

# SIMPACKS's FEA Interface

## New Features in 8.5 and Further Development

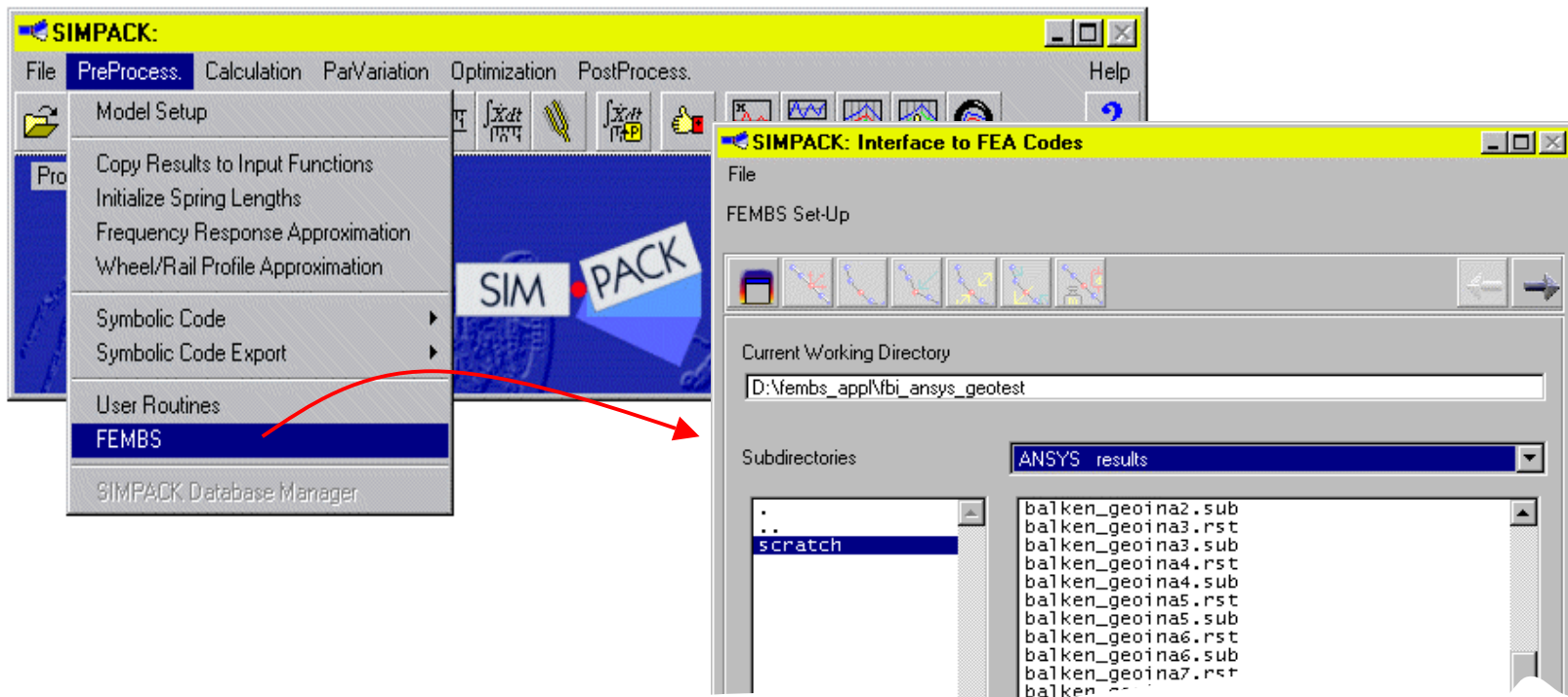
Stefan Dietz,  
INTEC GmbH

# Contents

- New Features in 8.5
  - integration into SIMPACK GUI
  - generalised file interface between FE-codes and SIMPACK
  - PERMAS interface
  - graphical representation of FE-meshes in SIMPACK
  - reference frame transformation
- Current Work
  - dynamic reduction of FE-models
  - durability interface
  - SIMBEAM a preprocessor for creating 3-D beam structures in SIMPACK
- Further Development
  - new methods for flexible body representation

