



Analyzing a Pyramidal Horn Antenna with the MLFMM

A pyramidal horn is analyzed with the MLFMM to obtain both near- and far-field plots. Results are compared to published literature.

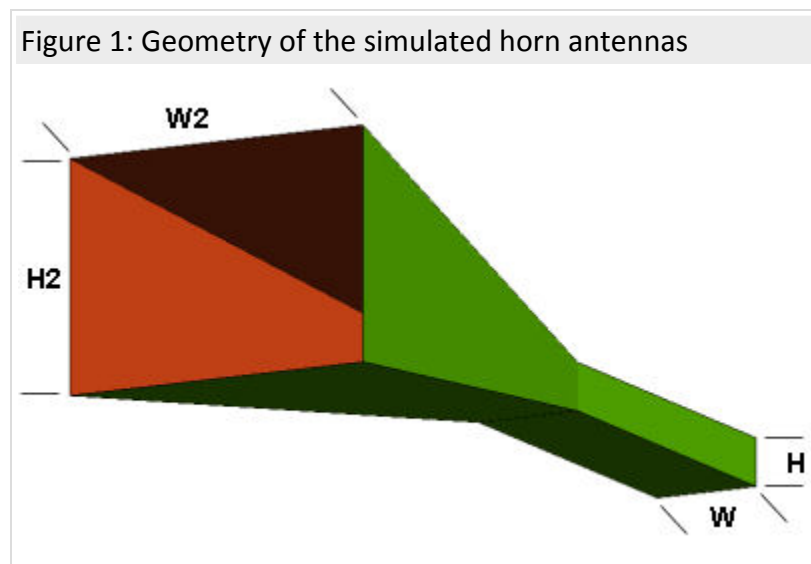
Introduction

Pyramidal horns are common structures in antenna engineering and can be used on their own or as feed elements for reflector antennas. A rigorous analysis was done by Liu *et al.* in [1] and is used as the basis for this analysis. The horns in this page were meshed with >13000 (15dBi antenna) and >30000 (20dBi antenna) which will consume significant resources when simulated with the Method of Moments (MoM). It was therefore analyzed with the Multilevel Fast Multipole Method (MLFMM).

Technical Information

Two separate models were created for the 15dBi and 20dBi versions of the antenna and both were excited with a TE₁₀ waveguide excitation. The dimensions of the antennas were as follows (see Figure 1):

- Waveguide section: 0.4" x 0.9" x 3.13" (H x W x L)
- Flare for 15dBi gain horn: 1.95" x 2.66" x 5.46" (H₂ x W₂ x L₂)
- Flare for 20dBi gain horn: 3.62" x 4.87" x 10.06" (H₂ x W₂ x L₂)
- Length of the waveguide and flare sections is measured along the centre axis of the horn.

