EURO

SLING

Primer tranzientne analize

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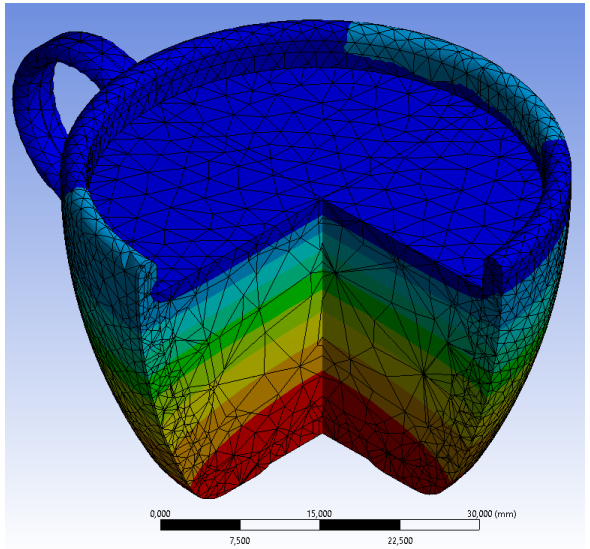
Transient analysis

- the evaluation of how a system responds to fixed and varying boundary conditions over time.
  - For fixed boundary conditions; the time to reach a steady state temperature.
  - For time-varying boundary conditions; can show the resulting thermal response.
- Many heat transfer applications involve transient thermal analyses:
  - Heat treatment problems
  - Electronic package design
  - Nozzles
  - Engine blocks
  - Pressure vessels



Transient analysis

- Thermodynamics: the principle of energy conservation

Energy input in the system

=

Energy output from system

+

Energy stored inside the volume

$\sum_k E_k$=constant

Transient analysis

- heat conduction through a solid:

$$k\left(\frac{\partial^2 T}{\partial x^2}+\frac{\partial^2 T}{\partial y^2}+\frac{\partial^2 T}{\partial z^2}\right)+q=\rho c\frac{\partial T}{\partial t}$$

Transient Term

$$k\nabla^2 T+q=\rho c\frac{\partial T}{\partial t}$$

heat conduction

heat flux/convection/ radiation/internal heat generation inside the volume

Energy stored inside the volume

k= Thermal conductivity $[W/K\cdot m]$
t= Time$T$= Temperature $[K]$
q= Rate of heat flux/convection/ radiation/internal heat generation inside the volume $[W]$
ρ= Density of the material $[kg/m3]$
c= Specific heat of the material $[J/kg\cdot K]$

Transient analysis

- Initial temperatures
  - A transient thermal analysis involves loads that are functions of time.
  - The first step in applying transient thermal loads is to establish the initial temperature distribution at time = 0.
  - Initial temperatures do not matter in steady-state analyses.
  - Initial temperatures are very important in transient analyses.
  - Leaving ice water and hot tea in the sun for 5 mins, the final temperatures will be different.

Transient analysis

- Thermal Capacitance
  - The product of density (ρ), specific heat (c) and volume (V) for a body is the **thermal capacitance** (C).
  - We can call the product $\boldsymbol{\rho c}$ the **thermal capacitance term**, which indicates the ability of the body to store thermal energy.
  - The larger the thermal capacitance term, the more time it will take to heat the body and vice-versa.

thermal capacitance term

$$k\left(\frac{\partial^2 T}{\partial x^2}+\frac{\partial^2 T}{\partial y^2}+\frac{\partial^2 T}{\partial z^2}\right)+q=\rho c\frac{\partial T}{\partial t}$$

  - In matrix form the transient thermal heat conduction can be written as:

$$C\{\dot{T}\}+K\{T\}=Q\{t\}$$

Thermal Capacitance Matrix — Thermal Conductivity Matrix — Heat Rate Vector

Before we start

- Login to NoMachine
- Copy files for the analysis

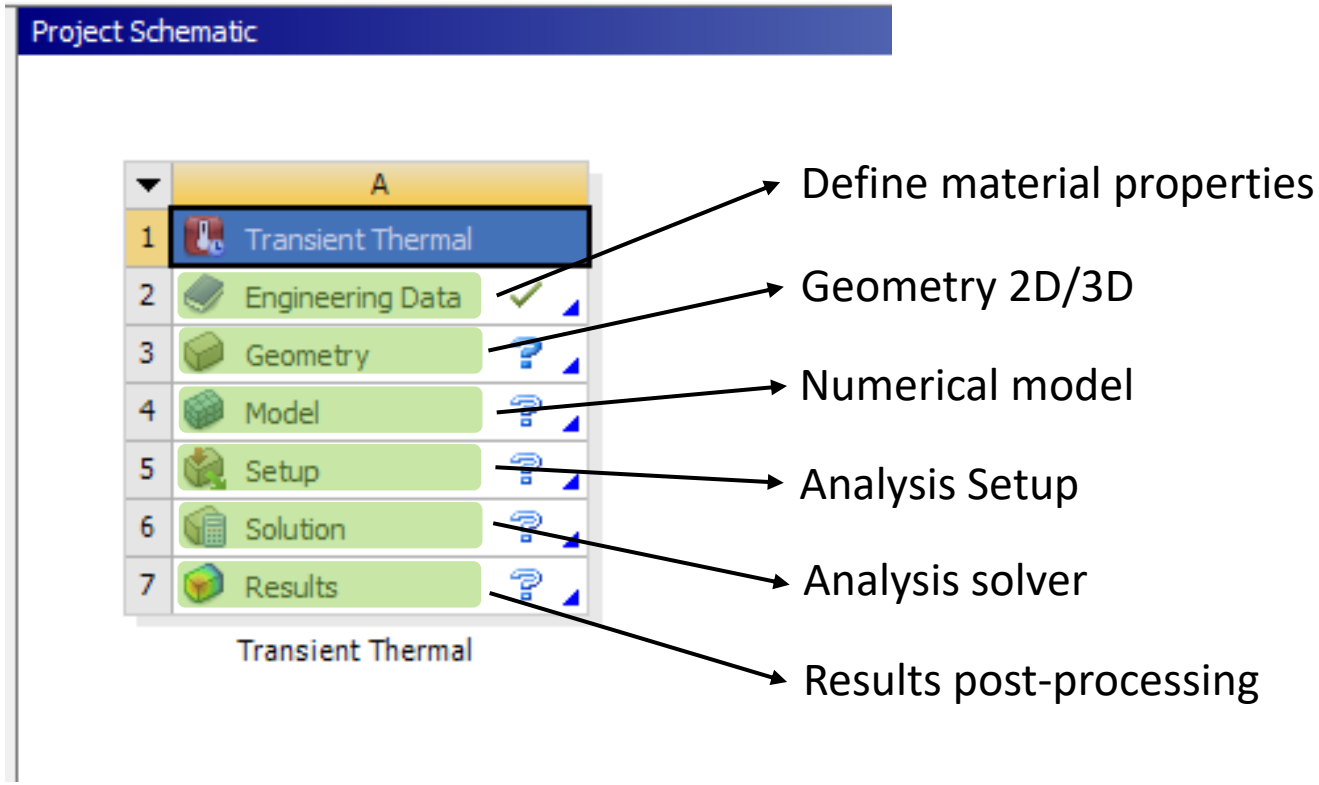
```
cp -R /tmp/EuroCC_HPC_FEM/Day_3 ./
```

