VEHICLE DYNAMICS EXPO 2009
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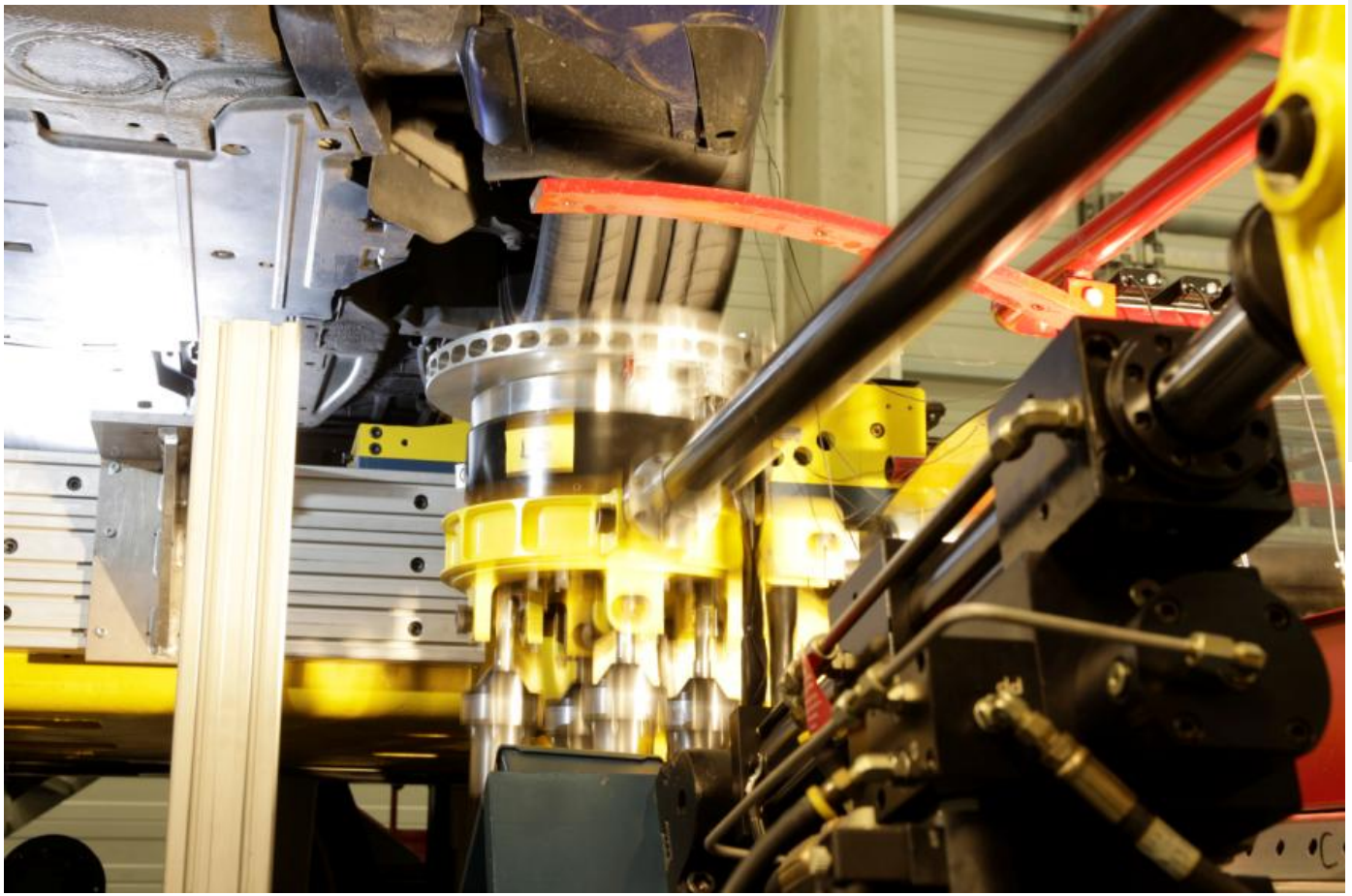

New Possibilities for Analysis Based on Dynamic K&C Data

Pascal Mast, Manager Dynamic Chassis Simulator (DCS); 2009/06/18

TÜV SÜD Automotive GmbH

New Possibilities for Analysis Based on Dynamic K&C Data

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The Challenge of Suspension Analysis

