Testing Facilities

Scientifically verified results

Simulation – Testing – Validation

fka has access to a unique testing and simulation infrastructure for all parts of a vehicle. Our cross-functional networking plus our close proximity to RWTH Aachen University's scientific research guarantee innovative solutions and resilient outcome.

fka

Chassis

Body Structures

Electrics / Electronics

Drive Train

Acoustics / NVH

Thermal Management

Driver Assistance

Test Track

Application

- investigation of longitudinal, lateral and vertical dynamics of passenger cars, commercial vehicles and motorcycles
- measurements of accelerated passing according to guideline DIN ISO 362 / UN/ECE R51.03)
- measurements of tyre noise and track noise
- development of control, information and communication systems
- investigation of driver-vehicle-interaction

Technical Data

- length: 400 m
- two circles:
  - diameter: 100 m
  - diameter: 40 m
- section with acoustics track (DIN ISO 10844/94):
  - width 20 m
  - length 45 m
- watering system
- low friction (µ-low) on plastic foil

Vehicle testing

Scope of testing activities

- Planing of test series & integration of measurement equipment to test vehicles
- Performance of driving tests (e. g. ISO, ECE or customer specific maneuvers)
- Post processing and evaluation of measurement data

Available measurement equipment

- Steering robot (Anthony Best Dynamics SR60)
- Measurement steering wheel (Corrsys Datron MSW)
- GPS supported Inertial Measuring Unit (IMAR iTrace F200-E)
- Optical velocity sensor (Corrsys Datron Correvit S350)
- Optical 3D-Measuring system (AICON Wheelwatch)
- Acceleration sensors (2 g, 10 g, 50 g)
- Various additional sensors and measurement components (e. g. travel sensors, pressure sensors, pedal force sensors)

Kinematic and Compliance Test Rig

Application

- kinematics and compliance investigations (K & C)
- measurement of complete vehicles or single axle modules

Technical Data

- 3D force application:
  longitudinal forces (x), lateral forces (y), vertical forces (z)
- 12 hydraulic actuators
- PC-controlled measuring procedure
- three-dimensional force and displacement measurement
- analysis of driving situations with combined load (rolling)
- max. vertical load: 13 kN
- max. horizontal load: 5 kN
- max. wheelbase: 3210 mm
- max. track width: 1640 mm

Vehicle Inertia Measurement Machine (VIMM)

Application

- measurement of vehicles, components and trailers

Technical Data

- measurement of all inertia parameters:
  - mass
  - centre of gravity position
  - moments of inertia
- servohydraulically controlled platform supported by spherical bearing
- test object weight: 300 kg – 2600 kg

Cornering & Traction Test Rig
MTS Flat-Trac IV CT plus

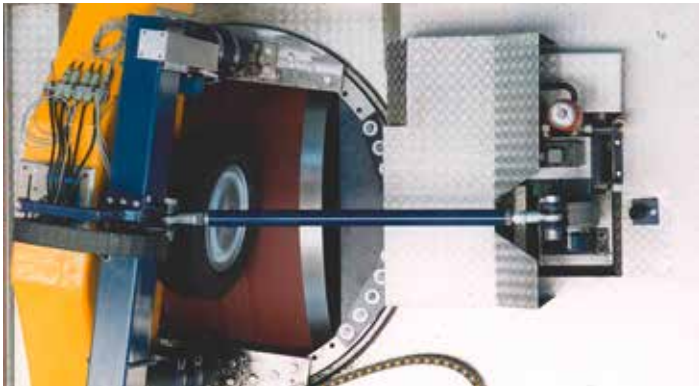
Applications

- steady-state force and moment measurement
- dynamic force and moment measurement
- slip angel sweeps tests
- tractive tests
- sinusoidal slip angle tests
- sinusoidal radial deflection tests
- simulation testing
- effective rolling radius measurement
- support of wet traction testing

