GBT MEMO 238

3 mm GBT Feed Tests

Gary N. Anderson

S. Srikanth

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Summary: Test data on the GBT 3 mm feed indicates that adding an IR filter and Vacuum Window has a measurable but minor effect on its performance.

Data: Raw data on the 3 mm feed was collected at the Green Bank Indoor Range and compared to data taken in January, 2003 on the same feed design on a Scientific Atlanta 5706 Compact Range located at the NASA/Goddard Space Flight Center in Greenbelt, Md. Results from this comparison are documented in Electronics Division Technical Note No. 200; let it suffice to say here that the measurements were in close agreement. This was the first use of the Green Bank range above 50 GHz; therefore the data was of great importance in validating the performance of the range.

The feed was supplied with a rail system mounting. (Figure 1) Fixtures were provided to hold both the feed and the IR Filter/Vacuum Window.

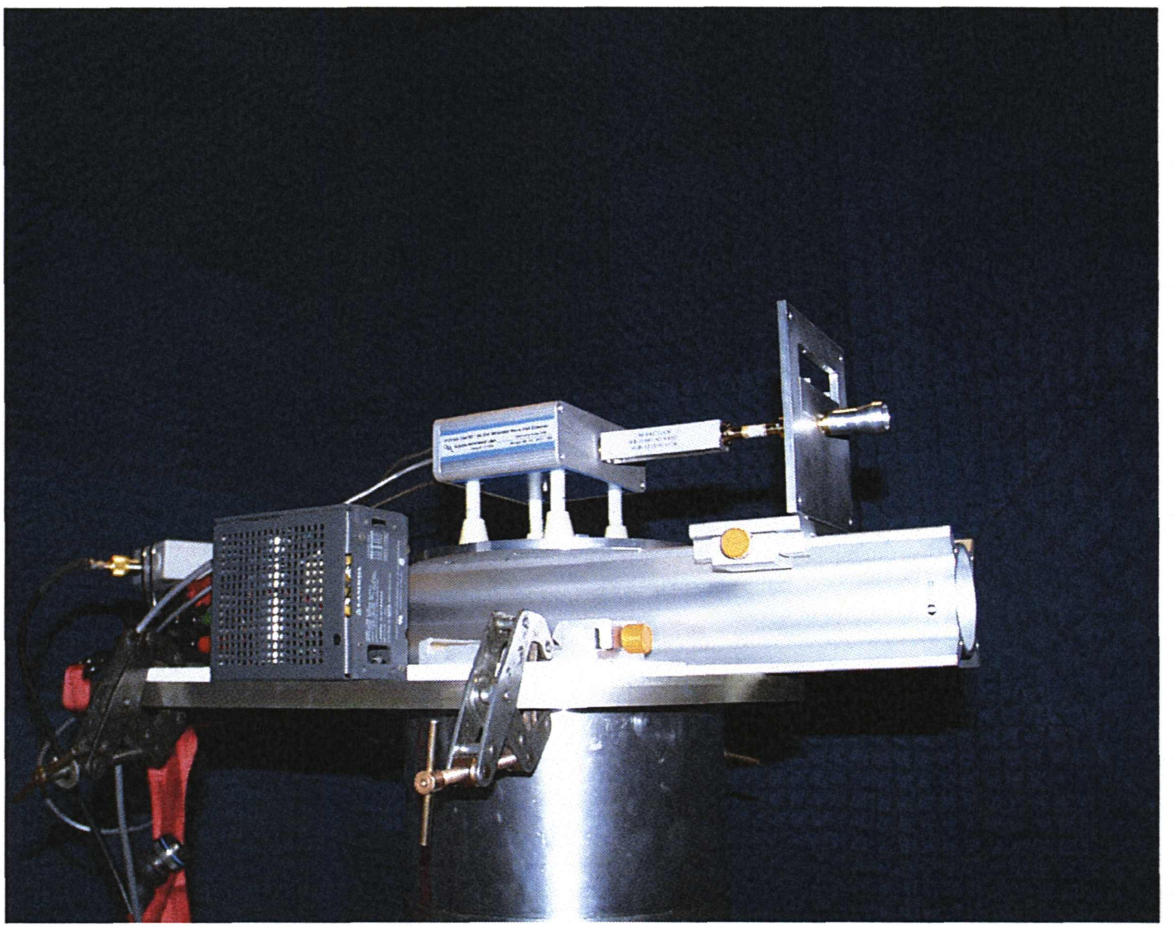

Figure 1: 3 mm Feed Test Setup (No Absorber)

Polarization positioners could not be used at these frequencies; therefore, they were removed from the range and the platforms upon which they would normally be mounted were used as tables to hold the test feeds and other hardware.

The frequency converters were manufactured by Oleson Microwave (now OML) and were designed to be used on a test bench in front of a Network Analyzer. They can be used directly if set up on a flat surface: they cannot be easily mounted for movement in rotation and translation. Therefore, the converters were set up on flat platforms as shown in Figure 1 (for the receive unit) and polarization rotation for both the Source Feed and Antenna Under Test (AUT) was performed with 45-degree and 90-degree waveguide twists as appropriate. This should be kept in mind when evaluating all data, especially the 45 degree Cross-Polarization data. Since no easy way was available to make small corrections in angle (i.e., to adjust the angle of either the source antenna or AUT for an output null when cross-polarized), the accuracy of this measurement depended upon the accuracy with which the twists were fabricated. Worst-case evaluations of the measured data indicate acceptable performance. Since an alignment error cannot increase the isolation between polarizations, we present the 45 degree Cross-Polarization results with this caveat.

The distance between transmit and receive antennas was 50 inches.

