Atacama Large Millimeter Array

Farfield Measurement of the Band 3 Feed+Lens at the Green Bank Indoor Antenna Range

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T. R. Hunter & S. Srikanth

0. Abstract

1. Introduction

In order to test the validity of the results of the North America FEIC beam scanner, we conducted farfield measurements of the Band 3 feedhorn plus lens combination at the Green Bank indoor antenna range. The tests were undertaken on December 3-5, 2008.

2. Equipment

The feed under test was S/N 007 and consisted of the horn + lens only (no filters or window). We believe this is the same unit that was scanned with the 2-D NSI scanner HIA (see section 4 of Claude (2007)). The equipment at the antenna range includes:

- A scanning tower with one axis of rotation (azimuth)
- Agilent 8530A Microwave Receiver
- 75-110 GHz VNA extenders
- HP37204 HPIB Extender
- ORBIT-FR 959 Spectrum control and analysis software

For further details, see Anderson (2005). Figure 1 shows photos of the rectangular source horn and its pedestal.

Figure 2 shows photos of the rectangular source horn and its pedestal.

The equipment that we gathered included a pair of 45° and 90° waveguide twists, the lengths of which are given in Table 1. These were installed on the source horn to obtain the desired plane of polarization illuminating the Band 3 horn. None of the waveguide twists were exactly perfect in their angle of rotation. Therefore, in order to obtain the most accurate cross-polarization scans, we constructed a mechanism for rotating the waveguide plumbing leading to the source horn by an arbitrary angle using a pair of circular to rectangular waveguide transitions and C-clamps (see Figure 3).

Fig. 1.— The rectangular source horn and its pedestal in the Green Bank indoor antenna range

