NATIONAL RADIO ASTRONOMY OBSERVATORY

Electronics Division Technical Note 206

Measurement of Microwave Absorbing Materials at Q and W bands

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Revised
7/13/2007

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The material identified as Emerson & Cuming Eccosorb H-10 in the original version is incorrect. Instead, it is Emerson & Cuming Eccosorb HR-10.

Three additional materials have been tested at W-band, and the results added to this report. See page 13.

Roger Norrod and Bob Simon, NRAO, Green Bank, WV

Introduction

This report documents reflection measurements made on various absorbing materials over the frequency ranges 40-50 GHz and 75-105 GHz. Six of the samples, consisting of various formulations of Stycast epoxy – carbon mixtures painted onto aluminum plates, were supplied to us by Simon Dicker of the University of Pennsylvania. These mixtures are representative of absorber mixtures used to paint cold surfaces in bolometer receivers at U. Penn.

Materials tested:
Sample A: 10% by mass, carbon in Stycast 2852FT+23LV, thin layer smooth
Sample B: 10% by mass, carbon in Stycast 2852FT+23LV, typical layer smooth
Sample C: 10% by mass, carbon in Stycast 2852FT+23LV, rough finish, used in critical places
Sample D: 10% by mass, carbon in Stycast 2852FT+23LV, thick slab, smooth finish
Sample E: 7.5% by mass, carbon in Stycast 2852FT+23LV, thick slab, smooth finish
Sample F: 7.5% by mass, carbon in Stycast 2852FT+23LV, thick slab, with size 16 silicon carbide
Material: Cuming Microwave 0.080” thick FF2, high loss silicone rubber sheet absorber
Material: Cuming Microwave 1/8” thick GDSS, high loss silicone rubber sheet absorber
Material: Emerson & Cuming Eccosorb HR10
Material: ¼” thick flexible foam absorber – Unknown manufacturer and type.

Figure 1: Samples A-F shown on left; Material HR10, round sample in center; FF and GDSS material on right; ¼" thick absorber, (white) shown on top

Calibration and measurement: For both Q and W band measurements, a waveguide calibration was done at the flange immediately in front of the feed horn. The feed was then installed and secured in the holding fixture. An aluminum shorting plate was then placed 1" from the feed aperture, and the response stored into memory. All data taken is in the form Data/Memory. All materials were measured with an aluminum plate immediately behind the sample.

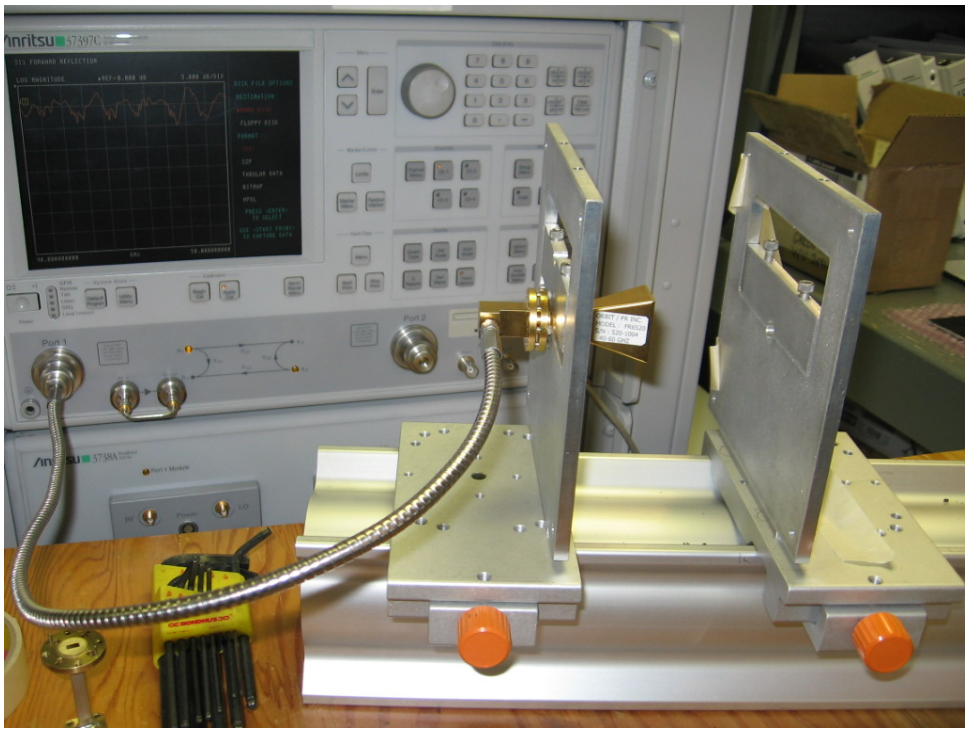


Figure 2: Q-band 40-50 Ghz measurement setup: Anritsu 37397C VNA in background; coax to waveguide transition; Orbit model FR6520, s/n 520-1004 horn in fixture holder.

