



Sector Profile Scanner

Inspecting passing trains

Fast, accurate and robust

Inspecting passing trains at full speed: A rotating polygon with eight flat mirrors deflects a laser beam, creating 800 profiles per second.

Shifted loads can cause accidents, particularly in tunnels and at stations, leading to costly closing of railway lines. The Sector Profile Scanner SPS by Fraunhofer IPM identifies such hazards and faults of the rolling stock by measuring the geometry of passing trains.

3D image reveals irregularities

The stationary system measures the conformity of passing trains by acquiring high-resolution 3D point clouds. The 3D image is available immediately after the train has passed and can be analyzed for geometrical irregularities such as loads violating the clearance profile, open doors and deformed containers as well as overriding of buffers and loose connections between wagons.

Four scanners for one profile

Laser scanners are at the core of each SPS. Four scanners are needed for the inspection of an entire train. One pole on each side of the track carries two scanners at different heights. A rotating polygonal scanner featuring eight mirrors deflects the modulated laser beam onto the passing train and collects the returning light for analysis. The laser beam covers a scanning angle

of 70 degree. The measured distance values form a two-dimensional profile of the corresponding train section. The four profiles are processed to a combined profile of the entire train. With the train moving, thousands of such profiles are measured, yielding a three-dimensional image of the inspected train. The distance between the profiles is determined by train speed and scanning rate. A high scanning rate is crucial to achieve a good profile density for fast moving trains.

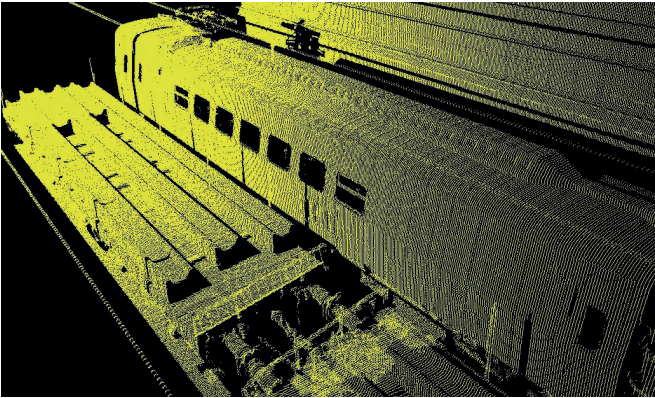
Up to 2 million data points per second

The laser scanner measures up to 2 million data points each second. Based on this extraordinary high measurement rate and the polygon mirror design, data capturing is flexible according to customers' need.

Besides the standard version, Fraunhofer IPM offers a *High Angular Resolution HAR* setup that provides 1,800 data points per profile

Railroad measurement systems by Fraunhofer IPM

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



Left: The 3D image is available immediately after the train has passed and can be analyzed for geometrical irregularities.

Right: Four scanners measure the geometry of passing trains.

at 800 profiles per second to address the requirements of freight trains and moderate speed passenger lines. The *High Profile Density HPD* setup is designed for use on high speed lines. It features 900 data points per profile with 3,200 profiles per second, which results in a density of 32 profiles per meter at 360 km/h.

The optical power of the infrared laser is optimized for a measurement range of about 10 m which allows inspecting the rolling stock even on double tracks while fully maintaining eye safety. By exploiting the advantages of the phase-shift technique a typical accuracy of 5 mm is achieved over the full measurement range. The scanners calibrate themselves before each profile measurement: This accounts for stable results over extended periods, practically independent of ambient temperature.

Reliable operation

The SPS design guarantees almost maintenance-free operation. The system's hermetic housing keeps dust and humidity away from optics and electronics. A baffle reduces stray light and pollution on the outside of the measuring window. Once the mirror stops rotating, the laser is switched off. This ensures eye-safe operation at any time. The SPS is eye-safe according to IEC60825.

Fast, accurate, robust

The SPS with its combination of high measurement speed, accurate results and robust design is ideally suited to the challenging task of inspecting passing trains at full speed. This holds true even under difficult light and environmental conditions.

Technical specifications

Scanning angle	70°
Distance range	1.3 – 10 m
Distance uncertainty	10 mm (1σ , 10 m, R = 50 %)
Point density	900 (one point every 12 mm at 10 m distance)
Measurement rate	1 million measurements per second (standard) 2 million measurements per second (HAR, HPD)
Profile rate	800 per second (standard) 3,200 per second (HPD)
Profile density at 100 km/h	35 mm (standard) 8.7 mm (HPD)
Housing	IP 67
Eye safety classification	Laser class 1
Operating temperature	-20 to + 55 °C

All specifications and features are subject to modification without notice.

**CLASS 1
LASER PRODUCT**

Contact

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

Dr. Kira Zschiesche
Group Manager
Mobile Railway Measurement Techniques
Phone +49 761 8857-172
kira.zschiesche@ipm.fraunhofer.de

Fraunhofer Institute for Physical
Measurement Techniques IPM
Georges-Köhler-Allee 301
79110 Freiburg, Germany
www.ipm.fraunhofer.de/en