# FEA Interface - New Features in 8.5 Integration in SIMPACK GUI

- start the FEA Interface „FEMBS“ in the SIMPACK Preprocessor

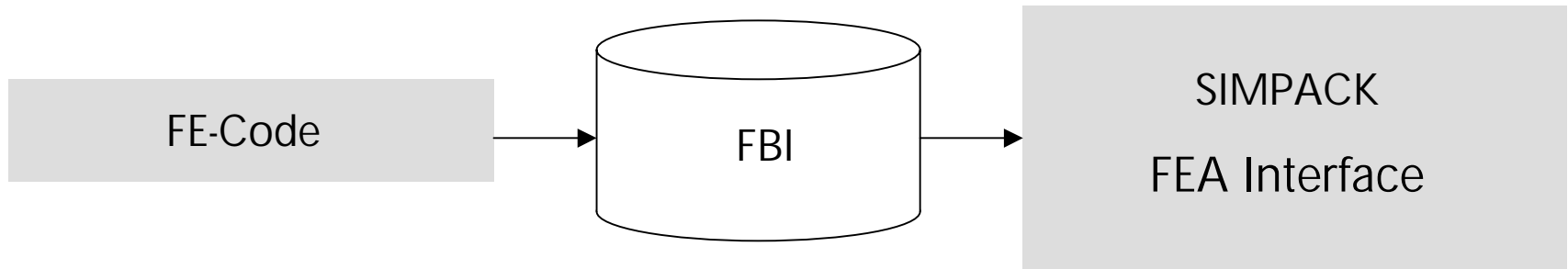


## FEA Interface - New Features in 8.5 Integration in SIMPACK GUI

- integration means
  - set-up of flexible bodies within SIMPACK's GUI
  - enhancements delivered and installed with SIMPACK
  - licensing by the SIMPACK license file
  - reduced effort for port to different hardware-platforms and delivery
  - improved quality control
  - increased capacity for achieving new methods for flexible body representation

## FEA Interface - New Features in 8.5

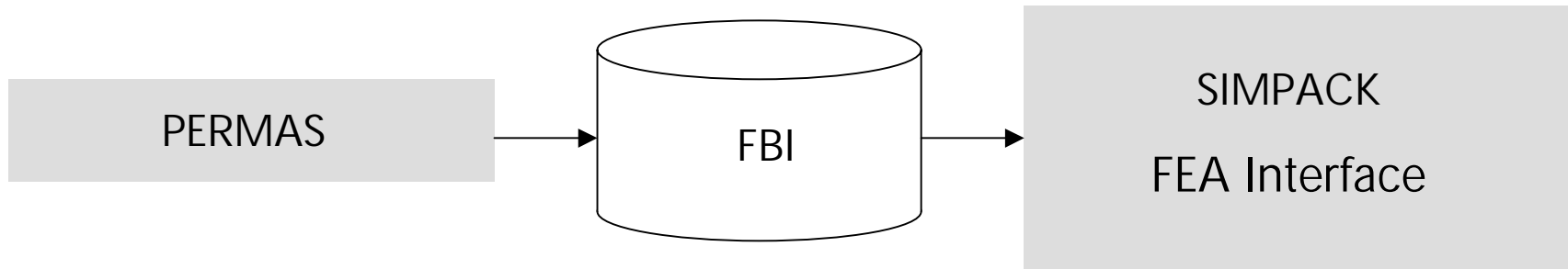
### Generalised File Interface Between FE-Codes and SIMPACK



- **Flexible Body Input** file contains
  - mass matrix
  - stiffness matrix
  - geometric stiffening matrices
  - normal modes
  - nodes
  - mesh for graphical representation of flexible bodies

