

# Sensors & Applications Tracks & Rail Traffic



More Precision

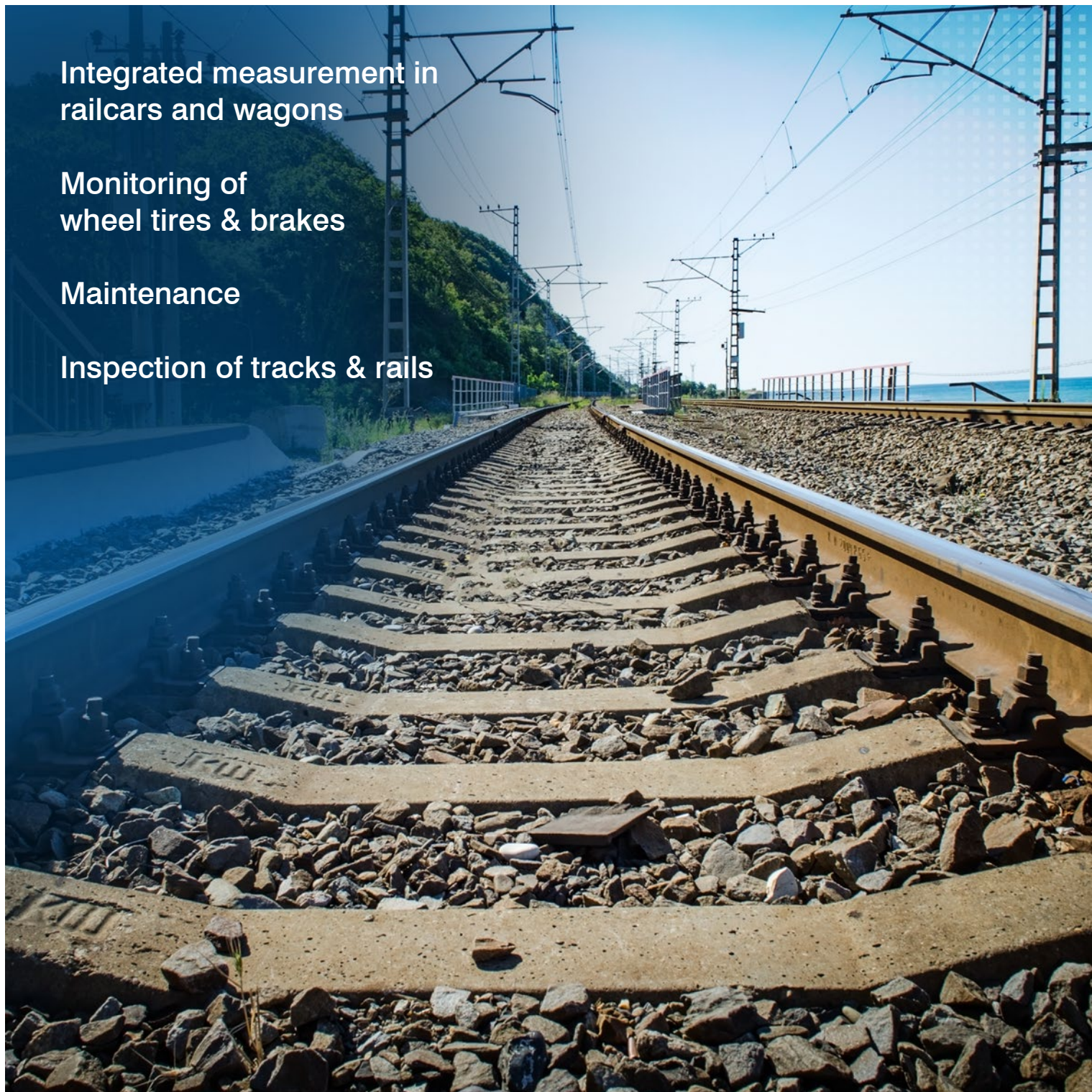


Integrated measurement in  
railcars and wagons

Monitoring of  
wheel tires & brakes

Maintenance

Inspection of tracks & rails



Guaranteeing the safety and stability when transporting passengers and goods on rails is critical.

Increased utilization of rail networks and higher speeds of modern trains cause high loads on the rail tracks. The condition of the tracks must be inspected regularly in order to prevent costly incidents.

Micro-Epsilon offers extensive knowledge for measurement tasks in the railway industry. Integrated in the train, in the measurement wagon, in test systems and measuring machines, the sensors are used in a variety of ways. In addition to their ease of integration, the sensors are characterized by high precision and robust designs. Laser optical sensors are used for the inspection and testing of tracks, wheelsets and overhead lines. Inertial sensors and inductive displacement sensors are integrated directly in the train and provide measured values with high precision.



**induSENSOR EDS**

Inductive long-stroke sensors with integrated controller

Displacement and position measurements with measuring ranges up to 630 mm

Pressure-resistant versions, insensitive to oil, dust & dirt

Ideal for displacement measurement in hydraulic cylinders

**eddyNCDT 3001 / 3005**

Inductive sensors (eddy current) for displacement, distance & position

Non-contact displacement and distance detection with measuring ranges from 1 to 6 mm

High frequency response for dynamic measurements

Temperature resistance for harsh ambient conditions

Pressure-resistant versions up to 2000 bar, resistant to oil, dust & dirt

**scanCONTROL**

High-end laser scanner for high precision 2D/3D measurements

Inline measurement of gaps, profiles, steps, angles

Red or blue laser line versions

Measurement on numerous surfaces, also reflecting and mat

**optoNCDT ILR**

Non-contact distance and displacement measurements with high precision

Precise measurement of displacement, distance & position on different surfaces

Large measurement areas for indoor and outdoor use

High repeatability

Fast response time



A high-speed train, likely a Shinkansen, is shown in motion, blurred background, with overhead power lines and a signal light visible. The train is white with a red stripe. The background is a mix of blue and orange, suggesting a sunset or sunrise. The text "Integrated measurement in railcars and wagons" is overlaid on the bottom left.

