On the Feasibility of South Baldy as a Site for the MMA

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This memo explores in more detail the feasibility of using the South Baldy mountain ridge, located about 40km west of Socorro, NM, as a site for the Millimeter Array. The positions, u-v coverage, and beam sizes of 2 arrays are considered. For the Extended Array a dense homogeneous u-v coverage from -2 to 2 megawavelengths is desired. For the Compact Array the desired u-v coverage is -700 to 700 kilowavelengths. For each of these arrays simulations are performed for declinations of -30, 0, 30, and 60 degrees. A summary of the u-v coverage results is found in figure 1 for the Extended Array and figure 2 for the Compact Array. The unreduced version of each summary can be found in figures 3 through 18. Each plot employs baselines from 40 antennas each with a dish 7.5 meters in diameter.

PROCEDURE

The purpose is to create two possibly practical configurations of antennas having a respectable u-v coverage at plus or minus 700 and 2000 kilowavelengths. There were two jobs involved in this task. One was to look at the topography of South Baldy Ridge and see where it might be feasible to put antennas. The other was to simulate the array's u-v coverage at different declinations.

In choosing a site, consideration was given to it's accessibility and to it's interference with the experiments of Langmuir Laboratory for Atmospheric Research. Sites immediately interfering with the existing experiments being performed on the mountain were avoided as were areas of steep incline and rough, rocky terrain. As a rough guideline: sites along the side of a preexisting road were considered to be the most desirable, those located on a ridge to which an access road may be built were created with caution, and remote sites, probably accessible only by helicopter, were put in as a last resort. To get a feel for the area, consult the topographic map shown in figure 19. Perhaps the most obvious place, and indeed the initial location of a set of antennas, is along the roadway up to Langmuir Laboratory. From this beginning array all other antennas were added as a matter of necessity to fill in the sparse areas in the u-v coverage. The arrays were modified based on some crude, preliminary on-site investigations of the area.

After a site is chosen as a possibility, it's latitude, longitude, and altitude was put into a format which can be read by the UVSIM program in AIPS. Obviously the next step was to enter it into the UVSIM program, choosing the parameters of declination, integration time, hour angle, minimum antenna elevation, and maximum amount of antenna blockage due to shadowing. Different declinations were used, but in each case the integration time was 600 seconds, the hour angle was -2 to +2 hours, the minimum antenna elevation was 10 degrees, and the minimum fraction of antenna blockage allowed was 0.01.

Then UVPLT was used to look at the results of UVSIM. Two scales were made. One was the targeted area for each array: -700 to 700 kilowavelengths for the Compact Array and -2 to 2 megawavelengths for the Extended Array. The other was an unscaled plot of all points. The latter plot demonstrates how many points at each declination

are in the target area. Consideration was given to keeping the as many of the baselines as possible in the targeted area. A more in depth look at each array will be discussed later.

Finally, to look at the sidelobe levels and beamfits, UVMAP and APCLN were used. In the case of the Extended Array, a cellsize of 0.02 arcseconds was used and 0.06 arcseconds for the Compact Array. Lists of the resultant values are given in tables 1 and 2.

EXTENDED ARRAY

The positions used in the Extended Array can be found on the map in figure 19 along with the corresponding latitudes, longitudes, and altitudes found in table 3. A preliminary on site inspection of all of the areas except the northern most arm was performed and some initial modifications were made. There are two areas contributing to the longer baselines which need to be discussed in some depth. The longest baselines, which are necessary for the u-v coverage at -30 degrees as can be seen from figure 1, could be supplied by two antennas. In order to make a minimum impact on the environment, these two antennas may have to be permanently fixed. The antennas, labeled 27 and 28 on the map, are found in the bottom left and right corners. Number 27 is at the end of a large grassy field and could be readily accessed by helicopter. The site for number 28 needs to be investigated furter, but it should be accessible either by helicopter or, possibly, a road built down from Langmuir Laboratory.

The other area, supplying the intermediate baselines, is the northern most arm. The idea here is that an access road may be built around South Baldy and along the ridge to make these antennas available for use in the Compact Array. Another questionable antenna site is number 39, found at 33 58 30 and 107 11 43. This was put there because it helped fill in gaps in the u-v coverage, but it may not be vital to the array. Therefore if it turns out that it is not feasible to access it then modification may be made to exclude it. But for now, it serves a purpose in the array and will be treated as accessible for use in the Compact Array.

The beam fits obtained from UVMAP and APCLN, using a cellsize of 0.02 arcseconds are found in table 2. The maximum values of the inner sidelobes as well as the rms level of the longer wavelengths for each declination can be found in table 1.

COMPACT ARRAY

The positions of the antennas in the Compact Array are displayed in figure 20 with their specific latitudes, longitudes, and altitudes listed in table 4. Figure 2 shows the summary of the u-v coverage at different declinations. Included for completeness are the two fixed antennas from the Extended Array. Aside from these the rest of the antennas are easily accessed from the road. Many of the positions from the Extended Array have been preserved, meaning less time in reconfiguration.

The beamfits for this array, using cellsize of 0.06 arcseconds, can be found in table 2 and the maximum value of the inner sidelobes as well as the rms of the outer sidelobes can be found in table 1.

CONCLUSION

South Baldy, a site noted for its high elevation and close proximity to Socorro, New Mexico, seems to be a feasible site for a Millimeter Array. A moderately respectable u-v coverage can be made by putting antennas along the ridgelines. Eighty percent of these antennas are fairly easily accessed by the preexisting roadway. Fifteen percent may be accessible after building a road, and only five percent (2) will be permanently remote.

TABLE 1

MAXIMUM INNER SIDELOBE LEVEL AND RMS OF OUTER SIDELOBES FOR EXTENDED ARRAY WITH NATURAL AND UNIFORM WEIGHTING.

DECLINATION	MAXIMUM SIDELOBE LEVEL (percent)	RMS OF OUTER SIDELOBES (percent)
NATURAL WEIGHTING		
−30	9.0	0.59
0	20.0	0.55
+30	16.0	0.68
+60	11.0	0.66
UNIFORM WEIGHTING		
−30	6.0	0.60
0	15.0	0.57
+30	4.0	0.65
+60	4.0	0.63

MAXIMUM INNER SIDELOBE LEVELS AND RMS OF OUTER SIDELOBES FOR COMPACT ARRAY WITH NATURAL AND UNIFORM WEIGHTING

NATURAL WEIGHTING		
−30	4.0	0.60
0	5.0	0.61
+30	4.0	0.62
+60	4.0	0.62
UNIFORM WEIGHTING		
−30	4.0	0.59
0	5.0	0.63
+30	3.0	0.62
+60	3.0	0.63

TABLE 2

BEAMFITS FOR EXTENDNED ARRAY

DECLINATION	FULL WIDTH HALF MAXIMUM (arcseconds)		ROTATION ANGLE
NATURAL WEIGHTING			
−30	0.106	0.077	−13.1
0	0.084	0.069	−61.5
+30	0.082	0.053	−75.3
+60	0.081	0.055	−75.2
UNIFORM WEIGHTING			
−30	0.088	0.069	−18.9
0	0.077	0.056	−71.7
+30	0.077	0.050	−76.0
+60	0.076	0.052	−76.0

BEAMFITS FOR THE COMPACT ARRAY

NATURAL WEIGHTING			
−30	0.264	0.187	3.8
0	0.197	0.148	84.5
+30	0.197	0.125	84.6
+60	0.196	0.138	82.9
UNIFORM WEIGHTING			
−30	0.246	0.178	4.1
0	0.196	0.130	84.9
+30	0.190	0.119	84.0
+60	0.191	0.132	83.0

TABLE 3

LATITUDES, LONGITUDES, AND ALTITUDES FOR EXTENDED BALDY ARRAY

	LATITUDE	LONGITUDE	ALTITUDE(m)
1)	33.0 59.0 22.46	107.0 11.0 4.22	3170
2)	33.0 59.0 30.52	107.0 10.0 58.99	3158
3)	33.0 59.0 30.78	107.0 10.0 51.12	3139
4)	33.0 59.0 31.2	107.0 10.0 36.51	3023
5)	33.0 59.0 32.09	107.0 10.0 31.24	3060
6)	33.0 59.0 27.72	107.0 10.0 22.48	3030
7)	33.0 59.0 21.04	107.0 10.0 14.53	3036
8)	33.0 59.0 18.87	107.0 11.0 18.06	3237
9)	33.0 59.0 15.37	107.0 11.0 18.06	3225
10)	33.0 59.0 11.04	107.0 11.0 19.30	3219
11)	33.0 59.0 5.48	107.0 11.0 19.61	3237
12)	33.0 59.0 0.00	107.0 11.0 17.19	3225
13)	33.0 58.0 55.27	107.0 11.0 14.96	3219
14)	33.0 58.0 49.29	107.0 11.0 11.74	3197
15)	33.0 58.0 46.78	107.0 11.0 10.50	3194
16)	33.0 58.0 44.85	107.0 11.0 8.99	3190
17)	33.0 58.0 40.00	107.0 11.0 5.89	3190
18)	33.0 58.0 37.30	107.0 11.0 3.1	3194
19)	33.0 58.0 34.17	107.0 10.0 59.30	3206
20)	33.0 58.0 31.98	107.0 10.0 54.34	3218
21)	33.0 58.0 46.26	107.0 11.0 14.53	3200
22)	33.0 58.0 45.48	107.0 11.0 17.44	3194
23)	33.0 58.0 44.43	107.0 11.0 21.86	3182
24)	33.0 58.0 43.29	107.0 11.0 26.2	3164
25)	33.0 58.0 42.4	107.0 11.0 31.86	3164
26)	33.0 58.0 42.09	107.0 11.0 36.82	3173
27)	33.0 57.0 19.74	107.0 9.0 29.06	2987
28)	33.0 57.0 13.03	107.0 11.0 48.75	2844
29)	34.0 0.0 3.81	107.0 11.0 36.57	3115
30)	33.0 59.0 21.09	107.0 10.0 47.76	3083
31)	33.0 59.0 19.74	107.0 10.0 45.0	3036
32)	33.0 59.0 23.68	107.0 10.0 39.38	3011
33)	33.0 59.0 25.26	107.0 10.0 41.25	3189
34)	33.0 59.0 40.26	107.0 11.0 26.25	3146
35)	34.0 00.0 34.74	107.0 11.0 3.75	2999
36)	34.0 00.0 17.5	107.0 11.0 23.52	3109
37)	33.0 58.0 33.16	107.0 11.0 30.0	3109
38)	33.0 59.0 26.84	107.0 9.0 54.5	2902
39)	33.0 58.0 25.26	107.0 11.0 43.12	3024
40)	33.0 59.0 47.36	107.0 11.0 51.6	3084

TABLE 4

LATITUDES, LONGITUDES, ALTITUDES FOR THE COMPACT BALDY ARRAY

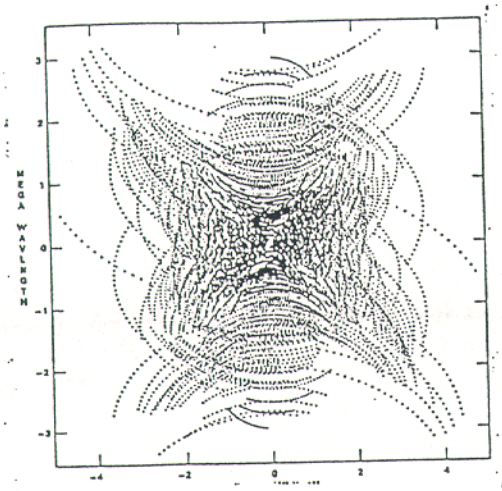
	LATITUDE	LONGITUDE	ALTITUDE(m)
1)	33.0 59.0 00.0	107.0 11.0 17.19	3225
2)	33.0 58.0 55.72	107.0 11.0 14.96	3219
3)	33.0 58.0 51.57	107.0 11.0 13.19	3200
4)	33.0 58.0 49.29	107.0 11.0 11.74	3197
5)	33.0 58.0 46.78	107.0 11.0 10.50	3194
6)	33.0 58.0 47.04	107.0 11.0 12.23	3200
7)	33.0 58.0 46.26	107.0 11.0 14.53	3200
8)	33.0 58.0 45.48	107.0 11.0 17.44	3194
9)	33.0 58.0 44.43	107.0 11.0 21.86	3182
10)	33.0 58.0 43.29	107.0 11.0 26.20	3164
11)	33.0 58.0 42.40	107.0 11.0 31.86	3164
12)	33.0 58.0 42.09	107.0 11.0 36.82	3173
13)	33.0 58.0 42.35	107.0 11.0 7.44	3188
14)	33.0 58.0 37.30	107.0 11.0 3.10	3194
15)	33.0 38.0 34.17	107.0 10.0 59.30	3206
16)	33.0 59.0 18.87	107.0 11.0 18.06	3237
17)	33.0 58.0 3.5	107.0 11.0 22.94	3206
18)	33.0 59.0 14.3	107.0 11.0 22.94	3213
19)	33.0 59.0 17.89	107.0 11.0 25.88	3194
20)	33.0 59.0 20.0	107.0 11.0 5.88	3146
21)	33.0 58.0 37.5	107.0 11.0 12.64	3170
22)	33.0 59.0 18.5	107.0 11.0 8.82	3158
23)	33.0 59.0 40.5	107.0 10.0 56.47	3170
24)	33.0 58.0 56.5	107.0 11.0 17.06	3225
25)	33.0 58.0 43.0	107.0 11.0 00.00	3182
26)	33.0 58.0 33.16	107.0 11.0 30.0	3109
27)	33.0 58.0 36.0	107.0 11.0 30.0	3109
28)	33.0 58.0 43.5	107.0 11.0 2.94	3176
30)	33.0 58.0 40.00	107.0 11.0 5.86	3190
31)	33.0 59.0 31.98	107.0 10.0 54.34	3218
32)	33.0 58.0 37.5	107.0 10.0 51.47	3219
33)	33.0 58.0 55.0	107.0 11.0 7.65	3185
34)	33.0 57.0 19.74	107.0 9.0 29.06	2987
35)	33.0 57.0 13.03	107.0 11.0 48.75	2843
36)	33.0 58.0 41.58	107.0 11.0 22.35	3170
37)	33.0 58.0 44.0	107.0 11.0 30.5	3161
38)	33.0 58.0 42.6	107.0 11.0 22.35	3170
39)	33.0 58.0 41.0	107.0 11.0 13.53	3182
40)	33.0 58.0 48.5	107.0 11.0 12.5	3207

