Precise Industrial 3D Metrology

ATOS Capsule

Optical Precision Measuring Machine

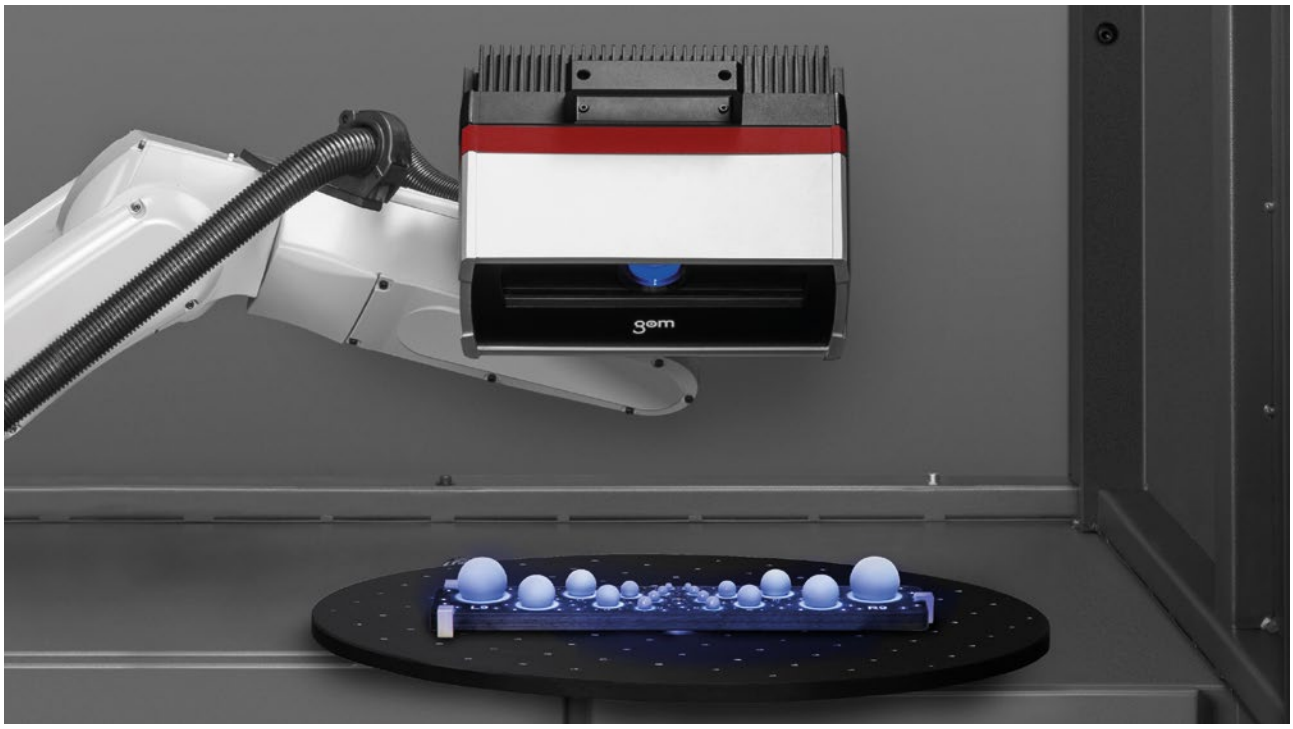
3D coordinate measurement
High-end scanning and inspection system
Quality control with highest resolution

Optical 3D Measuring Technology

In Industrial Quality Control

Optical 3D coordinate measuring machines are replacing tactile measuring systems and gages in many areas of industry. They capture more detailed and more easily interpretable quality information of an object with significantly shorter measuring times.

Whereas mechanical measuring systems capture data in a point-based or linear manner, optical measuring systems return full-field data about deviations between the actual 3D coordinates and the CAD data. As this measuring data contains all the object information, in addition to the surface deviations from the CAD, the software also automatically derives detailed information such as GD&T, trimming or hole positions.



