



TECHNISCHE  
UNIVERSITÄT  
DRESDEN

Faculty of Mechanical Engineering

# Interactive Simulation on a Motion Platform based on SIMPACK models

Philipp Goldmann  
Christian Schubert  
Günter Kunze  
Michael Beitelschmidt

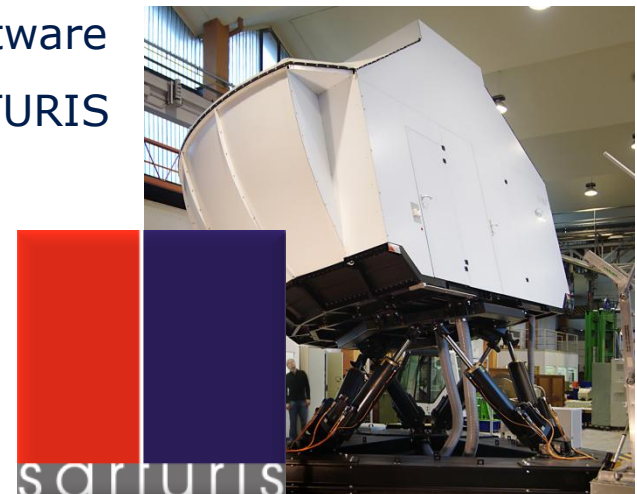
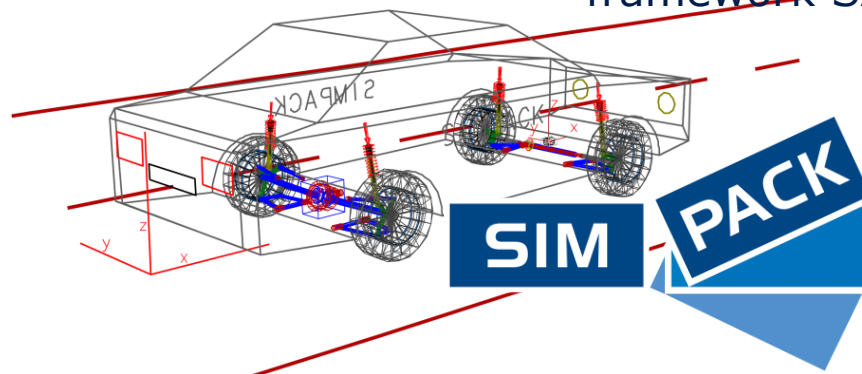
Salzburg, May 19<sup>th</sup> 2011  
SIMPACK User Meeting 2011

# Agenda

1. Motivation
2. Cosimulation – Theory & Systematics
3. Components needed and implemented
4. Testing & Experiences
5. Summary

## Motivation (1)

- Prof. Beitelschmidt  
Chair of Vehicle Modelling and Simulation:  
validated rail and automotive SIMPACK models, mbs expertise
- Prof. Kunze  
Chair of Construction Machines and Conveying Technology:  
motion platform with corresponding software  
framework SARTURIS



## Motivation (2)

- enabling use of SIMPACK models in interactive simulation scenarios
  - » investigation on
    - user acceptance
    - comfort
    - ergonomics and safety
    - operator influence on loads, performance and processes
- in full consideration of multi-body system dynamics!



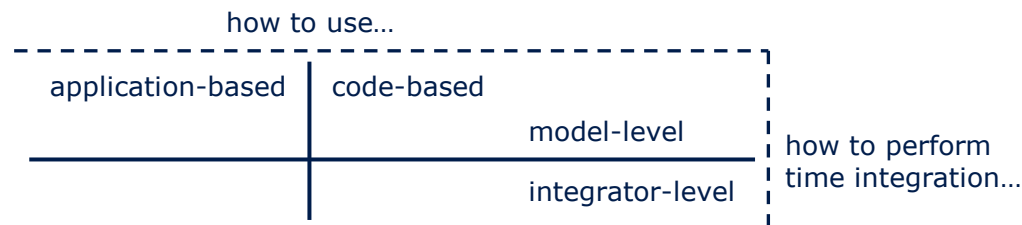
## Motivation (3)

