A fully-featured configuration design for the ALMA using 223 pads

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1. Description

A design for the ALMA is outlined which is fully-featured (being a zoom array from about 100 m to 14 km, with provision for observing with near-circular beams on all sizes of configuration up to about 1 km, over a wide range of zenith angles) while requiring only 223 pads.

The components are:-

1) a central "disc", consisting of 60 pads as densely-packed as possible whilst allowing transporter access to all pads. This disc is not exactly circular, but elliptical, with an aspect ratio of 1.27, the major axis being north-south;

2) an elliptical extension of the disc made up of 20 pads, aspect ratio 2, and again with the major axis north-south. With the 60 antennas appropriately placed either on the disc or evenly distributed over the disc and the extension, observations may be made to a zenith angle of 67 degrees (i.e. from the South Celestial Pole to Dec = +44 deg) with a beam whose aspect ratio is no greater than 1.27;

3) nine not-quite concentric rings, each of 10 pads, extending from about 200 m diameter to 5 km diameter in a minor modification of a standard inverse-square zoom array. The 5 km ring is included because of the difficulty of hybridizing two configurations as dissimilar in size as a 3 km zoom arrray to a 14 km outer ring. The innermost 4 rings are elliptical, aspect ratio 1.27, major axis north-south, in order to give near-circular beams as for the core; an aspect ratio of 2 is obtained for observations at high zenith angles by placing the antenns in an elliptical pattern on the zoom array, ignoring the layout of the rings. This flexibility is only required in snapshot mode because in earth-rotation mode near-circular beams may be obtained by choosing the hour-angle coverage instead, so the outer 4 rings are circular; the fifth has intermediate ellipticity as a compromise. The rings could not be designed to be concentric; the adopted position for the array centre and

the centre of the 5 km ring cannot be made coincident, and so the centres of the rings in the zoom array move eastwards and southwards as the diameter increases;

4) a 14 km ring of 45 pads whose shape is as near as possible a Reuleaux triangle, given the available terrain;

5) two hybrid branches, one of 7 pads running east from the 5 km array and south of Chascon, the other of 4 pads NE of Chascon. These are included to improve the uv-plane coverage of the hybrids between the 5 km zoom configuration and the outer ring.

The design specification called for minimizing the number of pads, for reasons of cost, and several strategies have been employed to keep the number below 250 (there are actually 223):-

a) the inverse-square zoom array has a low density of pads, about half what we have used in previous memos. This gives wonderfully clean dirty beams, with a (not-quite Gaussian) bell-shaped curve for the central peak and virtually no systematic sidelobes (only the low-level ones are present from the finite number of dishes);

b) keeping 9 or 10 of the dishes within the central disc even as the remainder are zoomed outwards to larger radii. This provides short baselines for wide-dynamic-range imaging, and reduces the number of pads by reducing the effective configuation size to 50 or 51: moving all the antennas that are going to be moved only requires this number of vacant pads, not the full 60;

c) pad-sharing between configurations. By shifting the centres of the disc and elliptical extension so that the edges of these components just touch the first zoom ring, only 4 of the 10 pads in that ring require new foundations. The other 6 already exist, 2 in the disc and 4 in the elliptical extension. Furthermore, by making the Reuleaux triangle go right across the 5 km zoom array, 15 of the pads of the latter may be chosen as part of the Reuleaux, which thus only requires 45 pads and not 60.

The design is highly modular and readily modified to accommodate any necessary changes. If, for example, the central disc is too compact, as it might be for proper access by the transporter, some other design for the central disc can easily be fitted in instead, and the same applies to the Reuleaux triangle and hybrid branches, where the terrain is a likely problem.

