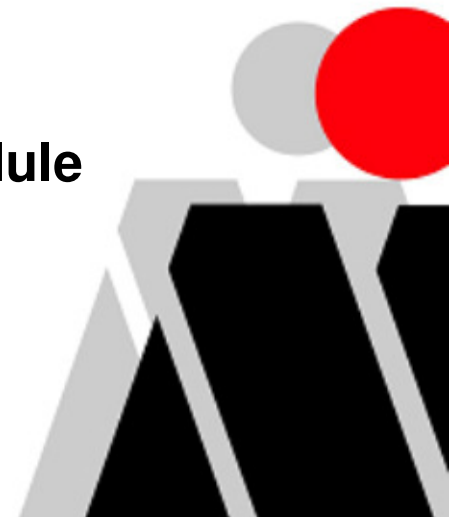




**The simulation of the thermal management of a battery module
for the propulsion of hybrid vehicles**

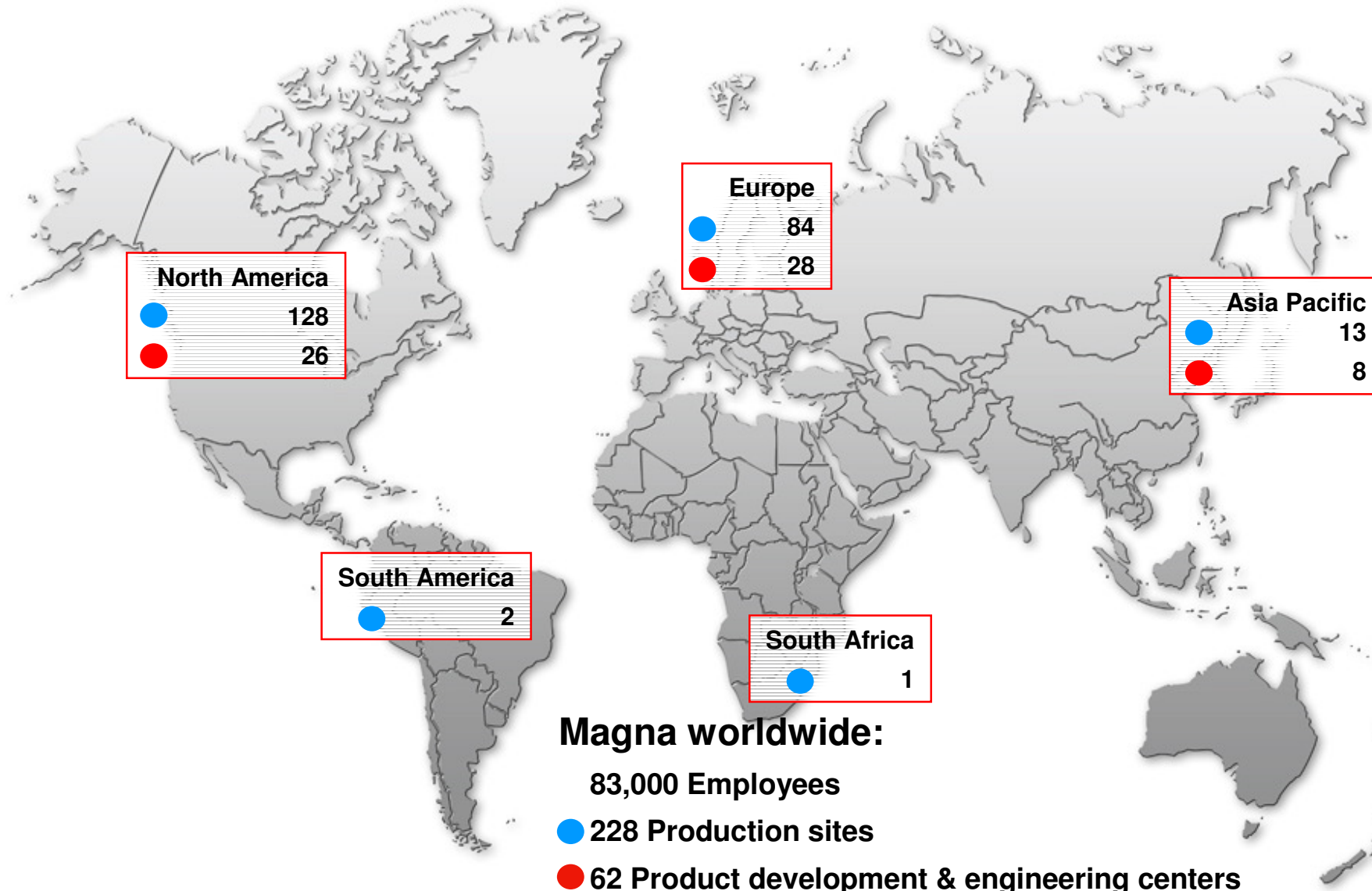
KULI Usermeeting 2007, Steyr



MAGNA Steyr Introduction I

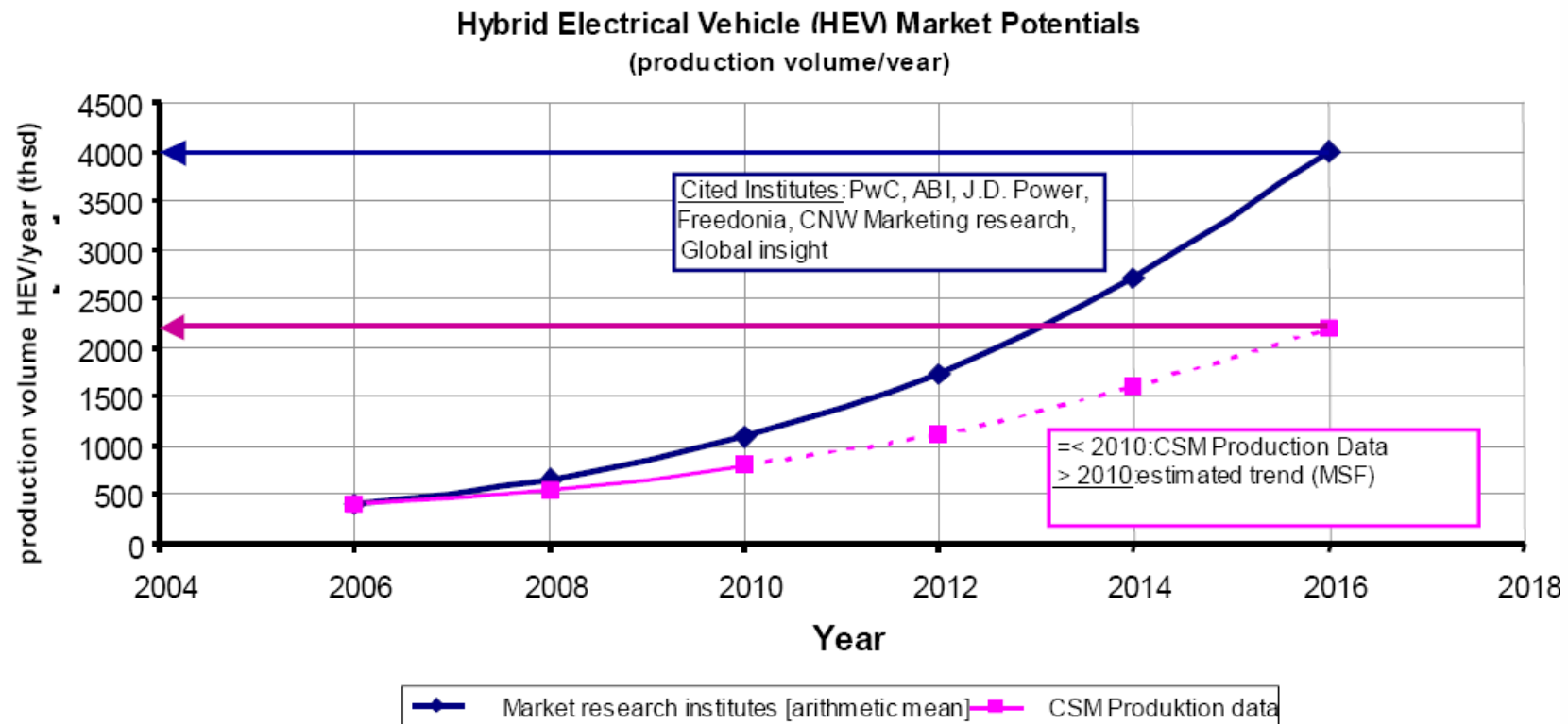


MAGNA Steyr Introduction II



Background

- Why Hybrid vehicles?