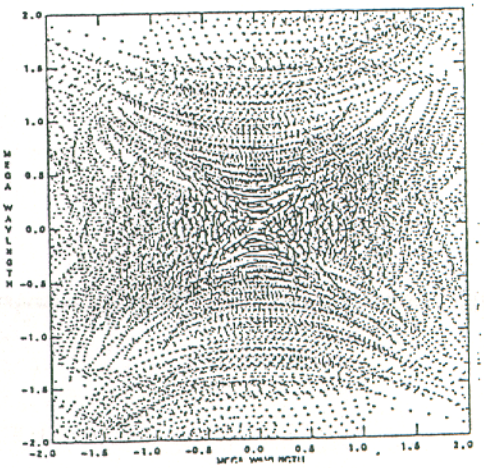
FIGURE 1

UNSCALED U-V COVERAGE

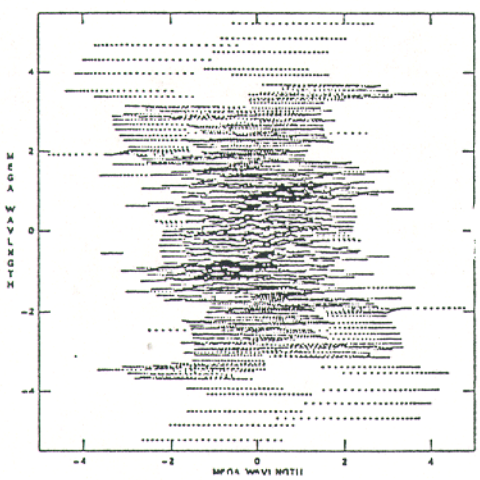
SCALED U-V COVERAGE

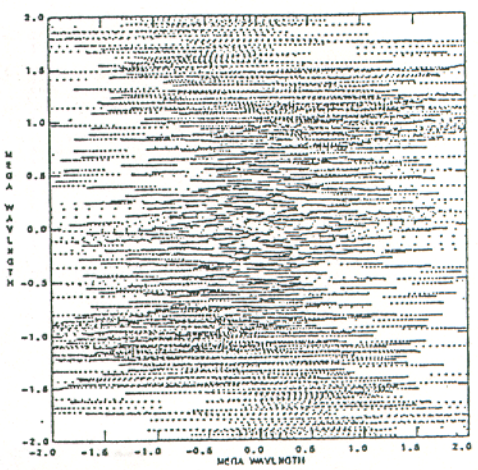
EXTENDED BALDY MMA
40 antennas
DECLINATION: -30.0
-2 to 2 hours
600 sec. integration



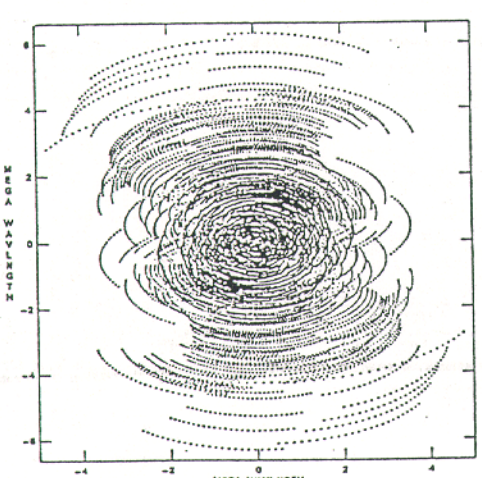


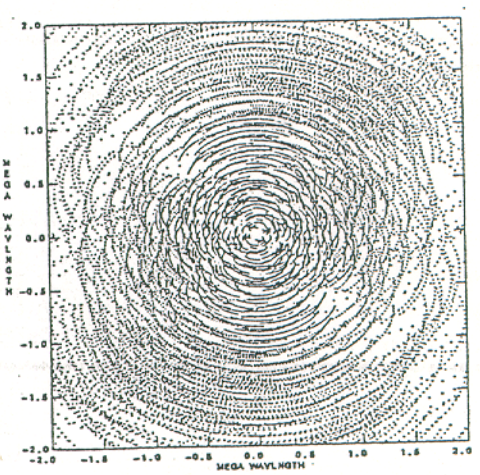
EXTENDED BALDY MMA
40 antennas
DECLINATON: 0.0
-2 to 2 hours
600 sec. integration



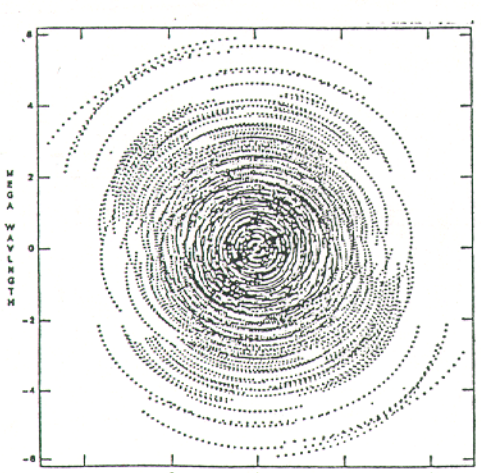


EXTENDED BALDY MMA
40 antennas
DECLINATION: +30.0
-2 to 2 hours
600 sec. integration





EXTENDED BALDY MMA
40 antennas
DECLINATION: +60.0
-2 to 2 hours
600 sec. integration



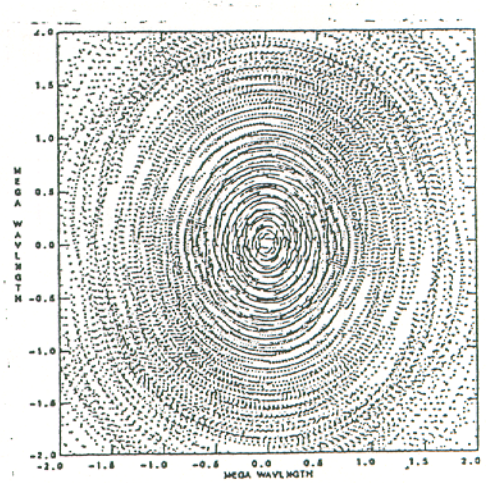
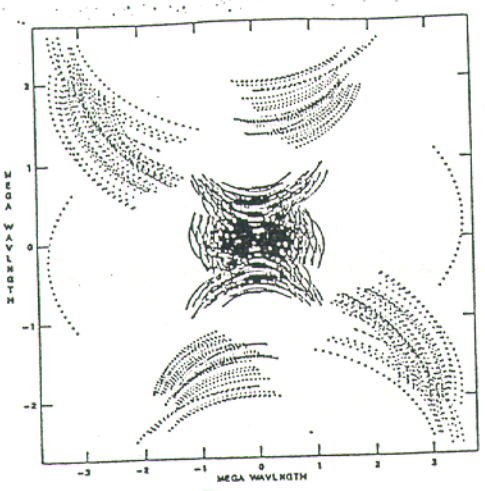


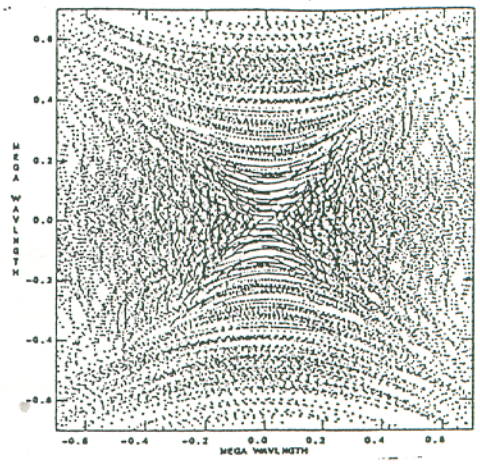
FIGURE 2

UNSCALED U–V COVERAGE

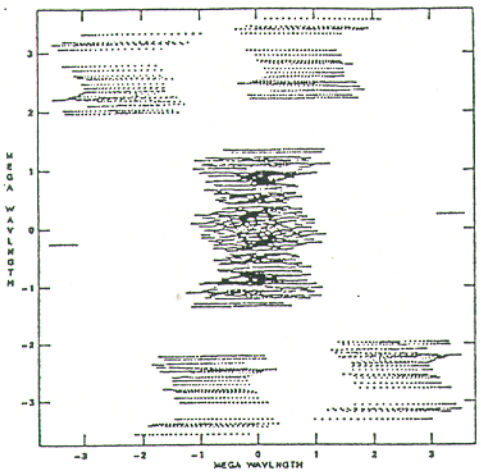
SCALED U–V COVERAGE

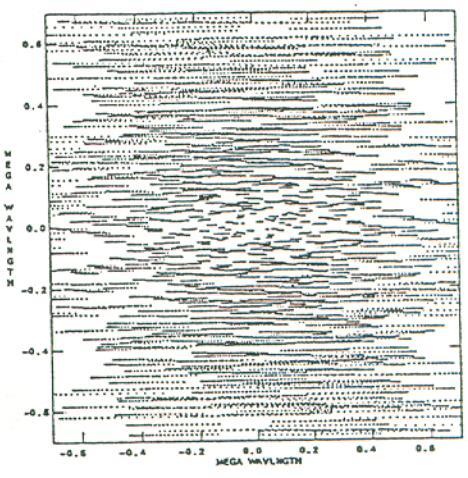
COMPACT BALDY MMA
40 antennas
DECLINATION: −30.0
−2 to 2 hours
600 sec. integration



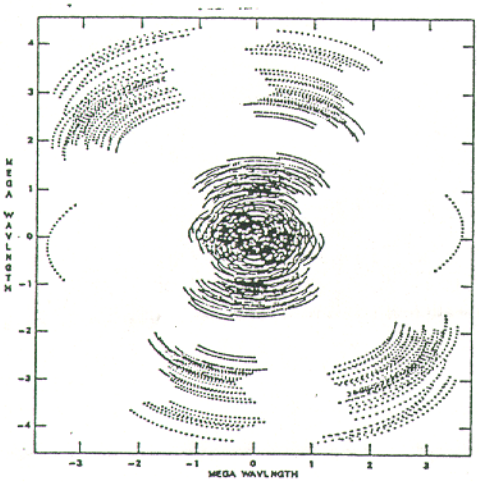


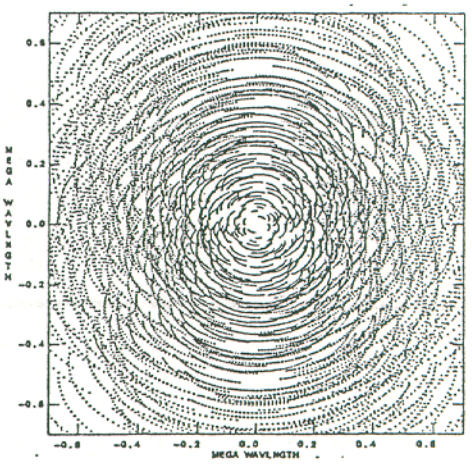
COMPACT BALDY MMA
40 antennas
DECLINATION: 0.0
−2 to 2 hours
600 sec. integration



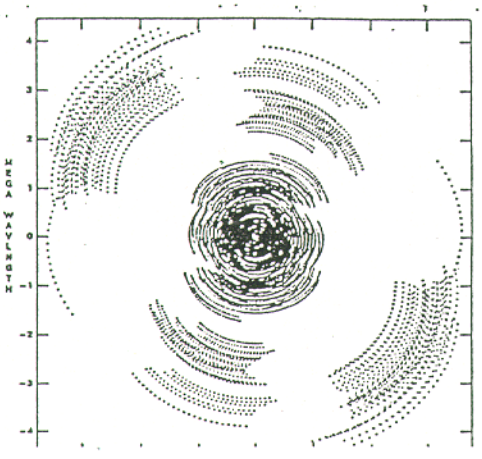


COMPACT BALDY MMA
40 antennas
DECLINATION: +30.0
−2 to 2 hours
600 sec. integration





