Microwave and Radar Week
MRW 2020

Open Access CAD, EM tools, and examples for teaching microwaves

M. Olszewska-Placha[1], M. Celuch[1], T. Le Quang[2], A. Gungor[3], J. Hoffmann[2], J. Smajic[3], J. Rudnicki[1]

[1] *QWED Sp. z o.o., Poland*
[2] *Federal Institute of Metrology METAS, Switzerland*
[3] *Institute of Electromagnetic Fields, ETH Zurich , Switzerland*

MIKON
MIKON-2020
IRS 2020
U.R.S.I. 2020 Baltic Symposium
Signal Processing Workshop 2020

Outline

- Motivation and Objectives
- Long-term goal
- Concept of the Open Platform
- EU H2020 MMAMA Open Platform
- Moving further …
- Summary

Motivation

- Visualising the invisible using simulation tools catalyses the understanding of physical phenomena among students and young engineers
- Teaching approach frequent at universities and increasingly accepted in industry
- Strongly dependent on accessibility of teaching releases of commercial simulation software
- Typically restricted to university usage
- Hinders invaluable simulation-supported education at companies

Objectives

- Increasing the accessibility of the results of publicly co-funded research - the desirable outcomes of EC funded R&D projects
- Fostering interdisciplinary collaboration
- Development of simulation tools with a focus on open access modelling platforms - open innovation environments

The modelling platforms are foreseen to implement research results of the projects' consortia and deliver them for the usage of a wide scientific community, including universities as well as industry.

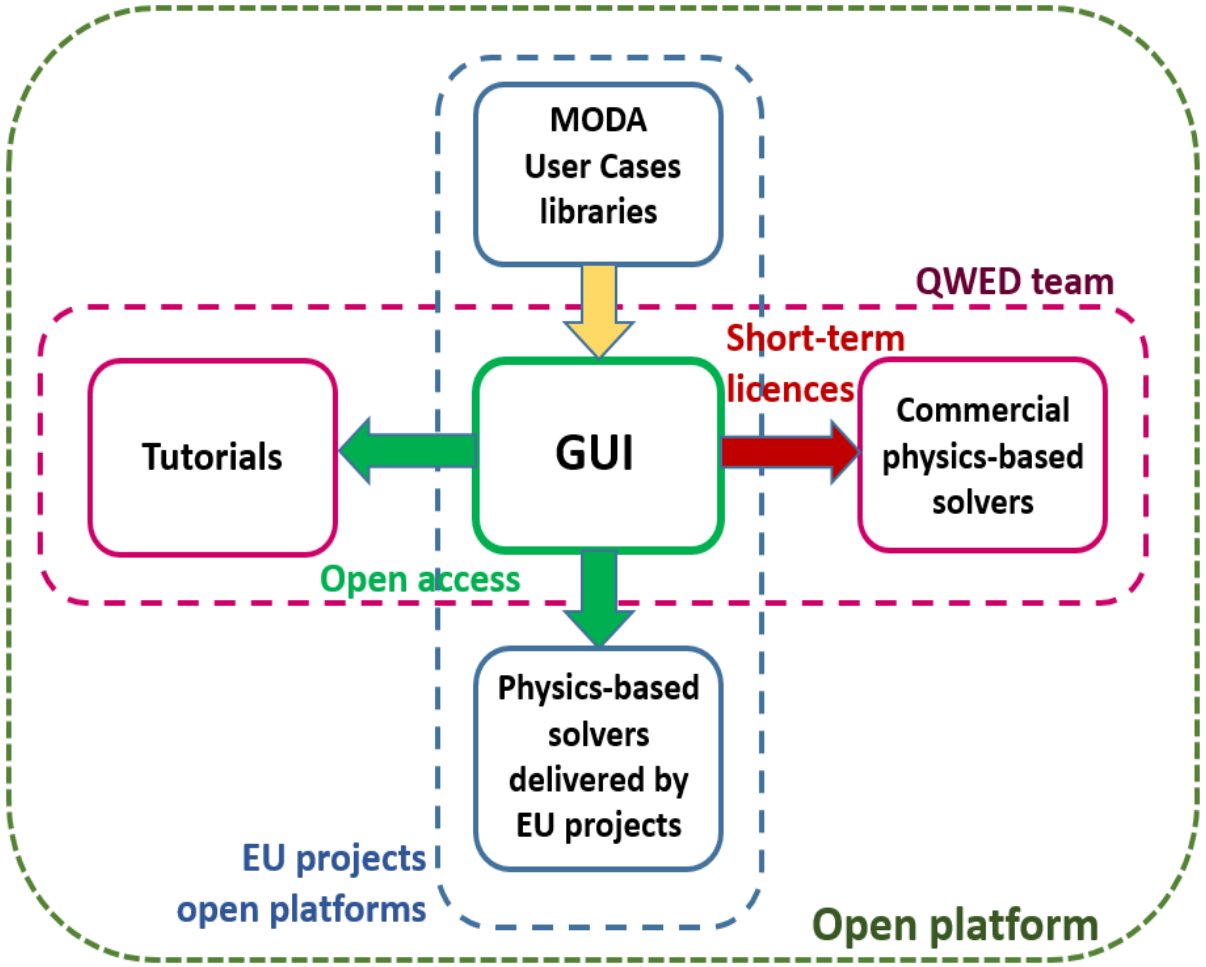
***F**indable**A**ccessible**I**nteroperable**R**eusable* data

