Characterization of an Open GTEM Cell with the COMSOL Multiphysics® Software

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GTEM CELL: a fundamental tool able to emulate the effects of an incident plane wave (**TEM** mode) on the equipment under test in a very wide frequency band.

This structure is obtained by replacing one port of a two-port TEM cell with a resistor/wave absorber termination [1].

The resonances of the non-transverse field components can be further avoided by physically removing the sidewalls (open GTEM cell) [2].

Figure 1. Open GTEM Cell

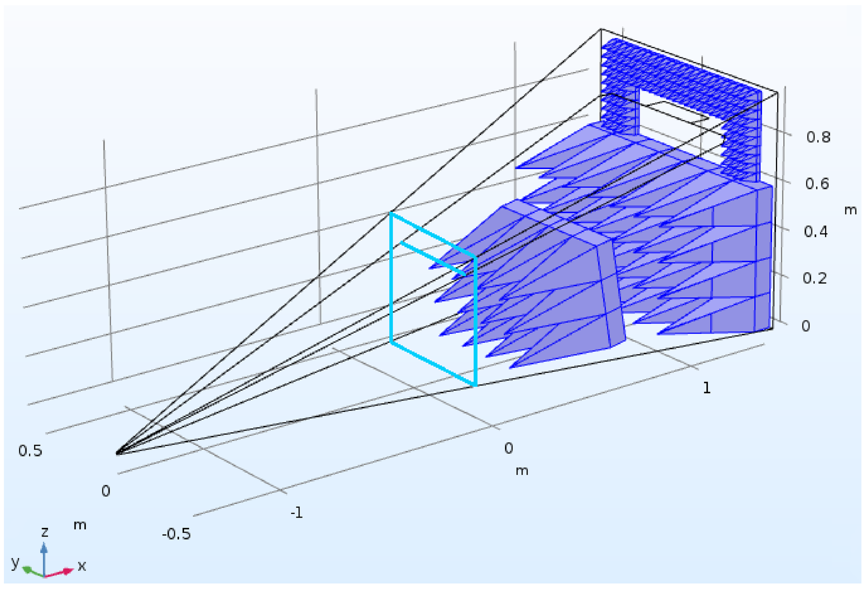


Figure 2. RF absorbers at the cell's backwall

EXPERIMENTAL VERIFICATION OF THE RESULTS: experimental values obtained by a Vector Network Analyzer (HP8753E) on the real GTEM cell have been compared to the simulated results, providing a good agreement with them. The simulation allowed us to compute the Voltage Standing Wave Ratio (VSWR) at the feeding port, evaluated over the whole operating frequency range.

$$\mathbf{VSWR} = \frac{\mathbf{1} + |\mathbf{S_{11}}|}{\mathbf{1} - |\mathbf{S_{11}}|} \geq \mathbf{1}$$

