MILLIMETER ARRAY
MEMO NO. 111

Preliminary MMA Configurations for Mauna Kea

M.A. Holdaway
National Radio Astronomy Observatory
Socorro, NM 87801

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1 Strawman Configurations on Mauna Kea

Preliminary MMA configurations were produced for the South Baldy and Springerville sites by Jing Ping Ge in MMA Memo 80. The Springerville site permits circular arrays, but the South Baldy site constrains the two largest arrays to follow the land. The 12,500 foot plain on the western side of Mauna Kea permits circular arrays, so my preliminary configurations for Mauna Kea are very similar to Jing Ping's Springerville configurations. Hence, I will not pay close attention to (u, v) coverage at this point in time.

Antenna locations for four configurations are listed in Tables 1-4, and a display of the configurations is shown on contour plots in Figures 1-5. By moving the antennas as close to the southern and western Puu's (A, B, C, and D on Figure 3), some of the array may not be visible from Hilo. However, the antennas must be far enough from the Puu's that the roads are not too steep and the antennas are not often shadowed by the Puu's. In the A configuration presented here, Puu A would shadow antennas 6, 28, and 11 during some observations at elevations below 20°. Puu B would sometimes shadow antennas 40, 3, and 23 below 7° elevation. Puu C shadows antennas 10, 30, and 39 below 6°, and Puu D will not be a problem.

Laying out the configurations concentrically will give us the option of using hybrid arrays for tapered (u, v) coverage. Again, it is desirable to keep the antennas as far south as we can. Hence, we have an "offset concentric" design. The exact location of one configuration within another needs to be optimized for hybrid array (u, v) coverage as well as visibility from Hilo.

Antenna locations may also need to change to make roads feasible, cheaper to construct and maintain, or to lessen the visual impact of the roads. The mean angle of the plain across the A array is 6.7°. However, some flat regions may be utilized to optimize the road layout. For example, just to the north of the northernmost antennas of the A array is a section of land which has no gradient in the direction of the array. However, if this section were used, the smaller arrays would be pushed further north, into the sites of Hilo residents, or the hybrid concentric arrays would be lost. In Figure 2, two different flat spots for the compact arrays are labeled with F. These flat spots are large enough to accomodate the C and D arrays with slopes of 3-4°. The southern spot might be less visible from Hilo, and the northern spot would allow hybrid arrays.

On Mauna Kea, the optimal array elongation will not be the same as on the Springerville site. The optimal array elongation will produce the minimum beam elongation averaged over the sky. Preliminary studies show that the array layouts presented here will change by less than 10 percent in extent. The exact placement of antennas will need to be optimized with the simulated annealing program. Multiconfiguration imaging will also need to be addressed as we study how the different arrays fit together optimally.

2 Warnings

The *Digital Elevation Model* (DEM) image for the Mauna Kea quadrangle was procured from the USGS. Since the digital image is in Universal Transverse Mercator (UTM) coordinates, the image has been munged a bit to get it into its current state (pixels are in North-South columns and East-West rows) which was required for efficiency in the simulated annealing program. Because of the complexity of the 40 element problem, no results from the simulated annealing program are presented with these strawman configurations. DEM images claim to be accurate to 3 meters in each vertical direction and to 7 meters horizontally. The munged image which I have used for the strawman configurations is found to have errors of about 30 meters horizontally (one pixel) and 5 meters vertically. Antenna locations are specified in meters East and North of a reference location at pixel 182, 217 with reference value 155°26′51.″187, 19°48′30.″749. The third component of the antenna location is meters above mean sea level.