**Integrated measurement in  
railcars and wagons**



### Measuring the tilt angle in passenger trains

Inductive EDS displacement sensors are integrated in high-speed trains to determine the inclination of the coach body required for cornering. This data is passed on to the control units in the following wagons, which tilt the coach body accordingly to compensate for the resulting lateral acceleration. When taking a bend, the coach body of the vehicle is tilted towards the inside of the bend with the help of hydraulic cylinders. The inclination is controlled by an induSENSOR EDS sensor. This reduces the effect of lateral acceleration forces on the passenger.

*Sensor: induSENSOR EDS series*



### Vibration measurement in trains

Wear and tear in the wheelset and bogie can cause natural vibrations that can be felt in the passenger area. Acceleration sensors from Micro-Epsilon are used to record these vibrations. Inertial sensors detect the vibration at various points in the railcar, in locomotives and in the wagons. These high-precision measurement values are used to compensate for the vibration.

*Sensor: inertialSENSOR*



### Automatic inspection of jammed brakes

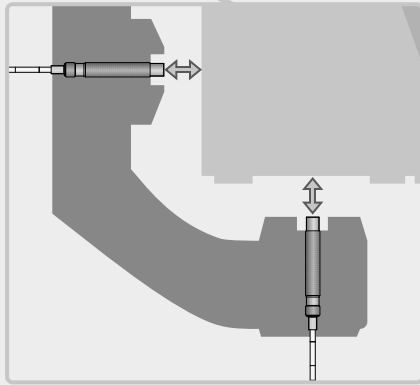
In order to test brake systems of wagons and railcars, test benches are used where infrared pyrometers or thermal imaging cameras are installed. These temperature measuring devices detect the passing train and measure laterally on the brake systems. Due to friction, jamming brakes develop high temperatures, which are detected by infrared temperature sensors. Non-contact temperature measurement enables automatic identification of those railcars and wagons with jammed brakes and marking them for maintenance.

*Sensor: thermoMETER*





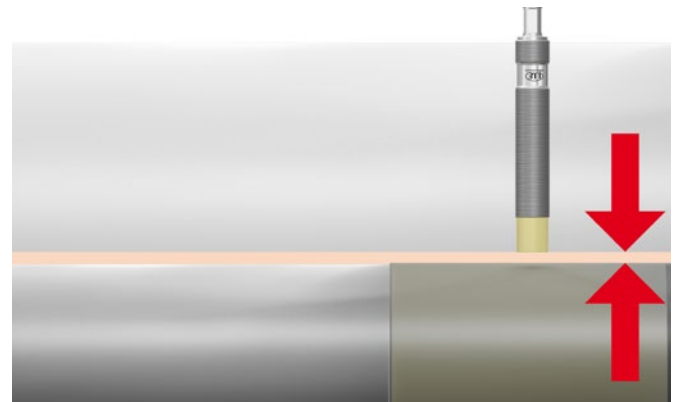
Integrated measurement in  
railcars and wagons



### Distance control in magnetic railways

In contrast to conventional railways, in magnetic railways the drive is not installed in the vehicle but in the track. In the Transrapid, wheels and rails of the conventional railway are replaced by a non-contact electromagnetic carrying, guiding and drive system. In order to keep the distance of the vehicle to the track constant, air gap control is required. Eddy current sensors from Micro-Epsilon are used for non-contact distance measurement to detect the distance to the mounting rails with high dynamics and accuracy. The measurement data is used for distance control. These robust sensors are insensitive to dirt, moisture and temperature fluctuations.

*Sensor: eddyNCDT*



### Measuring the bearing gap in axle bearings

In high-speed trains, the oil gap in axle bearings is permanently checked. The oil film in the lubricating gap prevents direct contact between the bearing surface and the shaft. The improved sliding properties of the bearing increase the turbine's effectiveness while prolonging its service life. eddyNCDT eddy current displacement sensors are used to monitor the bearing gap. Integrated into the control system, they acquire the measured values during operation. Thanks to their robust design, the sensors can be used at oil pressures of up to 2 bar and at high temperatures.

