

Antenna Placement based on Accurate Measured Source Representation and Numerical Tools

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Abstract— Accurate electromagnetic models of measured antennas are available from the expansion of the measured field using equivalent currents [1-4]. The constructed model is importable in commercial Computational Electromagnetic (CEM) solvers in the form of a Huygens Box [5-9]. In flush-mounted antenna applications, the measurement of the antenna sited in a locally relevant scenario and subsequent data processing require special attention.

This paper, discuss details of the appropriate characterization of the source antenna for numerical computation in flush mounted scenarios. Post processing features and successive link to commercial CEM solvers are covered. The achieved accuracy of the measured source representation is investigated by comparing to full wave simulation.

I. INTRODUCTION

Domain decomposition techniques based on near field description of the local domain are available in most CEM solvers [5-9]. This feature also provides a direct link between INSIGHT processing of measured antenna data and numerical simulation. as discussed in [1]. The purpose of this paper is to quantify the achievable accuracy of using measured sources in commercial CEM solvers and thus validating the link.

II. VALIDATION SCENARIO

The use of flush mounted, measured antennas in numerical simulation of larger complex structures is illustrated by an example relevant to a small antenna mounted directly on a larger structure as shown in Fig.1.

To minimize errors not directly related to the validation of the measurement/simulation link, the scenario is a rectangular plate of roughly $5\lambda \times 10\lambda$. The source antenna is a mono-cone SMC2200, antenna mounted in a corner of the plate positioned 1.5λ and 2λ distance from the nearest edges at the validation frequency. High precision machining of the mono-cone antenna and plate ensure good correlation with the simulated geometry used as reference.



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

III. USED OF MEASURED SOURCE

The determination of the electromagnetic model of the source antenna for flush mounted applications is more difficult than situation where the antenna is detached from the scattering structure. The proximity of scattering modifies the current distribution on the antenna itself.

An infinite ground plane boundary condition is a good approximation in flush mounted scenarios but very difficult to implement in a realistic measurement scenario. However, it can be emulated from measurements of the source antenna on a finite ground plane and the application of post processing as discussed in [11]. The post processing of the measured data eliminates the diffractive contributions from the edge of a finite ground plane creating a virtual infinite ground plane boundary condition. A circular ground plane with minimum 5λ diameter is considered adequate for most measurement source antennas. In the validation example, the mono-cone source antenna, has been measured on a circular ground plane of approximately 7λ diameter in the StarLab18GHz spherical NF system [10].

IV. NEAR-FIELD RESULTS

The measured source is represented as a Huygens Box by INSIGHT processing [2]. Simulations are performed using the Finite Integration Technique (FIT) [5]. The source model is imported in the CEM solver and placed on the validation structure as shown in Fig. 1.

The accuracy of the measured source representation is investigated by comparing near field simulations of the structure with the measured source with full-wave simulations of the entire structure. Fig. 2 and Fig. 3 show the calculated near field in a cut through the validation structure centred on the source antenna @ 5.28GHz. The good agreement between the near fields, even in the proximity of the antenna, confirm the accuracy of the source model.

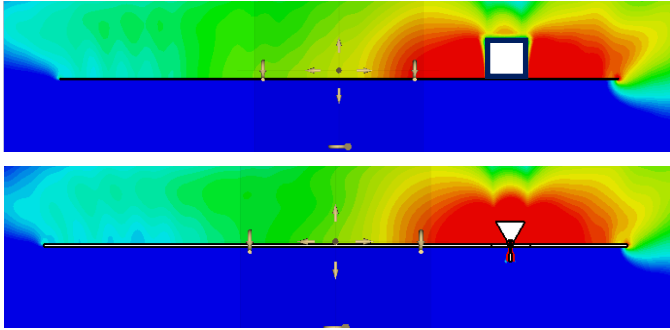


Fig. 2. Comparison of simulated E near field in cut plane through the SMC2200 mono-cone antenna on the validation structure @5.28GHz. 20dB dynamic range. Measured source (top, white box), Full wave simulation (Bottom).

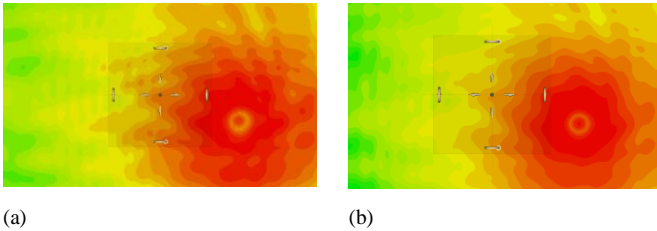


Fig. 3. Comparison of simulated E near field at plane λ , 56mm distance above validation structure @5.28GHz with 20dB dynamic range. (a) Measured source; (b) Full wave simulation.

V. FAR-FIELD RESULTS

As a second step in the validation, the simulated far-field pattern, have been compared to the measurements of the validation structure with the SMC2200 mono-cone antenna. The simulations use the measured monocone antenna as source and Finite Integration Technique (FIT) [5]. The measurements of the validation structure have been performed in the StarLab18GHz spherical NF system [10] as shown in Fig. 1.

Fig. 4 shows the comparison between measurement (red trace) and simulation using measured source, EQC+FIT (blue trace) for the $\phi = 0^\circ$ cuts. The plots also show the difference expressed as equivalent error level (green traces).

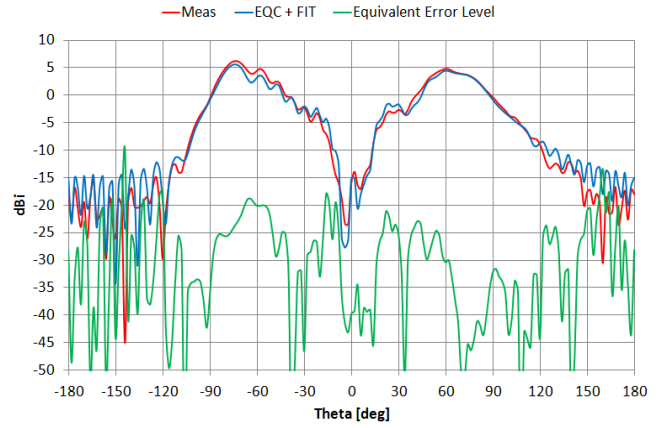


Fig. 4. Comparison between measurement (red trace) and proposed EQC + FIT method (blue trace) $\phi = 0^\circ$.

The equivalent error level averaged over all the pattern cut is -30.2dB along $\phi = 0^\circ$ and -33.2 dB on the full sphere. As expected, these equivalent error levels are comparable with the levels from comparing measurement and full-wave simulation. Therefore, the pattern deviation is primarily due to the measurement uncertainty and the accuracy of the numerical computation, rather than associated to the source modelling.

VI. CONCLUSION

A new method has been proposed as the missing link between numerical simulation and antenna measurements. The method has been validated in the case of a flush mounted antenna in antenna placement on complex structure scenarios. Measured source antennas can be imported in commercial numerical simulations tools with no apparent limitation on simulation approach.

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