

Heating-up of a Passenger Cabin Using KULI HEATSIM



Rolf Salomon, Markus Kovac

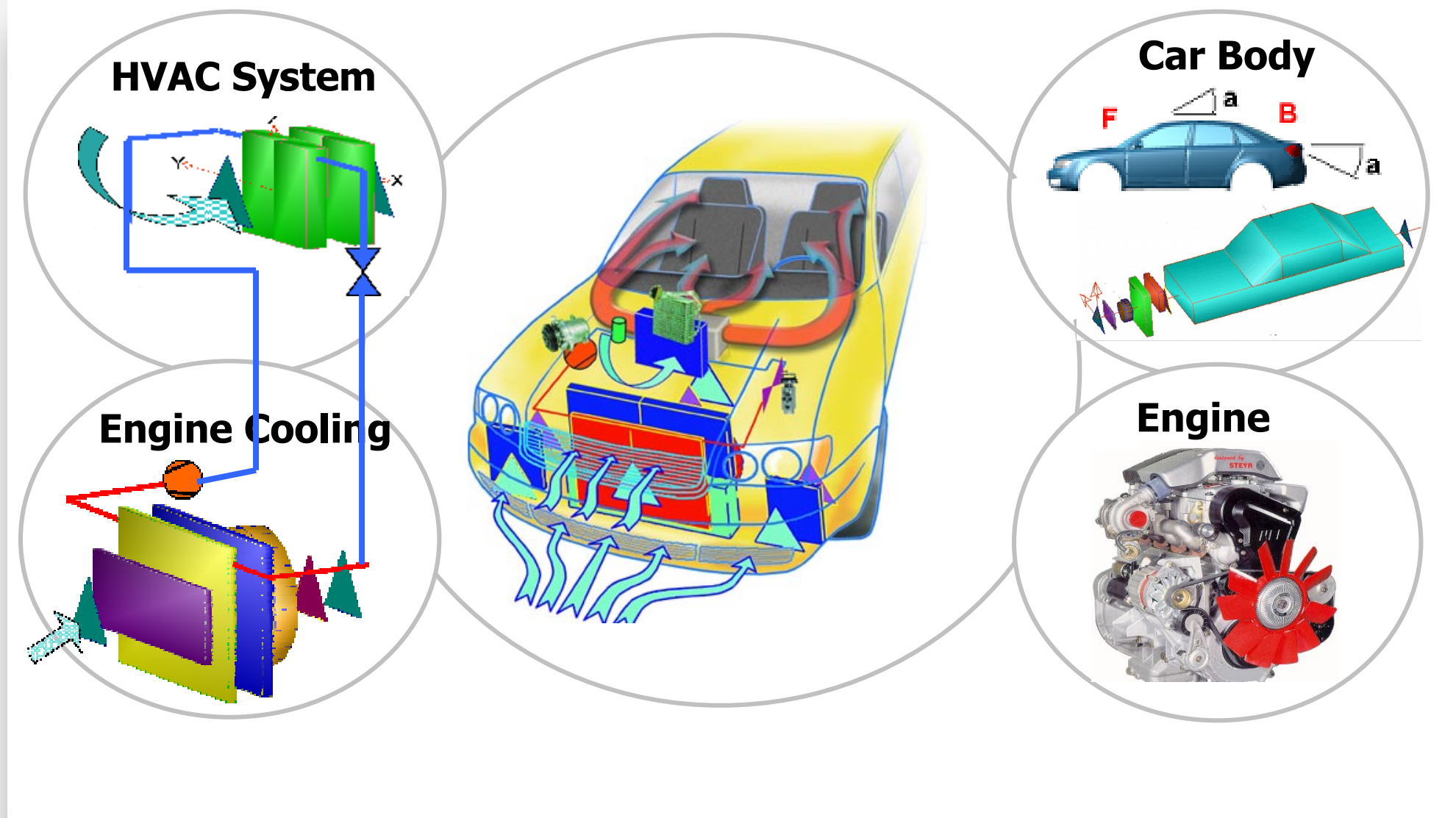
Overview

- 
- **Brief Description of KULI HEATSIM**
 - **Online Example**
 - **Future Development**

Target

Simulation of **time dependent** –
passenger compartment temperature varying parameters
of **HVAC-system**,
of **vehicle**,
of **engine** and
of **ambient values**
using **one** reference measurement

