



Department of Physics and Astronomy

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To: VLBA Configuration Group

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Subject: An Optimized Ten-Station Array

1.0 Introduction

We investigated systematic fine tuning of Craig Walker's current 'best' ten-station array (denoted below by W-1) by moving each of the stations in the four cardinal directions (N, S, E, W) in units of 100 km. The algorithm used was similar to Walker's fast algorithm (VLBA Memo No. 101), but with uniformly spaced grid cell points. The points were inverse radially weighted. The final array (denoted G-7) scored ~ 3% better than the original ten-station array. Given the large number of arrays analyzed and the systematic nature of the search, it is unlikely that another ten-station array will be found that would be substantially better than the one given here. Conversely, there are a fairly large number of somewhat different arrays which have about equal performance to the 'best' array.

2.0 Initial and Final Arrays

2.1 Initial Array:

1. Elephant Butte, NM
2. KPNO, AZ
3. Lamy, NM
4. Fort Davis, TX
5. Vermillion River Observatory, IL
6. Owens Valley Radio Observatory, CA
7. Haystack Observatory, MA
8. Wenatchee, WA
9. Honolulu, HI
10. Arecibo Observatory, PR

2.2 Final Array:

Same as A, but

Wenatchee, WA	→ Oroville, WA	(48.9, 119.5)
Lamy, NM	→ East of Lamy, NM	(35.5, 104.75)
Vermillion River Obs.	→ North Liberty, IA	(41.6, 91.6)

### 3.0 Gradients

The following graphs give the effective degradation in overall figure of merit (averaged over eight standard declinations of +64, +44, +30, +18, +6, -6, -18, -30) for movements in each of the four cardinal directions. We did not include Hawaii or Puerto Rico, since they involve only the longest baselines and are in any case constrained more by geography. Note that in our final array, there is a very slight improvement in moving the Ft. Davis, TX site north. The advantages of sighting at an existing observatory probably outweigh the slightly better (u-v) coverage, however, so that we have retained Ft. Davis in our final 'best' array. Also note that these gradients are computed by assuming the other nine stations are fixed; simultaneous movement of more than one station can affect the local minima found here without necessarily degrading the overall figure of merit.

200 km Offsets

$0.00\%$ $\uparrow$ $-1.00\% \leftarrow \text{Westford} \rightarrow -0.25\%$ $\downarrow$ $-0.25\%$	$-0.75\%$ $\uparrow$ $-0.50\% \leftarrow \text{Big Pine} \rightarrow -2.00\%$ $\downarrow$ $-1.50\%$
$-0.75\%$ $\uparrow$ $-0.75\% \leftarrow \text{Oroville} \rightarrow -0.25\%$ $\downarrow$ $-1.25\%$	$-1.50\%$ $\uparrow$ $-1.25\% \leftarrow \text{Iowa City} \rightarrow -0.75\%$ $\downarrow$ $-0.50\%$

100 km Offsets

$+0.25\%$ $\uparrow$ $-0.75\% \leftarrow \text{Fort Davis} \rightarrow -0.75\%$ $\downarrow$ $-0.75\%$	$-0.75\%$ $\uparrow$ $-1.00\% \leftarrow \text{Elephant Butte} \rightarrow -0.75\%$ $\downarrow$ $-0.75\%$
$-0.50\%$ $\uparrow$ $0.00\% \leftarrow \text{Kitt Peak} \rightarrow -0.75\%$ $\downarrow$ $-0.50\%$	$-0.75\%$ $\uparrow$ $-1.25\% \leftarrow \text{Lamy (East)} \rightarrow -1.50\%$ $\downarrow$ $0.00\%$

Fig. 1. Percentage change in overall figure of merit for movement of a single site keeping the other nine fixed.

4.0 Quality Measures

The tables below show the number of (u-v) cell points sampled, the percent redundancy, and the figure of merit for each declination.