Data taken of the feed alone are shown in Figures 2, 3, and 4:

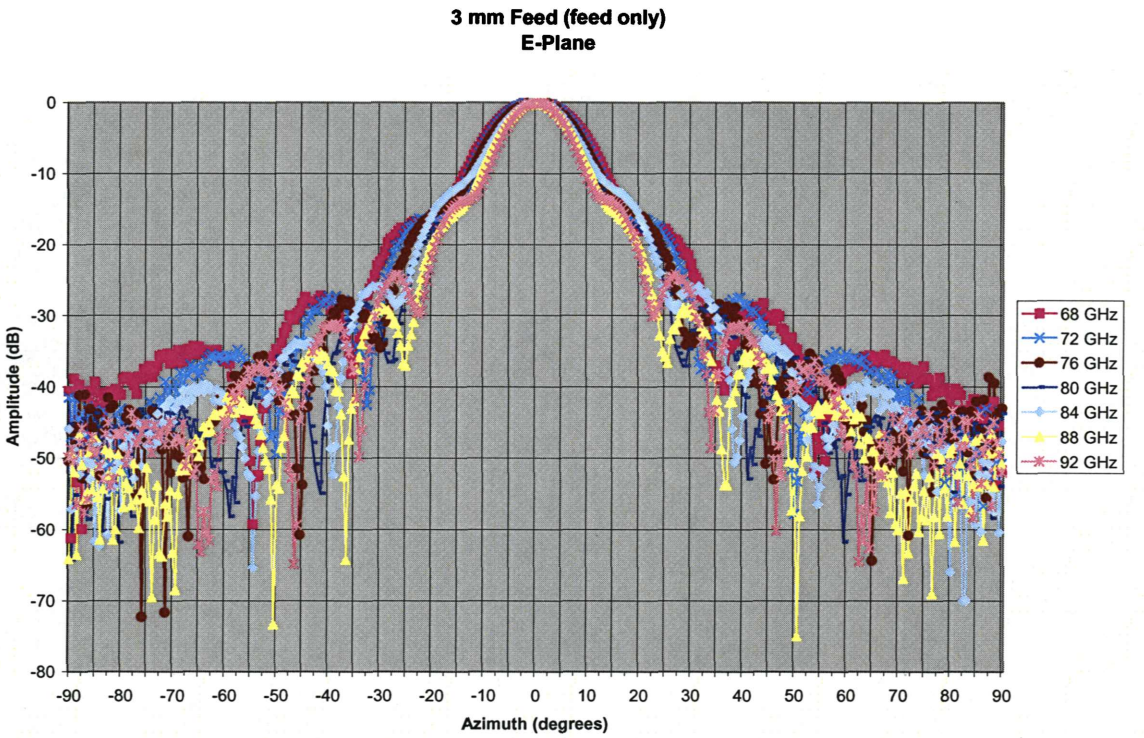

Figure 2: 3 mm Feed E-Plane Pattern

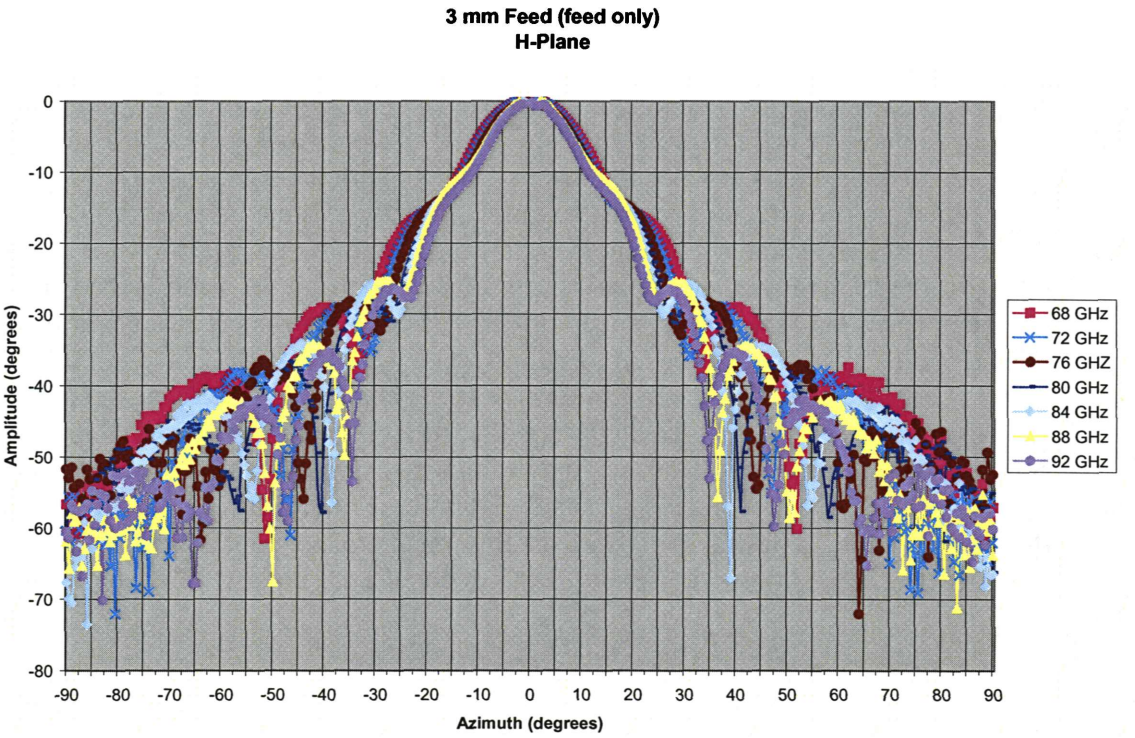

Figure 3: 3 mm Feed H-Plane Pattern

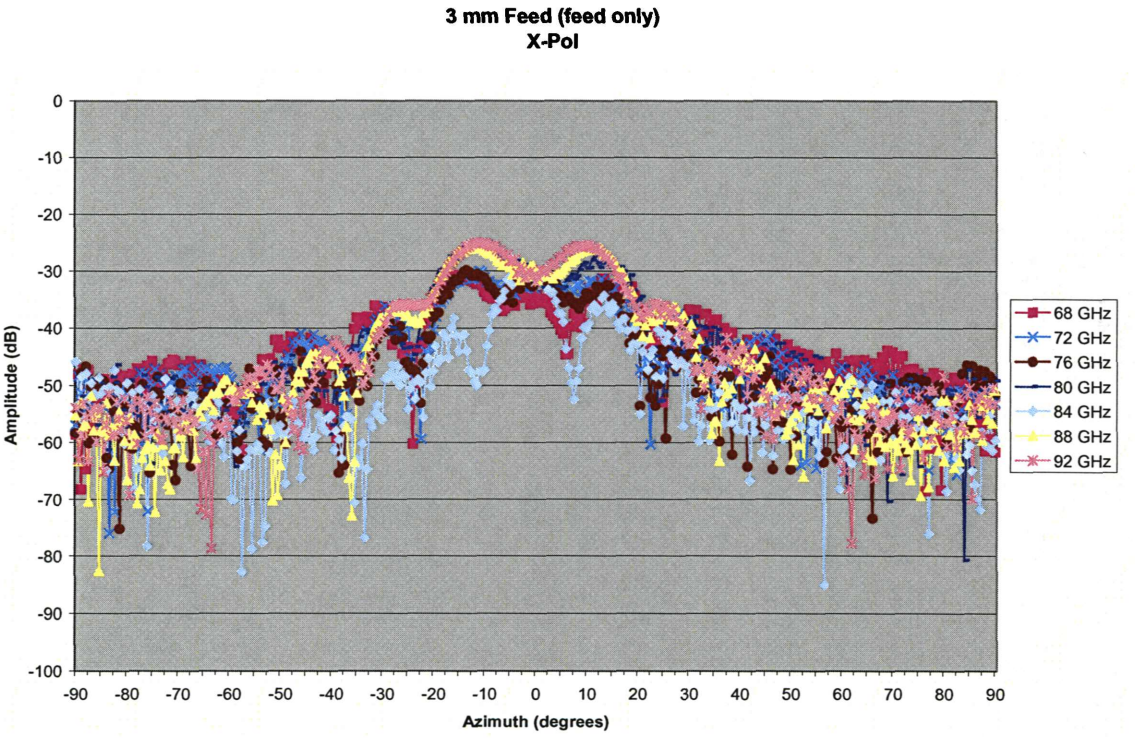

Figure 4: 3 mm Feed Cross-Polarization Pattern

This data gives a feed taper that varies with frequency from 11 to 16 dB. Worst-case cross-polarization is 25 dB down from the boresight amplitude.

