

1 The scanner creates a 3D image of the road surface with high precision and resolution.

2 The laser scanner (here PPS-Plus), barely larger than a shoe box, is mounted on a measuring vehicle. Since 2012, the PPS is certified by the German Federal Highway Research Institute for measurement of transverse road evenness.



## PAVEMENT PROFILE SCANNER PPS / PPS-PLUS

Good condition of road surfaces is important for the safety and comfort of road-based traffic. Pavement management systems (PMS) prove to be valuable tools for constantly monitoring the road condition and planning repairs and renewals. PMS operate based on highly precise measurement data from the road surface. The mobile measuring systems PPS and PPS-Plus, developed by Fraunhofer IPM together with industry partners, provide these data. The laser-based systems detect small irregularities on the pavement's surface even at high traveling speed.

ately four meters with submillimeter precision, even at 80 km/h. The scan provides a three-dimensional image of the road's surface, from which conclusions on its condition can be drawn. The high performance is made possible by the use of phase shift technology. This technology, used in many mobile scanning applications, allows for higher measurement rates and, at the same time, higher precision if compared to e.g. pulsed TOF technology. The scanner is integrated into a robust, shock proof IP67 housing, so that 24/7 use in even harsh environments is possible.

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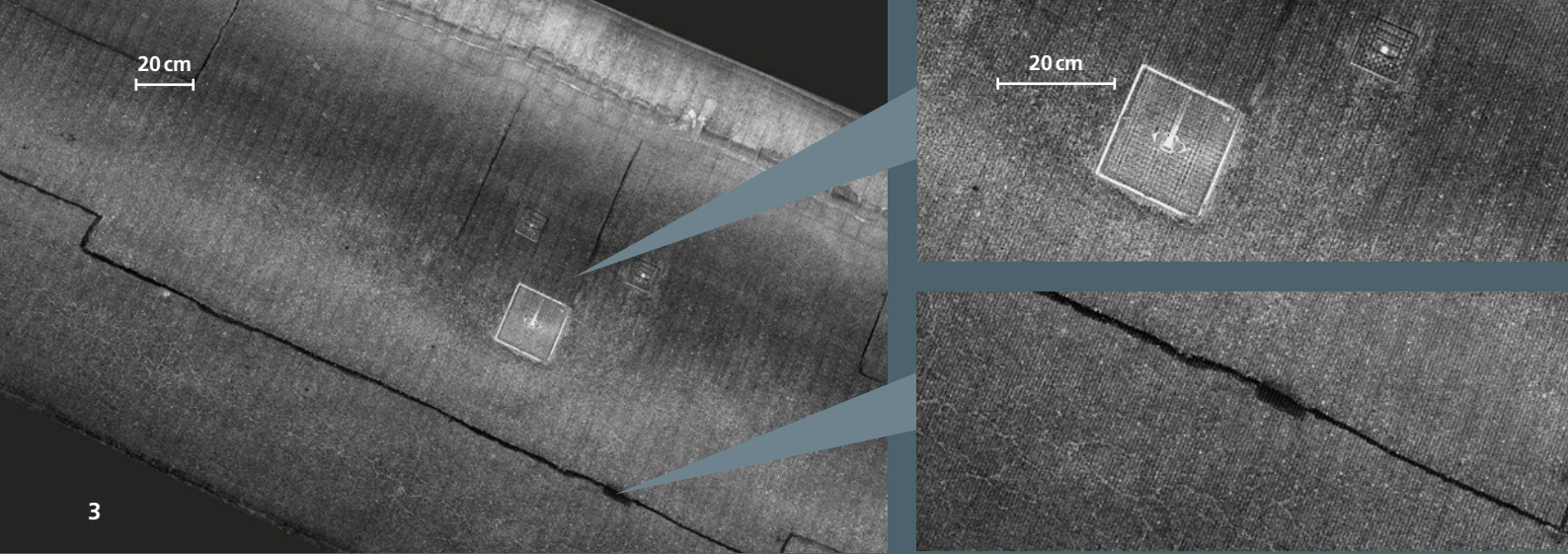
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#### Laser scanner: unachieved precision at high speed