Figure 3: Q-band cal kit: Short, termination, 4.9644mm offset short, 2.5438mm offset short

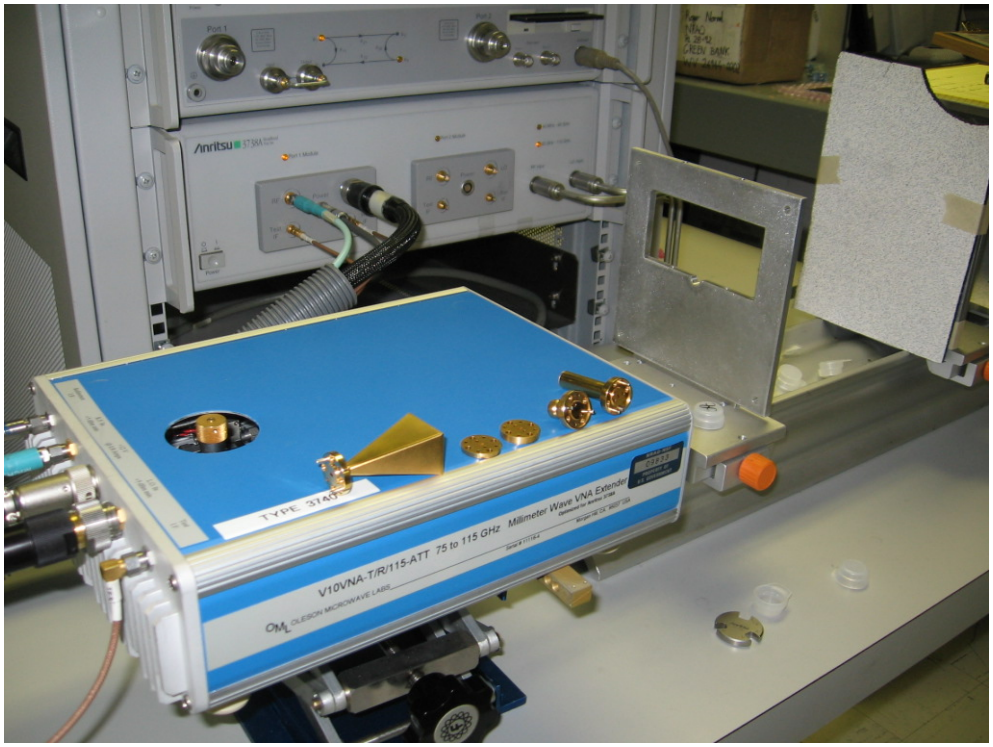


Figure 4: W-band measurement setup: Oleson model 3740, 75-105 Ghz extender; Orbit FR6523, s/n 523-1006, WR10 horn; 75-110Ghz Offsets, short, and termination for calibration.

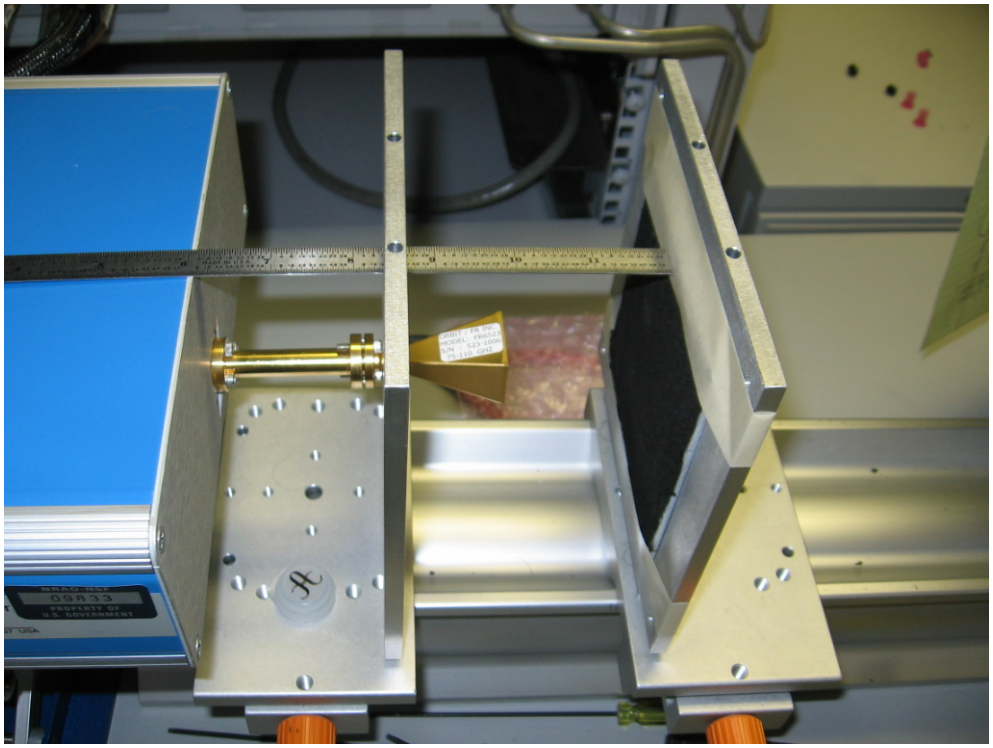
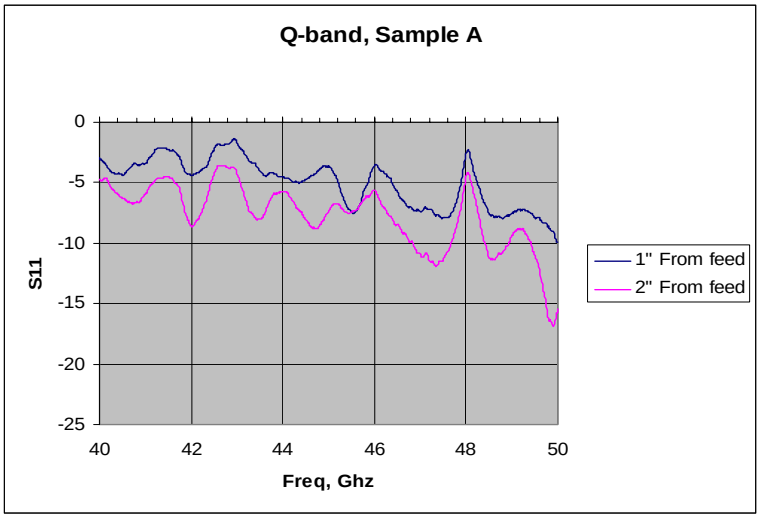
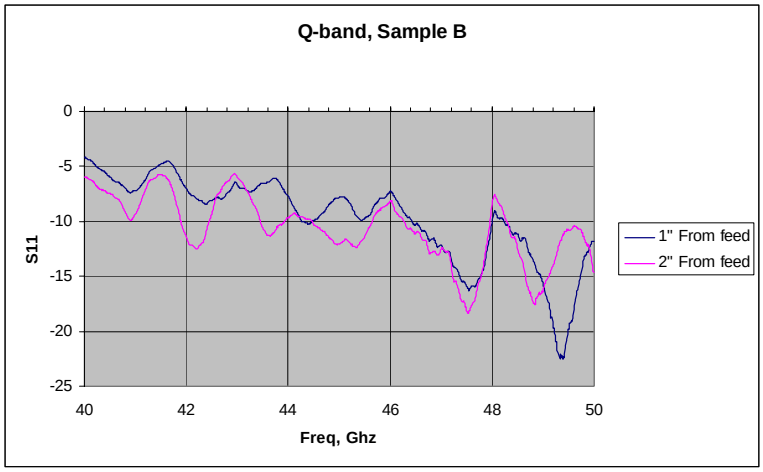