- The suspension affects two key characteristics of a vehicle: ride and handling
- Today's consumer expects a maximum of agility and comfort (=ride) and driving pleasure (=handling)
- Modern suspension systems must harmonize the traditional "opposites" of ride & handling as well as ensuring maximum safety
- Weight and CO_2 reduction requires new chassis and body concepts without disadvantages in vehicle dynamics performance

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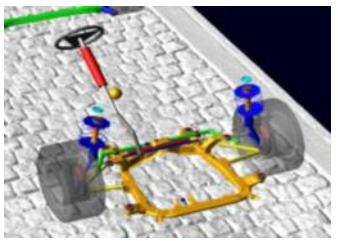
The Challenge







- Transient vehicle dynamics play an important role
- Enormous amount of dynamic phenomena must be controlled
- Parasitic effects have major impact on handling and ride
- Validated dynamic simulation models are required for cost reduction

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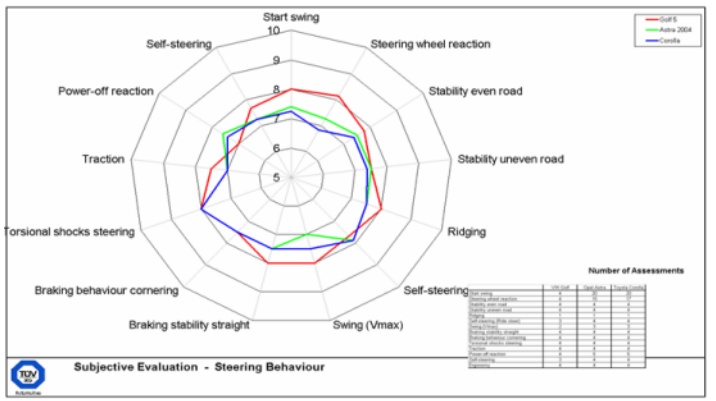
Analyses

Objective Benchmark

Measuring Placement Table — Measuring Car: X

no.	designation / measuring point (short description/installed position/ mounting position/arrangement)	range/ factor/ filter	incomming channel no.	DIAdem (Software) data-channel no.	sampling-rate (Hz)	channelname (DIAdem)	unit (phys.)	scaling	polarity (in positive direction)	symbol
general measuring points										
1	timechannel			1	-	time	s	0.005 s step	rising	t
2	longitudinal velocity	10V 1 1 kHz	0	2	200	v_x	km/h		forward	v
3	laterally velocity	10V 1 1 kHz	1	3	200	v_y	km/h		turn left	v
4	laterally acceleration	10V 1 1 kHz	2	4	200	a_y	g		turn left	a
5	yaw rate	10V 1 1 kHz	3	5	200	yaw_rate	°/s		turn left	ψ̇
6	ground to body distance right	10V 1 1 kHz	4	6	200	dist_right	mm		turn right	w
7	ground to body distance left	10V 1 1 kHz	5	7	200	dist_left	mm		turn left	w
8	steering-wheel angle low resolution	10V 1 1 kHz	6	8	200	str_angle_low	°		turn left	α

Subjective Benchmark



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Dynamic Chassis Simulator and dyn K&C Data

- Enables to analysis of dynamic kinematics & compliance and frequency response analysis for evaluation & validation
- Various application such as full vehicle as well as system and component testing
- New possibilities of researching dynamic and parasitic influences with respect to comfort, agility and safety
- Unique concept in Europe – Huge range of applications with quick measurements and advanced results

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- Force and displacement controlled, 2 x 16 channel 3D optical Krypton measurement device + further measurement device
- Direct data export to simulations software and data post processing with different software applications possible