Antenna	East	North	Elevation
1	1156.01	1373.30	3570.77
2	1087.85	326.537	3533.70
3	-718.058	-114.103	3700.68
4	-223.778	2421.26	3745.34
5	58.5872	2470.58	3711.16
6	-982.558	397.457	3774.14
7	-46.9279	-522.103	3624.62
8	-689.138	2090.54	3827.25
9	-912.758	1729.46	3842.12
10	366.054	-475.303	3584.30
11	-1041.39	644.297	3798.58
12	467.666	2372.42	3682.13
13	1189.37	790.337	3541.25
14	-988.178	1525.34	3843.37
15	535.014	-393.943	3567.91
16	1014.70	153.257	3537.79
17	1051.32	1707.74	3589.07
18	-504.678	2267.54	3803.30
19	922.608	1950.26	3608.22
20	-829.638	1891.82	3842.79
21	242.416	2451.98	3700.97
22	1197.62	978.617	3543.46
23	-611.818	-232.783	3683.09
24	-1061.24	1140.38	3834.75
25	-610.638	2175.14	3816.11
26	781.294	2132.42	3637.54
27	-398.538	-398.383	3658.97
28	-1015.10	515.657	3785.24
29	946.266	28.5771	3540.33
30	82.6102	-529.183	3610.97
31	607.258	2287.34	3662.14
32	-1042.38	1290.62	3833.77
33	1121.57	1510.70	3571.86
34	664.273	-302.143	3560.86
35	-1067.67	914.177	3819.60
36	-298.468	-450.343	3645.71
37	-1060.24	789.737	3811.70
38	1160.09	587.897	3533.82
39	256.556	-507.703	3601.02
40	-805.978	10.5771	3725.22

Table 1: Antenna locations for the A configuration. Antenna locations are given as meters East and North of the point 155°26′51″.187, 19°48′30″.749, the third location component being elevation above mean sea level.

Antenna	East	North	Elevation
1	306.087	280.480	3605.87
2	288.039	34.1802	3598.82
3	-190.120	-69.5000	3652.34
4	-59.2498	527.070	3671.53
5	15.5103	538.670	3662.71
6	-260.160	50.8701	3655.92
7	-12.4198	-165.500	3627.52
8	-182.470	449.250	3674.77
9	-241.680	364.290	3670.93
10	96.9222	-154.490	3620.39
11	-275.730	108.950	3660.04
12	123.827	515.580	3650.53
13	314.919	143.310	3592.16
14	-261.650	316.260	3667.02
15	141.659	-135.350	3615.55
16	268.670	-6.58984	3600.16
17	278.367	359.180	3619.00
18	-133.630	490.900	3670.38
19	244.286	416.240	3629.56
20	-219.670	402.490	3674.53
21	64.1852	534.300	3658.42
22	317.104	187.620	3598.22
23	-162.000	-97.4302	3652.66
24	-280.990	225.680	3669.13
25	-161.680	469.160	3672.85
26	206.869	459.110	3637.34
27	-105.520	-136.390	3642.22
28	-268.770	78.6802	3657.54
29	250.550	-35.9302	3600.30
30	21.8702	-167.170	3625.01
31	160.788	495.560	3644.75
32	-276.000	261.030	3667.67
33	296.967	312.810	3609.60
34	175.884	-113.750	3609.70
35	-282.700	172.450	3666.51
36	-79.0298	-148.620	3637.03
37	-280.730	143.170	3663.52
38	307.167	95.6802	3589.83
39	67.9293	-162.110	3622.33
40	-213.410	-40.1602	3651.07