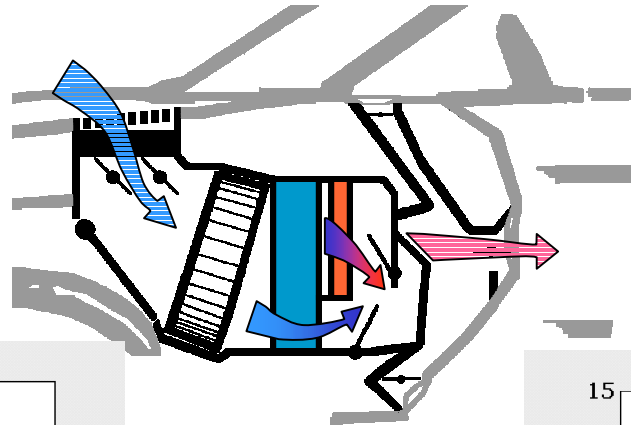
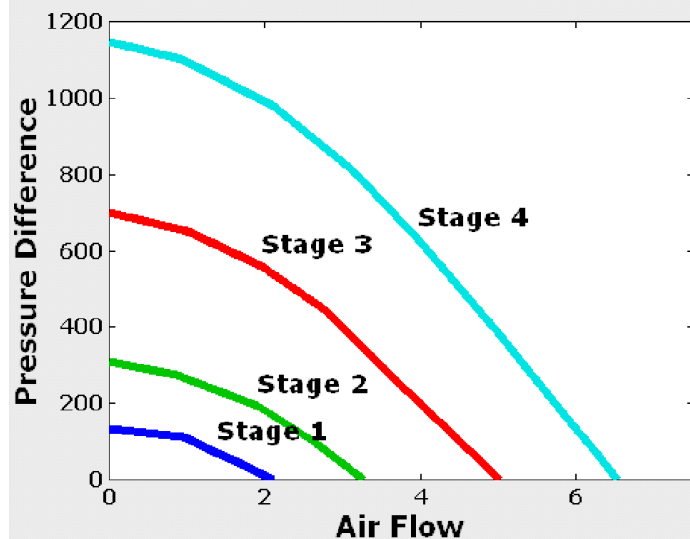
Thermal Management



