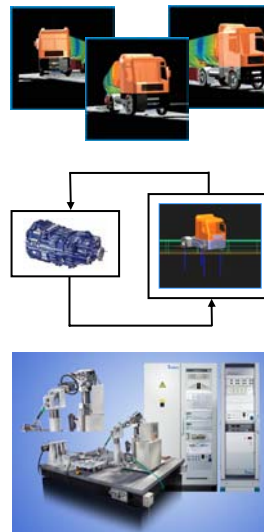


## Introduction

## Business Activities Test and Analysis Centre

- Fatigue and Static/Dynamic Testing of Aerospace Structures
- Experimental Investigations in Vehicle Technology and Plant Engineering
- Test Facilities
- Maintenance and Damage Analysis
- CAE Services
- **Mechatronics Services**
- Maglev Transportation
- Environmental Services



## Contents

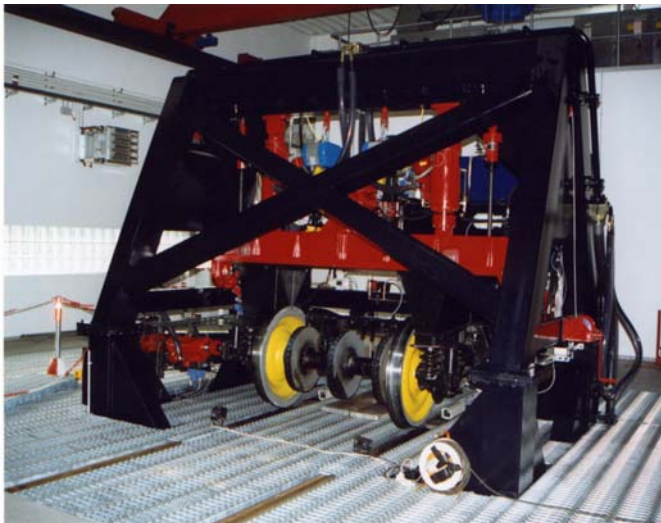
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- Project Introduction
- Application Areas
- Service Description
- SIMPACK with the Wheel/Rail System Test Rig (RASP)
- Summary

## Project Introduction

## Wheel/Rail System Test Rig

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Deutsche Bahn AG  
Forschungs- und  
Technologie-Zentrum  
Am Südtor  
14774 Brandenburg

## Application Areas

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General:

„Investigation of Interactions Concerning the Wheel Rail System“

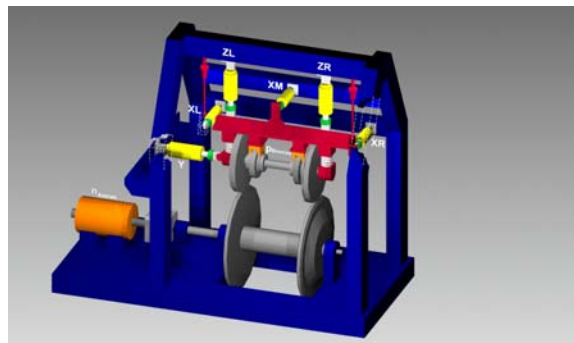
Examples:

- Investigation for the Causes and Mechanisms of Rolling Contact Fatigue
- Testing of Materials, Production Processes and Profile Combinations
- Analysis Concerning the Unround Phenomena of Wheels
- Testing of Components (e.g. Check Systems for Diagnosing Wheelsets)
- Investigation of the Noise Created and Propagated because of the Rolling Contact

