

Pad numbers and locations for the inner 172 pads

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Abstract

1 Introduction

This specification documents gives the pad numbers, positions and a reconfiguration scheme of the first 172 pads of baseline ALMA. The pads specified in this document will be used for configurations of ALMA with maximum baselines out to 4km. An additional number of pads (approximately 42) will be needed for the larger configurations. The positions and numbering of these pads will be presented in a future specifications document. The pads described in the document refer only to the requirements of baseline ALMA (joint US-Europe project). If there is future Japanese participation additional pads for both 12m diameter and smaller diameter antennas may be specified, these specifications are beyond the scope of this document.

Section 2 describes the pad numbers and positions. Section 2.1 and the landmarks and monuments which define the coordinate system and the relative and absolute pad positions. Section 2.2 describes the horizontal tolerances on the pad positions. Section 2.3 specifies the vertical displacement of the pads. Section 3 gives a partial reconfiguration scheme for the array which may be useful in designing the road topology.

2 Pad Numbers and Positions

2.1 Relative pad Positions for Surveying

Tables 1 to 4 give pad positions relative to the array centre point, and the position of the array centre point is defined relative to the monument 'Master 0'. This monument is approximately 50m East of the NRAO container. The array centre relative to this monument is defined to be

720.4 m SOUTH of 'Master

and

39.5 m WEST of 'Master 0'

The monuments 'Master 0' together with monument 'Master 71' is used to define absolute positions and directions at the site. Their positions have measured by differential GPS in the PSAm56 datum and were found to be,

Master0: E=627829.73 m; N=7453791.35 m
Master71: E=628080.54 m; N=7454663.06 m

These monuments have been chosen to define surveying at the site because both are visible in high resolution ariel photography. The pad positions have been fitted to digital elevation models derived from this photography. To ensure that there is no ambiguity in placing the pads relative to terrain features the pad positions are defined in Table 1 are referenced directly to the above monuments rather than given in absolute coordinates.

2.2 Absolute Pad Positions

To obtain absolute pad positions from the pad positions in Tables 1 to 4 for comparison with published the offsets must be added to the an absolute position for the array centre. As noted above the array centre is referenced to the position of 'Monument 0'. Using the position of Monument 0 and the offset of the array centre relative to this (both given in Section 2.1) the position of the array centre in the PSam56 datum is

Array Centre (PSam56 Datum) : E=627790.23 m; N=7453070.95 m

The contour .dwg maps produced by the AEROTOP ariel surveying company have been modified to account for the ellipsoidal deformation in the UTM system and the difference in height of points following the local topography. In this *Aerotop corrected PSam56* coordinate system the position of 'Monument 0' is E=627859.21 m, N= 7453793.38 m, hence in this reference frame the array centre is at absolute coordinates;

Array Centre (Aerotop corrected PSam56 Datum) : E=627819.71 m; N=7453072.98 m

For inter-comparisons with the above .dwg contour map produced by Aerotop the above array centre position should be used.

2.3 Horizontal Positions Tolerances

Tables 1 to 4 give two tolerances for the horizontal position of a pad relative to the centre. The astronomical performance depends on these relative pad positions, and these tolerances reflect the size of shifts in pad position which will start to effect astronomical performance. Any pad can be moved up to a distance of 'Tolerance 1' without any significant effect on performance. Tolerance 1 therefore indicates the size of required construction tolerance. The larger Tolerance 2 indicates the maximum distance any pad should be moved from its nominal position in order to avoid terrain obstacles. Only a limited number of pads should be moved this distance. The different pads are allocated 'Radius groups' depending on their distance from the centre of the array. It is recommended that no more than 5 pads in any radius group is displaced by amounts between 'Tolerance 1' and 'Tolerance 2'. Changes exceeding these guidelines should be referred back to the Configuration group of the Science IPT for confirmation.

For pads in radius group 1 the two tolerances are set equal to each other. For pads in this radius group tolerances are set primarily based on transporter access and telescope non-interference criteria.