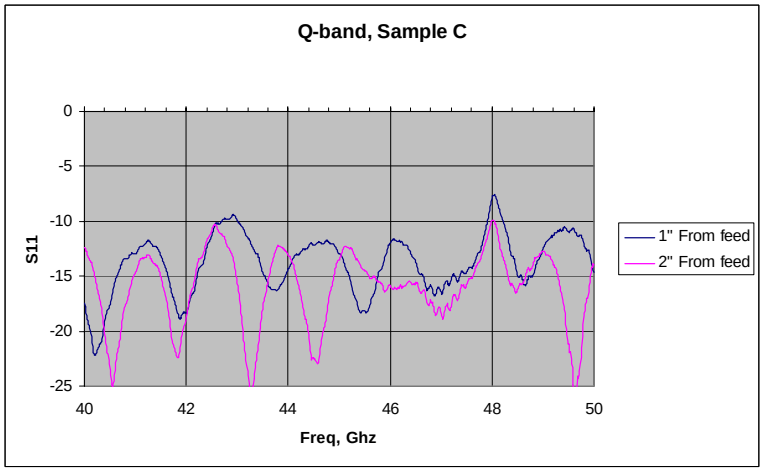
Figure 5: WR-10 feedhorn and test sample located 2” from feed aperture

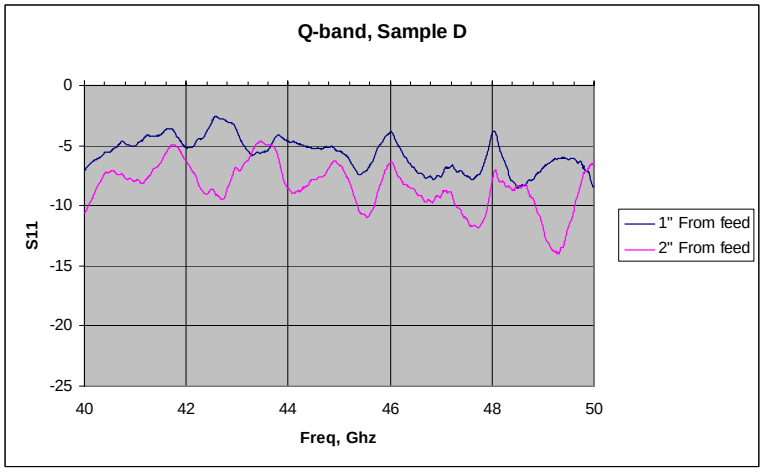
Measurement Results

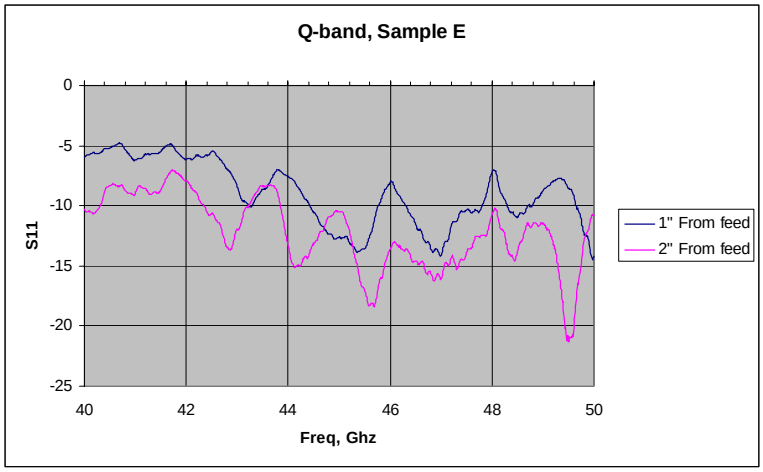
The following plots show the return loss of each material, measured at 1” and 2” from the feed aperture.