Array G-7

Stations:	ELE ARE	KIT IWA	LAY61 ORO	FDV HSK	HAW OVR				
CELL: 150.									
	-44	-30	-18	-6	6	18	30	44	64
# of UV pts		960	1445	1763	2026	2260	2535	2884	4047
#Cells turned on		409	527	576	697	888	1045	1244	1604
% of redun UVpts		57.2	64.2	67.2	66.2	61.2	59.2	57.2	60.2
Merit		22.	28.	31.	35.	43.	47.	53.	62.

Avg Merit= 40.1  
 Average redundancy for array is 61.3%

Array W-1

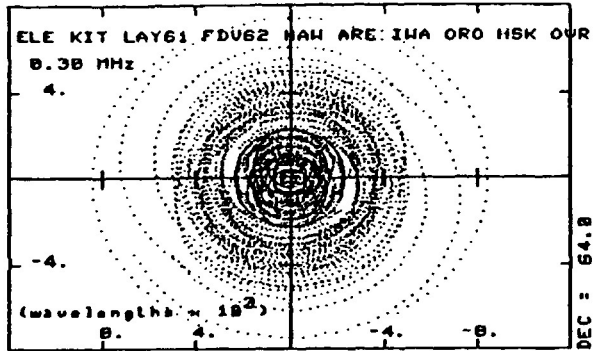
Stations:	ELE ARE	KIT ILL	LAY WEN	FDV HSK	HAW OVR				
CELL: 150.									
	-44	-30	-18	-6	6	18	30	44	64
# of UV pts		995	1456	1758	2023	2245	2515	2868	4043
#Cells turned on		402	511	560	688	859	1037	1207	1617
% of redun UVpts		60.2	65.2	68.2	66.2	62.2	59.2	58.2	60.2
Merit		21.	27.	30.	35.	41.	47.	50.	62.

Avg Merit= 39.1  
 Average redundancy for array is 62.1%

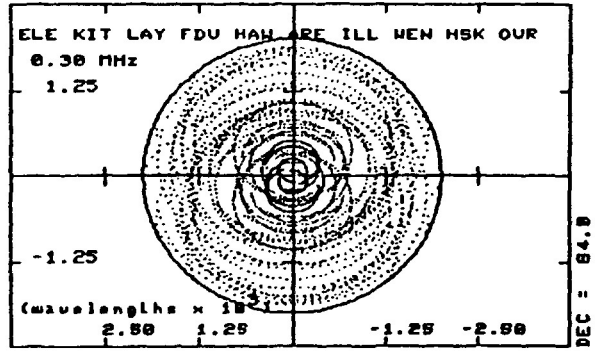
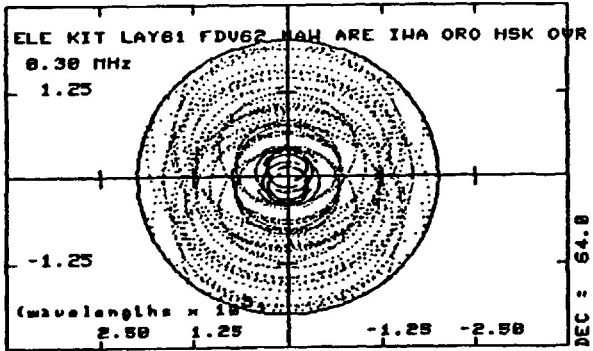
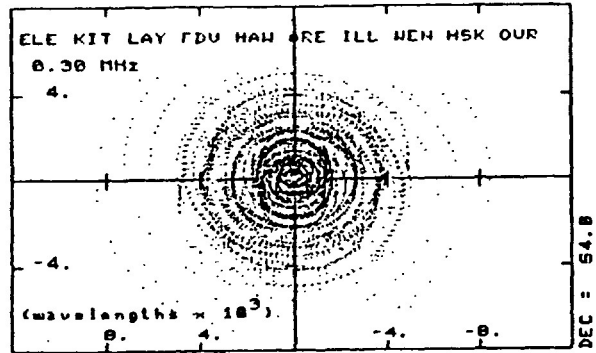
5.0 Transfer Function Plots

The (u-v) tracks of Walker's 'best' array (W-1) and the present array (G-7) are shown for all eight standard declinations on two scales: 'full' coverage (12000 x 8000 km) and 'inner' coverage (3750 x 2500 km).