*Sensor: eddyNCDT 3001*

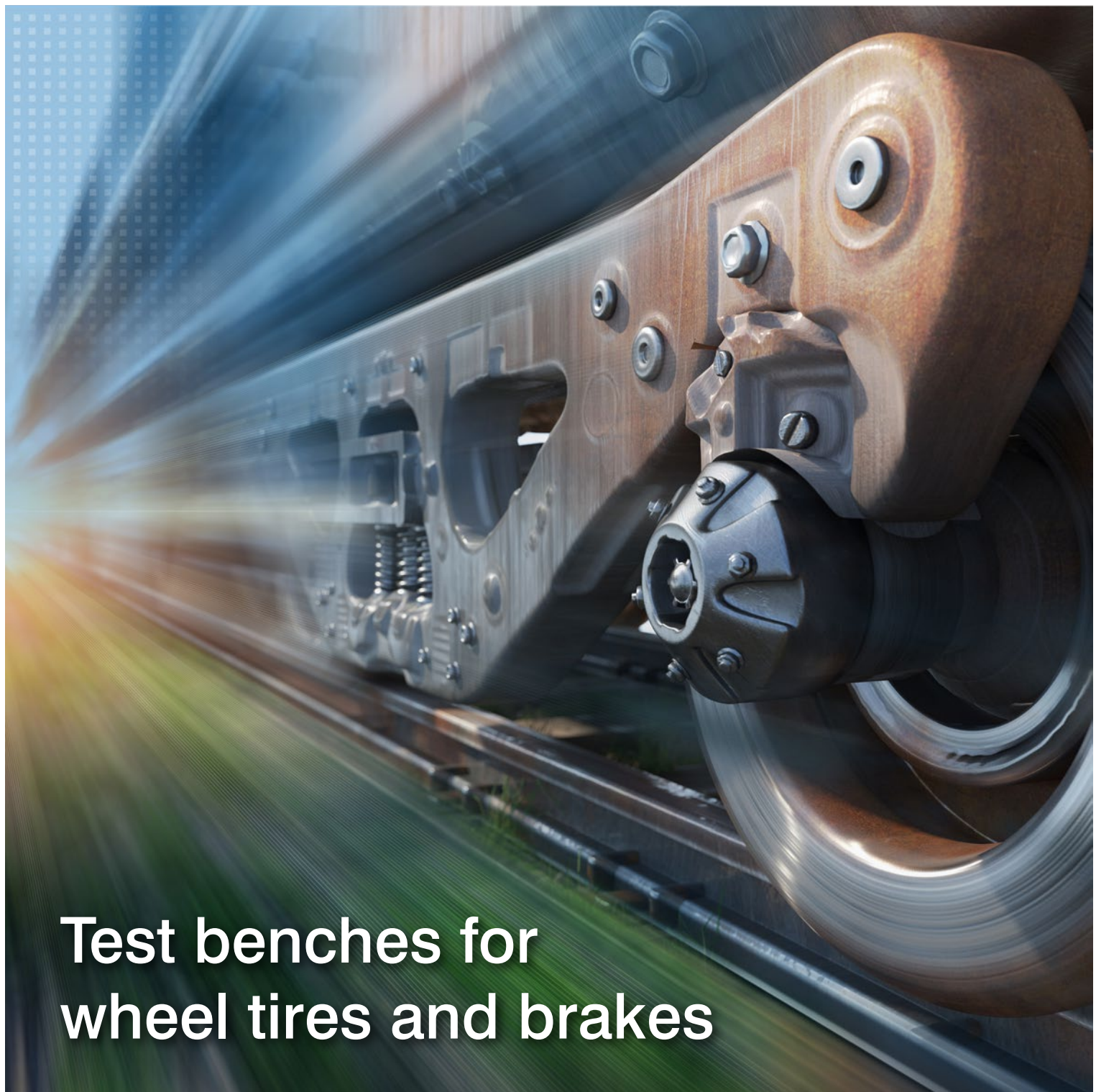


### Position control of the hydrodynamic coupling

An inductive EDS displacement sensor is used for stroke measurement of hydraulic cylinders in diesel-hydraulic drives. The inductive long-stroke sensor monitors the unintended traction of the locomotive and is thus a safety-relevant component in the drive system. Only when the transmission is fully disengaged can persons such as shunters work near the locomotive. The transmission of the locomotive is moved by a hydraulic cylinder. The inductive sensor monitors the piston stroke and thus determines the clutch condition. induSENSOR EDS models are insensitive to oil and pressure and can be integrated directly into the hydraulic cylinder.

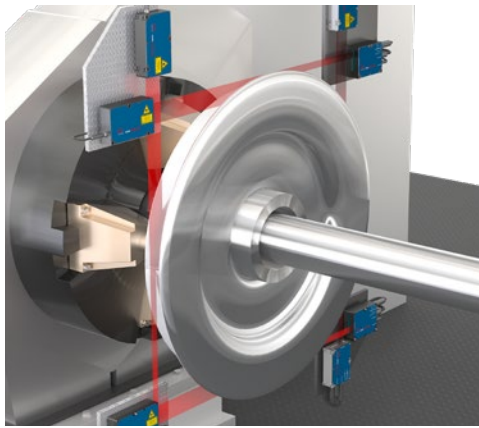
*Sensor: induSENSOR EDS*





**Test benches for  
wheel tires and brakes**





### Inspecting the ovality of wheel sets

Axle measuring machines are used to check the ovality or diameter of wheels, bearings and gears. These are equipped with 4 optoCONTROL laser micrometers that measure on the rotating axle. Thanks to their high accuracy, ovality or diameter can be determined extremely precisely. As the measuring distances are variable, micrometers can also be used for large object diameters.

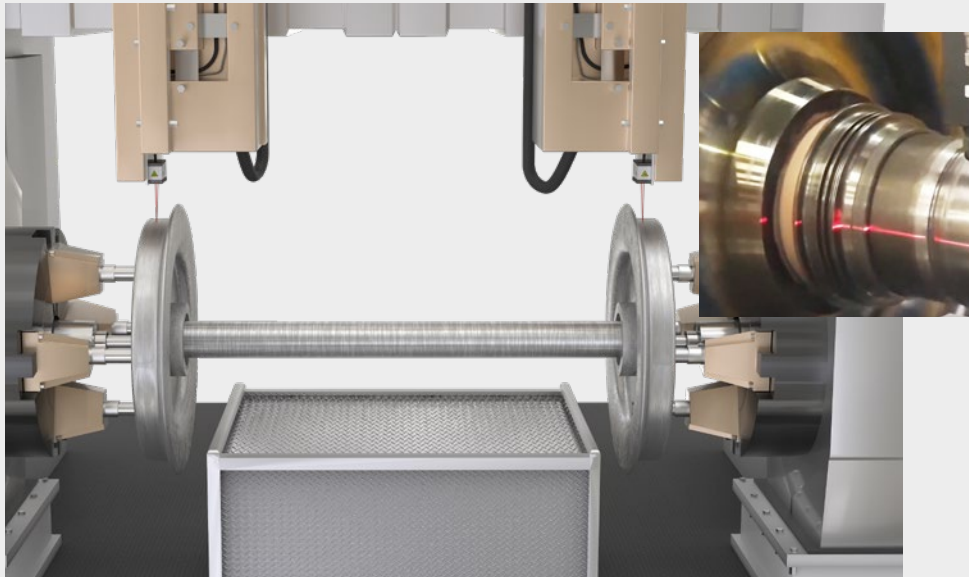
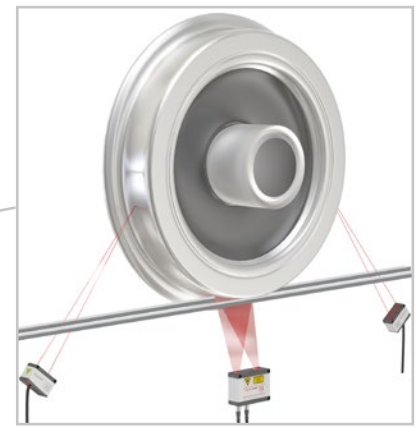
*Sensor: optoCONTROL 2520*