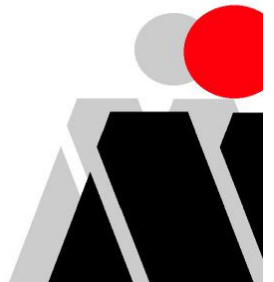


„optimistic View“:

Based on the arithmetic middle of the named forecast institutes

„conservative View“:

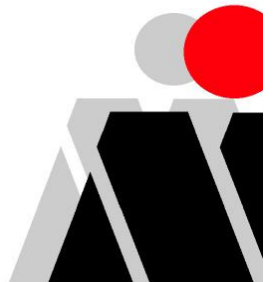
2006-2010: Decided OEM-Projects – Source CSM Production data;
starting from 2010 the data are extrapolated



The vehicle

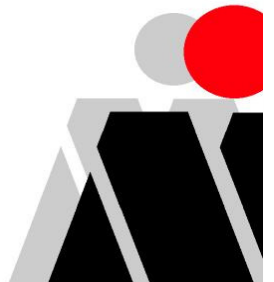
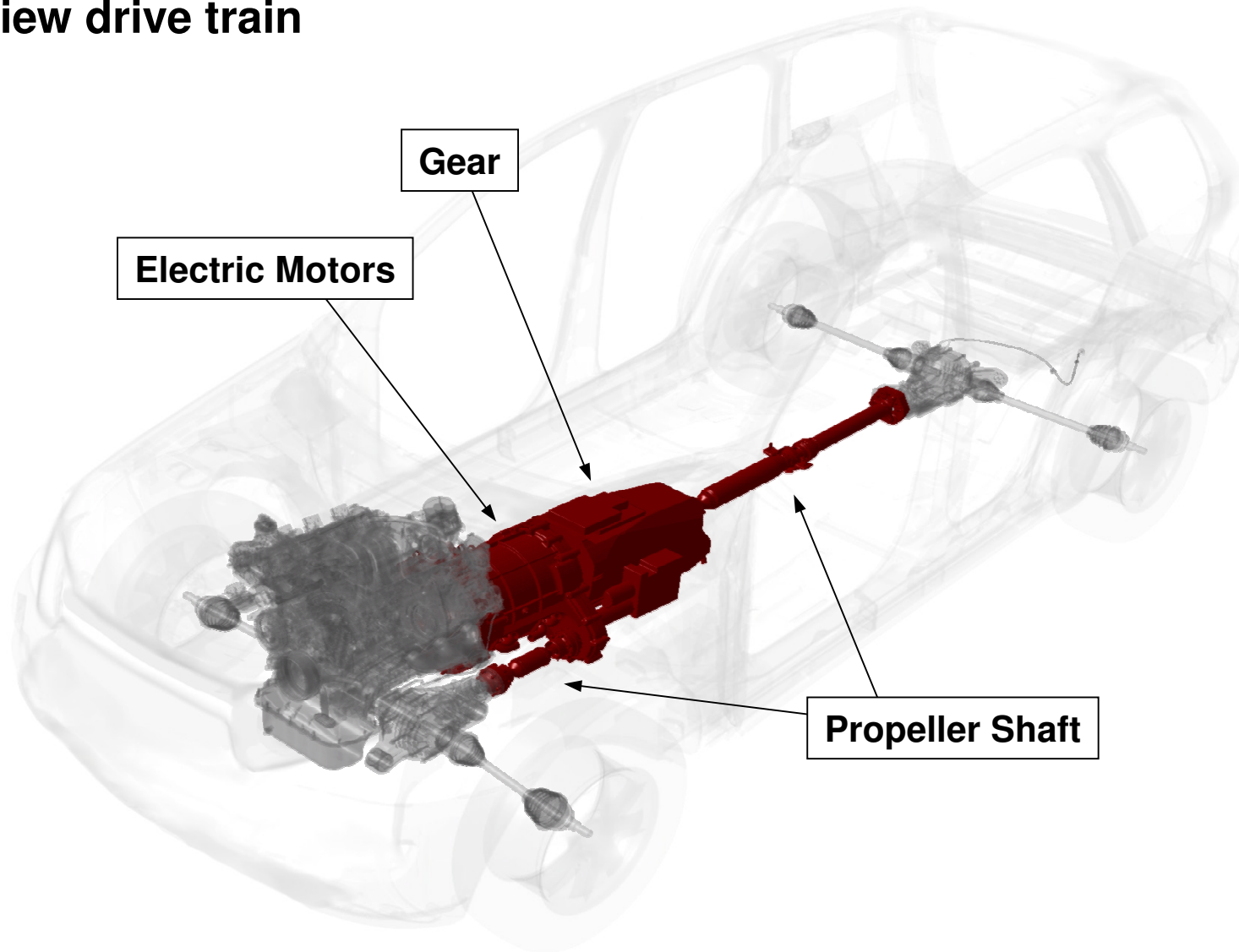
- **Specifications**

- Base vehicle: ML 350
- Full Hybrid SUV
- Voltage range: 200 – 410 V
- Electric power: 50 kW / E-motor
- Electric 4WD
- Combustion engine: 3,5l V6
- Gear: sequential 7 Gang
- Steering system: electric hydraulic



