

DAIMLER TRUCK

Thermal Optimisation Approaches to Reduce Heat Losses during Fast Charging

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Mercedes-Benz eActros 600



1.2 million km equals 10 years lifetime
new Lithium Iron Phosphate (LFP) cell technology



4 gear eAxle 400kW continuous / 600 kW peak
Torque @wheel > 40.000 Nm



Weight of up to 44t, payload of around 22t in the EU



~500 km range¹ with 3x200 kWh battery @ 750V
~1500kg battery weight each



MCS² > 1000kW under 30 minutes (20 to 80% SoC³)
CCS² ~ 400kW about 60 minutes (20 to 80% SoC³)

¹ on internal Longhaul cycle with 40t GCW (gross combination weight) ² MCS = Megawatt Charging System, standard is CCS = Combined Charging System ³ SoC = State of Charge

Heat Losses



Charging Power	Charging Efficiency	Heat Losses
100 - 200kW	~98%	~2 - 4kW
500kW	~95%	~25 kW
1000kW	~90%	~100 kW

100kW heat loss equals ~ 8-16 individual house heating systems

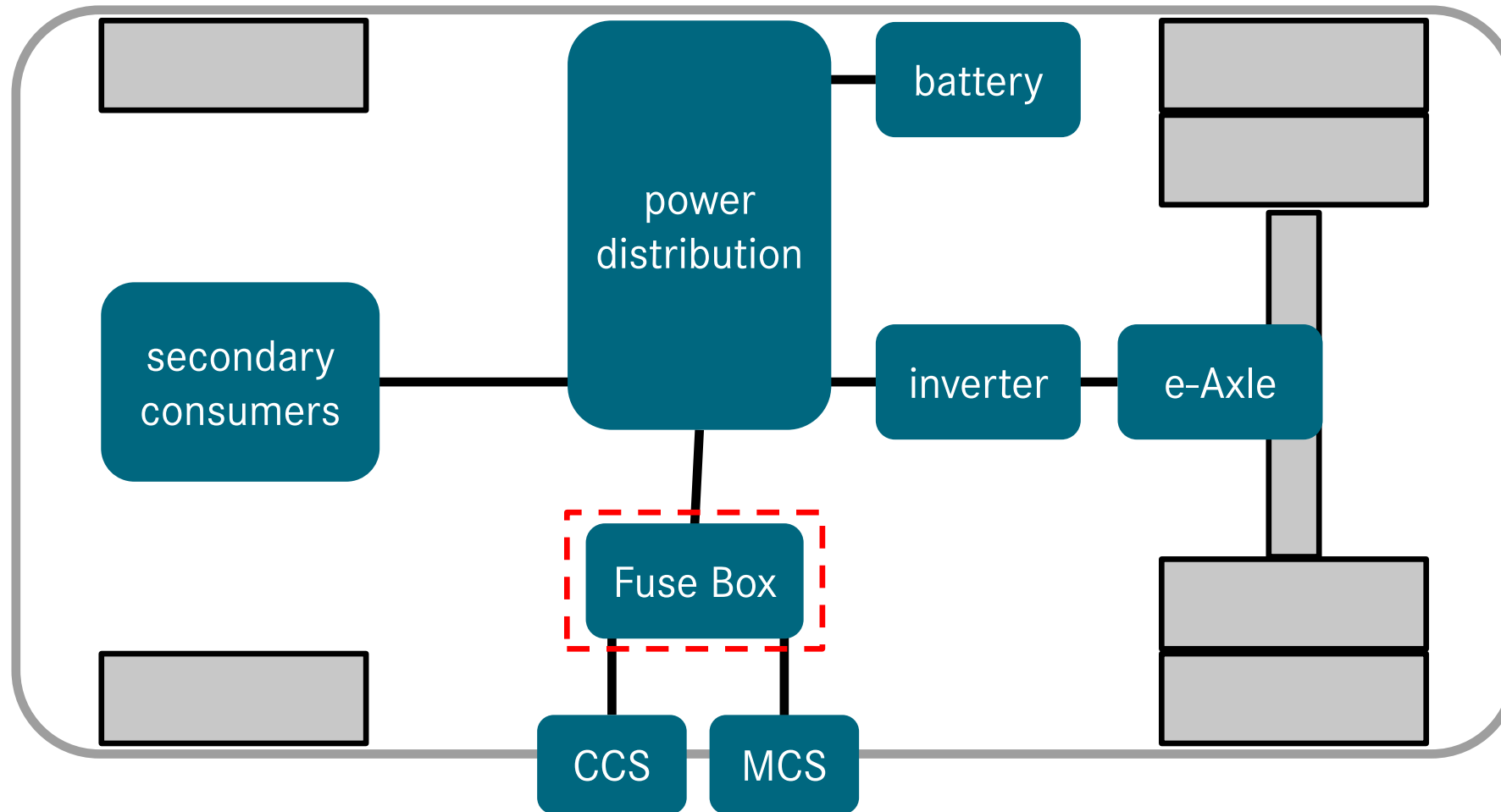
Optimisation options for components

$$P_{\text{ELECTRICAL}} = I^2 * R_{\text{ELECTRICAL}}$$

Reduction of resistance leads to:

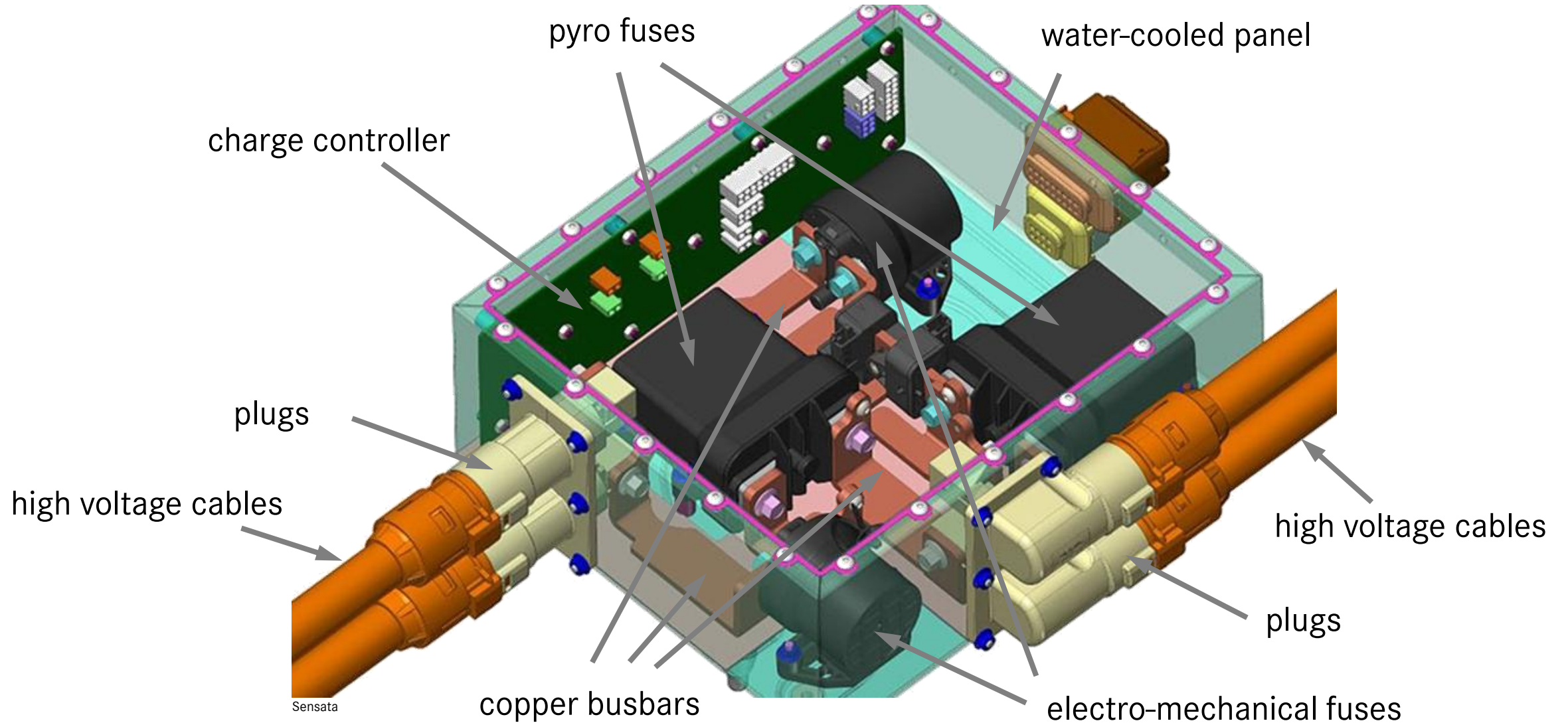
- lower heat losses
- longer charging at high current until temperature limit is reached

