

Afternoon Panel:
Eliminating Cooling Bottlenecks to
Ultra Fast and Megawatt Charging



Eliminating Bottlenecks at Charging

Heat loss reduction at high charging currents at charging inlets of electric vehicles
Wärmeverluste reduzieren bei hohen Ladeströmen an E-Fahrzeug Ladedosen

Mercedes-Benz eActros 600



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

Charging Power:
• MCS² > 1000kW under 30 minutes (20 to 80% SoC³)
• CCS² ~ 425kW

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

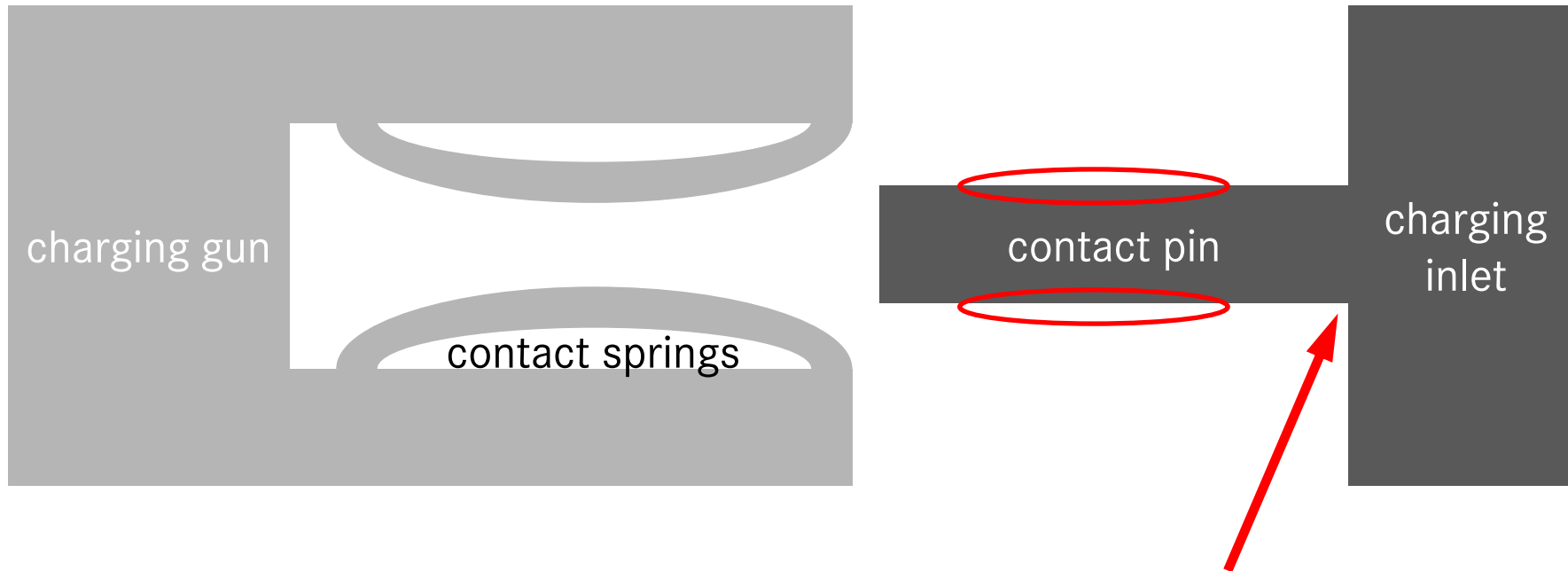
100kW heat loss equals ~ 8-16 individual house heating systems

