# High Gain Reflector Antenna for M3tera H2020 Project

I. Maestrojuan, M. Goñi, A. Martinez,
Anteral S.L., Campus Arrosadia s/n, Pamplona, 31006, Navarra, Spain

***Abstract*—The following paper presents design and fabrication process of a high gain reflector antenna system carried out within the H2020 M3tera project. This project is focused on the development of a complete microsystem able to work as high rate communication link at D-Band frequencies. The paper presents design and fabrication aspects of two prototypes one fabricated by conventional techniques and the second one by 3D printing. Comparative performance will be presented at the conference.**

## I. INTRODUCTION

NOWADAYS an important increased in the necessity of high data rate links in the telecommunication field has made of THz technology an attractive solution for these kind of application. This is the main motivation for M3tera H2020 project, developing a revolutionary platform for enabling volume-manufacturable, cost-efficiency, highly integrated terahertz systems mainly focused on high-speed telecommunication links for small-cloud networks.

Within M3tera project the antenna design of the THz microsystem is an important section since it is intended to support a high capacity link (up to 10 Gbit/s) at high frequencies (141-148 GHz) and with an antenna directivity higher that 40 dBi in order to transmit the signal a distance of 0.5 km.

## II. DESIGN

Bearing in mind that the antenna gain required for the M3tera project telecommunication application should be higher than 40 dB, the best option to reach this specification is to design a reflector antenna. For instance, corrugated horn antennas and spline antennas usually have directivities around 22-23 dB, moreover, pyramidal horn antennas are in the order of 26 dB. However, it could be possible to obtain a corrugated horn antenna with a directivity of 30 dB but its fabrication and dimensions would be too difficult and not feasible for this application. Another solution for the high gain antenna (> 40 dBi) could be the use of lens horn antennas but the physical dimensions of this antennas are in the same order as the reflector antenna. Moreover, both reflector antennas and lens horn antennas can achieve radiation efficiencies around 70% but lens horn antennas are lossier when increasing frequency. Finally, the use of a reflector enables the operation of 2 or 4 antenna array feeder making possible an electronically controlled aiming. For this reason the design presented in this paper is a reflector antenna configuration.

Within reflector antennas configuration the best alternative for M3tera project is the use of an offset parabolic system since this way, the feed antenna can be located out of the field of view of the reflector and the blockage is minimized. The main advantages an offset parabolic system has are: easy fabrication, no blockage. However it also has some disadvantages: more difficult aiming of the complete system than confocal configurations.

Taking into account all these aspects an offset reflector antenna systems has been designed. The system counts with a reflector antenna of 10 cm diameter and a D-band feed horn antenna in charge of transmitting the signal generated by the microsystem platform. Some pictures of the 3D design are depicted below, see Fig. 1.

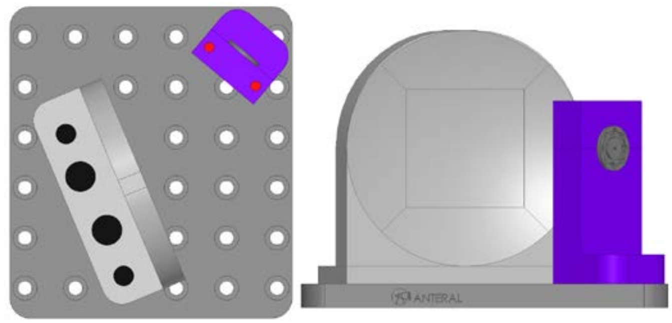

**Fig. 1.** 3D design of the M3tera offset parabolic system.

The simulation results of the designed antenna for the complete D-band frequency range fulfill the requirements of the M3tera project, see Table 1.

| Frequency | Directivity | $\eta$spill (dB) | Spill-over (dB) |
|---|---|---|---|
| 110 GHz | 39.57 dB | 1.2527 dB | -6.011 dB |
| 145 GHz | 42.56 dB | 0.2633 dB | -12.30 dB |
| 170 GHz | 43.54 dB | 0.2398 dB | -12.70 dB |

**Table 1.** Simulation results of M3tera offset parabolic system.

## III. FABRICATION

This section describes briefly the fabrication of the feed and the parabolic reflector that form the offset reflector antenna following two different techniques: conventional machining and a low cost 3D printing process. In order to fabricate the pyramidal horn antenna by conventional machining an Electrical discharge machining (EDM) process will be employed. This process strips off material by means of controlled electric discharges that sparks in a dielectric environment, between the electrode and the piece under fabrication. The parabolic reflector will be fabricated using a milling machine followed by a polishing process.

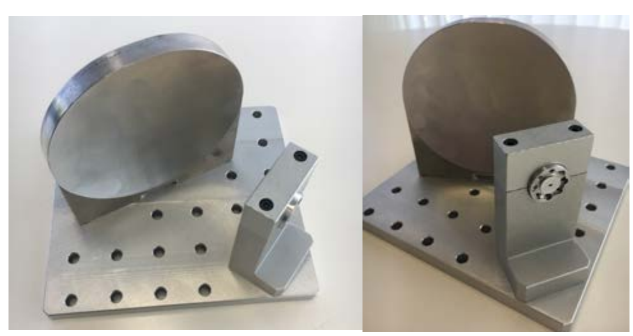

**Fig. 2.** Fabricated aluminum antenna system.

On the other hand, the complete reflector antenna system has been fabricated by means of a 3D printer providing this way a low cost solution. The reflector dish has been printed in plastic and metallized afterwards, and the feed has been directly printed on brass material.

