Axially and Radial Corrugated Horns

The axial corrugations may be combined with normal vertical corrugations to shorten the horn axial length [1]. Figure 10 shows a horn designed with an initial axially corrugated section at a cone angle of 30° followed by a linearly tapered normal corrugated section. The design goal was to achieve 22 dB of gain and compare it to a normal corrugated horn length designed in an example above. The normal horn with S = 0.2 is 12.6λ long while this horn is only 5.7λ long. While the linearly tapered horn has 100 corrugations, the bowl horn has 8 axial corrugations and 26 vertical ones. We have the axial section machined as a separate section and bolt it to the vertical corrugated section. The large radius of the vertical section eases the machining because it allows for a large diameter tool holder. Consult reference [2] for further instructions on how to join the two sections to prevent narrow radiating slots. The phase center lies at a point about halfway along the bell with only λ/15 astigmatism.

Constant depth slots were used for the bell in the designs below and gave acceptable performance. The excellent cross polarization performance was achieved by optimizing the depth of the axial slots using CHAMP (TICRA) while the length and aperture sizes of the bell were designed to achieve the desired gain [3].

Following report presents a series of designs ranging from 18 dB to 25 dB. In each case the first optimization was used to determine the approximate aperture radius using gain as the selection criterion. The second optimization minimized the cross polarization while keeping gain as a second requirement. Minimizing cross polarization produced designs with nearly identical patterns in the principal and diagonal planes for linear polarization. A minimum of 6 axial slots were necessary to produce good cross polarization optimization.

[1] Jorge Teniente, et al, Choked Gaussian Horn: Extremely Low Sidelobe Compact Antenna Design, *IEEE AWPL*, vol. 1, 2002, p. 200 – 202.

[2] Christophe Granet, et al, Chapter 3 Aperture Antennas: Waveguides and Horns, *Modern Antenna Handbook*, Wiley, 2008, p. 142f.

[3] Jorge Teniente, et al, Low Sidelobe Corrugated Horn Antennas for Radio Telescopes to Maximize G/T_s, *IEEE AP-S Trans.*, vol. 59, No. 6, June 2011, pp. 1886 – 1893.

