

Bottle in the Sauna

Real-world application using
Elmer/ElmerGUI

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Problem Outline

” Chilled drink (5 C) from fridge in Sauna (90 C)

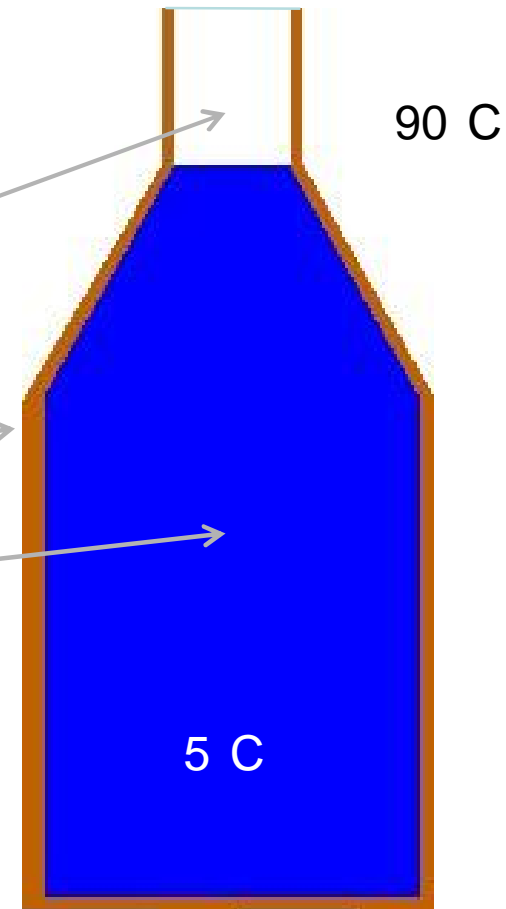
” Bottle:

- Air on top

- Glass (2 mm)

- Drink

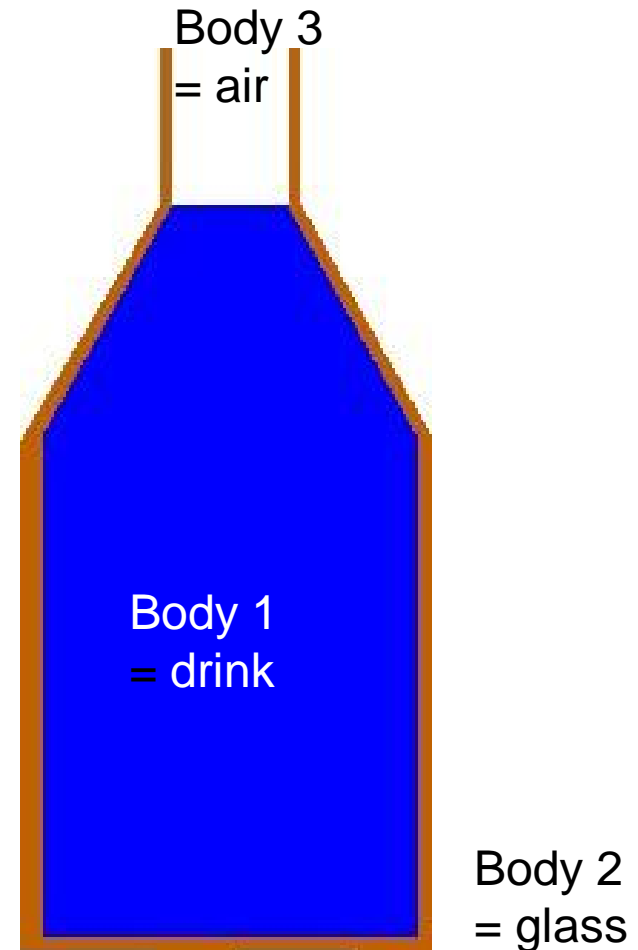
” Task: Temperature after 5 minutes in Sauna?



