Heat pump modelling

Current issues at E.ON EBC

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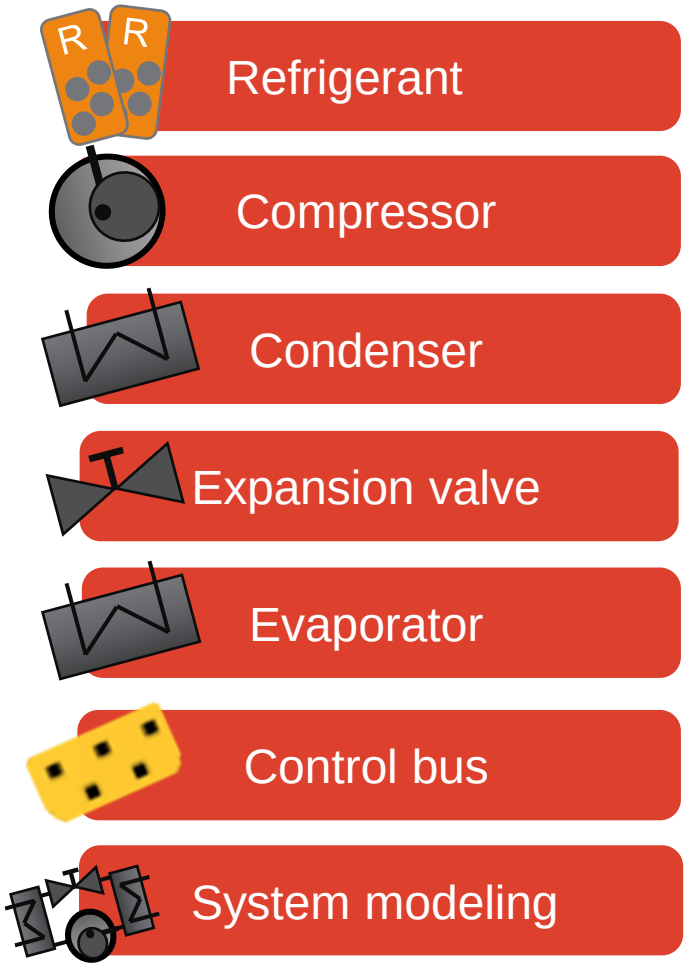
Component based modeling
Refrigerant



Fluid model development

- R134a
- R410A
- R290
- R32
- R744
- R407C (in progress)
- Improvement of regression approaches