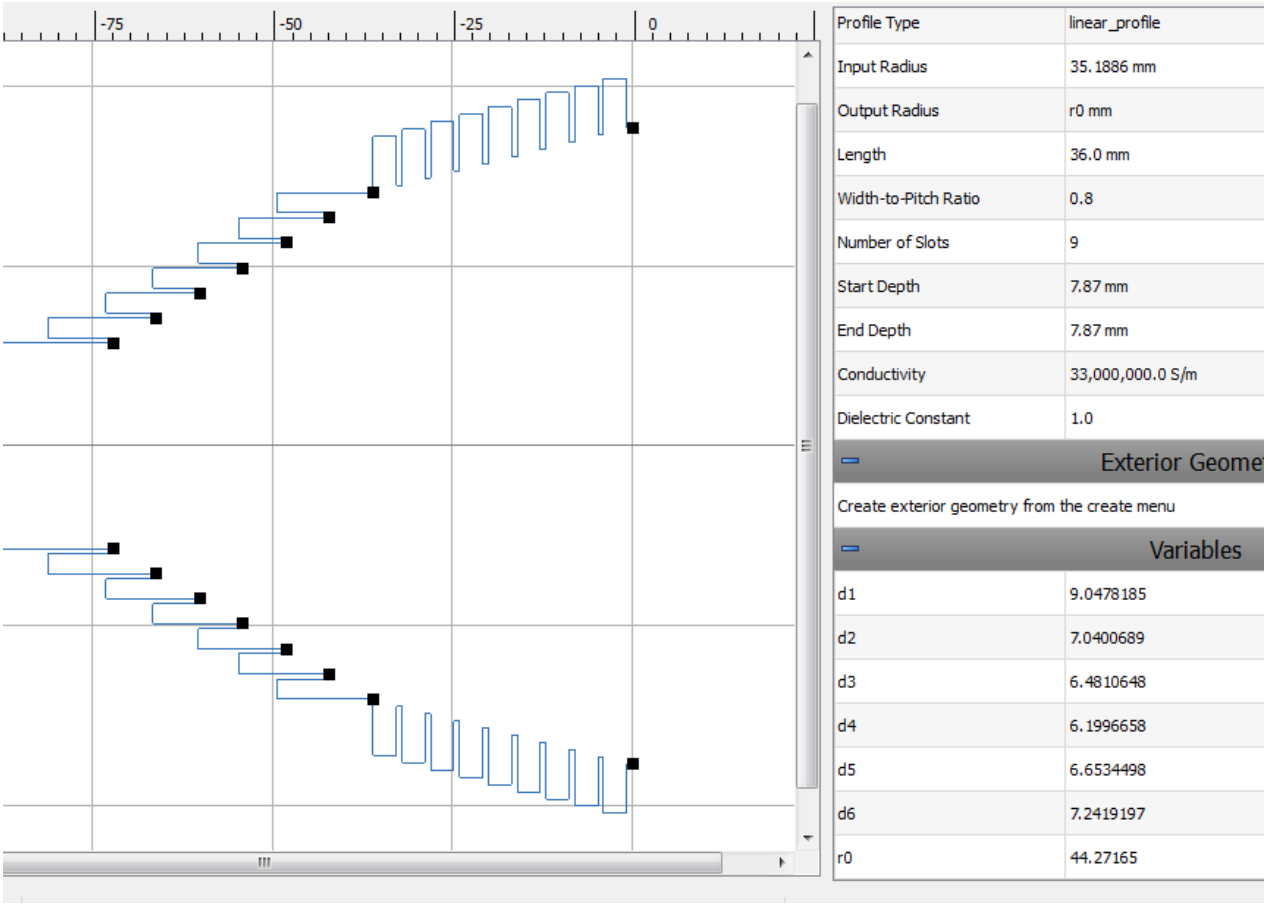

Figure 1 18 dB Gain Horn with 6 axial and 9 radial Corrugations CHAMP Model

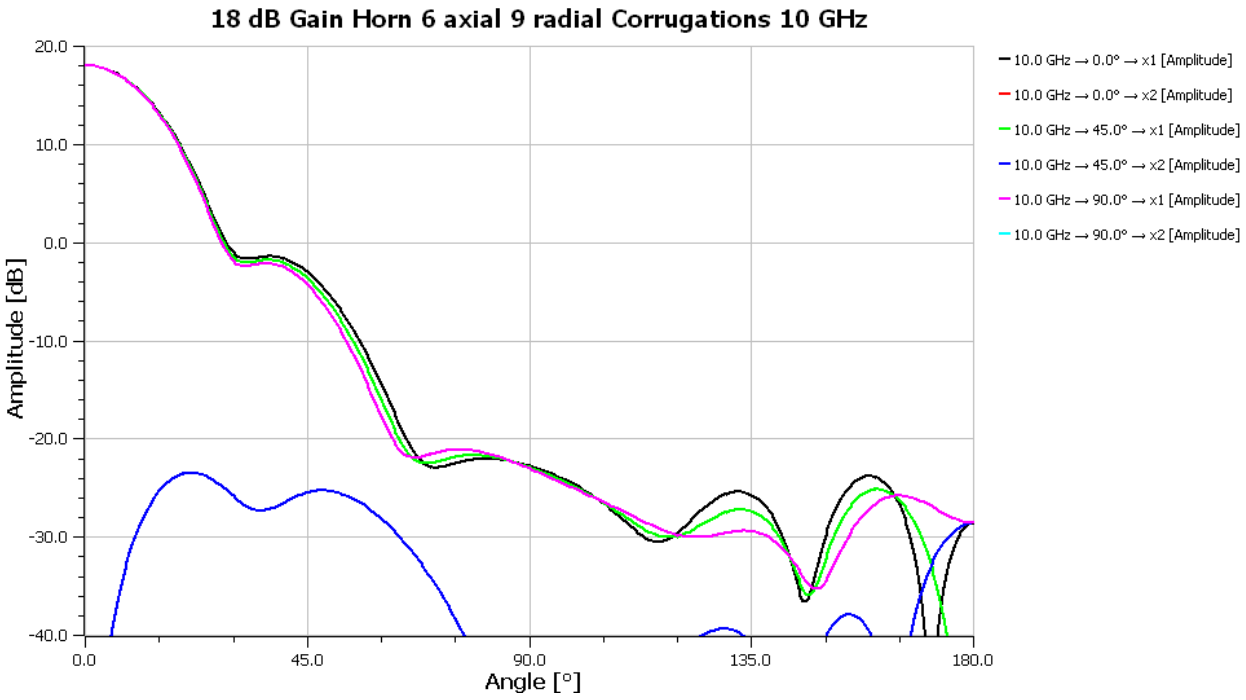

Figure 2 18 dB Gain Horn with 6 axial and 9 radial Corrugations 10 GHz

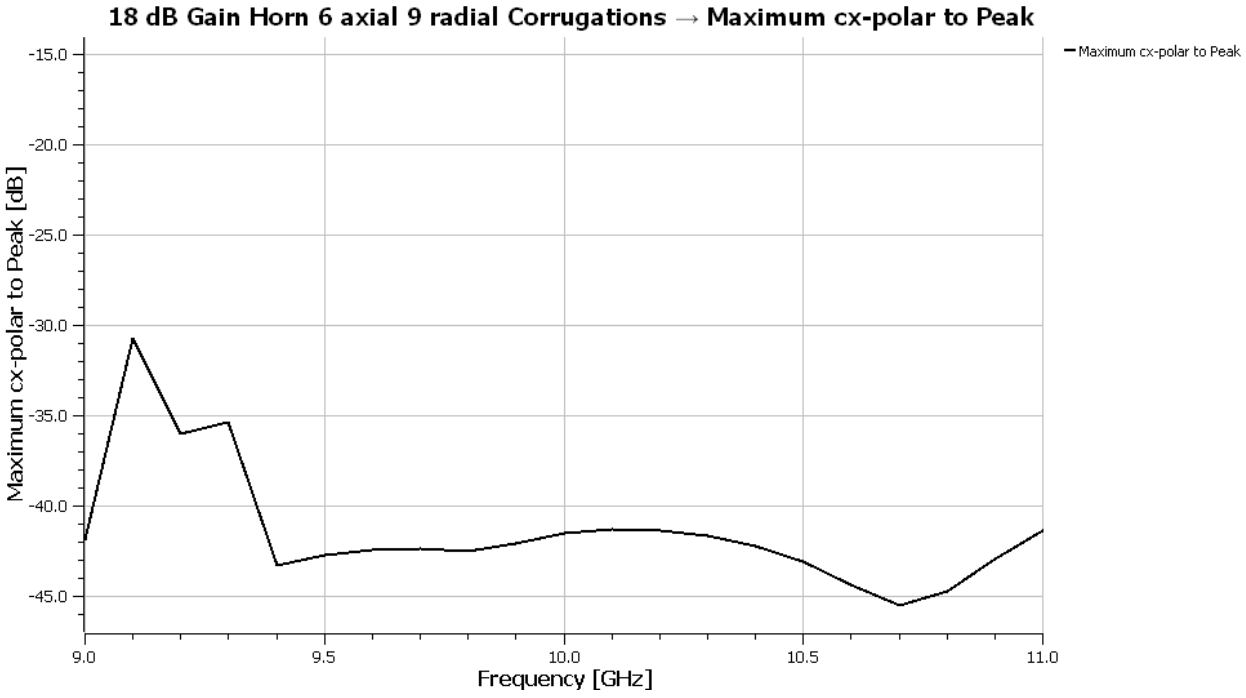

Figure 3 18 dB Gain Horn with 6 axial and 9 radial Corrugations Cross Polarization

