

DAIMLER

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Efficient analysis of drivetrain induced vibrations in commercial vehicles using an in-house tool based on Simpack Qt-Script
09.11.2017

Daimler Trucks



Challenge for Commercial vehicles: CO₂ reduction

Many drivetrain based fuel-efficiency measures, such as down speeding or increased cylinder pressure like in 2. generation Daimler OM471 lead to higher driveline excitation of the vehicle.



ALT GEGEN NEU: Je nach Fahrmodus beträgt der Verbrauchsvorteil für den aktuellen 1845 auf der hügeligen Messstrecke sechs bis zehn Prozent.

Source: Fernfahrer 7|2017

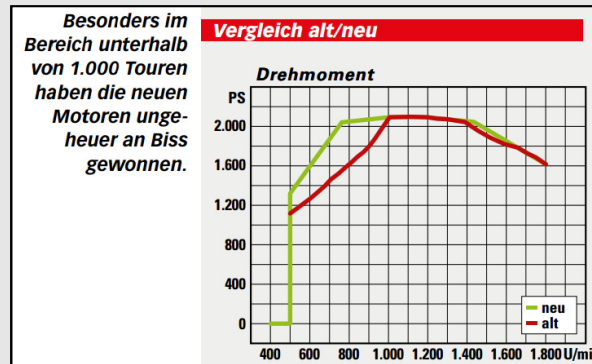


Source:
eurotransport.de
18.09.2015

2. GENERATION DES OM 471 VON MERCEDES

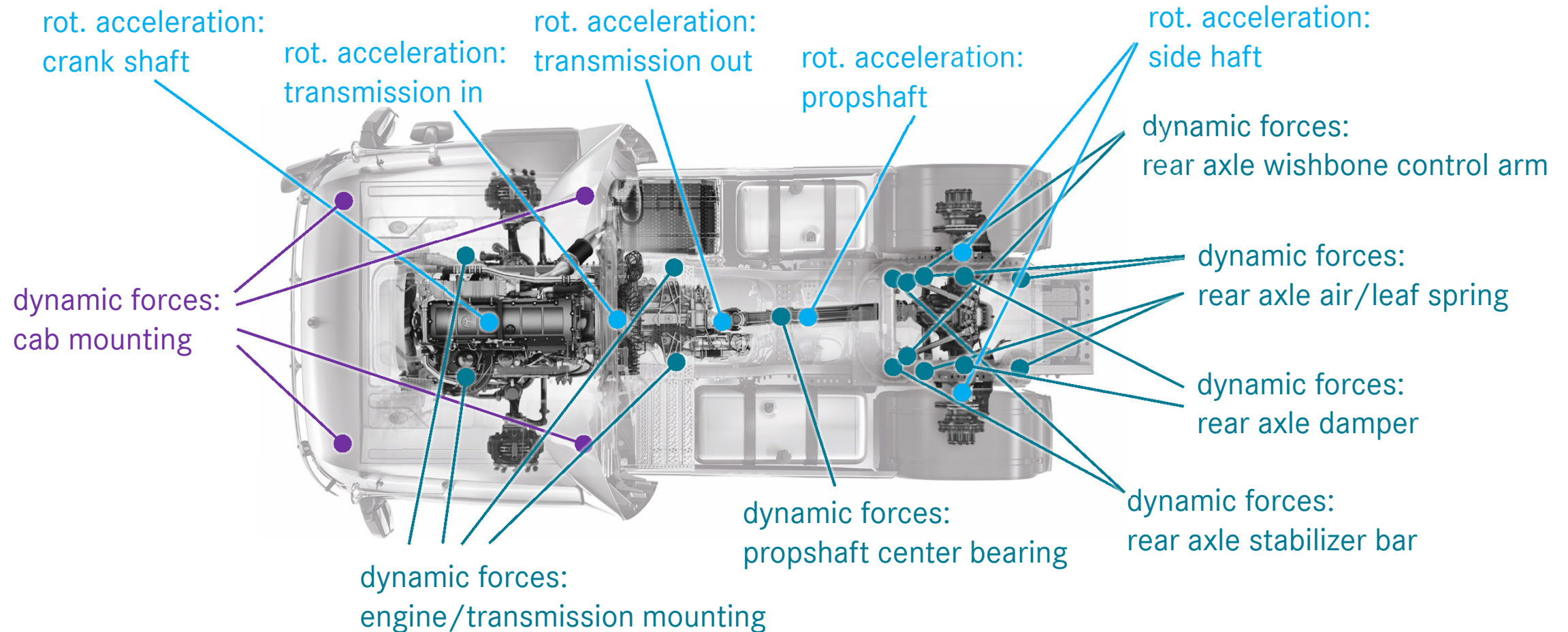
Kulturrevolution

Radikale Kräfte im Drehzahlkeller, Sensoren ihres Amts enthoben und insgesamt ein Linksruck bei den Motorkurven – der OM 471 musste eine kleine Kulturrevolution über sich ergehen lassen.