Technical Data

- longitudinal force F_x: ± 18 kN
- lateral force F_y: ± 20 kN
- max. wheel load F_z: 25 kN
- wheel torque: ± 6000 Nm
- slip angle: ± 20°
  (50 °/s max velocity)
- camber angle: ± 10°
  (8 °/sec max velocity)
- roadway velocity:
  ± 250 km/h
- max. tyre outside diameter:
  910 mm
- max. loaded tyre diameter:
  910 mm
- coating: Korund 3M P120
- electric drive system

Motorcycle Tyre Test Rig



Application

- determination of force transmission behaviour
- tyre wear behaviour

Technical Data

- max. wheel load F_z: 12 kN
- tyre slip angle: - 12 ° to 12 °
  (dyn.: ± 2 ° at 5 Hz)
- camber angle: - 45 ° – + 20 °
  (dyn.: ± 5 ° at 5 Hz)
- max. speed: 180 km/h
- drum diameter: 1.59 m
- drum coating: Korund 3M P80

Truck Tyre Test Rig

Application

- determination of force transmission behaviour
- rolling resistance measurements
- determination of tyre vibration characteristics
- tyre stiffness measurements

Technical Data

- max. wheel load F_Z: 50 kN
- max. brake torque: 16 kNm
- tyre slip angle: ± 15 °
- camber angle: ± 10 °
- max. speed: 120 km/h
- max. tyre diameter: 1070 cm
- drum diameter: 2.5 m
- drum coating: Korund 3M P120
- tyre pressure control device

Stiffness Tyre Test Rig

Application

- Fully automated static vertical, lateral, longitudinal and torsional stiffness measurements of non-rolling tyre; static stiffness data on sharp obstacles; contact patch pressure distribution and geometry analysis
- Precise measurement with low displacement rates and therefore high repeatability according to OEM and typre manufacturer requirements

Technical Data

- longitudinal force F_X: 40 kN
- lateral force F_Y: 40 kN
- max. wheel load F_Z: 40 kN
- camber angle: ± 9.5 °
- steering angle: ± 80 °
- max. travel XY: ± 130 mm
- max. tyre diameter: 1430 mm
- max. tyre width: 380 mm
- tire contact surface: Korund 3M P120

Cleat Tyre Test Rig

Application

- Measurements with highest demands on structural rigidity of the test rig

Technical Data

- longitudinal force F_x: ± 20 kN
- lateral force F_y: ± 20 kN
- max. wheel load F_z: 30 kN
- max. speed: 90 km/h
- max. tyre diameter: 850 mm
- drum diameter: 1.59 m
- drum coating: steel
- retention force of the clamp unit (μ = 0.3): 240 kN

Mobile Tyre Test Trailer

Application

- determination of tyre characteristics on real road surfaces and outer drum
- determination of tyre characteristics in different weather conditions
- rolling resistance measurements

Technical Data

- longitudinal force F_x: ± 40 kN
- lateral force F_y: ± 40 kN
- max. wheel load F_z: 60 kN
- max. braking torque: 25 kNm
- tyre slip angle: ± 45 °, 2 °/s
- camber angle: ± 10 °
  - camber axis on road surface
- max. speed: 90 km/h
- wheel diameter: 560 mm – 1240 mm
- dynamic wheel load control for higher measurement accuracy

Linear Friction Test Rig

Application

- investigation of different friction conditions
- investigation of influence of temperature on rubber friction
- investigation of influence of road roughness on friction coefficient

Technical Data

- specimen size: 60 mm x 60 mm
- pressure: 0.3 bar – 3.5 bar
- speed: 0.001 m/s – 1.5 m/s
- max. temperature: 80 °C
- 3D force measurement: ± 2000 N
- accuracy: ± 0.1 %
- device is portable

Dynamic Vertical Excitation Test Rig

Application

- investigation of highly dynamic stiffness and damping characteristics of passenger car and motorsports tyres
- investigation of the influence of wheel load fluctuations on side force generation
- vertical excitation up to 50 Hz, with or without slip angle