Phase Center = 21 mm

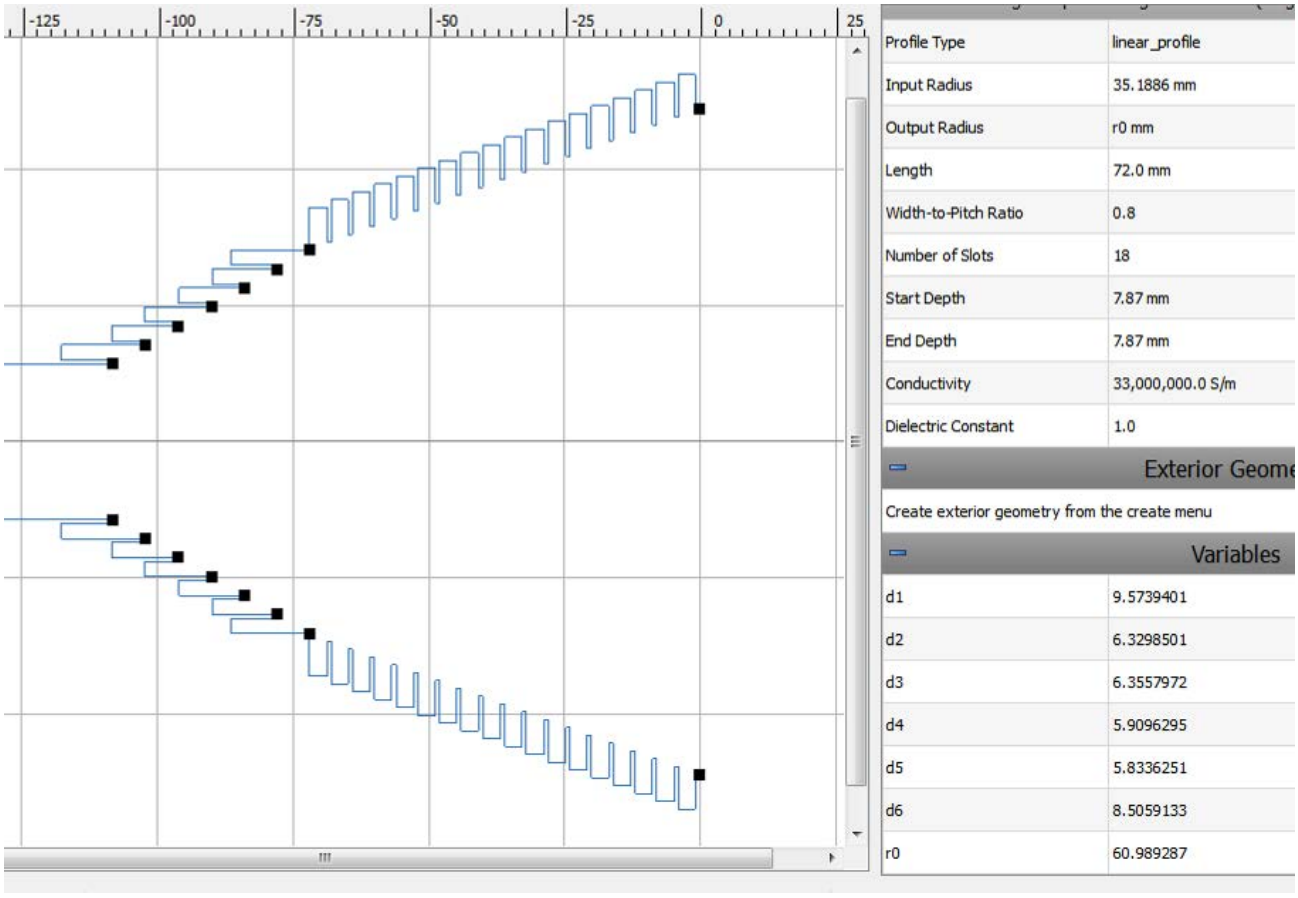

Figure 4 20 dB Gain Horn with 6 axial and 18 radial Corrugations CHAMP Model

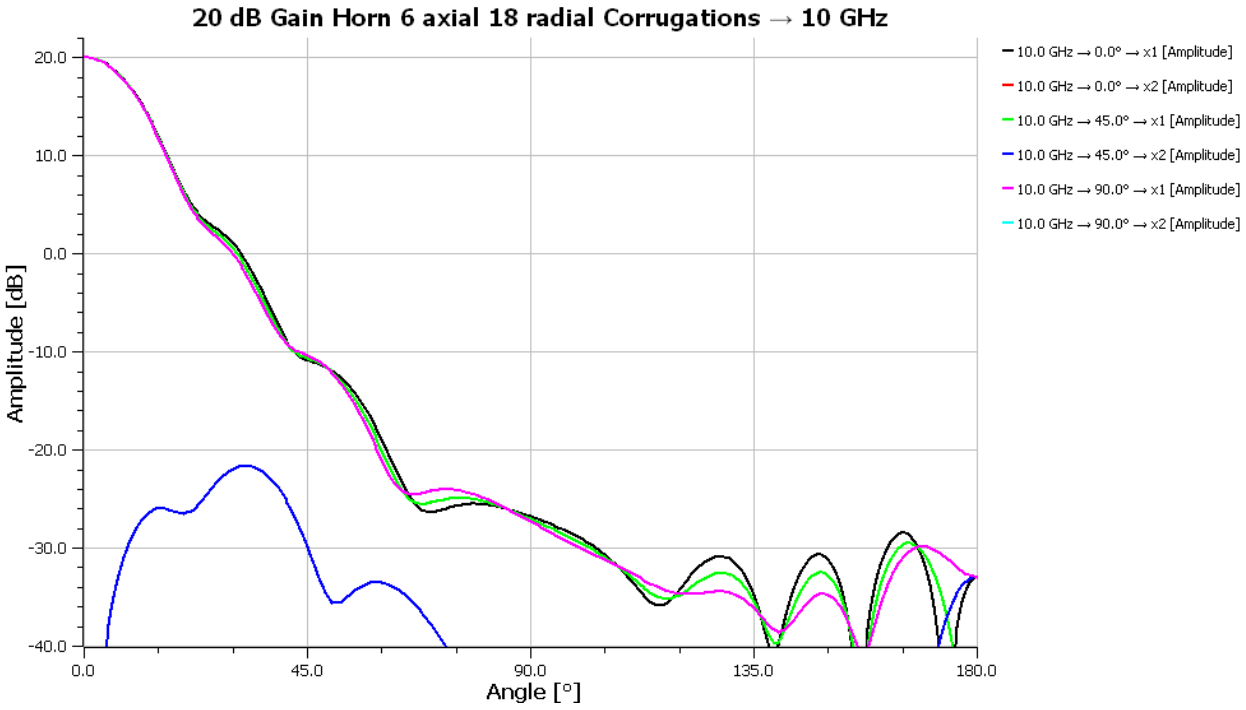

Figure 5 20 dB Gain Horn with 6 axial and 18 radial Corrugations 10 GHz

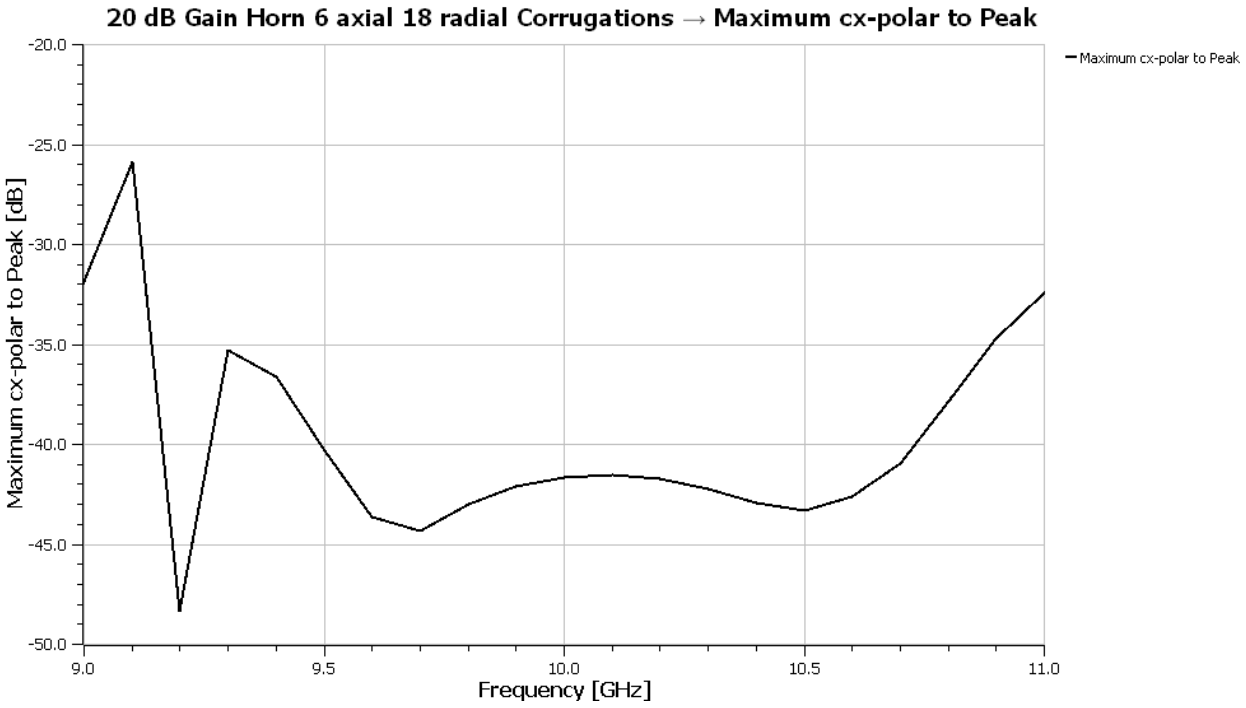

Figure 6 20 dB Gain Horn with 6 axial and 18 radial Corrugations Cross Pol.