### Measuring the profile of wheel tires in the test bench

Wheel wear on rail vehicles caused by high mileage affects safety and driving characteristics and generates high maintenance costs. Laser sensors from Micro-Epsilon, which are integrated in a test bench in the track bed, are used to preventively detect the profile sets of entire trains. The sensors are installed in three tubs that are embedded in the track bed one behind the other at right angles to the direction of travel. Two optoNCDT laser distance sensors are located in each of the tubs 1 and 3 to determine the wheel diameter and the position of the wheel tire. Tub 2 contains scanCONTROL laser profile sensors for measuring the wheel profile. The sensors measure through half-sided recesses in the rails on the wheel tires. The maintenance dates for reprofiling are determined on the basis of the profile data.

*Sensor: optoNCDT / scanCONTROL*



### Optical measurement of drive shaft, brake disc and wheel tires

Tread surfaces of wheel tires are exposed to enormous loads. Therefore, the wheel discs are checked regularly. This is the only way to determine the component condition, detect defects and take repair measures in time.

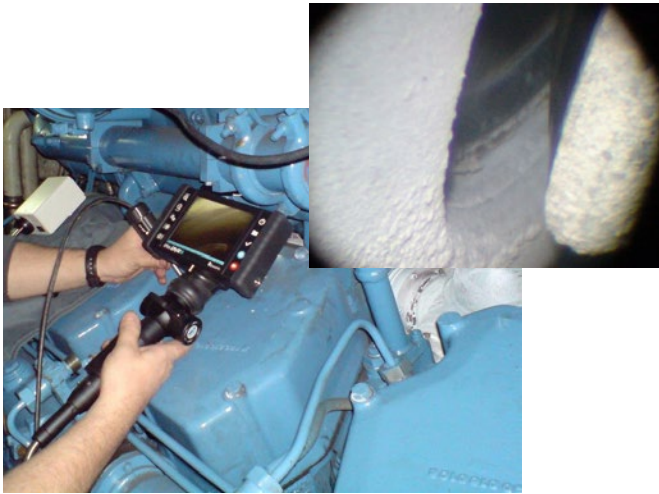
The wheel sets are first tested in measuring machines with optical sensors from Micro-Epsilon. The rotating wheelset is measured with laser distance sensors, which determine the axial and radial runout. Laser profile scanners also detect the complete profile at selected measuring points.

*Sensor: optoNCDT LL / scanCONTROL*



Maintenance





### Inspection of the combustion chamber in a diesel locomotive

For the inspection of diesel locomotives, regular inspection of the combustion chamber and documentation are required. Inadequate quality inspection or failures such as faulty valve seats or defective running surfaces can cause serious malfunctions of the engine and thus locomotive failures. The inspection is often performed in confined spaces and without direct power connection. For this reason, Eltrotec video endoscopes are used. These video endoscopes are lightweight, mobile and work independently of the mains. The robust probes are available in different lengths and designs to inspect even confined spaces. Images and movies are stored on an SD memory card.

*Eltrotec Video Endoscopes*



### Detection of the lift height in lifting platforms

During maintenance and servicing, it is often necessary to lift entire trains. Synchronous heavy-duty lifting systems are used for this purpose. In order to synchronize the lifting height of the individual columns, optoNCDT ILR laser time-of-flight sensors are used. They measure the vertical distance of the support arms to the ground and thereby determine the lifting height. Their modern interface concept, in combination with high accuracy enables synchronous tuning of the lifting unit. In addition, further optoNCDT ILR time-of-flight sensors measure the train's entry into the maintenance hall in order to stop the train at the correct position. Due to the large measuring range of the sensor, the entry is already detected and recorded at an early stage.

*Sensor: optoNCDT ILR3800*



### Monitoring the lathe

When turning the wheel tires, laser triangulation sensors monitor the distance to the rotating wheel tire. This means that the ablation is detected with high precision. Thanks to the high-performance sensors, the dimensional accuracy of the wheel tires is measured at high speed and with micrometer precision. In addition, laser distance sensors monitor the position of the wheel tires during automatic clamping.