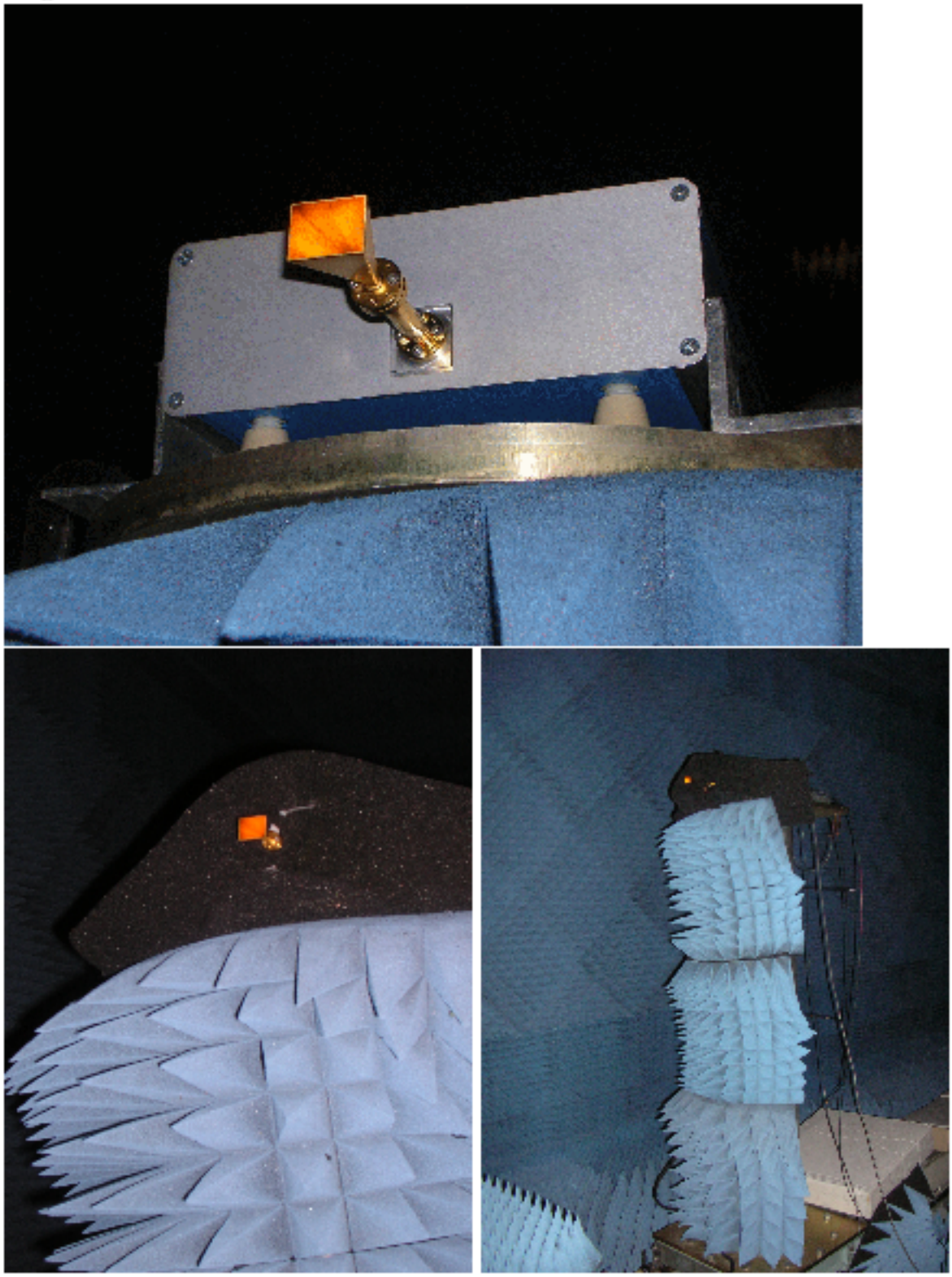


Fig. 2.— The Band 3 feedhorn under test attached to the VNA extender in the indoor antenna range

Fig. 3.— The mechanism for rotating the waveguide plumbing by an arbitrary angle using a pair of circular to rectangular waveguide transitions and C-clamps

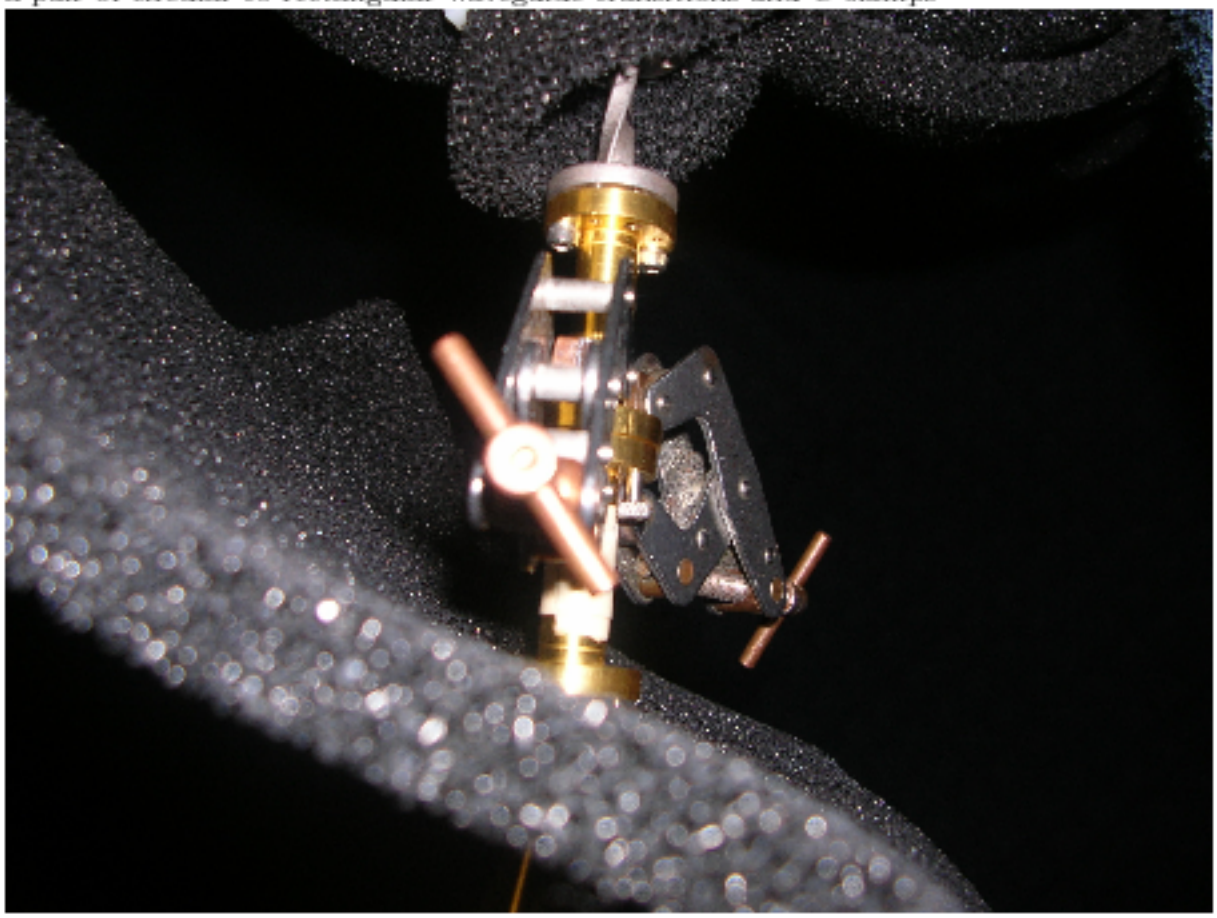


Table 1: Waveguide twists used in the experiments

Twist angle	**Unit**	**Length (inch)**
90°	1	1.260
90°	2	1.263
45°	1	1.246
45°	2	1.258

