

DEUTERIUM ARRAY MEMO #028

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To: Deuterium Array Group

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Subject: Optimum orientation of crossed-dipoles in an array

The optimum orientation of the dipole polarization in a regular square grid array of dipoles is not obvious and has been much debated. The usual orientation presented in articles on arrays is with the E-plane of the dipoles aligned with the square. We call this an array of “plusses”. An alternate orientation is one in which the E-plane is diagonal and refer to this case as an array of “crosses”. From another viewpoint an array of crosses on a square can be viewed as an array of plusses on a diamond arranged on a grid with alternating rows spaced  $1/\sqrt{2}$  apart with spacing of  $\sqrt{2}$  between dipoles within a row. The 2 orientations are illustrated in figure 1. For a 4x4 array with dipoles at a height of  $0.2\lambda$  and  $0.8\lambda$  apart the on-axis directivity is 20.9 dBi in both cases. The relative directivity as a function of the scan angle is given in the following table:

Scan angle (deg)	Cross/slant config			Plus/horiz config.			Average	
	E	H	X or Y	E or X	H or Y	45	Cross	Plus
0	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
10	0.95	0.97	0.95	0.97	0.91	0.96	0.96	0.95
20	0.74	0.88	0.75	0.84	0.67	0.80	0.79	0.77
30	0.48	0.75	0.56	0.61	0.52	0.61	0.60	0.58
40	0.27	0.62	0.41	0.38	0.44	0.44	0.43	0.42
50	0.13	0.44	0.28	0.19	0.35	0.28	0.28	0.27
60	0.05	0.28	0.17	0.07	0.25	0.16	0.17	0.16

Table. Directivity vs scan angle

In the absence of mutual coupling the directivity should approximate the measured performance. The mutual coupling in the cross configuration is less than in the plus configuration. The mutual coupling between adjacent slanted dipoles  $0.8\lambda$  apart (dipoles in echelon – see Kraus, Antennas) is -24 dB compared with -18 dB between parallel dipoles. The measured scan loss approximates the calculated directivity as shown in figure 2. A test of the on-axis gain of the configurations using the sun as a source showed no significant performance difference. Based only on an assumption that lower the cross-coupling, I conclude that the “cross” configuration is very slightly better than the “plus” configuration.