Table 2: Antenna locations for the B configuration

Antenna	East	North	Elevation
1	86.7230	29.8911	3620.63
2	81.6090	-39.8989	3623.50
3	-53.8700	-69.2690	3637.18
4	-16.7900	99.7510	3633.29
5	4.40002	103.0410	3631.47
6	-73.7100	-35.1689	3637.92
7	-3.52002	-96.4692	3631.91
8	-51.7000	77.7012	3634.25
9	-68.4700	53.6309	3634.26
10	27.4600	-93.3491	3628.86
11	-78.1200	-18.7090	3637.34
12	35.0800	96.4912	3627.30
13	89.2250	-8.97900	3622.12
14	-74.1300	40.0210	3634.40
15	40.1400	-87.9292	3627.55
16	76.1210	-51.4492	3624.06
17	78.8690	52.1812	3621.31
18	-37.8600	89.5010	3634.21
19	69.2130	68.3511	3622.35
20	-62.2400	64.4512	3634.15
21	18.1899	101.8008	3629.63
22	89.8440	3.57080	3621.62
23	-45.9000	-77.1890	3636.78
24	-79.6100	14.3608	3635.74
25	-45.8101	83.3408	3634.27
26	58.6110	80.4912	3623.79
27	-29.9000	-88.2290	3635.38
28	-76.1500	-27.2891	3637.76
29	70.9870	-59.7588	3624.63
30	6.19995	-96.9492	3630.87
31	45.5550	90.8208	3625.80
32	-78.2000	24.3711	3635.02
33	84.1390	39.0508	3620.84
34	49.8330	-81.8091	3626.53
35	-80.1000	-0.71923	3636.48
36	-22.3900	-91.6890	3634.36
37	-79.5400	-9.01904	3636.89
38	87.0290	-22.4692	3622.76
39	19.2500	-95.5088	3629.62
40	-60.4600	-60.9590	3637.29

Table 3: Antenna locations for the C configuration.

Antenna	East	North	Elevation
1	17.1415	21.0991	3626.21
2	-14.1786	12.0991	3629.21
3	24.0115	27.4492	3624.96
4	7.03149	-6.50098	3628.92
5	-24.5186	-26.2607	3634.54
6	13.6315	-13.4609	3629.10
7	-5.69849	-10.3608	3630.49
8	-17.0386	-2.73096	3630.47
9	9.15149	11.1489	3627.59
10	20.6115	4.94922	3626.67
11	5.53149	-24.1211	3631.00
12	-4.24854	-27.1812	3632.30
13	28.2914	-22.1108	3628.82
14	23.4514	-34.9810	3630.08
15	-20.5186	34.4292	3628.64
16	-2.50854	8.82910	3628.79
17	9.06152	-42.2808	3631.31
18	32.9714	-11.3110	3627.10
19	-1.97852	-38.8008	3632.37
20	-20.2085	19.6792	3628.95
21	-11.0486	31.6890	3628.35
22	-14.4885	-14.0107	3631.76
23	-24.4785	2.93896	3630.40
24	16.5115	-28.2607	3630.53
25	4.39148	27.9492	3627.64
26	- 0.48852	38.5791	3628.75
27	-15.3785	-27.3809	3633.63
28	8.14148	37.8589	3627.59
29	-30.6185	13.0889	3629.86
30	24.2114	-4.88086	3627.18
31	-9.39856	2.73926	3629.42
32	35.1815	0.24902	3625.67
33	-0.00854	-1.18115	3628.98
34	-31.8585	-1.77100	3631.42
35	-28.7686	-14.7109	3633.24
36	29.4615	12.9990	3625.22
37	-9.02856	20.8291	3628.61
38	16.5315	39.7891	3626.58
39	-11.0386	-40.3809	3633.47
40	-27.8185	24.2788	3628.75

Table 4: Antenna locations for the D configuration.

Figure 1: Contour map of the entire Mauna Kea Quadrangle with 20 m contours showing how the A array fits on the mountain.

Figure 2: Contour map of a subsection of the Mauna Kea Quad with 10 m contours showing the placement of the A, B, C, and d arrays. The VKBA antenna is shown as "V"

Figure 3: Contour map (10m) showing the locations of the A array antennas. Various Puu's are labled A, B, C, and D. The VLBA antenna is labled V. A flat spot which could accomodate the C and D arrays is labeled F.

Figure 4: Contour map (10m) showing the locations of the B array antennas. The flat spot which could accomodate the C and D arrays is labeled F.

Figure 5: Contour map (10m) showing the locations of the C and D array antennas. The C and D arrays are *not* layed out on the flat spot F.