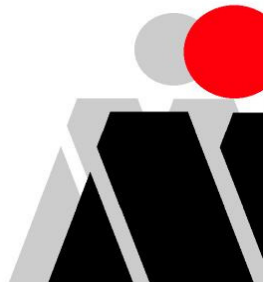
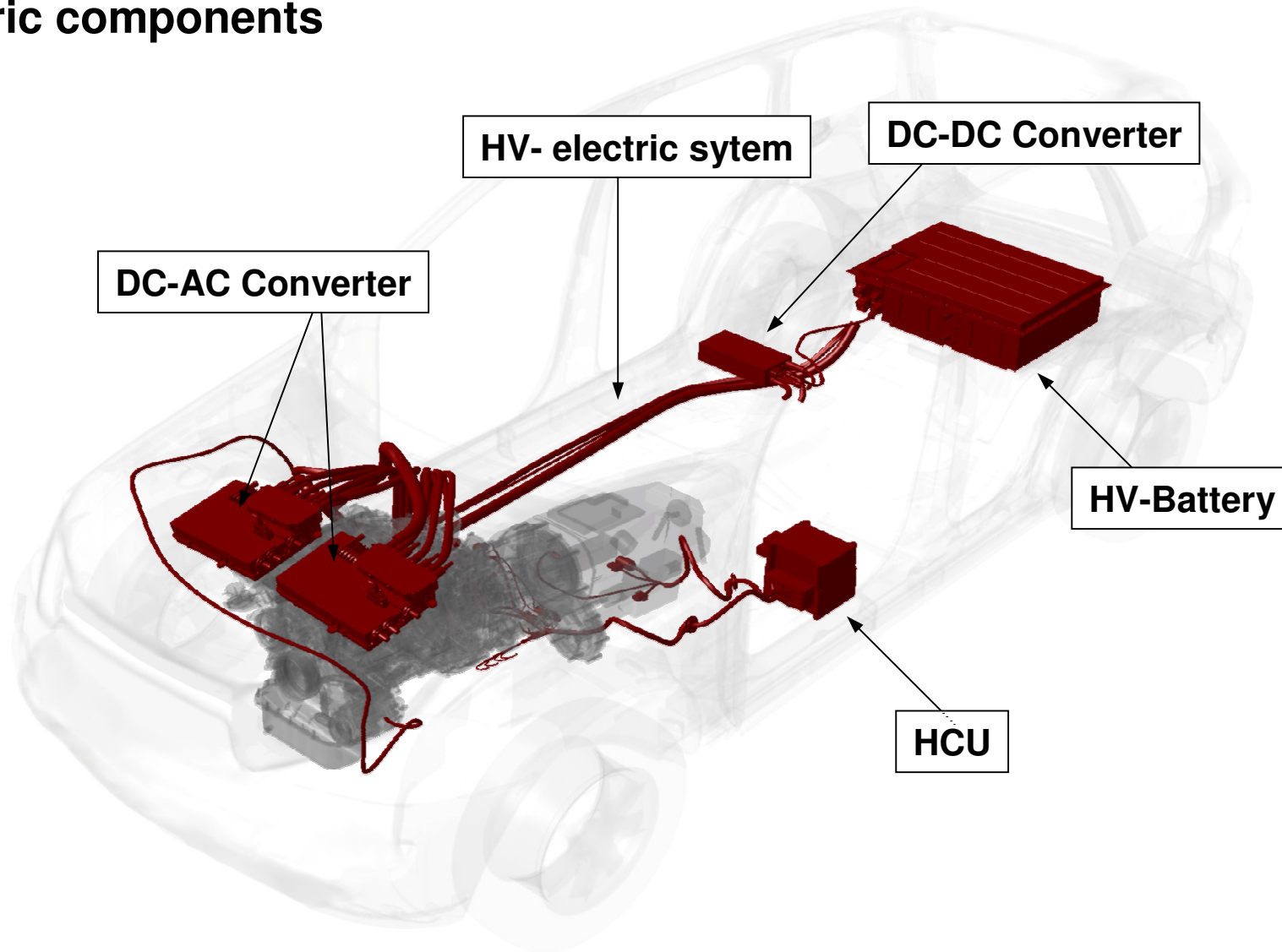
Technology

- Overview drive train



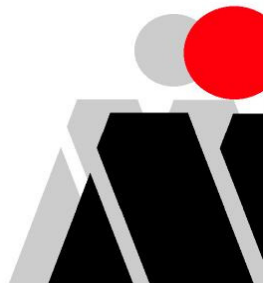
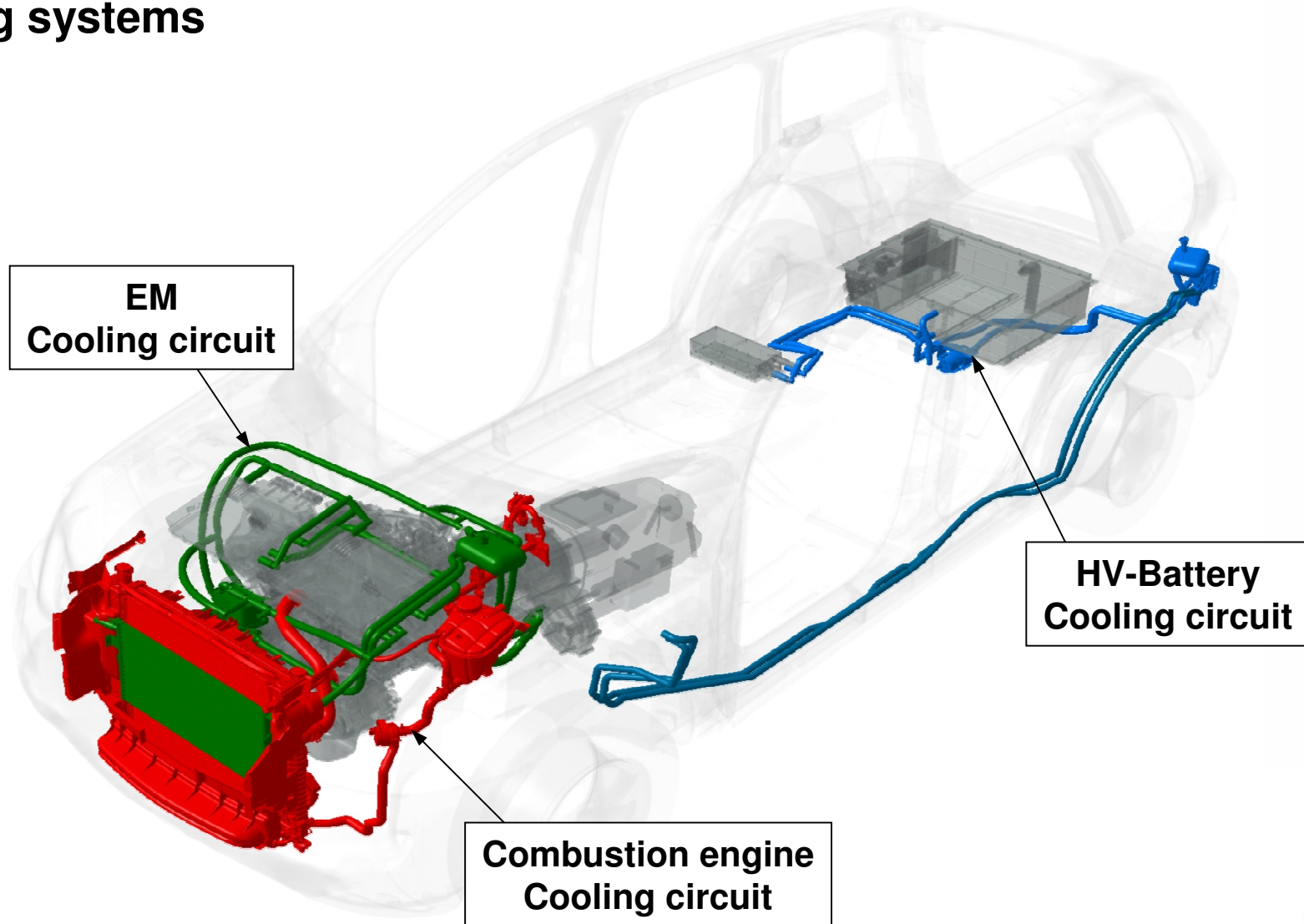
Technology