HVAC Module: Measured Data

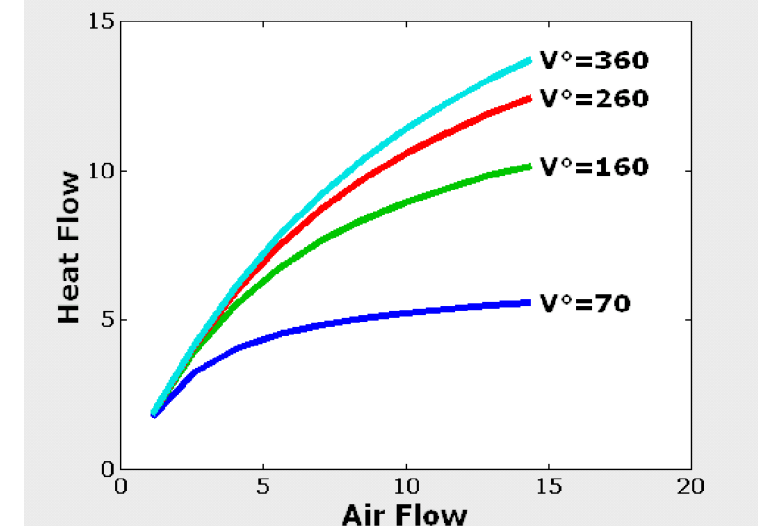
HVAC-test bench

HVAC module



Component test bench

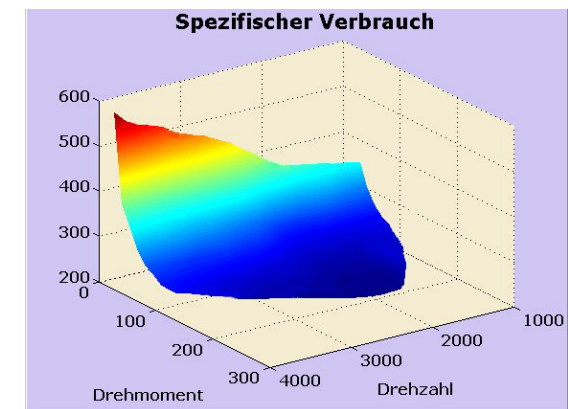
Heater



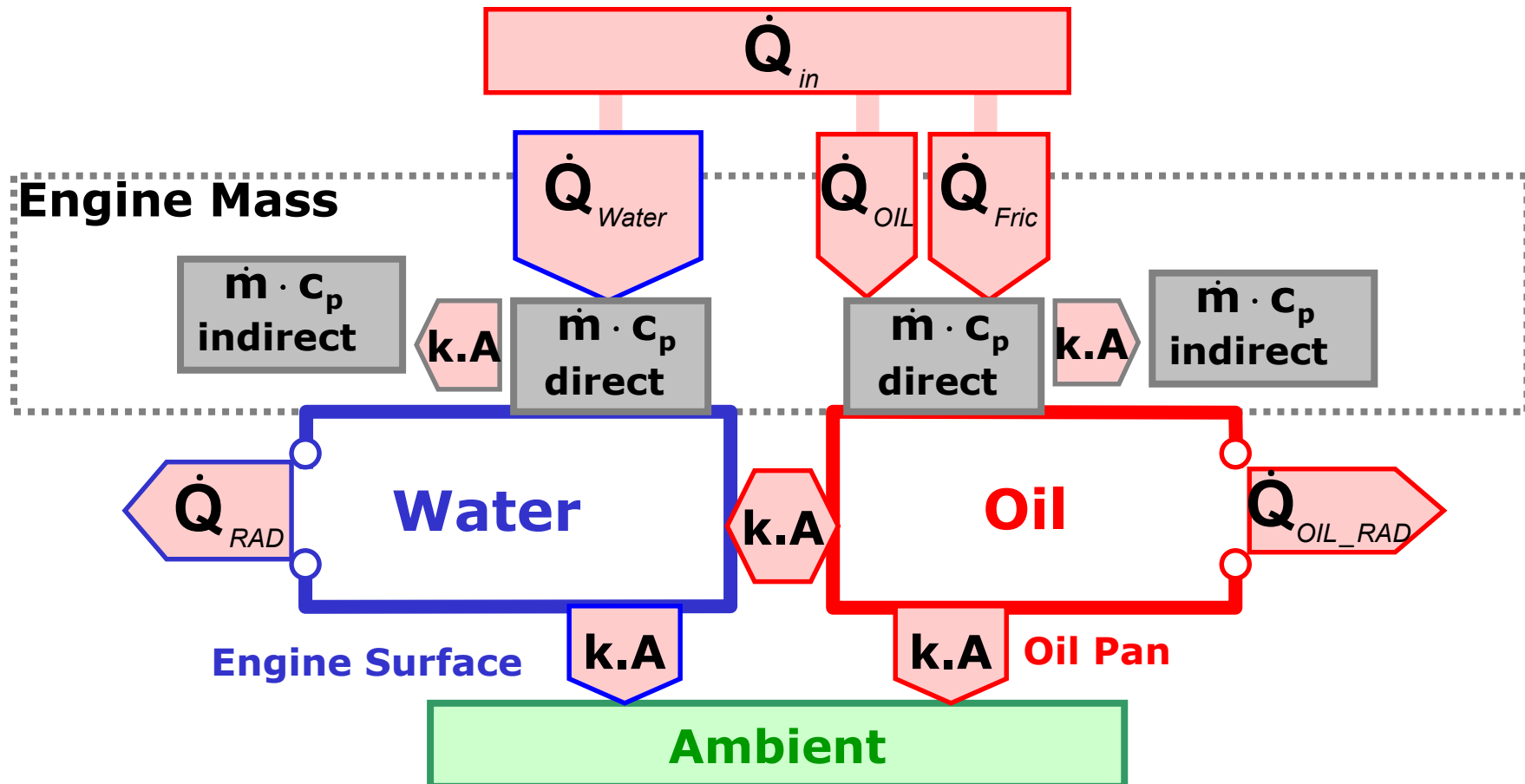
Measured Data – Engine Test Bench

Engine maps – steady state

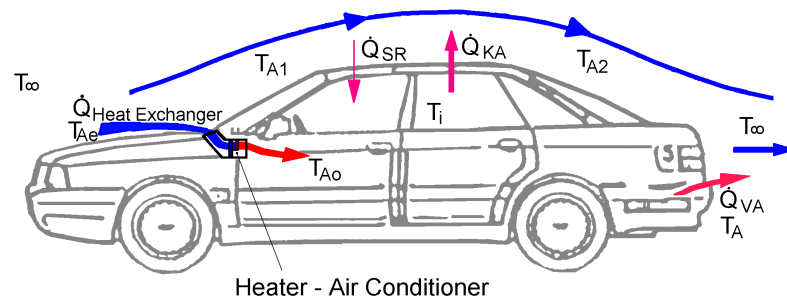
- Specific fuel consumption
- Coolant temperature
- Oil temperature
- Full load characteristic
- Heat dissipation to oil
- Heat dissipation to coolant



Engine Model



Basic Theory



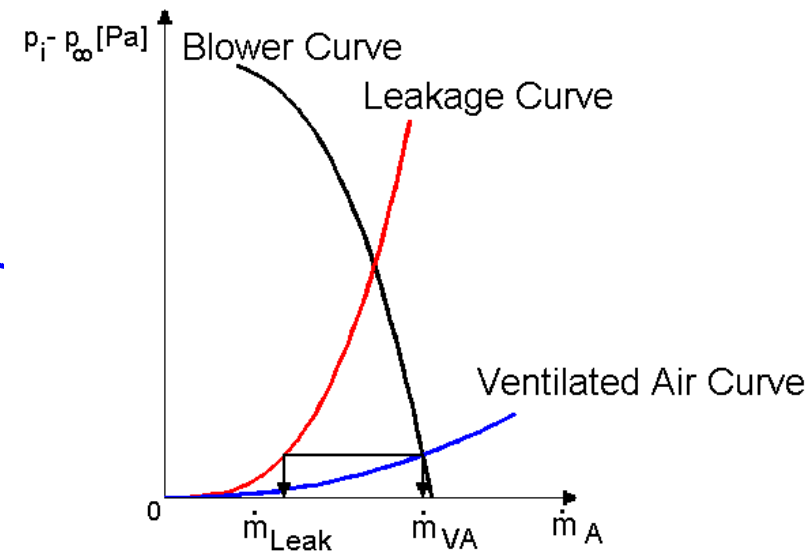
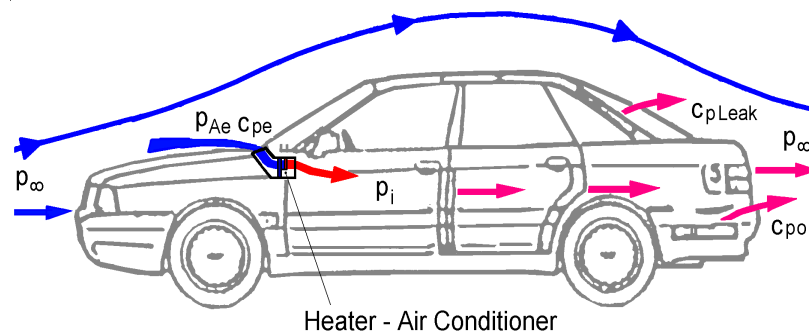
$$\dot{Q}_H + \dot{Q}_{SR} = \dot{Q}_{KA} + \dot{Q}_{VA}$$

