TLK-Thermo GmbH

Technische Universität Braunschweig

institut für thermodynamik ift

Method for designing WHRS in vehicles considering optimal control

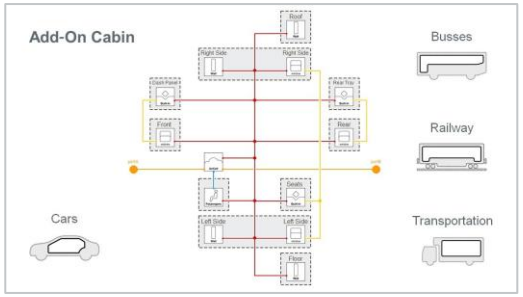
Philipp Petr, Wilhelm Tegethoff, Jürgen Köhler

4. International Seminar on ORC Power Systems

TLK-Thermo: Engineering Services and Software for Thermal Systems

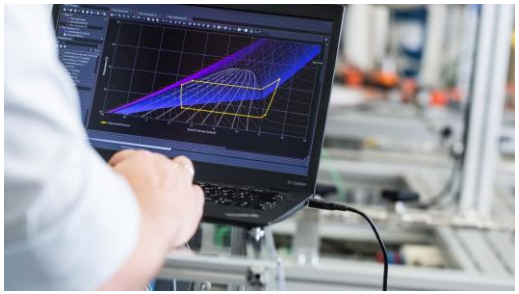
Simulation

fast and robust dynamic simulation models of thermal components and systems



Customized Software

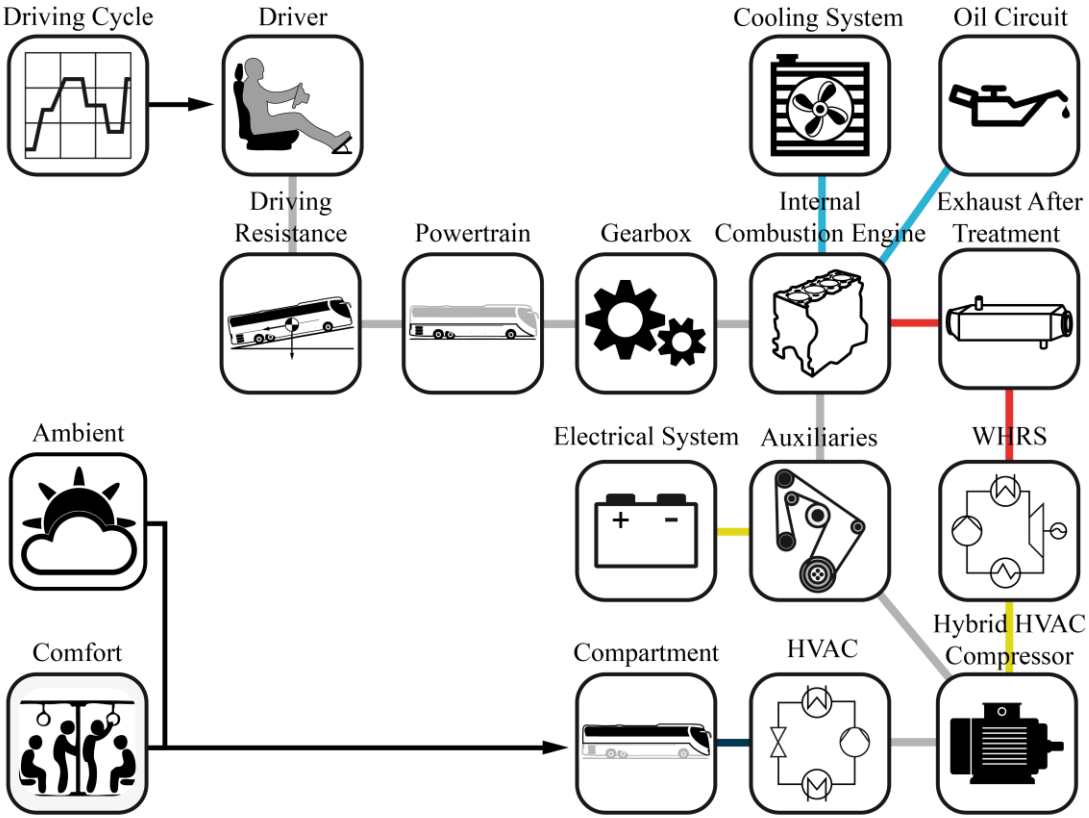
for model based development of thermal and other systems, visualization and model analysis