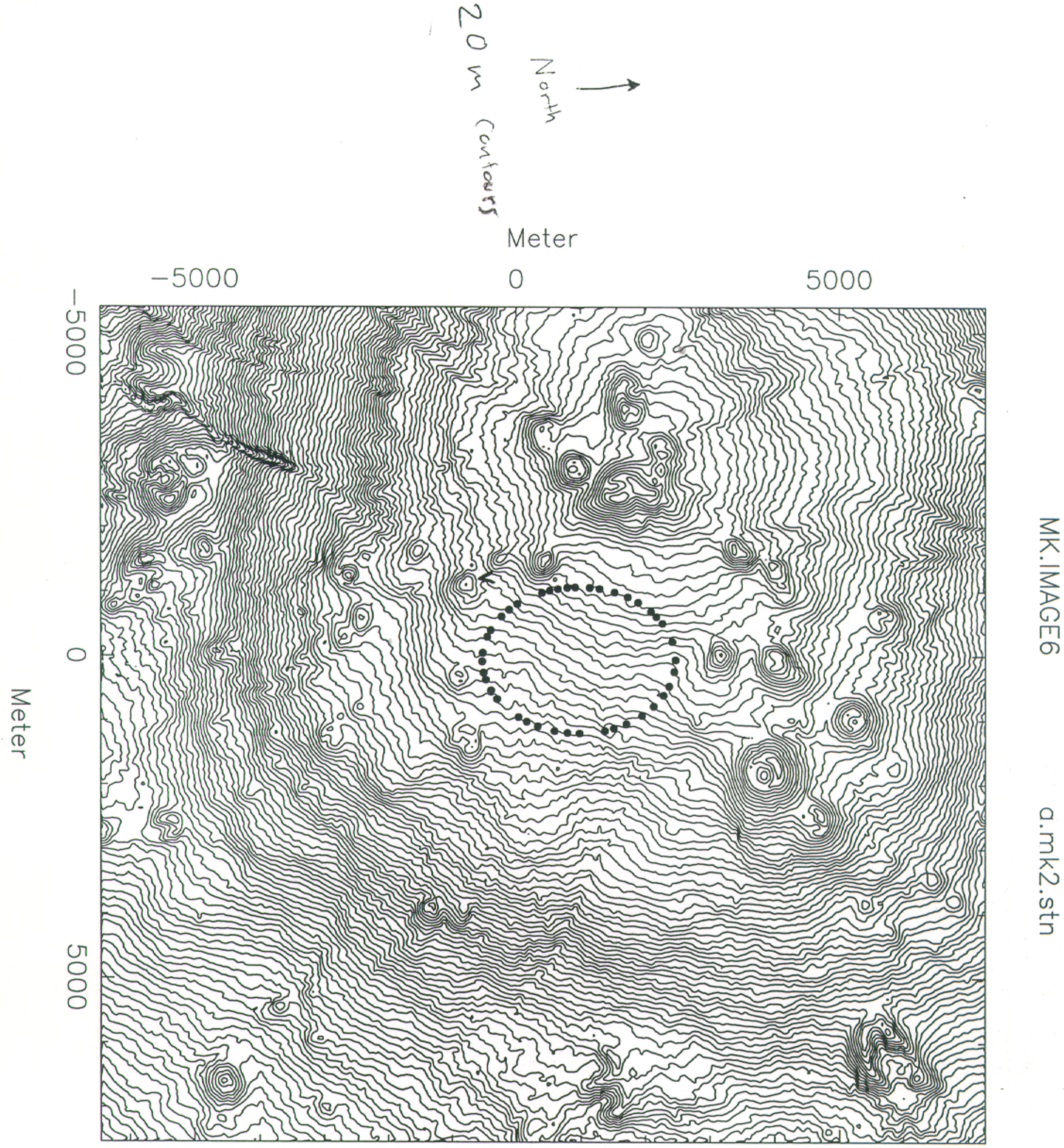

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Figure 1

