# Diagnostics of the BIOMASS Feed Array Prototype

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***Abstract*—The 3D reconstruction algorithm is applied to the prototype feed array of the BIOMASS synthetic aperture radar, recently measured at the DTU-ESA Spherical Near-Field Antenna Test Facility in Denmark. Careful analysis of the measured feed array data has shown that the test support structure of the array has a dominant influence on the measured feed pattern. The 3D reconstruction is then applied to the feed array measured data, allowing the identification of the undesired currents induced on the feed support structure. The results of the diagnostics and the corresponding improvements of the feed pattern obtained by removal of the undesired currents are presented and discussed.**

***Index Terms*— antenna diagnostics; measurements; uncertainty**

## I. INTRODUCTION

Accurate and general antenna diagnostics techniques have in recent years attracted the interest of the antenna measurements community. Several algorithms and two commercial software tools have been developed in the past years with the purpose of identifying from the radiated measured field the electrical and mechanical errors affecting the performances of the antenna under test. DIATOOL from TICRA is one of the available commercial software tools. One of its key features is its 3D reconstruction algorithm, which, with its higher-order Method of Moments-based implementation, makes it possible to reconstruct field and surface currents on arbitrary 3D surfaces enclosing the AUT [1].

An importance feature of the 3D reconstruction algorithm of DIATOOL is the ability of identifying and computing the undesired sources of radiation, such as leaking cables and antenna support structures, which can affect the performances of the antenna. Of particular interest for antenna diagnostics is the subsequent filtering of this undesired radiation, to obtain a more accurate measured field.

The purpose of this work is to apply the 3D reconstruction algorithm to the prototype feed array of the BIOMASS synthetic aperture radar, recently measured at the DTU-ESA Spherical Near-Field Antenna Test Facility in Denmark.

The BIOMASS candidate mission is undergoing its feasibility study in the selection process for the seventh Earth Explorer programme of the European Space Agency [2]. The main payload of the BIOMASS is a P-band (435 MHz) synthetic aperture radar with an antenna aperture of approximately 110 m$^2$ with full polarimetric and multi-pass interferometric capabilities [3]. The antenna configuration selected as the baseline is a large deployable reflector antenna illuminated by a small feed array (the pink structure), as illustrated in Figure 1. The dual-polarized feed is a 2×2 patch array of about 1 m$^2$ located atop of the satellite with dimensions of about 1×1.5×3 m$^3$.

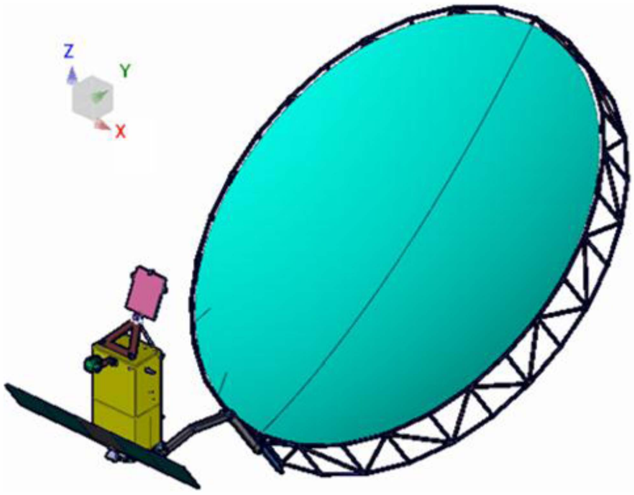


Figure 1. The feed array (in pink), the satellite body (in yellow) and the large deployable reflector (in blue).