Source: Fernfahrer 9|2015

Driveline excitation interfaces to vehicle and driver



⇒ **Many interface points to analyze**

Relevant excitation orders of vehicles with 6-cylinder engine

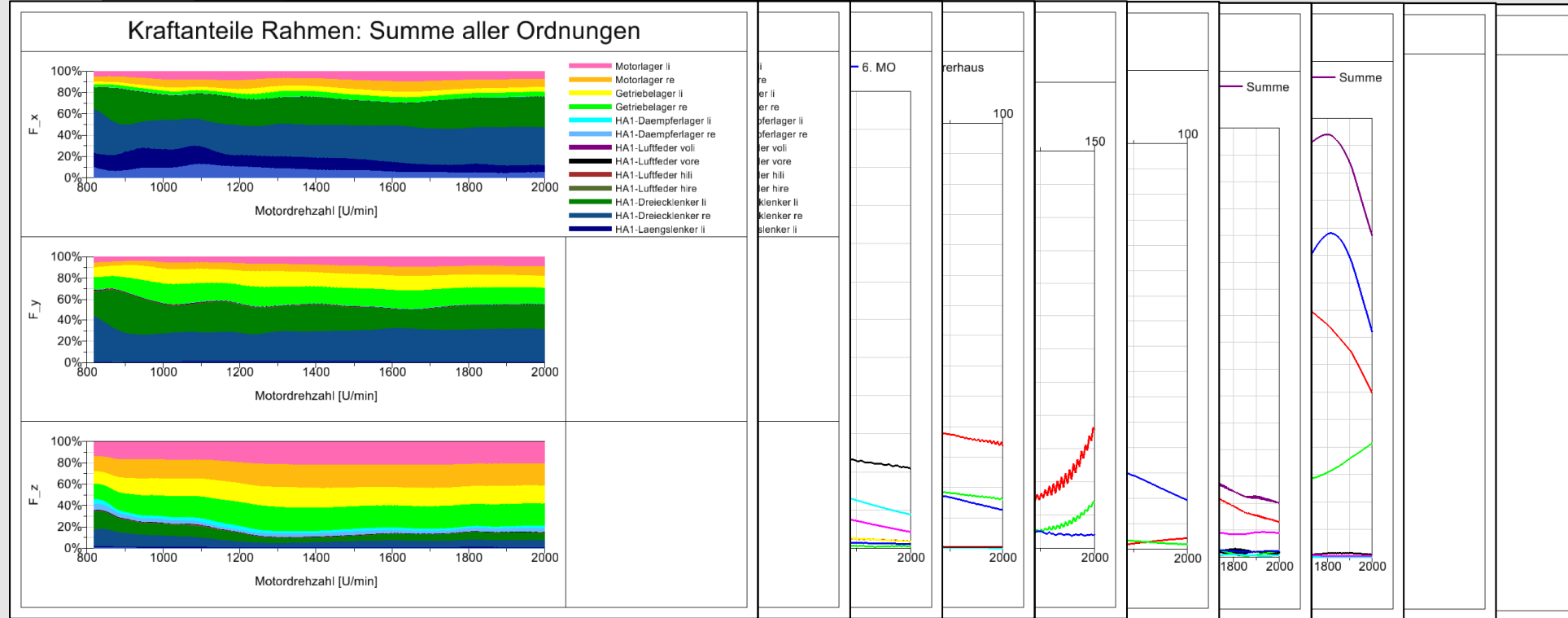
The basic load case for drivetrain induced vibrations is a full load engine run up where the driveline excitations interfaces are analyzed with order analysis filters:

- 0.5th engine order: fuel injection single cylinder differences (e.g. injector or air in/out-take) differences
- 1st engine order: unbalance of crankshaft, flywheel etc., fuel injection asymmetry between cylinder pairs
- 1.5th engine order: fuel injection bank differences
- 3rd engine order: combustion gas forces / 1st order inertial force
- 4.5th engine order: crankshaft / crankcase elasticity
- 6th engine order: 2nd order inertial force
- 1st driveline order: unbalance of propshaft
- 2nd driveline order: excitation through universal joints

⇒ Many orders to analyze

Result visualization

To get a good impression of the drivetrain excitation several result plots are needed:

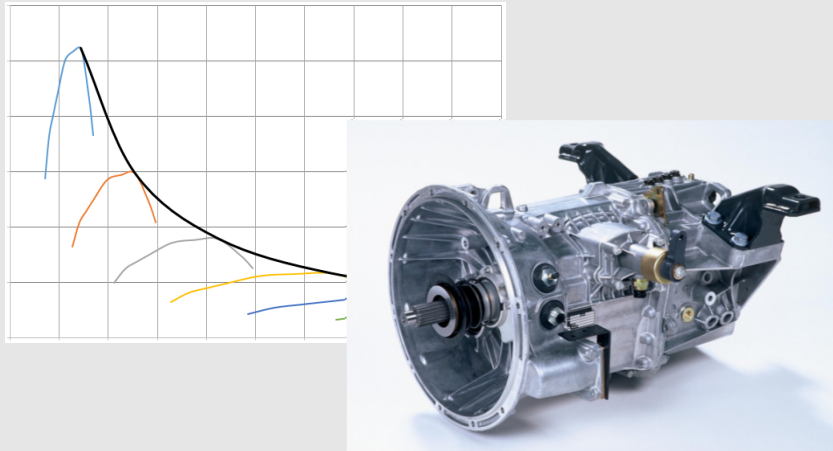


100% plot force distribution, sum of orders

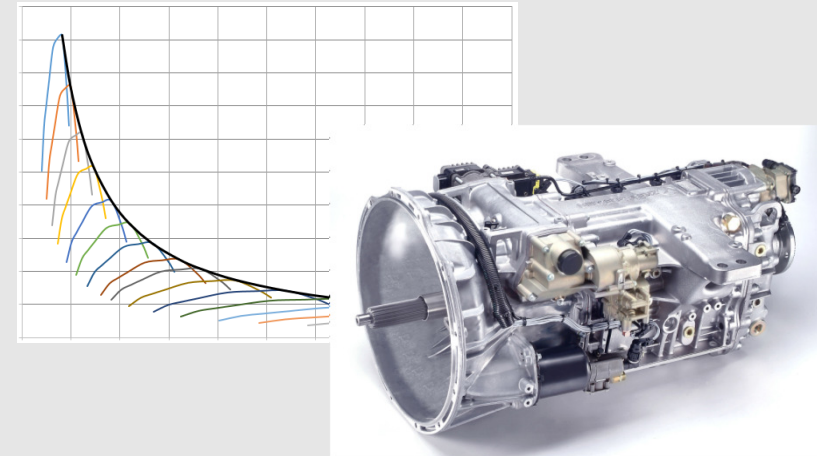
⇒ many different visualization types to create

Available gears in commercial vehicles

Usually the engine run up is analyzed for all available gears



Medium duty transmission with 6 gears

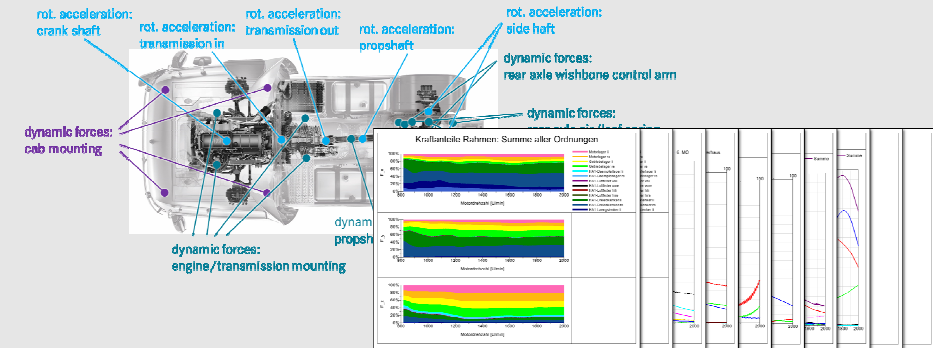


Heavy duty transmission with 16 gears

⇒ up to 16 gears to analyze

Analysis of a 4x2 tractor

- 18 dynamic force channels, 3 directions each
- 6 rotational acceleration channels
- various translational acceleration channels
- 8-10 different plot layouts
- 1 - 8 different orders



⇒ already over 400 plots for a 4x2 tractor...

Imagine a 8x8 tipper with 4 driven axles, 5 propshafts and a transfer case...

How to create several hundred plots?

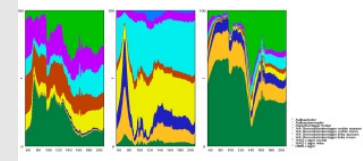
Manually?

Of course not!

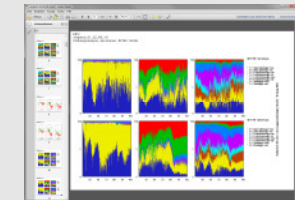
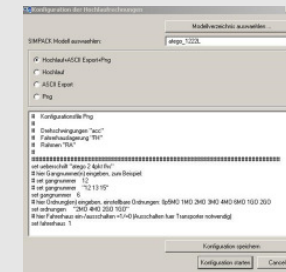
An automated process had to be created...