There are 9 pads that are in lettered Radius Groups A,B,C. Group A consists of pads 115,123,170. Group B of pads 114,122,171 and Group C of pads 124,132,172. The relative positions of pads in each lettered group are critical, hence all pads in group A must keep the same relative position. If a shift is applied to one pad in such a group it must be applied to all. The allowed maximum shift is given in the Tolerance 1 and 2 columns.

2.4 Vertical Position Tolerances

The pads numbers 1 to 68 are presently specified to have the same height within a tolerance of 1cm. Pads 78, 69 70, 71, 72 and 84 South of the compact group should have height within 0.5m of those of the compact groups. The configuration group is investigating the effects of allowing groups of antennas within the compact group (pad numbers 1 to 68) to have different heights ('terracing'). There is no specification on the heights of any other pads.

Table 1: Pad Number and locations relative to array centre

Pad Number	Radius Group	Position East of centre(m)	Position North of centre(m)	Tolerance 1 (m)	Tolerance 2 (m)
1	1	-0.41	8.64	0.01	0.01
2	1	16.29	11.61	0.01	0.01
3	1	11.11	27.75	0.01	0.01
4	1	28.29	-3.06	0.01	0.01
5	1	58.38	-22.38	0.01	0.01
6	1	53.75	-2.88	0.01	0.01
7	1	48.96	19.40	0.01	0.01
8	1	43.02	33.79	0.01	0.01
9	1	23.77	56.26	0.01	0.01
10	1	12.75	68.36	0.01	0.01
11	1	72.88	-33.42	0.01	0.01
12	1	71.93	-15.44	0.01	0.01
13	1	68.59	0.31	0.01	0.01
14	1	64.26	22.38	0.01	0.01
15	1	33.79	18.83	0.01	0.01
16	1	50.19	47.09	0.01	0.01
17	1	44.22	60.97	0.01	0.01
18	1	25.37	77.62	0.01	0.01
19	1	13.13	86.40	0.01	0.01
20	1	26.00	41.22	0.01	0.01
21	1	-7.95	-4.47	0.01	0.01
22	1	-16.80	10.21	0.01	0.01
23	1	-26.66	-1.78	0.01	0.01
24	1	-10.07	29.29	0.01	0.01
25	1	-9.88	68.51	0.01	0.01
26	1	-26.11	52.32	0.01	0.01
27	1	-40.04	35.99	0.01	0.01
28	1	-50.17	19.23	0.01	0.01
29	1	-52.83	-9.35	0.01	0.01
30	1	-59.45	-23.61	0.01	0.01
31	1	-9.73	83.80	0.01	0.01
32	1	-23.12	76.96	0.01	0.01
33	1	-36.23	64.93	0.01	0.01
34	1	-51.66	47.46	0.01	0.01
35	1	-33.34	20.86	0.01	0.01
36	1	-64.65	26.88	0.01	0.01
37	1	-69.74	2.88	0.01	0.01
38	1	-74.11	-18.77	0.01	0.01
39	1	-74.39	-34.07	0.01	0.01
40	1	-43.04	2.38	0.01	0.01
41	1	7.30	-4.76	0.01	0.01
42	1	-0.85	-22.42	0.01	0.01
43	1	17.80	-25.01	0.01	0.01
44	1	-17.69	-24.37	0.01	0.01
45	1	-45.37	-43.48	0.01	0.01
46	1	-31.10	-49.34	0.01	0.01
47	1	-9.83	-55.68	0.01	0.01
48	1	8.63	-56.62	0.01	0.01
49	1	34.58	-42.25	0.01	0.01
50	1	49.73	-43.82	0.01	0.01