On Bodies and Boundaries



- “ A **body** is a **distinct region of the model**
- “ Characterized by **different material** and/or different **physical models**



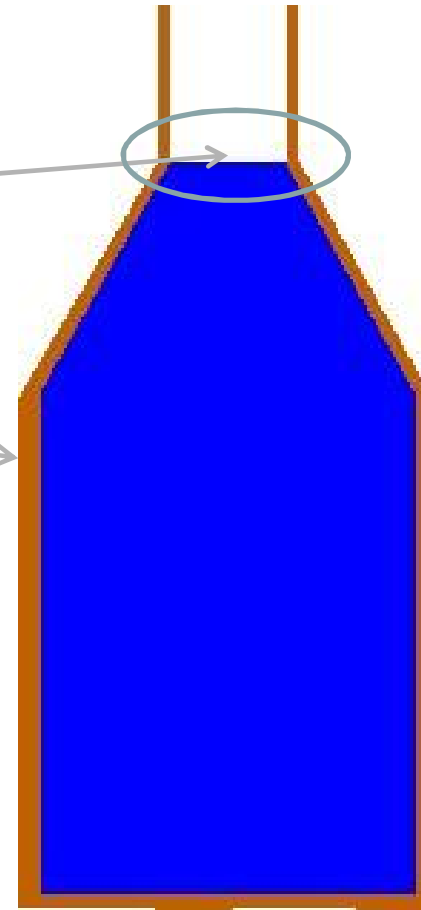
On Bodies and Boundaries



“ A **boundary** is a lower dimensional entity between **two bodies** or the **confinement of a body**

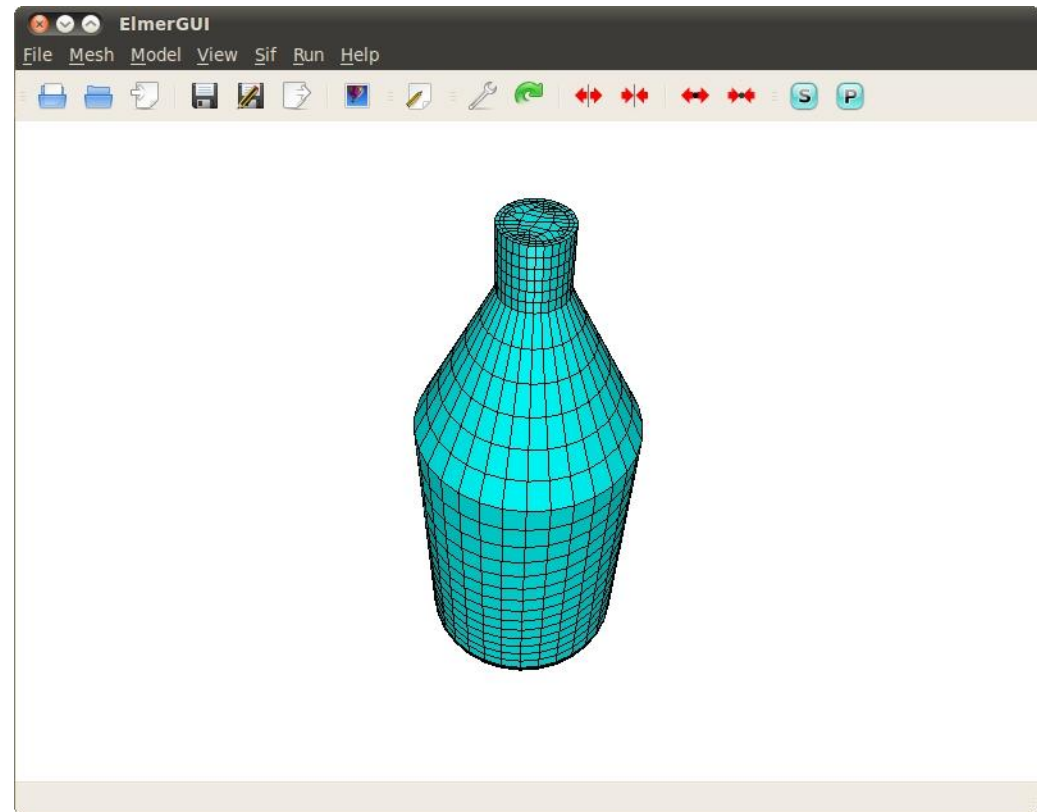
“ **Boundary conditions:**

- . Dirichlet (value)
- . Neumann (gradient)



