

IEEE 2015

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Exposure protocol setup for agrofood treatment: Method and system for developing an application for heating in reverberation chamber

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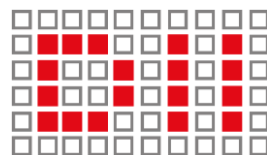
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Talk layout

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Microwave Heating

The microwave heating is an important treatment. It is used in a lot of situations [1], [2] as:

- Disinfestation of works of art
- Phitosanitary treatment
- Industrial processing
- Packaging disinfection
- Foods drying

[1] B. Bisceglia, R. De Leo, A. P. Pastore, S. von Gratowski, and V. Meriakri, "Innovative systems for cultural heritage conservation. Millimeter wave application for non-invasive monitoring and treatment of works of art," *Journal of Microwave Power and Electromagnetic Energy*, vol. 45, no. 1, pp. 36–48, 2011.

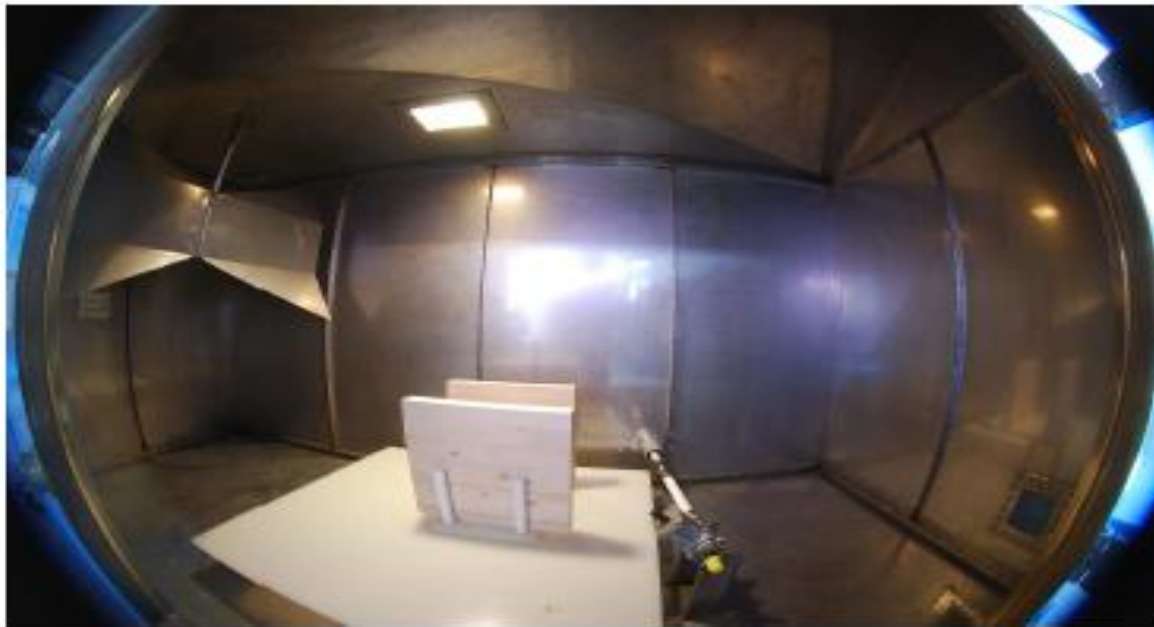
[2] B. Bisceglia, R. De Leo, and N. Diaferia, "Mw pallets disinfestations," *Journal of microwave power & electromagnetic energy* online.

Microwave Heating

- Promising application for treatment of agro food material.
- The food processed is safe for consumption.
- The food no radioactive or contaminated.
- There is no residual radiation remaining in the food.

