

HIGH CAPACITY | PRECISION | RELIABILITY

Plasser & Theurer

Magna/ECS Simulation Conference 2025

Potential of cooling and air conditioning system control in a rail vehicle

Markus Raup & Andreas Neulinger | May 2025



Potential of cooling and AC control in a TIV

Content

TIV ... track inspection vehicle



- Vehicle layout
- Simulation model
 - Track, component and ambient data for the driving simulation
 - Power pack & cooling system control
 - Air conditioning system
- Simulation Results
- Summary & Outlook



Potential of cooling and AC control in a TIV

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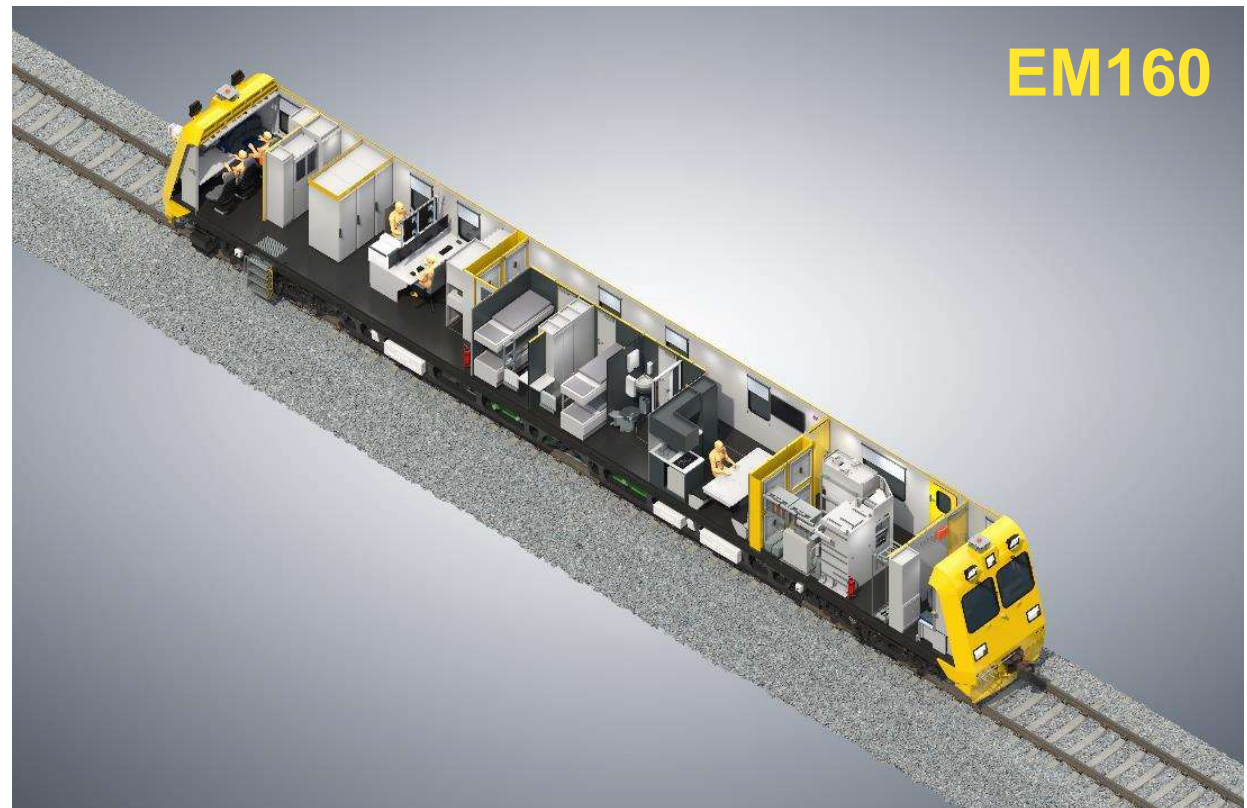
Vehicle layout