\dot{Q}_H Heat Flow – Heater Matrix

\dot{Q}_{SR} Heat Flow – Solar Radiation

\dot{Q}_{KA} Heat Flow – Car Body

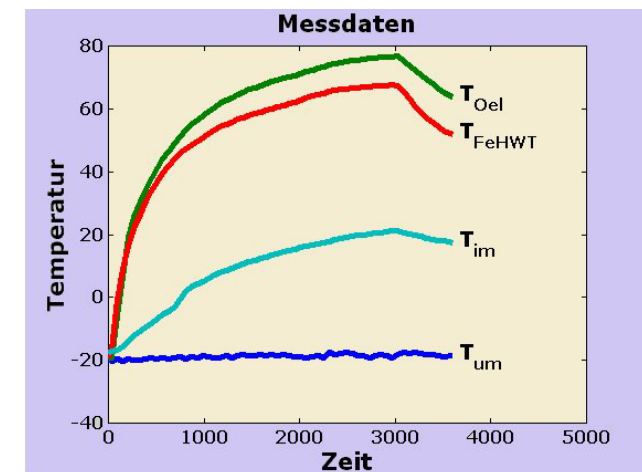
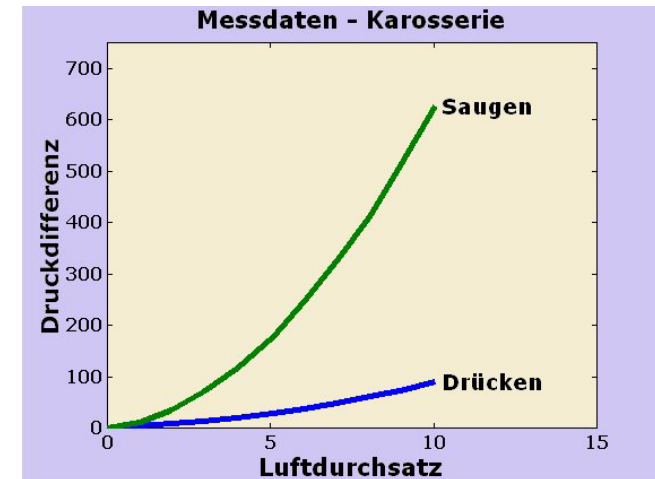
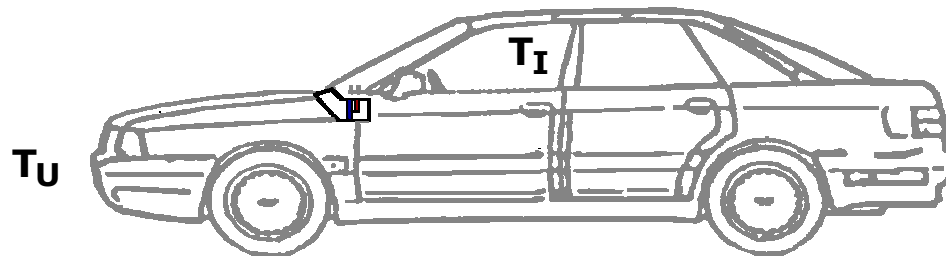
\dot{Q}_{VA} Heat Flow – Ventilated Air



Measured Vehicle Data

Characteristic Curves

- **Pressure Differences**
Sucking - Pushing
- **Reference Measurement**
Cabin Temperature = f (Time)



Definition of Body Data

The screenshot shows a software window titled "Vehicle body [-]*". It has a menu bar with "File" and "Extras". Below the menu bar is a toolbar with icons for file operations. The window has several tabs: "General data", "Geometric datas" (which is selected), "Pressure loss: Oppressive / Aspirate", "Heat transfer surrounding (k - value)", and "Abgleich". In the "Geometric datas" tab, there is a checkbox labeled "Simple geometric model" which is checked. To the right of this checkbox, there are two input fields: "Vehicle volume [m³]" with the value "6" and "Vehicle surface [m²]" with the value "15".