- Electric components



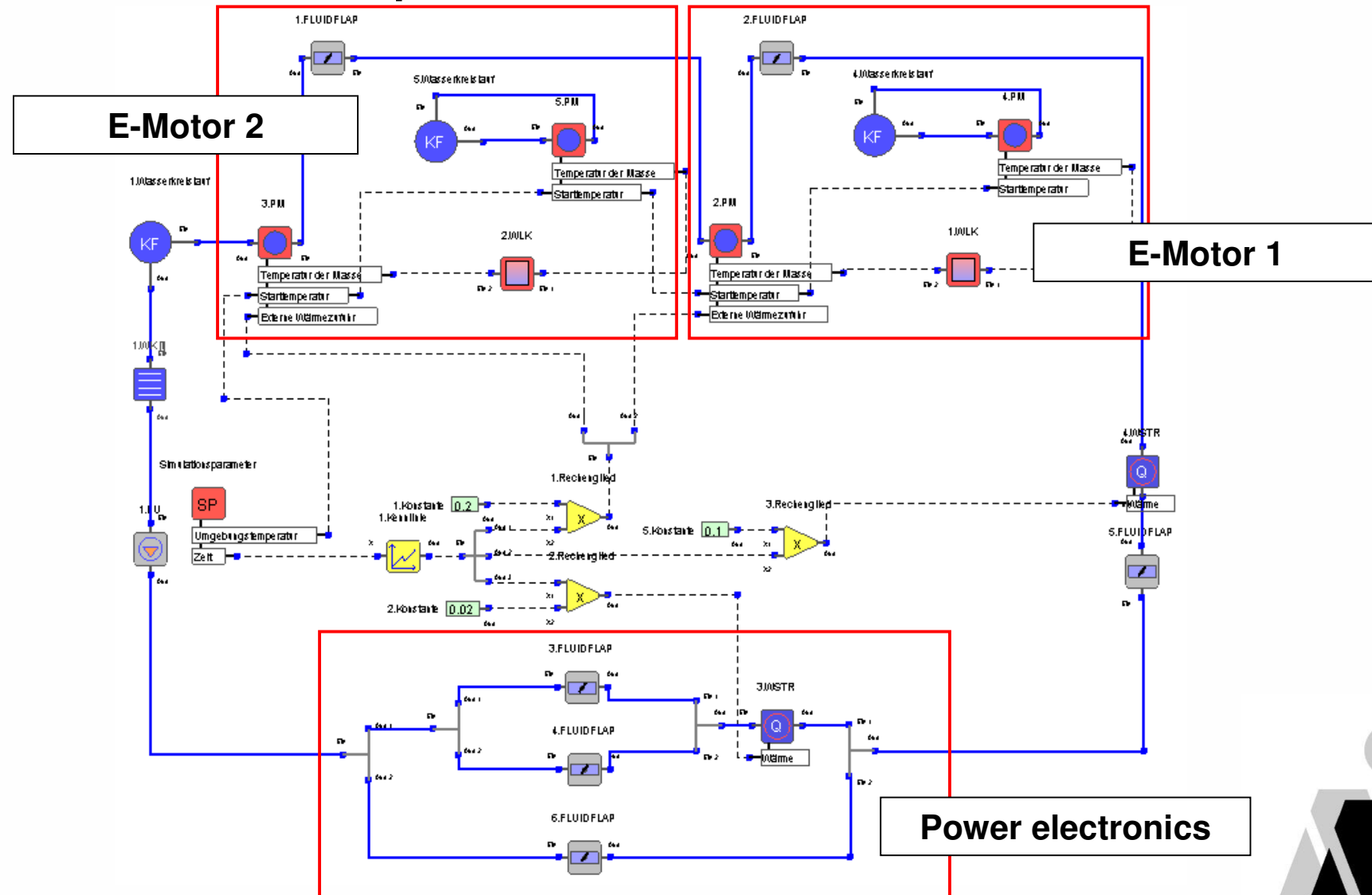
Technology

- **Cooling systems**



The simulation of the cooling systems

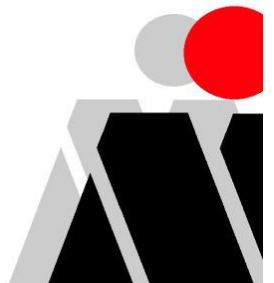
- Overview E-Motors and power electronics circuit



The simulation of the cooling systems

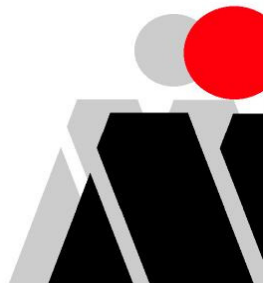
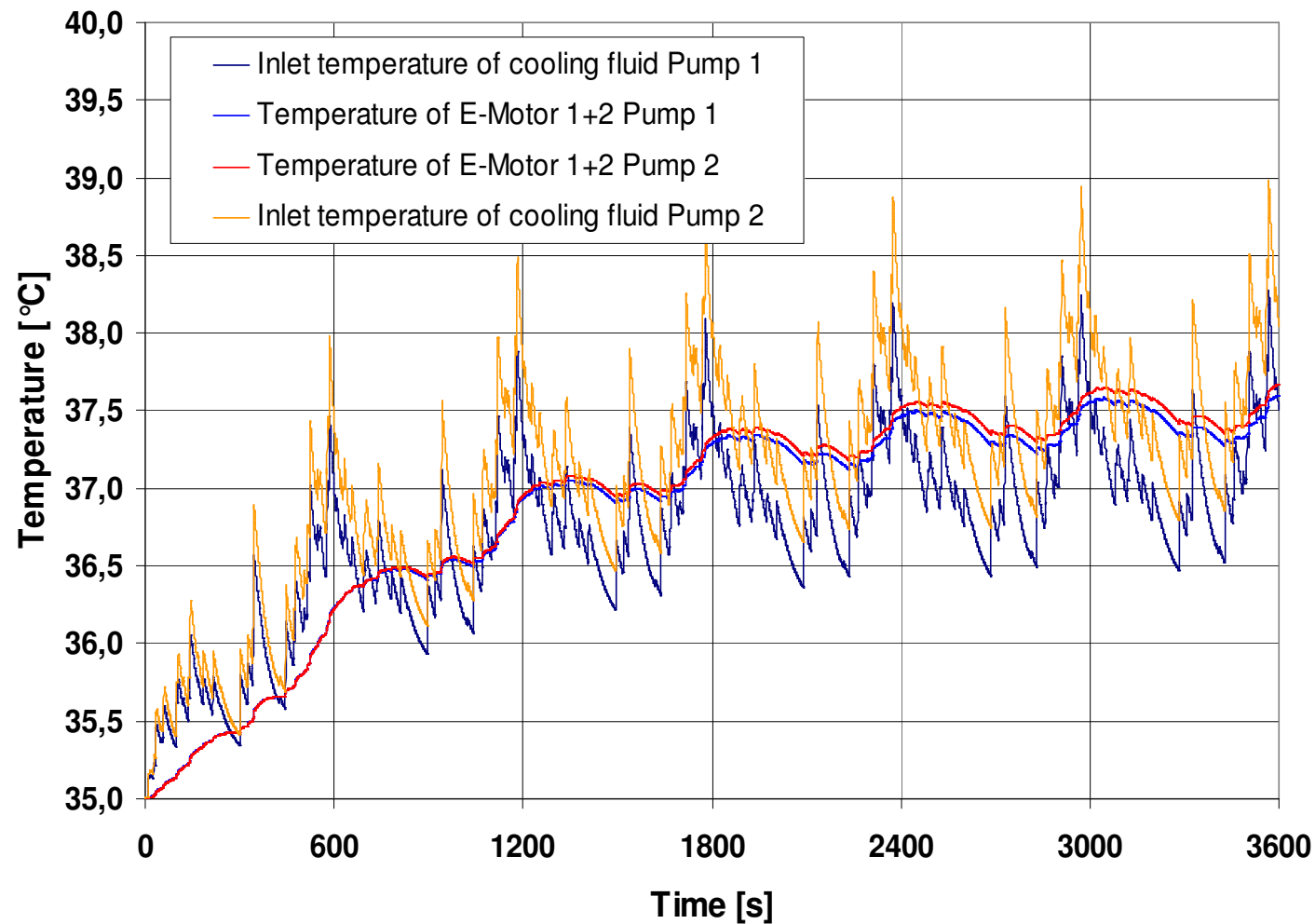
- **Boundary conditions for transient simulation**

- Load cycle: US06
- Efficiency E-Motors: ~ 0,82
- Efficiency power electronics: ~ 0,98
- Efficiency battery: ~ 0,95
- Outside temperature: 35 °C
- Fan: 600W modified auf 850W



