

FEKO

Comprehensive Electromagnetic Solutions

Simulating Anechoic and Reverberation Chambers

Introduction

A growing concern in the electronics industry is the increased pollution in the form of electromagnetic interference (EMI), radio frequency interference (RFI) and spurious signals caused by electronic devices and radiating cables. The effects of interference on radio, telecommunications, medical and aviation equipment (to name but a few), may vary from being mildly annoying to being life-threatening. As a result, many countries require by law that commercial and military products meet electromagnetic compatibility (EMC) standards before they may be marketed and sold.

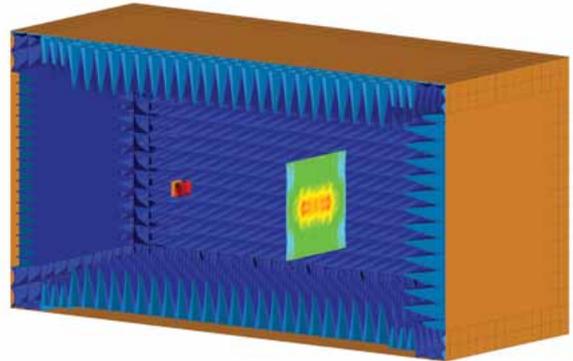
A manufacturer of electronic devices is obligated to ensure that a device has a certain level of immunity to electromagnetic (EM) disturbances to insure that the device operates as intended. Furthermore, the device is not allowed to be a source of EMI or RFI. Anechoic and reverberation chambers are used to test electrical and electronic devices against EMC / EMI standards and ensure their compliance.

The building of an anechoic chamber involves a substantial financial investment. As a result, the measurement community has an increasing interest in using computational electromagnetic (CEM) simulation tools to design custom anechoic chambers. The goal is to design an anechoic chamber without sacrificing performance, while also minimising the required financial resources.

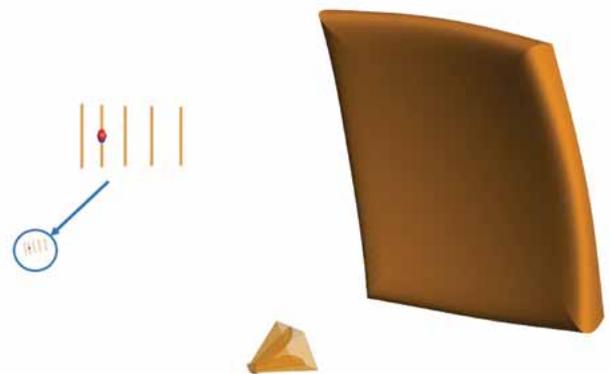
Engineers have traditionally analysed anechoic chamber designs with a method similar to ray tracing, to overcome the practical limitations of the resources available at the time. With recent technological advances, computational resources and numerical solvers emerged as powerful tools capable of analysing anechoic chambers. Emulating antenna measurement techniques in a virtual environment makes it possible to identify systemic error sources. The resulting insight facilitates convergence between measurement and simulation data, which instils confidence in the final characterisation.

Simulations can be used to:

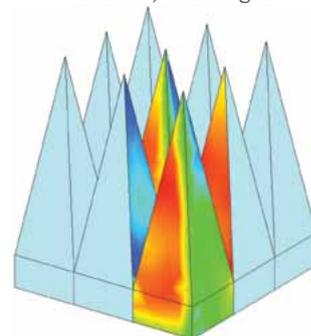
- Emulate antenna measurement setups
- Validate chamber designs
- Characterise the quiet zone
- Account for modifications to the chamber
- Account for non-ideal operating modes
- Perform compact range analyses
- Conduct absorber analyses



The electric fields shown in the quiet zone of an anechoic chamber



An antenna under test (log-periodic array) on the left (encircled in blue, with its enlargement), and broadband measure antenna (horn-fed reflector antenna) on the right



An analysis of absorbing material

Quiet Zone

Disturbances inside the quiet zone of an anechoic chamber were characterised in a case study with full-wave and asymptotic CEM methods. The characterisation used a custom low-gain source antenna, designed to increase reflections from the surrounding walls to represent a worst-case scenario. Electric fields in the quiet zone were computed explicitly in the presence and the absence of the anechoic chamber. The ratio of the two results produced a systemic error term that identified the quiet zone disturbances imposed by the anechoic chamber. The low-gain source antenna, operating at 500 MHz, imposed negligible disturbances (less than 1 dB). These minor disturbances validate both the chamber performance and the respective characterisation process. As the frequency of interest is increased, asymptotic methods (for example the hybrid method of moments and physical optics technique) offer an efficient alternative for modelling the anechoic chamber.

