



**HAL**  
open science

## Transmission line excited chamber : experimental and numerical analysis

Mario Alves dos Santos Junior, Carlos Antonio França Sartori, Djonny Weinzierl, Laurent Krähenbühl, José Roberto Cardoso

► **To cite this version:**

Mario Alves dos Santos Junior, Carlos Antonio França Sartori, Djonny Weinzierl, Laurent Krähenbühl, José Roberto Cardoso. Transmission line excited chamber : experimental and numerical analysis. EHE'09: International Conference on Electromagnetic Fields, Health and Environment, Nov 2009, São Paulo, Brazil. hal-00435206

**HAL Id: hal-00435206**

**<https://hal.science/hal-00435206>**

Submitted on 10 Dec 2009

**HAL** is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

# Transmission Line Excited Chamber: Experimental and Numerical Analysis

M.A. Santos Jr<sup>1,4</sup>, C. A. F. Sartori<sup>1</sup>, D. Weinzierl<sup>2</sup>, L. Krähenbühl<sup>3</sup>, J. R. Cardoso<sup>1</sup>

<sup>1</sup> Laboratório de Eletromagnetismo Aplicado LMAG/PEA/EPUSP. 05508-900 - São Paulo/SP – Brazil

<sup>2</sup> Centro Universitário Jaraguá do Sul – Rua dos Imigrantes 500, 89254-430 - Jaraguá do Sul/SC – Brazil

<sup>3</sup> Ampère (CNRS UMR5005), Université de Lyon, Ecole Centrale de Lyon, 69134, Ecully Cedex - France

<sup>4</sup> Centro Tecnológico da Marinha em São Paulo – 05508-000 - São Paulo/SP – Brazil

**Abstract** — This paper presents experimental and numerical results concerning Transmission Line Excited Chamber (TLEC). This chamber is an alternative for electromagnetic compatibility tests, notably radiated immunity. The E-field profile, frequency response, SWR, and S parameters are addressed and compared. Besides application regarding performance assessment of electro-medical equipment, this chamber could also be applied as a way to reload intra-body devices or to get biotelemetry information.

## I. INTRODUCTION

In this work, the main focus is to evaluate the TLEC parameters that affect the chamber performance, in order to satisfy specified merit indexes. A suitable TLEC performance is associated to a high working volume, and E-field average values. In order to compare these results, a numerical approach has been implemented by applying Finite Integration Technique (FIT).

The TLEC is proposed as a test environment for electric, electronic and electro-medical devices, as an alternative for the canonical chambers. The canonical chambers - Reverberation Chambers (RC) and TEM Chambers - are generally used for electromagnetic immunity testing. RCs using mechanical paddles or frequency stirring provide a statistical E-field uniformity in all the directions inside the work volume. Nevertheless, the frequency operation of RCs is inversely proportional to the chamber dimensions, and it represents a constraint for low frequencies tests. The International Standards recommend the RC configuration for immunity tests over 80 MHz frequencies [1].

The TEM Chambers present, at low frequencies, a deterministic E-field uniformity over a work area parallel to the septum, but not in all directions in the chamber [2].

Recently, the TLEC concept has been proposed based on a phase-shifting excitation of several transmission lines [3]. After this, other works has been carried out for TLEC performance evaluation through different approaches as well as numerical modelling and optimization [4]-[5].

At this paper we present both experimental and numerical approaches. The TLEC configuration, here presented, is based on two-wire excitation configuration, Fig. 1, with parallel wires, z-axis oriented.

Another possibility is to use this chamber in a way to reload a device installed inside a body or recover information for biotelemetry [6].

Section II presents the experimental procedures, with setup details. Section III describes some numerical aspects concerning the simulation parameters. Section IV shows some

experimental and numerical results. A comparison is addressed, and some comments are presented. Finally, some remarks are made.

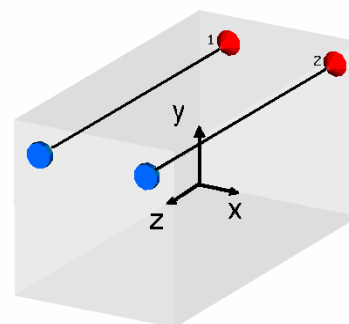


Fig. 1 - Sketch of two-wire TLEC configuration

## II. EXPERIMENTAL PROCEDURES

A TLEC prototype was build which steel walls, dimensions (0.6m, 0.6m, 1.2m), and two conductor set, given by 2mm diameter conductors, parallel to z axis placed at positions ( $x_1=0.1m, y_1=0.45m$ ) and ( $x_2=0.5m, y_2=0.5m$ ), respectively.

Each transmission line was excited by a 5.0W sinusoidal signal, and the resulting E-field was measured at various points, for two different load conditions:  $50\Omega$  and open circuit. Thus, the frequency response behavior and the spatial E-field profile of the chamber can be obtained.

After, S parameters were measured by using a vectorial network analyser, at the same conditions.

## III. SIMULATION PROCEDURES

The simulated E-field calculation was performed by applying the FIT method [4], [7], [8]. Proposed analysis methodology is based on the E-field values as a function of the position and frequency, and network S parameters. Both data are exported in ASCII format and read by Matlab<sup>®</sup>. The analysis is based on graphical results allowing comparison between experimental and simulated data.

## RESULTS

Some results were obtained based on measuring. The E-field results, at frequency domain, at chamber center point (0.3m, 0.3m, 0.6m) were compared with the numerical simulation ones, as show at Fig. 2 and Fig. 3. The values were parameterized by the maximum value of E-field for each curve. We can note that the curves shapes are almost the same. On the other hand, a frequency shift at maximum, less than

## 1. Electromagnetic Compatibility

10%, can be realized (Fig. 3). It can be probably caused by the PVC material placed inside the TLEC used to hold the probe fixed at the pré-defined point that was not considered at simulations.