Long-term goal

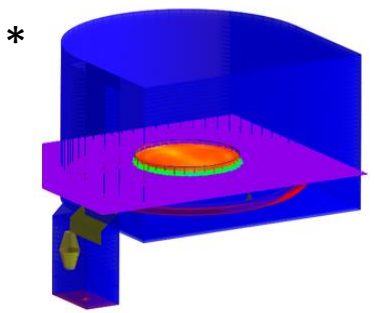
- Developing a common GUI, linked with different simulation tools and a database of examples
- Easy and continuous learning and skills enhancement process
- Elimination of expensive time overheads related to familiarising with different user interfaces
- Convenient way of
  - solving various types of coupled and linked EM and multiphysics problems
  - robust cross-comparison of different solvers.
- Delivering open access modelling tools, spanning across different science domains,

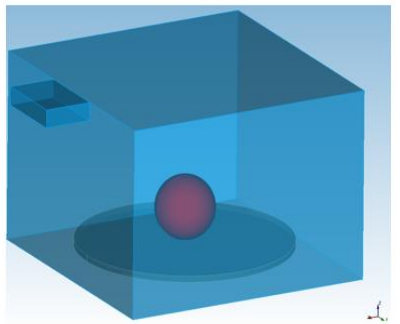
Encouraging different scientific groups to link their solvers to the Open Platform

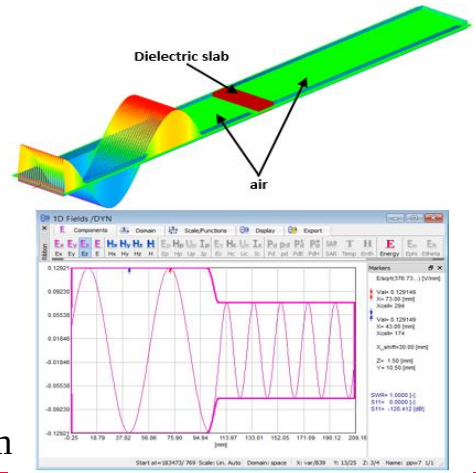
Open Platform environment concept



- ✓ **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.



