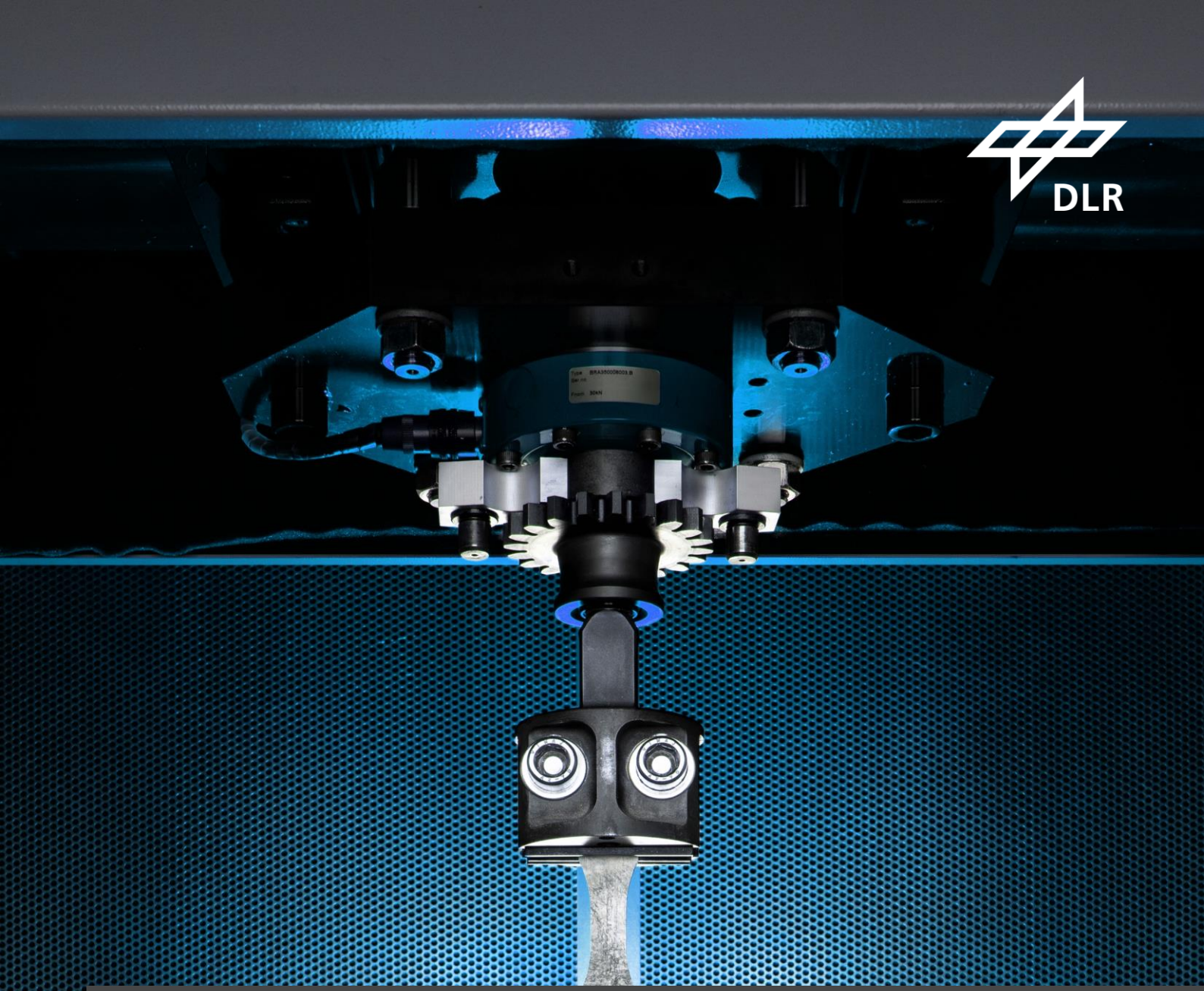

Overview of equipment and test facilities at the Institute for Vehicle Concepts

Technical data of the systems and equipment

Institute of Vehicle Concepts

Test benches of the Institute of Vehicle Concepts

We want to contribute to solving the major social challenges of our time. Topics such as climate protection, digitalisation and the availability of resources will determine our actions in the future.

The aim of engineering science is to shape the mobility of the future together with people around people. For this and many other reasons, mobility is in a process of constant change and optimisation.

To support this process, the Institute of Vehicle Concepts has an extensive portfolio of test benches. These test benches can be used to examine, characterise and optimise both partial and complete systems. Application clusters are focused on vehicle technologies in the road and rail sectors. Thanks to the institute's research activities, the test bench landscape is equipped with extensive measurement technology. The test facilities also offer a high degree of flexibility with regard to the test specimens to be analysed.

THE EQUIPMENT ENABLES RESEARCH INTO COMPLEX, TECHNOLOGY-INTENSIVE TASKS:

- Verification and validation of research and development solutions in the field of vehicle technologies for road and rail transport
- Development and application of new test procedures
- Support for complex technology topics through specialised testing

We are also happy to customise our test benches to your measurement requirements. Please contact us directly for a personalised consultation:

Kontakt-FK@dlr.de || Phone: 0711 6862 256

Institute of Vehicle Concepts

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Institute of Vehicle Concepts

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Institute of Vehicle Concepts

Chassis dynamometer with climate chamber

Technical data of the system and equipment

AREAS OF APPLICATION	
	Testing of research and prototype vehicles
	Range and consumption measurement
	Emission measurement (exhaust and non-exhaust)
ROLLER	
Type	4 independent driven 48" rollers
Vehicle class	Subcompact to small transporter
Drive	Front, rear, all-wheel drive
Continuous power	100 kW per roller (200 kW/axle)
Max. speed	200 km/h
Max. Tractive force	per roll 3,600 N
Vehicle mass	450 kg – 4.500 kg
Wheelbase	1,6 m – 4 m
Acceleration	4 m/s^2
CLIMATE CHAMBER	
Size	9,5 m x 5,5 m x 2,8 m
Temperature range	- 40 °C to +60 °C
Temperature deviation	< ±1 °C
Humidity range	0 to 80 % rel. humidity
Recirculated air volume	30000 m^3/h
AIRSTREAM BLOWER WLTP conformityy	
Air flow	41.660 m^3/h
Air velocity	0 - 135 km/h regulated
ANALYSIS MEASUREMENT TECHNOLOGY	
Exhaust gases	MEXA FTiR and PEMS
Non-Exhaust	CPC, OPS, PM10, PM2,5, EPLI+, DMS500
TRWP	DLR TRWP Measurement Method and System
Hydrogen	EI-Sense mass spectrometry
Electric	AC and DC charging power, energy minotoring
FUEL CONSUMPTION MEASUREMENT	
Hydrogen	Gravimetric and continuous via coriolis
other	Natural gas, methan, mixtures