# FEA Interface - New Features in 8.5

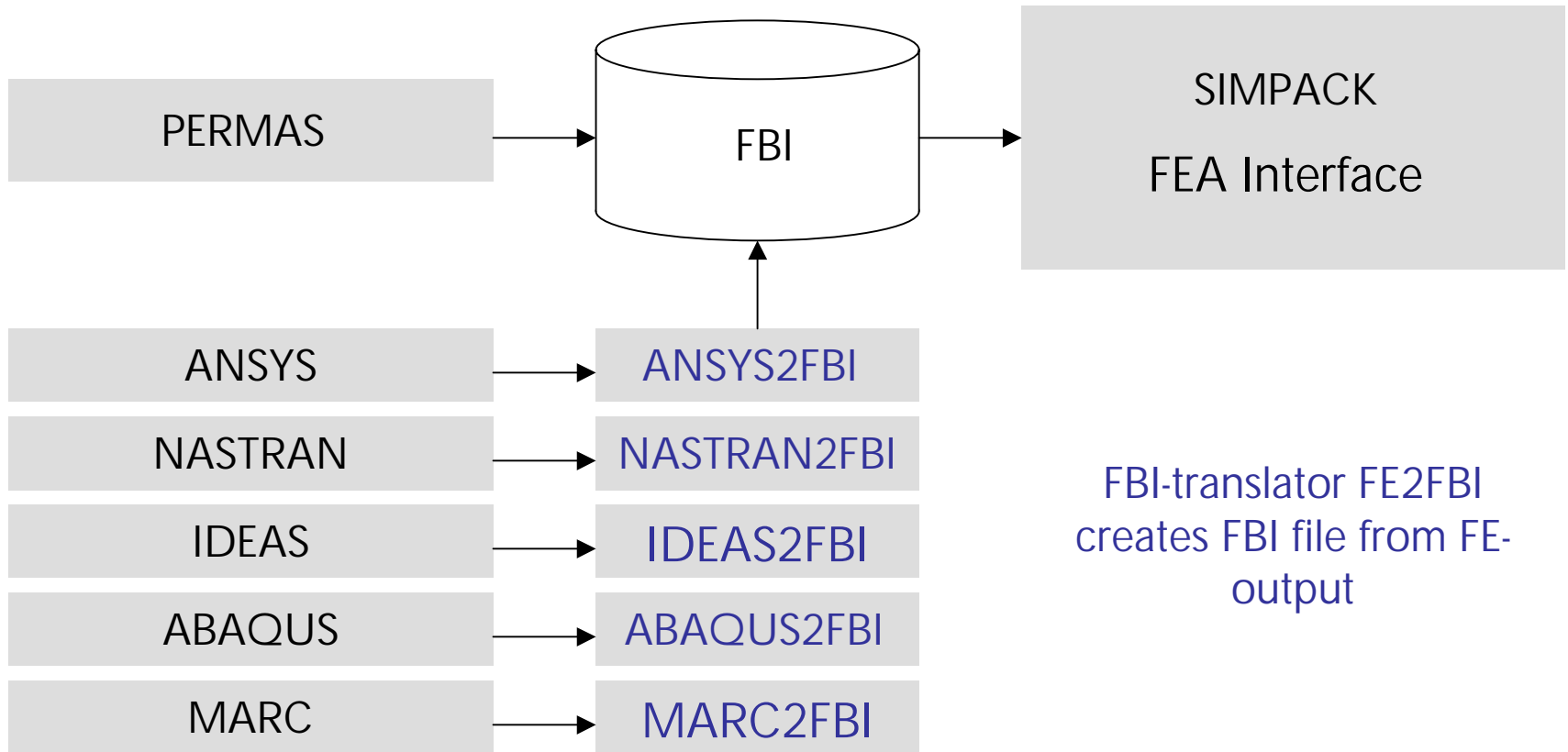
## Generalised File Interface Between PERMAS and SIMPACK



- **Flexible Body Input** file contains
  - mass matrix
  - stiffness matrix
  - geometric stiffening matrices
  - normal modes
  - nodes
  - mesh for graphical representation of flexible bodies

