PLANE-WAVE SYNTHESIS BY AN ANTENNA-ARRAY. APPLICATION TO RCS DETERMINATION.

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By its definition, Radar Cross Section (RCS) is a plane-wave (PW) concept, i.e., it is determined by the far-field scattering of an object when illuminated by a PW. RCS measurements of targets of about $2m$ in size performed in a $45m \times 13m \times 12m$ anechoic chamber are accurate for frequencies above, typically, 1GHz when employing the standard calibration technique with only one emitting antenna. For lower frequencies, this technique yields erroneous results essentially because the absorbers become ineffective and the field emitted by the antenna no longer satisfies the PW condition on the object – the size of the quiet zone decreases with the frequency.

A possible way to circumvent these difficulties is to use a phased array that synthesizes a PW in a bounded domain, called quiet zone (QZ), as proposed, e.g., in (M. P. Kestler et al., *Ultra-Wideband, Short-Pulse Electromagnetics 3*, pp. 295-304, 1997): The weights applied to each antenna are determined by requiring that the corresponding field is a PW in the QZ. However, this technique is ill-adapted to a closed, almost perfectly electrically conducting chamber. Also, a number of parameters, like the number of antennas or the array dimensions, need to be specified.

In this paper, we propose a calibration technique that allows an accurate RCS reconstruction of a target located in the near-field of the array, even when electrically conducting walls are present. A theoretical study of the problem at hand is presented, that allows us to specify clearly the hypothesis that are being made, and to identify the parameters that govern the accuracy of the RCS reconstruction. In particular, a far-field condition is derived, more realistic and much less constraining than the conventional D^2/λ one. When the target-array, antenna-antenna and target-walls-target interactions are neglected, it is mathematically demonstrated that this calibration technique synthesizes a PW in the QZ if the calibration object is a monopole (2D) or a dipole (3D). Finally, 3D numerical simulations performed with a dipole antenna-array and taking into account all the previously mentioned interactions illustrate the efficiency of this technique when the array and conducting walls are a few wavelengths apart from the target.