- Open Ansys

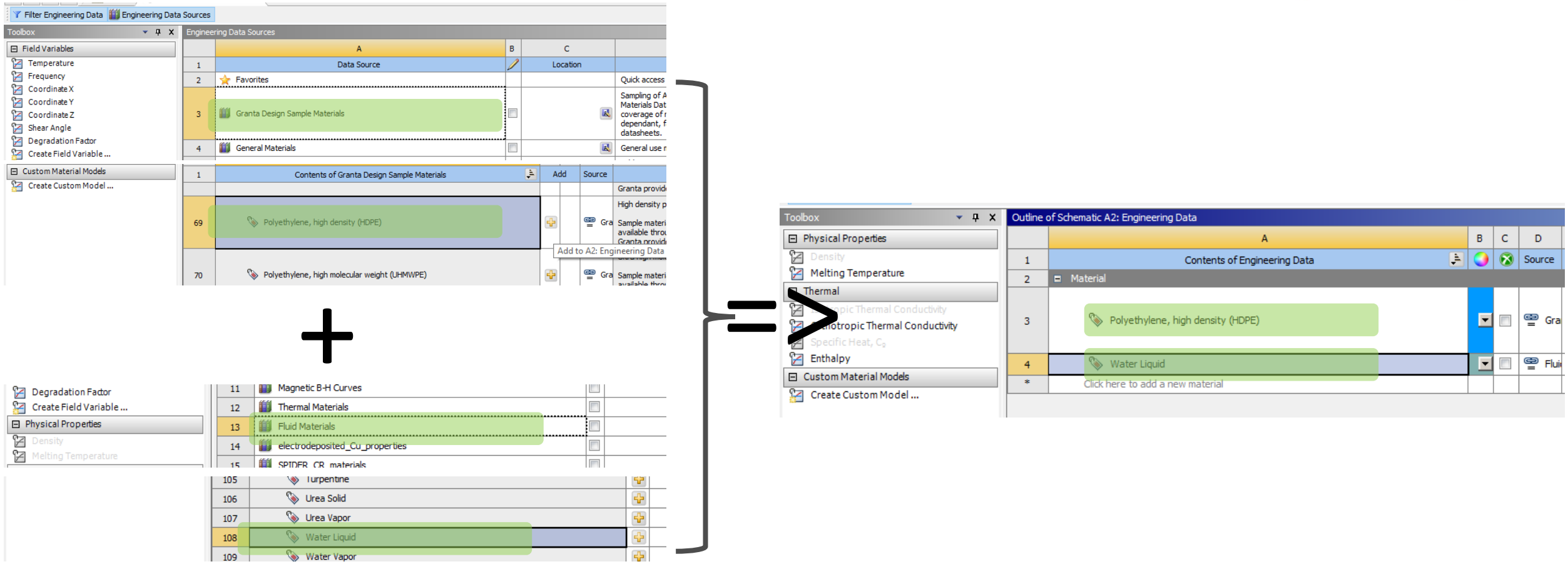
```
[user@viz ~]$ module load ANSYS
[user@viz ~]$ runwb2
```

