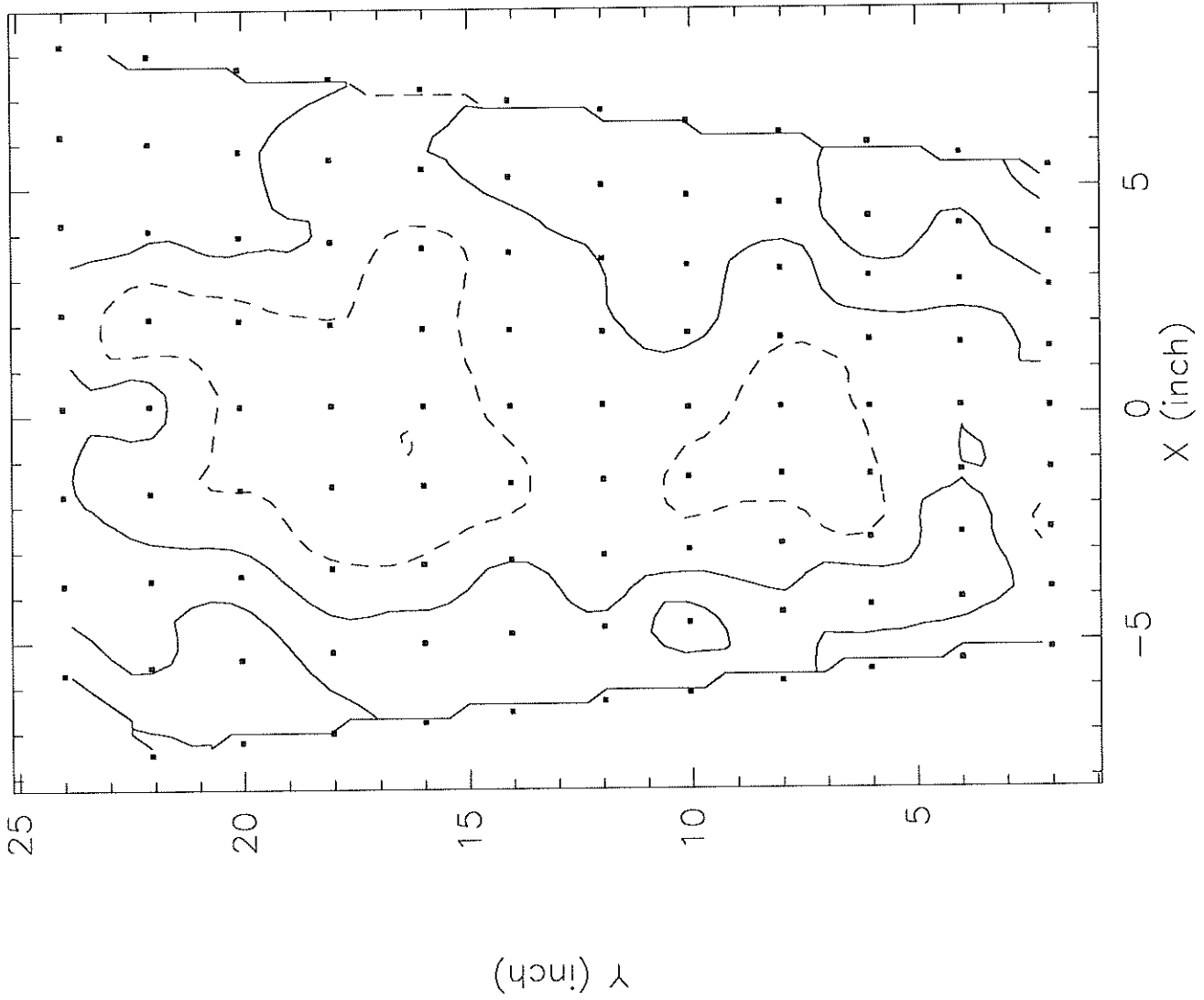


PANEL 1
rms = 0.2 mil
= 5 micron

Figure 2-1



File: panel.04feb91



