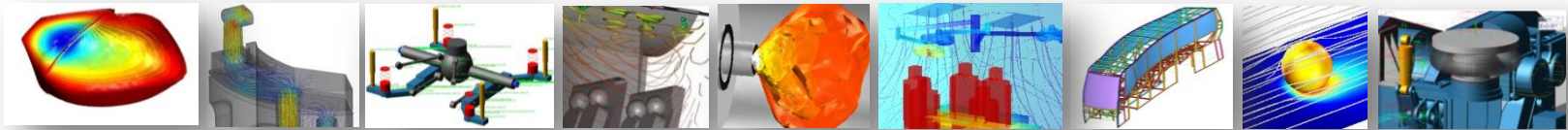# BE CAE & Test

How Apps Can Support COMSOL Multiphysics® Users?

Giuseppe Petrone and Carmelo Barbagallo

BE CAE & TEST, Viale Africa 170 Sc. A, 95129 Catania (ITALY)

Rotterdam, 18-20 October 2017

http://www.be-caetest.it

BE CAE & Test (http://www.be-caetest.it) provides consultancy services in several industrial sectors by using innovative **CAD/CAE modelling tools** and carrying out **experimental campaigns**

The company collaborates with **industrial partners** and **research centers** in several technologic fields

http://www.be-caetest.it/

Prodotti   Workshop   Webinar   Supporto   Contatti

BE CAE & Test

BE CAE & Test provides consultancy services for applications based on numerical simulations. Our company recognizes that virtual prototyping plays an important role in several engineering fields. It serves as a powerful tool for optimizing the design of products and processes, while also reducing the time to market ratio. We strongly believe that complex problems have to be analyzed using a multiphysics approach.

Our team of engineers and researchers supports companies and individuals during their products and processes development by using advanced CAD/CAE tools and organizing accurate experimental tests.

The experience gained in experimental vibro-acoustics, FEM and Multibody numerical simulation and the use of Multiphysics packages make BE CAE & Test the ideal partner to guarantee reliability, innovation and competitiveness of your products and processes.

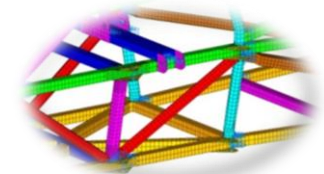© 2015 BE CAE & Test S.r.l. | P.I. 05230570870

multiphysics

➢ **Fluid dynamics and thermal analyses**

▪ Environmental energetics (HVAC, thermal comfort, IAQ)

▪ Industrial energetics (Thermal design, energy conversion, reacting flows)
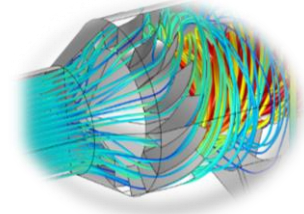
➢ **Structural analyses**

▪ Linear and non-linear statics, dynamic and vibro-acoustics analyses in industrial and civil applications

➢ **System dynamics and Multi-Body analyses**

▪ Vehicle and rail dynamics (handling, ride comfort)

▪ Kinematics, dynamics, rigid and flexible bodies analyses of mechanisms
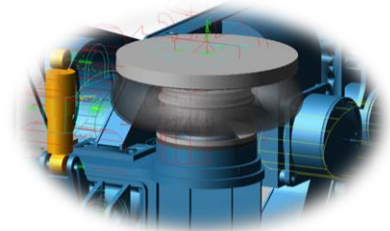
➢ **Experimental testing**

▪ Ride comfort (NVH), modal analyses

▪ Vibro-acoustics

▪ Indoor micro-climate

➤ Flow-chart for **"traditional" CAE** activities

1. Topics / targets / feasibility study

2. Data transmission (CAD, functional / operative conditions, …)

3. Model set-up (equations, parameters / functions, BC, meshing, solvers, …)

4. Test run /numerical study of the model / numerical-experimental validation
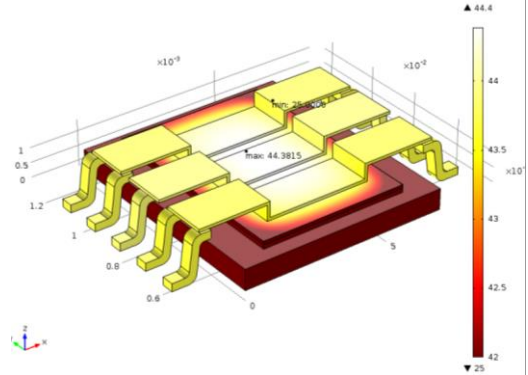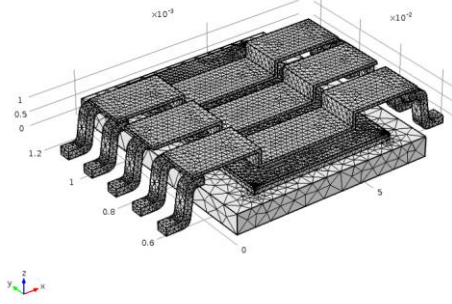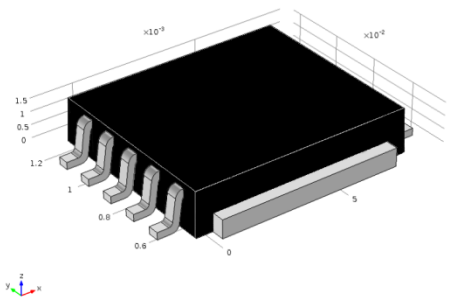
5. Parametric runs for predictive analyses
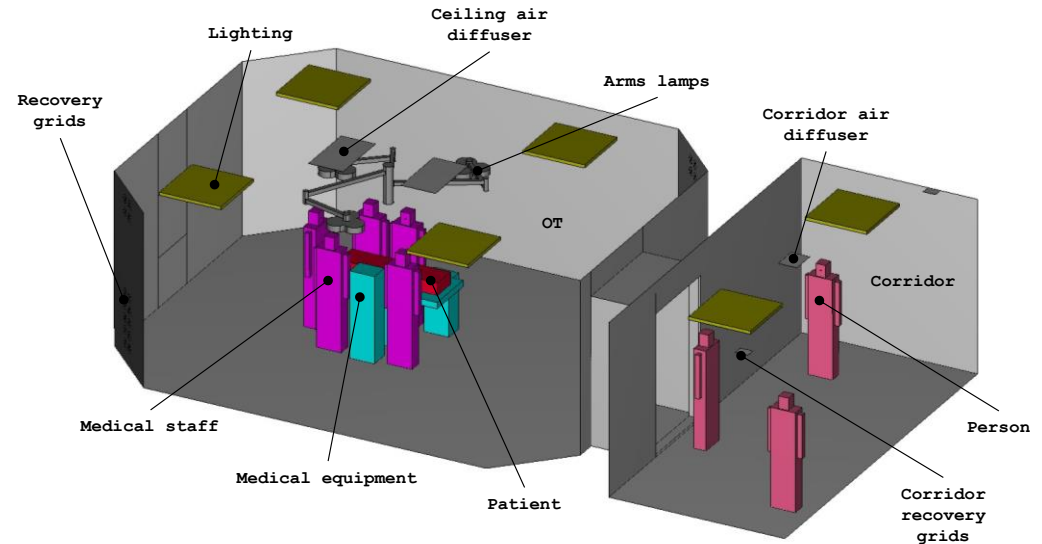
>> REPORT RELEASE <<
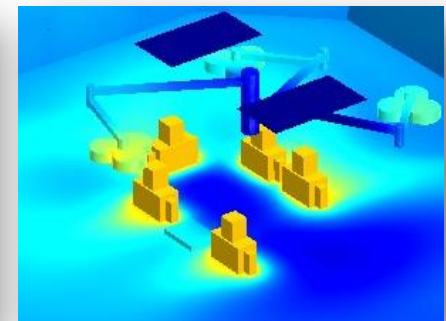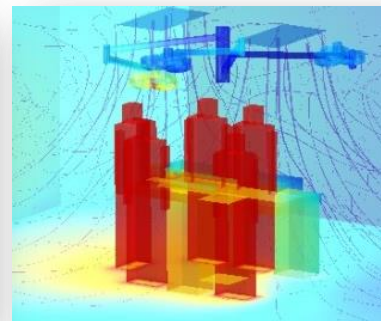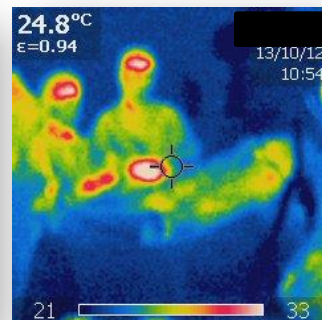
➢ **Beyond** a **traditionally relationship** with the **Customers**
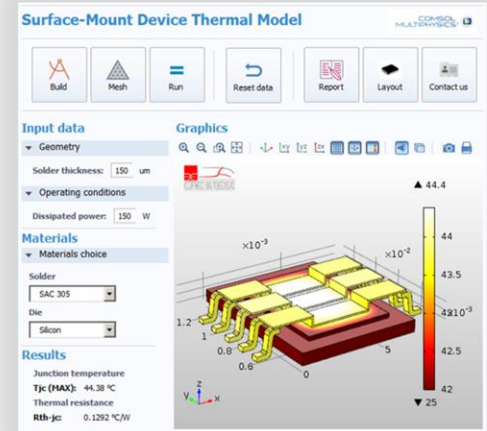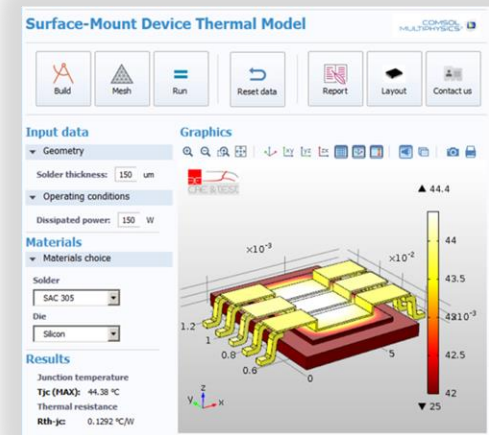