*Sensor: optoNCDT 1900 / optoNCDT ILR3800*



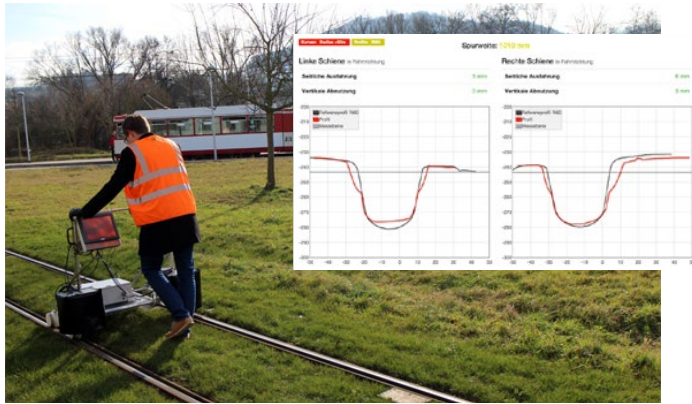
# Inspection of tracks & rails



*With laser sensors from Micro-Epsilon, we determine cross and longitudinal profiles of rails, groove geometries and track gauges in day and night operation. Measurements are made at speeds of up to 80 km / h and under adverse conditions with grinding dust and vibrations. Vossloh Rail Services GmbH has used robust and precise sensors from Micro-Epsilon for many years. We particularly appreciate the technical support in our long-term cooperation as well as the good support of the office and field service.*

Dr. Konstantin von Diest, Technical Manager, Vossloh Rail Services GmbH

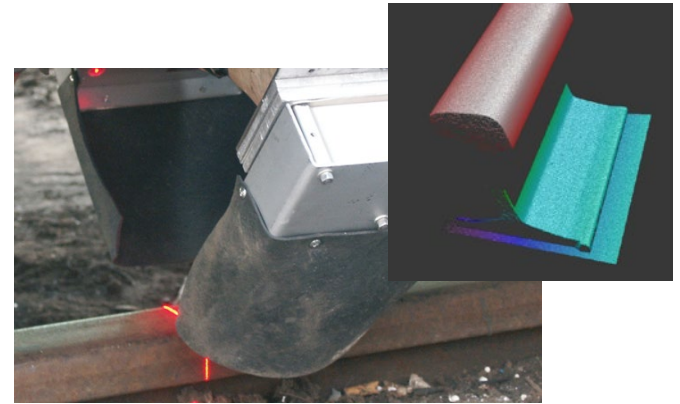




### Profile measurement of mounted tram rails

Increasing utilization of trams causes increased wear on the rails. In order to document the rail wear, measurement wagons equipped with laser scanners are used to detect, automatically evaluate and analyze the profile data. Laser profile scanners from Micro-Epsilon detect the rail cross-section without contact and therefore offer a reproducible and time-saving supplement to visual inspection. A link between the wear points and the map network enables the targeted repair of defects.

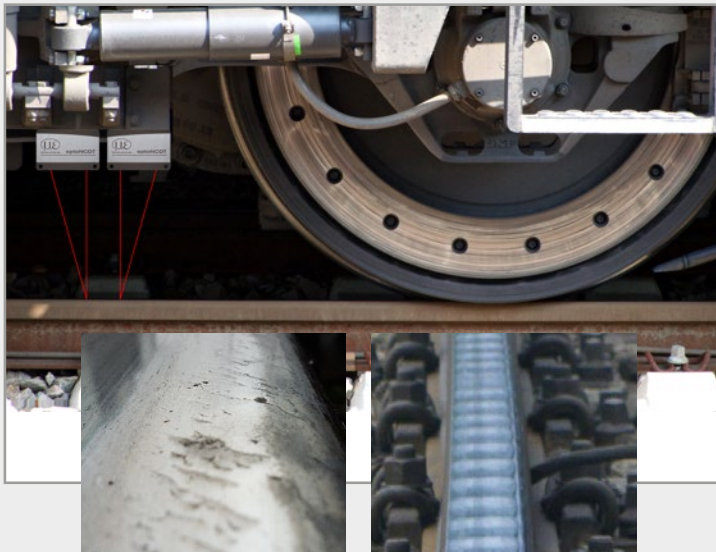
Sensor: scanCONTROL



### Measuring the wear of the rail head

The wear of the rail head is an important parameter in the reliable assessment of the condition of the tracks. In order to check the profile of the rail head, scanCONTROL laser profile scanners are used, which are integrated in measurement wagons. These can detect the condition of the rail heads even at high speeds. Profile data is detected at speeds up to 100 km/h, which is compared with target profiles. Deviations from the defined tolerance limit are marked on a map using GPS data. This information enables precise, well-directed repair measures to be carried out.

Sensor: scanCONTROL



Chipping of the rail head

Slip wave formation in narrow bends

### Measuring the wear of high-speed railway lines

To measure wear on high-speed roads, special measuring wagons inspect the tracks. The measuring van contains two laser displacement sensors from the optoNCDT 1900 series. These measure the distance to the track at a high measuring rate. Standard models with a small laser spot detect chipping and defects with high resolution. This determines wear, chipping and slippage.

optoNCDT LL sensors with a small laser line compensate for small irregularities and generate smoothed measurement value curves. This is particularly suitable for determining the longitudinal trend. Robust optoNCDT 1900 sensors offer high measurement accuracy and are hardly affected by fluctuating reflections and ambient light.

Sensor: optoNCDT 1900 / optoNCDT 1900LL





Inspection of tracks & rails

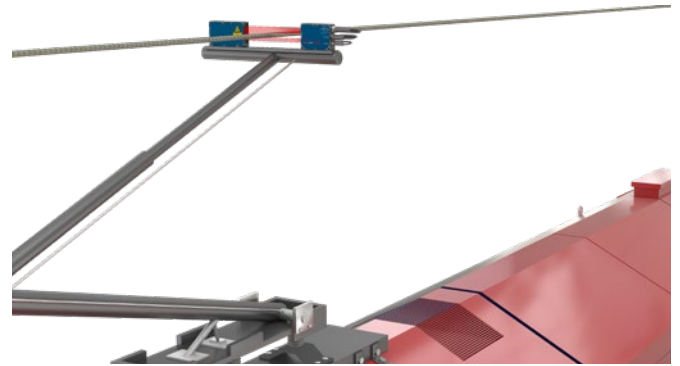
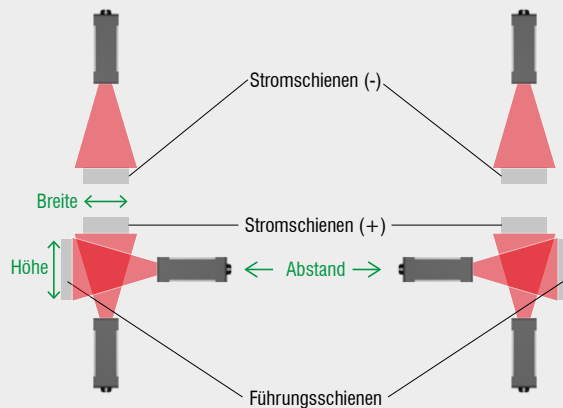