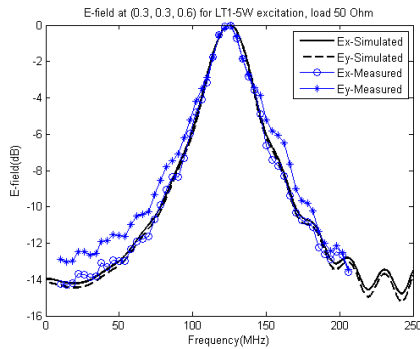


Fig. 2 - E-field (dBV/m) for LT1 excitation. Measured and Simulated values for 50  $\Omega$  load

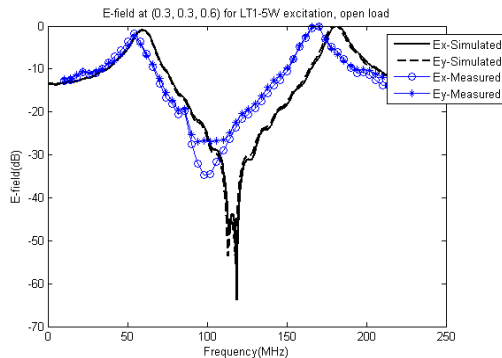


Fig. 3 - E-field (dBV/m) for LT1 excitation. Measured and Simulated values for open load.

Other results were also obtained such as the measured and simulated S11 parameter regarding LT1 ended with 50  $\Omega$  load (Magnitude Fig. 4 and Phase Fig. 5).

## IV. CONCLUSIONS

Some results concerning experimental and numerical simulation of TLEC, suitable for evaluate the chamber performance, and the validation methods is here presented. The comparison results lead us to a better comprehension of TLEC behavior, in order to recommend this kind of chamber to equipment and system test, as well as applications related to intra-body devices reloading, and biotelemetry information.

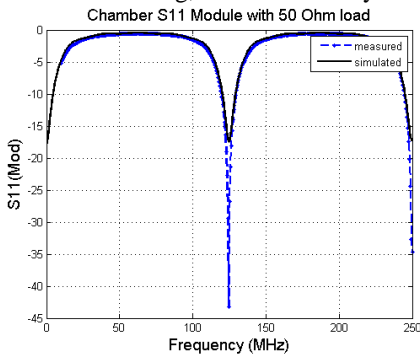


Fig. 4 - Measured and Simulated S11 (dB) for LT1 with 50  $\Omega$  load.

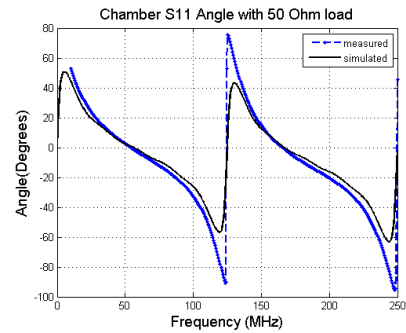


Fig. 5 – Measured and simulated S11 Phase Diagram for LT1 with 50  $\Omega$  load.

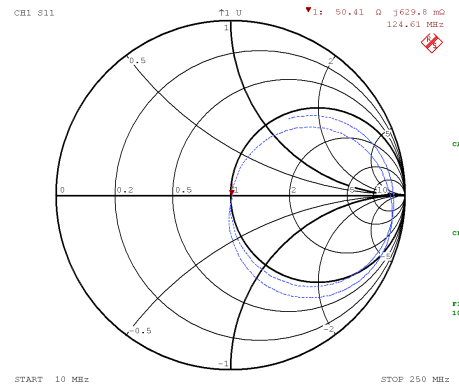


Fig. 6 - Measured Smith Chart for LT1 with 50  $\Omega$  load.

## V. ACKNOWLEDGMENT

This work was partially supported by Capes-Cofecub (07/0568), CNPq, and FAPESP (2007/51192-6).

## VI. REFERENCES

- [1] IEC61.000-4-21, Electromagnetic Compatibility (EMC), Part 4 - Testing and Measurement Techniques, Section 21 - Reverberation Chamber Test Methods, 2003.
- [2] IEC 61000-4-20, Electromagnetic compatibility (EMC), Part 4 - Testing and Measurement Techniques, Section 20 - Emission and immunity testing in Transverse Electromagnetic Waveguides (TEM), 2003.
- [3] J. Perini and L. S. Cohen, Extending the frequency of mode stir chambers to low frequencies, *IEEE International Symposium on Electromagnetic Compatibility*, v. 2, 633-637, 2000.
- [4] D. Weinzler et al., Numerical evaluation of non-canonical reverberation chamber configurations, *IEEE Transactions on Magnetics*, v. 44, n. 6, p. 1458-1461, 2008.
- [5] S. L. Avila et al., Maximum working volume evaluation in a non-canonical reverberation chamber, *IEEE Transactions on Magnetics*, 45 (3): 1646-1649, 2009.
- [6] W. H. Ko and S. P Liang, RF-Powered Cage System for Implant Biotelemetry, *IEEE Transactions on Biomedical Engineering*, vol. BME-27 (8), 460-467, 1980.
- [7] CST MICROWAVE STUDIO®, Advanced Topics ([www.cst.com](http://www.cst.com)).
- [8] T. Weiland, "Time domain electromagnetic field computation with finite difference methods," *Int. J. Num. Mod.: ENDF*, vol. 9, 259-319, 1996.