Combined Array for Research in Millimeter-Wave Astronomy

CARMA Memorandum Series #24

Antenna Configuration Evaluation

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ABSTRACT

In this memo we show that the array performance is improved by eliminating two stations, reducing the costs of stations, power and fiber connections and roads, and time spent in antenna reconfigurations. The modified C configuration uses station 57 instead of station 33 which was only used in CARMA C configuration. The modified A configuration uses station 20 from the B configuration instead of station 8 which was only used in the A configuration. For each configuration we simulated observations from -2 to +2 hours sampled at 36 sec intervals. In practice, observations will be interrupted by calibrations and not sampled symmetrically about transit. The effects of the proposed changes are smaller than the effect of the heterogeneous antenna sizes, different weighting, and non optimum sampling of the data. We eliminate a NS station and a section of the loop road and power and fiber distribution. The modified A configuration has a shorter minimum uv spacing and more overlap with the B configuration, allowing better calibration between A and B configurations and more reliable estimates of decorrelation from atmospheric turbulence.

Change Record

Revision	Date	Author	Sections/Pages Affected
	Remarks		
1.0	2004-Mar-24	MCHW	1-10
	Original email text mailed to CARMA working group		
1.1	2004-Apr-07	MCHW	1-10
	Added tables for heterogeneous arrays		
1.2	2004-Apr-28	MCHW	1-1
	improved abstract		
1.3	2004-Apr-29	MCHW	1-10
	submitted as CARMA memo		

1. Introduction

The current CARMA antenna configurations for Cedar Flat are based on studies of the uv-coverage and synthesised beam characteristics obtained with 15 antennas (CARMA memo 19 and 20)

Changes to the antenna configuration were required to accommodate the boundaries and topography of the chosen site, and a revised center location for the CARMA C/D/E arrays was chosen (CARMA memo 23)

In this memo we show that the beam characteristics are not significantly changed by eliminating two stations.

2. Results

We compare the performance of the original and modified CARMA configurations.

The fitting procedures are simple **unix csh** scripts which control **MIRIAD** tasks. (CARMA memo 5). These scripts are similar to those used for ALMA and ATA simulations, but are slightly more complex because of the different antenna sizes used in the heterogeneous CARMA telescope. The script generates uv-data for a point source with thermal and atmospheric phase noise, does a phase calibration, and makes an image and beam. A Gaussian fit is made to the synthesised beam, and the results written into a table. The brightness sensitivity, beam FWHM, and residual sidelobe level after the fit are calculated. In addition the script plots the uvcoverage and beam where one can inspect the 2D uvcoverage and sidelobe distribution.

Table 1 lists the synthesized beam FWHM, brightness sensitivity, Tb rms, synthesized beam sidelobe levels, fraction of unshadowed data used in synthesized beam, Nvis, and uvrange for declinations 30, 0 and -30 for the current configurations.

Table 2 compares the current and modified CARMA C configuration using station 57 instead of station 33 which was only used in CARMA C configuration. The beam characteristics are listed for the original and modified (Cp) configuration for declinations 45, 30, 15, 0, -15, and -30 degrees.

The original and modified beam FWHM are the same within 0.01 arcsec, the uvrange is the same, and the sidelobe levels are better for 4 of the 6 sampled declinations.

Table 3 compares the current and modified CARMA (Ap) configuration which uses station 20 from the B configuration instead of station 8 which was only used in the A configuration. Here, the goal was to eliminate a NS station and a section of the loop road and power and fiber distribution.

The change in the beam shape and sidelobe levels is again very small. The modified A configuration has a shorter minimum uv spacing and more overlap with the B configuration. Both these features have proved desirable from experience with the BIMA long baselines. The beam is rounder at all declinations, and the brightness sensitivity 10% better at high declination.

Table 4 and 5 list the beam characteristics for the CARMA configurations when the stations are populated with 6 and 10m antennas in two different ways. In Table 4 the first 6 antennas are 10m and the last 9 are

6m. In Table 5 the last 6 antennas are 10m and the first 9 are 6m.