Read the model

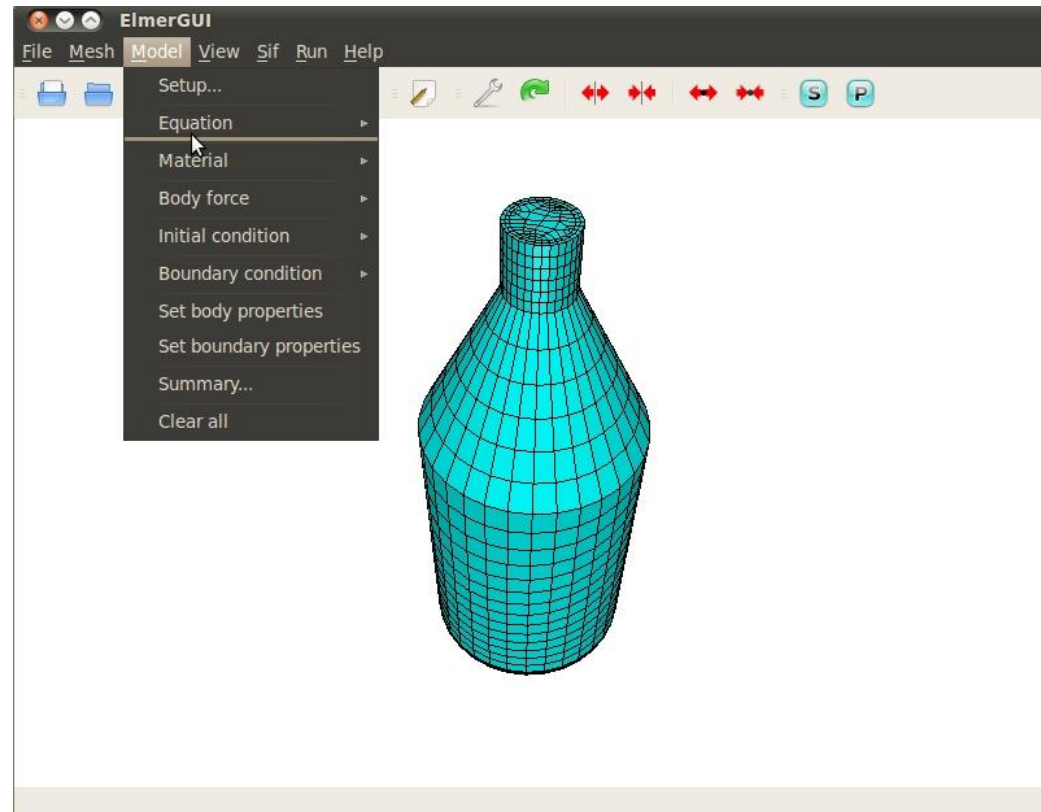
- “ **File** **Open**
- “ Look for folder containing your files
- “ Choose (Fidap neutral) beerbottle.
FDNEUT



Setup of model



- “ Chronological order
- “ Accessed via **Model Setup/Equation/...**



Setup of model



- ” **Model Setup**
- ” Choose Transient
- ” Timestep sizes 10
- ” Timestep intervals 360 (one hour)
- ” Rest: default
- ” **Apply**

The screenshot shows a 'Setup' dialog box with the following sections and fields:

- Header**
 - Check keywords warn
 - MeshDB: . [] . []
 - Include path: []
 - Results directory: []
- Simulation**
 - Max. output level: 4 (dropdown)
 - Steady state max. iter: 1 (input)
 - Coordinate system: Cartesian (dropdown)
 - Timestepping method: BDF (dropdown)
 - Coordinate mapping: 1 2 3 (input)
 - BDF order: 1 (dropdown)
 - Simulation type: Transient (dropdown)
 - Timestep intervals: 360 (input)
 - Output intervals: 1 (input)
 - Timestep sizes: 10 (input)
 - Solver input file: case.sif (input)
 - Post file: case.ep (input)
- Constants**
 - Gravity: 0 -1 0 9.82 (input)
 - Stefan Boltzmann: 5.67e-08 (input)
 - Vacuum permittivity: 8.8542e-12 (input)
 - Boltzmann: 1.3807e-23 (input)
 - Unit charge: 1.602e-19 (input)

An 'Apply' button with a green checkmark is located at the bottom right of the dialog.

