7-3.4 Scrimp Horn [17c]

A short axially corrugated horn with a single slot and a cylindrical extension radiates in the hybrid mode and produces suitable patterns over a waveguide band. The gain ranges from 10.9- to 13.3-dB. By using an input radius $a_i = 3\lambda_c / (2\pi)$, a flare angle of 25°, a slot pitch of $\lambda_c/8$, and $\delta = 0.8$, a series of horns were designed using the optimization in CHAMP (TICRA), a mode matching analysis program using minmax optimization to generate designs that produce the hybrid mode. The currents excited on the external surface of the horn must be included in the optimization because of the low gain. The design parameters are listed in Table 1.

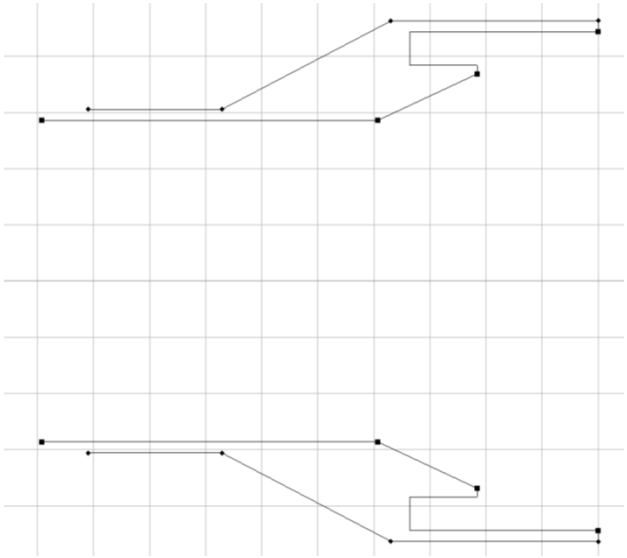


Figure 1 CHAMP Design of Scrimp Horn Geometry 0.74λ Outer Radius

Table 1 Scrimp Horn Designs with dimension, λ_c

Outer Radius	Gain dB	10 dB Beamwidth	Slot Depth	Axial Extension	Cross Polarization
0.62	10.86	102.8	0.2317	0.1599	39.8 dB
0.64	11.09	99.9	0.2344	0.1676	41.4
0.66	11.30	97.3	0.2292	0.1785	42.7
0.68	11.51	94.9	0.2241	0.1924	44.2
0.70	11.96	88.8	0.2097	0.3415	30.9
0.72	12.05	88.5	0.2151	0.2760	36.4
0.74	12.34	85.1	0.2004	0.3600	30.5
0.76	12.57	83.0	0.2031	0.3659	31.2
0.78	12.78	81.0	0.2032	0.3752	31.8
0.80	13.11	77.8	0.2070	0.4078	30.9
0.82	13.15	77.7	0.2000	0.3870	36.3
0.84	13.33	76.2	0.1990	0.3960	38.6

CHAMP (TICRA) was used to design the scrimp horn using optimization to determine the axial slot depth and axial extension. Figure 2 shows the design screen of CHAMP where initial values are entered and an exterior is added to the horn. The CHAMP design used 10 GHz for the optimization. Without the MoM solution of the exterior incorrect pattern results are obtained from the analysis because significant currents are excited on the exterior. Figure 3 illustrates the addition of the two variables in CHAMP. A mini-max optimization over a narrow frequecy range from 9.5- to 10.5-GHz was used to find the variables using the goals given in Figure 4 that minimized the cross polarization and minimized the variation be .

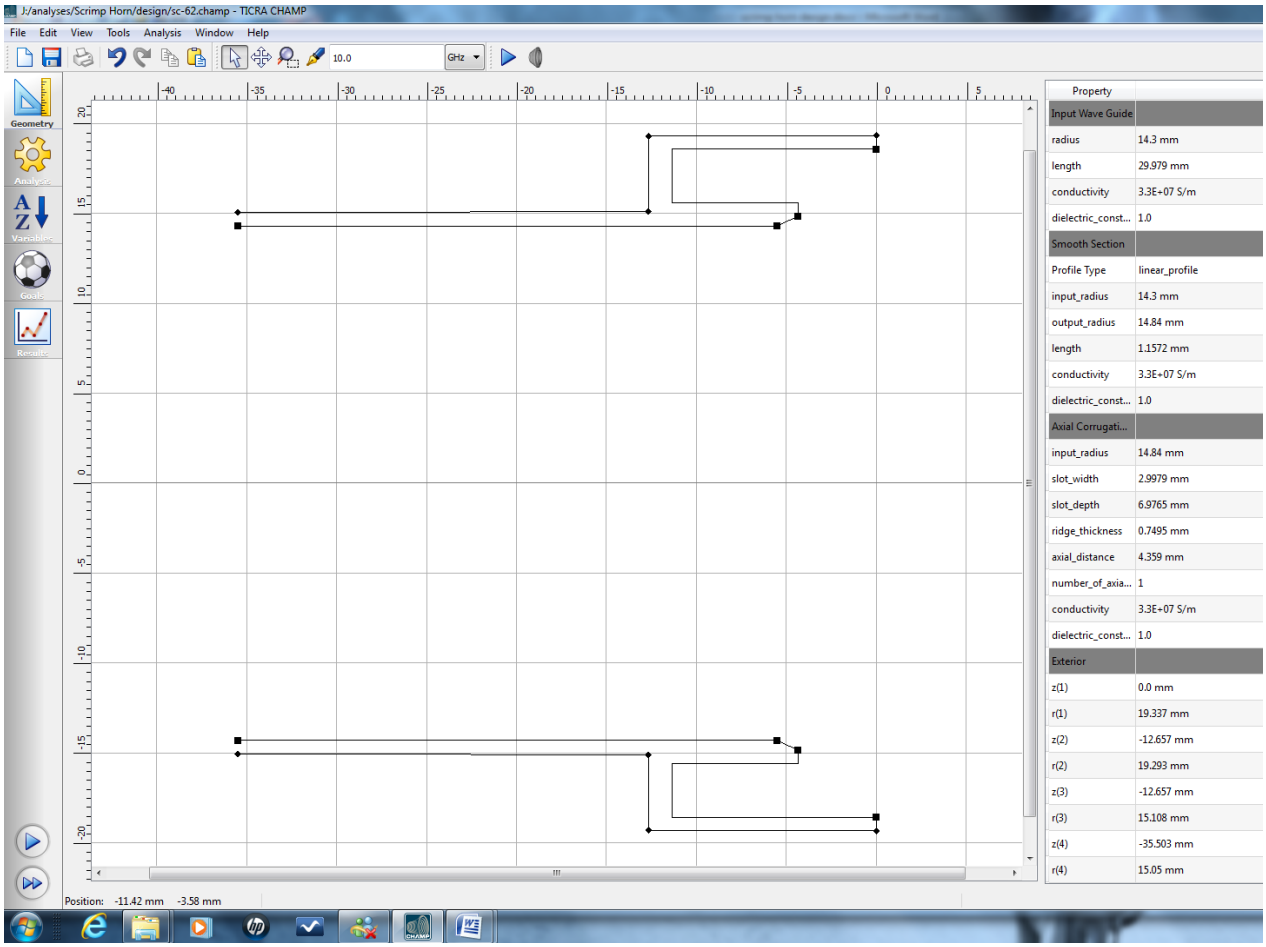


Figure 2 CHAMP design of Scrimp Horn with external surface

Axial Corrugati...			
input_radius	14.84 mm		
slot_width	2.9979 mm		
slot_depth	6.9765 mm	s1	
ridge_thickness	0.7495 mm		
axial_distance	4.359 mm	a1	
number_of_axia...	1		
conductivity	3.3E+07 S/m		
dielectric_const...	1.0		

Figure 3 CHAMP Optimization variables for Scrimp Horn

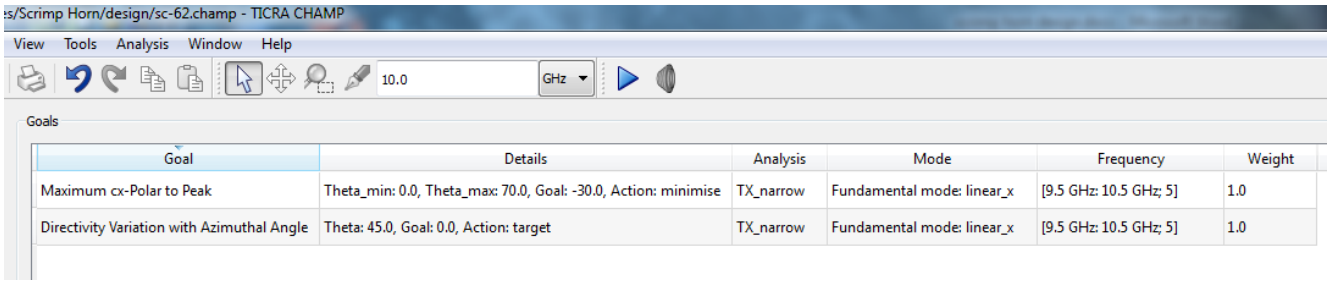


Figure 4 CHAMP Optimization Goals

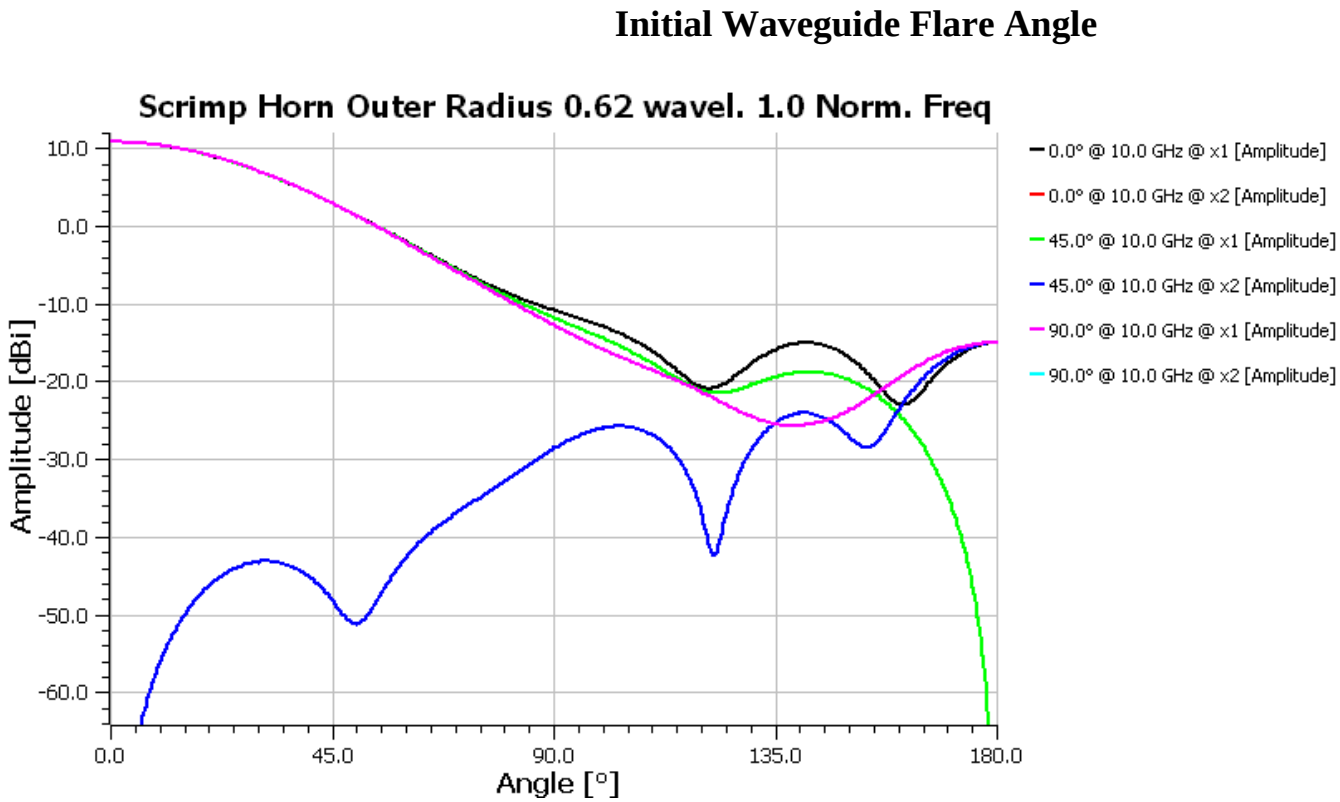


Figure 5 Center frequency pattern of Optimized Scrimp Horn 0.62λ Outer Radius

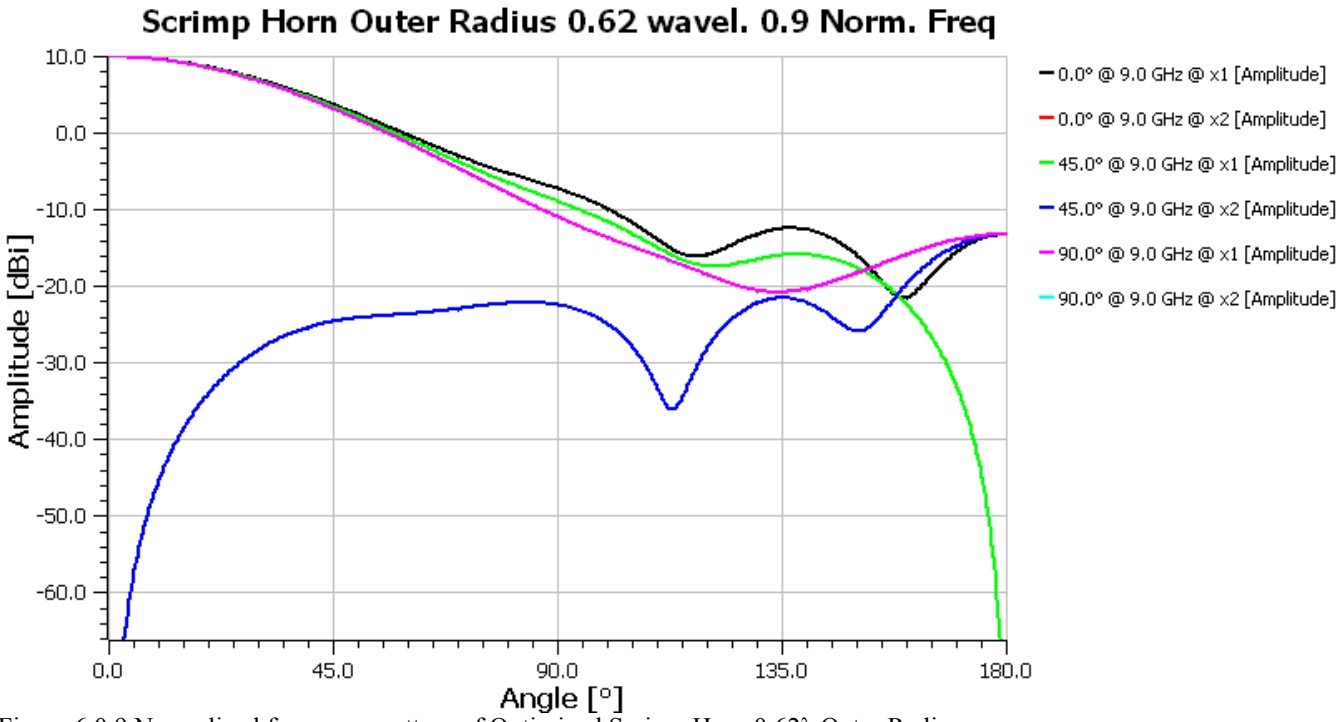


Figure 6 0.9 Normalized frequency pattern of Optimized Scrimp Horn 0.62λ Outer Radius