# FEA Interface - New Features in 8.5

## Generalised File Interface Between FE-Codes and SIMPACK



FBI-translator FE2FBI  
creates FBI file from FE-  
output

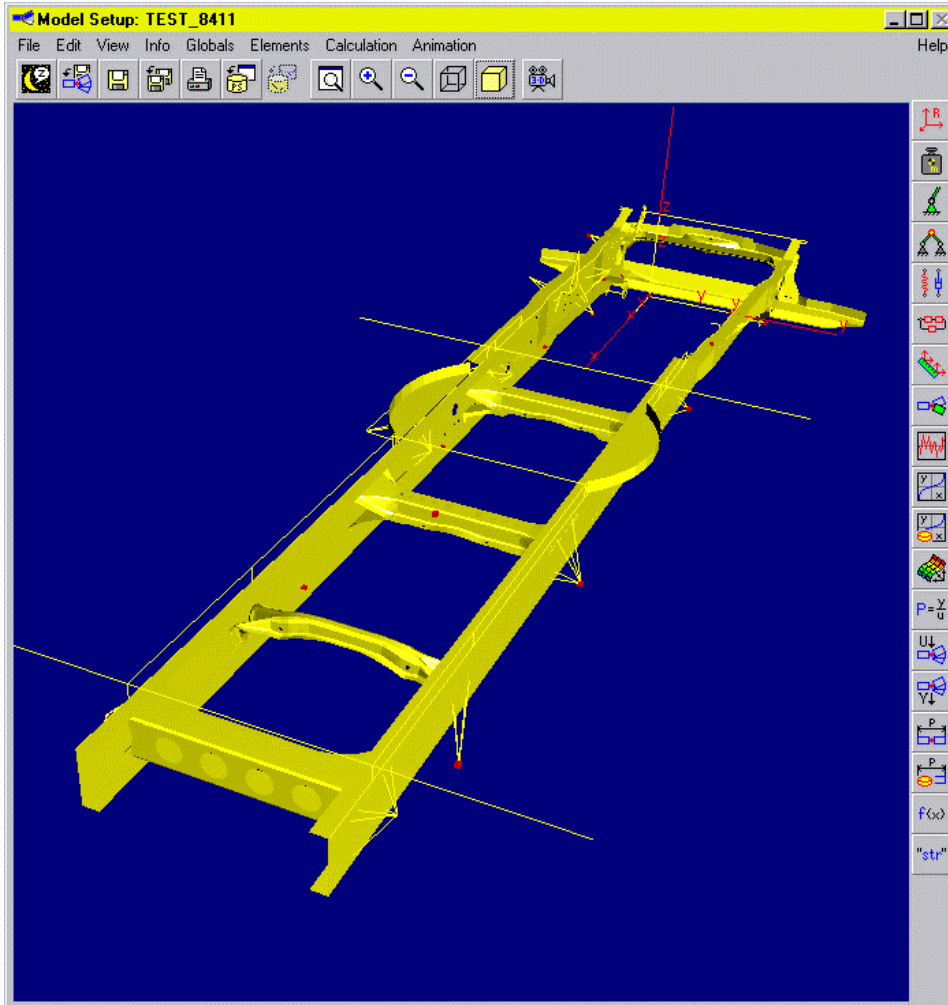
## FEA Interface - New Features in 8.5

### Generalised File Interface Between FE-Codes and SIMPACK

- The generalised **Flexible Body Input** file means
  - quick read access and fast set-up of SID files for SIMPACK
  - compact storage of FE-models
  - SIMPACK's FEA interface is no longer FE-code specific
  - SIMPACK-releases are independent from FE-code-releases
  - different releases of FE-codes may be used with one SIMPACK-release
  - less maintainace effort
  - increased capacity for achieving new methods for flexible body representation

# FEA Interface - New Features in 8.5

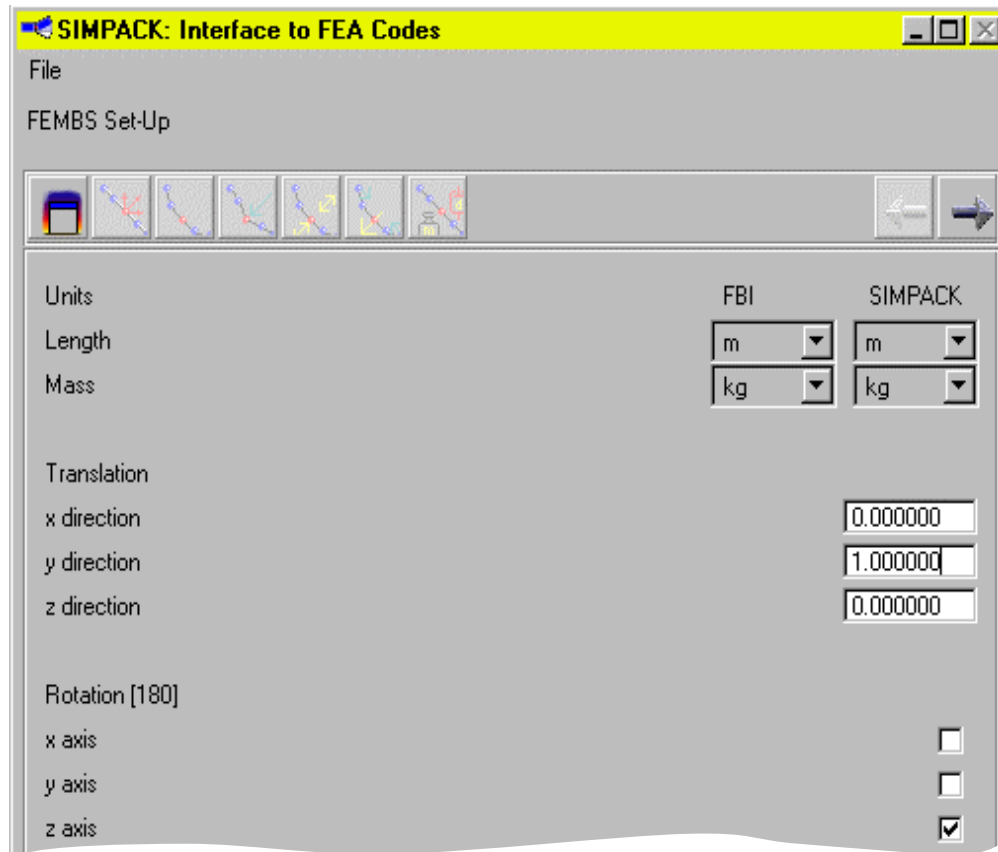
## Graphical Representation of FE-meshes in SIMPACK