## Service Description

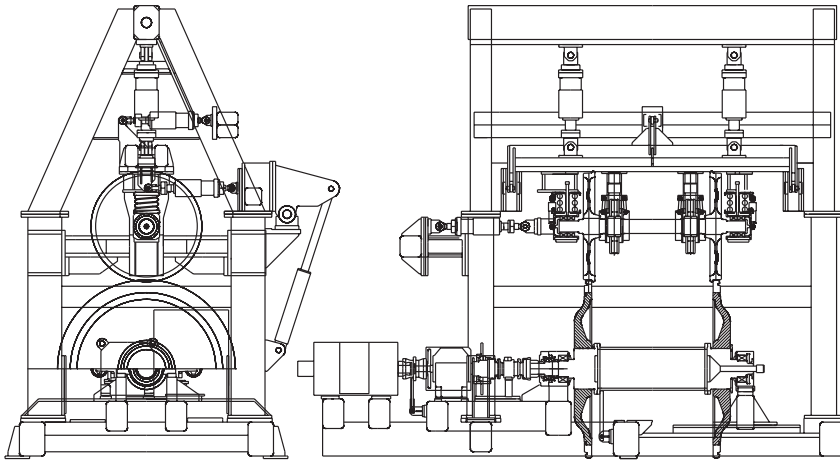
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„The RASP allows full-size wheelsets to be subjected to stressing on a pair of rollers under reproducible dynamic contact conditions“



## Service Description

## Structure / Functionality

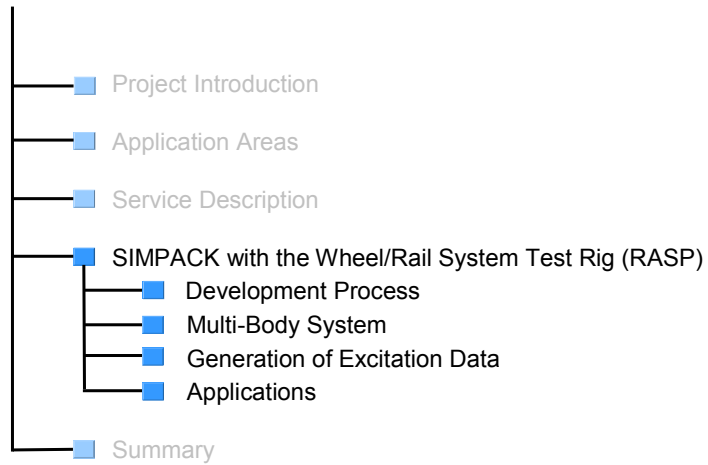


## Service Description

## Performance Data

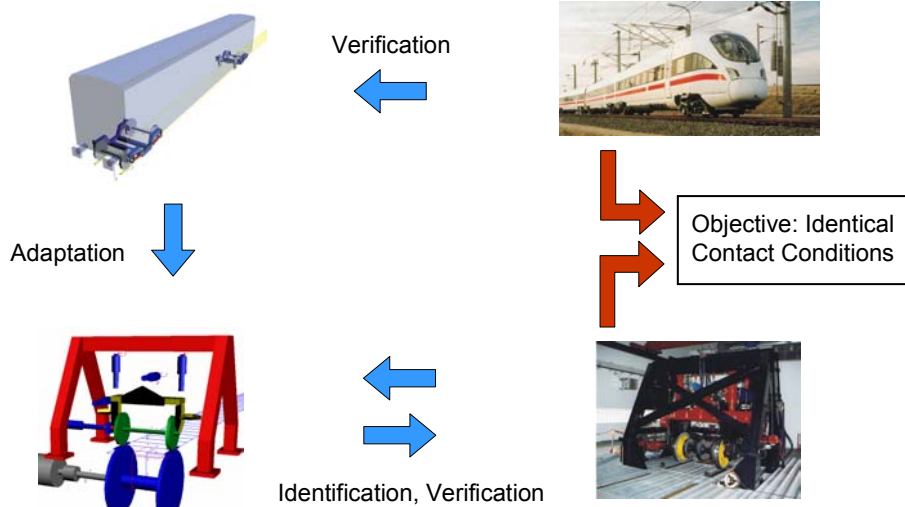
- |                                                                      |               |
|----------------------------------------------------------------------|---------------|
| • Rail Roller Diameter                                               | 2,1 m         |
| • Wheel Diameter                                                     | max. Ø 1,25 m |
| • Wheelset Load                                                      | max. 34 t     |
| • Running Speed                                                      | max. 330 km/h |
| • Re-profiling Unit for Roller and Wheel                             |               |
| • Roller Consists of Rail Material (900A)                            |               |
| • Controlled Braking of the Wheelsets                                |               |
| • Lubrication Unit                                                   |               |
| • Strain Gauge Measuring Method for Axle and Disc (Wheel and Roller) |               |