3. Measurements

3.1. Preliminary measurements

We first measured the repeatability of the motion of the feed positioner. We found that the azimuth angle undershoots by 0.04 inch, the x-axis undershoots by 0.009 inch, and the y-axis undershoots by 0.010 inch. These offsets were taken into account wihen issuing all future positioning commands.

Using a tape measure, we measured the distance from the transmitter horn to the feed under test to be 70 and 3/4 inch (i.e. approximately 600 wavelengths). The distance to the VNA extender waveguide flange was 71 and 3/16 inch.

In order to measure H-plane, E-plane, and 45°-plane cuts, our measurements required three different configurations of the horn and waveguide combination. We determined the center of rotation for each configuration and these are given in Table 2.

The definition of the E-plane and H-plane are showed in the pictures in Figure 4. Photos of two of the three configurations are shown in Figure 5.

3.2. Beam scans

The frequencies measured were 85, 90, 95, 100, 105 and 110 GHz. Measurements at 115 GHz were not possible because it was beyond the range of the LO. During each azimuth scan, the system repeatedly cycled the tuning through all six frequencies. We decided to adjust the geometry of the horn mounting to minimize the observed phase slope in the middle of the band (at 100 GHz). A log of the scans is given in Table 3. The scan results for the are shown in Figures 6 through 11.

4. Conclusions

Table 2: Center of rotation for each measurement configuration

Scanner setup	**Distance behind horn aperture (inch)**
H-plane	3.212
E-plane	1.0625
45° plane	2.138

Fig. 4.— The definition of the E and H-planes of the feedhorn

Fig. 5.— Left panel) The orientation of the horn for the H-plane measurement. Right panel) The orientation for the 45° plane measurement.

