

Further Developments and Applications of SIMPACK Code Export

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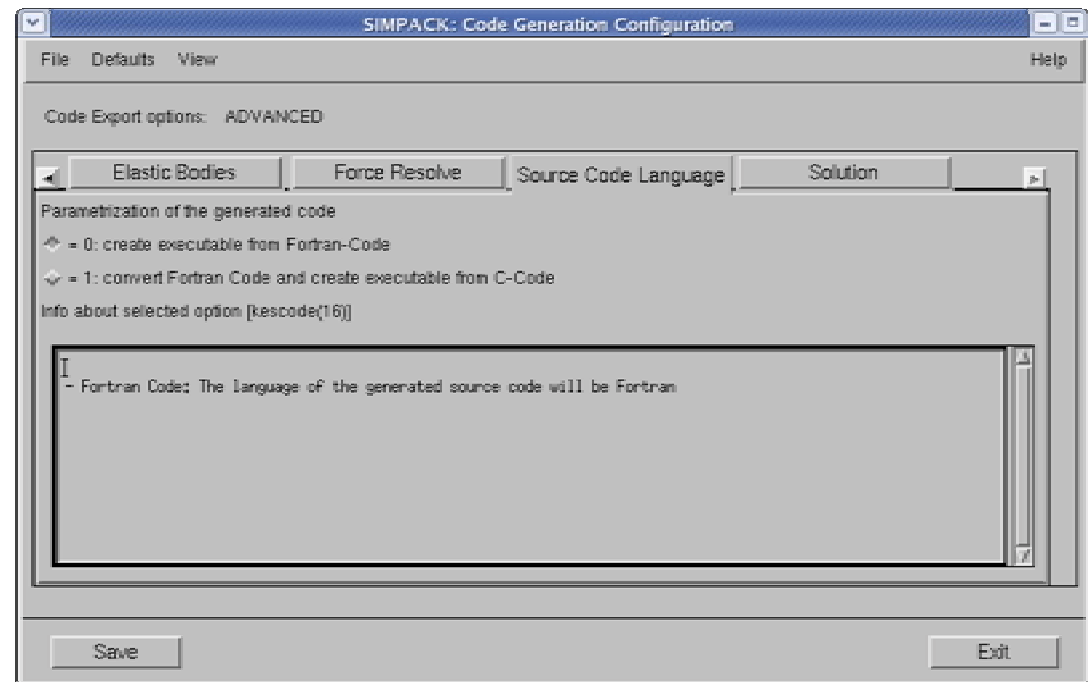
New Developments in SIMPACK Code Export

- C-Code Export
- Code Export-Executable usable as partner in Co-Simulation
- PostProcess results by SBR-File and SIMPACK PostProcessor
- Code Export for HIL-Simulation
- Code Export Excel Plug-In

C-Code Export

Export C-Code alternatively to F90-Code

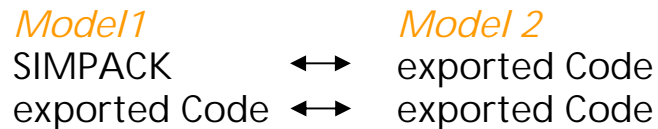
- required source code language can be selected by Configuration GUI
- uses converter ForC
- no Fortran compiler required any more
- enables access to arbitrary platforms, e.g. HIL targets
- available with SIMPACK 8900



Co-Simulation with exported code

Create Code Export executables using TCP/IP communication

- select, if exported code should act as Co-Simulation master or slave
- created executable can be used as client or server
- enables Co-Simulation:

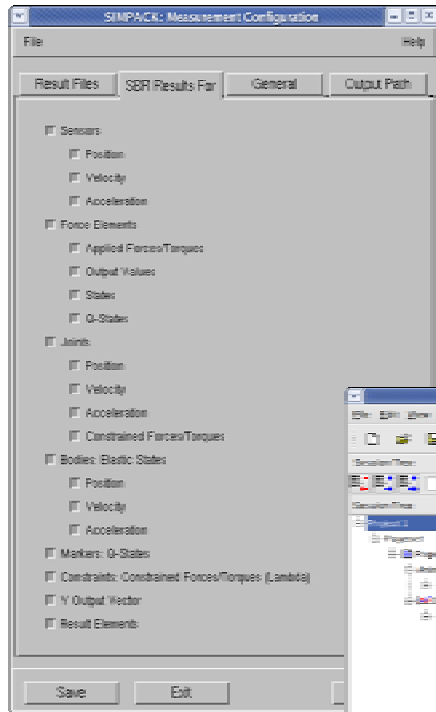


- Benefits:

- + Co-Simulation can be used to split model on 2 CPUs
- + use exported models as 'black box' functionality in SIMPACK

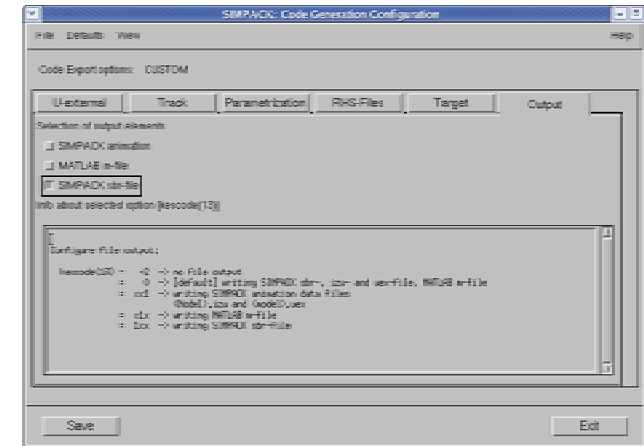
Code Export postprocessing by SBR-file

Plot and animate exported model in SIMPACK PostProcessor

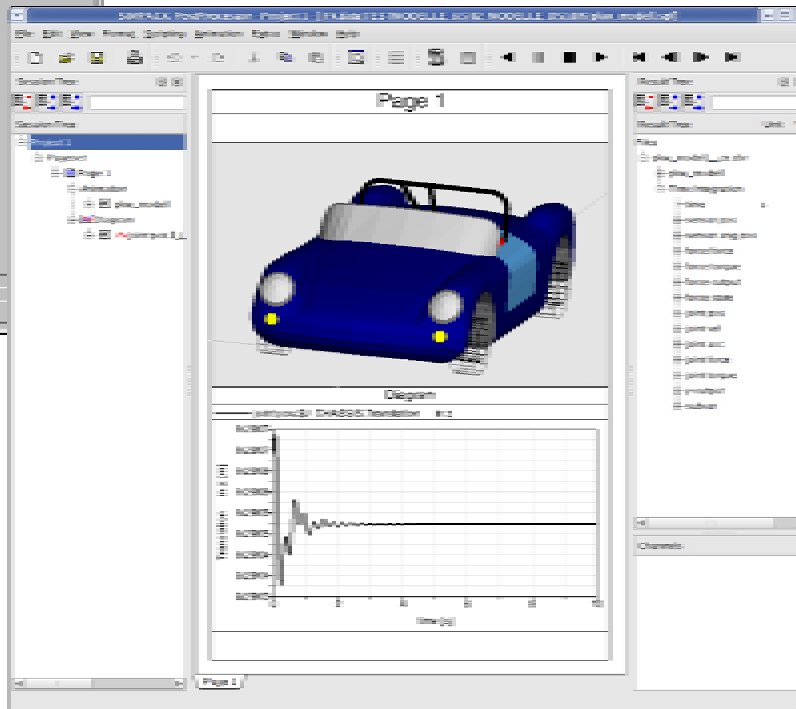


← select required results in SIMPACK Measurement GUI

activate generation of SBR-file in Code Export Configuration GUI



exported code creates SBR-File which can be post-processed in SIMPACK PostProcessor for plot and animation.