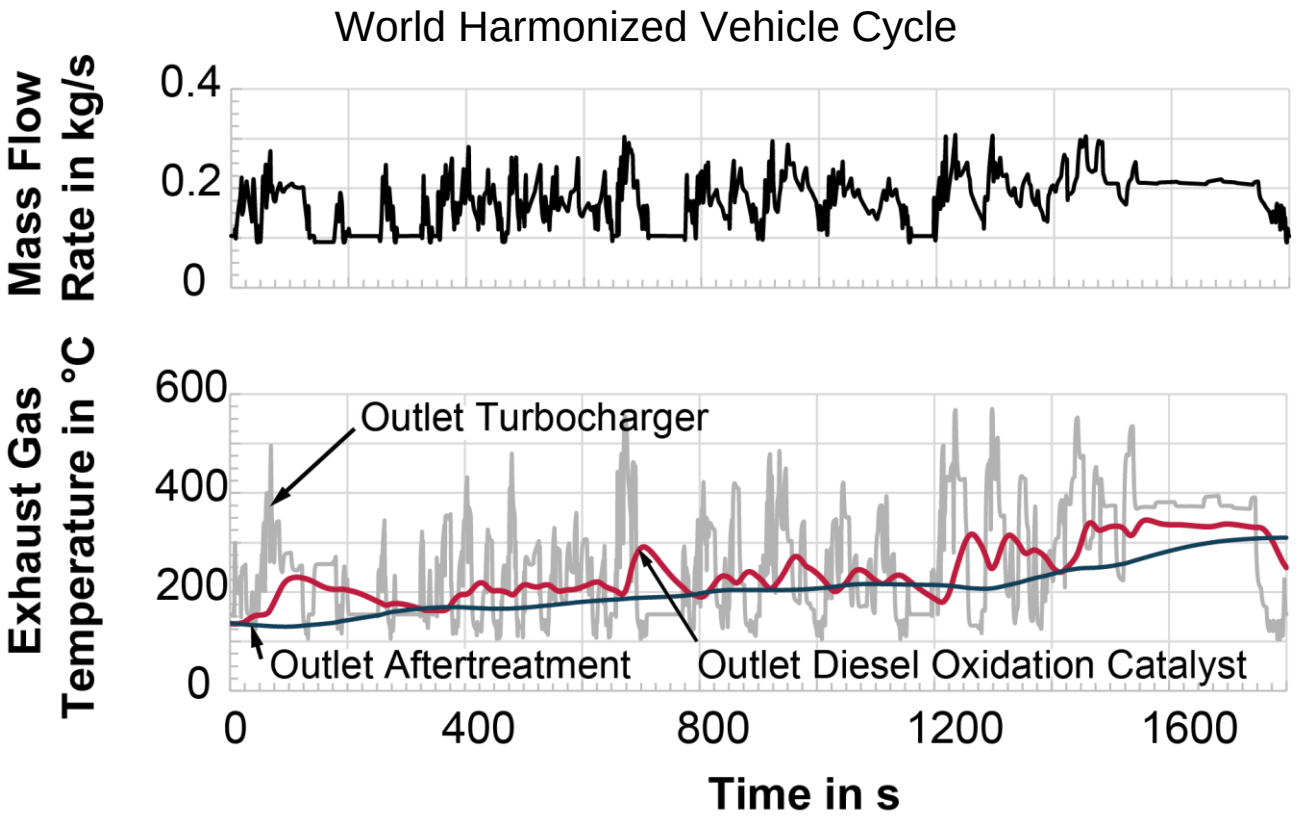
Test Benches

Design and development of testing concepts, measurement services

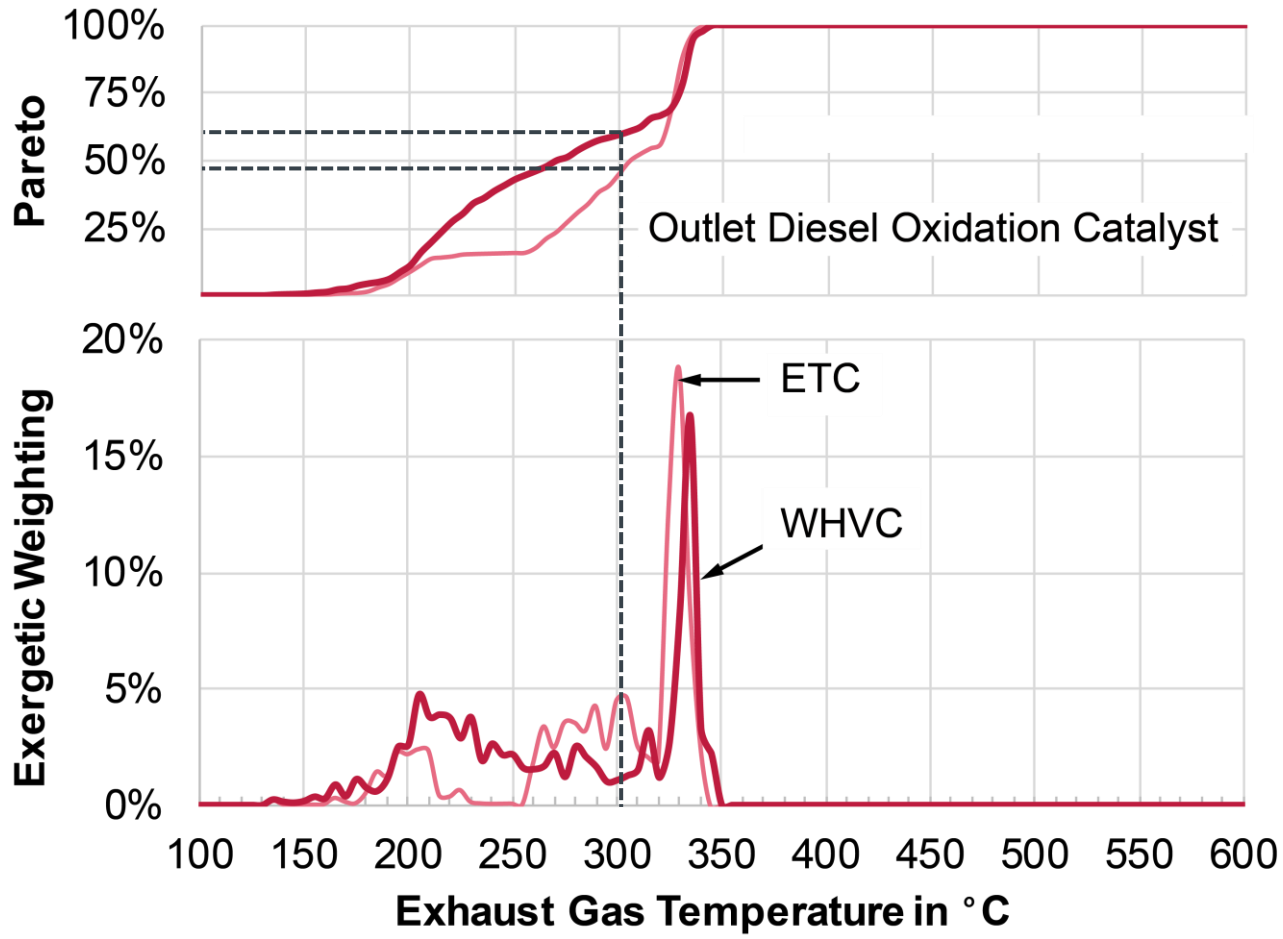
Longitudinal Dynamics and Thermal Systems Model of an Omnibus



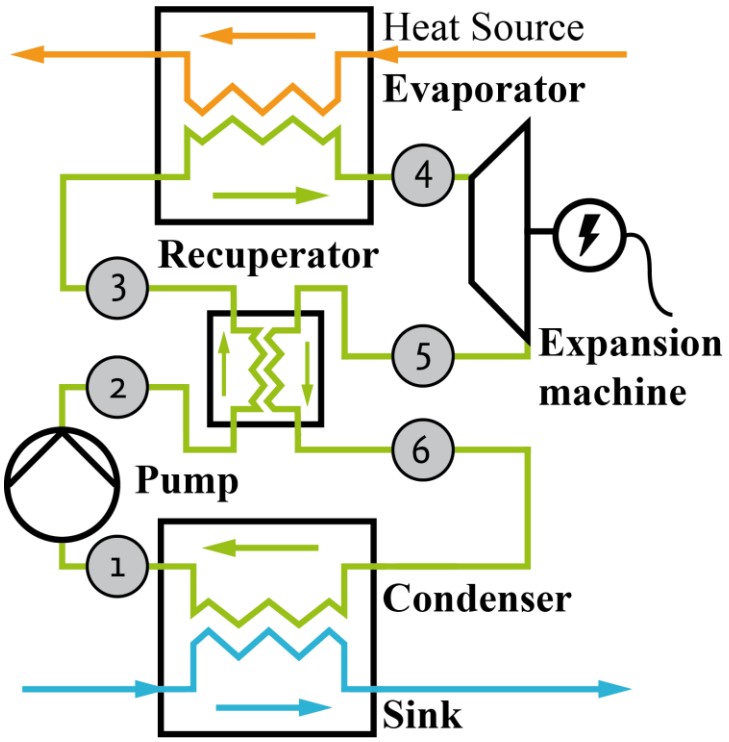
Transient Characteristics of the Exhaust Gas Flow in the WHVC