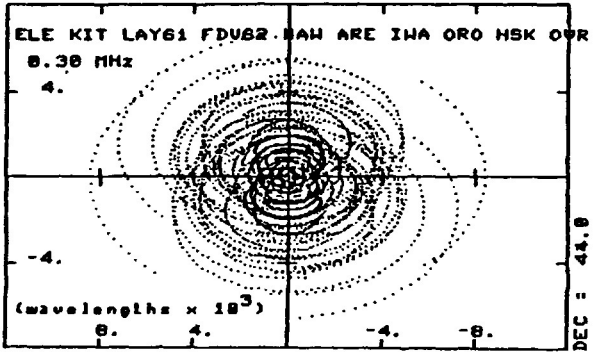
G-7



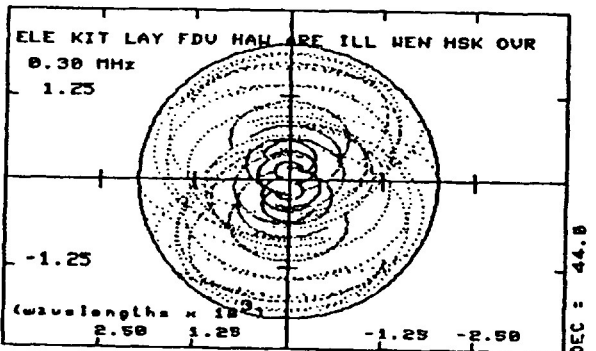
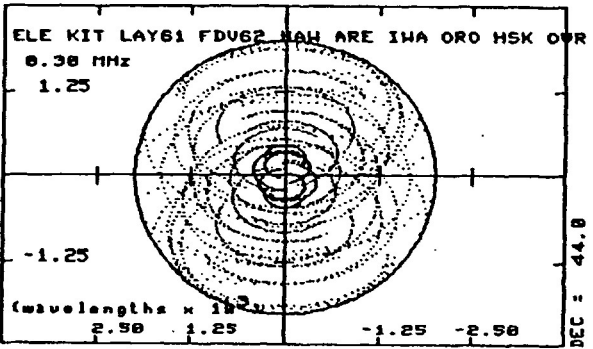
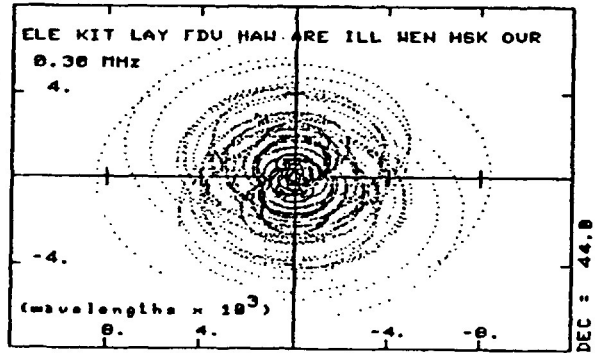
W-1