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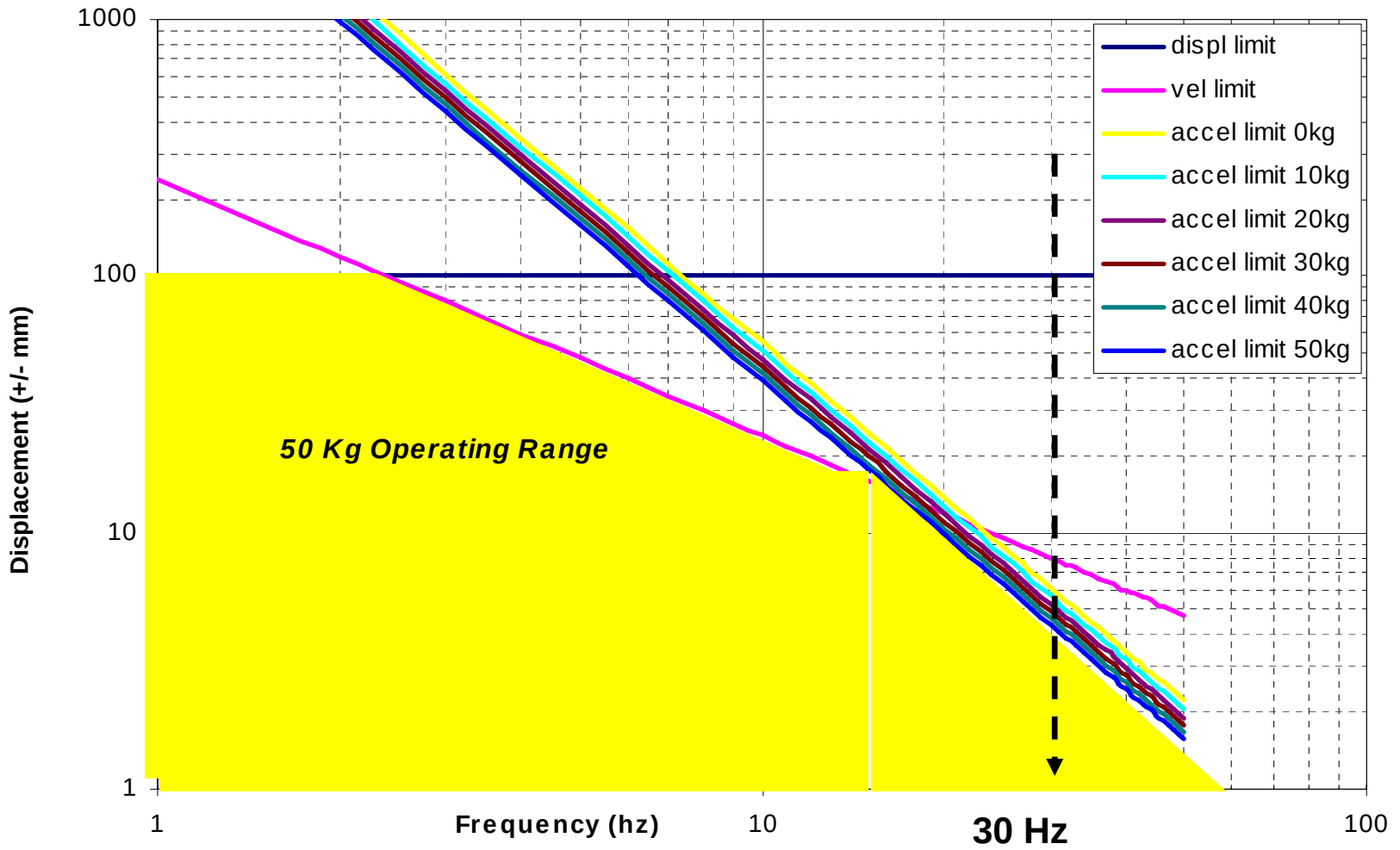
Operation area



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Dynamic Chassis Simulator and dyn K&C Data

- The dynamic K&C analysis expands the currently used static evaluation and validation processes
- It enables the comprehensive analysis of dynamic and transient characteristics.
- Investigations in single and combined directions with frequency response for handling as well as comfort aspects are feasible.
- Nonlinear effects such as hysteresis and friction can now be analyzed in more detail