Technical Data

- max. wheel load F_z: 20 kN
- static side slip angle: ± 6 °
- max. speed: 120 km/h
- wheel dimensions: 13 " – 20 "
- drum diameter: 2.5 m
- max. excitation frequency: 50 Hz (depending on wheel mass and amplitude)

Servo Hydraulic Test Centre

Application

- endurance strength investigation of complete vehicles, vehicle structures and components
- investigation of vehicle comfort characteristics
- determination of material parameters
- material property identification
- quasistatical crush testing for analyzing of body-in-white deformation and specimen deformation behavior (e. g. FMVSS 214)

Technical Data

- modular test bench system for individual testing
- 2 sprung foundations: 15 m x 6 m and 4 m x 3 m
- 20 hydraulic cylinders:
  - force: 10 kN – 350 kN
  - stroke: 100 mm – 1000 mm
  - frequency: f_{max} 150 Hz
- variable climate boxes
- 8 MTS-Flextest control loops (position- and force control, RPC for iteration further signals)

Crash Test Facility

Application

- full vehicle crash tests according to current standards (e. g. FMVSS 208, offset & pole impact)
- component and sled tests (e. g. AZT, IIHS, RCAR, ECE-R42 "Pendulum Tests")
- individual test configurations (e. g. kerb impact)
- measuring data analysis and reporting
- video data analysis (2D tracking of any number of crash marker (relatively and absolutely), measuring data and video data synchronization, storaging in iso-mme format)

Technical Data

- track: 50 m
- max. impact speed: 80 km/h
- max. sled weight: 4000 kg
- 2 crash-resistant onboard measuring systems with 32 channels each (max. 100 kHz/channel)
- 3-axial forces measurements of up to four load pathes and additionall two 6-axial load cells (F_x = 400 kN, M_y = M_z = 8 kNm)
- film pit
- digital high-speed video cameras with max. 5000 fps
- variable crash sleds with adjustable mass, centre of gravity, track width, wheel base and tyre dimensions

Drop Tower Test Bench

Application

- analysis of the energy absorption capability of structures and materials
- cost-efficient substitution of crash repair tests
- reproduction of impact configurations for pedestrian protection

Technical Data

- drop weights: 3.5 kg – 800 kg
- max. impact velocity: 42 km/h
- collection of impactor deceleration, impactor travel and reaction forces with 100 kHz
- digital highspeed video cameras with max. 5000 fps
- max. deformation: 500 mm

Pedestrian Protection Test Bench

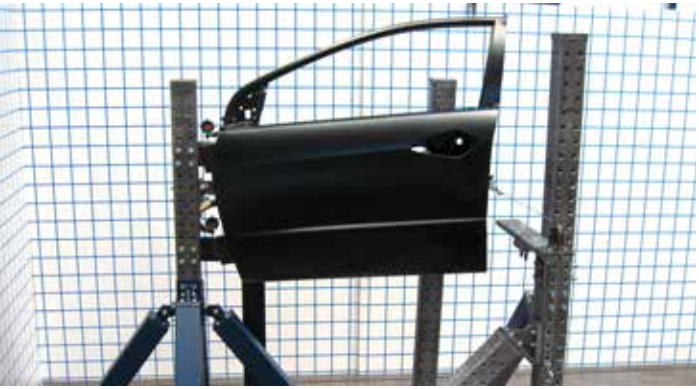
Application

- testing of pedestrian protection with head impactors according to:
  - 2009/78/EC
  - EURO NCAP
  - GTR No. 9

Technical Data

- max. impact speed: 45 km/h
- impact angle: 0 ° – 70 °
- head impactor according to the test procedure (e. g. 3.5 kg or 4.5 kg head impactor with sensors)
- sampling frequency: 100 kHz
- digital high-speed video system with max. 5000 fps