Table 2: Pad Number and locations relative to array centre

Pad Number	Radius Group	Position East of centre(m)	Position North of centre(m)	Tolerance 1 (m)	Tolerance 2 (m)
51	1	-60.71	-51.75	0.01	0.01
52	1	-47.25	-58.55	0.01	0.01
53	1	-30.78	-64.61	0.01	0.01
54	1	-12.51	-70.60	0.01	0.01
55	1	-2.13	-39.39	0.01	0.01
56	1	14.51	-73.58	0.01	0.01
57	1	30.33	-68.60	0.01	0.01
58	1	48.30	-60.23	0.01	0.01
59	1	62.56	-53.50	0.01	0.01
60	1	19.53	-43.28	0.01	0.01
61	1	-59.32	-82.47	0.01	0.01
62	1	-44.42	-84.96	0.01	0.01
63	1	-28.87	-89.73	0.01	0.01
64	1	-12.83	-95.51	0.01	0.01
65	1	12.21	-95.92	0.01	0.01
66	1	30.03	-95.15	0.01	0.01
67	1	44.22	-89.78	0.01	0.01
68	1	59.96	-84.46	0.01	0.01
69	1	-29.86	-114.82	0.01	0.01
70	1	-12.94	-118.65	0.01	0.01
71	1	14.50	-119.39	0.01	0.01
72	1	36.45	-114.65	0.01	0.01
73	1	58.61	65.83	0.01	0.01
74	1	-76.01	36.89	0.01	0.01
75	1	28.38	102.40	0.01	0.01
76	1	-113.99	-3.79	0.01	0.01
77	1	-27.99	103.51	0.01	0.01
78	1	-60.50	-105.84	0.01	0.01
79	2	123.5	-4.2	1.2	6.2
80	2	-94.9	77.0	1.2	6.1
81	2	-12.9	-143.0	1.4	7.2
82	2	96.9	79.9	1.3	6.3
83	2	-152.3	-3.1	1.5	7.6
84	2	49.3	-125.6	1.3	6.7
85	2	60.0	129.0	1.4	7.1
86	2	-146.1	-101.3	1.8	8.9
87	2	146.3	-60.2	1.6	7.9
88	2	-9.1	151.2	1.5	7.6
89	2	-46.6	-151.3	1.6	7.9
90	2	147.8	64.6	1.6	8.1
91	2	-123.0	143.1	1.9	9.4
92	2	55.0	-185.2	1.9	9.7
93	2	118.1	142.5	1.9	9.3
94	2	-186.6	38.5	1.9	9.5
95	2	167.7	-122.3	2.1	10.4
96	2	36.5	212.7	2.2	10.8
97	2	-215.4	-70.9	2.3	11.3
98	2	225.3	25.8	2.3	11.3
99	2	-103.1	211.7	2.4	11.8
100	2	-100.2	-240.5	2.6	13.0

Table 3: Pad Number and locations relative to array centre

Pad Number	Radius Group	Position East of centre(m)	Position North of centre(m)	Tolerance 1 (m)	Tolerance 2 (m)
101	2	175.8	147.1	2.3	11.5
102	3	-247	111	3	14
103	3	19	-257	3	13
104	3	105	286	3	15
105	3	-298	-51	3	15
106	3	152	-276	3	16
107	3	-53	301	3	15
108	3	-231	-181	3	15
109	3	226	-33	2	11
110	3	-276	193	3	17
111	3	-9	-404	4	20
112	3	218	159	3	13
113	3	-406	16	4	20
114	B	177	-374	20	20
115	A	205	331	20	20
116	3	-390	-193	4	22
117	3	432	-87	4	22
118	3	28	444	4	22
119	3	-143	-502	5	26
120	3	411	125	4	21
121	3	-278	443	5	26
122	B	129	-543	20	20
123	A	356	366	20	20
124	C	-548	220	20	20
125	4	478	-401	6	31
126	4	119	627	6	32
127	4	-599	-145	6	31
128	4	616	-27	6	31
129	4	-269	587	6	32
130	4	-423	-535	7	34
131	4	446	474	7	33
132	C	-618	359	20	20
133	4	5	-687	7	34
134	4	262	739	8	39
135	4	-786	11	8	39
136	4	516	-566	8	38
137	4	-184	1064	11	54
138	4	-674	-507	8	42
139	4	758	-215	8	39
140	4	-439	407	6	30
141	4	-193	-991	10	50
142	4	847	312	9	45
143	4	-1006	128	10	51
144	4	956	-590	11	56
145	4	584	995	12	58
146	4	-873	-686	11	56
147	5	878	-934	13	64
148	5	-1	1299	13	65
149	5	-544	-1123	12	62
150	5	1103	139	11	56