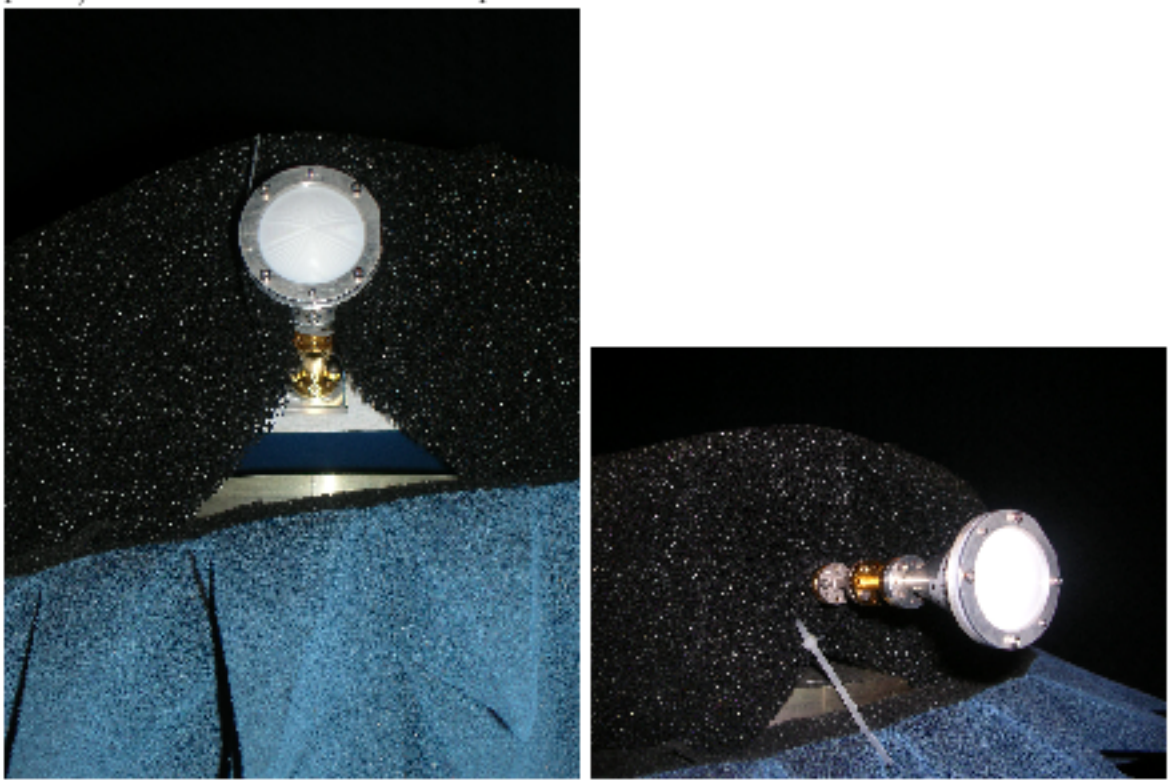


Table 3: Log of the scans recorded on December 4, 2008.

Scan type **Plane, pol**	**Configuration** **Configuration**	**100GHz peak** **(dB)**	**Offsets** **(inch)**
H, cross	#2 90° twist on Tx	-40	Y=-9.00
H, co		-11	
E, co	#1 90° twist on Rx, #290° on Tx	-13	X=0.00, Y=-11.15
E, cross	#1 90° twist on Rx	-38	
45°, co	#1 45° twist on Rx, #2 45° on Tx	-11	X=0.00, Y=-10.75
45°, cross	#1 45° twist on Rx, #2 45° +#1 90° on Tx	-31	
Note: Assembled and inserted ad hoc waveguide rotary joint			
45°, cross	#1 45° twist on Rx, #2 45° +#1 90° on Tx	-41 (min = -67)	
45°, co	#1 45° twist on Rx, #2 45° on Tx	-11	
H, cross	#1 90° twist on Tx	-46 (min = -71)	
E, cross	#1 90° twist on Rx		

Fig. 6.— Scan results for 85 GHz.