For each configuration we simulated observations from -2 to +2 hours sampled at 36 sec intervals. In practice, observations will be interrupted by calibrations and not sampled symmetrically about transit.

The effects of the proposed changes are smaller than the effect of the heterogeneous antenna sizes, different weighting, and non optimum sampling of the data.

3. Conclusion

In this memo we show that the beam characteristics are not significantly changed by eliminating two stations. The modified C configuration uses station 57 instead of station 33 which was only used in CARMA C configuration. The modified A configuration uses station 20 from the B configuration instead of station 8 which was only used in the A configuration. We eliminate a NS station and a section of the loop road and power and fiber distribution. The modified A configuration has a shorter minimum uv spacing and more overlap with the B configuration, allowing better calibration between A and B configurations and more reliable estimates of decorrelation from atmospheric turbulence.

Overall the array performance is improved by reducing the costs of stations, power and fiber connections and roads, and time spent in antenna reconfigurations.

REFERENCES

CARMA memo 5, Compact Configuration Evaluation for CARMA, Melvyn Wright, Sep 2002

CARMA memo 19, Version 1 CARMA Configurations for Cedar Flat, Tamera Helfer and Melvyn Wright, February 2004.

CARMA memo 20, Version 2 CARMA Configurations for Cedar Flat, Tamera Helfer, February 2004.

CARMA memo 23, Lots in Translation: A Revised Center Location for the CARMA C/D/E Arrays, Glen Petitpas, March 2004.

Table 1: current configurations

Config	DEC	HA	Rms	FWHM	Tb rms		Sidelobe[%]		Nvis	uvrange	
	degrees	[hrs]	[mJy]	[arcsec]	[mK]	Rms	Max	Min	[%]	[m]	
A	30	-2,2,.01	0.23	0.15 x 0.12	295.4	1.8	9.3	-7.0	100	181	1886
B	30	-2,2,.01	0.23	0.37 x 0.30	47.9	2.1	10.9	-6.9	100	82	946
C	30	-2,2,.01	0.23	0.91 x 0.75	7.8	2.0	10.0	-6.0	100	25	373
D	30	-2,2,.01	0.23	2.22 x 1.91	1.3	2.0	10.0	-6.2	100	10	149
E	30	-2,2,.01	0.23	4.49 x 3.95	0.3	1.9	8.8	-6.7	100	8	66
A	0	-2,2,.01	0.27	0.16 x 0.15	260.1	2.5	29.3	-7.1	100	144	1833
B	0	-2,2,.01	0.27	0.38 x 0.37	44.4	2.6	27.1	-11.6	100	65	899
C	0	-2,2,.01	0.27	0.94 x 0.91	7.3	2.6	34.5	-8.0	100	18	324
D	0	-2,2,.01	0.27	2.39 x 2.22	1.2	2.6	29.5	-9.6	100	8	129
E	0	-2,2,.01	0.27	5.00 x 4.44	0.3	2.6	47.0	-9.5	100	6	65
A	-30	-2,2,.01	0.56	0.32 x 0.15	269.7	1.8	9.0	-6.7	100	62	1692
B	-30	-2,2,.01	0.56	0.76 x 0.38	44.8	1.7	9.1	-6.6	100	31	809
C	-30	-2,2,.01	0.56	1.89 x 0.93	7.4	1.7	8.8	-6.3	100	10	284
D	-30	-2,2,.01	0.57	4.73 x 2.25	1.2	1.7	8.4	-6.5	96	5	113
E	-30	-2,2,.01	0.80	8.53 x 3.87	0.6	2.3	14.5	-9.0	49	3	56

Table 2: Modified CARMA (Cp) configuration using station 57 instead of station 33