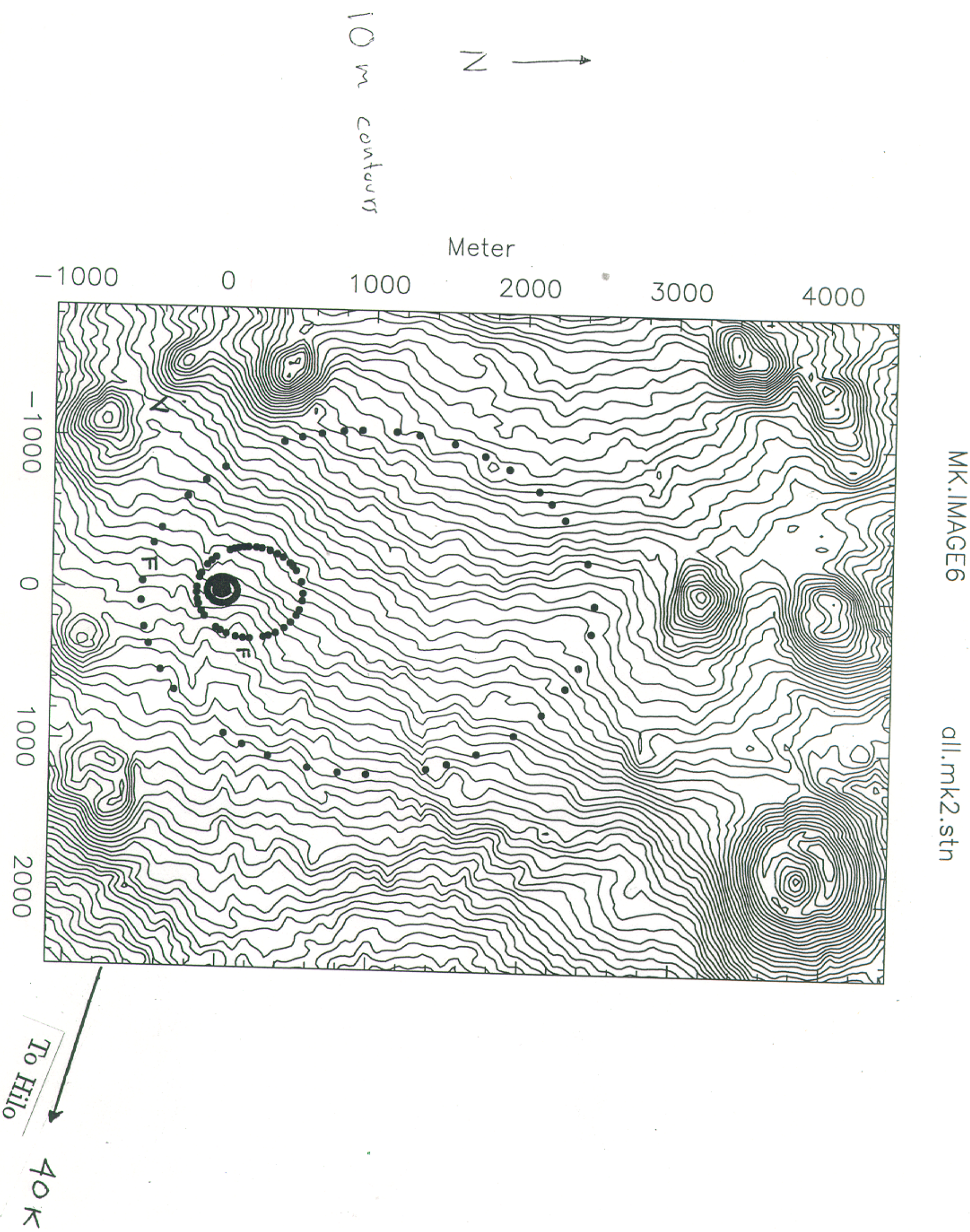
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Figure 2

