Hochschule Kempten
University of Applied Sciences

drive livinglab

ADAS Master WS 21/22
Lecture 8

Vehicle Dynamics in context of Advanced Driver Assistance Systems and Automated Driving.

Lecture program

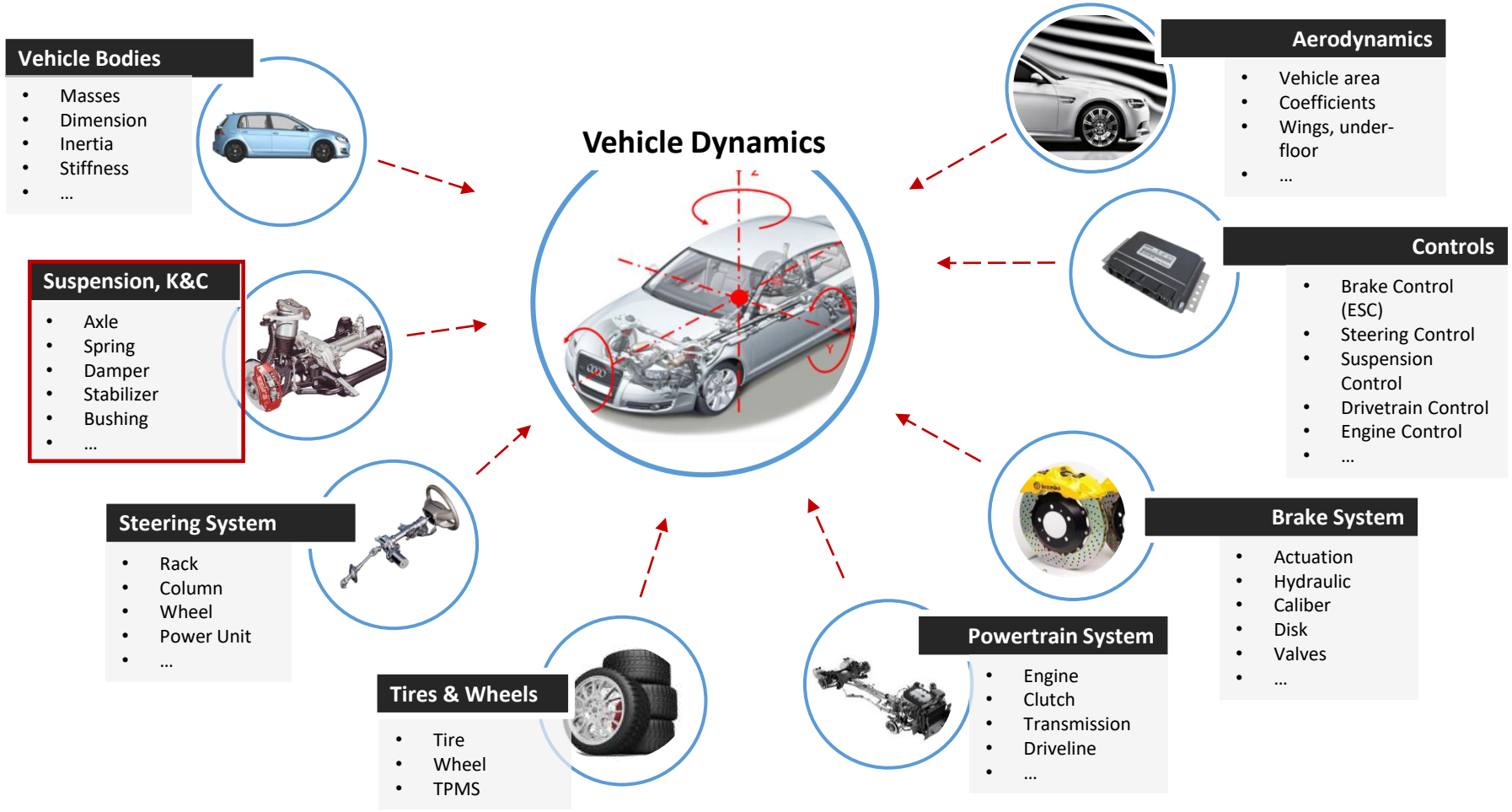
https://moodle2.hs-kempten.de/moodle/course/view.php?id=2914

Nr.	Datum	Inhalt	Ort	Von Wem
0		**Virtual Test Driving (VTD)** **CarMaker Quick Start Guide**	**T314** **T318**	**Self-study**
1	07.10.	Requirements for vehicles and their global attributes	T314 T318	Schick
3	14.10.	Vehicle dynamics attributes and their target conflicts	T314 T318	Schick
3	21.10.	Test and evaluation methods for vehicle attributes (1) **with practical simulation**	T314 T318	Schick
4	28.10.	Test and evaluation methods for vehicle attributes (2) **with practical simulation**	T314 T318	Schick
5	04.11.	Basic vehicle dynamics calculation and vehicle models with exercise	T314 T318	Böhle
6	11.11.	**ADAS DRIVING EVENT** Measurement Tech. Introductions **PSA - Introduction**	**IFM**	Günther/Riedlmüller/ Schwandke
7	18.11.	Chassis components and functions (1) Tire & Wheels **with practical simulation**	T314 T318	Schick
8	25.11.	Chassis components and functions (2) Axle & Suspension **w. practical simulation**	T314 T318	Schick
9	02.12.	Chassis controls and functions (1) Overview & Brakes & Steering	T314 T318	Schick
10	09.12.	Chassis controls and functions (2) ESP–Functions & Application & Process	T314 T318	Albert Lutz (BOSCH)
11	16.12.	**Chassis controls and functions (3)** **ESP–Application & Hands-On Workshop**	T314 T318	Albert Lutz (BOSCH)
12	13.01.	**Chassis controls and functions (4)** **ESP–Application & Hands-On Workshop**	T314 T318	Albert Lutz (BOSCH)
13	20.01.	TEND: ADAS Development for a sports car manufacturer	T314 T318	Manuel Höfer (Porsche)

Chassis components and functions – axle & suspension

The chassis provides the link between the vehicle body and the tyres/road.

Vehicle dynamics behavior is impact by numerous components



Chassis components and functions – axle & suspension

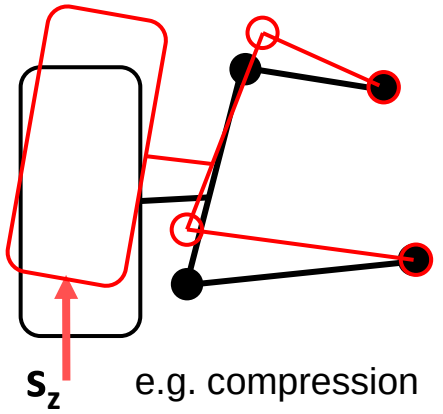
Chassis is responsible for the interconnection between the vehicle - including passengers and luggage - and the road

- Outer forces and moments are transferred via the tires via the suspension to the vehicle inner forces.
- The suspension is responsible to bring the tire into a optimal position for the force am moment transfer.

Important suspension characteristic behavior

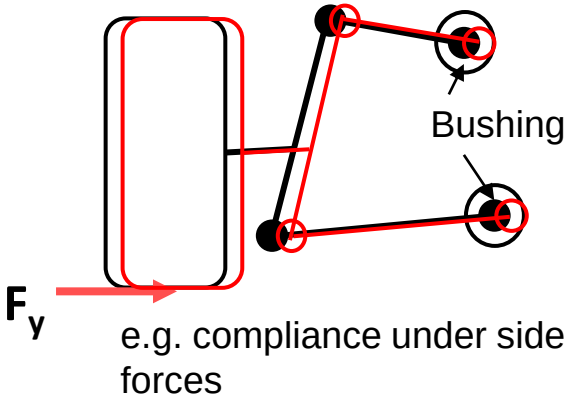
Kinematics

Description the change in the 3D wheel position which occur due to suspension compression, rebound and by steering movements.



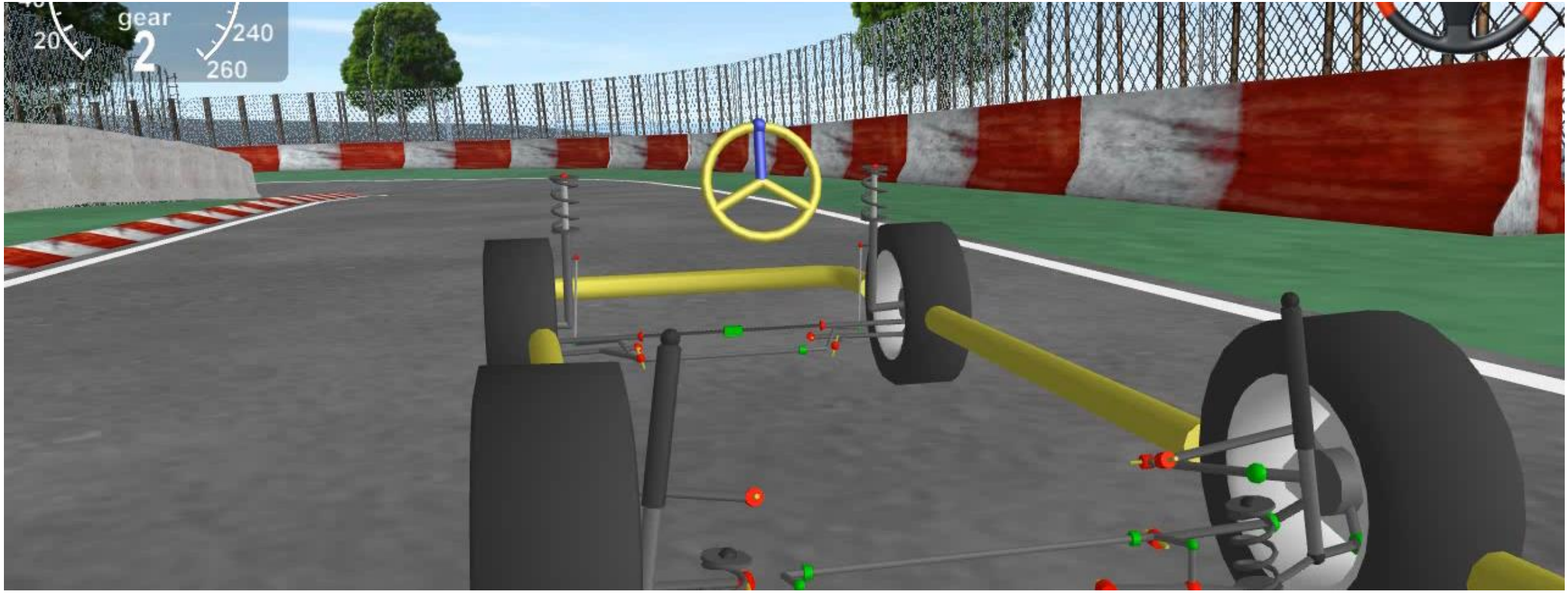
Compliance (elastokinematic)

Description the change in the 3D wheel position, which occur due to the forces and torques on the wheel / tire under targeted elastic interpretation of suspension parts.

