



# Vitesse

–

## Simulation of Active Vehicle Systems using SIMPACT Code Export

Dr. Udo Piram

Bernd Austermann

ZF Friedrichshafen AG, TB-3

→ Overview

→ Concept and Tools

→ MBS-Library, Preprocessor

→ Interface

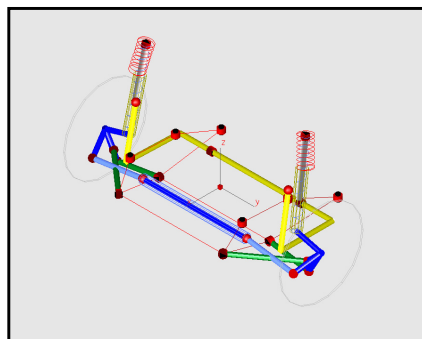


# Vitesse: Overview

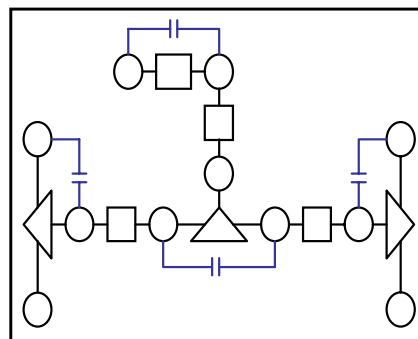
## Virtual Testing and Simulation Environment

→ Goal: Simulation of vehicles with active components in chassis and power train

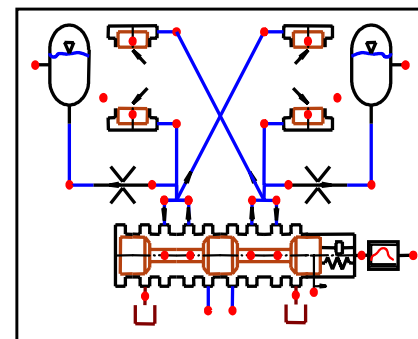
Multidisciplinary models



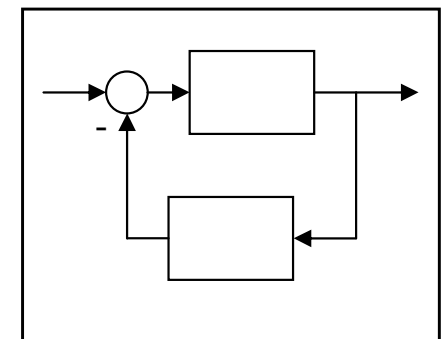
chassis



power train



hydraulics



control

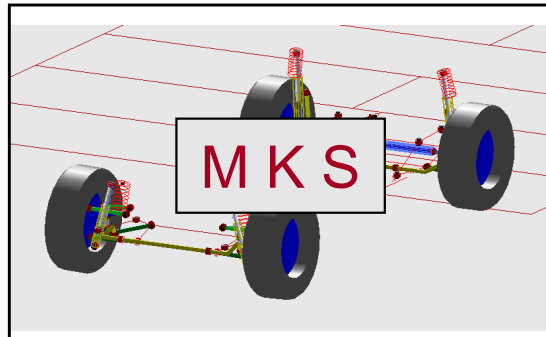


# Vitesse: Requirements

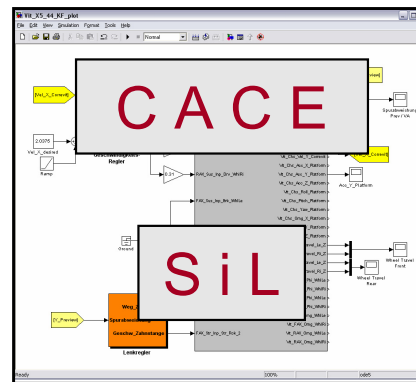
## → Structured model setup

- ◆ Subsystem with varying complexity
- ◆ Reusability, Circulation of models
- ◆ Integrated development process