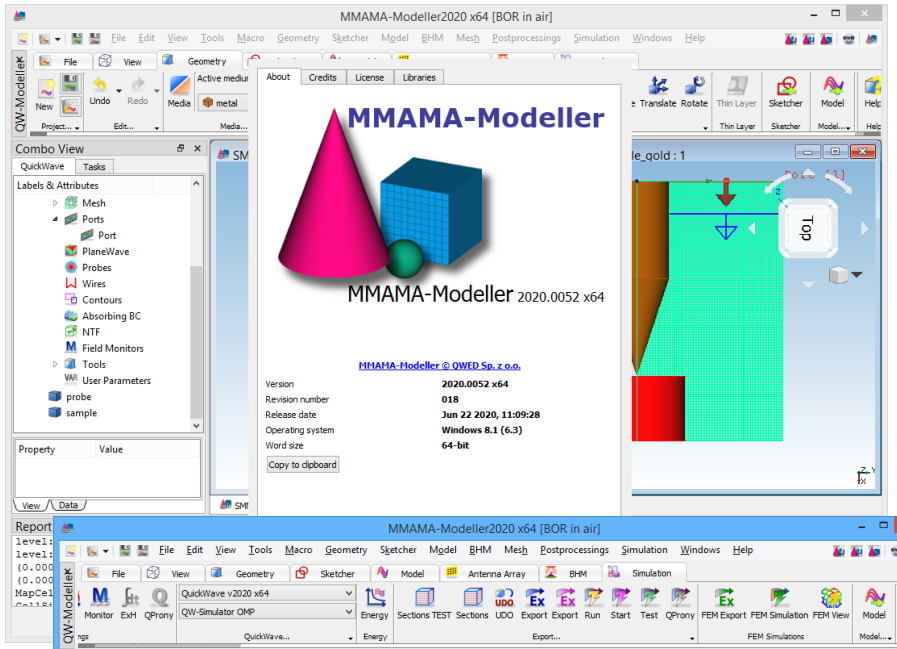


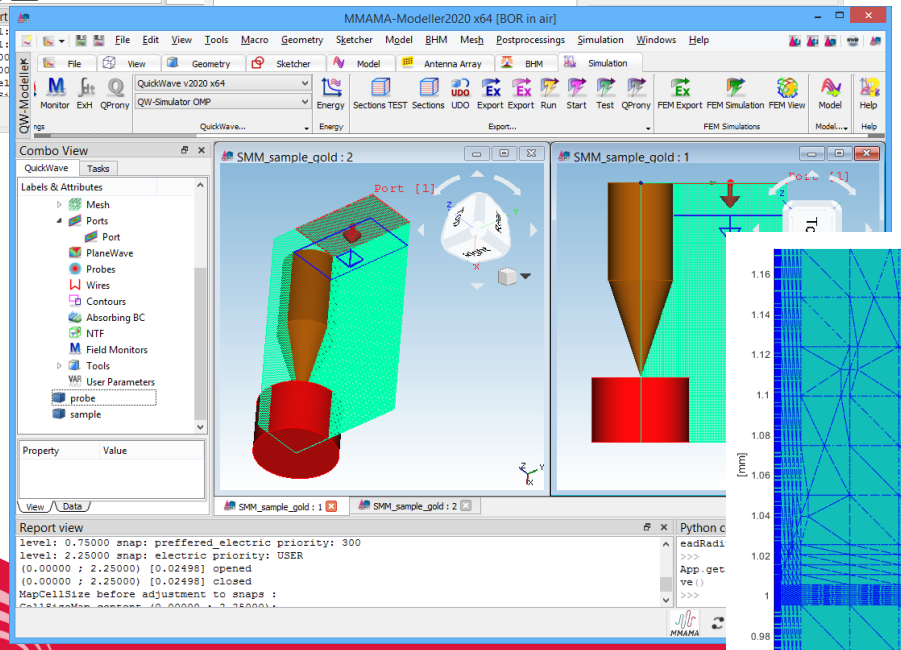


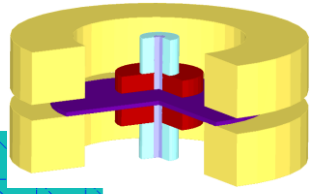
* Commercial microwave oven model courtesy of Whirlpool Sweden AB simulated with QuickWave software via Open Platform

