MILLIMETER ARRAY
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Evaluation of 1 KM Millimeter Array Configurations
With Attention to RMS Sidelobe Level and Antenna Number

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Numerical simulations were run to determine the RMS sidelobe level, as described by T. Cornwell in MM array memo number 18, for four different configurations of antennas for the proposed millimeter array. The four configurations were: 1) a VLA "wye" scaled down to an arm length of 530 meters; 2) a "spiralized" array configuration generated by R. M. Hjellming where the arms of the wye in configuration (1) were rotated counter-clockwise by an angle of $60.0\times(k/N)^{1.716}$ degrees, where k is the k'th antenna along each arm and N is the number of stations along each arm; 3) a circular array where the antennas are evenly spaced around the two pi radians of the circumference; and 4) an array developed by T. Cornwell minimizing the number of redundant UV points after gridding.

Numerical simulations were performed on each of the four antenna patterns for the number of antennas in each array ranging from fifteen to twenty-seven in steps of three.

The assumptions made for the numerical simulations were as follows: 1) All configurations were centered at the present VLA location of longitude 107 degrees 37 minutes and 3.819 seconds west and latitude 34 degrees 4 minutes and 43.497 seconds north; 2) the object simulated was a point source at 30 degrees north declination; and 3) the simulated object was tracked from horizon to horizon with the assumption that the telescopes were limited from viewing less than 10 degrees above the horizon.

The UV data was created by the VLB program FAKE and transferred to the AIPS area by the AIPS verb VBCIT. The data was then run through the AIPS verbs UVSORT, UVMAP, and FFT. The RMS sidelobe level was then calculated from the real part of the beam by the verb WEIGH written by R. Sault. The map created was a 256-256 map with a cell size of 0.33 arc seconds.

After the above sequence was completed, the RMS sidelobe level was normalized with respect to the 27 antenna wye configuration for each the uniform and natural weightings. The absolute RMS sidelobe level for uniform weighting was σ = 0.00970, while for natural weighting σ = 0.01923. The RMS sidelobes at a one arc second resolution, which corresponds to 1.33 beamwidths, was calculated to be

TYPE	WEIGHTING	27	24	21	18	15
WYE	UNIFORM	1.0000	1.0165	1.0515	1.1052	1.1928
SPIR	UNIFORM	0.9907	1.0155	1.0474	1.0979	1.1773
CIR	UNIFORM	1.0258	1.2052	1.1216	1.4082	1.3619
NRED	UNIFORM	1.04021	1.08557	1.15155	1.27629	1.50825
WYE	NATURAL	1.0000	1.0140	1.0213	1.0530	1.0879
SPIR	NATURAL	0.9896	0.9584	0.9828	1.0114	1.0312
CIR	NATURAL	1.0848	1.1836	1.0733	1.2423	1.1529
NRED	NATURAL	0.8460	0.8684	0.8887	1.0088	1.1216

where WYE is the VLA type configuration, SPIR is the "spiralized" configuration, CIR is the circular arrangement of antennas, and NRED is the non-redundant configuration. Note: The non-redundant array with twenty-seven antennas is not the same non-redundant array dealt with by R. Hjellming in millimeter array memo number 21, but is of a similar nature. The above results show interesting patterns.

The most immediate note is that the RMS sidelobe level is relatively flat with respect to antenna number for the VLA wye and the spiralized arrays. This suggests that the number of antennas chosen for the millimeter array could be made for other factors, such as cost of the correlator, the electronics system, or total collecting area. For twenty-seven antennas with uniform weightings, all four configurations show relatively even RMS sidelobe levels. This is because with uniform weighting all four configurations fill approximately the same number of cells after the UV data are gridded. However the natural weighting case turns out differently.

The non-redundant array configuration shows a clear advantage for RMS sidelobe level over the other array types when natural weighting and a relatively large number of antennas are considered.

The non-redundant array type shows a marked increase in the RMS sidelobe level in uniform weighting. All five variations of the non-redundant array were generated assuming a 40X40 array to grid the UV data. Since the number of UV points produced by an array is an N squared algorithm, the smaller arrays show an early convergence in the program developed by T. Cornwell due to the smaller number of UV data points. If more simulations of a non-redundant array with smaller number of antennas are desired then a smaller grid size is indicated.

The circular array shows an interesting relationship with respect to the number of antennas used. The circular array shows markedly lower sidelobe levels when an odd number of antennas were used. This effect is probably due to the increased redundancy present in the configuration with an even number of antennas. Any circular array with an even distribution will show mirror symmetry. An array with an even number of antennas will show mirror symmetry with respect to two perpendicular bisectors.