Contribution to EMC predictive modeling of electronic systems at frequencies above GHz.

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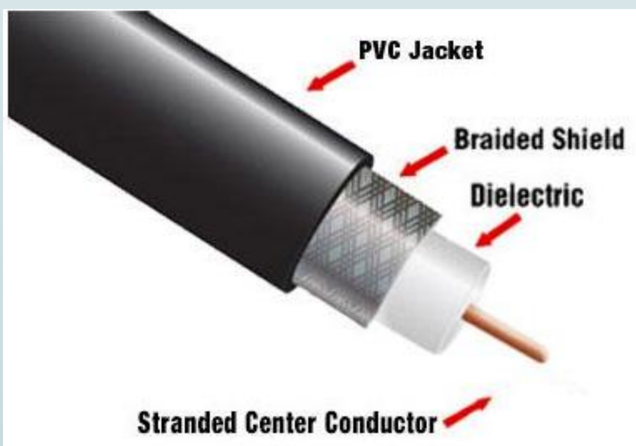
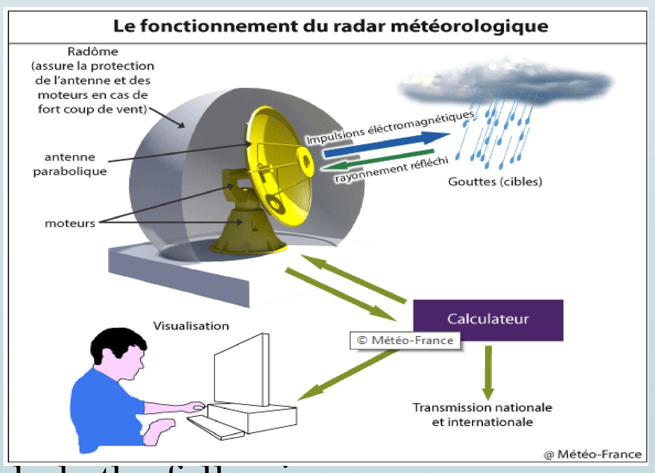
Introduction

The characterization of electronic systems, in particular in conducted emission, represents nowadays a theme pregnant with electromagnetic compatibility for frequencies higher than GHz. In order to have a predictive tool allowing the best modeling of all the electromagnetic couplings (conduction and radiation) occurring at the level of the different sub-parts of the system, the objective of the thesis is to develop a model under LTSpice for the determination of the voltages generated by it.

These systems include shielded cables whose role is crucial to the studied frequencies and characterize by their transfer impedance or their shielding effectiveness.