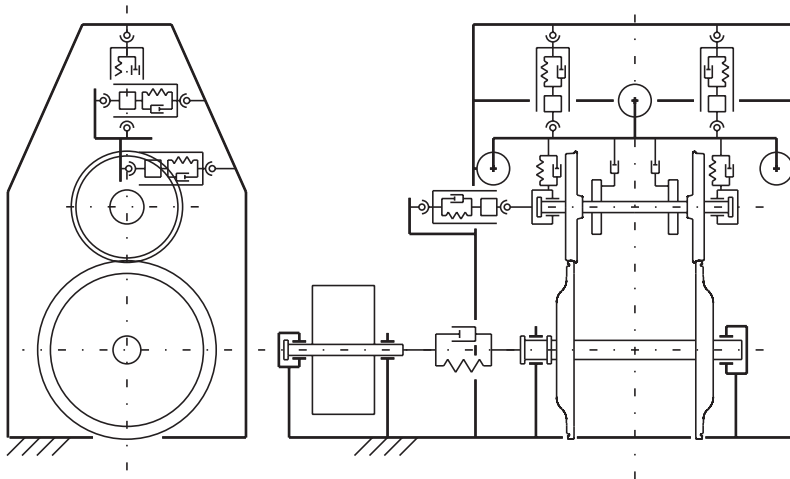
## Overview



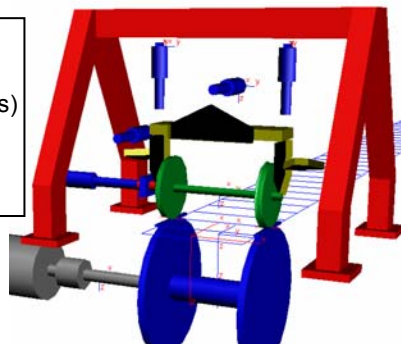
## Using SIMPACK

## Development Process



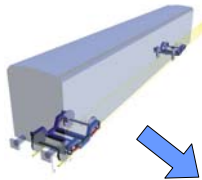


- 11 Rigid Bodies
- 7/9 Degrees of Freedom
- 6 Kinematic Loops (18 Constraints)
- Parametric Model
- Identified Parameters
- Non-linear Characteristic Lines



## Using SIMPACK

## Generation of Excitation Data



Target Values:  
• Contact Patch Area  
• Slip  
• Forces / Torques  
• Normal Stress  
• ...

„INDIRECT“

- Selected Positions
- Load Collectives

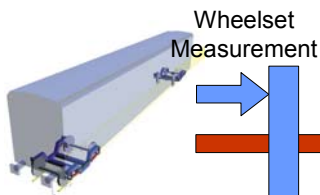


„DIRECT“

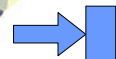
- Selected Wheelset

## Using SIMPACK

## Generation of Excitation Data



Wheelset  
Measurement

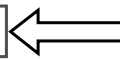


Adjustment

Transformation

Comparison

Expertise



Excitation  
Data



Output Values (Vehicle Model)

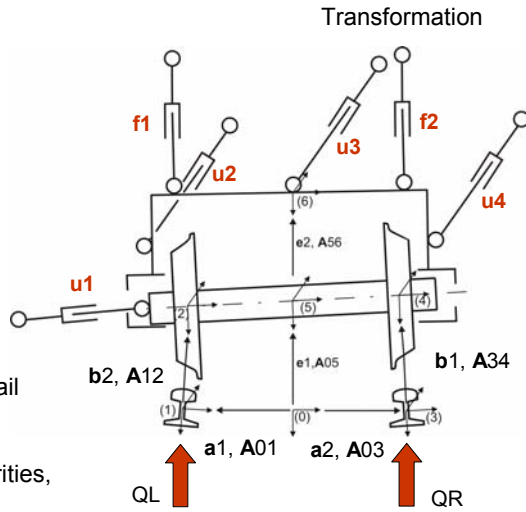
- Relative Measurement (Position, Orientation)
- Vertical Force in Track (Q)

Input Values (Test Rig Model)