### Conductor rail wear and gauge measurement

For the inspection of conductor rails, a measurement wagon is used which contains a total of six scanCONTROL laser profile scanners. These scanners detect the profile of the conductor rails from below, above and from the side. The large measuring field of the scanners allows for numerous parameters to be recorded within one measurement. The width of the conductor rails and the height of the guide rails on both sides are determined simultaneously and evaluated directly in the sensor. The scanners work reliably under changing environmental conditions and provide precise measurement results despite changes of the surface (e.g. due to dirt or light).

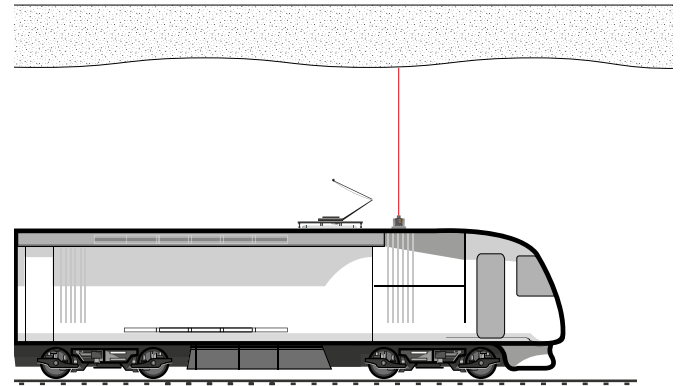
Sensor: scanCONTROL



### Diameter inspection of overhead lines

Especially in the case of high-speed trains, preventive inspection of overhead lines is important in order to ensure that the lines are passable. optoCONTROL laser micrometers are used to enable reliable diameter testing. These are installed on a maintenance locomotive and are guided over a frame to the overhead line during the journey. The high accuracy of the micrometers enables high precision wear measurements.