Fluid model development

Trade-off

Simulation Speed ⟷ **Accuracy**

Helmholtz-Equation of State

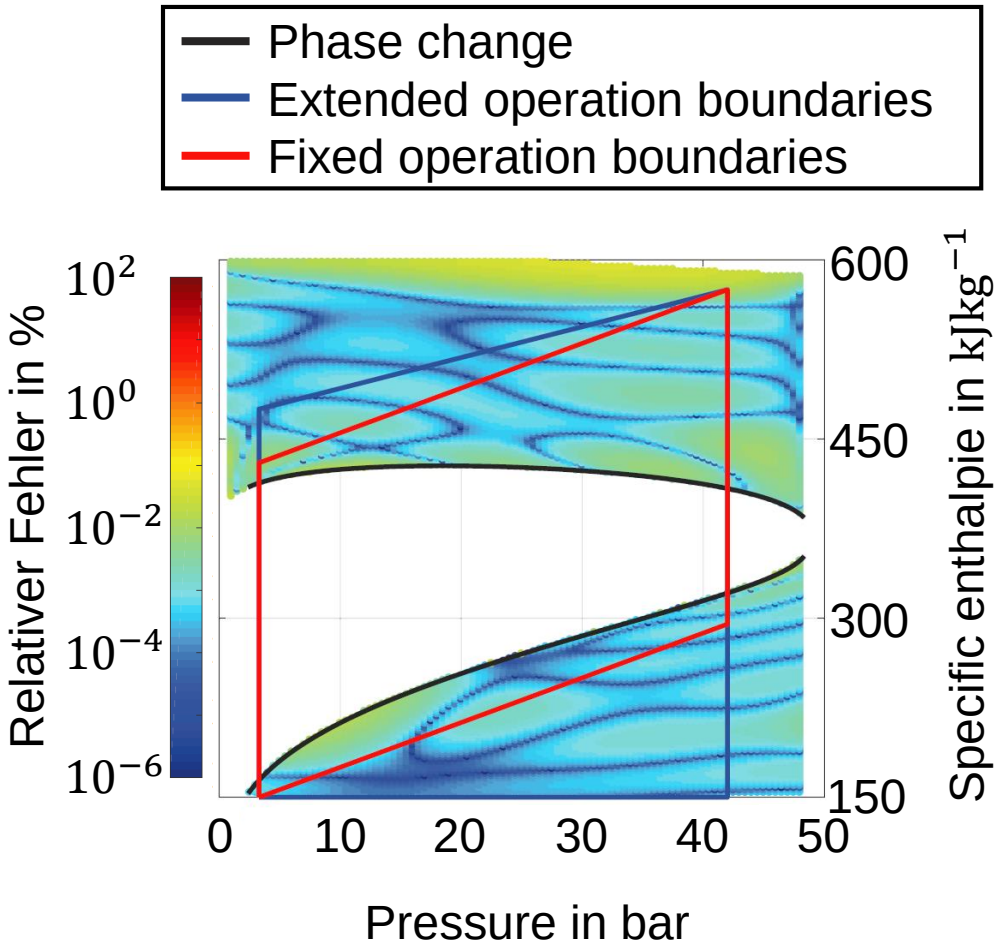
$$\alpha(\tau,\delta) = \frac{f(T,\rho)}{RT} = \underbrace{\alpha^{\mathrm{ig}}(\tau,\delta)}_{\mathrm{Ideal}} + \underbrace{\alpha^{\mathrm{ir}}(\tau,\delta)}_{\mathrm{Real}}, \tau = \frac{T_{\mathrm{crit}}}{T}, \delta = \frac{\rho}{\rho_{\mathrm{crit}}}$$

- Iterative calculation of thermodynamic states in two-phase region are very slowly
- Regression necessary

Refprop 9.1

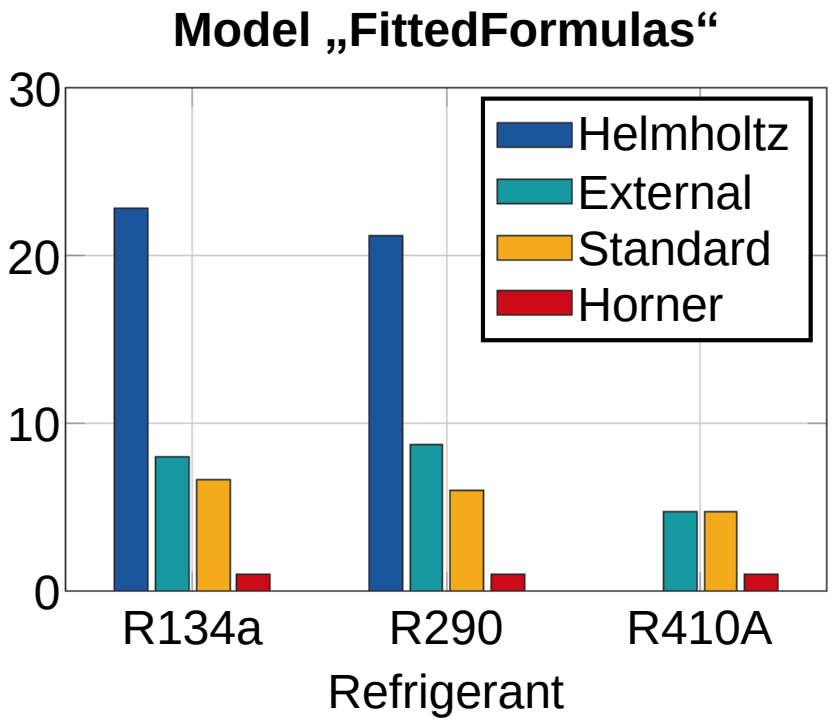
- External access necessary but precisely