Phase Center = 56 mm

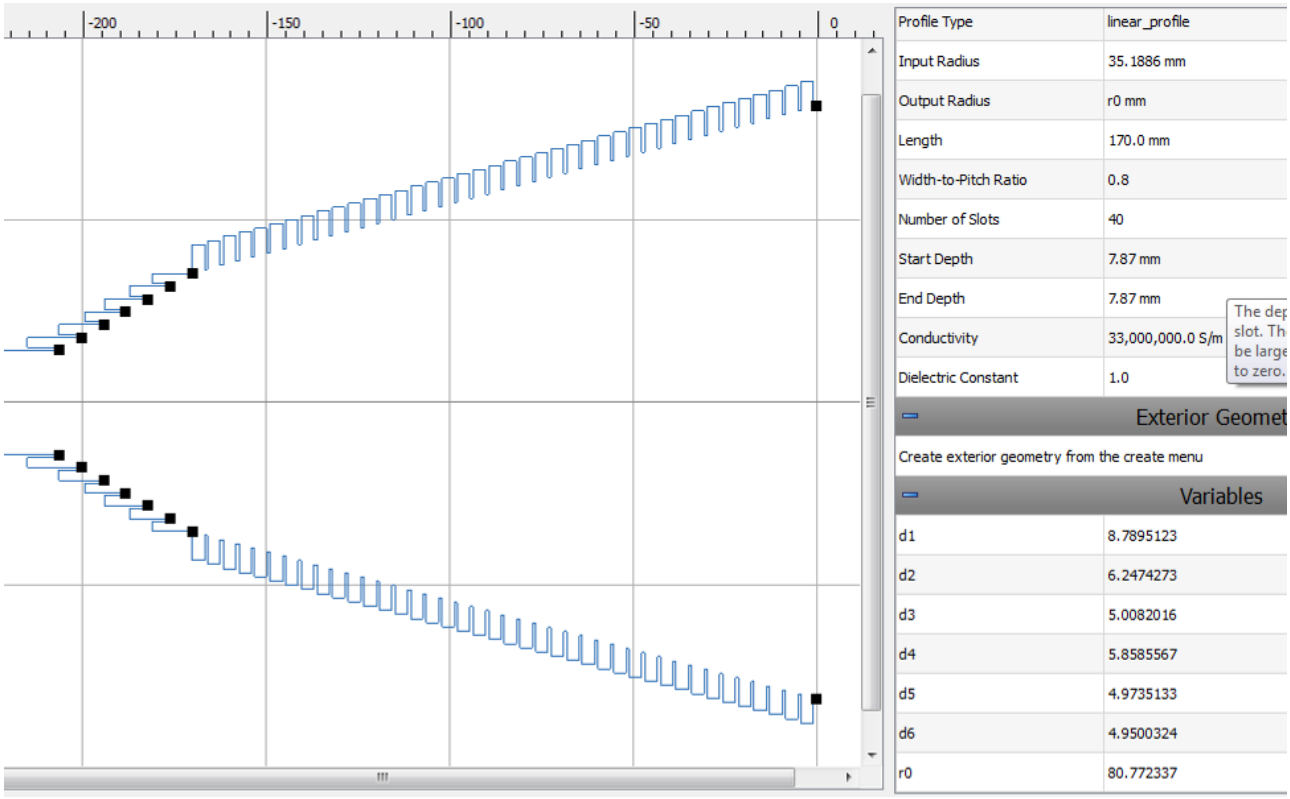

Figure 7 22 dB Gain Horn with 6 axial and 40 radial Corrugations CHAMP Model

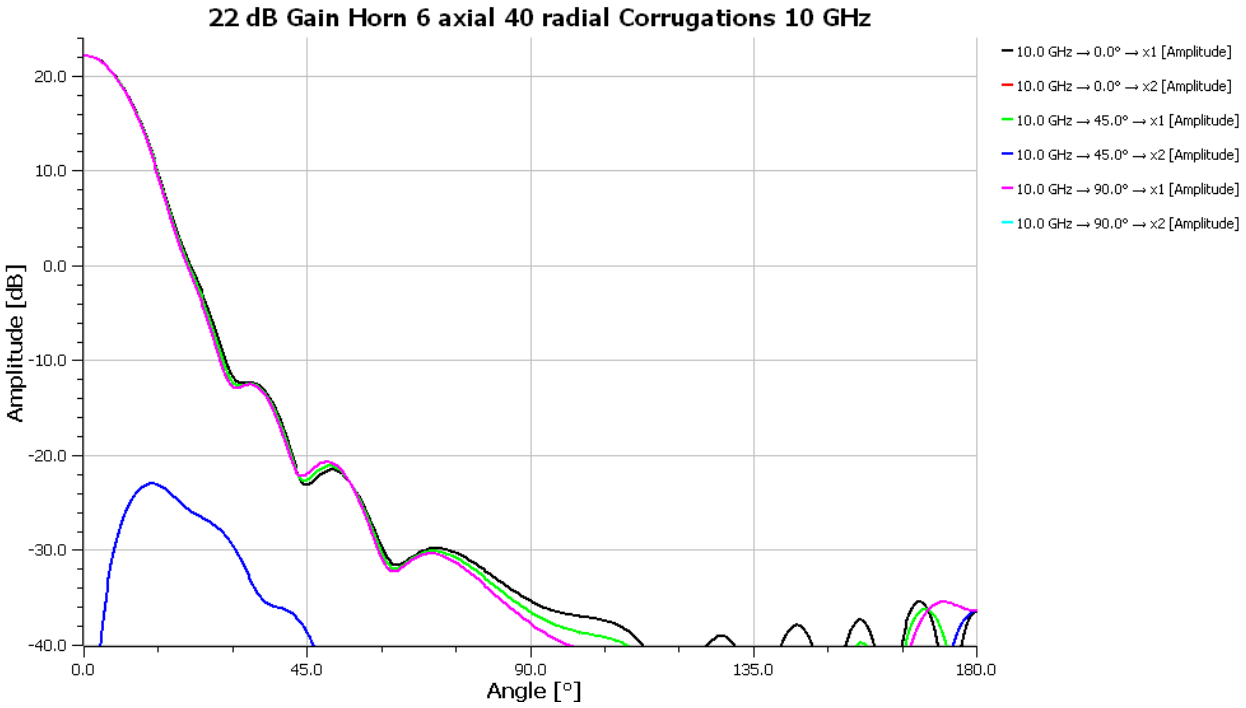

Figure 8 22 dB Gain Horn with 6 axial and 40 radial Corrugations 10 GHz

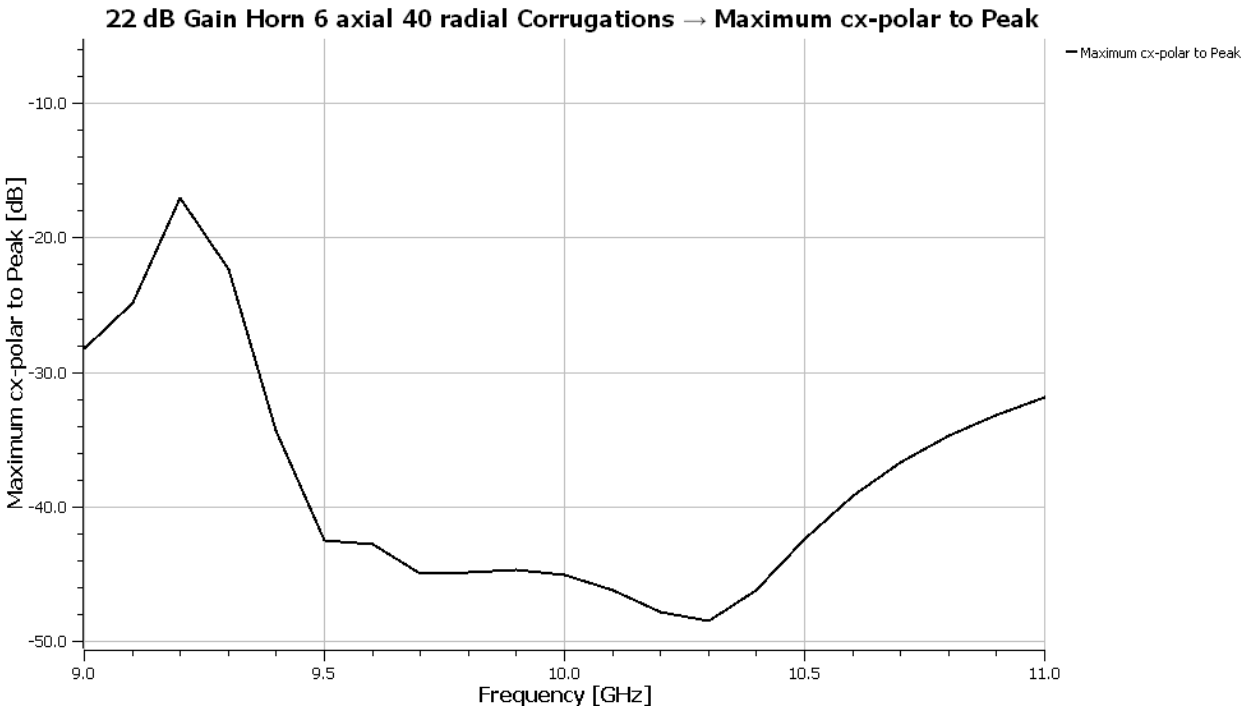

Figure 9 22 dB Gain Horn with 6 axial and 40 radial Corrugations Cross Polarization