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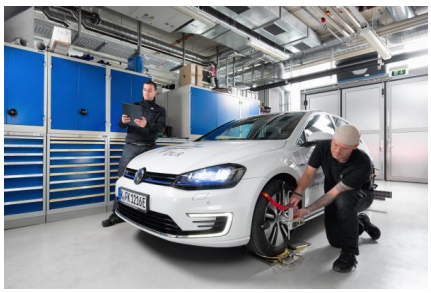
Four-engine all-wheel roller

Institute of Vehicle Concepts

Automotive workshop for prototypes

Technical data of the system and equipment

APPLICATION AREAS	
	Project-related conversions to vehicles, including electric and fuel cell vehicles
	Specific adaptations and modifications for research vehicles
TYRE BALANCING MACHINE	
	Max. wheel weight 70 kg
	Up to 22 inch rim width
	Max. Rim diameter 30 inch
TYRE FITTING MACHINE	
	Rim diameter 8 - 32 inch
	Max. Rim width 17 inch
LARGE STOCK OF MANUAL MACHINES AND TOOLS	
Conventional lathe machine	Work area H 2000 mm x W 2200 mm x D 1900 mm
Conventional milling machine	Work area H 2100 mm x W 2500 mm x D 1900 mm
COLUMN DRILL MACHINE	
LAUNCH DIAGNOSTIC DEVICE	
	Read out fault memory
	Read out and export data streams
	Service functions
BRAKE BLEEDING DEVICE	
MOBILE LIFTING PLATFORM	
	max. weight 2750 kg
AIR CONDITIONING SERVICE UNIT	
	Designed for refrigerant r1234yf
WHEEL ALIGNER	
	Mobile wheel aligner for basic suspension settings
QUICK START CHARGER	
	For 12 and 24 volt vehicle electrical systems



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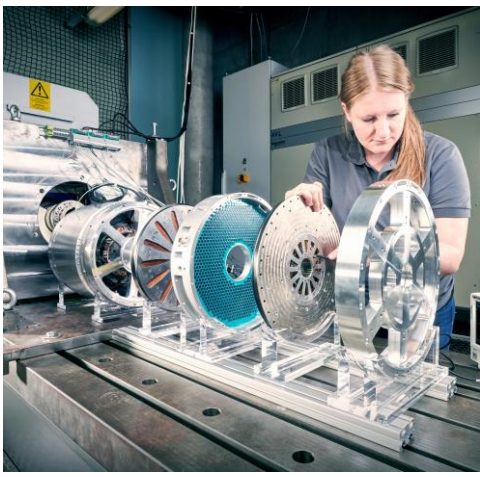
Automotive workshop for prototypes

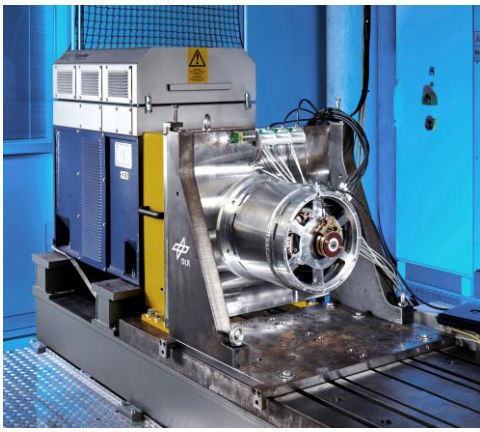
Institute of Vehicle Concepts

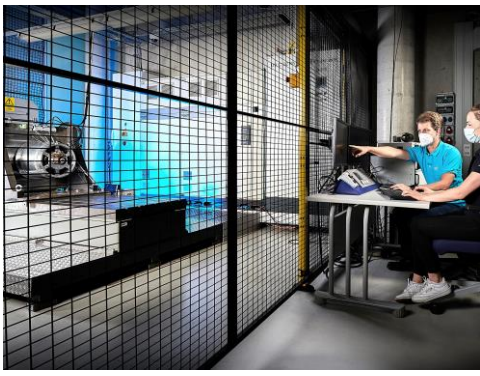
Electric motor test bench - Stuttgart

Technical data of the system and equipment

AREAS OF APPLICATION	
	Power and efficiency measurement of electrical machines
	Thermal measurement, cycle evaluation
TECHNICAL DATA	
Maximum drive power	220 kW
Maximum speed	12.000 U/min
Maximum torque	525 Nm
Shaft connection	Taper bush or custom solution
AVAILABLE COMPONENTS	
Inverter	CAN, RS422
Input voltage	0-850 V
Power output	160 kW
Output voltage	560 V AC
Output current	270 A Eff
Rotary encoder	Endat compatible
DC source	
Performance	250 kW
Current	600 A
Voltage	5 – 1000 V
Cooling water temperature control	90 kW cooling capacity / 6 kW heating capacity
Flow rate	up to 60 l/min
Pressure range	up to 3,8 bar
Temperature range	20-90 degrees
Auxiliary voltage	5, 12, 24, 48 and 72 V
Measurement technology	HBM GEN7ta (CAN acquisition, 6 phases)
Sampling rate	2 MS/s
Software	Perception
Sensors	LEM converter CT500 (500Aac) / CT100 (100Aac rms)
Torque range	HBM T40B 1000Nm
Temperature	Thermocouples type K







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Application example heavy commercial vehicles

