Wavefront Synthesis in a Reverberation Chamber: First Experimental Results

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When testing the response of a system under test (SUT) to impinging waves, a standard choice is to rely on locally-plane waves, e.g., generated within an anechoic environment. The free-space paradigm is so deeply ingrained in radio engineers that it is often presented as though it was the only possible solution. Still, anechoic environments, simulated thanks to absorbers, are a poor energy-efficient solution, as most of the radiated power is dissipated into thermal power. Moreover, since only line-of-sight propagation is possible, the source and/or SUT position needs to be mechanically modified as soon as a new direction of arrival is to be tested.

An alternative to this standard scenario is offered by the Time-Reversal Electromagnetic Chamber (TREC), an experimental facility based on the idea of Generalized Time Reversal (GTR). In short, GTR avoids the need for the “radiation” phase required in standard time reversal; this is a critical advantage, since standard time reversal would require repeating the radiation phase with a varying position, orientation and nature of the source, as different testing wavefronts are required, e.g., in order to change their direction of arrival.

GTR and the TREC were theorized in a recent paper (A. Cozza, IEEE Trans. on Antennas and Propagation, **60**, 2012, pp. 3838 - 3852), where it was shown how a wave-diffusive environment allows synthesizing arbitrary coherent wavefronts from a single antenna. Of particular importance is the implication that the antenna position, type, orientation, etc., have theoretically no impact on the quality of the resulting wavefront.

In our talk, we will present the first experimental results obtained with a recently developed fully-automatic prototype TREC. The focus will be on the quality of reproduction of the wavefront within a 50-cubic meter reverberation chamber. In particular, the contrast between the coherent portion of the wavefronts and the background speckle fields, their focusing power, and polarization purity will be discussed. Of great importance will be the experimental validation of the independence of the TREC performance with respect to direction of arrival and polarization, i.e., its ability to offer a homogeneous and isotropic test environment.

In fact, the experimental validation of the TREC is a key step toward the development of the MIMOCHIC project, which aims to introduce and develop the idea of EMC coupling imaging. This project, which constitutes a larger framework, requires the availability of a tool as the TREC in order to infer the behavior of an SUT from live data.