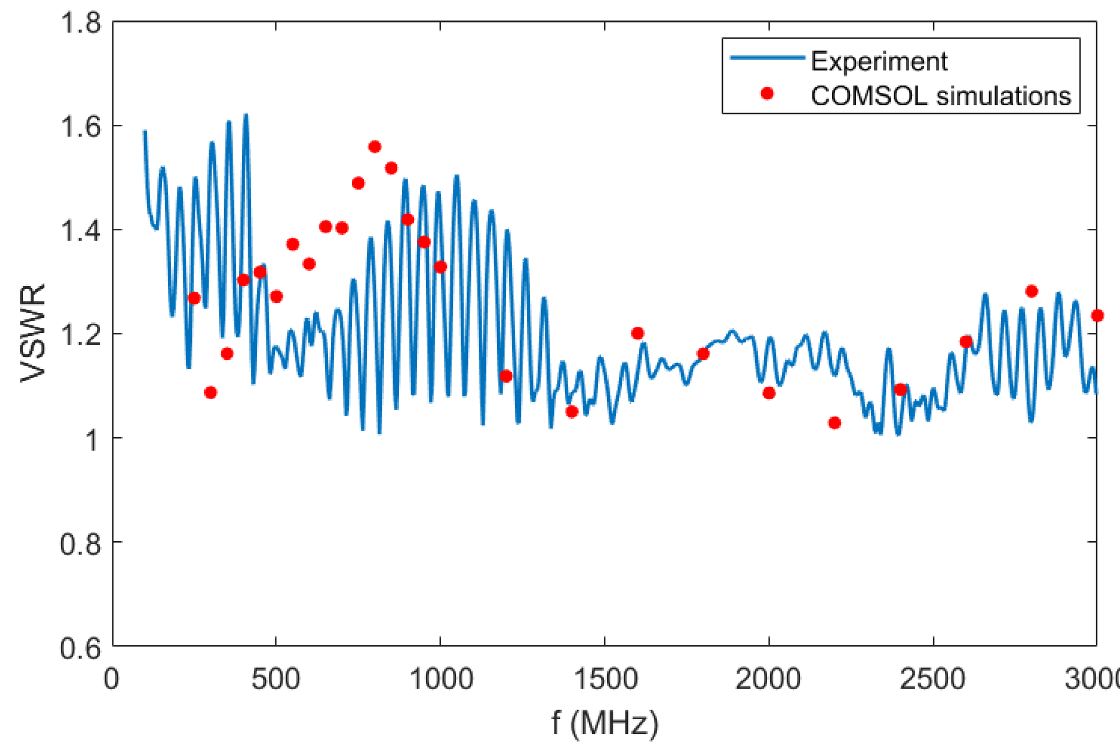
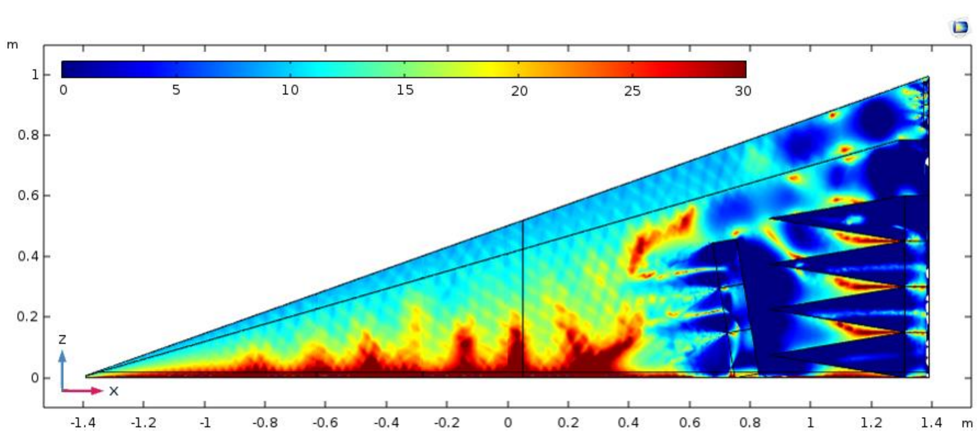


Figure 5. VSWR *vs* frequency

COMSOL® MODEL AND RESULTS:

Thanks to the internal symmetry, the device has been modeled taking advantage of the PMC (Perfect Magnetic Conductor) condition of the COMSOL® RF Module. Internal E and H fields have been simulated; the regions inside the cell with the most purely TEM propagating mode have been identified by means of the "axial ratio"