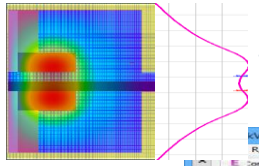
MMAMA Open Platform

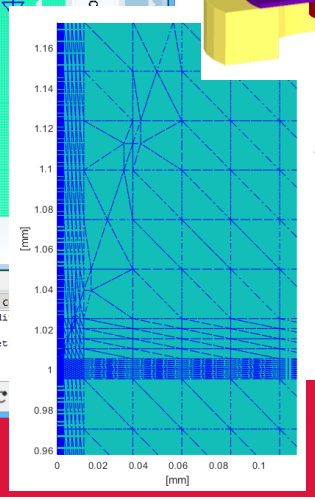
- ✓ Developed within EU H2020 MMAMA project
- ✓ Microwave microscopy of materials e.g. organic semiconductors
- ✓ MMAMA Modeller
- ✓ Dedicated to modelling scenarios with axial symmetry
- ✓ FDTD and FEM EM solvers by QWED and ETH Zurich
- ✓ Coupled EM and Poisson-drift-diffusion analysis for semiconducting materials





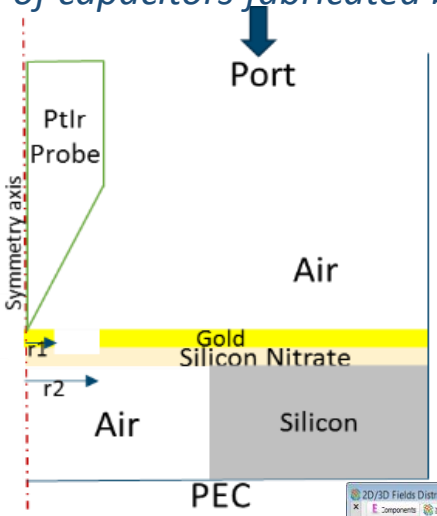


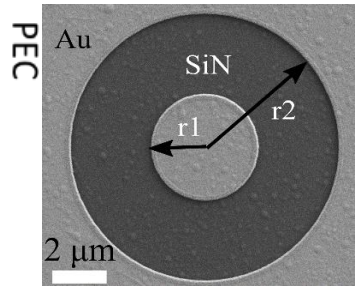




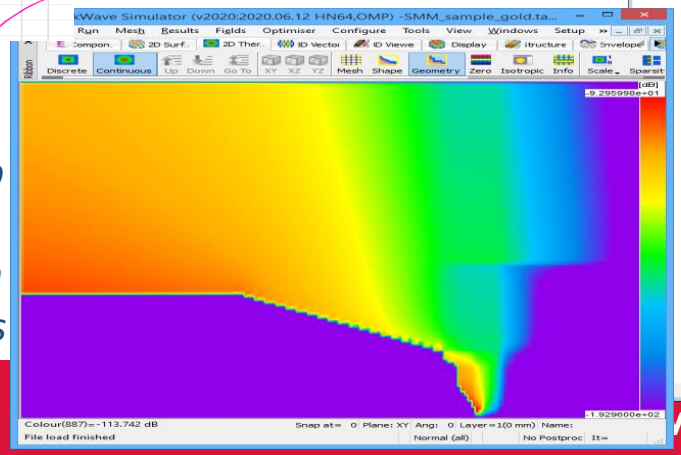
Scanning Microwave Microscopy (SMM) tip applied to dielectric material analysis with FEM and FDTD solvers