The accuracy of optical measuring machines is not due to expensive and high-maintenance precision mechanics, but is rather based on state-of-the-art optoelectronics, precise image processing and mathematic algorithms. Few precision standards and automated calibration that can be performed by the customer ensure the accuracy of the machine. This also means no loss of accuracy due to wear under harsh conditions. As with tactile machines, measuring uncertainty is certified with the help of ball bars or step gauges.

Over 14,000 GOM measuring systems worldwide ensure the dimensional quality of automotive, sheet-metal, cast and injection molded products as well as turbine blades and wheels. In most cases, the detailed analyses are not used for a simple "OK"/ "not OK" evaluation, but rather form the basis for the optimization of production and machine parameters as part of a value-added measuring procedure.

Measuring Room

Typically, a wide range of different parts are handled in the measuring room. The measurement engineer creates both the measuring programs and the evaluation templates, together with the measuring reports, offline on the computer in a CAD-like environment. Special Auto Teaching functions speed up programming and ensure process reliability. After the actual measurement, the previously created evaluation templates are filled with real measuring data, deviations from the nominal value are calculated and the reports are automatically generated.

Production

Robustness, measuring speed and compensation for temperature fluctuations are convincing factors in production, enabling traceable results to be captured even under harsh conditions. As the machines can be operated close to production, the work-intensive transportation of components can be omitted. The operator works on the system in an encapsulated mode (Kiosk Interface), which means that precise measurements can be performed and measuring reports can be created without any knowledge of measuring technology.

GOM Sensors

High Tech in Robust Machines

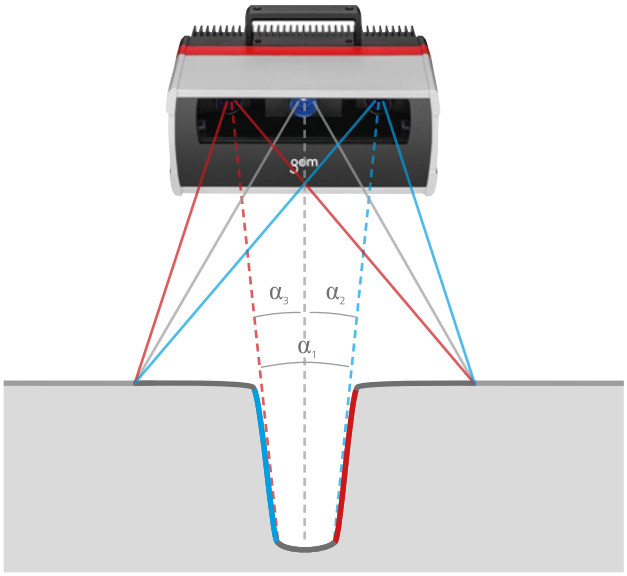
ATOS 3D Sensors

The core of all the ATOS ScanBox systems is the ATOS 3D scanner, which GOM has offered since 1995. The ATOS sensor is currently available in three different model ranges for diverse applications.

High image resolution and measuring speed – The ATOS sensors return full-field distributed 3D coordinates for each individual measurement. Up to 12 million independent measuring points are captured within 1 to 2 seconds. The measuring data is characterized by very high detailed reproduction, thus also enabling very small component features to be measured.

ATOS Plus – In GOM's automated measuring machines, ATOS sensors can be operated together with the Plus Box. This is a photogrammetric add-on sensor, which is directly mounted onto the ATOS system. It allows for fully automated measuring of reference point markers with a deviation of 3 µm to 15 µm. These reference point markers create a 3D volume, in which the detailed individual measurements of the ATOS Capsule are transformed automatically. Thus, the overall accuracy of the overarching photogrammetric measurement is achieved.