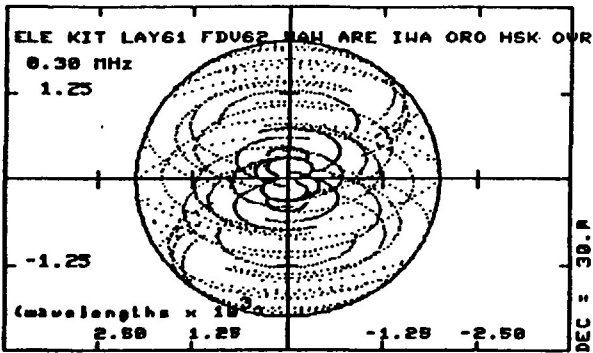
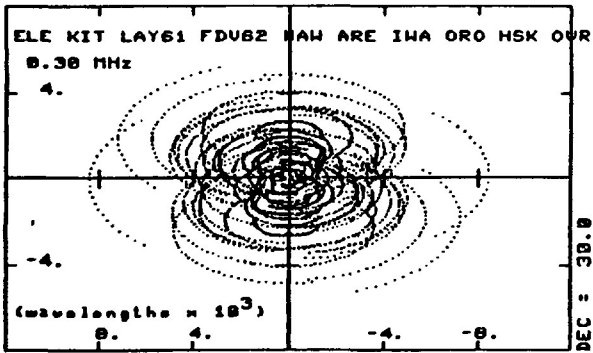
G-7



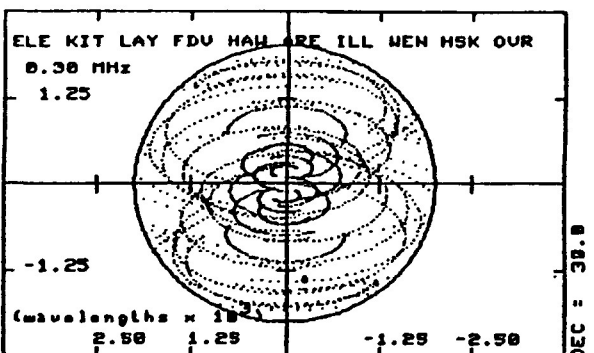
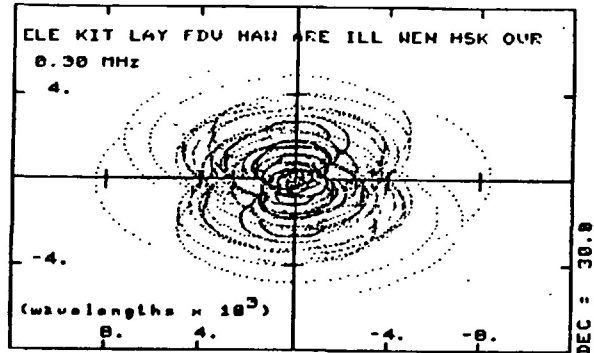
W-1



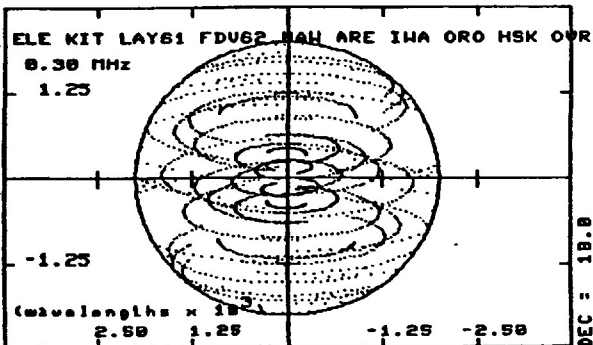
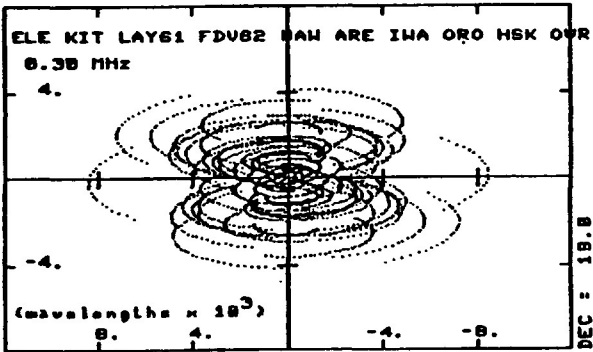
G-7