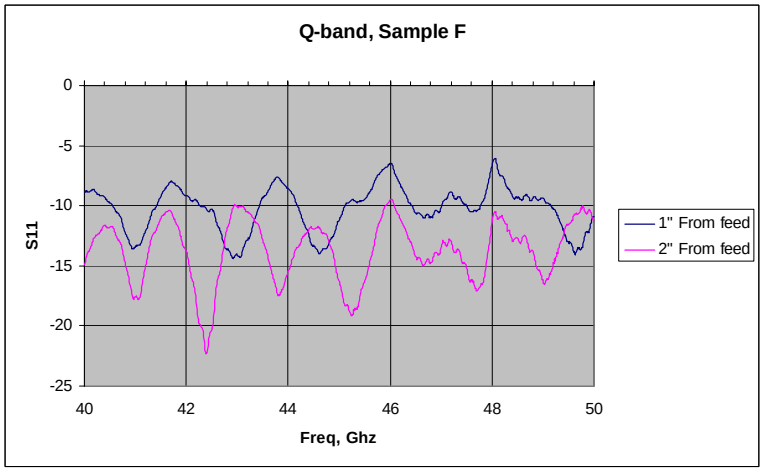


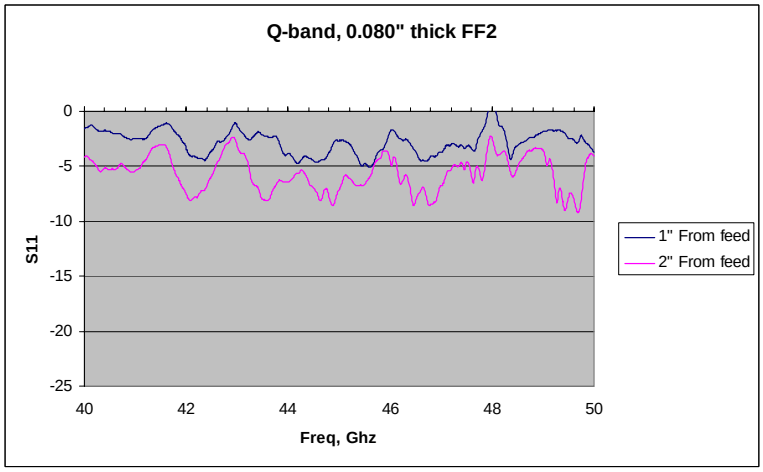

Q-band, Sample B
0
-5
-10
-15
-20
-25
S11
40
42
44
46
48
50
Freq, Ghz
1" From feed
2" From feed

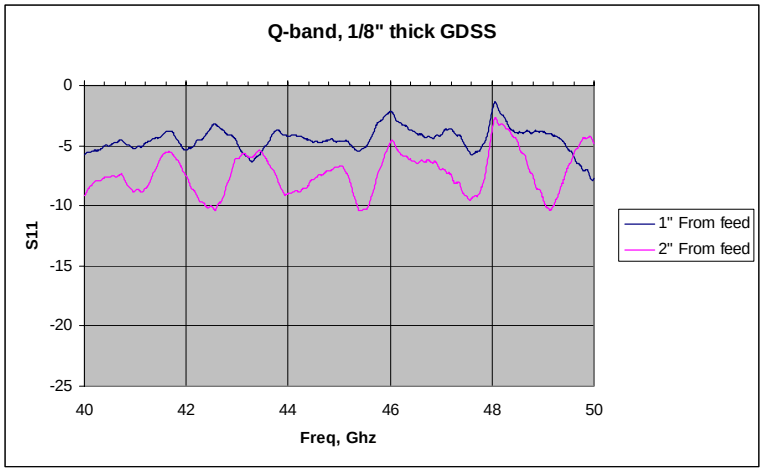

Q-band, Sample C
0
-5
-10
-15
-20
-25
S11
40
42
44
46
48
50
Freq, Ghz
1" From feed
2" From feed


Q-band, Sample D
0
-5
-10
-15
-20
-25
S11
40
42
44
46
48
50
Freq, Ghz
1" From feed
2" From feed