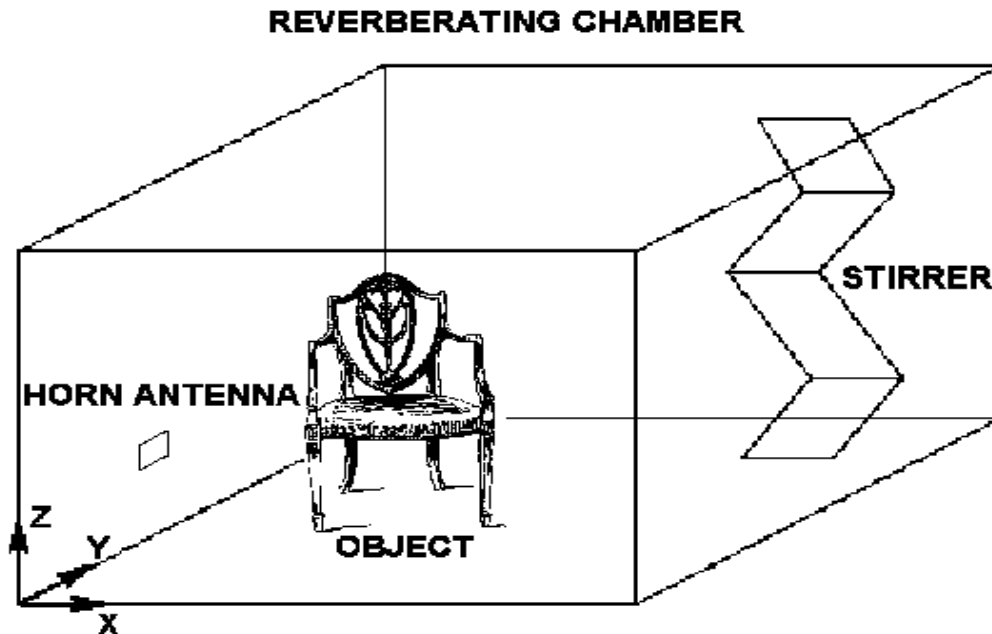
Reverberation chamber

The reverberation chamber is a room with metal and reflective walls, in which electromagnetic waves enter through an antenna.



Reverberation chamber

There are inside also metal and reflective panels (stirrer), that continually change the trajectories of reflected waves with their movement. These numerous reflections create an area where the field is statistically uniform as amplitude and extremely varied from the point of view of polarization and phase of the waves, both with respect to position and time.



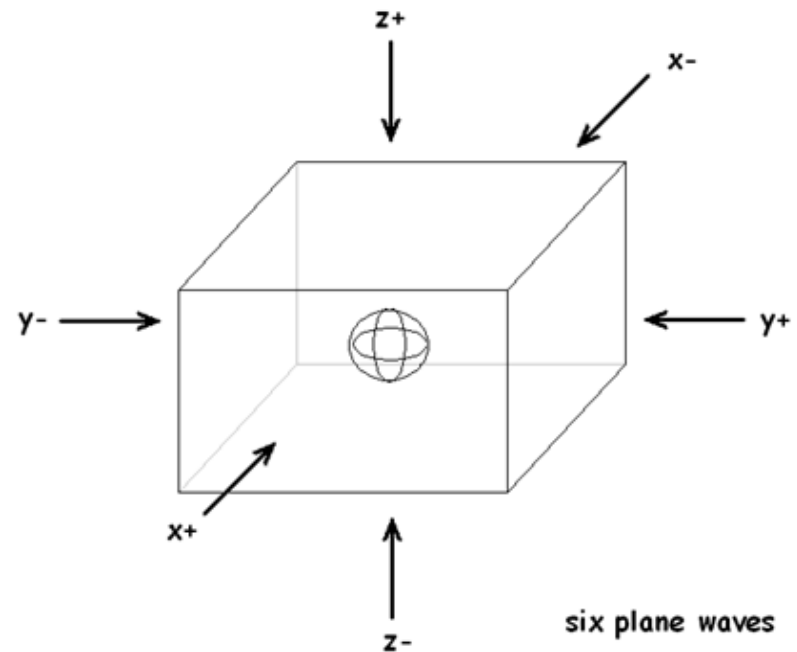
Goals

The aim of the proposed project, is an application that simulates the heating of an object, assimilated to a sphere, in reverberation chamber. This application is built in COMSOL Multiphysics [3], an environment for various physics and engineering applications, especially coupled phenomena, or multiphysics. The packages are cross-platform (Windows, Mac, Linux) and they enable you to create accurate models in a very fast way.



