PhD subject description
Starting date: October 1st 2022

Contactless Characterization of Miniature and Buried Antennas Within Reverberation Chambers

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1 Context

Smart cities rely on the use on wireless sensor networks in order to ensure monitoring activities for a large panel of applications: structural health, soil composition, air and water quality… Sensors are therefore either in contact or embedded within a lossy medium such as concrete, soil or water. Such complex environment in the sensor's vicinity implies a degradation of the radio performances and in particular a decrease in the antenna radiation efficiency. The estimation of such efficiency, critical parameter to limit power consumption, is barely possible with conventional measurement methods in the case of buried and miniature antennas. Indeed, conventional measurement approaches necessitate to connect the antenna under test to an analyzer whereas the presence of the cables in the antenna reactive near-field zone disturbs the radiation and impedance properties [1]. This perturbation can be considered as negligeable for large antennas but not for small ones. In that context, innovative efficiency measurement methods are required to overcome current limitations of conventional methods [2], [3].

2 Subject of the PhD work

Reverberation chambers (RCs) have become a reliable alternative to anechoic chambers to perform antenna radiation pattern [4] and efficiency measurement [5], [6]. Based on preliminary results established at the ESYCOM laboratory in 2021 [3], this PhD objective is to develop a **breakthrough antenna radiation efficiency measurement method suitable for miniature and buried antennas**.

The preliminary work plan is as follows:

- Development of a theoretical model to describe antenna absorption and scattering properties within diffuse field. Special care will be given to take into account the case of buried antennas. The measurement protocol required to retrieve the antenna radiation efficiency will then be set up.
- Measurement of electrically large canonical antennas to validate the proposed method. Uncertainties will be evaluated and compared with conventional methods.
- Measurement of miniature and buried antennas and assessment of the sensitivity measurement limit regarding the antenna radiation efficiency.

3 Scientific and academic setting

The ESYCOM laboratory has a strong expertise in RCs, in particular in the evaluation of its statistical properties [7],[8], in miniature antenna [9] and antenna characterization within RC [3]-[5]. Also, the lab owns a large mode-stirred RC (19 m^3), three anechoic chambers of different size, and several analyzers and RF devices including VNAs up to 67 GHz.

Moreover, collaborations with other institutes are to be expected: Institut Langevin, Paris (Julien de Rosny, CNRS Research Director) and IETR, Rennes (Philippe Besnier, CNRS Research Director).

4 Sought profile for the candidate

The ideal applicant has the following profile:

- Hold a MSc, Master or engineer school degree in either electrical engineering or physics.
- Have knowledges in electromagnetism, antennas, statistics.
- Speak French and/or English.

5 Practical information

Starting date and duration

The PhD is expected to start between October and December 2022 for an exact duration of three years (36 months).

Compensation

The PhD is fully funded for its whole duration, with a monthly compensation of about 1350 euro per month net salary. This salary can be increased by about 300 euros per month if the PhD candidate is additionally recruited for a teaching assistant position (64 hours per year teaching duty). Note however that the availability of teaching vacancies varies each year, and that they remain usually limited for non-French speaking PhD candidates.

Geographical location

The PhD candidate will work at the ESYCOM laboratory location, in Champs-sur-Marne, Paris metropolitan area. The center of Paris is at about 25 minutes using public transportation.

Housing

The university can help foreign PhD students to find housing at an affordable price.

6 Contact

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Applications (a cover letter, a resume and full academic transcripts) have to be sent to both contacts.

7 Bibliography

[1] T. Fukasawa, N. Yoneda and H. Miyashita, *Investigation on Current Reduction Effects of Baluns for Measurement of a Small Antenna*, **IEEE Trans. Antennas Propag.**, vol. 67, no. 7, pp. 4323-4329, July 2019, doi: 10.1109/TAP.2019.2911360.

[2] L. Huitema, C. Delaveaud and R. D'Errico, *Impedance and Radiation Measurement Methodology for Ultra Miniature Antennas*, **IEEE Trans. Antennas Propag.**, vol. 62, no. 7, pp. 3463-3473, July 2014, doi: 10.1109/TAP.2014.2320534.

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[4] A. Reis, F. Sarrazin, P. Besnier, P. Pouliguen and E. Richalot, *Contactless Antenna Gain Pattern Estimation From Backscattering Coefficient Measurement Performed Within Reverberation Chambers*, **IEEE Trans. Antennas Propag.**, doi: 10.1109/TAP.2021.3111184. open access

[5] W. Krouka, F. Sarrazin and E. Richalot, "*Influence of the reverberation chamber on antenna characterization performances*," **Int. Symp. Electromagn. Compat. (EMC Europe)**, Amsterdam, 2018. open access

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[7] F. Sarrazin and E. Richalot, *Accurate Characterization of Reverberation Chamber Resonant Modes From Scattering Parameters Measurement*, **IEEE Trans. Electromagn. Compat.**, vol. 62, no. 2, pp. 303-314, April 2020, doi: 10.1109/TEMC.2019.2902361. open access

[8] K. Selemani, J.-B. Gros, E. Richalot, O. Legrand, O. Picon and F. Mortessagne, *Comparison of Reverberation Chamber Shapes Inspired From Chaotic Cavities*, **IEEE Trans. Electromagn. Compat**., vol. 57, no. 1, pp. 3-11, Feb. 2015, doi: 10.1109/TEMC.2014.2313355.

[9] F. Sarrazin, S. Pflaum and C. Delaveaud, *Radiation Efficiency Improvement of a Balanced Miniature IFA-Inspired Circular Antenna*, **IEEE Antennas Wireless Propag. Lett**., vol. 16, pp. 1309-1312, 2017, doi: 10.1109/LAWP.2016.2633308. open access