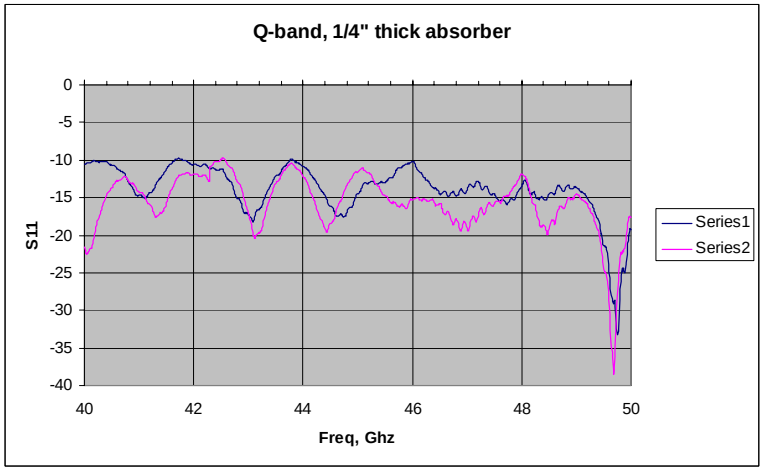

Q-band, Sample E
0
-5
-10
-15
-20
-25
S11
40
42
44
46
48
50
Freq, Ghz
1" From feed
2" From feed

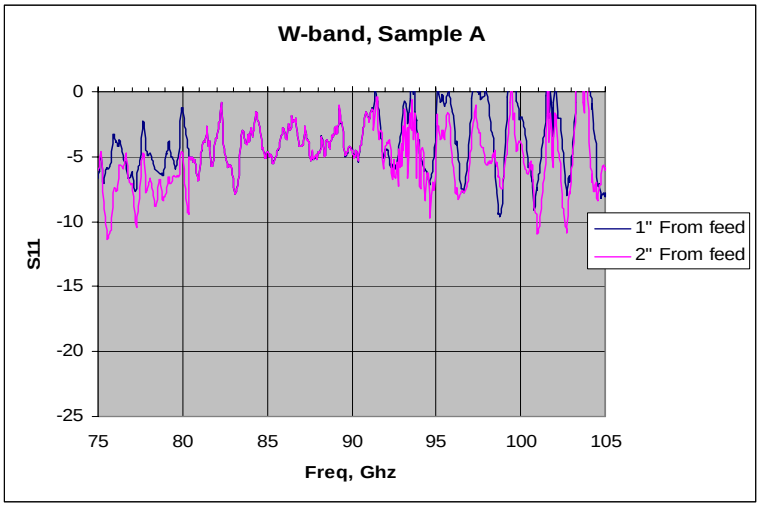

Q-band, Sample F
0
-5
-10
-15
-20
-25
S11
40
42
44
46
48
50
Freq, Ghz
1" From feed
2" From feed

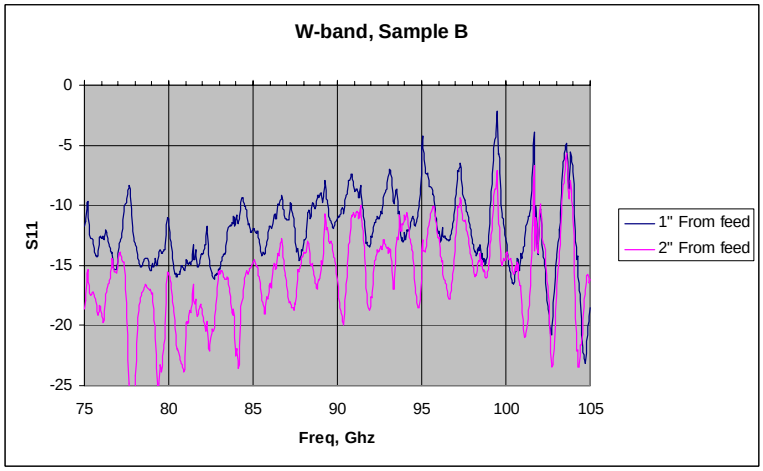

Q-band, 0.080" thick FF2
0
-5
-10
-15
-20
-25
S11
40
42
44
46
48
50
Freq, Ghz
1" From feed
2" From feed

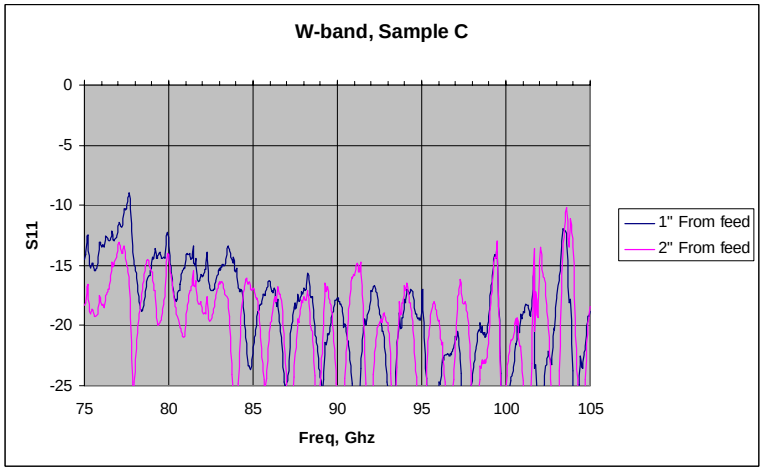

Q-band, 1/8" thick GDSS
0
-5
-10
-15
-20
-25
S11
40
42
44
46
48
50
Freq, Ghz
1" From feed
2" From feed