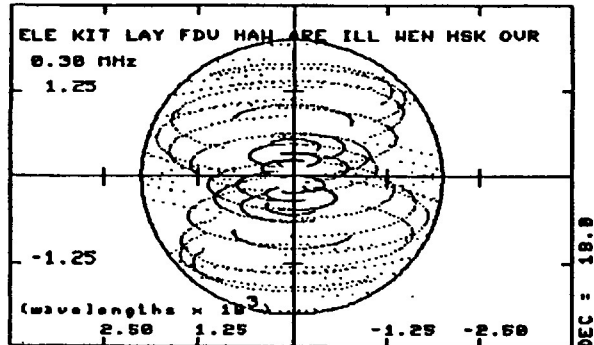
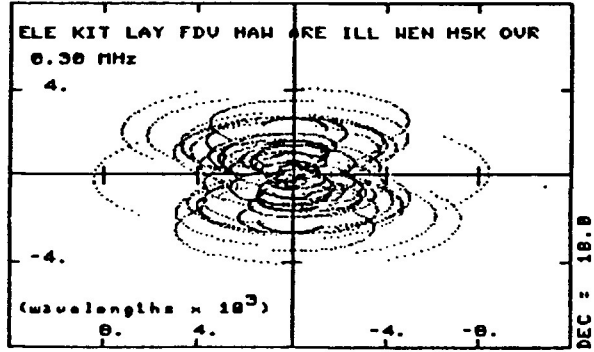
W-1



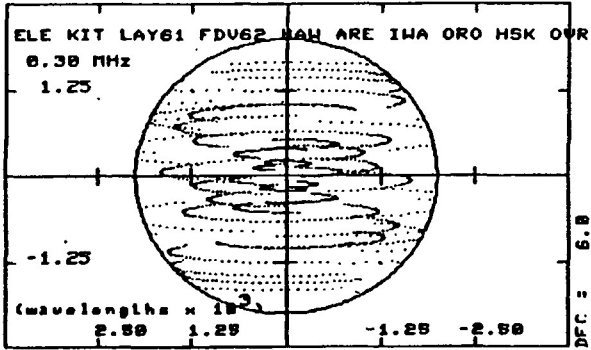
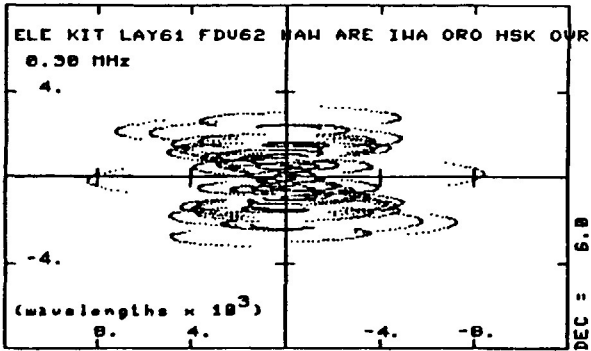
G-7



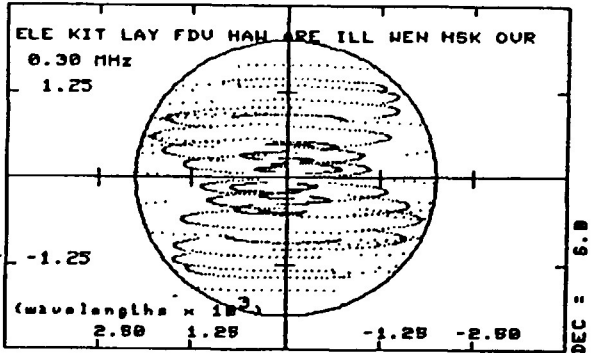
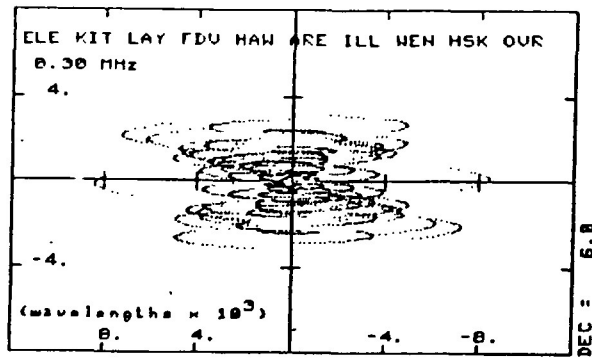
W-1



