Open platform GUI for comparative FDTD and FEM computation of material microwave measurement scenarios

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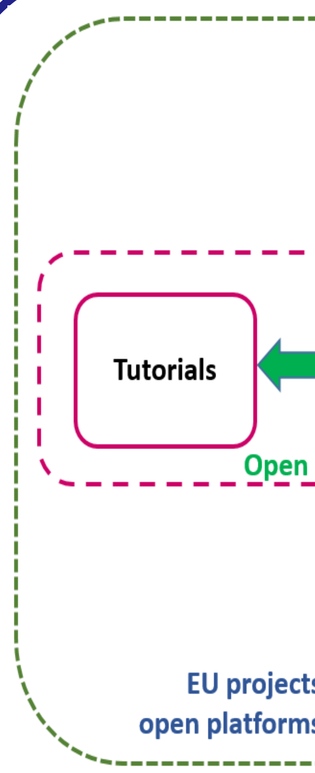
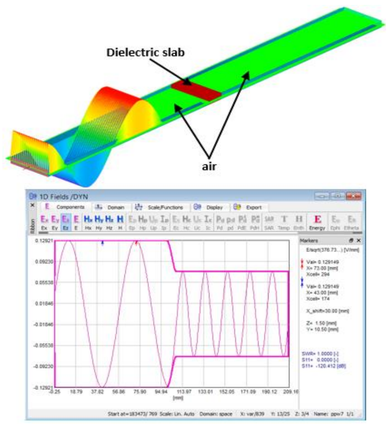


Concept of the Modelling Open Platform

- ✓**Interoperable, licence-free, time-unrestricted CAD-based GUI**
- ✓**Tutorials** – teaching and project's results dissemination
- ✓**Library of modelling examples** – also documented in EC supported MODA format
- ✓**Physics-based solvers** - solvers coming from EU projects or other initiatives, willing to provide their tools as open-access.
- ✓**Commercial solvers –** linked through reading and processing the data in text files exported by GUI. This creates a unique capability to run full-power simulations of examples created in the free-to-use GUI.



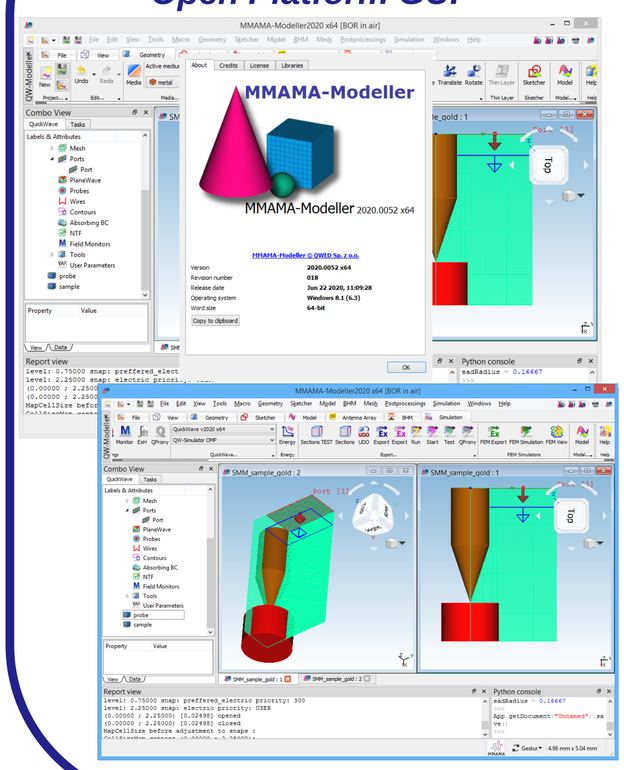
QWED's Microwave Course – ***free tutorial*** *with simulation examples*

A common GUI is developed to meet four objectives:

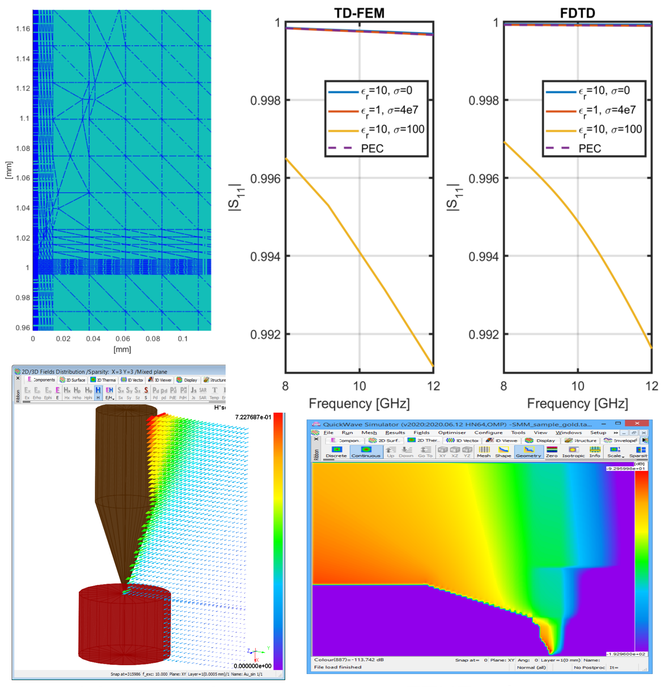
- industrial adequacy through import and export of standard CAD and Gwyddion files,
- convenient choice of the most relevant meshing and solver,
- robust cross-comparisons of the different solvers,
- free access, in accordance with the European strategy of open innovation environments.

Open Platform Examples launched from interoperable GUI

MMAMA Modeller – Open Platform GUI



Scanning Microwave Microscopy (SMM) tip applied to dielectric material analysis with FEM and FDTD solvers

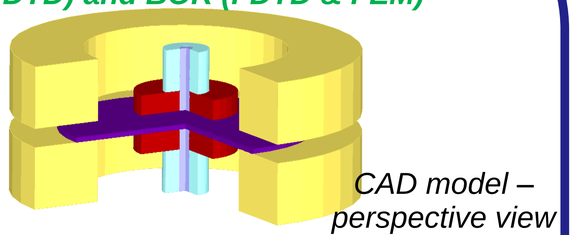


QuickWave solver — ETHZ solver

FDTD and FEM field distribution

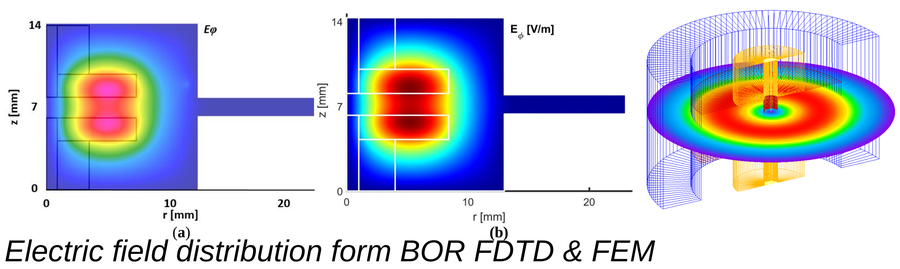
Split-Post Dielectric Resonator test-fixture for low-loss dielectric measurements – 3D (FDTD) and BOR (FDTD & FEM)

QWED's commercial SPDR



CAD model – perspective view

	FDTD			FEM
meshing	0.4 mm	0.2 mm	0.1 mm	0.1 mm
BOR: [GHz]	4.9151	4.9097	4.9075	4.9075
comp. time	35 sec	50 sec	1min 30sec	1.16sec
3D: [GHz]	4.9245	4.9145	4.9099	-
comp. time	2min	6min 30sec	1h 20min	

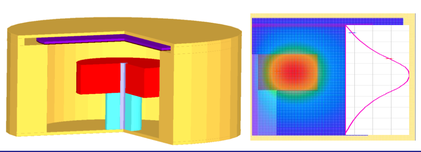


Electric field distribution form BOR FDTD & FEM

Future developments of Modelling Open Platform

- Creating Open Innovation Environment with various access rights (open access, licenced access to commercial tools, etc.)
- Extending current Open Platform with number of solvers, from various science domains → ***Encouraging different scientific groups to link their solvers to the Open Platform***
- EU H2020 NanoBat project – extending capabilities of current MMAMA Modeller with features enabling:
  - ❖Launching open-access solvers concerned with battery modelling
  - ❖Simulation-based calibration of measurement test-fixtures dedicated to battery materials, e.g. electrolyte, solid electrolyte interphase (SEI), graphene anodes, etc.
  - ❖Heat transfer analysis in battery cells, incl. reversible heat
  - ❖Coupled EM – electrochemical analysis of battery cells

SiPDR for measurements of graphene anodes of battery cells.



aims to develop a novel nanotechnology toolbox for quality testing of Li-ion and beyond Lithium.

Long-term goals

- ❑ Elimination of expensive time overheads related to familiarising with different user interfaces
- ❑ Convenient way of
  - ❑ solving various types of coupled and linked EM and multiphysics problems
  - ❑ robust cross-comparison of different solvers.
- ❑ Delivering open access modelling tools, spanning across different science domains → **interoperability**

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