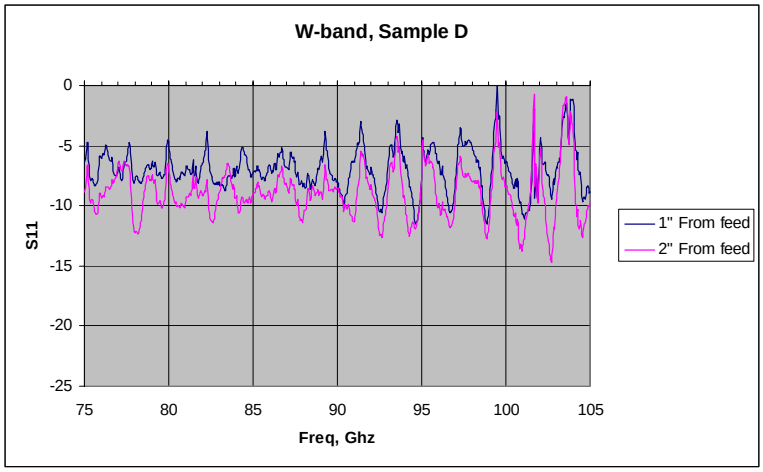

Q-band, Material HR-10
0
-5
-10
-15
-20
-25
-30
-35
-40
S11
40
42
44
46
48
50
Freq, Ghz
1" From feed
2" From feed

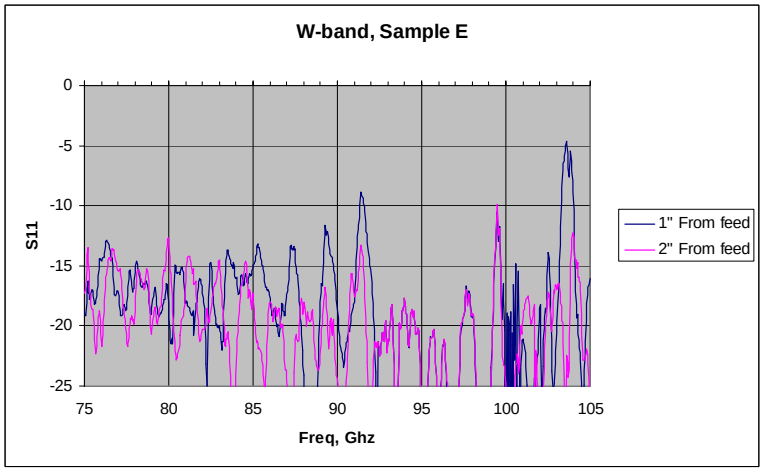

Q-band, 1/4" thick absorber
0
-5
-10
-15
-20
-25
-30
-35
-40
S11
40
42
44
46
48
50
Freq, Ghz
Series1
Series2

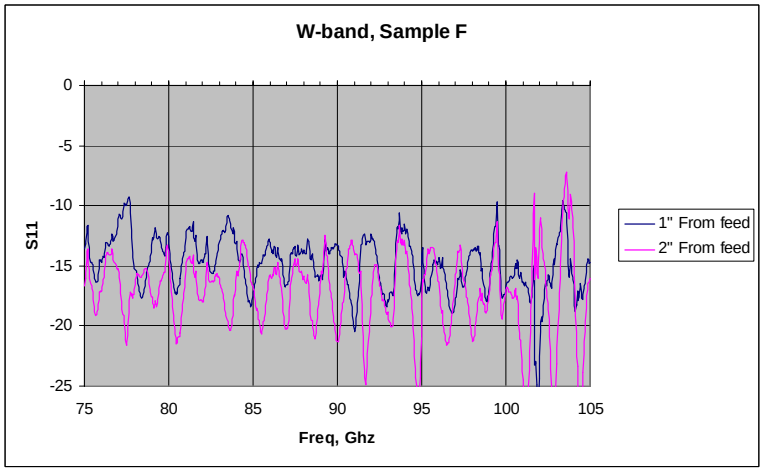

W-band, Sample A
0
-5
-10
-15
-20
-25
S11
75
80
85
90
95
100
105
Freq, Ghz
1" From feed
2" From feed

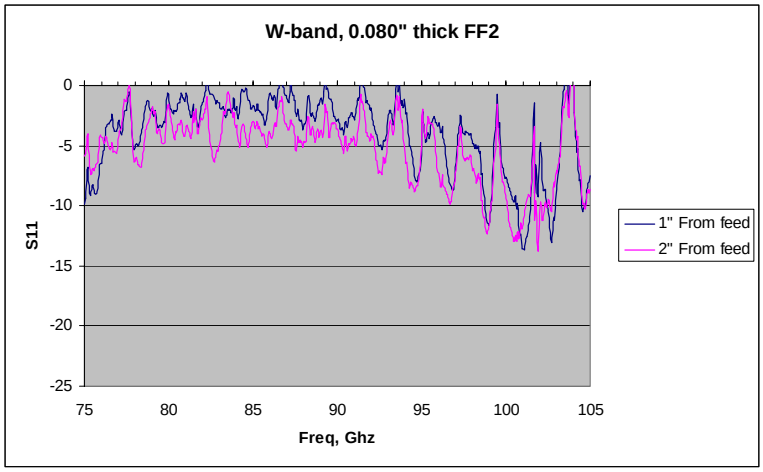

W-band, Sample B
0
-5
-10
-15
-20
-25
S11
75
80
85
90
95
100
105
Freq, Ghz
1" From feed
2" From feed