Results of R410A
Accuracy due to regression



Result: Deviation of regression model < 1 %

Simulation speed results



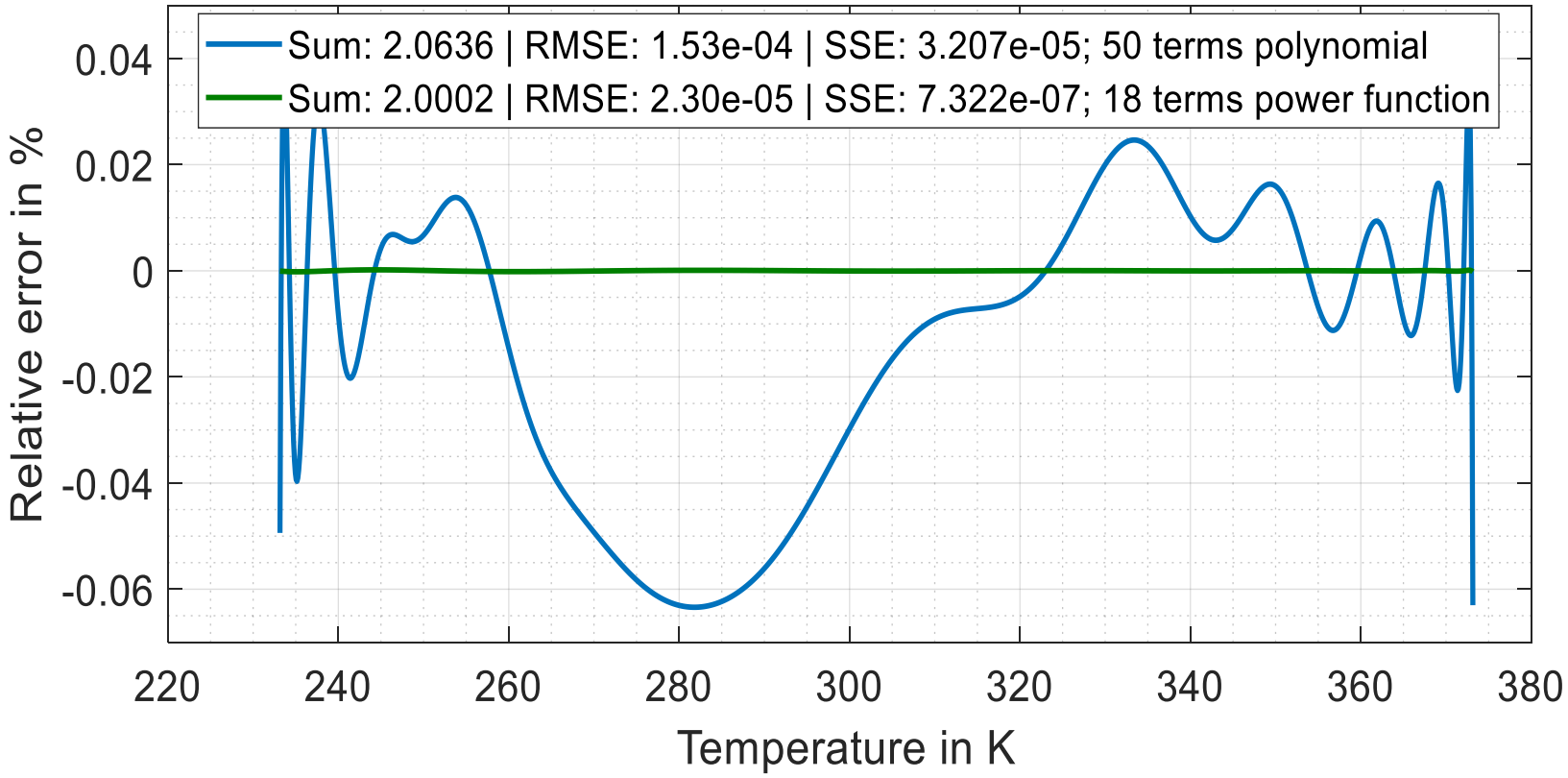
Accelaration by a factor of ≈20 (Helmholtz) und ≈ 8 (External)