Table 4: Pad Number and locations relative to array centre

Pad Number	Radius Group	Position East of centre(m)	Position North of centre(m)	Tolerance 1 (m)	Tolerance 2 (m)
151	5	-707	1142	13	67
152	5	450	-972	11	54
153	5	921	1101	14	72
154	5	-1246	113	13	63
155	5	1151	-1078	16	79
156	5	301	1811	18	92
157	5	-1398	-423	15	73
158	5	1595	-32	16	80
159	5	-634	1502	16	82
160	5	-1021	-1560	19	93
161	5	1583	1096	19	96
162	5	-1214	1112	16	82
163	5	-289	-1283	13	66
164	5	688	1951	21	103
165	5	-1691	-139	17	85
166	5	1131	-1943	22	112
167	5	-365	2246	23	114
168	5	-1676	-1611	23	116
169	5	1837	-883	20	102
170	A	240	343	20	20
171	B	168	-409	20	20
172	C	-558	249	20	20

3 Pad Occupation Scheme

In this section we give a pad occupation scheme assuming 60 operational telescopes (other telescopes are assumed in repair or not functional due to receiver faults etc). Modified occupation schemes in which the additional pads to be occupied when there are more than 60 antennas will be given in a future specification.

The array will be reconfigured continuously. Pads will start in the 'Compact array' (Configuration 1) with pads 1 to 60 occupied. Every 2 to 5 days (depending on the long term reconfiguration schedule) 4 antennas will be moved (2 pads per transporter and 2 transporters). Antennas are generally picked up from the centre and deposited on one of the lowest numbered unoccupied pads. Motion of pads is therefore primarily radial. In the scheme indicated in Table 5 there are 28 different circularly symmetric configurations. There will be approximately 10 more configurations in the outer part of the array which will utilise pads of numbers 173 and higher (to be specified). Once the largest array is reached pads will be reconfigured in reverse moving pads from the outside to the inside. In this phase the pad occupation scheme for small numbered arrays will be modified to produce so-called North-South extended arrays for observing sources at low elevations. One of these North-South extended arrays is specified in Table 5. A complete specification of low numbered NS extended arrays will be given in a future specifications document.

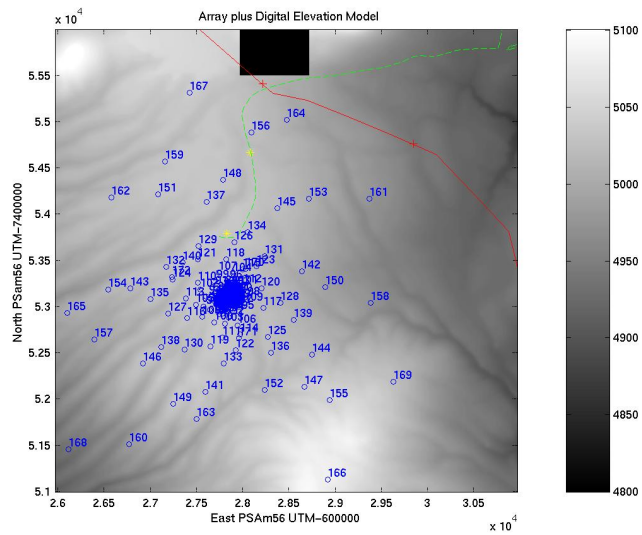


Figure 1: The pad positions overlaid on a grayscale showing Elevation (Black 4800m - White 5100m). The horizontal and vertical scales use the array centre defined in the unmodified PSAm56 Datum (see Section 2.1). The two yellow stars indicate the monuments 'Master 0' and 'Master 71'. The green dotted line is the existing access road to the site from the Jama highway. The red line is the pipeline and red crosses the positions of reinforced crossing points.