COMPACT BALDY MMA
40 antennas
DECLINATION: +60.0
−2 to 2 hours
600 sec. integration



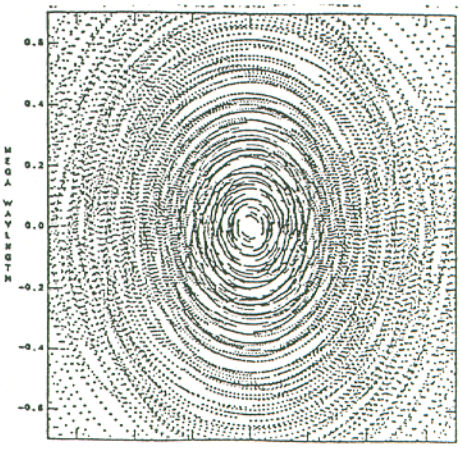


FIGURE 3

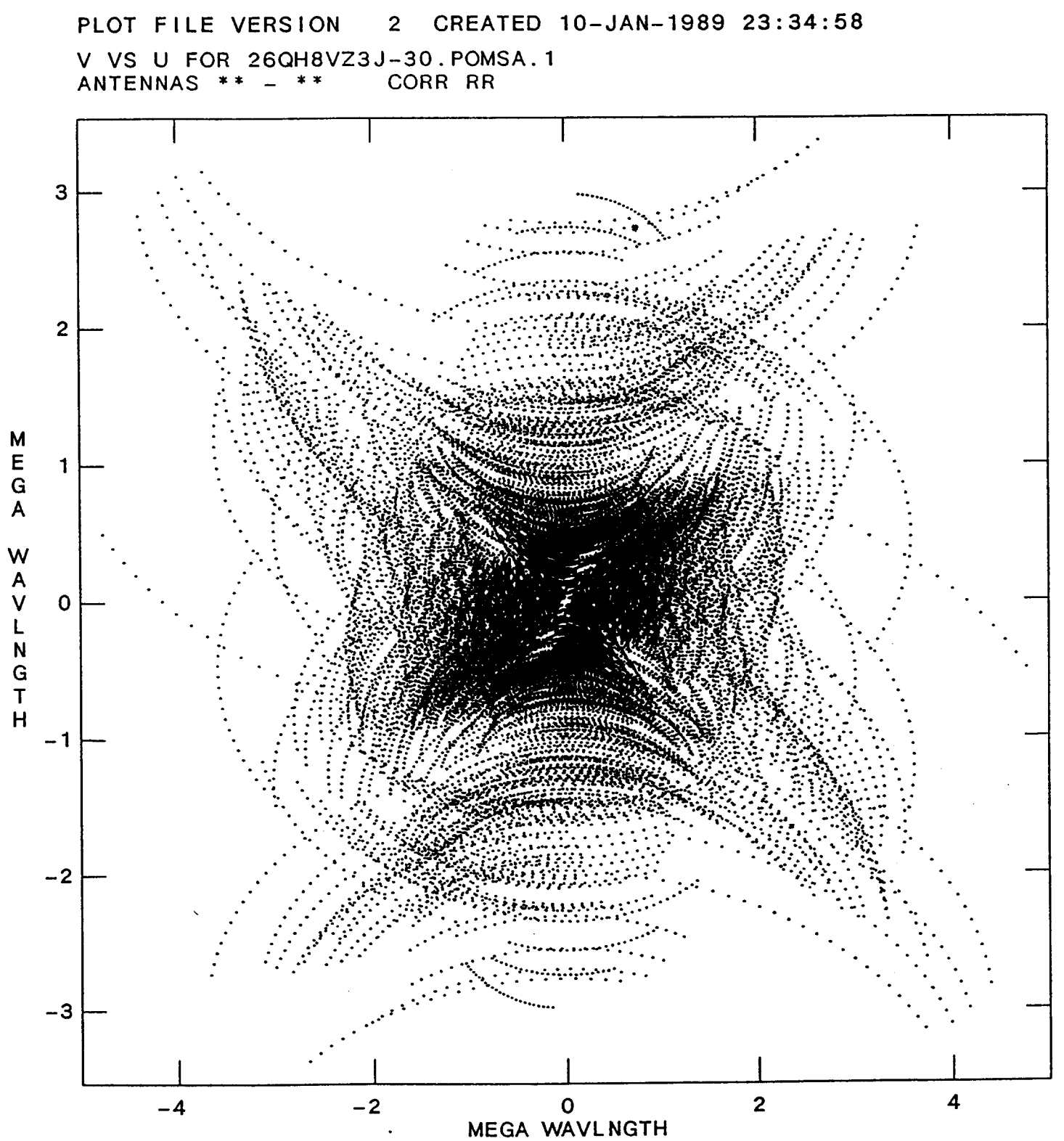

PLOT FILE VERSION 2 CREATED 10-JAN-1989 23:34:58
V VS U FOR 26QH8VZ3J-30.POMSA.1
ANTENNAS ** - ** CORR RR
MEGA WAVLNGTH
3
2
1
0
-1
-2
-3
-4
-2
0
2
4
MEGA WAVLNGTH

FIGURE 4

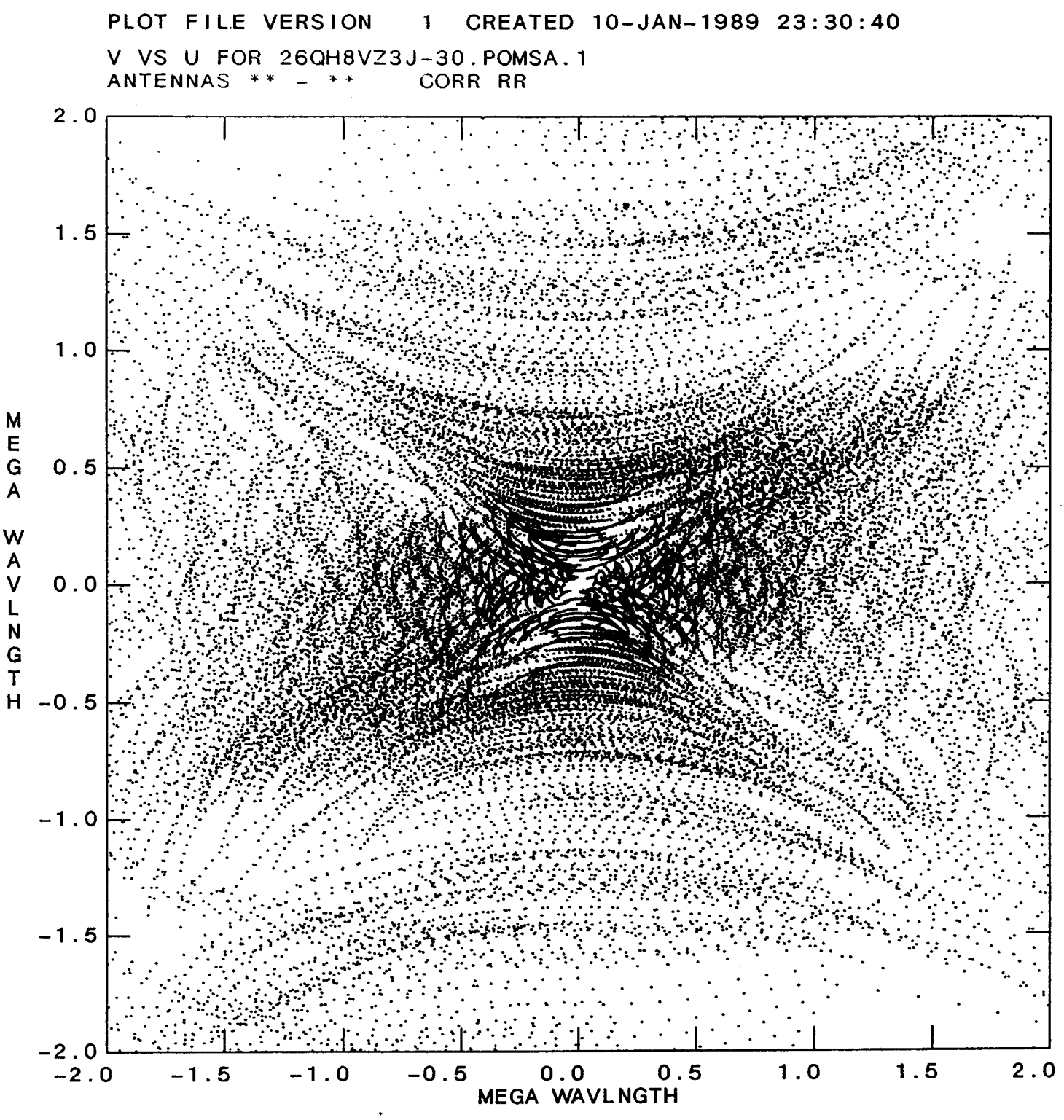

PLOT FILE VERSION 1 CREATED 10-JAN-1989 23:30:40
V VS U FOR 26QH8VZ3J-30.POMSA.1
ANTENNAS ** - ** CORR RR
2.0
1.5
1.0
0.5
0.0
-0.5
-1.0
-1.5
-2.0
MEGA WAVLNGTH
-2.0 -1.5 -1.0 -0.5 0.0 0.5 1.0 1.5 2.0
MEGA WAVLNGTH

FIGURE 5

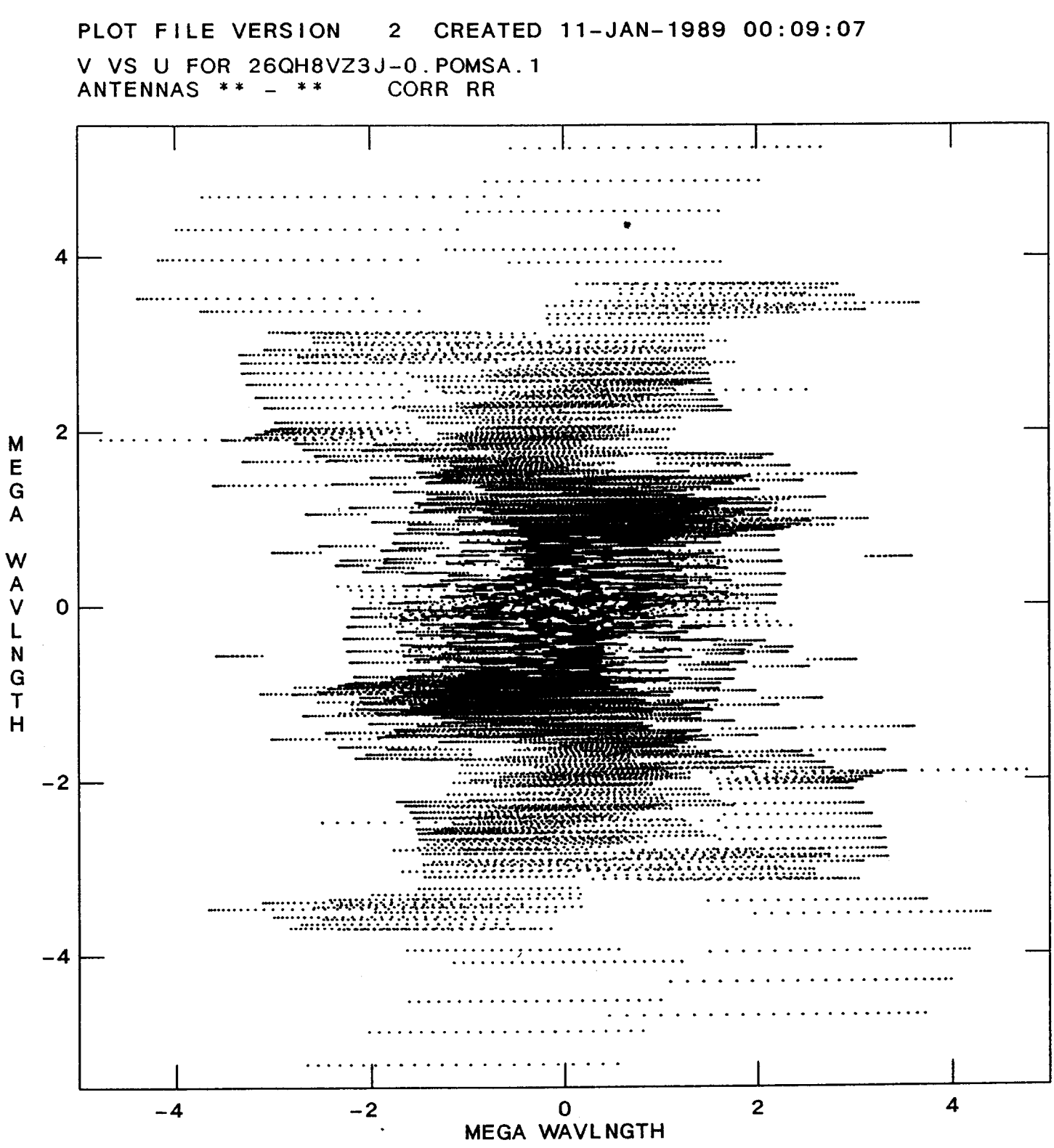

PLOT FILE VERSION 2 CREATED 11-JAN-1989 00:09:07
V VS U FOR 26QH8VZ3J-0.POMSA.1
ANTENNAS ** - ** CORR RR
MEGA WAVLNGTH
4
2
0
-2
-4
-4
-2
0
2
4
MEGA WAVLNGTH