10 dB Half Beam Width = 13 Phase Center = 68 mm

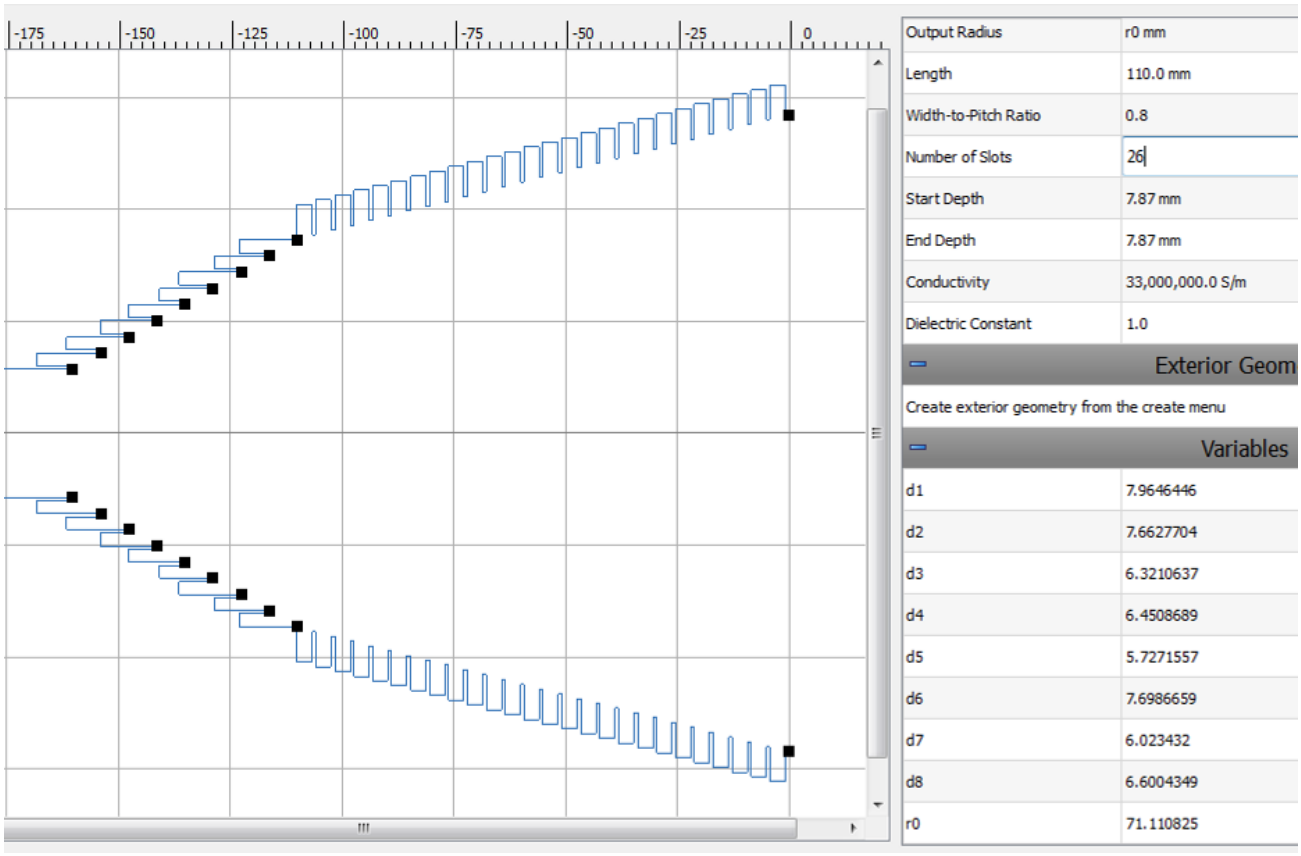

Figure 10 22 dB Gain Horn with 8 axial and 26 radial Corrugations CHAMP Model

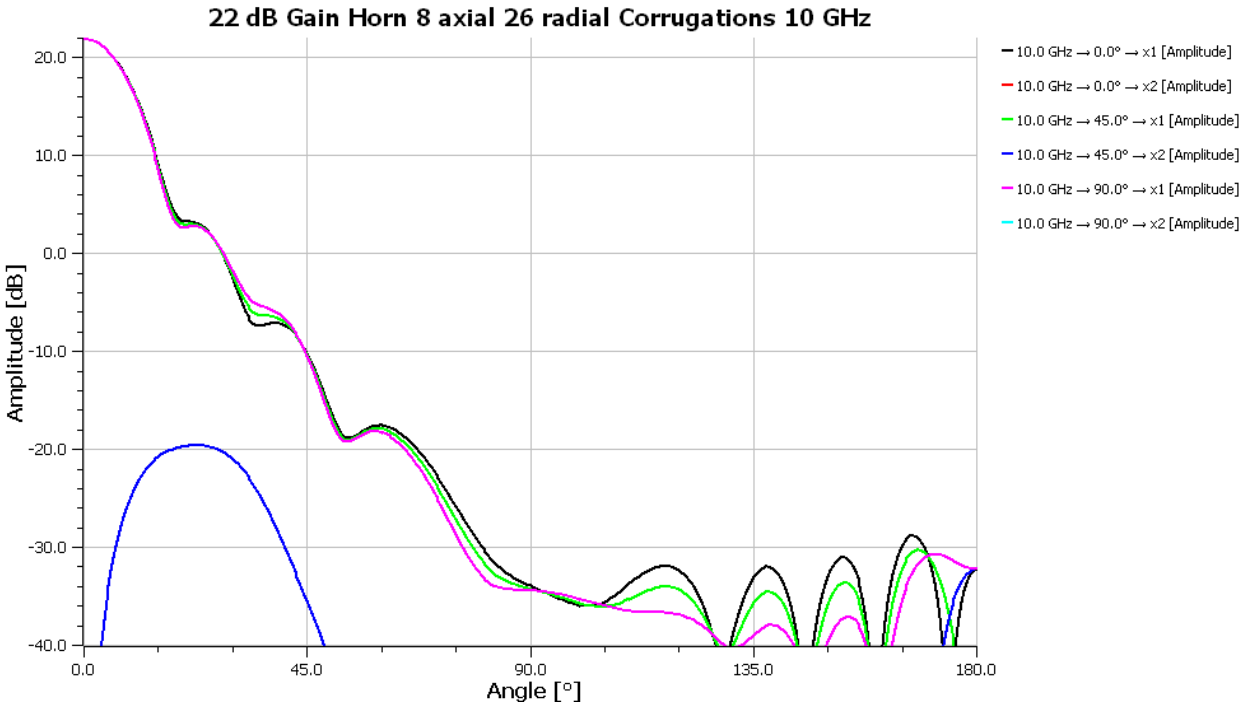

Figure 11 22 dB Gain Horn with 8 axial and 26 radial Corrugations 10 GHz

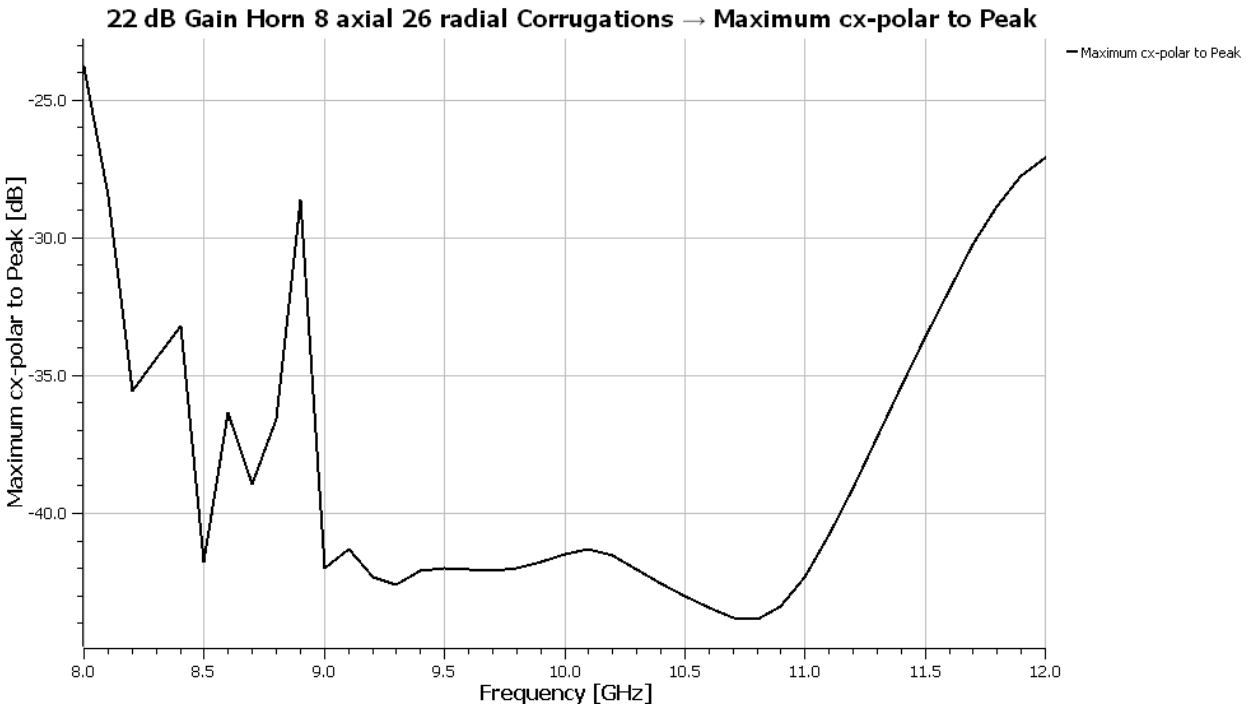

Figure 12 22 dB Gain Horn with 8 axial and 26 radial Corrugations Cross Polarization

Phase Center = 65 mm

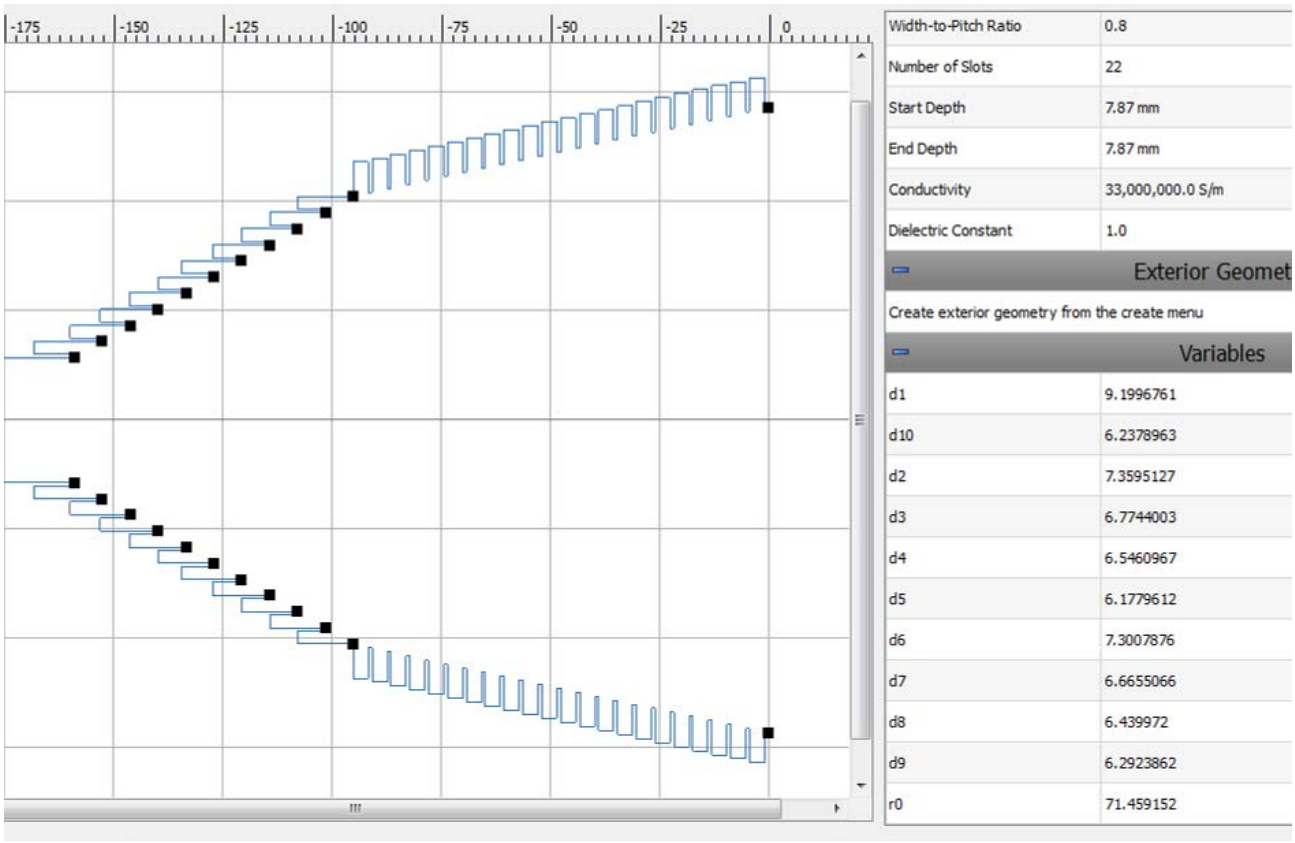

Figure 13 22 dB Gain Horn with 10 axial and 22 radial Corrugations CHAMP Model

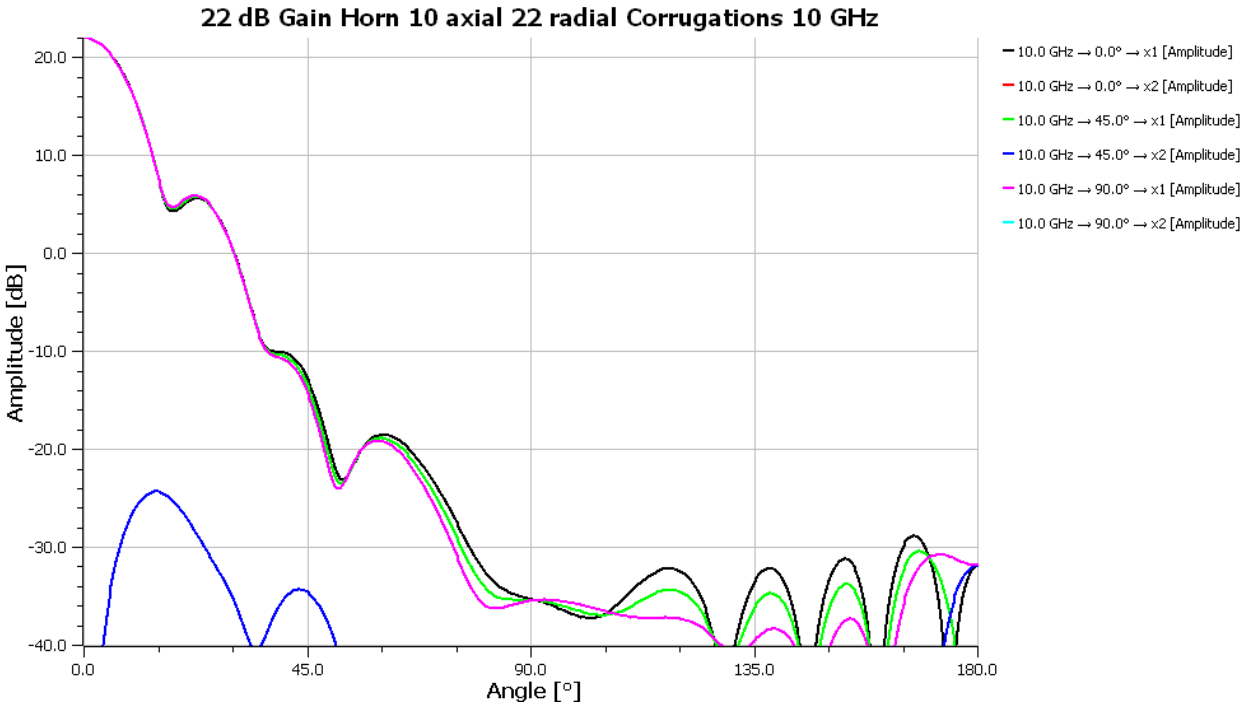

Figure 14 22 dB Gain Horn with 10 axial and 22 radial Corrugations 10 GHz

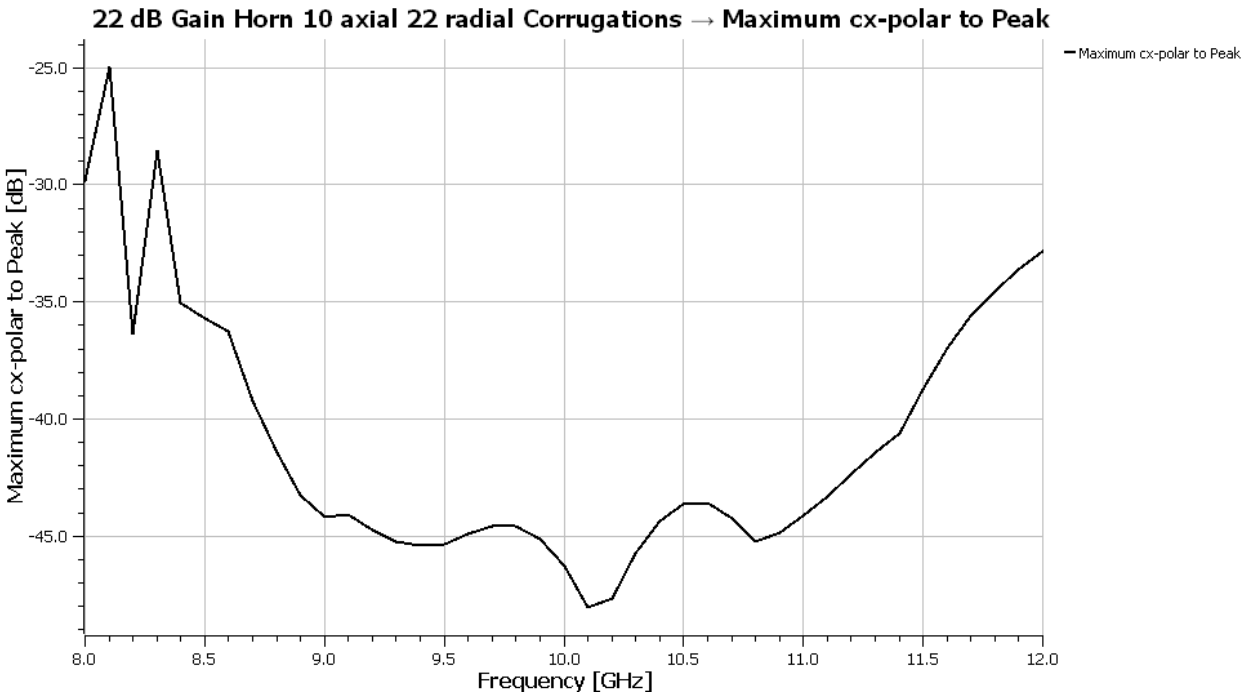

Figure 15 22 dB Gain Horn with 10 axial and 22 radial Corrugations Cross Polarization