Institute of Vehicle Concepts

Electric motor test bench- Ilmenau

Technical data of the system and equipment

AREAS OF APPLICATION	
	Power and efficiency measurement of electrical machines
	Thermal measurement
TECHNICAL DATA	
Maximum drive power	400 kW
Maximum speed	8.000 U/min
Maximum torque	3000 Nm
Shaft connection	Clamping hub or custom solution
AVAILABLE COMPONENTS	
Inverter	CAN, RS422
Input voltage	0-850 V
Power output	160 kW / 320 kW
Output voltage	560 V AC
Output current	270 A Eff
Rotary encoder	Endat compatible
DC source	
Performance	120 kW
Current	720 A
Voltage	0 – 1000 V
Cooling water temperature control	90 kW cooling capacity / 6 kW heating capacity
Flow rate	up to 60 l/min
Pressure range	up to 3.8 bar
Temperature range	6-90 degrees
Auxiliary voltage	5, 12, 24, 48 and 72 V
Measurement technology	HBM GEN7ta (CAN detection, 6 phases)
Sampling rate	2 MS/s
Software	Perception
Sensors	LEM transducer IN500 (500Aac rms)
Torque range	Kistler 50 / 100 / 500 / 3000 Nm
Temperature	Thermocouples type K

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Application example heavy commercial vehicles

Institute of Vehicle Concepts

NVH analysis / vibration measurement

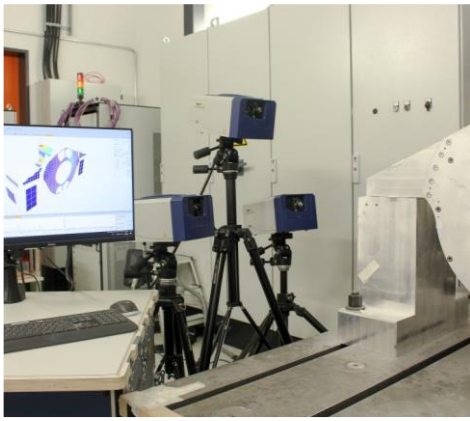
Technical data of the system and equipment

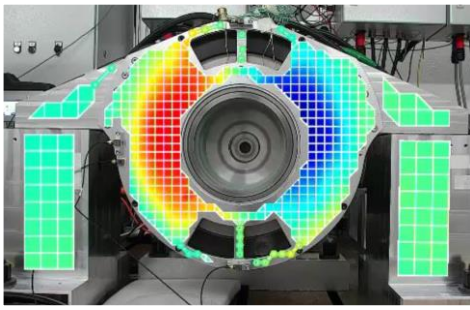
AREAS OF APPLICATION	
	Vibration measurement
	Harmonics of mechanical excitation
	Harmonics of electromagnetic excitation
	Evaluation of mechanical noise sources
	Modal analysis

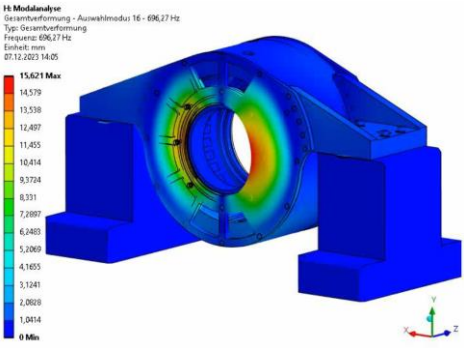
POLYTEC PSV QTEC SCANNING VIBROMETER	
Frequency range	up to 20 kHz
Resolution range	24 bit
Velocity measuring range	25 mm/s to 12,5 m/s
Scan angle H x V	50° x 40°
Shortest measuring distance	125 mm
Accessories	Modal hammer, reference sensor

ACCELEROMETER HBK 4528-B-001	
Quantity	4 pieces (can be used simultaneously)
Frequency range X, Y	0,3 Hz to 10 kHz
Frequency range Z	0,3 Hz to 12,8 kHz
Max. acceleration	700 m/s² (71 g)
Operating temperature	-60 to +165 °C

EVALUATION SOFTWARE	
	BK Connect







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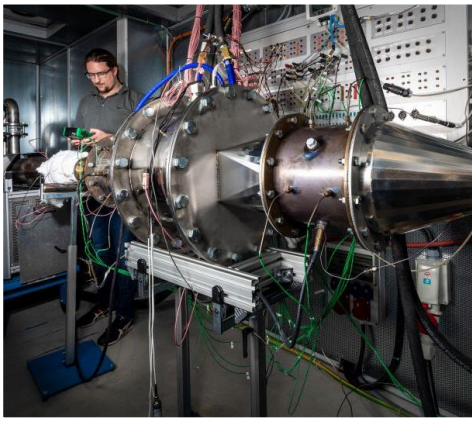
[Application example of heavy commercial vehicles]

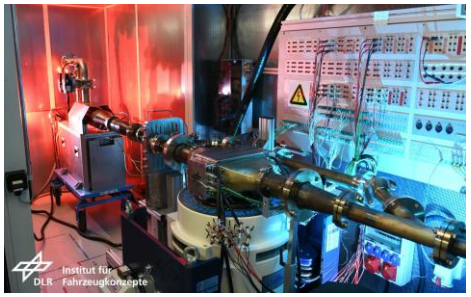
Institute of Vehicle Concepts

Hot gas test bench

Technical data of the system and equipment

APPLICATION AREAS	
	Thermodynamic investigation of thermoelectric generators
	Testing of components of the exhaust gas train
	Heat generation
	Simulation of the exhaust gas temperature in the driving cycle
	Thermal shock tests
HOT GAS BURNER	
Power output	2 - 200 kW
Temperature range	100 – 1200 °C
Mass flow	30 – 1000 kg/h
	High dynamics due to bypass
MODULAR MEASUREMENT TECHNOLOGY	
	90x thermocouples type N
	50x thermocouples type K
	4x current measurements
	20x voltage measurements
	5x absolute pressure measurements
	4x differential pressure measurements
	10x force measurements (strain gauge)
ELECTRICAL VEHICLE ELECTRICAL SYSTEM	
Nominal power	4x 400 W, 1x 1500 W
Current	max. 4x 52 A, 1x 200 A
Voltage	max. 4x 60 V, 1x 80 V
Resistance	0-100 Ω
COOLING SYSTEM	
Cooling capacity	max. 160 kW
Heating capacity	max. 20 kW
Pumping capacity	max. 200 l/min (max. 8,7 bar)
Temperature range	10-110 °C
COMPONENT TEST BENCH	
Temperature	max. 1000 °C
Thermal output	max. 2x 5000 W
Vacuum housing	bis -950 mbar
Contact pressure	max. 125 kN
FURTHER TEST EQUIPMENT	
	Shaker
	Long-term test bench