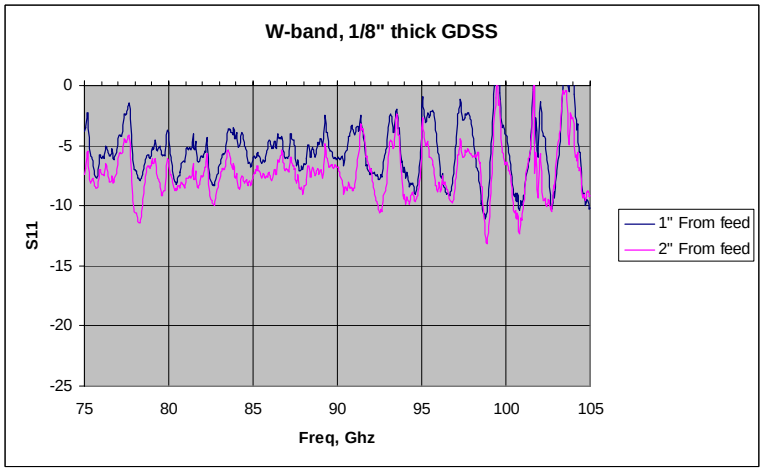

W-band, Sample C
0
-5
-10
-15
-20
-25
S11
75
80
85
90
95
100
105
Freq, Ghz
1" From feed
2" From feed

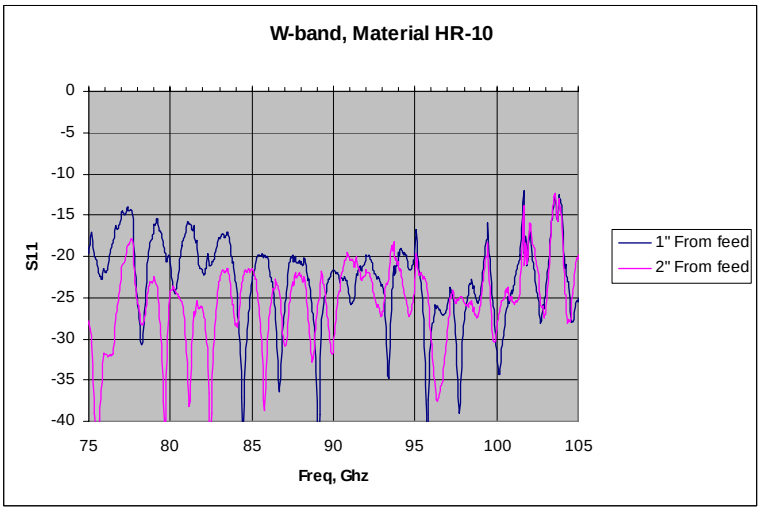

W-band, Sample D
0
-5
-10
-15
-20
-25
S11
75
80
85
90
95
100
105
Freq, Ghz
1" From feed
2" From feed


W-band, Sample E
0
-5
-10
-15
-20
-25
S11
75
80
85
90
95
100
105
Freq, Ghz
1" From feed
2" From feed


W-band, Sample F
0
-5
-10
-15
-20
-25
S11
75
80
85
90
95
100
105
Freq, Ghz
1" From feed
2" From feed


W-band, 0.080" thick FF2
0
-5
-10
-15
-20
-25
S11
75
80
85
90
95
100
105
Freq, Ghz
1" From feed
2" From feed


W-band, 1/8" thick GDSS
0
-5
-10
-15
-20
-25
S11
75
80
85
90
95
100
105
Freq, Ghz
1" From feed
2" From feed


W-band, Material HR-10
0
-5
-10
-15
-20
-25
-30
-35
-40
S11
75
80
85
90
95
100
105
Freq, Ghz
1" From feed
2" From feed