Setup of equation(s)



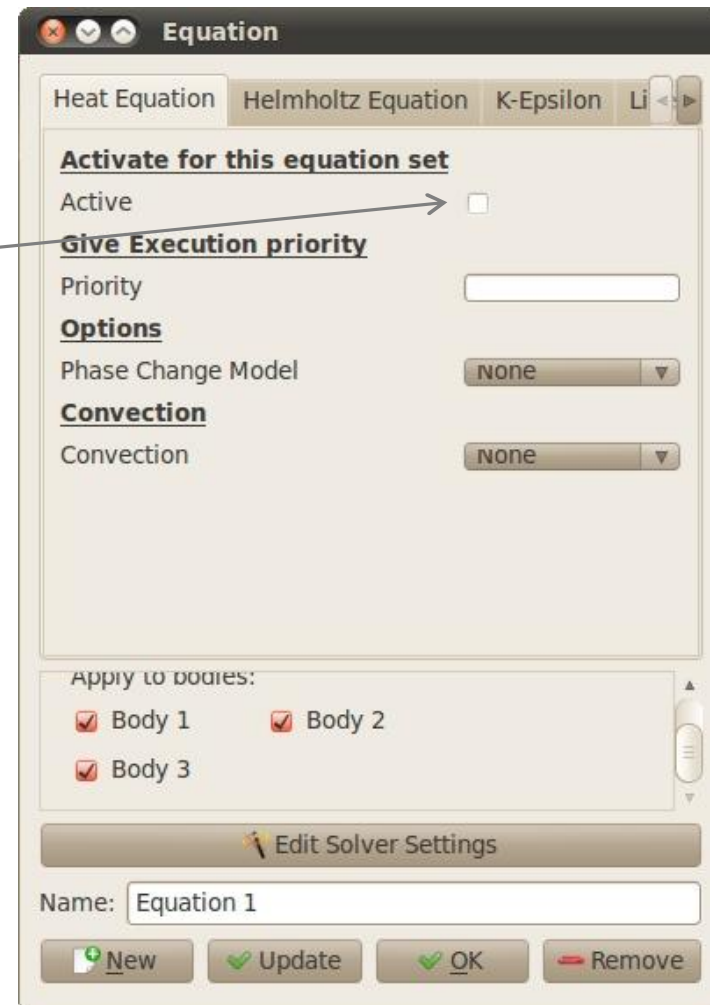
” **Model Equation**

” Tick *Active* (!!)

” Apply to all bodies

” **Update**

” **OK**



Setup of material(s)