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Hot gas test bench

Institute of Vehicle Concepts

Thermal high-performance storage for vehicle application

Technical data of the system and equipment

APPLICATION AREAS	
	Experimental investigation and measurement of thermal storages with metallic phase change materials
	Endurance tests and cycling
	Measuring of heating systems in vehicles such as buses and trains
	Precise temperature measurement at high temperatures
MEASUREMENT	
Measurement data acquisition	Delphin Expert Logger 400 + various slave modules
Test bench control	Delphin ProfiSignal
Temperature measurement	60x thermocouple type N
Air mass flow measurement	Measuring sections with Höntzsch TA10 probe
Pressure measurement	Absolute and differential pressure measurement: Kimo C310
Current measurement	1-phase up to 5 A, 3-phase up to 63 A
Auxiliary voltage	5 V, 12 V, 24 V
ELECTRICAL HEATING	
AC	Up to 20 kW
DC	Up to 250 kW
COOLANT SUPPLY	
Cooling capacity of cooling water	Max. 50 kW
Temperature range	Cooling water: 20 to 90 °C
Max. Flow rate	80 l/min
Max. Flow temperature	150 °C
AIR SUPPLY	
Cooling air mass flow	Up to 500 m3/h
OTHER AVAILABLE COMPONENTS	
High-temperature oven	Type: Carbolite Gero CWF 12/23. Max. Temperature: 1200 °C. Chamber size: 245 x 240 x 400 mm (HxWxD)
Precision measurement technology	Precision thermocouple sensor type S class 1 up to 1400 °C. Precision resistance sensor Pt100 class 1/10 B up to 400 °C. Various temperature equalisation blocks for calibration. Ahlborn data logger Almemo 710

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Thermal high-performance storage for vehicle application

Institute of Vehicle Concepts

Laboratory for hydrogen and fuel cell applications

Technical data of the system and equipment

PERFORMANCE	
Fuel-Cell Stacks/ Systems	Up to 120 kW
H2-Supply	Supply from H_2 bundle station

KAESER COMPRESSOR CHARACTERISTICS	
Operating pressure	7.5 bar
Max. Delivery quantity	1.859 m³/min (= 40 g/s)

VOLTAGE	up to 400 V (0.2 %, 0.01 %)
CURRENT	0-400 A (0,2 %, 0,01 %)

BLOWER CHARACTERISTICS	
Operating pressure	1.2 bar
Max. Delivery quantity	2500 l/min

MEASURING EQUIPMENT - DYNAMICS AND MEASURING ACCURACY	
100 measuring channels	21 bit, 0.01 %, Pot.trenn.650/750 V
5 Coriolis flow sensors	Liquid 0.1 %, gases 0.5 % for water, hydrogen and air
8 differential pressure sensors	in the range from 0.01 to 4 bar (0.065 %)
Single cell voltage measurement	for 240 (600) cells (0.1 %, time <1 ms/cell, isol. 1 kV)
Pressure sensors	0 - 6 bar, 0.5 %
Temperature sensors	Class A, 0.15 °C
4 sensors for relative humidity	0 - 100 % rH, 0.5+1.5 % v.Mw, up to 100 °C
Conductivity	0.001 - 200 µs/cm, 0.5 %
Others	Highly dynamic media supply (fast hydraulic valves, 0 - 100 % - 1 s)

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Areas of application: Energy management

Institute of Vehicle Concepts

Fuel Cell Test Bench

Technical data of the system and equipment

AREAS OF APPLICATION & UNIQUE SELLING POINTS	
	Characterisation of fuel cells or batteries
	Single cell, cell groups and system measurements
	Different operating conditions can be realised
	Can be flexibly extended to meet special test requirements
	Highly dynamic media supply (fast hydraulic valves, 0 - 100 % - 1 s)
	Cyclovoltammetry and U-I characteristic curves

PERFORMANCE	
Fuel Cell Systems	up to 120 kW
Air supply	Air compressor or blower
H2 supply	Supply from H2 bundle station

COMPAIR COMPRESSOR CHARACTERISTICS	
Operating pressure	7:5 bar
Max. delivery volume	13.98 m3/min

BLOWER CHARACTERISTICS	
Operating pressure	1.2 bar
Max. delivery volume	2.500 l/min
VOLTAGE	up to 650 V (0.2 %, 0.01 %)
CURRENT	0 - 400 A (0,2 %, 0,01 %)

MEASURING EQUIPMENT - DYNAMICS AND MEASURING ACCURACY	
100 measuring channels	21 bit, 0.01 %, Pot.trenn.650/750 V
5 Coriolis flow sensors	Liquid 0.1 %, gases 0.5 % for water, hydrogen and air
8 differential pressure sensors	in the range from 0.01 to 4 bar (0.065 %)
Single cell voltage measurement	for 240 (600) cells (0.1 %, time <1 ms/cell, isol. 1 kV)
Impedance spectroscopy	Single cells and systems up to 100 V and 400 A. 10 µHz - 2 MHz, ±5 V - ±15 V, AC amplitude 0 - 6 V or 0 - 2 A
Pressure sensors	0 - 6 bar, 0.5 %
Temperature sensors	Class A, 0.15 °C
4 sensors for relative humidity	0 - 100 % rH, 0.5+1.5 % v.Mw, up to 100 °C
Conductivity	0.001 - 200 µs/cm, 0.5 %

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Areas of application: Energy management

Institute of Vehicle Concepts

Stack testing and health monitoring

Technical data of the system and equipment

AREAS OF APPLICATION	
	Measurement of electrical power under realistic operating conditions
	Investigation of behaviour under variable load and operating conditions
	Identification of power losses and determination of the causes
	Analysis of efficiency levels and optimisation of energy conversion
	Long-term tests to determine the degradation mechanisms
	Identification of critical ageing processes on membranes and electrodes
	Testing new materials to improve efficiency and durability

PERFORMANCE	
Stacks	Up to 120 kW
H_2 supply	Supply from H2 bundle station
Coolant supply	20-90 °C, 60 l/min

COMPAIR COMPRESSOR CHARACTERISTICS	
Operating pressure	7.5 bar
Max. delivery volume	13.98 m3/min

CHARACTERISTICS OF THE AIR CONDITIONING SYSTEM	
Operating pressure	4 bar
Max. delivery volume	2,333 m^3/min
Temperature range	5–90 °C
Air humidity	20–85 %

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Areas of application: Energy management

