Measured Antenna Models for Numerical Simulations of Antenna Placement Scenarios

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***Abstract*— Accurate numerical models of a given antenna can be derived from measurements using the inverse source technique [1-3]. Using this technique, measured antenna patterns can currently be imported and used as numerical sources in a number of commercial Computational Electromagnetic (CEM) solvers [4-9]. This method has been validated experimentally and the achievable accuracy investigated for both stand-alone and flush-mounted antennas [10-12].**

The reported validation activities have been concentrated on flush mounted antennas physically extending from the ground plane. Such antennas can easily be modelled by equivalent currents on a representative structure. In this paper, we investigate the derivation of the numerical model of a measured aperture type antenna, when mounted in a larger flat structure. Following the procedure in [10-12], a numerical model of the aperture is created from measurements of an open-ended waveguide when mounted in a representative ground plane. The accuracy of the model is investigated by comparison of the radiated Near Fields (NF) from the model and full-wave simulations. Future activities, comprise validation with measurements including different CEM tools.

Keywords—antenna, measurement, simulation.

I. Introduction

In numerical simulation of antenna placement scenarios, the accuracy of the numerical model representing the antenna is vital for the reliability of the results. Integration of measured data in Computational Electromagnetic (CEM) solvers opens new perspectives for placement analysis. Indeed, it is possible to replace the simulated model of the antenna by a model derived from measurements, which represent the real antenna. No additional information about mechanical and/or electrical parameters of the source antenna is required [1-3]. A validation campaign of this approach mixing measurements and numerical simulation applied to antenna placement scenarios is on-going [10-12].

This paper focus on a new test case consisting of an open-ended waveguide (OEW) mounted in a flat rectangular plate. This antenna has been selected to investigate applicability and accuracy of the equivalent source method when the source polarization is parallel to the flat structure. This scenario is different from previous investigations, using source antennas, like monocones [12] having polarization orthogonal to the plate. The validation scenario is shown in Fig. 1. Preparation of the source and preliminary analyses of the validation scenario are described in the following sections.

II. Validation Scenario

The open-ended waveguide OEW antenna flush mounted on a rectangular plate of dimensions 4λ x 9λ @ the validation frequency 4380MHz is shown in Fig.1. The OEW as source antenna is mounted in the center of the plate.

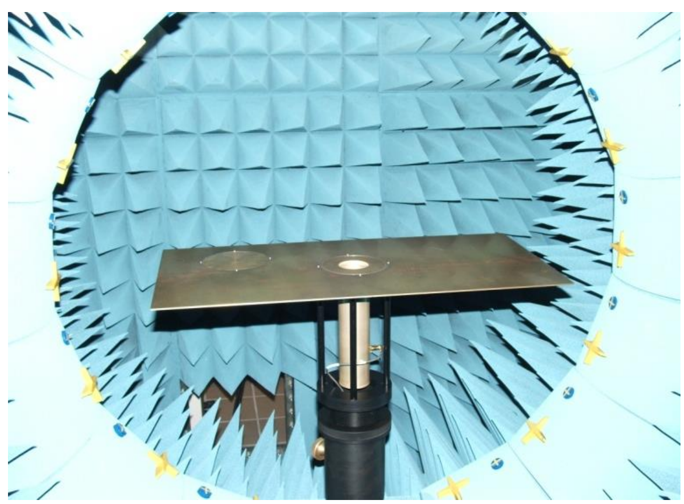
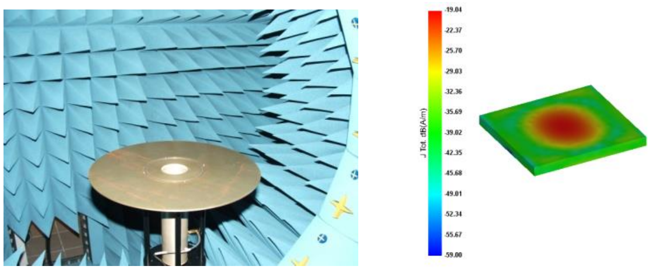


Fig. 1. Validation structure during measurement in the Spherical Near Field antenna measurement system, StarLab18GHz [10].