Analysis setting

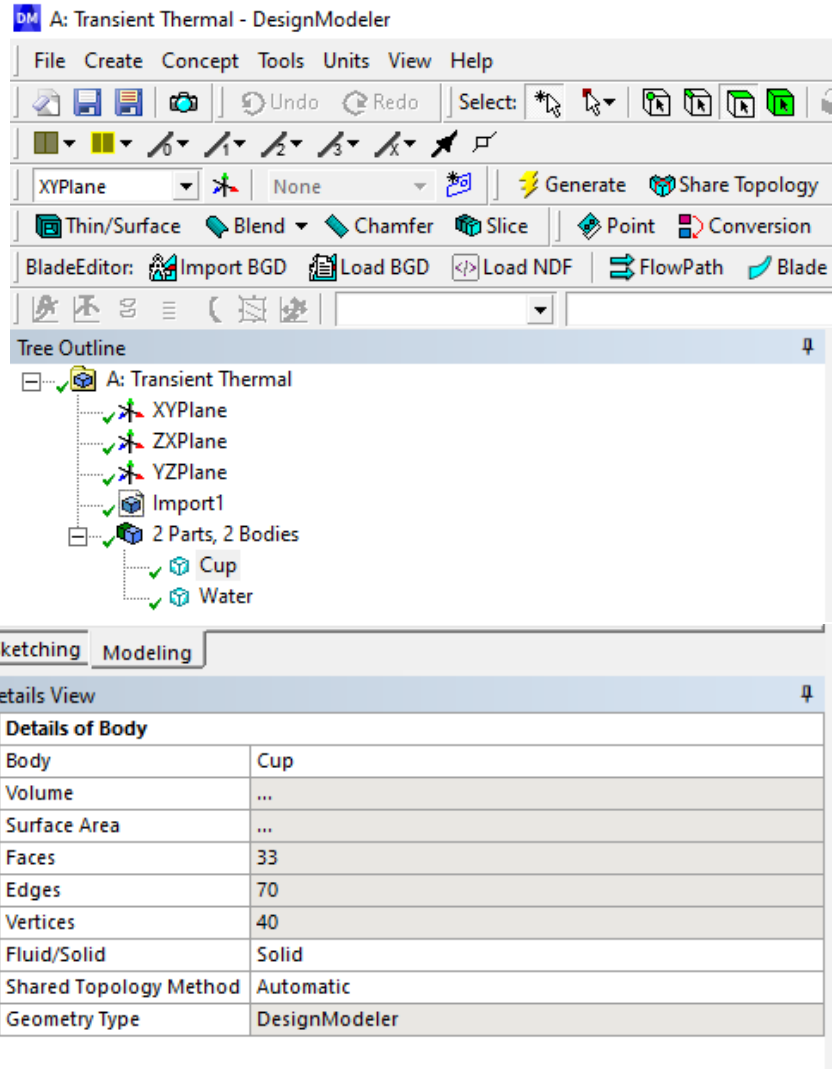
Choose Transient Thermal analysis

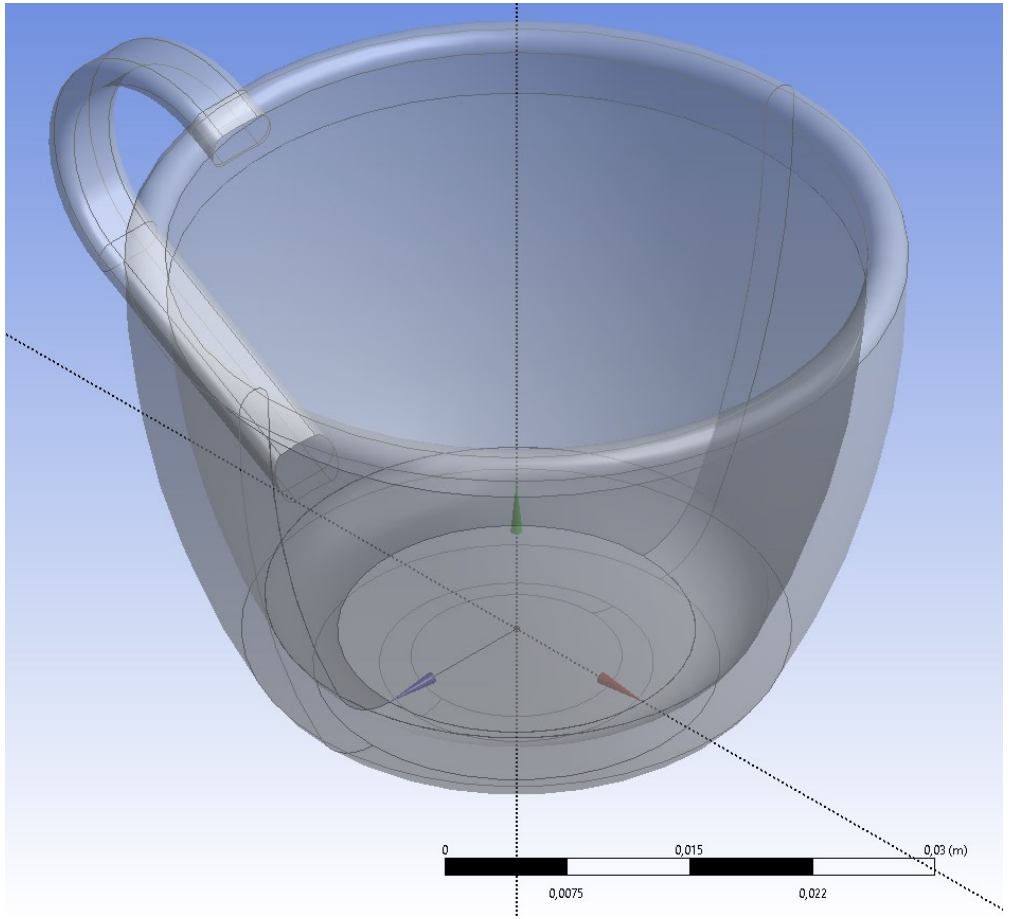


Defining the material

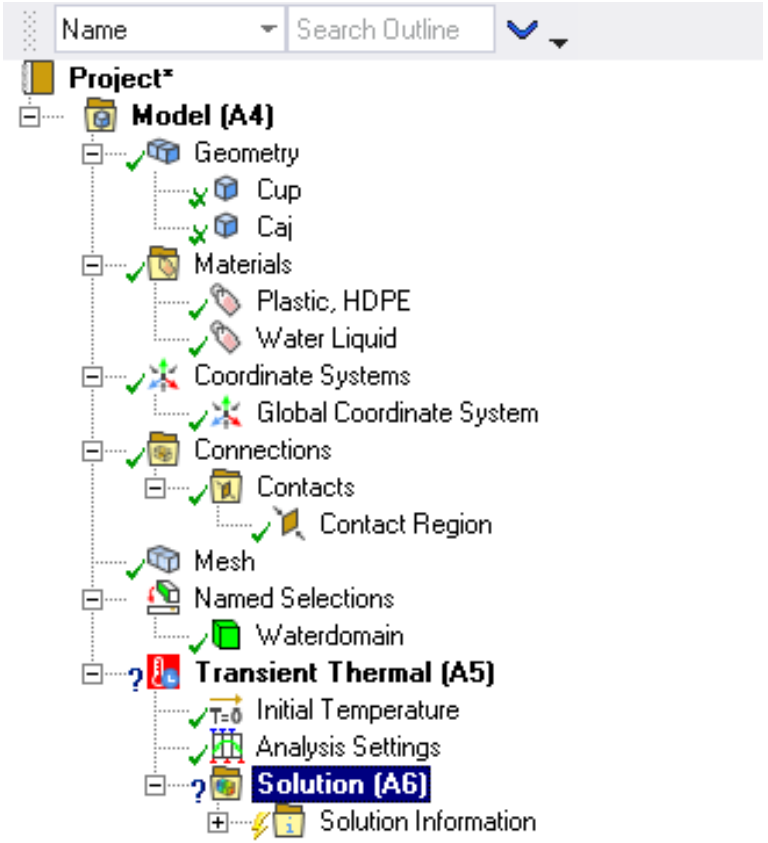


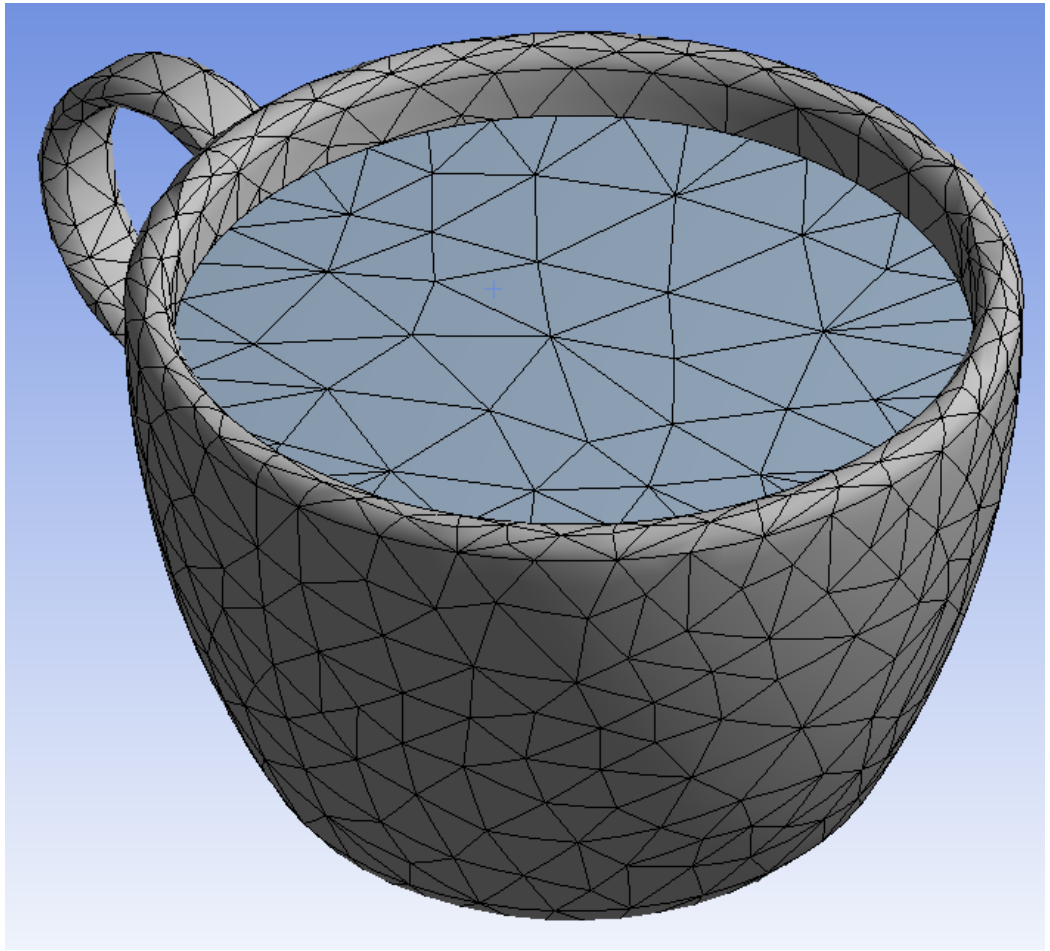
Geometry


A: Transient Thermal - DesignModeler
File Create Concept Tools Units View Help
Undo Redo Select:
XYPlane None Generate Share Topology
Thin/Surface Blend Chamfer Slice Point Conversion
BladeEditor: Import BGD Load BGD Load NDF FlowPath Blade
Tree Outline
A: Transient Thermal
XYPlane
ZXPlane
YZPlane
Import1
2 Parts, 2 Bodies
Cup
Water
Sketching Modeling
Details View
Details of Body
Body Cup
Volume ...
Surface Area ...
Faces 33
Edges 70
Vertices 40
Fluid/Solid Solid
Shared Topology Method Automatic
Geometry Type DesignModeler