Institute of Vehicle Concepts

Stack testing and health monitoring

Technical data of the system and equipment

MEASUREMENT EQUIPMENT - DYNAMICS AND MEASUREMENT ACCURACY	
100 measuring channels	21 bit, 0.01 %, Pot. separ. 650/750 V
5 Coriolis flow sensors	Liquid 0.1 %, gases 0.5 % for water, hydrogen and air
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Impedance spectroscopy (single cells and systems up to 100 V and 400 A)	10 µHz- 2 MHz, ±5 V-±15 V, AC amplitude 0 - 6 V or 0 - 2 A
Pressure sensors	0 - 6 bar, 0.5 %
Temperature sensors	Class A, 0.15 °C
4 sensors for relative humidity	0 - 100 % rH, 0.5+1.5 % v.Mw, up to 100 °C
Conductivity	0.001 - 200 µs/cm, 0.5 %

OTHER EQUIPMENT	
	Highly dynamic media supply (fast hydraulic valves, 0 - 100 % - 1 s)
	Cyclovoltammetry
	U-I characteristic curves

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Areas of application: Energy management

Institute of Vehicle Concepts

Impedance spectroscopy

Technical data of the system and equipment

FIELDS OF APPLICATION	
	For analyzing batteries, rechargeable batteries, super caps, fuel cells and thermoelectric modules
Manufacturer	Zahner
Frequency range	10 µHz to 12 MHz
Resolution	32 bit DC and 24 bit AC
AC Amplitude	0 - 6 V for EIS
Impedance range	0 - 10 MOhm
Internal potentiostat	12 V, 1 A, 12 W
Electrical load	1000 W, 200 A expandable to 600 A with external load, ± 4 V expandable to ± 100 V
Power multiplexer	17 channels
4-Quadrant Power Potentiostat	±40 A, ±20 V
Electrochemical measurement methods	Electrochemical impedance spectroscopy, I-V curves, linear sweep voltammetry, cyclic voltammetry, battery cycling, AC-DC-AC test procedures

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Institute of Vehicle Concepts

Future Lab for Additive Manufacturing & Engineering (FLAME)

Technical data of the system and equipment

AREAS OF APPLICATION AND RESEARCH	
	Research along the entire process chain of additive manufacturing processes in the field of plastics
	AM-compatible component design (DfAM)
	Development of slicing/path/process planning algorithms
	Process monitoring & integrated quality assurance
	Digital system twins for simulation/optimisation
	Integration of data from planning, production and quality assurance in a digital component twin
	Powder recycling and graded components
ADDITIVE MANUFACTURING TECHNOLOGIES	
Extrusion	Robotic Screw Extrusion Additive Manufacturing (Robotic SEAM)
Pulverbett	High Speed Sintering (HSS)
TESTING SYSTEM	
Geometry acquisition	3D scanning: GOM Atos Core 300 Photogrammetry: GOM TRITOP Laser light section sensor: Keyence LJ-X8000
Thermography	FLIR A655sc FOV 15° (640 x 480 pixels, 50-200 Hz)
	Micro-Epsilon thermoIMAGER TIM VGA (640 x 480 pixels, 50-200 Hz)
Moisture measurement	Mettler Toledo HX204 Halogen moisture analyser 0.001 % MC (0.1 mg) Readability
OTHER DEVICES	
Blast cabinet	Normfinish DI 14

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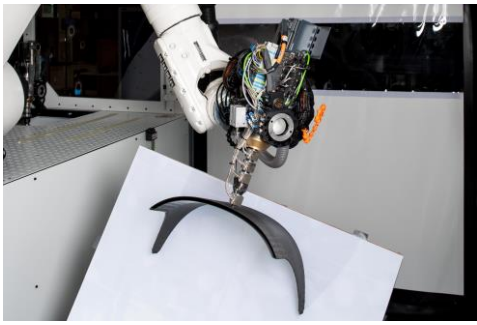
FLAME

Institute of Vehicle Concepts

FLAME: Robotic Screw Extrusion Additive Manufacturing

Technical data of the system and equipment

Manufacturer	Yizumi Germany GmbH
Types	I. SpaceA 2000-500-H2 II. SpaceA 900-500-S
AREAS OF APPLICATION	
	Series production with low quantities
	Prototyping
	Large components in real 3D
	Mold production
	Hybrid production: Printing of existing parts
	Hybrid manufacturing: Combination of additive & subtractive
	6-axis high-precision flexibility for tool positioning
TECHNOLOGY	
Positioning Unit	I. 2x KUKA KR30 HA + KUKA DKP II. KUKA KR10
Build Space	I. 2000 x 1500 x 1500 mm II. 800 x 600 x 500 mm
Build Platform	I. 1000 x 1000 mm heatable on DKP II. 500 x 500 mm or 300 x 300 mm heatable & coolable Both with interchangeable panels & different substrates
Extruder	All extruders are open 3-zone screw extruders 3 x (D=16 mm, n_{max}=130 rpm, Q_{max}=3500 cm^3/h) 1 x (D=24 mm, n_{max}=250 rpm, Q_{max}=10000 cm^3/h) 1 x (D=16 mm, n_{max}=130 rpm, Q_{max}=3500 cm^3/h)
Digital Twin	Simulation, optimization and trajectory planning
Data Management	I. Data acquisition module II. System for managing heterogeneous research data III. Data analysis and visualization IV. Ontologies



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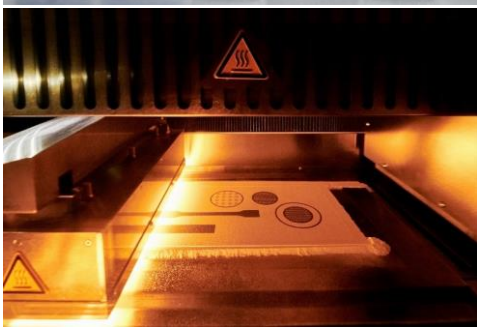
Robotic SEAM

