

# Clearance Profile Scanner

**Precise, fast, robust and non-contact**

*The CPS laser scanner can be mounted on mobile platforms for different applications. Its compact sensor head is encapsulated in a robust housing for reliable operation under harsh environmental conditions.*

Capturing the 3D geometry of road environments is of key value for urban planning. For railroad operators, measuring structure gauge is part of predictive maintenance. Laser scanning is the perfect technology for these tasks and widely used in mobile mapping. Operating from mobile platforms, the Clearance Profile Scanner CPS by Fraunhofer IPM records 3D-data fast and non-tactile. In its CPS-Plus version, the system provides data on surface moisture in addition to geometrical data.

## Infrastructure data in real time

The CPS measures clearance profiles in road and rail environments fast and with high precision. The optical system is typically mounted at the back or front of an inspection vehicle, i.e. a road car or train wagon, providing three-dimensional data on gauge profiles. For railroad applications, the track's center line is extracted from the data and potentially infringing objects are identified. In urban environments, the laser scanner collects valuable 3D data for infrastructure planning.

## Up to two million measurements per second

The CPS uses a rotating mirror to project a high frequency modulated laser beam on the surroundings and detect the returning light. Phase shift technology is used for determining the distance. The exact position of each measurement point is calculated from the measured distance

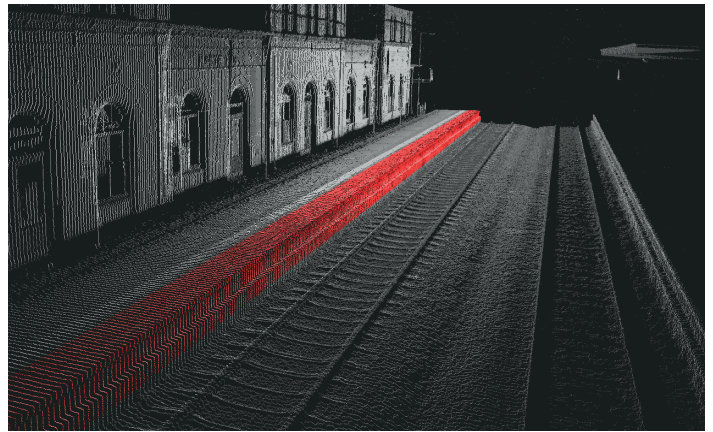
value and the angle of the scanning mirror. A two-dimensional image is derived from the mirror's rotational movement, the inspection car's motion provides the third dimension. The system works at scanning frequencies in the range of 10 to 200 Hz with a sampling frequency of up to 2 million measurements per second. Internal calibration before every scan guarantees precise and stable results – even at extreme temperatures and over long periods. A computer, located inside the inspection car, evaluates and visualizes the data before sending it to the inspection car's PC network.

## Robust housing

The sensor unit comprises a fixed optical window and is located in a hermetically sealed housing. When not in operation, a casing protects the sensor head from dirt or vandalism. Buffered vehicles can have a sensor head mounted on a slide, which is moved automatically into measurement position.

## Road and railroad measurement systems by Fraunhofer IPM

Fraunhofer IPM develops optical measurement systems for condition monitoring and mapping of rail and road infrastructure. Experts in measuring techniques and optics, designers, electrical and software engineers work together on supplying turnkey solutions for the special requirements of infrastructure operators, planners and providers of surveying services. The robust measurement systems are deployed throughout the world and are characterized by their speed, precision and reliability.



Above: The CPS' scanning data provides information on objects interfering with the clearance profile (marked red).

Left : (a) Exemplary point cloud section in grayscale based on intensity return of the LiDAR system. (b) Same section but colored using moisture values from blue (dry) over white to red (high moisture).

### CPS-Plus: Additional moisture detection

The scanner's extended version CPS-Plus uses two different wavelengths for measuring the clearance. From the difference of the signals, the water content on the surface can be extracted for every single measurement point, without compromising the precision of the measured distance value. This enables the reliable identification of vegetation and at the same time the detection of water ingress, which is a critical issue for the safety of civil engineering structures.

The clearance profile scanner's design is in accordance with DIN EN 60825-1:2008. The CPS is eye-safe according to IEC60825.

The system has been successfully deployed on measurement vehicles around the world for more than 15 years and is continuously being enhanced.

### Technical specifications CPS /CPS-Plus

Measurement range	1 – 10 m (up to 30 m, depending on reflectivity)
Distance resolution	about 1 mm
Intensity resolution	12 bit
Uncertainty at an object reflectivity of 90 %	3 mm at 5 m ( $\sigma$ -value)
Uncertainty at an object reflectivity of 10 %	7 mm at 5 m ( $\sigma$ -value)
Scanning angle	$\approx 350^\circ$
Scanning speed	10 – 200 rev./s
Measurement rate	up to 2 mio. measurements per s
Number of measurements per profile	10,000 (at 200 rev./s)
Point distance at 5 m	3.1 mm
Profiling density at 50 km/h	one profile each 7 cm (at 200 rev./s)
Ambient temperature	–20 °C to +50 °C (in operation; temp. control incl.)
Moisture detection (CPS-Plus)	10 levels of moisture

All specifications and features are subject to modification without notice.

### Contact

Prof. Dr. Alexander Reiterer  
Head of Department  
Object and Shape Detection  
Phone +49 761 8857-183  
[alexander.reiterer@ipm.fraunhofer.de](mailto:alexander.reiterer@ipm.fraunhofer.de)

Dr. Kira Zschiesche  
Group Manager  
Mobile Railway Measurement Techniques  
Phone +49 761 8857-172  
[kira.zschiesche@ipm.fraunhofer.de](mailto:kira.zschiesche@ipm.fraunhofer.de)

Fraunhofer Institute for Physical  
Measurement Techniques IPM  
Georges-Köhler-Allee 301  
79110 Freiburg, Germany  
[www.ipm.fraunhofer.de/en](http://www.ipm.fraunhofer.de/en)

CLASS 1  
LASER PRODUCT

Road application



Rail application