0
0,015
0,03 (m)
0,0075
0,022

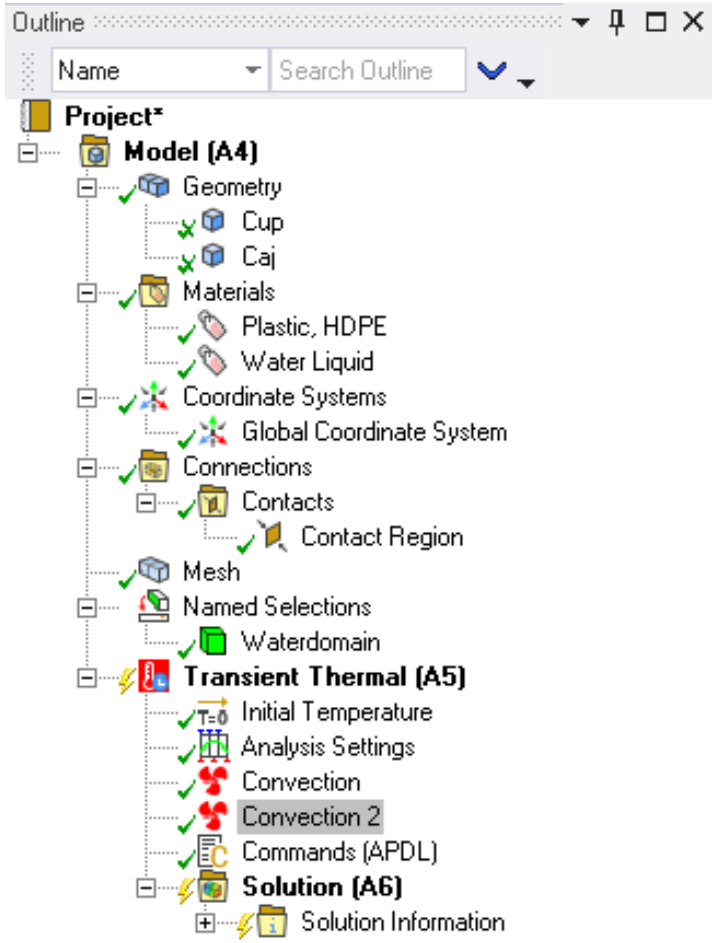
Numerical model

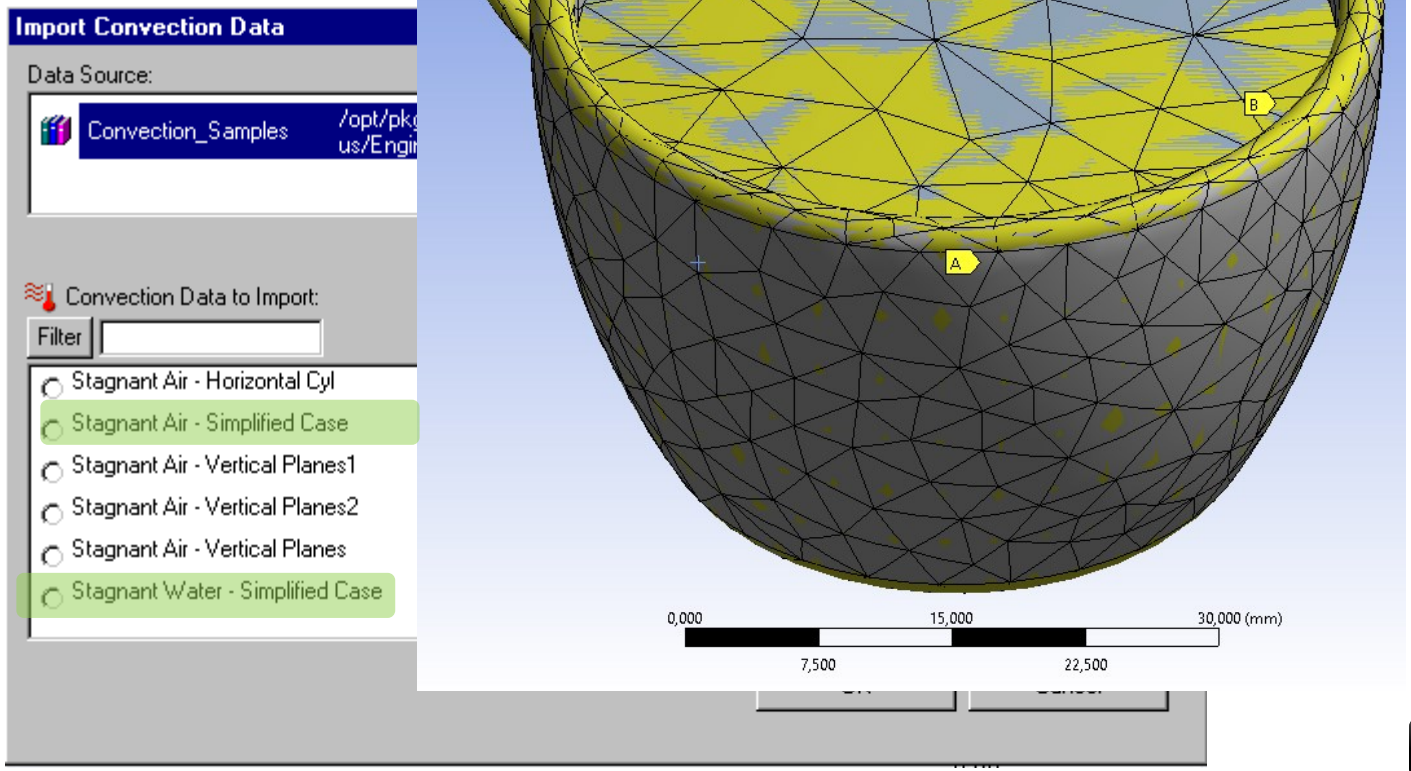




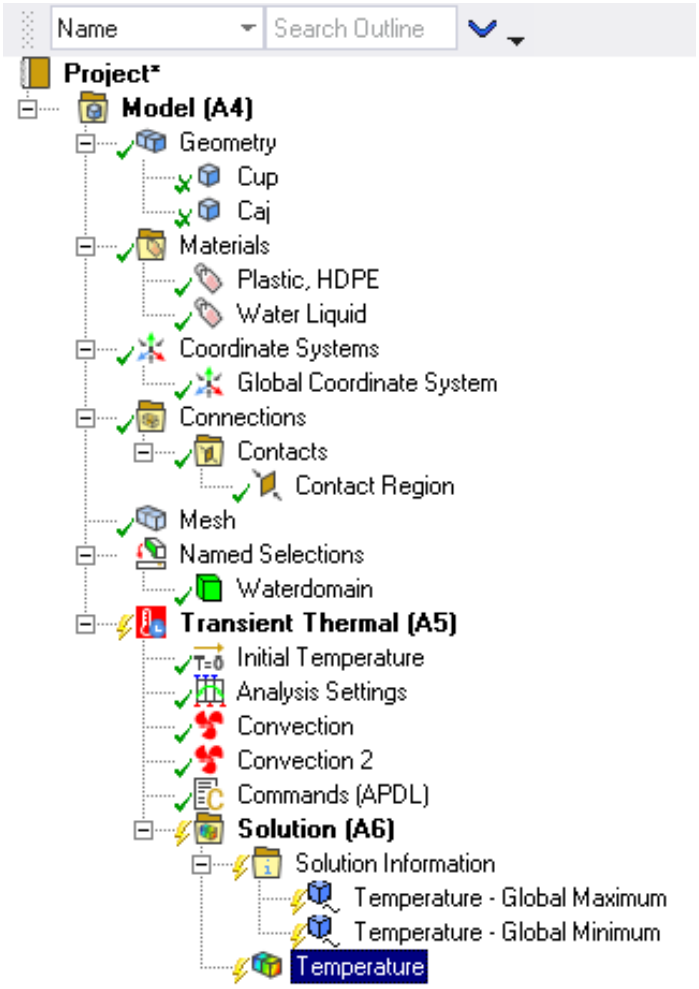
Analysis setup

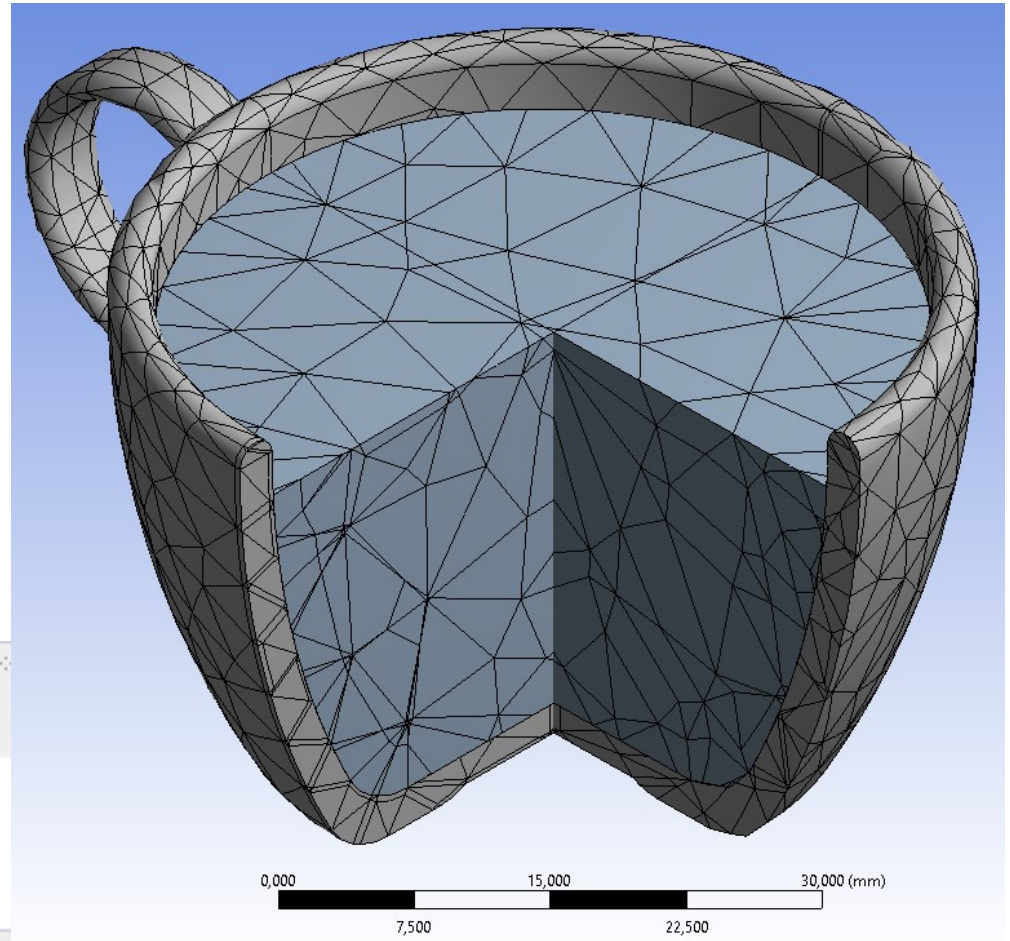
IC,Waterdomain,TEMP,90