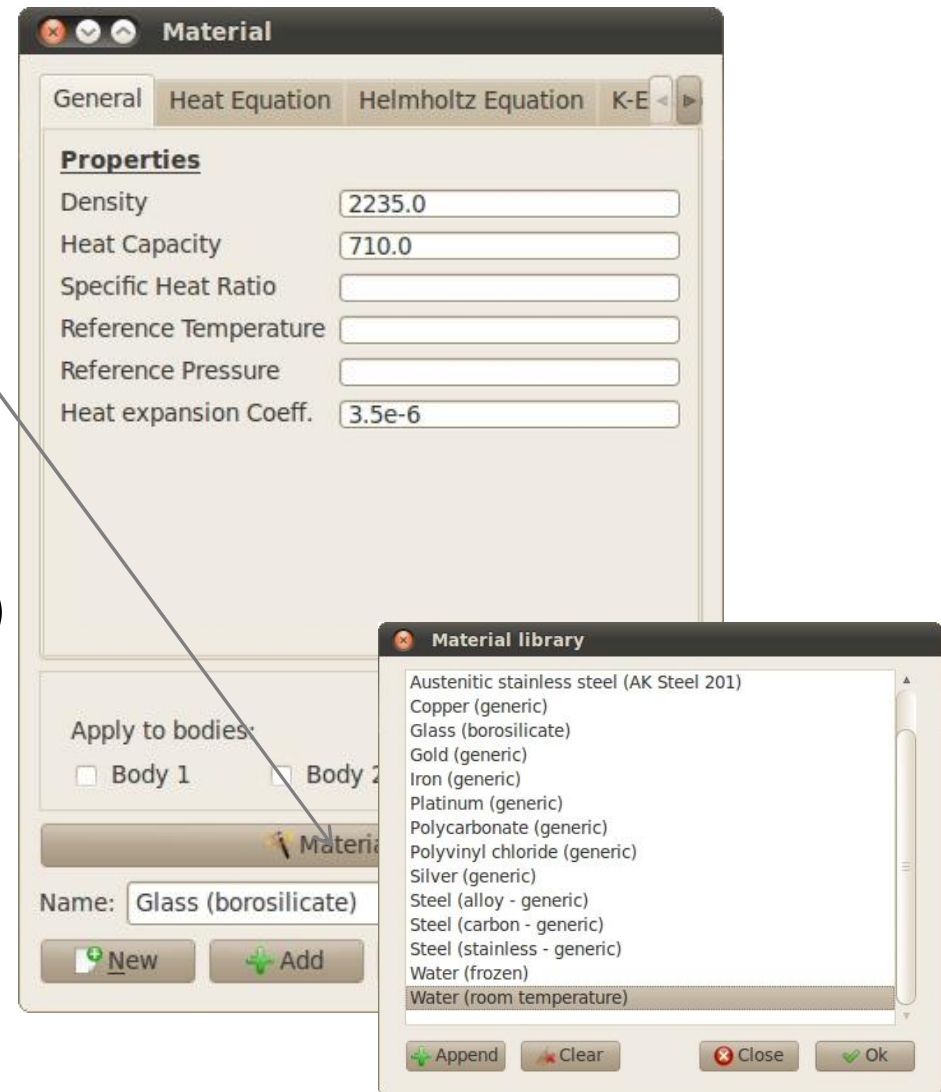
” **Model Material**

” *Use Material library*

1. Water(room temperature) for drink
2. Glass (borosilicate)
3. Air (room temperature)

” After each, press

- . **OK**
- . **Model Material Add...**





Setup of body force(s)

” **Model Body Force**

” Use to add `+right-hand-side+` of PDE

” For example:

- . FlowSolve: gravity
- . HeatSolver: volumetric heat source
- . FreeSurfaceSolver: accumulation/ablation flux

” Not needed this time (so skip it)

Setup of initial condition(s)

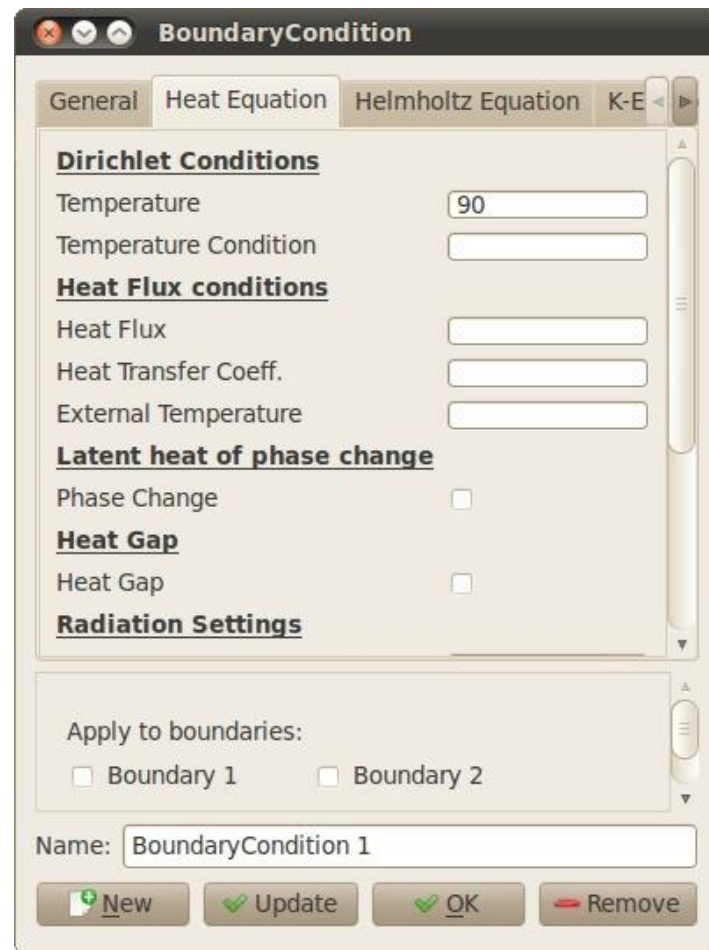


- ” **Model Initial condition Add**
- ” *Heat Equation*
- ” *Temperature 5*
- ” Apply to all bodies
- ” **OK**



