12 METER MILLIMETER WAVE TELESCOPE
MEMO No. 245

National Radio Astronomy Observatory
Tucson, Arizona

May 17, 1989

MEMORANDUM

To: 12 Meter Memo Series & Distribution

From: P. R. Jewell

Subject: Mechanical Hysteresis in Feedleg Sag

For some time, observers have complained of an apparent hysteresis in radio pointing between rising and setting sources or when driving the telescope up and down in elevation angle. This effect has been seen in optical pointing results, as well. Measurements done on 1989 May 15 with the laser quadrant detector indicate that this effect may be produced by mechanical hysteresis in feedleg sag, as the telescope is moved up and down in elevation angle.

The laser quadrant detector system consists of a laser mounted at the elevation hub (on top of the elevation axle) and a quadrant detector mounted at the apex. The unit was installed to measure X and Y translation of the apex relative to the vertex. The X and Y positions of the quadrant detector are displayed on a readout chassis in the control room. The results were obtained by moving the telescope in steps of 5° of elevation from 90° down to 15°, then back to 90°. Two data sets were taken on the afternoon and early evening of May 15.

Figures 1 and 2 show the change in Y position for Data Sets 1 and 2, respectively. The hysteresis loop between descending and ascending motion has a maximum separation of about 0.36 units. Measurements made about 6 weeks ago indicated that to bring these units into true millimeters of displacement, one must multiply by about 1.36. The prime focus plate scale is 34 arcsec/mm. Multiplying the loop separation by these two factors gives 16.7". This is certainly within the range of pointing hysteresis that observers and staff have observed.

Figures 3 and 4 show the change in X position for Data Sets 1 and 2, respectively. It remains a puzzle as to why there should be an X displacement at all as the telescope tips in elevation. Misalignment of the measurement axes of the quadrant detector can account for only a very small portion of the observed X displacement. Some hysteresis is also evident in these curves. The data points for both sets are given in the table.

Obviously, we should try to cure this problem. John Payne, Jeff Kingsley and others have suggested that the feedlegs might be slipping in their mooring joints in the backup structure. Currently, the joints are only bolted; a welding tack of the joining plates has been suggested as a fix. In addition, it is also known that the feedleg guy wires currently have unequal tension. If we can torque these into equal tension without distorting the surface figure, we should do so (a summer shutdown project). I would appreciate comments on these matters.

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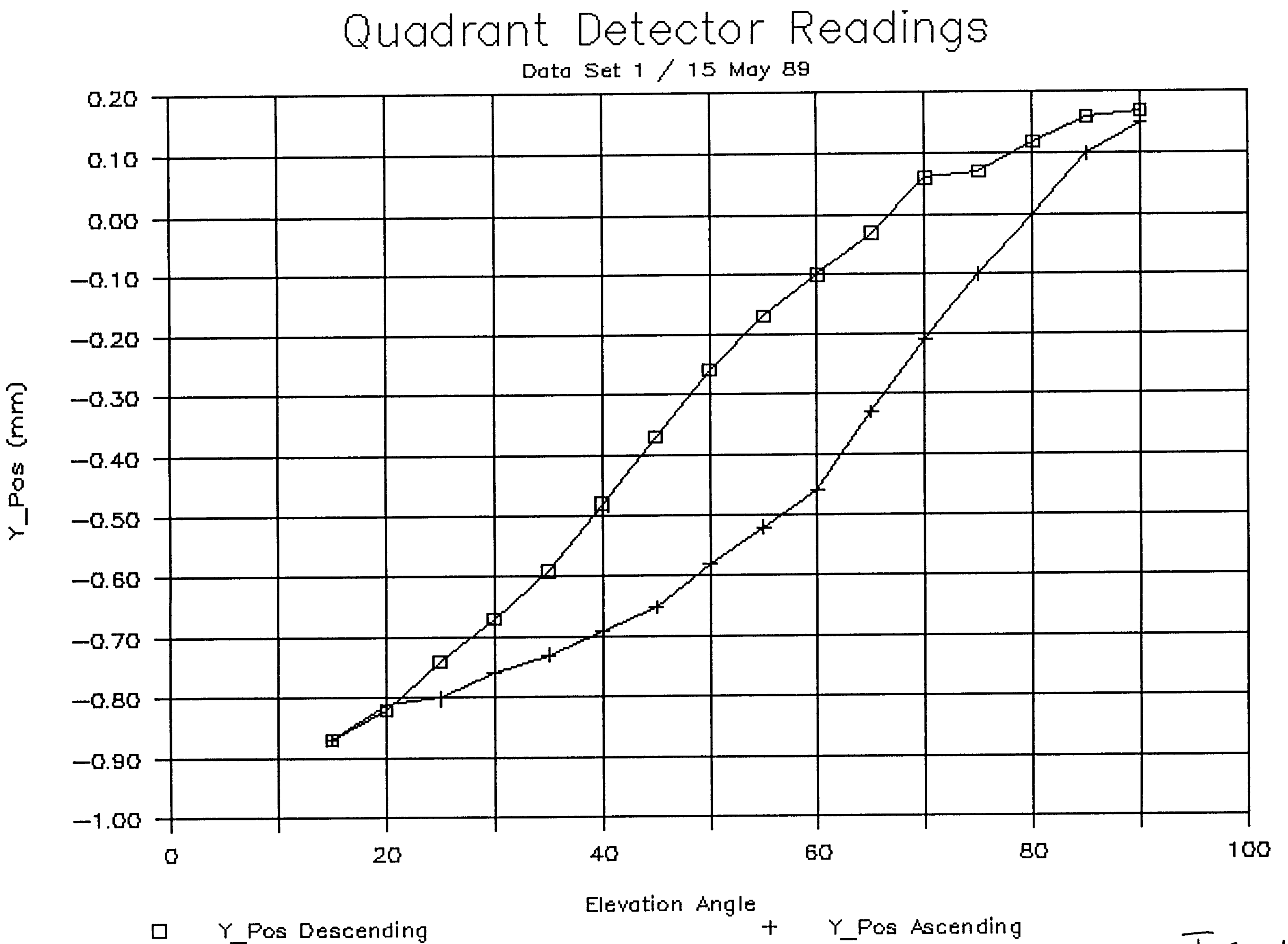