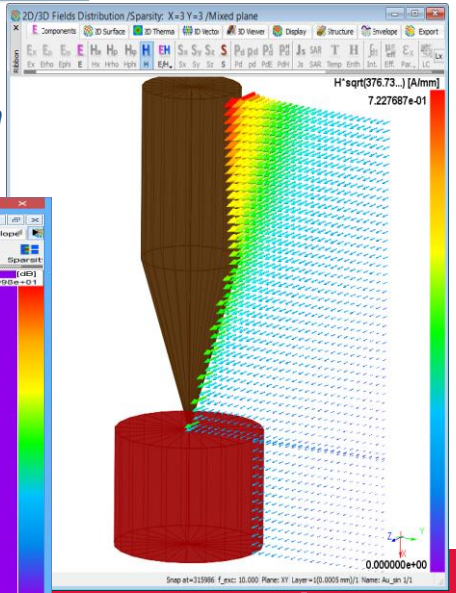
SMM tip applied to extraction of capacitance of capacitors fabricated by METAS





SPDR resonator for characterisation of semiconducting materials



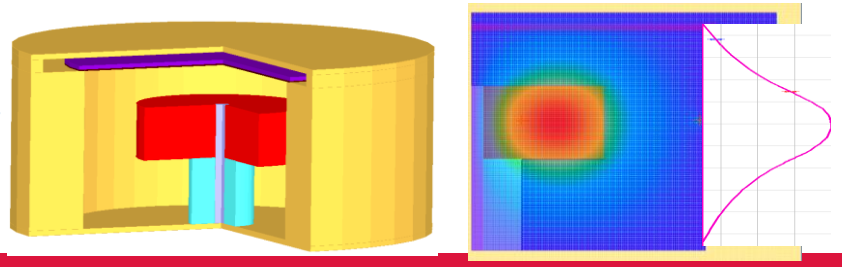


www.mrweek.org

Moving further - Horizon 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
- 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.

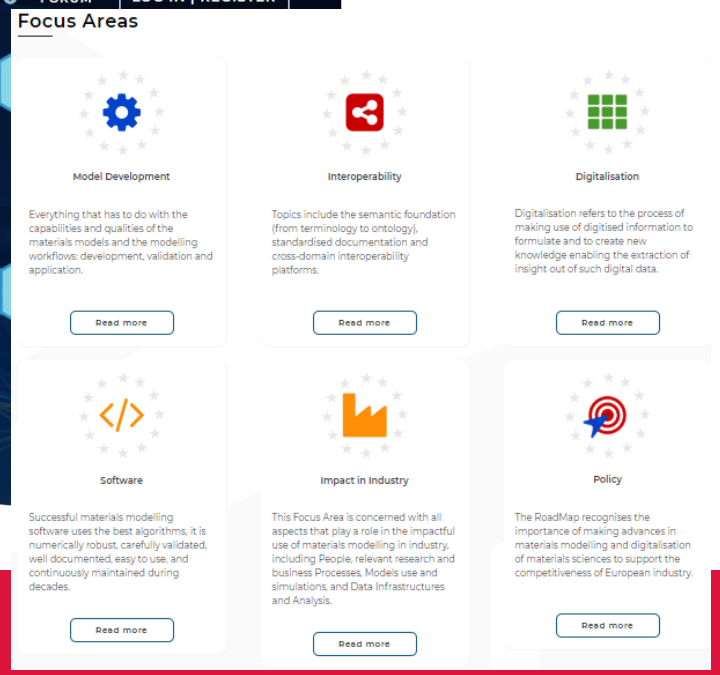


NanoBat

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

Moving further - Horizon Open Platform

- Linking to European modelling communities such as European Materials Modelling Council (EMMC):
  - Extending features of the Open Platform GUI allowing for multi-scale multi-physics material analysis from the electronic level, through atomistics and mesoscale to continuum modelling (and possibly also data-based modelling)
  - *Coupling and Linking* task group proposed within *Model Development* and *Interoperability Focus Areas*
  - Setting up a collaboration with Materials Modelling MarketPlaces