FROM MODEL TO APP

➢ **Why building a COMSOL App[*]?**

*"… Apps mark a **revolutionary page in** the history of mathematical **modeling** and numerical simulation: these specialized and **user-friendly tools bring the power of numerical simulation to a larger group of users…**."*

*"… people with no prior experience from FEA or mathematical modeling can **access, exploit, and benefit from analysis…"***

*"…simulation apps can create **more business opportunities with customers**. Beyond simply providing them with a technical report, you are also supplying them with an interactive tool…they can use to **investigate the problem on their own …"***
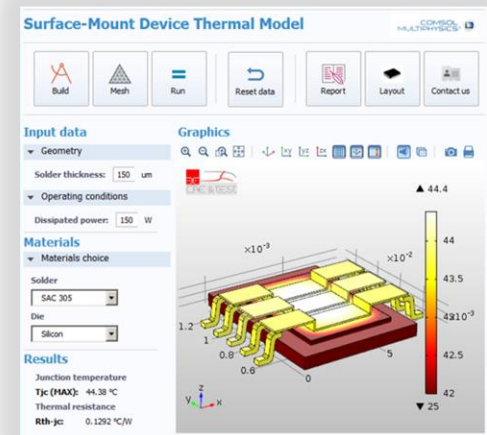
FROM MODEL TO APP
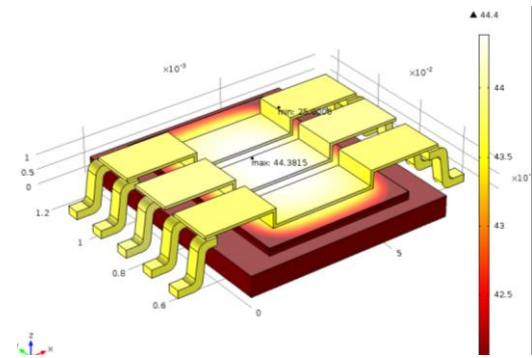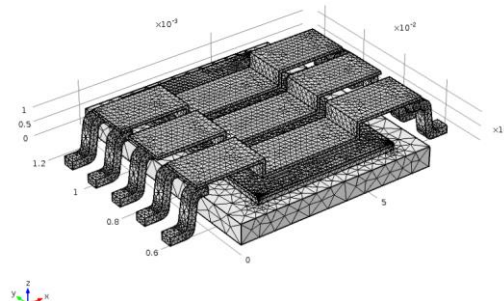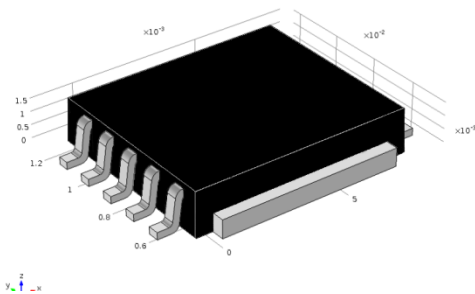
[*]*Extract from COMSOL Press Release «Simulation Apps Pave New Frontier for Virtual Prototyping of Surface-Mount Devices» https://www.comsol.com/press/news/article/3231/*

➢ **What is a COMSOL App?**

- Customized GUI allowing users to carry-out parametrical simulations without build models

➢ **Which kind of «parametric» analysis?**

- **Geometrical**

- **Constitutive**: materials, assumption (i.e. plasticity model in structural analysis, flow regime in fluid dynamics, …)

- **Funcional**: any operational or working condition

- **Derived value**: any value derived from FE dependent variable solved (i.e. a thermal flux from temperature solution in thermal analysis)