Charging path architecture

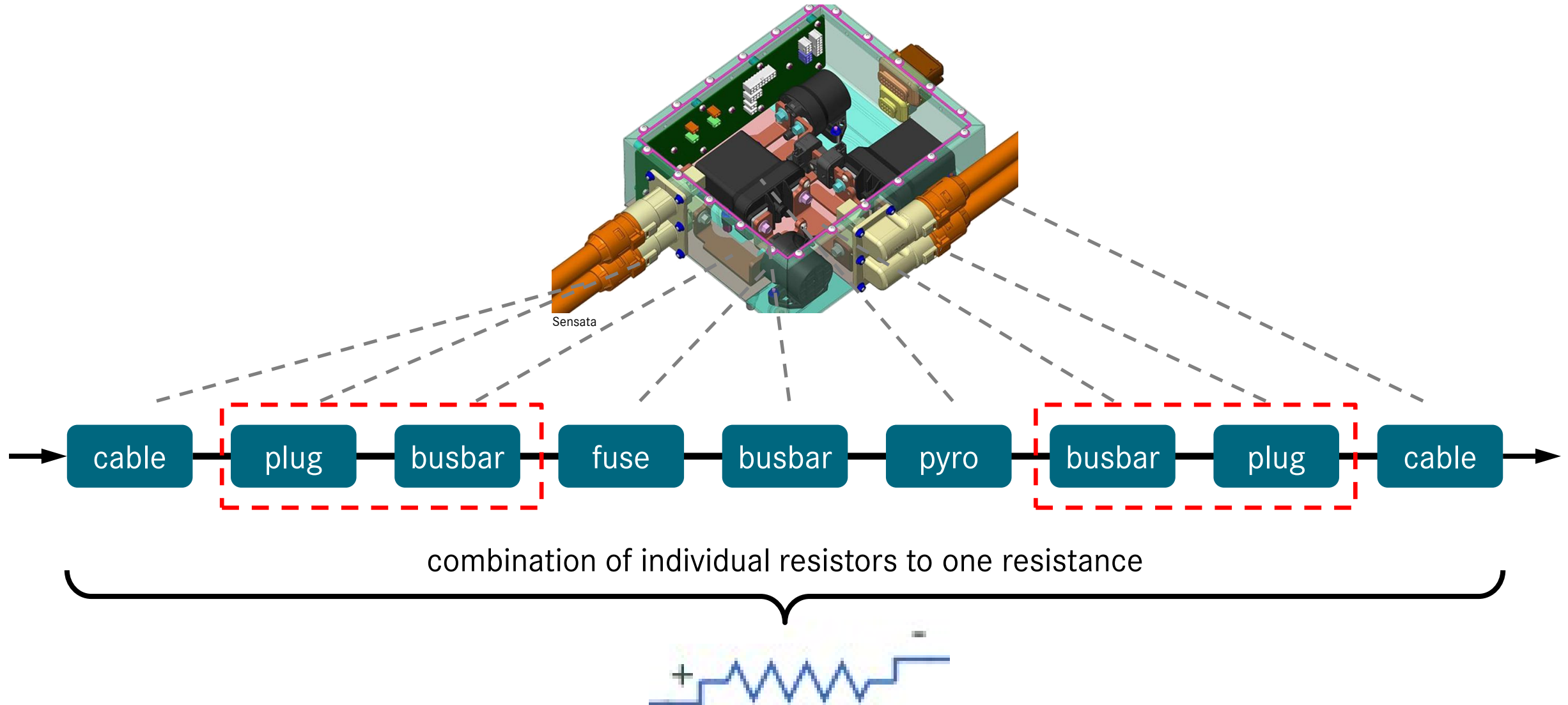


CCS (Combined Charging System)
MCS (Megawatt Charging System)