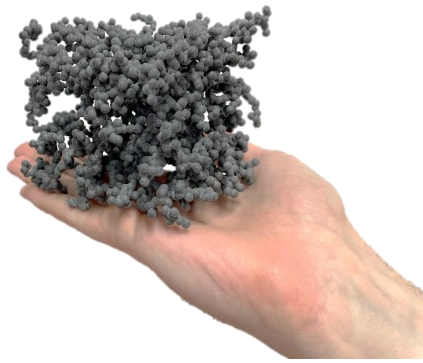
Institute of Vehicle Concepts

FLAME: High-Speed Sintering

Technical data of the system and equipment

Manufacturer	Voxeljet AG
Type	VX200 HSS
AREAS OF APPLICATION	
	Thermoplastic components
	Small series production
	Prototyping
	Complex geometries (design freedom)
	High level of detail
	Brackets, housings, interior components, models, etc.
TECHNLOGY	
Materials	Plastic powder (PA12, TPU, PP)
Build Space	290 x 140 x 180 mm
Energy Source	Infrared lamp
Functional Principle	Absorber (black ink) is printed locally on the powder layer at the points where a component is to be generated. Thermal energy from the infrared lamp is absorbed by the coloured areas. Powder fuses locally, layer by layer, to form the component.
Layer Duration (constant)	Approx. 20 s (independent of the number of components)
Layer Thickness	80 µm (customizable)
Resolution	Print resolution: 360 dpi; Recommended minimum wall thickness: 0.5 mm
Optional post-treatment:	Vapor Surface Smoothing





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High Speed Sintering

Institute of Vehicle Concepts

Laboratory for automated material card calibration

Technical data of the system and equipment

FIELDS OF APPLICATION	
	Dynamic material characterization
	Static material characterization
	Climatised material characterization

AVAILABLE COMPONENTS	
	Pendulum Impact Testing Machine IMPETUS (4a)
	Universal Testing Machine Zwick Roell
	Electro-dynamic Testing Machine LINOVIS (4a)
	Climate Chamber

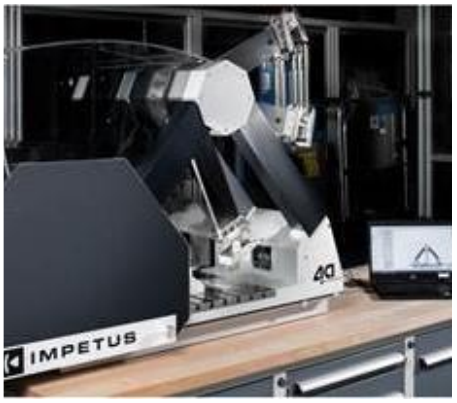
AUTOMATIC MATERIAL CARD CALIBRATION	
Optimizer	Valimat ®, LS-Opt, CS-Opt
Solver	LS-DYNA©, VPS© (Pam-Crash)

TEST SETUPS	
	Compression test
	Tensile test
	Puncture test
	Bending test
	Component test

MATERIALS	
	Foams / Honeycombs
	Plastics
	Light metals
	Steel
	Composites

DYNAMIC MEASUREMENT	
Velocity range	0,1 mm/s – 3,2 m/s (LINOVIS, cyclic loading possible) 0,5 m/s – 4,4 m/s (IMPETUS)
Impact energies (max.)	600J, 25kN (LINOVIS) – speed controlled 50J, 20kN (IMPETUS) – gravity driven
Temperature / humidity	-40° to 180° / 10% - 95% r.h.

ADDITIONAL MEASUREMENTS	
	Strain field measurement, GOM
	Digital Image Correlation
	High-speed camera



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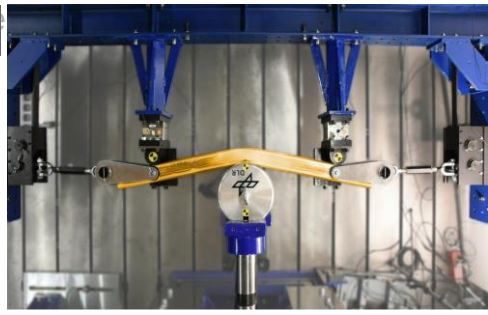
Material card calibration laboratory

Quelle Bild LINOVIS: https://www.4a-engineering.at/products/linovis/

Institute of Vehicle Concepts

Quasi-static component testing system - Clamping field

FIELDS OF APPLICATION	
	The testing system is suitable for uniaxial or multiaxial quasi-static tensile and compression tests on components or structures.
TEST FIELD	
Dimensions of the test area	6m x 3,5m x 2m
Stroke	max. 700mm
Speed	60 mm/s
TEST CYLINDER	Synchronised operation of up to four cylinders possible for multi-axis loads
5 hydraulic cylinders	1x 25kN, 2x 100kN, 2x 250 kN
Maximum forces	250 kN pressure, 160 kN tension
Maximum travel distance	700 mm
TESTING TECHNOLOGY	
	4 compact cameras triggered via the system (colour, 1920x1080 pixels @ 25-1,000 fps)
	Recording of forces, strains and deformations with up to 30 channels
	The measurement and film technology of the dynamic component testing system can also be used on the clamping field



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Clamping field

Dynamic High Strain Component Test Facility - Crash Test Facility

FIELDS OF APPLICATION	
	Modular system for various crash configurations
	Linear guided sled system for scientific simulation/testing
TESTING SYSTEM	
Crash energy	205 kJ
Speed	64 km/h at 1300 kg
Dimensions of the test area	approx. 2 x 3.5 x 3 m (L x W x H)
MEASUREMENT AND EVALUATION TECHNOLOGY	
	Acceleration sensors, 3- and 6-axis force sensors (up to 400 kN)
	Strain gauges, draw-wire potentiometers
Onboard data acquisition system	max. 100 kHz
High-speed cameras	2 x colour, 1024 x 1024 pixels @ 1,000 fps, 2 x colour, 1024 x 1024 pixels @ 2,000 fps, 1 x colour, 1920 x 1440 pixels @ 1,125 fps
	Software for 2D & 3D point tracking in the HS images
	3D scan before and after test execution possible

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Crash Test Facility

Institute of Vehicle Concepts

Load testing laboratory
Component and sample testing

Technical data of the system and equipment

AREAS OF APPLICATION & UNIQUE SELLING POINTS	
	Quasi-static and cyclic testing of materials under standardised conditions
	Quasi-static testing of materials under extreme conditions: High temperature, low temperature and exposure to hydrogen up to 200 bar
	Special test methods: Punching, shear tensile, three- and four-point bending, compression test, head tensile
UNIVERSAL TESTING MACHINE ZWICK ROELL RETROLINE 250 kN	
Maximum test load	±250 kN
Maximum travel	1678 mm (minus holding devices)
Load types	Tension, compression, bending
Temperature chamber	--40 °C to +250 °C
Internal measurement technology	Load cell, crosshead travel (based on spindle rotation)
External measurement technology	Macros, bending sensors, inductive probes, pressure sensors, strain gauges, infrared camera, DIC
Measuring accuracy	Class 0.5 for force; class 1 for macros; class 0.5 for bending sensor
UNIVERSAL TESTING MACHINE ZWICK ROELL RETROLINE 20 kN	
Maximum test load	±20 kN
Maximum travel	1458 mm (minus holding devices)
Load types	Tension, compression
Internal measurement technology	Load cell, crosshead travel (based on spindle rotation)
External measurement technology	ClipOn extensometer, DIC
Measuring accuracy	Class 0.5 for force
HIGH FREQUENCY PULSATOR	
Maximum test load	±30 kN
Maximum static load	±30 kN
Maximum dynamic load	±15 kN
Frequency range	from 35 to 300 Hz
Measuring accuracy	Class 0.5 for force
Clamping table with hole pattern	750 x 500 mm