Setup of boundary condition(s)

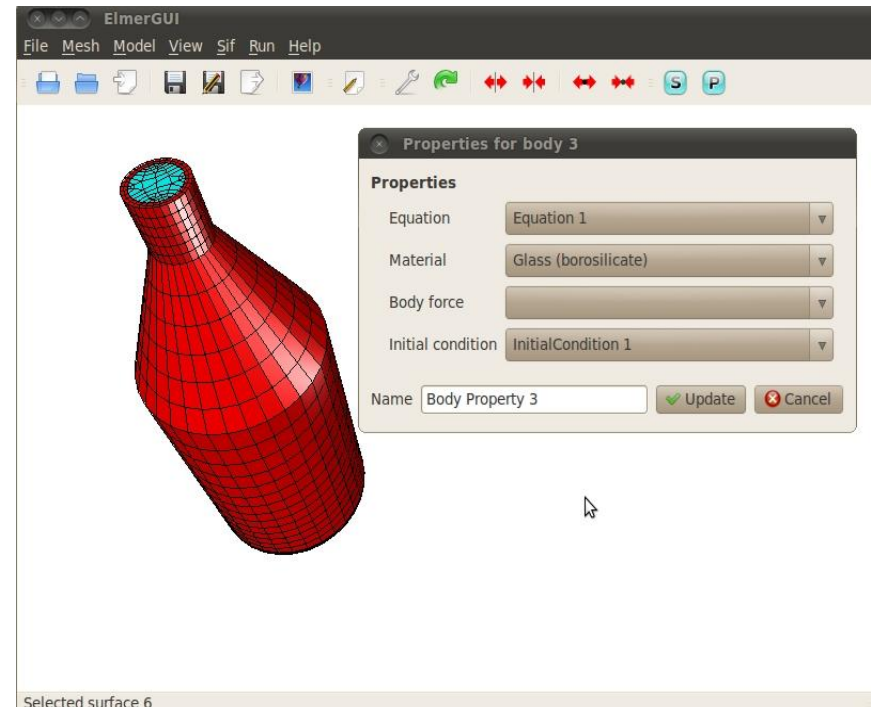
- ” **Model Initial condition Add**
- ” *Heat Equation*
- ” *Temperature 90*
- ” Do not apply to any boundary
- ” **Update**
- ” **OK**



Assignement of bodies boundary conditions



- ” **Model Set body properties**
- ” Double click on glass
 - . Assign Material *Glass*
 - . Assign *Initial Condition 1*
- ” Same with air and water
- ” Hint: hide active bodies with Ctrl+H
- ” **Update**



