Gaussian Mode Analysis of THz Horn using CST Microwave Studio

Monika Sharma[2], Surbhi Adya[2,*], Rajendra Kumar Verma[1,2], Shivendra Maurya[1,2], V.V.P Singh[2]
[1]*Academy of Scientific and Innovation Research (AcSIR),*
[2]*Council of Scientific and Industrial Research - Central Electronics Engineering Research Institute (CSIR-CEERI), Pilani, Rajasthan 333031, India.*
[*]surbhiadya@gmail.com

***Abstract*- This paper presents the theoretical investigation done in analysis of the Gaussian modes of the rectangular pyramidal horn at 0.17THz or 170GHz by using CST Microwave Studio to assess their generated modes. The results revealed the generation of combination of $TEM_{0,0}$ and $TEM_{2,0}$ mode. Using the resultant generated TEM mode, an alumina RF window at 170GHz was characterized via free space test setup. On the basis of above analysis it is concluded that horn antenna has harmonics as its dominant mode and not the fundamental mode. It produces a non-gaussian mode.**

***Index Terms*—High power microwaves, Gaussian beam propagation, CST Microwave Studio, MATLAB, Pyramidal horn antenna, TEM modes, Alumina RF Window.**

I. INTRODUCTION

A pyramidal horn antenna is a four-sided shaped pyramid, with a rectangular [6] cross section (Fig. 1). They are a common type, used with rectangular waveguides, and radiate linearly polarized radio waves. It is the simplest and the best horn as it has equal radiation patterns in both E-plane and H-plane along with its high gain and directivity. These antennas are widely used in various applications in the microwave range due to its robustness, high gain, moderate bandwidth, simple construction, easy excitation and low voltage standing wave ratio VSWR and are very popular at UHF and higher frequencies. Horn antennas have a wide impedance-bandwidth, implying that the input impedance is fairly constant over a wide frequency range. The design parameters for window and antenna are listed in Table I and II. They are sufficiently good match for most applications, and they are far easier and much cheaper to fabricate. There are several computer tools available to characterize them.

Figure 1.Geometry of a pyramidal horn.

TABLE I
PARAMETERS FOR ALUMINA WINDOW ELECTROMAGNETIC SIMULATIONS

Parameter	Value
Material	99.5% Alumina(ε_r=9.5)
Disc diameter, D_D	90mm
Disc thickness, t	3mm
Window aperture/waveguide diameter, D	80mm
Circular waveguide length, L	15mm
Waveguide Wall thickness, t_w	4mm

TABLE II
PARAMETERS FOR HORN ANTENNA DESIGN

Parameter	Value
Horn cross-section dimension	A=14mm B=10.9mm
Horn length	26.4 mm
Horn beam width	6.6^{o}
Horn feed mode	TE_{10}
Horn far field mode	TEM

The design, simulation and characterization of the antenna and window have been bone on CST Microwave Studio in order to verify the simulated and the practical (experimental setup) results. Hence, the pyramidal horn and the window are characterized.

II.DESIGN

It is a half-wave resonant window Transmission Line Theory which predicts that the window will be resonant at all those frequencies for which the alumina disc [4] thickness follows the following relation.

$$t = n\lambda_g/2$$

The expression for the electric field is given by the below equation [5].

$$E(r,z)=\left(\frac{2}{\pi w^2}\right)^{0.5}\exp\left(\frac{-r^2}{w^2}-jkz-\frac{j\pi r^2}{\lambda R}+j\varphi_0\right)$$