$$\text{Axial ratio (dB)} = 20\log_{10}\left(\frac{|E_z|}{|E_{xy}|}\right)$$



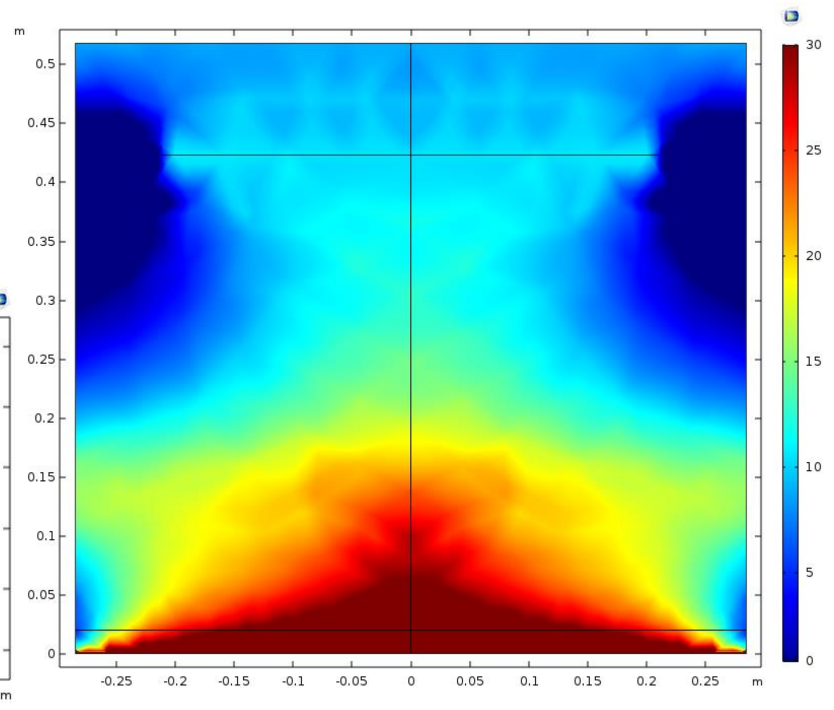


Figure 3. Axial ratio relative to the electric field, displayed on the cell longitudinal plane y = 0 (*left*) and the transversal plane (right) @ *f = 1 GHz.*

