PhD Proposal 2017

School: CentraleSupelec	
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Collaboration with other partner during this PhD: **In France:**	**In China:**

Title: Echo-based near-field antenna measurements
Scientific field: Electromagnetism
Key words: Antennas, near-field measurements, echogenic environments, fast field characterization

Details for the subject:

Background, Context:

Antennas and more generally any source of electromagnetic fields are routinely characterized in special facilities that are covered in radiofrequency absorbers. The main effect of this procedure is to reduce reflection and scattering phenomena to negligible levels, earning these facilities their name of anechoic chambers, i.e., without echoes. The radiation from antennas is then sampled by means of probes oriented along one direction at the time. As a consequence, the characterization of antennas over 4π steradian is typically very expensive and time consuming.

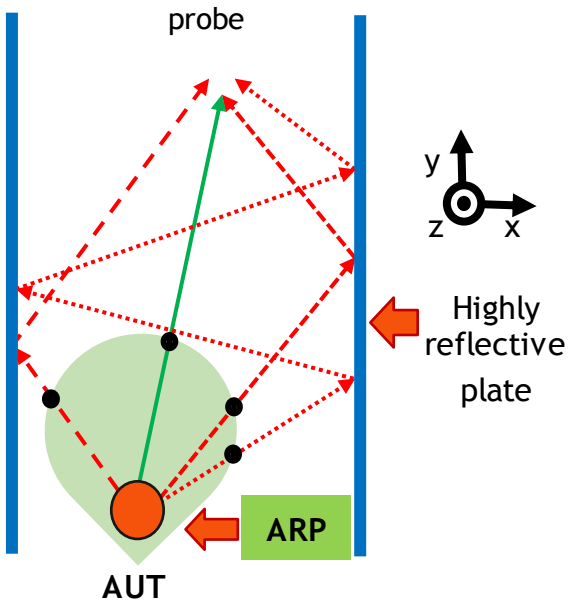
Our laboratory has studied the possibility of speeding up antenna measurements by exploiting echoes generated by ad hoc planar reflectors. The idea is essentially to use the reflector as a mirror allowing to observe the antenna along two, or more, directions at the same time. In practice, separating the two contributions is complex and requires carefully chosen positions.

The existence of optimal positions and the feasibility of antenna testing in presence of reflectors has recently been demonstrated by our team theoretically and numerically, while experimental tests are planned in the near future.

The main limitation of these results is their being based on a far-field assumption, which requires unpractically large distances to be considered. Dispensing with this requirement stands at the core of the proposed Ph.D. proposal. Practical implications of the outcome of the thesis would be compact and fast near-field measurement systems that would not require the use of fully anechoic chambers, thus also reducing their cost.

Research subject, work plan:

Building on these preliminary investigations, the Ph.D. candidate will start by defining a theoretical framework for the description of near-field distribution around antennas. Standard approaches exists, such as modal descriptions (e.g., vector spherical expansions), which are routinely used in near-field anechoic facilities. While such descriptions could be applied, the Ph.D. candidate will rather look for alternative approaches that could be better suited to the problem at hand.



One such approach is based on Wilcox expansion, which presents the remarkable feature of keeping a mathematical form close to geometrical optics, while extending it to near-field reactive regions. The inversion of experimental data through this kind of model will need to study its well-posedness, as a function of the distance between probe, antenna and ground planes, as well as of their respective positions.

An alternative approach will be provided by defining the problem of near-field antenna testing as a full-wave inverse problem, based on the use of Green functions in presence of ground

planes. Solutions to this approach will be defined in terms of equivalent current distributions of the antenna under test, rather than in terms of radiation patterns.
The main topics of this thesis will make use of numerical as well as theoretical tools; a strong emphasis will be put on the accuracy of the characterization methods, requiring a statistical analysis for accuracy as well as robustness to noise and errors. Experimental validations are possible within our facilities.

References:

A.Cozza, F. Monsed, M. Djedidi, "Method and device for measuring the radiation pattern of a radiative source in an echogenic medium", WO2016055739 (A2), 2014.
M. Djedidi, F. Monsef, A. Cozza, "Preliminary study on the use of complex media for antenna characterization", 2015 IEEE Int. Symposium on Antennas and Propagation.