Body Components Benchmarking



Application

- determination of global stiffnesses of closures

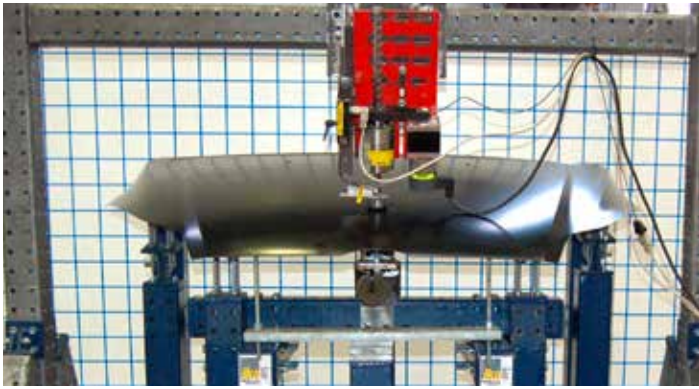
Load Cases Hoods/Tailgates

- torsional stiffness
- longitudinal stiffness
- lateral stiffness

Load Cases Doors

- window frame stiffness
- door sag
- over opening
- beltline stiffness

Denting Test Benches



Application

- determination of oil canning and dent resistance
- analysis of closures of any vehicle classes
- measurement of the deflection using a laser measuring device
- use of different indenters for oil canning and dent resistance
- execution of hailstorm tests using special steel balls

Body Stiffness Test Bench

Application

- determination of torsion and bending stiffness of body in white with and without hang-on parts
- determination of stiffness courses

Technical Data

- max. vehicle length: 6 m
- application of torsion moments of 1000 Nm, 2000 Nm and 3000 Nm in the strut towers of the body
- measuring of the deflections at about 60 measuring points

Optical Measuring Methods

GOM TRITOP

Application

- measuring of 3D component deformations and motions
- simultaneous analysis of multiple measuring locations at the same time

Technical Data

- measuring accuracy: 0.2 mm

GOM ATOS

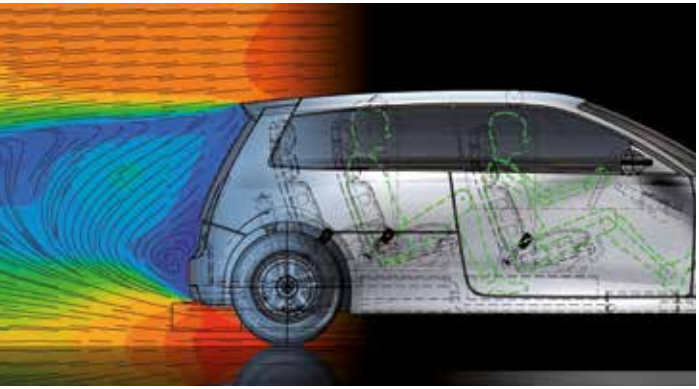
Application

- digitising of any geometries of body, drivetrain, chassis, electronics and interior components
- representation of component geometries as STL point clouds
- polygonised display of component geometry as a basis for CAD and FE modelling
- quality check (direct comparison of identical component geometries and dimensions for the assessment of deviations)

Technical Data

- two measuring areas: 500 mm x 400 mm and 1000 mm x 800 mm
- measuring accuracy: 0.1 mm (according to VDI directive VDI 2634)

CAE Tools



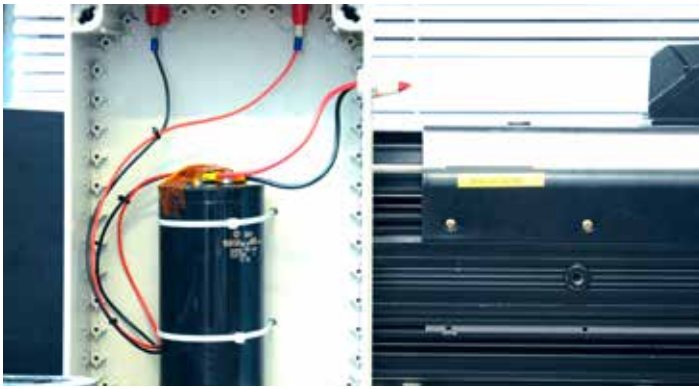
Application

- linear and non-linear structural analysis
- crash and fatigue simulation
- modal analysis and noise emission
- simulation of torsional oscillations in drive systems
- simulation of longitudinal and lateral dynamics
- traffic-flow simulation
- aerodynamic analysis
- 2D-tracking for crashtesting
- analyzing and reporting of measurements and measurement, control and monitoring systems