Quadrant Detector Readings
Data Set 1 / 15 May 89
0.20
0.10
0.00
−0.10
−0.20
−0.30
−0.40
−0.50
−0.60
−0.70
−0.80
−0.90
−1.00
Y_Pos (mm)
0
20
40
60
80
100
Elevation Angle
□ Y_Pos Descending
+ Y_Pos Ascending

FIG. 1

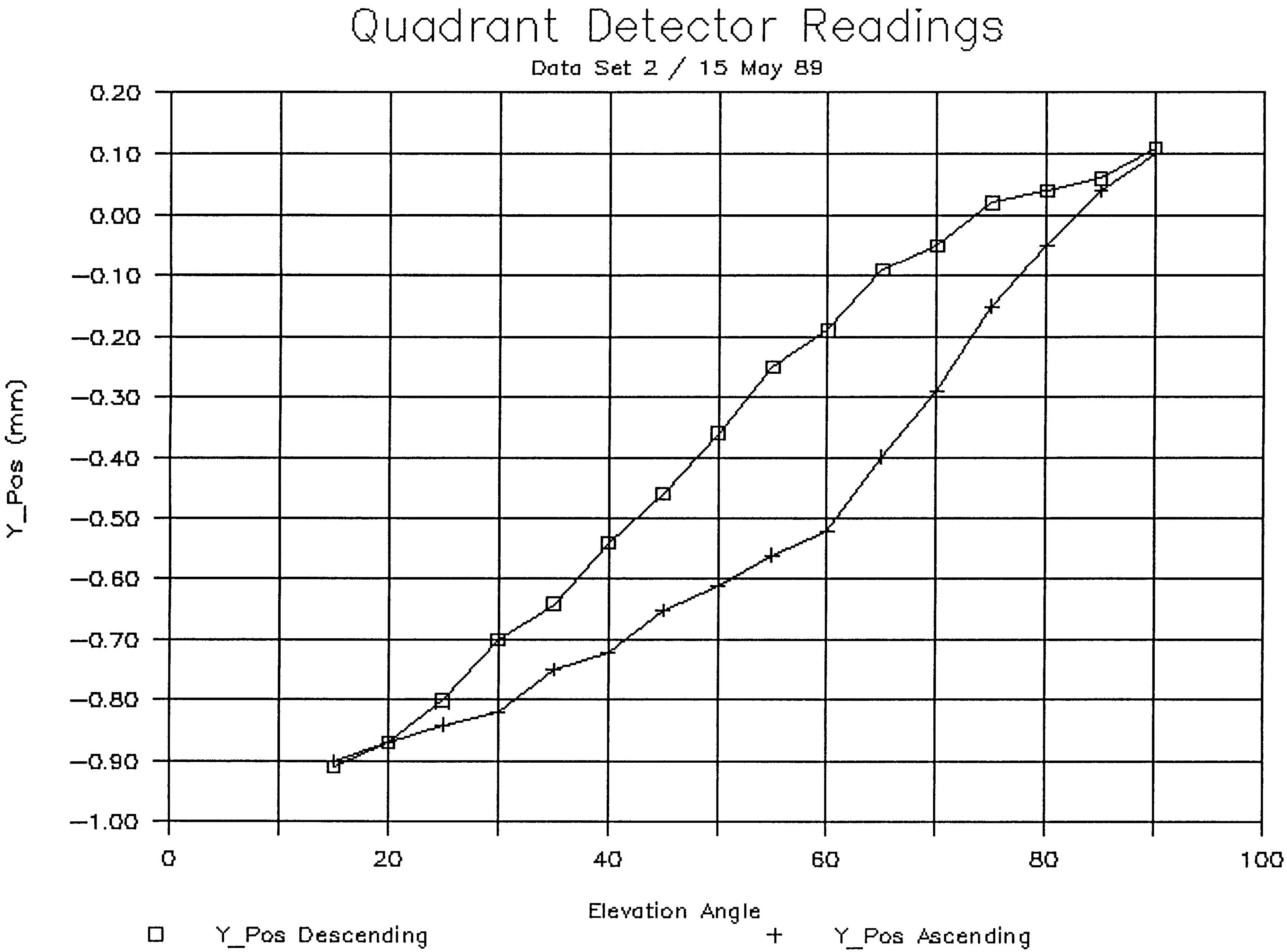

Quadrant Detector Readings
Data Set 2 / 15 May 89
Y_Pos (mm)
0.20
0.10
0.00
−0.10
−0.20
−0.30
−0.40
−0.50
−0.60
−0.70
−0.80
−0.90
−1.00
0
20
40
60
80
100
Elevation Angle
□ Y_Pos Descending
+ Y_Pos Ascending