Model of Reverberation Chamber

We consider a copper block, in the shape of a cube, which incorporates inside a sphere of a second material, all invested by six plane waves.



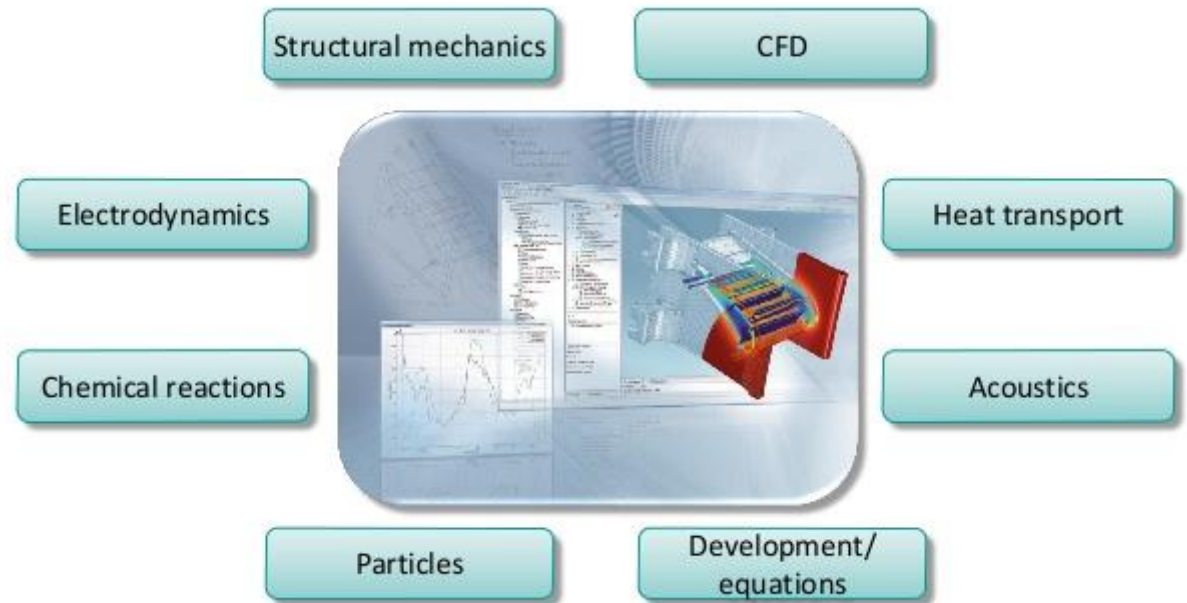
Model of Reverberation Chamber

We calculate:

- Stored energy with $\mathbf{E} = 1 \text{ V/m}$;
- Power dissipated on the walls from \mathbf{Q} ;
- Power loss on the body or in treatment with **FDTD** or with the model of a transmission line;
- Actual value of \mathbf{E} ;
- Power dissipated in the body;
- Incident power entering in the chamber.