III. Preparation and Use of the Measured Model

The equivalent numerical model of a measured antenna for flush mounted applications are prepared according to a slightly more complex procedure with respect to the case of antennas detached from scattering structures [12]. The antenna is measured on a representative ground-plane to take into account the local antenna ground-plane interactions. Diffractions from the finite sized ground-plane are eliminated, in a measurement post-processing step, imposing infinite ground plane boundary conditions on the measured data [10]. The equivalent currents of the aperture are computed from the measured data on a box surrounding the aperture.

The 3D radiation pattern of the OEW has been measured in the StarLab18GHz spherical NF measurement system shown in Fig. 2(a) [13]. The antenna was placed on a circular ground-plane of diameter approximately 9λ @ 4380MHz. Using the commercial tools INSIGHT, the equivalent currents of the measured antenna have been computed on a box, including only the antenna aperture [3] as shown in Fig 2 (b).



(a) (b)

Fig. 2. Source preparation procedure: (a) OEW on a cirucal ground pèlane in the StarLab measurements system (c) equivalent electric J currents, Huygens box @4380MHz.

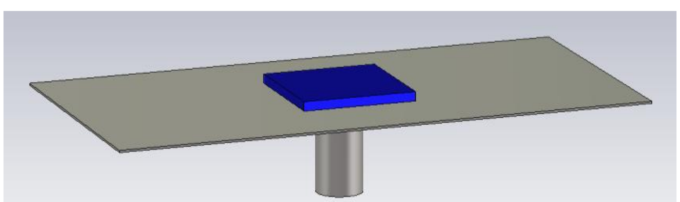


Fig. 3. Measured antenna model of the OEW in the simulated validation scenario [4].

IV. Results

From the equivalent currents and INSIGHT processing, a numerical model compatible with different CEM tools [4-9] can be derived. The radiation pattern of the validation structure shown in Fig. 1 and Fig. 3 has been computed using the numerical model of the aperture obtained from measurements. The pattern has been compared to results obtained from full wave simulation using Finite Integration Technique (FIT) [4]. The far field pattern compare very well (not shown here). The very near fields from both methods are shown in Fig. 4. In the simulation with the numerical source from measurement, the waveguide body under the plate, has been modeled by a cylinder entirely filled by metal, (white box in Fig. 4 (b)). The good agreement, confirms the accuracy of the measured source representation of the OEW antenna.

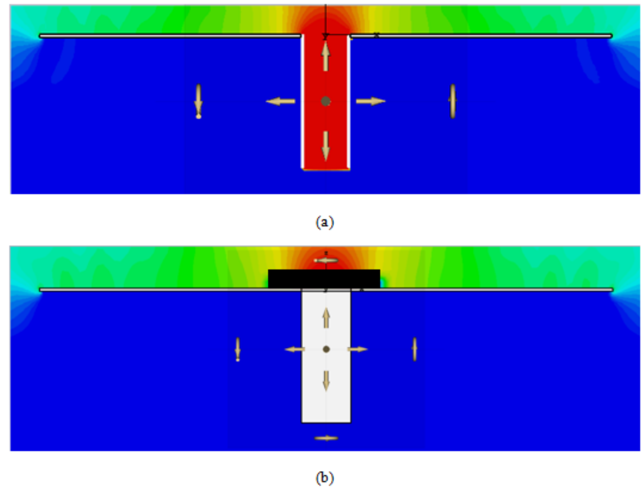


Fig. 4. OEW on the ground plane, E near field comparison at x=0mm @4380MHz [5]. (Up) Measured source (EQC) (black box); (Bottom) Full wave simulation. Upper face of the ground plane is center with respect to the xy plane and placed at z=0mm. The dynamic range is 40dB.

V. Conclusion

A numerical model of a measured aperture antenna has been derived from measurements of an open-ended waveguide when mounted in a representative ground plane. Good agreement has been found between the NF fields of the measured source and numerical simulation confirming the validity of the approach. Future activities comprise validation of a reference validation scenario and simulations using different CEM tools.

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