The simulation of the cooling systems

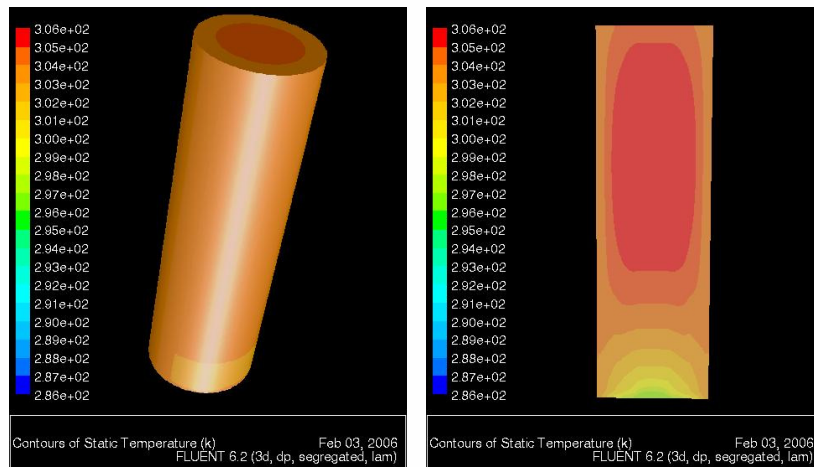
- Overview temperatures after 10 loadcycles



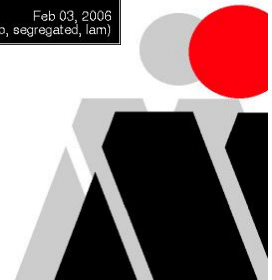
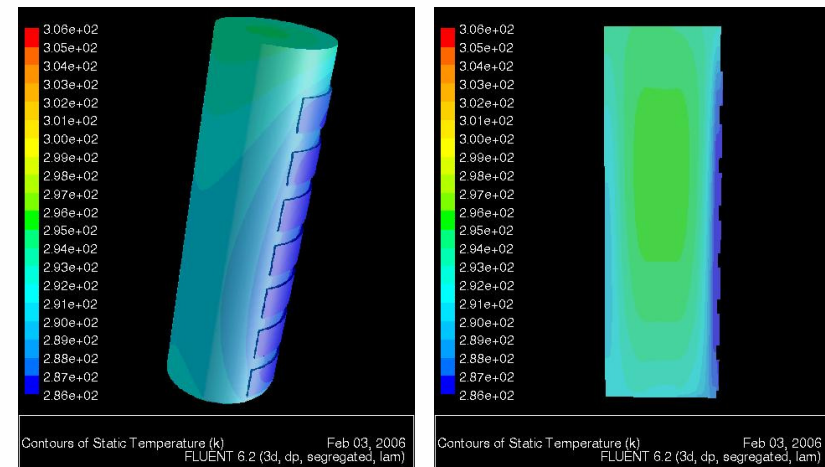
The simulation of the cooling systems

- **Method Battery-cooling I**
 - Decision finding (wall-cooling, floor-cooling)
 - Calculation generation of heat and heat transfer coefficient

Floor-cooling

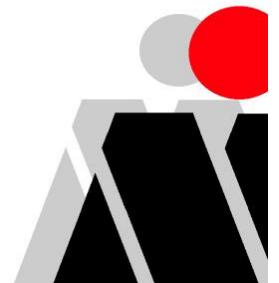
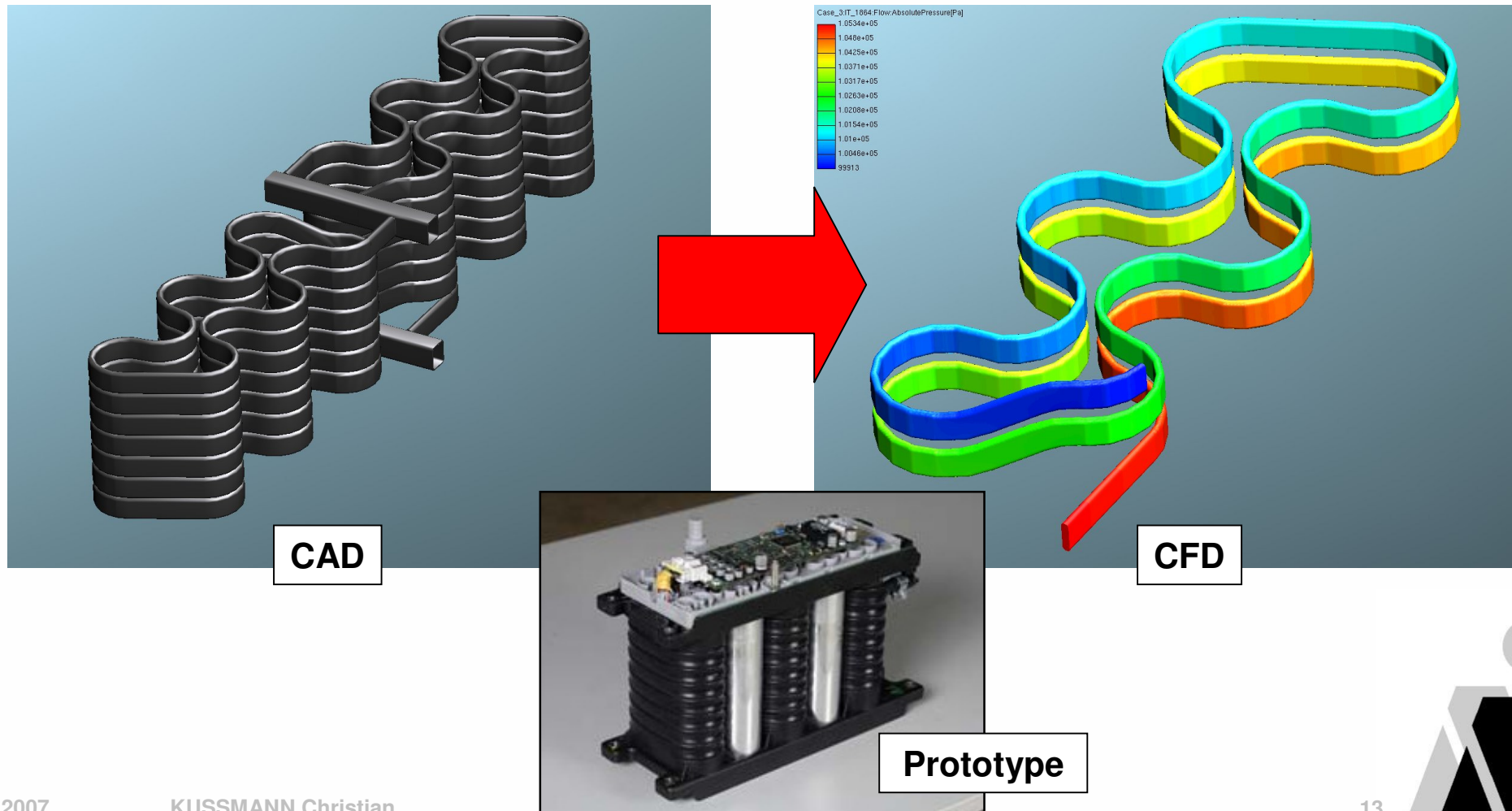