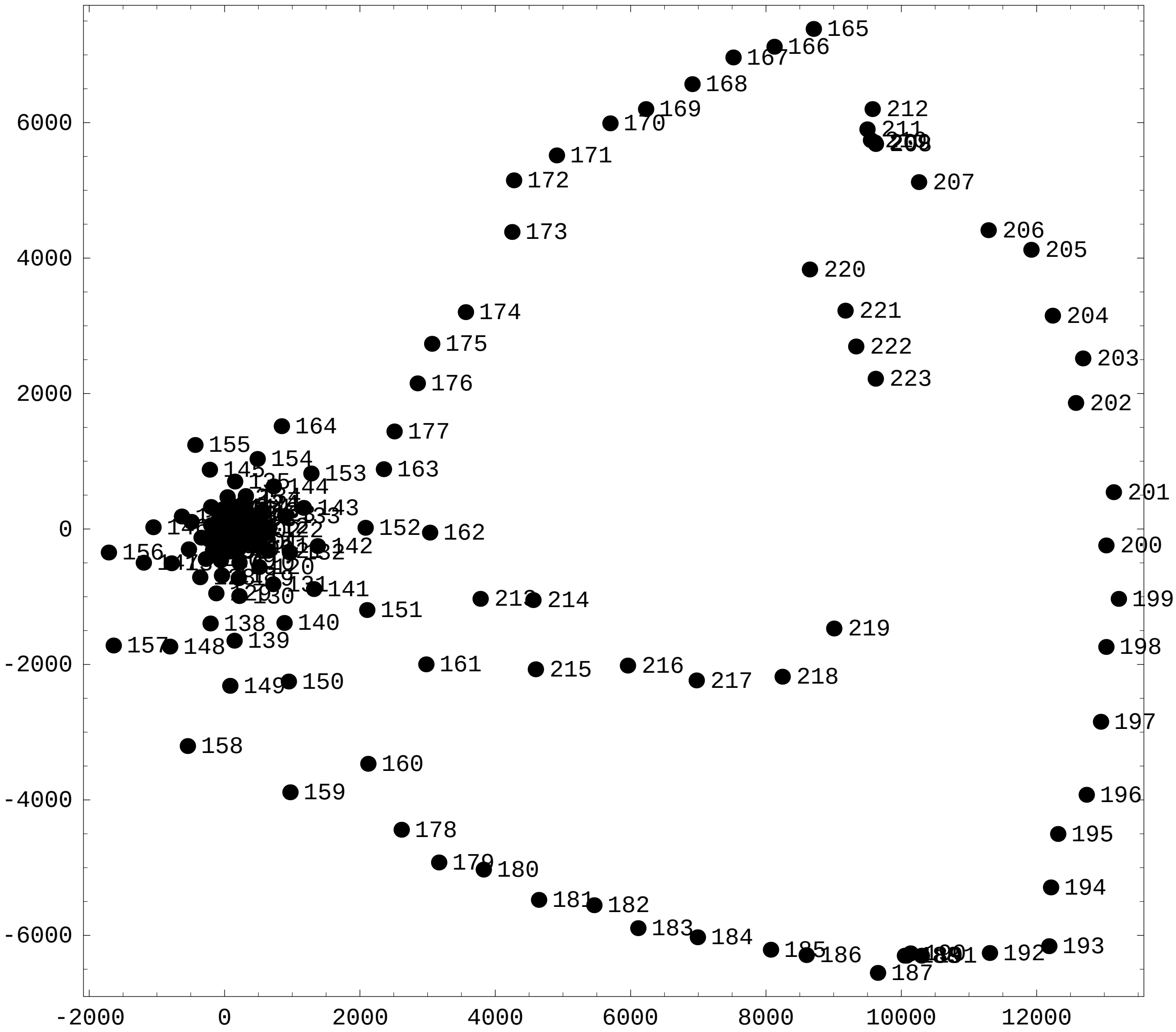

Fig. 1.— The grand view of the pad layout. The numbers correspond to those in Table 1. The coordinates are metres offset from the niminal array centre (see caption to Table 1)