Triple Scan Principle – Precise fringe patterns are projected onto the surface of the object and are recorded by two cameras, based on the stereo camera principle. As the beam paths of both cameras and the projector are calibrated in advance, 3D surface points from three different ray intersections can be calculated: Visual beam camera/camera, visual beam camera on left/projected beam projector and camera on right/projected beam projector. This automatic principle offers advantages for measuring reflective surfaces and objects with indentations. If a ray intersection is not possible for a ray combination due to reflection or indentation, the other two are used. The result is complete measuring point distributions without holes or erratic points.



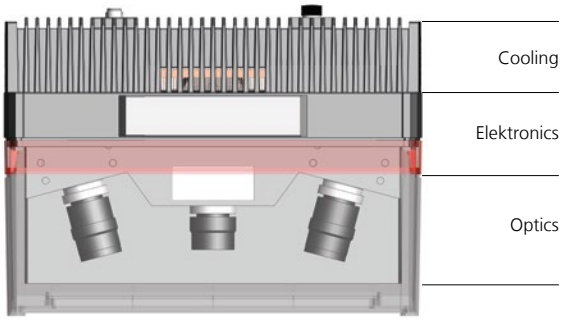
Blue Light Technology – GOM projection technology works with narrow-band blue light, which means that interfering ambient light during image acquisition can be filtered out. The light sources are so powerful that short measuring times can be achieved even on uncooperative surfaces. In addition, they have a life expectancy of well over 10,000 hours.

Self-monitoring system – ATOS Capsule is a self-monitoring system. The sensor recognizes changing ambient conditions during operation and is able to compensate these changes. To do so, the software of the sensor is continuously monitoring the calibration status, the transformation accuracy, environmental changes and part movements to ensure the quality of the measuring data.

ATOS Capsule

Optical Precision Measuring Machine

The ATOS Capsule is an optical precision measuring machine for full-field digitizing of contoured part geometries. The fringe projection system of the ATOS series is used for production quality assurance of small to medium-sized parts and excels by its high precision for fine details. ATOS Capsule is used, for example, for first article inspection of gears, turbine blades and wheels as well as medical parts. Due to its housing design, the ATOS Capsule provides process stability for automated applications.



Made of aluminum, the precisely manufactured unibody housing ensures maximum stiffness and precise measuring results for industrial use. Optics and electronics are protected against dust and splashing water. For this purpose, the lenses are protected by a cover, integrating a thin non-reflecting glass pane. In addition, the sensor electronics are hermetically sealed and the cooling takes place via external cooling fins along the housing. Industrial ports increase process reliability and ensure an interference-free data transfer.

Technical Data

Two versions of ATOS Capsule are available with different levels of detail. The system captures 8 or 12 million points per scan. The dimensions of the sensor, its low weight and the short working distance simplify its application in practice. The measuring areas of this sensor can be changed easily, covering a range of different part sizes.

Measuring Volumes	MV 70	MV 120	MV 200	MV 320
Measuring area [mm]	70 × 50	120 × 80	200 × 140	320 × 240
Working distance [mm]	290	290	290	290
Sensor types	8 or 12 million points per scan (pps)			
Dimensions [mm]	Approx. 310 × 220 × 150			
Weight	Approx. 7 kg			
Operating temperature	+5 °C to +35 °C (non-condensing)			
Housing	Dustproof, splashproof			

ATOS Capsule in Use

In the standardized measuring machine ATOS ScanBox, the ATOS Capsule is used for fully automated measuring and inspection of contoured parts. The ATOS ScanBox is a complete optical 3D measuring machine that was developed by GOM for an efficient quality control in production and manufacturing processes. Various measuring systems are available for different part sizes and applications.

Used in the ATOS ScanBox of series 4, the ATOS Capsule serves as a mobile and therefore flexible measuring system for small parts. In the ATOS ScanBox models of series 5 and 6, the ATOS Capsule can be extended with a Plus Box photogrammetry add-on. Thus, bigger components or several parts can be measured simultaneously.

Manually, the ATOS Capsule is used with a studio stand or a desk stand. For the semi-automatic use, a 3-axis motorization kit, including a lift module for the sensor and a Tilt and Swivel Unit for the fixture, is available.