Wall-cooling



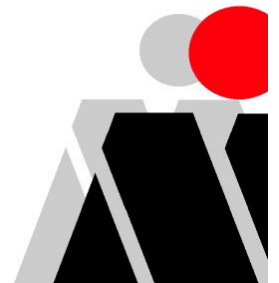
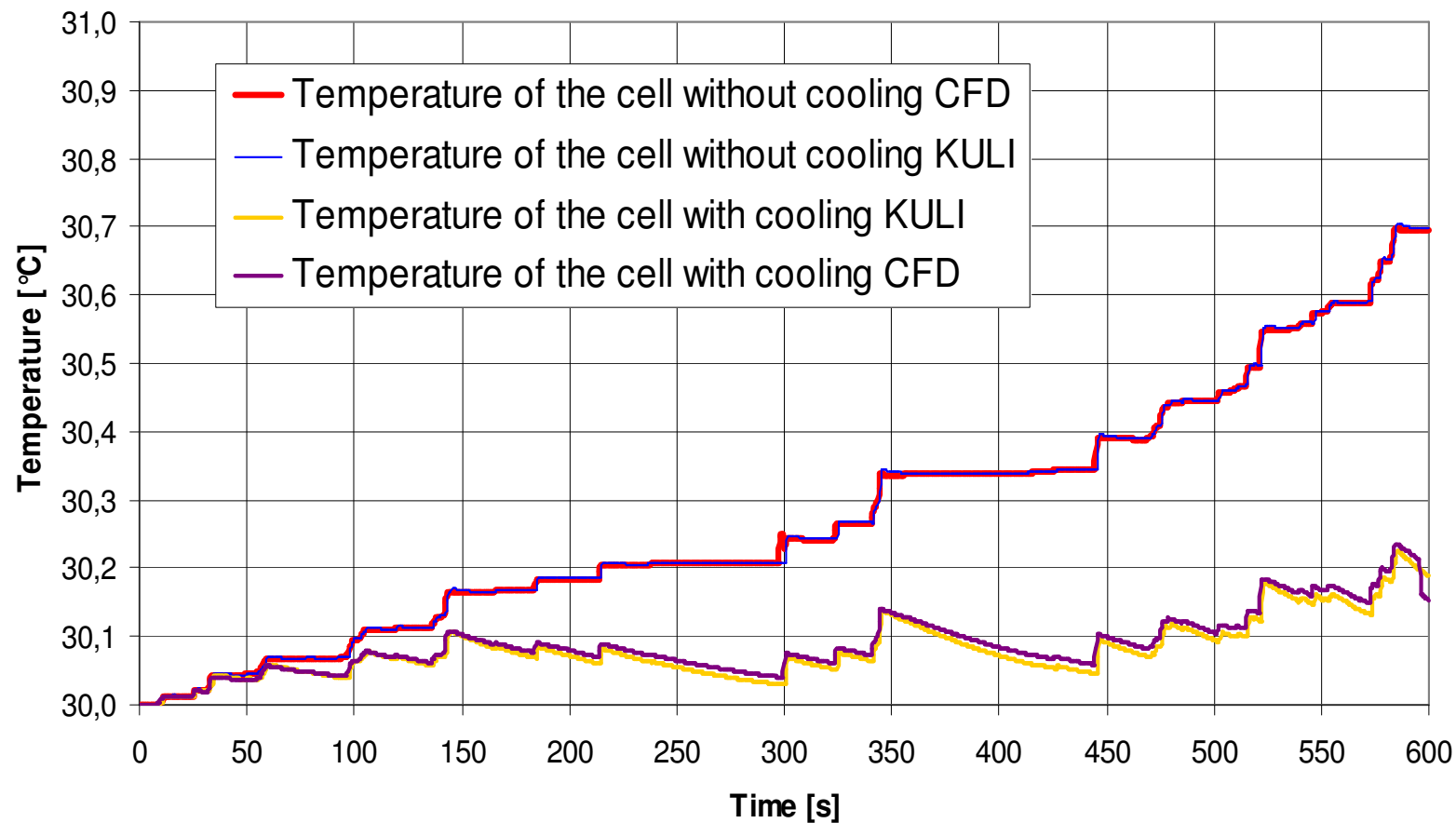
The simulation of the cooling systems

- **Method Battery-cooling II**
 - Simulation and optimisation of the coolant pipes



The simulation of the cooling systems

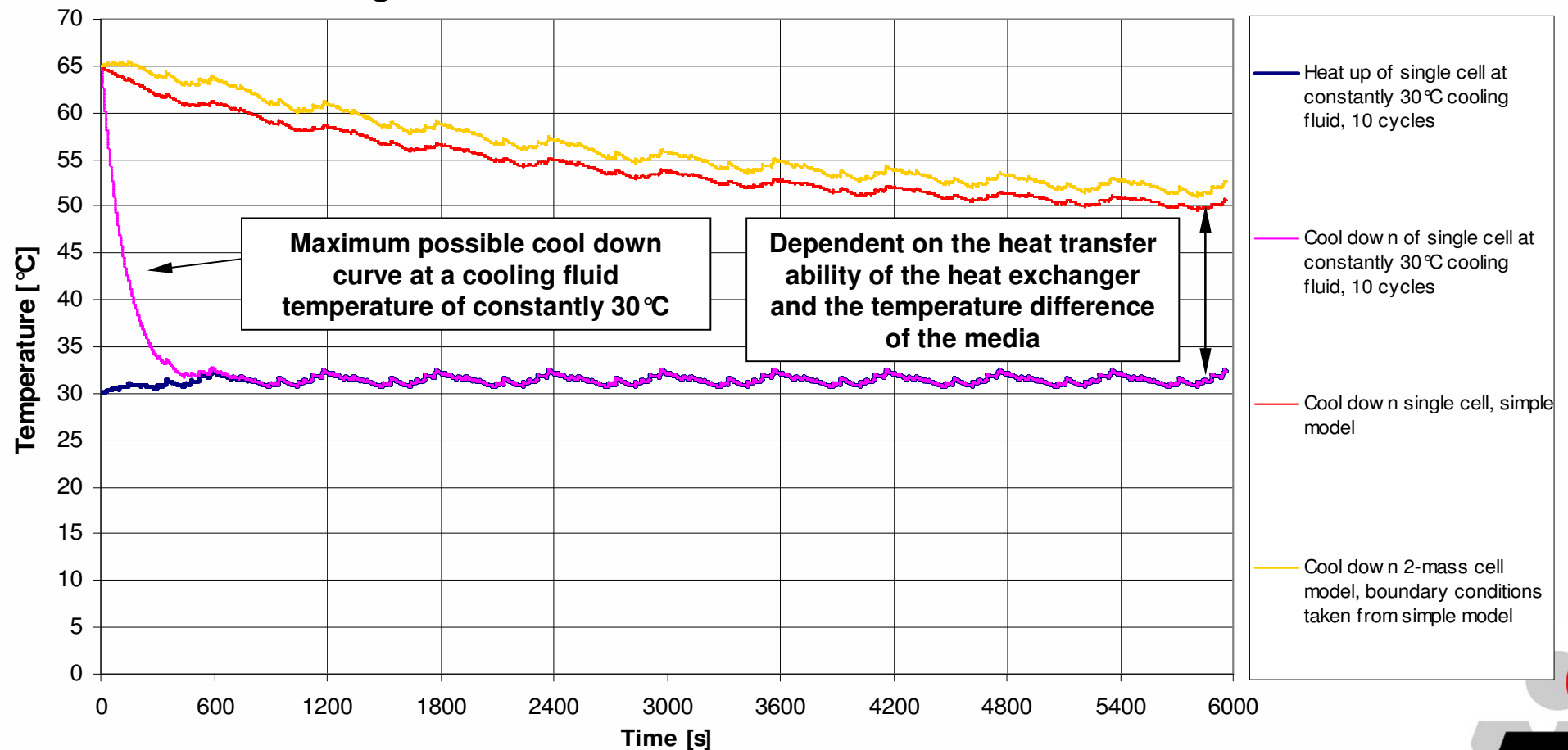
- **Method Battery-cooling III**
 - Validation CFD - KULI