Assignment of bodies boundary conditions

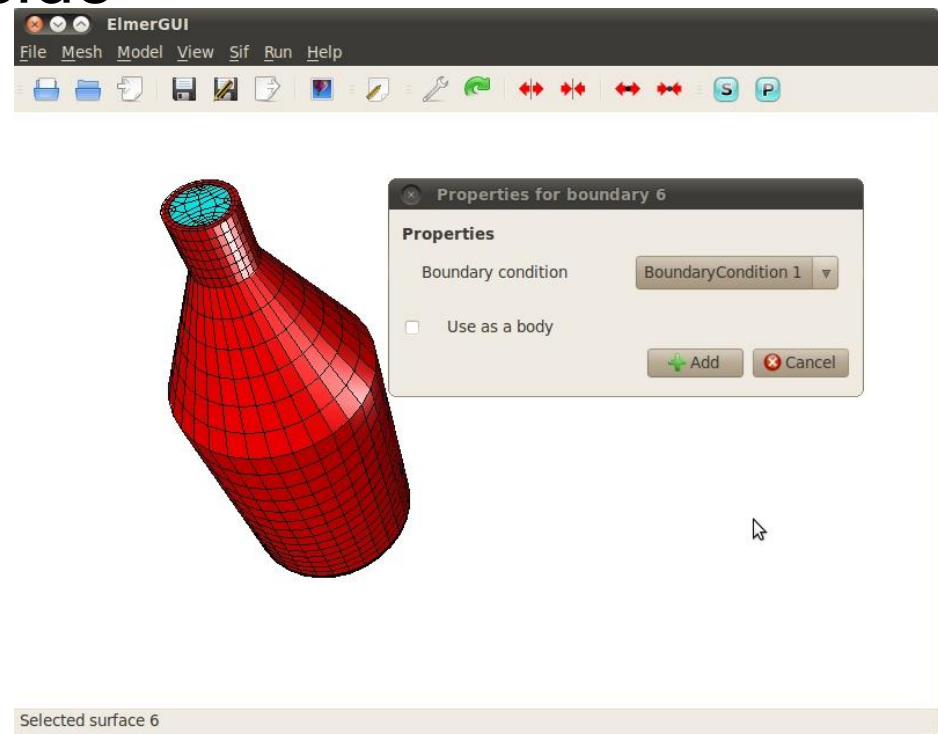


” **Model Set boundary properties**

” Double click on outside of glass

- Assign *Boundary Condition 1*

” **Add**



Towards the simulation

” **Model Summary ...**

- . Checks for consistency of input

” **SIF Generate (Ctrl+G)**

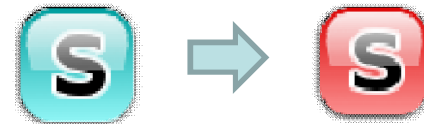
- . SIF = Solver Input File

” Save (mesh and SIF)



” Save (project)

” Congratulations! You are done.

” Run the simulation by pressing





Control the simulation

- “ A log-window and a graphical convergence history is opening
- “ During the simulation, the symbol  stays red
- “ Kill the simulation by:
Run  **Kill Solver**

Post-processing

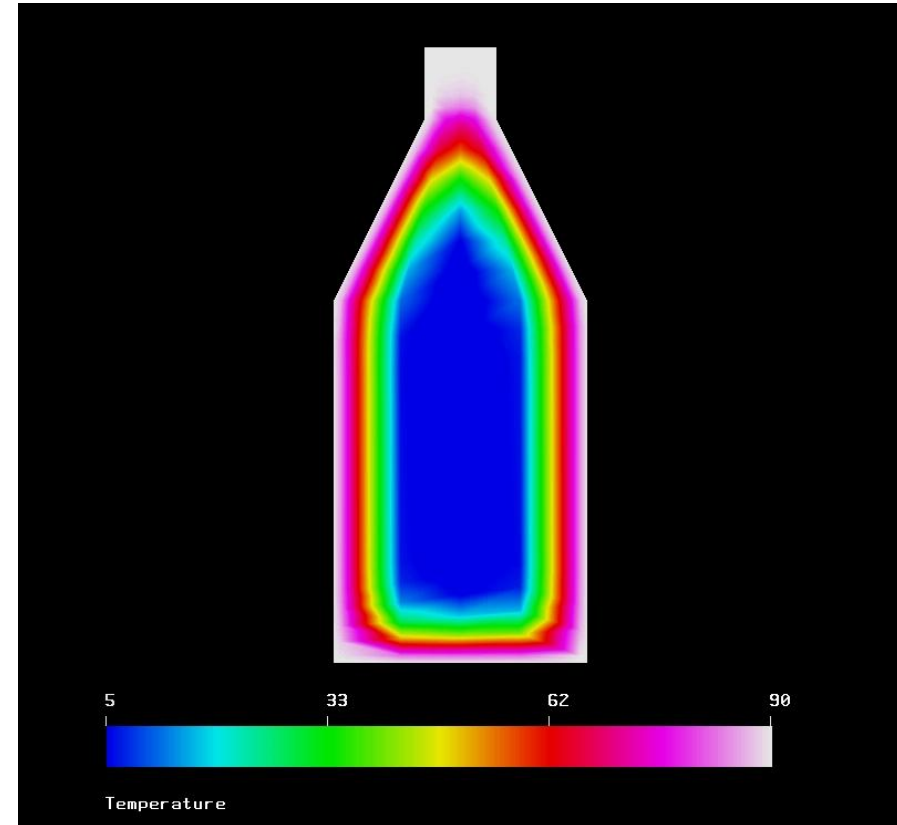


- ” Press the symbol  → 
- ” ElmerPost is launched
- ” In order to load all timesteps:
 - . Read Model File + *Select Time Steps: All*
 - . **Use Edit Timestep Control**