- include FE-mesh in the FBI-file
- FEMBS automatically converts the FE-mesh into the wavefront format
- the wavefront representation can be used as a SIMPACK-CAD-primitive
- available for PERMAS, NASTRAN, ANSYS, IDEAS

# FEA Interface - New Features in 8.5

## Reference Frame Transformation



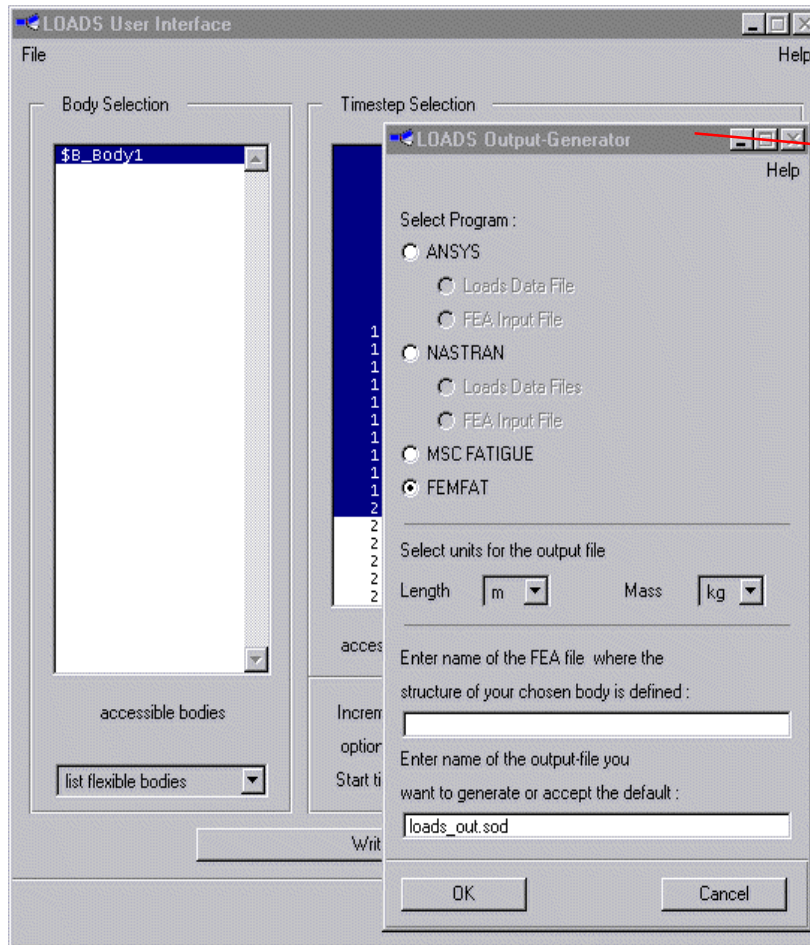
- FEMBS set-up enables the user to align the reference frame of the FE model with the reference frame of the MBS model
  - by translation
  - and rotation (180°)

## FEA Interface - Current Work

### Dynamic Reduction of FE-Models

- a FEMBS prototype enables the use of dynamically reduced FE-models
  - details will be presented in the contribution „The Application of Dynamic Reduction in Modelling an Exhaust System as a Flexible Body“
  - the presentation will include
    - procedure of dynamic reduction with NASTRAN
    - NASTRAN and SIMPACK results by comparison