The simulation of the cooling systems

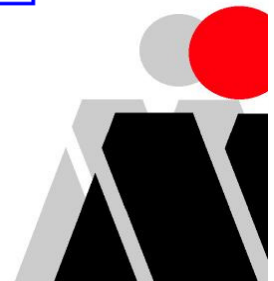
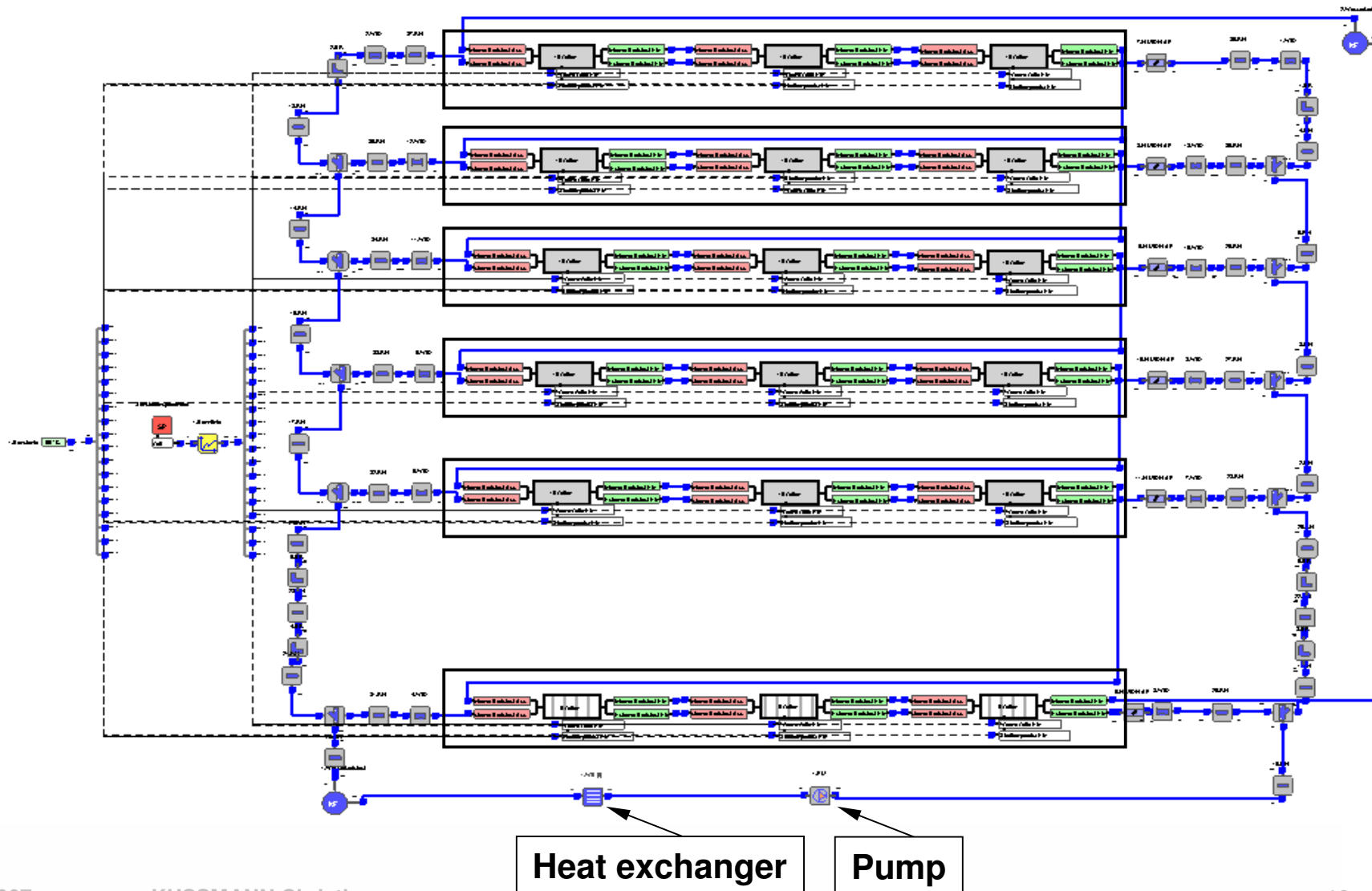
- **Method Battery-cooling III**

- Simulation single-cell with KULI



The simulation of the cooling systems

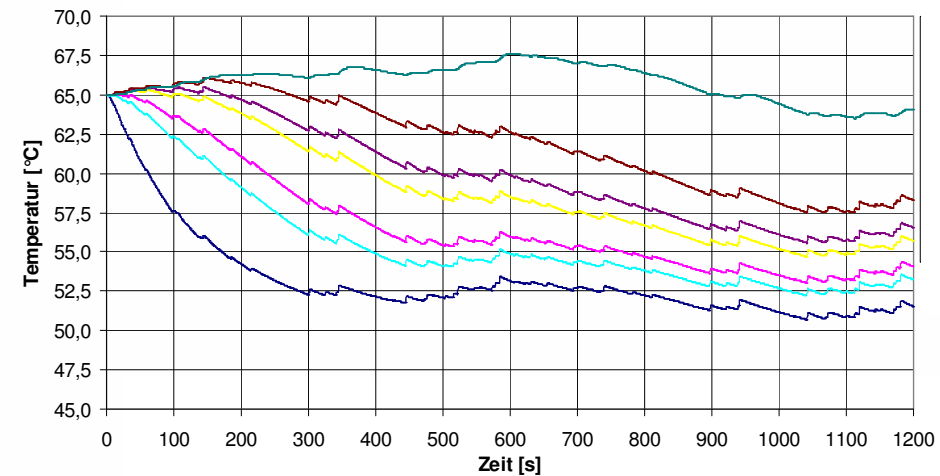
- Modelling Battery module I



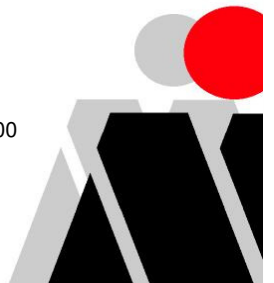
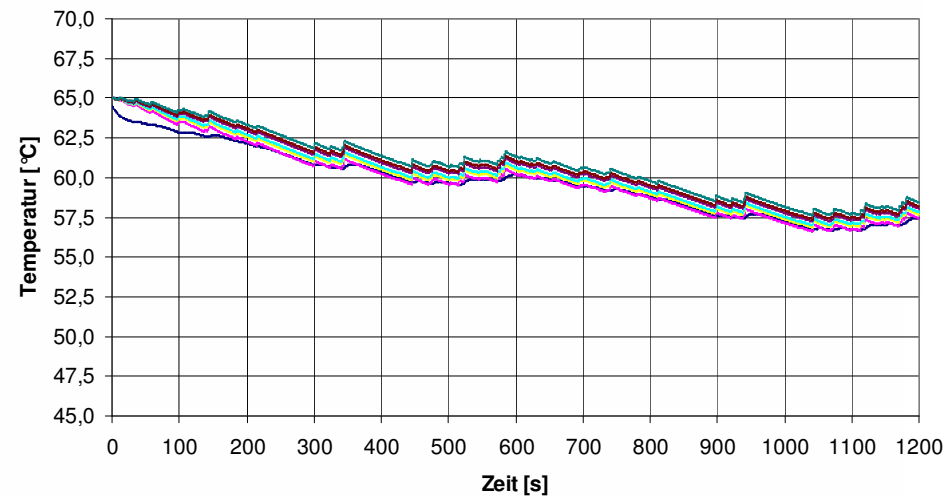
The simulation of the cooling systems