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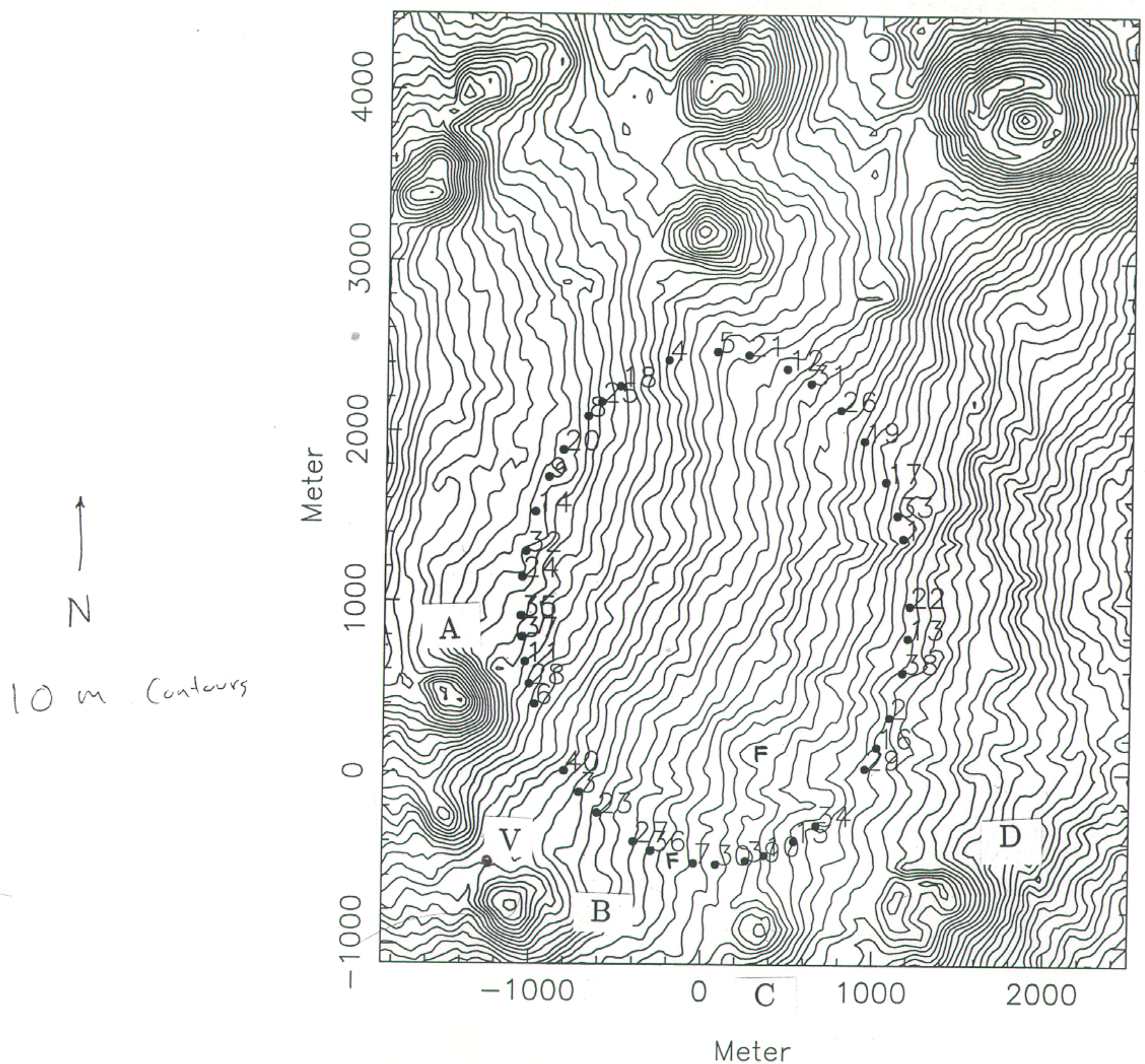