Phase center locations were also determined at three frequencies:

Frequency	68 GHz	80 GHz	92 GHz
E-Plane Position (in. from aperture)	.56	.94	1.34
H-Plane Position (in. from aperture)	.69	1.01	1.16

After adding an IR filter and vacuum window to the assembly, the measurements were repeated. The measured patterns are shown in Figures 5, 6, and 7.

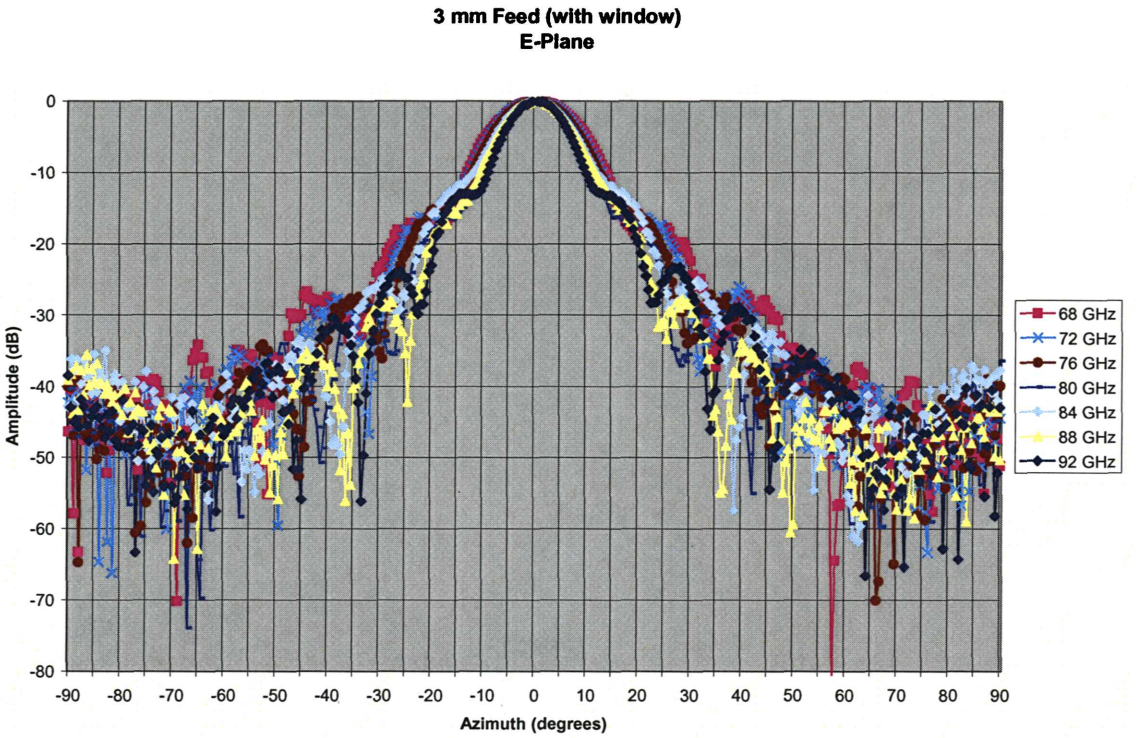

Figure 5: 3 mm Feed E-Plane Pattern (with Window)