Workflow

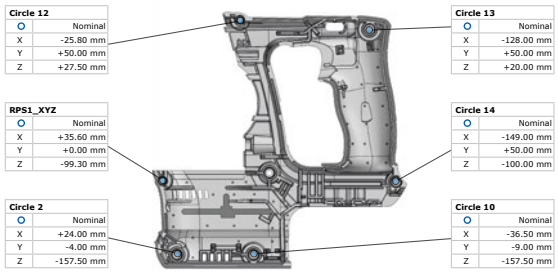
ATOS Professional VMR Software

Measurement Planning

Manual application – Based on CAD data and measurement plan, the inspection planning can be prepared. Then, the ATOS sensor is positioned freely in front of the component. After each measurement, the sensor or the part is moved in order to measure those areas that were not covered by the previous scan. All individual measurements are automatically transformed into a common coordinate system and result in a complete 3D point cloud.

Automated application – The virtual measuring room (VMR) is the central control station and measurement planning software for all elements of the ATOS measuring cells. It offers the functional representation of a real measurement environment in a virtual simulation. Due to the VMR, the user can work with the system without the requirement for specific robot programming skills. All robot movements are simulated and checked for safety before being performed in the virtual measuring room.

Inspection planning – The CAD data set is imported together with the associated measurement plan. The inspection features stored there are automatically assigned to the inspection characteristics from the measurement plan. The measuring report can also be prepared offline in advance. The actual measuring results can be displayed after the measurement procedure.

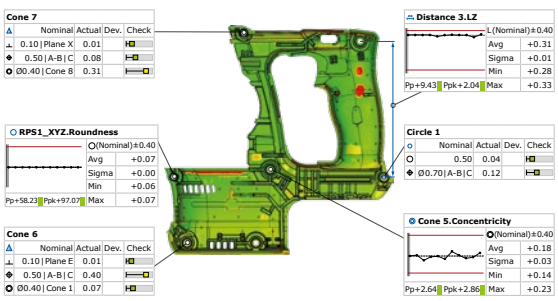


Robot programming – The Auto Teaching function in the VMR calculates the required sensor positions for all inspection features and CAD surfaces. The subsequent path optimization improves the sequence of the positions in terms of runtime and collision avoidance. Thanks to Auto Teaching, the time required for creating reliable and runtime-optimized robot programs is kept to a minimum.

Burn-in – The measuring programs created offline are only once "burned in" in the ATOS ScanBox using an automated process. The robot moves to the measurement positions, where it defines the individual measurement parameters, e.g. exposure times, on the real life component. Using a special procedure, the software automatically detects component mirroring and adapts the fringe projection in order to prevent measuring errors caused by mirroring.

Series measurement – Ready-to-use measuring programs can be utilized for inspecting other components. The robot is fully controlled by the software and successively moves along the measurement positions. A check is carried out on each measurement as to whether the results meet the quality criteria. Changes to the data status of the CAD or the measurement plan can be quickly updated by the parameterized software.

Measuring evaluation – After data acquisition has been performed, the software calculates a polygon mesh of the surface of the component as well as the actual values of the inspection feature plan. This data is compared with the nominal data and is presented in a report. The measuring results are automatically saved in special export formats, e.g. databases for statistical quality control. The measuring procedure for different components can be performed fully automatically.