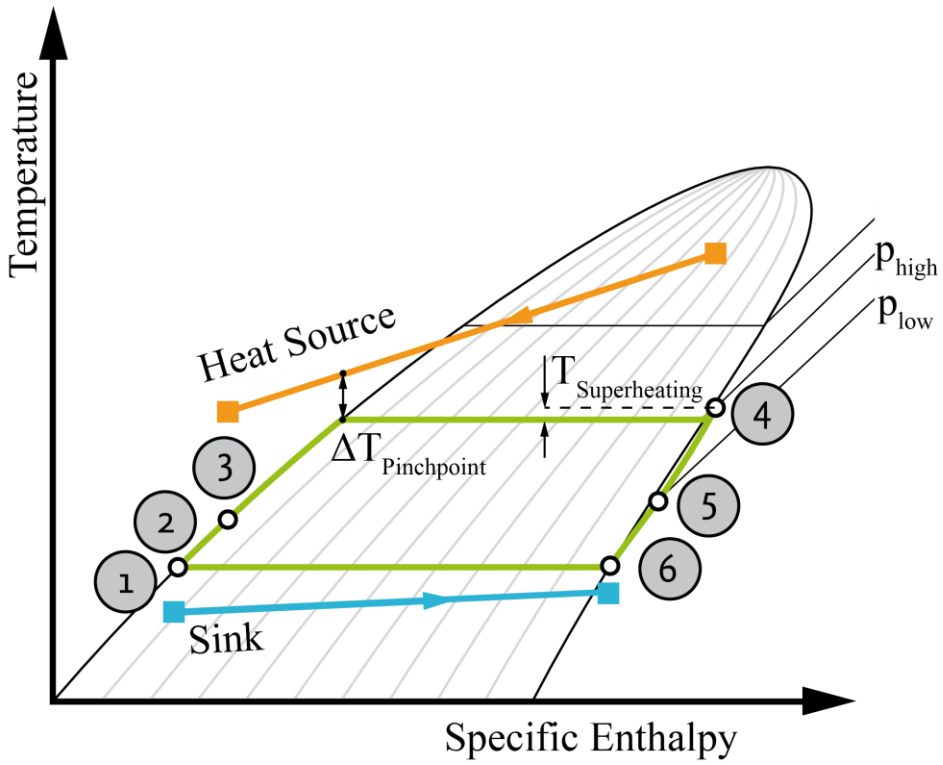


Exergetic Weighting of Occuring Exhaust Gas Temperatures

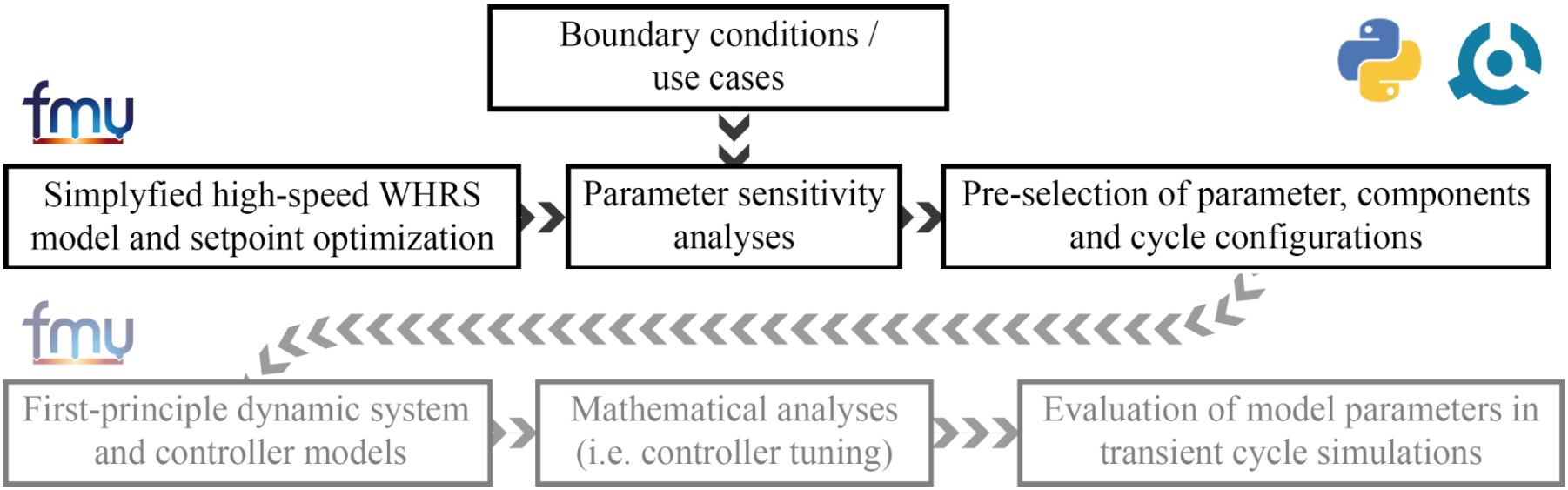


Considered Rankine Cycle Base Configuration



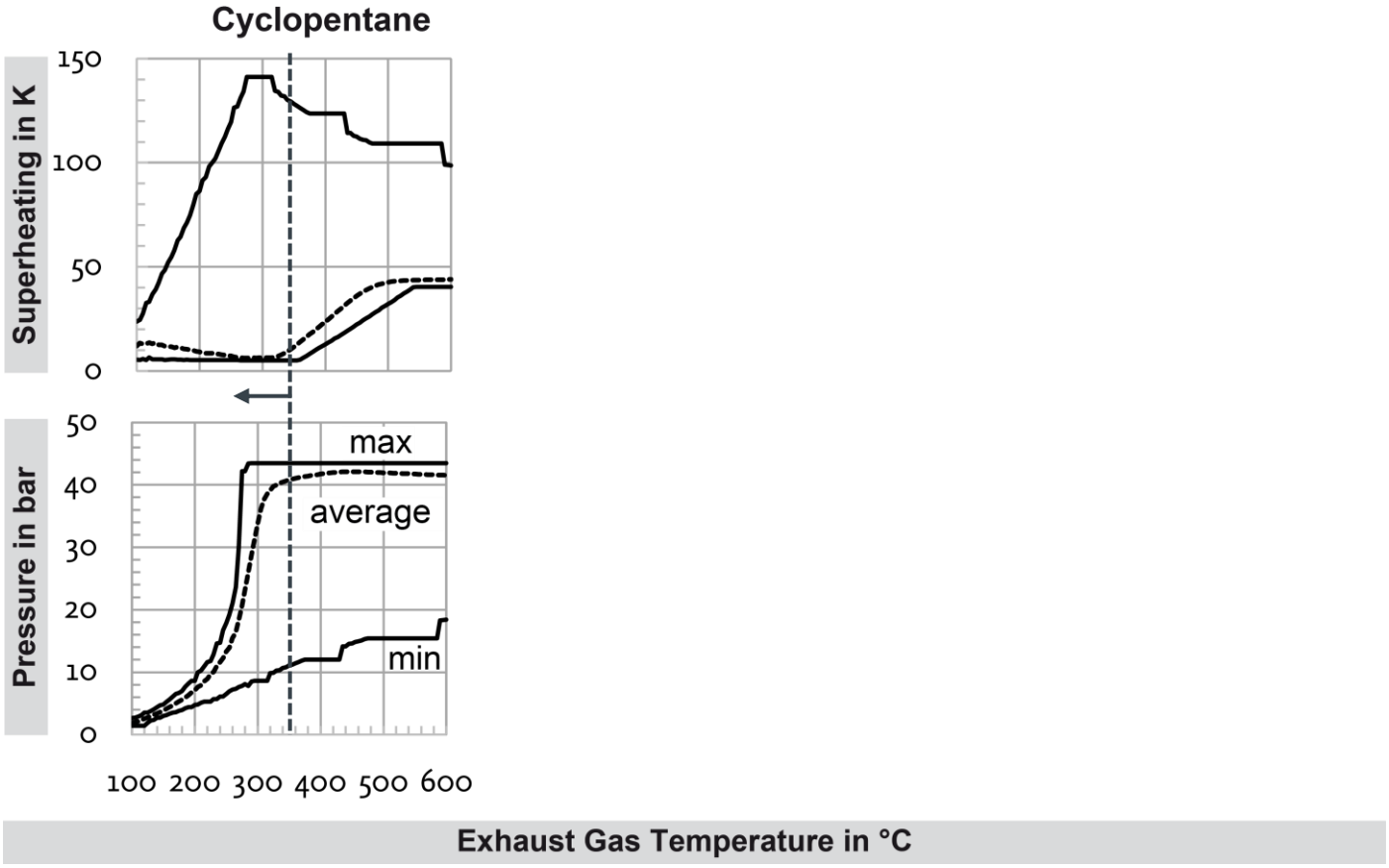


Developed Method

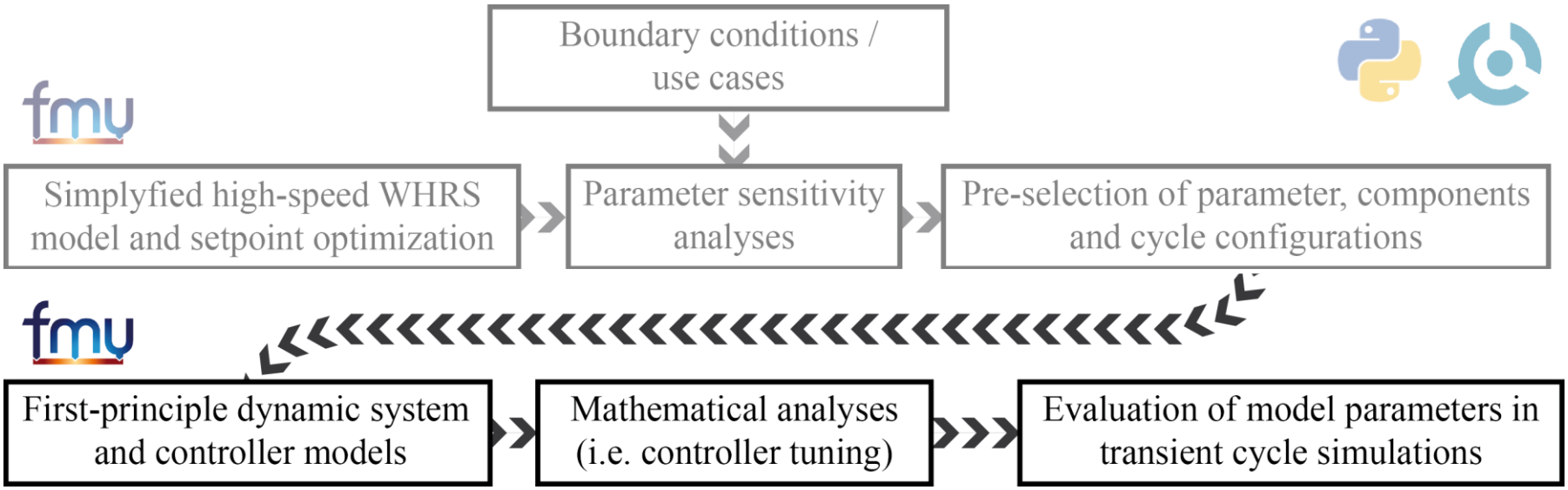


Distribution of Optimum Control Values for Various Component Efficiencies

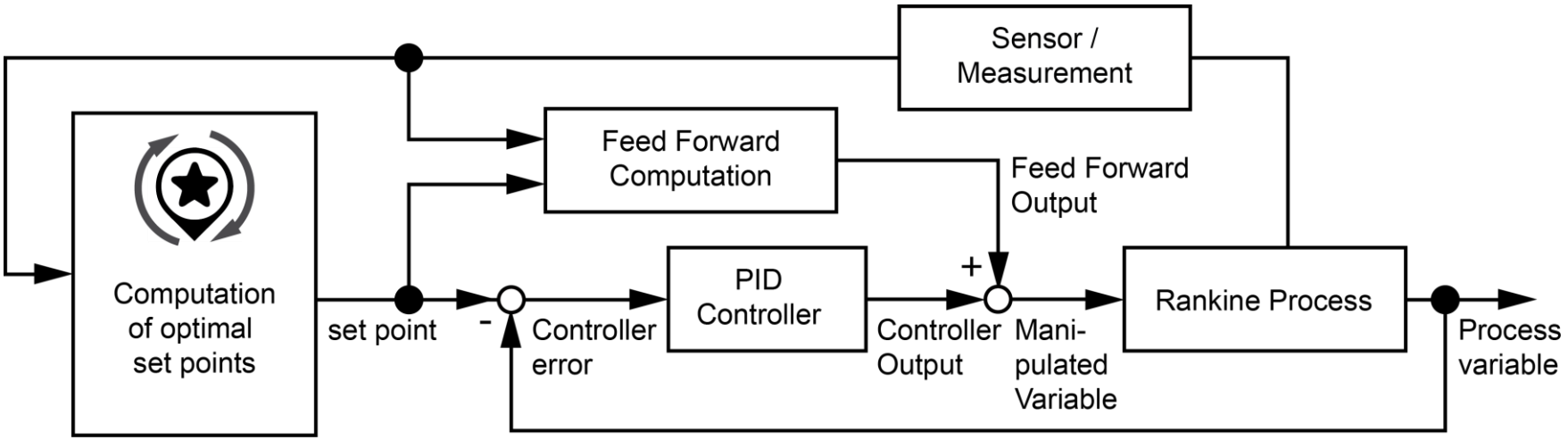
Investigation of 2800 cycle characteristics per working fluid