## II. THE PROTOTYPE FEED ARRAY

The prototype feed array of the BIOMASS consists of four quadrilater patches, properly excited, and located on a quadrilateral ground plane, see Figure 2. The feed array has recently been measured at the DTU-ESA Facility Spherical Near-Field Antenna Test Facility to establish an optimum on-ground performance verification methodology for the BIOMASS payload [4]. To mount the antenna on the antenna positioner, an appropriate and stiff support structure was necessary, as shown in Figure 2. The support structure is a rectangular frame of square aluminum tubes with outer dimensions of 50 mm X 50 mm. Ideally, the support structure should not affect the feed array radiation pattern. In practice, careful analysis of the measured data has shown that the support structure has an influence on the measured pattern.

In order to study the effect of the support structure, two measurement set-up were considered, see Figure 3. In configuration A the support structure was located 100 mm behind the feed array, while in configuration B the distance was set to 400 mm.

Figure 2. The feed array and its support structure.

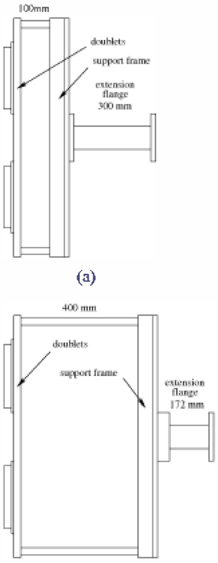


Figure 3. Measurement configuration A (at the top), and measurement configuration B (at the bottom).

The amplitude of the measured field for phi=0 deg, is shown in Figure 4. It is seen that the main differences appear for theta between 90 deg and 180 deg. At the same time, a shift of the first sidelobe can be seen. Similar behaviors were noted in other phi cuts.

The diagnostics of the measured data for the prototype feed array is then carried out with DIATOOL. On the basis of the measured field of configuration A and B, the corresponding equivalent currents are reconstructed on a box enclosing the feed array and the support structure, see Figure 5 for configuration B where the four patches are clearly identified on the top face of the box. Later on, the currents present on the lower part of the box, where the frame is located, are selected and are imposed as non-radiating. The field radiated by the currents reconstructed on the upper part of the box is then computed and compared with the measured field. The same procedure is repeated by using as input to DIATOOL, instead of the measured field, the field computed by a GRASP model of the feed array and support structure, with 60 dB noise added. Results of the diagnostics and the corresponding improvements of the feed pattern obtained by removal of the currents induced on the support structure will be presented and discussed.

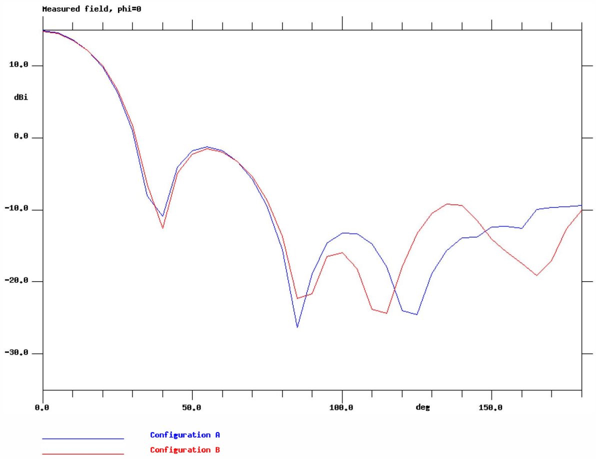


Figure 4. Measured field for configuration A and B, phi=0 deg.

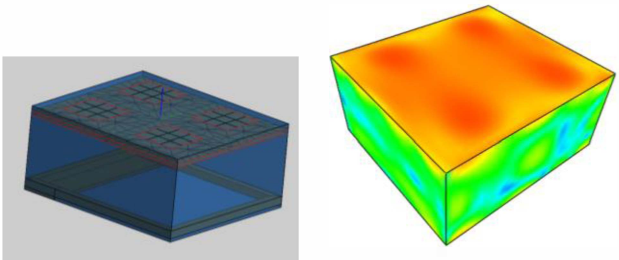

Figure 5. The feed array and the support structure of configuration B, together with the reconstruction surface (a blue box enclosing the antenna), on the left. The amplitude of the total electrical currents computed by DIATOOL, for configuration B.

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