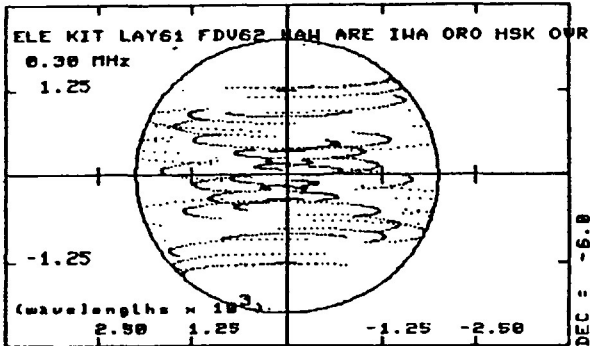
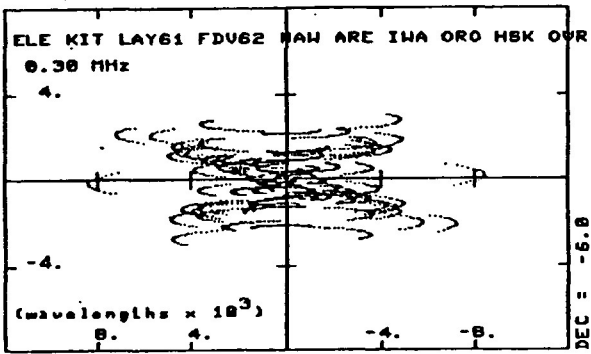
G-7



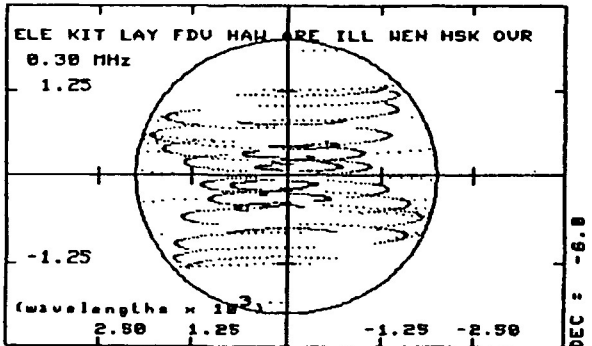
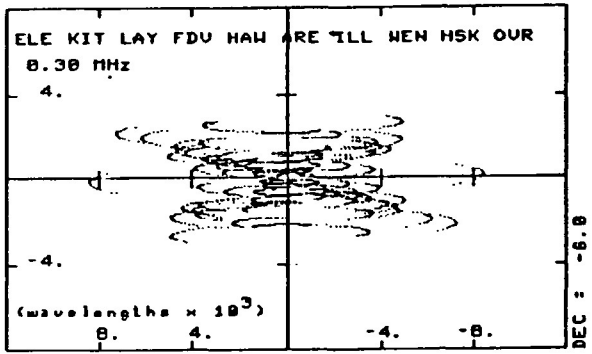
W-1