- Cylinder Displacement
- Cylinder Force

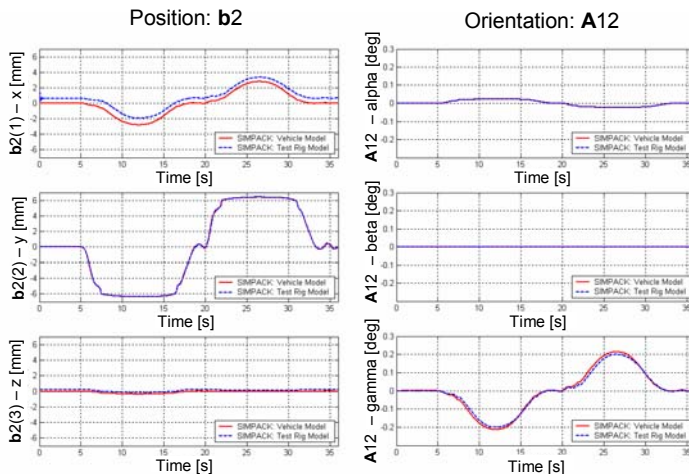
Boundary Conditions

- Wheelset Positioning
- Difference Between Roller & Rail
- Elastic Wheelset Suspension
- Rigid Roller Axle (Curved Tracks, Track Irregularities, Superelevation)

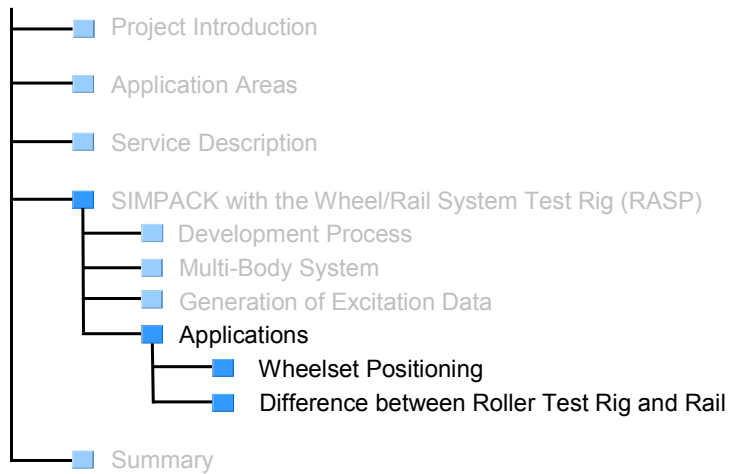


Comparison of In- and Output Values: Relative Measurement

Transformation







Intention: Centering – Exact Position of the Wheelset

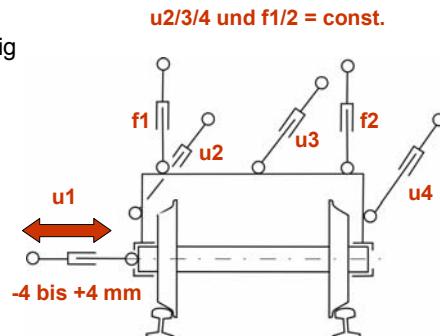
- Wheelset Displacement
- Geometrical Displacement of the Test Rig
- Tolerances (Wheelset and Roller)

Procedure:

- Model Based Analysis/Identification of the Wheelset Displacement
- Test: Constrained Lateral Deflection of the Wheelset

Result:

- Procedure to position the Wheelset
- Quantification of the Effect of Tolerances

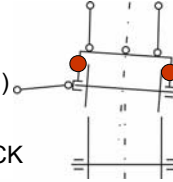


## Using SIMPACK

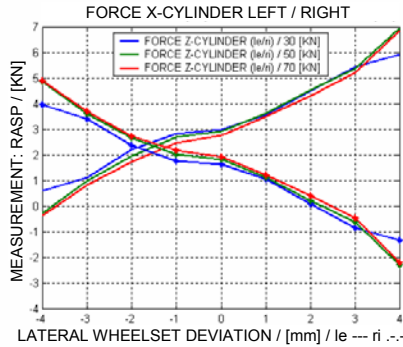
## Wheelset Positioning

Wheelset Displacement : Lateral Offset (1.5 mm)