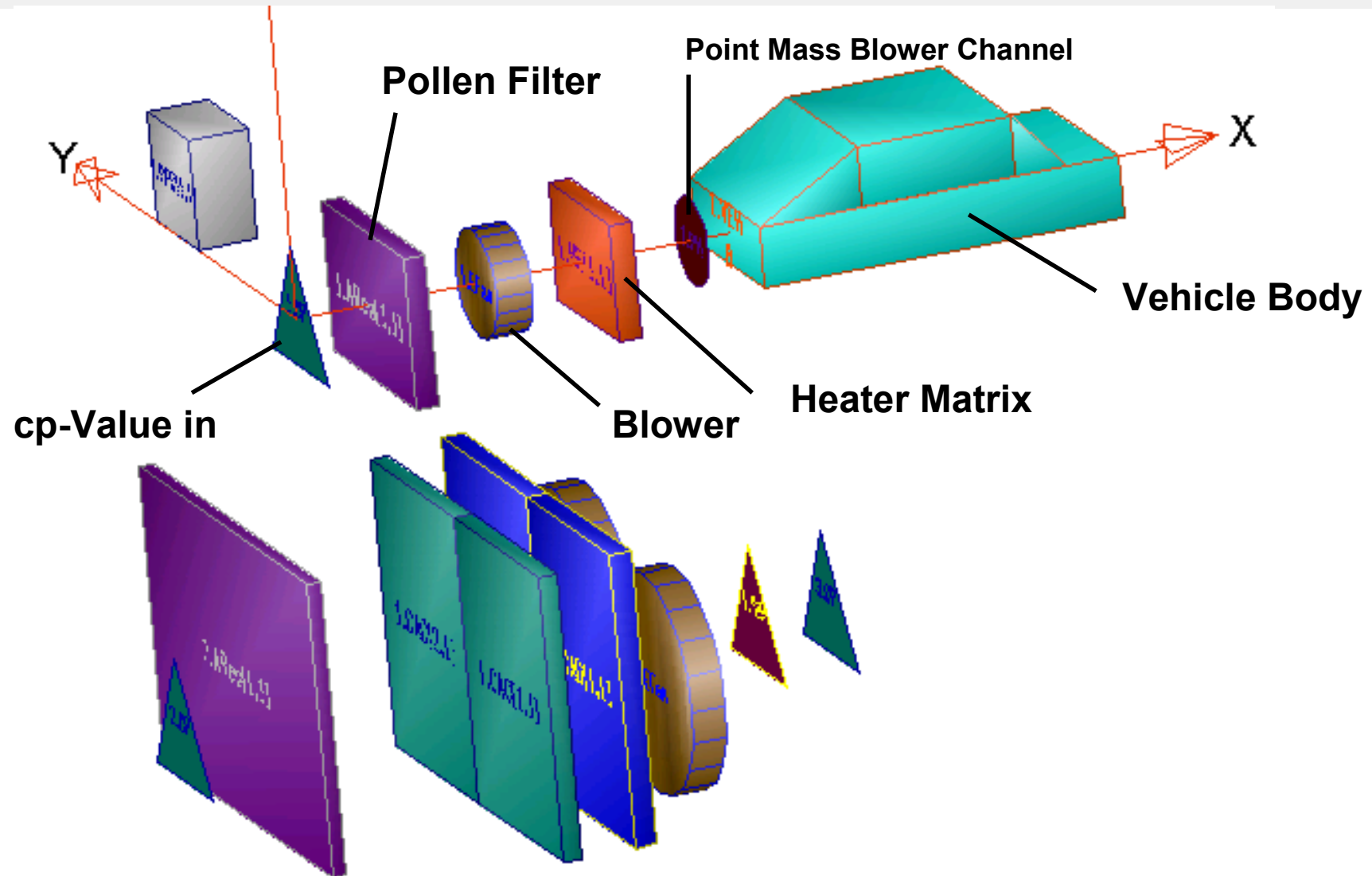
Simple Geometric Model:

- Vehicle Volume [m^3]
- Vehicle Surface [m^2]

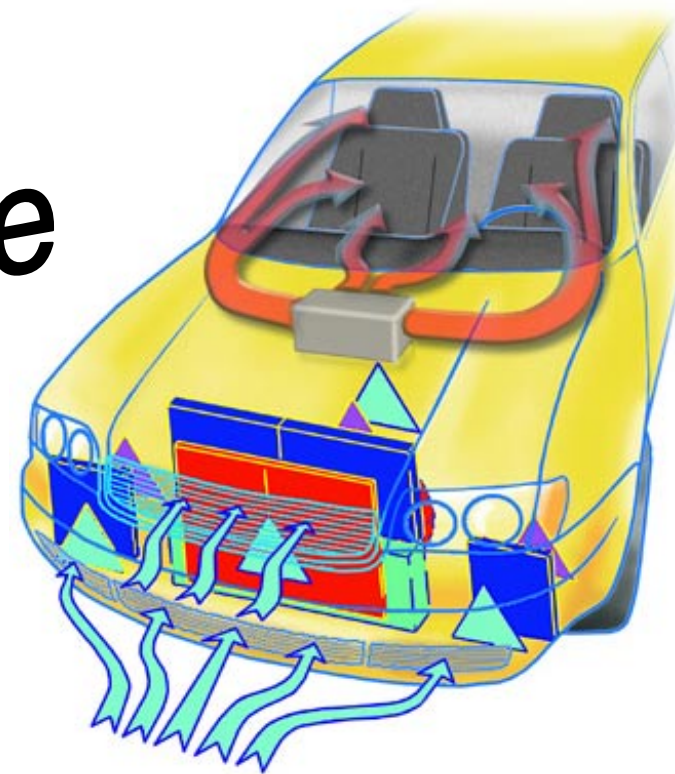
Simulation Parameters

- **Ambient Parameters (Temperature, Pressure, Humidity)**
- **Blower Type and Blower Voltage**
- **Heater Matrix**
- **Air Resistances (Pollen Filter, ...)**
- **Auxiliary Heater (Electrical Heater PTC, Fuel Heater, ...)**
- **Engine Type**
- **Operation Point (Engine, Vehicle)**
- **Fresh-Air Mode, Recirculation Mode**
- **Body Type**