- …

FROM MODEL TO APP

Extract from COMSOL Press Release «Simulation Apps Pave New Frontier for Virtual Prototyping of Surface-Mount Devices»
https://www.comsol.com/press/news/article/3231/
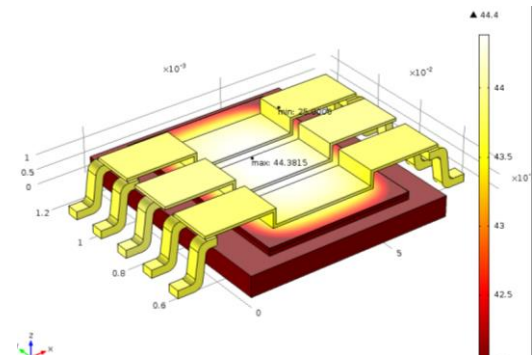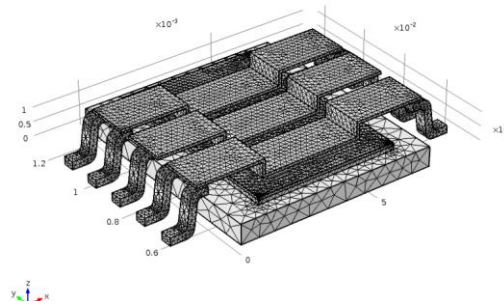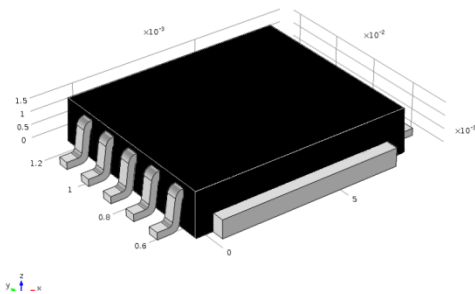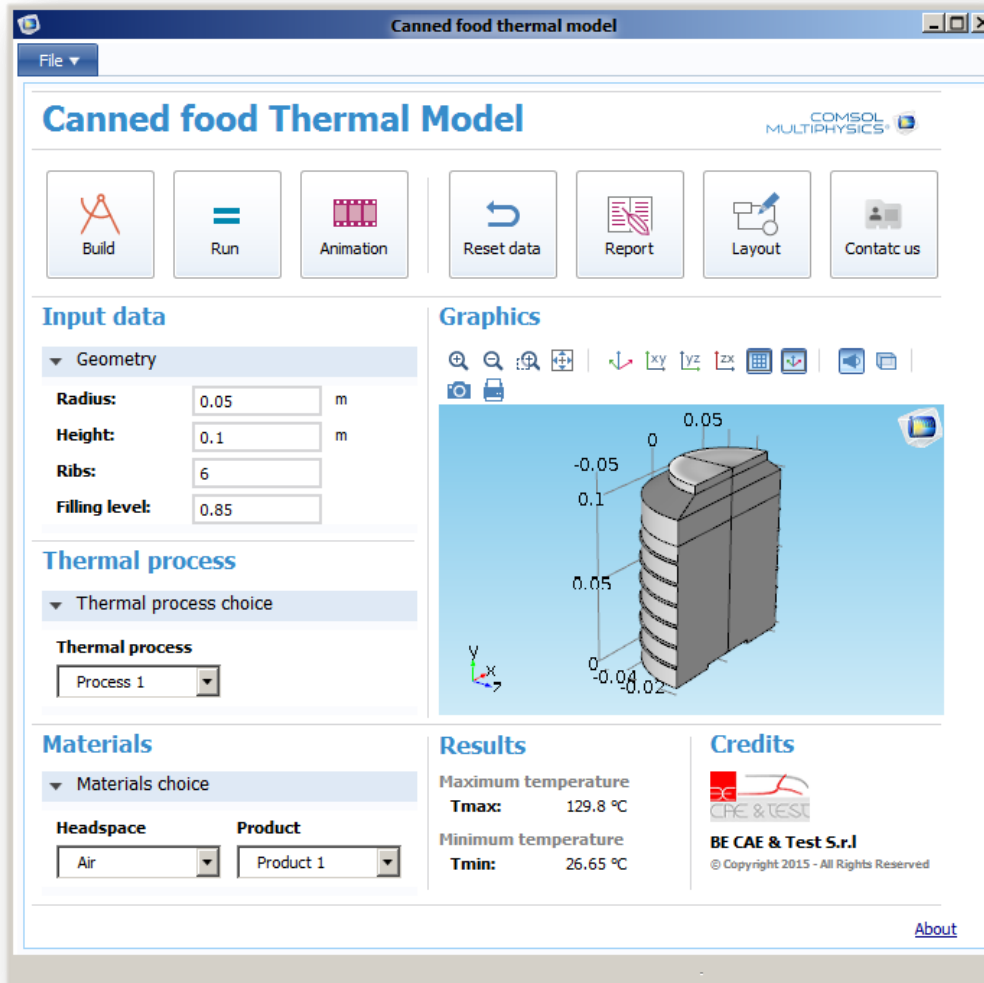
FOOD THERMAL TREATING

- "**Food thermal treatment**": procedures for **destroying micro-organisms by the application of heat**.

- Numerical model allowed **simulating the heat transfer during a given process** implemented for food sterilization.

- It is needed a flexible tool allowing modification of **product type, quantity**, **shape of tray**, **type of heating cycle**,...

- Some specific quality indexes for the process need to computed in **post-processing analysis**.
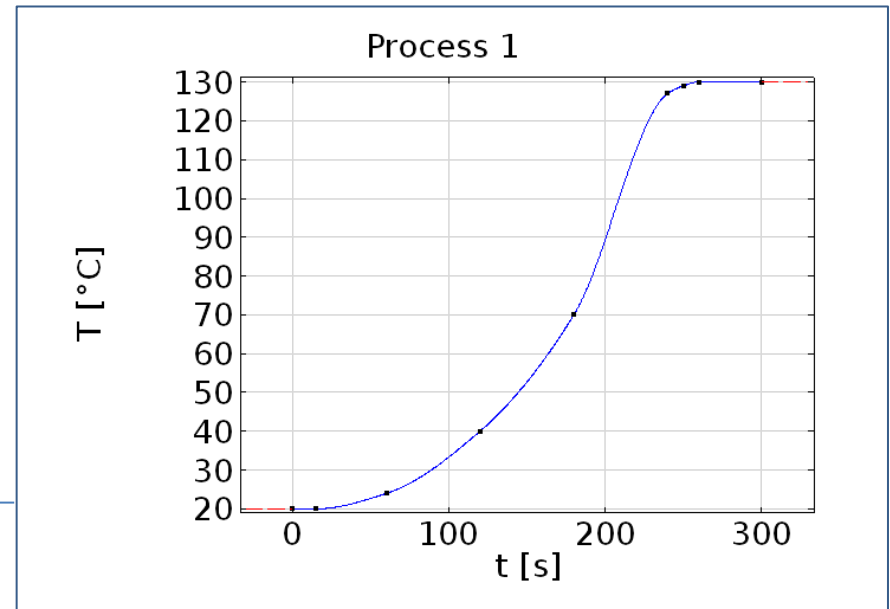
A parametric geometry...

Headspace

F (filling level)

Nr (ribs)

Product

H (heigth)