# FEA Interface - Current Work Durability Interface



- MBS output:
- forces
  - moments
  - rigid body motion
  - modal co-ordinates

FE-Code (e.g. ANSYS)

linear relation between stresses and MBS output stress-load-matrix

Durability Code (e.g. FEMFAT-MAX)

## FEA Interface - Current Work Durability Interface

- the process
  - get modal MBS output by time integration
  - calculate stress load matrix by FEA
  - calculate and evaluate stresses using a durability tool
- characteristics of SIMPACK's LOADS durability interface
  - stress load matrix for dynamic load cases
  - stress load matrix includes combination of eigenmodes and frequency response modes

# FEA Interface - Current Work

## SIMBEAM - creating 3-D beam structures in SIMPACK

**SIMPACK: MBS Define Body**

File Help

Name:

DataBase...:

Type:  Rigid  Elastic

Mass[kg]:

Centre of Mass[m]:

	x	y	z
Centre of Mass	<input type="text" value="5.1242"/>	<input type="text" value="0"/>	<input type="text" value="0"/>

I-Tensor[kgm<sup>2</sup>]:

	x	y	z
x	<input type="text" value="0.0123"/>	<input type="text" value="0"/>	<input type="text" value="0"/>
y	<input type="text" value="..."/>	<input type="text" value="399.991"/>	<input type="text" value="0"/>
z	<input type="text" value="sym"/>	<input type="text" value="..."/>	<input type="text" value="399.995"/>

I-Tensor Relative to:

Markers **Flexible Components** 3D Geometry

Show Body Reference Frame Show Center of Mass

OK

- fast set-up and variation of flexible bodies

- no FE-Code required
- definition of

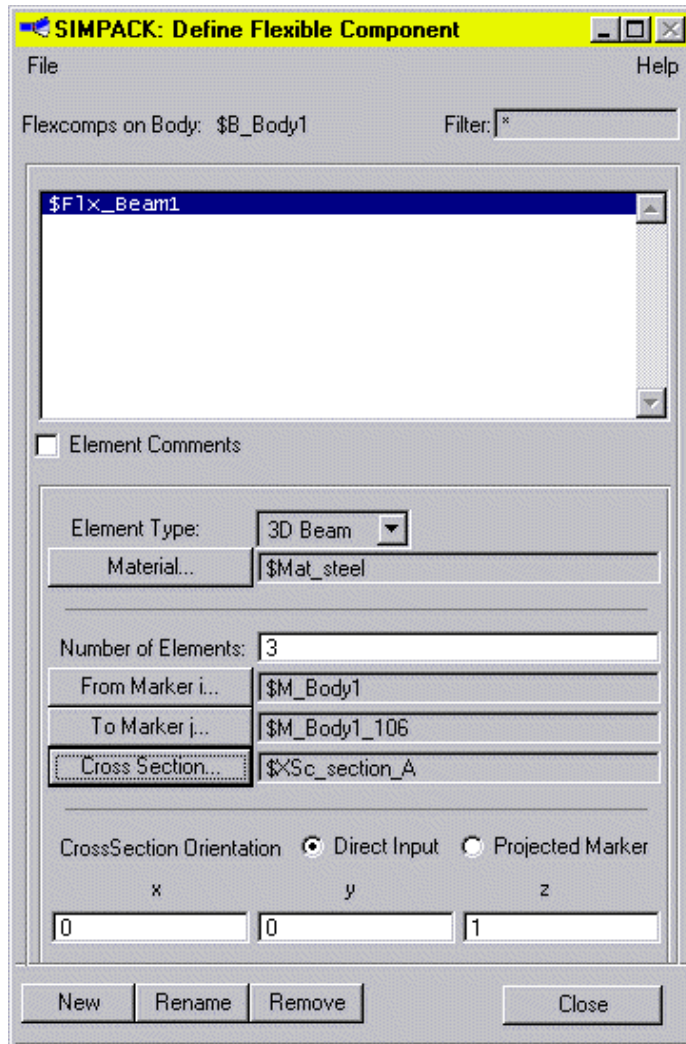
- stabilizer bars
- leaf springs

in SIMPACK's model set-up

- SIMBEAM starts in the „MBS Define Body“ window
  - define a body with markers
  - define flexible components connecting the markers

# FEA Interface - Current Work

## SIMBEAM - creating 3-D beam structures in SIMPACK



- for each straight beam (flexible component) the user can define
  - material
  - cross section
  - from marker
  - to marker
- SIMBEAM creates a finite element model of the 3-D beam structure
  - stored in a FBI file
  - as input for SIMPACK's FEA interface