- providing access to a proven mbs solution (including its existing and validated models!) for the SARTURIS framework
- SARTURIS
  - comprehensive software framework developed at the Chair of Construction Machines and Conveying Technology
  - modular design to enable cosimulation or interactive simulation featuring the above-mentioned motion platform
- » providing I/O (from triggers and buttons to force-feedback devices and CAN-bus), visualization, movement etc. using a Linux cluster

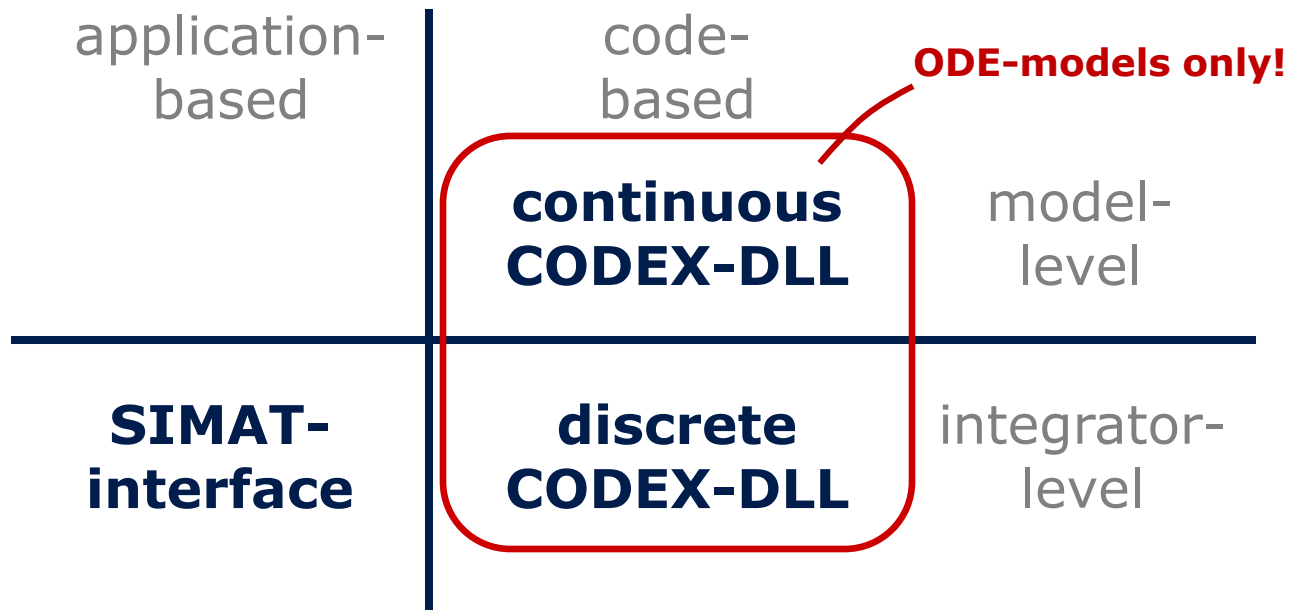


## Cosimulation – Theory & Systematics

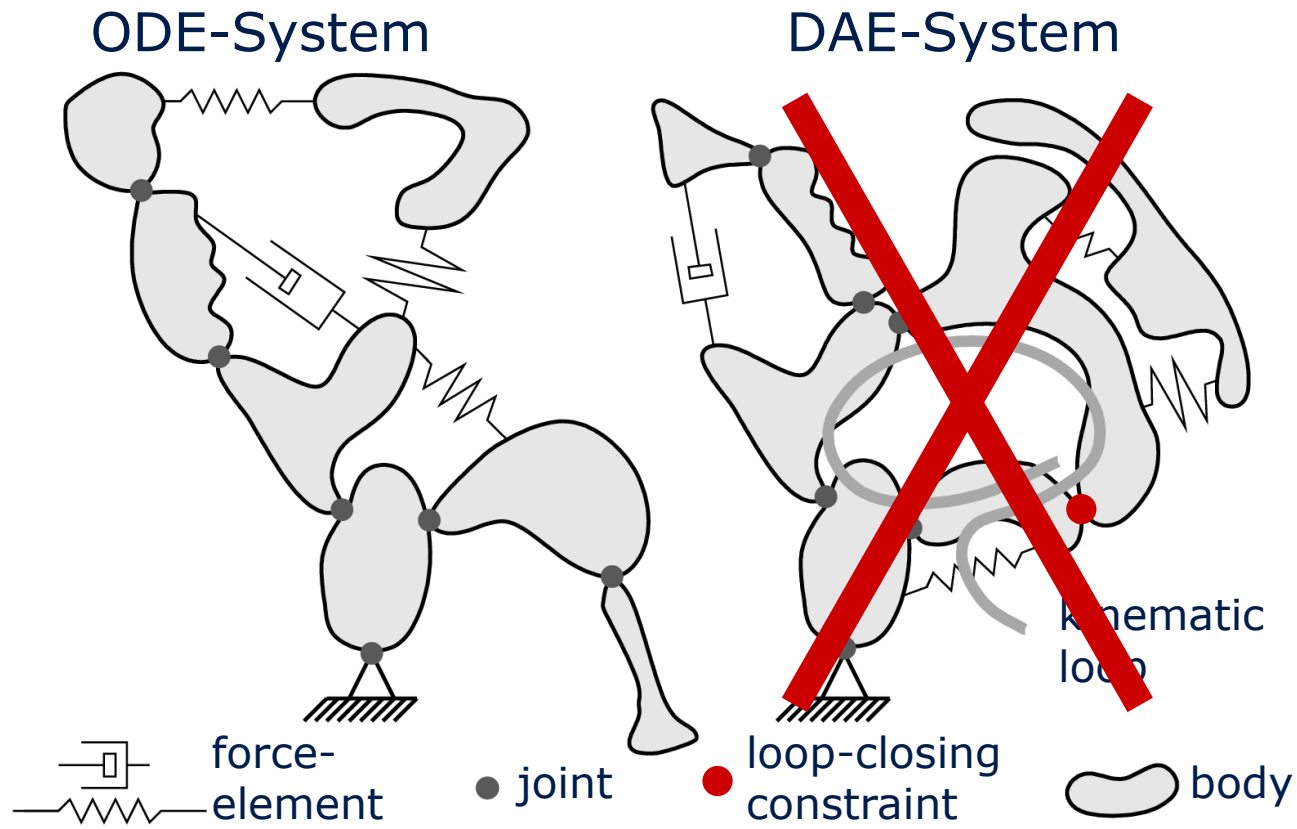
- how to use:  
*application-based vs. code-based*
- how to perform time integration:  
*coupling on model-level vs. integrator-level*
- » adds up to four types of cosimulation:



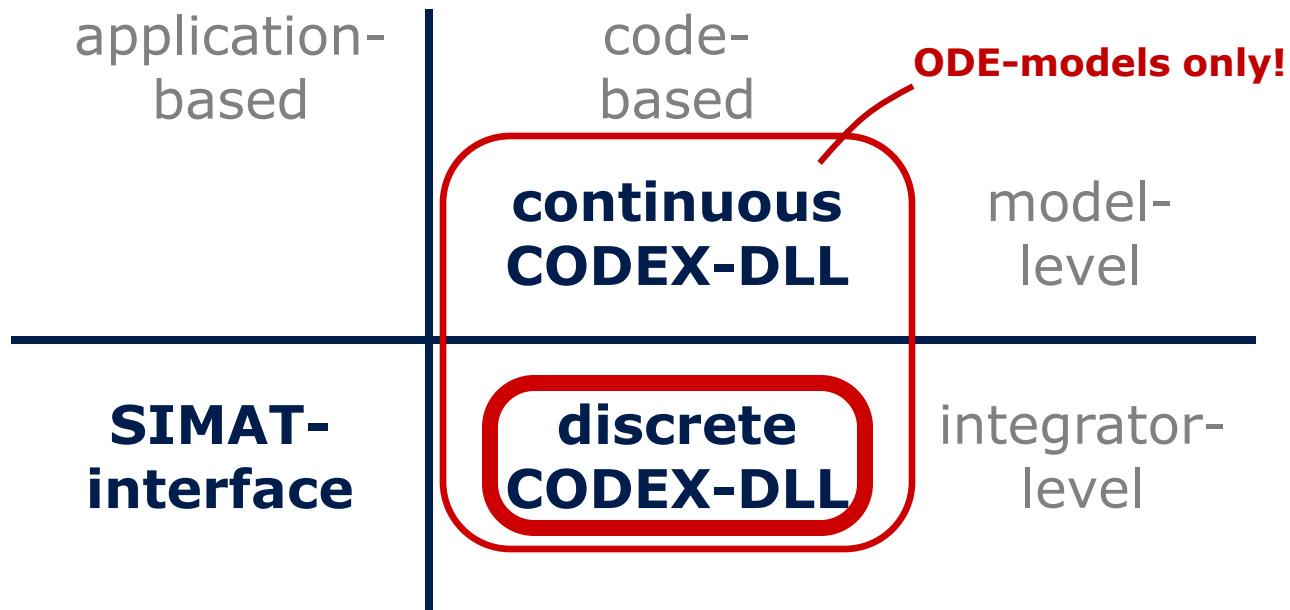
## Cosimulation – with SIMPACK



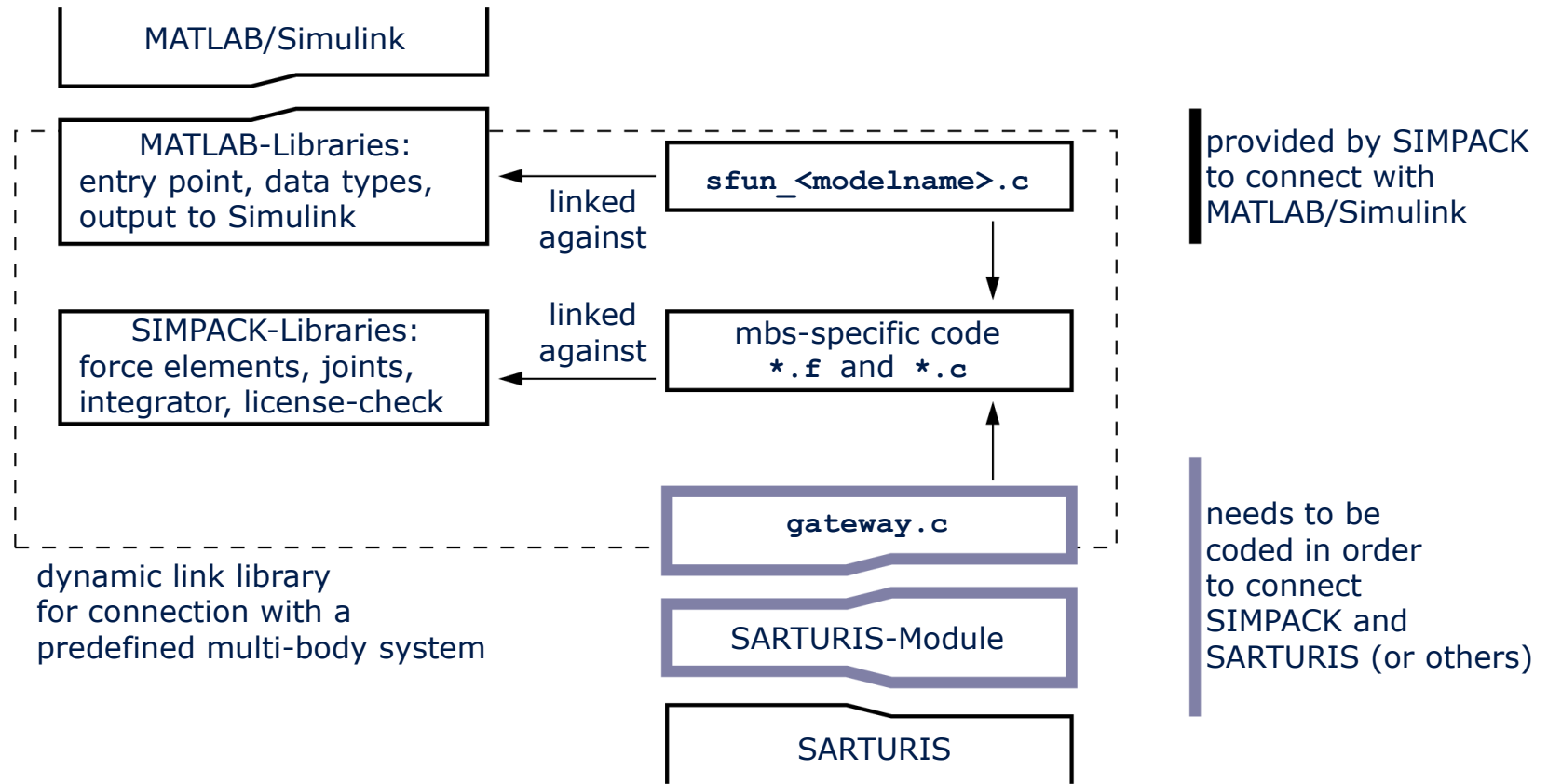
## Structure of Multi-Body Systems

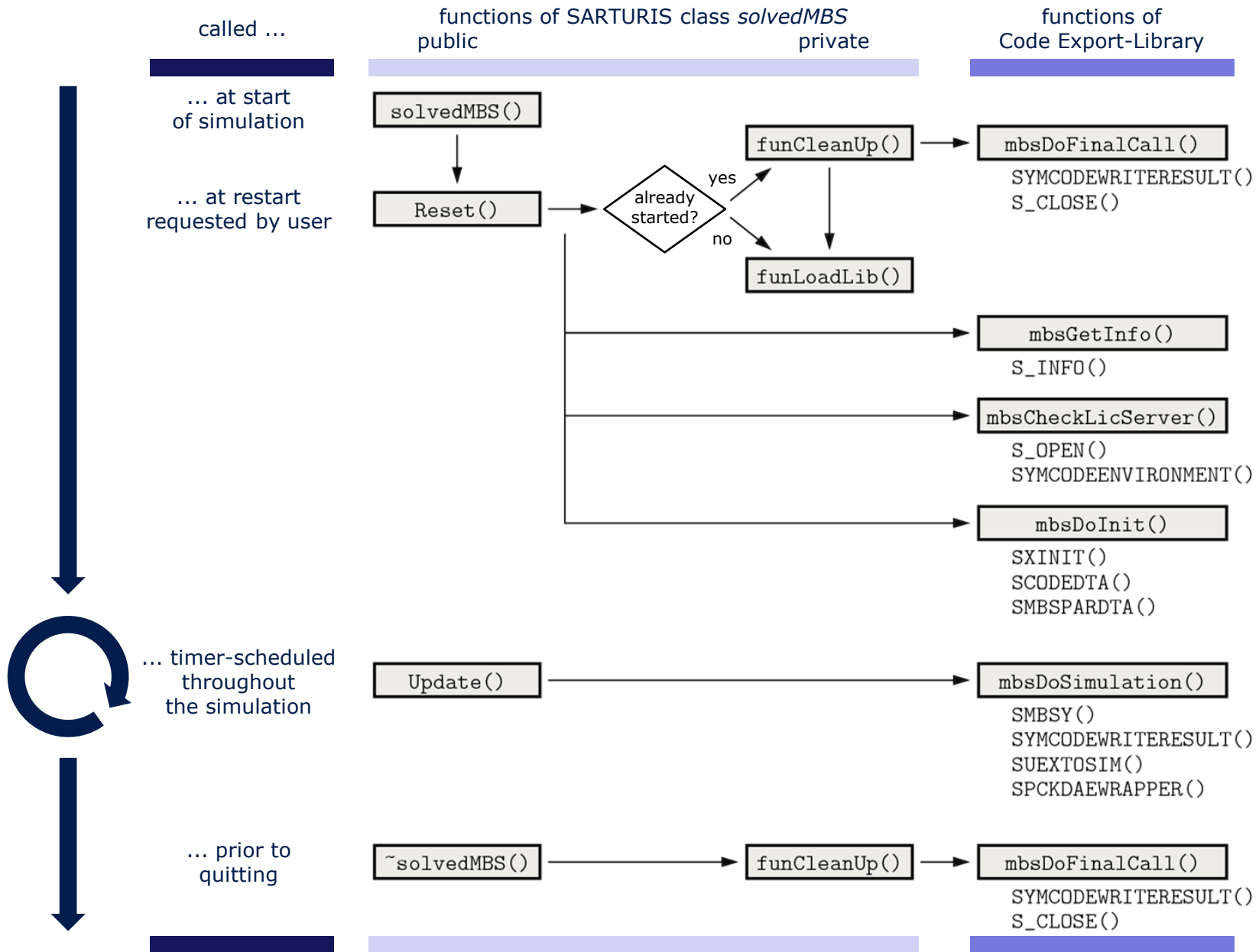