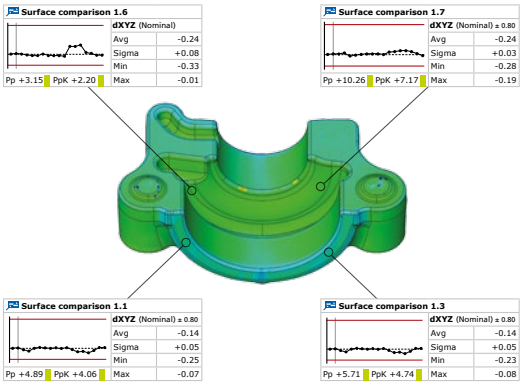
Evaluation and Measuring Reports

ATOS Professional VMR Software

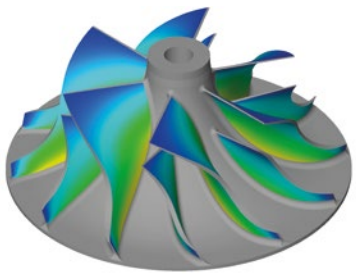
Certified Inspection Software

To ensure precise measuring accuracy, the GOM software packages have been tested and certified by the two institutes PTB and NIST. The accuracy of the inspection software is confirmed by the comparison of the results obtained with the reference results. The GOM software has been placed in Category 1, the category with the smallest measurement deviations.

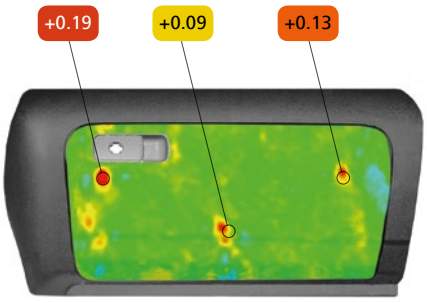
Actual-nominal comparison – The calculated polygon mesh describes free-form surfaces and standard geometries. These can be compared with the drawing or directly with the CAD data set with the help of a surface comparison. A 3D analysis of surfaces as well as a 2D analysis of sections or points can be implemented in the software. CAD-based generation of standard geometries such as lines, planes, circles or cylinders is also possible.

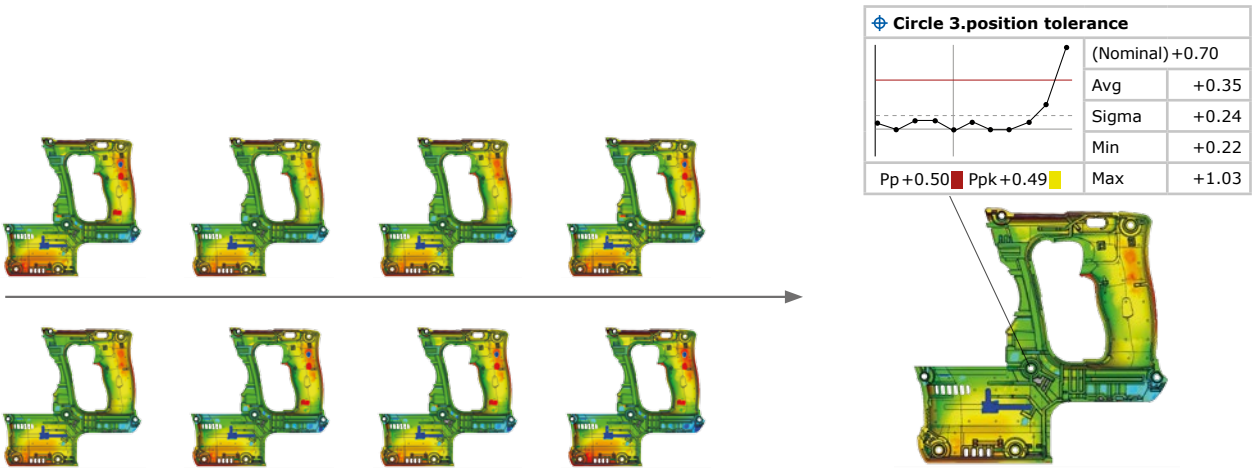


Alignment – The GOM 3D software contains all standard alignment functions. These include RPS alignment, hierarchical alignment based on geometric elements, alignment in a local coordinate system, using reference points as well as various best-fit methods such as global best-fit and local best-fit. Customers can also use their own specific alignments, e. g. for turbine blades, such as balanced beam or equalized nested.