FIGURE 6

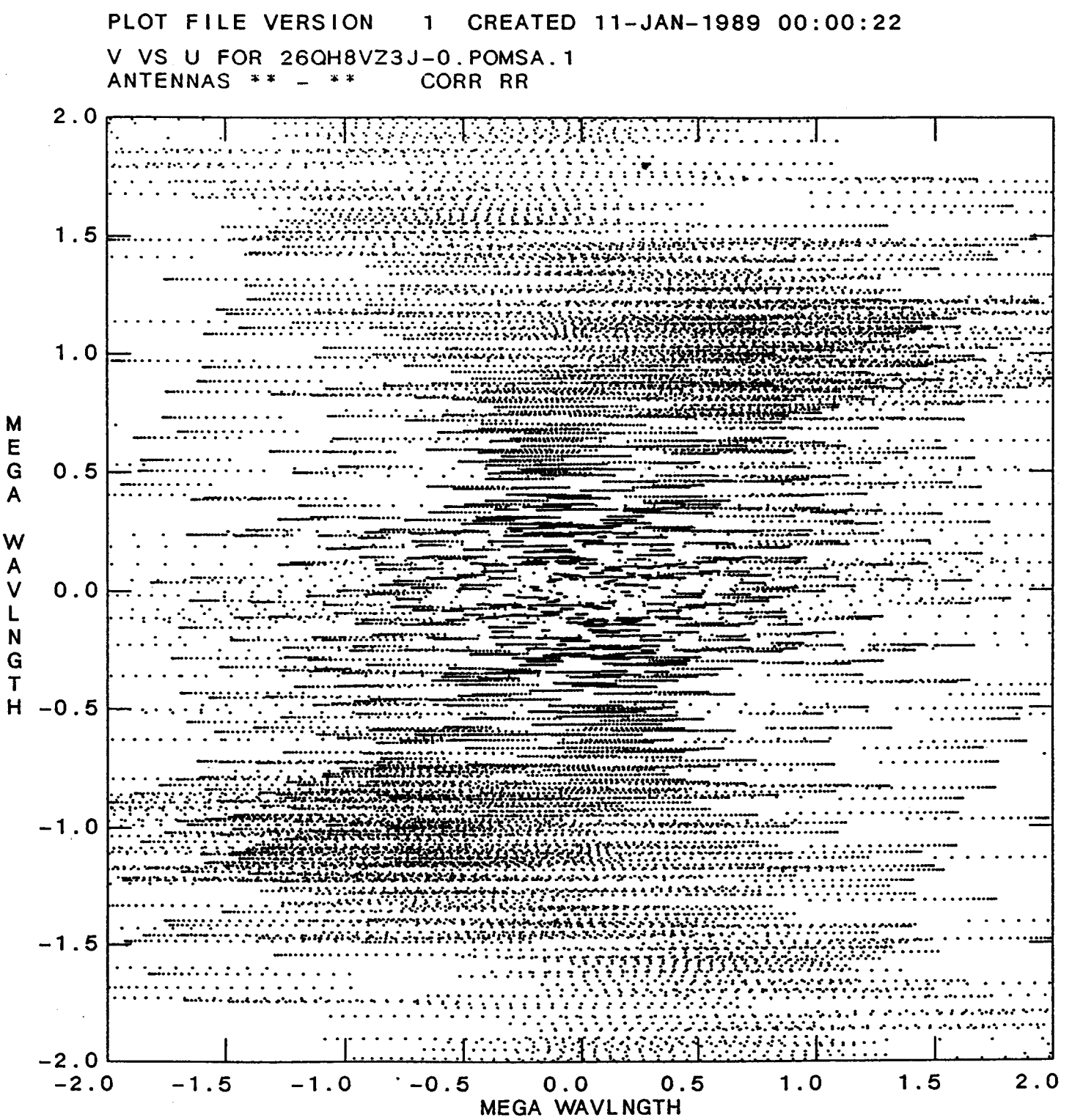

PLOT FILE VERSION 1 CREATED 11-JAN-1989 00:00:22
V VS U FOR 26QH8VZ3J-0.POMSA.1
ANTENNAS ** - ** CORR RR
2.0
1.5
1.0
0.5
0.0
-0.5
-1.0
-1.5
-2.0
MEGA WAVLNGTH
-2.0
-1.5
-1.0
-0.5
0.0
0.5
1.0
1.5
2.0
MEGA WAVLNGTH

FIGURE 7

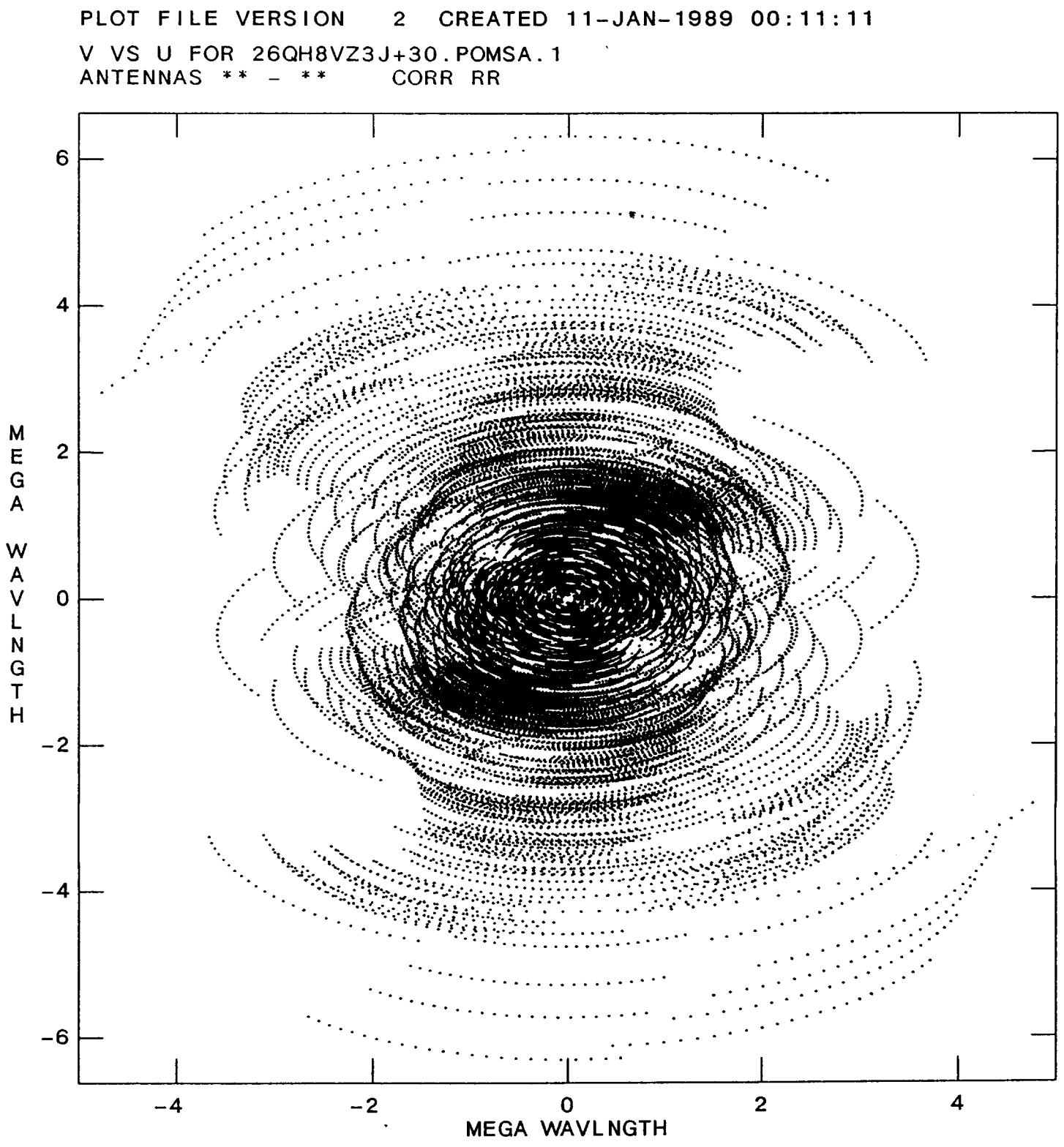

PLOT FILE VERSION 2 CREATED 11-JAN-1989 00:11:11
V VS U FOR 26QH8VZ3J+30.POMSA.1
ANTENNAS ** - ** CORR RR
6
4
2
0
-2
-4
-6
MEGA WAVLNGTH
-4
-2
0
2
4
MEGA WAVLNGTH

FIGURE 8

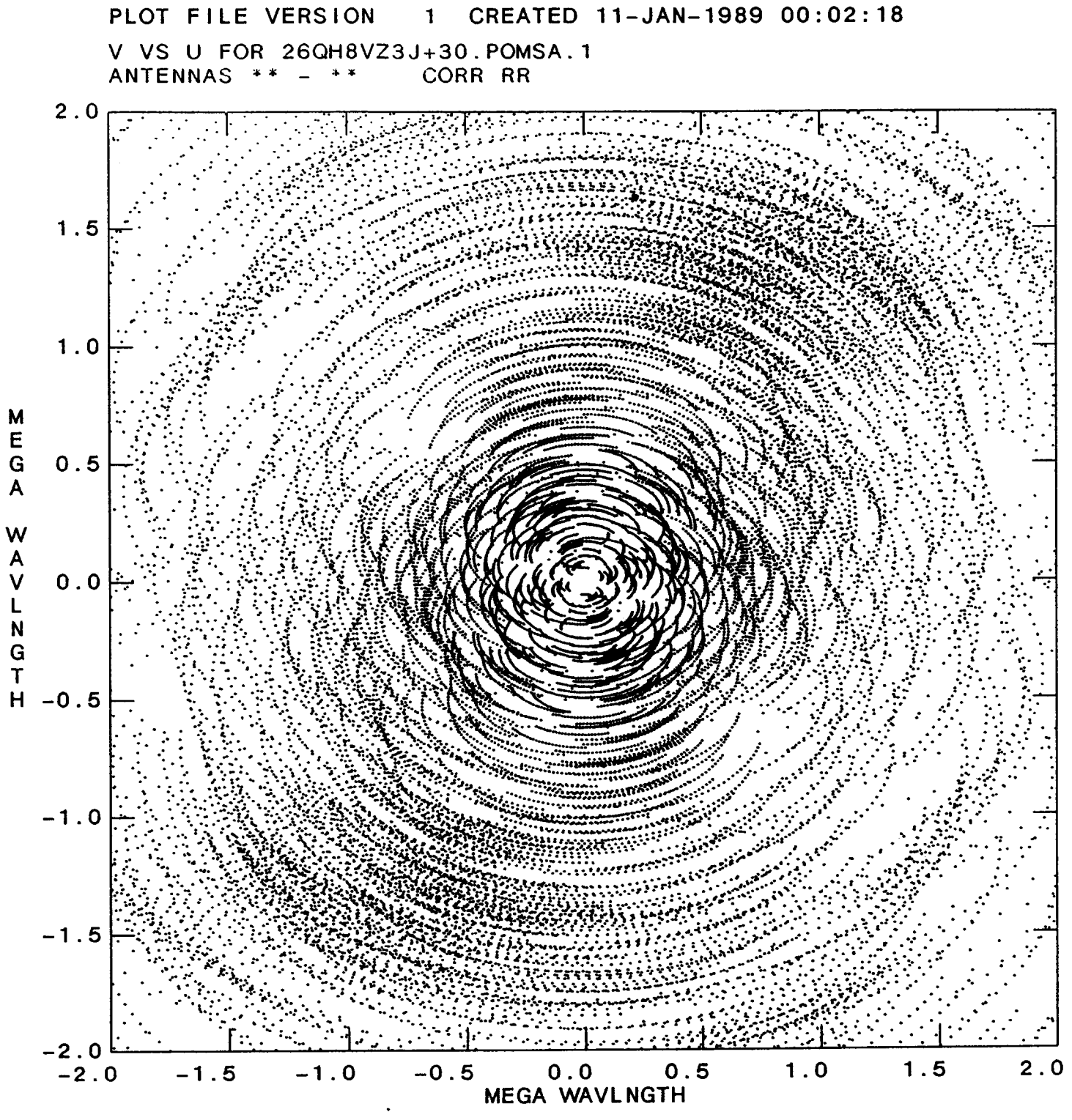

PLOT FILE VERSION 1 CREATED 11-JAN-1989 00:02:18
V VS U FOR 26QH8VZ3J+30.POMSA.1
ANTENNAS ** - ** CORR RR
2.0
1.5
1.0
0.5
0.0
-0.5
-1.0
-1.5
-2.0
MEGA WAVLNGTH
-2.0 -1.5 -1.0 -0.5 0.0 0.5 1.0 1.5 2.0
MEGA WAVLNGTH