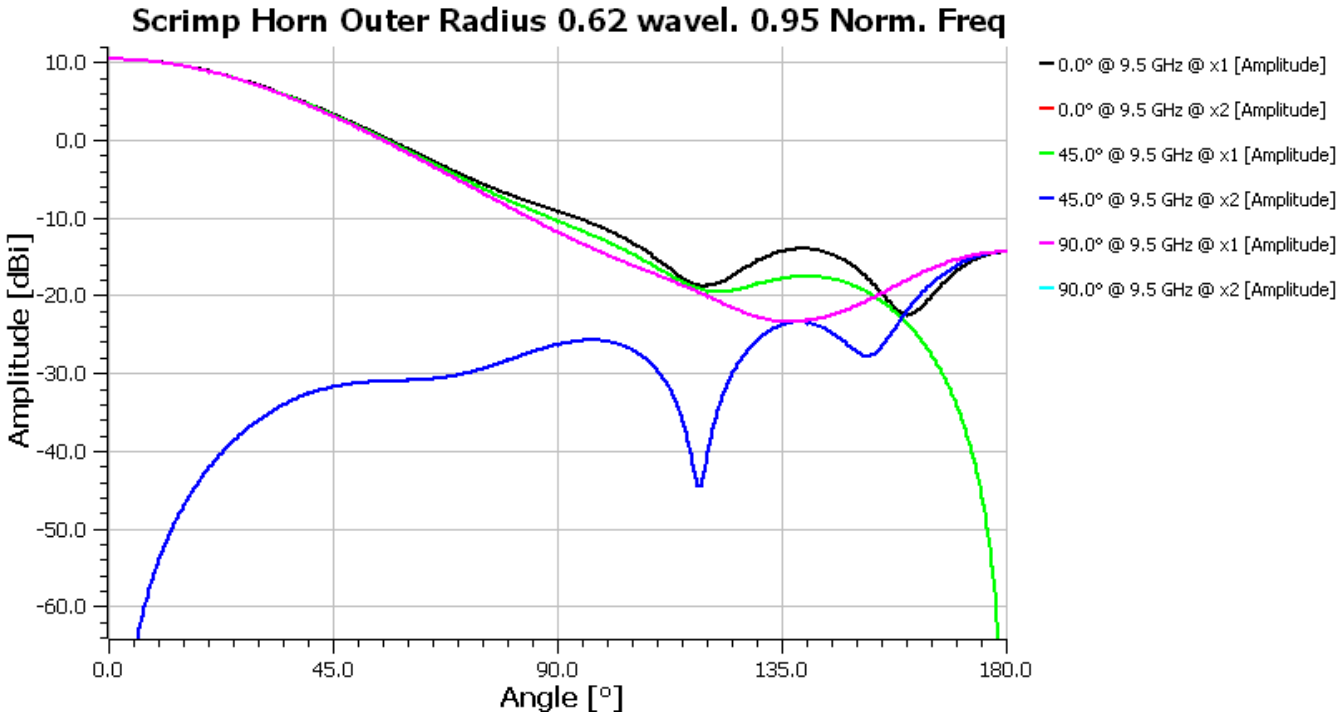


Figure 7 0.95 Normalized frequency pattern of Optimized Scrimp Horn 0.62λ Outer Radius

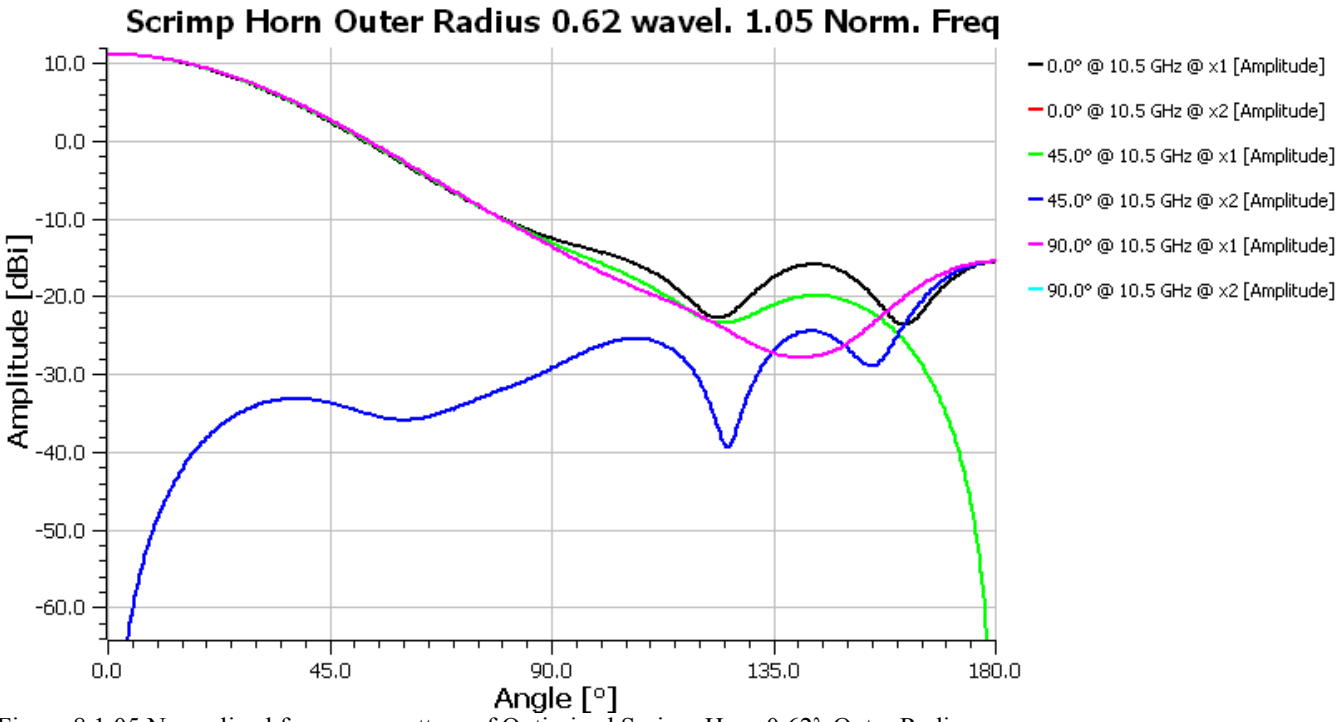


Figure 8 1.05 Normalized frequency pattern of Optimized Scrimp Horn 0.62λ Outer Radius

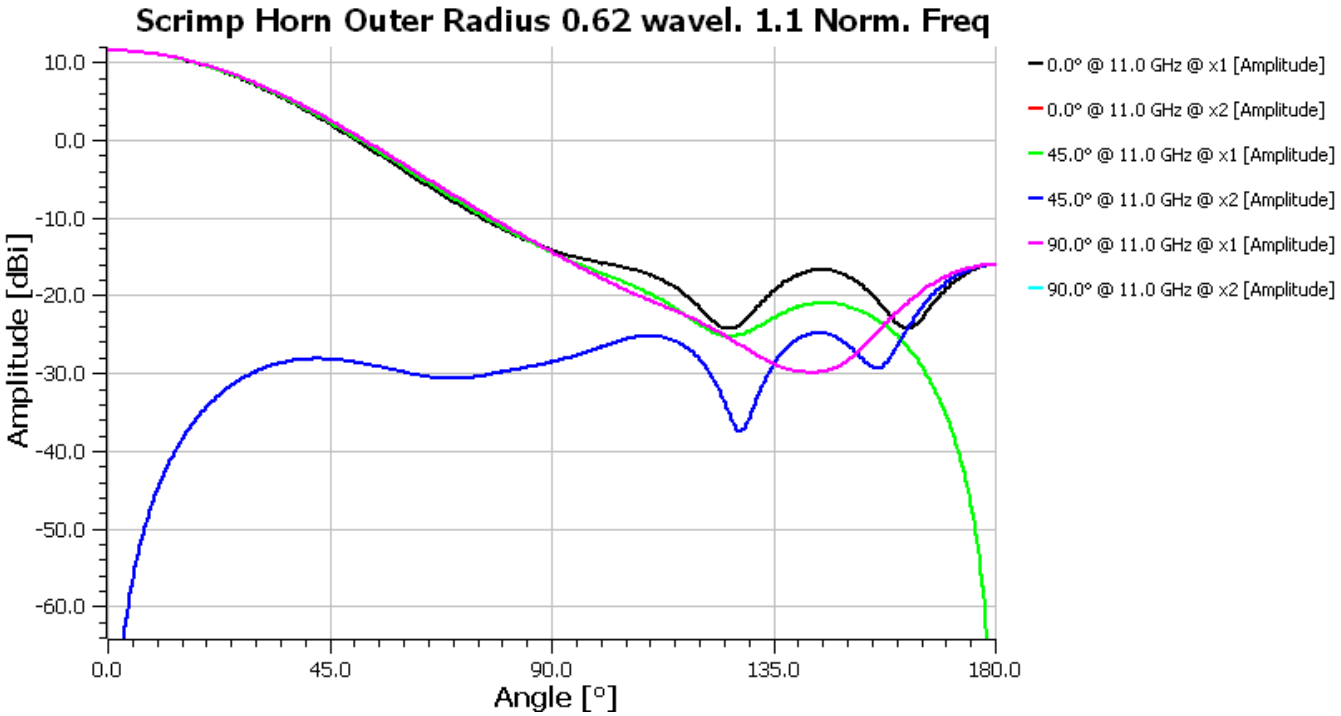


Figure 9 1.05 Normalized frequency pattern of Optimized Scrimp Horn 0.62λ Outer Radius

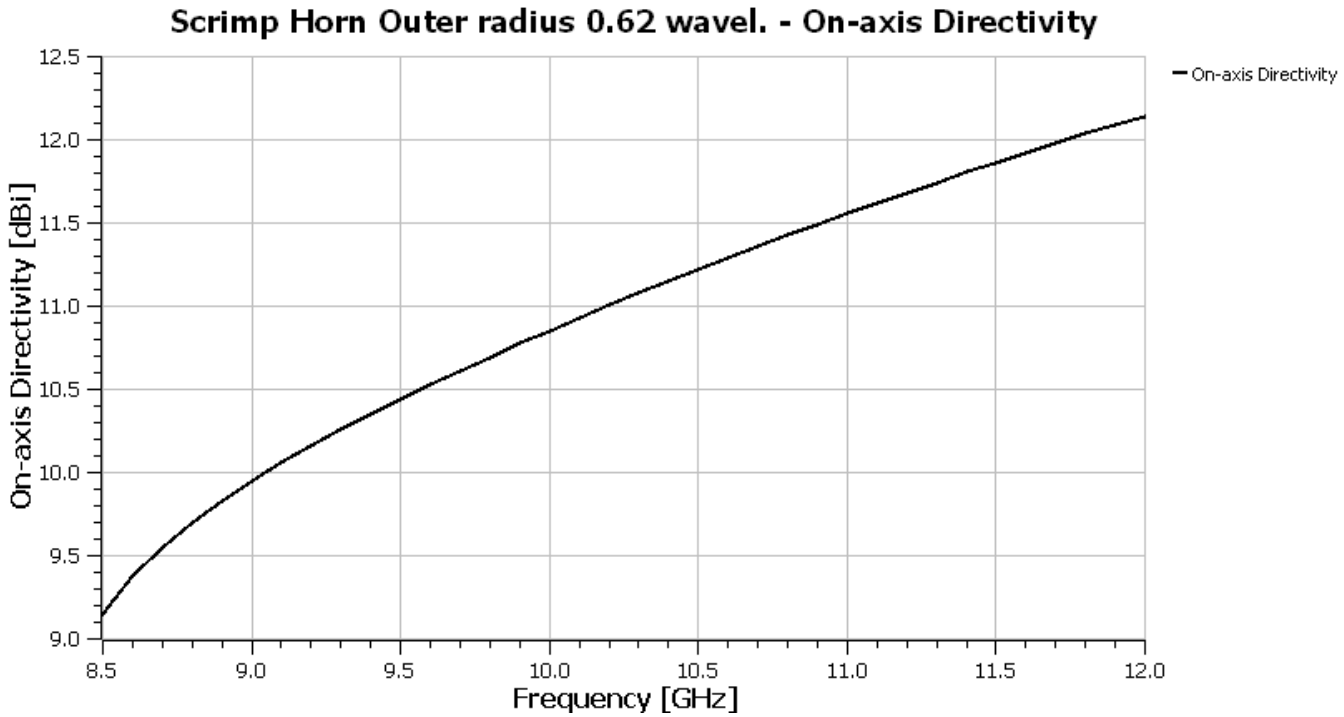


Figure 10 Directivity of Optimized Scrimp Horn with 0.62λ Outer Radius 10 GHz Center Frequency