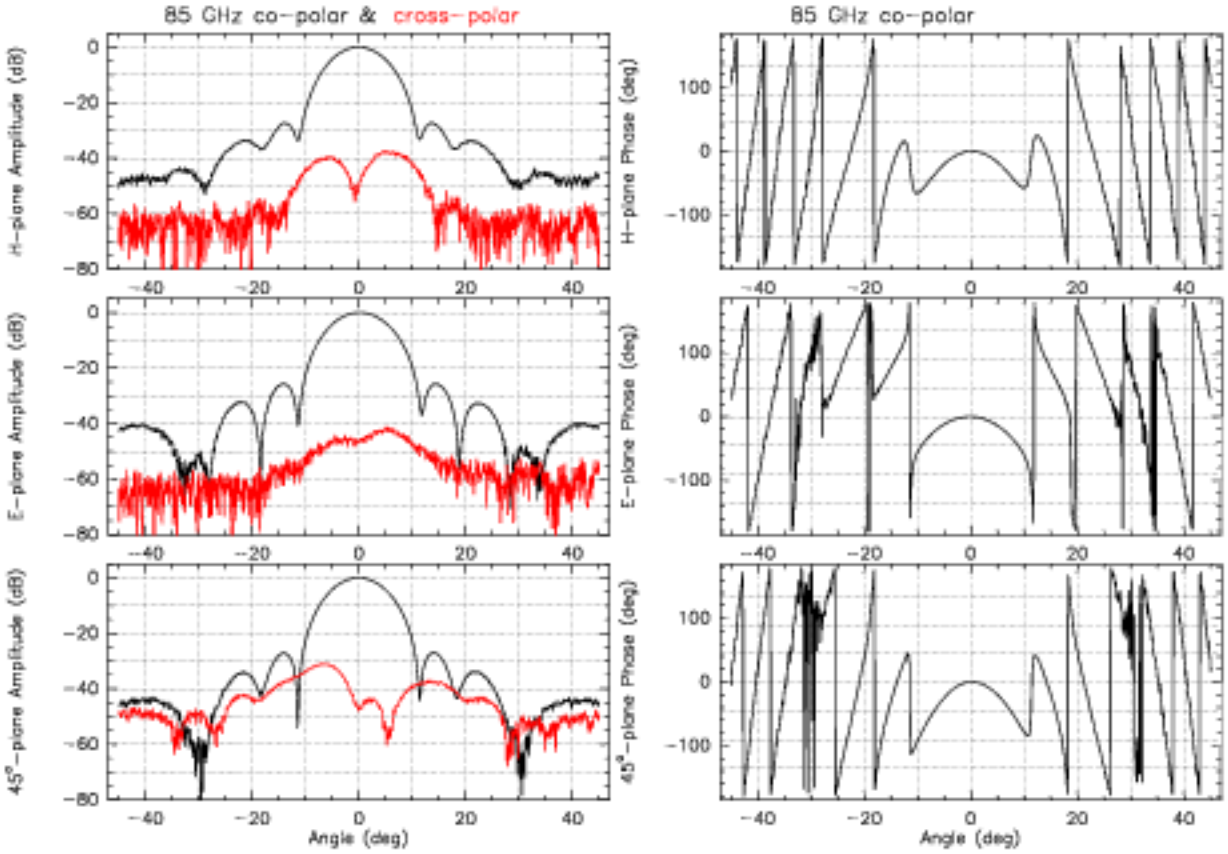


Fig. 7.— Scan results for 90 GHz.

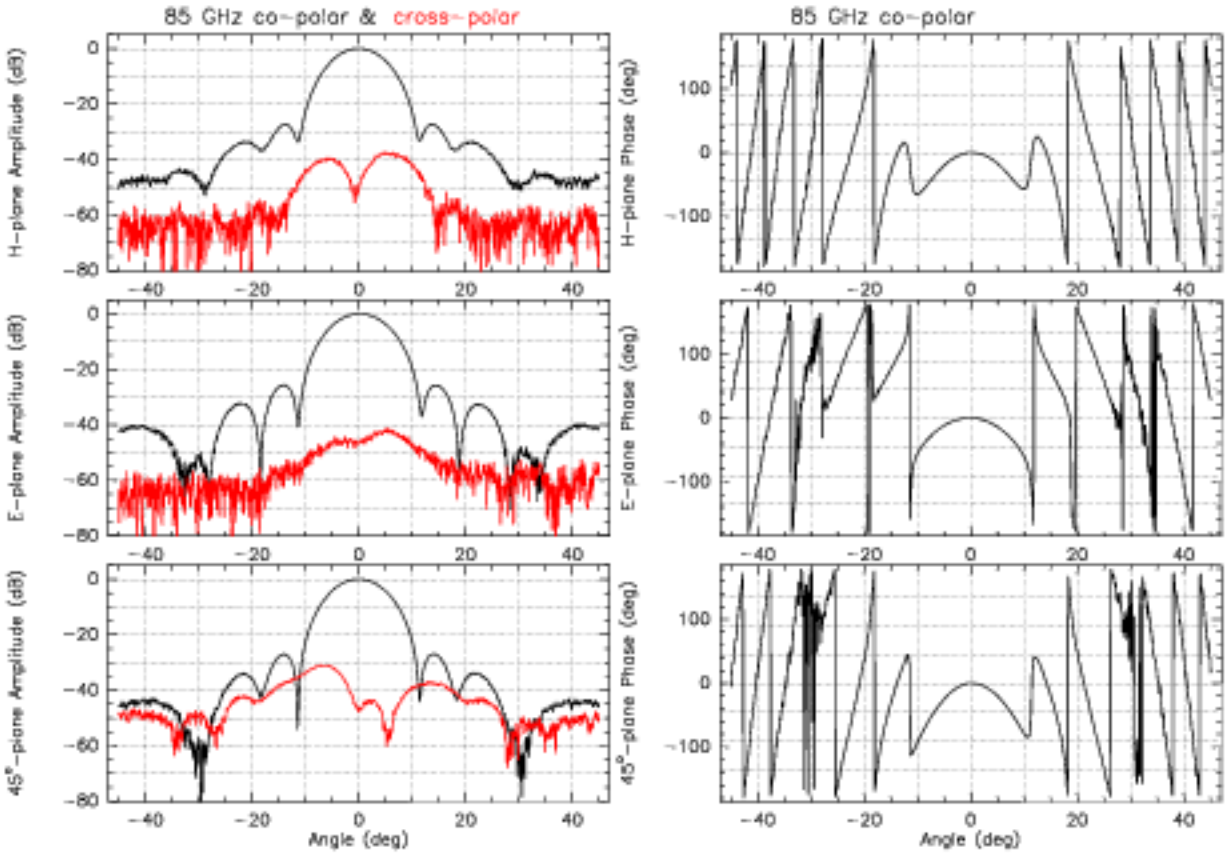


Fig. 8.— Scan results for 95 GHz.