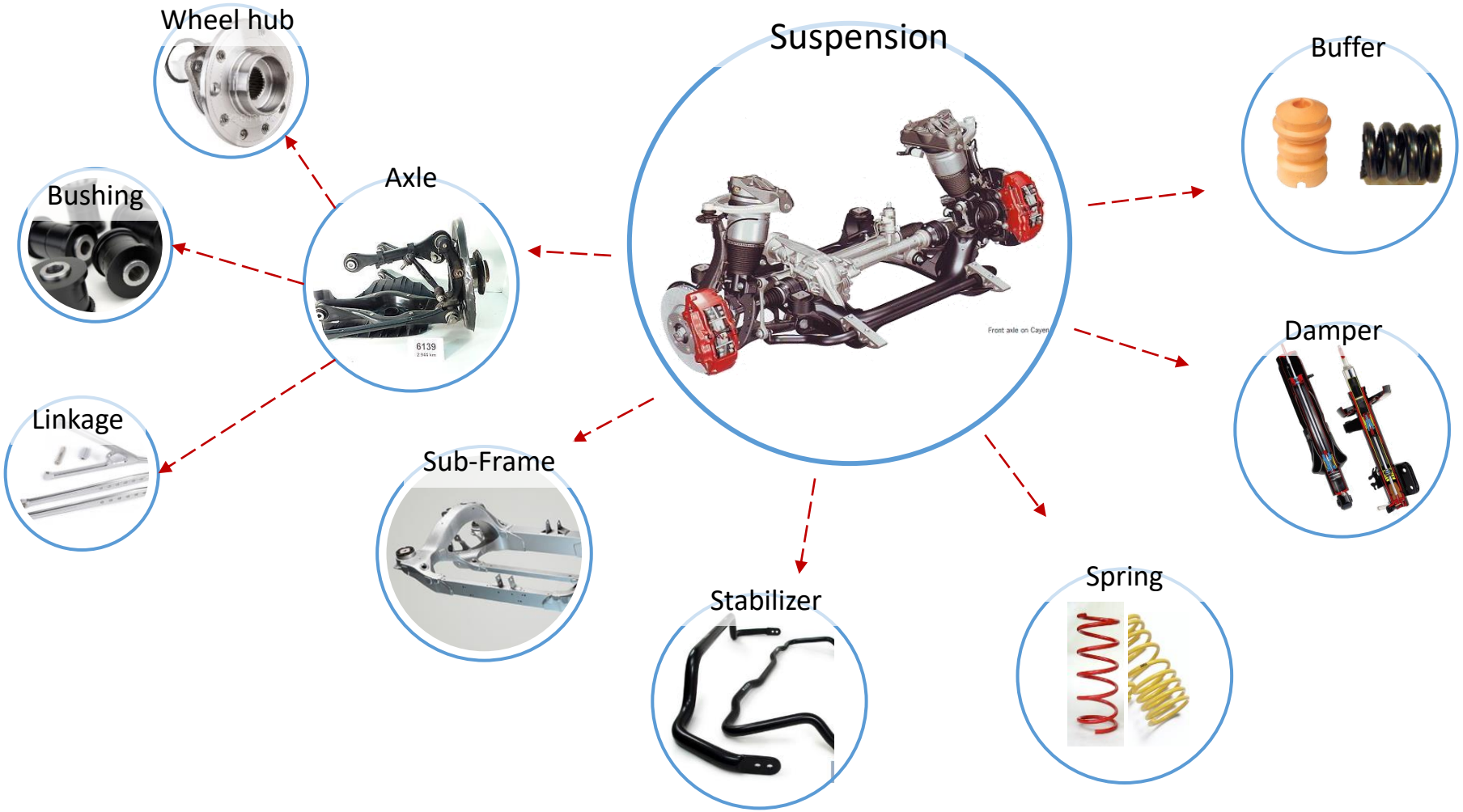


Chassis components and functions – axle & suspension

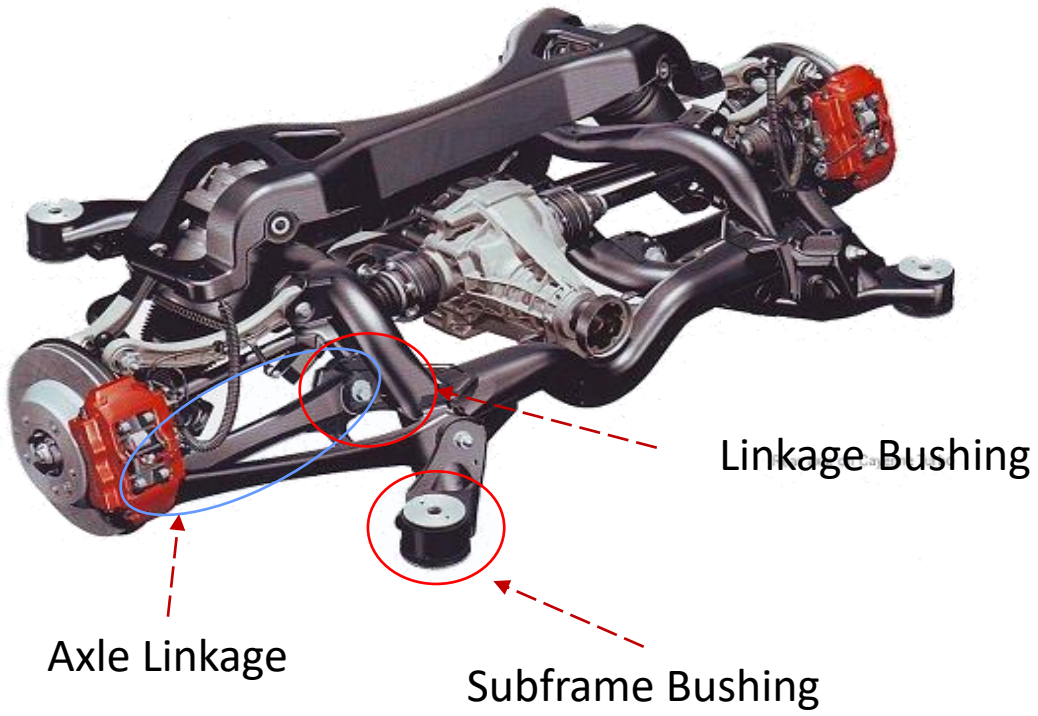
Axle, suspension, kinematics & compliance characteristics

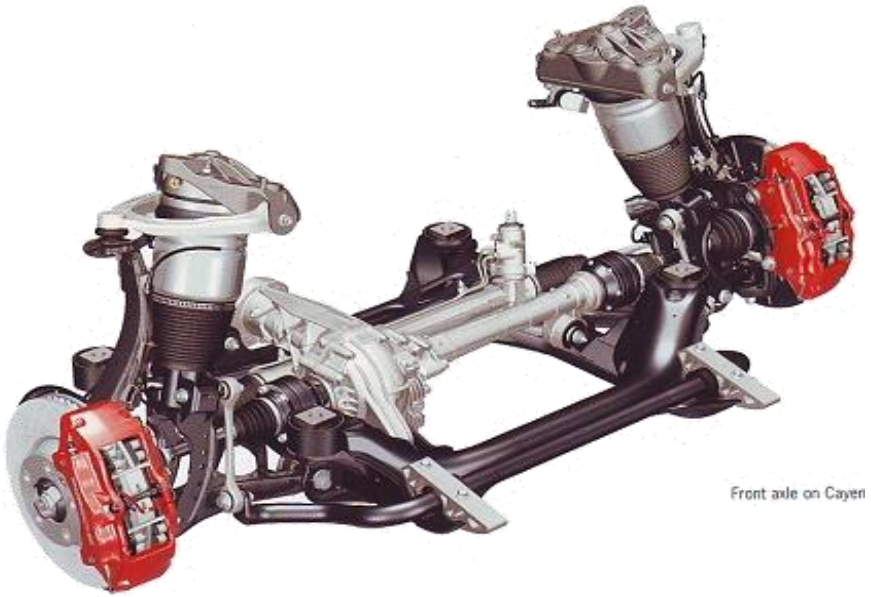


Suspension components

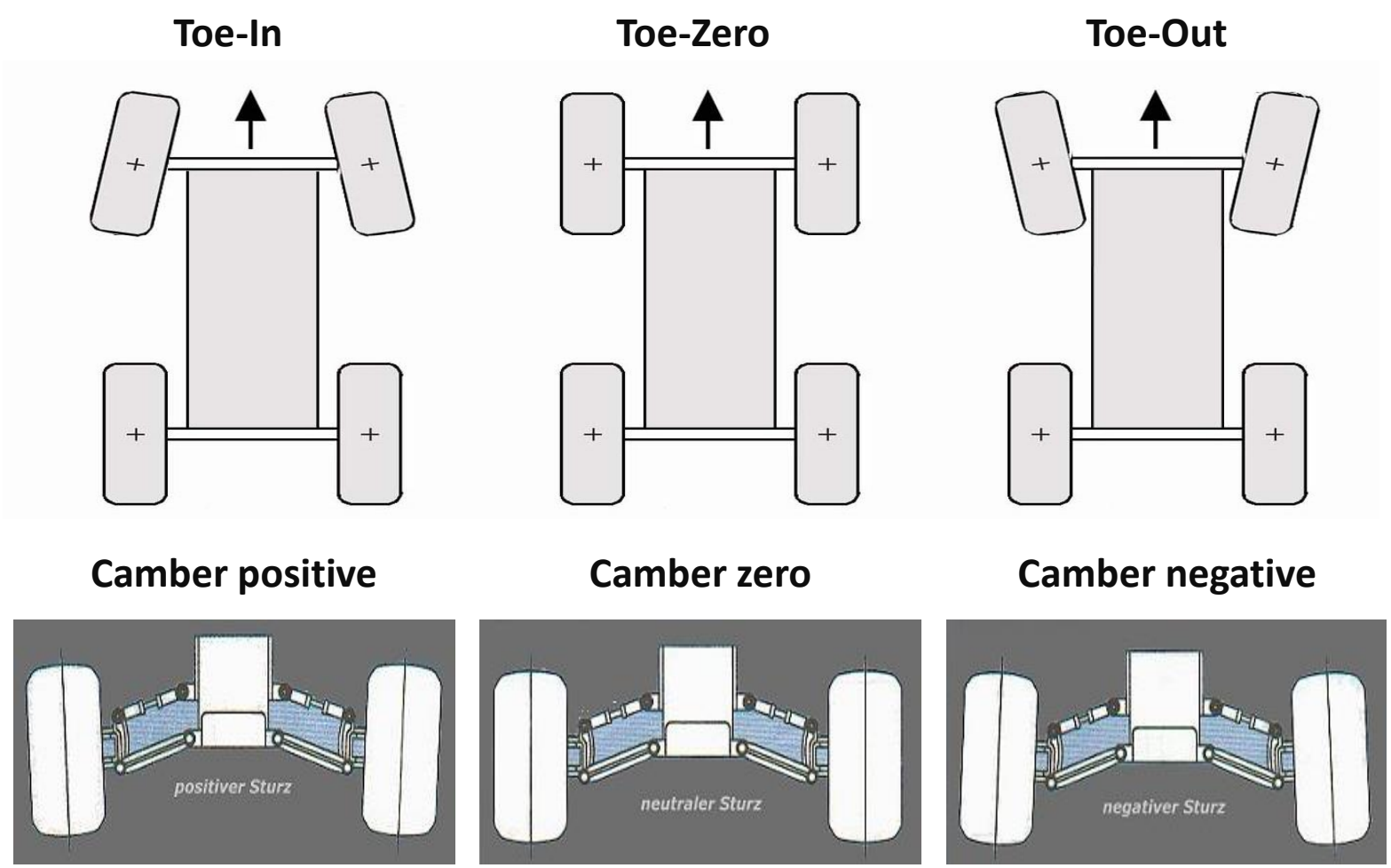


Suspension components

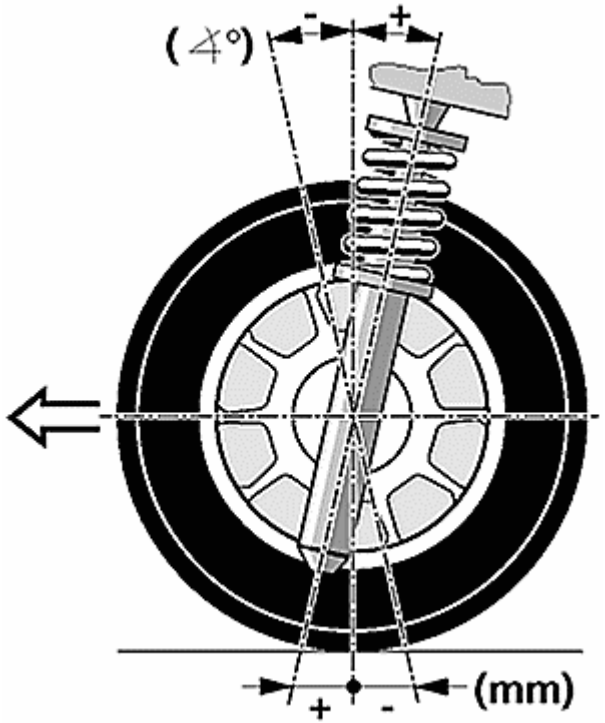




Static axle alignment

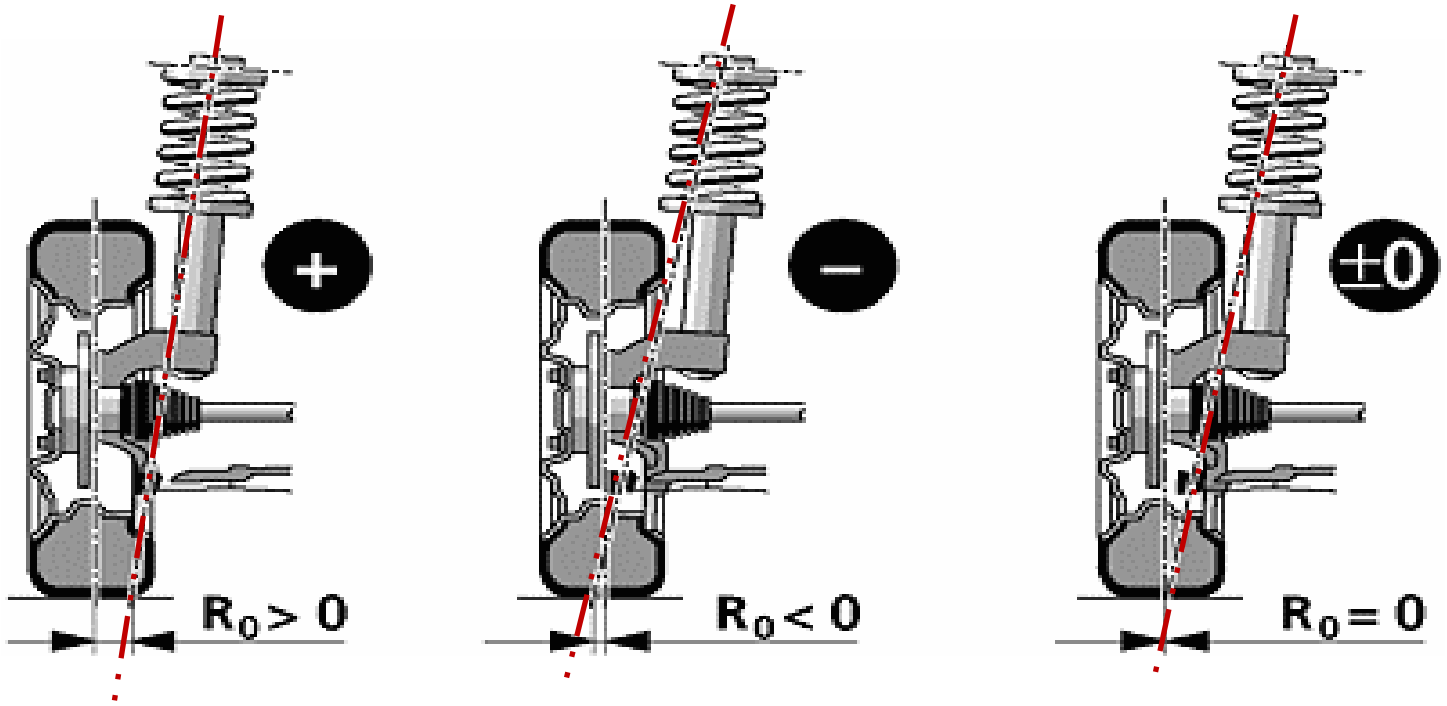


Important geometrical suspension characteristic values

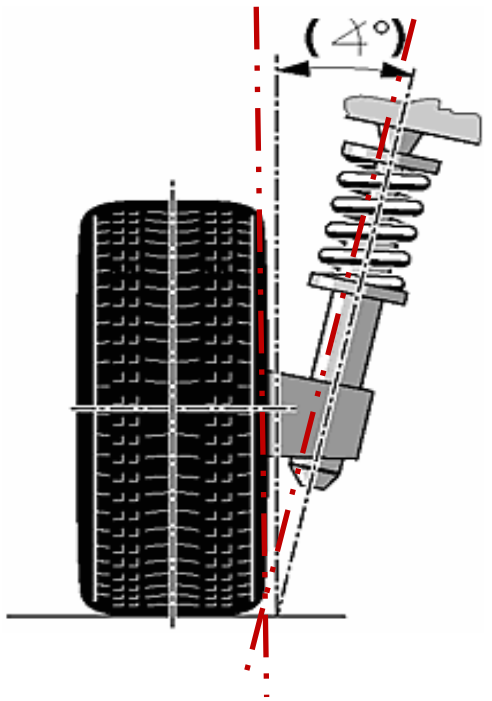


→ Bigger caster leads more wheel stability but higher steering torque.