Config	DEC	HA	Rms	FWHM	Tb rms		Sidelobe[%]		Nvis	uvrange	
	degrees	[hrs]	[mJy]	[arcsec]	[mK]	Rms	Max	Min	[%]	[m]	
C	45	-2,2,.01	0.23	0.91 x 0.75	7.8	1.8	11.7	-5.9	100	24	369
Cp	45	-2,2,.01	0.23	0.90 x 0.75	7.9	1.8	11.1	-5.9	100	24	369
C	30	-2,2,.01	0.23	0.91 x 0.75	7.8	2.0	10.0	-6.0	100	25	373
Cp	30	-2,2,.01	0.23	0.90 x 0.75	7.9	2.0	9.1	-6.3	100	25	373
C	15	-2,2,.01	0.24	0.91 x 0.81	7.5	2.2	12.1	-6.8	100	22	359
Cp	15	-2,2,.01	0.24	0.90 x 0.80	7.7	2.2	13.1	-7.1	100	22	359
C	0	-2,2,.01	0.27	0.94 x 0.91	7.3	2.6	34.5	-8.0	100	18	324
Cp	0	-2,2,.01	0.27	0.94 x 0.90	7.4	2.6	30.6	-8.3	100	18	324
C	-15	-2,2,.01	0.34	1.22 x 0.91	7.1	2.0	9.8	-6.2	100	14	305
Cp	-15	-2,2,.01	0.34	1.21 x 0.91	7.1	2.0	12.0	-6.4	100	14	305
C	-30	-2,2,.01	0.56	1.89 x 0.93	7.4	1.7	8.8	-6.3	100	10	284
Cp	-30	-2,2,.01	0.56	1.88 x 0.93	7.4	1.7	7.5	-6.1	100	10	284

Table 3: Modified CARMA (Ap) configuration using station 20 instead of station 8

Config	DEC	HA	Rms	FWHM	Tb rms		Sidelobe[%]		Nvis	uvrange	
	degrees	[hrs]	[mJy]	[arcsec]	[mK]	Rms	Max	Min	[%]	[m]	
A	45	-2,2,.01	0.23	0.15 x 0.12	295.4	1.7	8.7	-7.2	100	182	1885
Ap	45	-2,2,.01	0.23	0.15 x 0.13	272.7	1.7	7.4	-7.2	100	140	1885
A	30	-2,2,.01	0.23	0.15 x 0.12	295.4	1.8	9.3	-7.0	100	181	1885
Ap	30	-2,2,.01	0.23	0.15 x 0.13	272.7	1.8	8.2	-7.0	100	143	1885
A	15	-2,2,.01	0.24	0.15 x 0.13	284.6	1.9	13.3	-6.9	100	163	1884
Ap	15	-2,2,.01	0.24	0.15 x 0.13	284.6	2.0	14.1	-6.9	100	127	1884
A	0	-2,2,.01	0.27	0.16 x 0.15	260.1	2.5	29.3	-7.1	100	144	1833
Ap	0	-2,2,.01	0.27	0.16 x 0.15	260.1	2.5	33.4	-7.1	100	104	1833
A	-15	-2,2,.01	0.34	0.20 x 0.15	262.0	1.9	10.8	-6.8	100	108	1720
Ap	-15	-2,2,.01	0.34	0.20 x 0.15	262.0	1.9	10.8	-6.6	100	77	1720
A	-30	-2,2,.01	0.56	0.32 x 0.15	269.7	1.8	9.0	-6.7	100	62	1692
Ap	-30	-2,2,.01	0.56	0.33 x 0.15	261.6	1.7	9.2	-6.6	100	53	1692

Table 4: Heterogeneous array where the first 6 antennas are 10m and the last 9 are 6m