Proposed Method

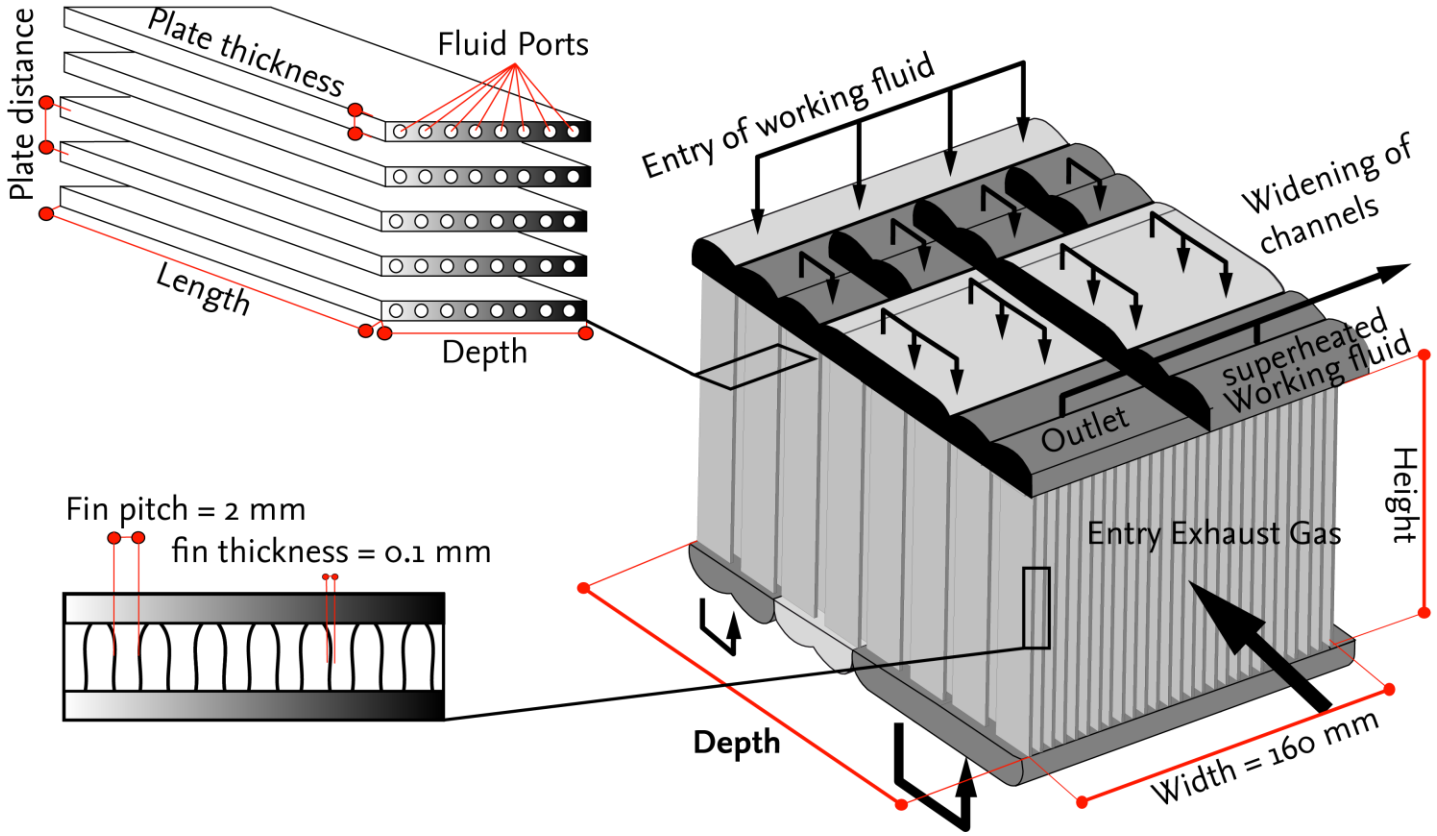


Online Computation of Optimal Operation Points and Control Values

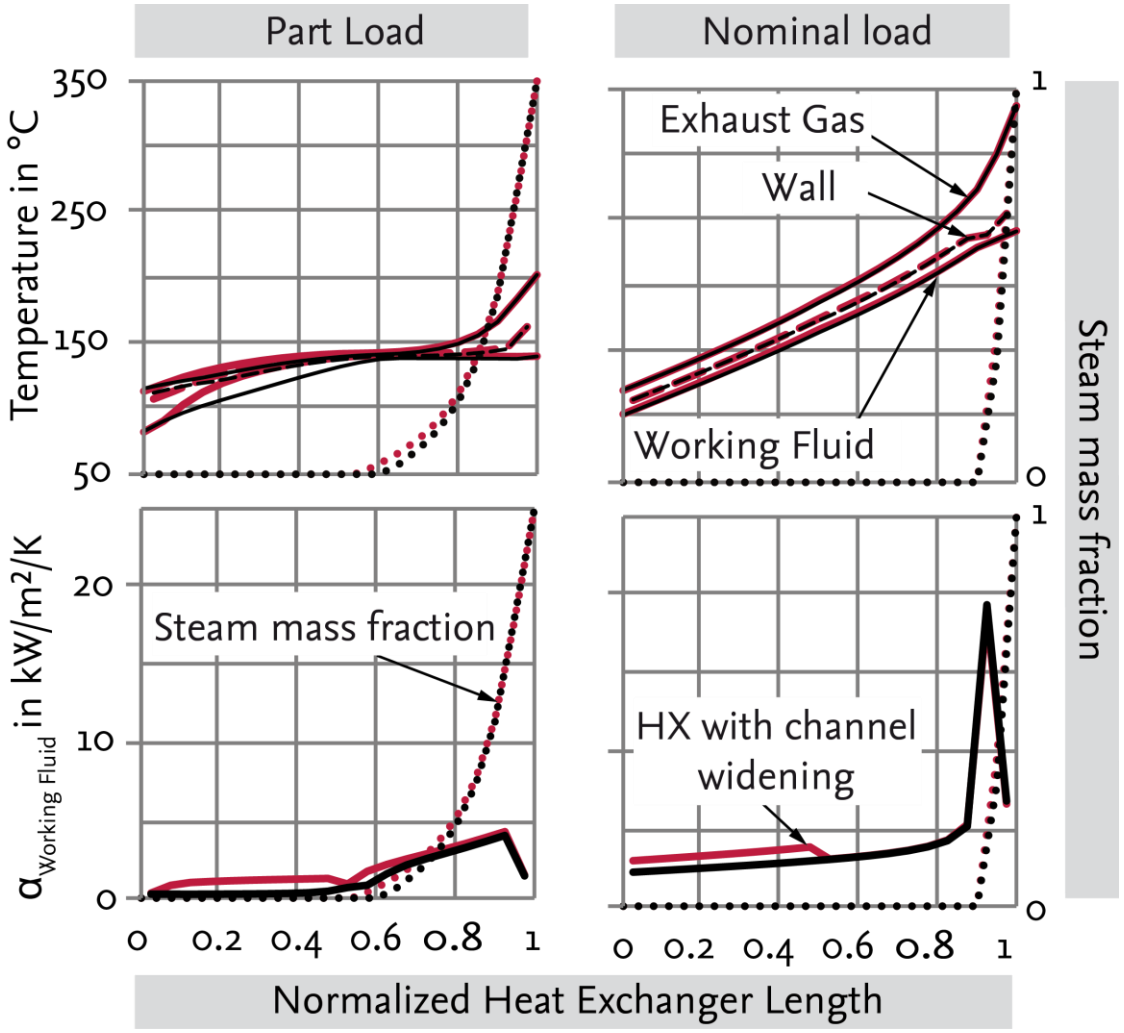


Dynamic Evaporator Model

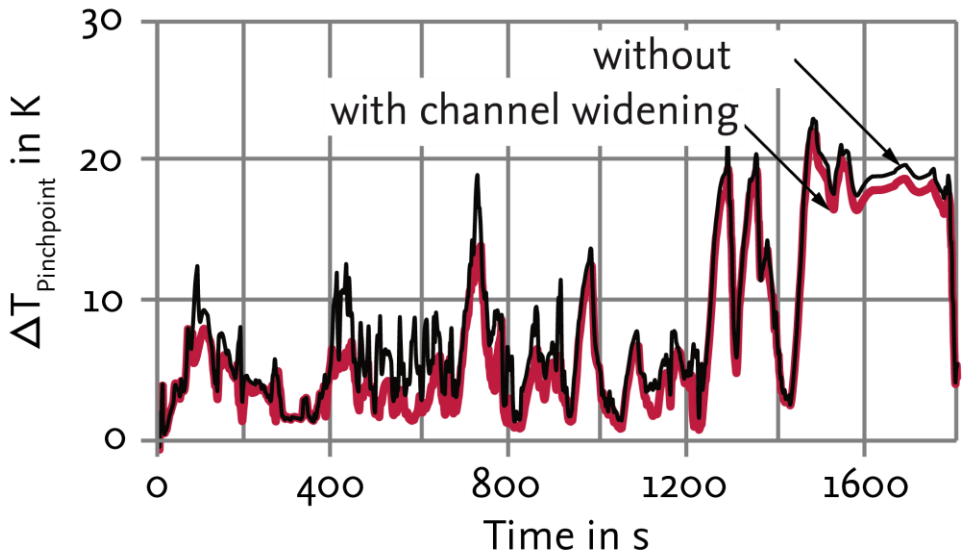
Sophisticated counterflow heat exchanger Modelica model based on TIL and TILMedia Library

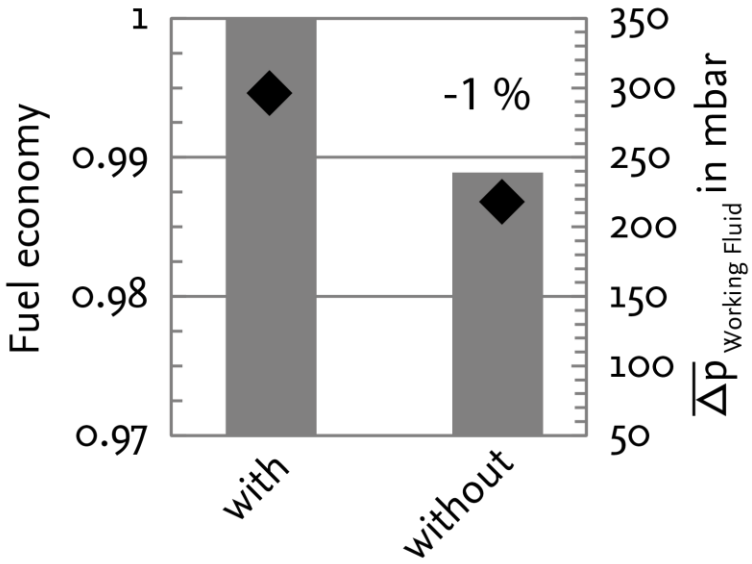


Two Heat Exchanger Snapshots

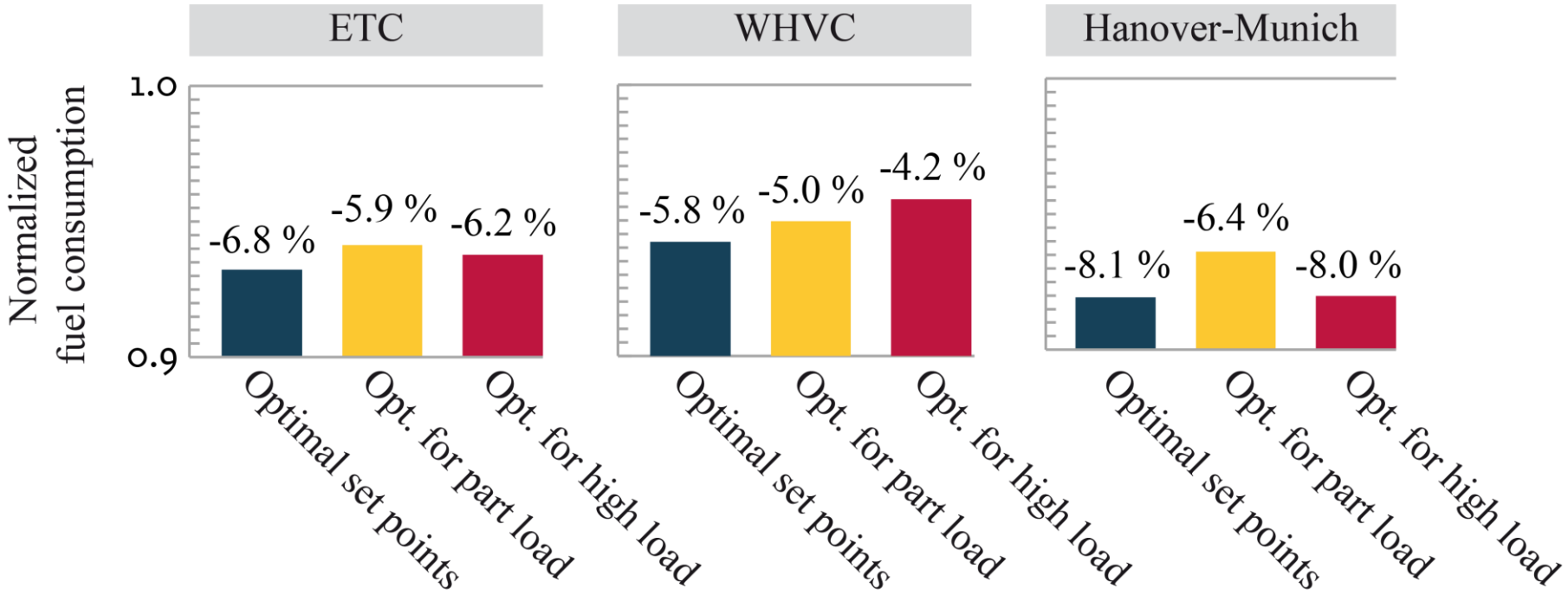


Results of Measure „Reduced Tube Cross Sectional Area for Liquid Phase“





Evaluation of Optimized Process Control and Components in Virtual Test Drives



Conclusion

1. High benefit of optimizing process control
2. Significant shift of optimal operating points with change in component losses
3. Need for considering varying operating points in the design stage
4. Development of method and software tool chain for model based design