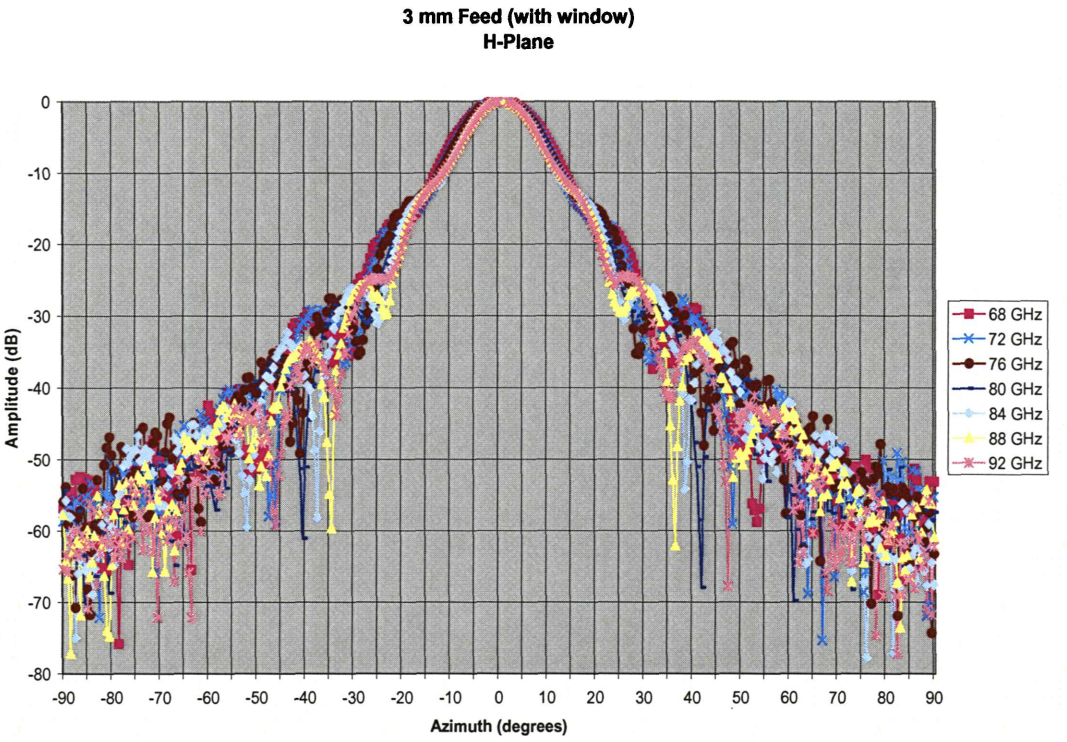

Figure 6: 3 mm Feed H-Plane Pattern (with Window)

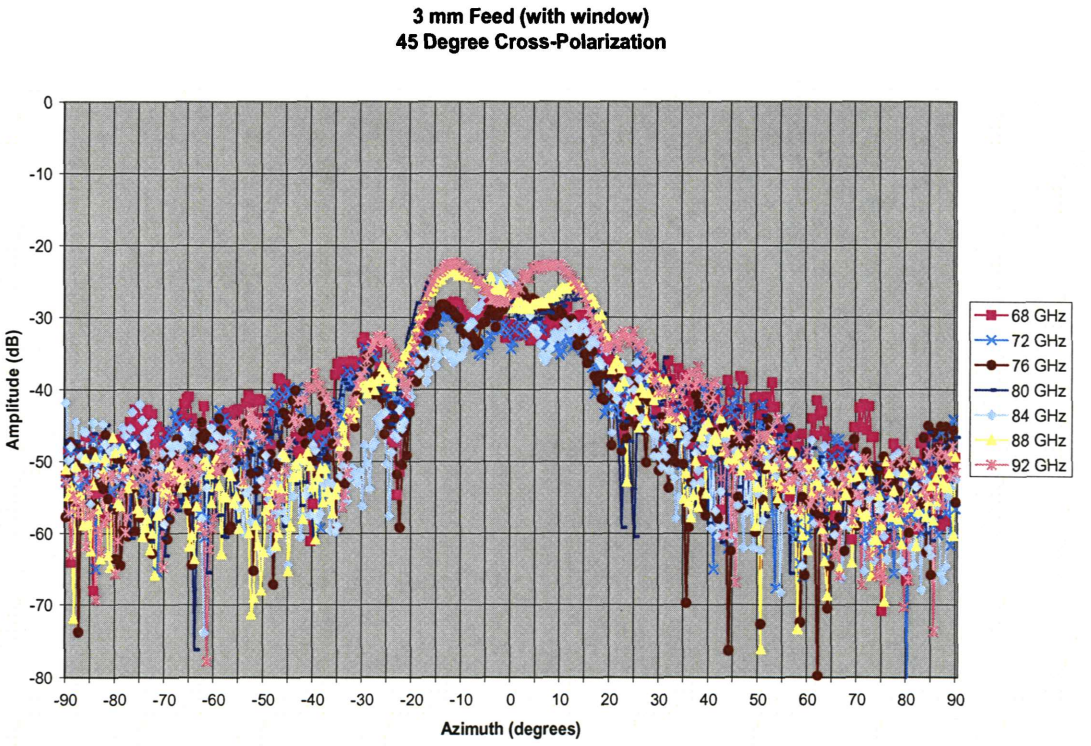

Figure 7: 3 mm Feed Cross-Polarization Pattern (with Window)

The 15 degree taper varies with frequency from 11 to 16 dB. Worst-case cross-polarization is 23 dB down from the boresight amplitude. This is 2 dB worse than the measurement made with the feed alone.

For comparison, the phase center was measured with the IR filter and Quartz window in H-Plane only:

Frequency	68 GHz	80 GHz	92 GHz
H-Plane Position (in. from aperture)	.58	.78	.94

In the following figures, patterns of the feed with and without the quartz window and IR filter are overlaid at three different frequencies. The patterns agree very well in the E-plane, while in the H-plane the agreement is good in the +/- 50-degree range. In the 45-degree plane, cross-polarized sidelobes measured with the filter are 2 dB higher compared to those measured without the filter.

