Drop calorimetry – Development of accompanying simulations

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Within the framework of a European Metrology Programme for Innovation and Research (EMPIR) project, the Physikalisch-Technische Bundesanstalt (PTB) is developing an isoperibol drop calorimeter for the determination of traceable heat capacities of materials at very high temperatures. The measurement uncertainty in the temperature range up to 1000 °C should not exceed 0.5 % and, for temperatures up to 3000 °C, 1.5 %.

To support the developing process, accompanying finite element method (FEM) simulations using COMSOL Multiphysics software are performed. The simulations serve as an optimization tool for an already-built prototype with special emphasis on the:

- temperature distribution within the calorimeter during electrical calibration
- heat loss of the sample during the drop and
- temperature distribution of the sample in the induction furnace.

Simulation results for the temperature distribution during electrical calibration within the calorimeter show good agreement but emphasize the need for the precise definition of the boundary conditions. Figure 1 is an example for the FEM calculated temperature distribution within a calorimeter after a certain time.

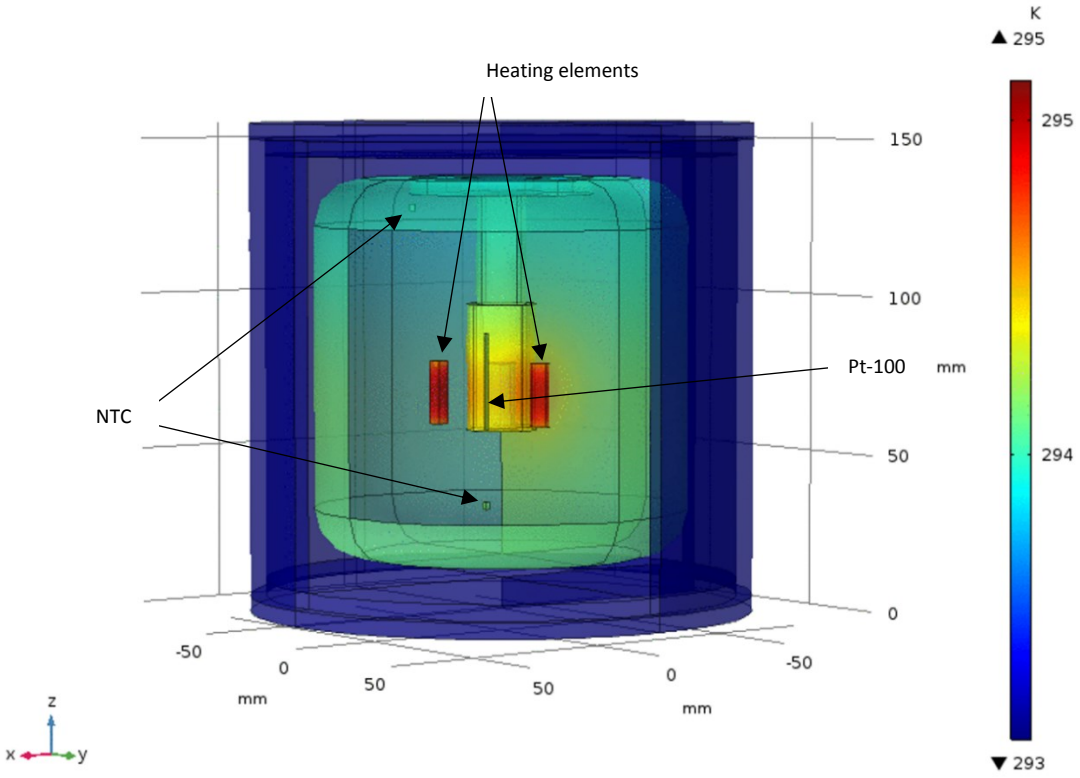

Figure 1: Resulting temperature distribution within the calorimeter after 61.2 s of electrical heating using COMSOL-Multiphysics. Starting overall temperature: 293.15 K. The calorimeter is electrically heated for 120 s with a power of 70 W in total. The heat spreads from the red colored heating elements out to the surrounding calorimeter block (turquoise). The isothermal surroundings are marked blue