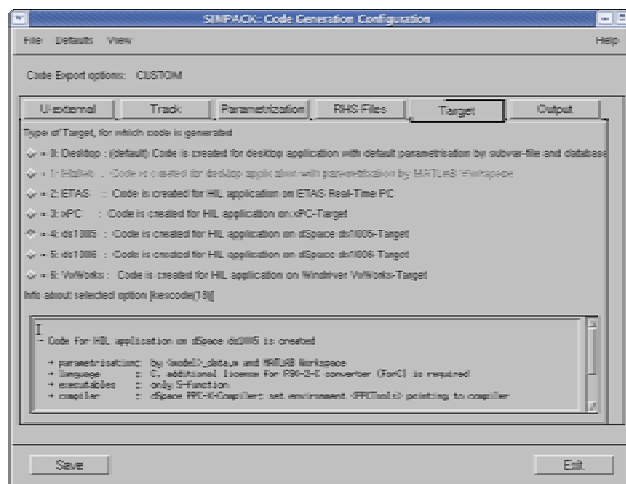
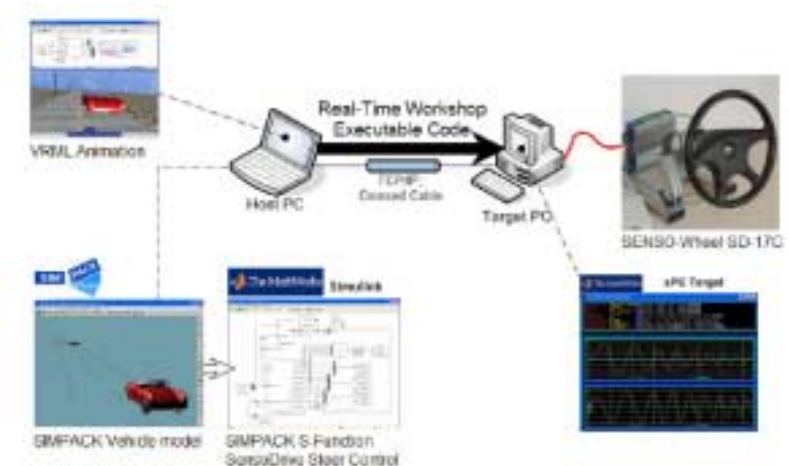
Code Export for HIL-Simulation

Code Export for HIL-Simulation

What is Hardware-in-the-Loop-(HIL)-Simulation ?

A real existing 'hardware' component (e.g. electronic control unit, suspension, steering wheel) is connected to a virtual simulation environment.

Simulation is carried out on a Real Time Target with specified real-time operating system



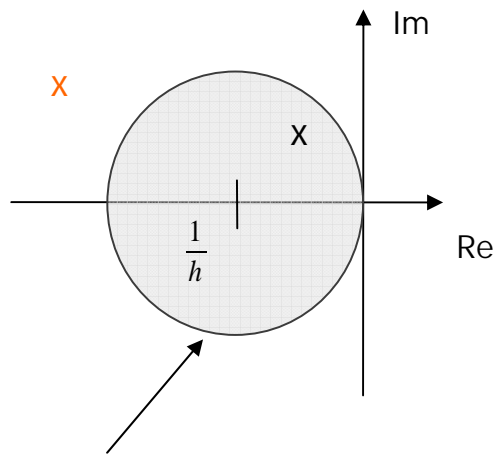
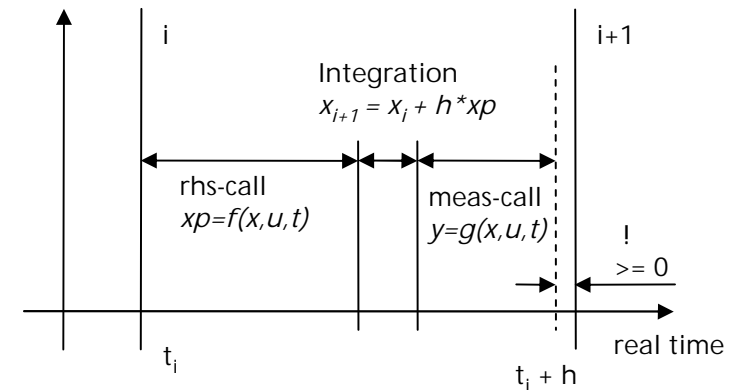
Automatic generation and compilation of code for HIL Targets.