Negligible error in relevant range

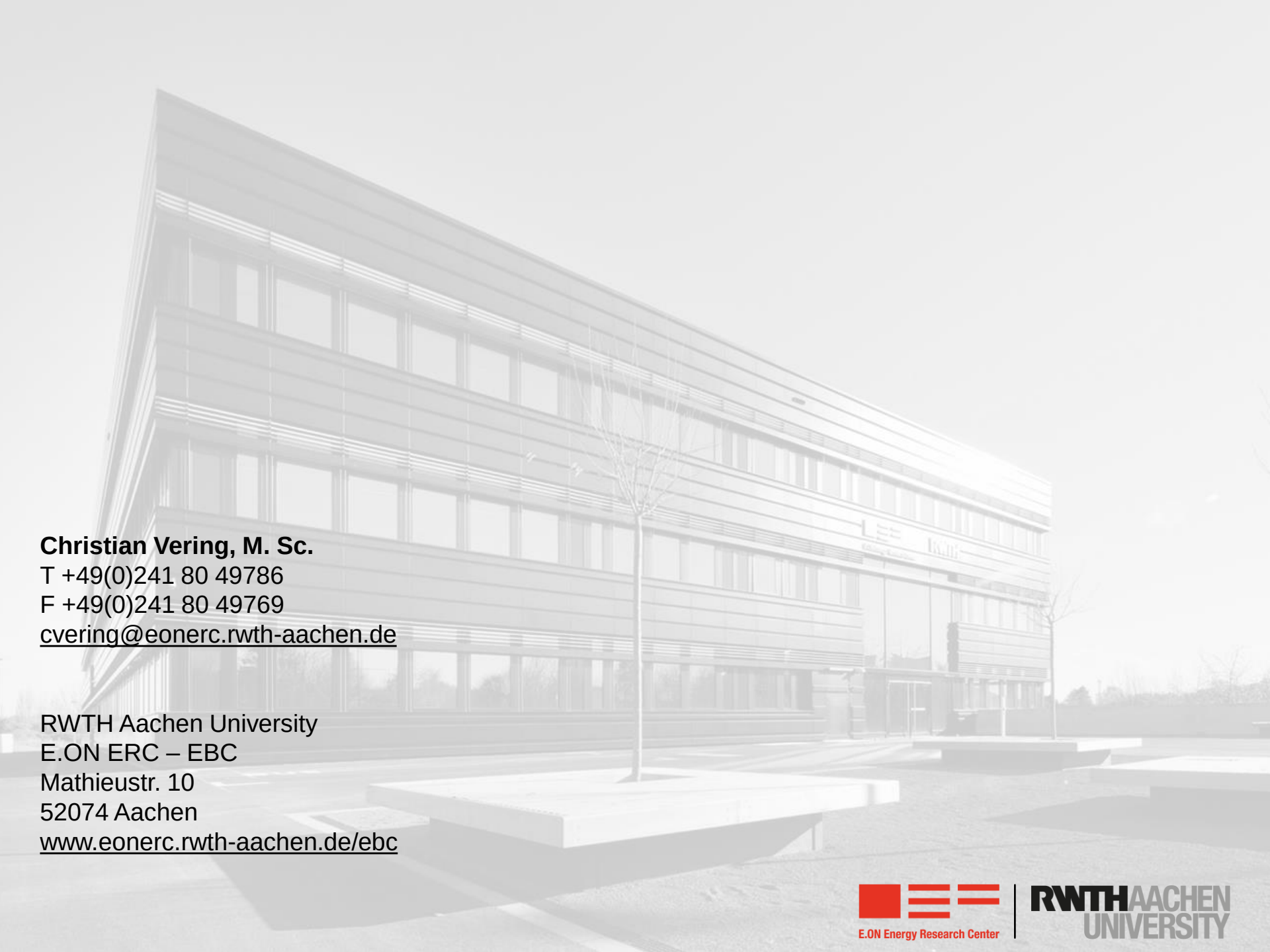
Fluid model development

- New regression approach for two phase region
  - Power function:
  - $y = \sum_{i=0}^{n} a_i \, x^{\frac{i}{3}}, i \leq 20$
  - Required terms reduced from 50 to 20 compare to polynomial
- Development of fluid model for R744
  - Regression over critical point necessary
  - Division into 4 regions
    - Two-phase region
    - Super cooled region
    - Superheated region
    - Hypercritical region

Results of R134a accuracy density at dew state



- Less terms
- Higher accuracy



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