FIG. 2

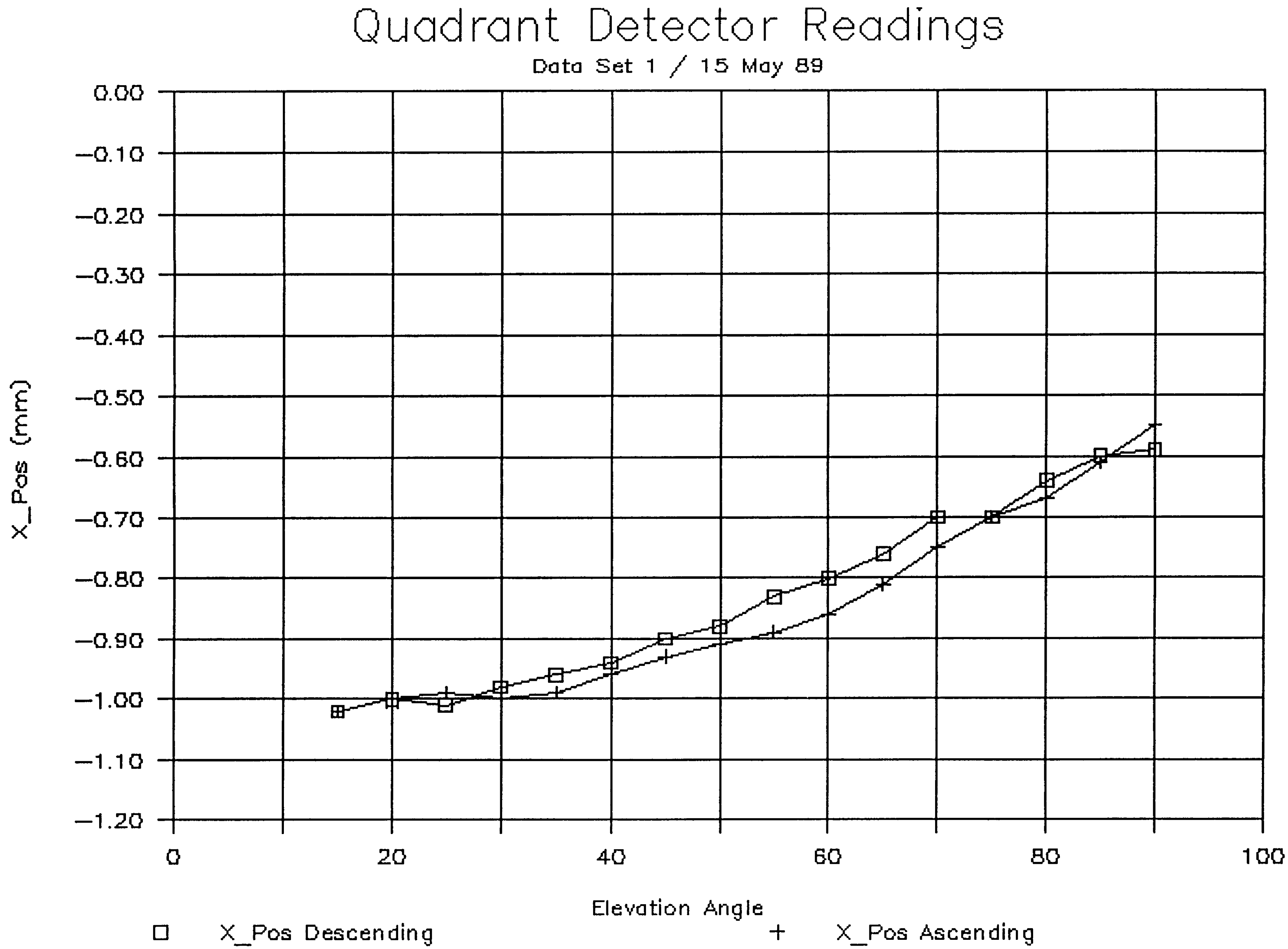