Phase Center = 68 mm

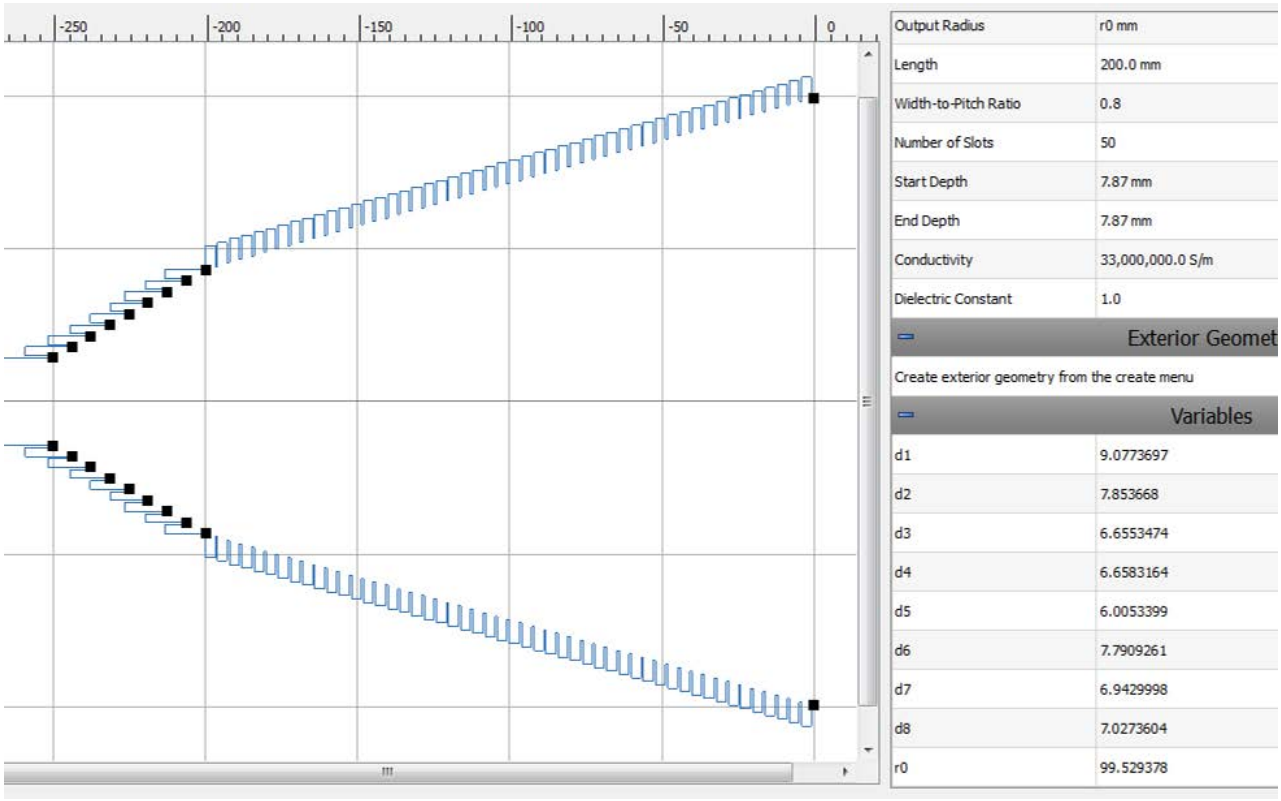

Figure 16 24 dB Gain Horn with 8 axial and 50 radial Corrugations CHAMP Model

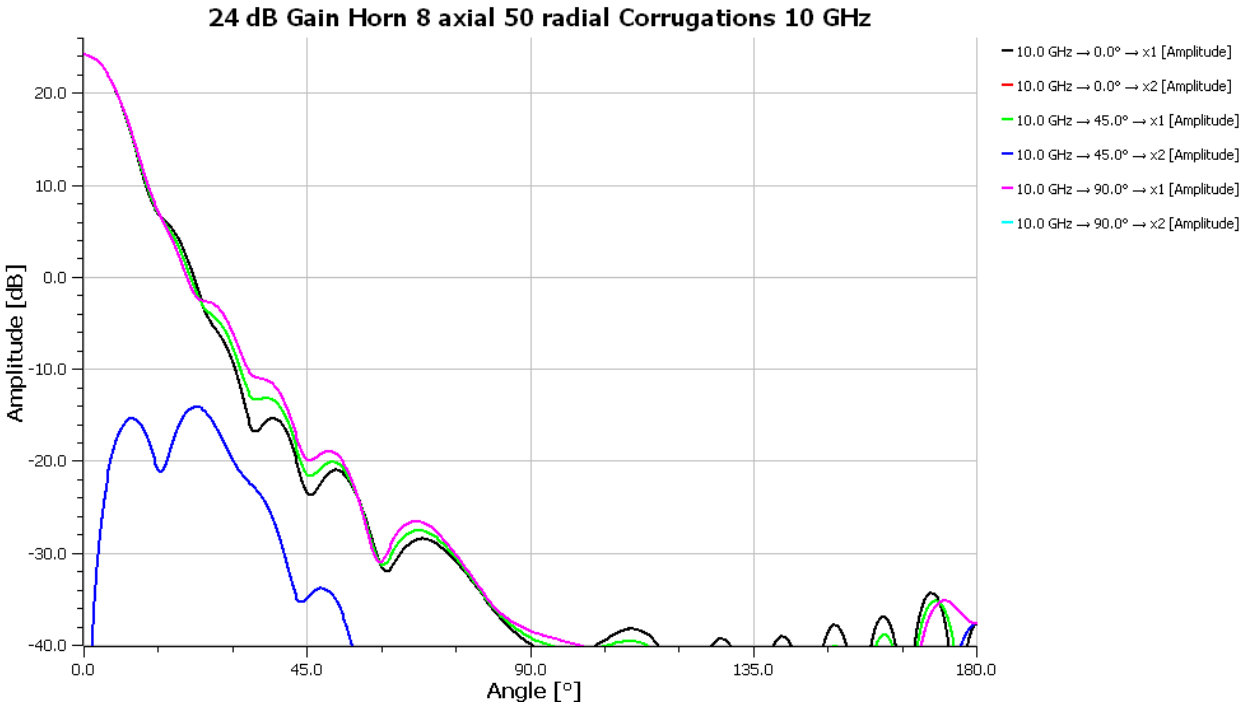

Figure 17 24 dB Gain Horn with 8 axial and 50 radial Corrugations 10 GHz

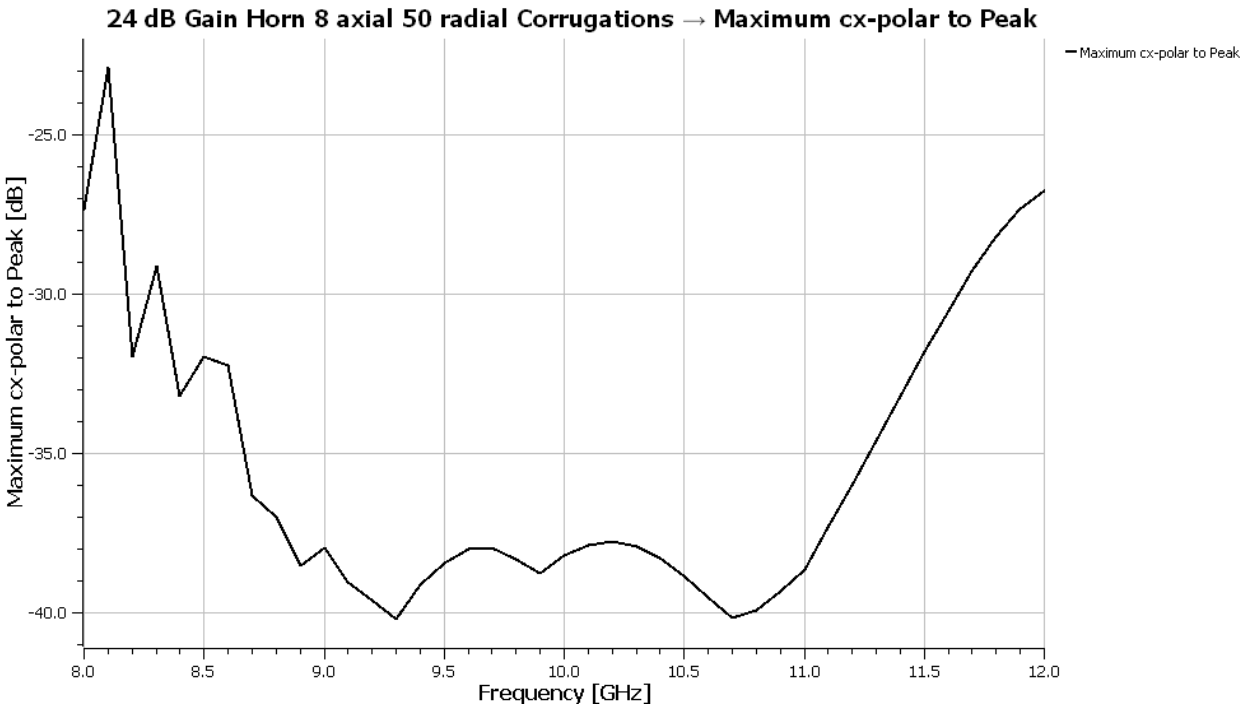

Figure 18 24 dB Gain Horn with 8 axial and 50 radial Corrugations Cross Polarization