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

Position CCS and MCS inlet



Plug Connection



contact pin temperature sensor
CCS: max. 90°C / MCS: max. 100°C

Optimization options for components

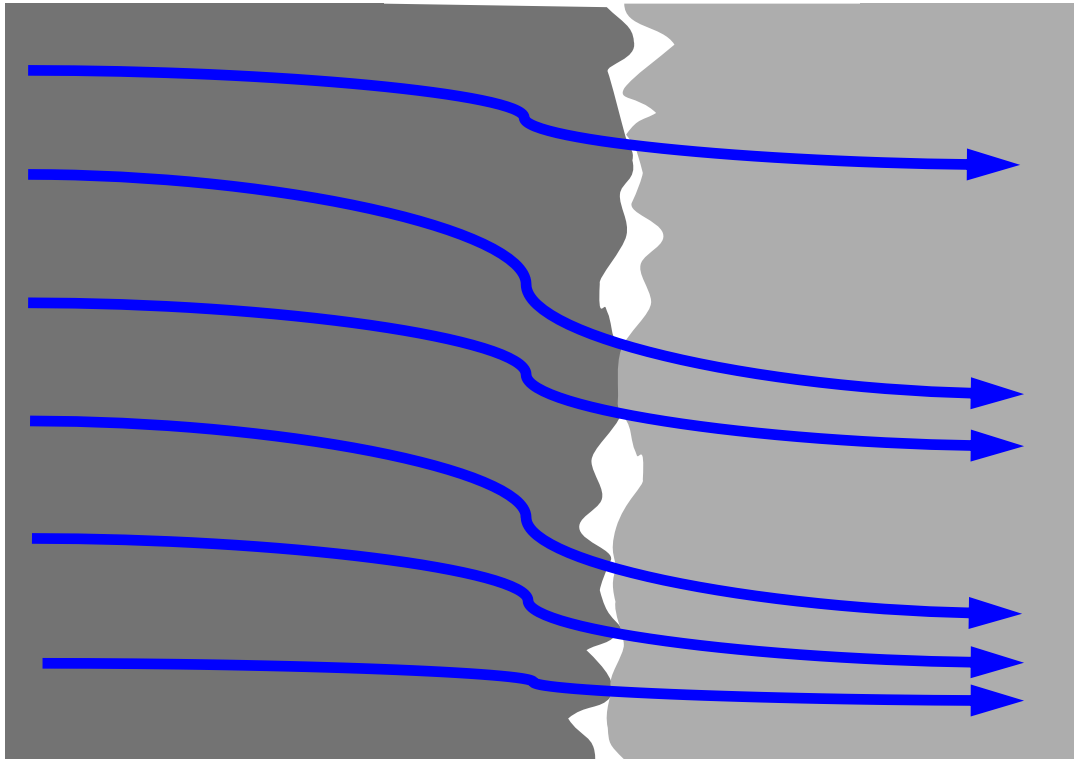
$$P_{\text{ELECTRICAL}} = I^2 * R_{\text{ELECTRICAL}}$$

Reduction of resistance leads to:

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

Electrical resistance

electrical contact resistance = surface contamination resistance + constriction resistance
elektrischer Kontaktwiderstand = Fremdschichtwiderstand + Engewiderstand



Detailed view of contact partners

surface contamination resistance:

- corrosion, oxidation, ageing
- contamination, moisture

⇒ improvement through surface finishing

constriction resistance:

- Roughness, dimensional deviations

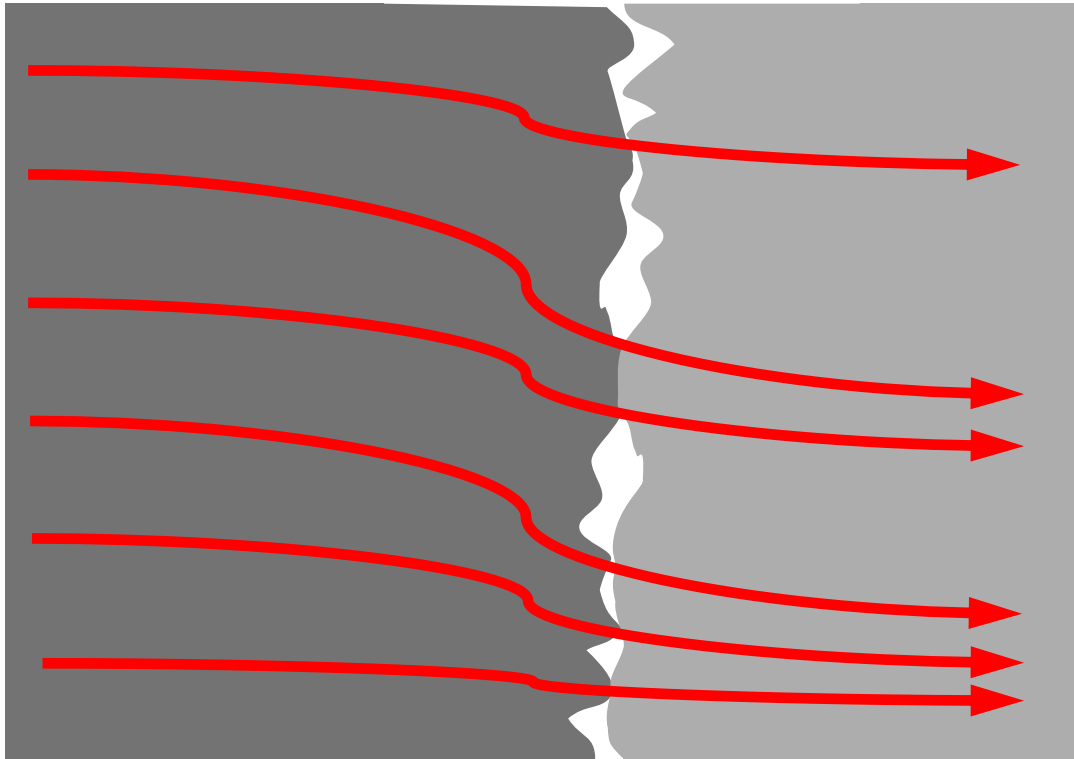
⇒ Measure: softer contact materials ⇒

however, lead to more wear

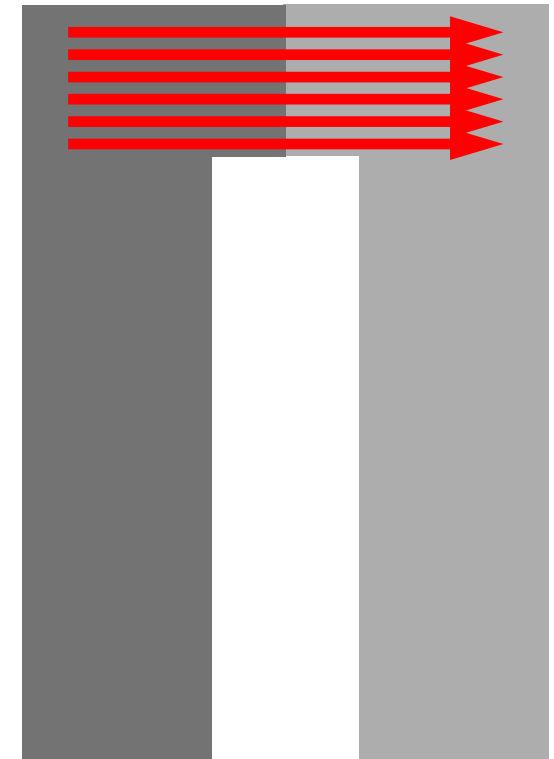
⇒ **higher contact force**

Thermal resistance

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



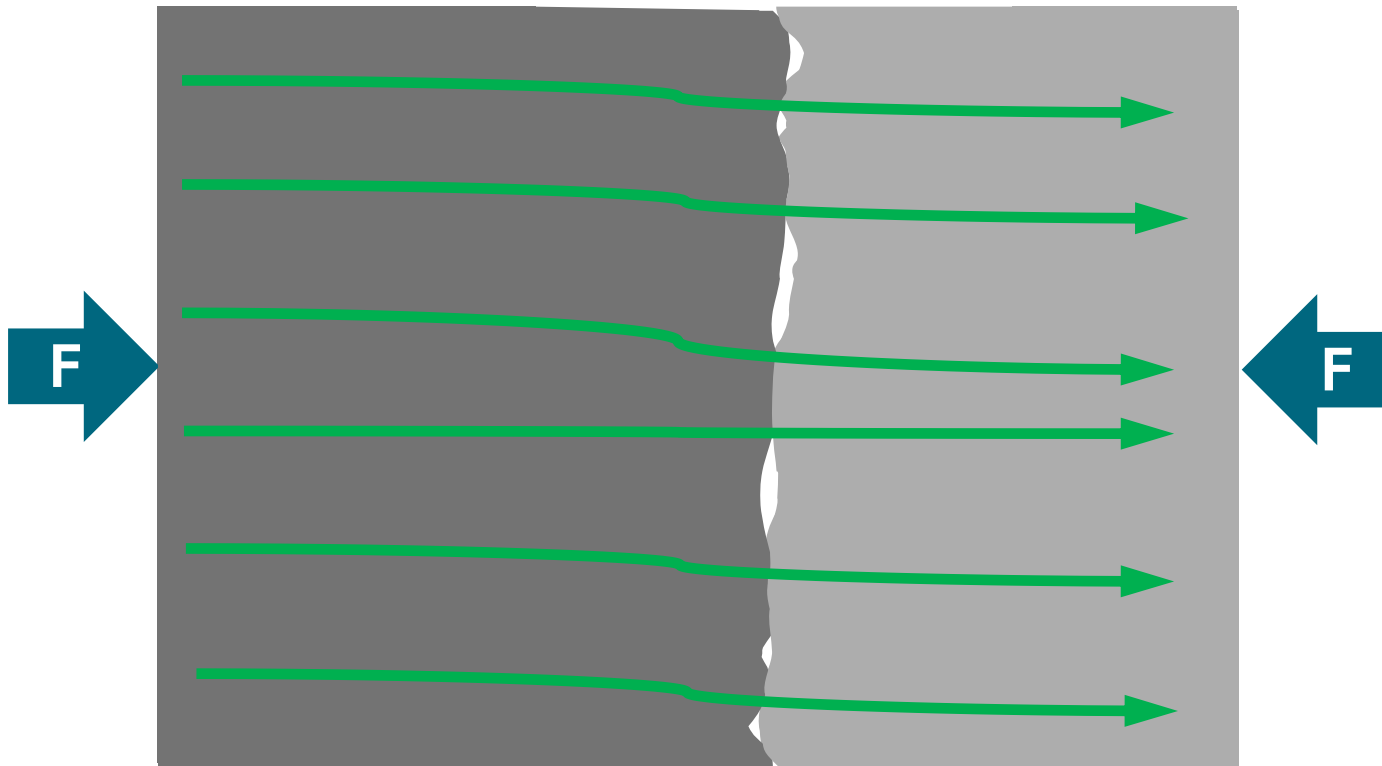