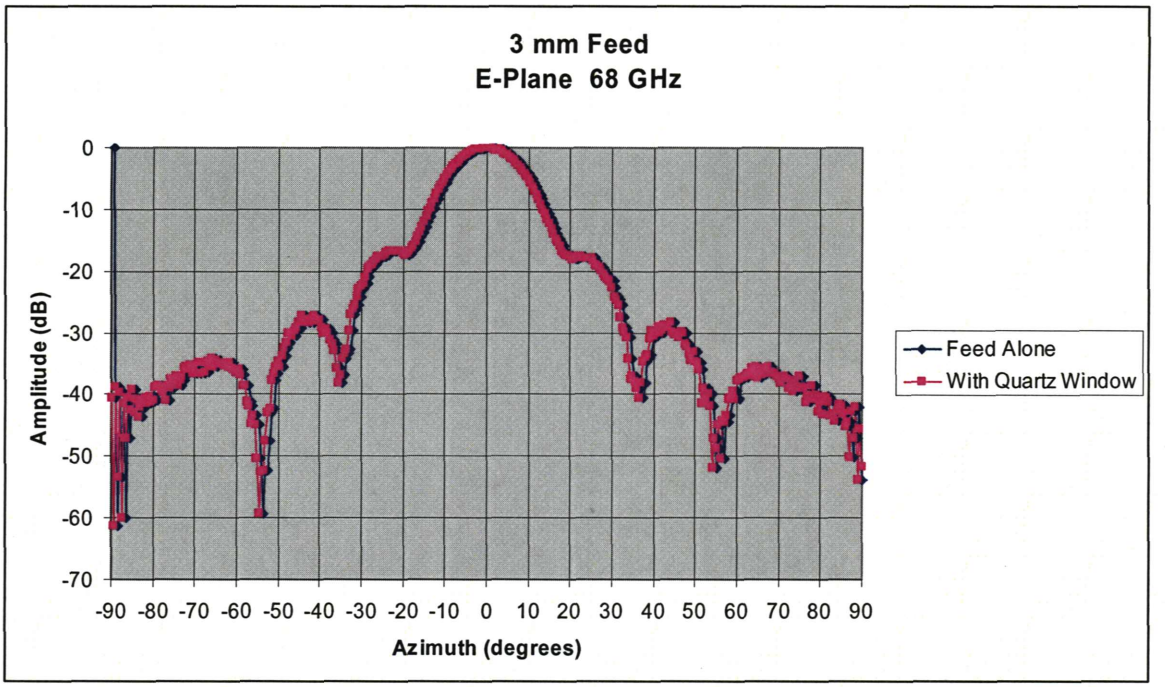

Figure 8: E-Plane, 68 GHz Comparison (with vs. without Quartz Window and IR Filter)

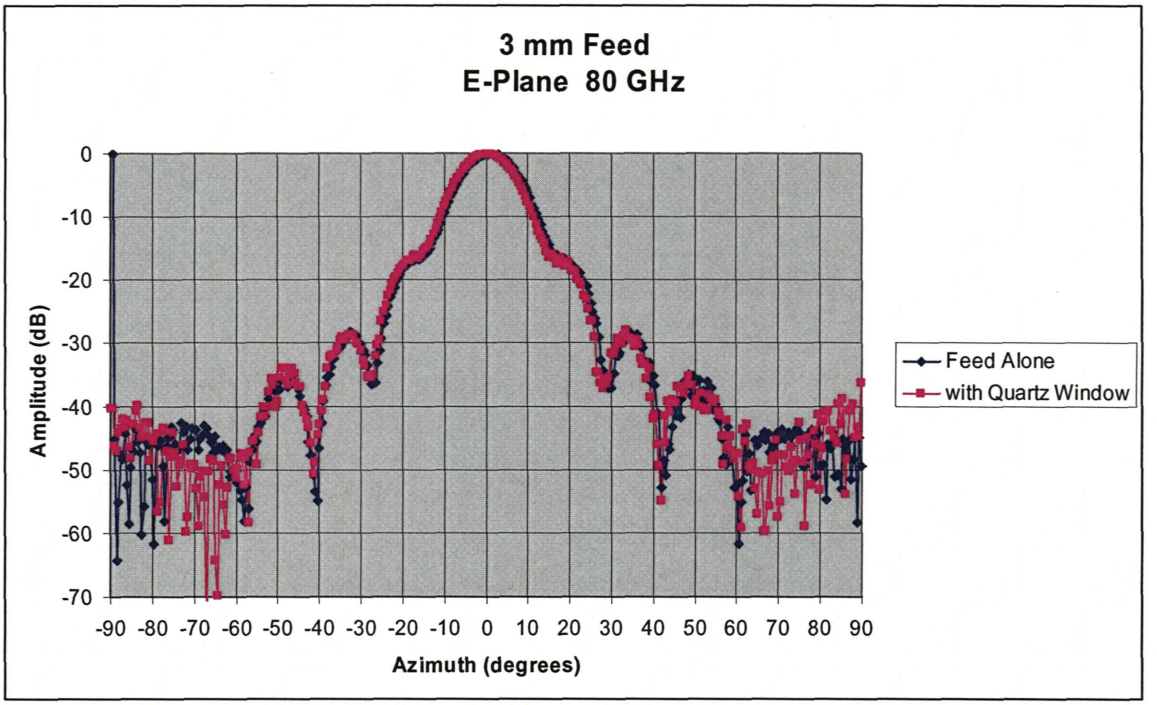

Figure 9: E-Plane, 80 GHz Comparison (with vs. without Quartz Window and IR Filter)