## Cosimulation – with SIMPACK

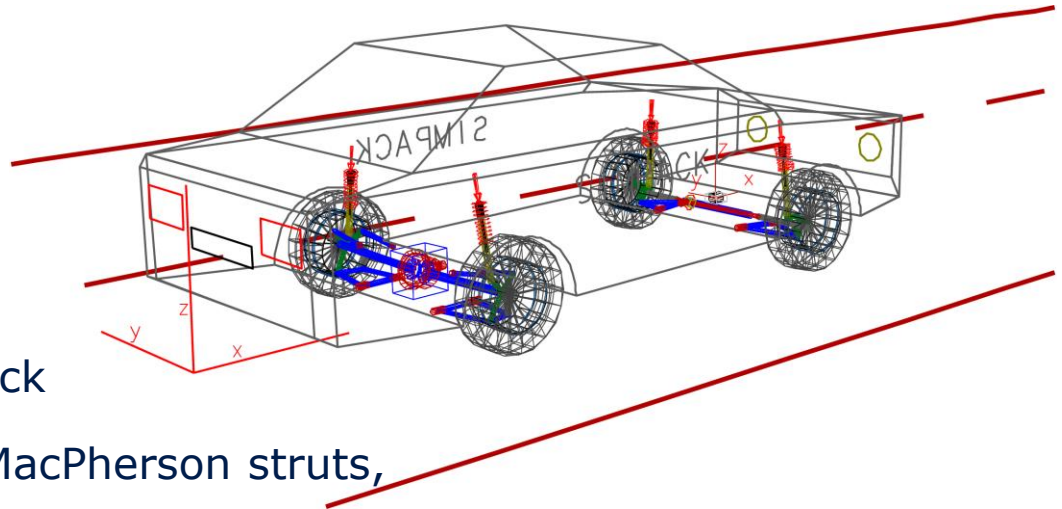


## Components needed to connect with SIMPACK





## Testing & Experiences – Example Model

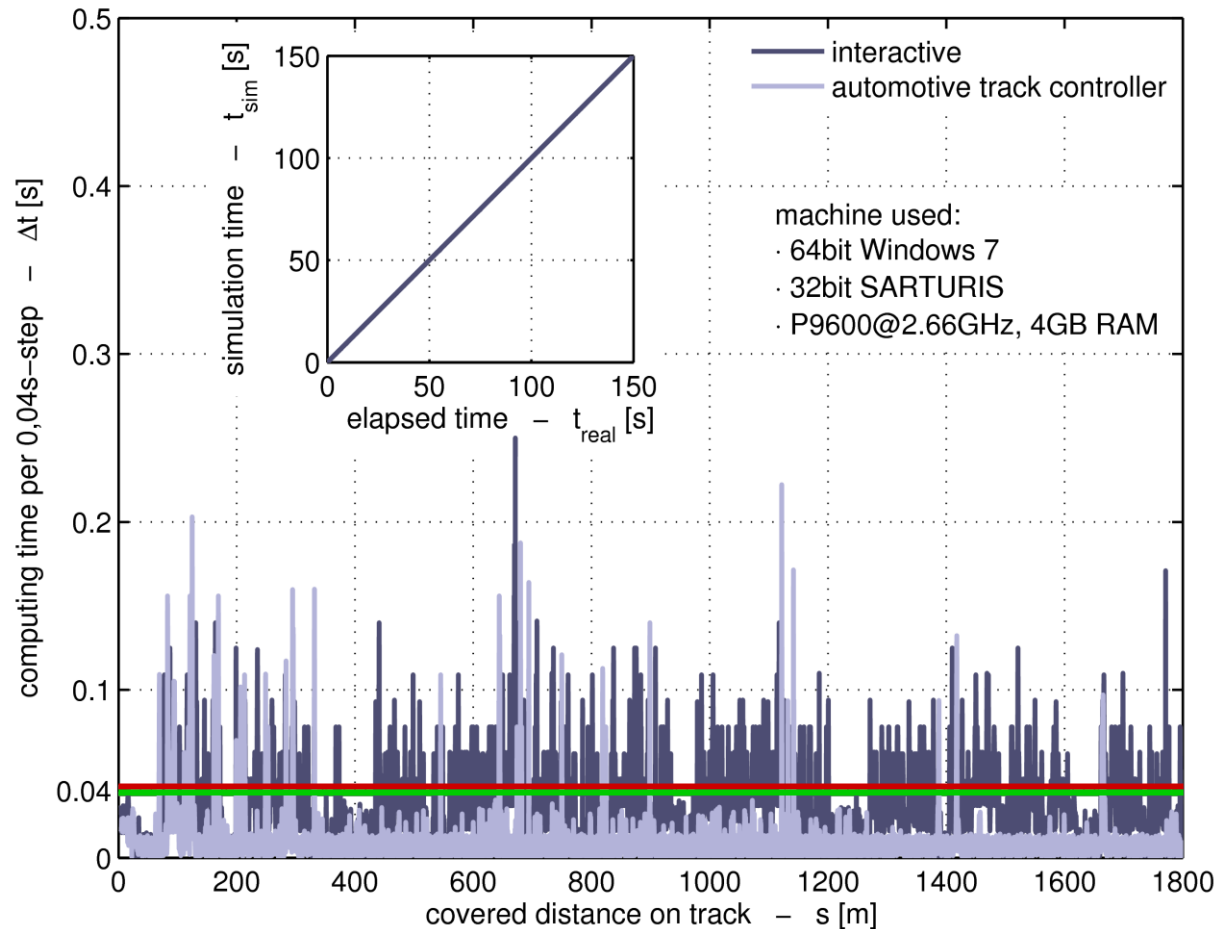


- vehicle-dynamics  
on a 2 km circuit track
- main components: MacPherson struts,  
multi-link rear suspension, differential gears, steering assembly
- kinematic loops closed with force elements instead of constraints
- » ODE-System made up of 36 bodies, resulting in 127 states