- ETAS Real Time PC
- xPC Target (The Mathworks)
- dSpace ds1005
- dSpace ds1006
- VxWorks (Wind River)

Code Export for HIL-Simulation

Requirements for SIMPACK Code to run on HIL targets

- simulation needs to be running in "real-time"
- consecutive result output at discrete time steps
- function evaluation, integration and measurements within a certain time range for every time step
- non-iterative solver with fixed step size
(conventional solution: explicit solver, e.g. Explicit Euler)



stability region of Explicit Euler

- model eigenvalues must be within stability range of solver
- for explicit solvers stability range depends on stepsize

⚡ usage of Explicit Euler enforces limitations in frequency range and modelling details (e.g. virtual elements, look-up tables, etc) ⚡

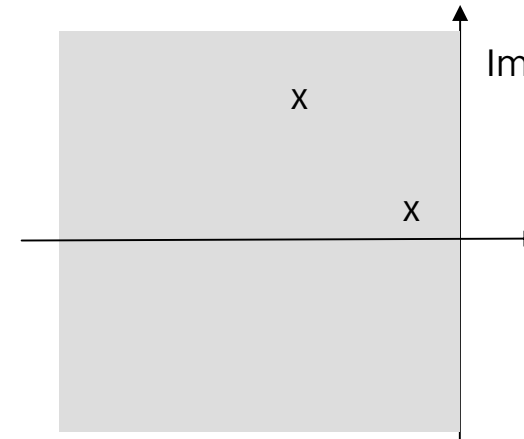
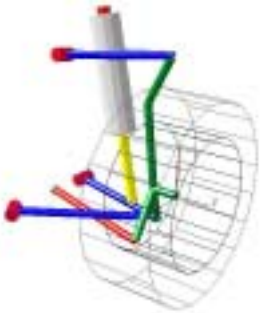
INTEC solution →

Code Export for HIL-Simulation

SIMPACK Real Time Solver

- linear-implicit Euler with constant step size
- provides a-(absolute)-stability of solution

$$x_{n+1} = x_n + hf(x_{n+1}, t_n)$$



.....> enables part-based modelling

- avoid model redundancy
- avoid data redundancy
- improve result quality

one model for offline and online (HIL) simulation !

Code Export Excel Plug-In

Motivation

Initial Situation:

- on the one side SIMPACK as a complex MBS modelling and simulation tool providing high-end solutions for expert users
- on the other side increasing demand for high-value MBS-simulation by users
 - with no modelling experience
 - with reduced requirements in flexibility and functionality
 - accustomed to their familiar working environment

Solution

combine SIMPACK Code Export with wide spreaded application tool:

→ Excel Plug-In

make complex MBS simulation available to non-MBS experts

Code Export Excel Plug-In

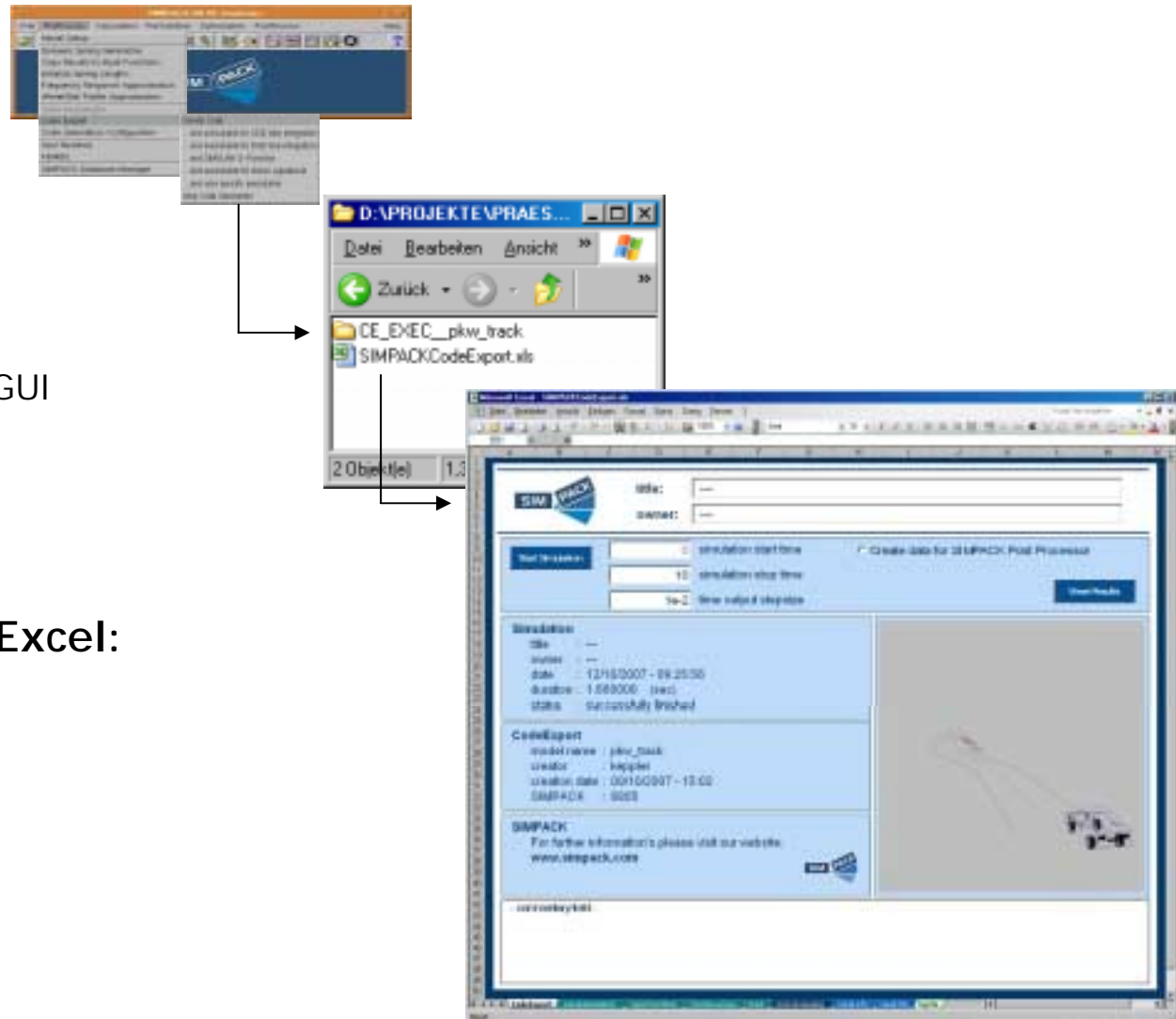
Application Szenario

SIMPACK Expert User:

- creates MBS model
- exports model with Excel template GUI

Standard User, operates in Excel:

- parametrises model
- executes simulation
- postprocesses result



Code Export Excel Plug-In

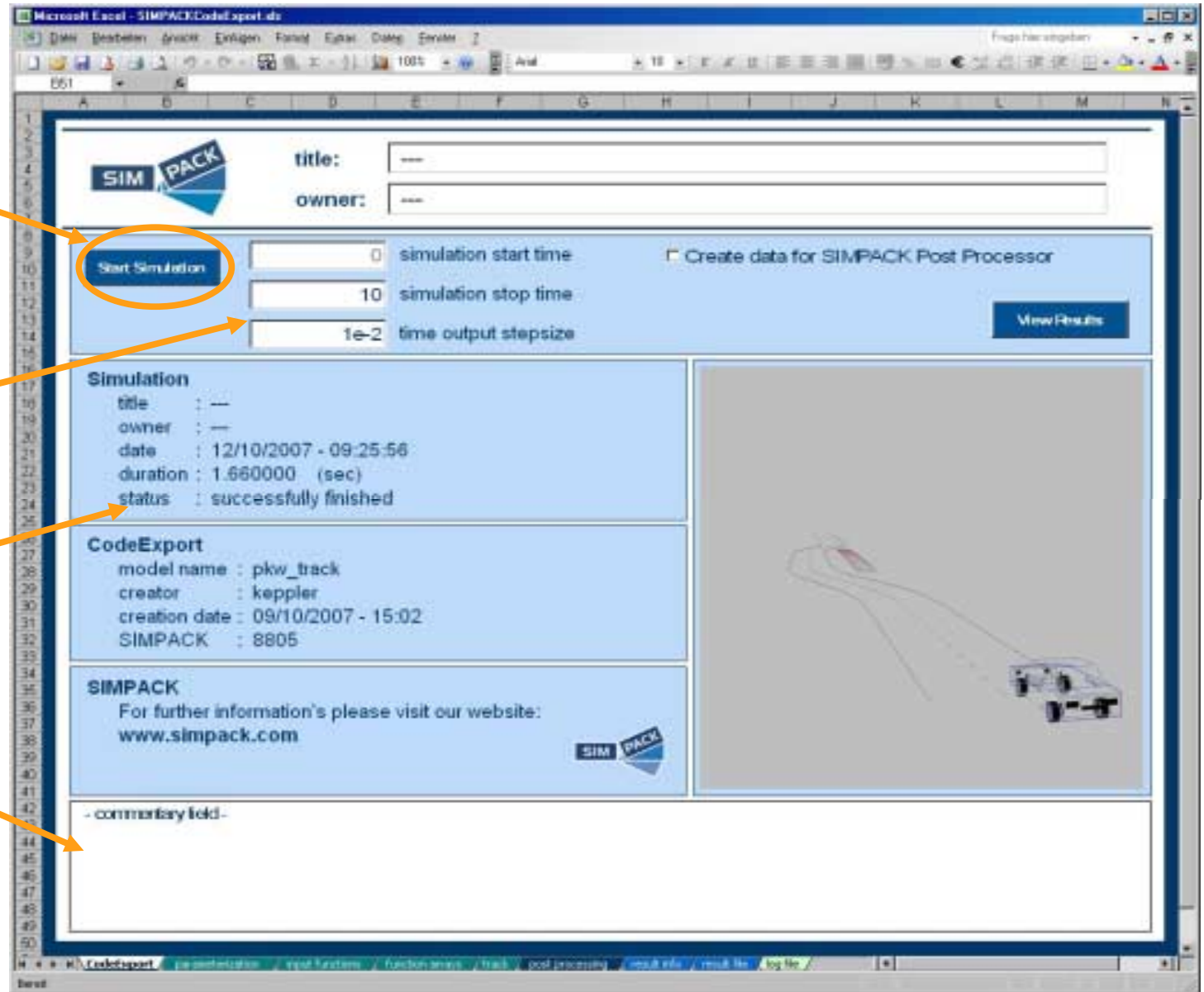
Features - Simulation

- start Simulation of exported models using SIMPACK Time-Domain DAE Solver

- set simulation end-time
- set output stepsize

- get info about simulation state

- add coments

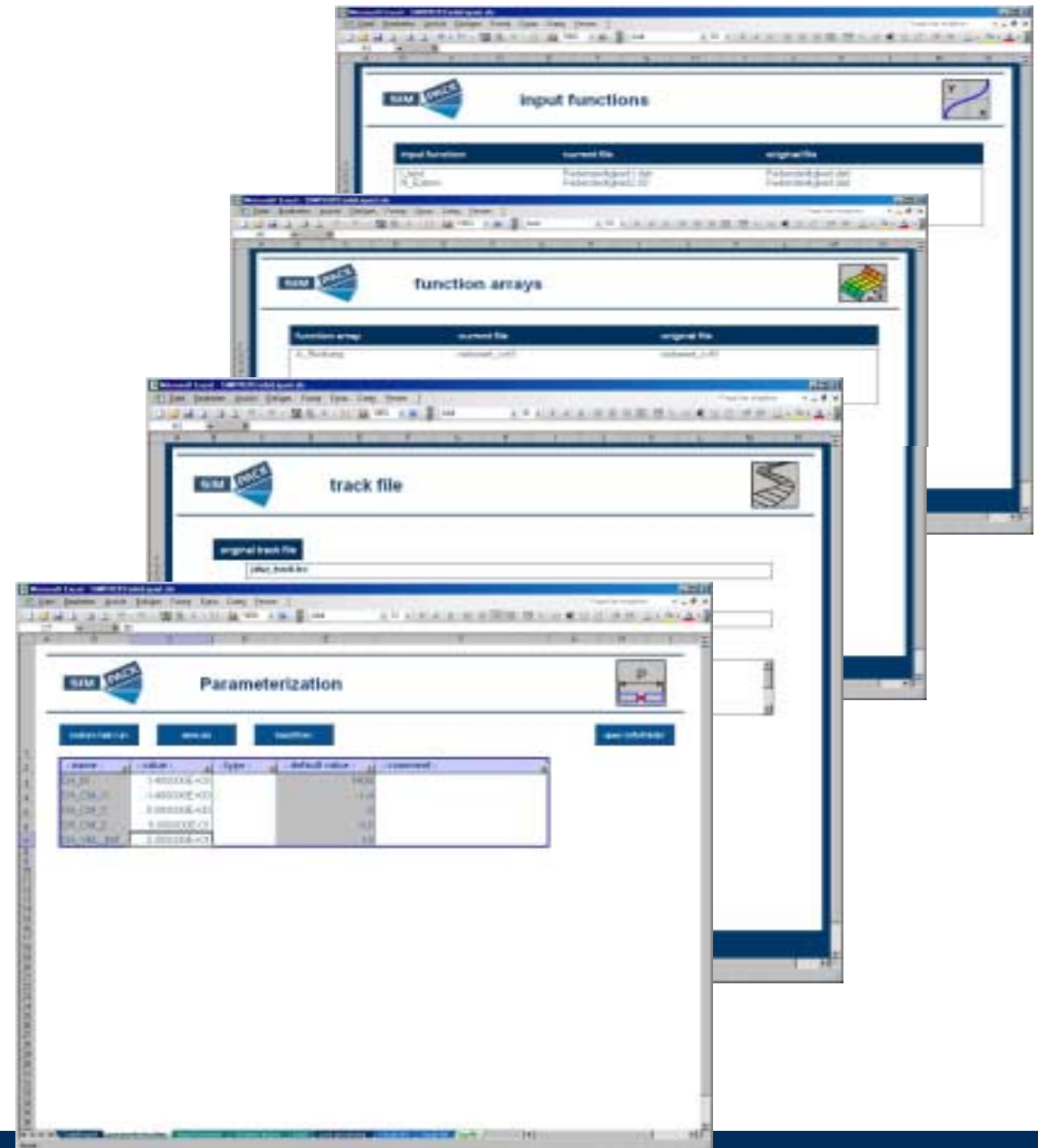


Code Export Excel Plug-In

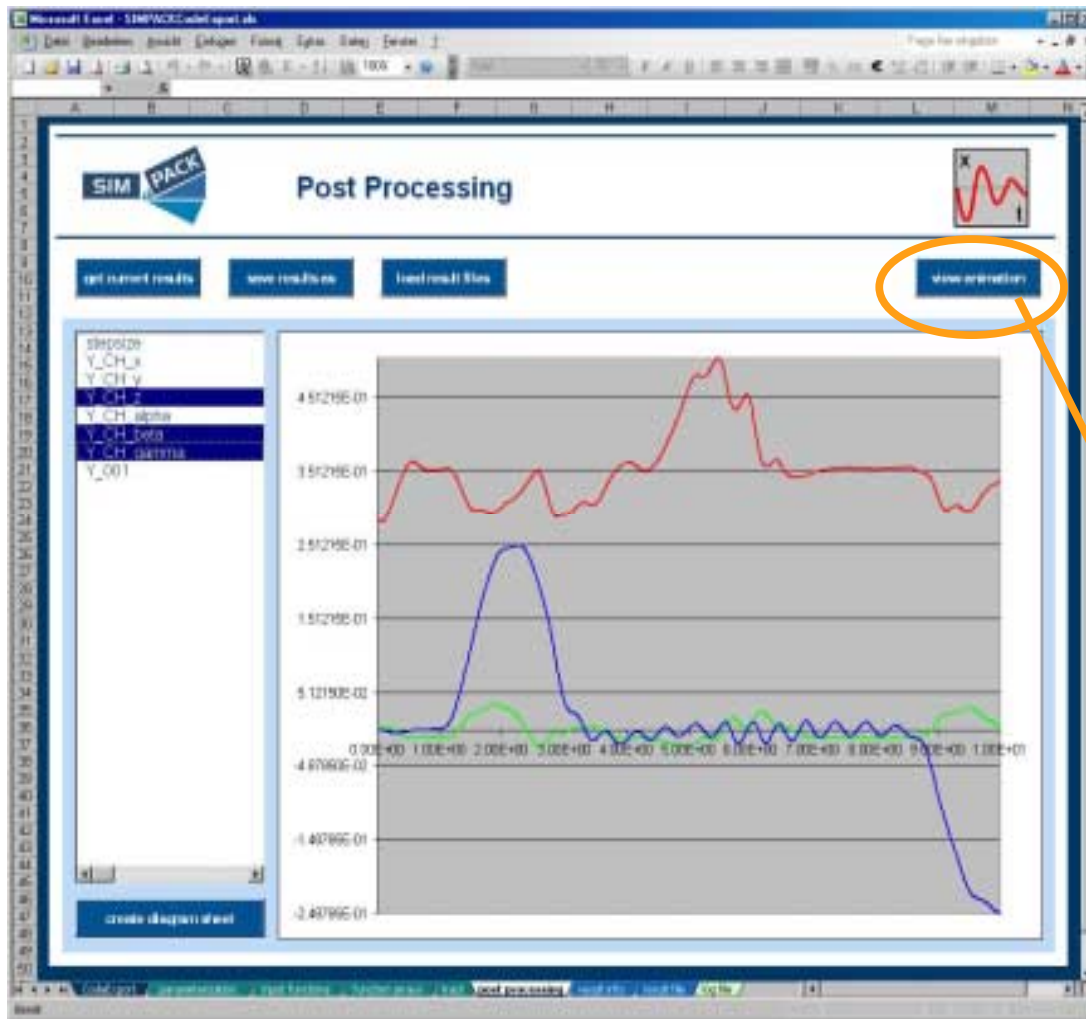
Features -
Parametrisation

Exported model can be parametrised

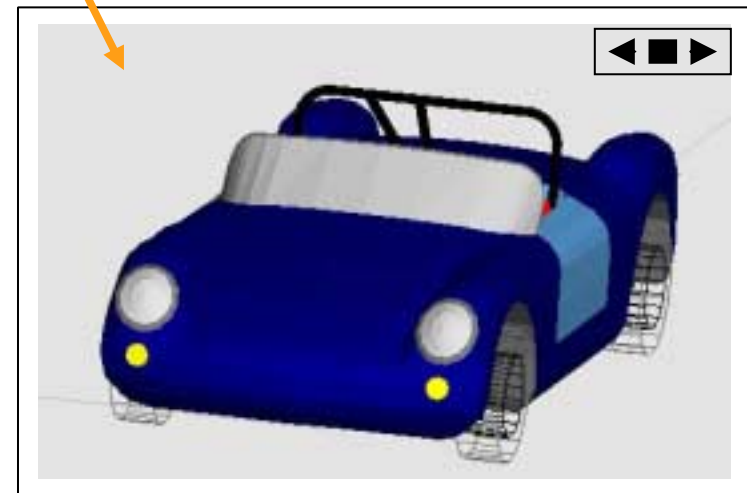
- edit selected substitution variables (subvars)
- exchange database elements, e.g.
 - Input Functions
 - Function Arrays
 - Track
- dialog enables access to database elements



Code Export Excel Plug-In

Features -
PostProcessing

- use Excel internal functionality to plot simulation results (y-output vector)
- animation can be provided by animation viewer



Benefits

- provides easy-to-use GUI to simulate, parametrise and post process exported models
- customized GUI can be expanded by Excel standard functionality
- high availability by wide spreading of Excel installations
- is independent from full SIMPACK installation
- provides easy access to high-value SIMPACK models to non-MBS experts

Code Export presentations at SIMPACK User Meeting 2007

- Development of an Experimental and Test Environment for Vehicle Real-Time Simulation

Gerd Bitsch, Fraunhofer-Institut
Afternoon Session, 1st day

- SIMPACK Realtime Models for HiL Testing at DC Trucks

Klaus Wüst, Daimler Nutzfahrzeuge
Automotive Session, 2nd day

- Real-Time SIMPACK Lookup Table Model for a Multi-Processor HiL-Testrig

Uwe Heitz, ZF Friedrichshafen AG
Automotive Session, 2nd day

- ... also visit our Code Export stand