Post processing setup

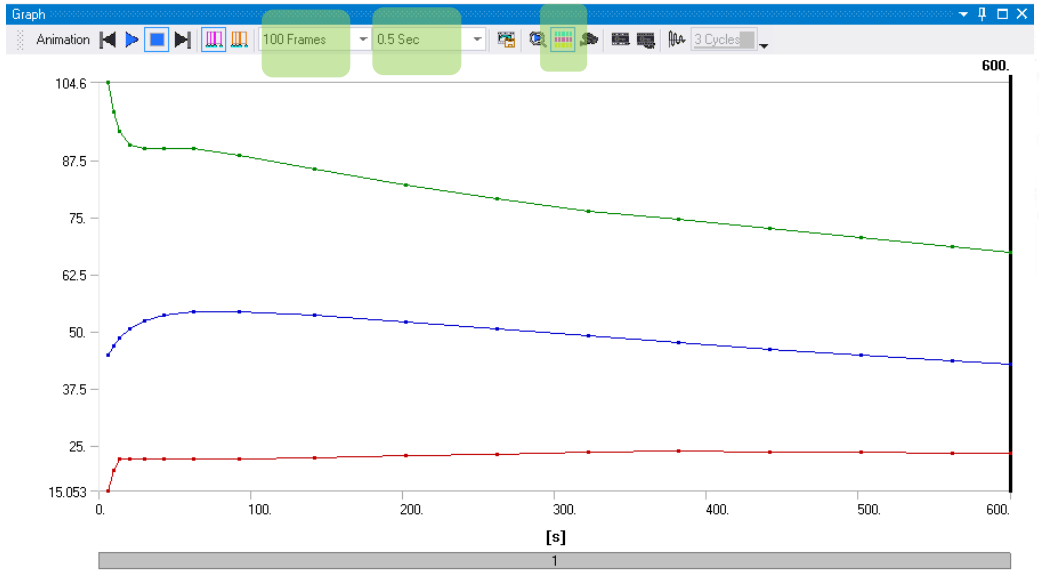


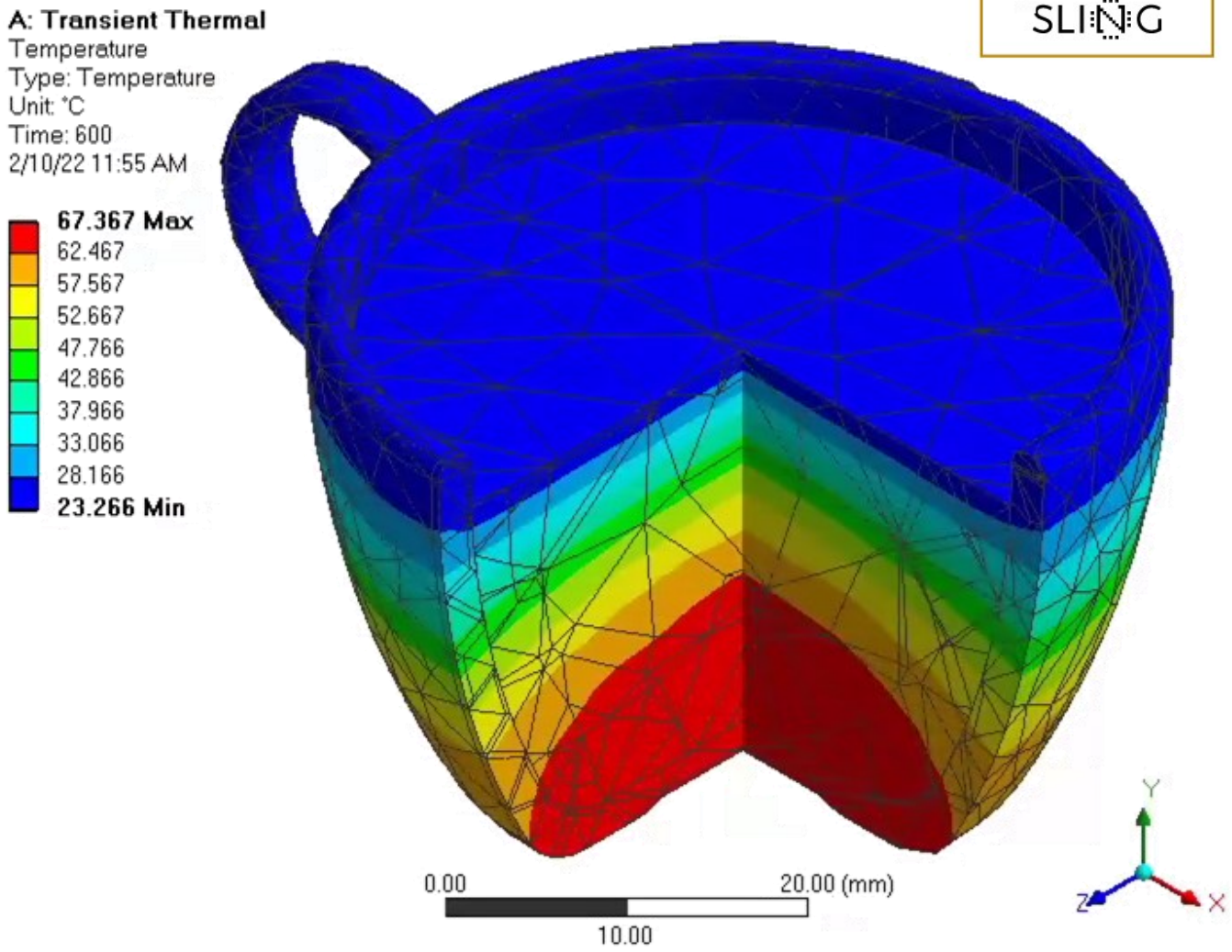


Post processing

Details of "Model (A4)"

Lighting	
Ambient	0.3
Diffuse	0.6
Specular	1
Color	
Filter Options	
Control	Enabled