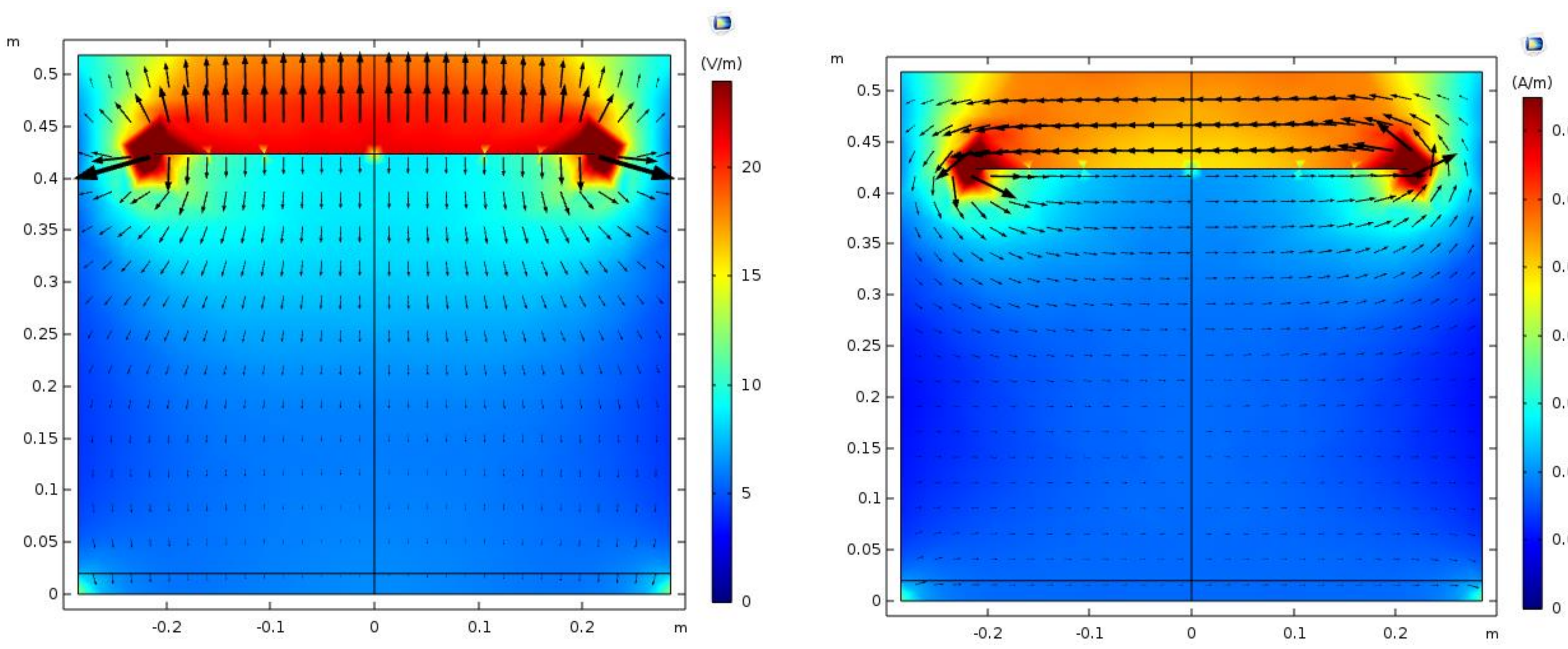


Figure 4. |E| (left) and |H |(right) on the transversal plane (left) @ *f = 1 GHz*.

<u>EM-Scan RFX [3]</u>: is a compact bench-top electromagnetic (EM) scanner able to performs a very near field mapping of the magnetic field; intended for antenna characterization, has been used here to assess the H field distribution in the GTEM internal test region.

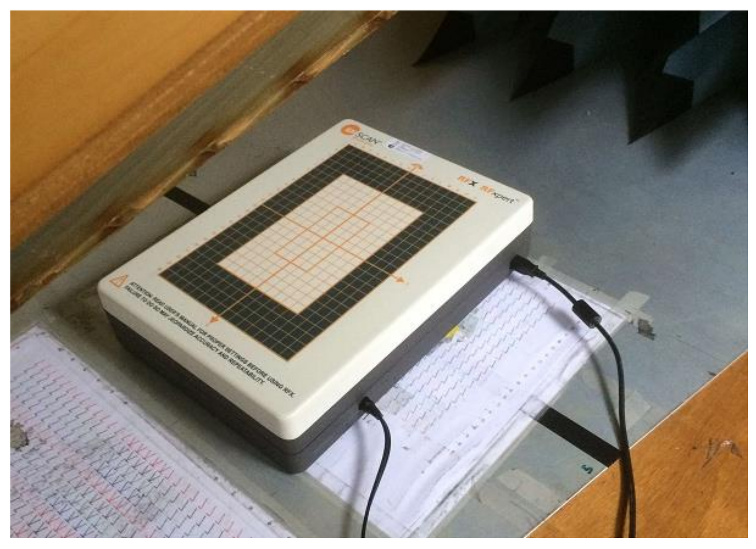


Figure 6. RFX EM-Scan

The mapped field values are in very good agreement with the simulated ones.