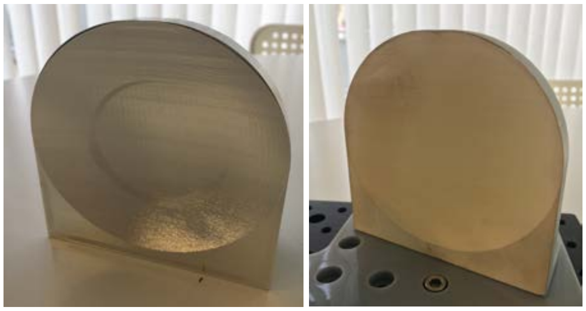

**Fig. 3.** Fabricated 3D printed reflector antenna.

Two different metallization processes have been validated obtaining in both cases similar results. The first one using a high vacuum aluminum plating process and the second one employing a by two steps coating process in Ag.

## IV. Measurements

The performance of both antenna systems has been measured. The total antenna directivity as well as the radiation pattern have been calculated by means of a transformation from planar near field measurement to far field measurement. The results are depicted below.

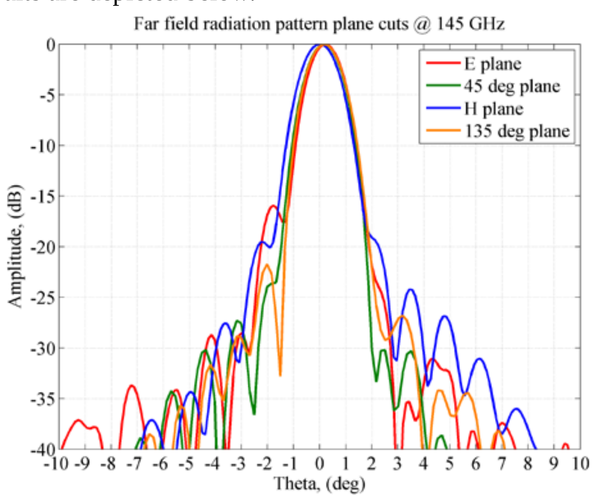


**Fig. 4.** Reflector antenna system far field radiation pattern.

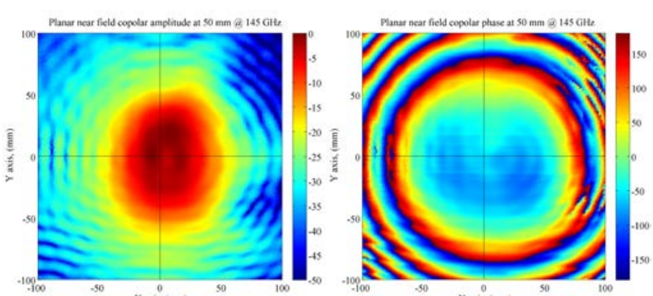


**Fig. 5.** Reflector antenna system planar near field.

The antenna system directivity has been measured from 140 to 150 GHz obtaining a value higher that 42 dB for the complete frequency band for both antenna systems, see Fig. 6. Furthermore, an equal performance for both antenna systems has been achieved. This is an important milestone since it is the first time that this kind of plastic reflector and metallizing process is employed as part of a communication antenna system instead of the commonly employed aluminum reflectors. This new solution allows a low cost and low weight system which can be of real interest for the aforementioned application and specifically for the M3tera project.

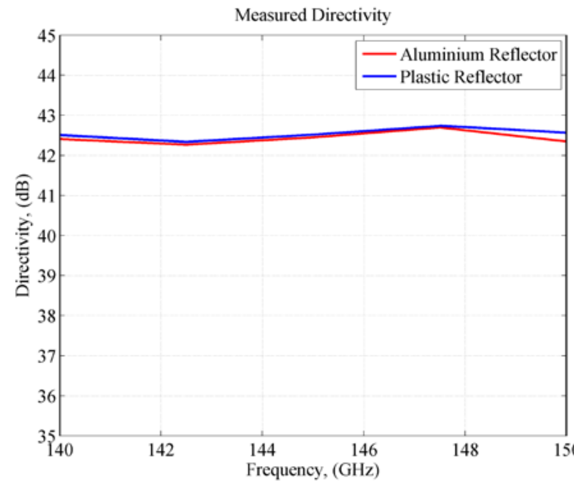


**Fig. 5.** Measured directivity comparison.

## V. Summary

This paper has presented the design and fabrication process by conventional and low cost techniques of the reflector antenna system developed within H2020 M3tera project. Moreover, the test performance of both systems has been depicted obtaining an equal performance for both of them complying perfectly with the simulation values. Therefore, two reflector antenna systems with 42 dB directivity at 145 GHz have been developed for the M3tera project telecommunication prototype fulfilling perfectly the required project specifications.

## Acknowledgment

This project has received funding from the *European Union's Horizon 2020 research and innovation programme* under grant agreement NO.644039.

## References

[1]. https://m3tera.eu/