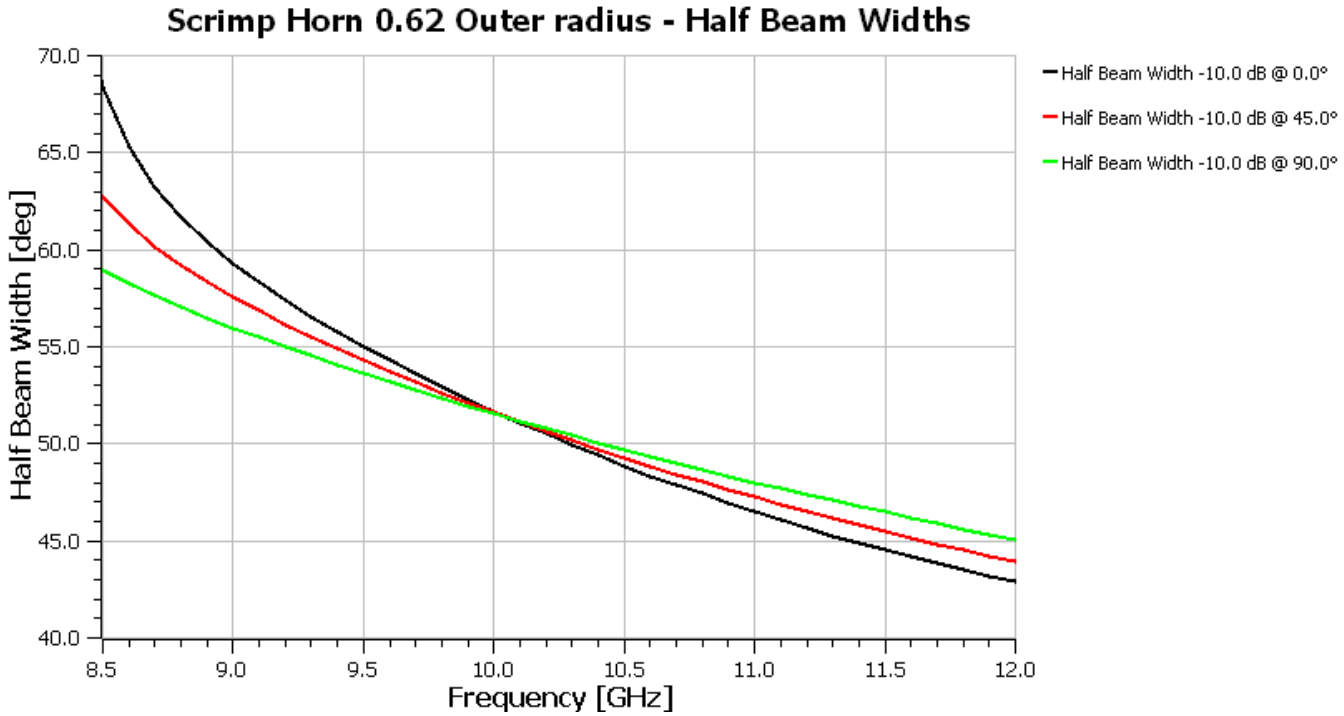


Figure 11 10-dB Half Beamwidth of Optimized Scrimp Horn with 0.62λ Outer Radius 10 GHz Center Frequency

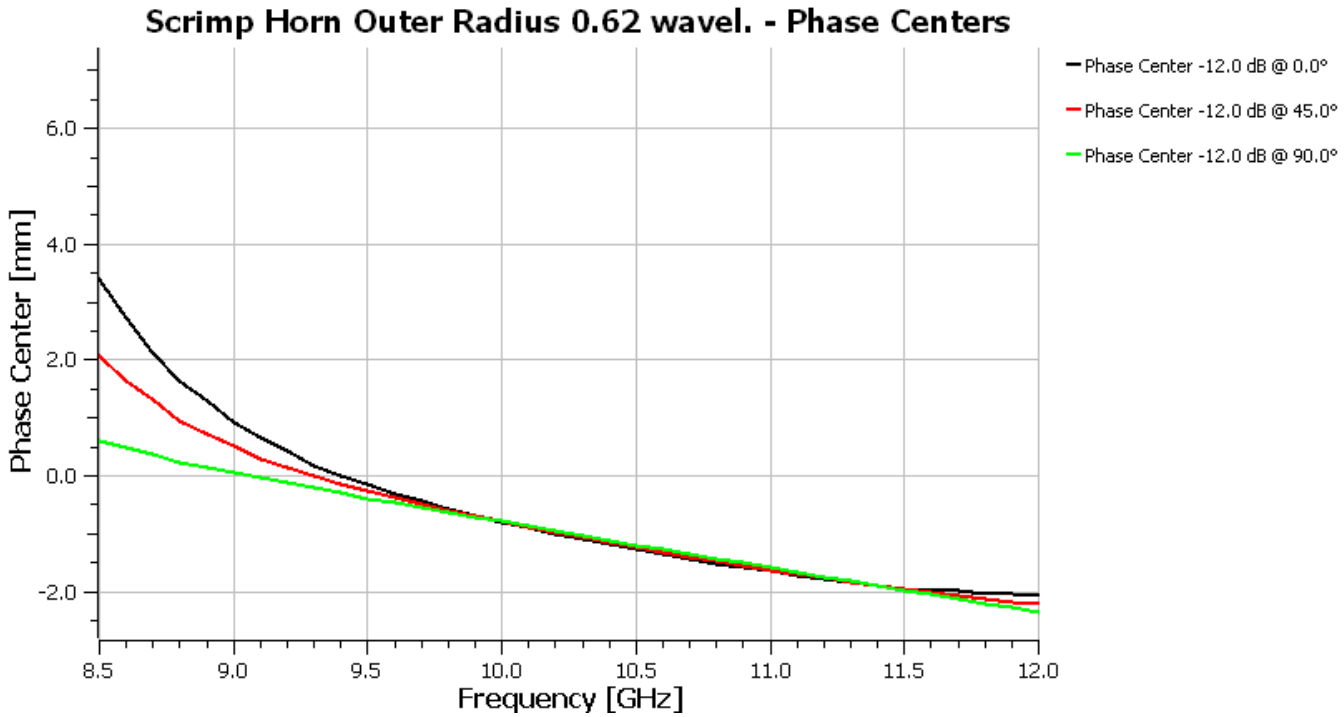


Figure 12 Phase Center of Optimized Scrimp Horn with 0.62λ Outer Radius 10 GHz Center Frequency

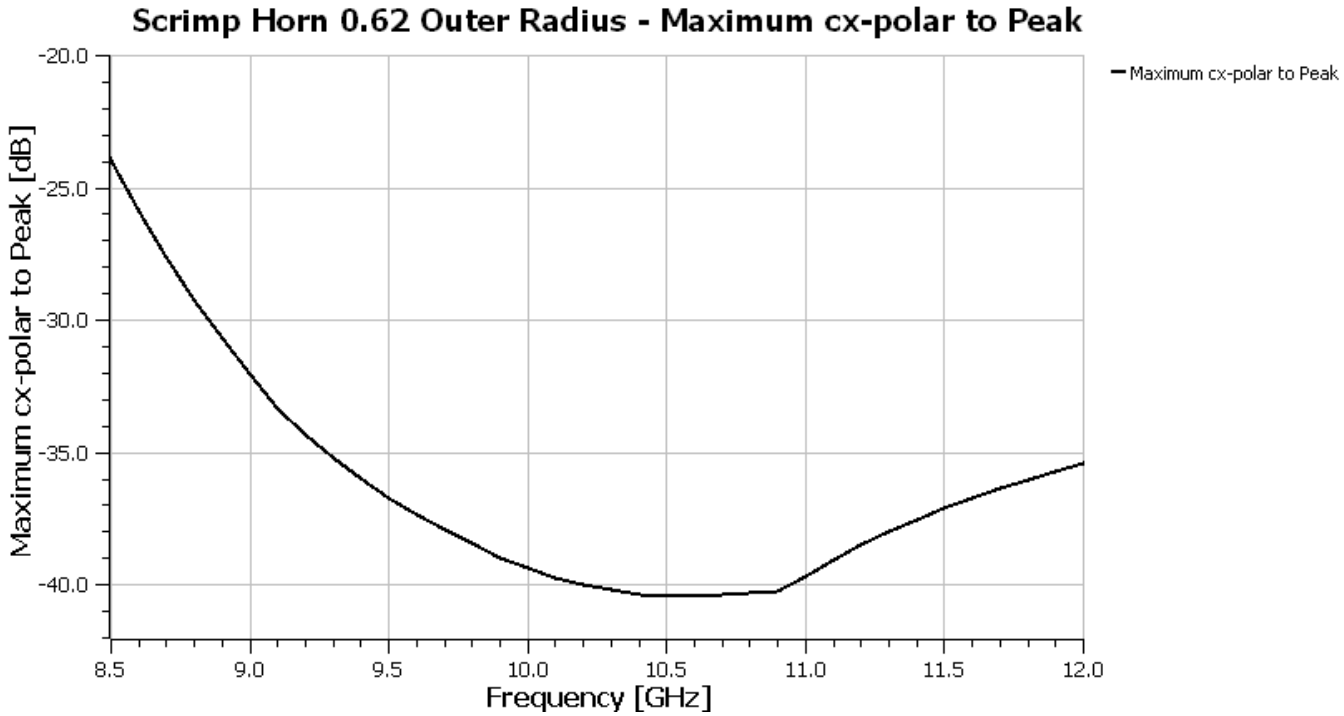


Figure 13 Maximum X-Pol. of Optimized Scrimp Horn with 0.62λ Outer Radius 10 GHz Center Frequency

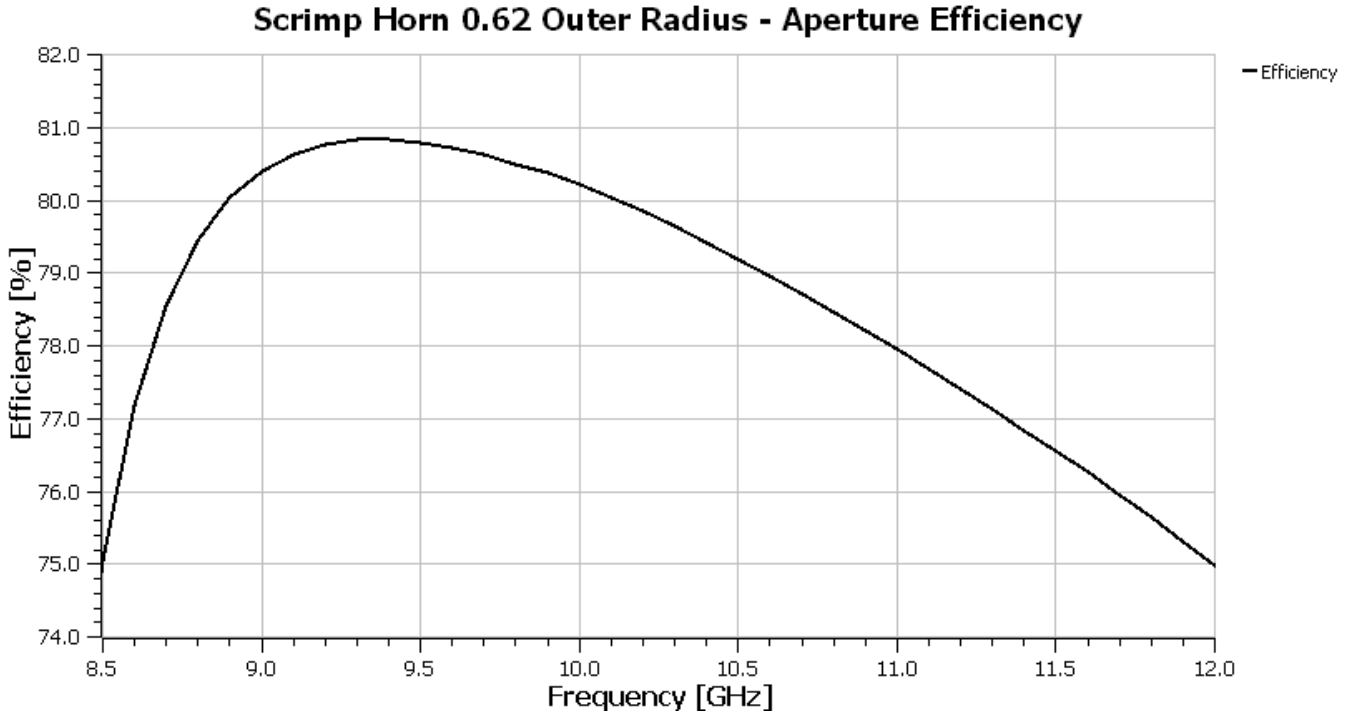


Figure 14 Aperture Efficiency of Optimized Scrimp Horn with 0.62λ Outer Radius 10 GHz Center Frequency

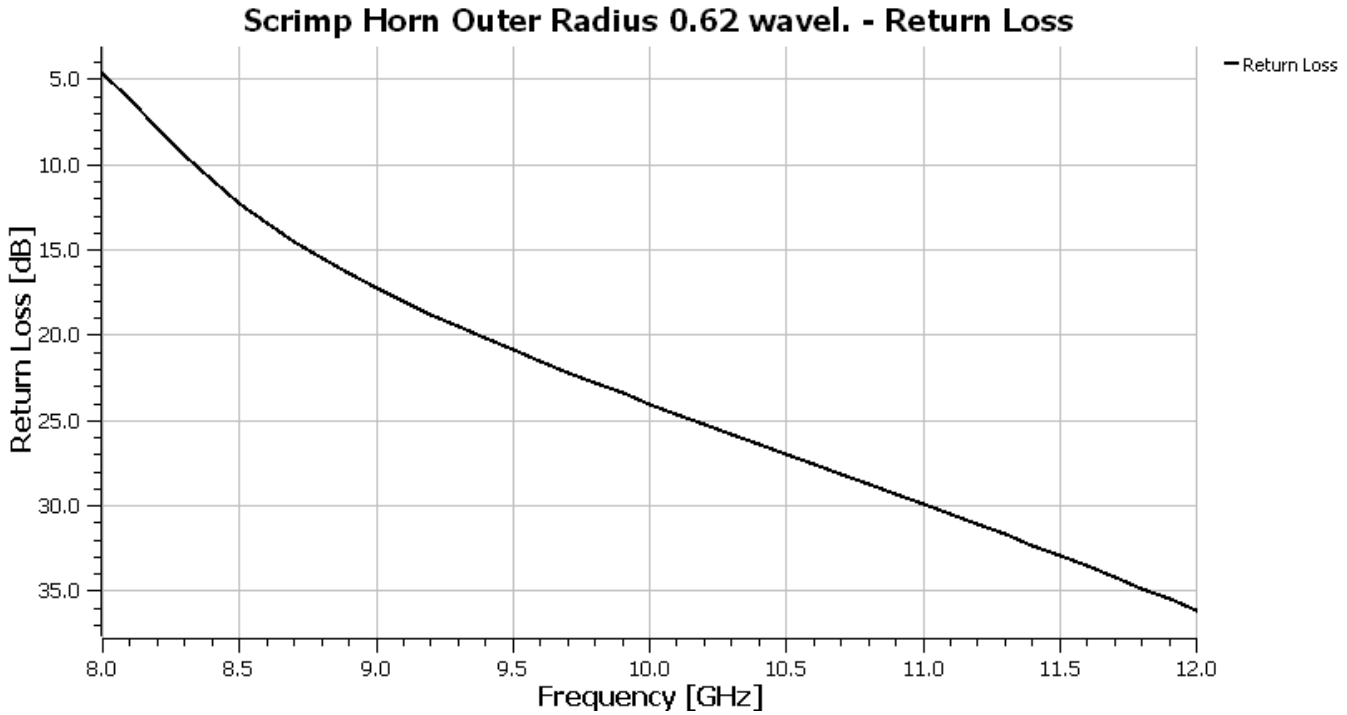


Figure 15 Return Loss of Optimized Scrimp Horn with 0.62λ Outer Radius 10 GHz Center Frequency