# FEA Interface - Further Development

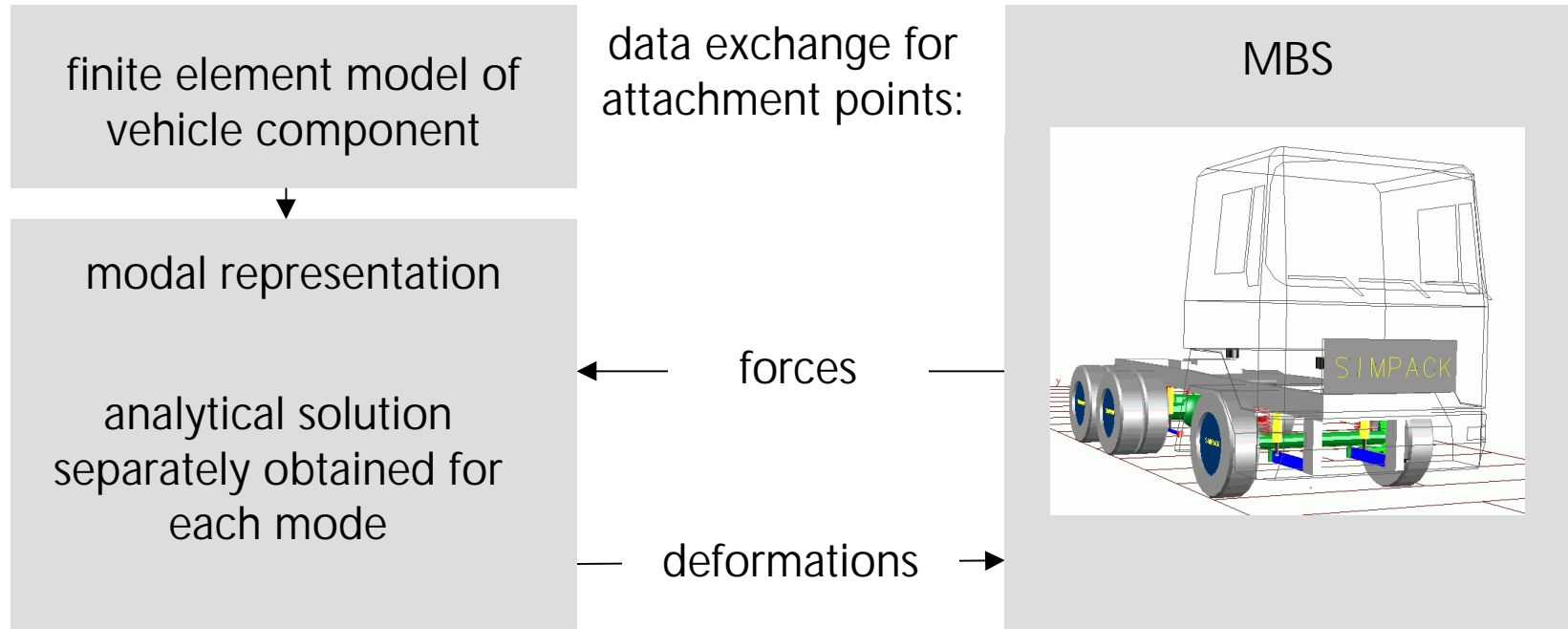
## New Methods for Flexible Body Integration

- sufficient flexible body representation sometimes requires
  - a large number of modes (e.g. NVH applications)
  - high frequency modes (e.g. constrained flexible bodies)
- how to achieve an enhanced method for flexible body integration
  - which enables the use of a large number of high frequency modes ?
  - which guarantees small computation times ?