## → Different Simulation Environments



Simulation of components



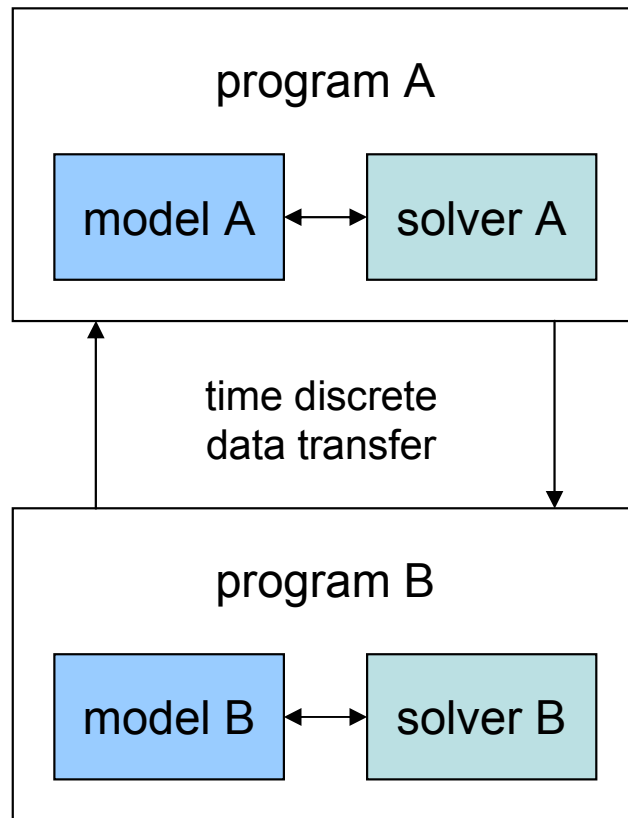
Control strategy



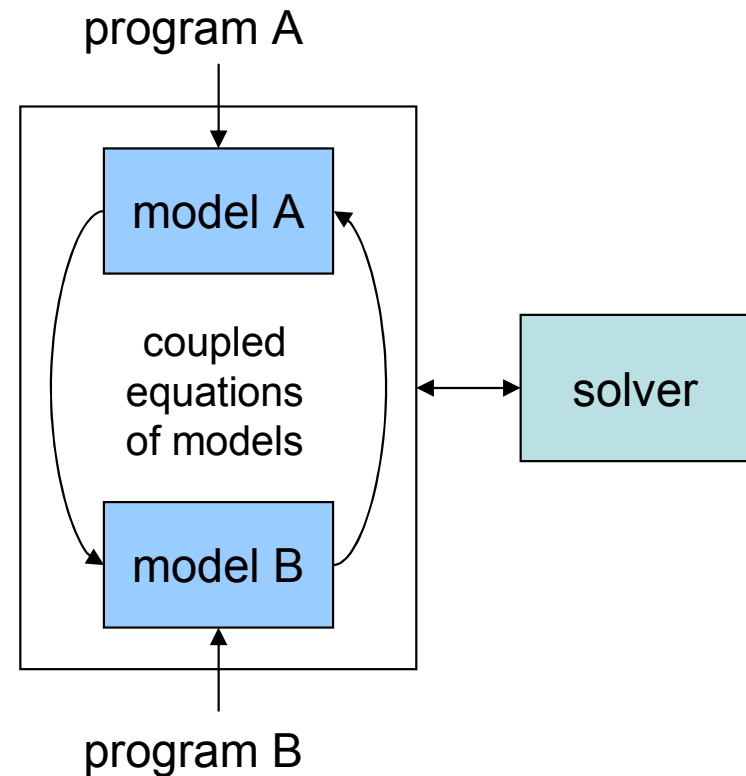
Test bed  
Driving Tests

# Simulation of Coupled Systems (1)

## Co-Simulation



## Coupled Equations





## Simulation of Coupled Systems (2)

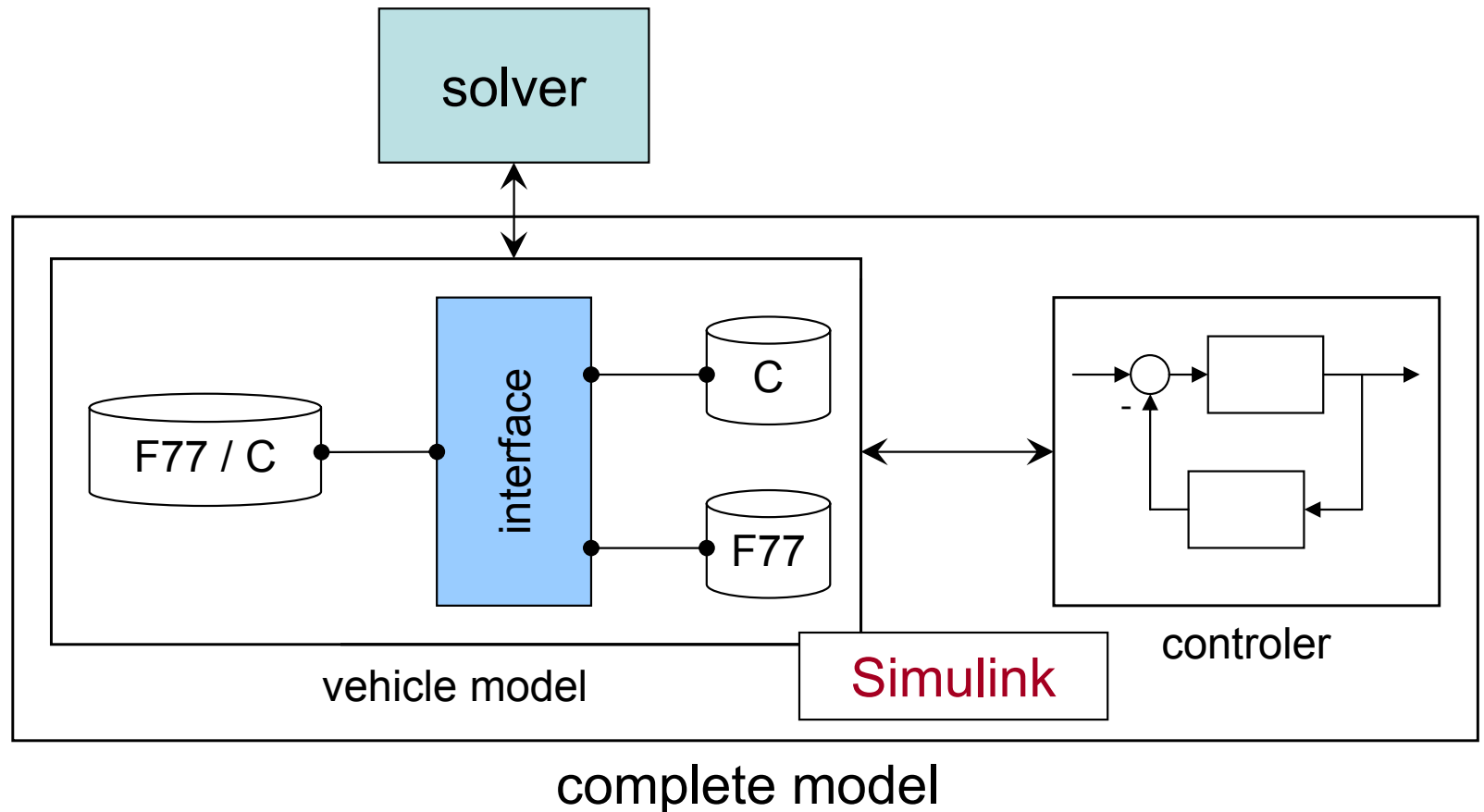
→ Advantages of coupled equations (time continuous systems):

- ◆ Better stability of simulation
- ◆ Shorter computation time
- ◆ Rigid coupling of subsystems possible

→ Computation time: test example

- ◆ Chassis and power train with elastic coupling
- ◆ Co-Simulation stable up to 500 Hz sampling rate
- ◆ Coupled equations stable up to 100 Hz and lower
- ◆ Speed gain  $> 2$