R (radius)
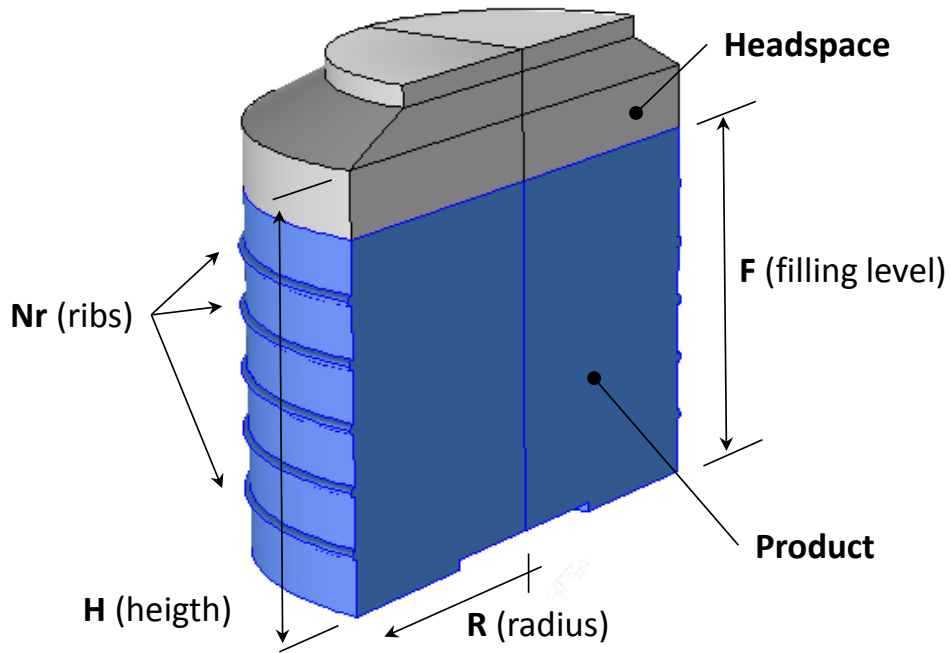
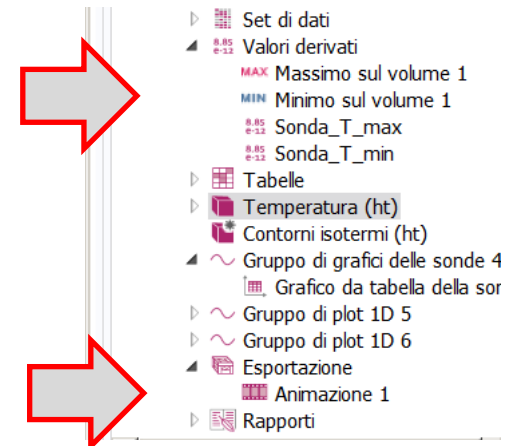**Customized libraries for material choice: "canned food (product)" and "headspace"**
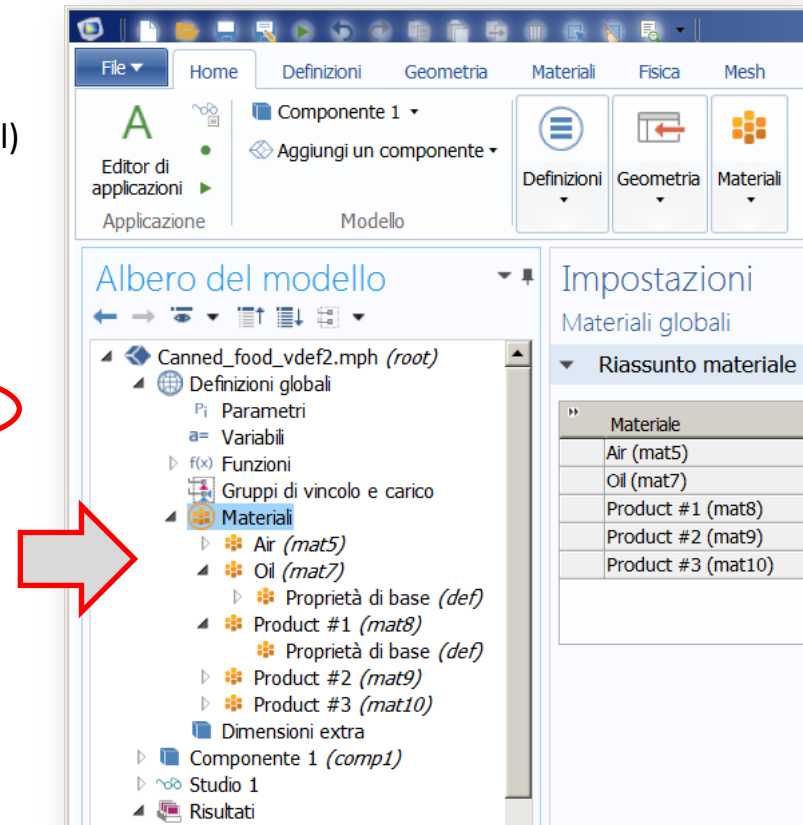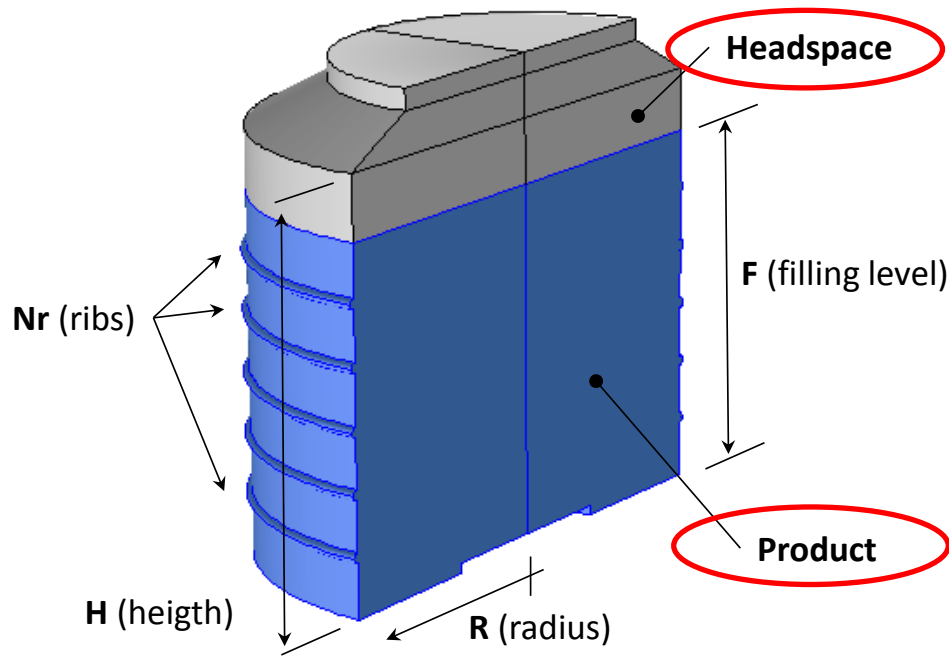
Choice of applied thermal process (retort temperature)
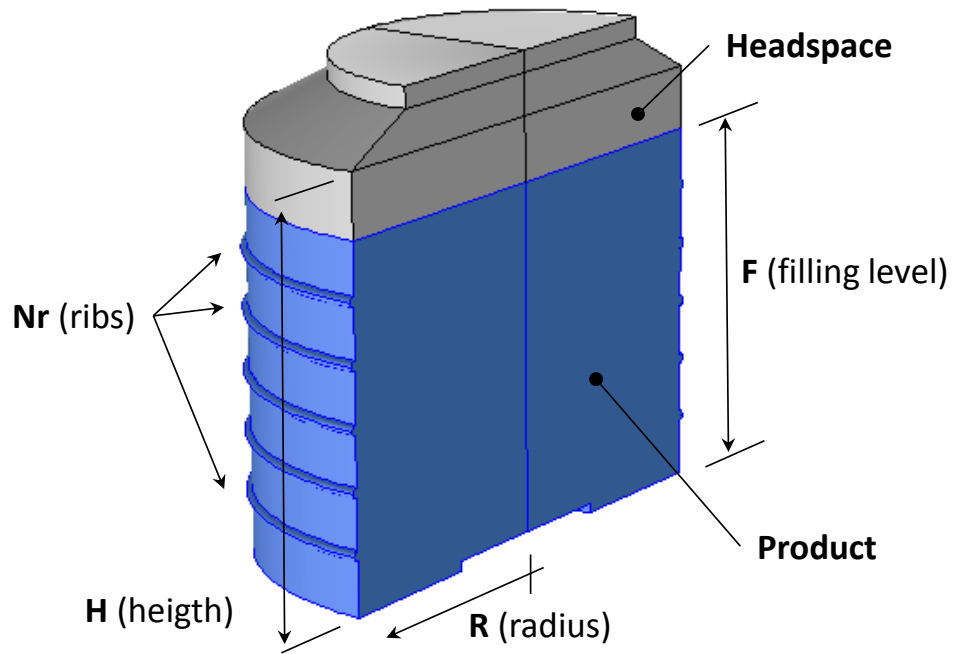