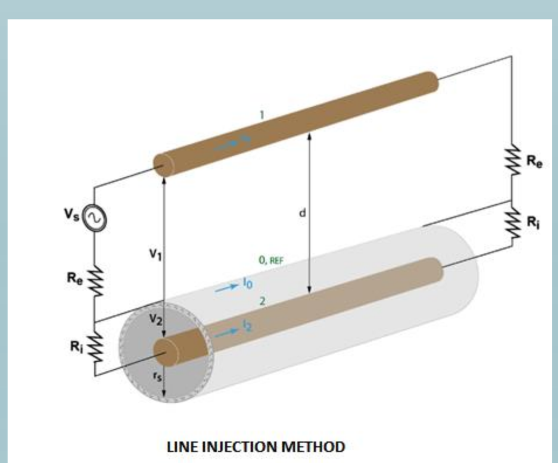


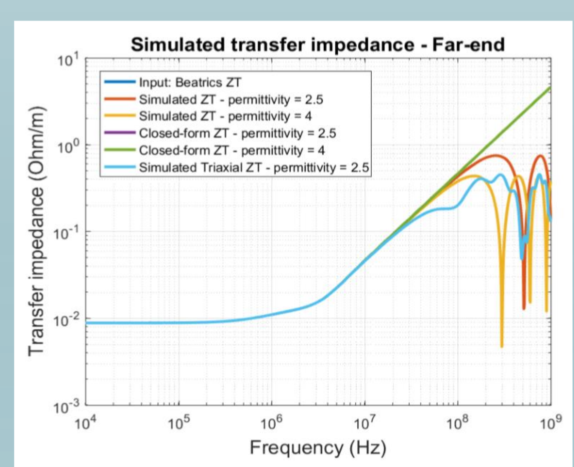


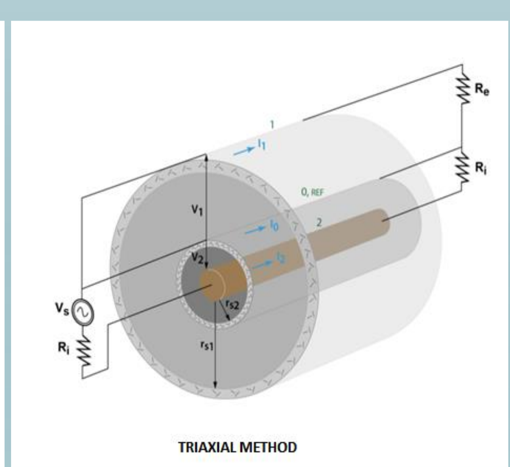
The applications of coaxial cables are diverse and include the following areas: • aerospace, • telecommunications, • radio / television, • cameras, • various measuring devices, • computer, • medical: scanners, ultrasound, • military: radars, measurements…

Methods

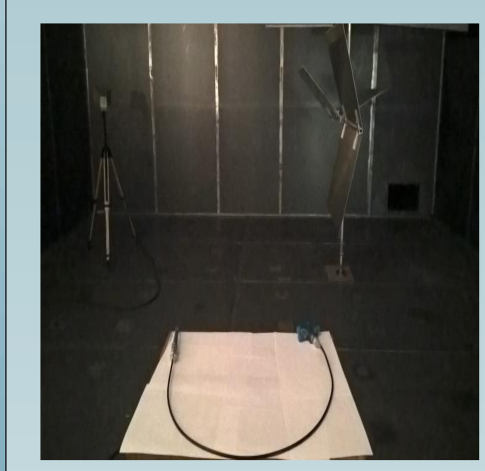
Different experimental techniques have been developed to evaluate the immunity of cables against electromagnetic interference. Among the best known, can be mentioned BCI method (Bulk Current Injection) or Triaxial or Quadriaxial banks, the principles implemented requiring extensive control of the various elements of the set up measurement and giving rise to frequency limitations.