# Vitesse: Concept and Tools





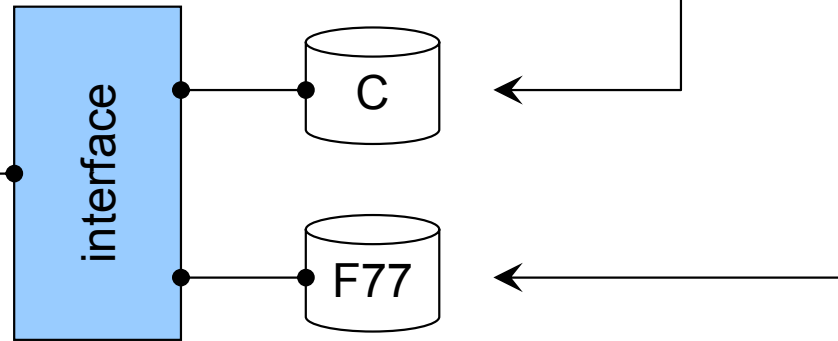
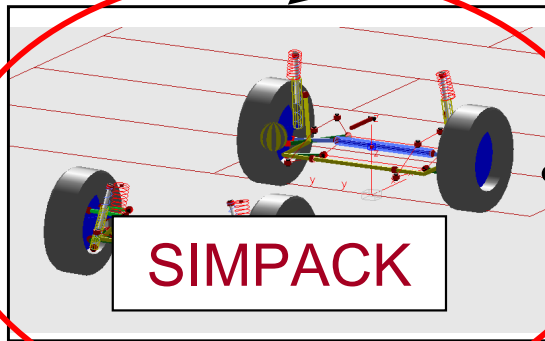
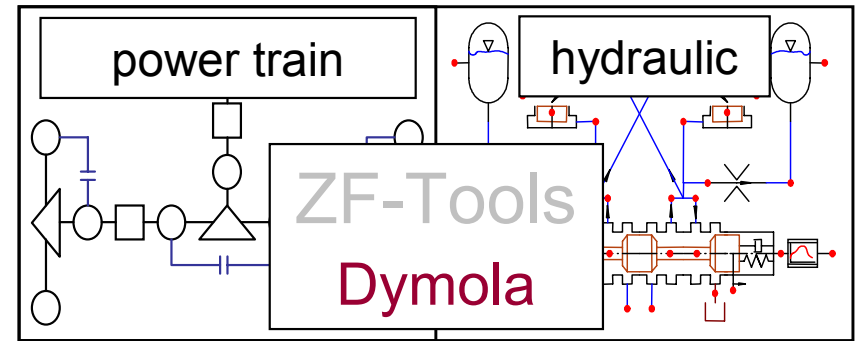
# MBS-Library and Preprocessor

Vitesse –  
Preprocessor

Name		Huber			Zuer			Vuer		
	Type	x	y	z	x	y	z	x	y	z
Ch_SaRf	Lat	0.247	-0.495	0.102						
Ch_SaRf	Lat	0.248	-0.495	0.102						
Ch_SaRf	Lat	0.249	-0.495	0.102						

Ch_SaRf	Rigt	Ch_SaRf	Ch_SaRf	Ch_SaRf
Ch_Sp	Rigt	Ch_Sp	Ch_Sp	Ch_Sp
Ch_Sp	Rigt	Ch_Sp	Ch_Sp	Ch_Sp
Sa_Sp	Rigt	Sa_Sp	Sa_Sp	Sa_Sp





# MBS-Model Library: Requirements

- Data and structure are separated
- Fully parameterized substructures
  - ◆ Body, suspension, steering, tires, ...
  - ◆ No mirroring used, symmetry by dependant parameters
- Multiple usage of substructures
- Parameter names are global for complete vehicle



⇒ Local copies of substructures



# MBS-Model Library: Solution

- Global library with substructures (read only)
- Local copy of substructures
  - ◆ Parameterization
  - ◆ Possibly additional elements, e.g. sensors
  - ◆ Prefix to label position (front axle, rear axle ...)
  - ◆ Automatic renaming
- Rules for nomenclature of parameters
- Preprocessor for SIMPACK model



# Vitesse Preprocessor

- ZF-Tool to simplify handling of substructures/parameter
  - ◆ Access to global model library
  - ◆ Interface for parameter changes for not experienced user
  - ◆ Structured display of parameters (masses, hardpoints, ...)
  