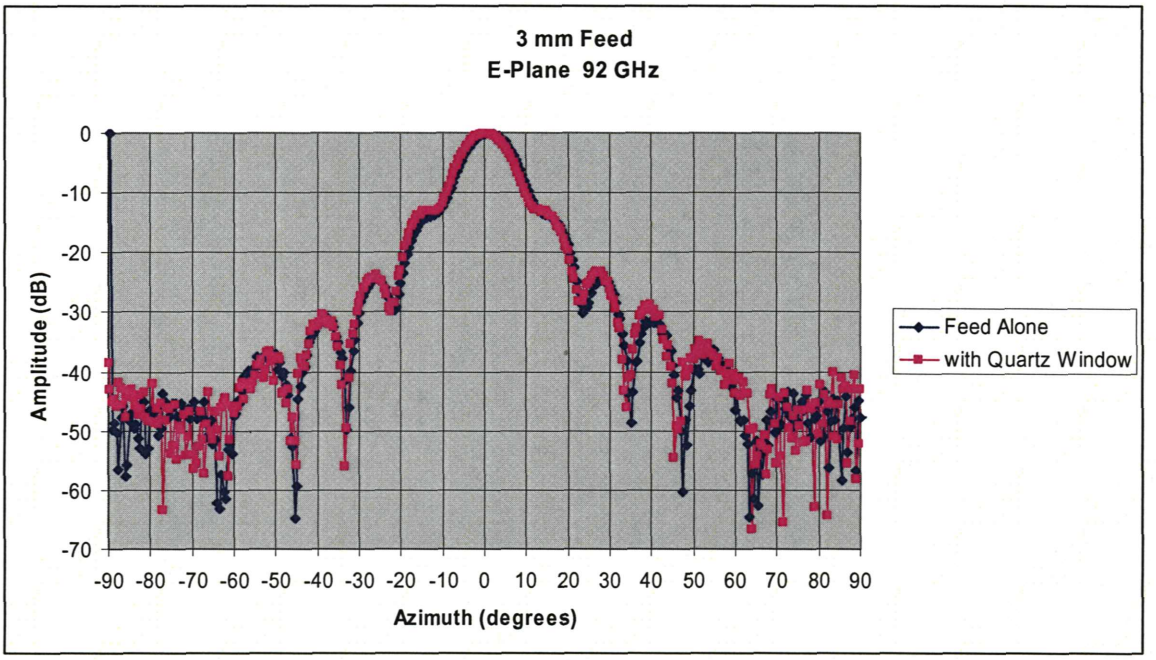

Figure 10: E-Plane, 92 GHz Comparison (with vs. without Quartz Window and IR Filter)

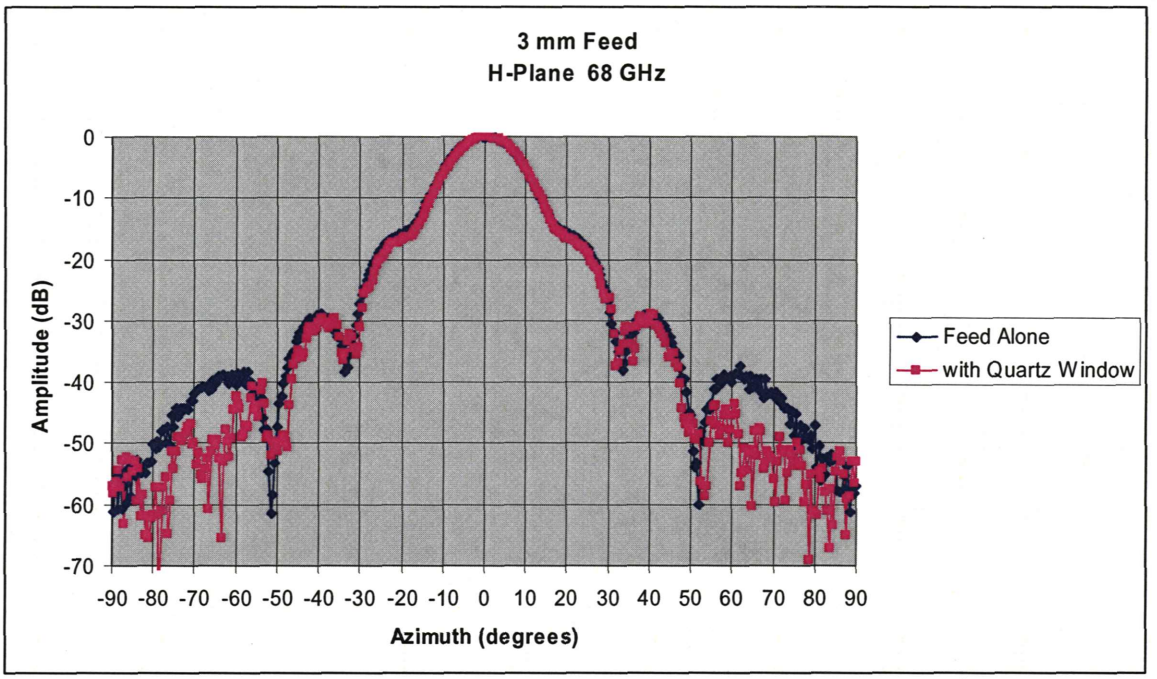

Figure 11: H-Plane, 68 GHz Comparison (with vs. without Quartz Window and IR Filter)