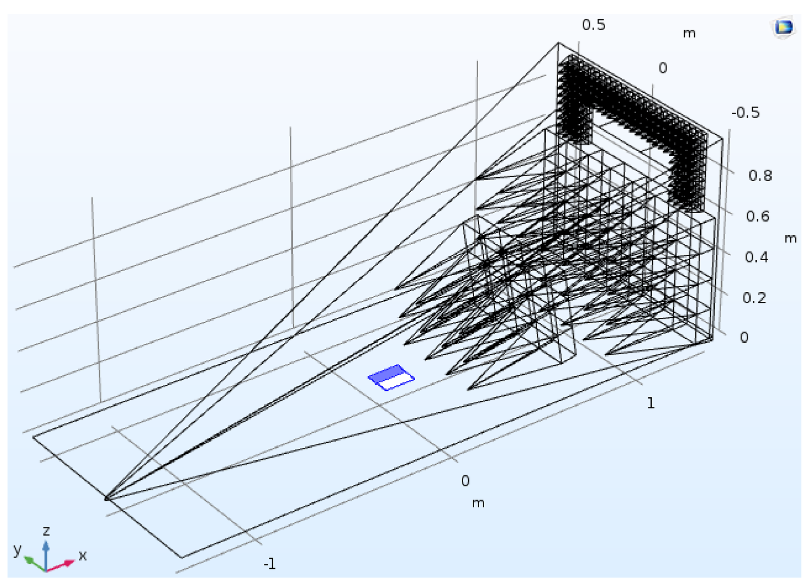


Figure 7. Region internal to the GTEM cell where the EM scanner was experimentally located

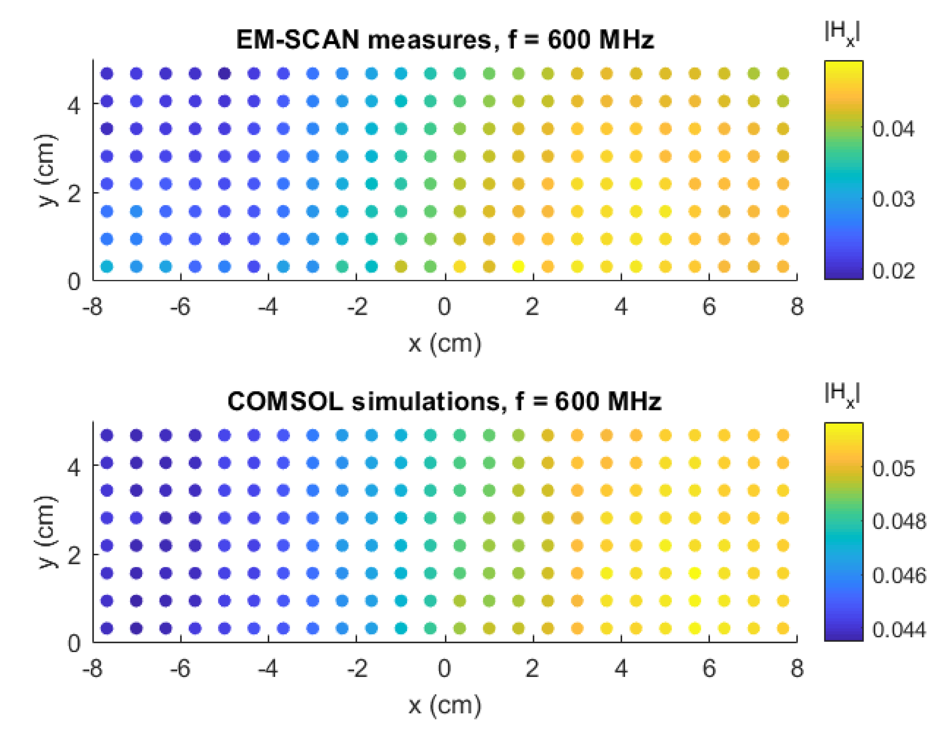


Figure 8. $|H_x|$ measured with the RFX scanner (up) and simulated (down) *@ f = 600 MHz.*

CONCLUSIONS: COMSOL Multiphysics® proved to be a very efficient tool for our analyses, allowing us to get reliable results in good agreement with a large series of experimental measures.

REFERENCES:

[1] D. Konigstein and D. Hansen, "A New Family of TEM-cells with Enlarged Bandwidth and Optimized Working Volume", *Proceedings of the 7th International Zurich Symposium on Electromagnetic Compatibility, 127-130, Zurich (1987).*
[2] R. Rambousky and H. Garbe, "Analysis of Open TEM-Waveguide Structures", Ultra-Wideband, Short-Pulse Electromagnetics 10, 49-58, Springer, New York (2014).
[3] *EM-Scan-RFX2-Datasheet, Calgary, Canada.*