Headspace

F (filling level)

Nr (ribs)

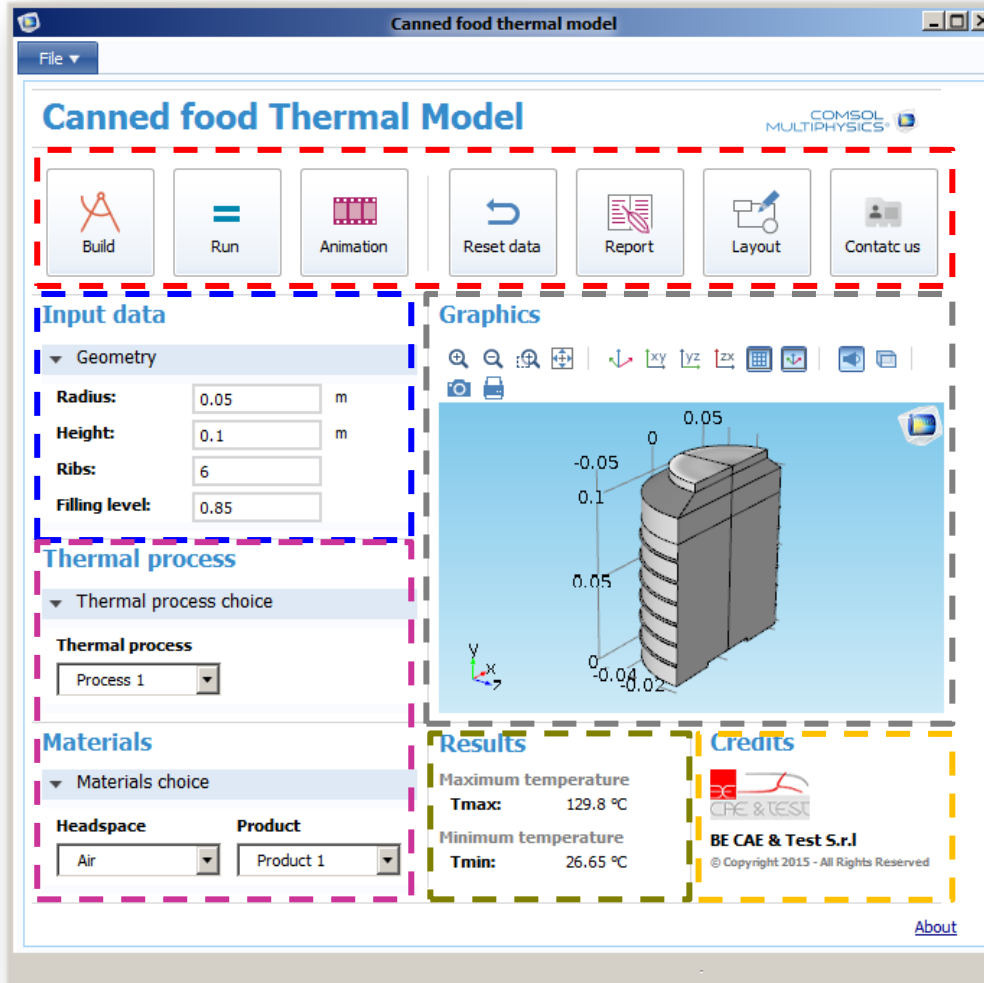**Product**

H (heigth)

R (radius)
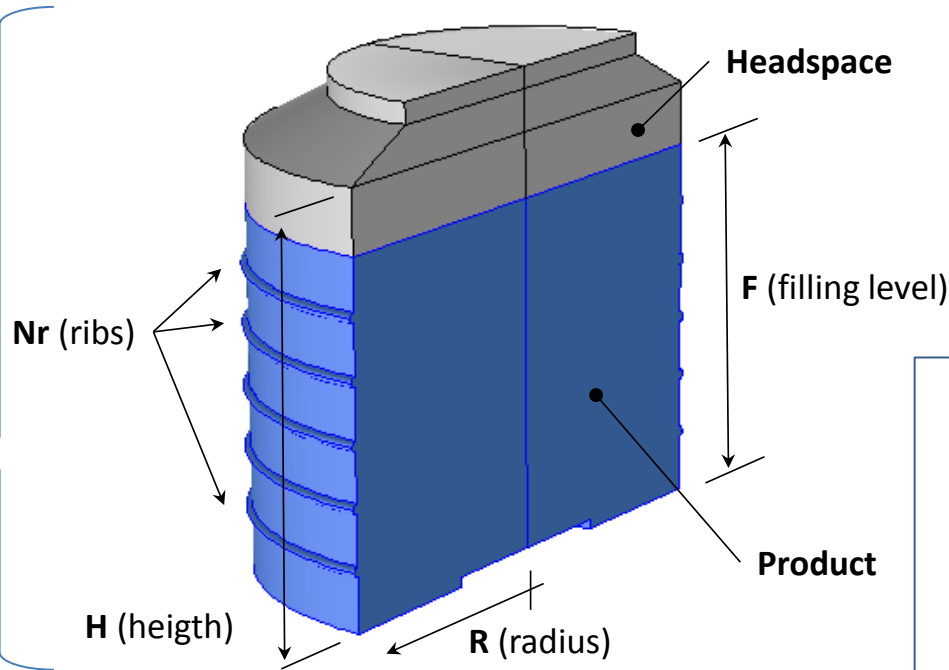
Boundary condition on "external" surfaces

Post-processing: thermal maps, animation of transient analysis, probe values…
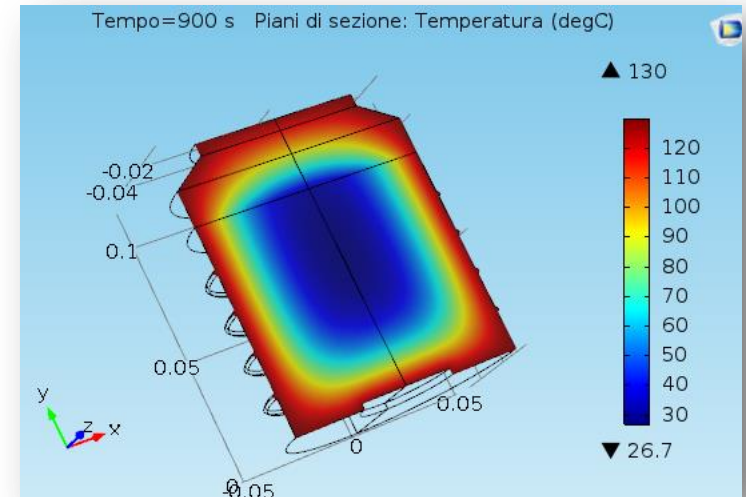
Graphical interface built by using some of the Form Editor features

- ▪ **Action button**
- ▪ **Input field**
- ▪ **Combo Box**
- ▪ **Graphics**
- ▪ **Data Display**
- ▪ **Picture / text**

SIMULATION OF HEAT TREATING PROCESSES

➢ Optimizing the heating/cooling equipment.