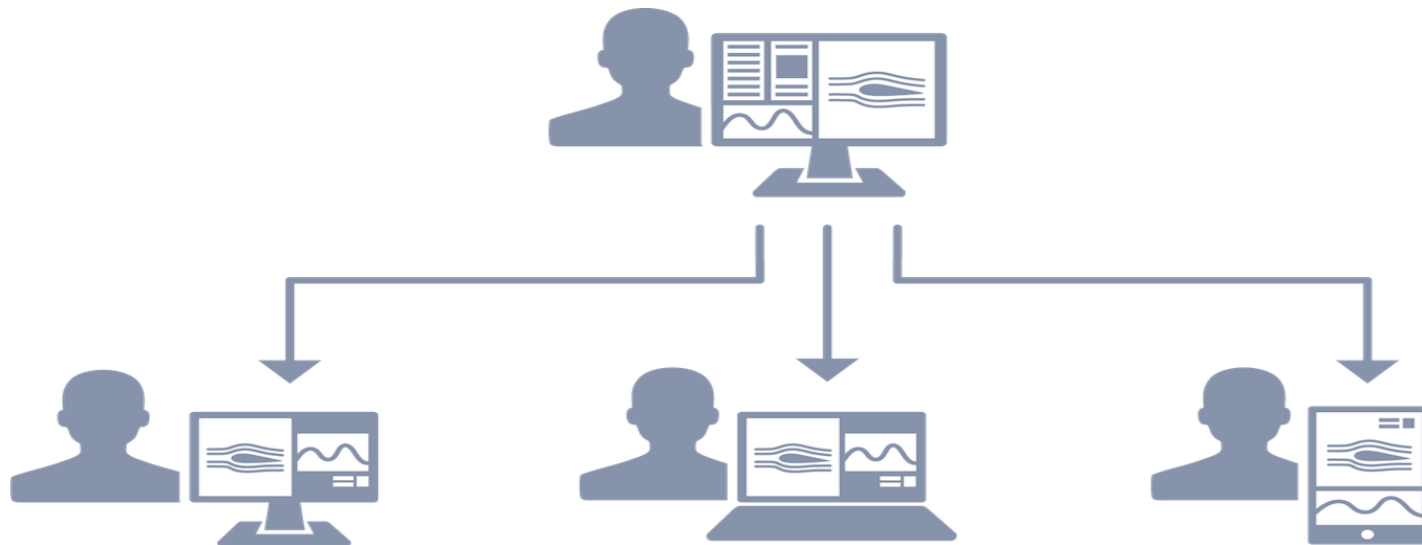
COMSOL Application

Simulation and development



COMSOL Application

COMSOL version 5.0 introduces new features and new products including the Application Builder that allows to create specialized applications based on COMSOL models, so that they can be used by all engineers and designers of the company.