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Vehicle layout



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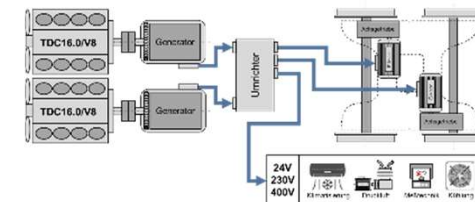
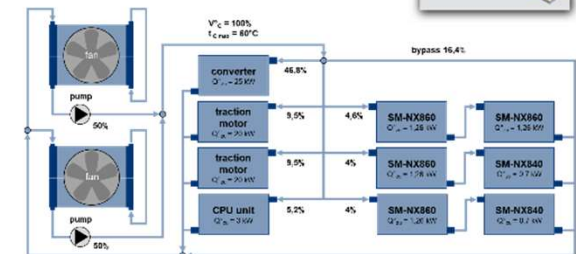
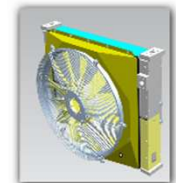
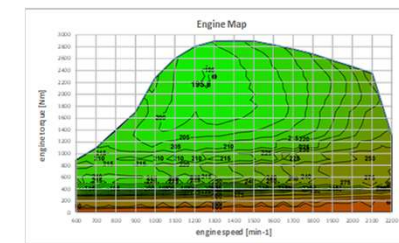
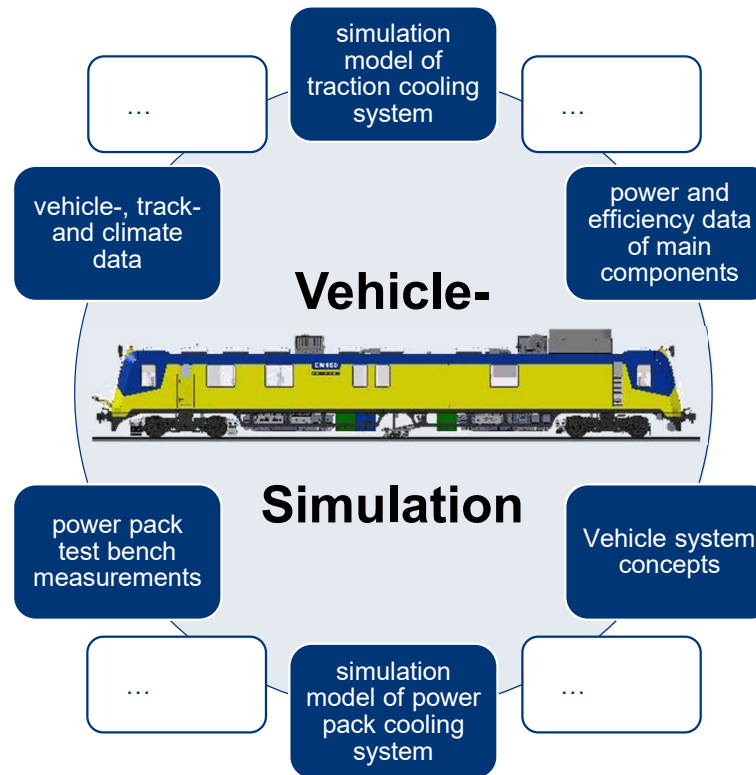
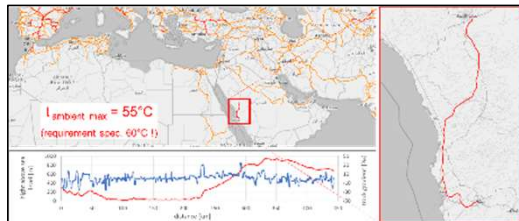
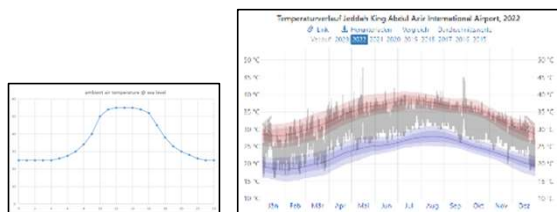
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Simulation model