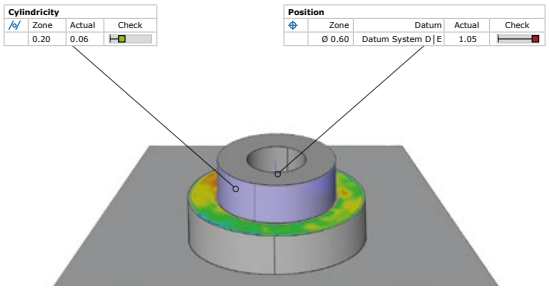
Surface defect map – The function detects small defects and visualizes e. g. dents or sink marks. To visualize and quantify local bulges and depressions, the surface defect map directly works on meshes. By comparing the nominal and actual surface inspection, the new feature allows the compensation of global curvatures.



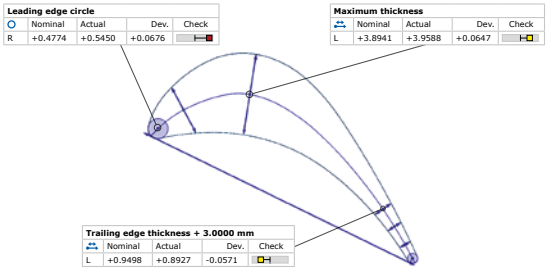


Trend, SPC and deformation analysis – The parameter-based approach of the GOM software enables trend analysis for multiple evaluation, e. g. for statistical process control (SPC) or deformation analysis. As a result, several parts or stages within a single project can be evaluated in a full-field manner, and statistical analysis values such as Cp, Cpk, Pp, Ppk, Min, Max, Avg and Sigma can be determined.

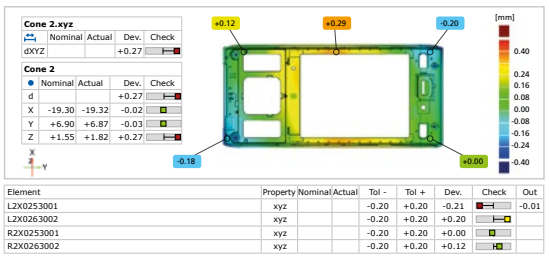
GD&T analysis – In contrast to the pure dimension analysis, the GD&T analysis focuses on the functional aspect of the part. Corresponding GD&T elements are, for example, planarity, parallelism or cylindricity. Both, a standardized analysis of 2-point distances and of the maximum material requirement as well as the position tolerance in local datum and coordinate systems are possible.



Airfoil inspection – Special functions are available for the quality control of turbine blades, which can be used, for example, to inspect the profile mean line, profile chord line or profile thickness of turbine blades on the basis of 2D sections. The profile centroid, profile radii and profile twists can also be calculated.



Reporting – The reporting module enables users to create reports containing snapshots, images, tables, diagrams, texts and graphics. The results can be visualized and edited in the user interface as well as exported as a PDF file. Templates are reusable, and each scene saved in a report can be restored in the 3D window.



ATOS ScanBox

Complete System from a Single Source

The ATOS ScanBox is a complete optical 3D measuring machine which was developed by GOM for efficient quality control in the production and manufacturing process. The ATOS ScanBox has been installed several hundred times worldwide and is successfully used in a variety of industries. Nine models are available for different part sizes and applications.

Standardized quality – The ATOS ScanBox is a standardized measuring machine which is certified in accordance with the machinery directive and is already in use in many applications. There is no risk for the customer in terms of costs, performance or delivery date – in contrast to projected individual systems. Even before an order is placed, test measurements can be performed in an identically designed ATOS ScanBox to verify measuring equipment capability.

An ATOS ScanBox is usually supplied ex stock at short notice. Depending on the type, commissioning may take a few hours for the small boxes (Series 4) and up to two weeks for the large boxes (Series 7 and 8). The entire kinematics is based on robust automation components instead of precision mechanics. The machines are hardly subject to any wear even under harsh ambient conditions and retain their full accuracy.