# FEA Interface - Further Development

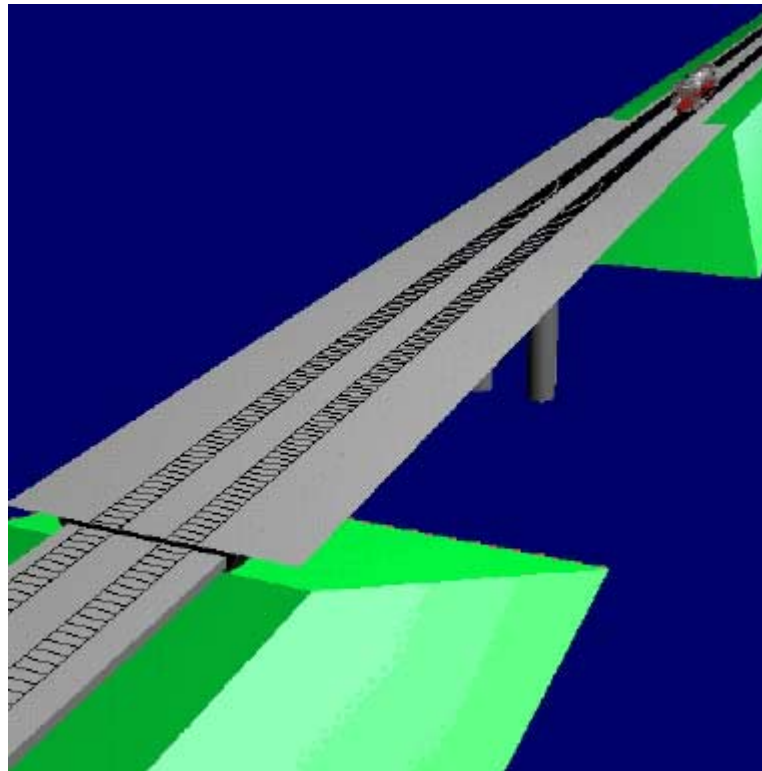
## New Methods for Flexible Body Integration

- The concept - modular time integration



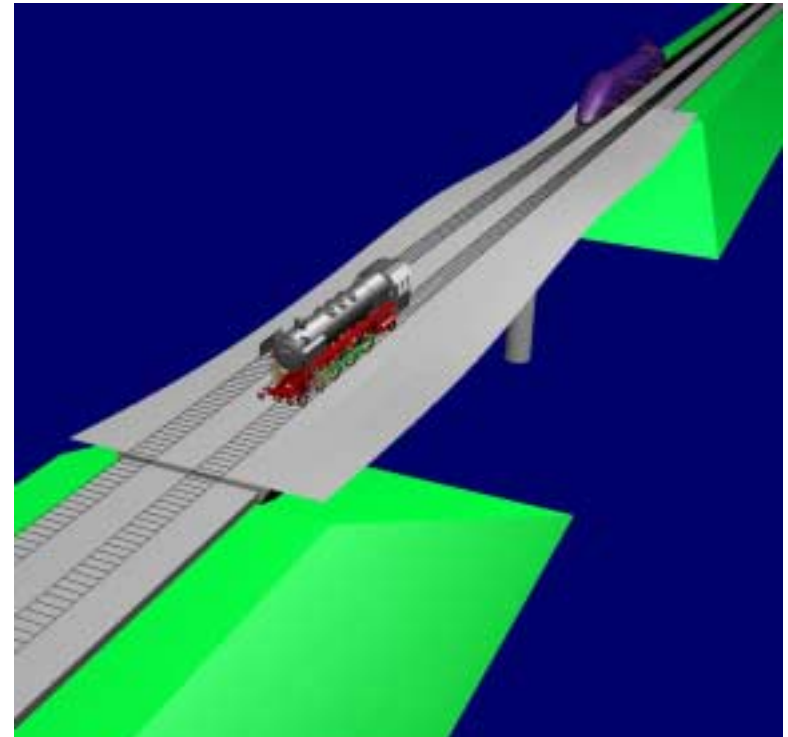
# FEA Interface - Further Development New Methods for Flexible Body Integration

- prototype for flexible tracks



## FEA Interface - Further Development New Methods for Flexible Body Integration

- vehicle models
  - 306 degrees of freedom
  - 58 bodies
  - 20 moving contact points
  - 295 sec CPU time PIII 500
- bridge
  - 90 modes
  - 580 sec
- application to vehicle components



## FEA Interface - Summary

- SIMPACK 8.5 includes a redesigned FEA interface „FEMBS“
  - more usability (integration, FBI, FE-mesh visualisation, ref. frame transformation)
  - less maintainace (integration, FBI)
  - more capacity for further enhancements
- Current Work
  - SIMBEAM enables the set-up of 3D beam structures in SIMPACK's GUI
  - durability interface
  - dynamic reduction of FE-models for applications in the higher frequency range
- Further development
  - powerful methods for flexible body integration for sophisticated MBS simulations (NVH, constrained flexible bodies, ...)
  - enhanced FE-mesh animation