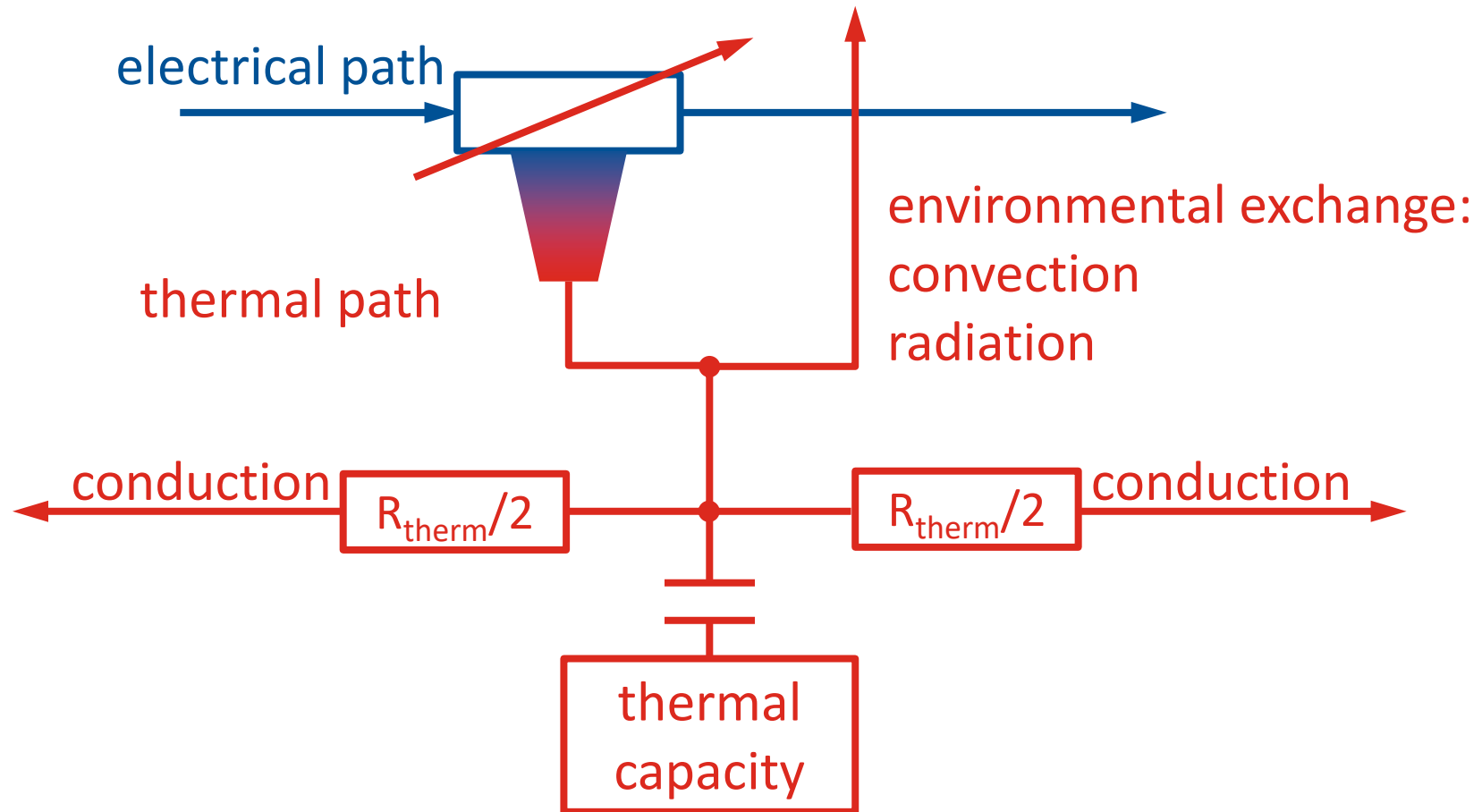
Detailed view: Fuse Box



Equivalent circuit diagram: Fuse Box



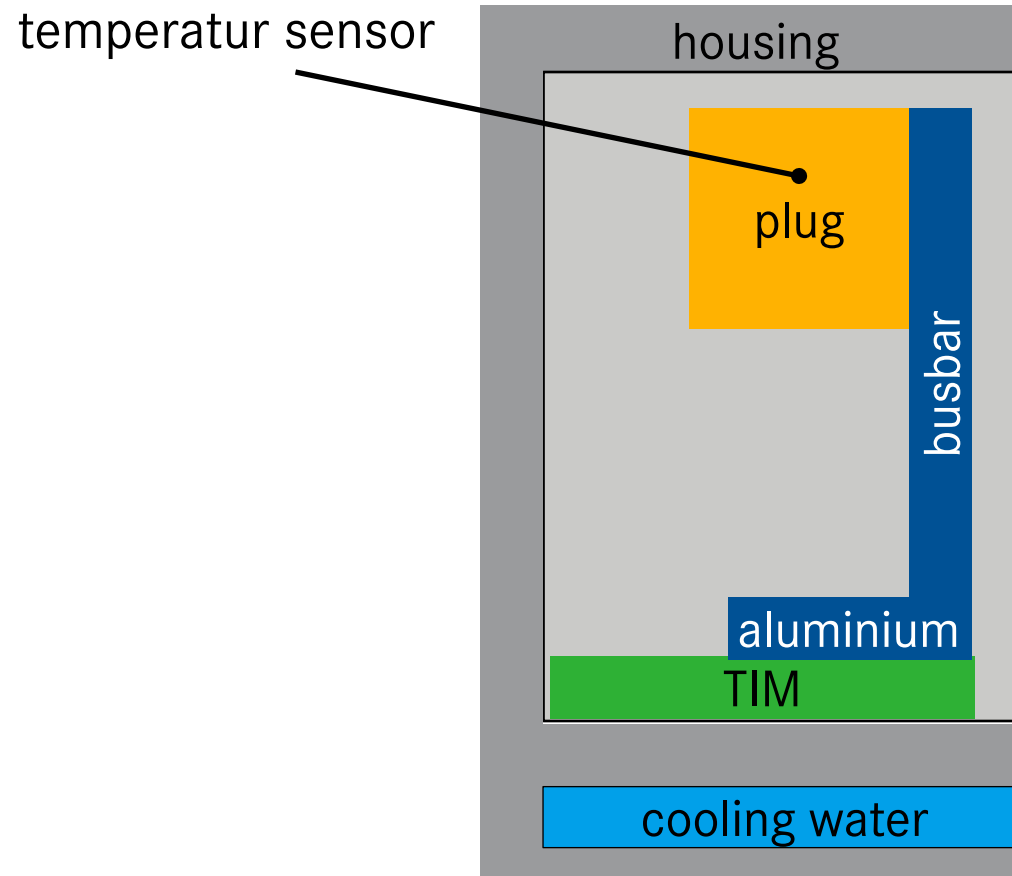
Simulation creation



How to handle heat?

- Absorb unavoidable heating
- Delayed heat dissipation
- Delaying the critical temperature

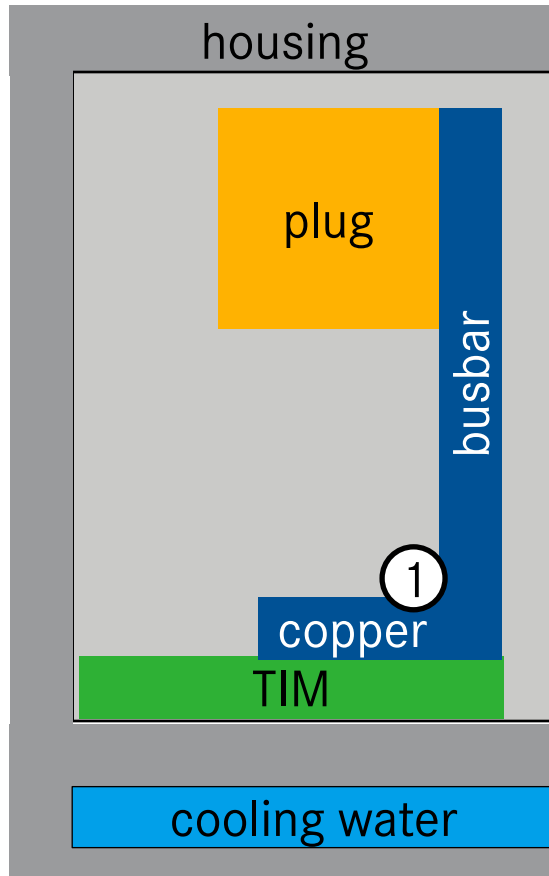
Detailed view: Fuse Box (cross section: plug)