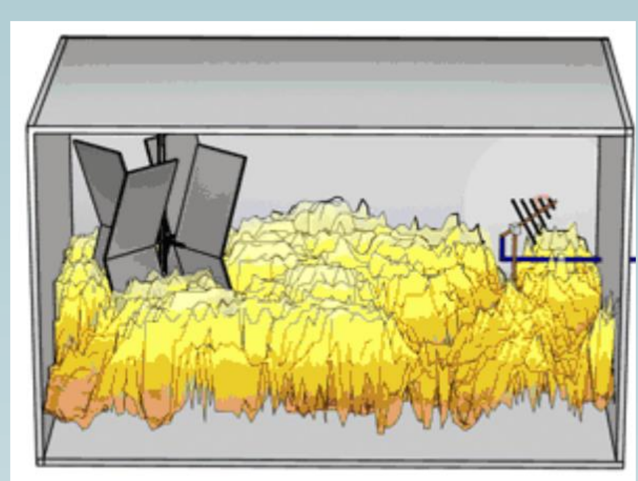


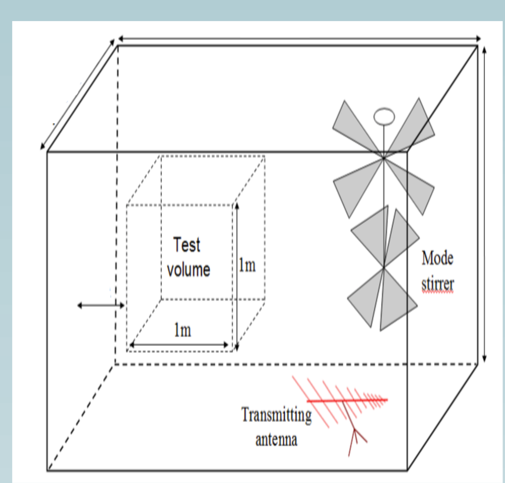




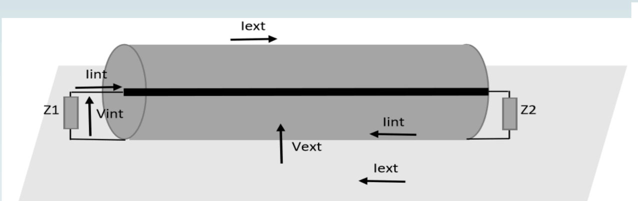
For these different reasons, it is advisable to move towards measurements in Reverberant Chamber with Mode Mixing (RC) allowing to generate a statistically homogeneous and isotropic electromagnetic field, of random polarization. This structure makes it possible to reproduce a real electromagnetic environment at high frequencies (above 150 MHz for the Institut Pascal Pascal RC).







It should be noted that for the cable transfer impedance measurement benches previously mentioned, the shielding is subjected to a TEM wave. Screening effectiveness measurements of RG58 type cable samples will be carried out using several methods and the results obtained will be validated by comparison with theoretical data (obtained from transmission line theory and MS CST).



$$(Z_T)_{dB} = log\left|\frac{2Z_{c-int}(1e^{+\gamma_{int}L} - \rho_0\rho_L e^{-\gamma_{int}L})}{(1-\rho_L)(1-e^{-\gamma_{int}L})(e^{+\gamma_{int}L} - \rho_0)(1-e^{-\gamma_{int}L})}\right| - SE_{dB}$$

Improvements to the methods available in the literature will be proposed as part of the thesis.

Results

Several measurements were performed in the IP laboratory RC, on the RG58 cable samples, and then compared to the results obtained by CST simulations.

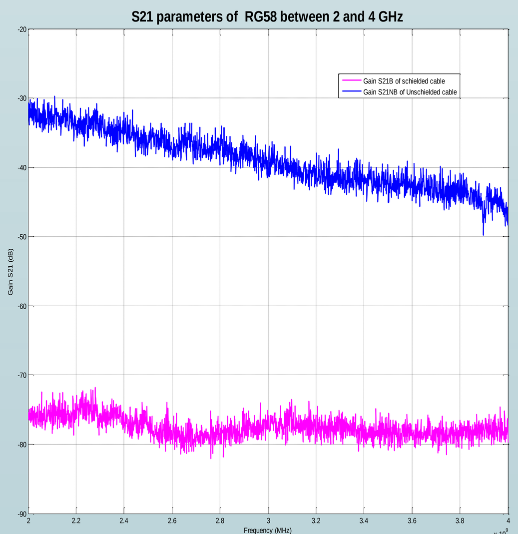
The RC measurements of the power received on a shielded ($S21_B$) and unshielded ($S21_{NB}$) cable make it possible to determine the shielding effectiveness SE as:

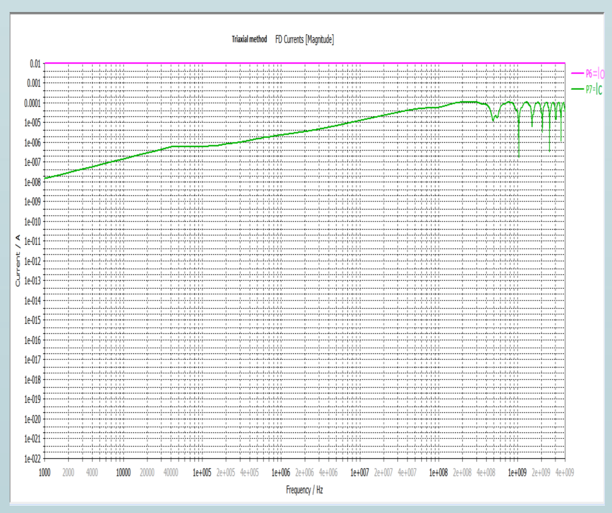
$$\mathrm{SE} = 10log_{10}\left(\frac{S21_{NB}}{S21_B}\right)$$