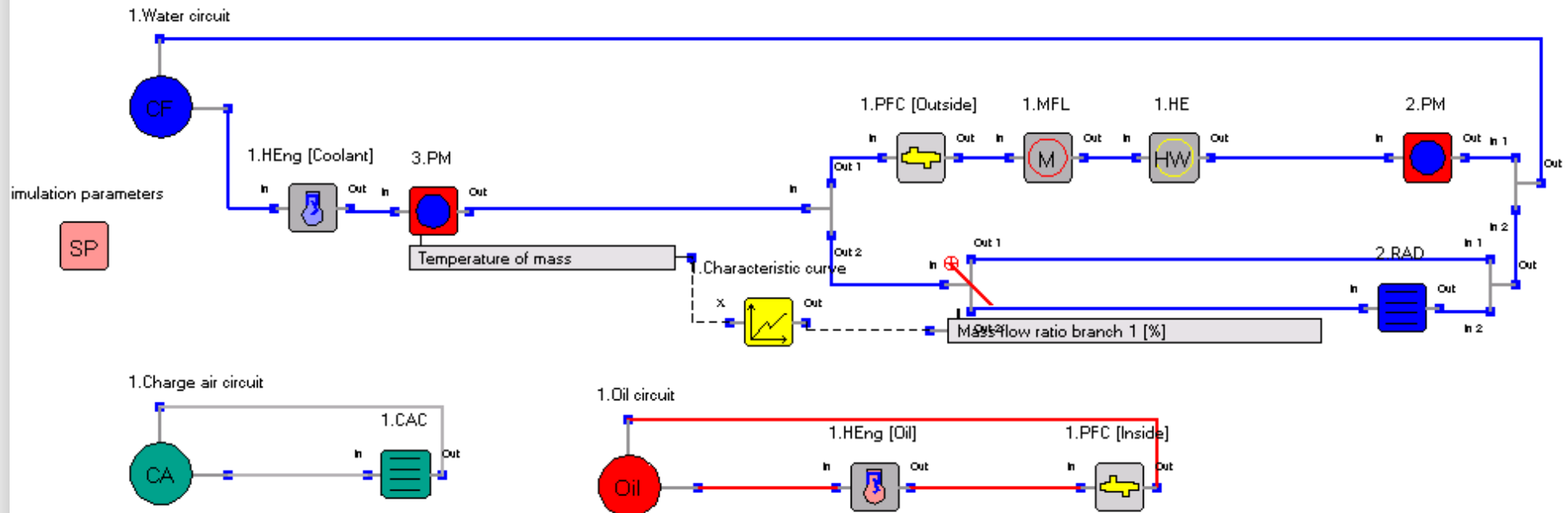
Simulation Model



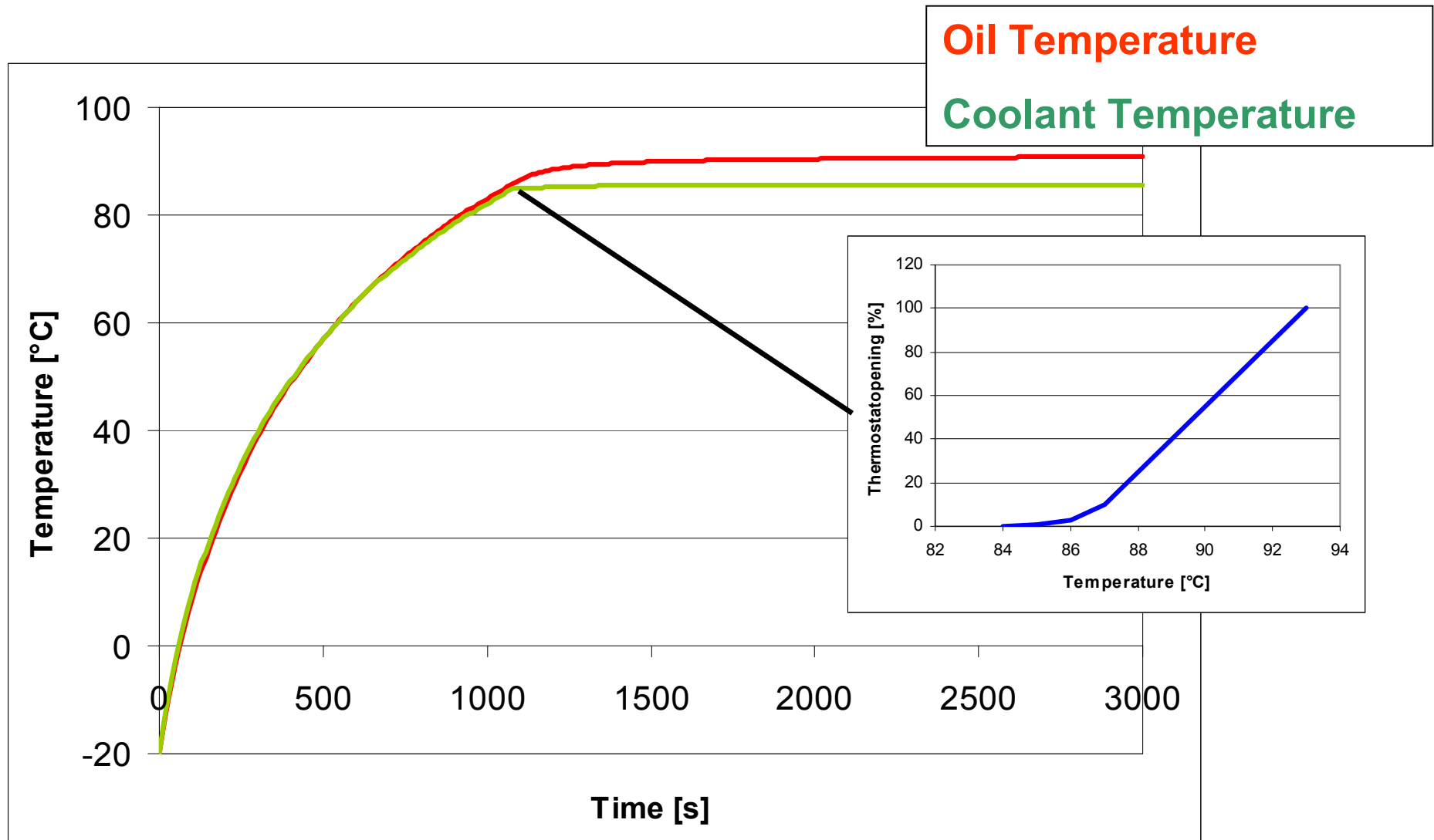
Online - Example



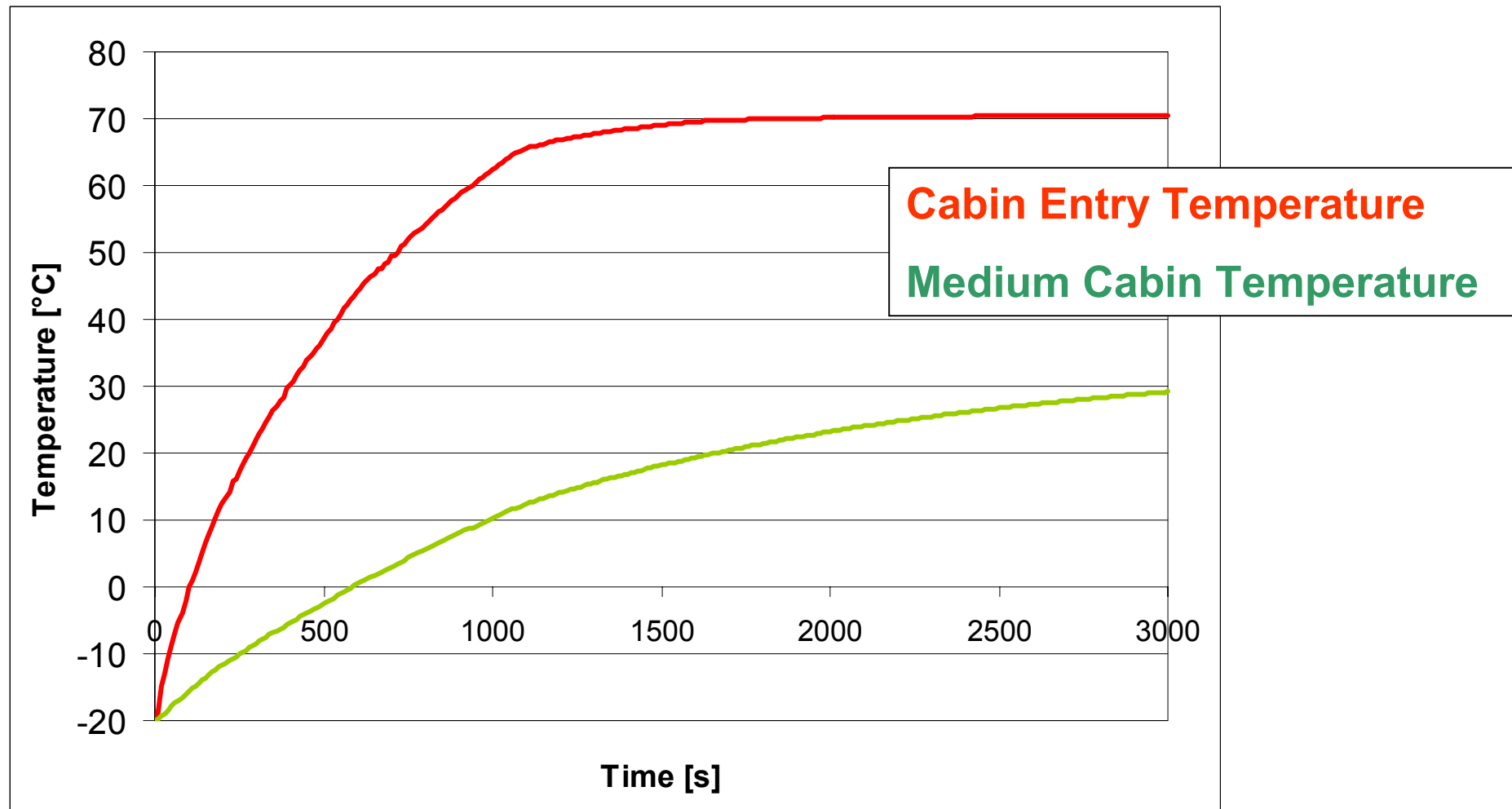
Inner Circuits



Engine Warm-up

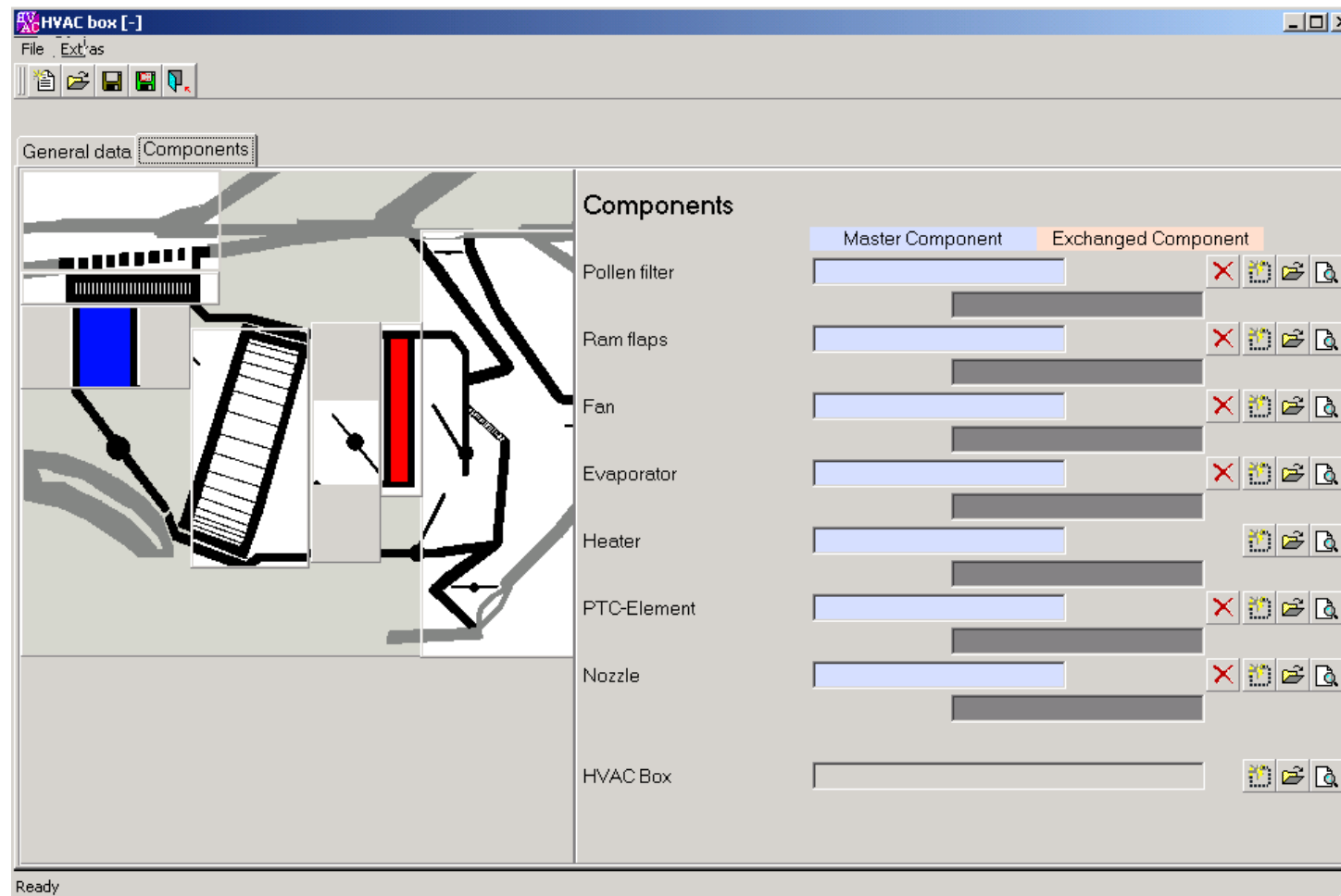


Vehicle Body Warm-up



Future Development HVAC Module

Change of Single Components