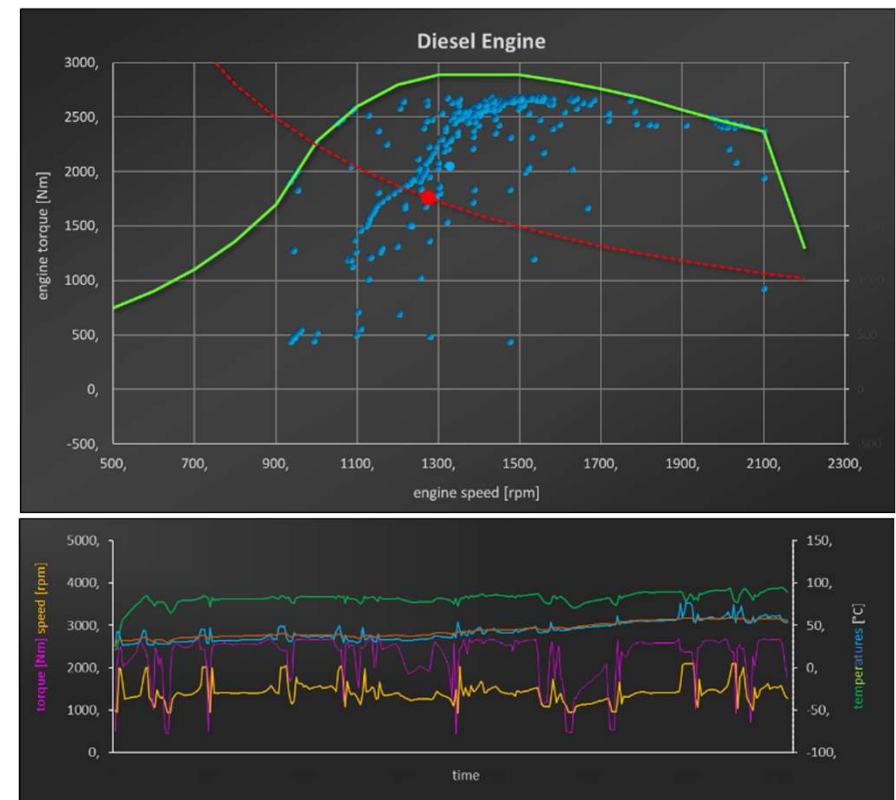
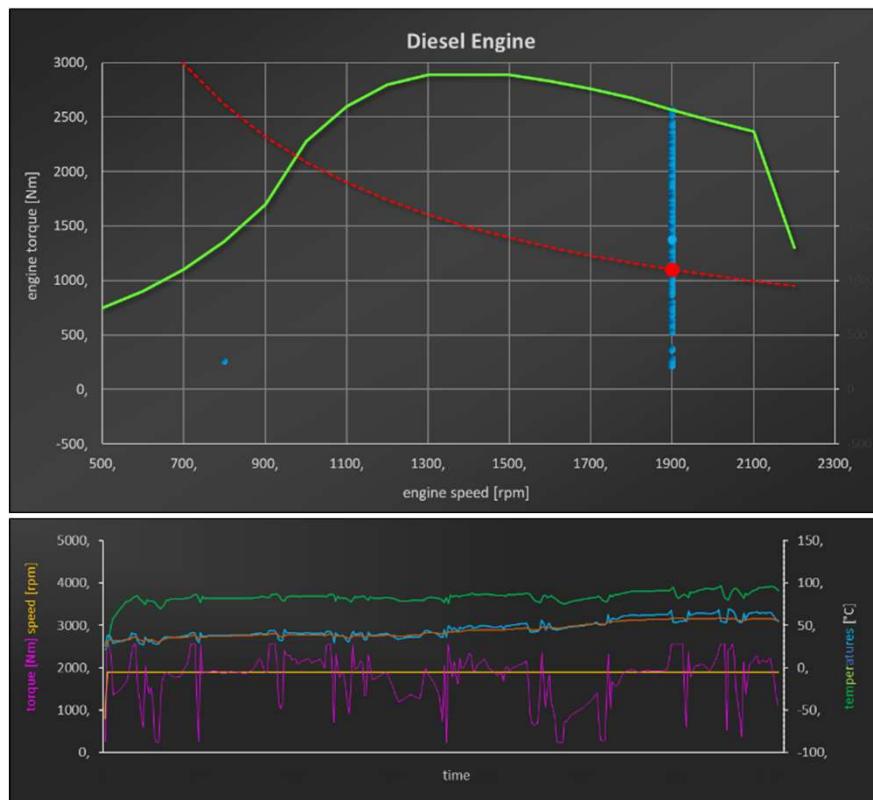