Figure 3

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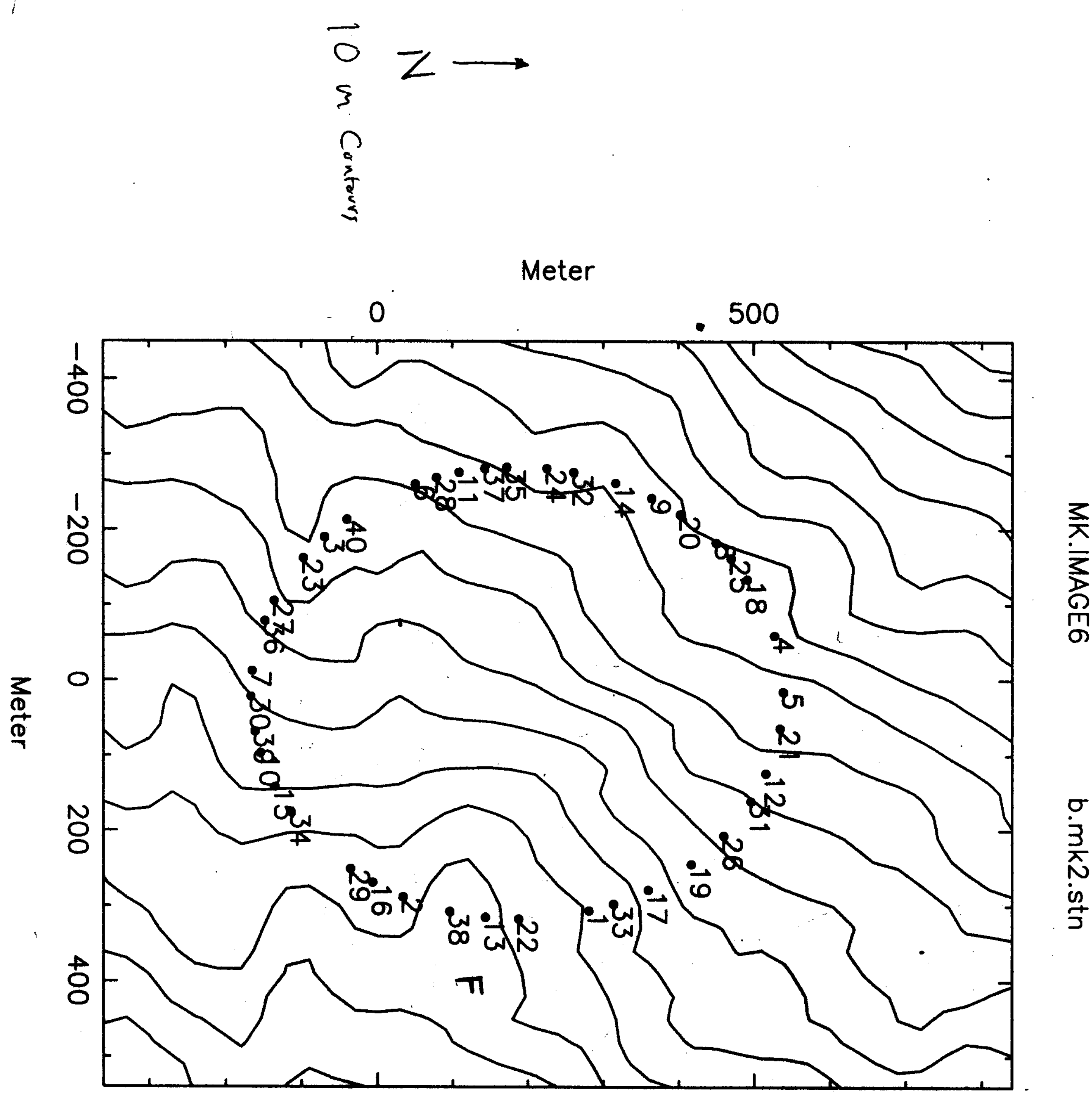