AnSim-PD Analysis and Simulation of Powertrain Dynamics

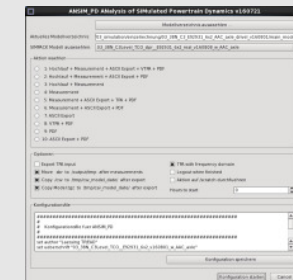
2004: First automation of interface force export and creation of plots with tcl-scripts and the graphing utility gnuplot



2007: First introduction of qt-script gui.
Export of results with user-filter within pre-defined spf-Files
Script to create pdf-documents using tcl pdf-library



2016: Final version of AnSim-PD including several tool optimizations, new features and adjustments to latest tcl and gnuplot versions



⇒ **AnSim-PD uses 4 different script languages, sub-tools and libraries**

⇒ **Usability within Daimler CAE-Network difficult**

AnSim-PD 2.0

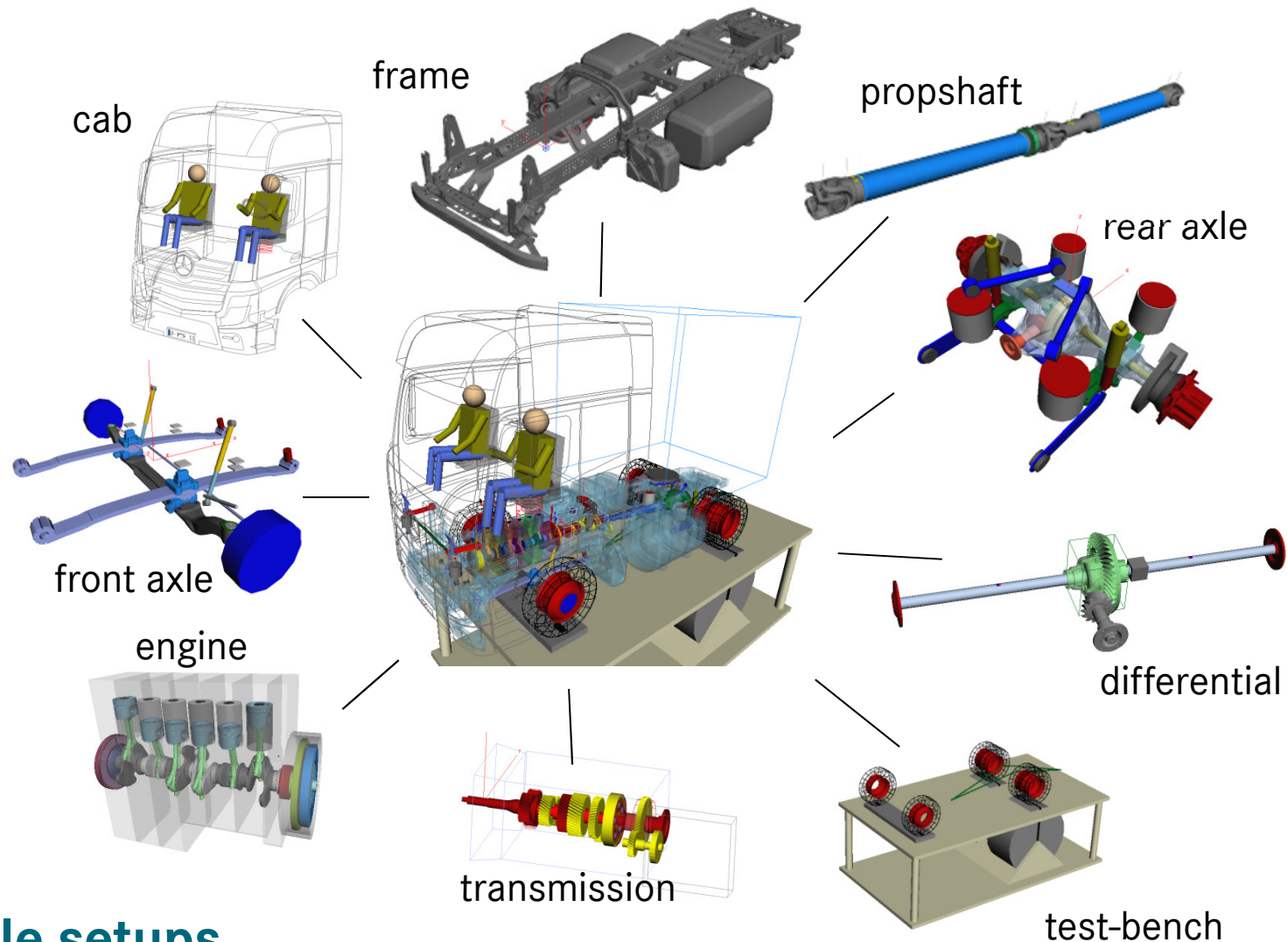
2017: The in-house tool AnSim-PD was redeveloped and completely transferred to Simpack_2018 in cooperation with the Simpack Center of Excellence

- Complete process from time integration to pdf creation within Simpack scripting
- platform independent
- no extra software needed
- easy to use within the Daimler CAE network

⇒ **together with Simpack communicator technology an efficient analysis of drivetrain induced vibrations is now available**