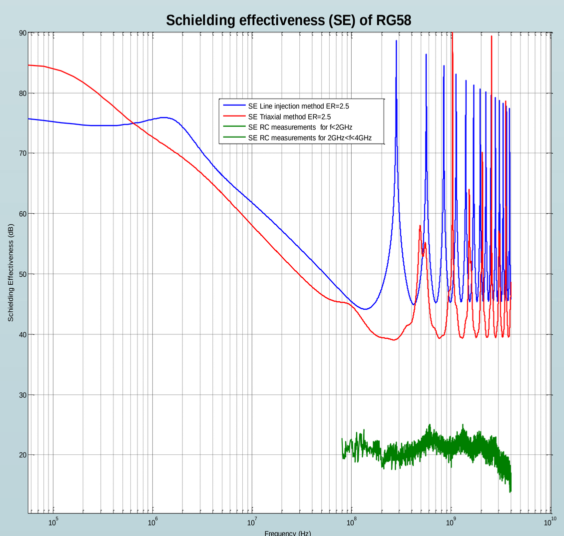
With the Triaxial and injection line method simulations, we get the currents flowing in the core (I_c) and the braid (I_o) of the cable to calculate the shielding effectiveness as:

$$SE(z) = 20log_{10}\frac{I_c(z)}{I_0(z)}$$

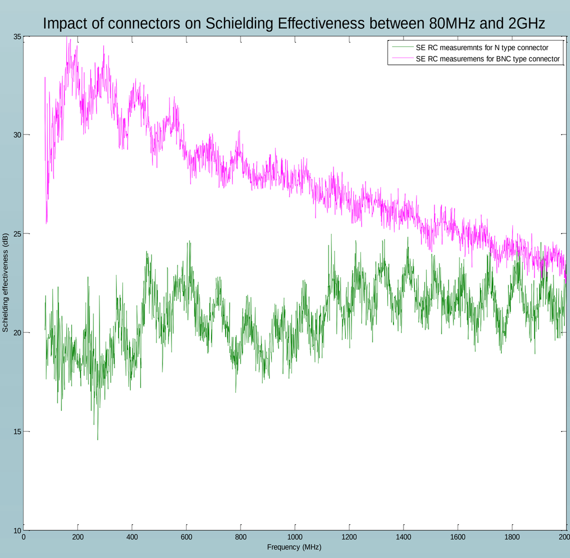
The following illustrations show how differents are the results according to the method.

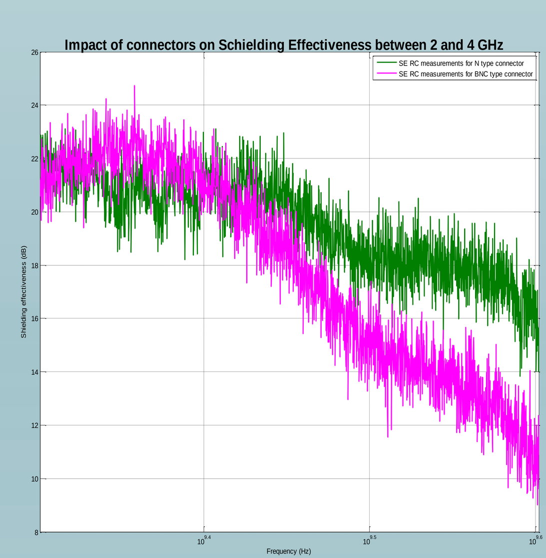






Several elements could justify this dispersion, we propose to see on the illustrations below, the impact of the non-taking into account of the type of connector, in the evaluation of the shielding effectiveness.





Conclusions

The Triaxial method and the injection line method do not take into account the influence of the connectors and the geometrical braiding structure, which could justify the difference in the evaluation results of the shielding effectiveness achieved compared to the shielding effectiveness measured in RC.

In the modeling of systems at frequencies above GHz, we would take account of the characterization of the geometrical discontinuities of the wired systems and the grounding at high frequencies.

Different numerical approaches including the so-called "full-wave" methods based on the numerical resolution of the Maxwell equations, and methods based on the theory of TLT transmission lines. Their influence must imperatively be considered in the numerical simulation of electronic systems at frequencies above GHz, the second part of the thesis will be devoted to the development of models reproducing the electromagnetic behavior of these elements.

Bibliography

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