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Component and sample testing

Institute of Vehicle Concepts

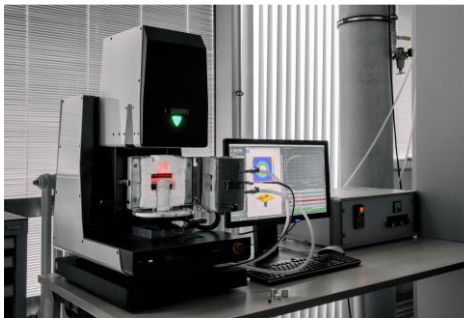
Joining laboratory: Blind riveting tool

Technical data of the system and equipment

Manufacturer	Wilhelm Böllhoff GmbH & Co. KG
Type	P 2002
AREAS OF APPLICATION & UNIQUE FEATURES	
	Production of joints
	Pneumatic-hydraulic manual setting tool
	Adjustable rivet nail extraction
	Anti-kickback and noise-damped
TECHNICAL DATA	
Weight	2.0 kg
Setting stroke	21 mm
Setting force	14 kN
Compressed air consumption	5 - 7 bar per cycle with rivet nail extraction
Sleeve materials	Aluminium, steel, copper, stainless steel
Shank diameter	Blind rivet: 2.4 / 3.0 / 3.2 / 4.0 / 4.8 / 5.0 / 6.0 / 6.4 mm
AVAILABLE COMPONENTS	
	Collecting container for ragged mandrels
	Changeable mouthpieces
	Pressure control unit
	Pneumatic supply hose

Joining laboratory: Hardness and strength testing machine

Technical data of the system and equipment



Manufacturer	Imprintec GmbH
Type	i3D COMPACT
AREAS OF APPLICATION & UNIQUE FEATURES	
	Low-destructive component testing
	Mechanical quality assurance of components and specimens according to the indentation method DIN-SPEC 4864
	Determination of flow curve, yield strength, tensile strength and hardness
	Suitable for a wide range of steel, aluminium, nickel
TECHNICAL DATA	
Table size (fixed table)	375 x 270 mm
Test loads	5, 10, 15, 30, 60, 150 kg
Penetration depth	2 – 300 µm
Test indentation	Diameter 0.2 – 1 mm
Minimum specimen thickness	10 x indentation depth
Measuring times	20 – 60 s
AVAILABLE COMPONENTS	
Cross table (manual)	Area 100 x 100 mm, travel distance 50 mm (x/y-axis)
Oven module	Incl. control unit for temp. up to 800 °C (prototype)

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Joining laboratory

Institute of Vehicle Concepts

Joining laboratory: High-speed bolt setting device

Technical data of the system and equipment

Manufacturer	Wilhelm Böllhoff GmbH & Co. KG
Type	RIVTAC® Portable
AREAS OF APPLICATION & UNIQUE FEATURES	
	Production of joints
	Joining without pilot hole with one-sided accessibility
	Mixed, multilayer and hybrid joints
	Pneumatic-hydraulic manual setting tool
TECHNICAL DATA	
Weight	3.5 kg
Setting pressure	Min. 4.5 bar; Max. 8.0 bar
Setting bolt dimensions	Length / head / shank diameter: 15.4 / 8 / 3.15 mm
Magazine capacity	24 pcs.
Sound level (max.)	107 db
Cycle times	1 – 2 ms
AVAILABLE COMPONENTS	
Joining fixtures	For shear, head and peel tensile tests
Devices	For recording the process forces
	Magazine strip, depth adjustment, pressure control unit, pneumatic supply hose

Joining laboratory: Bonding equipment

Technical Data of the system and equipment

AREAS OF APPLICATION & UNIQUE FEATURES	
	Scientific bonding of specimens according to standards and prototype components
APPLICATION/DEVICE OVERVIEW (AND AREAS OF USE)	
Manual application	Several guns for different cartridges
Pneumatic application	Several guns for different cartridges, with air pressure up to 10 bar
Electric, heated glue gun	With pressure up to approx. 17 bar (3.5 kN) and temperatures up to 200 °C
Preheater	For two adhesive cartridges and temp. up to 160 °C
Silicone moulds Substance samples	DIN EN ISO 572-2 type 1B & 1BA, temp. up to 200 °C
Universal gluing device	For shear- and cross-tension specimens developed for specimen throughput, e.g. DIN EN 1465 & DIN EN ISO 14272
3x bonding devices for shear tensile specimen	e.g. DIN EN 1465
AVAILABLE COMPONENTS	
	Guns, devices, pretreatment accessories, cleaning agents, adhesives
	Aids for adjusting the adhesive layer thickness, suitable test devices and other accessories

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Joining laboratory:

Institute of Vehicle Concepts

Joining laboratory: Flow-drill screwing system

Technical data of the system and equipment

Manufacturer	WEBER Schraubautomaten GmbH
Type	RSF25
AREAS OF APPLICATION & UNIQUE FEATURES	
	Production of joints
	Joining without pilot hole with one-sided accessibility
	Mixed, multilayer and hybrid joints
	Detachable and repeatable multiple times
TECHNICAL DATA	
Torque (max.)	15 Nm
Speed (max.)	8000 rpm
Axial / hold-down force	Max. 3.6 kN / Max. 1.4 kN
Screw dimensions (max.)	Length / head / shank diameter: 30 / 15 / 13 mm
Process times	≥ 1,6 s
AVAILABLE COMPONENTS	
	WEBER screwdriving control C50RSF V3
	Joining devices for shear-, cross- and peel-tensile specimens