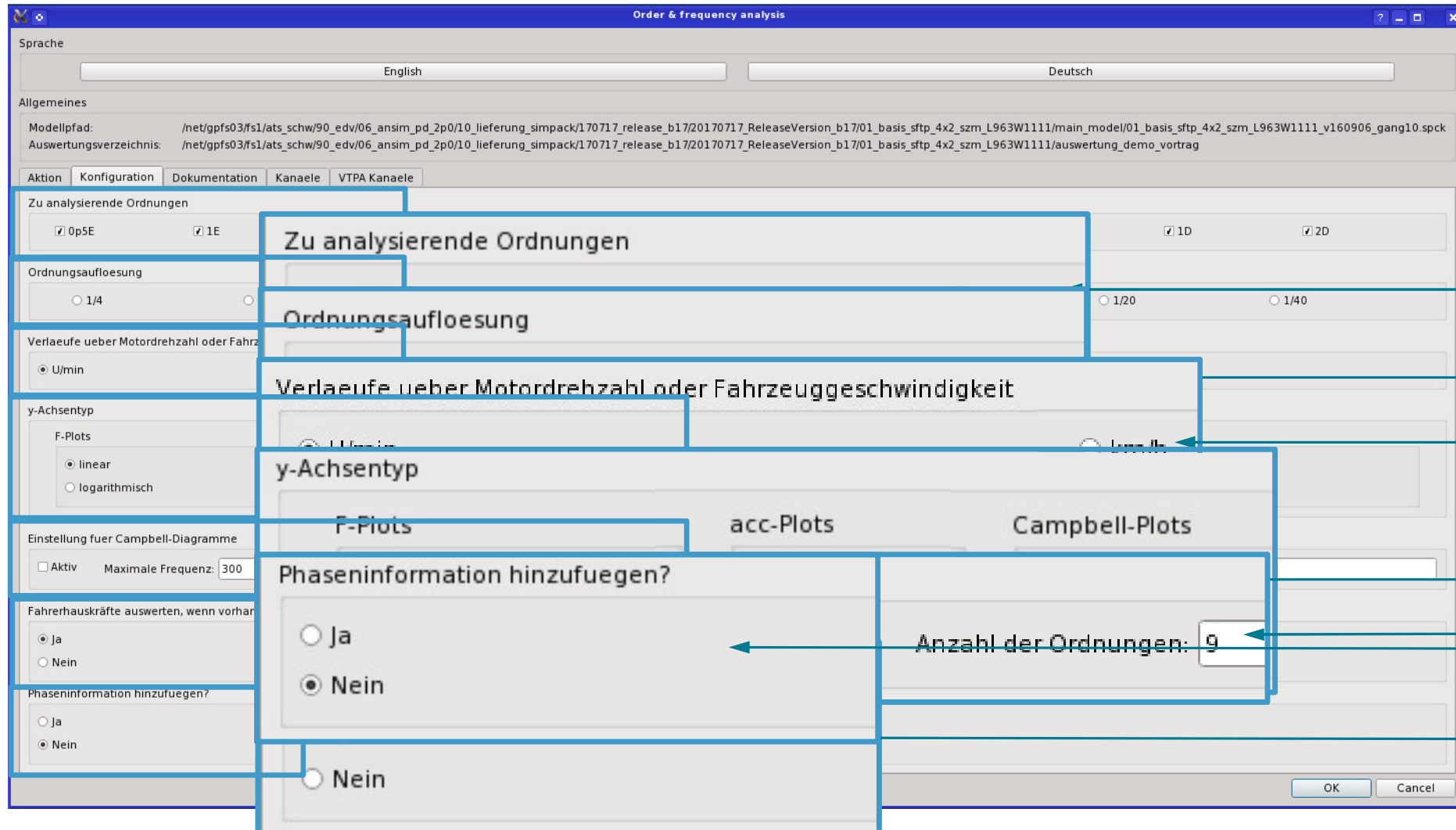
Automated modelsetup

- Interdisciplinary substructure modelling
- Internal modeling guideline defining mandatory communicators
- Standard load case full load engine run up on test-bench
- Interface forces exported via result elements