Post-processing

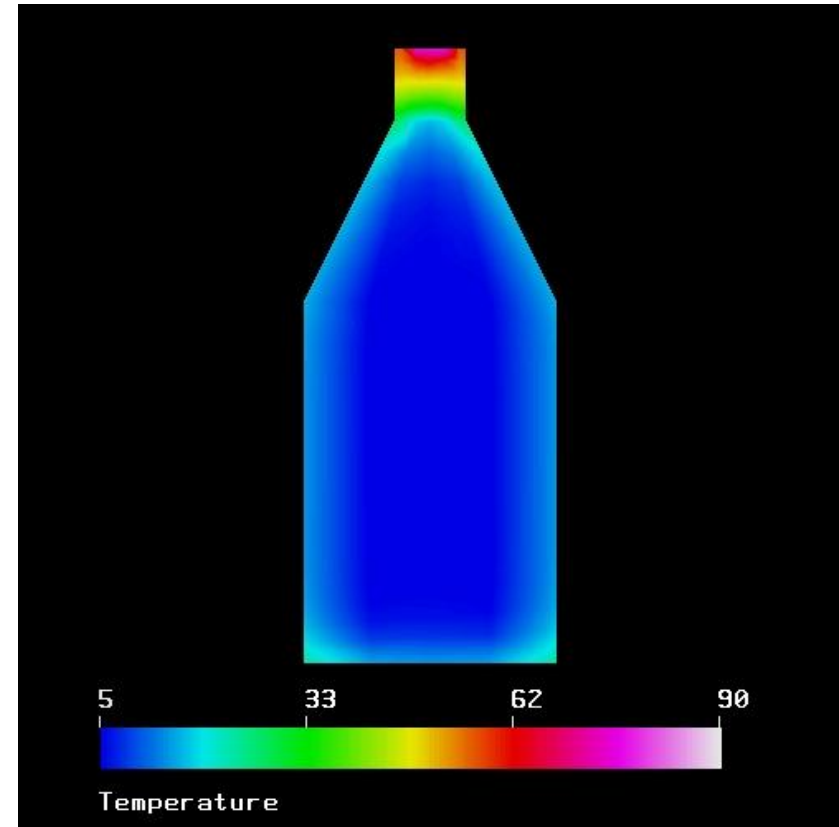
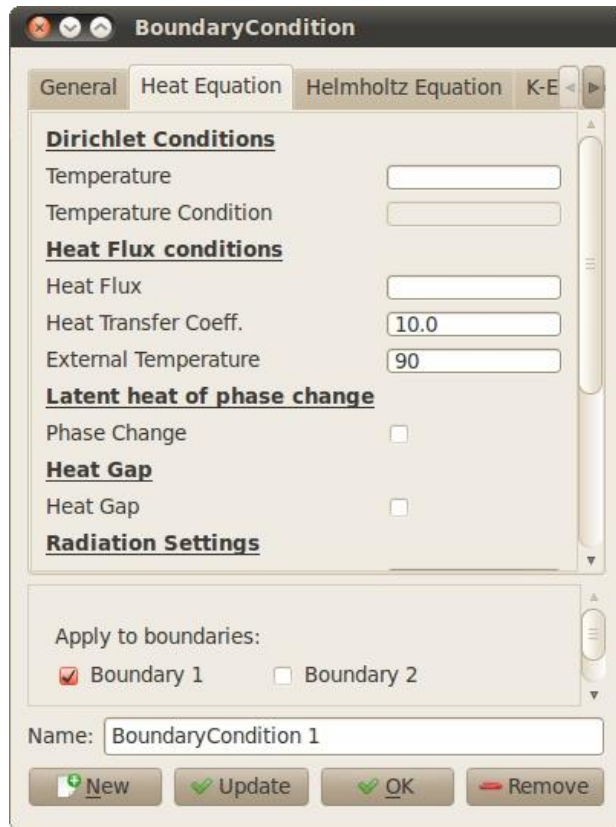


- ” Temperature is much to quickly rising
- ” Wrong physics in boundary condition?



Temperatures after 5 minutes

Physically more sane boundary condition



Temperatures after 5 minutes