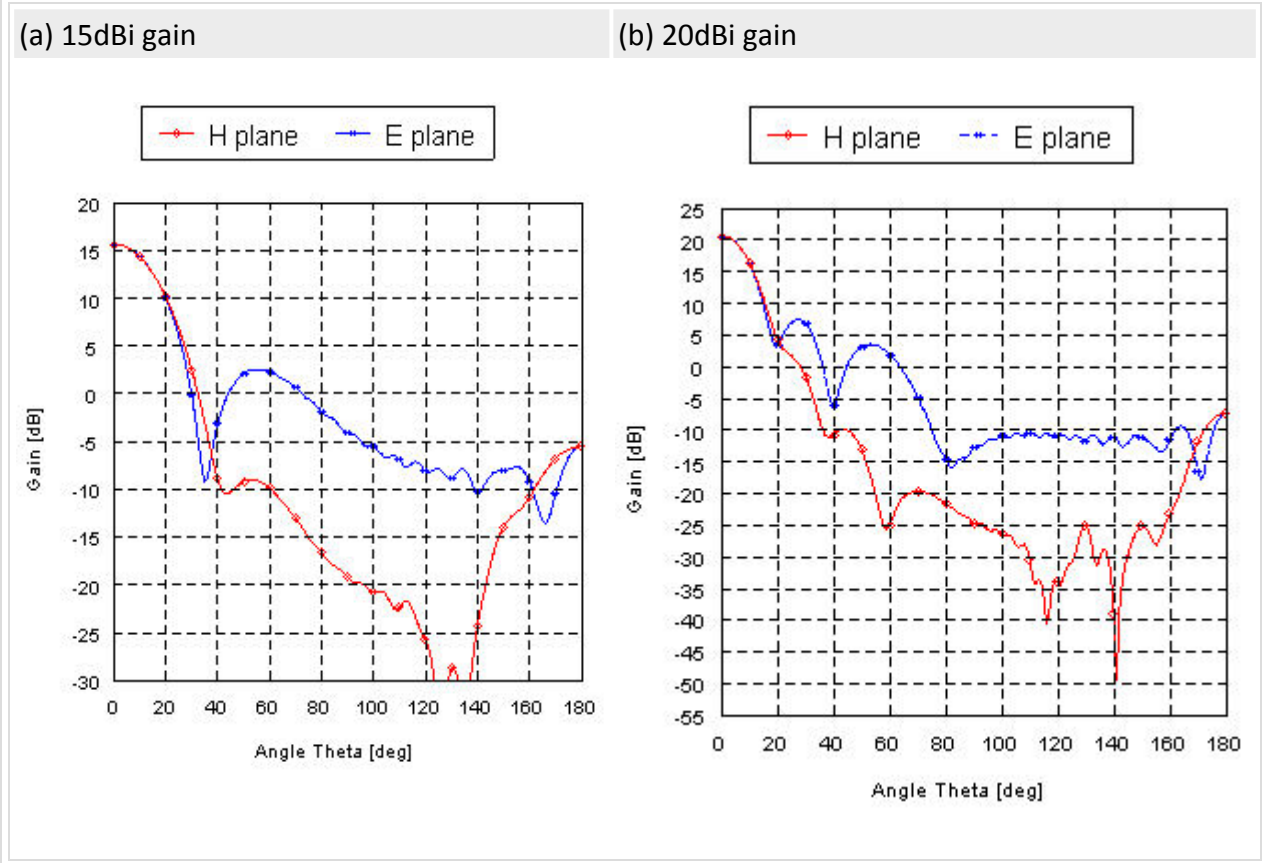


Results

Radiation patterns

Figure 2 shows the far-field gain patterns for both antennas. The results show excellent comparison with the published results [1, Figures 6, 7].