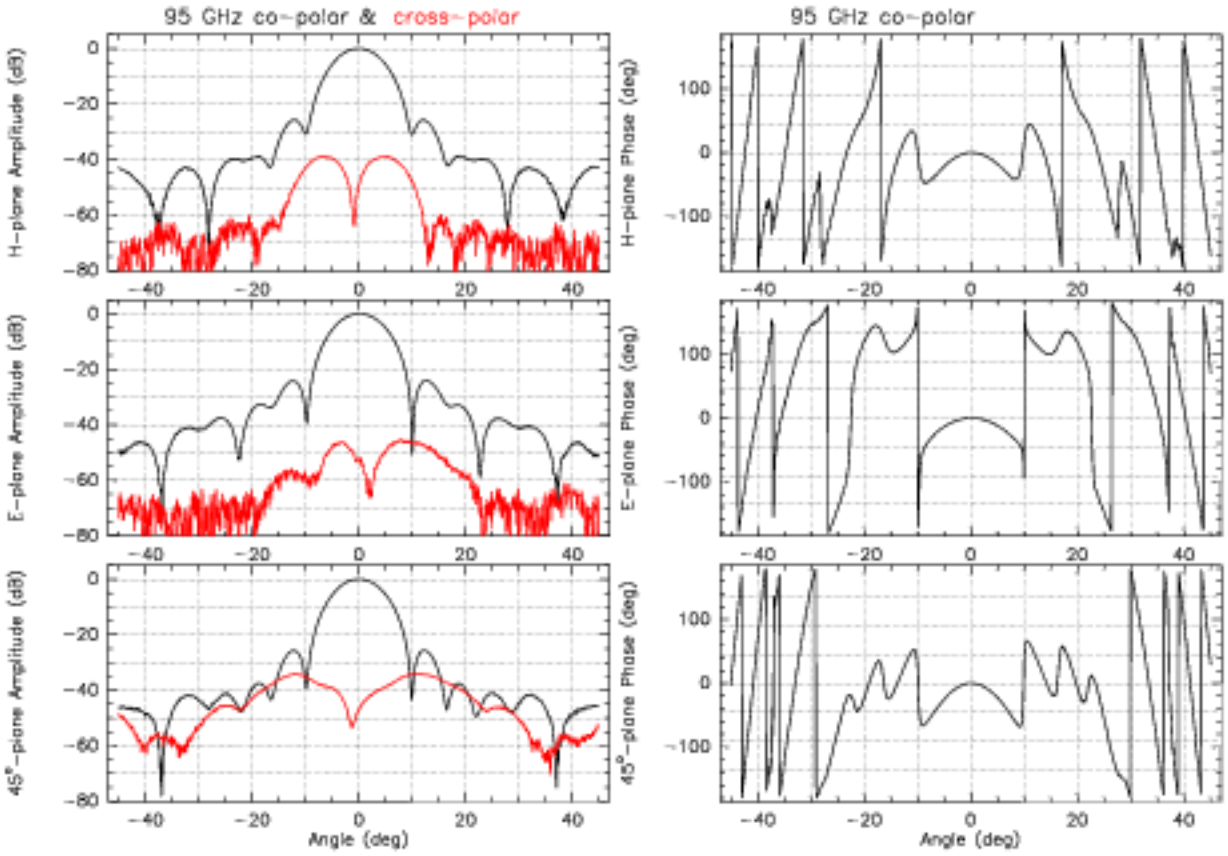


Fig. 9.— Scan results for 100 GHz.