- Setup of new projects
  - ◆ SIMPACK model database is generated
  - ◆ Selection from templates
  - ◆ Copy of files from global library with automatic renaming
  
- Assembly of system in SIMPACK by expert user



# Vitesse Preprozessor

## → Working within a project

- ◆ Graphic representation of structure of assembly
- ◆ Replace input functions (.if2-files for spring, damper etc.)
- ◆ Replace parameter files
- ◆ Display and change of parameters

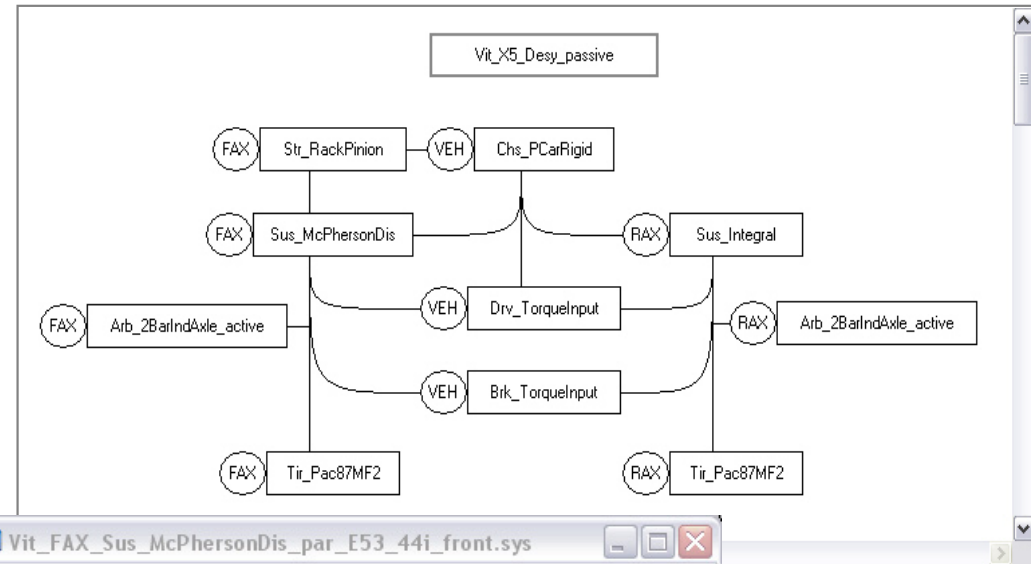
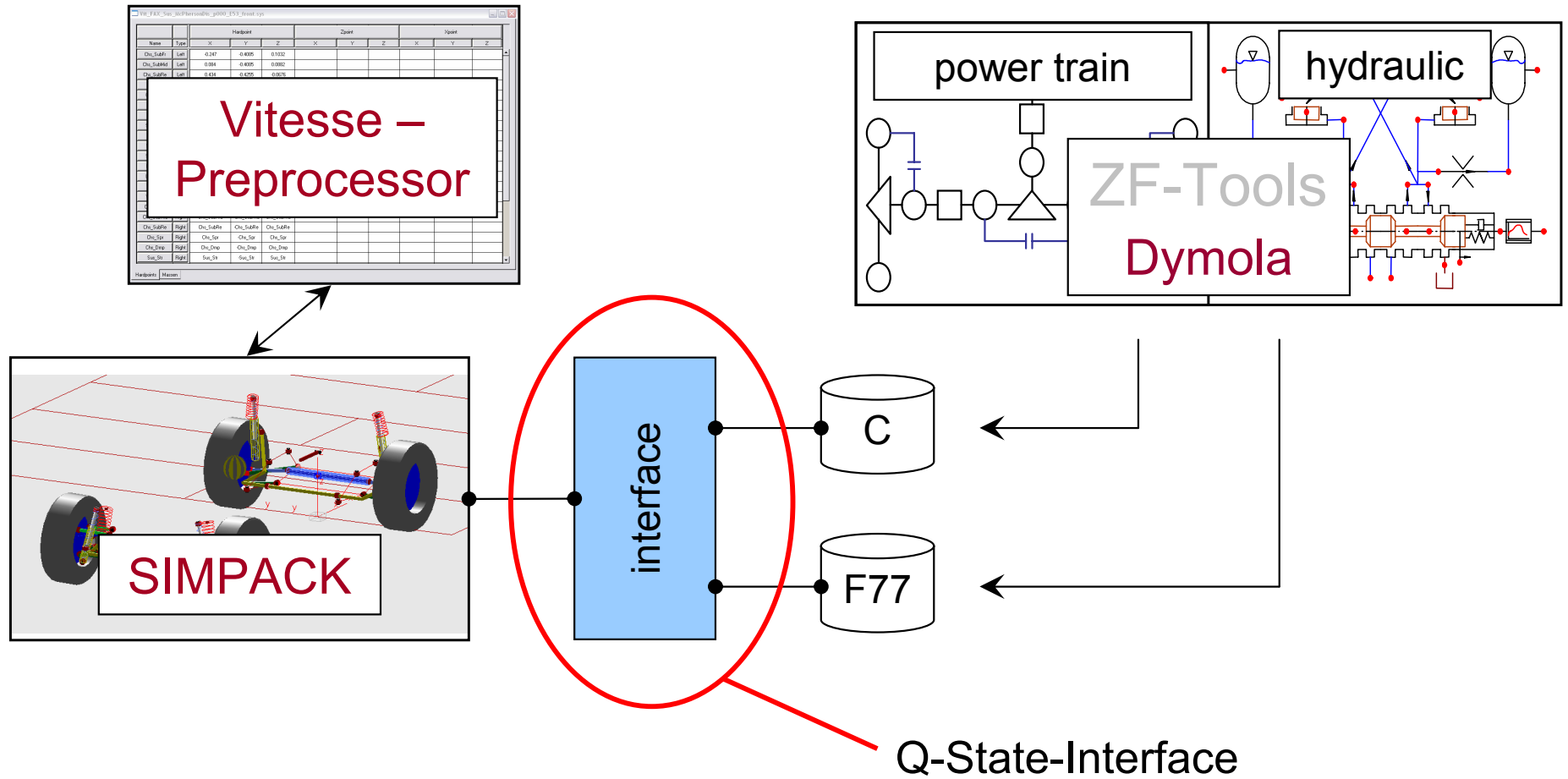