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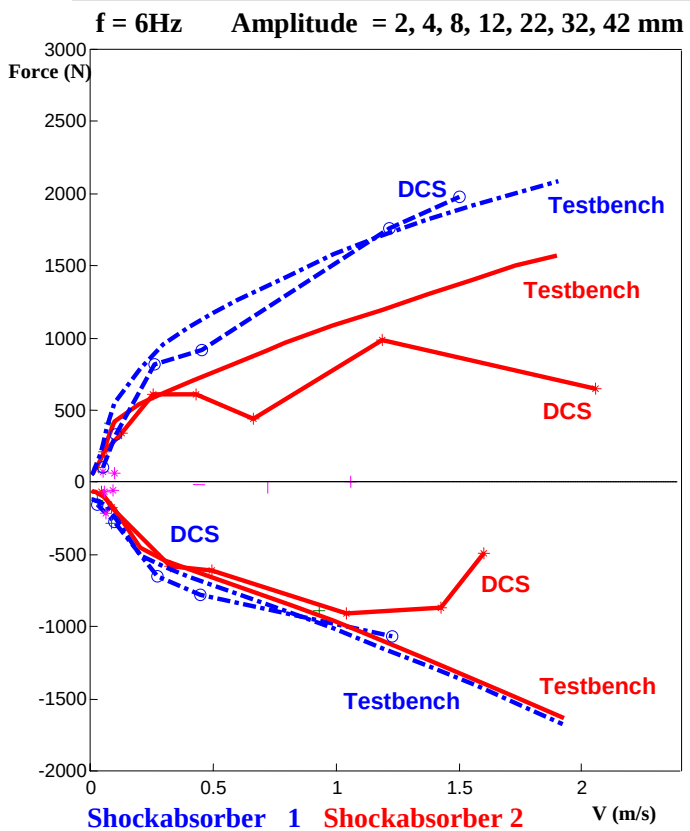
Applications

- **Damping Characteristic:**
  Comparison between Damper Dynamometer and DCS



- Analyses of Shockabsorber behaviour under real conditions
- Variable damping charateristic in combination with axle models (HIL)
- Body characteristic is considered
- Dynamic effects could be allocated

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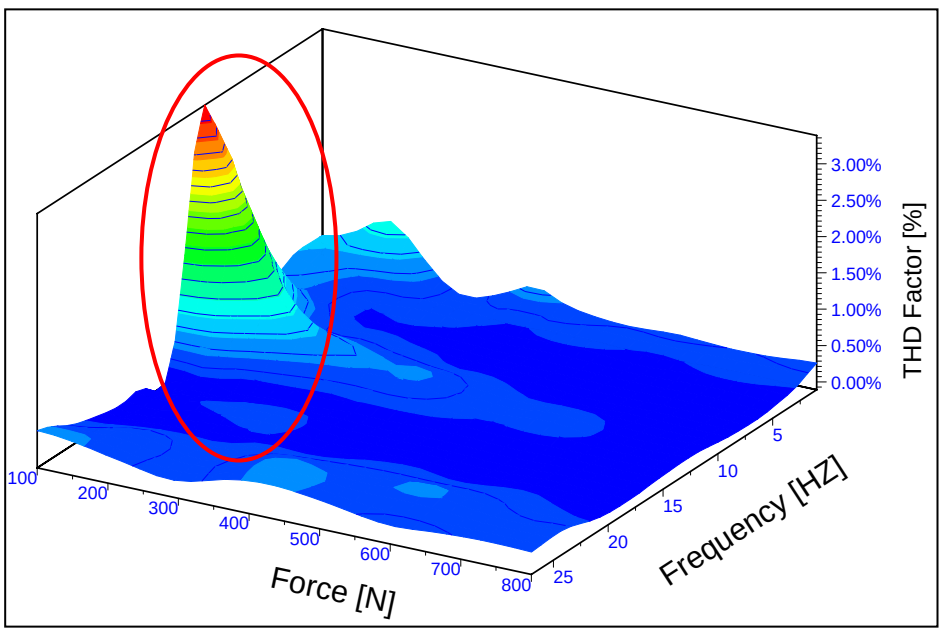
Applications

- **Steering characteristic:**
  Frequency response analyses



- Total Harmonic Distortion

$$\mathrm{THD}_{\%} = \sqrt{\frac{P_{\mathrm{h}}}{P_1}} \cdot 100$$

- Complete range of force and frequency possible

- All chassis parts are involved

- Nonlinear effects, hysteresis and friction can be analyzed in more detail, and the hole steering characteristic could be compared