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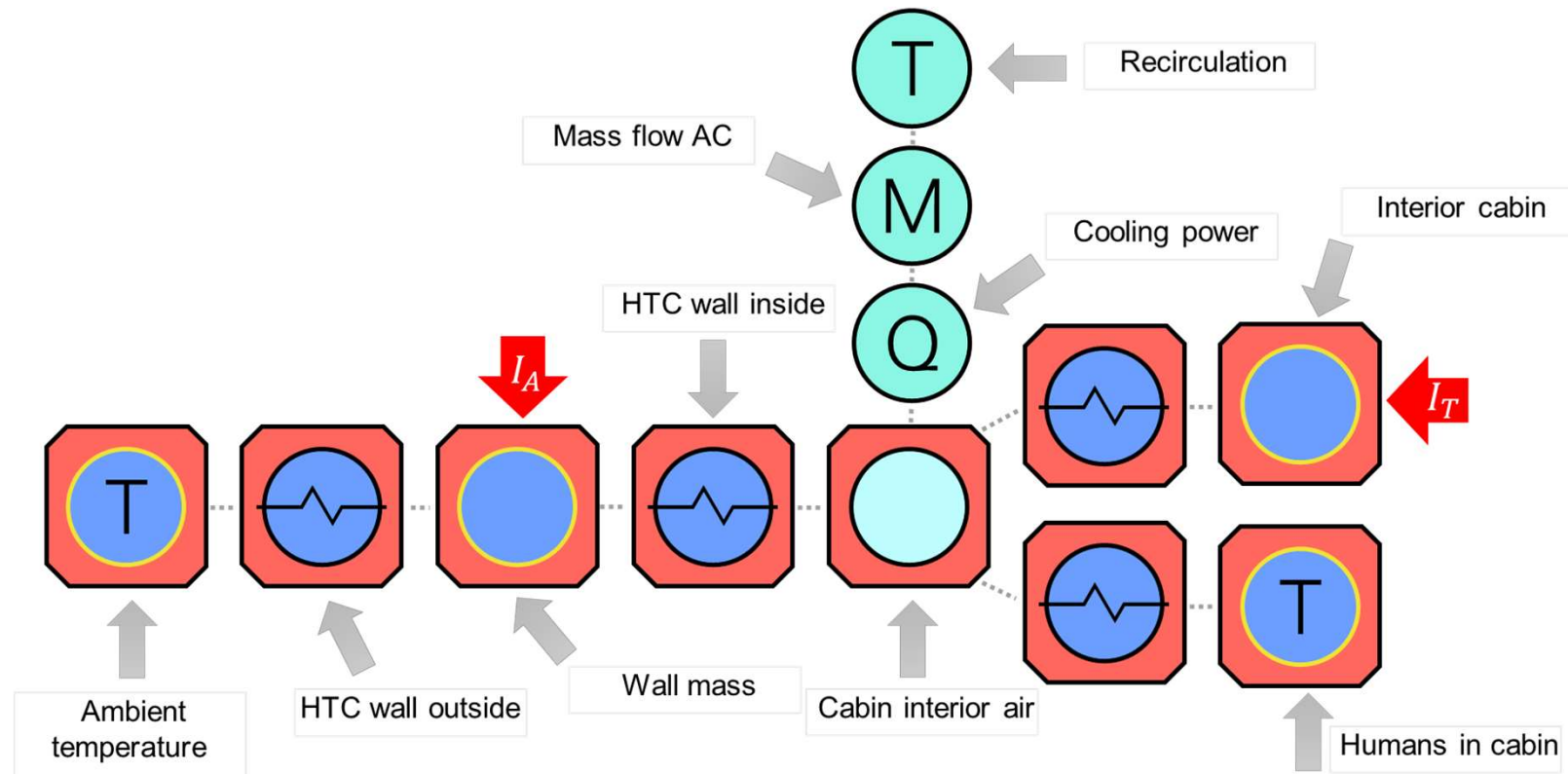
Power pack & cooling system control

