SUPERB GAUSSIAN BEAM EFFICIENCY CORRUGATED HORN ANTENNAS

Jorge Teniente[1], Ramón Gonzalo[2], Carlos del Río[3]
Antenna Group. TSC Area. IEE Department. Public University of Navarra
Campus de Arrosadía. 31006. Pamplona (Navarra) Spain
[1]jorge.teniente@unavarra.es
[2]ramon@unavarra.es
[3]carlos@unavarra.es

Introduction: Corrugated horn antennas have been widely used as feedhorns for radiometers and radio telescopes. It is well known the corrugated horn high performance radiation patterns that have made them famous for very stringent applications as radio astronomy requires. However, in the last decade some very important improvements have been made to corrugated horns in terms of length, return loss, sidelobe level and manufacture simplicity; maintaining their well known properties of wide bandwidth, symmetrical quasi-gaussian beamwidth and low crosspolarization.

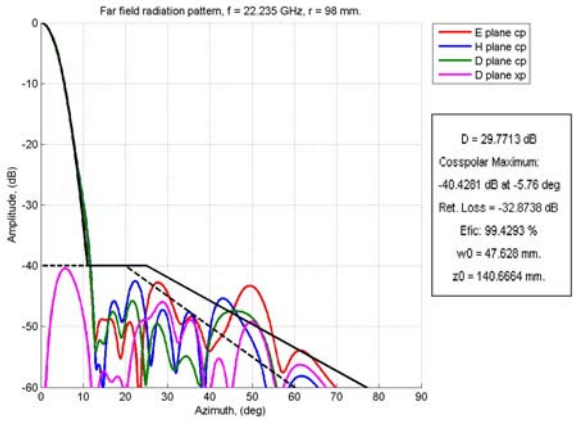

Fig.1: Simulated radiation pattern of corrugated horn antenna for water vapour radiometer and 30 dB gain

For radio astronomy or any other application involved in the detection of extremely weak signals, the sensitivity of a radiometer--i.e., the ability to measure weak sources of radio emission--depends on the area and efficiency of the antenna, the sensitivity of the radio receiver used to amplify and detect the signals, and the duration of the observation. However, optimization of the antenna efficiency is less important than optimizing the ratio of efficiency to system noise temperature or gain over system temperature, G/T_s. This means that using a feed with low sidelobes and slightly under-illuminating the dish may reduce T_s by more than it reduces G and so improve sensitivity. With advent of superb Low Noise Amplifiers (LNAs), the antenna noise temperature is a very important performance parameter along with the gain or equivalent effective aperture. Antenna noise originates from the sky background, ohmic losses, and ground pickup or *spillover* from sidelobes. Moreover, weak signals can be easily masked by terrestrial radio interference, and great effort must be taken to protect radiometers from man-made interference. While the sky noise is fundamental, the reduction of losses and sidelobe levels are particularly important for a good feedhorn design.

In this paper we are presenting the possibilities of corrugated horn antennas that combine horizontal and vertical corrugations. This corrugated horn antennas discovered in 2002 by the Antenna Group of the Public University of Navarra in Spain have reduced dramatically the length of corrugated horn antennas as well as improved return loss and made easier the manufacture process. Axial corrugations are selected for return loss improvement and throat region length reduction, perpendicular corrugations profile is particularly important for sidelobe level reduction as well as corrugation depth for crosspolar level reduction. The combination of axial corrugations for the throat region and perpendicular corrugations for the flare region reduces also the design optimization computational effort.

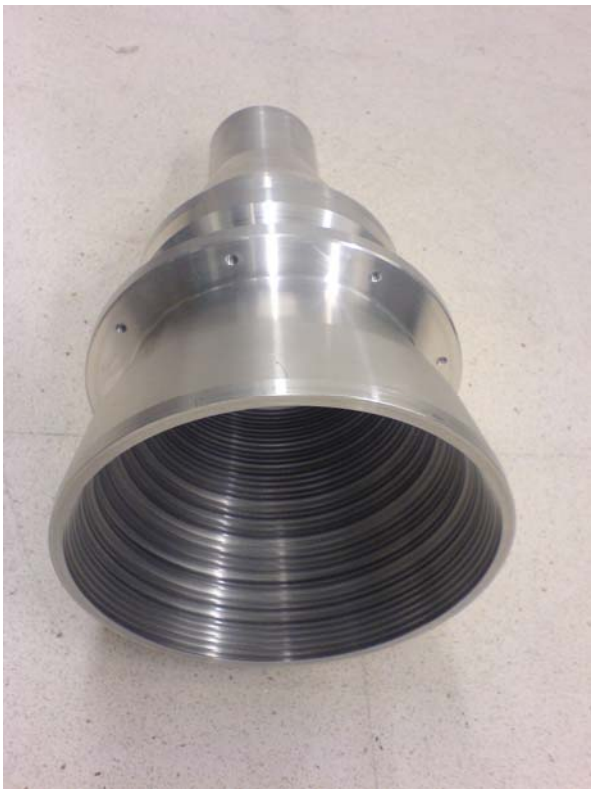

Fig.2: Manufactured corrugated horn antenna for water vapour radiometer and 30 dB gain

Several designs for radiometers and radio telescopes are being presented, making special emphasis in the low sidelobe level design possibilities with measured prototypes with -45 dB sidelobe level, and the ultra high gaussian efficiency obtained in such designs (designs above 99.9% efficient to fundamental gaussian beam in around 10% bandwidth, compared to designs above 98.5% efficient to fundamental gaussian beam in the corrugated horn limit 40% bandwidth) which will improve the sensitivity of modern radio telescopes.

REFERENCES

[1] J. Teniente, R. Gonzalo and C. del Río, "Choked Gaussian Antenna: Extremely Low Sidelobe Compact Antenna Design", *IEEE Antennas and Wireless Propagation Letters*, Vol. 1, November 2002.

[2] C. Straub, A. Murk, J. Teniente and N. Kämpfer, "Optical Design for a Compact 22 GHz Radiometer for Middle Atmospheric Water Vapor", *Proc. of the Second European Conference on Antennas and Propagation, EuCAP 2007*, Edinburgh, Scotland, November 2007.