Important geometrical suspension characteristic values

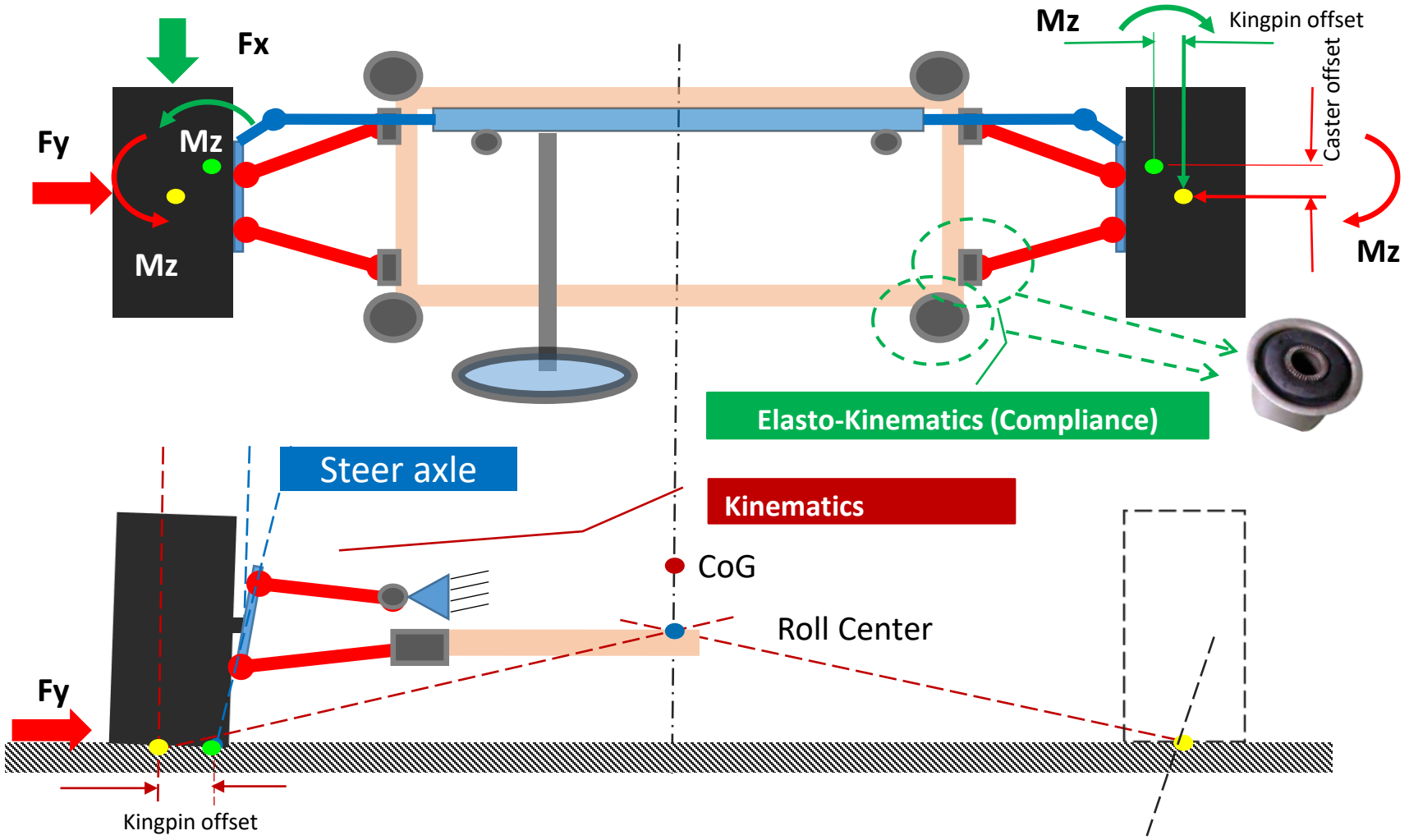


King-Ping Offset (Lenkrollhalbmesser)

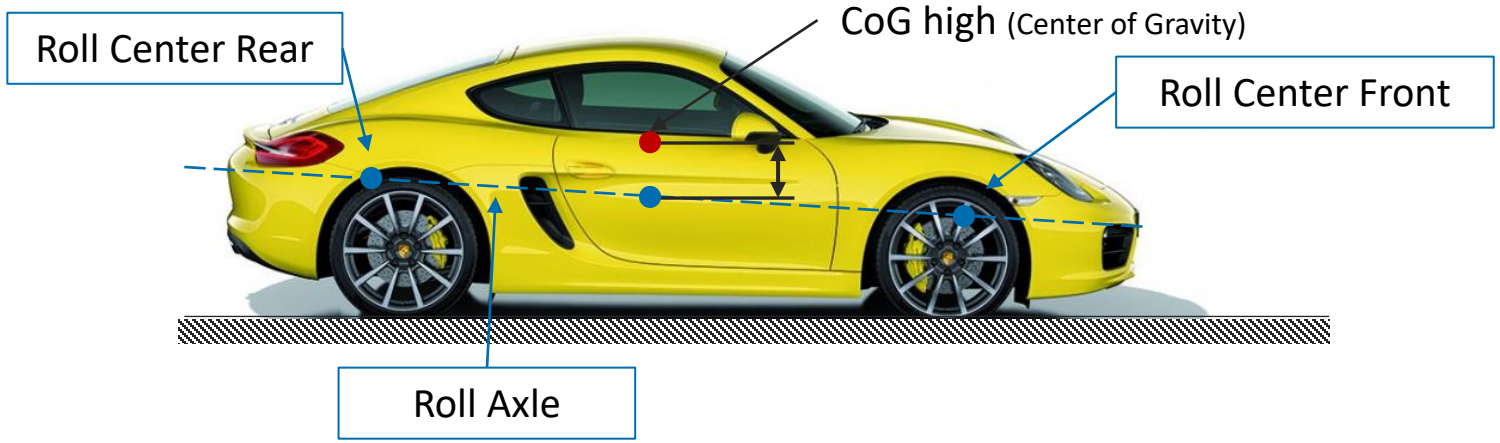


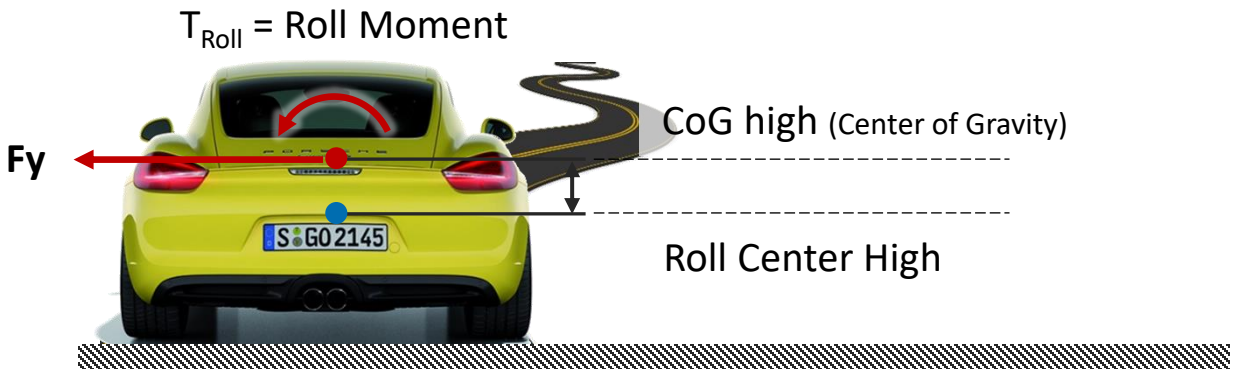
King-Ping Inclination

Important geometrical suspension characteristic values



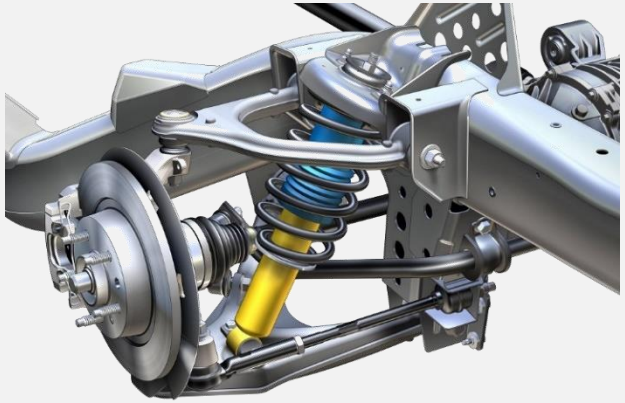
Important geometrical suspension characteristic values