Figure 4

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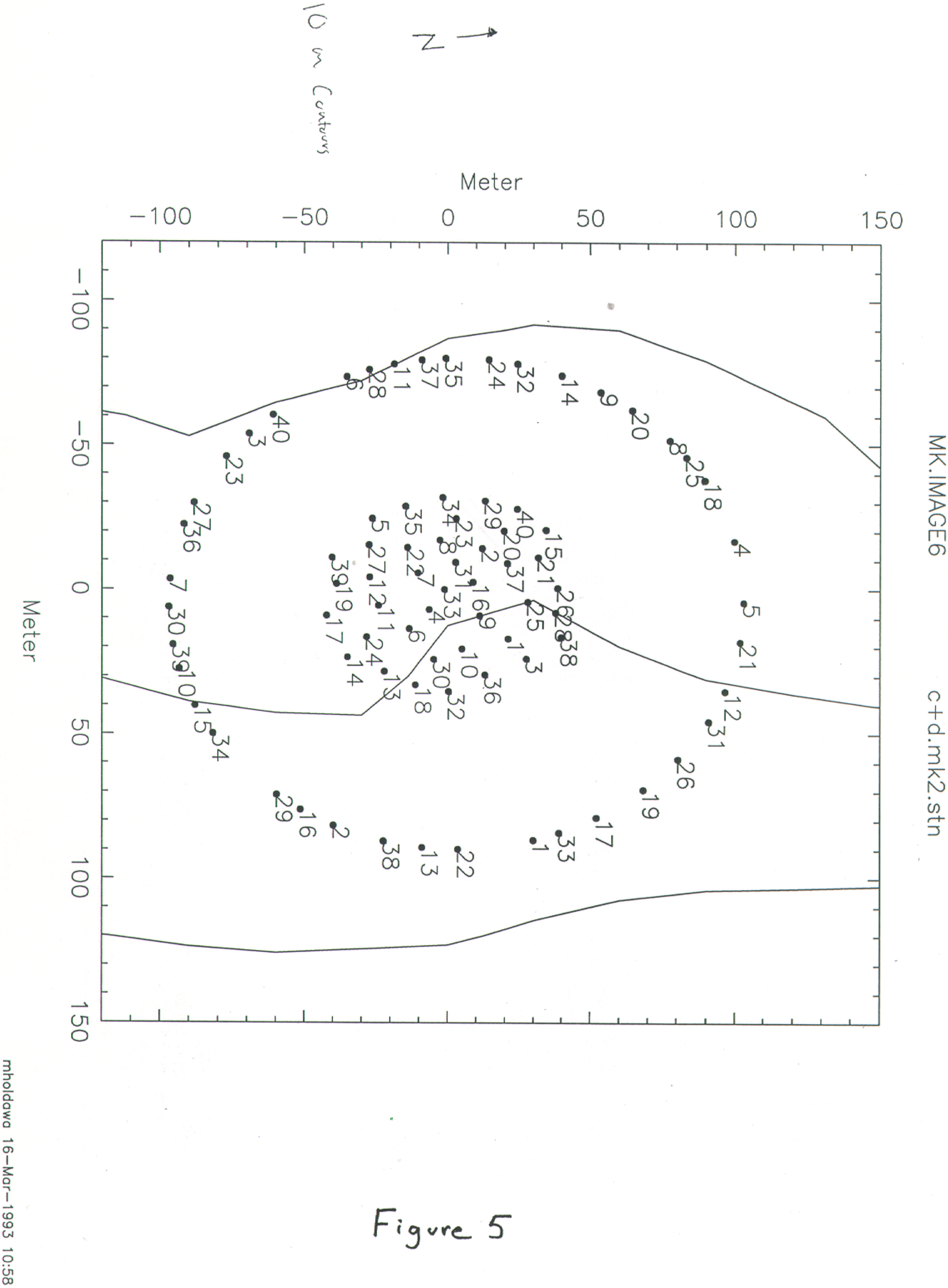
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Figure 5