FIGURE 9

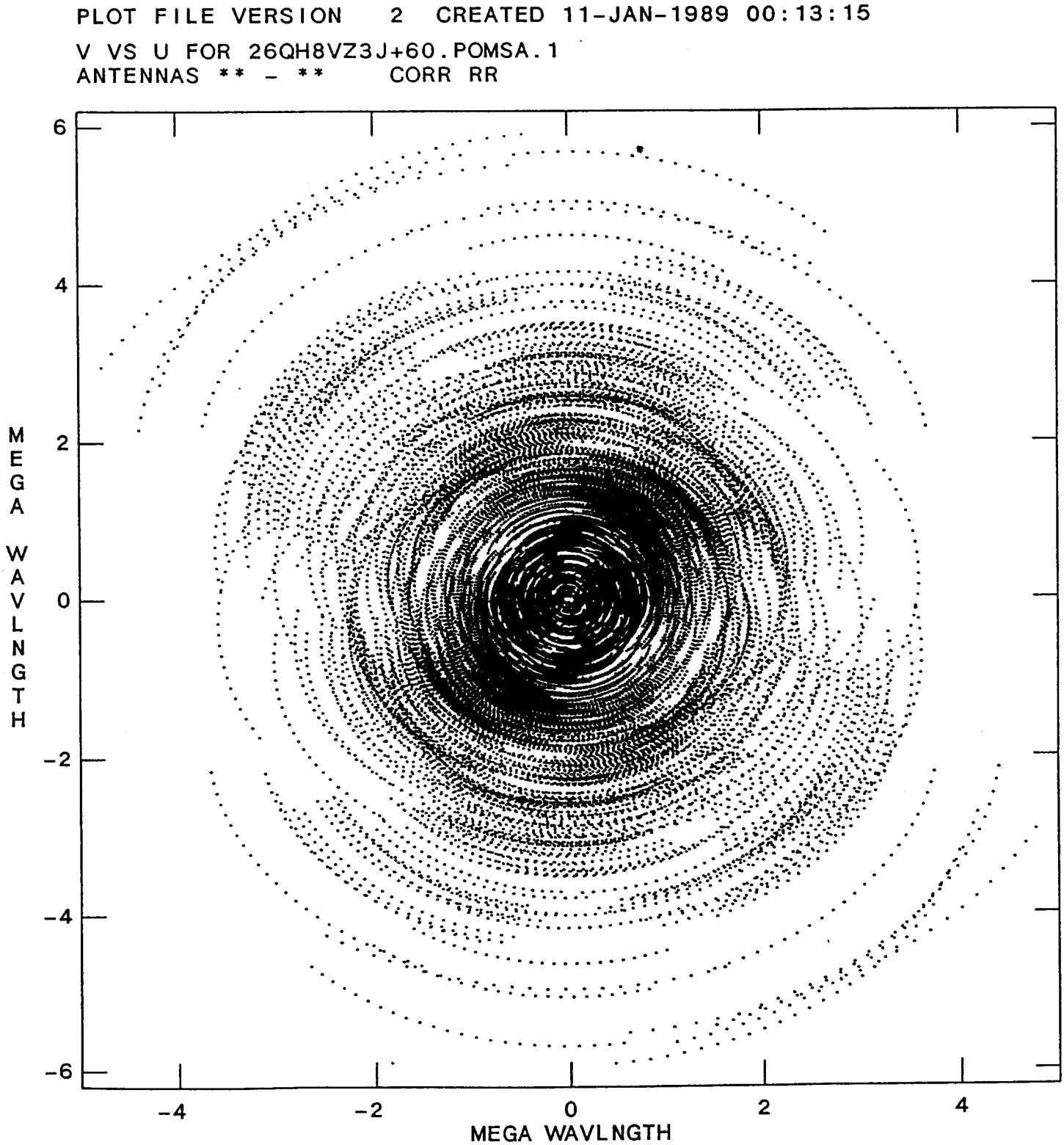

PLOT FILE VERSION 2 CREATED 11-JAN-1989 00:13:15
V VS U FOR 26QH8VZ3J+60.POMSA.1
ANTENNAS ** - ** CORR RR
6
4
2
0
-2
-4
-6
MEGA WAVLNGTH
-4
-2
0
2
4
MEGA WAVLNGTH

FIGURE 10

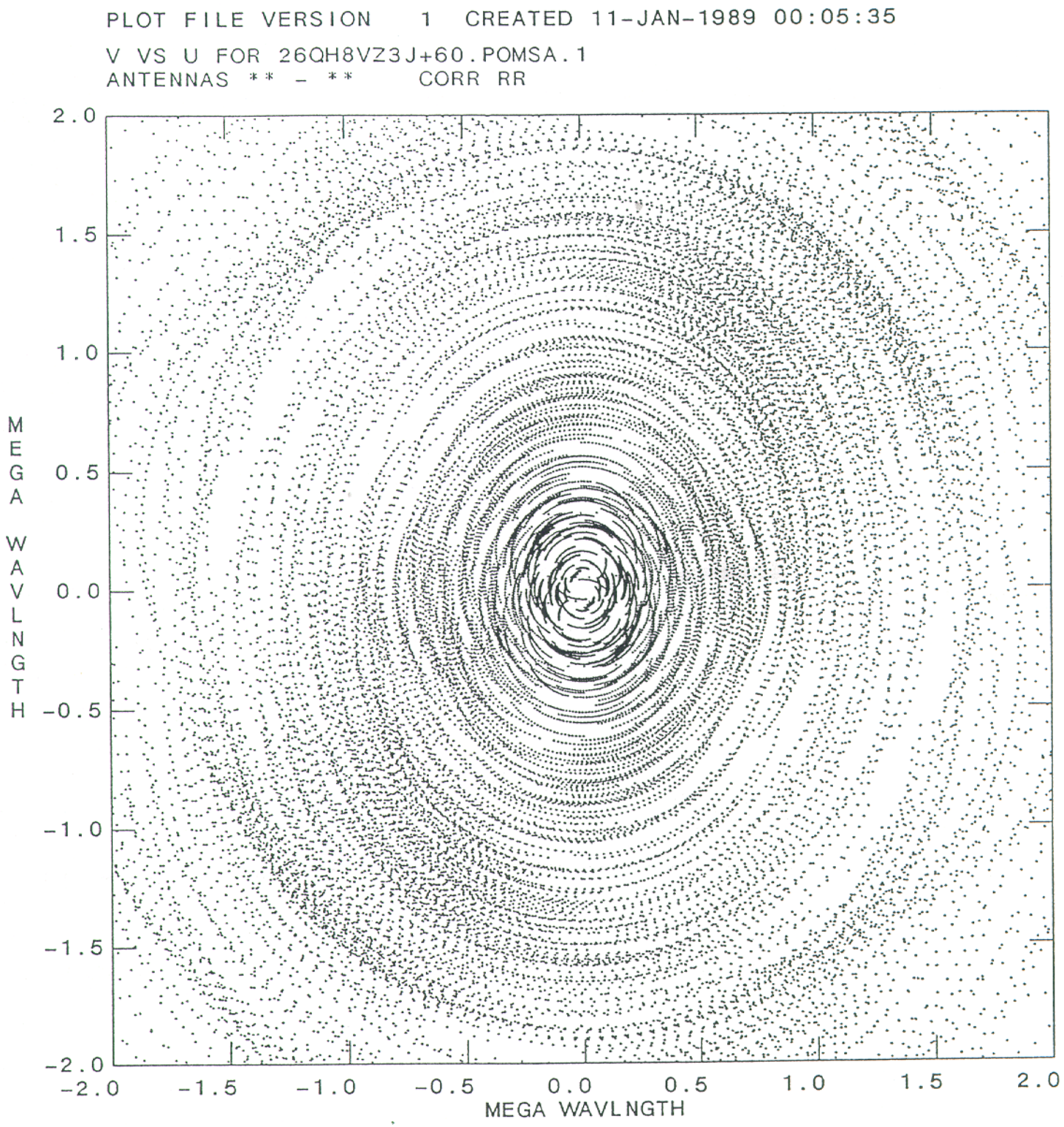

PLOT FILE VERSION 1 CREATED 11-JAN-1989 00:05:35
V VS U FOR 26QH8VZ3J+60.POMSA.1
ANTENNAS ** - ** CORR RR
2.0
1.5
1.0
0.5
0.0
-0.5
-1.0
-1.5
-2.0
MEGA WAVLNGTH
-2.0
-1.5
-1.0
-0.5
0.0
0.5
1.0
1.5
2.0
MEGA WAVLNGTH

FIGURE 11

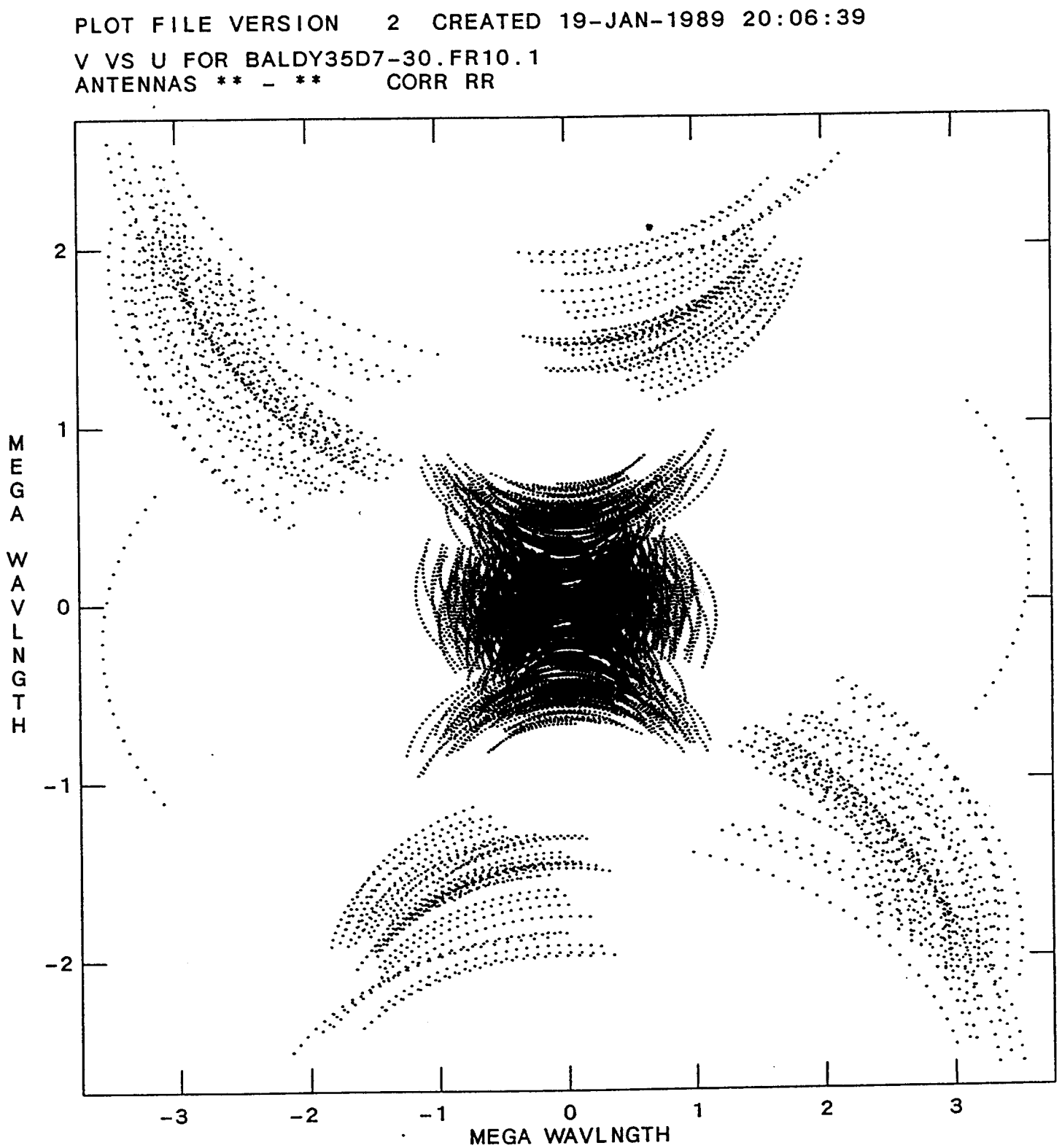

PLOT FILE VERSION 2 CREATED 19-JAN-1989 20:06:39
V VS U FOR BALDY35D7-30.FR10.1
ANTENNAS ** - ** CORR RR
MEGA WAVLNGTH
2
1
0
-1
-2
-3
-2
-1
0
1
2
3
MEGA WAVLNGTH