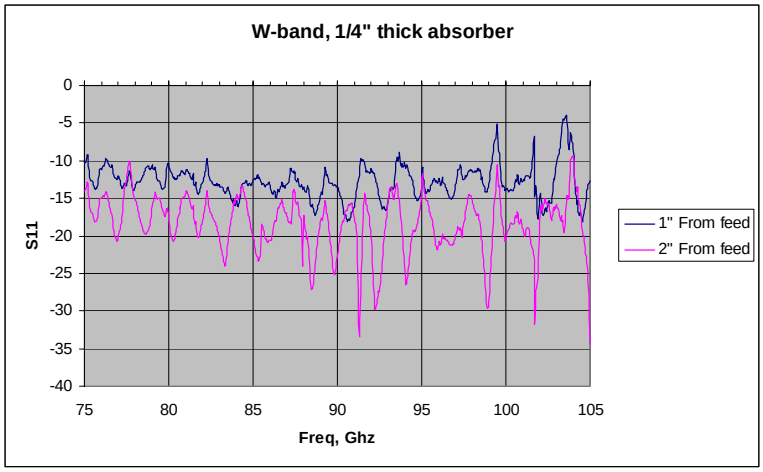
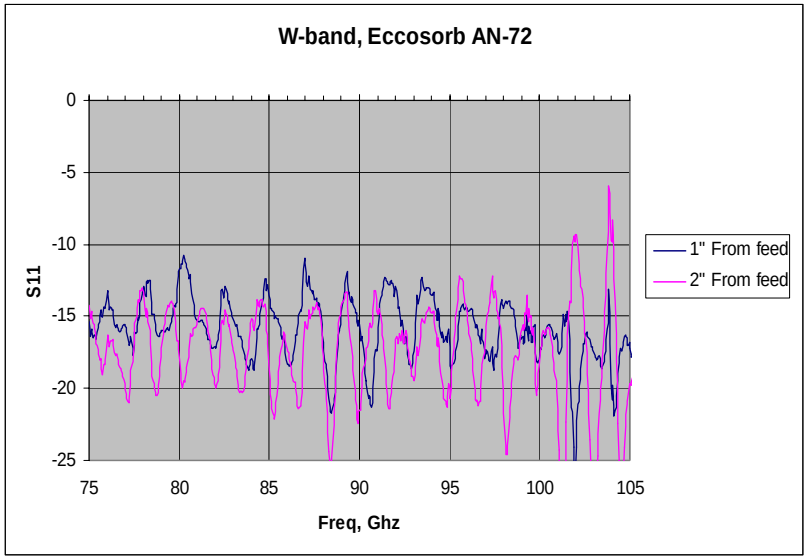
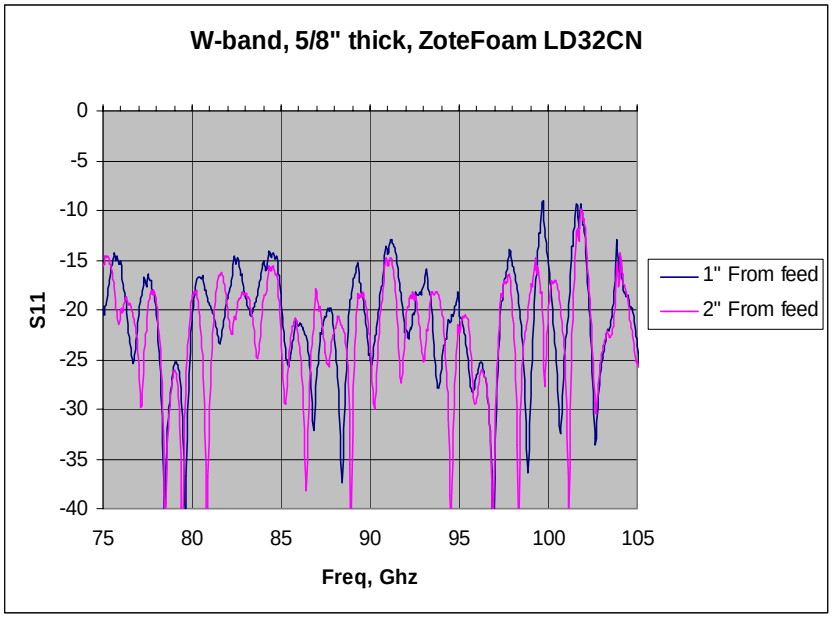
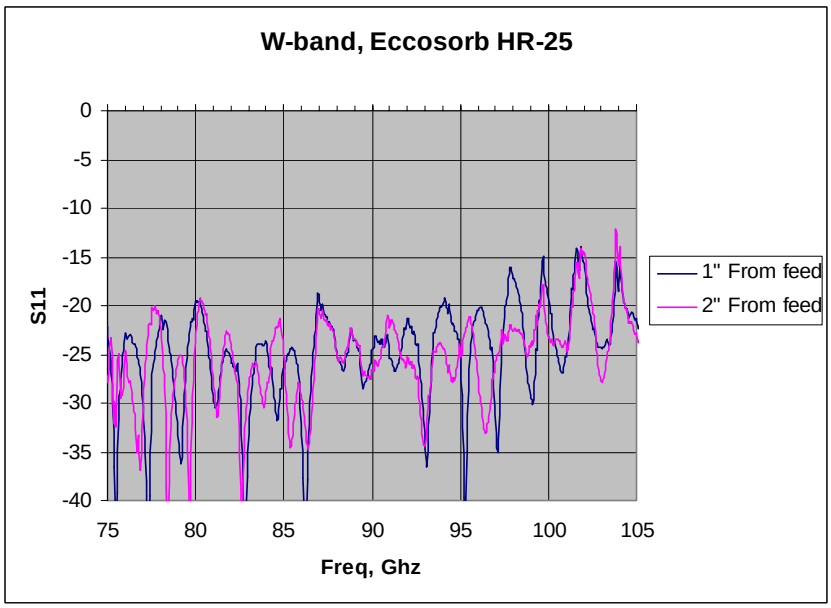

W-band, 1/4" thick absorber
0
-5
-10
-15
-20
-25
-30
-35
-40
S11
75
80
85
90
95
100
105
Freq, Ghz
1" From feed
2" From feed

Figure 6: Additional materials tested at W-band. From left, Emerson & Cuming Eccosorb AN-72, Zote Foam LD32CN, Emerson & Cuming Eccosorb HR-25.




W-band, 5/8" thick, ZoteFoam LD32CN
0
-5
-10
-15
-20
-25
-30
-35
-40
S11
75
80
85
90
95
100
105
Freq, Ghz
1" From feed
2" From feed


W-band, Eccosorb HR-25
0
-5
-10
-15
-20
-25
-30
-35
-40
S11
75
80
85
90
95
100
105
Freq, Ghz
1" From feed
2" From feed