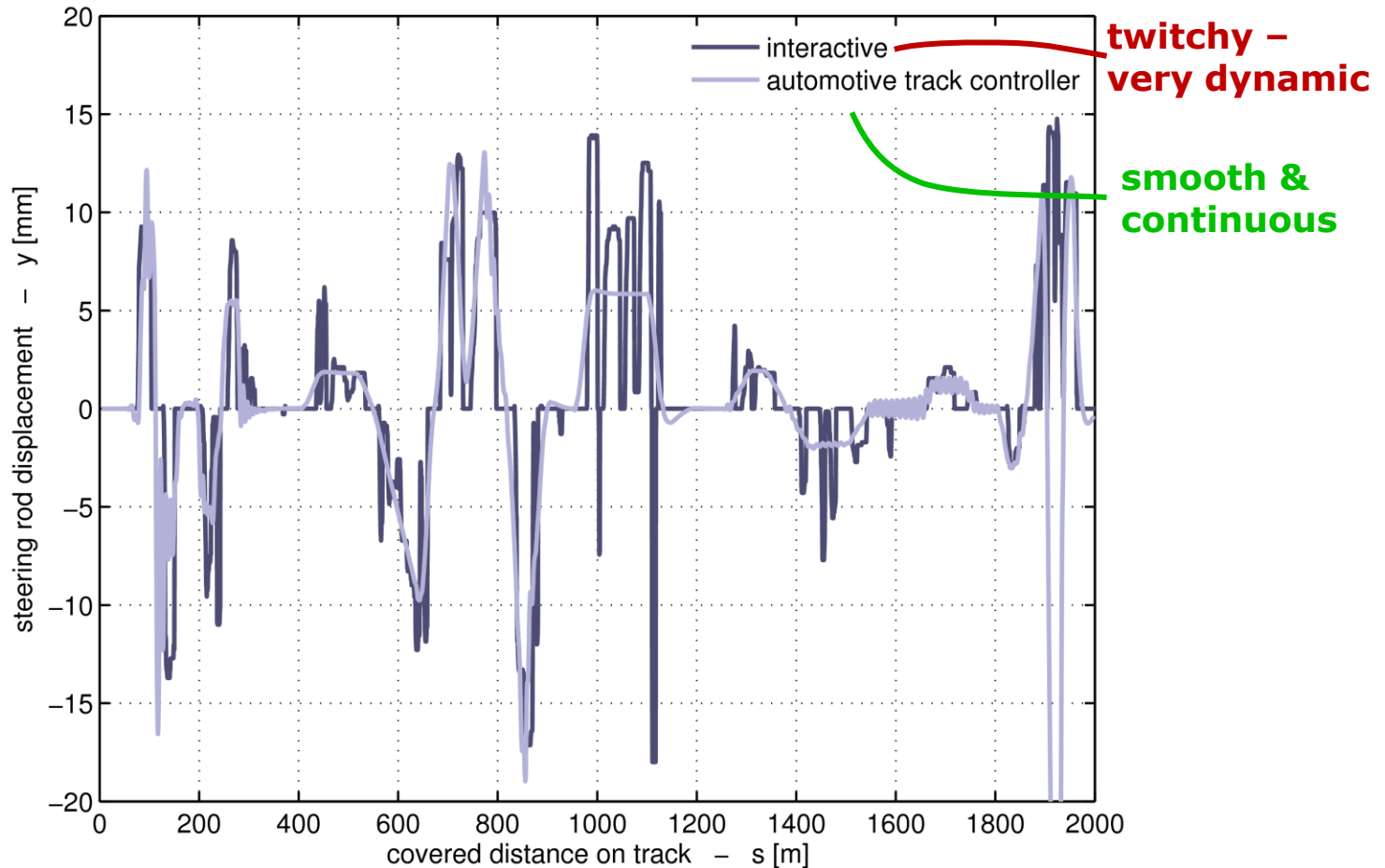
## Testing & Experiences – Possible Scenario

- comparing integration performance:
  - SIMPACK automotive track controller vs. human driver*
- SARTURIS can measure system idle-time at each integration step
  - » means to evaluate real-time performance

## Testing & Experiences – Computation Time



## Testing & Experiences – Controller Output



## Summary

- cosimulation working on integrator-level
- interactive simulation is possible

### PRO

- no special (expensive) hard- or software needed
- DLL is application-independent, linked only against SIMPACK libs
- high-speed cosimulation (compared to SIMAT interface)

### CON

- models still need adjustments to meet soft real-time requirements
- two different databases for track data (SIMPACK + SARTURIS)



**»Wissen schafft Brücken.«**

Philipp Goldmann  
TU Dresden  
Institute of Power Engineering  
+49 351 463-32815  
[philipp.goldmann@tu-dresden.de](mailto:philipp.goldmann@tu-dresden.de)