FIGURE 12

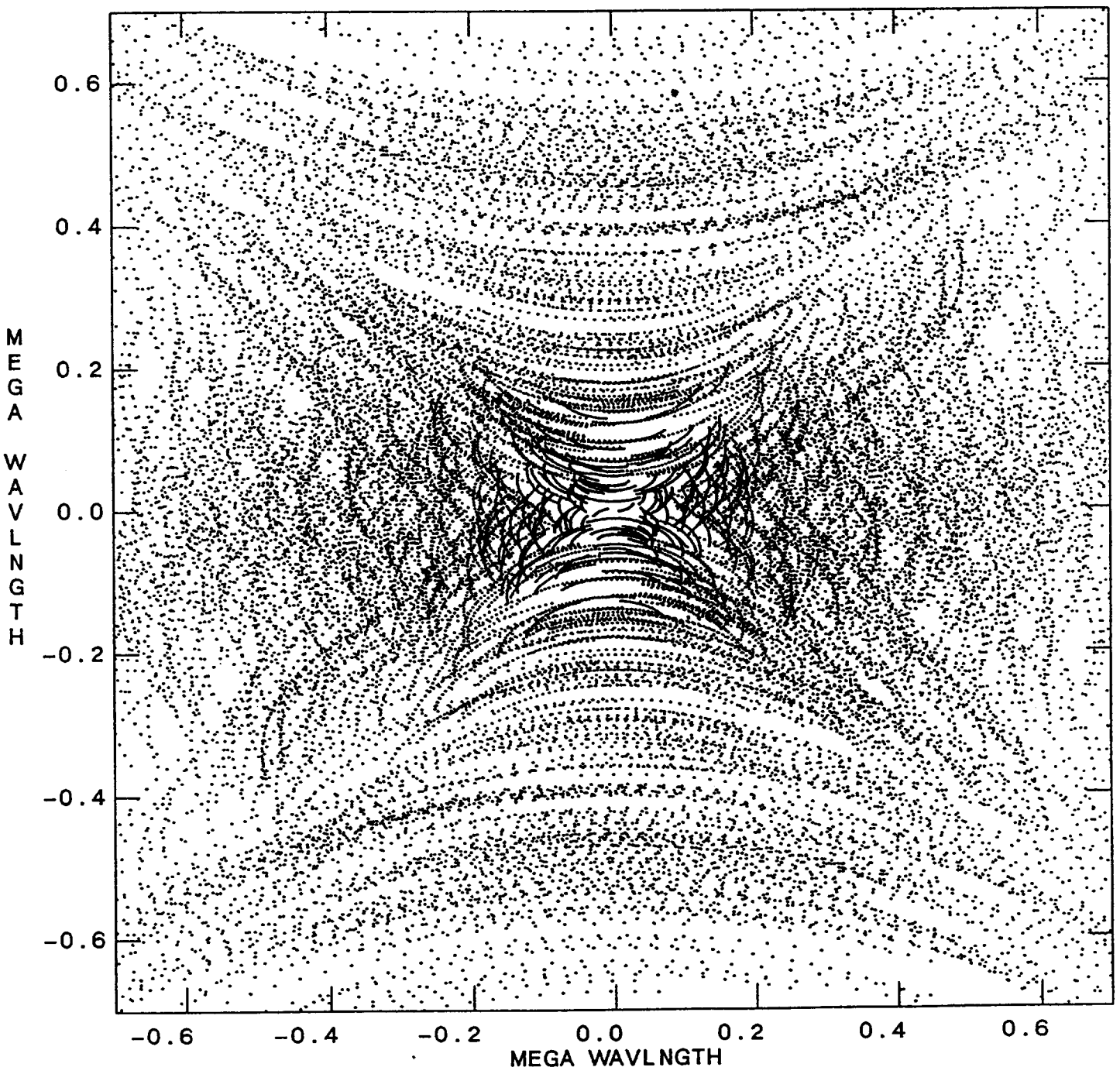

PLOT FILE VERSION 1 CREATED 19-JAN-1989 20:03:33
V VS U FOR BALDY35D7-30.FR10.1
ANTENNAS ** - ** CORR RR
0.6
0.4
0.2
0.0
-0.2
-0.4
-0.6
MEGA WAVLNGTH
-0.6
-0.4
-0.2
0.0
0.2
0.4
0.6
MEGA WAVLNGTH

FIGURE 13

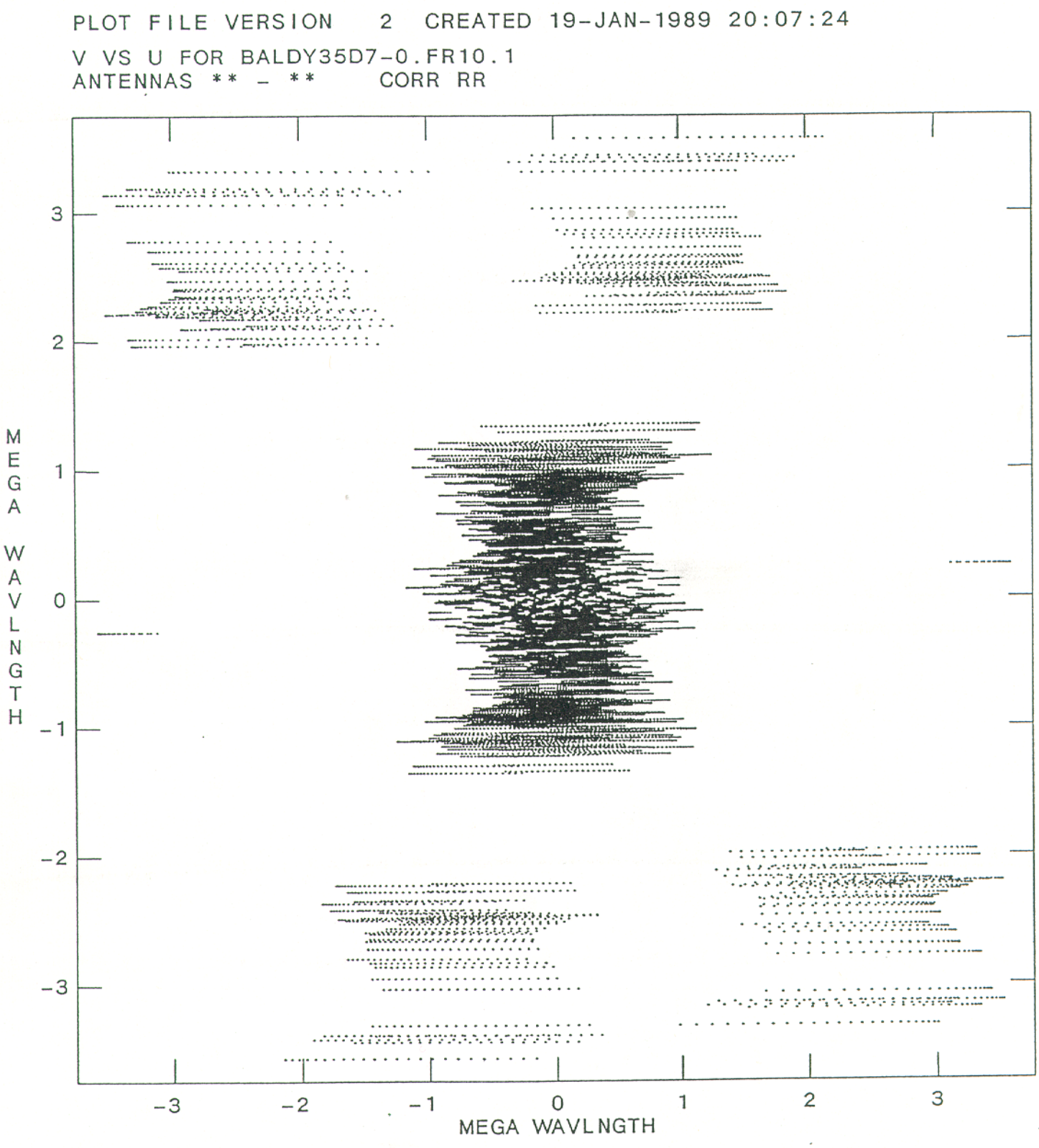

PLOT FILE VERSION 2 CREATED 19-JAN-1989 20:07:24
V VS U FOR BALDY35D7-0.FR10.1
ANTENNAS ** - ** CORR RR
MEGA WAVLNGTH
3
2
1
0
-1
-2
-3
-3
-2
-1
0
1
2
3
MEGA WAVLNGTH

FIGURE 14

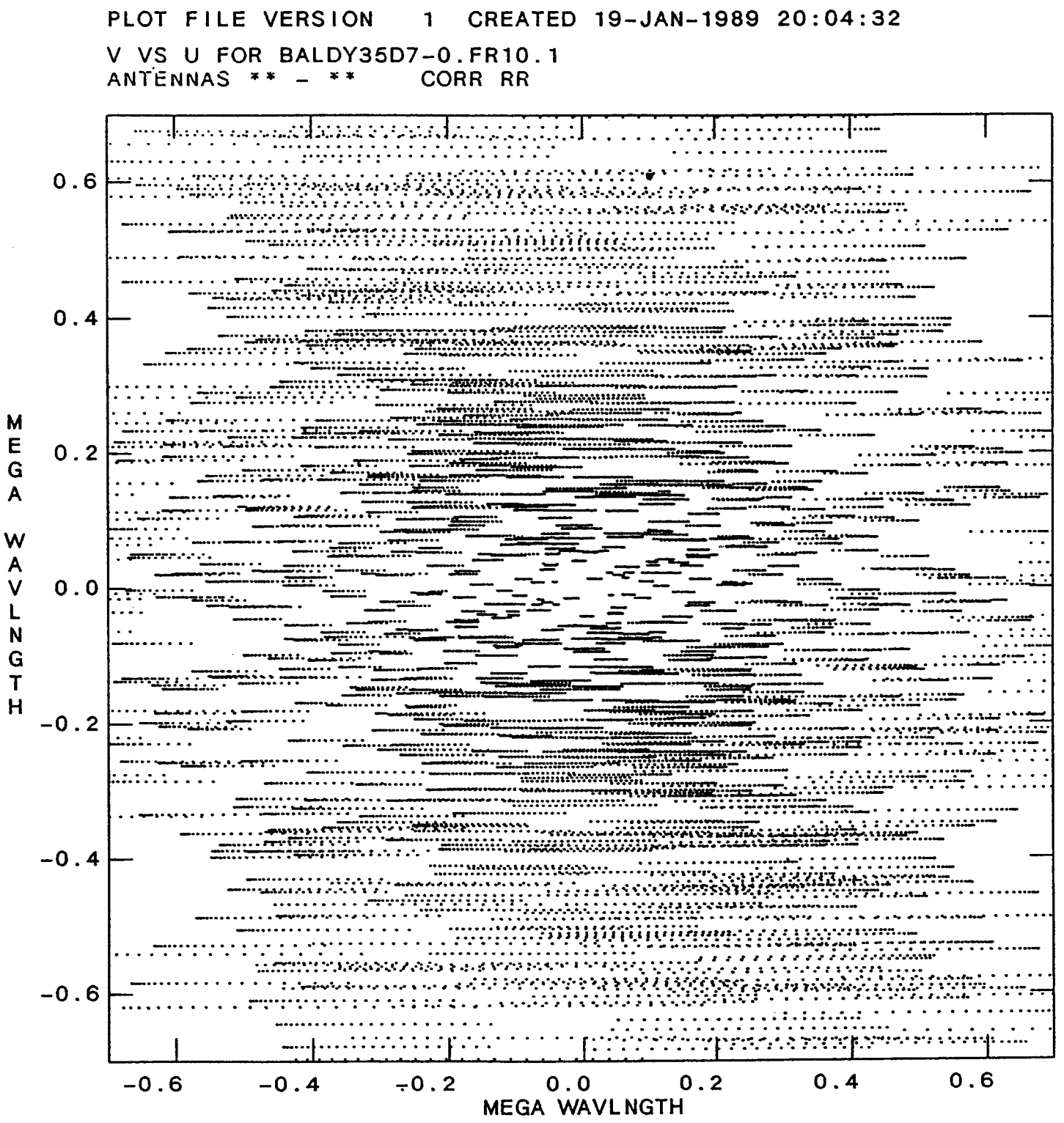

PLOT FILE VERSION 1 CREATED 19-JAN-1989 20:04:32
V VS U FOR BALDY35D7-0.FR10.1
ANTENNAS ** - ** CORR RR
0.6
0.4
0.2
0.0
-0.2
-0.4
-0.6
MEGA WAVLNGTH
-0.6
-0.4
-0.2
0.0
0.2
0.4
0.6
MEGA WAVLNGTH