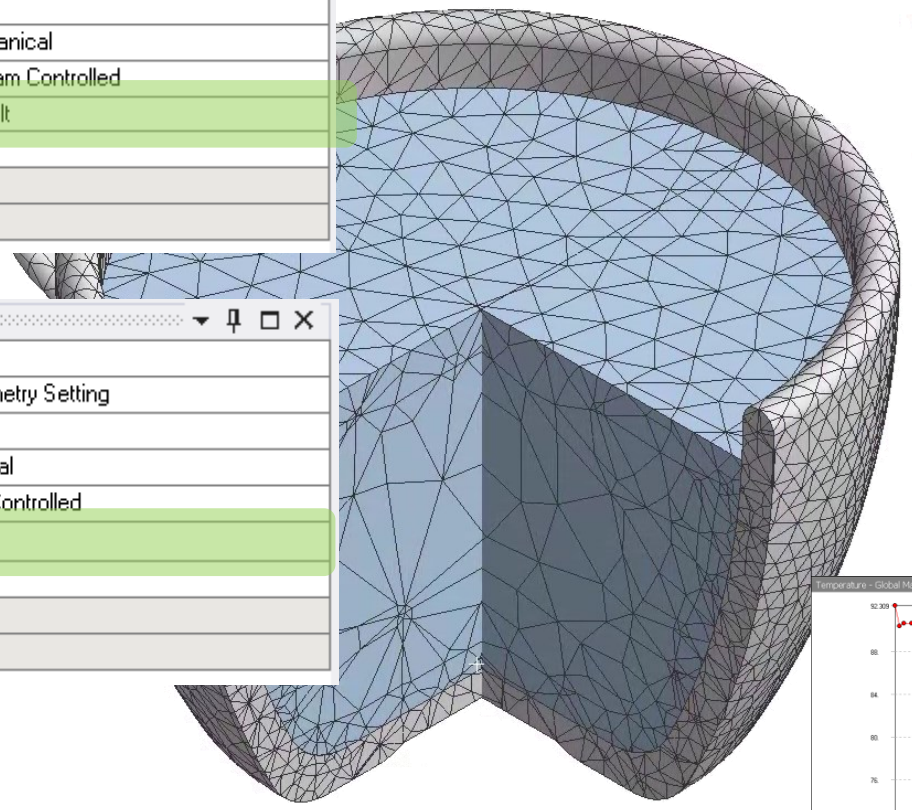


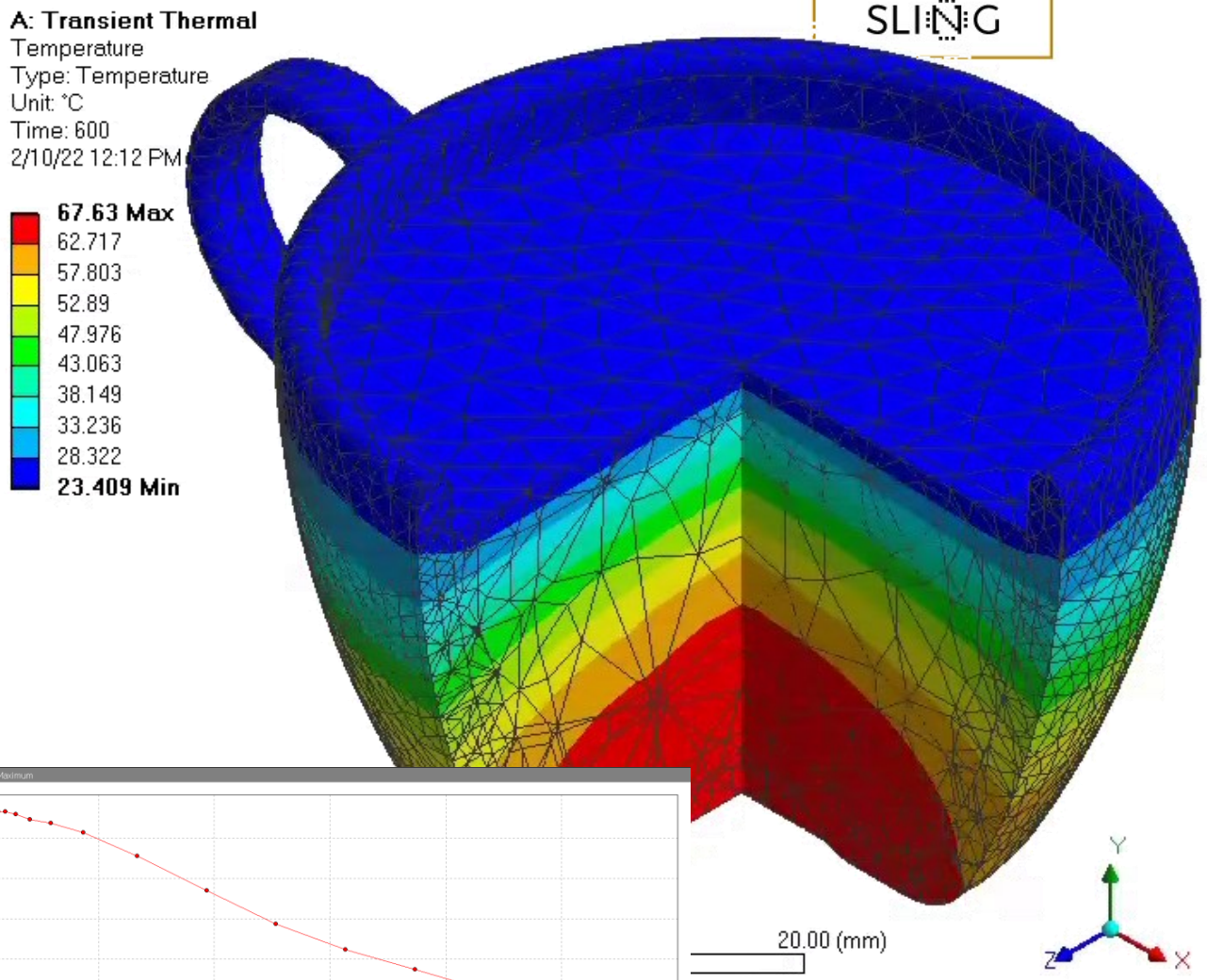
Changing the mesh element size

Element size: 1,5mm

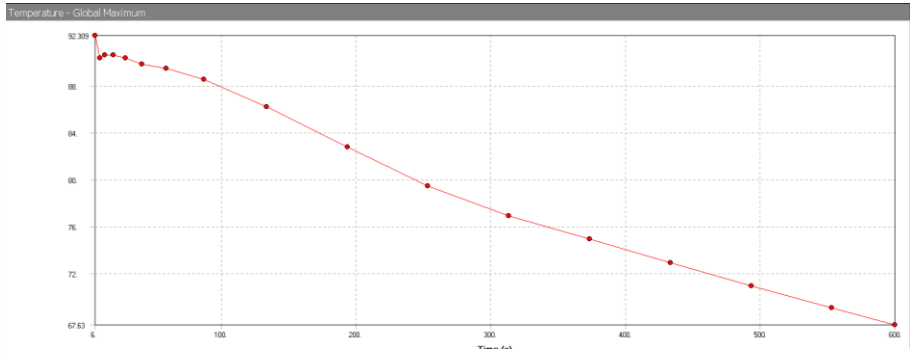
Details of "Mesh"	
Display	
Display Style	Use Geometry Setting
Defaults	
Physics Preference	Mechanical
Element Order	Program Controlled
Element Size	Default
Statistics	
Nodes	7336
Elements	3703

Details of "Mesh"	
