Laser Tracker: A portable 3D metrological system using laser technology to effectively and precisely measure huge components, devices and machines. The system measures 3D coordinates of a target. In real time, this system captures the 3D position of the target by means of highly accurate rotary encoders and ADM (absolute distance measurement). Due to its accuracy of up to 0.025 mm and a spheric operating volume with a diameter of 70 m, it is most suitable to application under production conditions.

Specific Applications
Aviation: control and certification, mounting automation systems
Automobile: Prototype construction, prototyping, reverse engineering
Tool and device shop: tool design and setting
On-site measuring, testing and adjustment of machined or unmachined heavy component parts

Technical Data
Resolution: 0.5 µm
Touch speed: bis zu 10000 points/sec
Accuracy: 10 µm + 0.4 µm/m
Angular accuracy: 18 µm + 3 µm/m
Max. angular acceleration: 180°/sec
Accuracy of levelling function: ± 2 angular seconds
Horizontal displacement: +/- 270°
Vertical displacement: +75° bis -50°

Wellhead size: 280 x 554 mm²
Wellhead weight: 20 kg
Controller size: 160 x 180 x 280 mm³
Controller weight: 5 kg
Minimum test distance: 0 m
Maximum test distance: 35 m
Vertical range: 700 m a.s.l. bis 2450 m a.s.l.
Humidity: 0 bis 95% non-condensing
Operating temperature: -15 °C to 50 °C

Laser Tracer: The laser beam automatically follows a reflector and is therefore capable to conduct length measurement in nearly any direction with highest accuracy values. Contrary to conventional devices, Laser Tracer uses a patented principle which enables an unprecedented accuracy of the center of turning: a ball showing shape deviation on nano-scale conduces as optical reference to the interferometer.

Specific Applications
Laser Tracer is an ideal measuring device for the calibration and tracing of measuring devices and machine tools as well as of common production lines in connection with the Etalon software solutions Trac-Cali and Trac-Check.

Technical Data
Measurement uncertainty (k=2): 0.2 µm + 0.3 µm/m
Resolution: 0.001 µm
Measuring range: 15 m (extentable in nearly any way by math. composition)
Laser interferometer: As a calibration system, Laser interferometer supplies information on geometrical deviation of machine tools for the control of production. Laser interferometer conduces to the following tests: compliance test, regular calibration, fast checking, error diagnosis and documented evidence for ISO 9000. The equipment secures the accuracy of machine movement and its positioning accuracy. Also, it measures both all six possible degrees of freedom for all axes and orthogonality.

Specific Applications
A laser interferometer is applied in the field of gauging. In this process the following geometrical data of a machine tool is determined: positioning accuracy, straightness, parallelism, evenness, orthogonality.

Technical Data
- Wave length: 632.99 nm
- Accuracy of wave length: +/- 0.1 ppm
- Resolution of linear optics: 10 nm
- Reflector resolution: 5 nm
- Max. measuring length with linear optics: 40 m
- Max. measuring length with extension kit: 80 m

Infrared camera: The infrared equipment condition monitoring ThermaCAM™ S65 consists of an infrared camera with an integrated 36-mm-object lense, a daylight color camera, a laser pointer, a IrDA cutting point (wireless communication with the camera), a 4-color-LCD-display on a detachable remote control as well as diverse auxiliary equipment. The infrared camera first captures the infrared light radiated by an object and displays it after that. As the infrared radiation is a function of the surface temperature of an object, the camera is able to calculate and display this temperature. Color pictures with high resolution (infrared or daylight) are displayed in real time either on the integrated finder or on the LCD display of the remote control. For documentation purposes pictures can be taken and saved with portable compact flash cards or the intern flash storage. You can analyze taken pictures either on-site by the help of the integrated real time functions of the camera software or by the help of software for infrared analysis and report generation by FLIR systems on any computer.

Specific Applications
- Measurement of extremely high temperatures
- Investigations of the temporal heat flow/ the temperature distribution
- Temperature measurement with moving/rotating objects
- Location of heat sources viz. heat sinks
- Investigation of the energy efficiency of buildings

Technical Data
- Geometric resolution: 1.3 mrad
- Accuracy: ± 2 °C / ± 3.6 °F oder ± 2 %
- Frame rate: 50 / 60 Hz, non-interlaced
- Electronic zoom function: 2x, 4x, 8x – interpolation
- Focal point: automatic or manual
- Specific features: digital picture editing and adaptive digital noise suppression
- Integrated digital video: 640 × 480 pixel, colored
Cross grid: The cross grid device KGM181/182 by Heidenhain is suitable for the dynamic testing of the path behavior of CNC controlled machine tools. Circularity tests, for example, can be moved with radii of 115 mm to 1 µm with path feed rates up to 80 m/min. Furthermore, KGM enables the conduction of free form tests in two axes.