Initial Waveguide Flare Angle

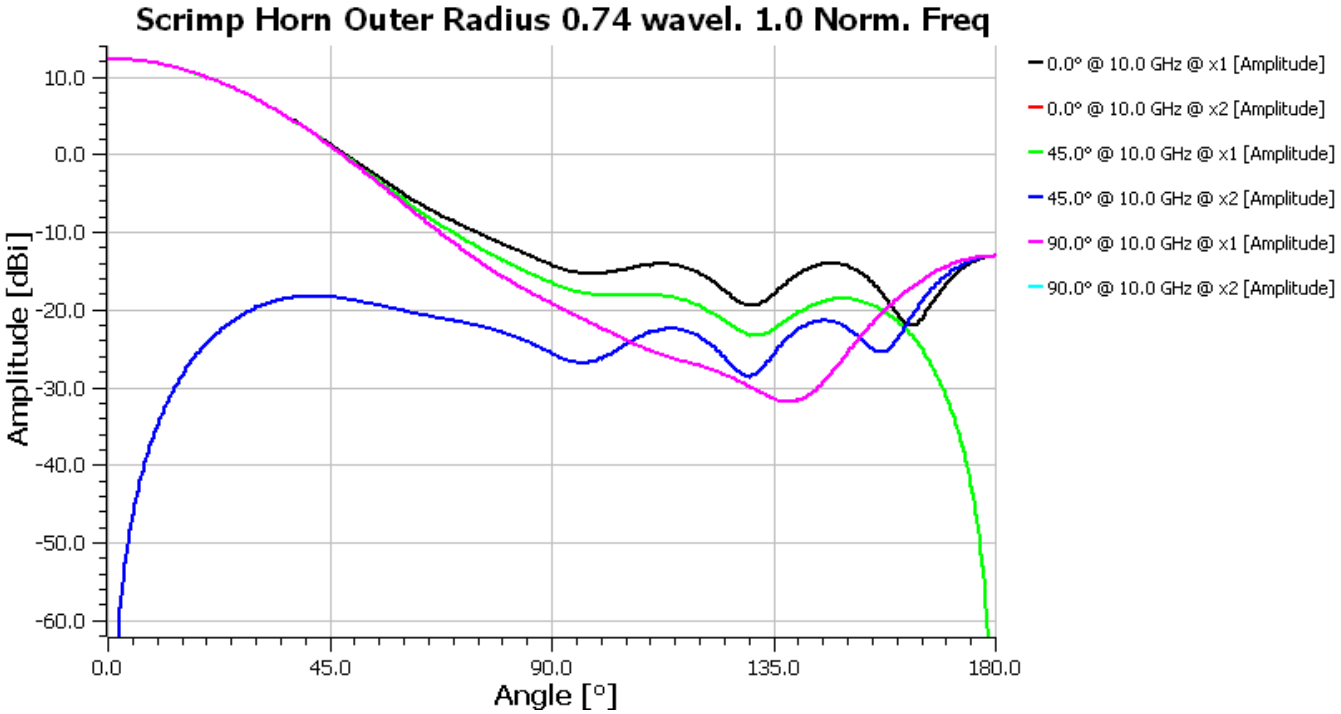


Figure 16 Center frequency pattern of Optimized Scrimp Horn 0.74λ Outer Radius

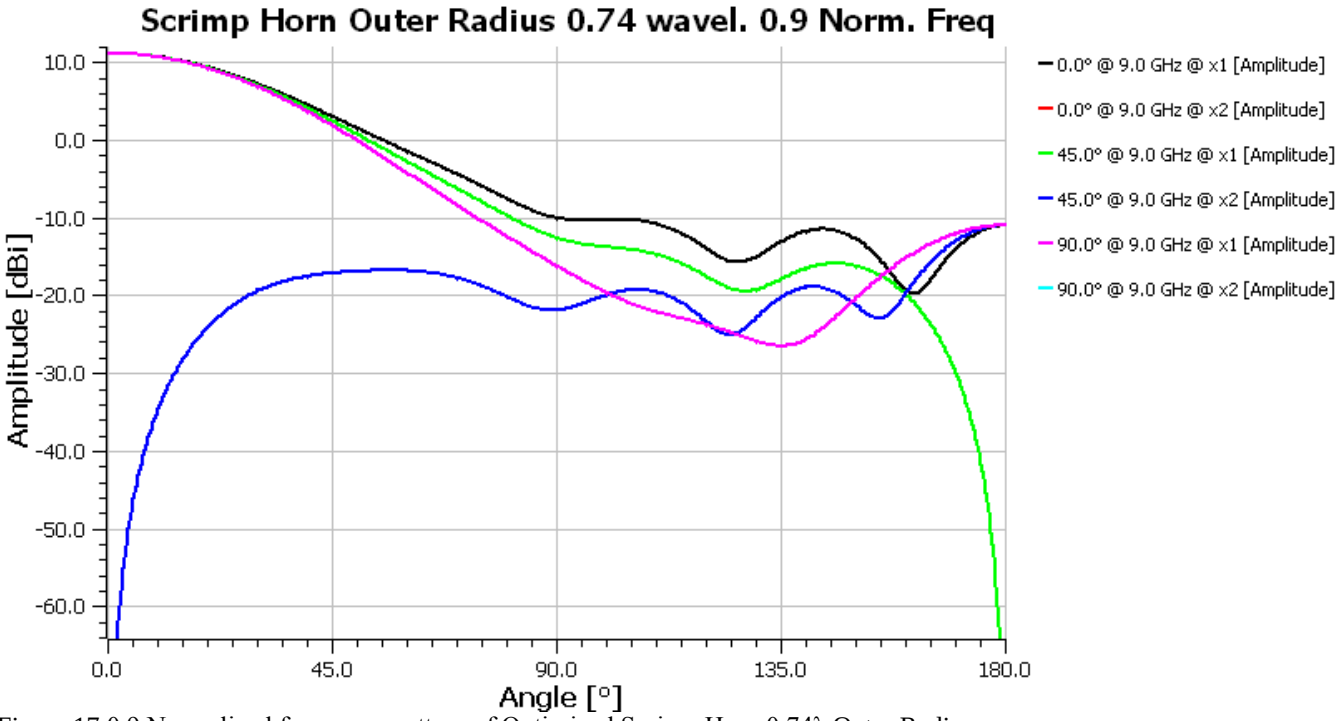


Figure 17 0.9 Normalized frequency pattern of Optimized Scrimp Horn 0.74λ Outer Radius

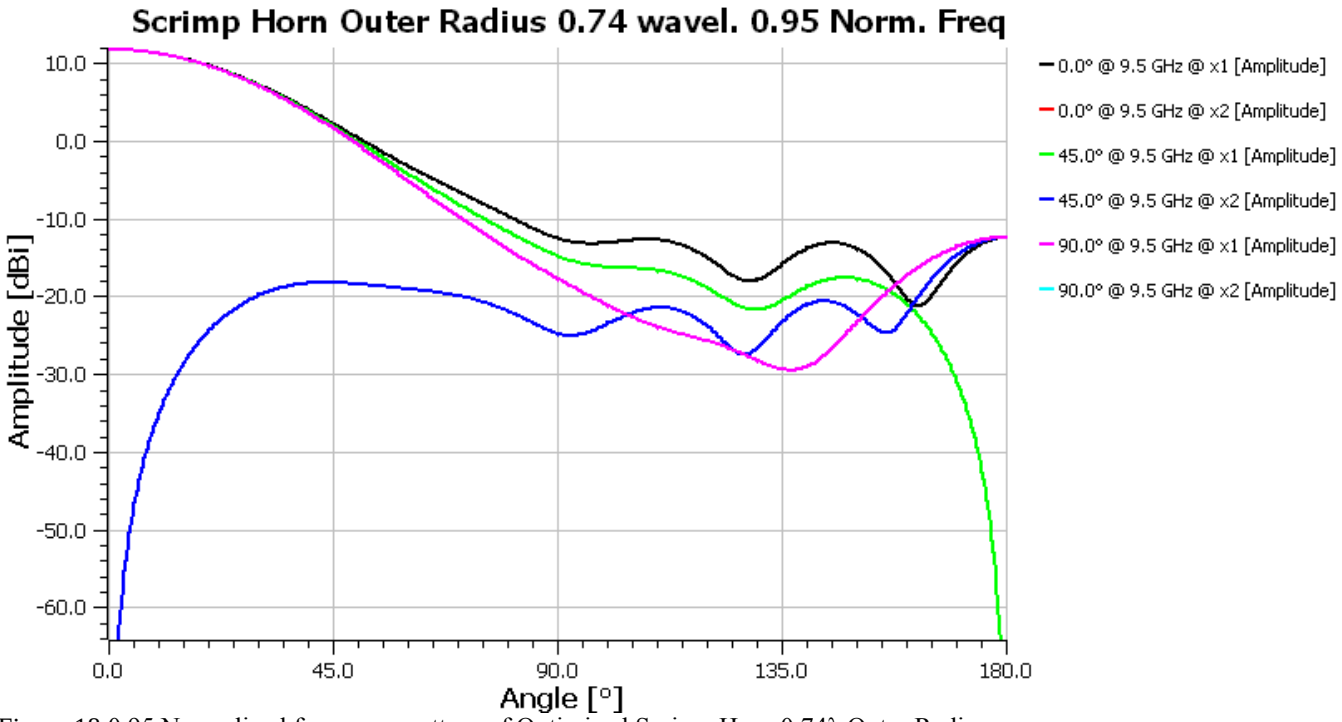


Figure 18 0.95 Normalized frequency pattern of Optimized Scrimp Horn 0.74λ Outer Radius

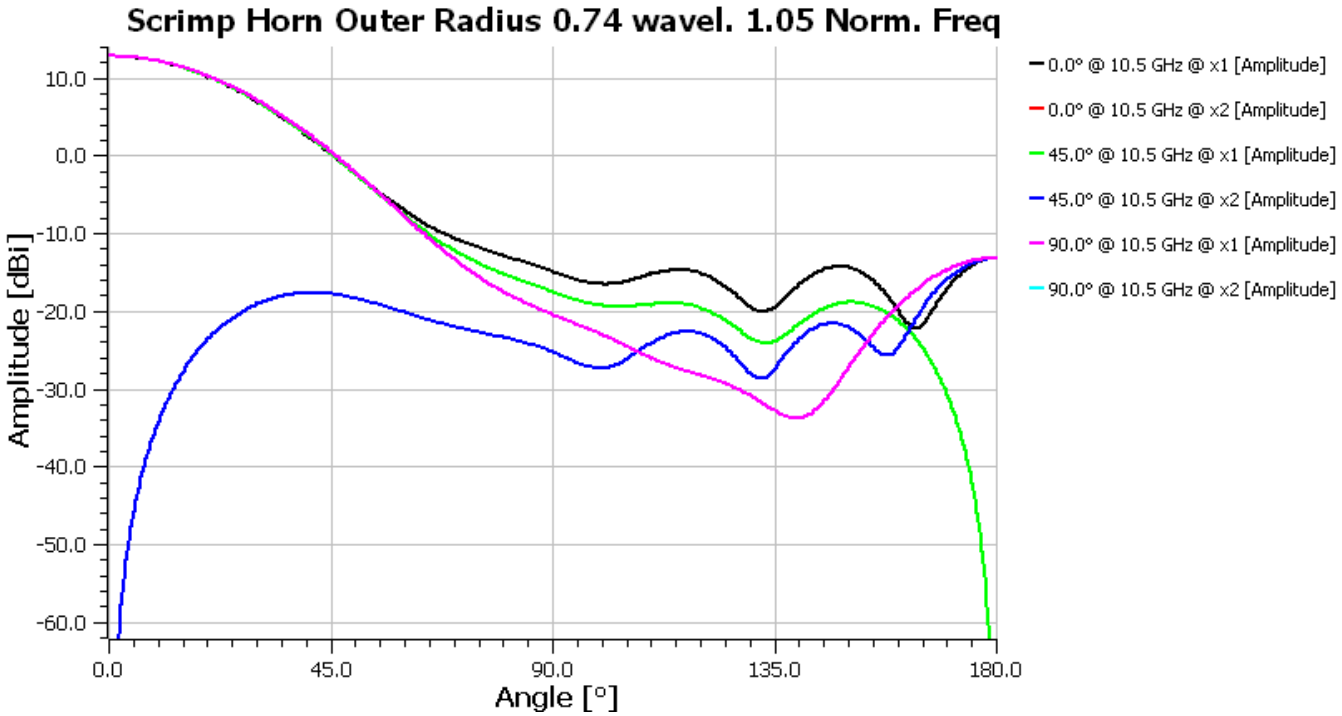


Figure 19 1.05 Normalized frequency pattern of Optimized Scrimp Horn 0.74λ Outer Radius

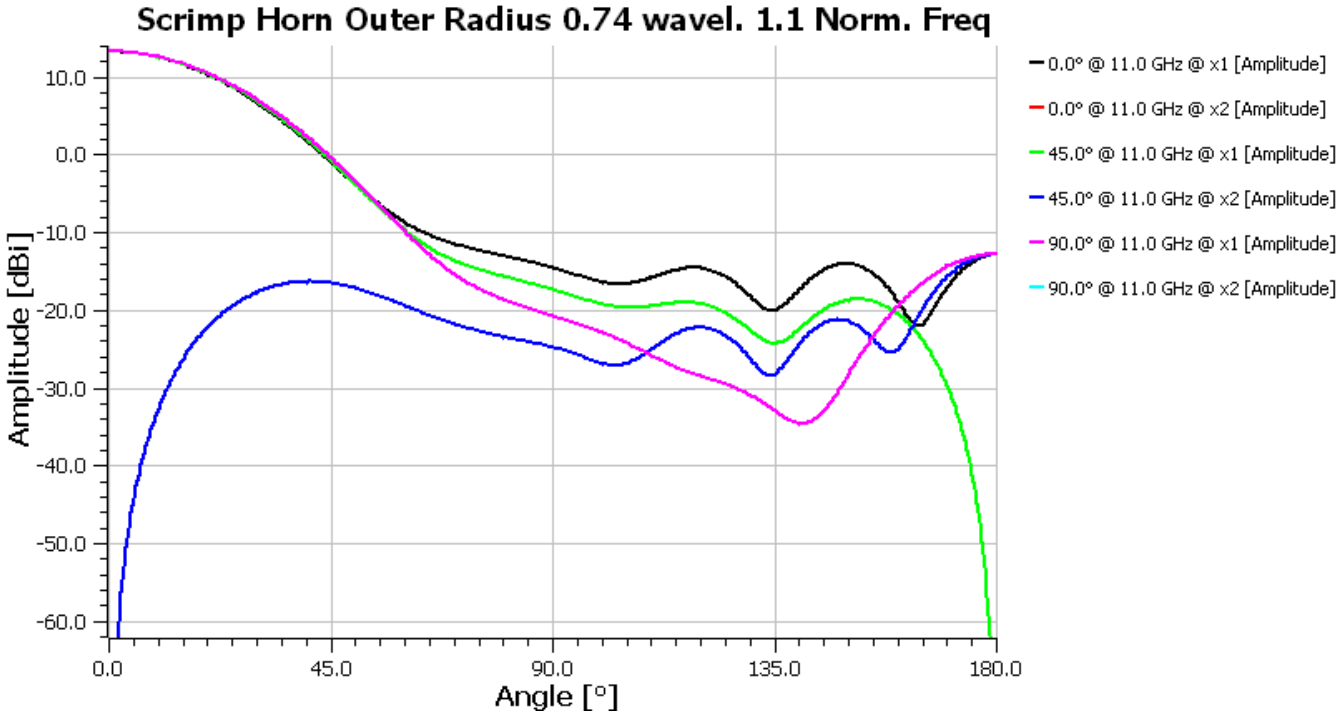


Figure 20 1.1 Normalized frequency pattern of Optimized Scrimp Horn 0.74λ Outer Radius