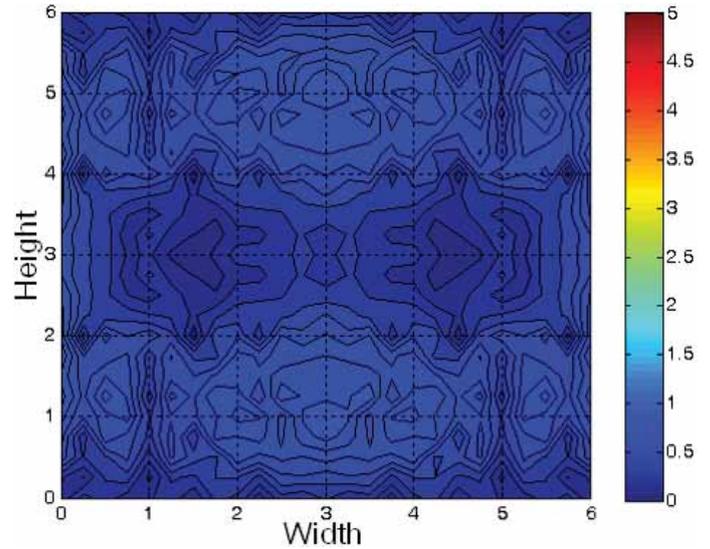
Reverberation Chambers

Reverberation chambers (RCs) are increasing in popularity for EMC testing since they offer the following advantages:

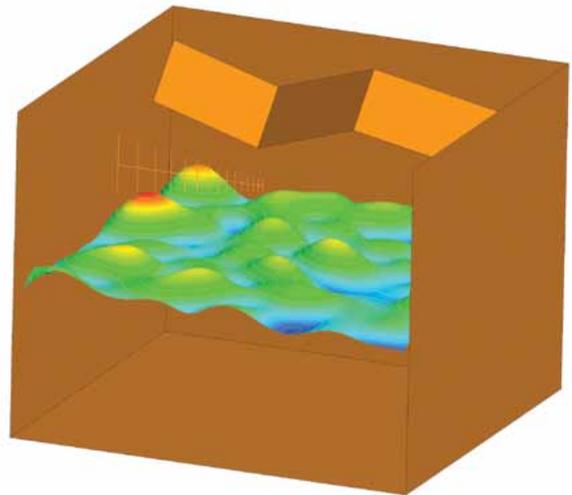
- High fields can be achieved with reduced input power
- Low investment cost (no absorbers required)
- Isotropic illumination (from all directions and polarisations) of equipment under test (EUT)

Large mode stirrers physically rotate and change the electromagnetic field distribution within the chamber. The stirring provides a statistically isotropic and homogeneous field in a designated test area over the duration of the measurements. This is particularly useful for electronic devices with complex radiation patterns spanning a broad frequency range. Simulation of RCs is not only beneficial for the design and possible standardisation of RCs, but also for the users to understand the field distributions.

The numerical Green's function (NGF), offered with the method of moments (MoM) in FEKO, is extremely efficient in that it treats the walls of the chamber as a static sub-domain and the rotating mode stirrer as a dynamic sub-domain. An additional advantage of the MoM for reverberation chamber modelling, is that it does not require meshing of the free-space between the dynamic stirrer and the chamber wall, since it is a boundary discretisation method.



The quiet zone error imposed by the anechoic chamber when operating at 500 MHz



Large mode stirrers physically rotate and change the electromagnetic field distribution within a reverberation chamber