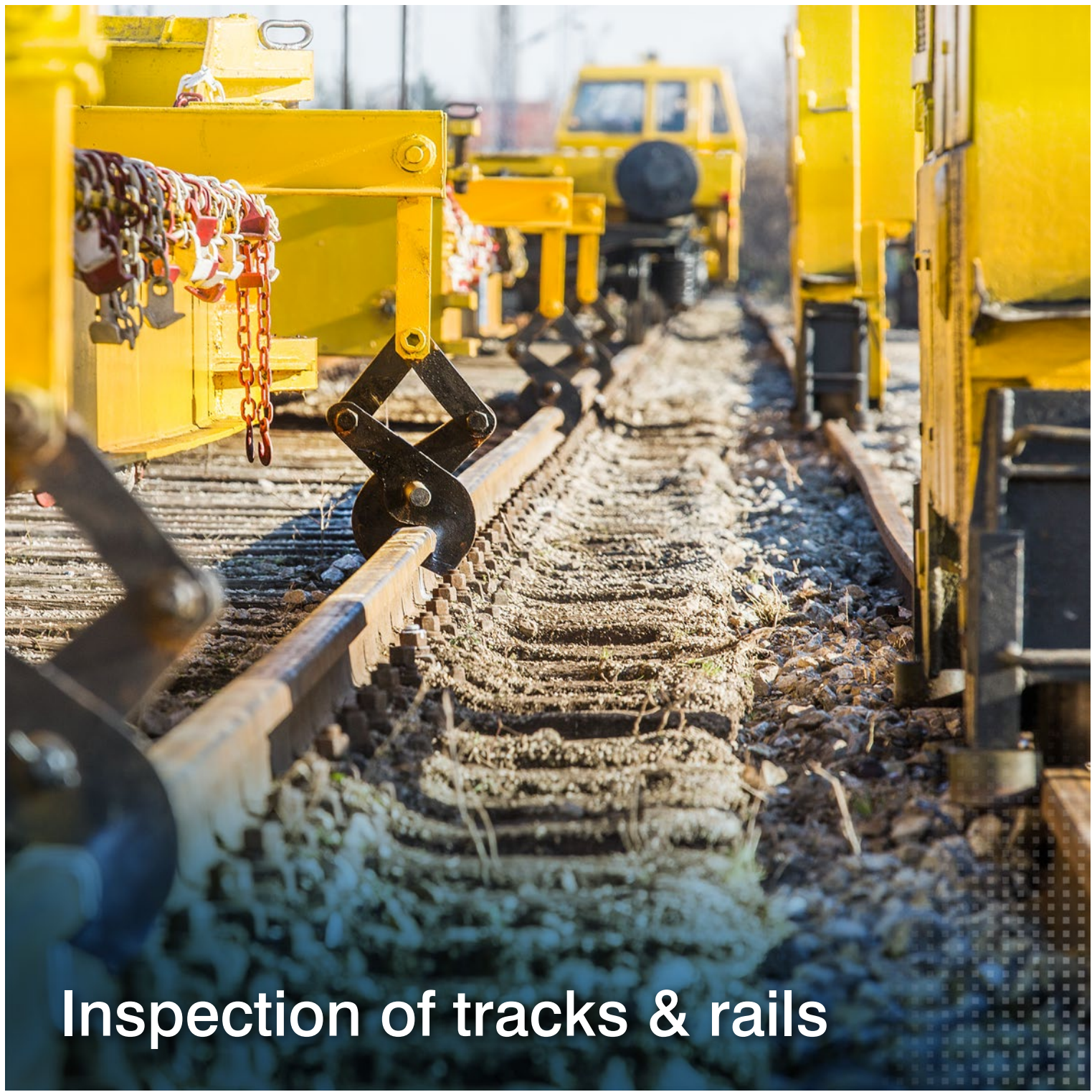
Sensor: optoCONTROL 2520



### Measuring the distance from tunnels & bridges

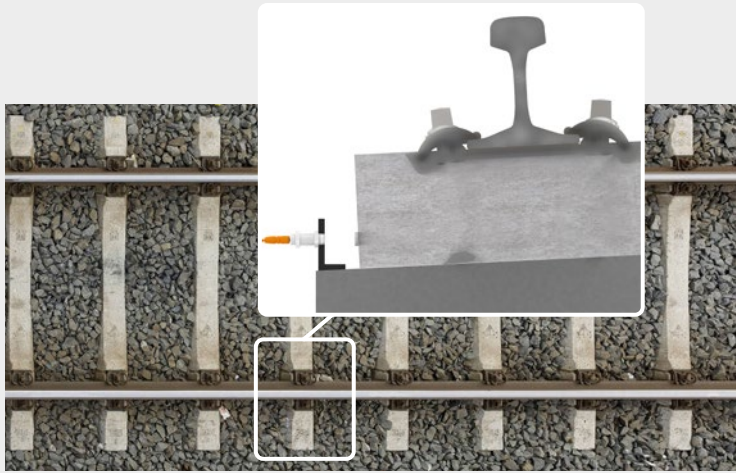
In order to inspect the building geometry of bridges and tunnels, optoNCDT ILR laser time-of-flight sensors are used, which are mounted on maintenance hoists. The sensor detects the vertical distance from the moving train to the building. A longitudinal profile is acquired from the distance data. If limit values are exceeded, maintenance of the road section is initiated. Laser sensors from Micro-Epsilon provide stable measurement signals even with weak surface reflections.

Sensor: optoNCDT ILR3800



Inspection of tracks & rails





### Deformation measurement of concrete joints and railway sleepers

The load on rails and sleepers is very high, especially in highly frequented curves. Magneto-inductive displacement sensors are used to test the movement and deformation of concrete sleepers in curves. The sensors are fixed in the subsoil and measure to a magnet which is applied to the concrete joint or sleeper. Thanks to their robust design, the sensors are ideal for outdoor use and provide long-term stable measurement results that allow statements to be made about deformation.

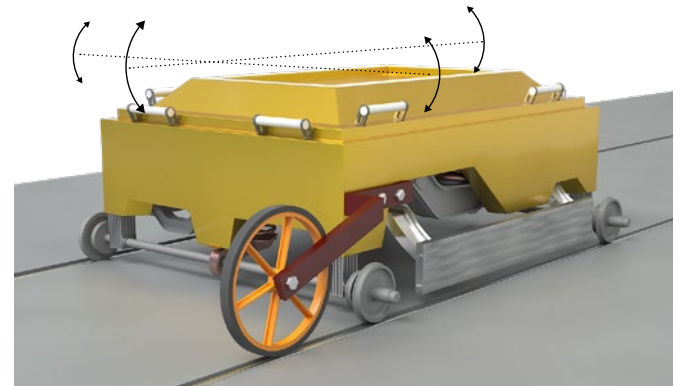
*Sensor: mainSENSOR*



### Planarity inspection of rails

optoCONTROL laser micrometers are used to selectively check railway tracks for flatness and deflection. These are integrated in a test trolley and detect the track at three points with high accuracy, regardless of the condition of the track surface. Depending on the requirements of the measurement task, the distance between the micrometers can be varied. The optoCONTROL 2520 laser micrometer can also be used for different variation depths. No additional systems are required.

*Sensor: optoCONTROL 2520*



### Measurement of track position errors

In rail transport, the new construction and reconstruction of track sections is subject to ever increasing requirements. A faultless track geometry is essential, especially for high-speed lines. In order to ensure this, tamping machines are used, which compact the ballast lying under the sleepers to give the track the necessary grip and avoid positional errors. To evaluate the exact position of the track, precise information about the condition and position of the track in front of the track tamping machine is required. Two INC5701 inclination sensors from Micro-Epsilon record the transverse and longitudinal inclination in a mobile measuring device and transmit this information to the tamping machine driving behind it. This enables a precise position of the tracks.