TLK-Thermo GmbH

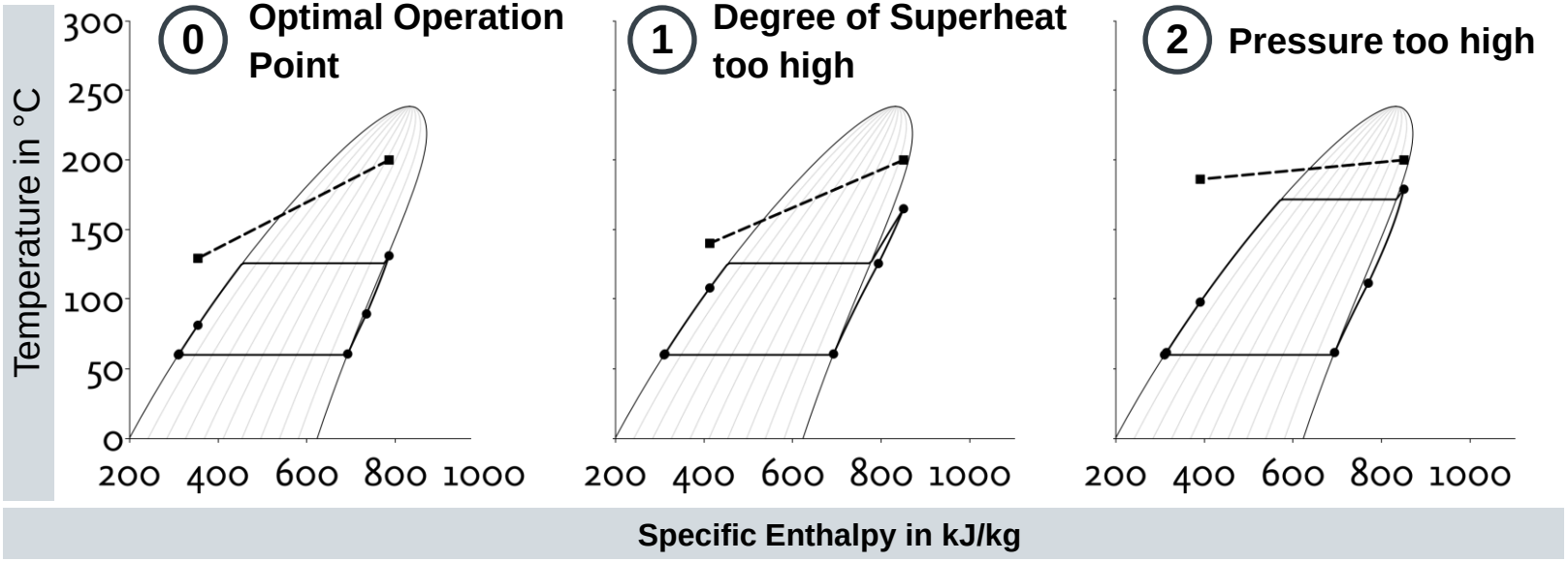
I am pleased to answer your questions!

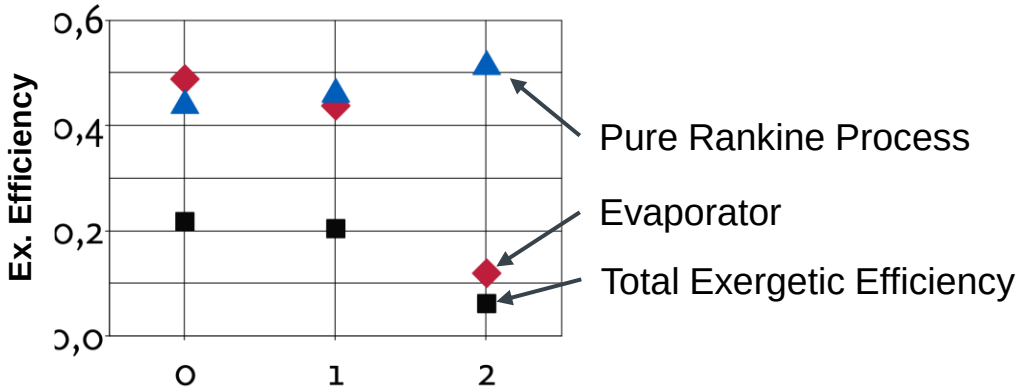
Philipp Petr
p.petr@tlk-thermo.com

TLK-Thermo GmbH
Hans-Sommer-Str. 5
38106 Braunschweig
www.tlk-thermo.de

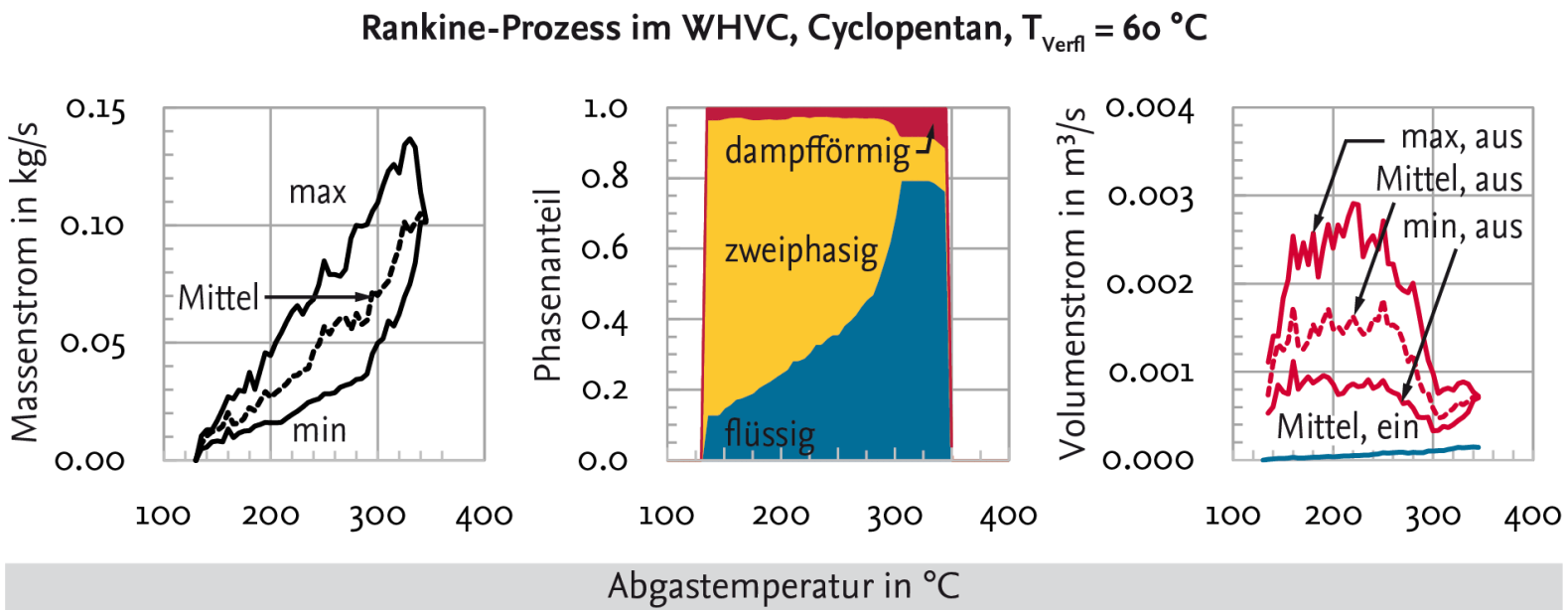
Tel.: +49/531/390 76 - 260
Fax: +49/531/390 76 - 29