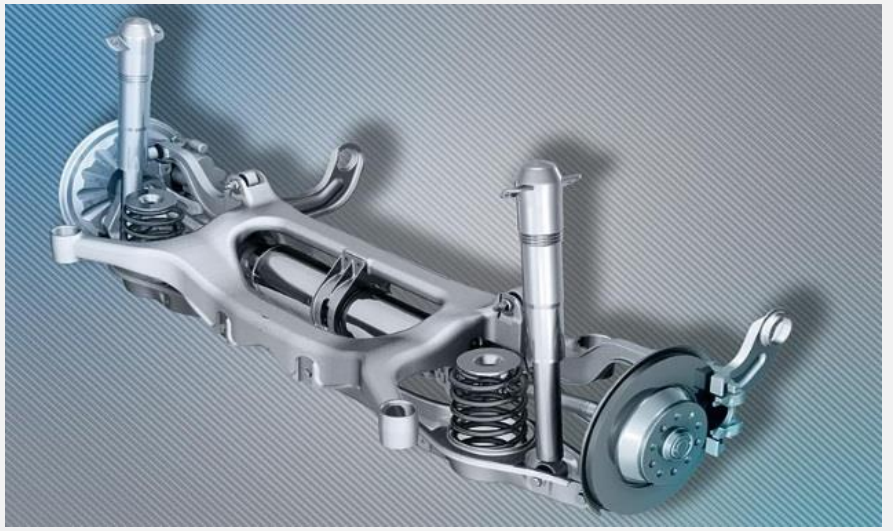




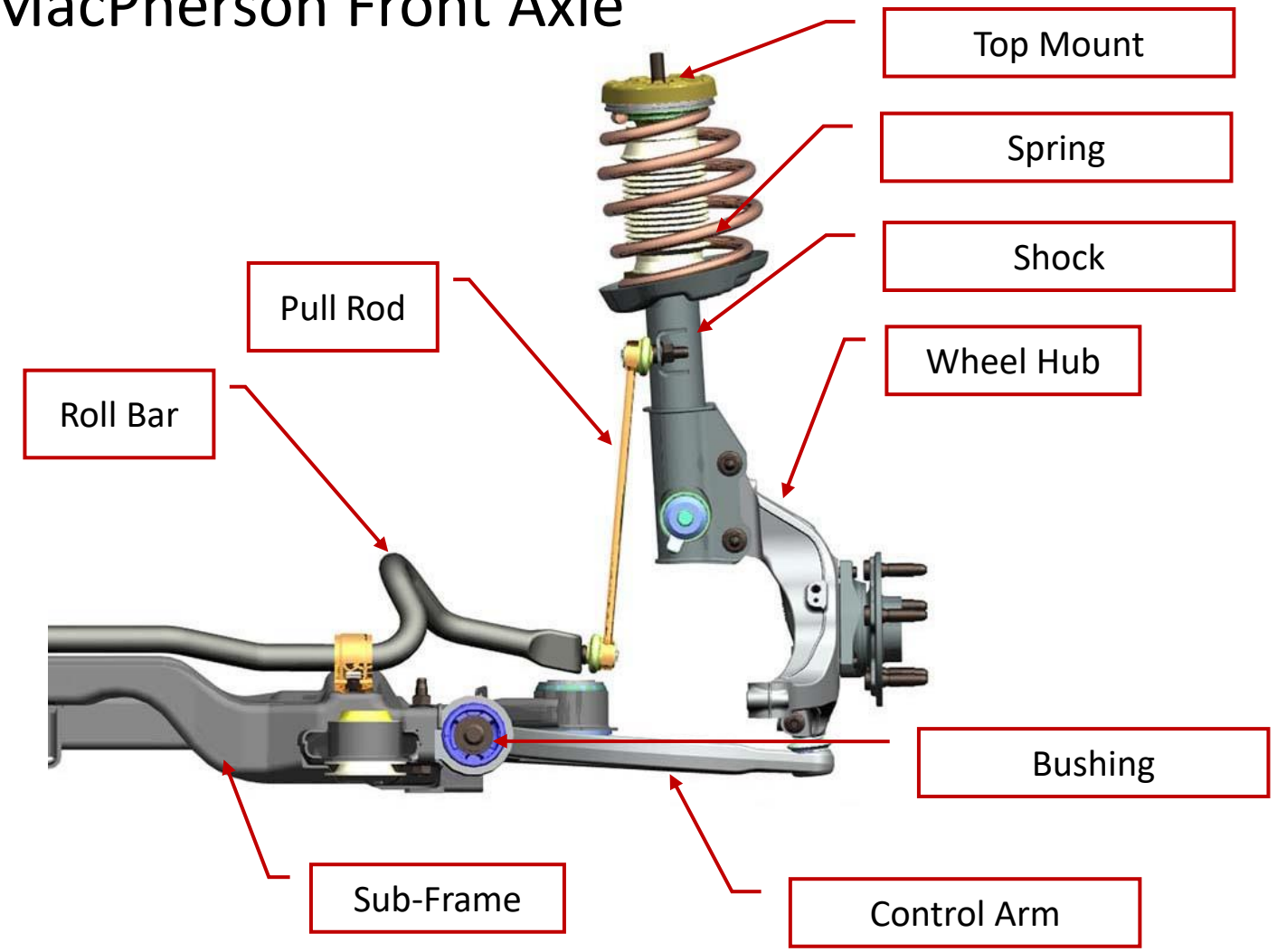
Suspension types

Front Suspension	Rear Suspension
• McPherson Axle • Double Wishbone Axle • Rigid axle • Strut Axle • …	• Rigid axle • Twist Beam Axle • Double Wishbone Axle • 4-Linkage Axle • Multi-Linkage Axle • Sword Linkage Axle • Strut Axle • Longitudinal Linkage Axle • Semi Trailing Arm Axle • …



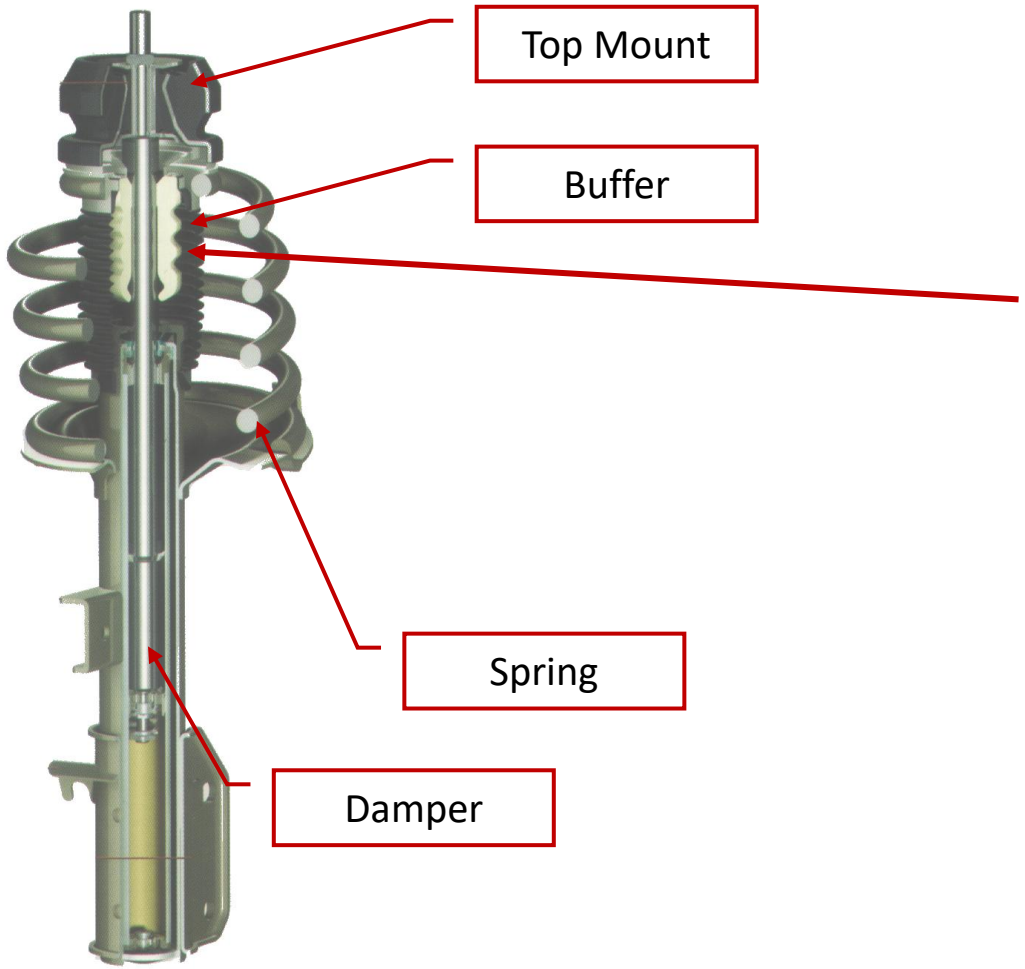


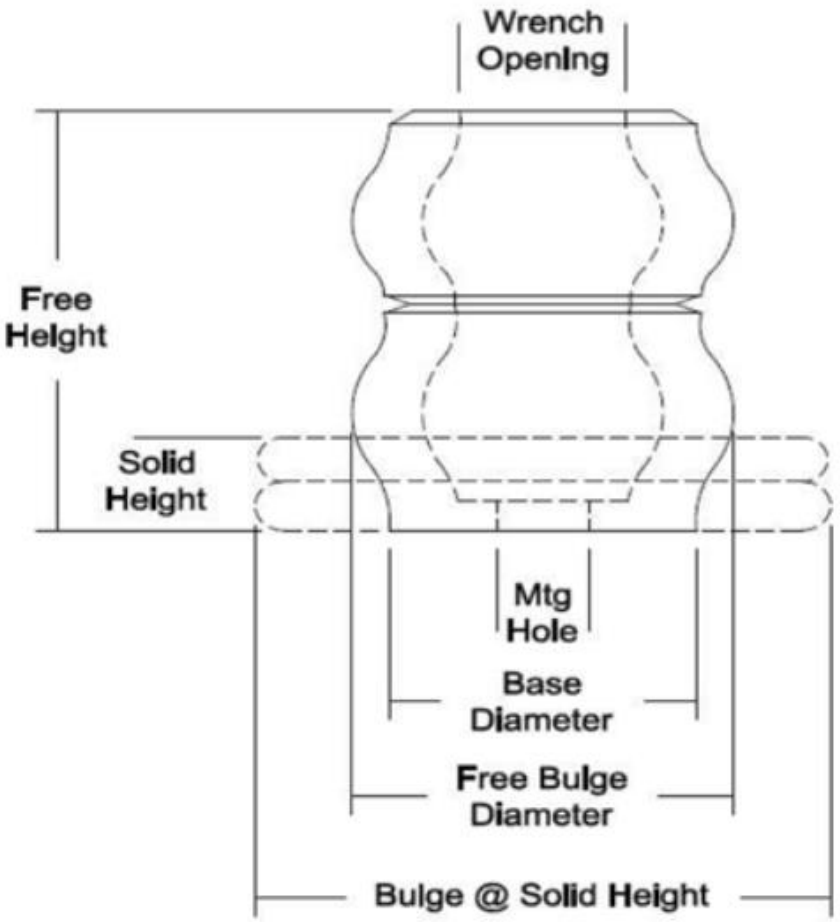
Suspension types: MacPherson Front Axle



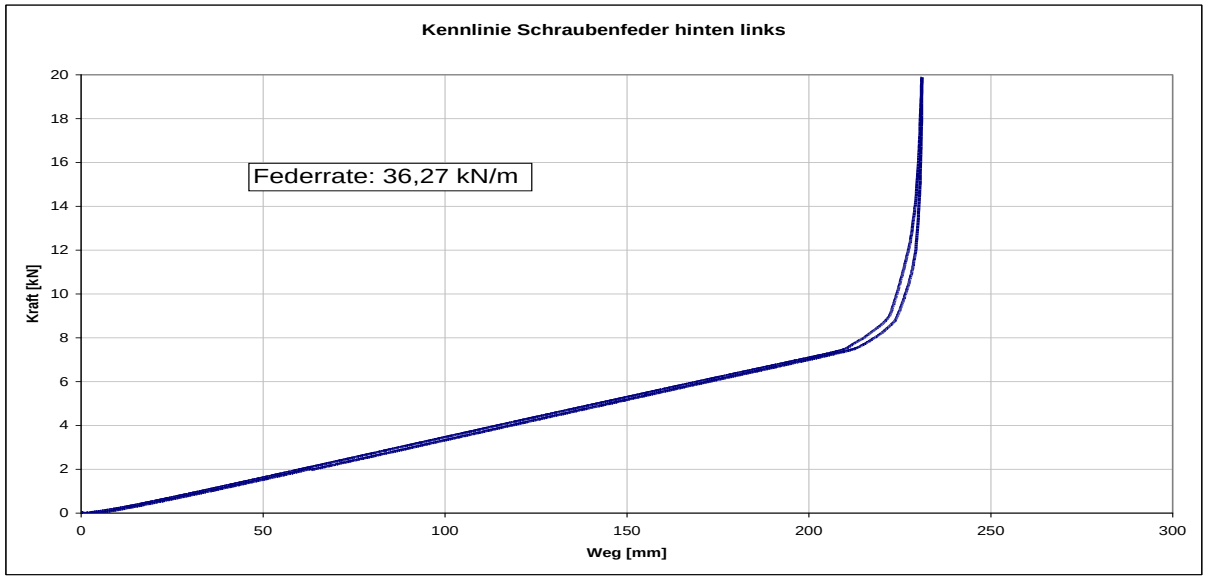
Bushing for force reactive wheel position and isolation