Figure 2: 2D Far-field gain patterns

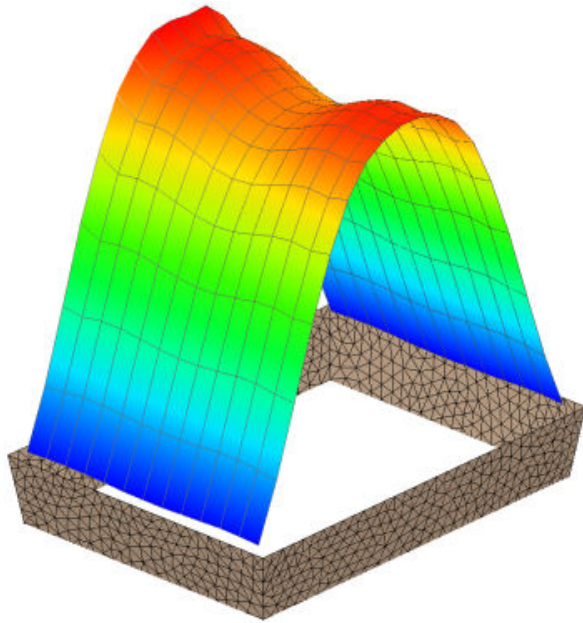


Aperture field distribution

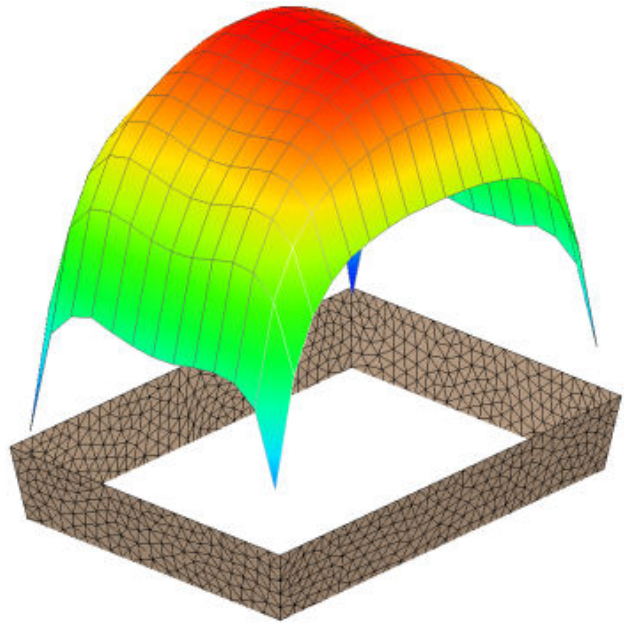
Liu *et al* [1] illustrated that the field distribution in the aperture of the pyramidal horn does not have a pure TE_{10} with parabolic phase distribution but that it has been distorted by the transition from the waveguide to pyramidal horn. The near-fields inside and outside the antenna can be studied with ease with FEKO. The magnitude and phase distributions of the 15-dB standard gain horn at 10GHz is shown in Figure 3. The agreement in amplitude with the reference results (Figure10) is good. This, however, is not true for the phase distributions. The reason for this was not investigated.

Figure 3: Aperture field distributions for 15dBi gain horn

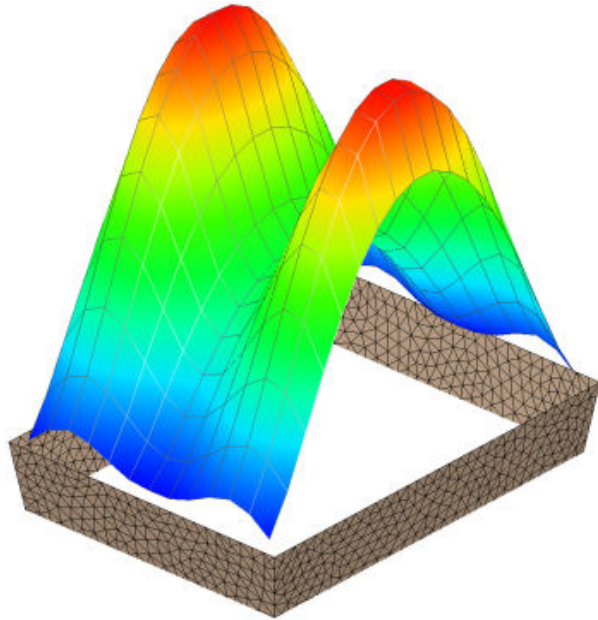
(a) E_y magnitude



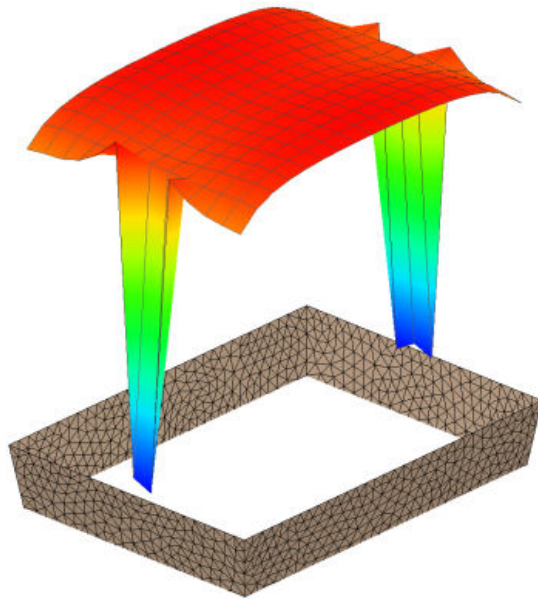
(b) E_y phase



(c) H_x magnitude



(d) H_x phase



References

- [1] K. Liu, C.A. Balanis, C.R. Birtcher, and G.C. Barber, "Analysis of Pyramidal Horn Antennas Using Moment Methods," IEEE Trans. on Antennas and Propagation, Vol. 41, No. 10, October 1993



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