Detailed view of contact partners



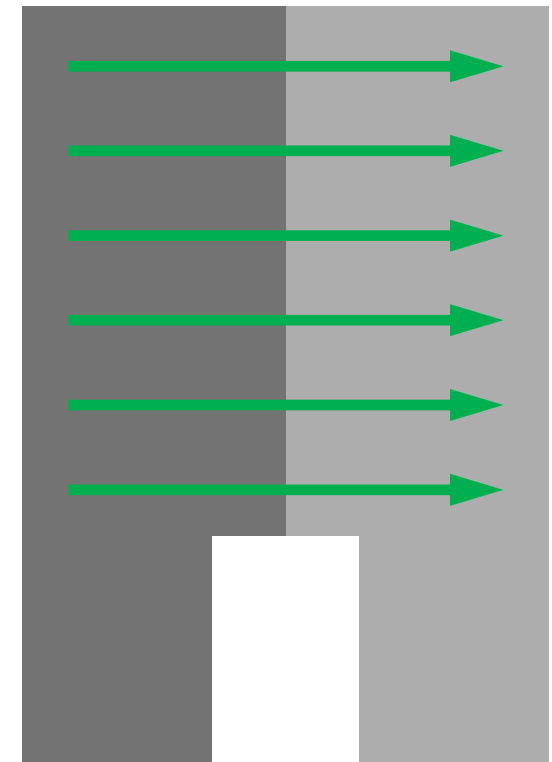
equivalent illustration

Reduction of electrical and thermal resistance by higher contact force

- higher contact forces increase contact area
- improved electrical resistance and heat conduction
- heat isolating air between contact partners is reduced