➢ Monitoring the time evolution of the pieces "core" temperature as a function of :

- Size;
- Constituting material;
- Relative position of the pieces in the cooling equipment;
- Magnitude of the cooling forced flow.

This kind of study can be carried out by **three steps**, setting different boundary conditions and physical variables coupling from one step to another:

1. **Fluid dynamical** solution of the **permanent velocity field**;

2. **Steady thermal simulation** of temperature distribution at cooling process beginning;

3. **Transient thermal analysis** during the cooling process.

**Build an App for managing a sequence of computational steps to be run by using different physical settings**

< Cooling duct >

< Coolant outcoming >

< Coolant incoming >
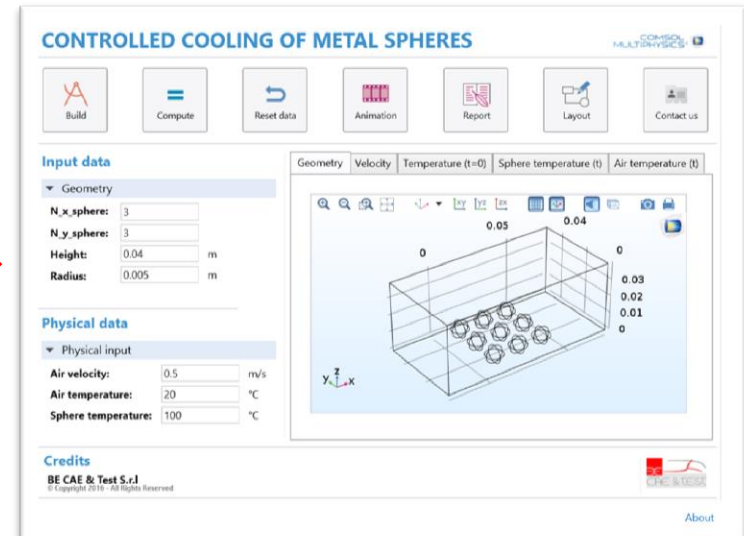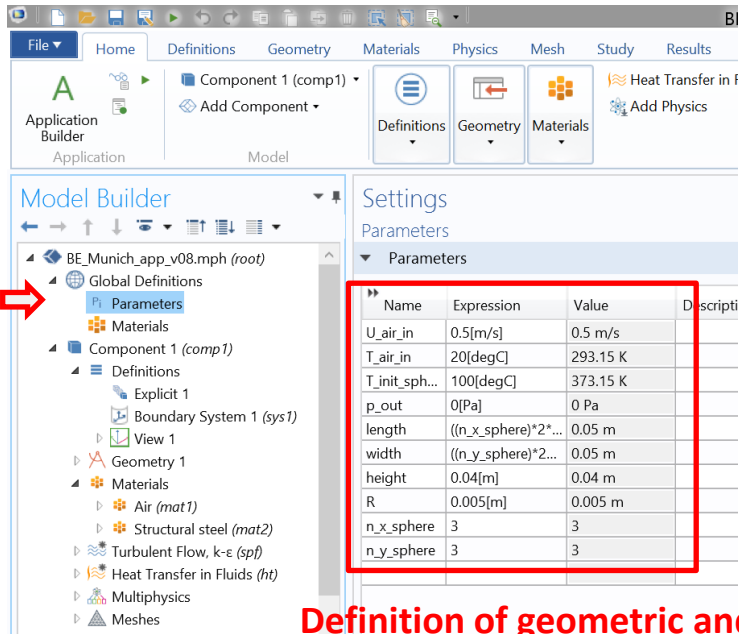
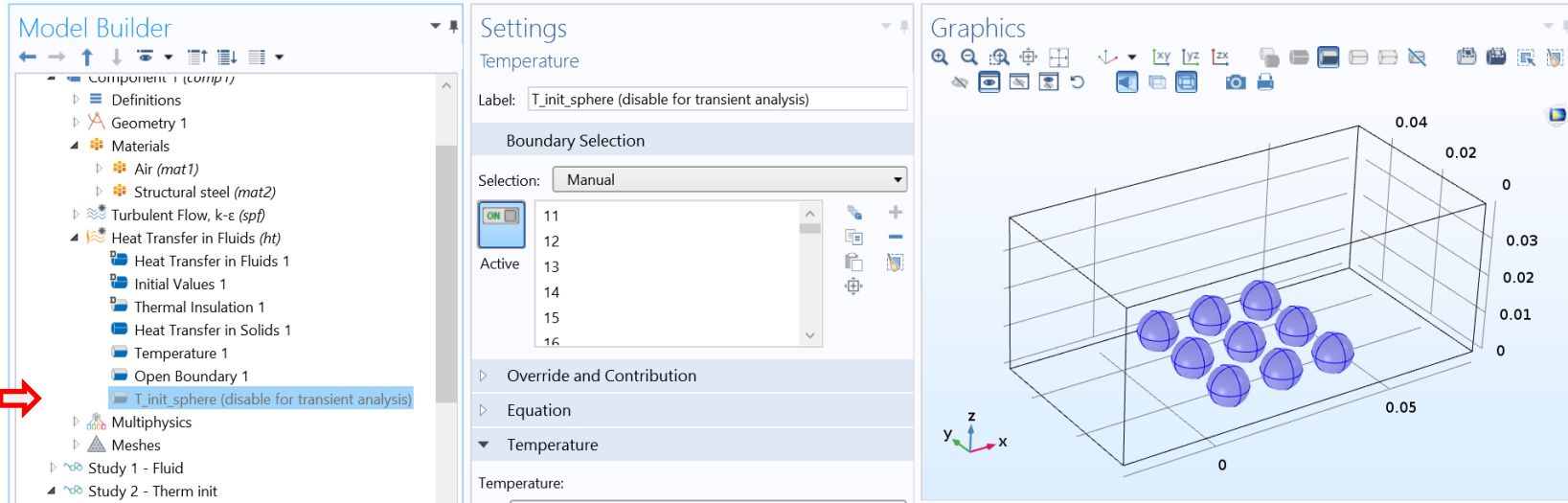< Metal spheres >

Definition of geometric and process parameters
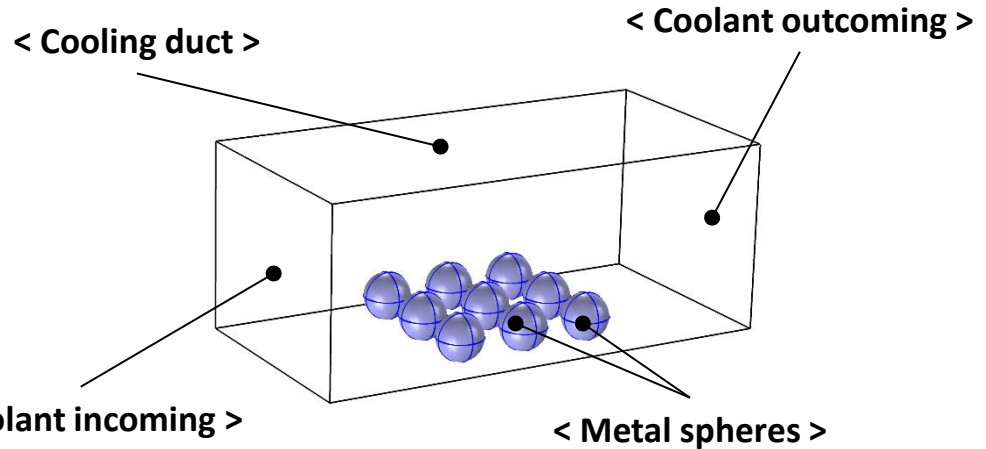
Parametric» analysis