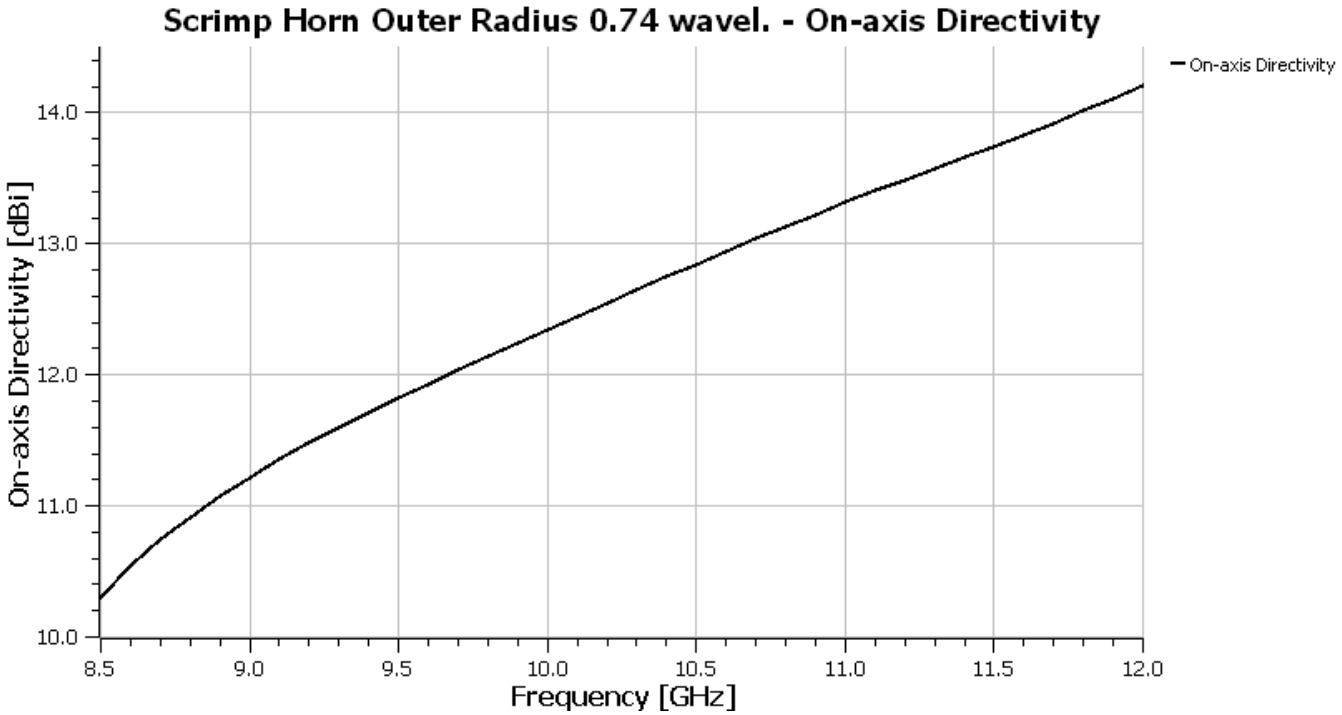


Figure 21 Directivity of Optimized Scrimp Horn with 0.74λ Outer Radius 10 GHz Center Frequency

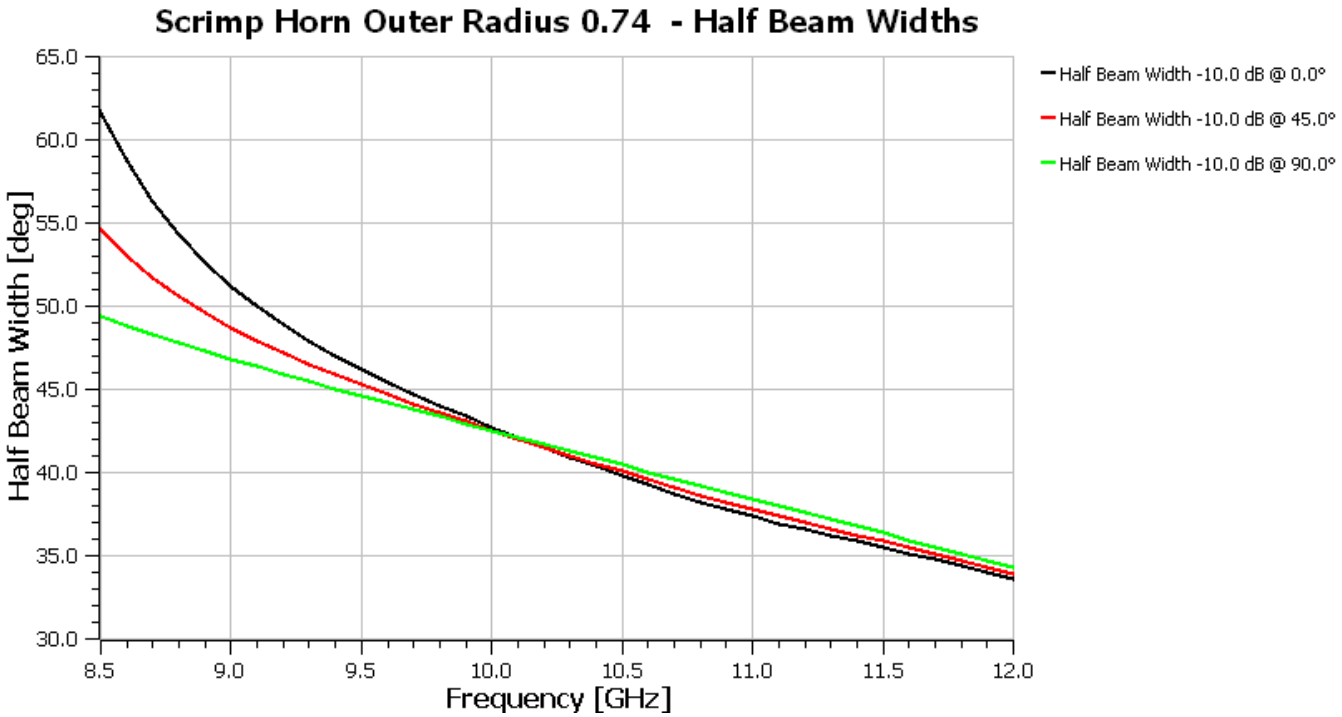


Figure 22 10-dB Half Beamwidth of Optimized Scrimp Horn with 0.74λ Outer Radius 10 GHz Center Frequency

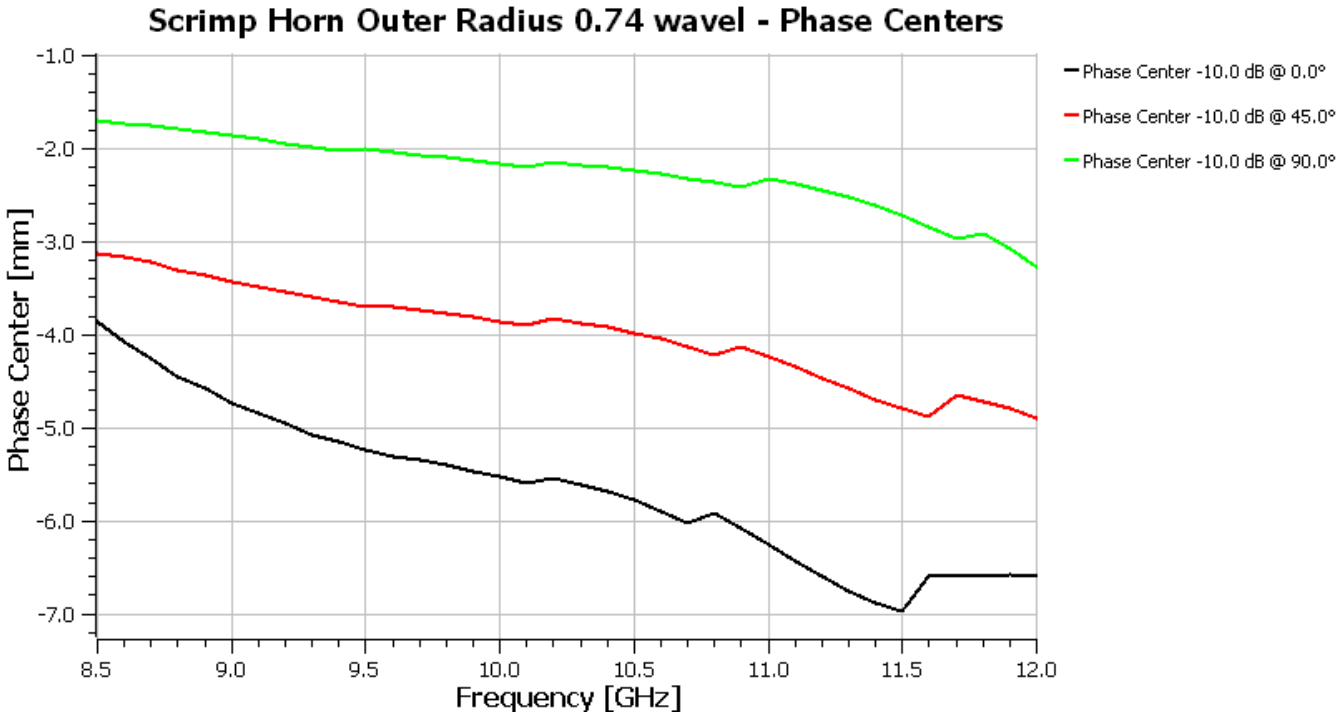


Figure 23 Phase Center of Optimized Scrimp Horn with 0.74λ Outer Radius 10 GHz Center Frequency

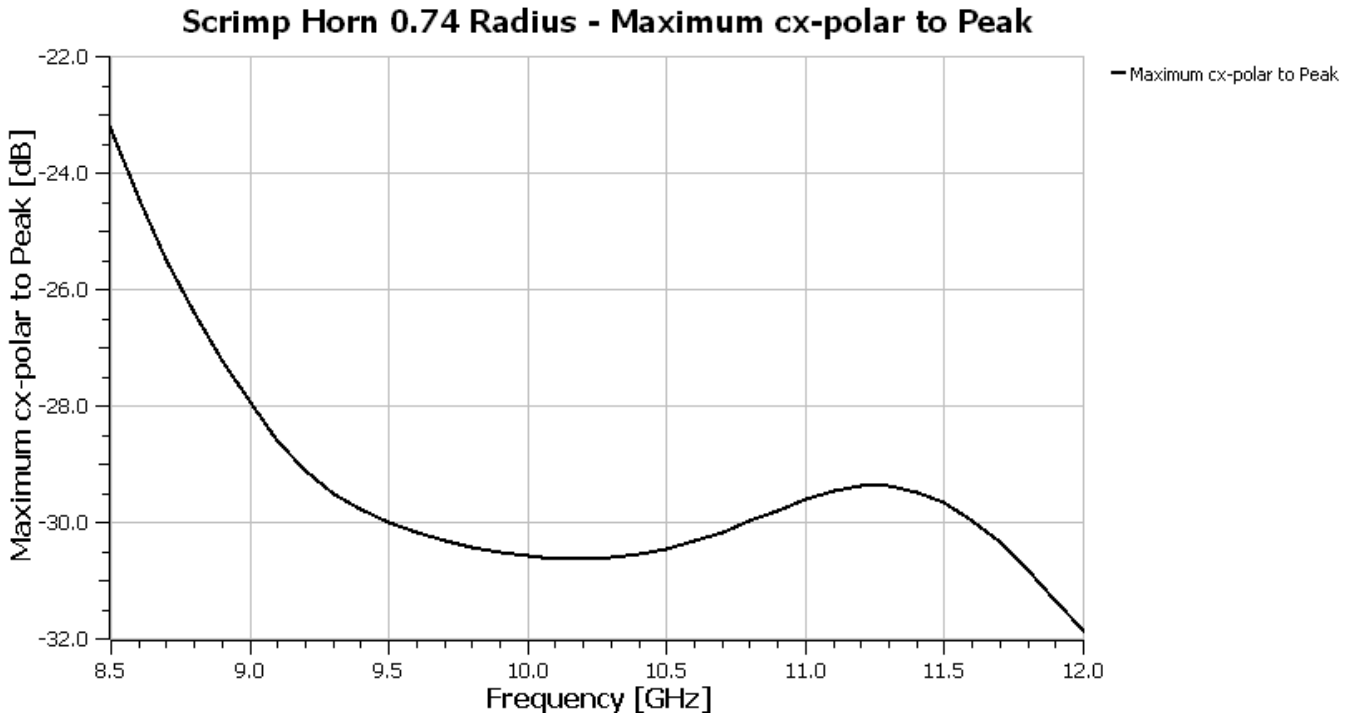


Figure 24 Maximum X-Pol. of Optimized Scrimp Horn with 0.74λ Outer Radius 10 GHz Center Frequency