⇒ **Fast creation of different vehicle setups**

Ansim-pd 2.0 gui: configuration



define order analysis

define order resolution

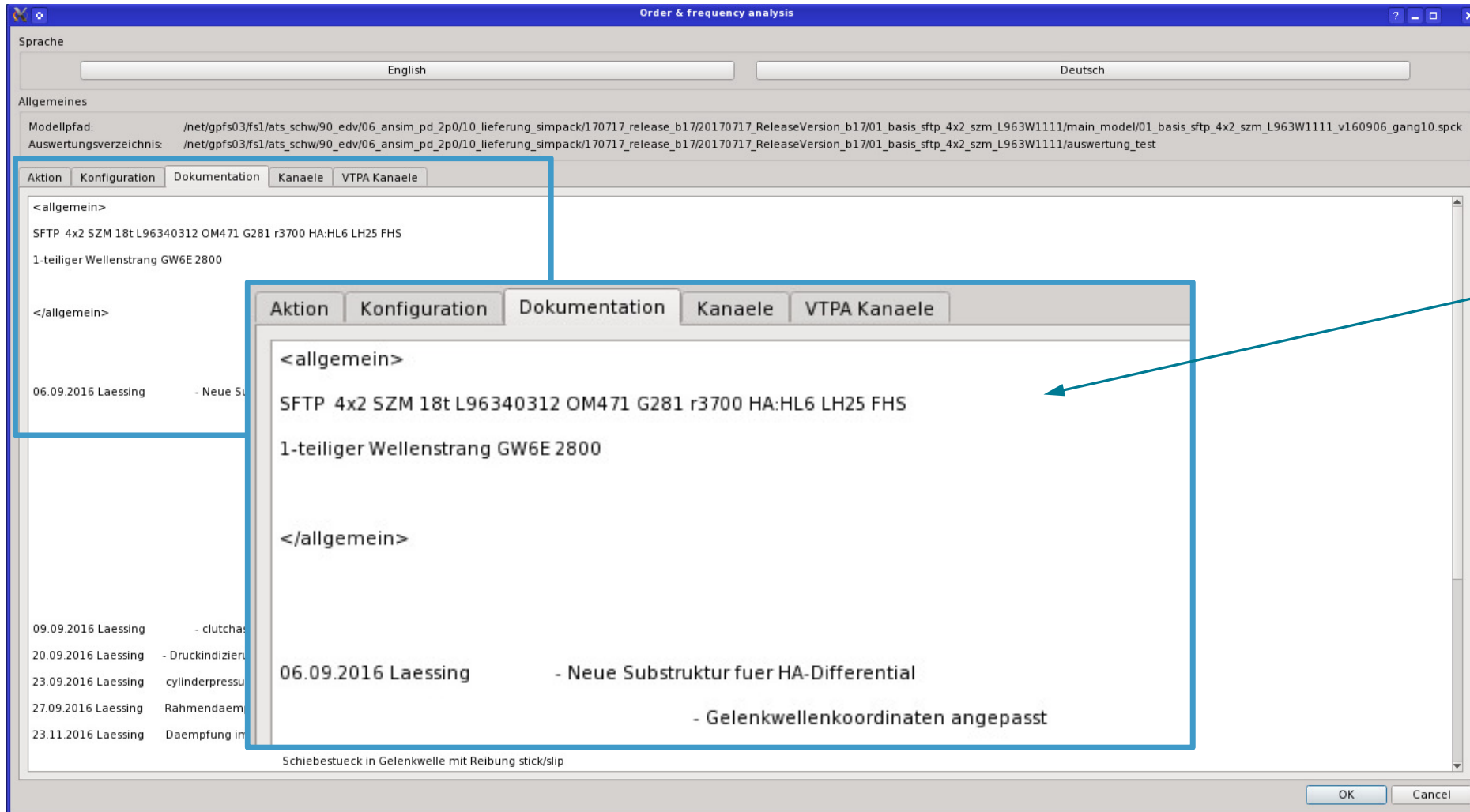
define x-axis

define y-axis scaling

switch on phase-
diagramms
information

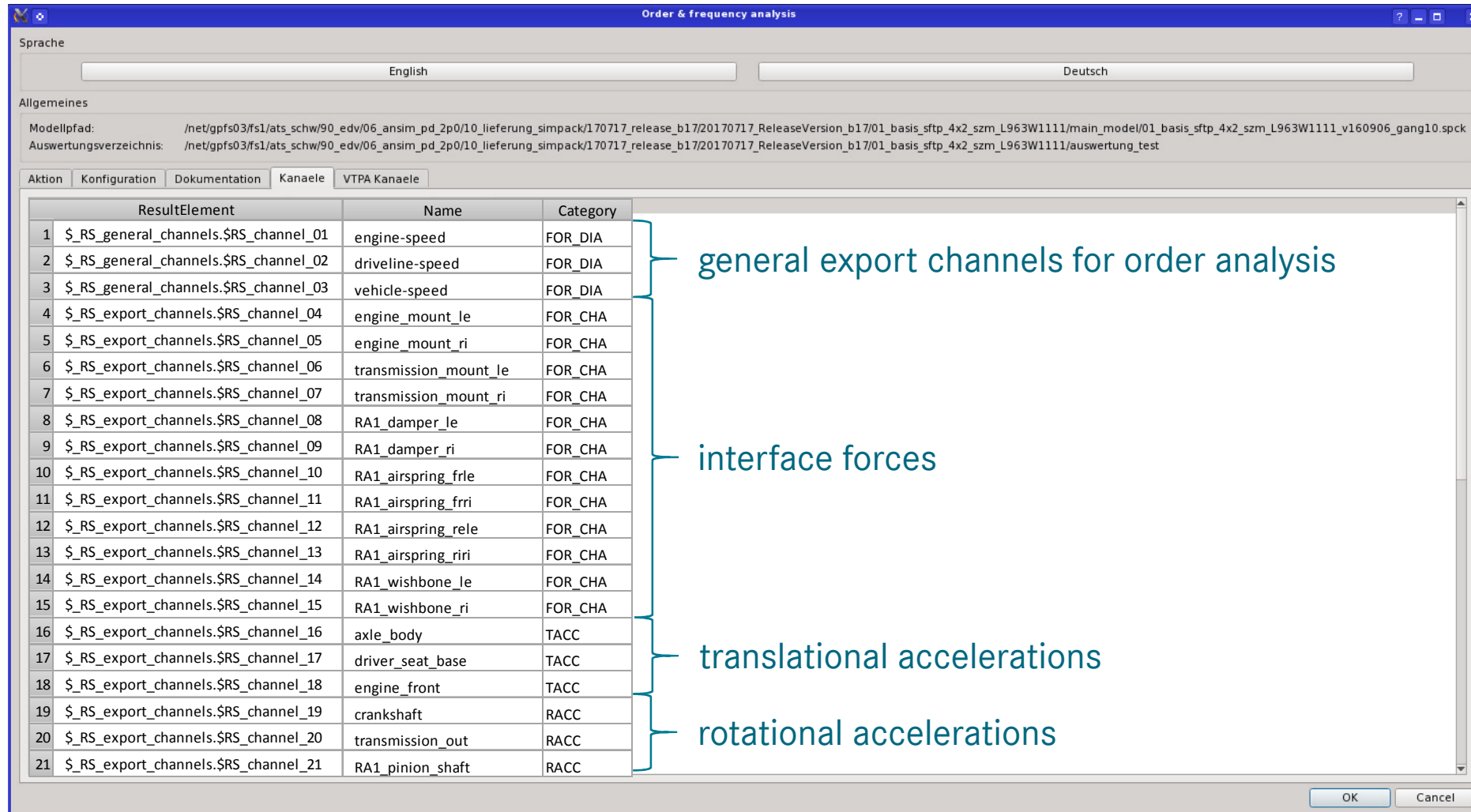
switch on cab analysis
truck/van

Ansim-pd 2.0 gui: documentation