- **Geometrical (**spheres number and dimension, duct dimensions**)**

- **Functional** (Coolant flowrate and temperature, initial spheres temperature)
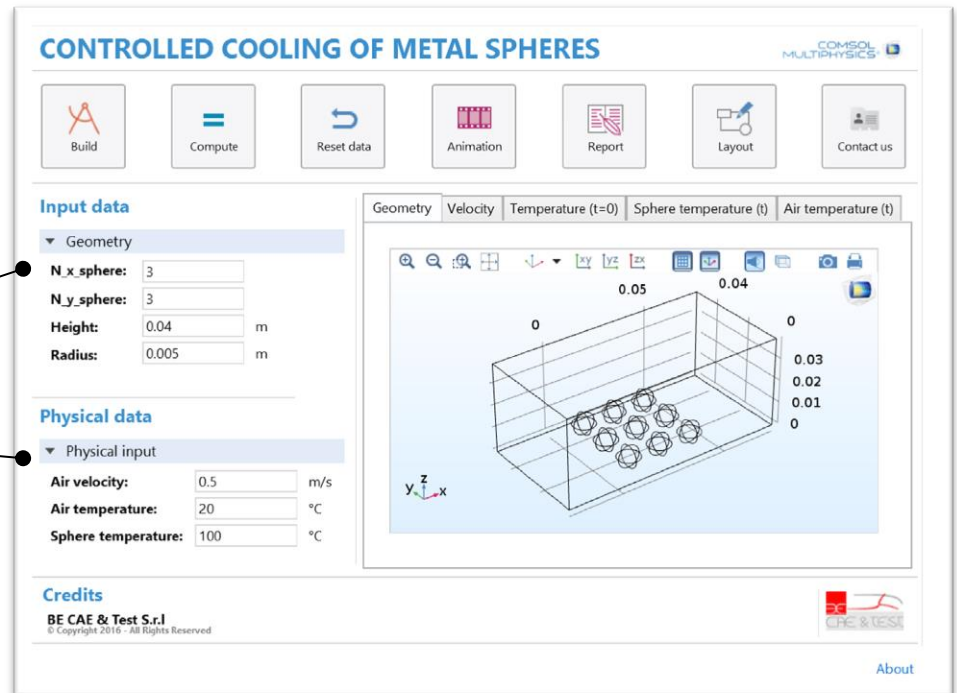
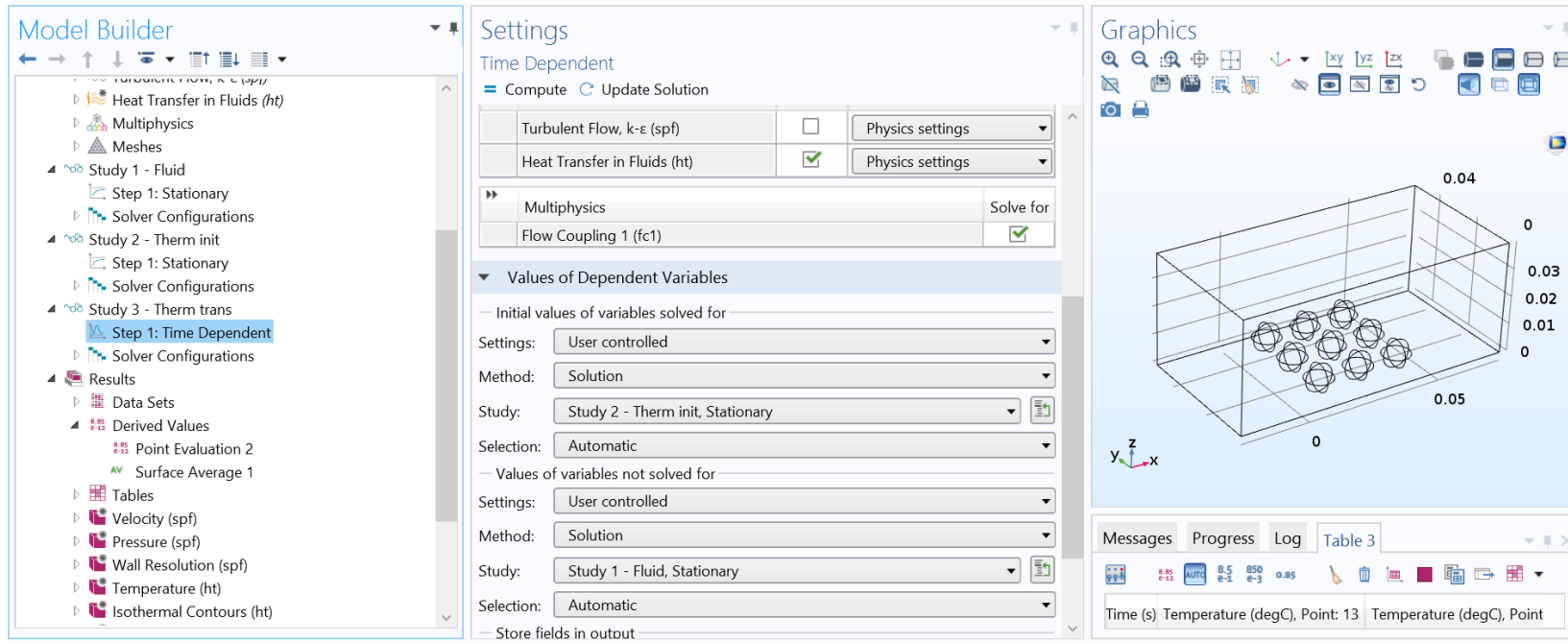**Definition of probes (parametric also)**

Parametric» analysis

- **Derived values (**time-evolution of the «core» temperature for each sphere, time-evolution of the average temperature of out-flowing air**)**