Founding Organisational Members

Fraunhofer IFAM (DE)
Fundación IMDEA Materiales (ES)
Johnson Matthey Public Limited (UK)
AC2T research GmbH (AT)
Software for Chemistry & Materials B.V. (NL)
ESI Group (FR)
QWED Sp. z o.o. (PL)
IDENER (ES)
FUNDACIÓ EURECAT (ES)
RINA Consulting S.P.A. (IT)
IRES - Innovation in Research and Engineering Solutions (BE)
NTNU Norwegian University of Science and Technology (NO)
Evonik Creavis

Summary

- The open access modelling platform has been presented
- CAD-based, unlicensed GUI allows launching solvers relevant to microwave technology
- EU H2020 MMAMA Open Platform includes a set of modelling examples concerned with microwave microscopy of materials
- Modelling examples and results are accumulated in standardised formats (MODA and Gwyddion), for easy re-use
- The MMAMA Open Platform is planned to be extended with a set of solvers representing other physical sciences and technologies areas, fostering interdisciplinary collaboration

Acknowledgement

The work presented has received funding from the

European Union's Horizon 2020

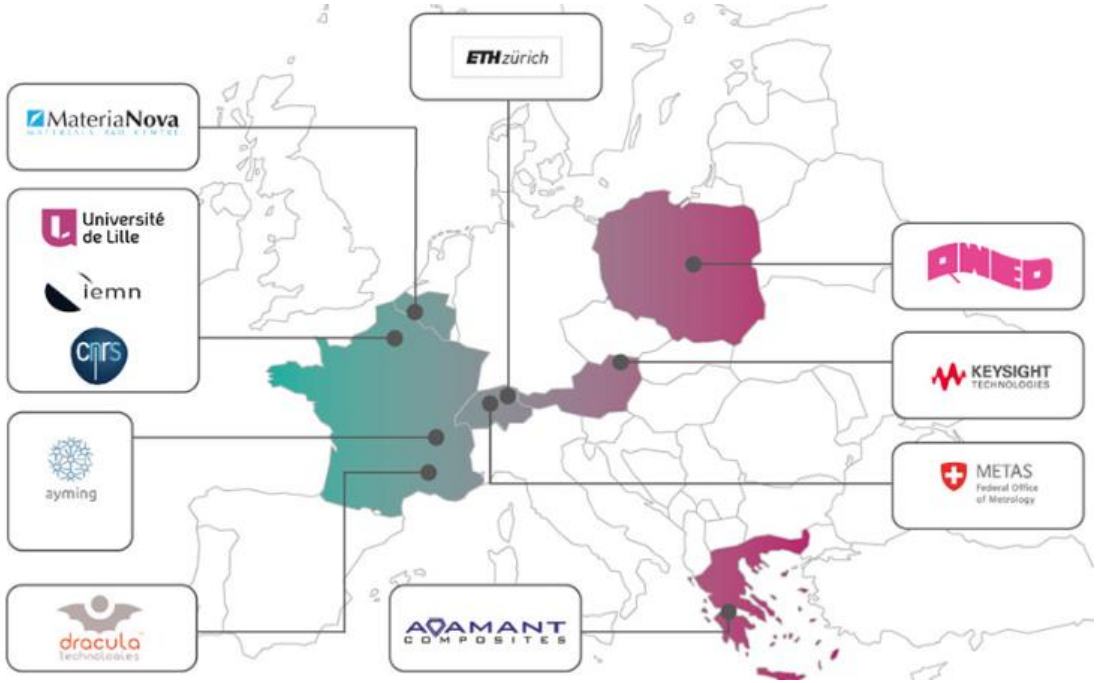
research and innovation programme (H2020-NMBP-07-2017)

under grant agreement

MMAMA n°761036.

(website: www.mmama.eu)

MMAMA



Microwave and Radar Week

MRW 2020

Thank You!

MIKON

MIKON-2020

IRS 2020

U.R.S.I. 2020 Baltic Symposium

Signal Processing Workshop 2020