The core of the PPS and PPS-Plus is a laser scanner that measures with hitherto unachieved precision, resolution and speed. Mounted on a measuring vehicle about three meters above the street, it scans the road's surface over a width of approxi-

#### 800 profiles per second

In road surface measurement, precision requirements are high: Averaged over small surface elements, typically of 2 cm × 2 cm or 10 cm × 10 cm, extreme height resolution of a few tenths of a millimeter is required. Only by combining high accuracy, high measurement rates and high scanning



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speeds can these requirements be met. The PPS-(Plus) scans the street surface crosswise from the measuring vehicle's forward movement using a rotating polygon mirror. In this way, it creates 800 transverse profiles per second. The distance to the street surface is measured up to two million times per second, resulting in up to 1 800 measuring points per profile. Even at a speed of 80 km/h, a surface element of 10 cm × 10 cm still contains up to one hundred 3D measurement points. No other laser scan-

ner currently on the market offers such a high point density together with precision, while still categorized laser class 1.

**PPS-Plus: Photorealistic image of the road surface**

In its PPS-Plus version, the system uses an additional laser that scans the road's surface line by line, measuring the intensity of the backscattered light. These 2D inten-

3 High-resolution image of the road surface acquired by the PPS-Plus.

sity measurements provide photorealistic images normally provided by additional cameras. With a resolution of 1.2 mm × 1.7 mm at a driving speed of 80 km/h, the images reveal even tiny surface defects. Optics and mechanics of the patented setup are synchronized with the hardware of the 3D laser scanner, which significantly reduces the effort normally required for merging the scanner and camera data.

| Technical Specifications  | CLASS 1 LASER PRODUCT                          |  |
|---|--|--|
|   | PPS  | PPS-Plus   |
| <b>Acquisition range for distance measurement</b>   |  |  |
| • unambiguous measurement range   |  | 1.2 m  |
| • within a distance of minimum  |  | 1.3 m  |
| • within a distance of maximum  |  | 5.0 m  |
| Sampling rate: distance / intensity   | 2 MHz / 2 MHz                                  | 1 MHz / 64 MHz (16 × 4 MHz)                              |
| Resolution of intensity measurement (at 80 km/h driving speed, 3 m mounting height)             | 4.5 mm × 28 mm                                 | 1.2 mm × 1.7 mm  |
| Standard deviation (distance measurement) of the mean value of 100 points (3 m mounting height) |  |  |
| • 80% reflection  | < 0.15 mm                                      | < 0.15 mm  |
| • 20% reflection  | < 0.3 mm                                       | < 0.3 mm   |
| Acquisition angle   | 70°  | 75°  |
| Scanning frequency  | 25–800 Hz                                      | 25–800 Hz<br>intensity is measured by 16 single elements |
| Data interface / Scanner status indication  | Gigabit Ethernet (optical) / LEDs upon request |  |
| Other interfaces  |  |  |
| IP-Class  | 67   |  |
| Operating system  | Windows, Linux                                 |  |
| Synchronization input   | yes  |  |

All specifications and features are subject to modification without notice.

The Pavement Profile Scanners PPS / PPS-Plus are eye-safe according to IEC60825. Since May 2012, the PPS is certified by the German Federal Highway Research Institute for the measurement of transverse road evenness.

**Comprehensive process chain for 3D data acquisition**

Fraunhofer IPM develops optical measuring systems for infrastructure monitoring. The systems are designed for examining the condition of road surfaces (PPS/PPS-Plus) and mapping urban surroundings (CPS). Integrated into one single system (MUM), measuring vehicles set-up by Fraunhofer IPM provide a comprehensive solution for the efficient digitization of urban planning processes.

Mobile mapping solutions by Fraunhofer IPM also comprise AI-based tools for automated data interpretation (3D-AI) adapted to the hardware employed and designed for specific application scenarios.