target speed = 160 km/h



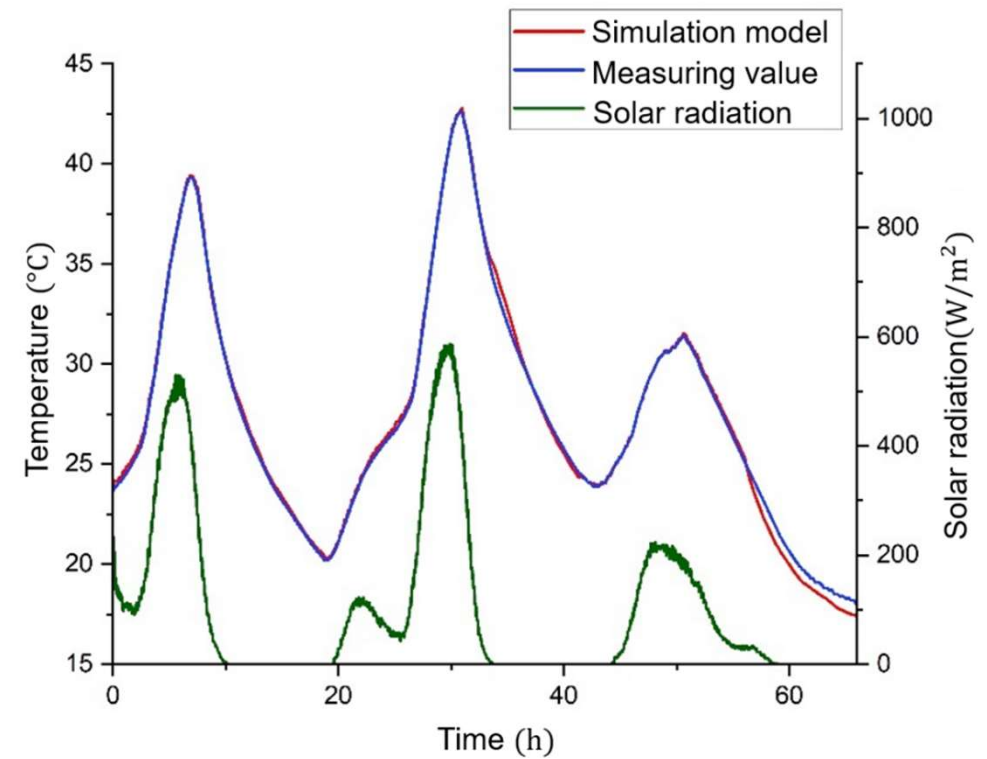
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Air conditioning system – basic model



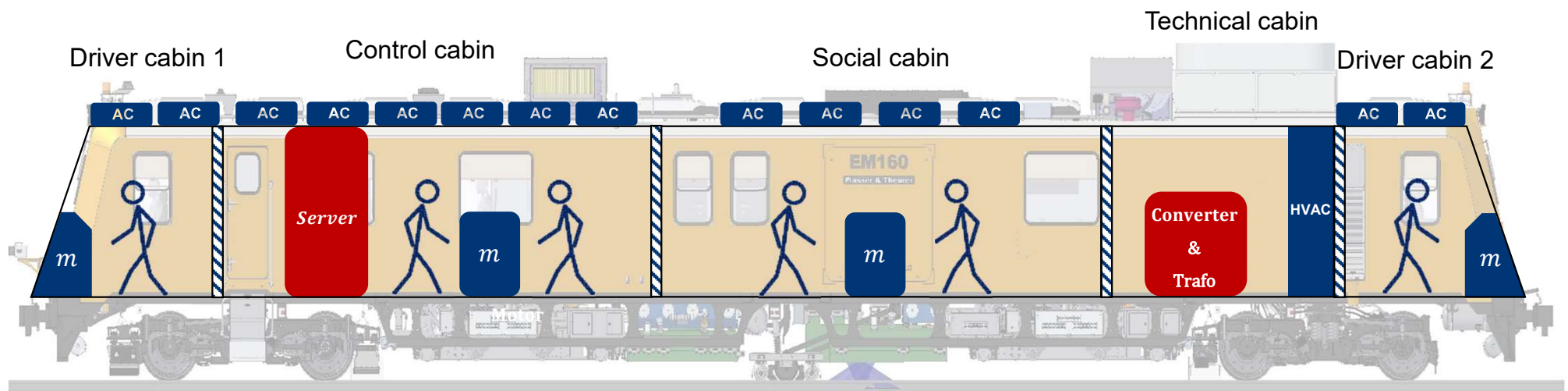
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Air conditioning system – determination of the masses



