Design curves for the Picket-Potter horn-reflector antenna for THz applications

A. Airalucksanawong, S. Wangsuya, P. Kittara and G. Yassin

email: tepcy@mahidol.ac.th, ghassan@astro.ox.ac.uk

A feed may be considered suitable for high performance THz detectors if it satisfies the following requirements: 1. efficient coupling of radiation from telescopes to the detector. 2. easy to fabricate. Conventionally, THz detectors have employed corrugated horn to couple radiation from the telescope to the detector since they are known to have low side lobes and cross polarization levels over a substantial fractional bandwidth. It is well known, however, that fabrications of corrugated horns at THz frequencies are difficult since several corrugation per wavelength are needed in order to guarantee a pure hybrid mode over a large bandwidth.

In previous papers [1,2], we describe a feed called the Pickett-Potter horn (PPH) antenna which has only a single step discontinuity at the horn throat. We have demonstrated that this antenna exhibits a performance which is comparable to corrugated horns over a fractional bandwidth of 15%. Analysis of the Pickett-Potter horn (PPH) antenna was carried out using the modal matching technique. The radiation patterns of the horn are then calculated using a diffraction theory method. To collimate the beam, we place the phase centre of the horn at the focus of a 90-degree offset parabolic reflector to form a Pickett-Potter horn-reflector (PPHR) antenna. To find radiation patterns of the PPHR antenna we propagate the horn field into the projected aperture using a conformal mapping method.

From the discussion above, we notice that calculating the radiation pattern of the PPHR antenna exactly is quite involved. In this paper, we present design formula, procedures and graphs that allow computing the radiation pattern of the PPH and PPHR antennas. For example, we shall provide design curves that give optimized horn parameters for a required radiation patterns. This includes the step dimension, the input waveguide radius and the horn parameters as function of the phase error scaled to wavelengths. We shall also give analytical expression that relates the beamwidths of the PPH to that of the PPHR antenna.

[1] P. Kittara *et al*, "A Pickett-Potter horn-reflector antenna for submillimetre-wave applications," *Proc. 11th ISSTT*, pp. 598-607, 2000
[2] P. Kittara *et al*, "A 700-GHz SIS Antipodal Finline Mixer Fed by a Pickett–Potter Horn-Reflector Antenna", *IEEE Trans. Microwave Theory Tech*., 52(10), pp. 2352-2360, Oct. 2004