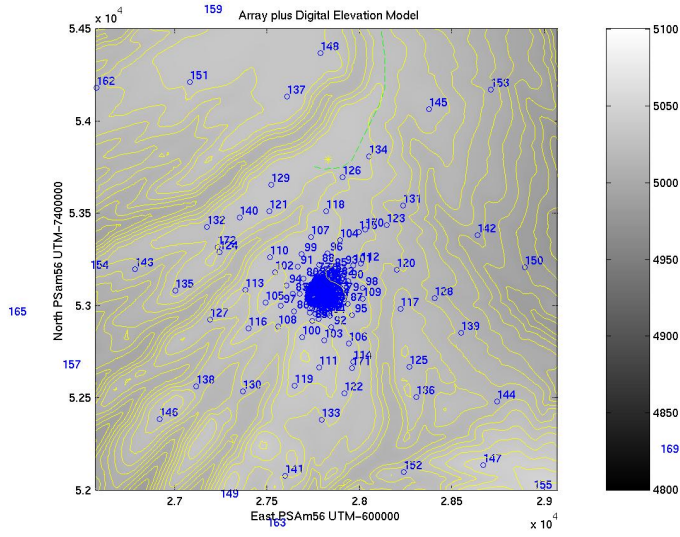


Figure 2: Zoom of the outer intermediate pads. Grayscale is elevation. Contours are at 5m intervals.

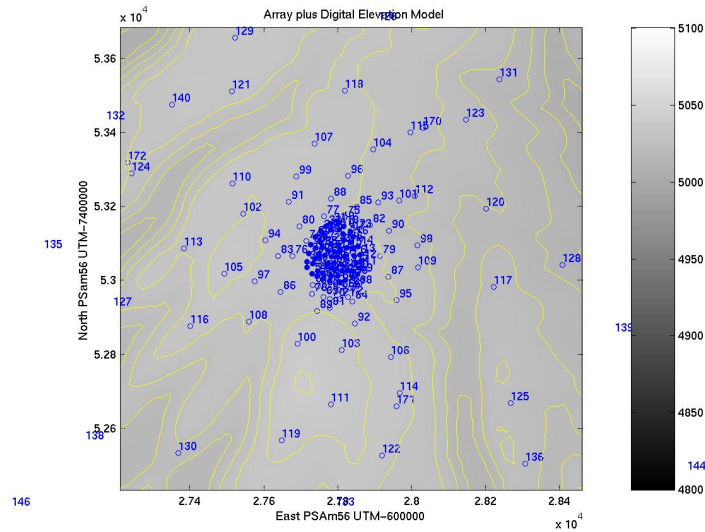


Figure 3: Zoom of the inner intermediate pads. Grayscale is elevation. Contours are at 5m intervals.

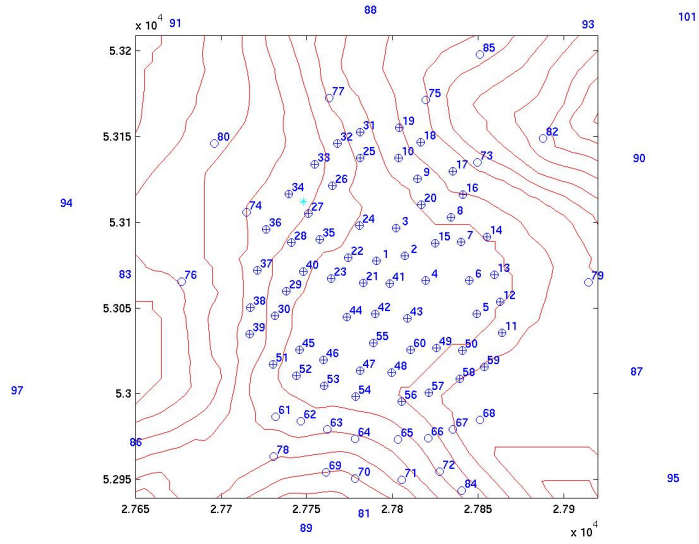


Figure 4: The Compact part of the area. Contours are at 0.5 intervals.