Table showing parameters for 'Vit\_FAX\_Sus\_McPhersonDis\_par\_E53\_44i\_front.sys':

Name	Masse	Trägheit		
		lxx	lyy	lzz
	MAS			
Sub	26.403	2.449	1.522	3.7835
LAFLe	3.399	0.0699	0.0049	0.0657
LARLe	1.140	0.0158	0.0002	0.0157
KnuLe	6.292	0.0423	0.0490	0.0188
DaLLe	3.430	0.0433	0.0439	0.0034
DaULe	1.360	0.0155	0.0155	0.0001
TrdLe	0.794	0.0121	0.0001	0.0121
WhlLe	35.000	1.200	2.200	1.200

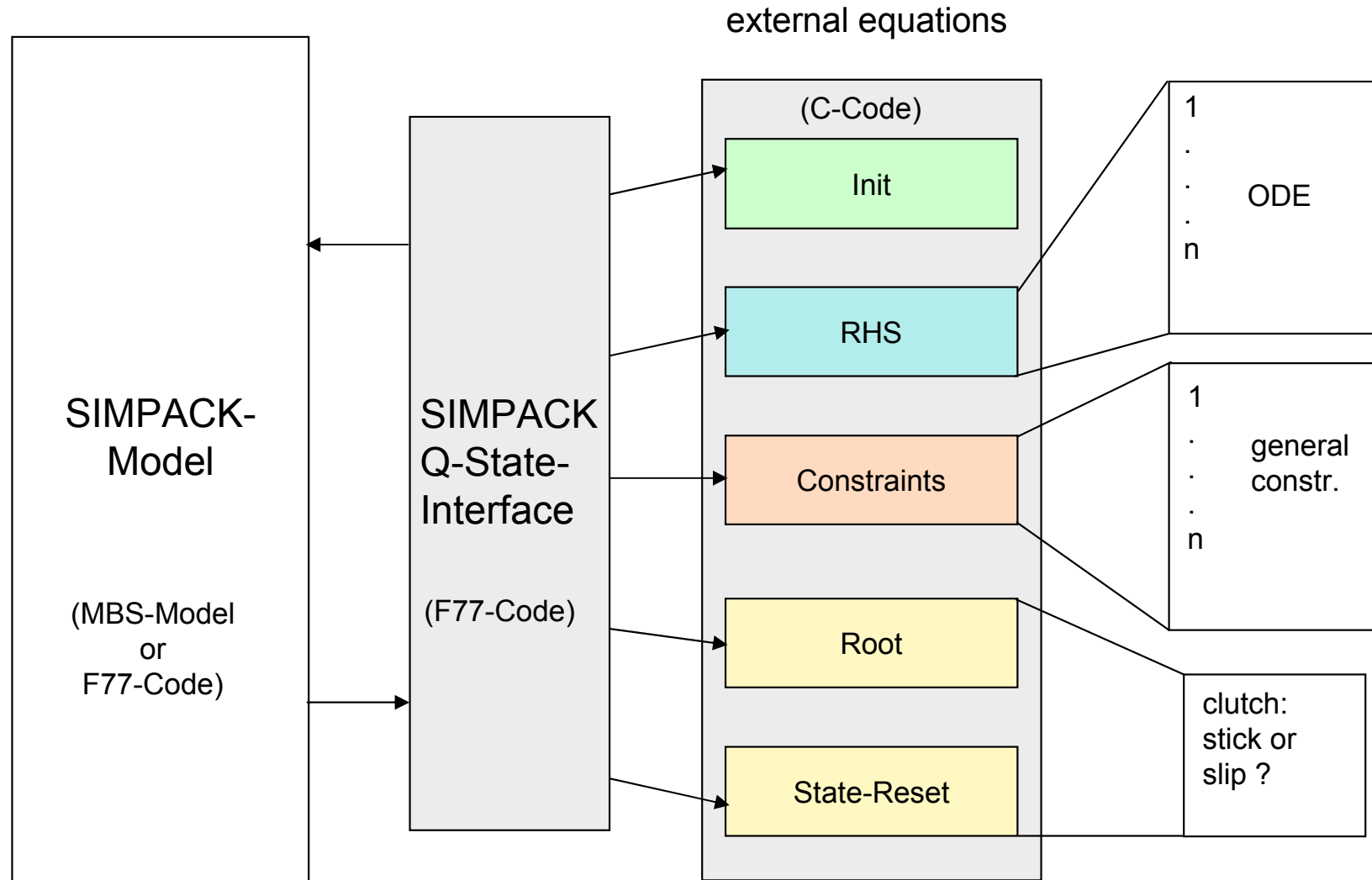


# Vitesse: Interface





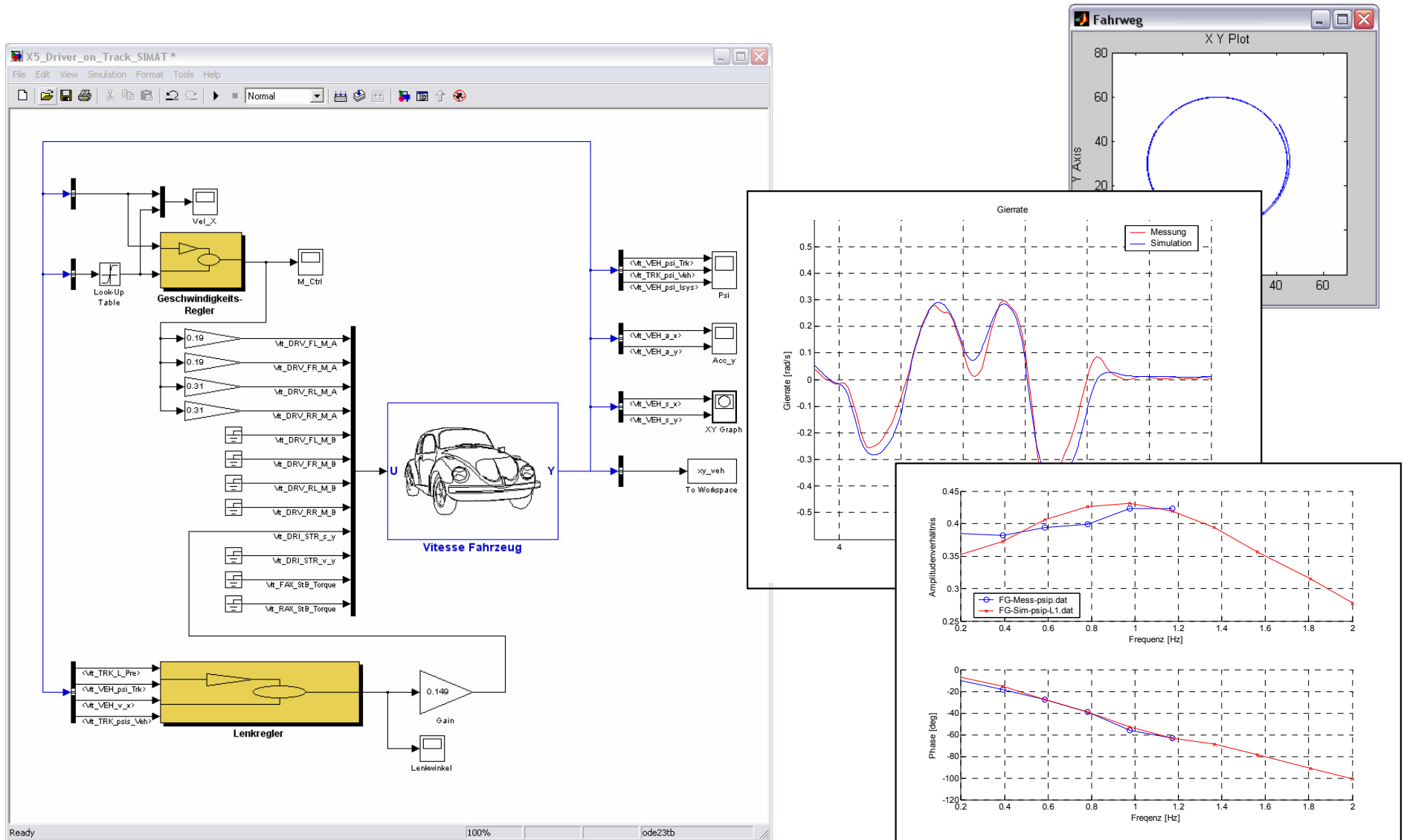
# Q-State-Interface





# Application Example

## Simulation in Matlab/Simulink





# Status of Project

## → SIMPACK Code Export

- ◆ First tests with V8.0
- ◆ Setup of library using V8.5 and V8.6
- ◆ Meanwhile large changes in code export
- ◆ Time delay in project plan
- ◆ Q-State-Interface in code export not yet satisfactory

## → Models in use at different departments (using Co-Simulation)

## → Distribution of tools in corporation



## Summary / Comment

- MBS-Models in SIMPACK using own library
- Equation coupling using Q-State-Interface
- Consistent approach for simple and complex models

😊 Project only possible with SIMPACK

😊 Intec open for new suggestions

😊 Support

😞 Delay in delivery of Code Export

If successful test in SIMPACK:

😞 ? Successful test in Code Export ?