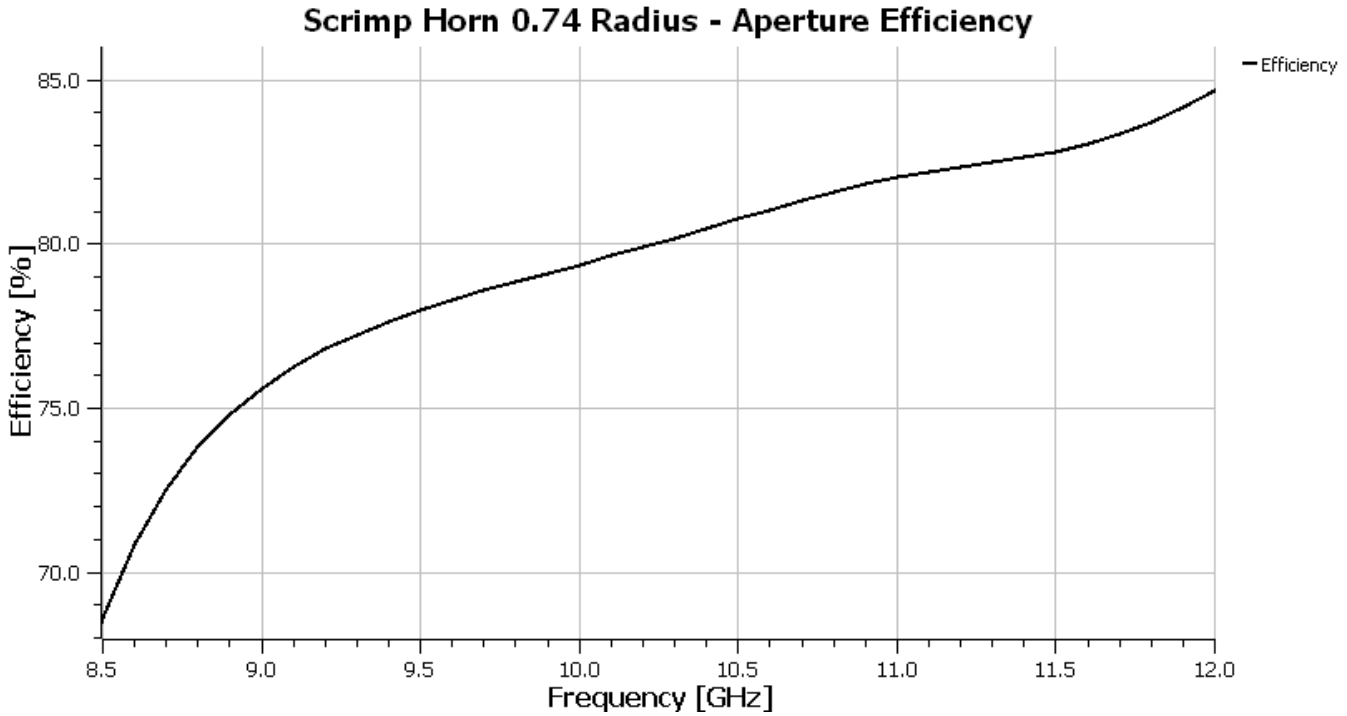


Figure 25 Aperture Efficiency of Optimized Scrimp Horn with 0.74λ Outer Radius 10 GHz Center Frequency

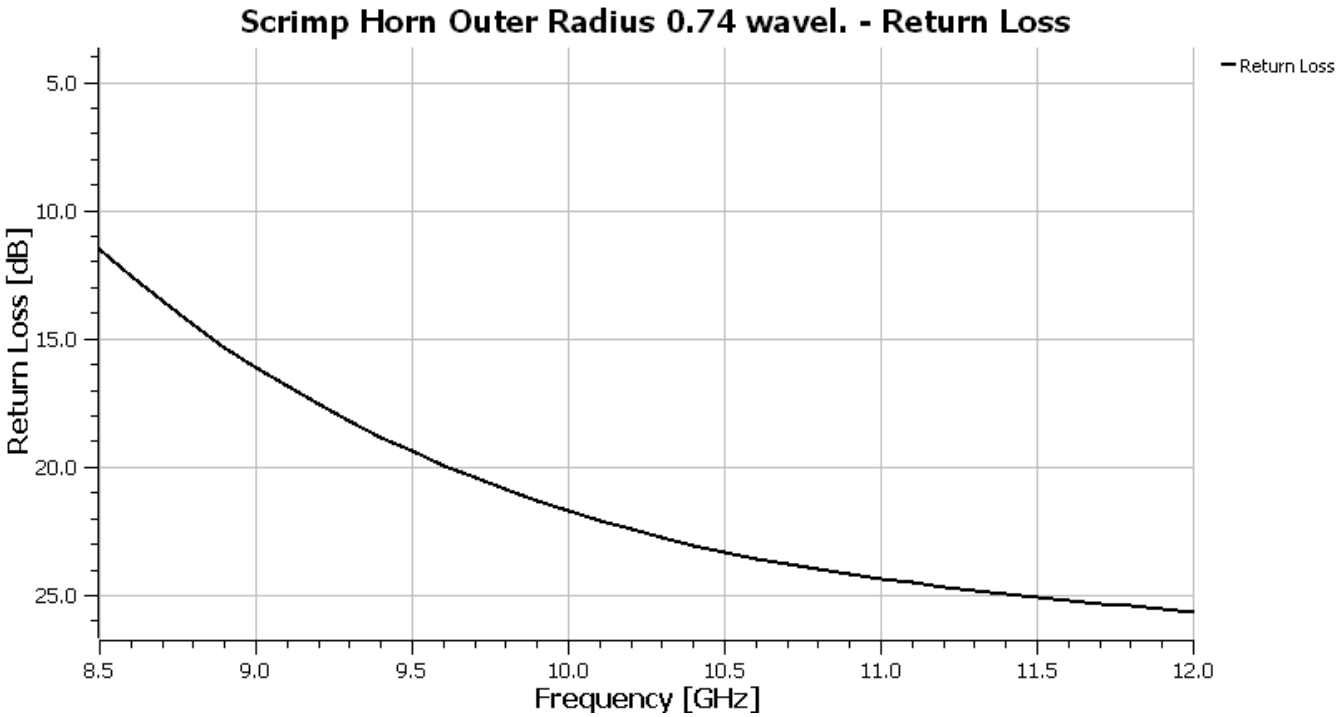
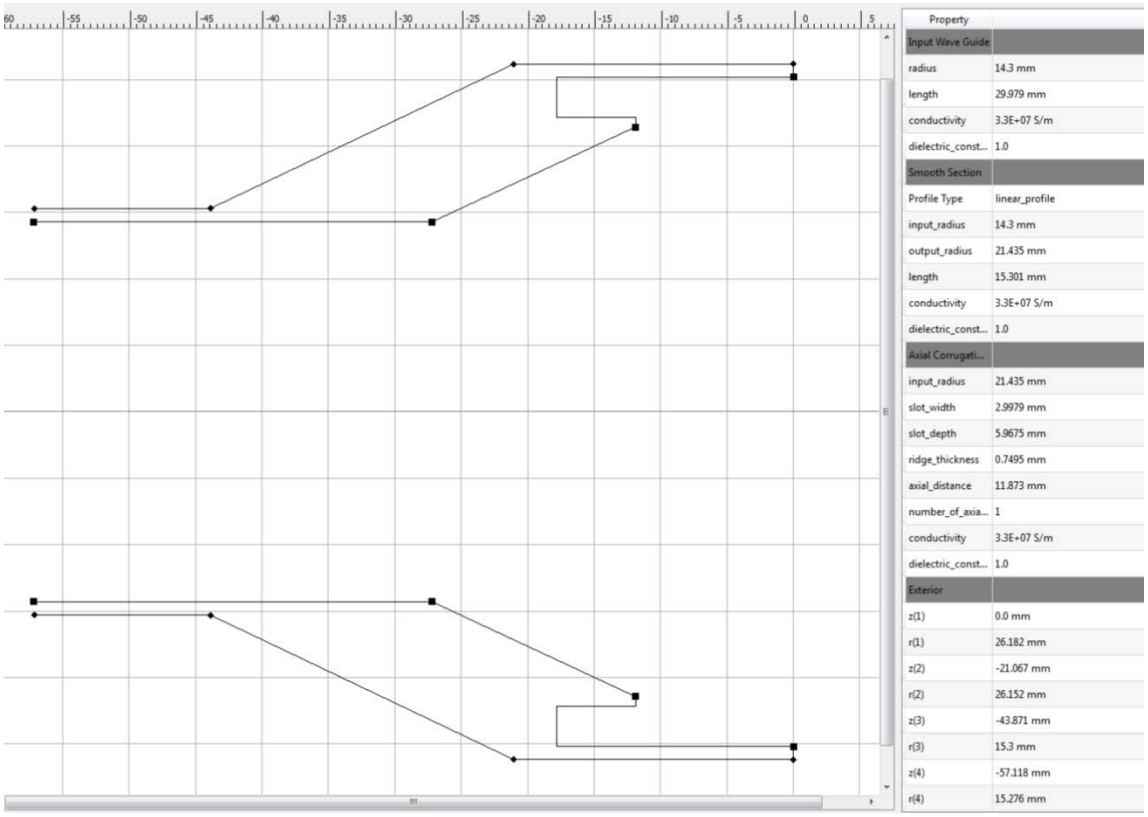


Figure 26 Return Loss of Optimized Scrimp Horn with 0.74λ Outer Radius 10 GHz Center Frequency

Initial Waveguide Flare Angle



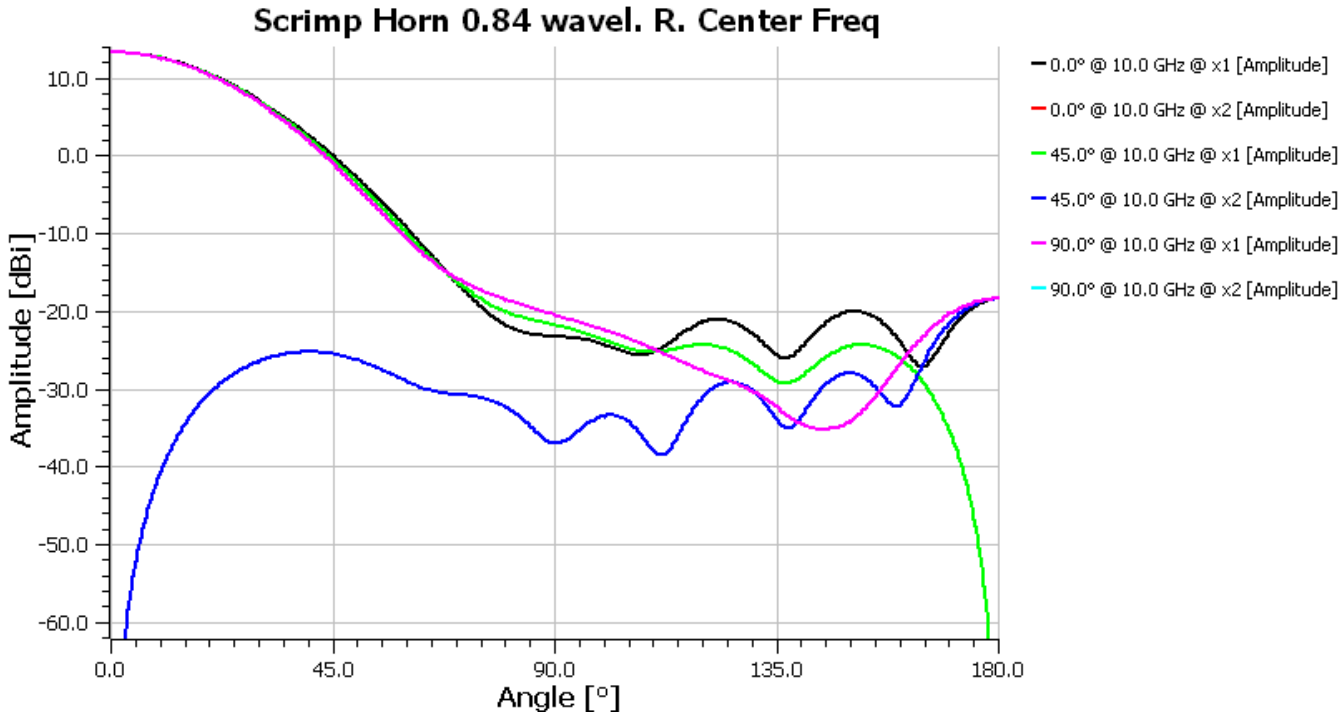


Figure 27 Center frequency pattern of Optimized Scrimp Horn 0.84λ Outer Radius

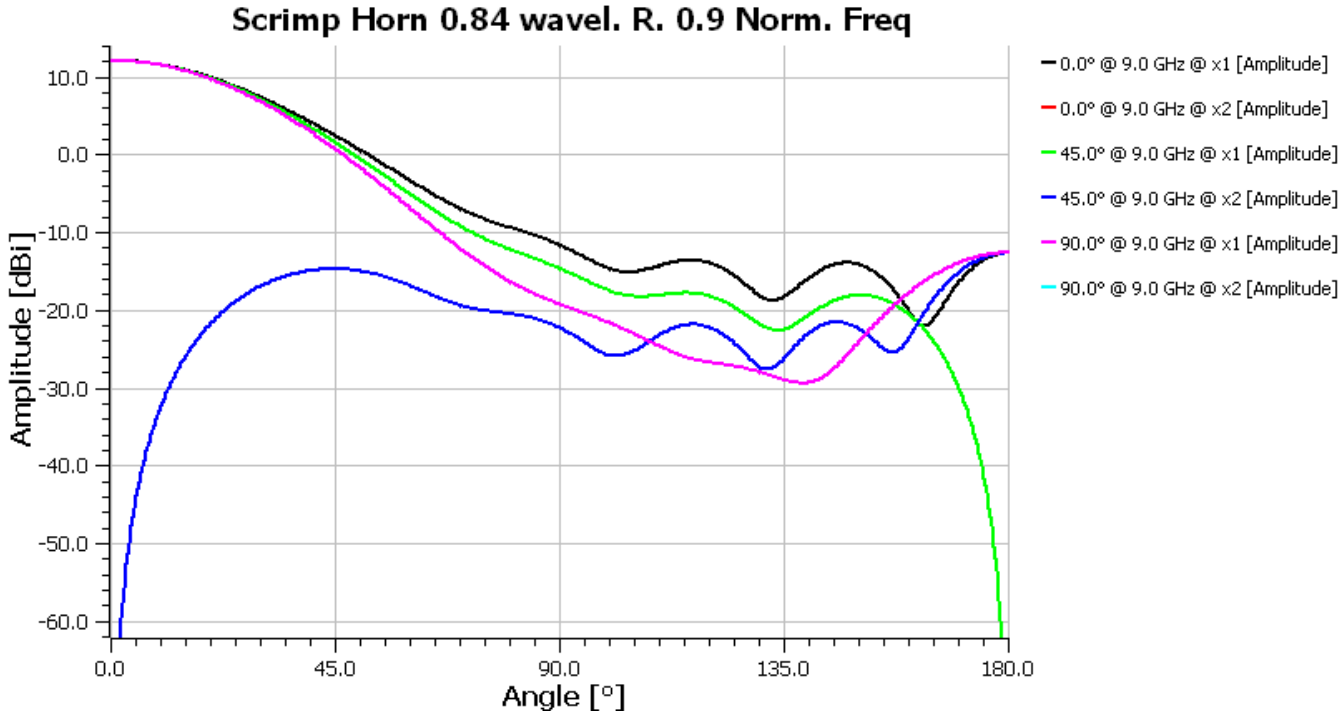


Figure 28 0.9 Normalized frequency pattern of Optimized Scrimp Horn 0.84λ Outer Radius