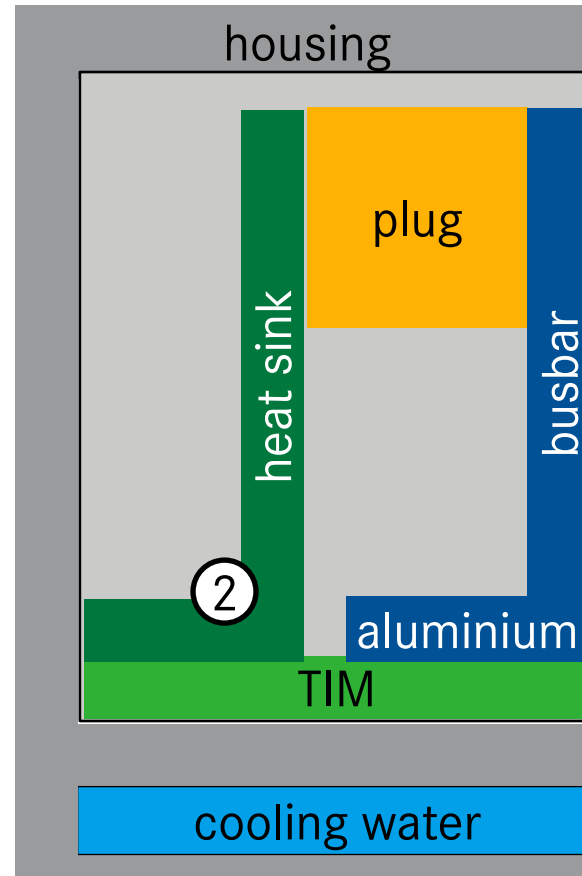
TIM (Thermal Interface Material)