- Temperature spread of the cells

Temperature distribution
at ~1l/min cooling flow

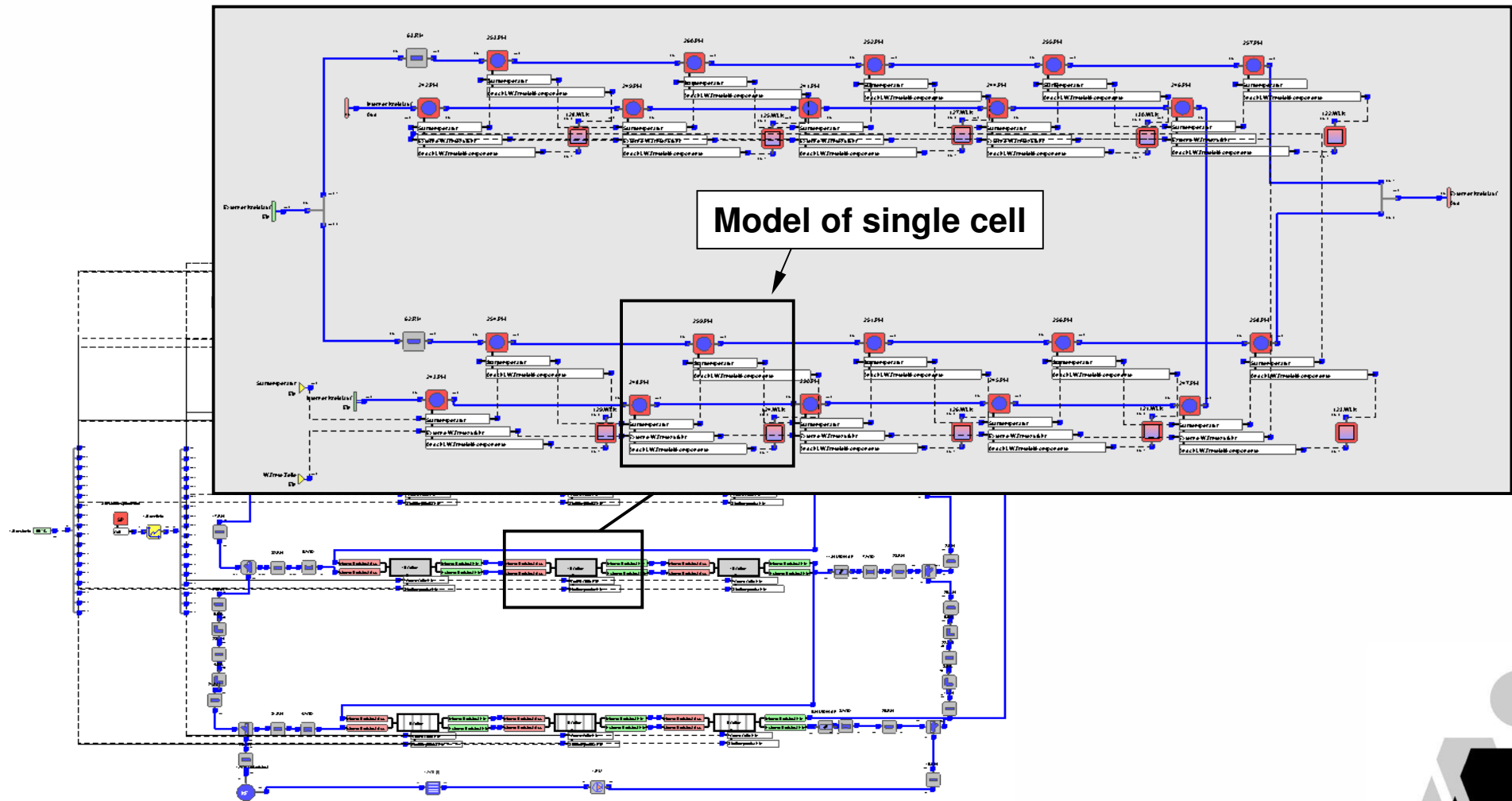


Temperature distribution
at 10l/min cooling flow



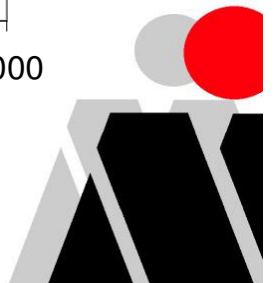
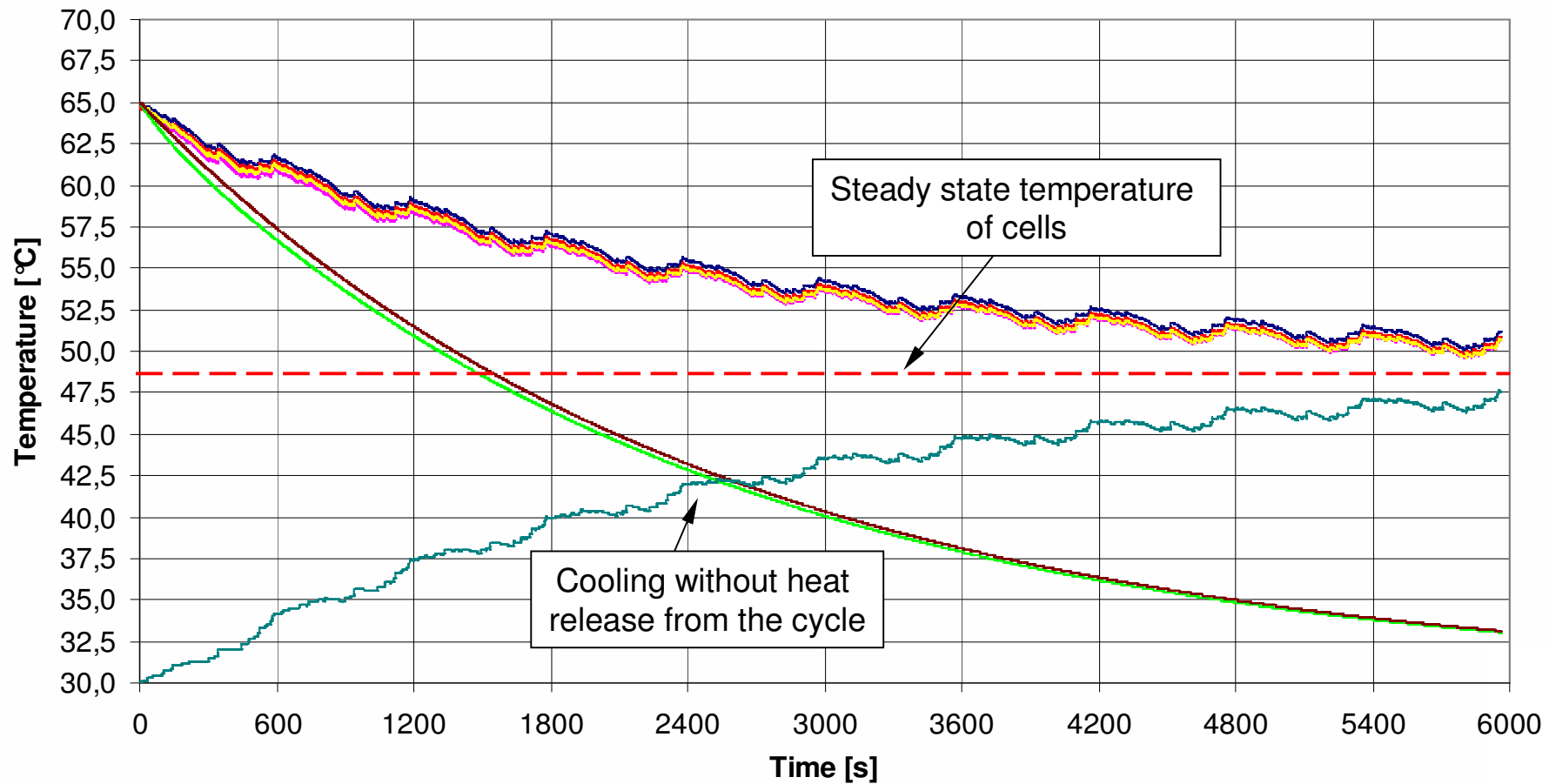
The simulation of the cooling systems

- Modelling Battery module II



The simulation of the cooling systems

- Simulation results KULI



The simulation of the cooling systems

- **Summary**
 - Essential part for the simulation of all relevant cooling-systems of a Hybrid vehicle
 - Helps in understanding the basic function and the critical parameters
- **Future activities**
 - Implementing of KULI A/C for Battery cooling
 - Control of A/C and cooling requirements for the Battery module