Display	
Display Style	Use Geometry Setting
Defaults	
Physics Preference	Mechanical
Element Order	Program Controlled
Element Size	1.5 mm
Statistics	
Nodes	47526
Elements	26640

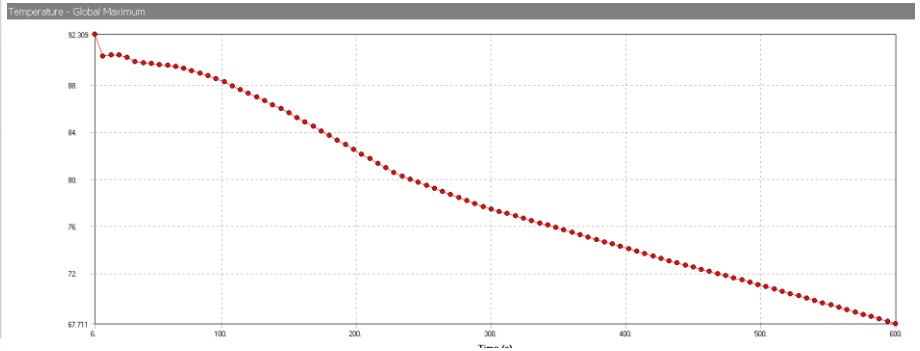




Changing the time step

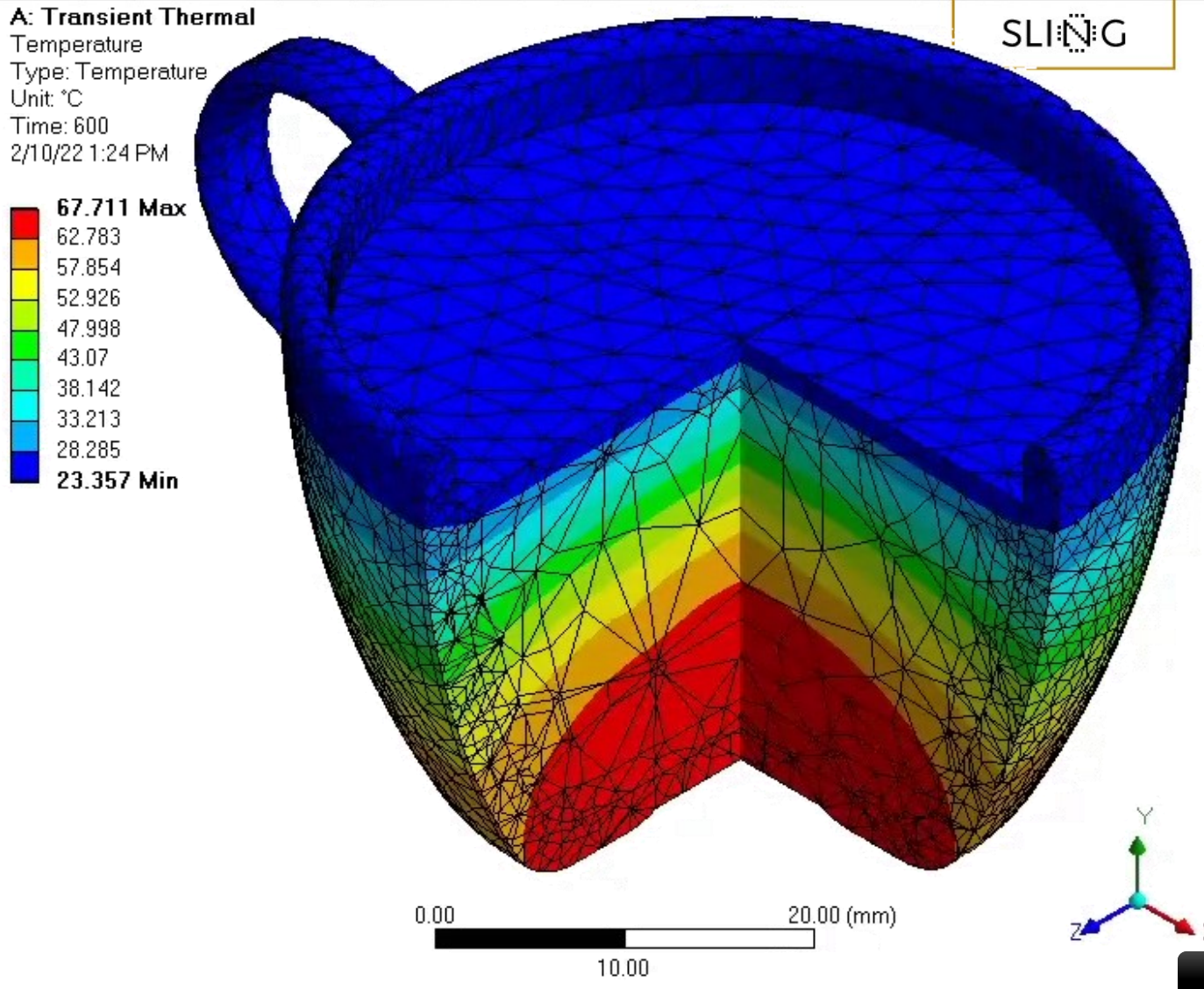


Timestep: 6 sec



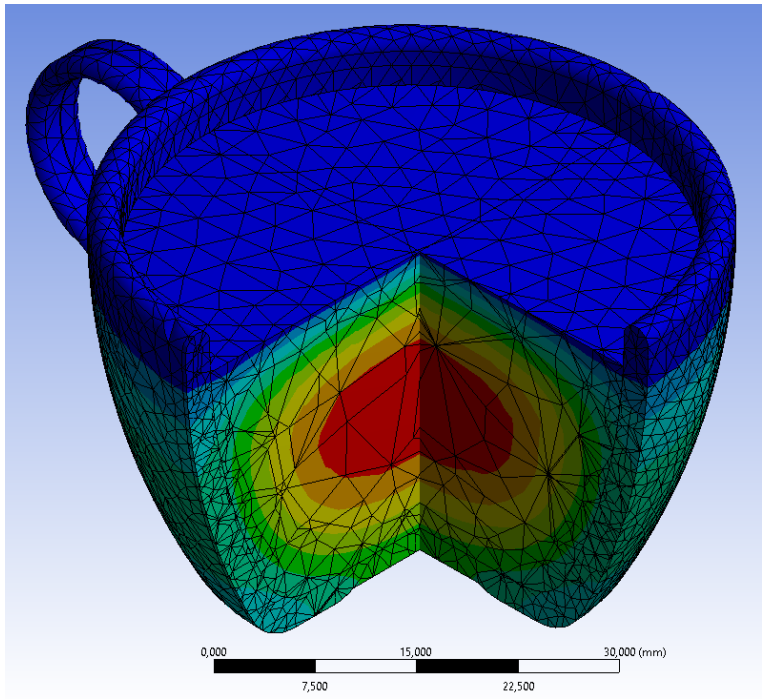
Details of "Analysis Settings"