3 different Thermal Optimisation Approach to reduce heat at the plugs

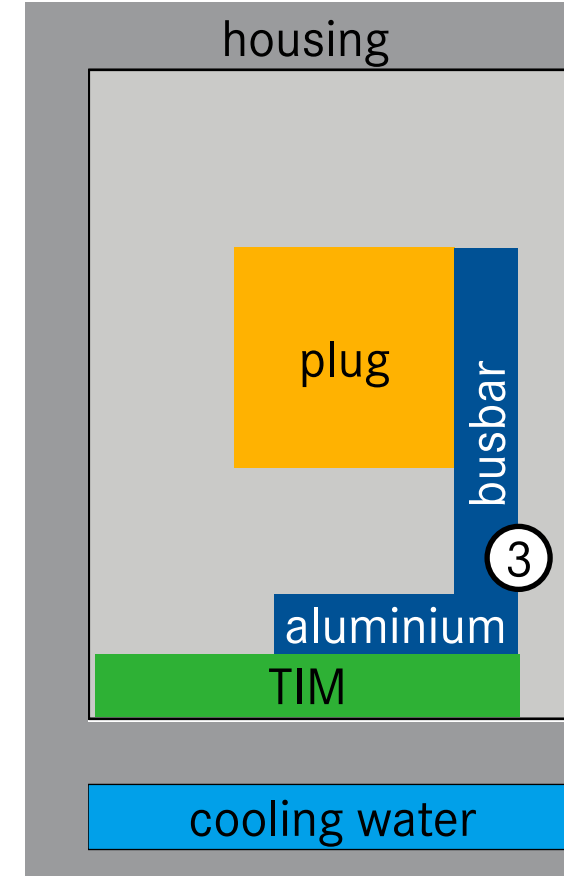
different busbar material



additional heat sink



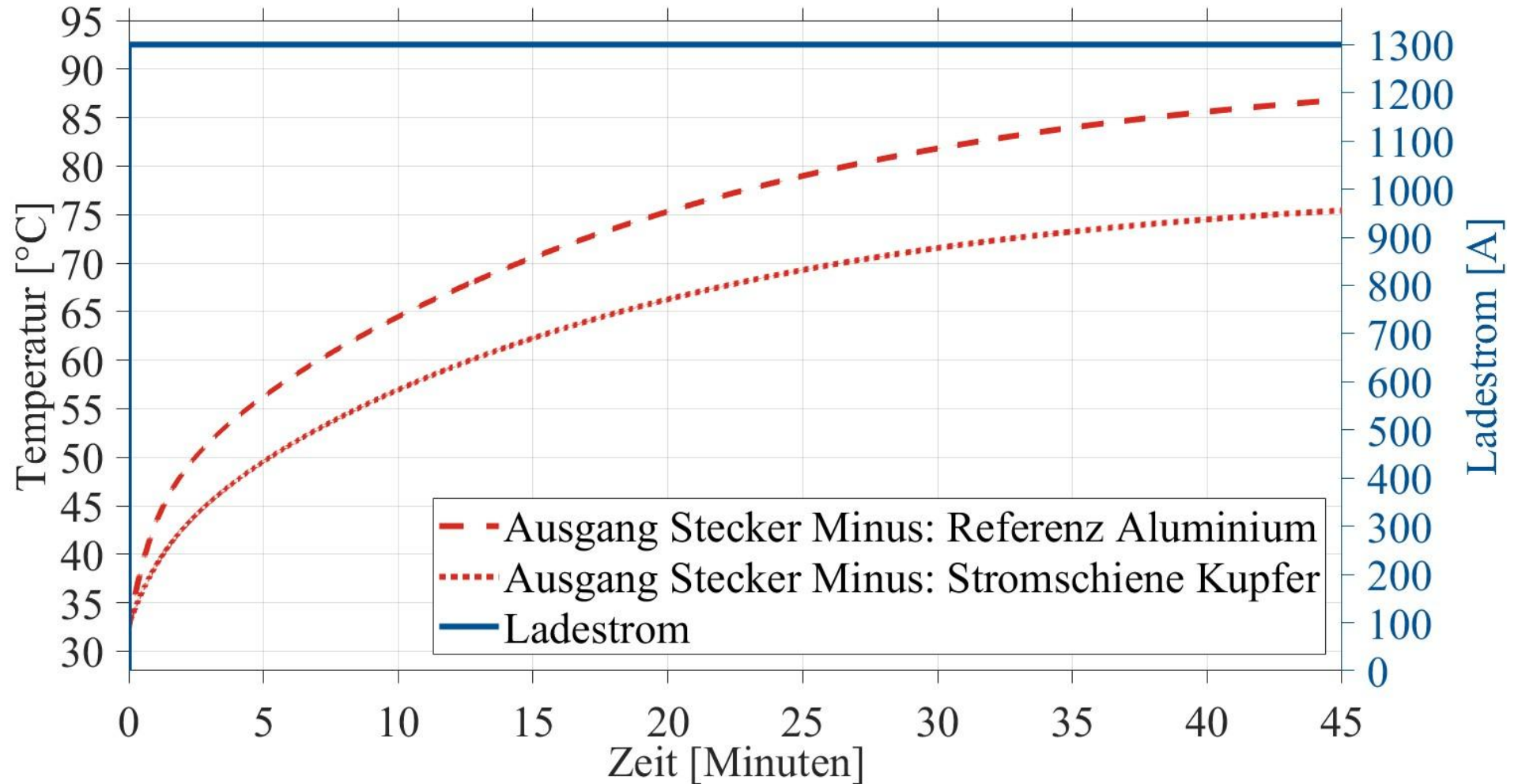
shorter busbar



TIM (Thermal Interface Material)