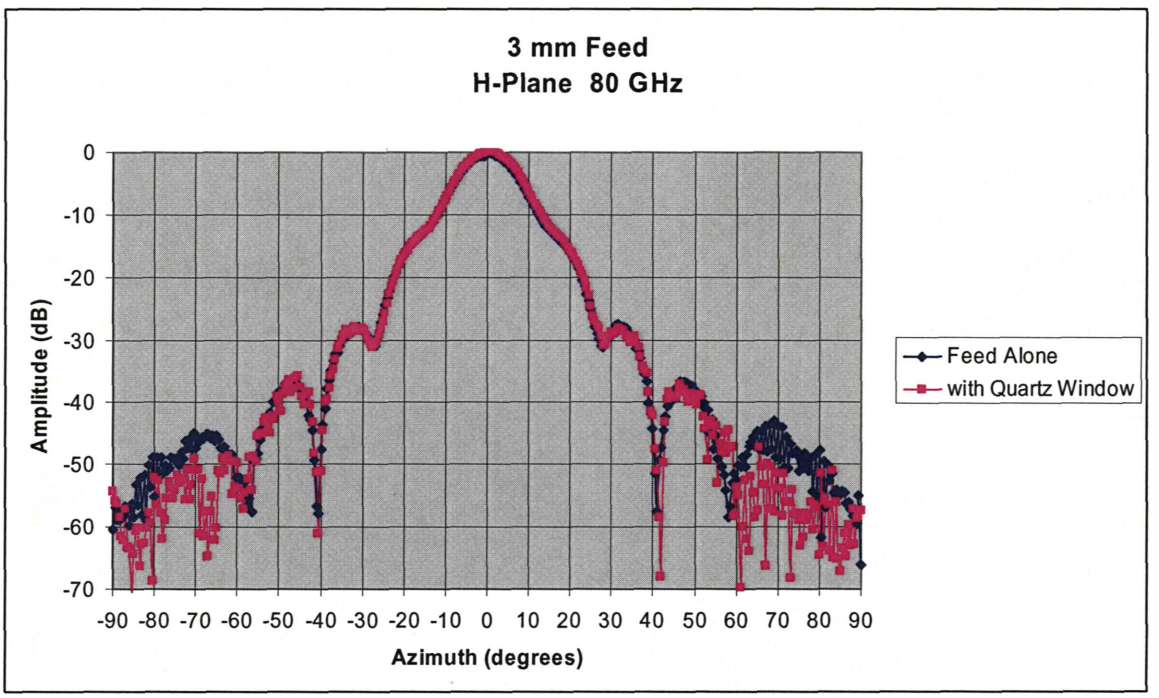

Figure 12: H-Plane, 80 GHz Comparison (with vs. without Quartz Window and IR Filter)

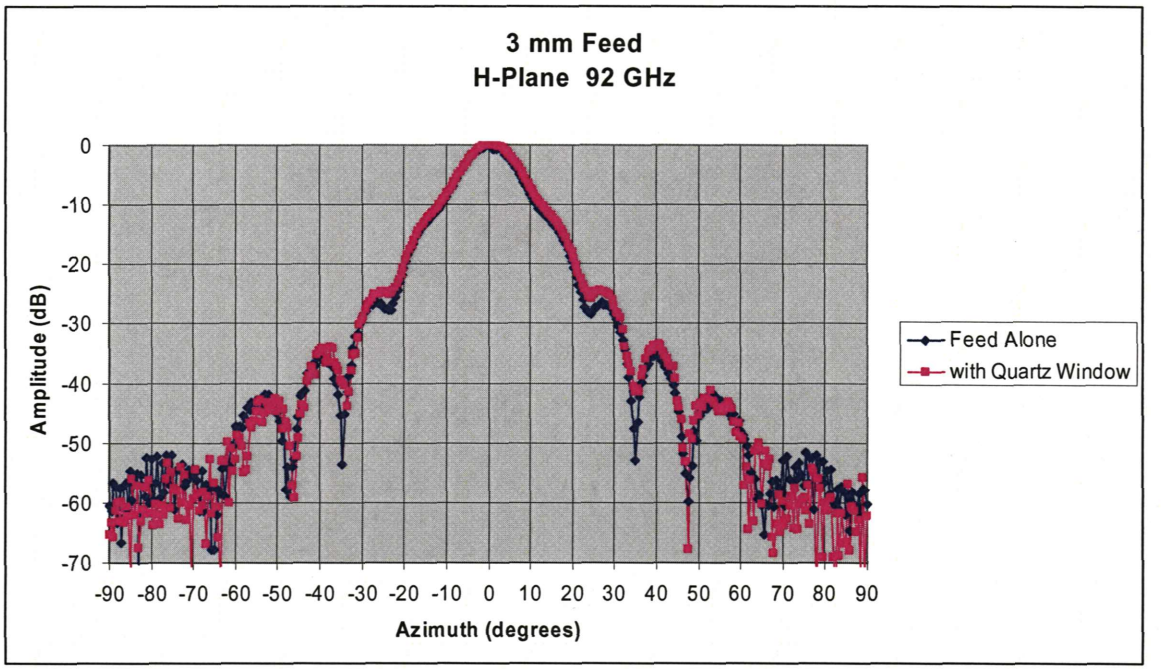

Figure 13: H-Plane, 92 GHz Comparison (with vs. without Quartz Window and IR Filter)

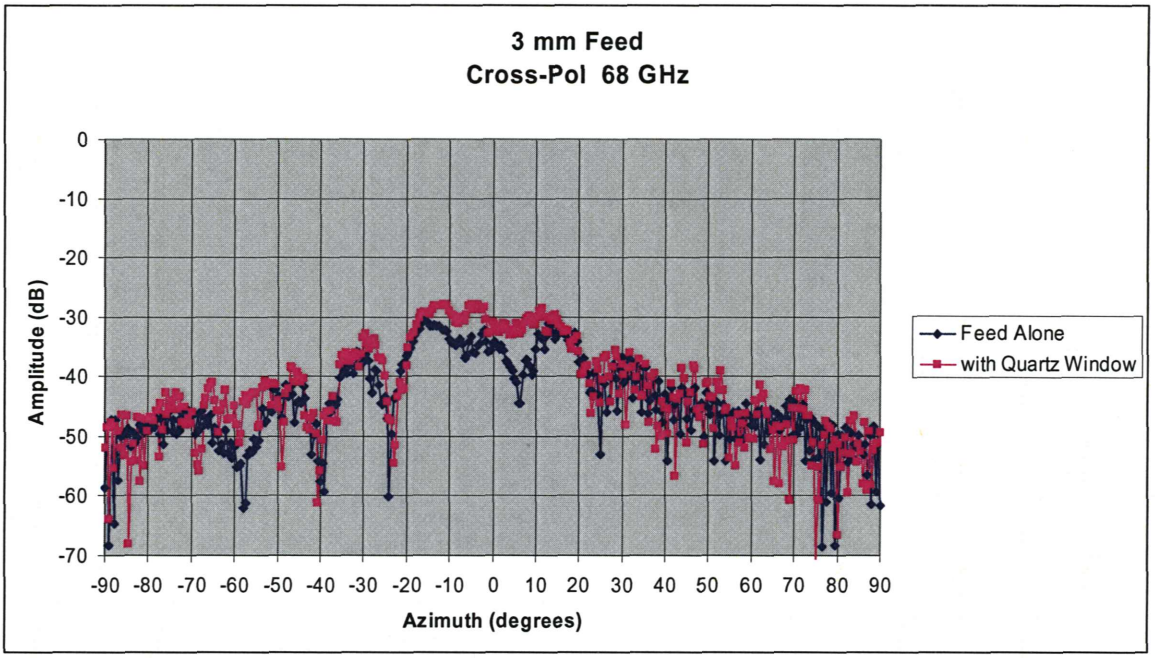

Figure 14: Cross-Pol, 68 GHz Comparison (with vs. without Quartz Window and IR Filter