Physics setting
(Specific BC are used for computing specific initial thermal states exploited as initial solution for transient analysis**)**
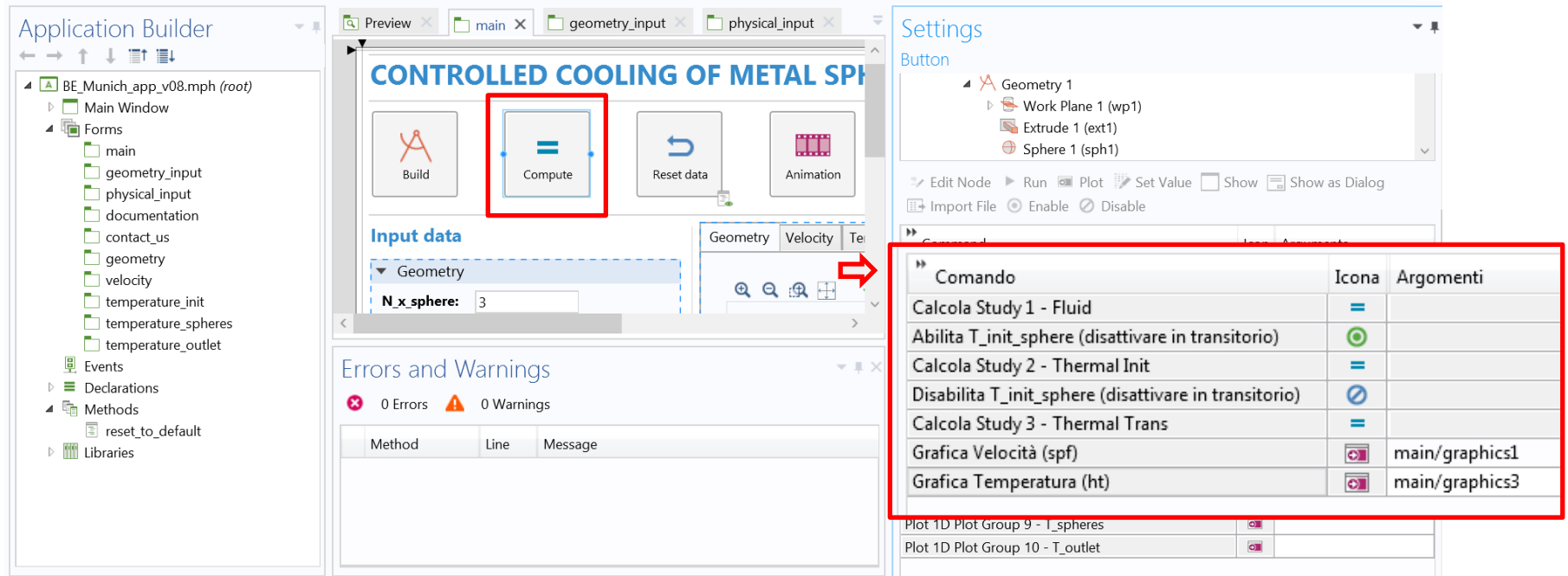
«Manual» work-flow by using the embedded model:

- Run < Study 1 – Fluid > for solving the velocity and pressure fileds

  Waiting for solution

- Set (enable) specific BCs (surface spheres temperature)

- Run < Study 2 – Therm init > to get a specific thermal state (or distribution) at the initial time

  Waiting for solution

- Disable specific BCs (surface spheres temperature)

- Run < Study 3 – Therm trans > to perform the transient analysis

«Manual» work flow by using the embedded model:

- Run < Study 1 – Fluid > for solving the velocity and pressure fileds

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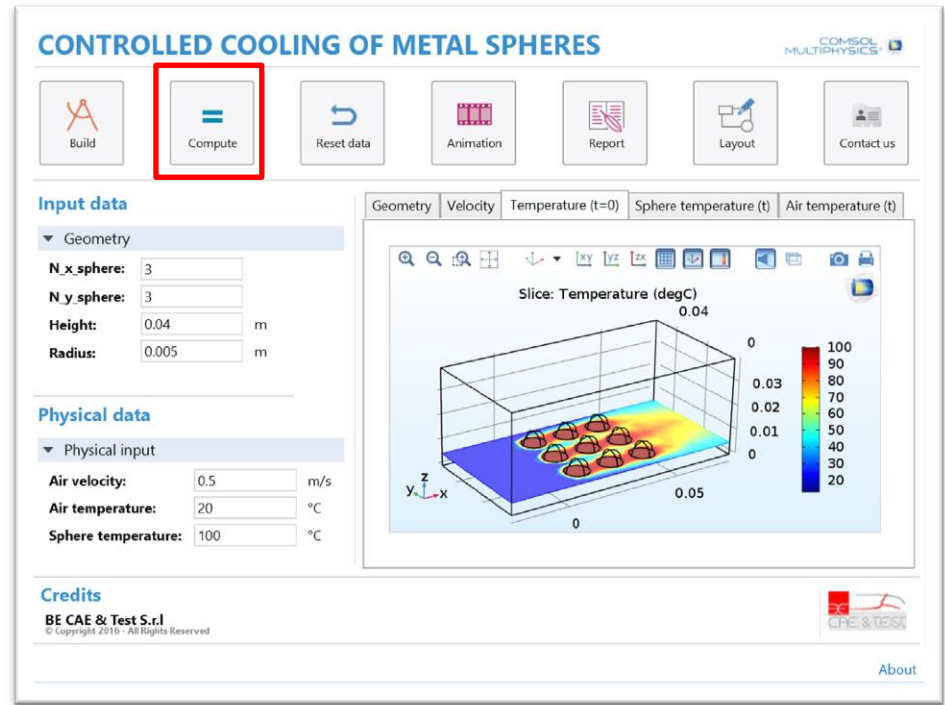- Run < Study 3 – Therm trans > to perform the transient analysis

➢ **The Application Builder allows to EXECUTE a «work-flow» of commands by a single «action button»**

«Manual» work flow by using the App:

- Click the «Compute» buttom ….

FROM MODEL TO APP

«Manual» work flow by using the embedded model:

- Run < Study 1 – Fluid > for solving the velocity and pressure fileds

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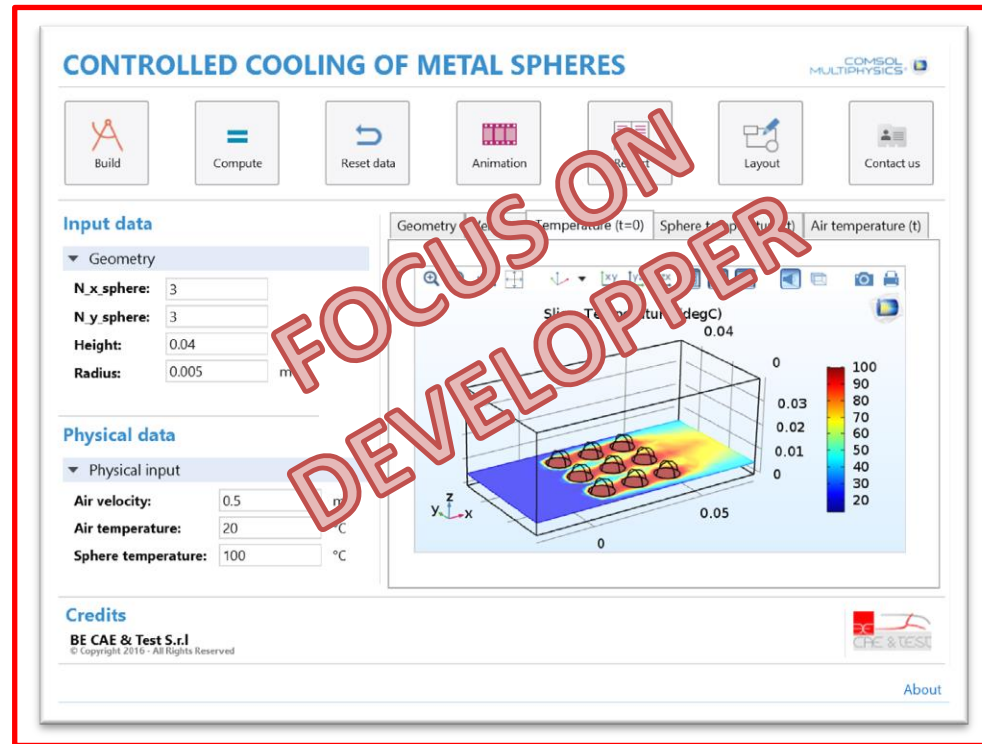
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PEC: info@pec.be-caetest.it

FROM MODEL TO APP

THANK YOU!

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