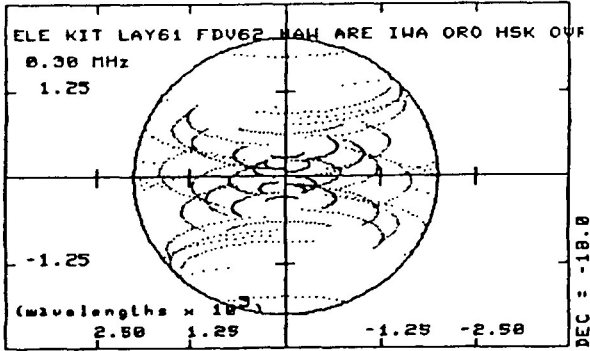
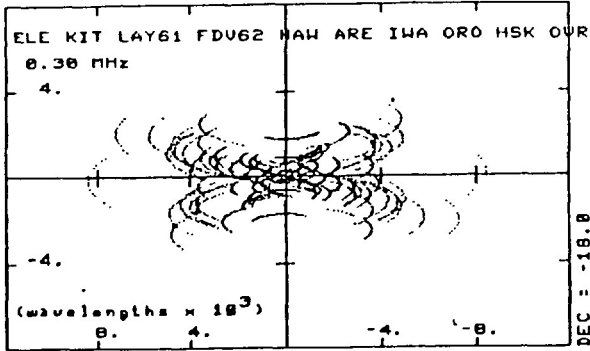
G-7



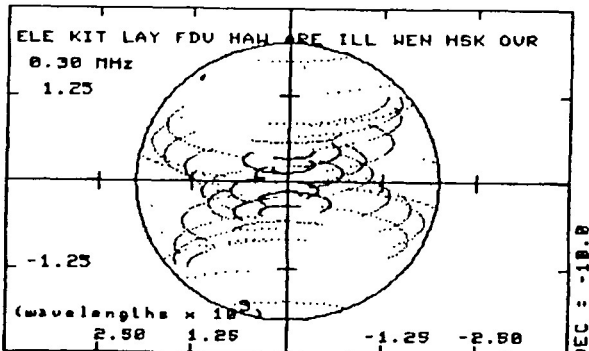
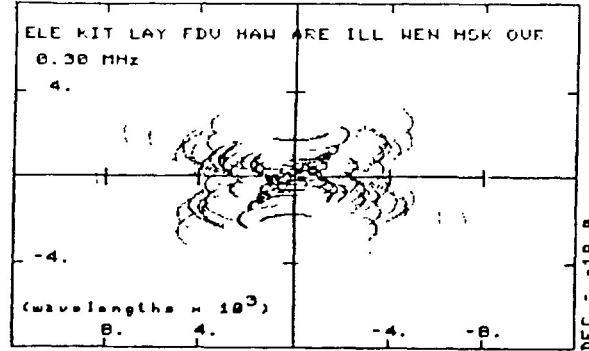
W-1



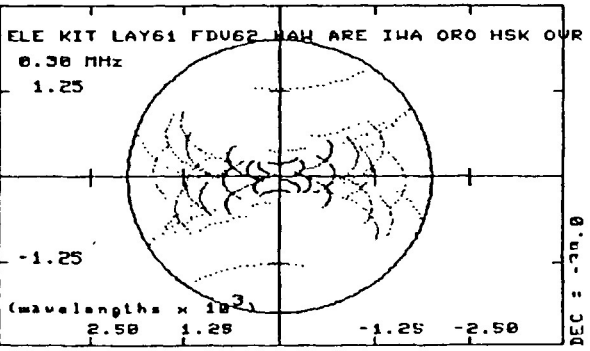
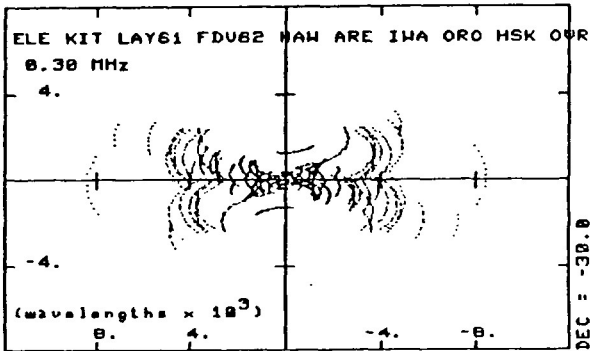
G-7



W-1



G-7



W-1