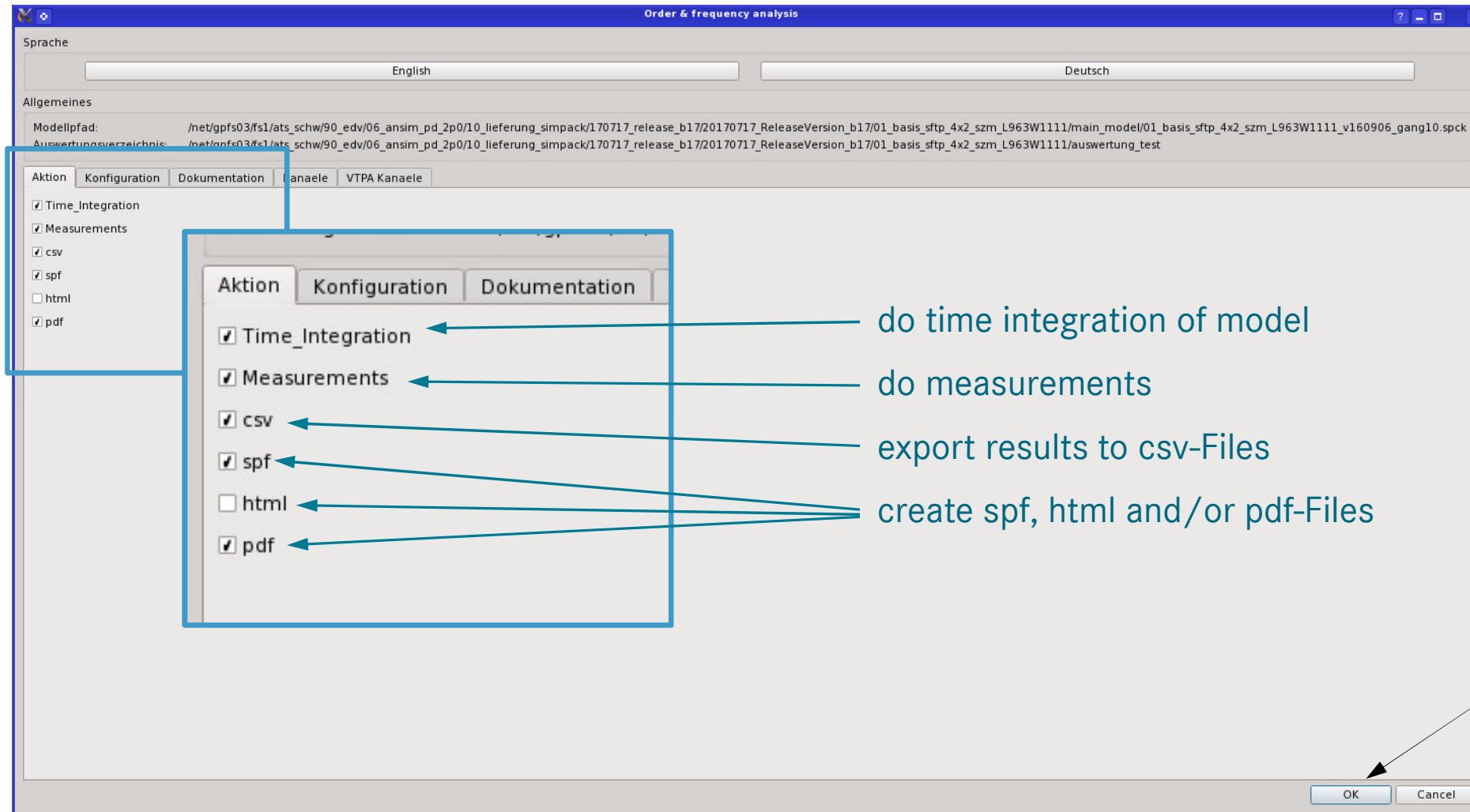


text file for
documentation e.g.
model history

Ansim-pd 2.0 gui: exported channels



Ansim-pd 2.0 gui: task setup → start process

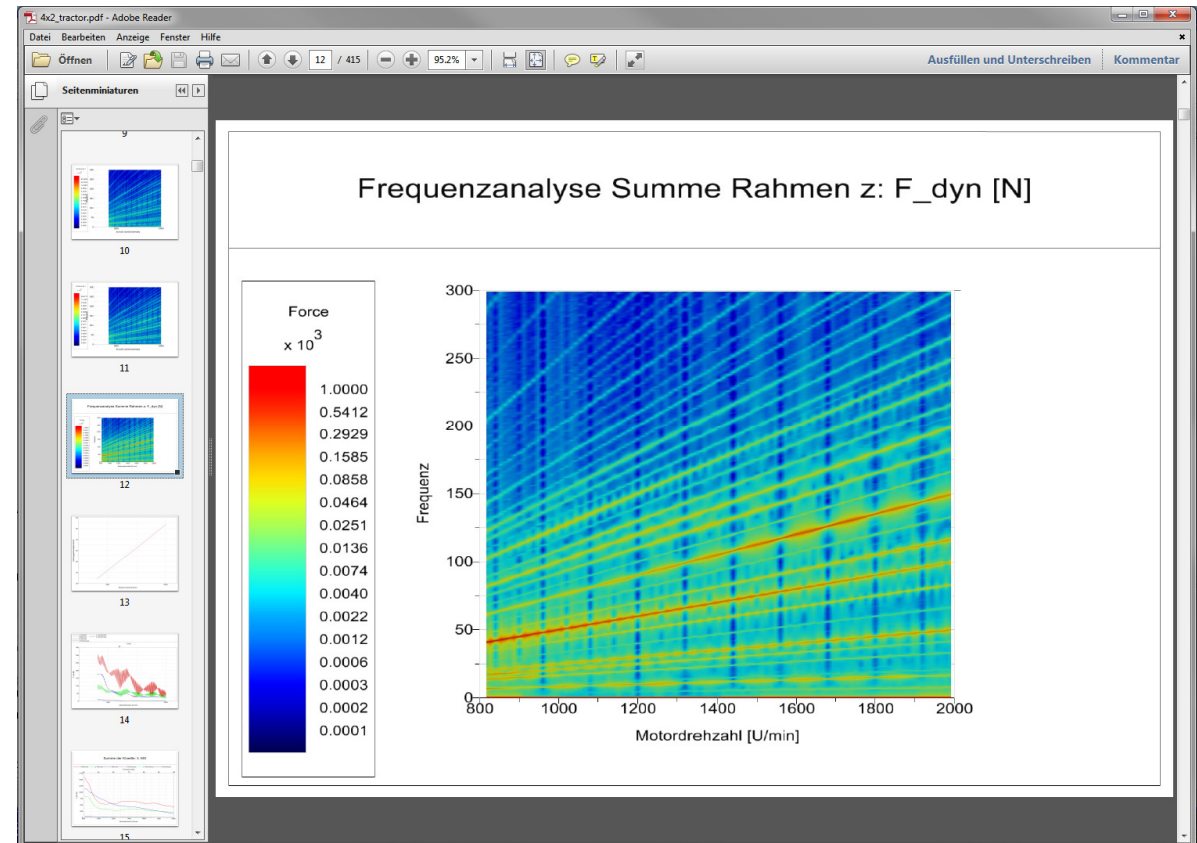


start ansim_pd
process:

1. run time integration
2. run measurements
3. create all analysis plots
4. export plots to pdf-document

Final PDF document

- pdf document for a 4x2 tractor
- 415 pages including:
 - model documentation
 - Campbell diagrams
 - order analysis plots of all defined orders for interface forces, translational and rotational accelerations
 - 100% plots



⇒ **complete engine run up analysis for specific vehicle in one document with a view mouse clicks**

Thank you for your attention !