Potential of cooling and AC control in a TIV

Air conditioning system – simulation model

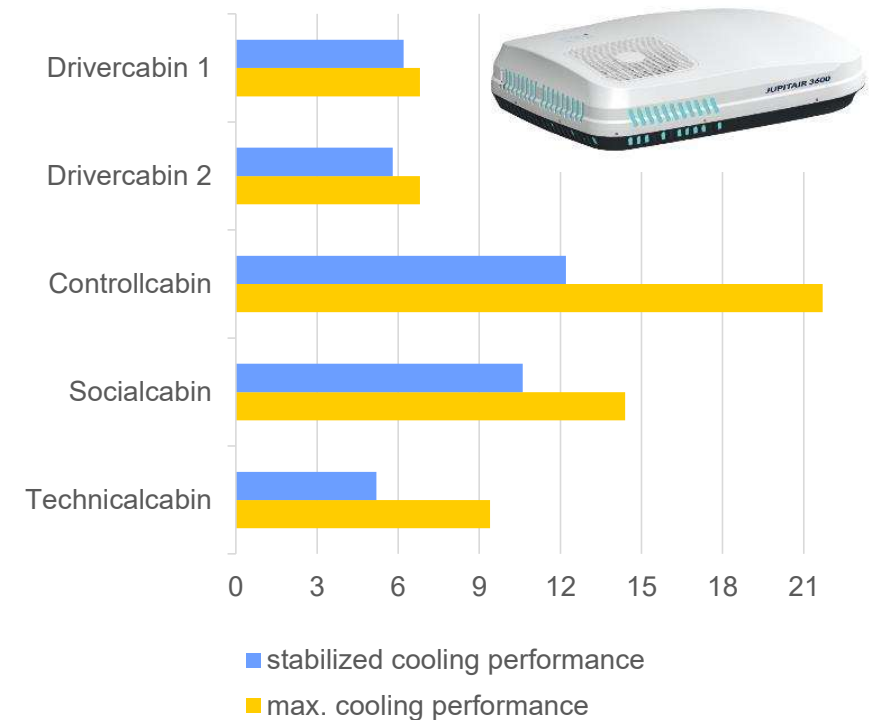


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Air conditioning system – cabin conditions

Air-Conditioning		DC 1	DC 2	CC	SC	TC
Ambient-temperature	°C	55	55	55	55	55
Initial-temperature	°C	65	65	65	65	65
Humans in Cabin	-	3	0	3	4	0
Driving speed	km/h	160	160	160	160	160
AC mass flow	kg/s	0,35	0,35	1,05	0,7	0,31
Settling time	min	120	30	5	10	8
Max. cooling Power	kW	6,8	6,8	21,7	14,4	9,4
Settling cooling Power	kW	6,2	5,8	12,2	10,6	5,2



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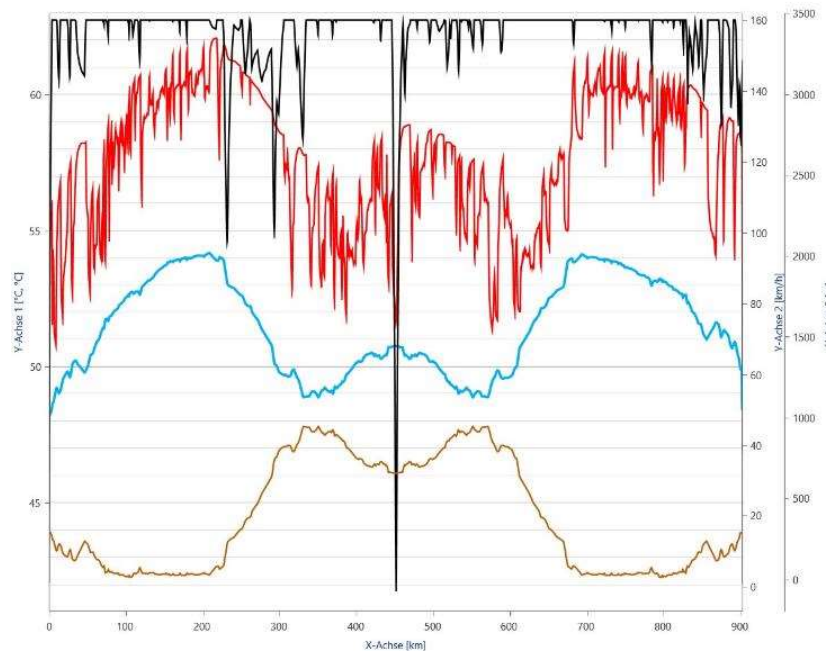
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Simulation results