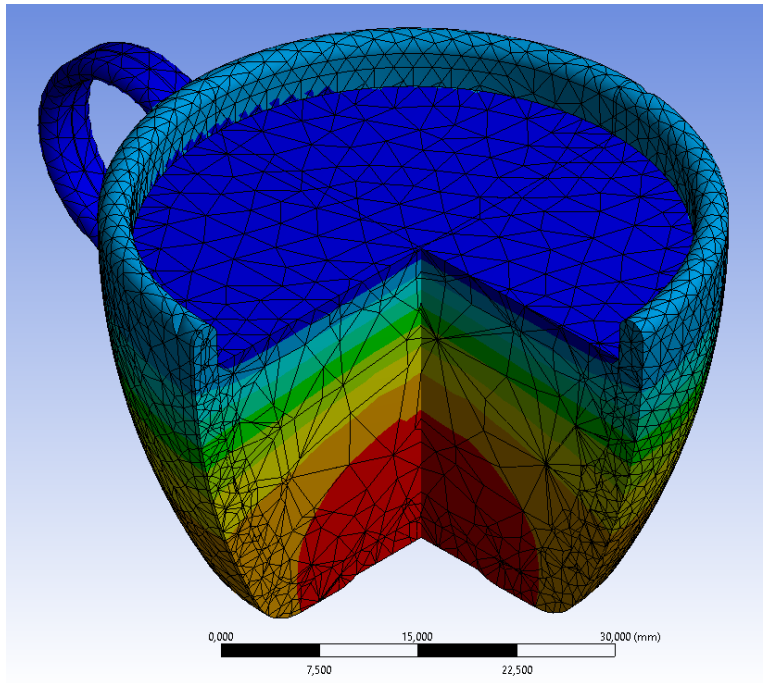
Step Controls	
Number Of Steps	1.
Current Step Number	1.
Step End Time	600. s
Auto Time Stepping	Off
Define By	Time
Time Step	6. s
Time Integration	On

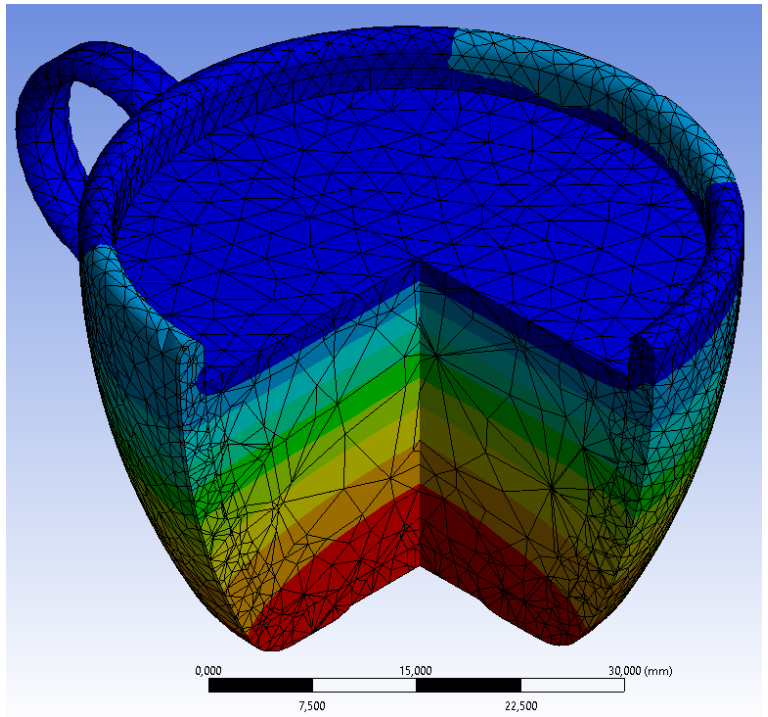


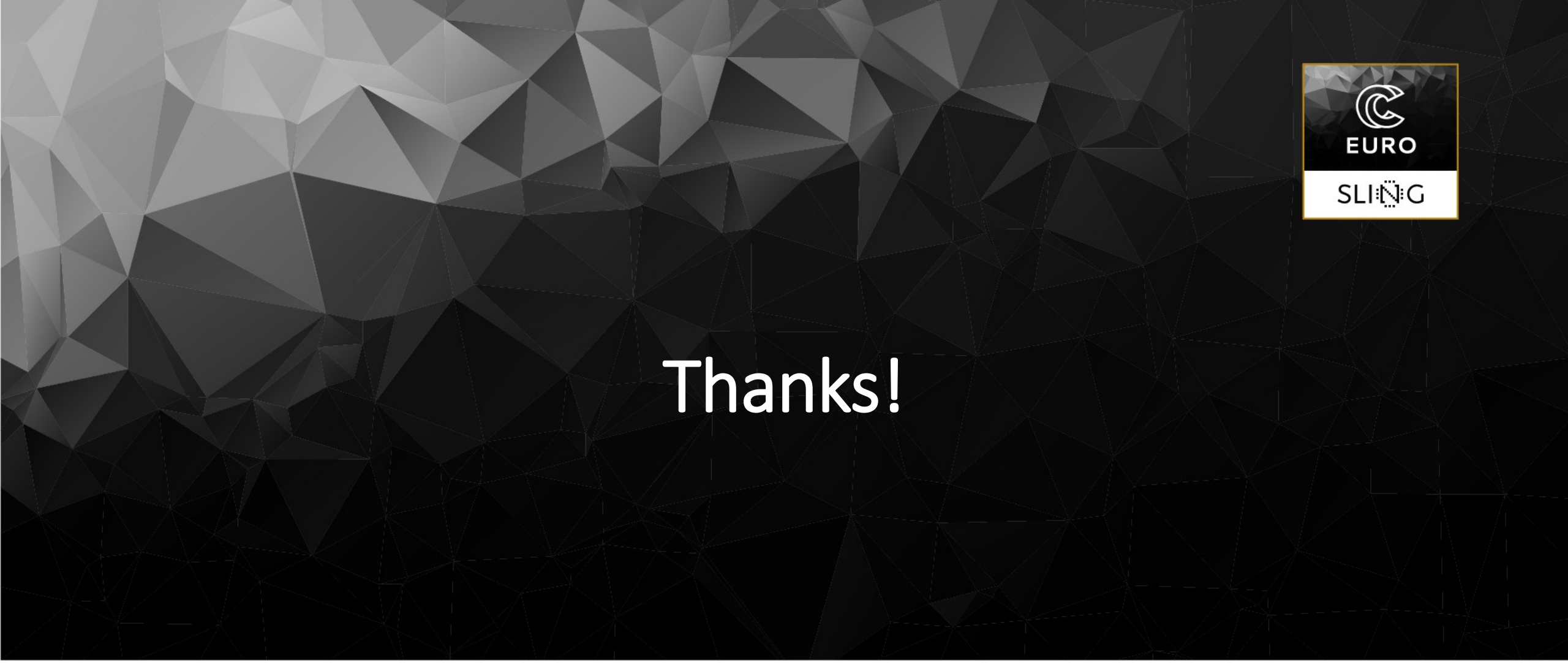
Your changes

- Better mesh?
- Timestep?









Thanks!

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