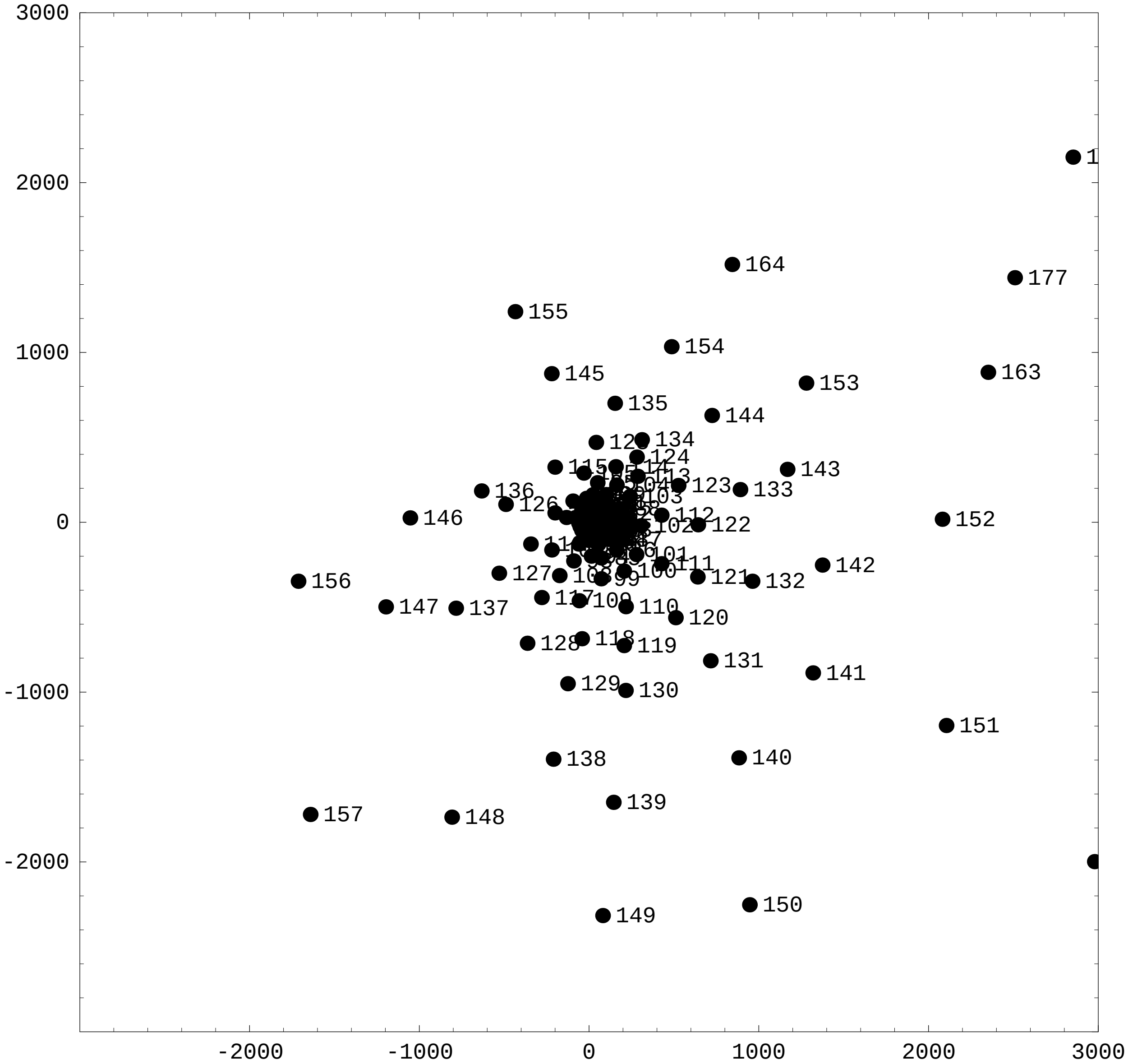

Fig. 2.— The zoom part of the array showing the not-quite-concentric rings.