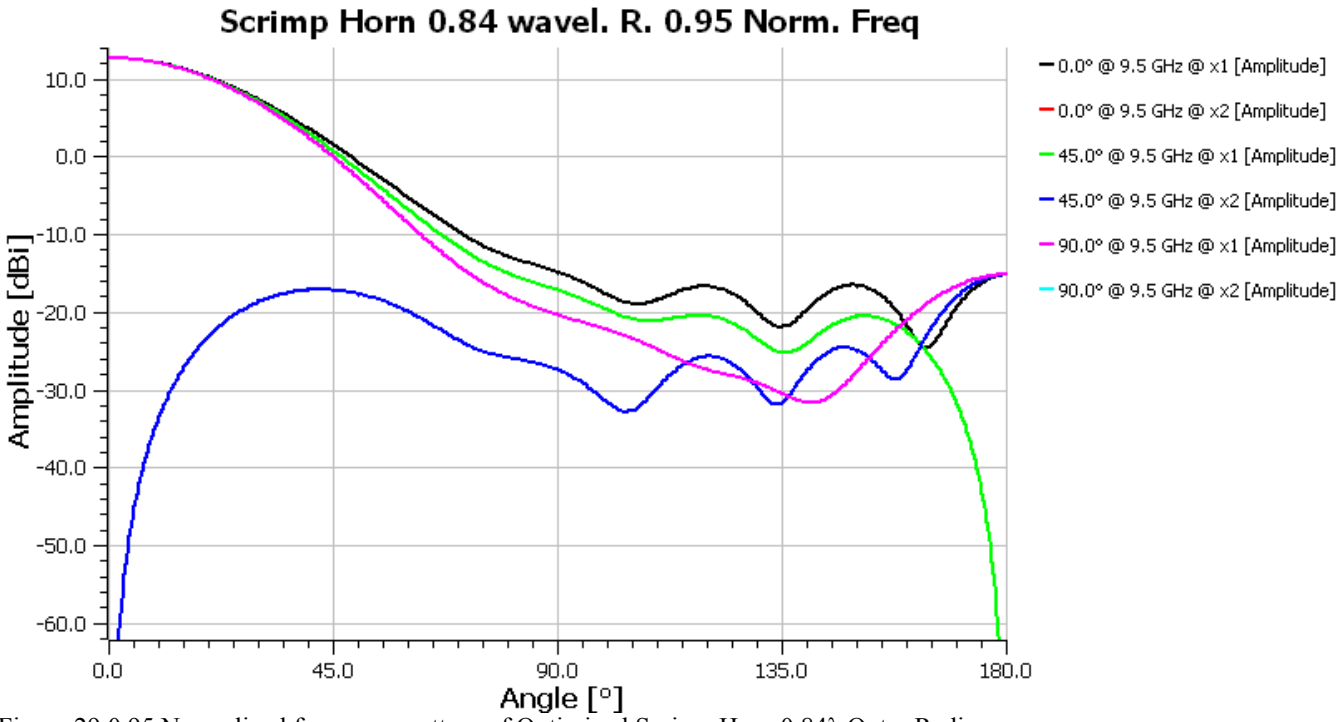


Figure 29 0.95 Normalized frequency pattern of Optimized Scrimp Horn 0.84λ Outer Radius

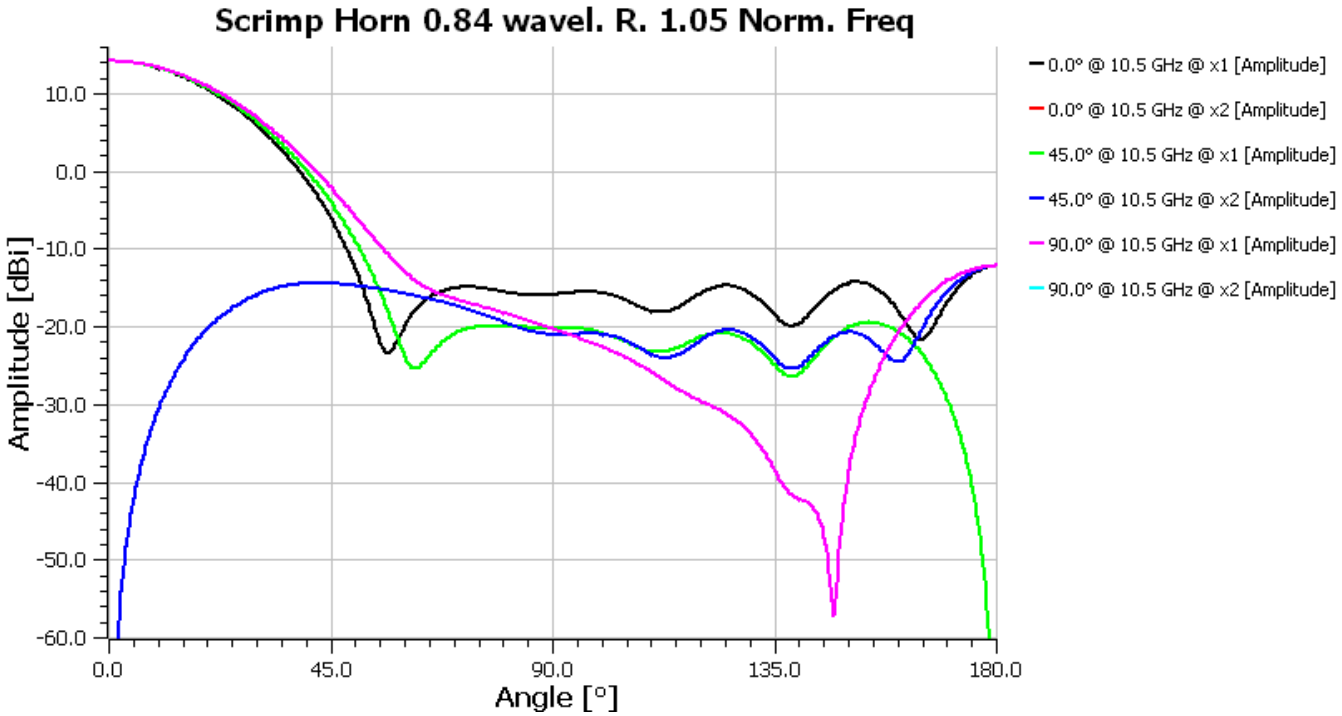


Figure 30 1.05 Normalized frequency pattern of Optimized Scrimp Horn 0.74λ Outer Radius

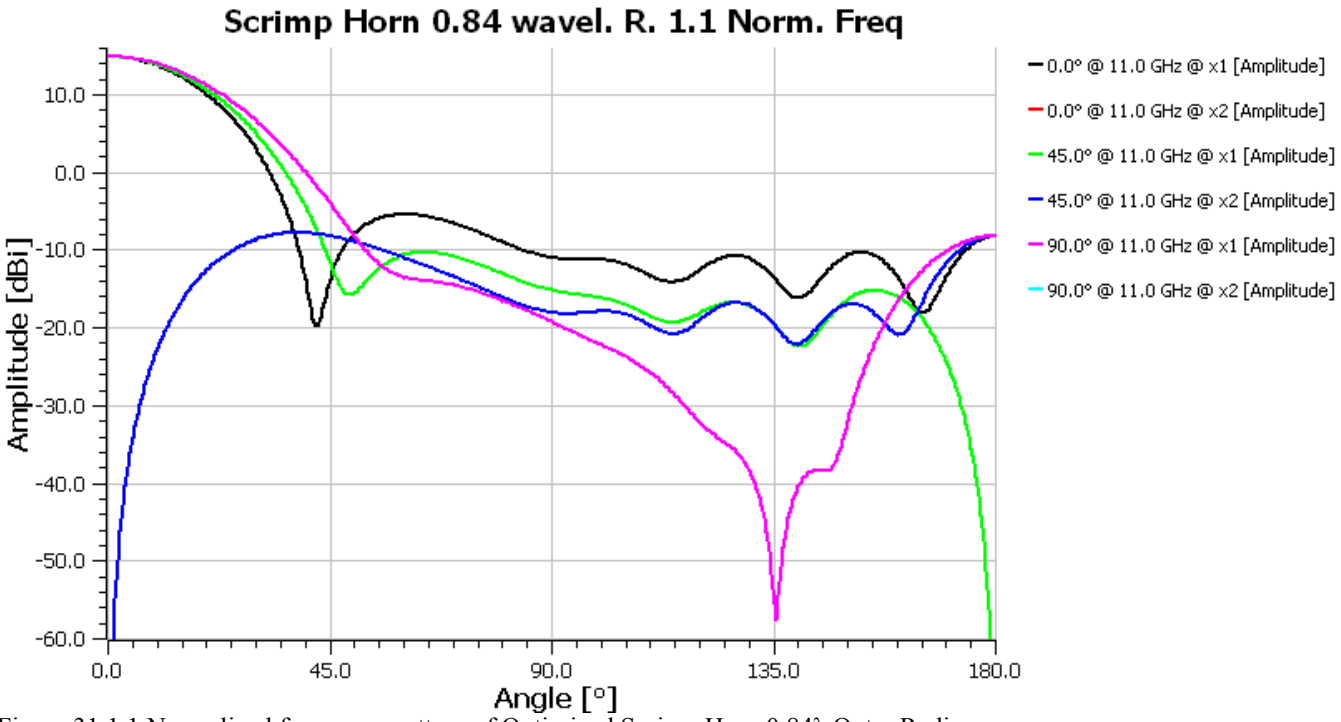


Figure 31 1.1 Normalized frequency pattern of Optimized Scrimp Horn 0.84λ Outer Radius

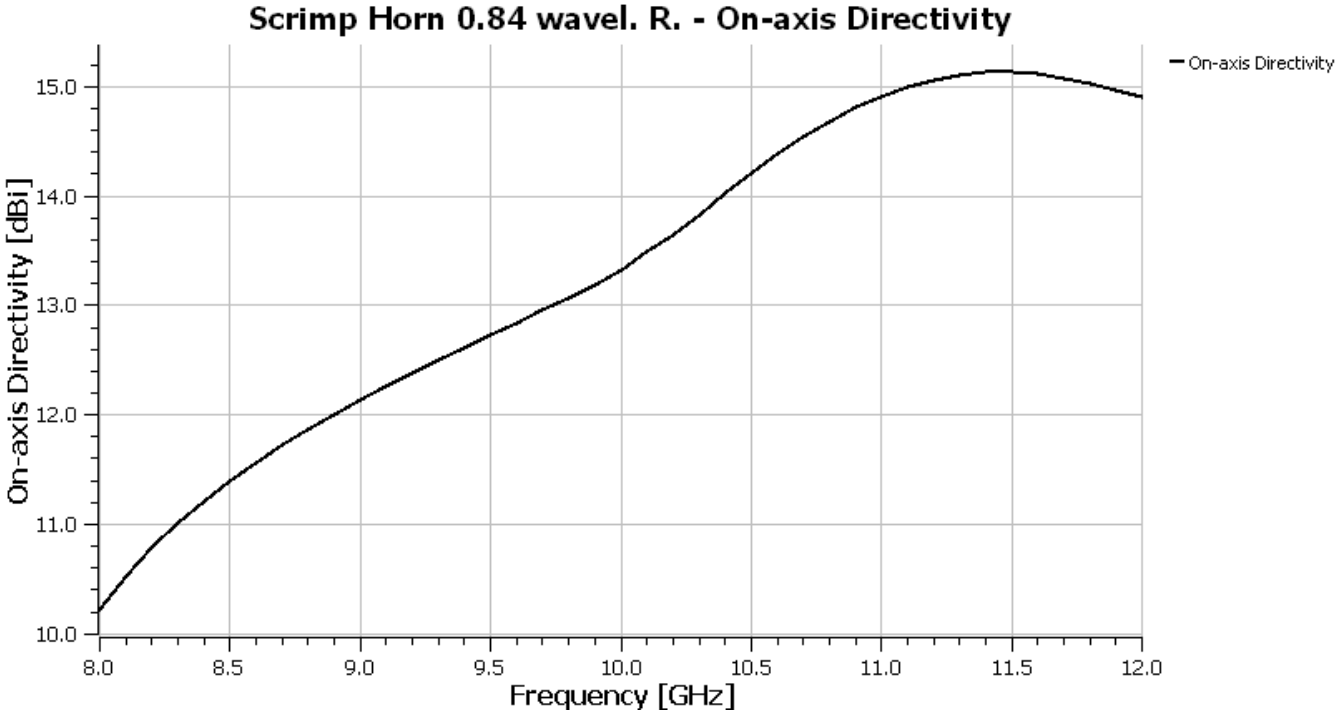


Figure 32 Directivity of Optimized Scrimp Horn with 0.84λ Outer Radius 10 GHz Center Frequency