FIGURE 15

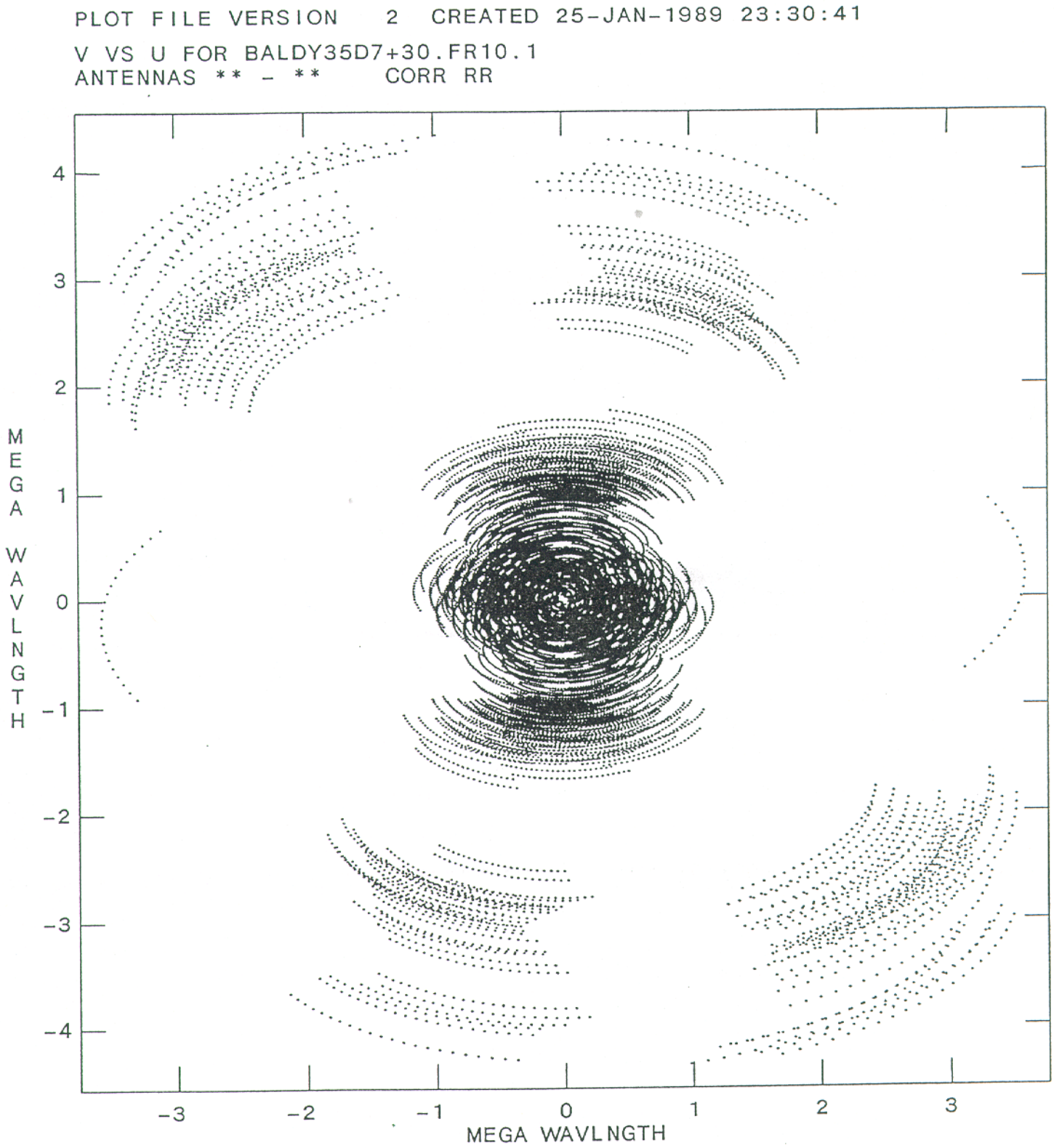

PLOT FILE VERSION 2 CREATED 25-JAN-1989 23:30:41
V VS U FOR BALDY35D7+30.FR10.1
ANTENNAS ** - ** CORR RR
MEGA WAVLNGTH
4
3
2
1
0
-1
-2
-3
-4
-3
-2
-1
0
1
2
3
MEGA WAVLNGTH

FIGURE 16

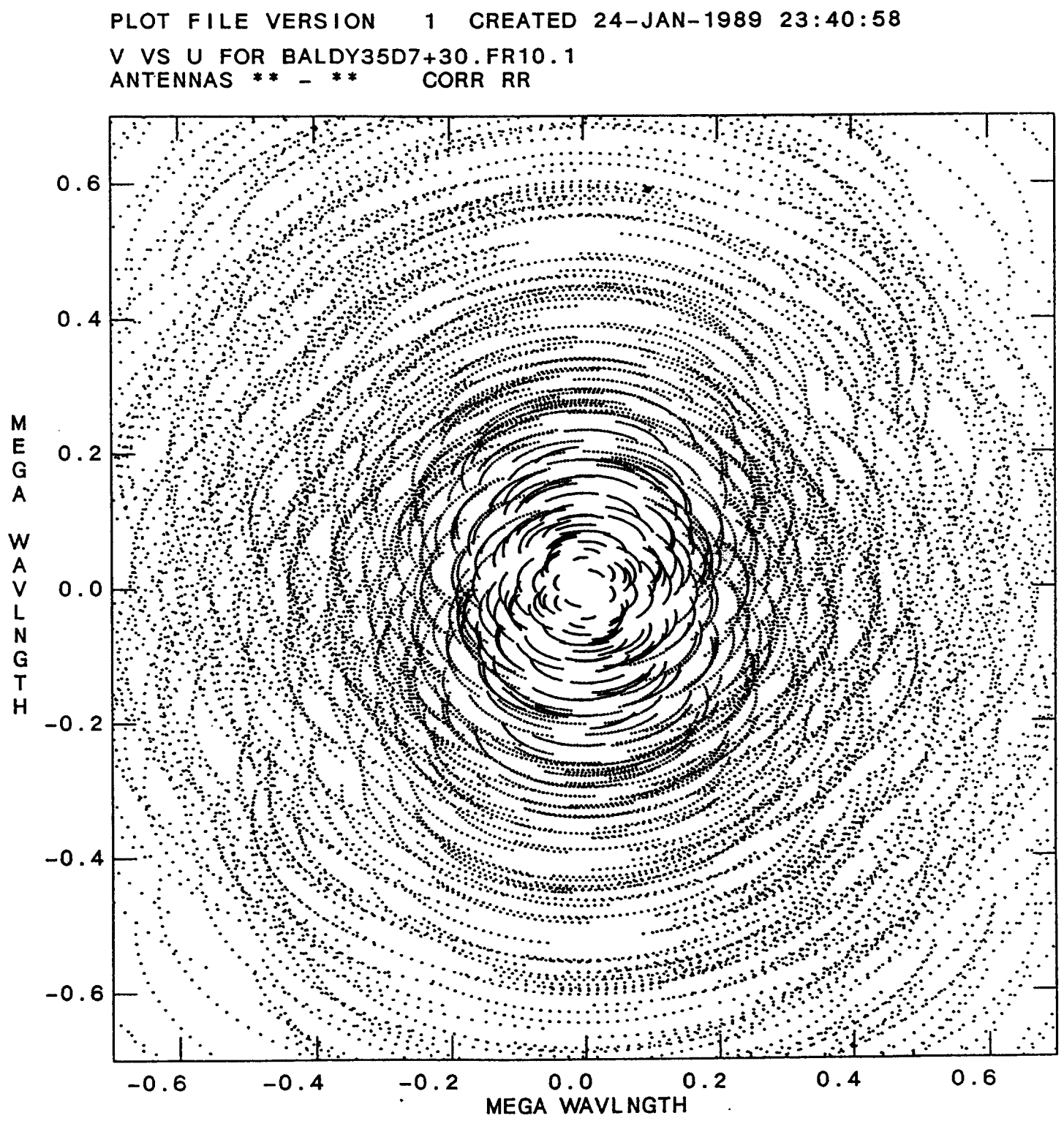

PLOT FILE VERSION 1 CREATED 24-JAN-1989 23:40:58
V VS U FOR BALDY35D7+30.FR10.1
ANTENNAS ** - ** CORR RR
0.6
0.4
0.2
0.0
-0.2
-0.4
-0.6
MEGA WAVLNGTH
-0.6
-0.4
-0.2
0.0
0.2
0.4
0.6
MEGA WAVLNGTH

FIGURE 17

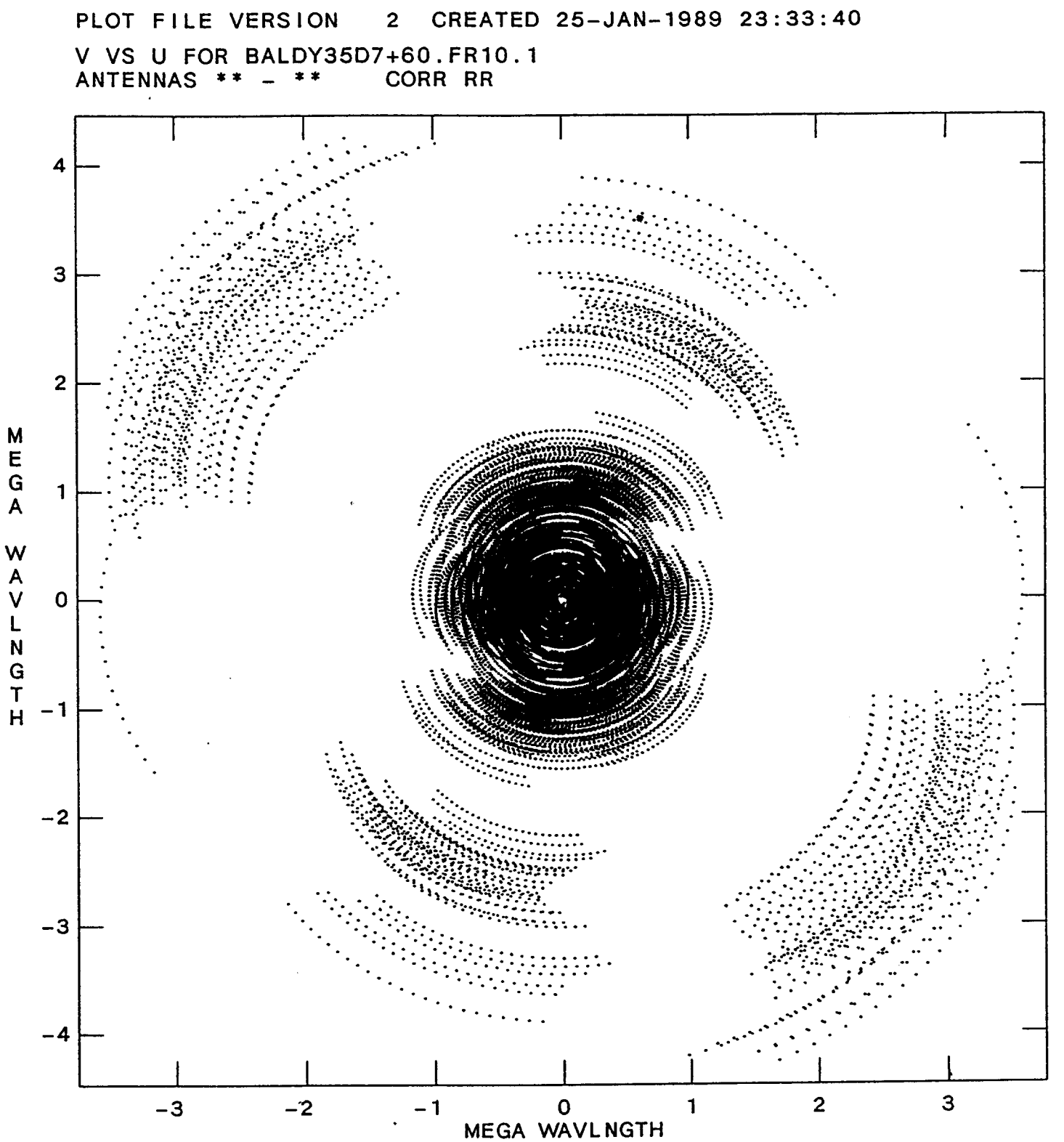

PLOT FILE VERSION 2 CREATED 25-JAN-1989 23:33:40
V VS U FOR BALDY35D7+60.FR10.1
ANTENNAS ** - ** CORR RR
MEGA WAVLNGTH
4
3
2
1
0
-1
-2
-3
-4
-3
-2
-1
0
1
2
3
MEGA WAVLNGTH

