



1 A stationary system measures the conformity of passing trains by acquiring and analyzing high-resolution 3D point clouds.

2 A rotating polygon with eight flat mirrors deflects the laser beam, creating 800 profiles per second.



SECTOR PROFILE SCANNER SPS

Inspection of passing trains

Shifted loads can cause accidents, particularly in tunnels and at stations, which leads to costly closing of railway lines. To identify such hazards and faults of the rolling stock Fraunhofer IPM has developed the Sector Profile Scanner SPS, which measures the geometry of passing trains. A three-dimensional image, which is available immediately after the train has passed, 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 the wagons.

ner motor 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. Due to the train movement thousands of such profiles are measured, which yield a three-dimensional image of the inspected train. The distance between profiles is determined by the train speed and the scanning rate. To achieve a good profile density for very fast trains a high scanning rate is crucial.

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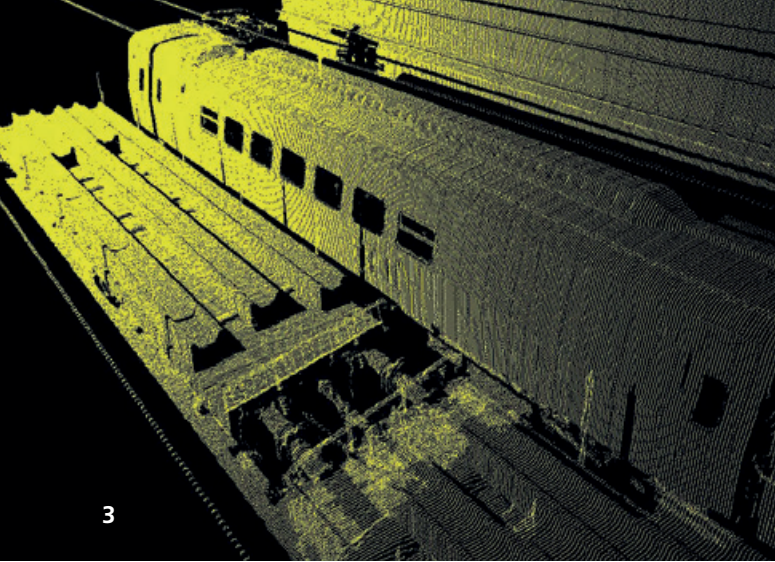
www.ipm.fraunhofer.de/railway

Four scanners for one profile

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 (see Fig. 4). A laser scanner forms the core of each SPS. A polygonal scan-

800 profiles each 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. Besi-



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des the standard version Fraunhofer IPM offers a *High Angular Resolution HAR* setup providing 1,800 data points per profile at 800 profiles per second to address the requirements of freight train and moderate speed passenger lines. The other end is marked by the *High Profile Density HPD* setup designed for use in high speed lines. It features 900 data points per profile with 3,200 profiles per second resulting 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 design of the SPS guarantees almost maintenance-free operation. The 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. If 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 Profile Scanner SPS with its combination of high measurement speed, accurate results

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

4 Four scanners measure the geometry of passing trains.

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.

Railway Measurement Technology at 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 turnkey 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. Other railroad measurement systems made by Fraunhofer IPM:

- High Speed Profiler HSP
- Clearance Profile Scanner CPS
- Contact Wire Recording System CRS
- Laser Pole Detection System LPS
- Wire Wear Monitoring System WWS
- Rail Track Scanner RTS

Technical Specifications

**CLASS 1
LASER PRODUCT**

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.



Railroad measurement systems by Fraunhofer IPM are qualified according to TransQ-standards.