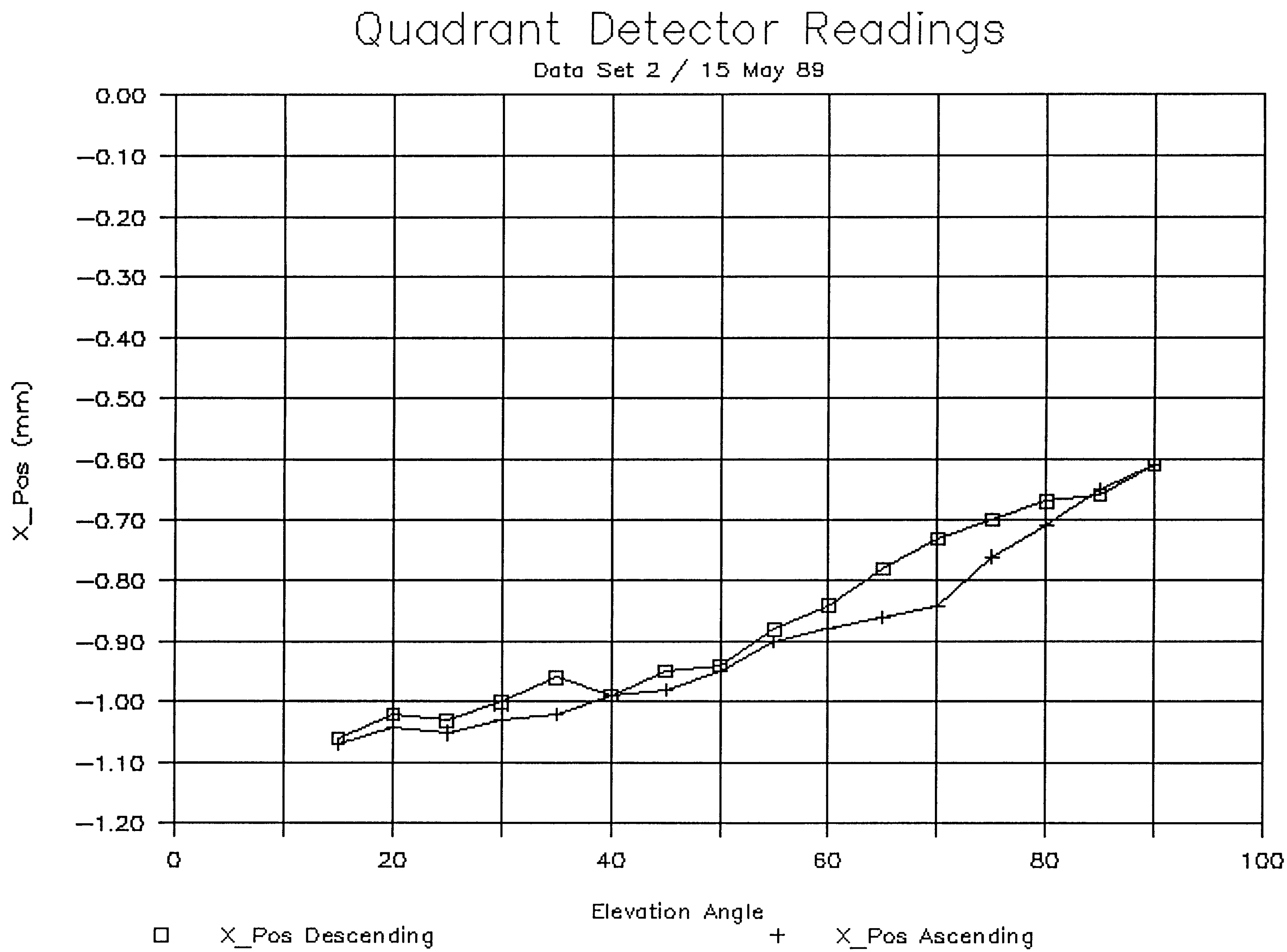