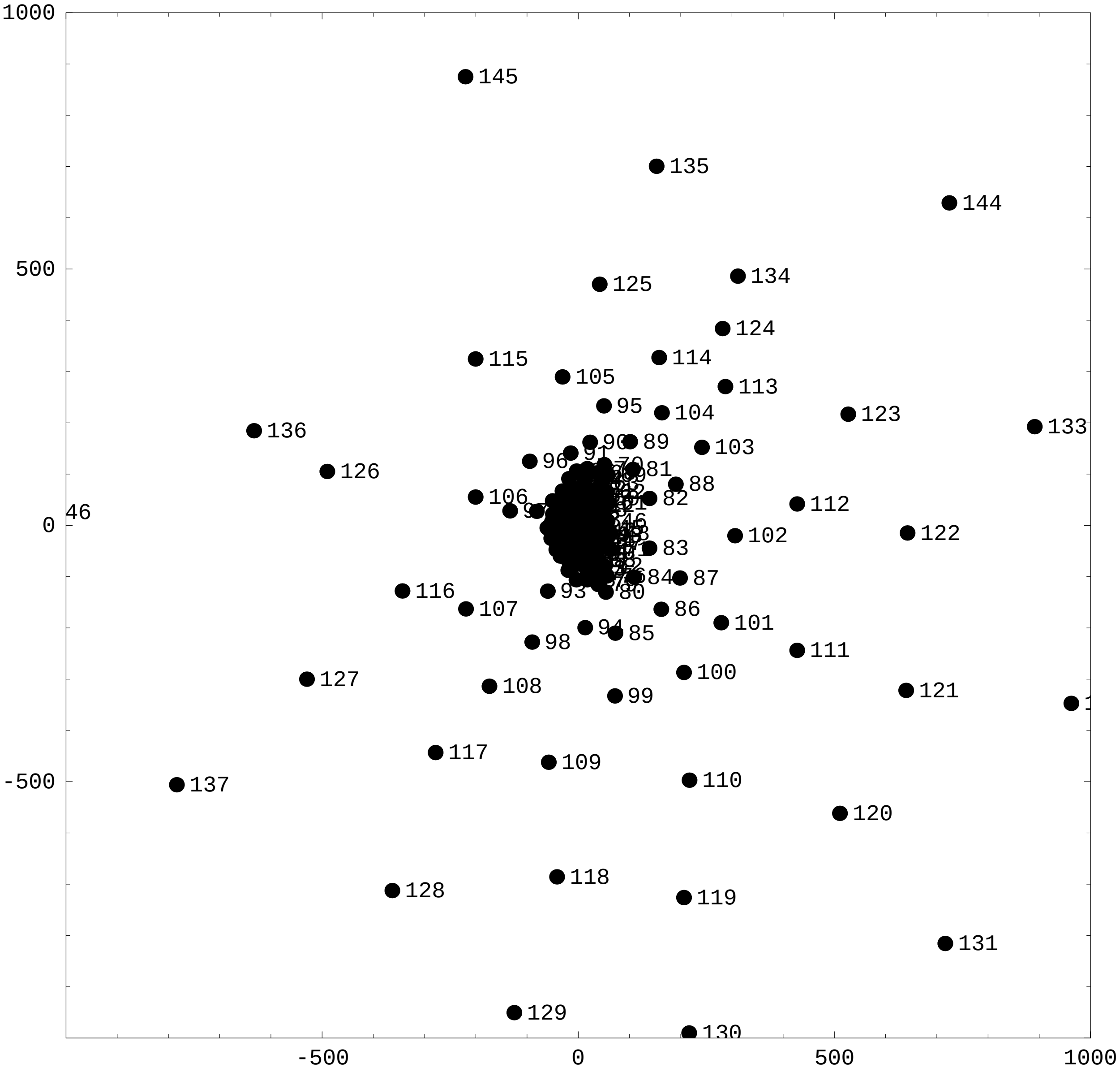

Fig. 3.— The inner rings.