Influence of Process Control on Exergetic Efficiency

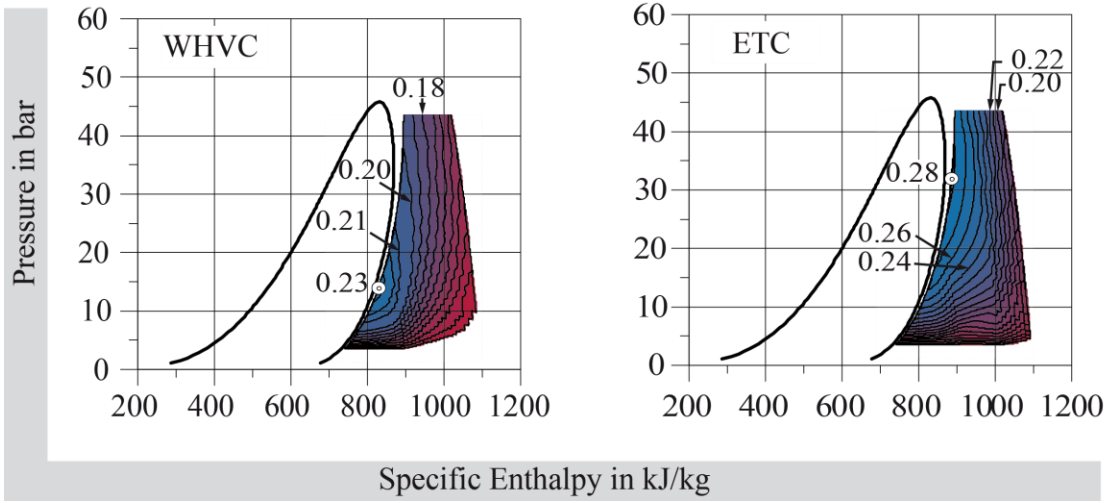


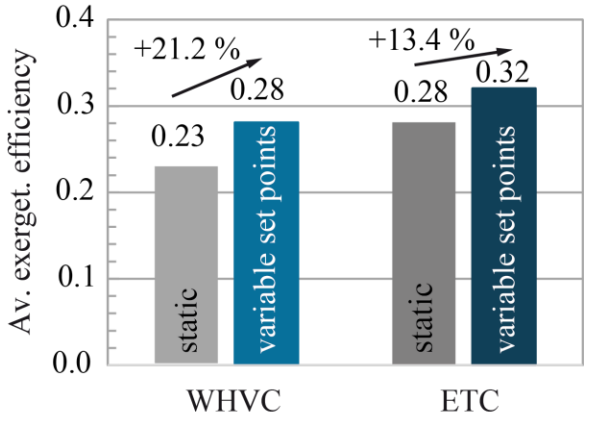


Predicted Working Fluid Mass and Volume Flow Rates in the WHVC

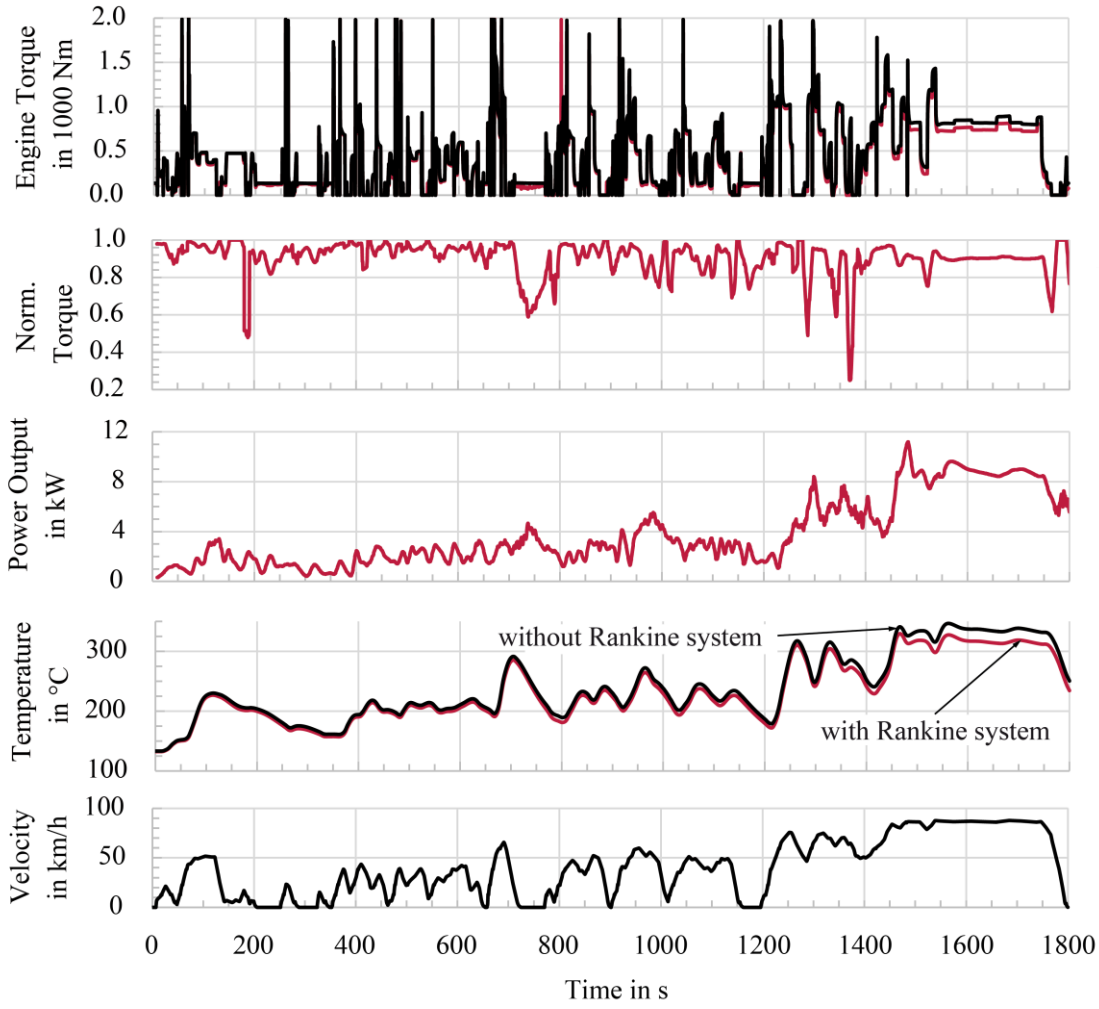


Average Exergetic Efficiencies of WHRS with Static Process Control

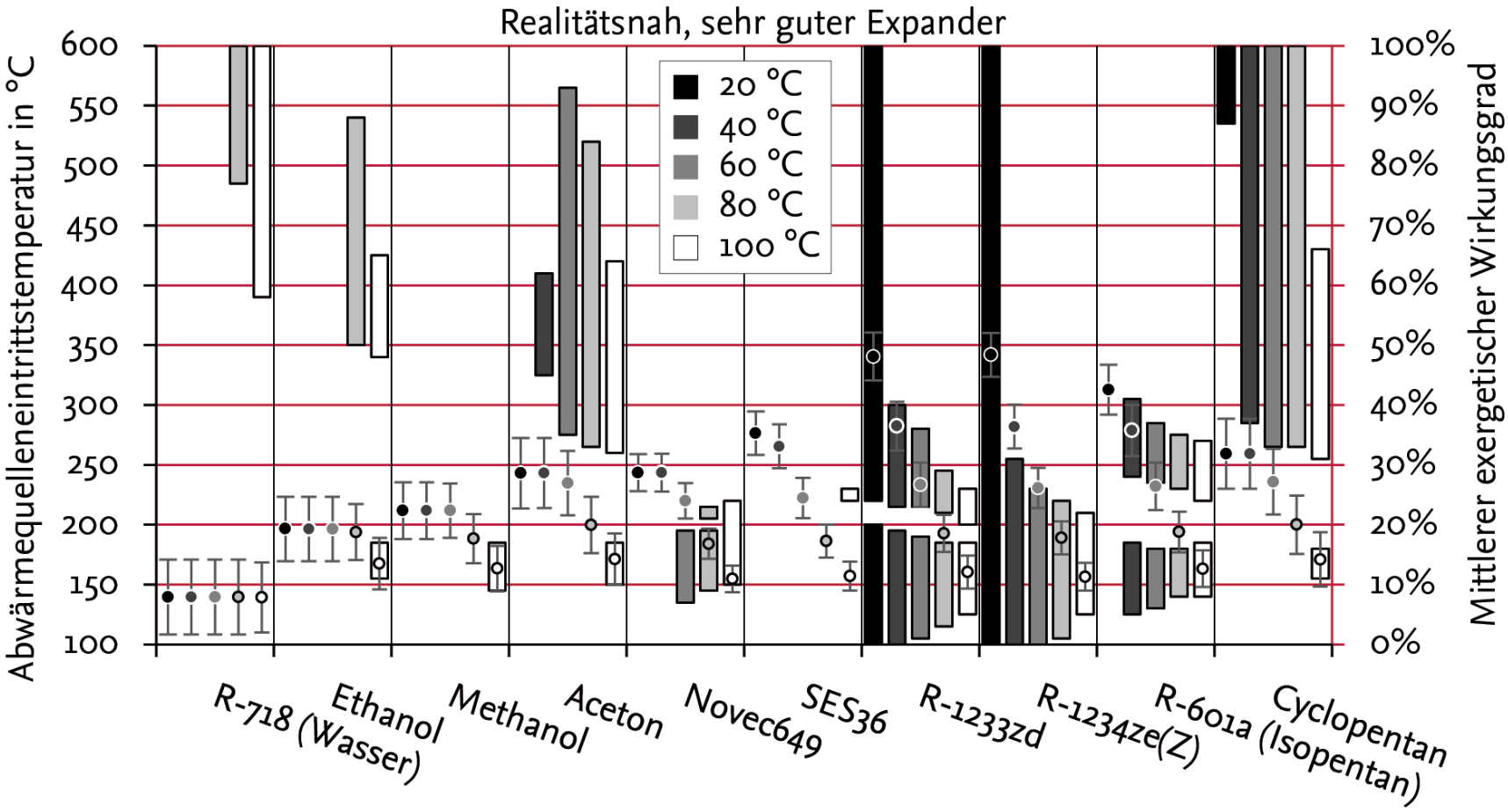




Results of Virtual Test Drive



Evaluation of different working fluids



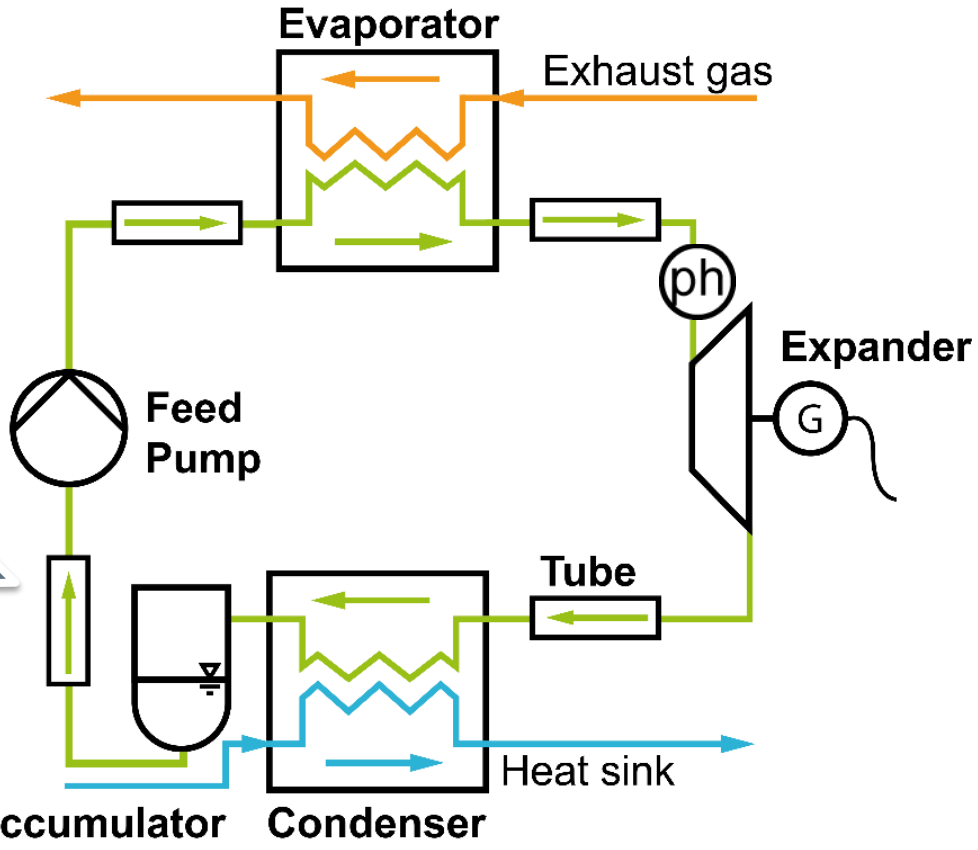
Sehr guter Expander: $\eta_{Expander,isen} = 0.75, \eta_{Pumpe,isen} = 0.5, \Delta T_{Pinch} = 20\ K, \eta_{Interner\ W\ddot{U}} = 0.8, \Delta p_{W\ddot{U}} = 0.5\ bar$