Space saving – All ATOS ScanBox models are characterized by their compact design. The ATOS ScanBox models 4105, 5108 and 5120 do not have to be anchored in the floor of the factory or on special measuring tables. They can easily be transported to the required place within a short period. All that is needed at the location is a power connection.

ATOS ScanBox Series

Series 4

Series 5

Series 6

Simple operation – The Kiosk Interface is a special user interface for a simplified operation of the ATOS ScanBox. The software handles the entire process control and performs the measuring and inspection procedure automatically. As human interaction is reduced, high precision and data quality are guaranteed: Measurement parameters, data, and the operating system are protected.

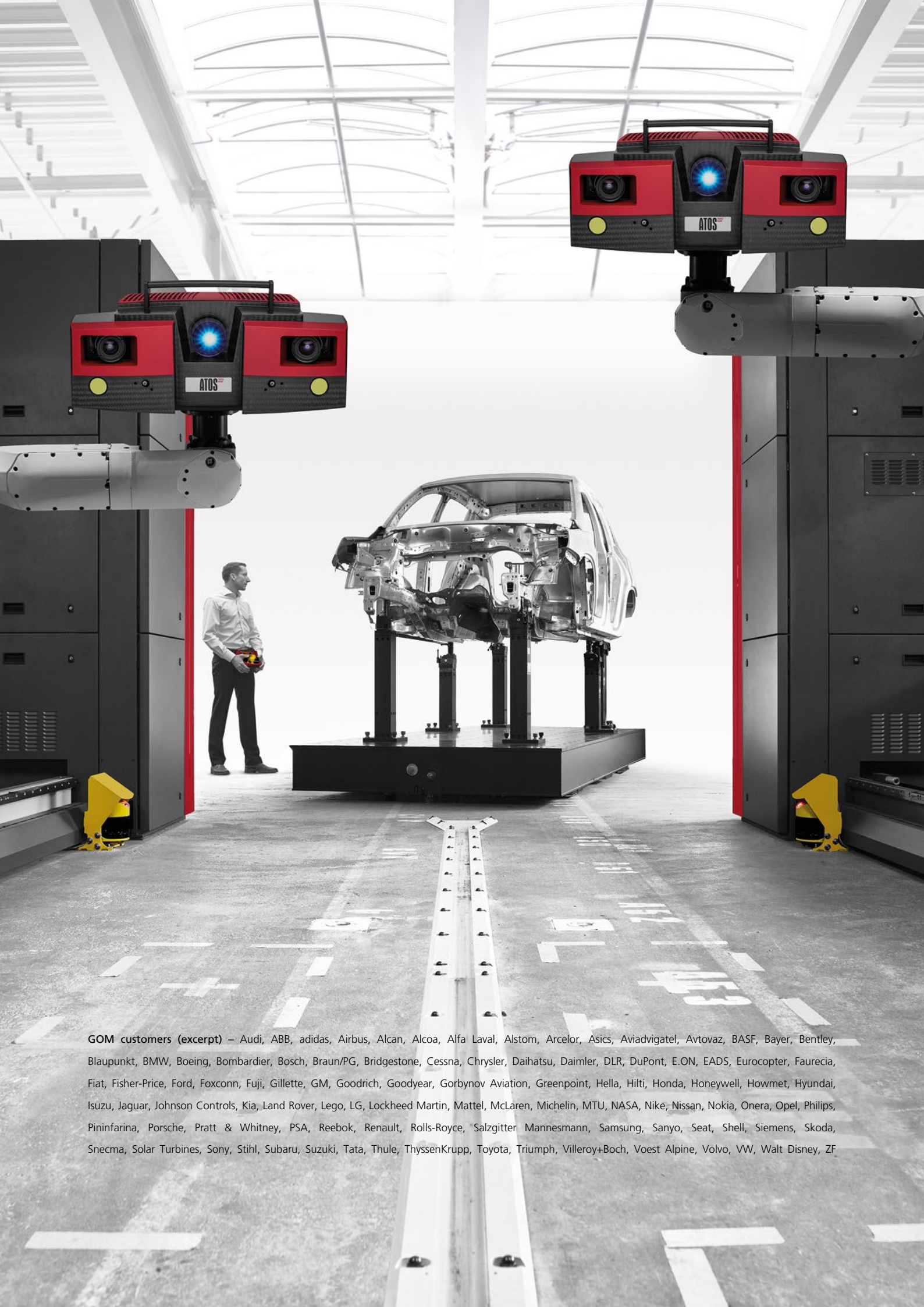
High measuring speed – Compared to a traditional tactile coordinate measuring system, the ATOS ScanBox can reduce the measuring and inspection time for a component by more than half.