Bumper the additional spring

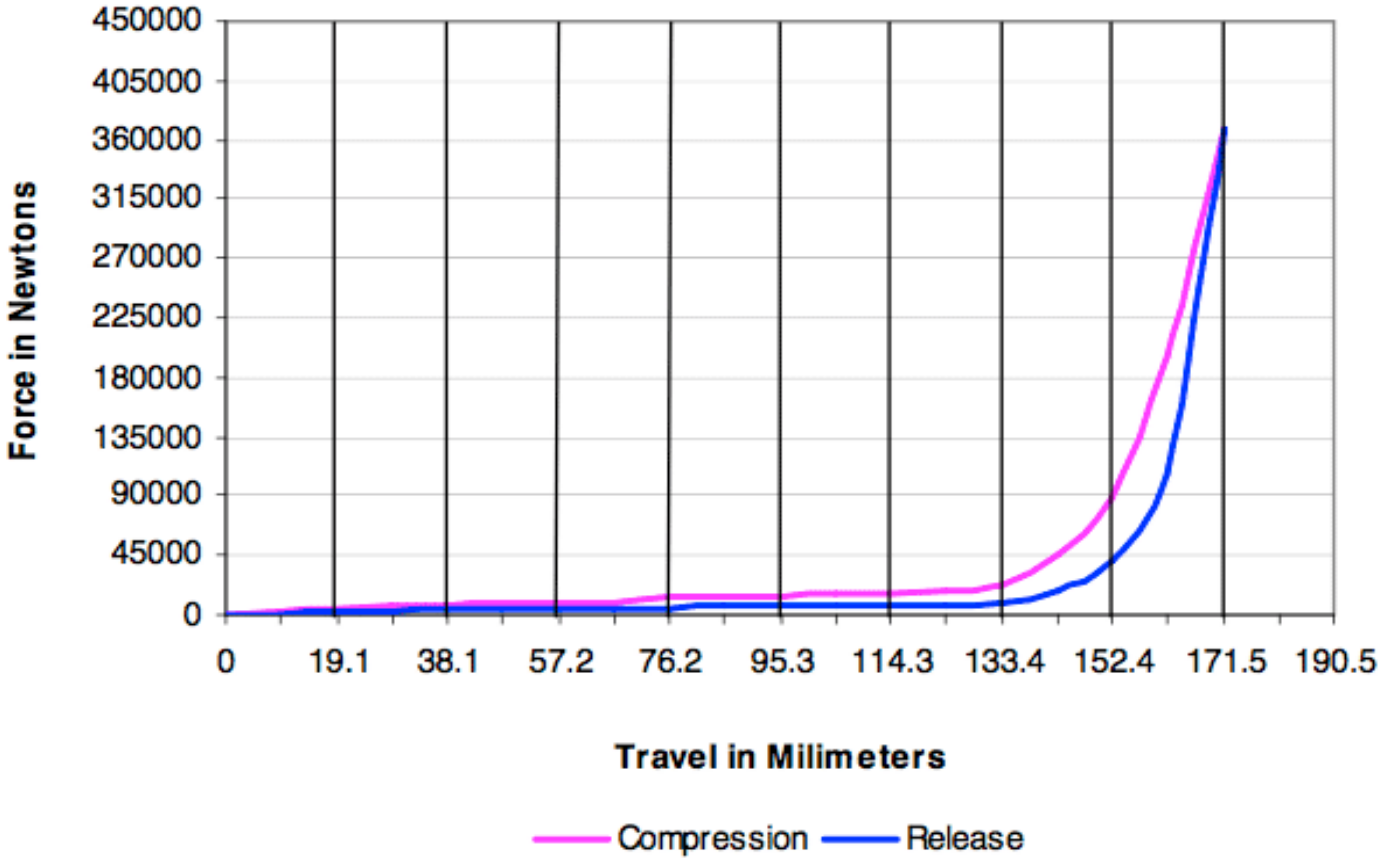




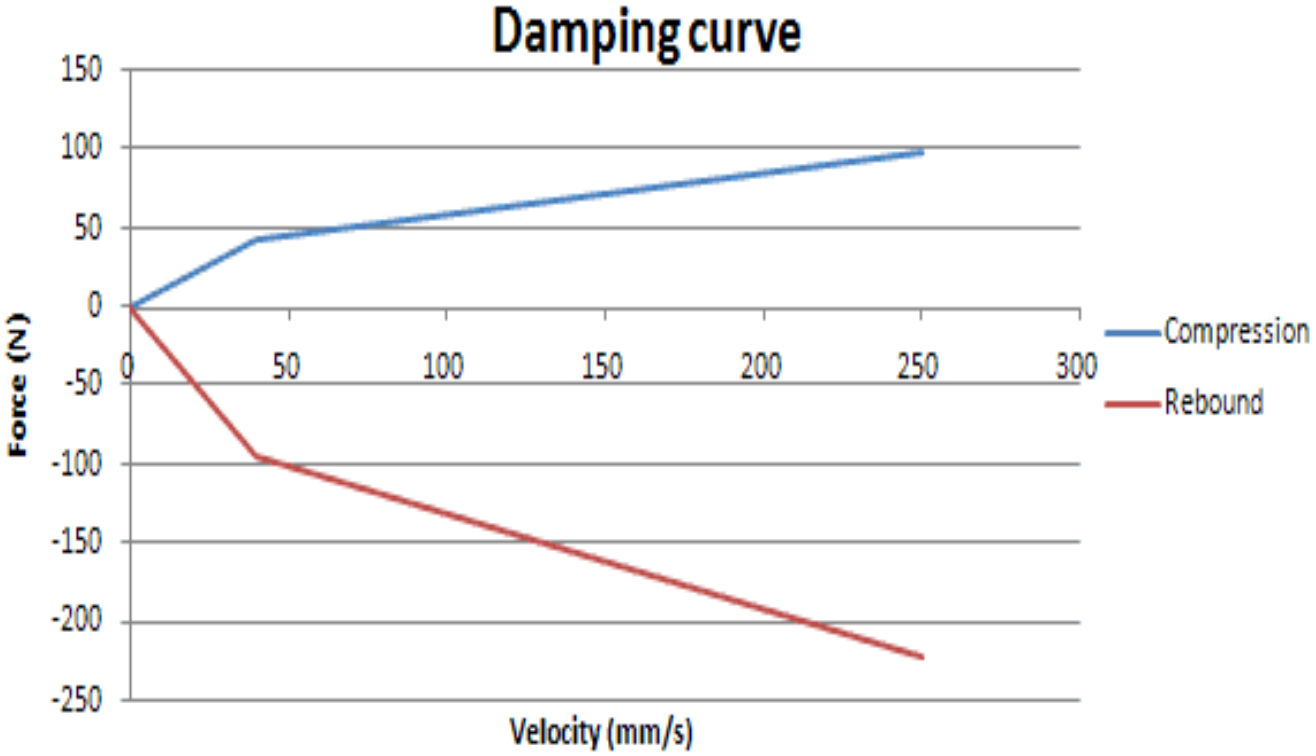
Spring & Damper & Buffer

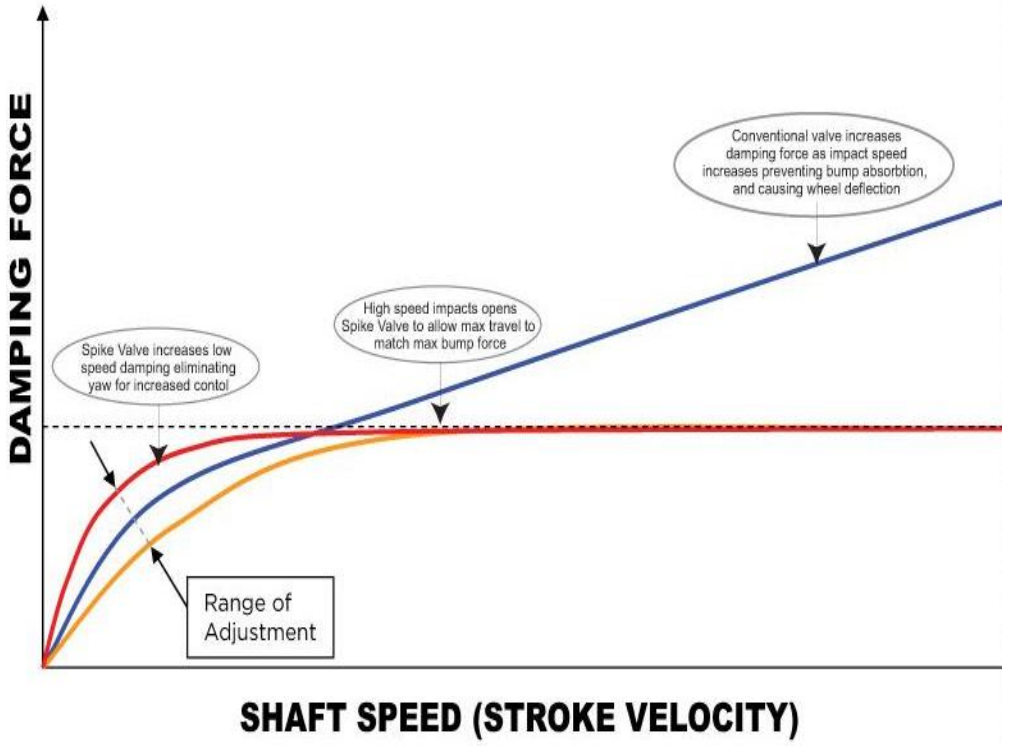


Bumper the additional spring

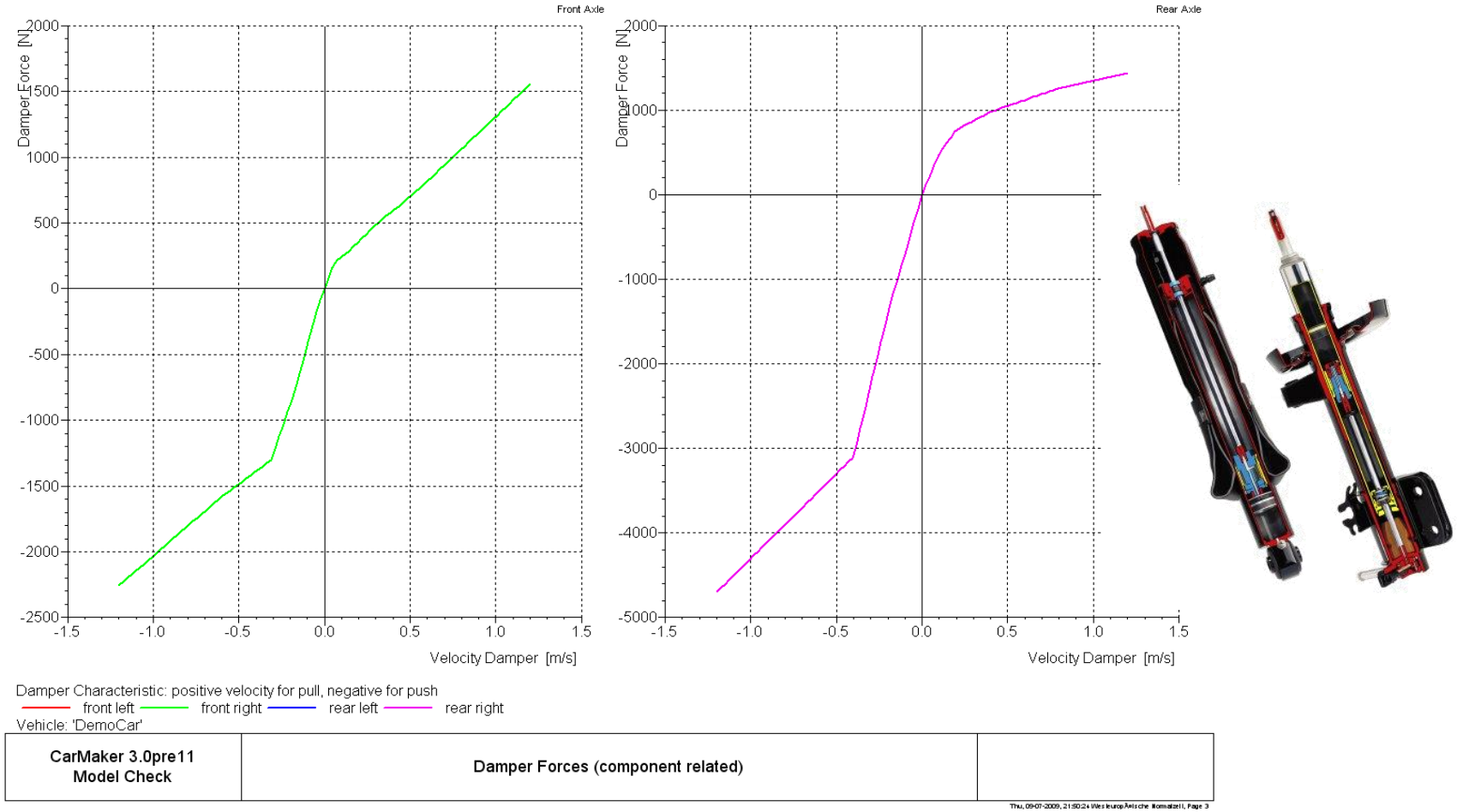


Damping curve and measurement

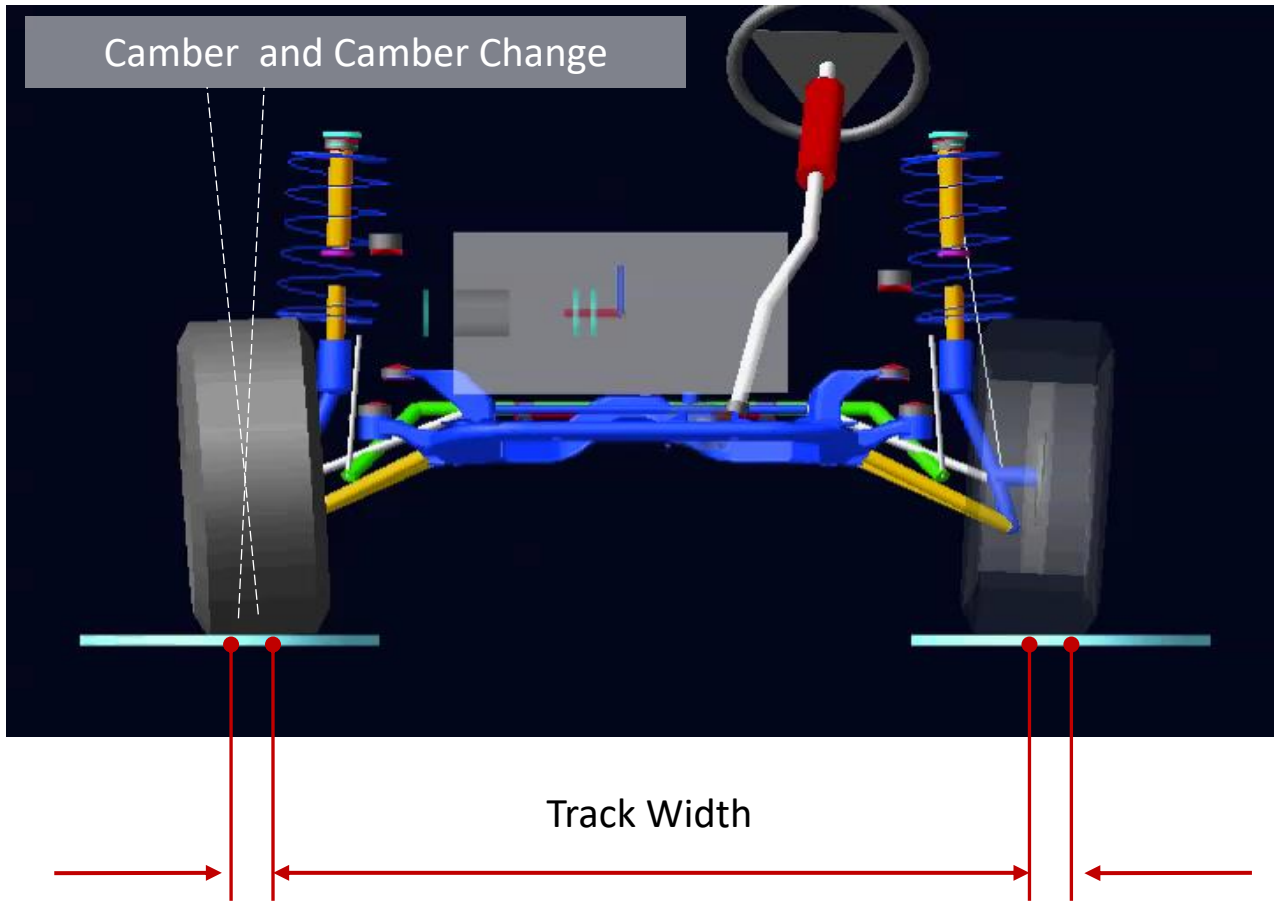


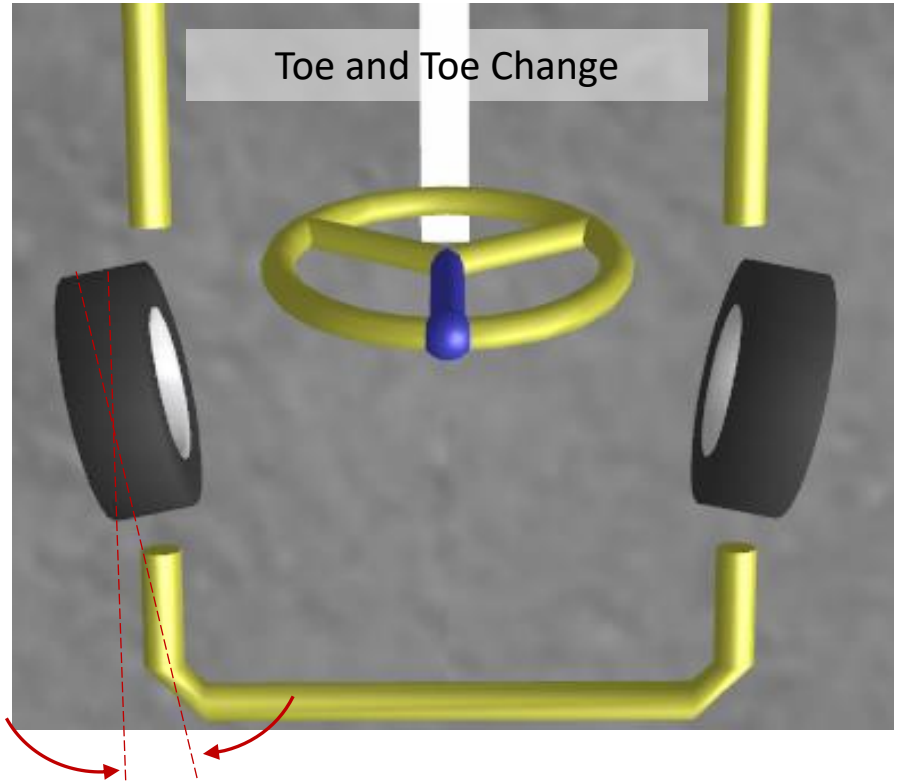


Damping curve and measurement



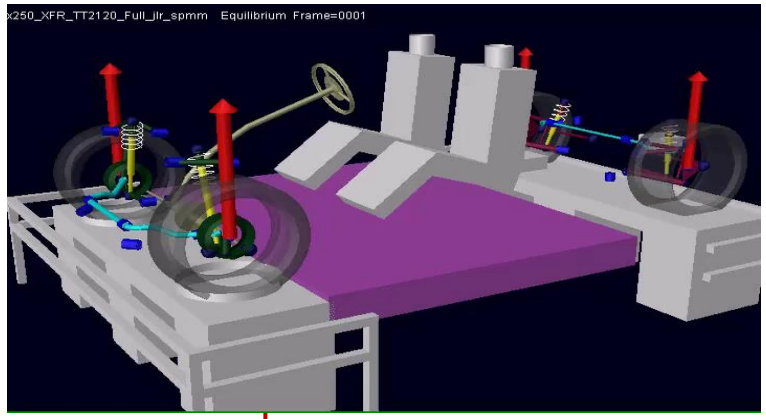
K&C (kinematic & compliance) behavior





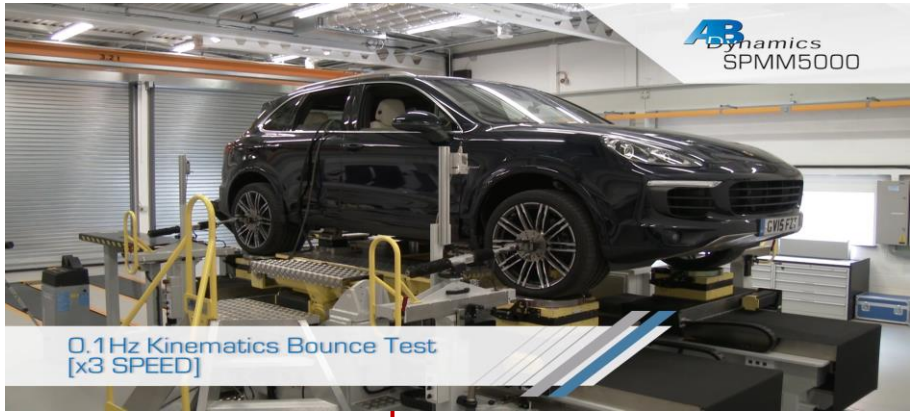
Virtual and real K&C test benches in a modern development