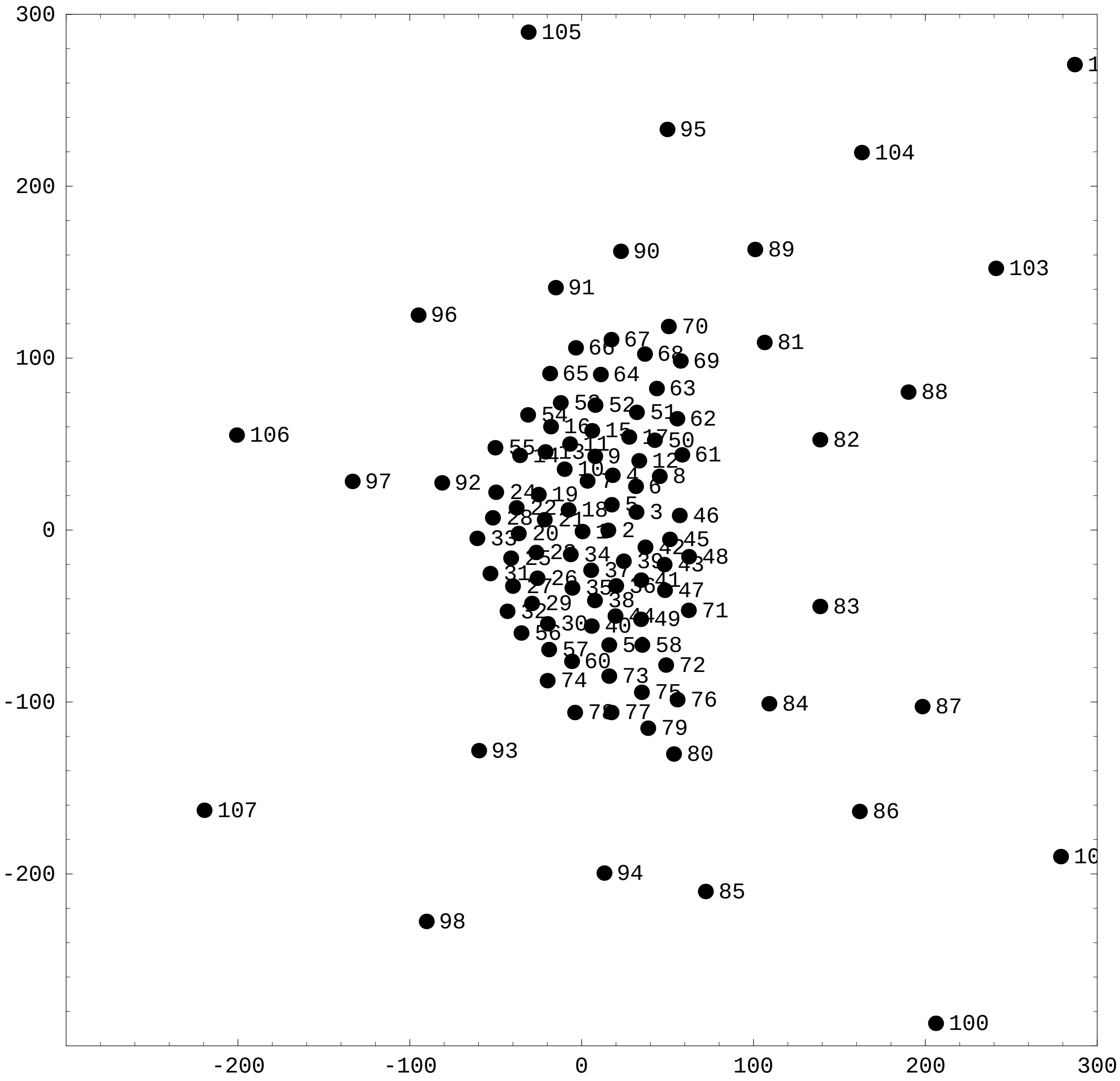

Fig. 4.— The central disc and elliptical extension.