Fuse Box: 1. Thermal Optimisation Approach

Different busbar material: aluminium versus copper



Optimisation approach

$$Q = m * c * \Delta T$$

Optimisation approach: increase in mass increases heat capacity

Q = heat

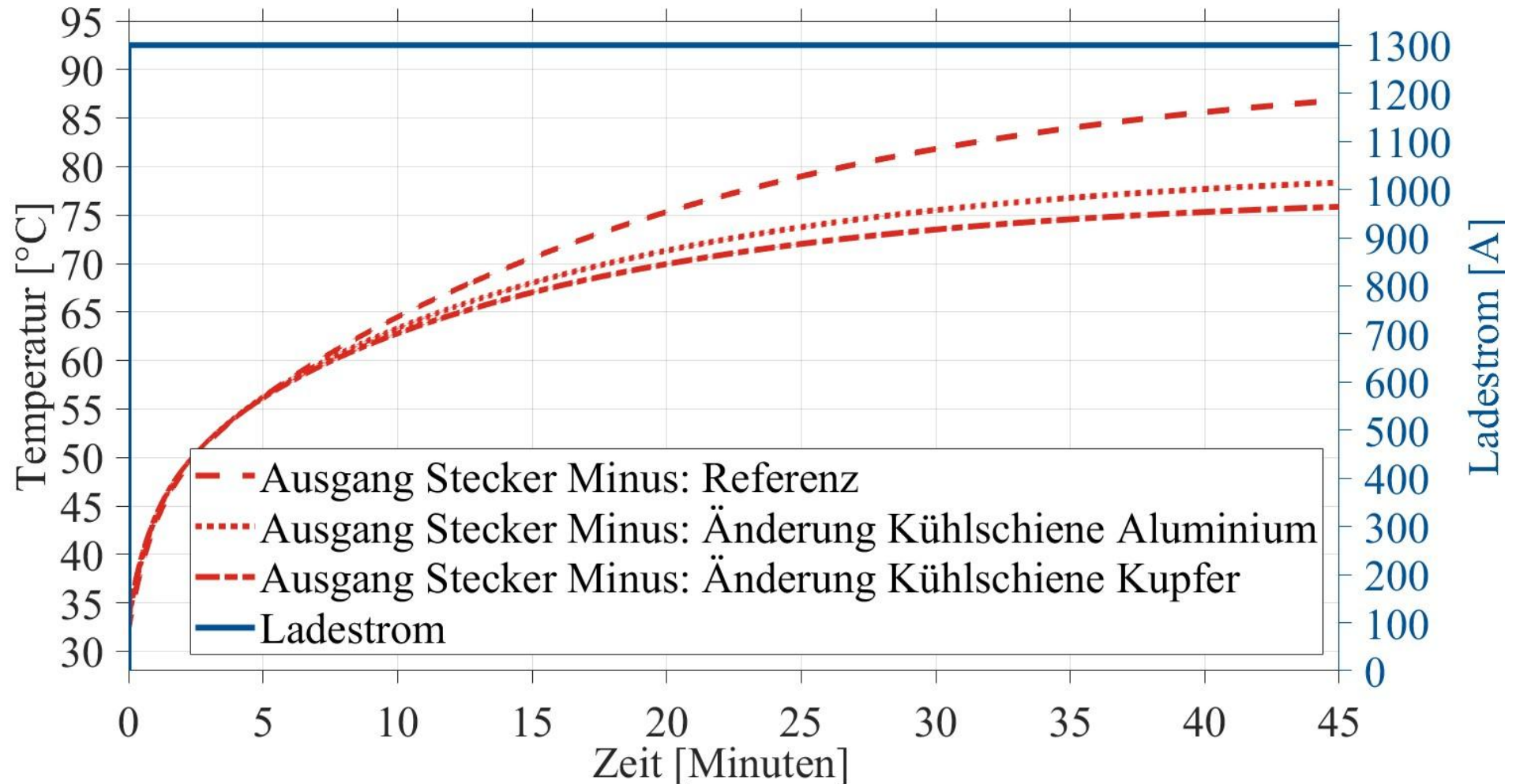
m = mass

c = specific thermal capacity

ΔT = temperature difference

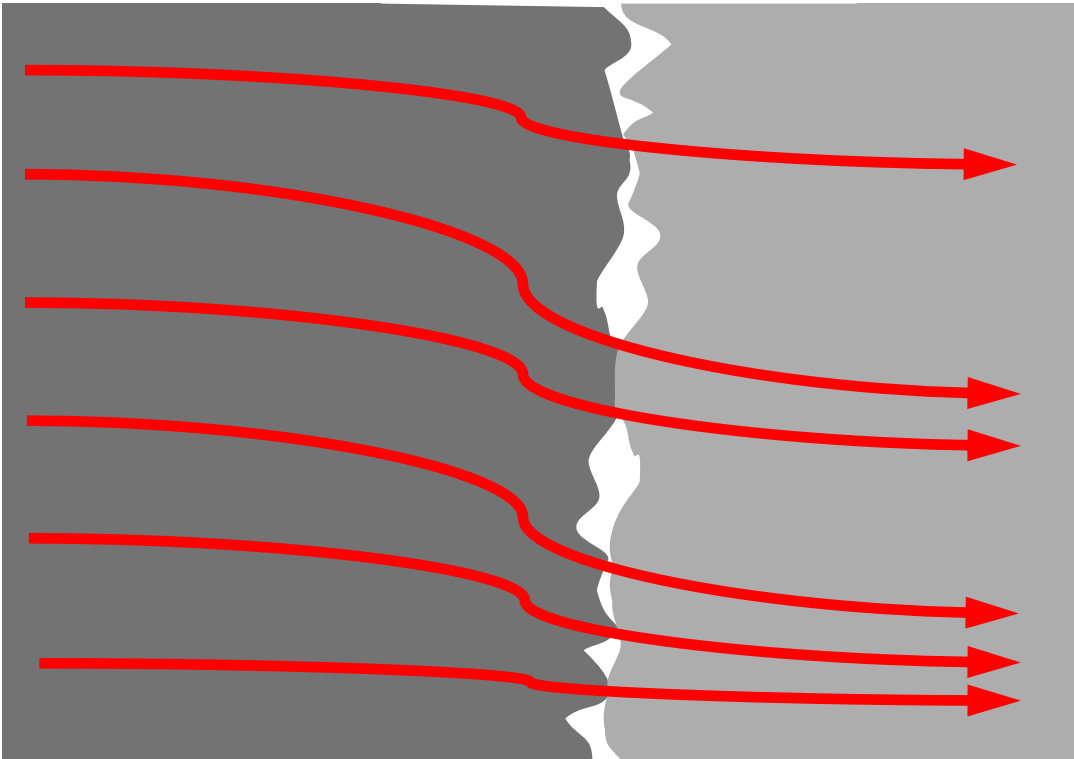
Fuse Box: 2. Thermal Optimisation Approach