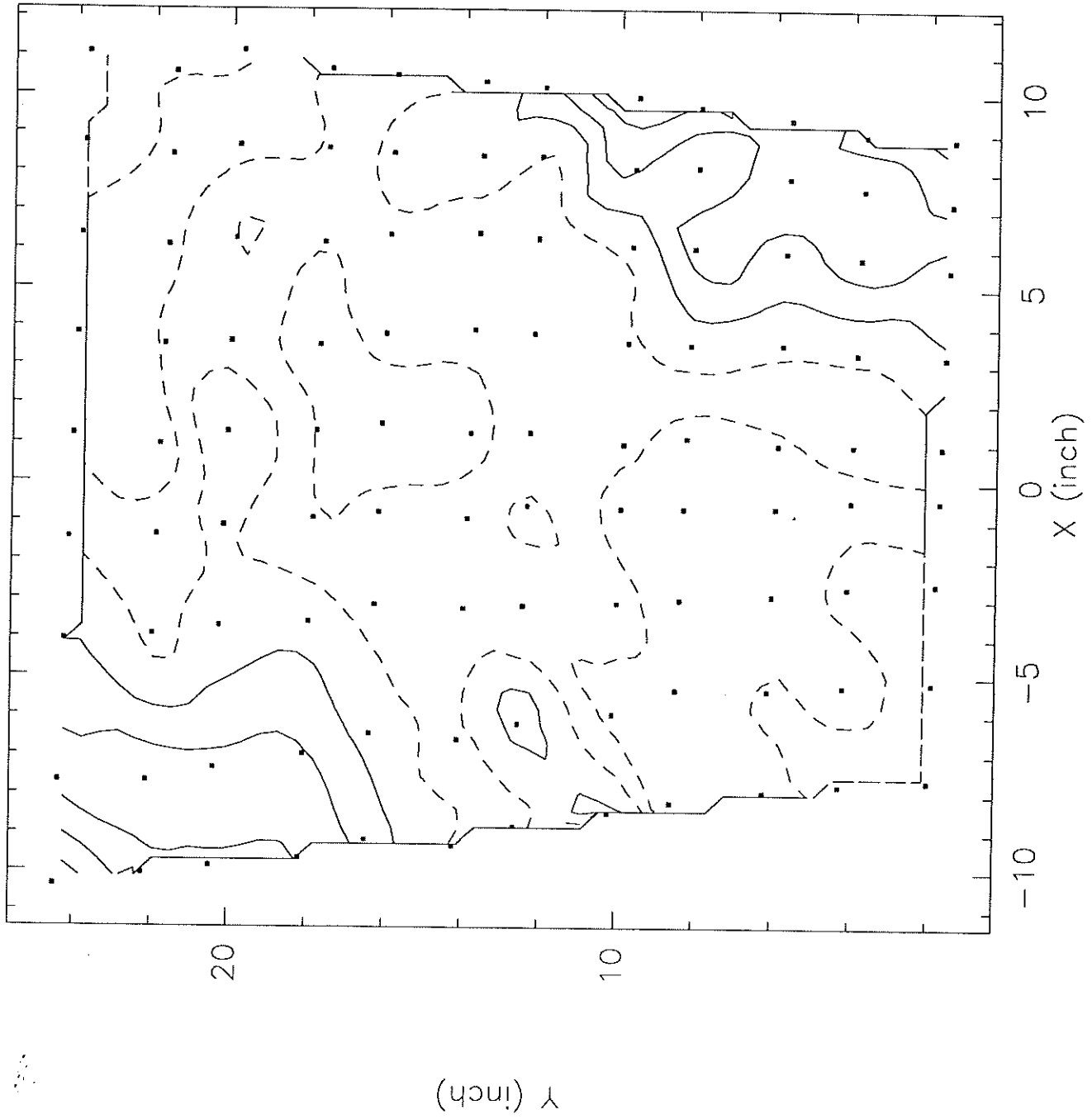
PANEL 2

rms = 0.23 mil

= 6 micron



panel3-1.05mar91 3-p fit (contour interval 0.25 mil)