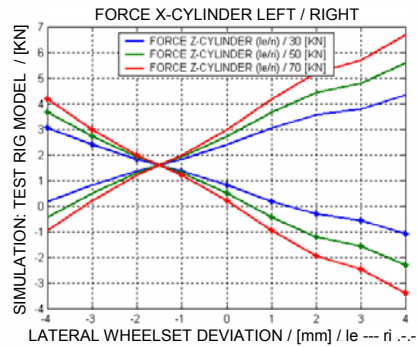
Constrained Forces of the Yaw Cylinders (X-Cylinders;  $u_2$  and  $u_4$ )



Test: RASP



Simulation: SIMPACK

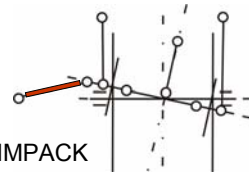


## Using SIMPACK

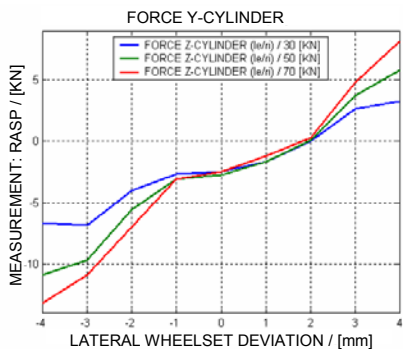
## Wheelset Positioning

Wheelset Displacement: Tangential Deviation (0.06 deg)

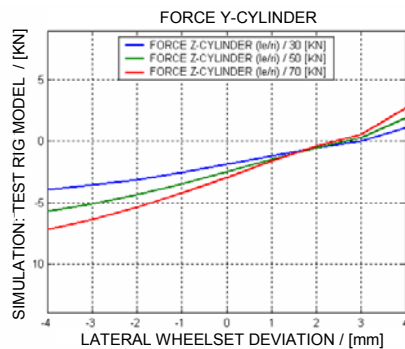
Constrained Force of the Lateral Cylinder (Y-Cylinder;  $u_1$ )



Test: RASP

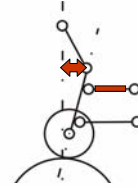


Simulation: SIMPACK

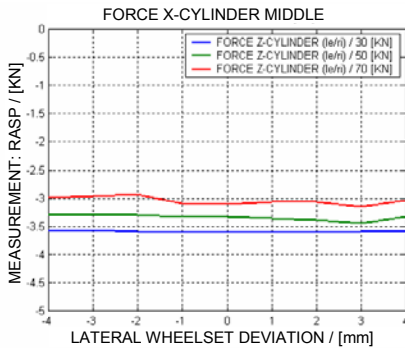


Geometrical Displacement of the Test Rig: Mismatch (6.5 mm)

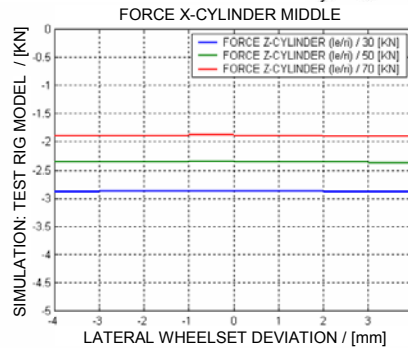
Constrained Force of the Pitch Cylinder (X-Cylinder;  $u_3$ )



Test: RASP



Simulation: SIMPACK

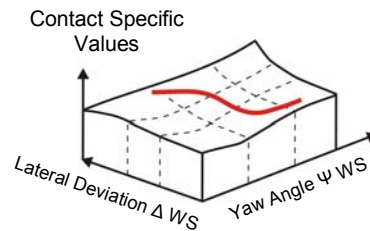


Intention: Adjustment – Difference Between Roller Test Rig and Rail

- Test Rig Dependency
- Vehicle Model / Dynamic Maneuver

Procedure:

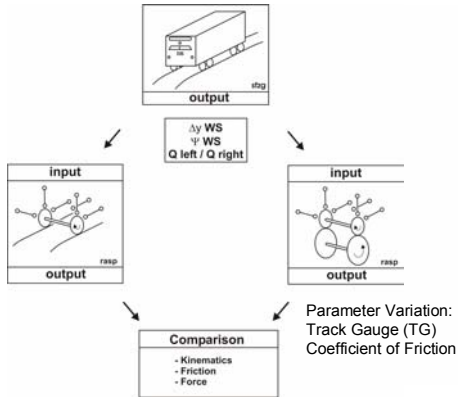
- Analysis of the Differences Using MBS-Simulation



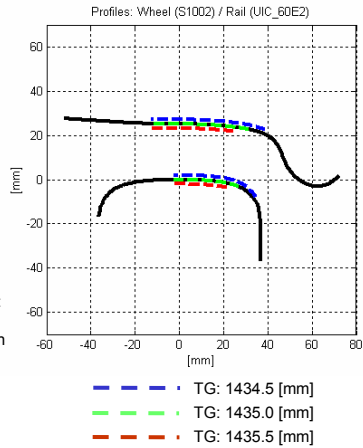
Result:

- Quantification of the systematic Differences
- (Effect of variations in Friction and Track Gauge)

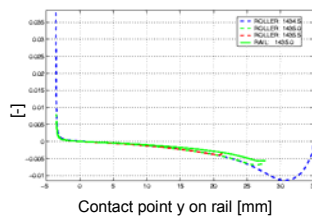
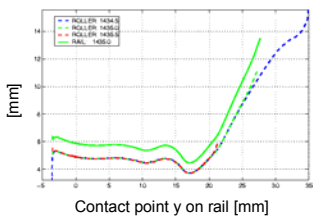
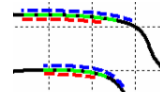
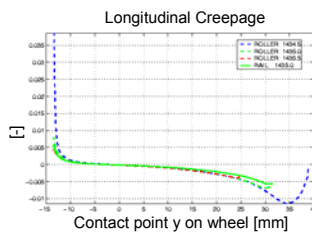
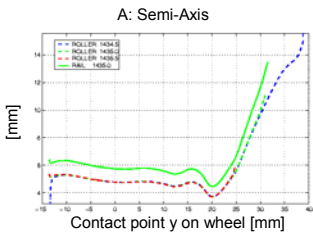
Procedure:



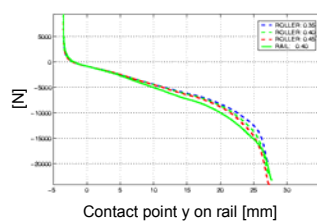
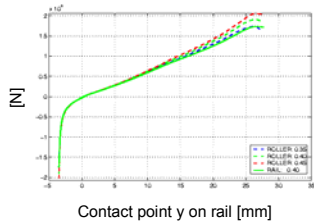
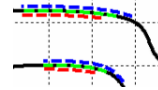
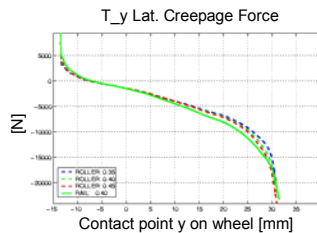
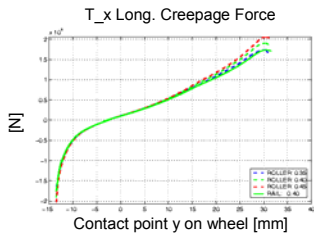
Used Contact Patch Area



Track Gauge Variation: ± 0.5 mm



S-Curve 630 m  
Superelevation 0.138 m  
Wheelset Load 13.2 t  
Velocity 100 km/h

Coefficient of Friction Variation:  $\pm 12.5\%$ 

S-Curve 630 m  
 Superelevation 0.138 m  
 Wheelset Load 13.2 t  
 Velocity 100 km/h

“SIMPACK is an important tool within the development environment of the wheel/rail system test rig (RASP)”

#### Suggestions:

- Documentation of the Output Format – Direct Access (Time Integration-, Linear System- Analysis and Parametervariation)
- Further Development for Using the Batch – Mode on Operating System Platforms
- Info about the Complete Solver Input – Possibility to Check the Actual Used Parameters (Main Model, Database, ...)
- Possibility to Define Time Excitations within a Sub-Structure Model
- Possibility to Select Characteristic Lines within a Parameter Input File