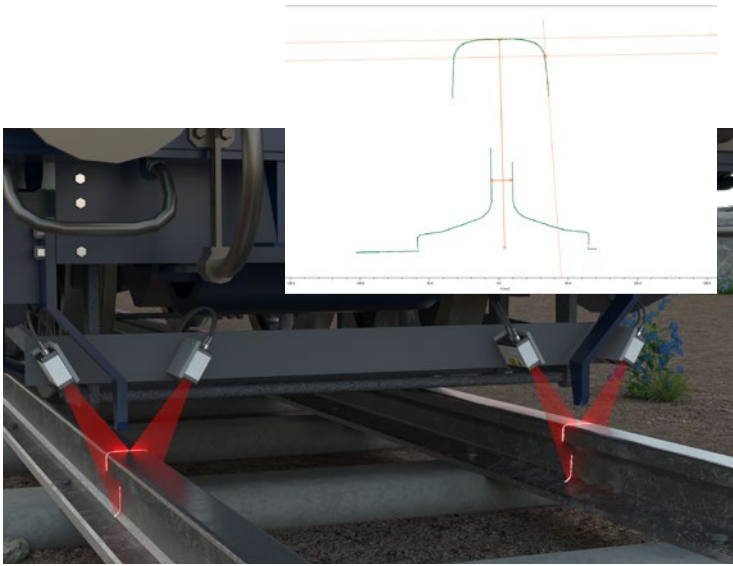
*Sensor: inertialSENSOR INC5701*





**Inspection of tracks & rails**

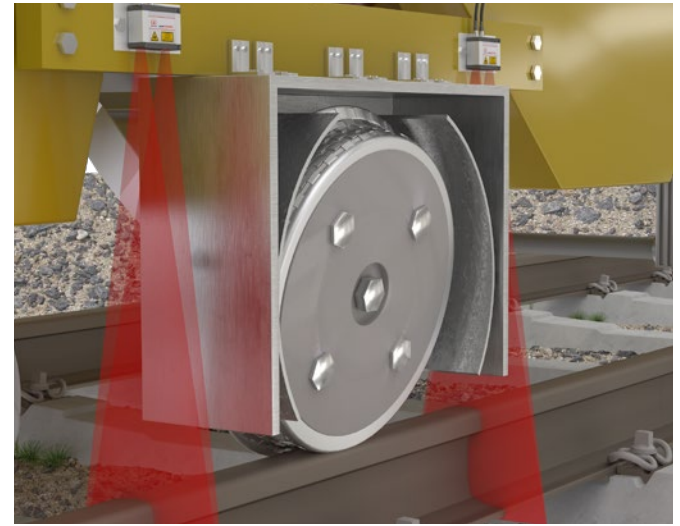




### Welding of rail sections

Track-bound welding robots are used for maintenance and for the construction of new railway lines. Thanks to the high degree of automation, the robots achieve rail welds of consistently high quality. To align the rail ends, scanCONTROL laser scanners are used in combination with the 3D Profile Unit. Several laser scanners capture the rail profile, which is converted into a common coordinate system by the 3D Profile Unit. This is how a composite 2D profile or a composite 3D point cloud can be generated.

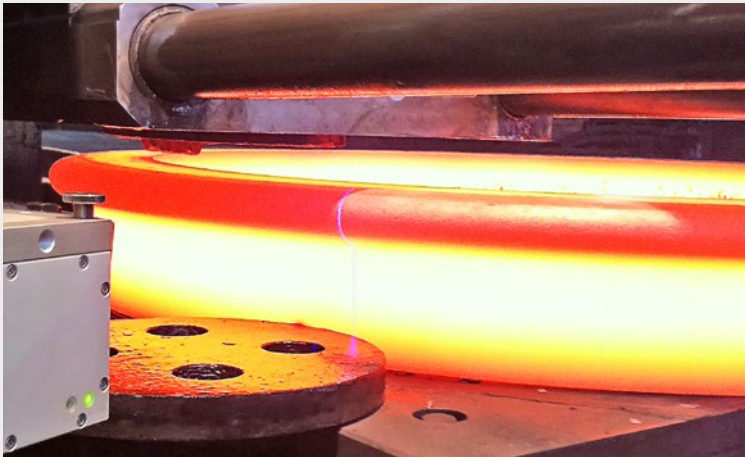
*Sensor: scanCONTROL / 3D Profile Unit*



### Inspection of the rail profile during grinding and milling

Rail milling trains are used for repair work on tracks. In order to detect the rail profile before and after milling, scanCONTROL laser profile sensors are used immediately before and after the grinding wheel. The target and actual status are thus recorded automatically and transferred to the central control unit in the milling train. The scanCONTROL laser scanners have an integrated controller, whereby the profile evaluation takes place directly in the sensor. Thanks to the high resolution and the high profile frequency, the scanners can be used during ongoing driving operations.

*Sensor: scanCONTROL*



### Profile measurement and distance control during forging of wheel tires

Blue laser scanners from Micro-Epsilon are used to monitor the dimensional accuracy of wheel tires during forging. Conventional laser scanners reach their limits with red-hot glowing steel, as its radiation intensity is too high for the sensor element. The Blue Laser Technology from Micro-Epsilon is patented for measurement tasks with glowing steel. This allows the wheel tire profile to be continuously monitored during forging in order to feed the measurement data to the control system. In addition, the position of the wheel tire during handling is detected by laser time-of-flight sensors.

*Sensor: scanCONTROL BL / optoNCDT ILR3800*

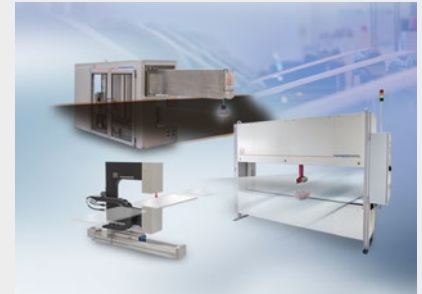
## Sensors and Systems from Micro-Epsilon



Sensors and systems for displacement, distance and position



Sensors and measurement devices for non-contact temperature measurement



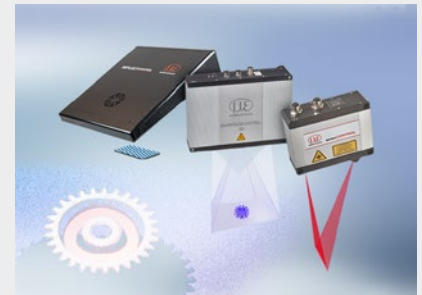
Measuring and inspection systems for metal strips, plastics and rubber



Optical micrometers and fiber optics, measuring and test amplifiers



Color recognition sensors, LED analyzers and inline color spectrometers



3D measurement technology for dimensional testing and surface inspection

## More Precision

Whether it is for quality assurance, predictive maintenance, process and machine monitoring, automation or R&D – sensors from Micro-Epsilon make a vital contribution to the improvement of products and processes. High precision sensors and measuring systems solve measurement tasks in all core industries – from machine building to automated production lines and integrated OEM solutions.



[www.micro-epsilon.com](http://www.micro-epsilon.com)