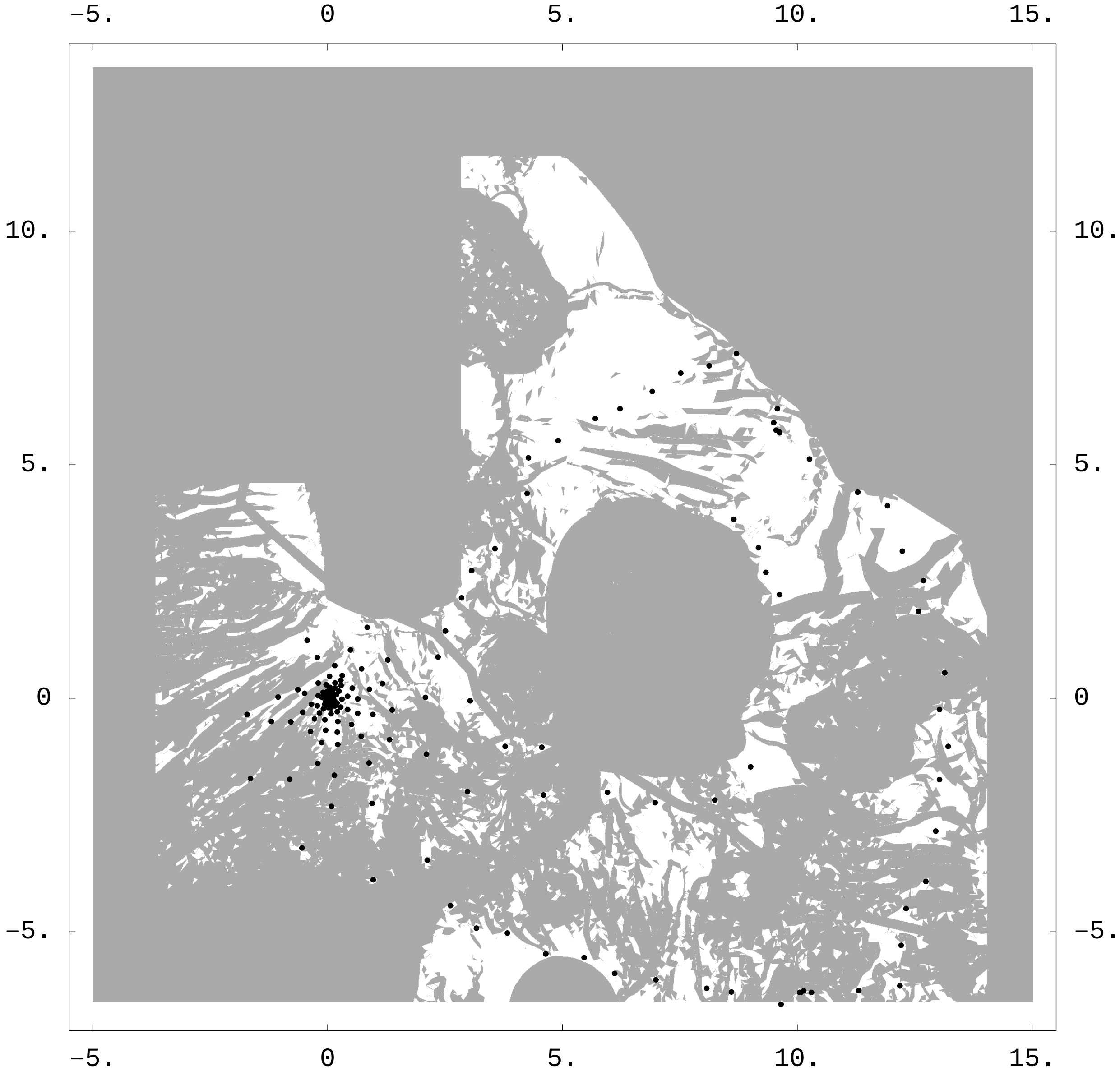

Fig. 5.— The pads superimposed on Bryan Butler's 5 degree mask.

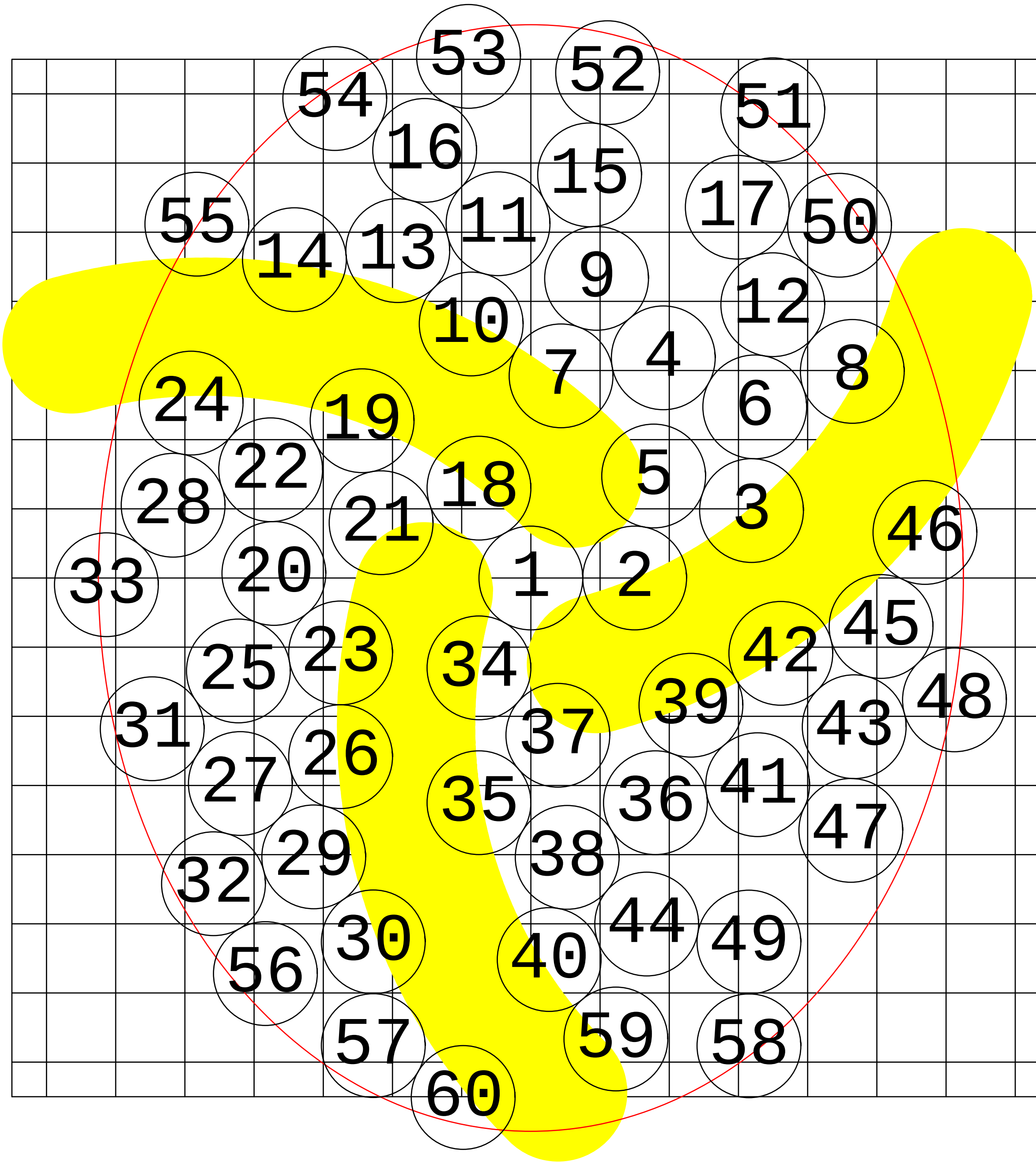

Fig. 6.— The central disc, showing the modest ellipticity and the 3 main roads into this most compact part of the array.