Specific Applications
Dynamic testing of the path behavior of CNC controlled machine tools

Technical Data
- Material measure: Two-coordinate-TITANID-phase grid-separation on glass (cross grid)
- Therm. linear expansion coefficient: 8 · 10⁻⁶ K⁻¹
- Accuracy class: ± 2 µm
- Measuring range: ø 230 mm
- Output signal: 1 V
- Signal period: 4 µm in the direction of measurement I and II
- Recommended measuring step: >=0.001 µm (with IK 220)
- Power supply: 5 V ± 5 % / < 100 mA (per axis)
- Max. movement speed: <= 80 m/min
- Receiver: scanning head ø 20h7
- Electronical evaluation: PC-digital display unit IK 220
- Software evaluation: ACCOM
- Weight: Measuring disk ca. 3.1 kg, scanning head ca. 0.6 kg

Double-Ball-Bar: Circularity tests with radii of 150 to 300 mm with path feed motions of 6 to 10 m/min can be moved with the double-ball-bar DBB 110 by Heidenhain. Geometrical errors of machines are captured by the use of these huge radii by the help of circularity tests. Furthermore, DBB has a reference point enabling a simple radii measurement. DBB 110 consists of an incremental measuring unit with high accuracy, which is integrated into a telescope bar. At both ends of this bar precision balls are installed. Programming of the circularity tests for DBB 110 is also effected by the evaluation software ACCOM that compiles the NC program after inquiring all necessary parameters. As a consequence, distance changings are caused between the two balls and are communicated as sinusoidal measuring signals to a computer with Heidenhain display unit IK 220. After editing these signals in IK 220, the outcome result is measuring steps up to 0.1 µm. Analysis according to the standard ISO 230-4 is also effected by the software ACCOM by Heidenhain.

Specific Applications
Acceptance and control of machine tools, checking of the geometrical behavior of machine tools

Technical Data
- Material measure: Measuring unit with DIADUR grid division
- Signal period: 10 µm
- Total length between ball centers: 150 mm (without lengthening), 200 mm, 250 mm, 300 mm (with lengthening)
- Reference point in the middle of the measurement range
- System accuracy: ± 1 µm
- Output signal: 11 µA
Heidenhain Linear: The linear VM 182 by Heidenhain conduces to testing and calibrating of machine tools and measuring devices with traveling distances of up to 1520 mm. Linear as well as nonlinear error patterns and reverse errors of machine axes according to ISO 230-2 can be determined by VM 182.

Specific Applications
Final inspection and control of machine tools

Technical Data
Solid measure: two-coordinate DIADUR phase grid – partitioning with a steel reference mark
Coefficient of linear thermal expansion: 10 · 10^-6 K^-1
Accuracy class: ± 1 µm (longitudinal), ± 1.5 µm (lateral direction)
Reference mark at the front of the gauge length
Output signal: 1 V
Signal period: 4 µm in lateral and longitudinal direction (orthogonal)
Recommended measuring step: >= 0.001 µm (with IK 220)
Power supply: 5 V ± 5 % / < 100 mA (per axis)
Max. Movement speed: <= 80 m/min
Electronical evaluation: position marker ND 281B or digital display unit IK 220
Software evaluation: ACCOM
weight: measuring unit approx. 340 g, scanning head approx. 1.86 kg

Metrology for the investigation of the dynamic and static machine behavior: The research group Machine Investigation and Evaluation carries a large stock of professional equipment for the investigation of the static and dynamic machine behavior. A well defined static/dynamic force is added to the machine structure in order to analyze the static and dynamic behavior. Furthermore, the force is added to determine the compliance behavior and to measure the force as well as the resulting displacement afterwards. The measuring device used at WZL is piezoelectric quartz in order to capture the forces and inductive travel sensor to detect the displacement.

Electrohydraulic and piezoelectric exciter are part of the equipment of the group Machine Investigation and Evaluation. Dependent on the necessary (absolute or relative) animation and on the frequency spectrum that is to investigate, the adequate exciter is used for the operational discharge of forces. The collection and evaluation of measuring data is effected by the software Test.Lab by LMS.

The following services are offered by the group Machine Investigation and Evaluation:
• Investigation of the static behavior
• Investigation of the dynamic behavior
• Experimental modal analysis
• Analysis of the operating oscillation
• Stability investigation

Chair of Machine Tools
WZL of RWTH Aachen University
Manfred-Weck Haus
Steinbachstraße 19
52056 Aachen

Telephone: +49 241 80 27408
Fax: +49 241 80 22293
Maschinenuntersuchung@wzl.rwth-aachen.de