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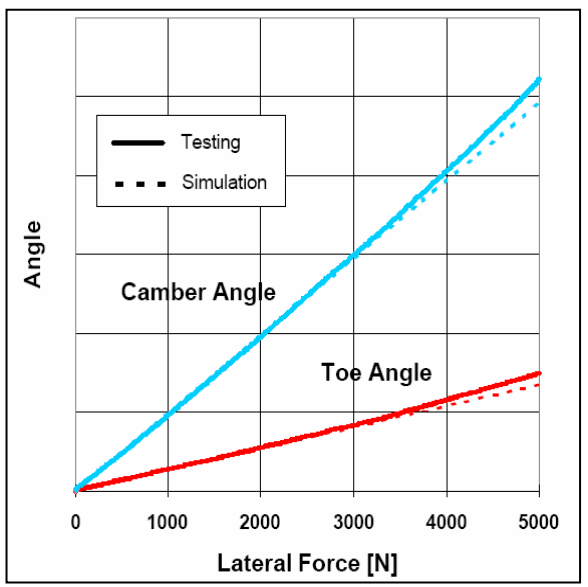
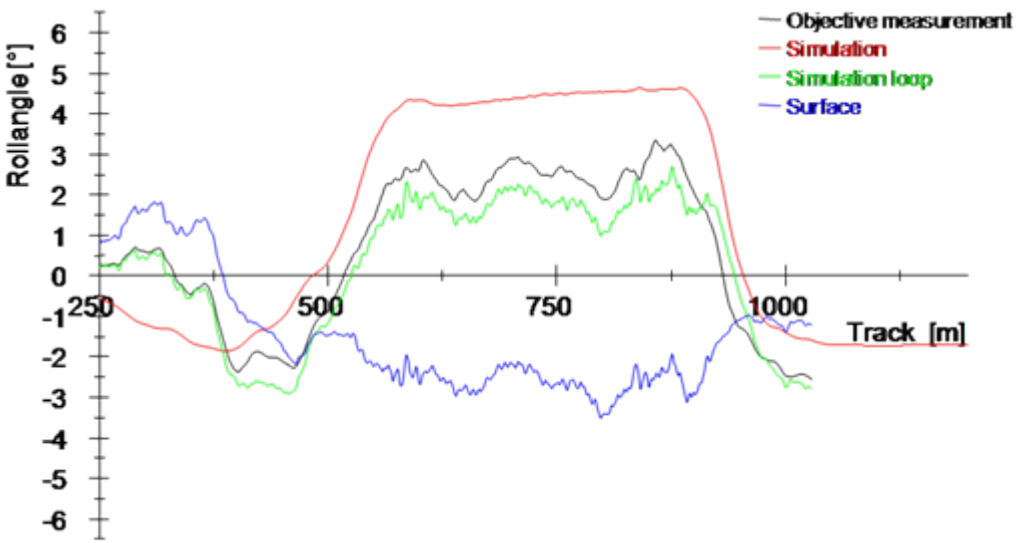
Applications

- **Virtual Vehicle:** Validated simulation models based on K&C / Damping curve / Center of gravity / Inertia axis / Objective data /





- Output: e.g.:

Toe and Camber vs. [F] Roll angle [°] vs. track [m]

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Combining the benefits of measurement and simulation

- The generated and validated axle simulation data can now be directly used for virtual driving maneuvers which are not possible on the test rig e.g. sinusoidal steer maneuver.
- The simulation results can be compared with measured track data or characteristic values.
- Objective characteristics and subjective benchmarks can be derived under realistic testing scenarios.

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Outlook and Summery

- The DCS expands the static K&C testing, rig testing and component analysis
- Based on measured results, the vehicle tuning could be done very precisely, parts could be easily changed and replaced
- The DCS combines the benefits of objective and subjective evaluation and simulation

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TÜV SÜD Automotive at TESTING EXPO 2009

- Visit us in Hall 1 Stand: 1620

- DCS Publication May 2009:
  ATZ/MTZ Special “Engineering Partners 2009”

- Internet:
  www.tuev-sued.de/automotive