Table 1: The positions of the pads. The (x,y) coordinates are in metres and are quoted twice, first from an origin at the array centre, (627807.166, 7453228.830 UTM) and secondly in the Chilean UTM system.

pad	x	y	x	y
1	0	0	627808	7453229
2	15	0	627823	7453229
3	32	10	627839	7453239
4	18	32	627825	7453261
5	17	15	627825	7453244
6	32	25	627839	7453254
7	3	29	627811	7453257
8	45	31	627853	7453260
9	8	43	627815	7453272
10	-10	35	627797	7453264
11	-7	50	627800	7453279
12	33	40	627841	7453269
13	-21	45	627786	7453274
14	-36	43	627771	7453272
15	6	58	627813	7453287
16	-18	60	627789	7453289
17	28	54	627835	7453283
18	-8	12	627799	7453241
19	-25	21	627782	7453249
20	-37	-2	627770	7453227
21	-22	6	627786	7453235
22	-38	13	627769	7453242
23	-27	-13	627781	7453216
24	-50	22	627757	7453251
25	-41	-16	627766	7453212
26	-26	-28	627781	7453201
27	-40	-33	627767	7453196
28	-52	7	627755	7453236
29	-29	-43	627778	7453186
30	-20	-55	627787	7453174
31	-53	-25	627754	7453204
32	-43	-47	627764	7453182
33	-61	-5	627746	7453224
34	-6	-14	627801	7453215
35	-5	-34	627802	7453195
36	20	-32	627827	7453196
37	5	-23	627813	7453205
38	8	-41	627815	7453188
39	24	-18	627832	7453211
40	6	-56	627813	7453173

Table 2: Table 1 continued.

pad	x	y	x	y
41	35	-29	627842	7453200
42	37	-10	627844	7453219
43	48	-20	627855	7453209
44	20	-50	627827	7453179
45	51	-5	627858	7453223
46	57	8	627864	7453237
47	48	-35	627856	7453194
48	62	-15	627870	7453213
49	34	-52	627842	7453177
50	42	52	627850	7453281
51	32	68	627839	7453297
52	8	73	627815	7453301
53	-12	74	627795	7453303
54	-31	67	627776	7453296
55	-50	48	627757	7453277
56	-35	-60	627772	7453169
57	-19	-70	627788	7453159
58	35	-67	627842	7453162
59	16	-67	627823	7453162
60	-6	-76	627801	7453152
61	58	44	627866	7453273
62	56	65	627863	7453294
63	44	82	627851	7453311
64	11	90	627818	7453319
65	-18	91	627789	7453320
66	-3	106	627804	7453335
67	17	111	627824	7453340
68	37	102	627844	7453331
69	58	98	627865	7453327
70	51	118	627858	7453347
71	62	-47	627869	7453182
72	49	-79	627856	7453150
73	16	-85	627823	7453144
74	-20	-88	627787	7453141
75	35	-94	627842	7453134
76	56	-99	627863	7453130
77	17	-106	627824	7453123
78	-4	-106	627803	7453123
79	39	-115	627846	7453114
80	54	-130	627861	7453099

Table 3: Table 1 continued.

pad	x	y	x	y
81	106	109	627914	7453338
82	139	53	627946	7453281
83	139	-44	627946	7453184
84	109	-101	627916	7453128
85	72	-210	627879	7453019
86	162	-164	627969	7453065
87	198	-103	628005	7453126
88	190	80	627997	7453309
89	101	163	627908	7453392
90	23	162	627830	7453391
91	-15	141	627792	7453370
92	-81	27	627726	7453256
93	-60	-128	627747	7453101
94	13	-200	627820	7453029
95	50	233	627857	7453462
96	-95	125	627712	7453354
97	-133	28	627674	7453257
98	-90	-228	627717	7453001
99	71	-333	627879	7452896
100	206	-287	628013	7452942
101	279	-190	628086	7453039
102	306	-20	628113	7453209
103	241	152	628048	7453381
104	163	220	627970	7453448
105	-31	290	627776	7453518
106	-201	55	627606	7453284
107	-220	-163	627588	7453066
108	-174	-314	627633	7452915
109	-58	-462	627749	7452767
110	217	-497	628024	7452732
111	427	-244	628234	7452985
112	427	42	628234	7453271
113	287	271	628094	7453500
114	158	327	627965	7453556
115	-201	325	627606	7453553
116	-343	-128	627464	7453101
117	-279	-443	627528	7452786
118	-42	-686	627765	7452543
119	206	-726	628013	7452503
120	511	-562	628318	7452667