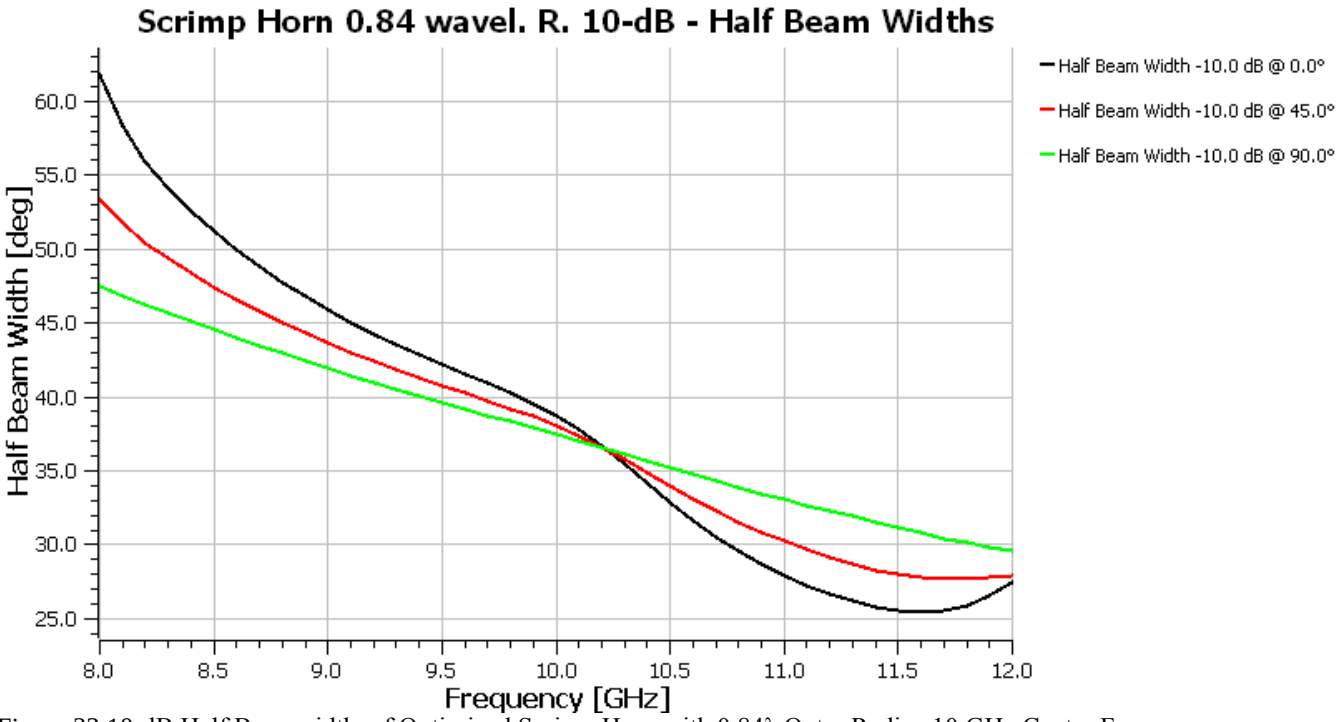


Figure 33 10-dB Half Beamwidth of Optimized Scrimp Horn with 0.84λ Outer Radius 10 GHz Center Frequency

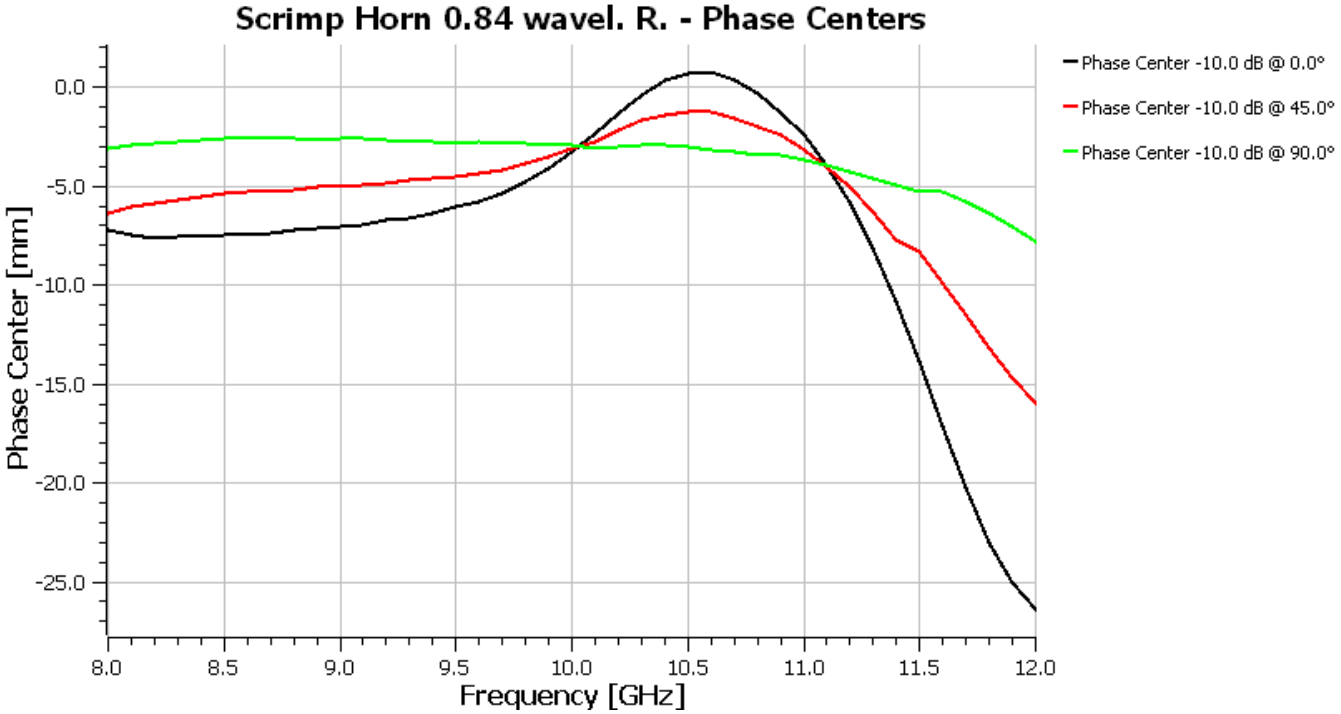


Figure 34 Phase Center of Optimized Scrimp Horn with 0.84λ Outer Radius 10 GHz Center Frequency

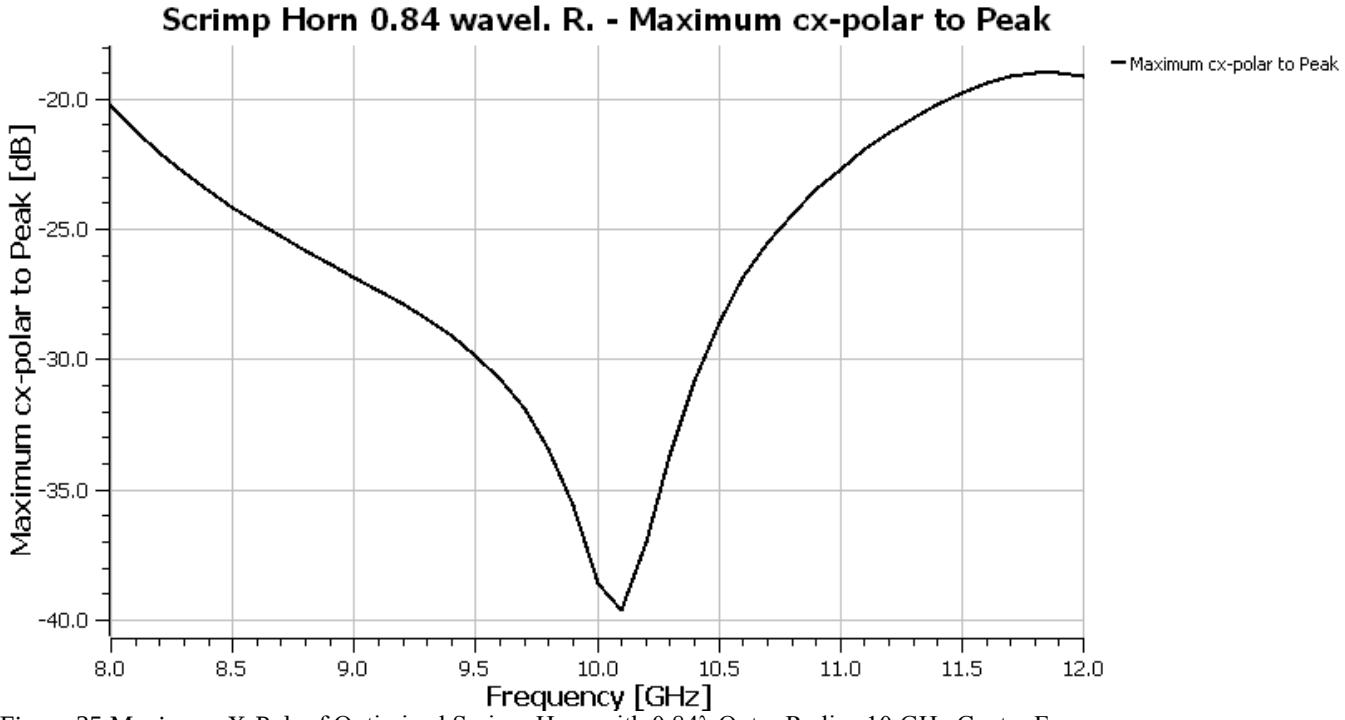


Figure 35 Maximum X-Pol. of Optimized Scrimp Horn with 0.84λ Outer Radius 10 GHz Center Frequency

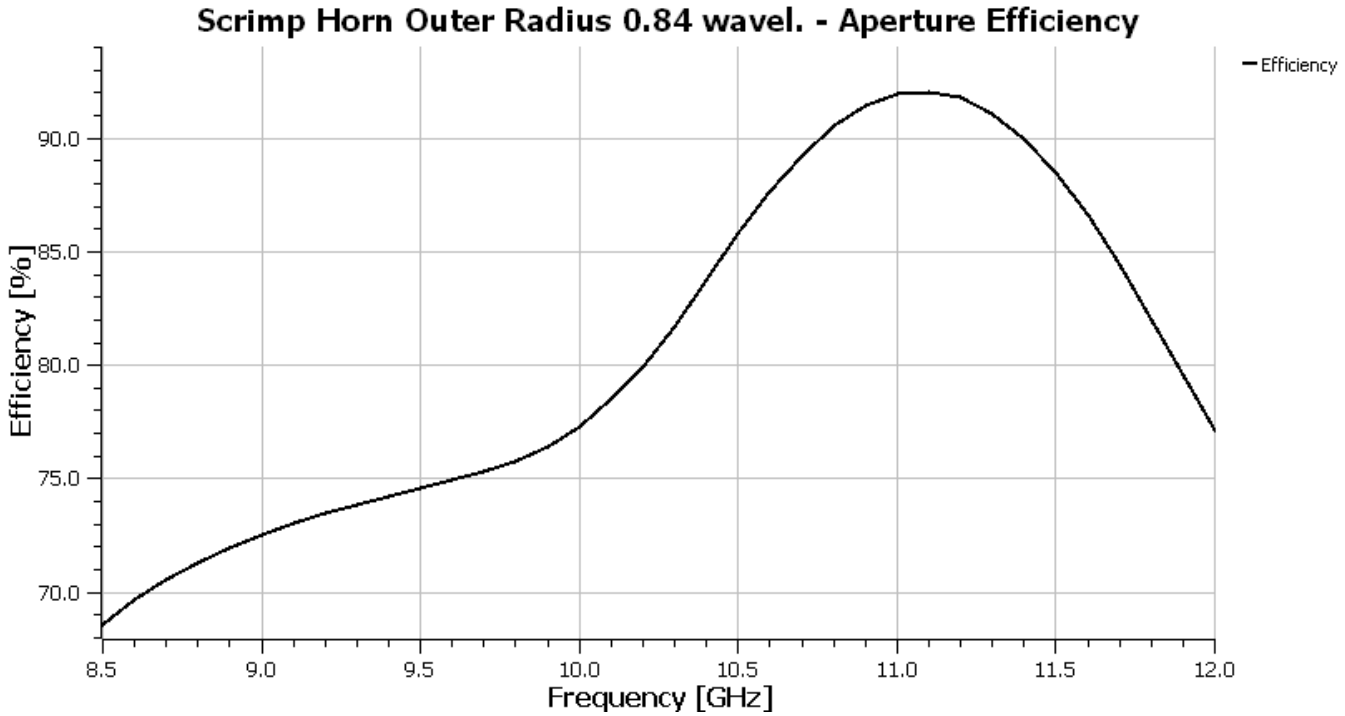


Figure 36 Aperture Efficiency of Optimized Scrimp Horn with 0.84λ Outer Radius 10 GHz Center Frequency

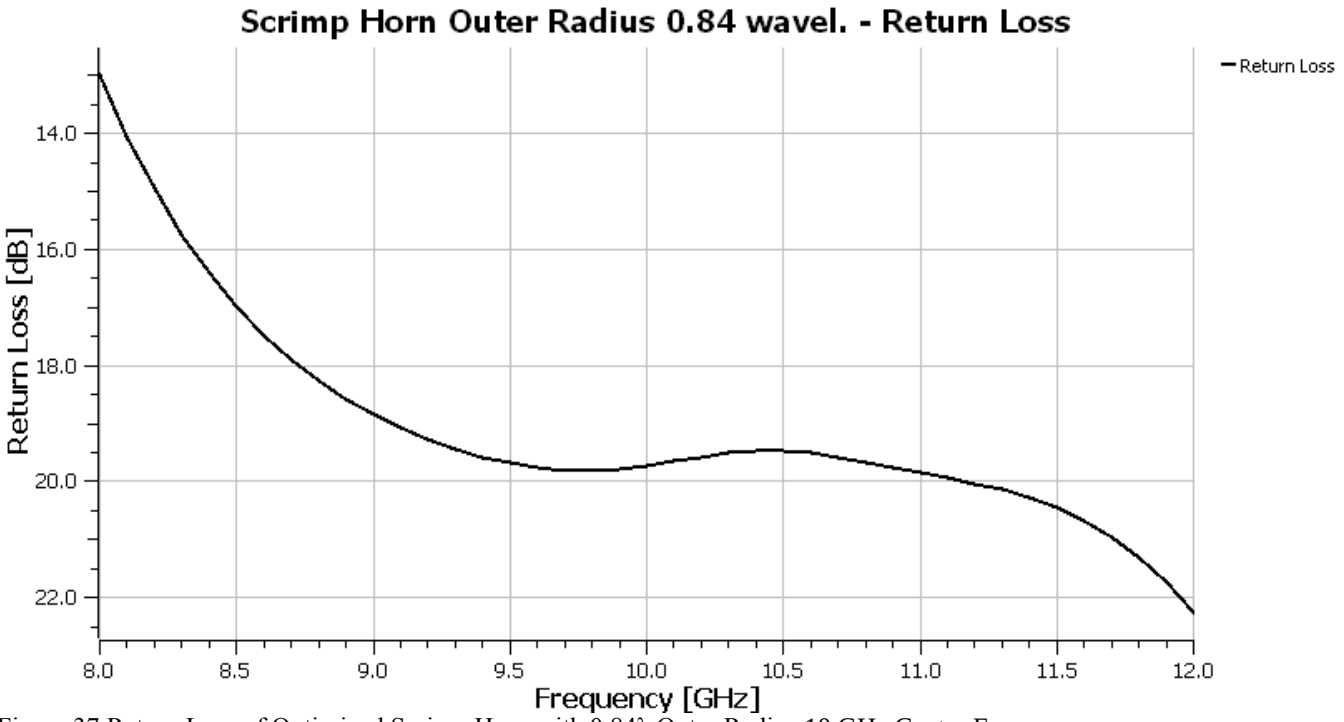


Figure 37 Return Loss of Optimized Scrimp Horn with 0.84λ Outer Radius 10 GHz Center Frequency

17c H. Wolf and E. Sommer, "An Advanced Compact Radiator Element for Multi-feed Antennas," *18th European Microwave Conference,* 1988, pp. 506-511