Software Tools

- CATIA, ProEngineer
- HyperWorks, Primer
- ABAQUS/Implicit, ANSYS, NASTRAN, OptiStruct
- ABAQUS/Explicit, LS-DYNA, MADYMO, PAM-CRASH, RADIOSS
- ADAMS-CAR, CarMaker
- Matlab-Simulink, Dymola, Modelica
- PELOPS
- StarCCM+, AcuSolve
- LMS Virtual.Lab
- Signum Bildtechnik Motion Analysis
- National Instruments LabVIEW und DIAdem

Battery Conditioning and Powernet Testing



Application

- verification of vehicle powernet topologies (12 V / 48 V), operating strategies and components
- controlled charging/discharging and cyclic conditioning of batteries to desired state of charge (SoC)
- testing of inductive charging systems and analysis of effects on the vehicle powernet

Technical Data

- charging by the use of standard battery chargers or power supplies up to 400 A
- discharging with constant current (600 A), constant resistance and constant power (5.6 kW)
- max. engine load emulation: 18 kW
- verification of 12 V / 48 V topologies
- components featuring diverse communication interfaces can be integrated in test setup
- induktive charging with up to 7.2 kW at 85 kHz
  - automatic position measurements (0.125 mm)

Dynamic Transmission and Axis Test Benches

Testobjects

- drivesystems
- drivetrain components
- supply of DC-power up to 1000 V, 1000 A

Application

- transient road tests similar to the test track
- function study and characteristic behaviour / performance of drive train components
- endurance strength with and without time scaling
- power output and efficiency measurements
- energy and fuel consumption
- structure-borne noise measurements and transfer path

Technical Data

- max. driving power: 500 kW
- braking power: 2 x 560 kW
- max. velocity: approx. 340 km/h
- max. wheel torque: 4700 Nm

Test Bench Infrastructure

Available components

- micro drive for auxiliary power and towing capacity measurements
- high-precision torque measurement technique (HBM T12)
- analysers for electrical power output measurements 1- and 3-phase (ZES Zimmer)
- flow-rate meter for fuel consumption measurements (Pierburg PLU, Swissline Uniflowmaster)
- damage early detection system, level- and spectrum based (RedAnt MIG16)
- device for application of axle loads to the tested (commercial/ utility) vehicle axis
- gear shift automat (GIF GSE2)
- adaption gear to adapt the test item characteristics to the testing machine (high revolution, high torque, ...)

Four-wheel Test Bench

Testobjects

- complete vehicles
- drivesystems
- drivetrain components
- supply of DC-power up to 1000 V, 1000 A

Application

- transient road tests analog to test track
- benchmarking of operation strategies
- function study and characteristic behavior / performance of drive train components
- endurance strength with and without time scaling
- power output and efficiency measurements
- energy and fuel consumption
- noise analysis

Technical Data

- max. driving power: 330 kW
- braking power: 4 x 120 kW
- max. velocity: approx. 250 km/h
- simulated vehicle mass: 600 kg – 3000 kg
- max. wheel torque: 1800 Nm (respectively 6255 Nm)