Config	DEC	HA	Rms	FWHM	Tb rms		Sidelobe[%]		Nvis	uvrange	
	degrees	[hrs]	[mJy]	[arcsec]	[mK]	Rms	Max	Min	[%]	[m]	
A	30	-2,2,.01	0.18	0.14 x 0.12	247.7	2.3	13.0	-9.9	100	181	1886
B	30	-2,2,.01	0.18	0.31 x 0.23	58.4	2.1	12.1	-9.0	100	81	701
C	30	-2,2,.01	0.18	1.21 x 1.02	3.4	3.4	15.7	-9.7	100	48	273
D	30	-2,2,.01	0.18	3.00 x 2.58	0.5	3.5	19.7	-10.0	100	21	108
E	30	-2,2,.01	0.18	5.77 x 5.21	0.1	2.9	16.8	-9.0	100	10	50
A	0	-2,2,.01	0.21	0.16 x 0.13	233.4	3.1	35.6	-15.7	100	144	1834
B	0	-2,2,.01	0.21	0.31 x 0.29	54.0	2.9	39.0	-14.5	100	64	696
C	0	-2,2,.01	0.21	1.43 x 1.08	3.1	4.2	48.0	-10.4	100	38	266
D	0	-2,2,.01	0.21	3.60 x 2.70	0.5	4.3	39.7	-15.3	100	17	105
E	0	-2,2,.01	0.21	7.10 x 5.29	0.1	4.2	42.6	-15.4	100	8	50
A	-30	-2,2,.01	0.43	0.32 x 0.14	221.9	2.2	12.1	-10.1	100	110	1692
B	-30	-2,2,.01	0.43	0.60 x 0.31	53.5	1.9	12.3	-8.0	100	30	688
C	-30	-2,2,.01	0.43	2.56 x 1.13	3.4	3.0	14.1	-7.5	100	25	242
D	-30	-2,2,.01	0.44	6.37 x 2.74	0.6	3.2	11.3	-8.2	96	10	96
E	-30	-2,2,.01	0.73	10.70 x 4.24	0.4	3.6	22.7	-11.7	50	3	50

Table 5: Heterogeneous array where the last 6 antennas are 10m and the first 9 are 6m

Config	DEC	HA	Rms	FWHM	Tb rms	Sidelobe[%]			Nvis	uvrange	
	degrees	[hrs]	[mJy]	[arcsec]	[mK]	Rms	Max	Min	[%]	[m]	
A	30	-2,2,.01	0.18	0.15 x 0.13	213.4	2.5	10.6	-11.8	100	181	1886
B	30	-2,2,.01	0.18	0.39 x 0.30	35.6	2.9	12.5	-11.5	100	81	701
C	30	-2,2,.01	0.18	1.18 x 0.61	5.8	2.6	14.3	-19.9	100	48	273
D	30	-2,2,.01	0.18	2.86 x 1.55	0.9	2.5	14.3	-20.3	100	21	108
E	30	-2,2,.01	0.18	3.90 x 3.52	0.3	2.2	19.2	-14.5	100	10	50
A	0	-2,2,.01	0.21	0.17 x 0.15	190.4	3.3	38.5	-13.8	100	144	1834
B	0	-2,2,.01	0.21	0.40 x 0.37	32.8	3.8	27.9	-23.8	100	64	696
C	0	-2,2,.01	0.21	1.17 x 0.76	5.5	2.8	33.8	-19.8	100	38	266
D	0	-2,2,.01	0.21	2.82 x 1.92	0.9	2.8	37.6	-21.7	100	17	105
E	0	-2,2,.01	0.21	4.42 x 3.90	0.3	3.1	43.4	-18.4	100	8	50
A	-30	-2,2,.01	0.43	0.35 x 0.16	177.5	2.4	11.6	-11.4	100	110	1692
B	-30	-2,2,.01	0.43	0.77 x 0.40	32.3	2.4	12.0	-8.0	100	30	688
C	-30	-2,2,.01	0.43	1.54 x 1.18	5.5	1.9	9.7	-15.9	100	25	242
D	-30	-2,2,.01	0.44	3.85 x 2.85	0.9	1.9	11.3	-16.7	95	10	96
E	-30	-2,2,.01	0.55	7.32 x 3.44	0.5	2.7	16.2	-14.0	43	3	50