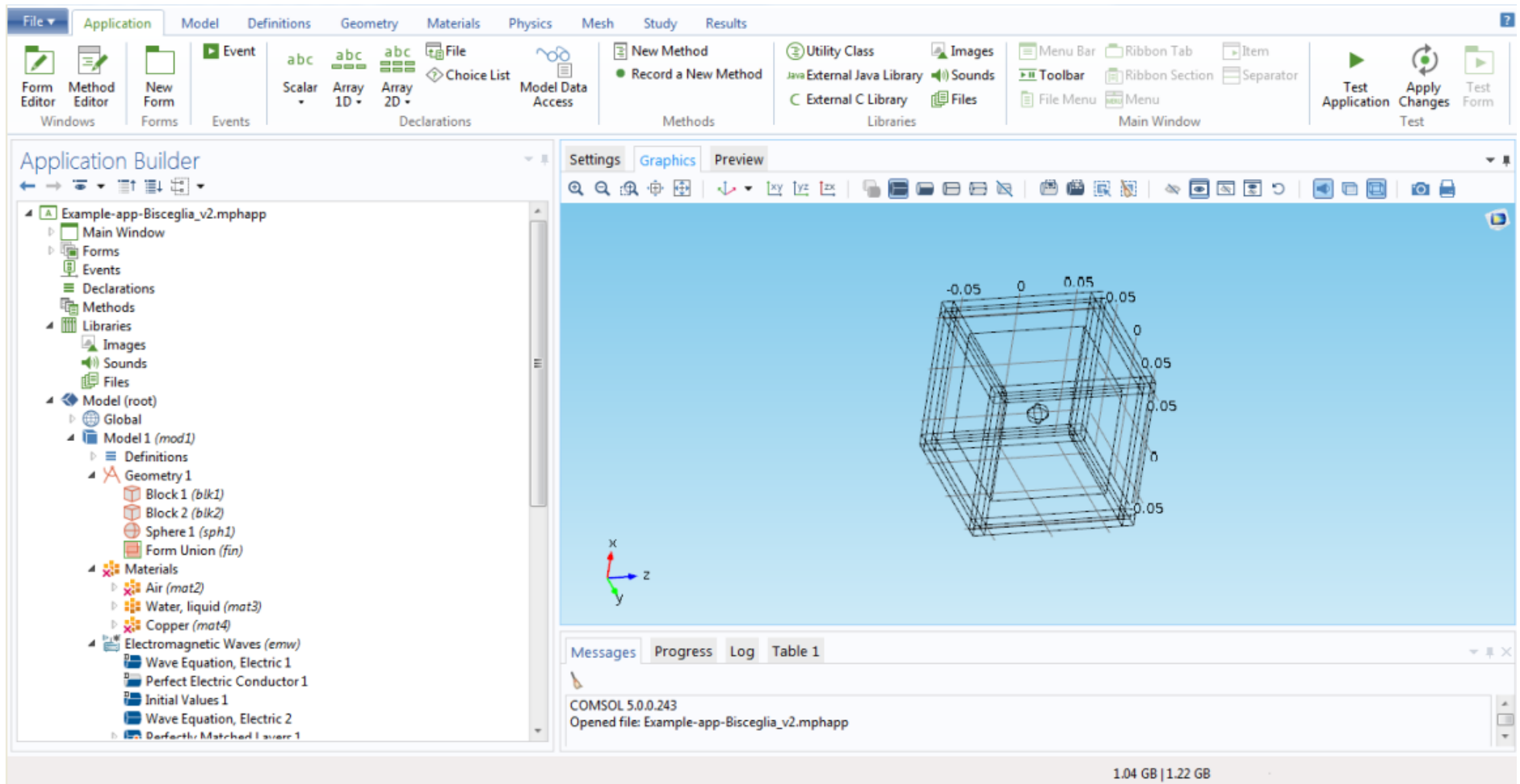


COMSOL Application

In COMSOL Multiphysics, it is also possible to run an application:

- Test Application in the ribbon or in the Quick Access Toolbar
- Run Application in the File menu or in the Quick Access Toolbar.
- Select Test in Web Browser in the ribbon.Application Builder window and ribbon tab

COMSOL Reverberation chamber Application



Application Builder Interface

Demo

Untitled.mphpp - LegnoSfera0p0127

File View Plot

Frequenza di lavoro:	2.45[GHz]	1/s
Lato x del dominio:	14[cm]	m
Lato y del dominio:	14[cm]	m
Lato z del dominio:	14[cm]	m
Spessore zona PML:	1[cm]	m
Lato x del blocco:	10[cm]	m
Lato y del blocco:	10[cm]	m
Lato z del blocco:	10[cm]	m
Raggio sfera d'acqua:	8.8127[mm]	m
Posizione x centro sfera d'acqua:	0[cm]	m
Posizione y centro sfera d'acqua:	0[cm]	m
Posizione z centro sfera d'acqua:	0[cm]	m
Angolo longitudine in gradi:	0	
Angolo Latitudine in gradi:	0	
Angolo polarizzazione in gradi:	0	
Temperatura ambiente/iniziale:	25[degC]	K
Ampiezza campo elettrico:	2000	
Conversione gradi->radianti:	pi/180	
Ampiezza campo normale:	$E_{max} \cdot \cos(\text{GrToRad} \cdot \text{Alfa})$	
Ampiezza campo trasversale:	$E_{max} \cdot \sin(\text{GrToRad} \cdot \text{Alfa})$	
Componente x del campo elettrico:	$K E_t \cdot \sin(\text{GrToRad} \cdot \text{Fi}) - K E_n \cdot \cos(\text{GrToRad} \cdot \text{Teta}) \cdot \cos(\text{GrToRad} \cdot \text{Fi})$	
Componente y del campo elettrico:	$-K E_t \cdot \cos(\text{GrToRad} \cdot \text{Fi}) - K E_n \cdot \cos(\text{GrToRad} \cdot \text{Teta}) \cdot \sin(\text{GrToRad} \cdot \text{Fi})$	