Joining laboratory: Self-pierce riveting and clinching machine

Technical Data of the system and equipment

Manufacturer	Wilhelm Böllhoff GmbH & Co. KG
Type	MTF-FC / SC 2505 P 75 S
AREAS OF APPLICATION & USP	
	Production of joints
	Joining without pilot hole with two-sided accessibility
	Mixed, multilayer and hybrid joints
	No thermal influence
TECHNICAL DATA	
Max. setting pressure	250 bar
Max. setting force	50 kN
Rivet diameter	5 mm
Die fixture	ø 8 mm
Process times	≤ 1,5 s
AVAILABLE COMPONENTS	
	Joining devices for shear- and cross-tensile specimens
	Device for recording the process forces during self-pierce riveting
	Different dies and magazine strips

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Joining laboratory:

Institute of Vehicle Concepts

Corrosion test laboratory: Corrosion test system

Technical data of the system and equipment

Manufacturer	Ascott Analytical Equipment Ltd
Type	617/450
AREAS OF APPLICATION & UNIQUE FEATURES	
	Carrying out changing climatic conditions, salt spray and water condensation tests
	VDA 233-102, ISO 3768, ISO 9227, DIN EN ISO 9227 or DIN EN ISO 6270-2 as well as climate change test standards
	Tests according to international standards
	Individual test conditions
TECHNICAL DATA	
Test chamber volume	450 litres
Test chamber dimensions	(L x H x W) 1010 mm x 640 mm x 1140 mm
Temperature working range	-40 °C to +70 °C
Climate working range	+10 to +60 °C
Humidity range	5 to 98 % r.h.
Humidity constancy	± 5,0 % r.h.
Salt spraying	up to a maximum of +50 °C
AVAILABLE COMPONENTS	
	Software for programming and documentation
	External mobile storage tank for spraying solution (80 litres)
	Grid for holding the test specimens
	Sample holder with fixed slots
	Bar for test specimen holder

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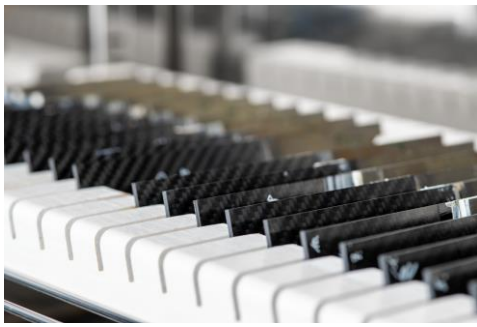
Corrosion test laboratory

Institute of Vehicle Concepts

Corrosion test laboratory: Climatic test chamber

Technical data of the system and equipment

Manufacturer	CTS GmbH
Type	C-40/200
AREAS OF APPLICATION & UNIQUE FEATURES	
	Environmental simulation - temperature and humidity
	Conditioning of samples and components
	Individual test conditions
TECHNICAL DATA	
Test chamber volume	200 litres
Test chamber dimensions	(L x H x W) 650 mm x 750 mm x 400 mm
Feedthrough	ø 50 mm
Temperature working range	-40 °C to +180 °C
Cooling rate according to IEC 60068-3-6	4,0 K/min
Heating rate according to IEC 60068-3-6	4,0 K/min
Temperature constancy	≤ ± 0,3 K
Climate working range	+10 to +95 °C
Humidity range	10 to 98 % r.h.
Humidity constancy	≤ ± 0,3 % r.h.
AVAILABLE COMPONENTS	
	Software for programming and documentation
	Insert grids (height-adjustable)
	Specimen holder with fixed slots
	Bar for test specimen holder



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Corrosion test laboratory

Institute of Vehicle Concepts

Thermal imaging camera

Technical data of the system and equipment

MEASURED VARIABLES	
Name	Optris PI 400 O38T900
Camera dimensions	46 mm x 56 mm x 90 mm
Camera weight	320 g
Type	IR only
Temperature range	-20 – 900 °C
Spectral range	7,5 – 13,0 µm
Detector	382 pixel x 288 pixel at 80 Hz
Objective lens	38° x 29°
System accuracy	max {±2 °C or ±2 %}
Temperature resolution	0,1 K

SYSTEM DESCRIPTION	
	For recording real-time thermal images at maximum speed
	The camera is enclosed in a water-cooled housing and can therefore be operated at a constant camera temperature even at high outside temperatures.

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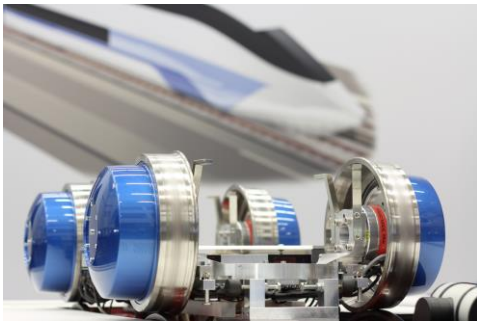
Component and sample testing

Institute of Vehicle Concepts

1:5 rolling test rig with rotating independently driven wheels

Technical data of the system and equipment



AREAS OF APPLICATION	
	Demonstrator for a new railway running gear to realise ground-level access and minimise wear and tear
	Testing of different control and sensor concepts
	Maximum operating speed approx. 15 km/h

ACTUATORY	
Wheel motor	Robodrive ILM115-25
Roller motor	Varicon 65900

SENSORICS	
Encoder	Heidenhain ECN 113 EnDat01
Laser sensors lateral offset	optoNCDT LD1605-50
Laser sensors yaw angle	Allsens AM300-15-CAN
IMUs	BC-3A
Force/torque sensor	FTS-78

OTHER	
Wheels Radius	0,1 m
Roller/rail distance	0, 3 m
Inverter	Solo Guitar ABS 028B
Real-time hardware	Simulink Realtime/dSpace

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1:5 rolling test rig

Institute of Vehicle Concepts

Virtual Reality Lab

Technical data of the system and equipment

AREAS OF APPLICATION	
	The virtual reality laboratory is used for vehicle concept development, requirements and ergonomics testing, and conducting user studies. With the help of 3D data models and various virtual environments, scenarios can be generated, simulated, and experienced immersively.

TECHNICAL EQUIPMENT	
	HTC-Vive Pro Virtual Reality Headset
	Meta Quest 3 Virtual Reality Headset
	Mini vehicle seat box with HTC Vive Ultimate Tracker for integrating passive haptics into mixed reality scenarios
	Video wall for display and presentation

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