Table 4: Table 1 continued.

pad	x	y	x	y
121	640	-322	628447	7452907
122	643	-15	628450	7453214
123	527	217	628334	7453446
124	282	384	628089	7453613
125	42	470	627849	7453699
126	-490	105	627317	7453334
127	-530	-300	627277	7452929
128	-363	-712	627444	7452516
129	-125	-950	627682	7452278
130	216	-990	628023	7452239
131	716	-816	628523	7452413
132	962	-347	628769	7452882
133	891	192	628698	7453421
134	311	486	628119	7453715
135	153	700	627960	7453929
136	-633	185	627174	7453413
137	-784	-506	627023	7452723
138	-210	-1395	627597	7451834
139	145	-1649	627952	7451580
140	883	-1387	628690	7451842
141	1319	-887	629127	7452342
142	1375	-252	629182	7452977
143	1169	312	628976	7453540
144	724	629	628531	7453858
145	-220	875	627587	7454104
146	-1054	26	626753	7453255
147	-1197	-498	626610	7452731
148	-808	-1736	626999	7451493
149	81	-2316	627888	7450913
150	946	-2252	628754	7450977
151	2105	-1197	629912	7452032
152	2081	18	629889	7453247
153	1280	820	629087	7454048
154	486	1034	628293	7454263
155	-435	1240	627372	7454469
156	-1713	-347	626095	7452882
157	-1641	-1720	626166	7451508
158	-546	-3205	627261	7450024
159	970	-3887	628777	7449342
160	2121	-3467	629928	7449762

Table 5: Table 1 continued.

pad	x	y	x	y
161	2978	-1998	630785	7451231
162	3034	-54	630841	7453175
163	2351	883	630158	7454112
164	843	1518	628650	7454747
165	8704	7383	636511	7460612
166	8124	7120	635931	7460349
167	7518	6962	635325	7460191
168	6911	6568	634718	7459797
169	6226	6200	634033	7459428
170	5699	5989	633506	7459218
171	4908	5516	632715	7458745
172	4275	5148	632082	7458377
173	4249	4385	632056	7457614
174	3563	3202	631370	7456431
175	3065	2734	630872	7455963
176	2852	2150	630659	7455379
177	2509	1440	630316	7454669
178	2614	-4440	630422	7448788
179	3168	-4923	630975	7448305
180	3827	-5029	631634	7448200
181	4644	-5476	632451	7447753
182	5461	-5555	633268	7447674
183	6111	-5893	633918	7447335
184	6990	-6028	634797	7447201
185	8071	-6212	635878	7447017
186	8598	-6291	636405	7446938
187	9653	-6554	637460	7446675
188	10050	-6300	637857	7446929
189	10075	-6300	637882	7446929
190	10136	-6265	637943	7446964
191	10300	-6300	638107	7446929
192	11307	-6260	639114	7446969
193	12183	-6159	639991	7447069
194	12210	-5292	640017	7447937
195	12315	-4503	640122	7448726
196	12737	-3924	640544	7449305
197	12948	-2846	640755	7450383
198	13027	-1742	640834	7451487
199	13212	-1032	641019	7452197
200	13027	-243	640834	7452986

Table 6: Table 1 continued.

pad	x	y	x	y
201	13137	543	640945	7453772
202	12579	1861	640386	7455090
203	12684	2518	640491	7455747
204	12236	3149	640043	7456378
205	11920	4122	639727	7457351
206	11287	4411	639094	7457640
207	10259	5121	638066	7458350
208	9622	5684	637429	7458913
209	9609	5706	637416	7458934
210	9549	5741	637356	7458969
211	9497	5901	637304	7459129
212	9574	6200	637381	7459428
213	3780	-1031	631588	7452197
214	4560	-1050	632368	7452179
215	4597	-2071	632404	7451157
216	5958	-2017	633765	7451212
217	6974	-2236	634781	7450993
218	8244	-2181	636051	7451048
219	9006	-1469	636813	7451760
220	8647	3832	636454	7457060
221	9173	3223	636980	7456452
222	9331	2694	637138	7455923
223	9620	2218	637427	7455447