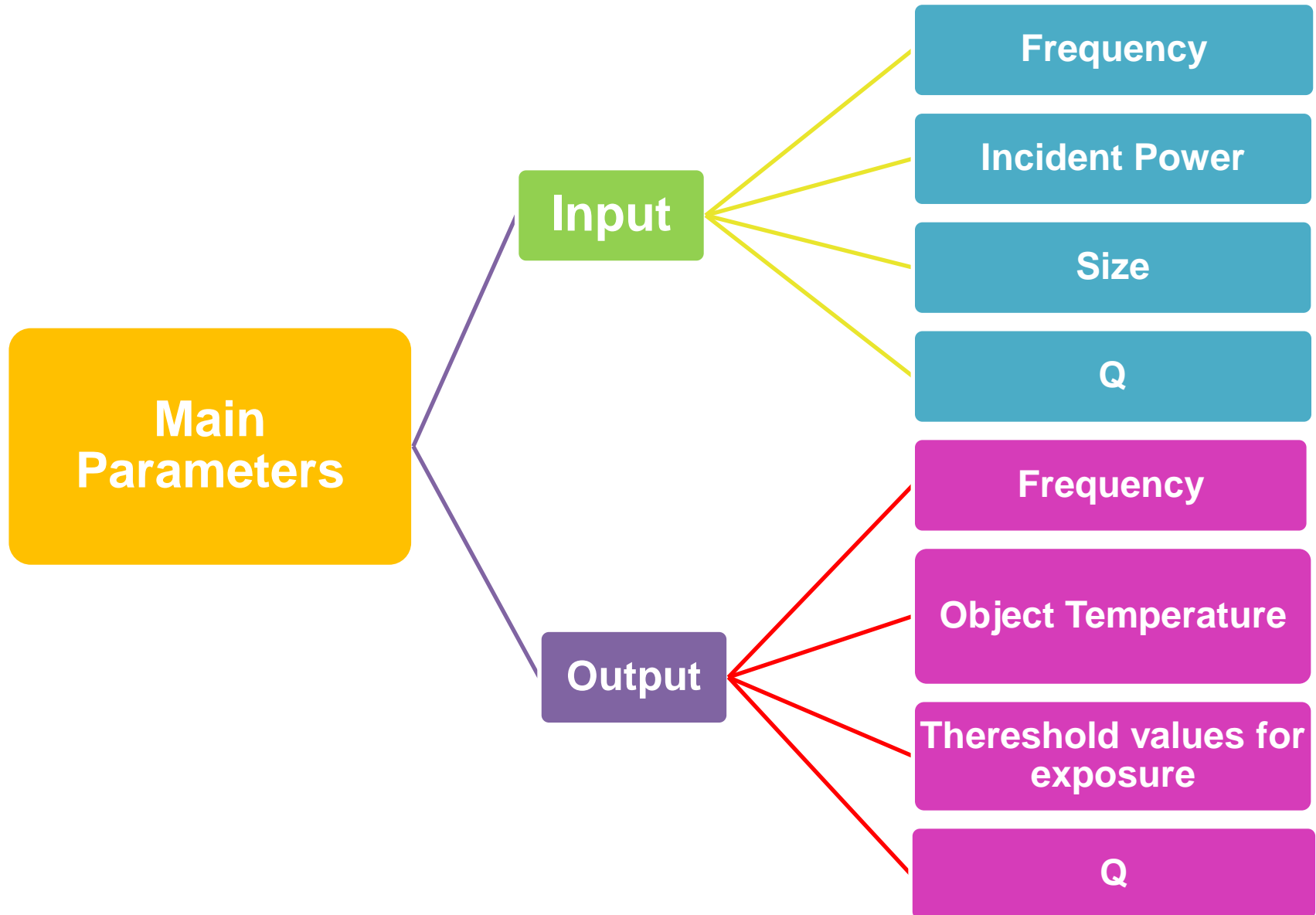
Geometry Plot Temperature Profile Plot Temperature Block Sphere

13:54
23/10/2015

COMSOL Reverberation chamber Application

- Preliminary result of the interface of our application.
- Simple and intuitive even for who does not know the main principles of electromagnetism.
- User-friendly application featuring a rich graphical user interface.
- Very useful tool for the electromagnetic simulation.

Application parameters



Conclusion

- Novel method for building an application very useful for electromagnetic simulation.
- Preliminary result of the interface of our application.
- Future works will be to make this application more rich and more useful.

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Thanks for your attention!

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