Phase Center = 160 mm

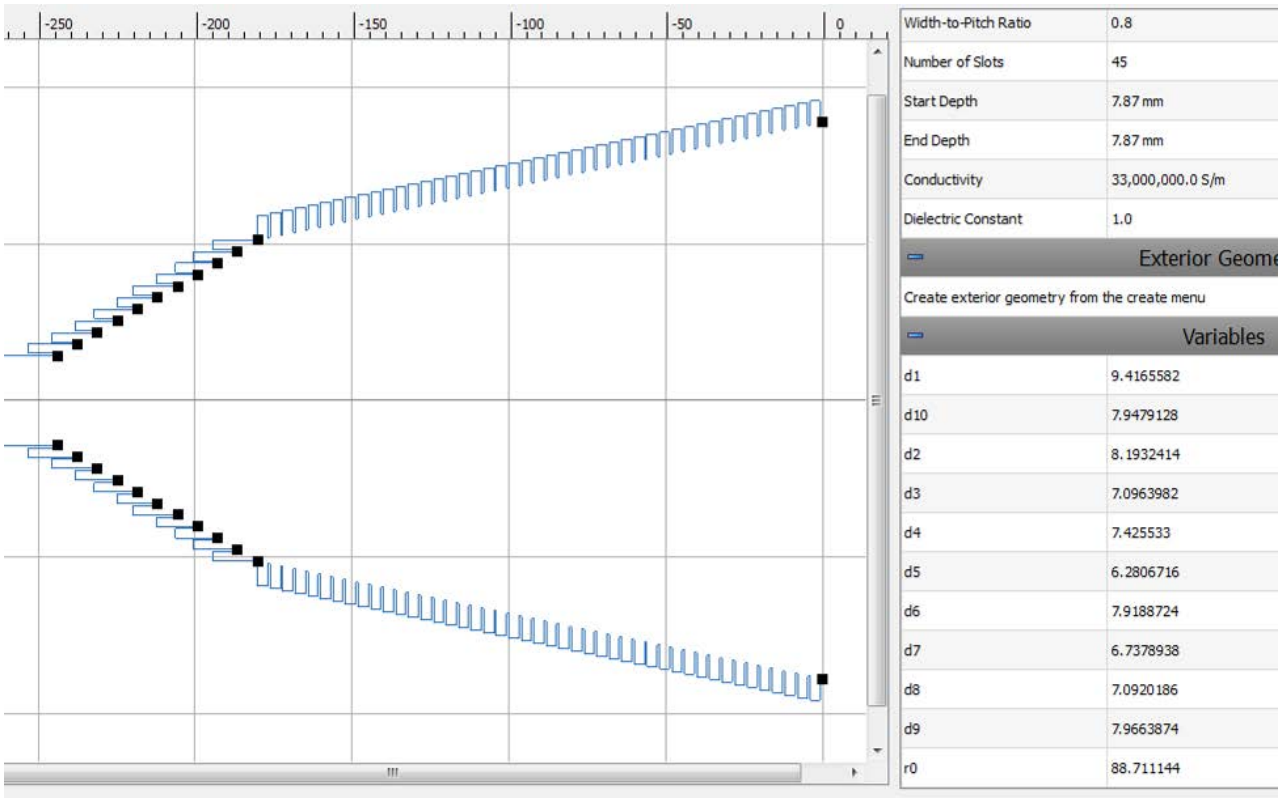

Figure 19 24 dB Gain Horn with 10 axial and 45 radial Corrugations CHAMP Model

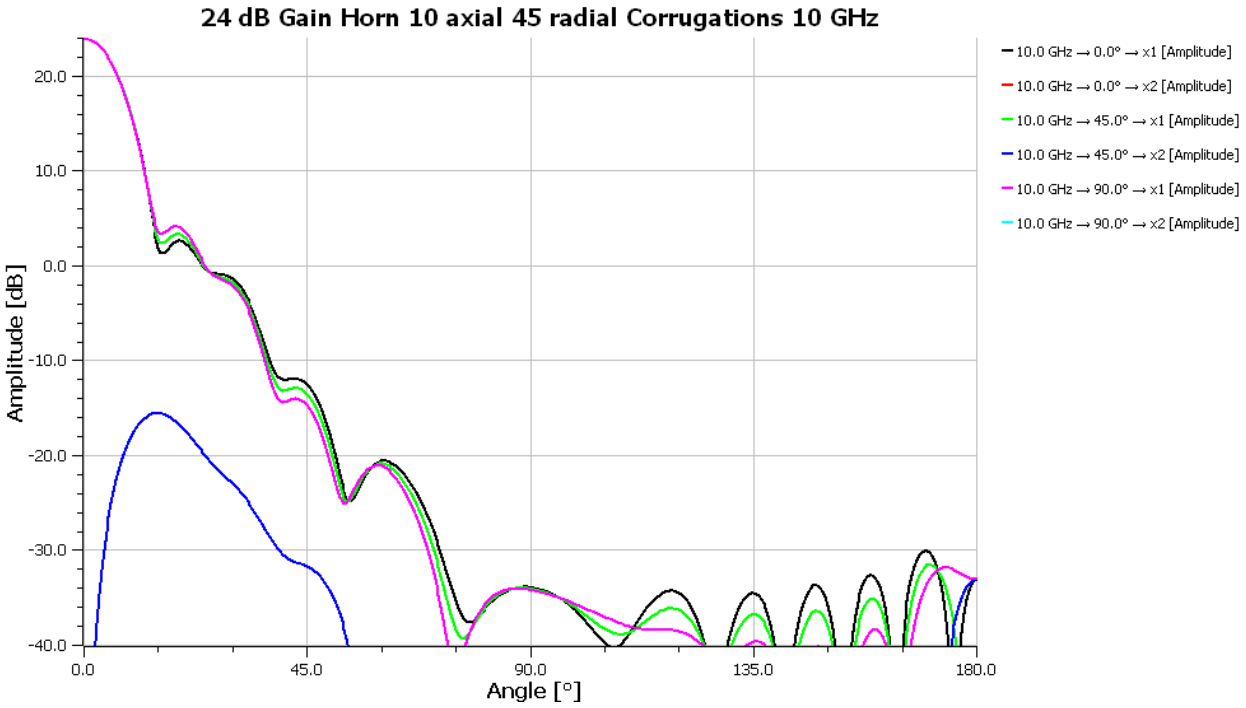

Figure 20 24 dB Gain Horn with 10 axial and 45 radial Corrugations 10 GHz

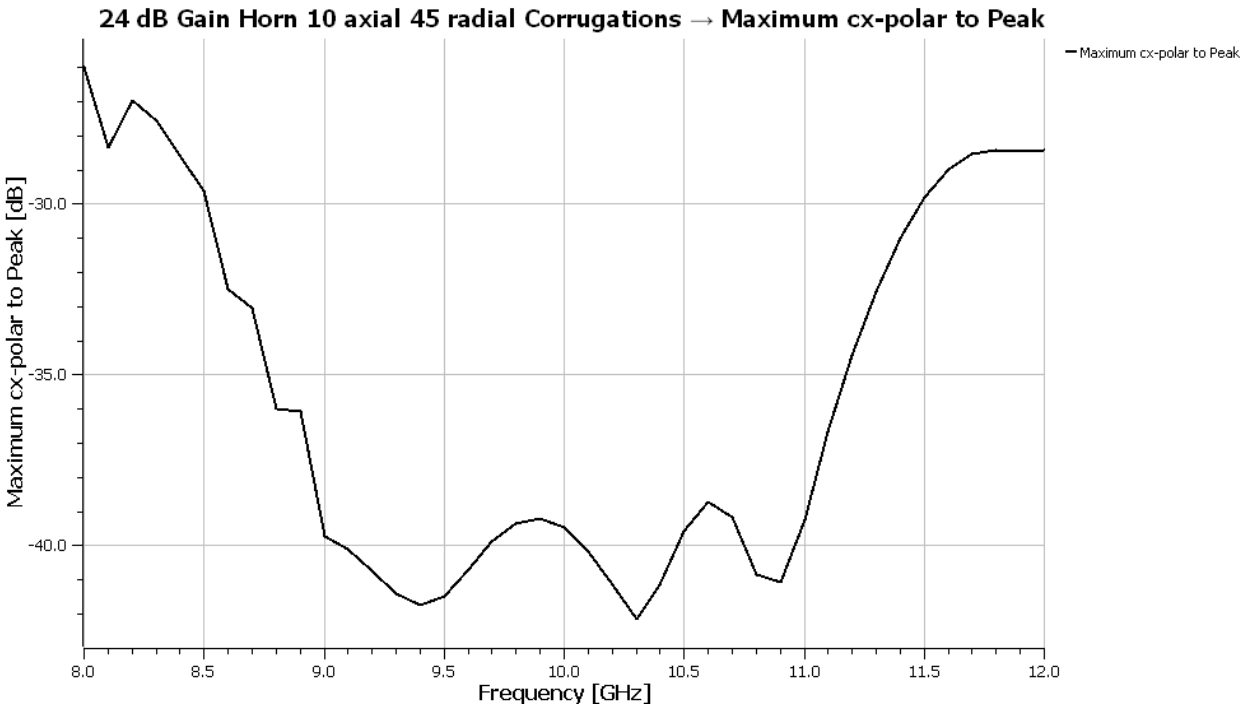

Figure 21 24 dB Gain Horn with 10 axial and 45 radial Corrugations Cross Polarization