Virtual K&C Test Bench
MBS-Model

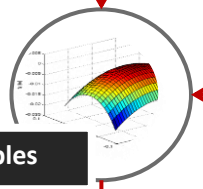


- Bounce Test
- Roll Test
- Steer Test
- Side Force Test
- Accel. & Brake Test

Real K&C Test Bench
Sample ABD SPMM 5000



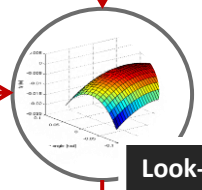
K&C Variants



Look-up Tables

Validation

K&C Variants

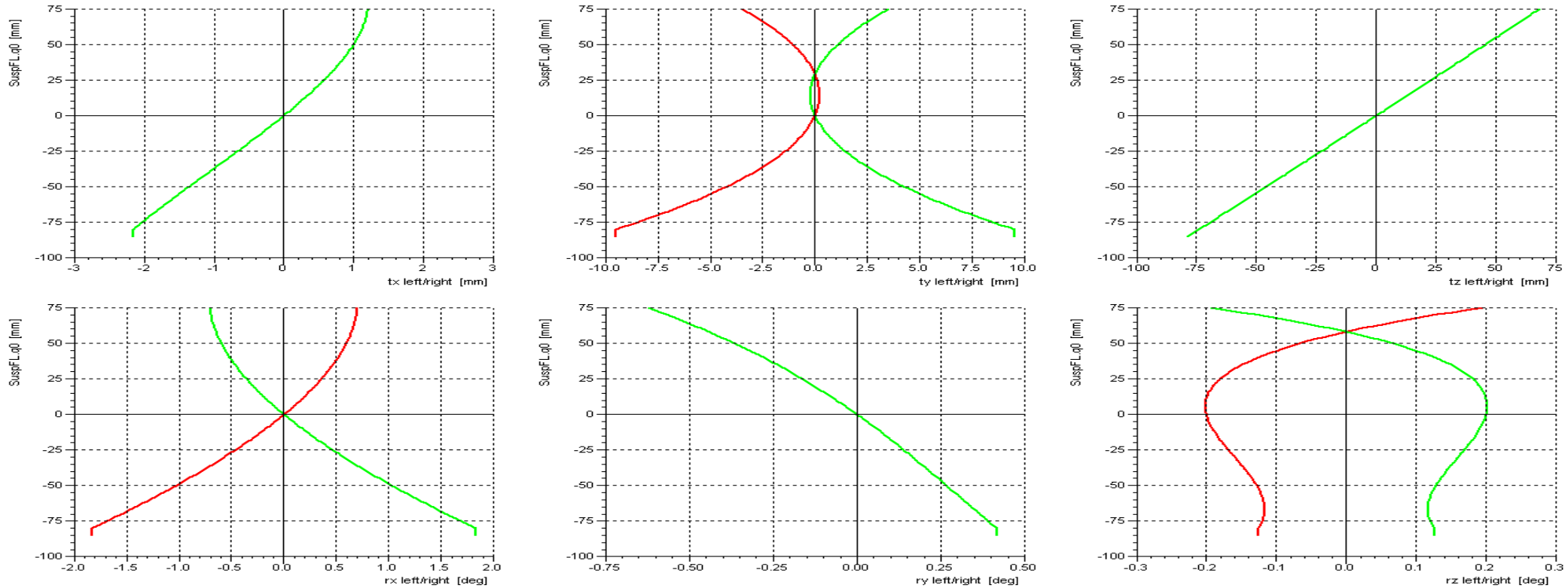


Look-up Tables

Parametrization

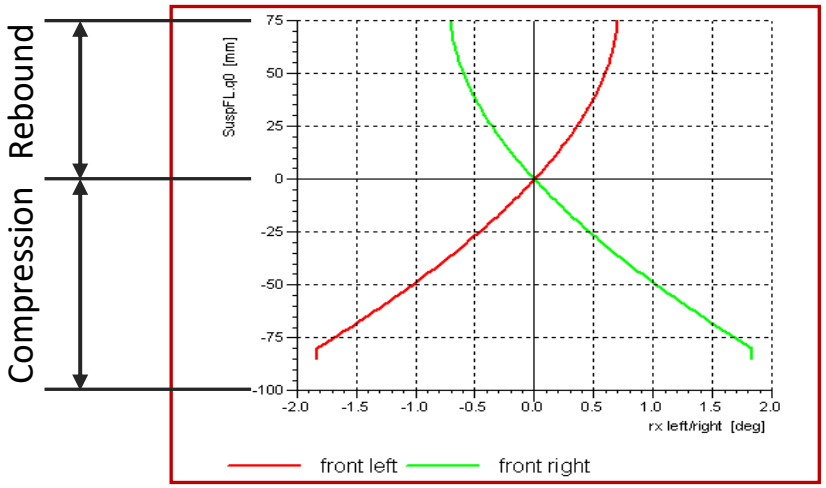
Parametrization

Suspension – Kinematics & Compliance

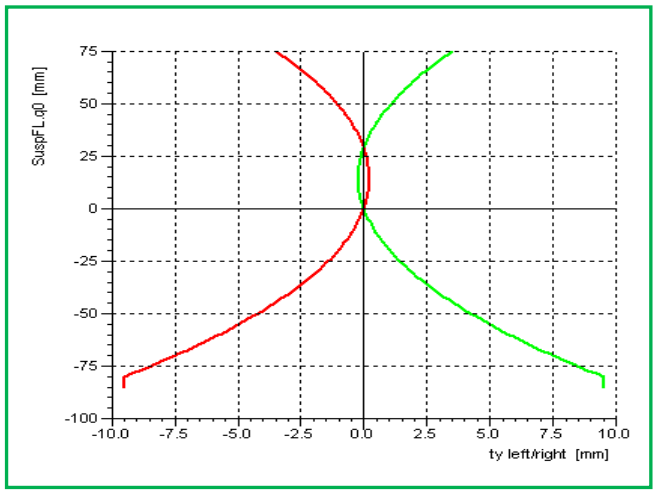


Suspension – Kinematics & Compliance

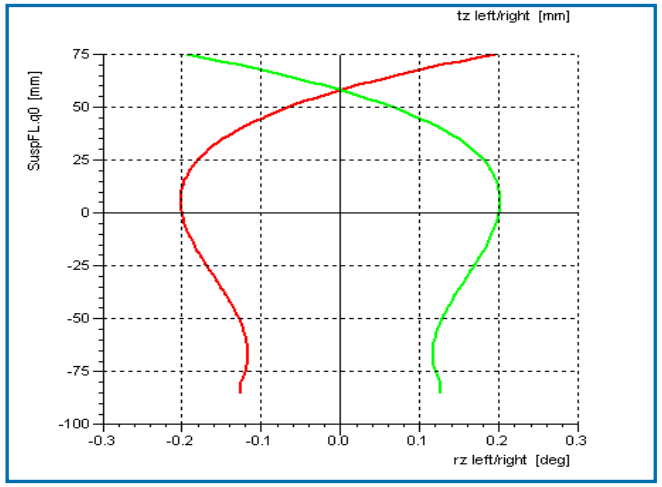