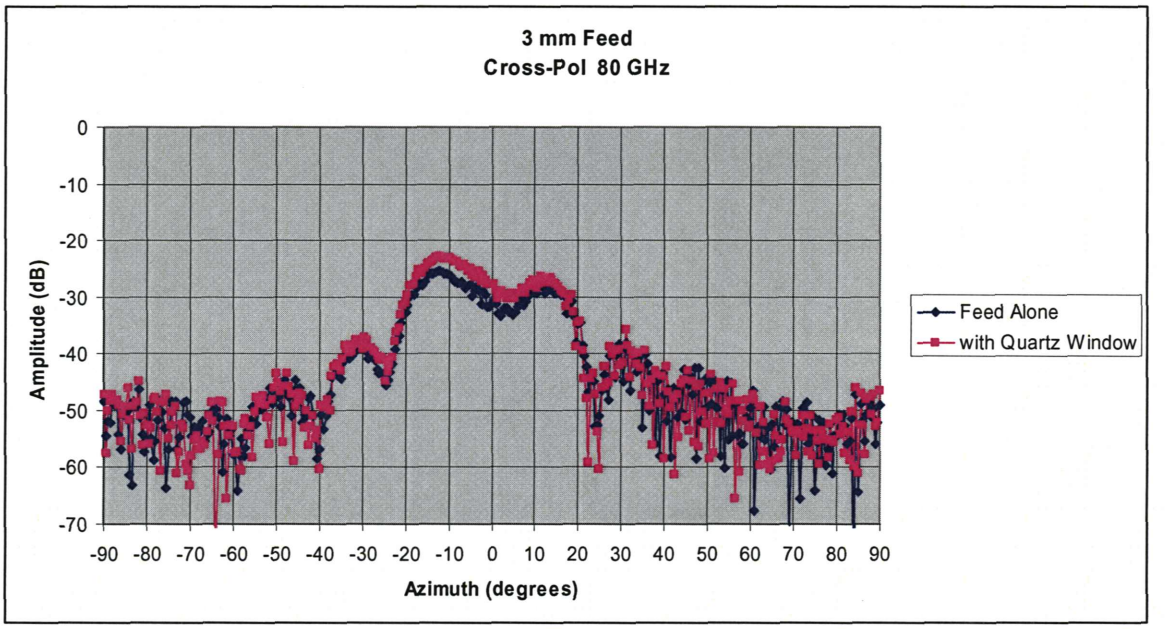

Figure 15: Cross-Pol, 80 GHz Comparison (with vs. without Quartz Window and IR Filter)

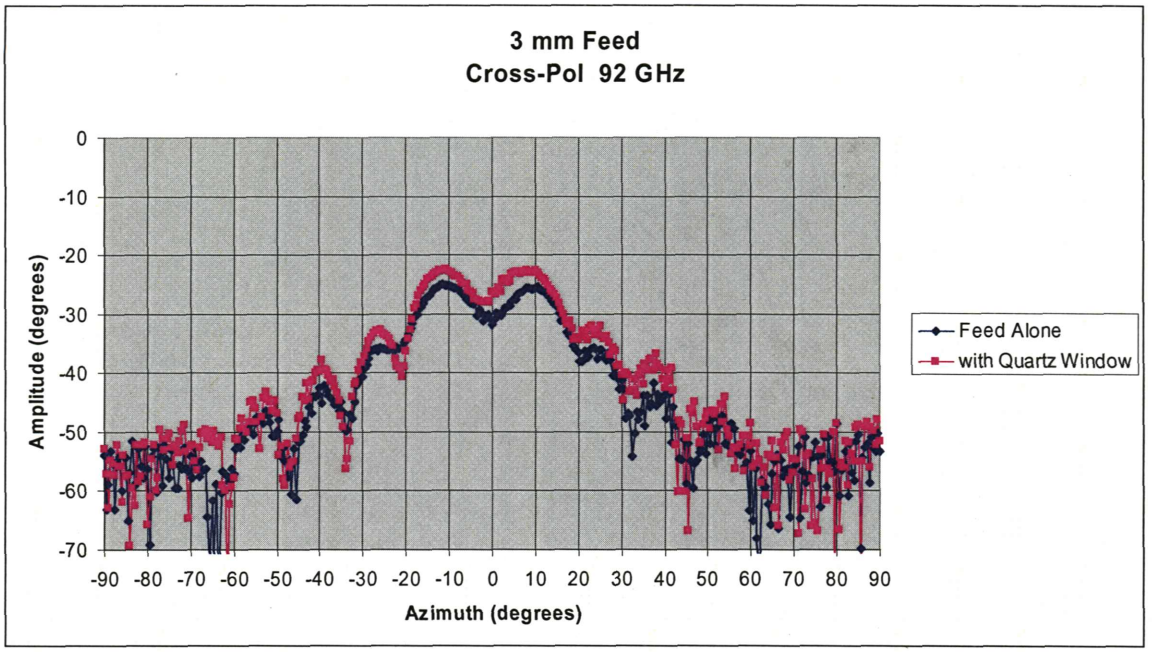

Figure 16: Cross-Pol, 92 GHz Comparison (with vs. without Quartz Window and IR Filter)