Dynamic Roller Test Bench

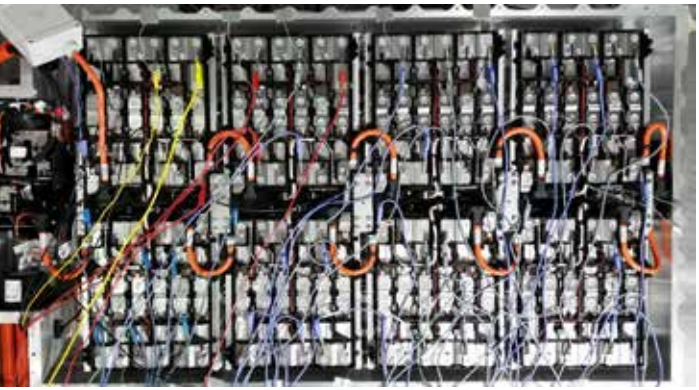
Application

- testing of conventional and alternative drive systems
- analysis of energy consumption
- noise and vibration analysis
- function development and application

Technical Data

- max. speed: 200 km/h
- max. static axle load: 3000 kg
- flywheel classes: 450 kg – 2270 kg
- max. tractive-resistance losses: 60 kW
- max. traction force: 1700 N
- terminal box of battery simulation system

Battery Test and Simulation System I



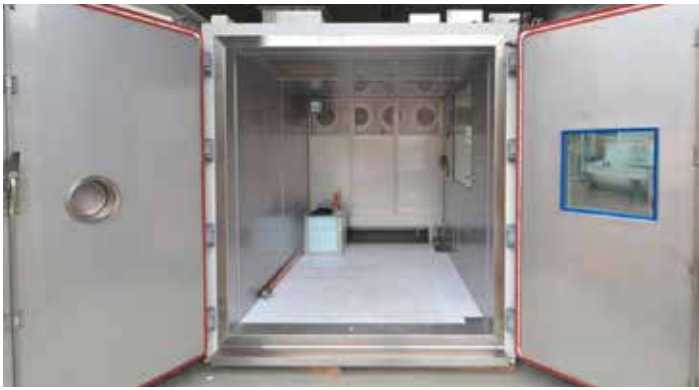
Application

- characterisation of energy storages
- simulation of energy storages
- voltage source/sink to implement high voltage components
- combinable with other test benches

Technical Data

- voltage range: 0 V – 650 V
- current range: ±1 A – 400 A
- dynamics (0 % – 95 % scheduled value): 0.1 s
- CAN-interface to connect with battery management systems

Battery Test and Simulation System II



Application

- characterisation of energy storages including a cooling system under varying climatic conditions
- development and testing of cooling systems and thermal management systems
- development and testing of battery management systems
- simulation of energy storage systems based on Matlab/Simulink models

Technical Data Battery Tester

- voltage range: 10 V – 1000 V
- current range: ± 1000 A
- max. power: ± 400 kW
- dynamics (load step 10 % – 90 %): 1 ms
- interface to Matlab/ Simulink
- rest bus simulation

Climatic Chamber

- inner dimensions (w/d/h): 2 m x 2.50 m x 2.20 m
- temperature range: - 40 °C – 70 °C
- humidity range: 10 % – 95 % rel. humidity
- dew point range: 5 °C – 68.8 °C
- dynamics: 2 K/min
- testing up to hazard level 6 possible

Psycho Acoustics Laboratory

Application

- binaural analysis of interior and exterior noises
- subjective noise evaluation
- sound design

Technical Data

- presentation room providing a video screen
- separated control room
- software: Head Acoustics ArtemiS
- artificial head systems