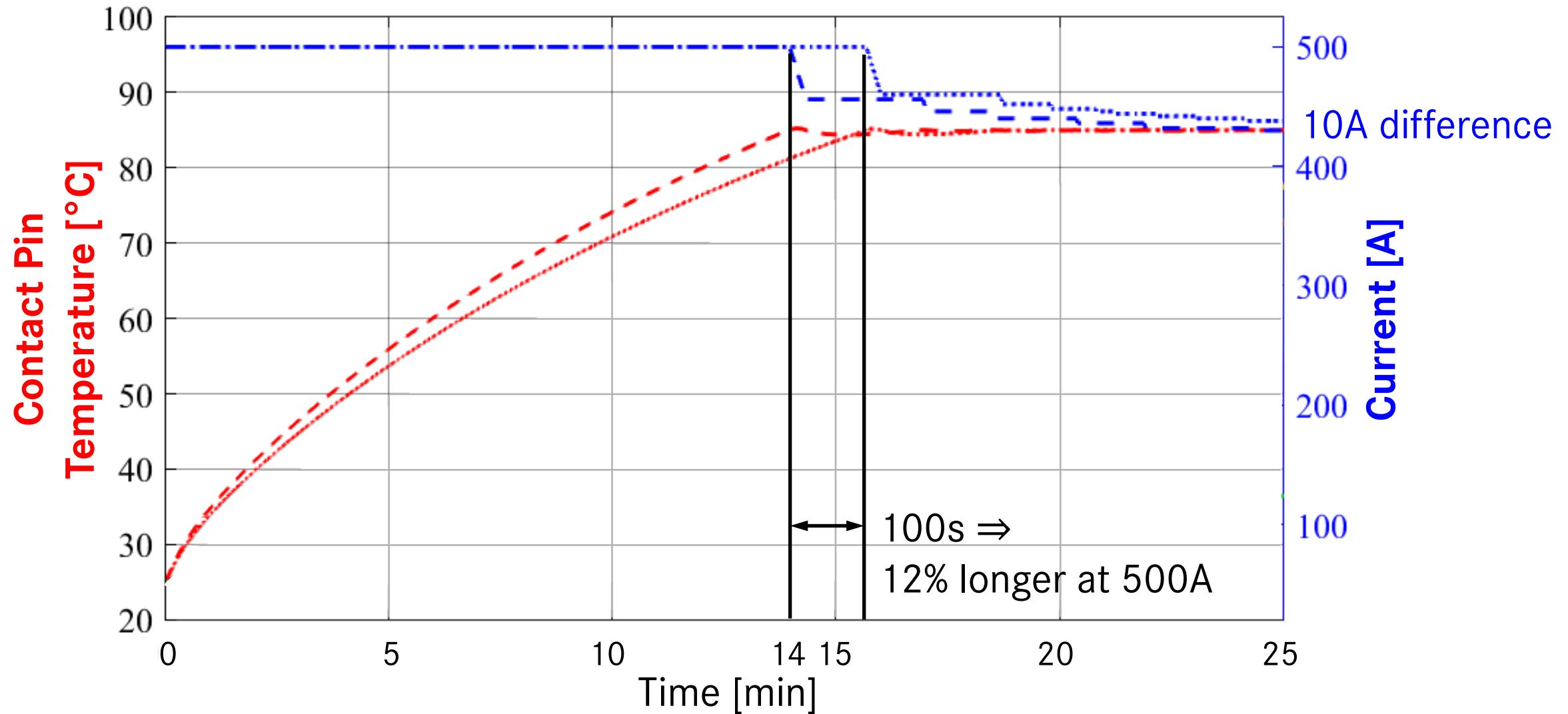


Detailed view of contact partners



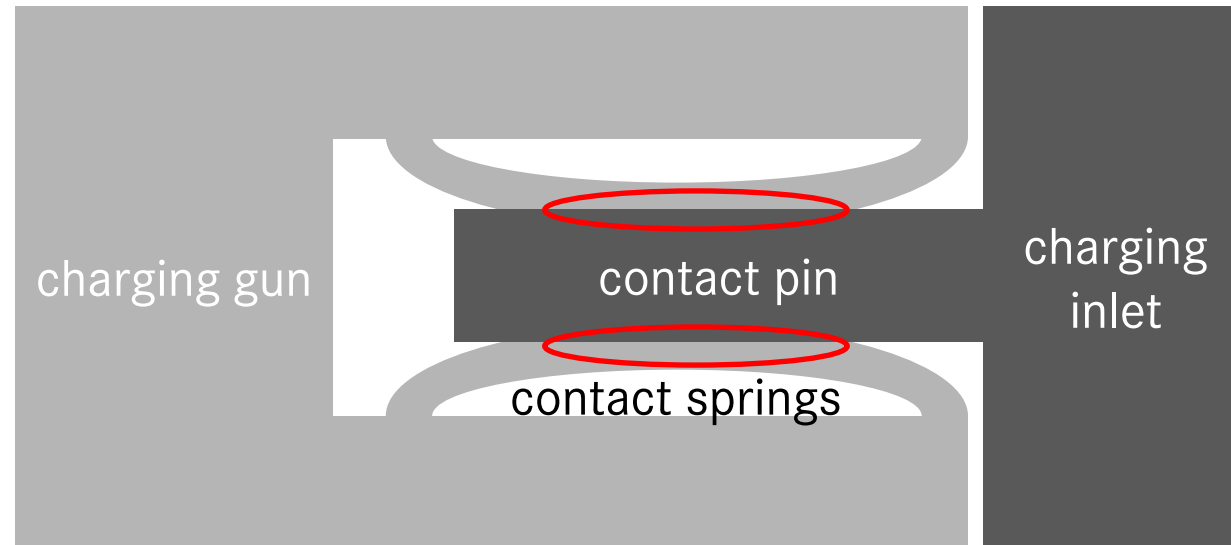
equivalent illustration

Contact forces 80N versus



Summary of the presentation

- higher contact forces reduce electrical and thermal resistance
- charging time is reduced



Still not blown away?

Just 2 minutes?



**DAIMLER
TRUCK**

www.daimlertruck.com

Let's discuss!

Author / Co-Authors:

Daimler Truck AG:

Jochen Krings

jochen.krings@daimlertruck.com

doctoral candidate

Peter Ziegler

peter.z.ziegler@daimlertruck.com

manager eCharging Components

Paul Steinmetz

paul.ps.steinmetz@daimlertruck.com

working student

FKFS (Forschungsinstitut für Kraftfahrwesen und Fahrzeugmotoren Stuttgart) University of Stuttgart:

Prof. Dr.-Ing. Hans-Christian Reuss info@fkfs.de