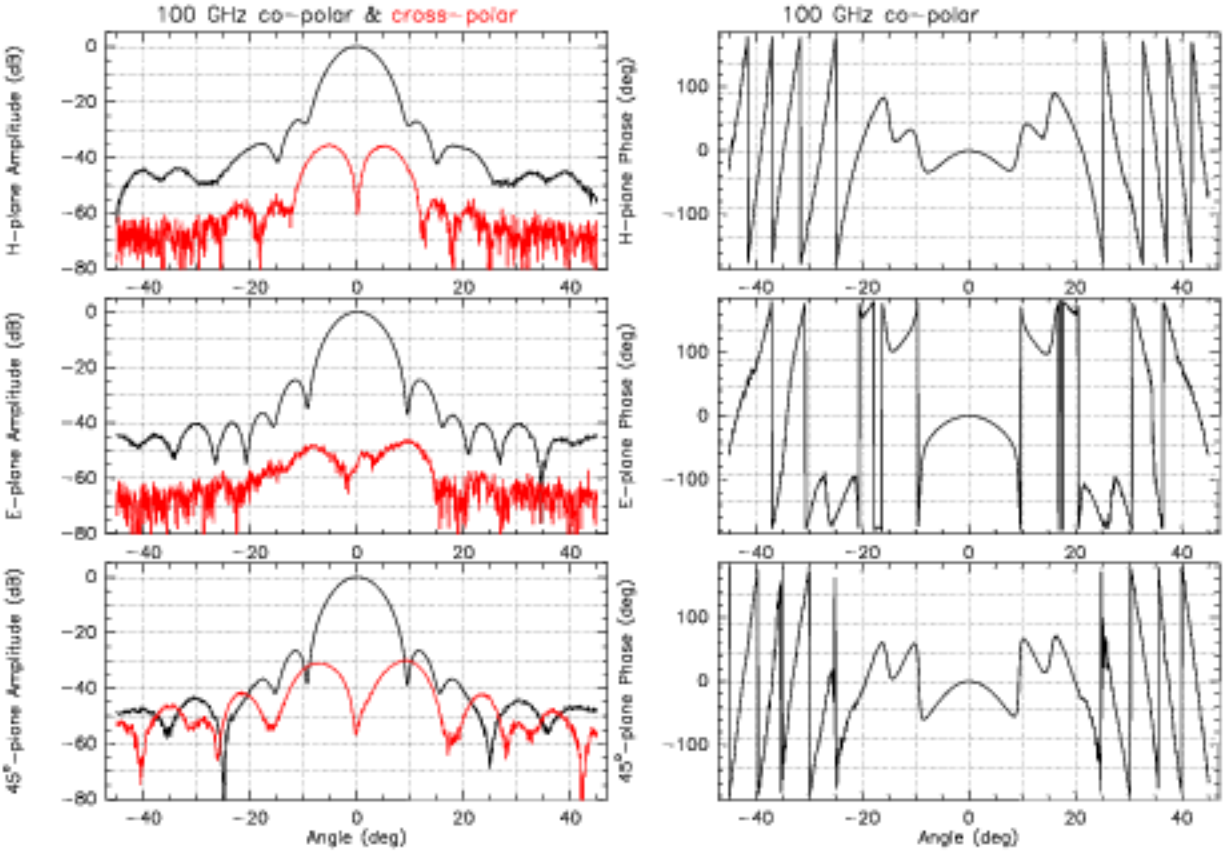


Fig. 10.— Scan results for 105 GHz.