FIGURE 18

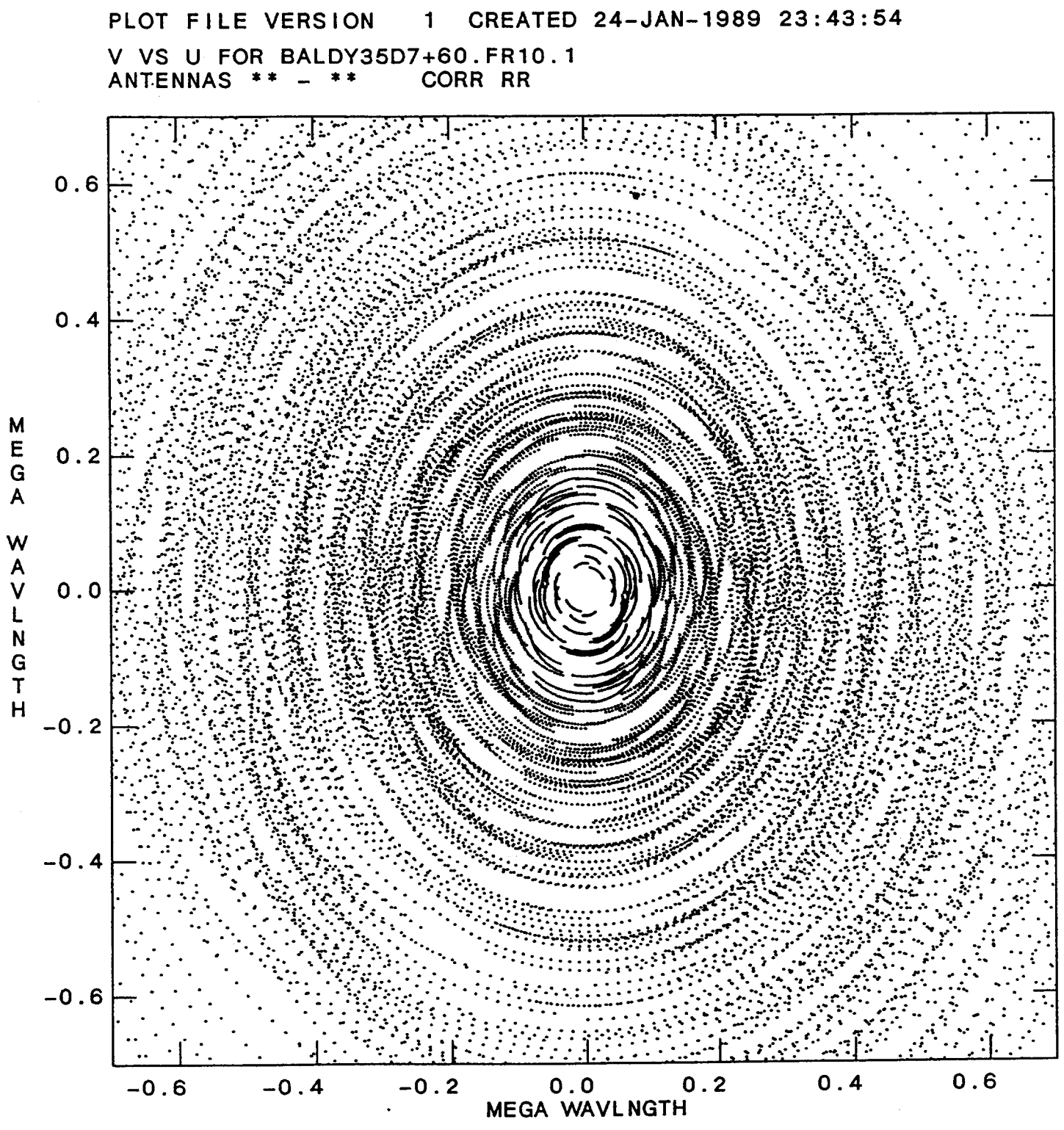

PLOT FILE VERSION 1 CREATED 24-JAN-1989 23:43:54
V VS U FOR BALDY35D7+60.FR10.1
ANTENNAS ** - ** CORR RR
MEGA WAVLNGTH
0.6
0.4
0.2
0.0
-0.2
-0.4
-0.6
-0.6 -0.4 -0.2 0.0 0.2 0.4 0.6
MEGA WAVLNGTH

FIGURE 19

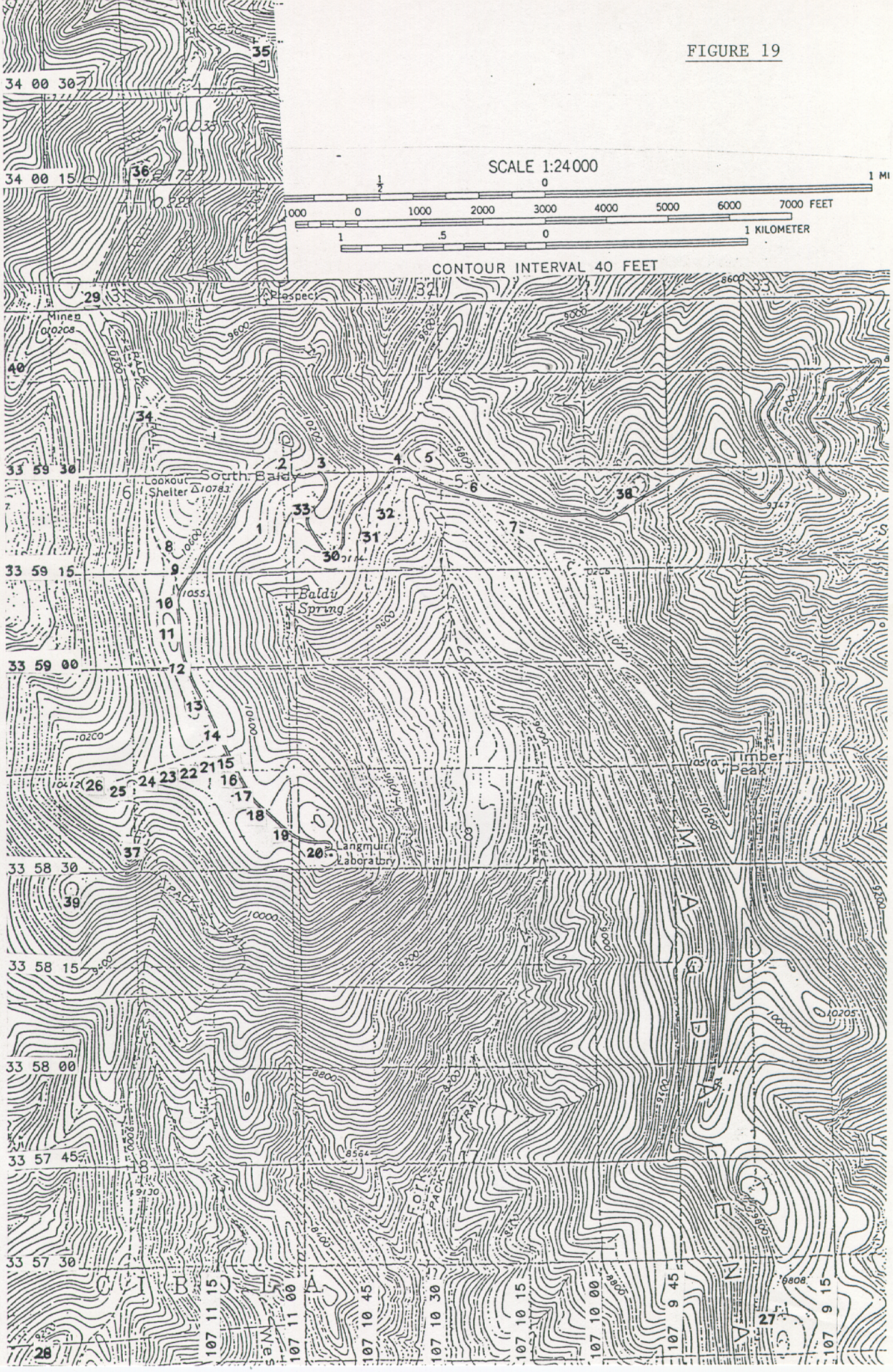
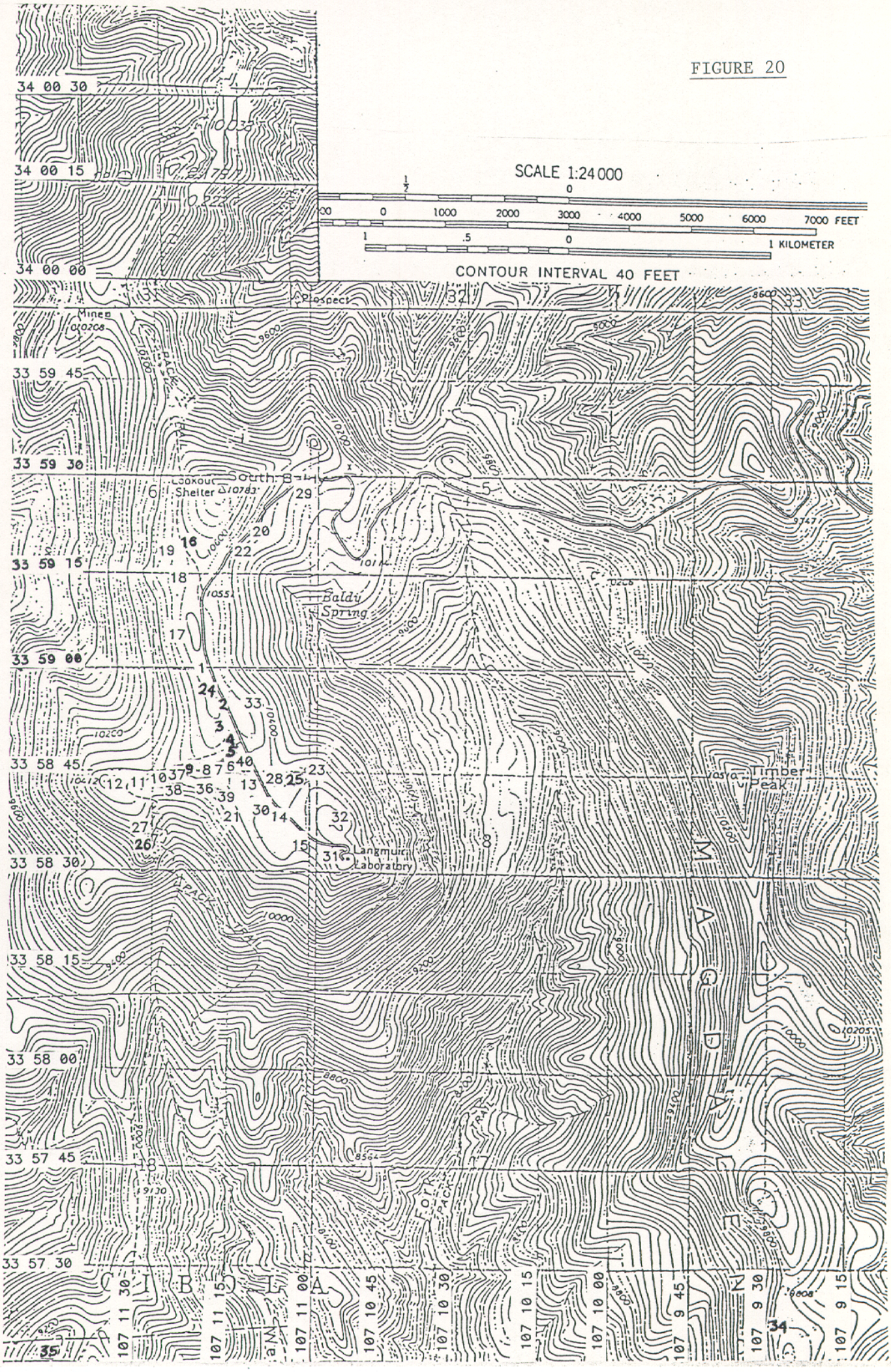

SCALE 1:24000
1 MI
7000 FEET
1 KILOMETER
CONTOUR INTERVAL 40 FEET
Prospect
Mines
South Baldy
Lookout Shelter
Baldy Spring
Timber Peak
Langmuir Laboratory
SAN MATEO
MOUNTAINS
CIBOLA
NATIONAL
FOREST
34 00 30
34 00 15
33 59 30
33 59 15
33 59 00
33 58 30
33 58 15
33 58 00
33 57 45
33 57 30
107 11 15
107 11 00
107 10 45
107 10 30
107 10 15
107 10 00
107 9 45
107 9 15

FIGURE 20


SCALE 1:24 000
0 1000 2000 3000 4000 5000 6000 7000 FEET
0 .5 0 1 KILOMETER
CONTOUR INTERVAL 40 FEET
34 00 30
34 00 15
34 00 00
33 59 45
33 59 30
33 59 15
33 59 00
33 58 45
33 58 30
33 58 15
33 58 00
33 57 45
33 57 30
107 11 30
107 11 15
107 11 00
107 10 45
107 10 30
107 10 15
107 10 00
107 9 45
107 9 30
107 9 15
Prospect
Mines
South Base
Lookout Shelter
Baldy Spring
Langmuir Laboratory
Sierra Blanca Peak
MESCALERO APACHE INDIAN RESERVATION
FORT STANTON
CIBOLA
LINCOLN