Additional heat sink made of aluminium or copper



Thermal resistance

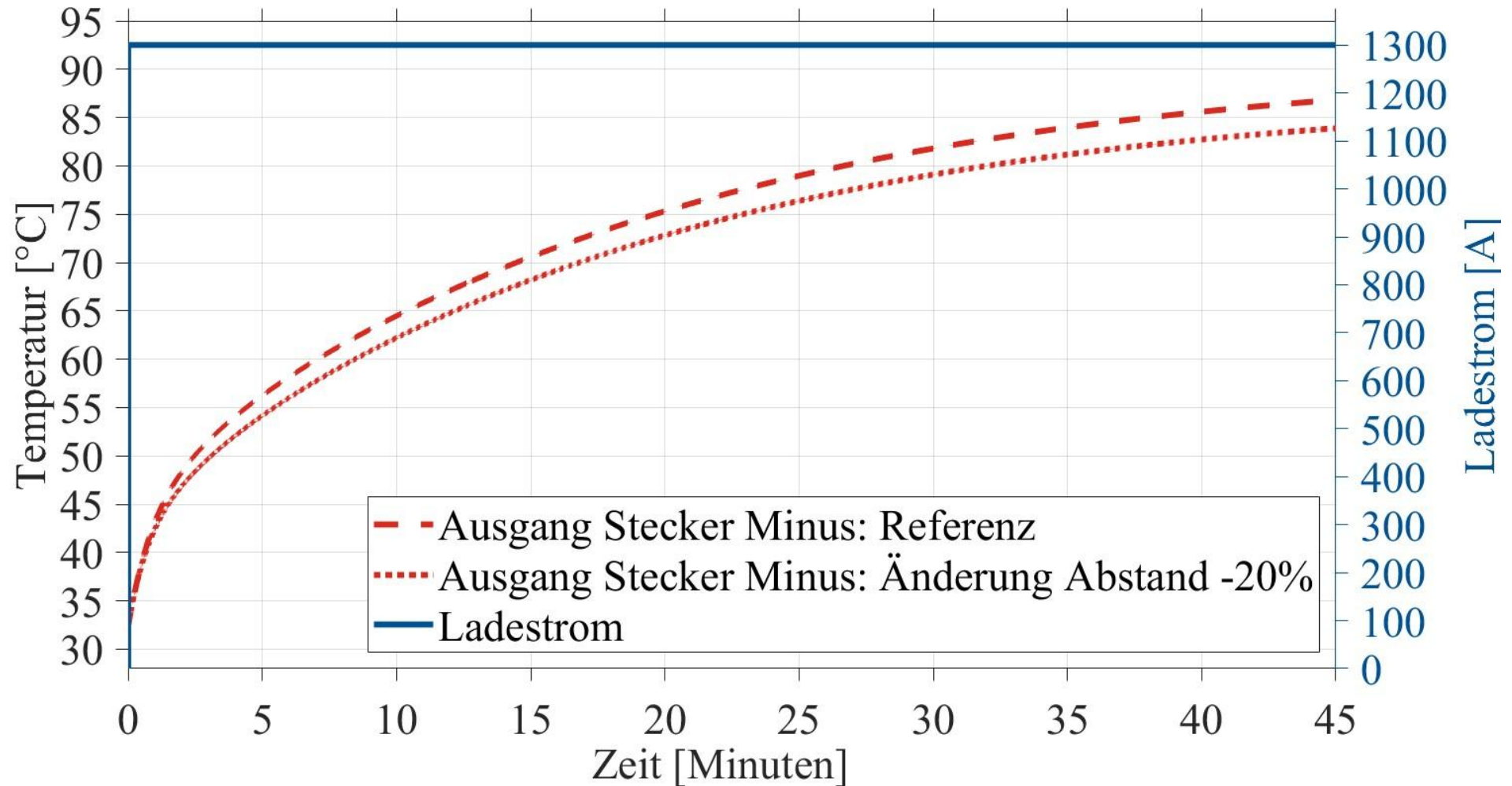
$$\dot{Q} = P_{\text{THERMAL}} = \frac{\Delta T}{R_{\text{THERMAL}}}$$



Detailed view of contact partners

Fuse Box: 3. Thermal Optimisation Approach

20% shorter busbar

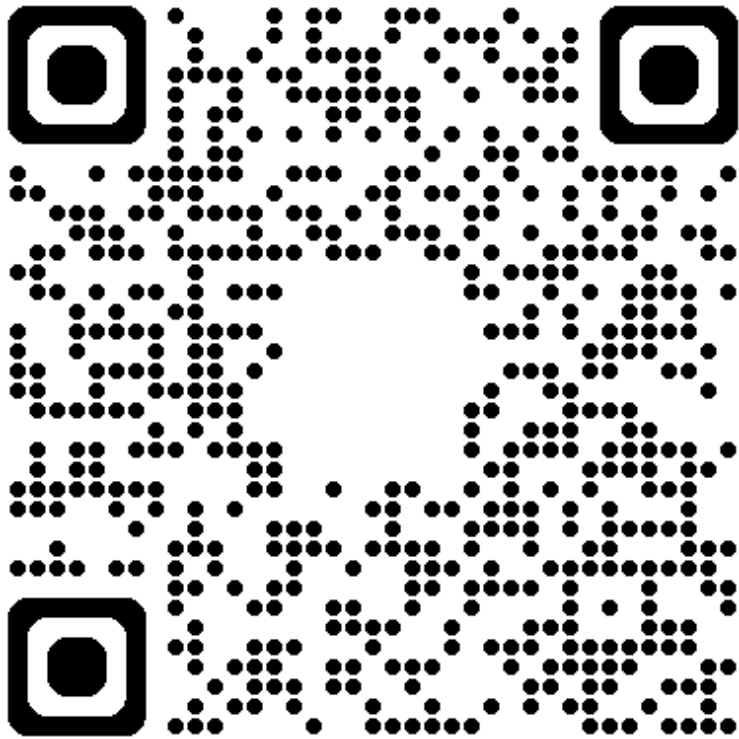


Thermal Optimisation Approaches to Reduce Heat Losses during Fast Charging

1. Copper busbars lower temperatures significantly but are more expensive than aluminium busbars
2. Existence of heat sink matters more than material choice
3. Shorter busbars show a noticeable difference without extra costs

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Let's discuss!

Further information:
Dr.-Ing. Jochen Krings:
Thermische Simulation des
elektrischen Ladepfads bei
Elektro-Nutzfahrzeugen

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