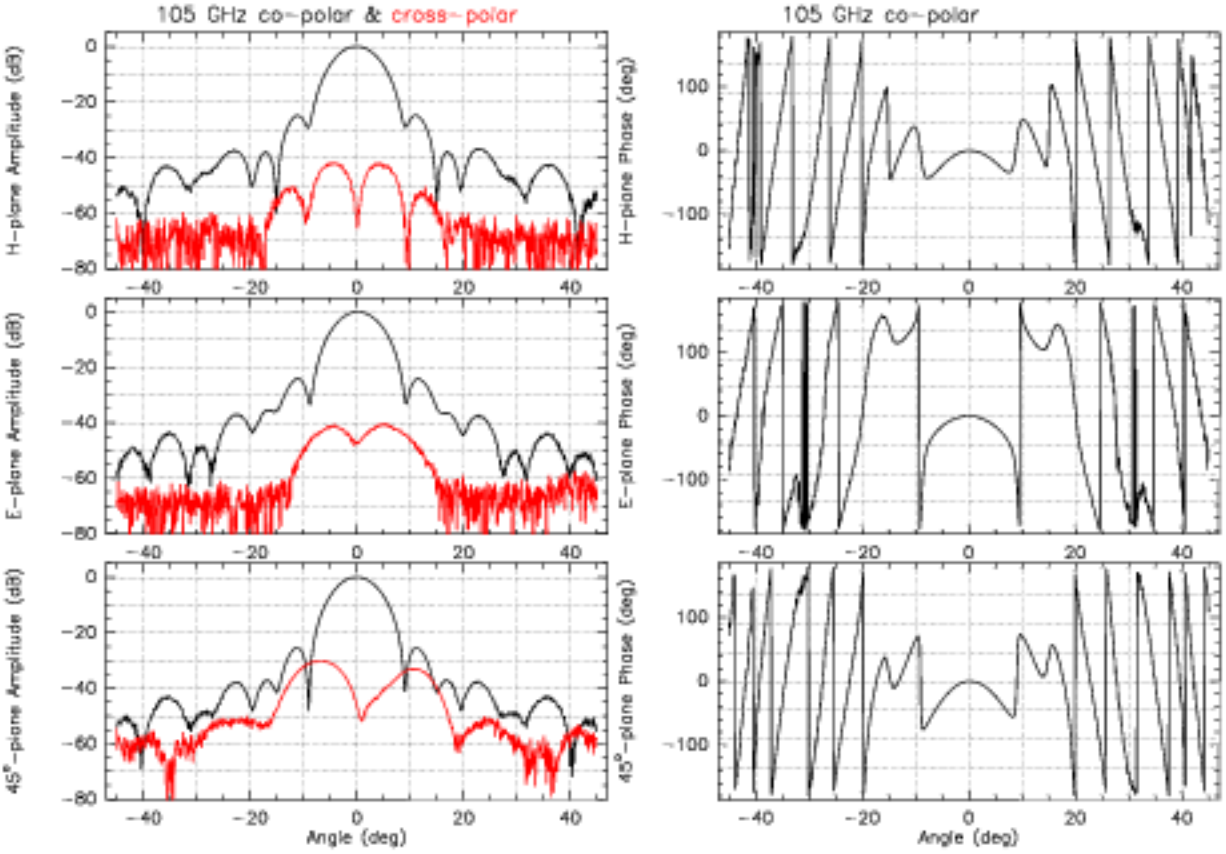
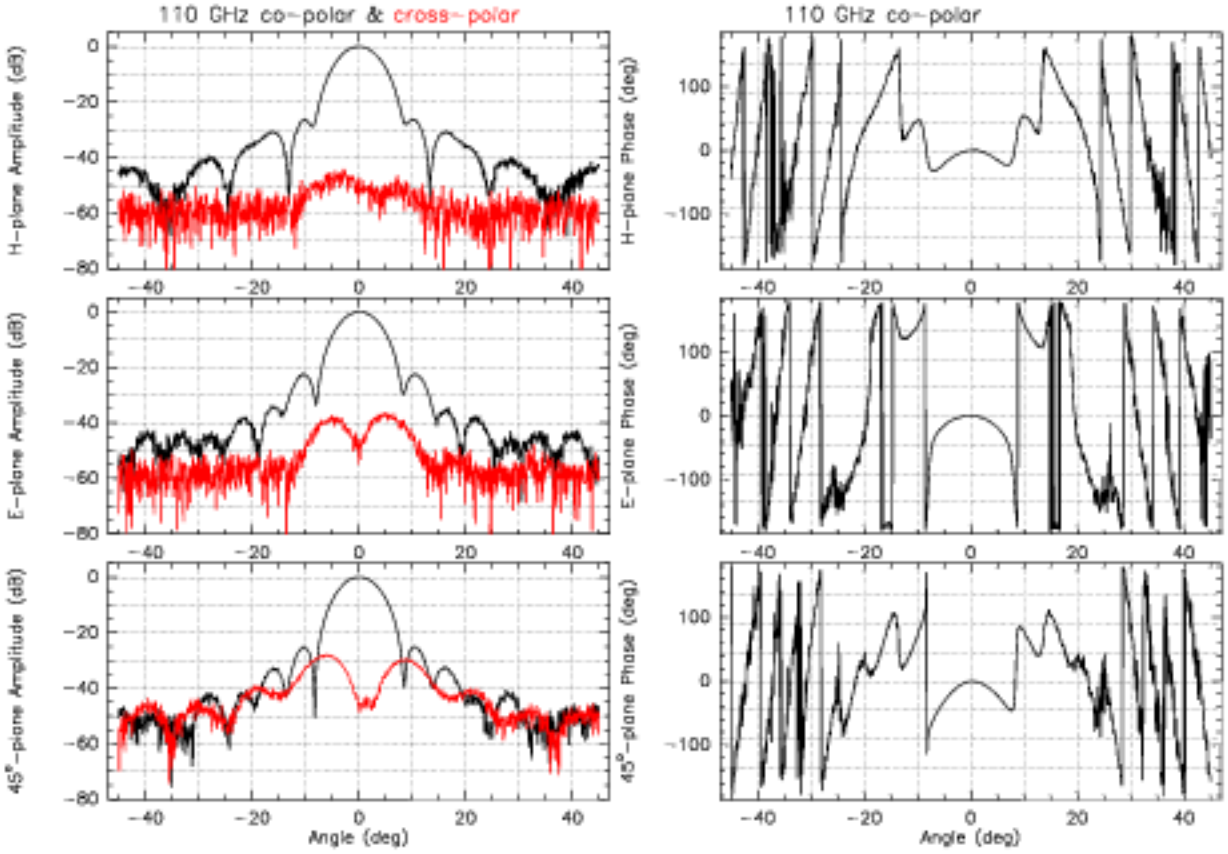


Fig. 11.— Scan results for 110 GHz.



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