Control Concept for the Rankine Process

Control concept

Expander inlet pressure
controlled by
expander speed

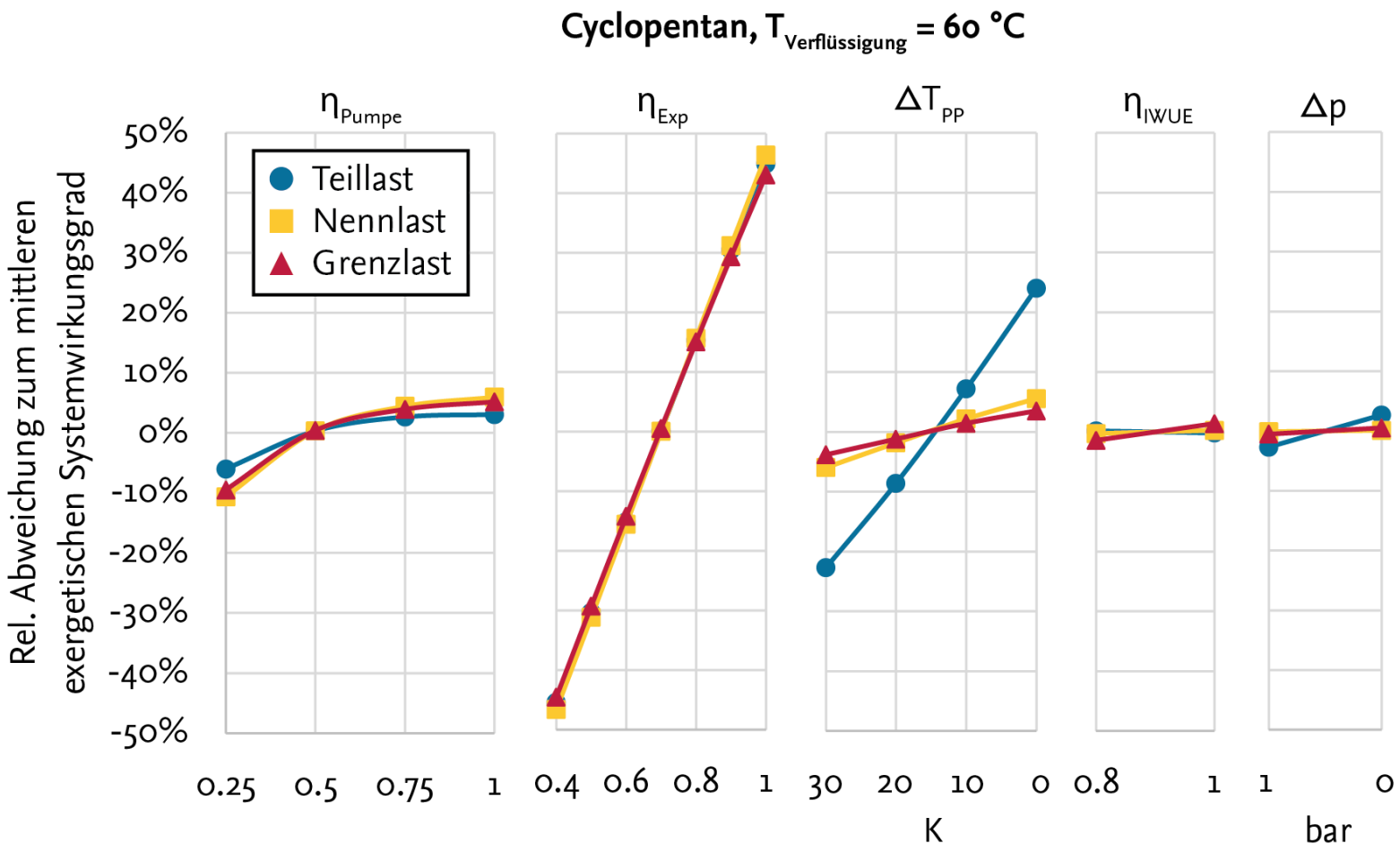
Expander inlet enthalpy
controlled by
pump speed



Extent of Parameter Sensitivity Analysis

Parameter	Values
$\eta_{Expander}$	{1, 0.9, 0.8, 0.7, 0.6, 0.5, 0.4}
η_{IHX}	{1, 0.8}
$\Delta p_{WF,HX}$	{0, 1 bar}
η_{Pump}	{1, 0.75, 0.50, 0.25}
ΔT_{PP}	{0, 10, 20, 30 K}
$T_{Condensing}$	{20, 40, 60, 80, 100 °C}
$n_{Optimization\ Problems}$	**226.240 (per Working Fluid)**

Influence on single parameters on the exergetic efficiency of the process



Two Process Snapshots