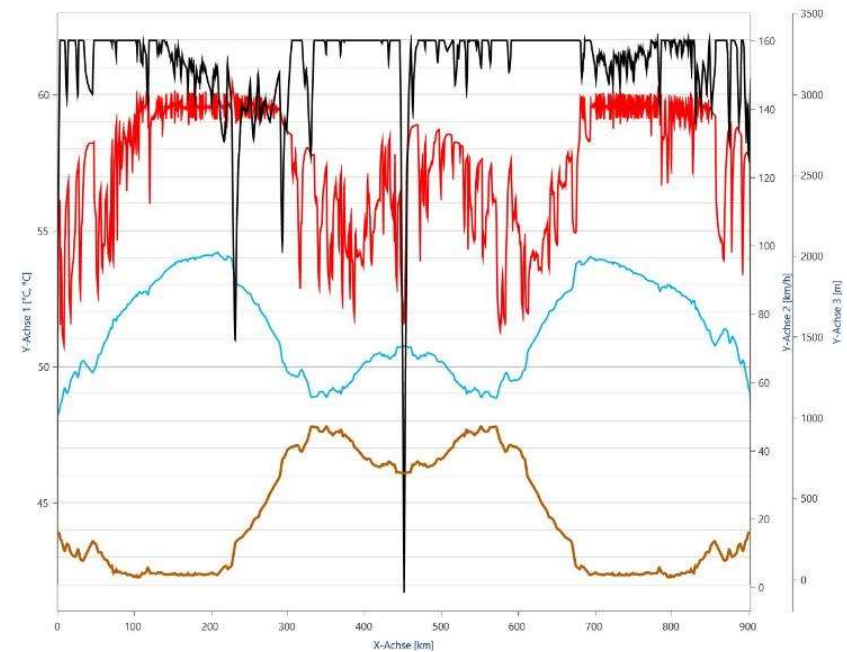
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- Driving speed
- Converter entry temperature
- Ambient air temperature
- Altitude

Converter entry temp. “unlimited”



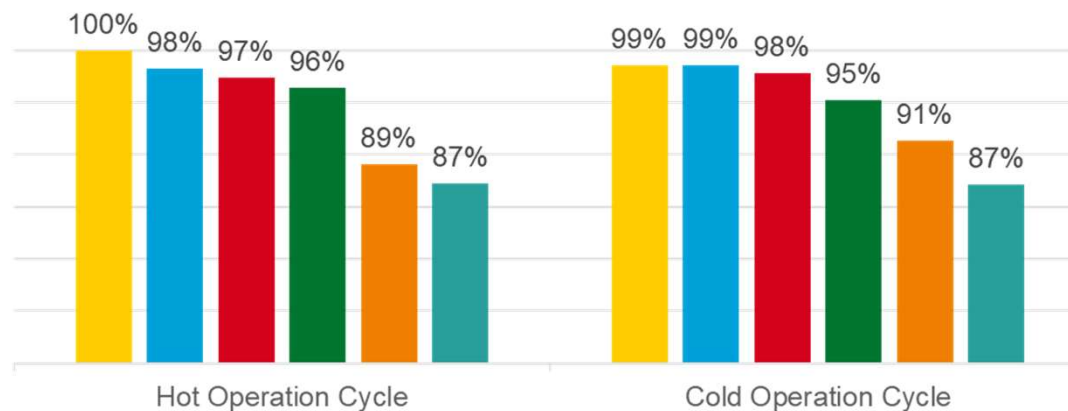
Converter entry temp. “limited”



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Simulation results

Full Vehicle Cooling Model		Var. 1	Var. 2	Var. 3	Var. 4	Var. 5	Var. 6
Engine rpm	-	constant	constant	constant	constant	adaptive	adaptive
CAC rpm	-	constant	constant	adaptive	constant	constant	adaptive
Airconditioning	-	constant	constant	constant	adaptive	constant	adaptive
Hot Operation Cycle	h	6,06	6,16	6,15	6,17	6,17	6,16
Cold Operation Cycle	h	6,09	6,09	6,09	6,09	6,09	6,09



Remark: Var. 1 without the speed reduction depending on the converter temp.

Reduction of 12,8%
with all the optimizations !



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Summary & Outlook

Summary: "What did we already achieve ?"

- Established and calibrated transient system model ✓
- Component optimization and parameter definition for the controllers ✓
- Functional guarantee for extreme use conditions ✓
- Potential of fuel consumption reduction for TIV in a range of > 12% ✓

Outlook: "What are the next steps ?"

- Standardization of system components and control strategies □
- Thermal management optimization of all vehicle types @ P&T □
- Increase overall vehicle efficiency of all types => CO₂-reduction □



KULI - a great tool to work with !

Many thanks for your attention !





Markus Raup

Head of Track Inspection Vehicles, FSO-M2



Andreas Neulinger

Track Inspection Vehicles, FSO-M2