Acoustic Parameter Test Benches

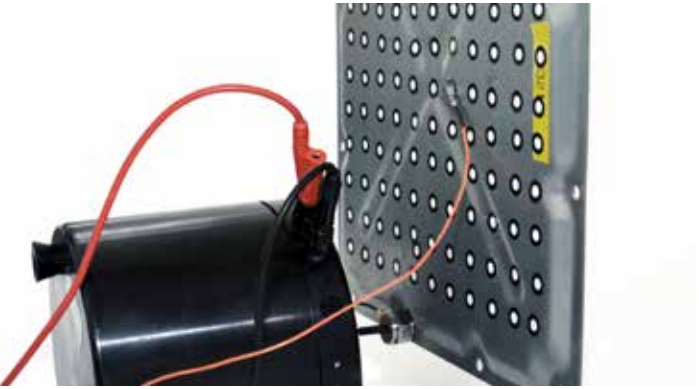
Reverberation Room / Window Test Bench

- transmission loss and sound radiation characteristics determination of materials or components
- airborne noise excitation with frequency range up to 16 kHz
- structure-borne vibration excitation by electro dynamic shakers with forces up to 2.7 kN and frequency range up to 10 kHz
- measurement equipment: microphones, sound intensity probe, laser vibrometer
- reverberation room
  - max. window size: 2.2 m x 1.9 m
  - volume: 7.4 m^3
  - mass: 7.5 t

Impedance Tube including Transmission Loss Kit

- determination of acoustic parameters (e. g. sound absorption, transmission loss etc.)
- measurement according to DIN ISO 10534-2 and ASTM E2611-09
- specimen diameter: 29 mm and 100 mm
- data acquisition system
  - dynamic: 160 dB
  - sampling rate: 51.2 kHz
  - resolution: 24 bit

Modal Analysis and Transfer Path Analysis

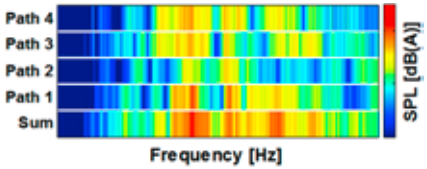


Modal Analysis

- experimental and virtual determination of eigenfrequencies, natural modes and modal damping
- vibration excitation via shaker and impulse hammer
- system response measurement with acceleration sensors or laser vibrometer
- simulation with established FEM software, e. g. Abaqus, Nastran, Optistruct

Transfer Path Analysis (TPA)

- full vehicle investigation of the vibration and noise transfer paths
- vibration excitation via shaker, impulse hammer and airborne noise source
- binaural noise measurement with artificial head system
- data acquisition with up to 136 channels
- different software for current TPA methods available, e. g. matrix inversion (principle components analysis as option) or stiffness method



CV-joint Test Bench for Functional Tests

Application

- joint efficiency tests (caloric test method)
- 3rd order axial force measurements
- plunging force measurements
- joint types:
  - ball joints
  - tripo joints
  - cardan joints
  - prototype joints
- joint benchmarking

Technical Data

- speed: 0 min^{-1} – 1000 min^{-1}
- torque: 0 Nm – 1000 Nm
- plunging excitation: 0.1 mm – 15 mm
- plunging frequency: 0 Hz – 50 Hz
- bending angle: 0 ° – 20 °
- joint temperatures: 20 °C – 140 °C

Thermal Conductivity Test Bench

Application

- heat flux coefficient determination for different materials and material combinations
- contact resistance determination for different surface combinations as function of the contact pressure

Technical Data

- temperature range: -20 °C – 200 °C
- pressure range: 0 bar – 10 bar
- test sample geometry: 50 mm x 50 mm x (1 – 50) mm

Spray Truck

Application

- artificial generation of spray cloud
- testing and evaluation of driver assistance systems and environmental sensors

Technical Data

- basic vehicle: Mercedes Benz SK 2448
- 6 water tanks with 1000 l each
- power of the pump: 600 l/min
- water pressure: 6 bar
- 5 separate switchable circles for different spray cloud configurations
- different nozzle configuration for the variation to the spray density

ADAS-Testing Trucks
IVECO Stralis 500 und 480

Application

- development and evaluation of driver assistance systems
- component tests (sensors, control algorithm etc.)
- analysis of driver behavior

Available functions

- ACC with Stop&Go, Lane Keeping Assist (car / trucks)
- Platooning (trucks)
- AEB (car)
- Traffic Jam Assist (car)
- fully automated parking (car)
- automated valet parking (car)
- trajectory planning- and following-controller for automated driving (car)

Technical Data Testing Trucks

- interface for full braking & max. acceleration
- EHPS with torque superposition and steering angle and torque interface (up to 12 Nm)
- integrated lidar and radar sensors
- mono camera with integrated lane detection
- V2V and V2X communication
- dSpace Autobox: model based development (Simulink)