Future Development Vehicle Body Data

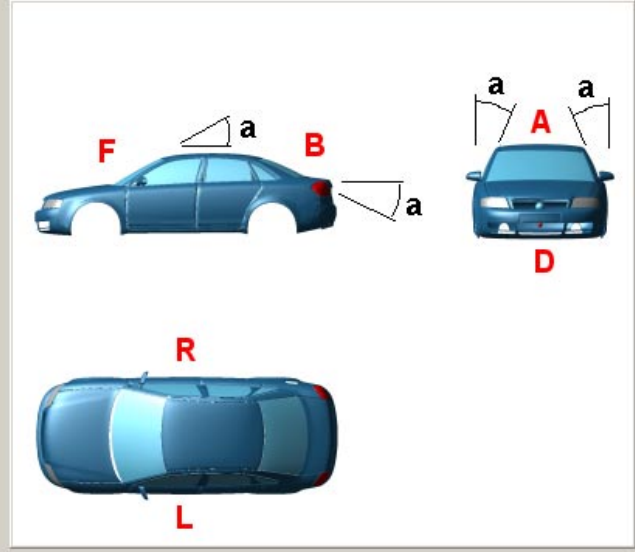
Allgemeines | Geometrische Daten | Druckverlust: Druecken / Saugen | Sonnenstrahlung

☐ Einfaches Geometriemodell
 Fahrzeugvolumen [m³]

☒ Erweitertes Geometriemodell

ID	Fläche [m²]	Orient.	a [°]	Material
A 1	1.2	F	40	test_kar_a2.body_mat
A 2	1.3	B	36	test_kar_a2.body_mat
A 3	0.9	R	10	test_kar_a2.body_mat
A 4	0.9	L	10	test_kar_a2.body_mat
A 5	3.5	A	0	test_kar_a2.body_mat
A 6	3.6	D	0	test_kar_a2.body_mat



-Body Surfaces:

Material data, heat transmission, absorption, reflection, ...

- Sun radiation

Future Development Pull Down