Phase Center = 87 mm

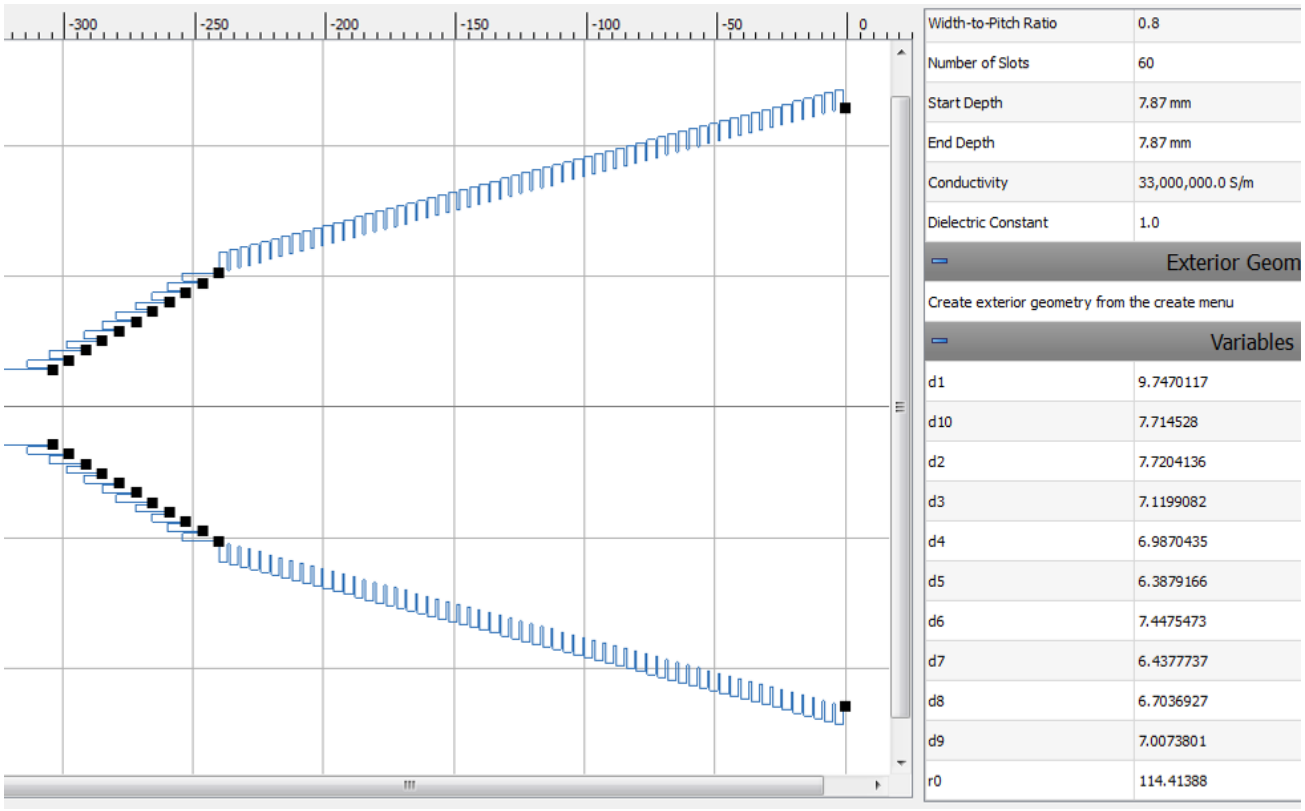

Figure 22 25 dB Gain Horn with 10 axial and 60 radial Corrugations CHAMP Model

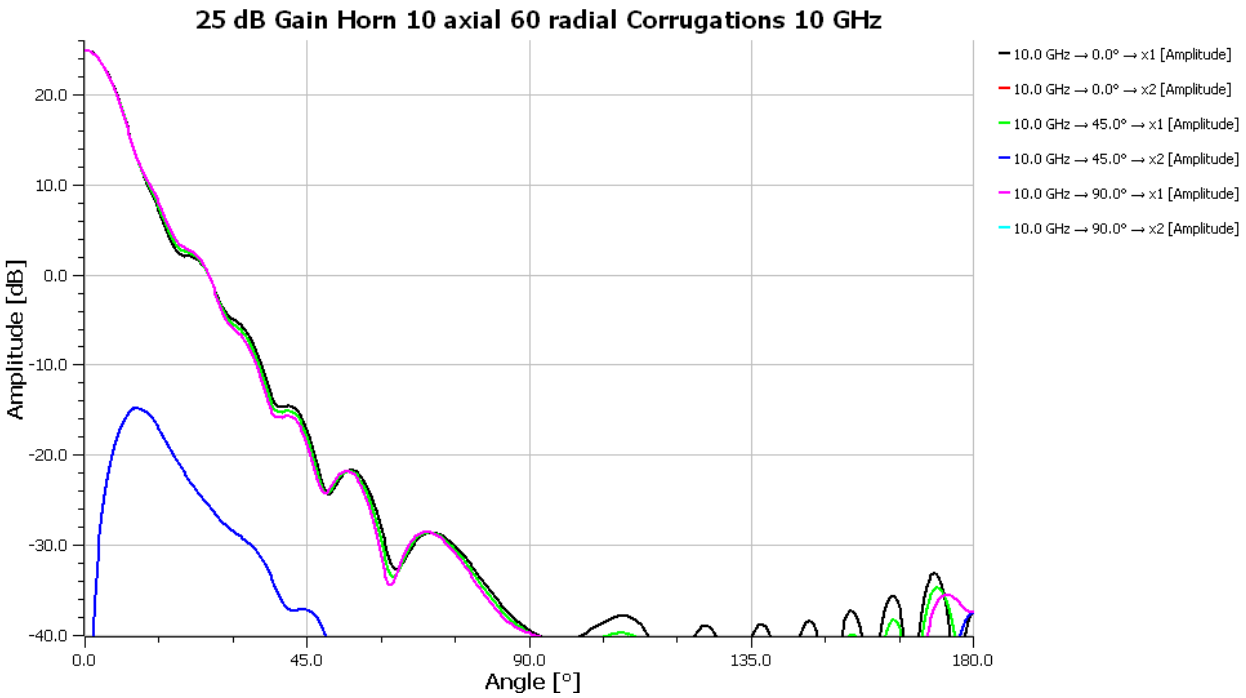

Figure 23 25 dB Gain Horn with 10 axial and 60 radial Corrugations 10 GHz

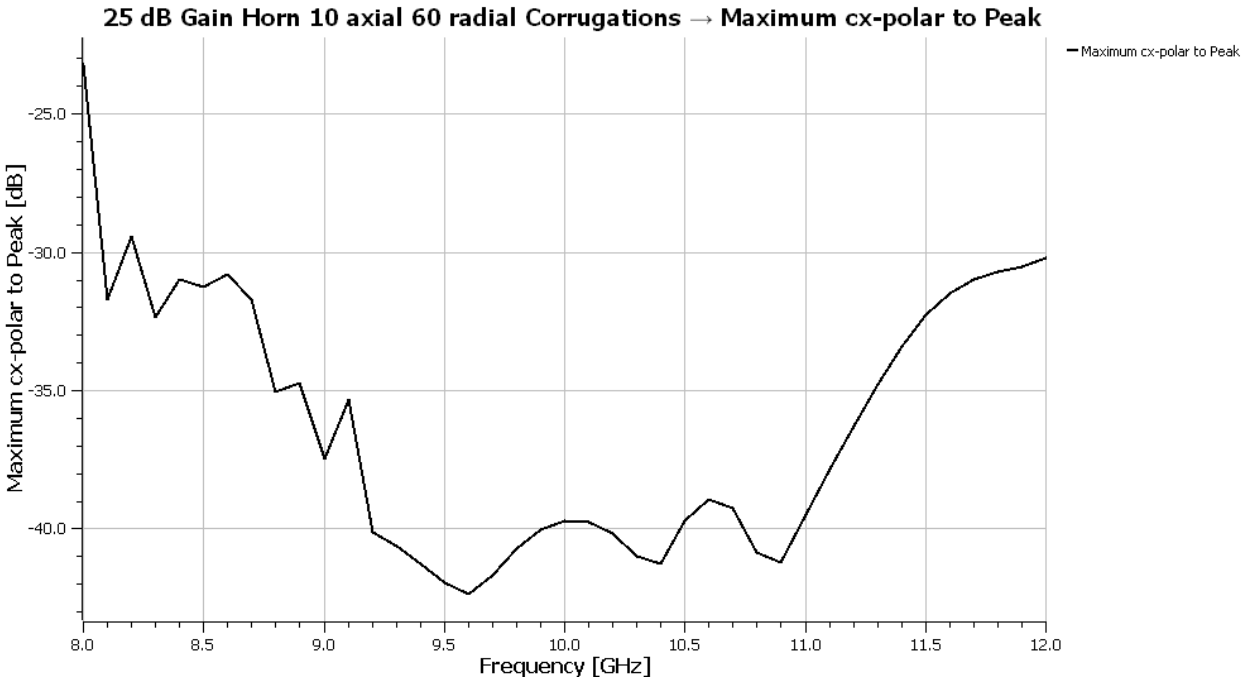

Figure 24 25 dB Gain Horn with 10 axial and 60 radial Corrugations Cross Polarization

Phase Center = 270 mm