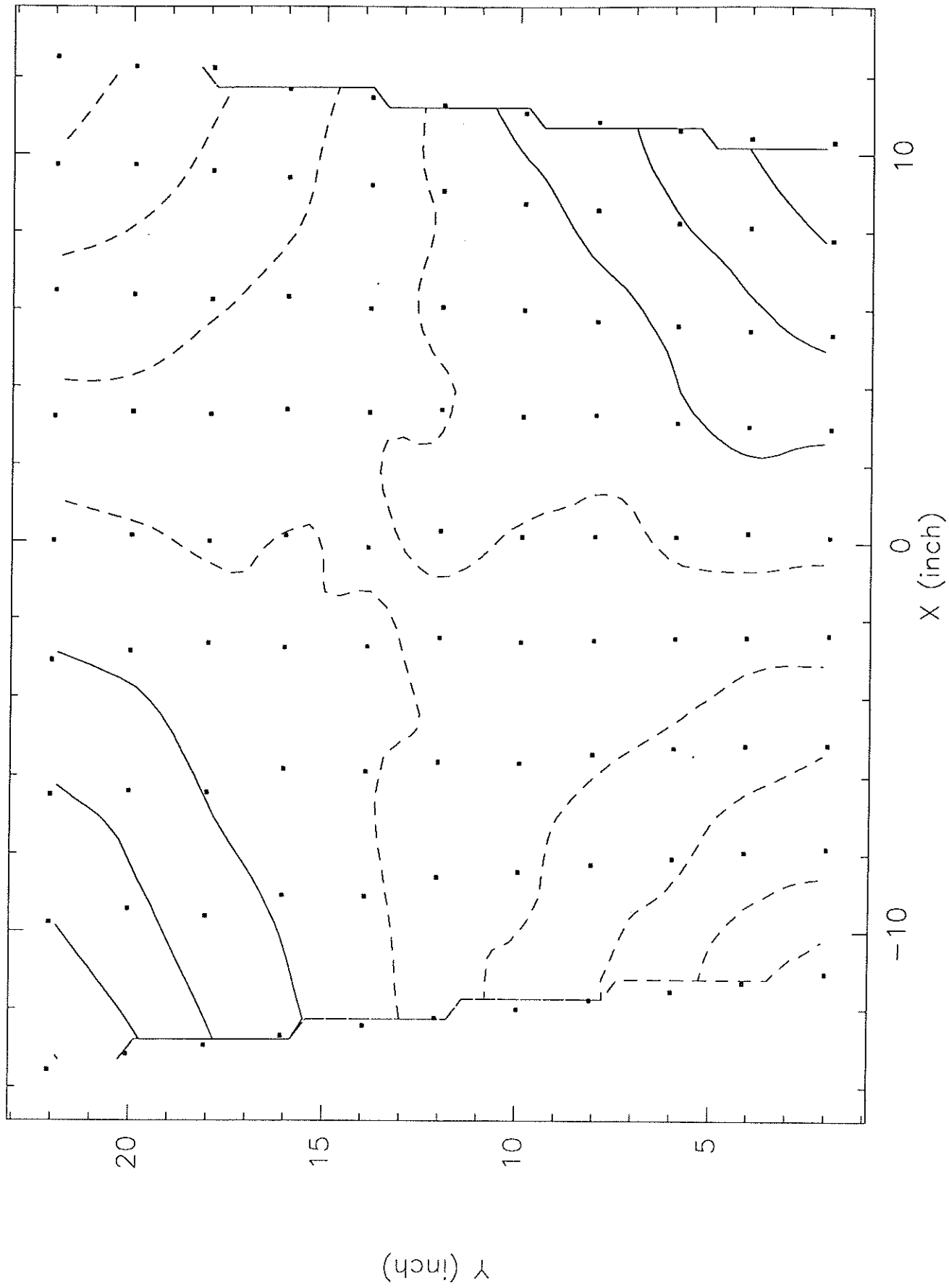


PANEL 3

rms = 0.43 mil
= 11 micron

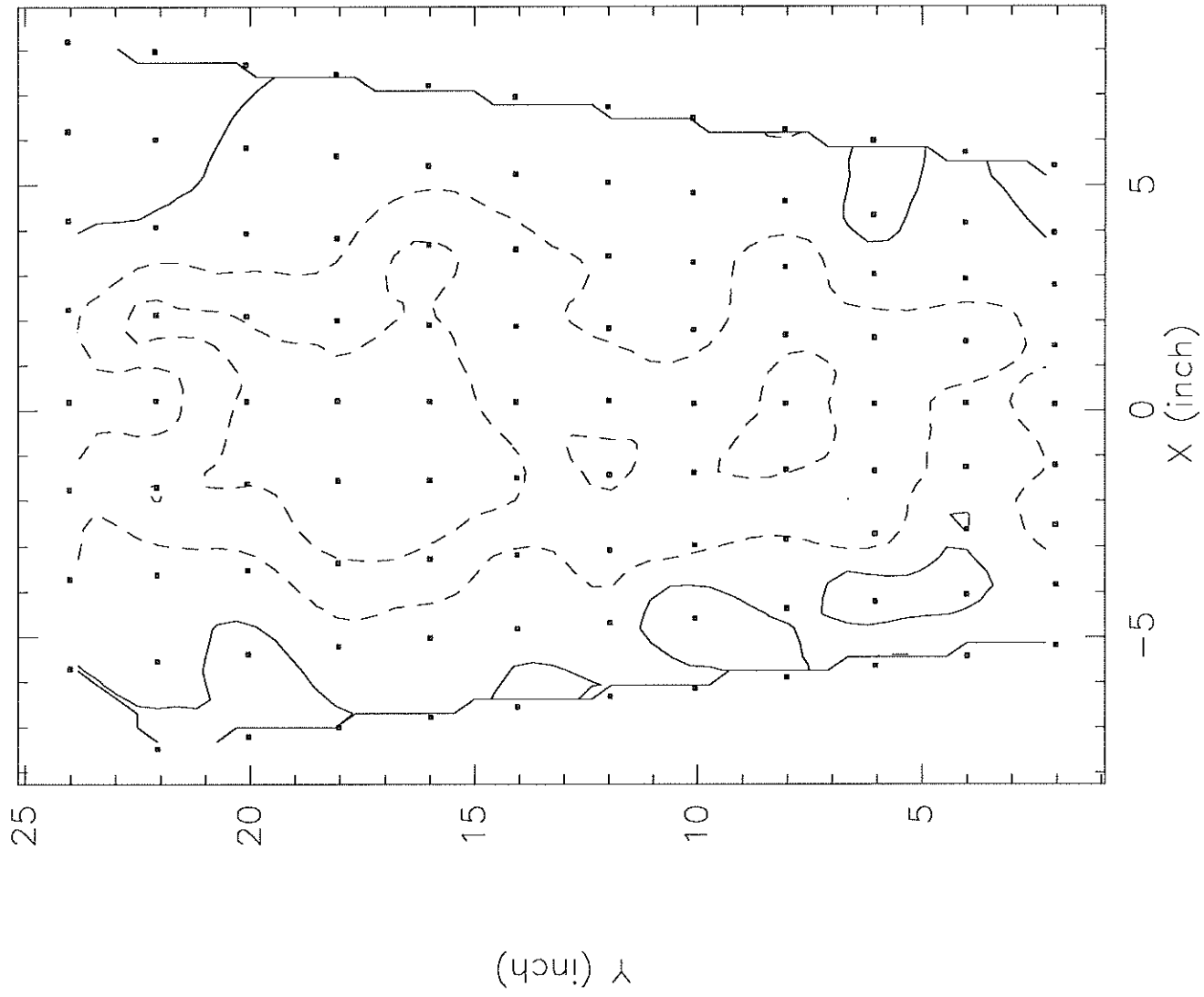


panel4-3.05mar91 3-p fit (1 mil contour interval) rms = 1.6 mil



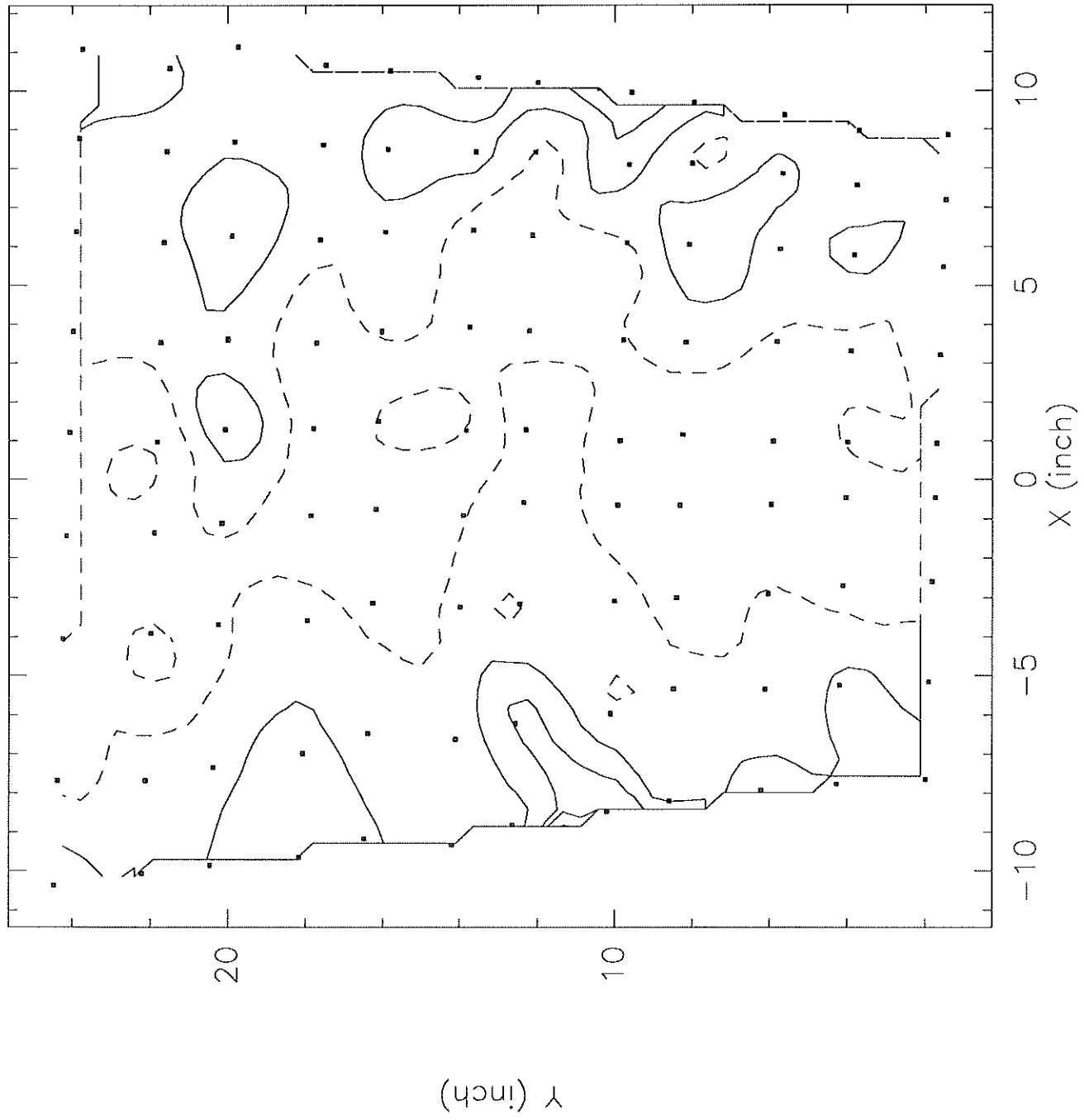


Panel2-1.05mar91 3p fit + WARP (0.25 mil contour interval)





Panel3-1.05mar91 3p fit + WARP (0.25 mil contour interval)



panel4-3.05mar91 3p fit + WARP (0.25 mil contour interval) rms = 0.6 mil
= 4 micron