ADAS-Testing Car
Passat

Technical Data Testing Car

- acceleration interface (-3.5 m/s² – 2.5 m/s²)
- brake booster (full deceleration capability)
- electric accelerator pedal for acceleration
- EPS with steering angle and torque interface
- Shift-By-Wire interface
- 6 radar sensors (4 x short range, 2 x mid/long range)
- 1 laser scanner (front facing)
- 12 ultrasonic sensors
- mono camera with integrated lane- and object detection
- mono camera for algorithm development
- dSpace MicroAutobox/MPC565: model based (Simulink/C)
- Vehicle-PC: EB Assist ADTF & Robot Operating System (ROS)

Optional measurement instrumentation

- 2 Velodyne VLP-16 laser scanner
- RTK-GPS: OXTS RT3003 (with SmaRT-Range for target vehicle)
- Smart Eye eyetracker
- V2X communication: Cohda Mk5 Onboard Unit
  - ITS-G5 and WAVE protocol using 802.11p
  - Standardised (CAM, DENM, SPAT etc.) & free defined message format

Tools for Evaluation and Validation of ADAS Sensors and Functions

Application

- sensor tests (radar, lidar, image processing)
- ACC evaluation
- AEB evaluation according to Euro NCAP protocol
- evaluation of driver behaviour

Technical Data

- sensor target reflectors
- lane markings
- balloon cars
- dynamic slab car
- Oxts RT3003 RTK-GPS with SmaRT-Range
- scenario catalogue
- test tracks

Static Driving Simulator

Application

- Driver behavior analysis
- HMI usability and acceptance studies
- Support in early decision phases for Development of new assistance systems
- Demonstration of not yet secured or incomplete Systems

Technical Data

- Different, interchangeable mock-ups (full-size & half-size)
- Freely programmable displays (Instrument Cluster & Centerdisplay)
- PC-supported 5.1 noise simulation
- I-Beam structure-borne sound transducer
- 3 channel front projection
- perspective split rear projection
- 220°x40° Field of View
- Use of real rearview mirror & mirror replacement system possible
- Separate test person rooms
- 16 years of experience

Optional measurement technology

- Remote eye tracking system from Smarteye
- Tobii Pro Glasses for eye tracking

Highly Dynamic Driving Simulator

Application

- driver behaviour analysis
- driver assistance systems assessment
- demonstration of future steering and control concepts
- "time machine" for future mobility and vehicle concepts

Technical Data

- unscaled motion simulation of highly dynamic driving manoeuvers
- hexapod on y-table
- acceleration: approx. 10 m/s² (at 1000 kg payload)
- speed: approx. 10 m/s (at 1000 kg payload)
- max. payload: about 2000 kg
- eyetracker: SmartEye Pro 6.0
- dome diameter: 7.0 m
- max. mockup height: 1.90 m
- fits SUVs
- field of view: 360 ° x 45 °

V2X Communication

Application

- evaluation and development of connected ADAS
- evaluation and analysis of V2X hardware

Technical Data

- completely covered test track with DSRC (ITS 5G Standard) and numerous track elements
- traffic signals in public traffic with V2X communication
- highly flexible mobile cooperative traffic signal for test track
- research intersection with permanently installed traffic light system with 6 signal groups and connection to V2X roadside units
- processing of standardized (e. g. CAM, DENM, SPAT) and also proprietary messages
- Cohda wireless communication devices for data exchange according to European (ETSI ITS G5) and American (SAE J2735 WAVE) standard based on 802.11p WiFi
- road side units mounted on flexible tripod with power supply
- reference sensor systems for motion measurements of e. g. pedestrians or cyclists and allocation of the data via V2X communication
- Vector CANoe software with C2X interface

fka
Steinbachstr. 7
52074 Aachen
Germany

+49 241 8861 0
info@fka.de
www.fka.de
www.fka.de/xing
www.fka.de/linkedin