Chamber Change



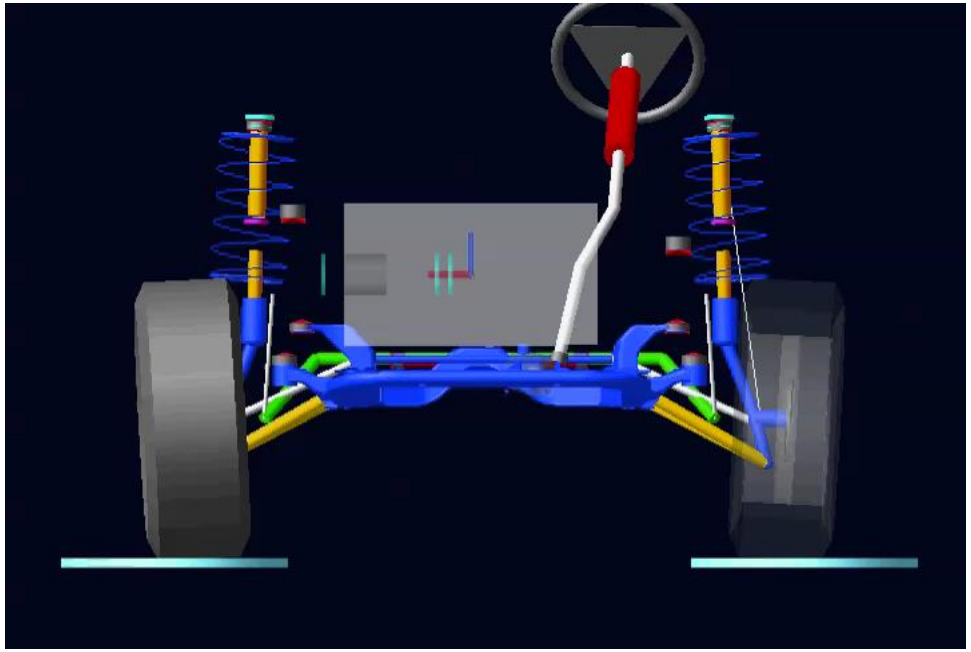
Track Width Change

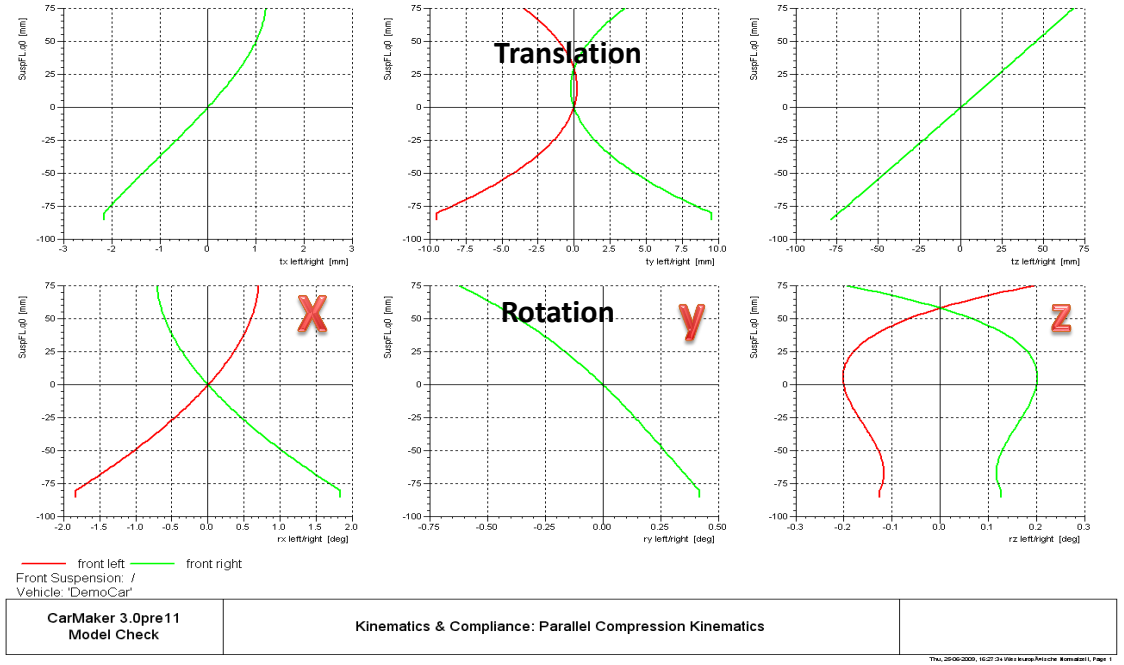


Toe Change

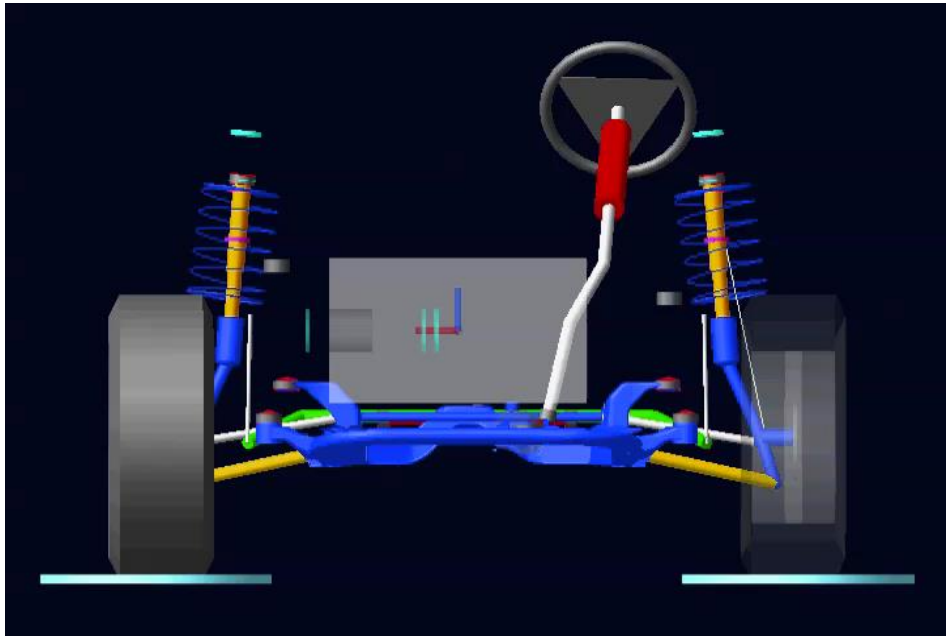


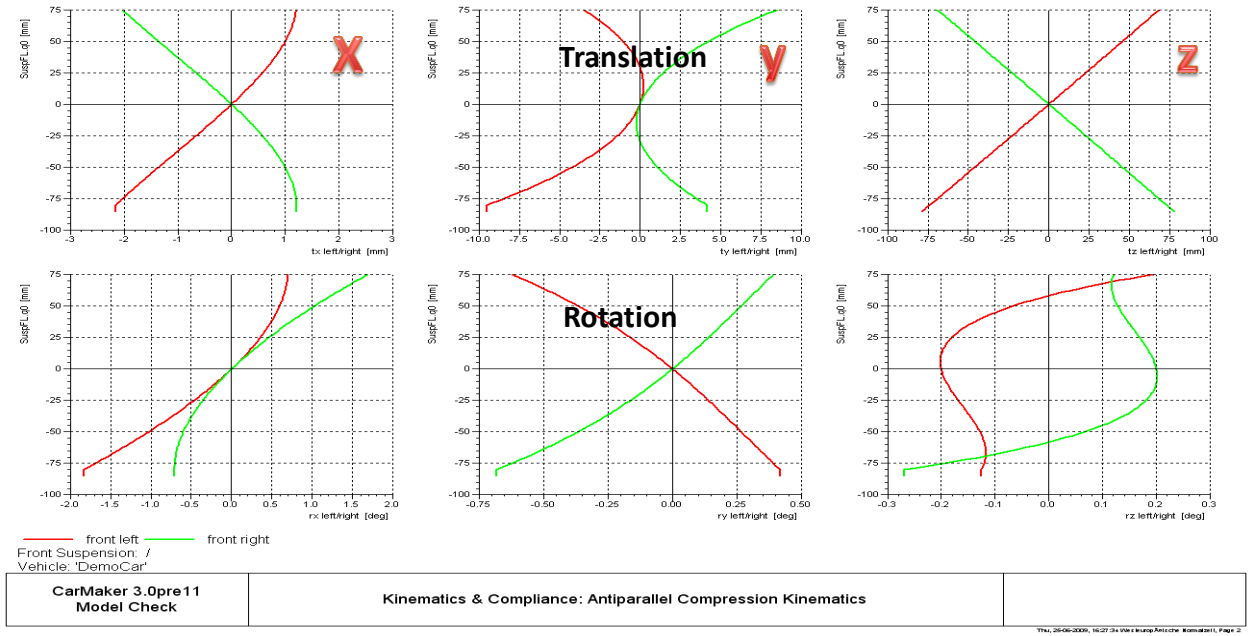
Kinematics & Compliance – Stroke or Bounce Test



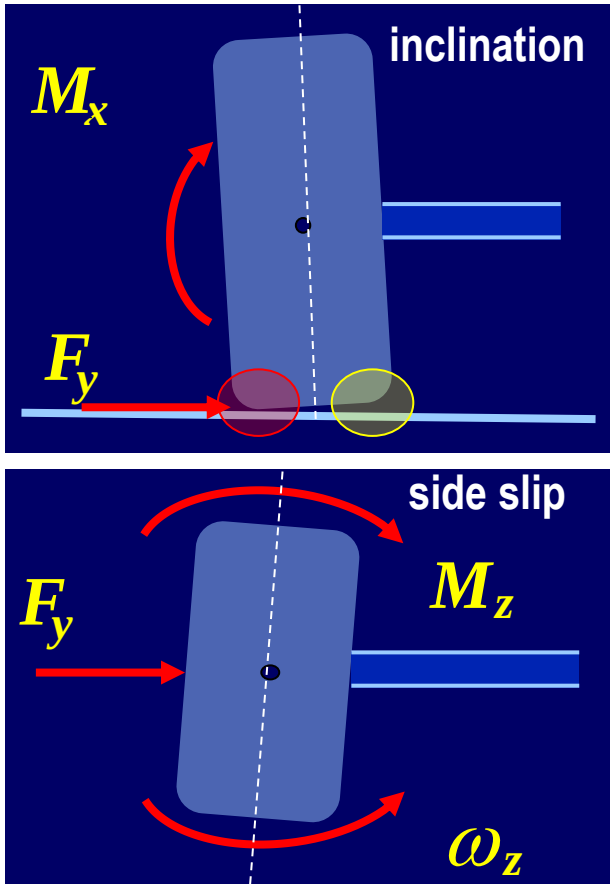


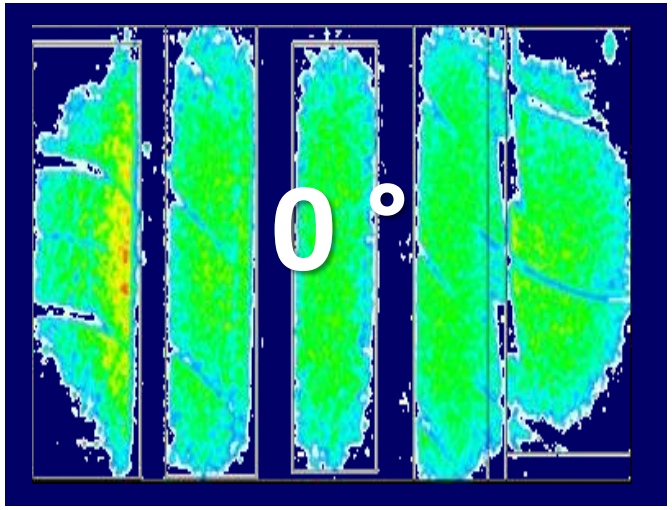
Kinematics & Compliance - Roll Test

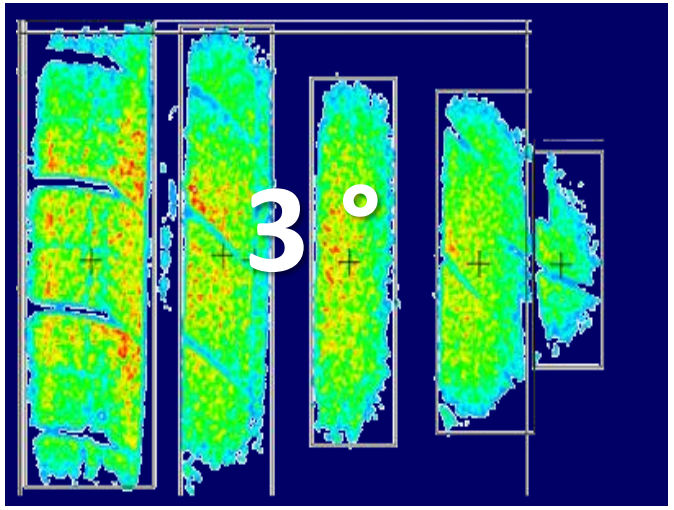




Suspension – Kinematics & Compliance



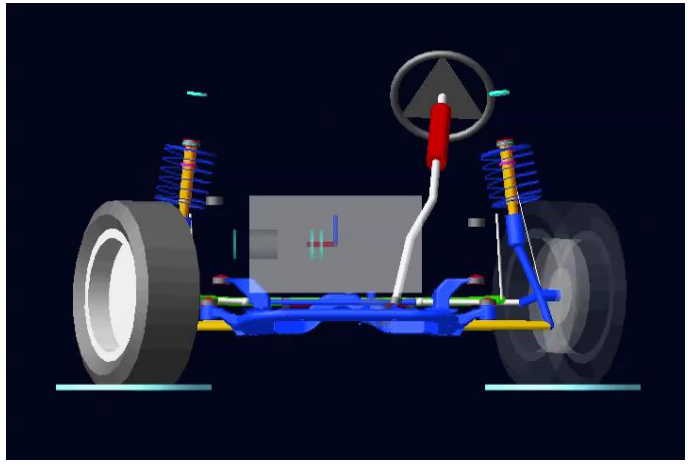


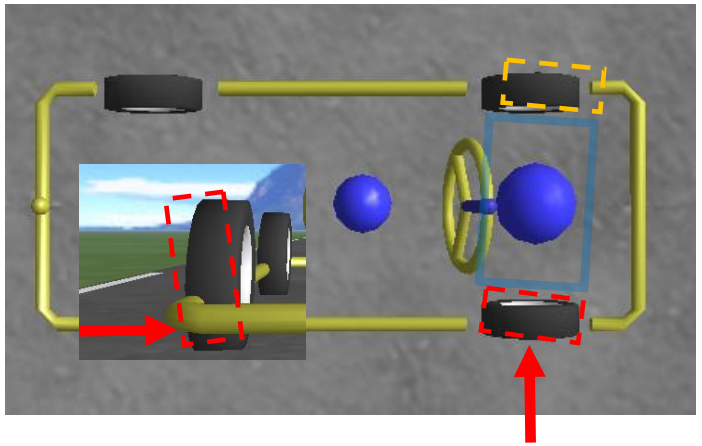


Vehicle Dynamics Rule No. 2:

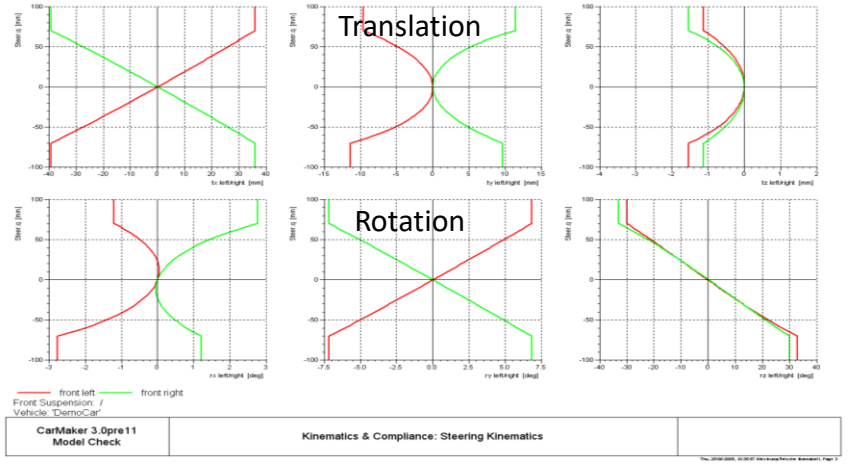
Produce a harmonic foot print

Suspension – Kinematics & Compliance

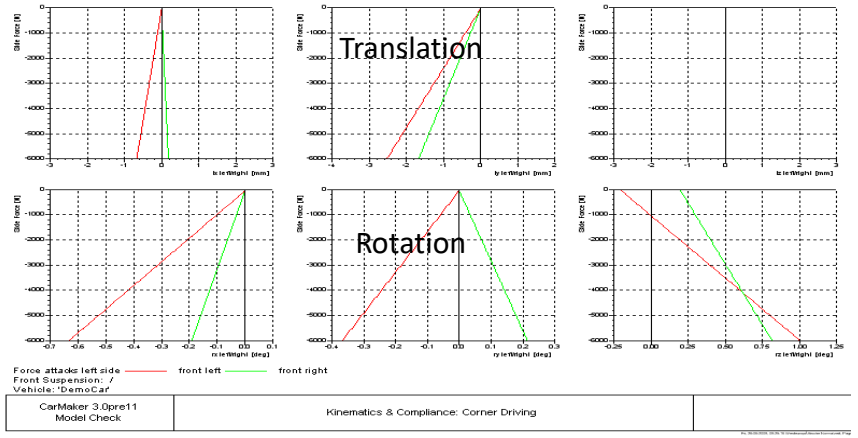




Steer Test



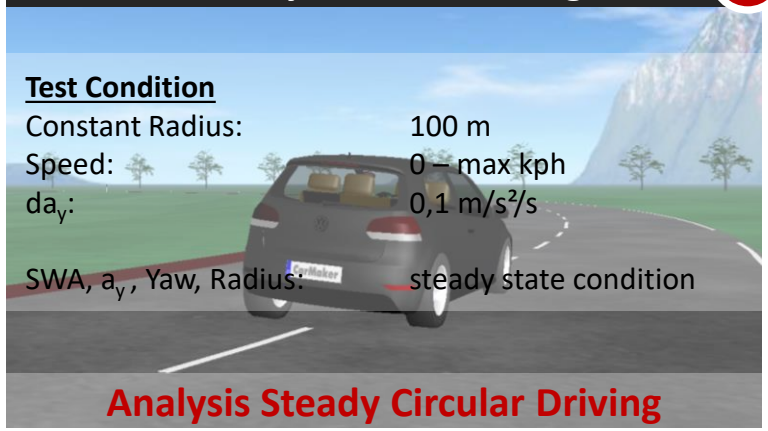
Side Force Test



Parameter Study for K&C, spring, damper, roll bar

Steady Circular Driving

1

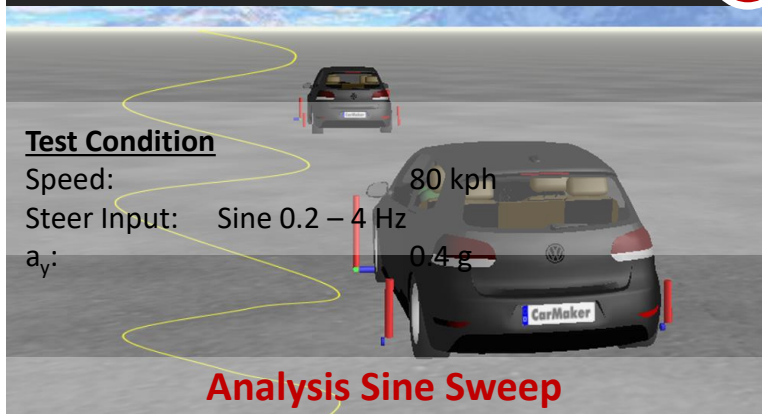


Find the sensitivity of parameters such as

- Roll bar stiffness
- Spring, buffer
- Toe change front / rear (K&C)
- Camber change front / rear (K&C)
- …

Sine Sweep

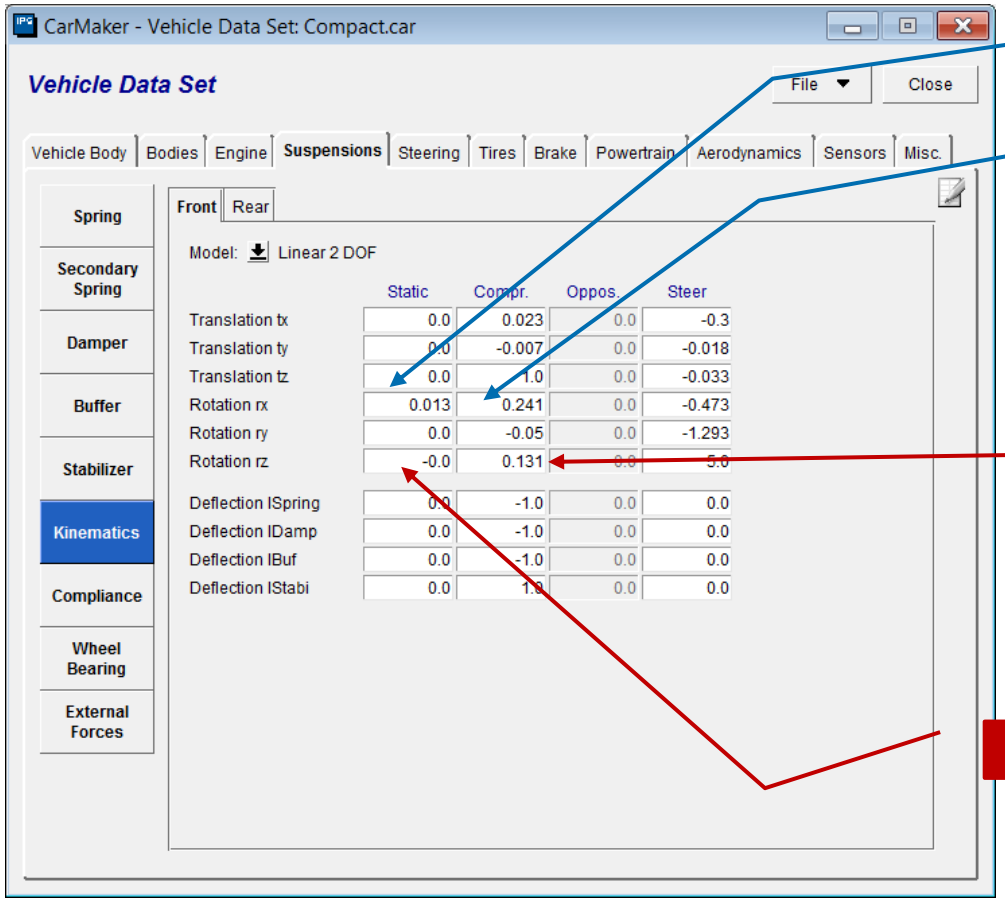
2



Find the sensitivity of parameters such as

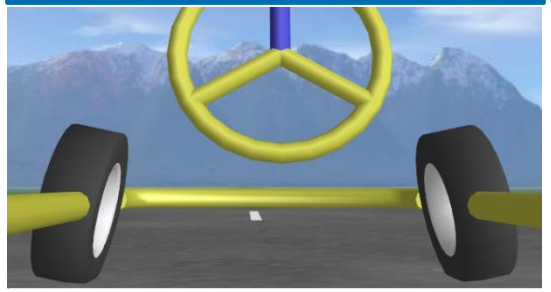
- Mass/Mass distribution / inertia
- Roll bar stiffness
- Damper
- Tire side slip stiffness
- …

Linear 2DOF kinematic model (bounce &steer) parameter

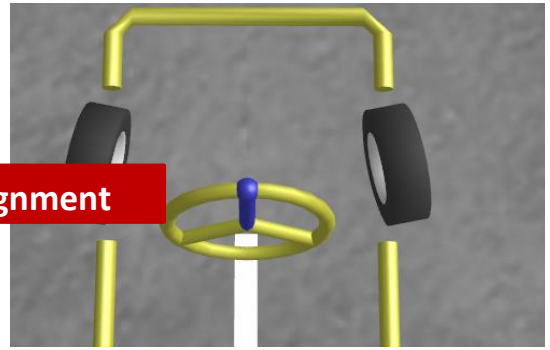


Static Camber of axle alignment

Camber In (stroke)

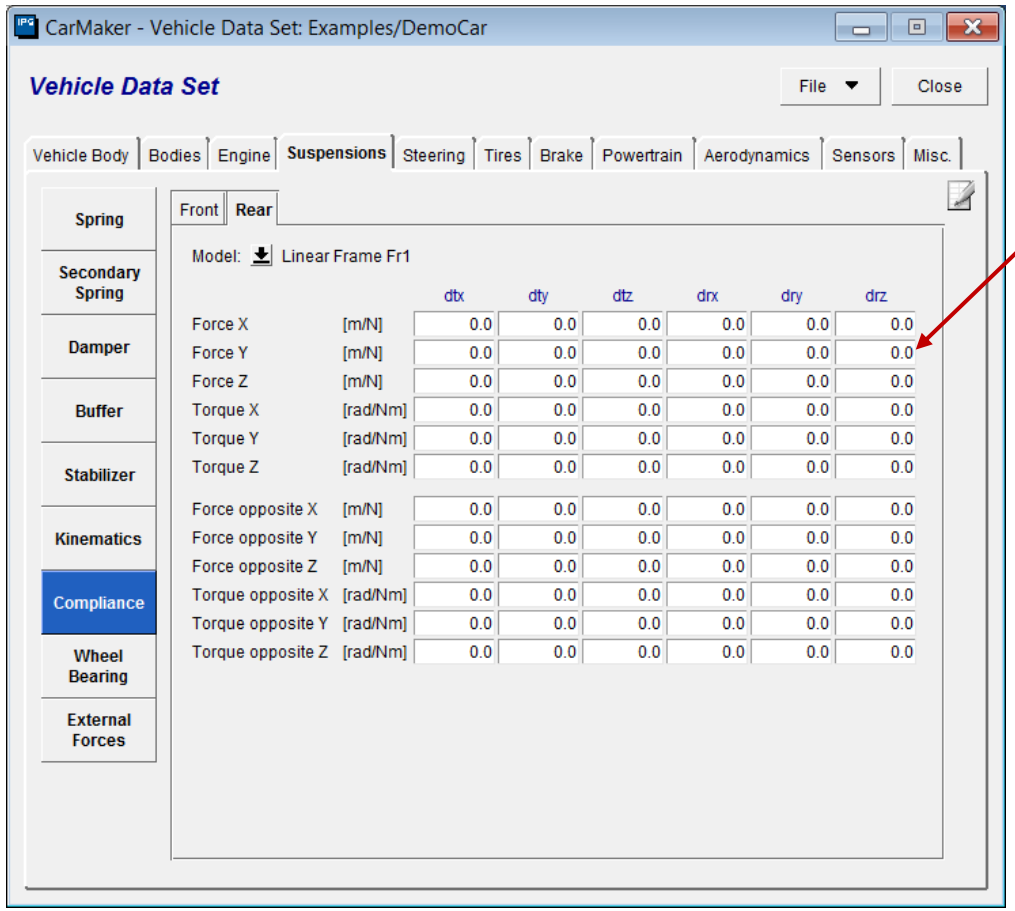


Toe In (stroke)



Static Toe of axle alignment

Linear compliance model parameters



Side Force Steer