Bringing Numerical Simulation and Antenna Measurements Together

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***Abstract*—This paper describes a new procedure allowing the use of measured antenna sources in commercially-available numerical computational environments. The procedure is fully general and can be used with common antennas in complex environments of arbitrary shape and complexity. The accuracy and effectiveness of the procedure has been illustrated by an example. An offset-fed reflector has been measured and the measurements compared to a simulation using the proposed numerical modeling procedure, with measurement of the isolated feed and numerical modeling of the reflector. Finally, the results have been compared to a dedicated computation analysis of the full antenna model.**

***Index Terms*—antenna, simulation, measurement.**

I. Introduction

Numerical modeling or Computational Electromagnetics (CEM) solvers are an increasingly important engineering tool for supporting the evaluation and optimization of antenna placement on complex platforms. While antenna measurements are still required for final validation due to the finality and high reliability of the measured data, numerical modeling is increasingly used in the initial stages of antenna placement optimization and to ensure that final testing, often a complex procedure, has a positive outcome.

In the numerical analysis scenario, the engineer is interested in examining and control items such as pattern distortion, inter-antenna coupling, near-field susceptibility and so on. Both the antennas and the platform structures have to be included in the same numerical model. This requirement is easily satisfied when a single full-wave model including both the antennas and the complex structure is available. However, the full-wave representation of the source antenna is often not available in the format required by the desired CEM solver. In other cases, the antenna is from a third party, making full-wave information unavailable.

In these cases, an equivalent model of the antenna must be constructed. To achieve accurate results, the CEM solvers require an accurate source representation. For instance, if the source is placed flush to the scattering structure, its pattern must exist only in the forward half space and, usually, an equivalent model based on electric or magnetic currents, or a combination of both, is needed to match the basic assumptions of the underlying modeling technique.

The use of equivalent currents, derived from measured data on the isolated antenna, has been introduced as a highly efficient source representation of the measured antenna in complex environment analysis using appropriate CEM solver [1-4]. The initial use of the equivalent current source representation has been limited to proprietary CEM tools since some modification to the source representation was required. The equivalent source representation of the measured antennas has been further developed as a very efficient diagnostics and echo reduction tool in general antenna measurement scenarios as described in [5-10].

II. Results

The new procedure has been illustrated by an example. The single offset reflector SR-40 and the dual ridge horn SH4000 operating in the band of 4-40 GHz are shown in Fig. 1. The reflector and feed have been measured in the SG-64 spherical near field range in Paris as shown in Fig. 2 (left). The isolated SH4000 dual ridge horn has been measured in the StarLab 18 GHz in Pomezia, Italy as shown in Fig.2 (right).

The measured data of the isolated SH4000 has been used as input to INSIGHT for calculation of the equivalent current fully representing the antenna [5]. The equivalent current representation has been used directly in the CST STUDIO SUITE® software [11-14]. The frequency of 4 GHz was selected for the initial analysis.

The comparison between the proposed procedure, the direct measurement and the full wave analysis of the entire structure at 4 GHz is shown in Fig.3. The measurements and the full wave analysis of the feed and reflector show an excellent correlation. This confirms the relevance of both sets of results as reference cases. There is also a very nice correlation between these reference results and a simulation of the proposed procedure validating the procedure.

The results from the proposed procedure based on measurements and simulation also show a nice correlation with both references confirming the validity of the approach. Some differences are noticeable in the range of elevation angles between -50° and -80°. This is due to a relevant difference in back radiation level of the isolated feed, between measurement and simulation. This effect will be further investigated in the full paper.

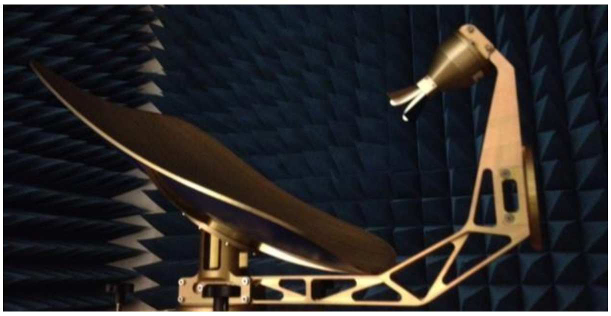

Fig. 1. The reflector antenna used in the validation experiment. SR-40 offset reflector and SH4000 dual ridge horn operating from 4-40 GHz from MVG.

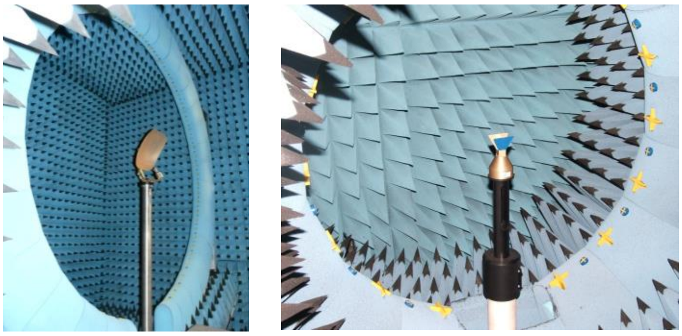

Fig. 2. Reference measurements of the reflector antenna and feed in the MVG SG-64 spherical near field facility in Paris (left). Measurement of the isolated SH4000 dual ridge fed in the MVG StarLab 18 GHz facility in Pomezia, Italy (right).

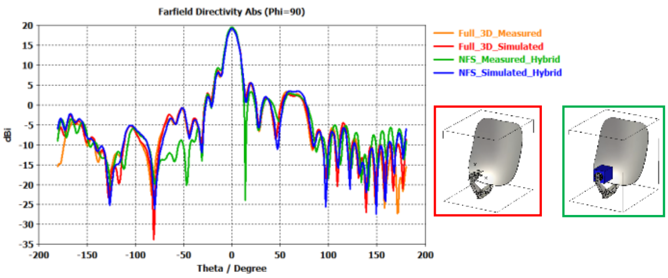

Fig. 3. Elevation plane pattern of the offset reflector antenna feed by the dual ridge horn at 4 GHz. Results from the proposed method combining measured feed pattern and numerical modelling, compared with direct measurement and full numerical modelling.

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