Quadrant Detector Readings
Data Set 1 / 15 May 89
0.00
−0.10
−0.20
−0.30
−0.40
−0.50
−0.60
−0.70
−0.80
−0.90
−1.00
−1.10
−1.20
X_Pos (mm)
0
20
40
60
80
100
Elevation Angle
X_Pos Descending
X_Pos Ascending

FIG. 3



Quadrant Detector Readings
Data Set 2 / 15 May 89
0.00
-0.10
-0.20
-0.30
-0.40
-0.50
-0.60
-0.70
-0.80
-0.90
-1.00
-1.10
-1.20
X_Pos (mm)
0
20
40
60
80
100
Elevation Angle
X_Pos Descending
X_Pos Ascending

FIG. 4

Quadrant Detector Data Set 1 15 May 89

	Descending (90-15)		Ascending (15-90)	
El	X_Pos	Y_Pos	X_Pos	Y_Pos
15.0	-1.02	-0.87	-1.02	-0.87
20.0	-1.00	-0.82	-1.00	-0.81
25.0	-1.01	-0.74	-0.99	-0.80
30.0	-0.98	-0.67	-1.00	-0.76
35.0	-0.96	-0.59	-0.99	-0.73
40.0	-0.94	-0.48	-0.96	-0.69
45.0	-0.90	-0.37	-0.93	-0.65
50.0	-0.88	-0.26	-0.91	-0.58
55.0	-0.83	-0.17	-0.89	-0.52
60.0	-0.80	-0.10	-0.86	-0.46
65.0	-0.76	-0.03	-0.81	-0.33
70.0	-0.70	0.06	-0.75	-0.21
75.0	-0.70	0.07	-0.70	-0.10
80.0	-0.64	0.12	-0.67	0.00
85.0	-0.60	0.16	-0.61	0.10
90.0	-0.59	0.17	-0.55	0.15

Quadrant Detector Data Set 2 15 May 89

	Descending (90-15)		Ascending (15-90)	
El	X_Pos	Y_Pos	X_Pos	Y_Pos
15.0	-1.06	-0.91	-1.07	-0.90
20.0	-1.02	-0.87	-1.04	-0.87
25.0	-1.03	-0.80	-1.05	-0.84
30.0	-1.00	-0.70	-1.03	-0.82
35.0	-0.96	-0.64	-1.02	-0.75
40.0	-0.99	-0.54	-0.99	-0.72
45.0	-0.95	-0.46	-0.98	-0.65
50.0	-0.94	-0.36	-0.95	-0.61
55.0	-0.88	-0.25	-0.90	-0.56
60.0	-0.84	-0.19	-0.88	-0.52
65.0	-0.78	-0.09	-0.86	-0.40
70.0	-0.73	-0.05	-0.84	-0.29
75.0	-0.70	0.02	-0.76	-0.15
80.0	-0.67	0.04	-0.71	-0.05
85.0	-0.66	0.06	-0.65	0.04
90.0	-0.61	0.11	-0.61	0.10