"Closed Loop" vs. "Open Loop" – With robot-based measuring systems, an optical scanner is moved over the component. To bring the measurements from all the positions into a coordinate system, these must be defined with high precision, as the positioning accuracy of the robot is not sufficient for metrological tasks.

Using "Open Loop", the scanner is tracked with a second measuring system. As movements of the tracking system result in measuring errors, floor movements and vibrations are disturbing. Complete measurements or measurements inside a car body are in this case problematic as the optical tracker cannot track the scanner. Using "Closed Loop", 3D coordinates of the characteristics of an object are first determined photogrammetrically without any interference from any ambient influences. During subsequent scanning, the scanner determines its position itself on the basis of the previously determined characteristics and transforms with high precision into a global coordinate system.

Series 7

Series 8



GOM customers (excerpt) – Audi, ABB, adidas, Airbus, Alcan, Alcoa, Alfa Laval, Alstom, Arcelor, Asics, Aviadvigatel, Avtovaz, BASF, Bayer, Bentley, Blaupunkt, BMW, Boeing, Bombardier, Bosch, Braun/PG, Bridgestone, Cessna, Chrysler, Daihatsu, Daimler, DLR, DuPont, E.ON, EADS, Eurocopter, Faurecia, Fiat, Fisher-Price, Ford, Foxconn, Fuji, Gillette, GM, Goodrich, Goodyear, Gorbynov Aviation, Greenpoint, Hella, Hilti, Honda, Honeywell, Howmet, Hyundai, Isuzu, Jaguar, Johnson Controls, Kia, Land Rover, Lego, LG, Lockheed Martin, Mattel, McLaren, Michelin, MTU, NASA, Nike, Nissan, Nokia, Onera, Opel, Philips, Pininfarina, Porsche, Pratt & Whitney, PSA, Reebok, Renault, Rolls-Royce, Salzgitter Mannesmann, Samsung, Sanyo, Seat, Shell, Siemens, Skoda, Snecma, Solar Turbines, Sony, Stihl, Subaru, Suzuki, Tata, Thule, ThyssenKrupp, Toyota, Triumph, Villeroy+Boch, Voest Alpine, Volvo, VW, Walt Disney, ZF

GOM

Precise Industrial 3D Metrology

GOM develops, produces and distributes software, machines and systems for industrial and automated 3D coordinate measuring technology and 3D testing based on latest research results and innovative technologies.

With more than 60 sites and an employee network of more than 1,000 metrology specialists, GOM guarantees professional advice as well as support and service to operators on-site in their local languages. In addition, GOM shares knowledge on processes and measurement technology in training courses, conferences and application-based workshops.

GOM has been developing measuring technology in Braunschweig since 1990. In the respective research and development departments, more than 100 engineers, mathematicians and scientists shape the measuring technology of the present and the future.

Today, more than 14,000 system installations improve product quality and accelerate product development and manufacturing processes for international companies in the automotive, aerospace and consumer goods industries, their suppliers as well as many research institutes and universities.

GOM headquarters in Braunschweig, Germany

www.gom.com