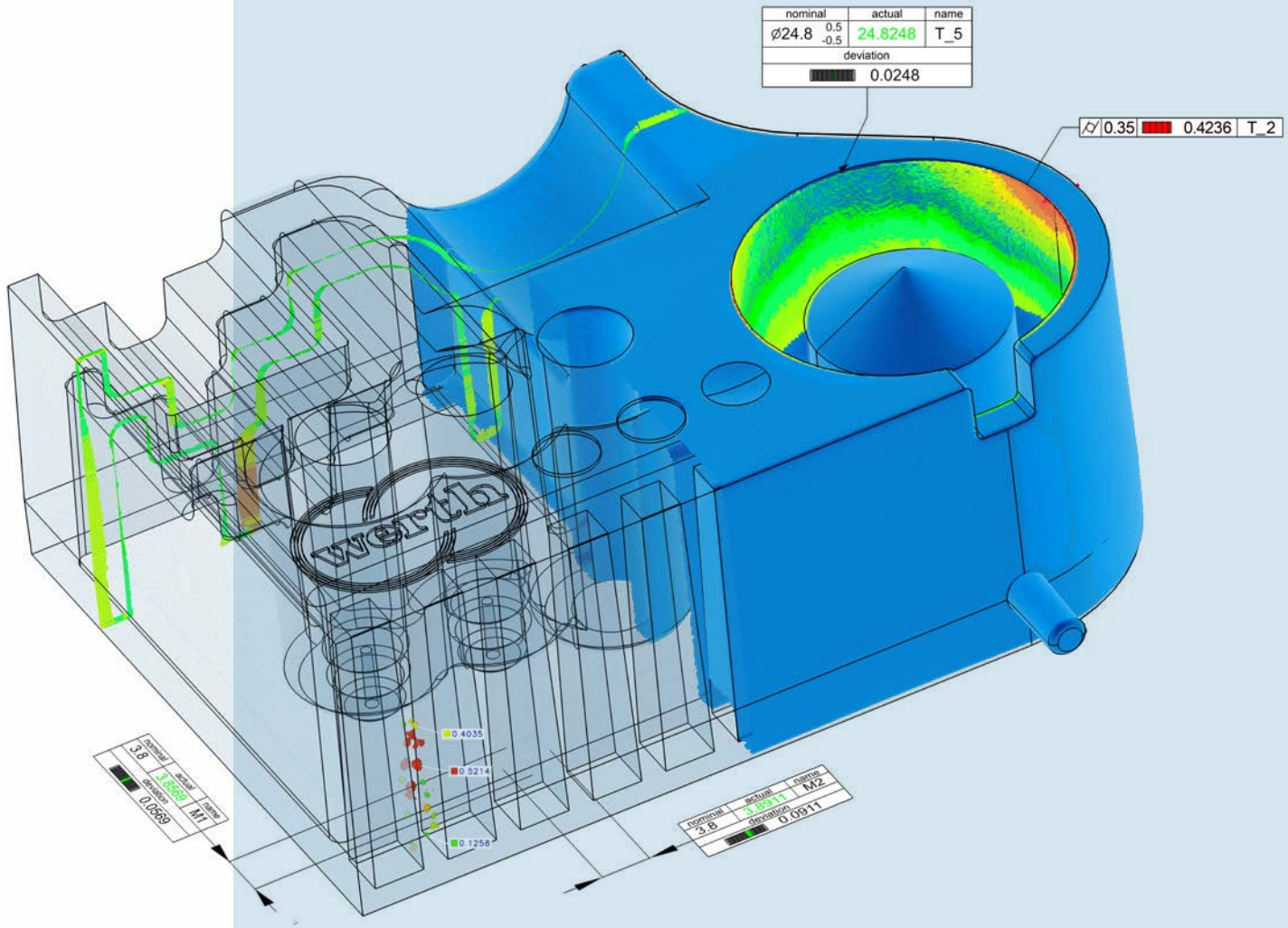
# Multisensor

Innovative Measurement Technology
for your Quality Products



Cover picture: The WinWerth® measuring software offers a wide range of evaluation possibilities for volume data and point clouds. The measured workpieces and the CAD data can be displayed, for example, together with the color-coded deviations from a nominal-actual comparison in 2D or 3D. Inclusions in the volume are visualized and the measured geometric properties are displayed as values.


The ScopeCheck® FB DZ machine series was expanded. The multi-ram concept is now available for large workpieces. This allows multisensor measurements to be carried out without restriction and avoids collisions.

# Optical Sensors, Computed Tomography, and Multisensor Technology continue to gain Ground

The progressive digitalization and automation of manufacturing has a substantial impact on metrology. Thanks to detailed digital workpiece models created from numerous measuring points, optical sensor technology and computed tomography (CT) often have an advantage over conventional probes. As a result of dynamic further development, Werth introduced two new coordinate measuring machines (CMM) and a new sensor in 2020.

The new TomoScope® XS FOV (Field of View) enables fully automatic measurements with computed tomography. With this third model in the powerful and compact TomoScope® XS product line, Werth now offers computed tomography at the price of a small conventional 3D coordinate measuring machine. Like all TomoScope® systems, an FQ (Fast Qualifier) version is also available for quick inline and atline applications. With the success of the TomoScope® XS family, our expectation that these compact designs would pave the way for the widespread introduction of CT technology in the measuring room and in production has been fulfilled.

The ScopeCheck® FB DZ multisensor CMM family, with the flexible multi-ram concept, has been further expanded and is now available with significantly larger measuring ranges. Thanks to two or even three independent sensor axes, multisensor measurements can be performed without restriction.

The integration of several measuring capabilities in a single sensor increases the flexibility and ergonomics of measuring machines. The new Chromatic Focus Zoom CFZ combines two powerful Werth sensors, the Image Processing with Zoom and the Chromatic Focus Probe CFP. Thus, non-contact measurements with high accuracy and speed in all three spatial directions can be performed.

The WinWerth® measurement software was again expanded last year with many new functions. One focus was the evaluation of CT measurements, such as the determination of burrs, optimization of inline applications, and automatic multi-object tomography. With the workshop user interface Scout (see page 24) now integrated in WinWerth®, measurement results can be easily viewed as figures or 3D graphics from several workstations throughout the network.

In addition to other technical innovations and user reports, the current version of “Multisensor” presents some of our subsidiaries and sales partners abroad. A look behind the scenes is again provided by selected employees at the Giessen headquarters, where all Werth coordinate measuring machines are manufactured to the highest quality standards.

Due to the current global pandemic, we have been unable to participate in trade fairs and have missed out on face-to-face discussions that have provided us with many suggestions and starting points for new projects in the various sectors. As an alternative, we would be pleased to present Werth’s new 2020 products in our demonstration centers or through “live” online demonstrations. These showcases will be tailored to your requirements and our experts will answer your questions. We are optimistic that we will be able to contribute to our customers’ success even in these difficult times. The Werth team is looking forward to continuing our many excellent relationships.

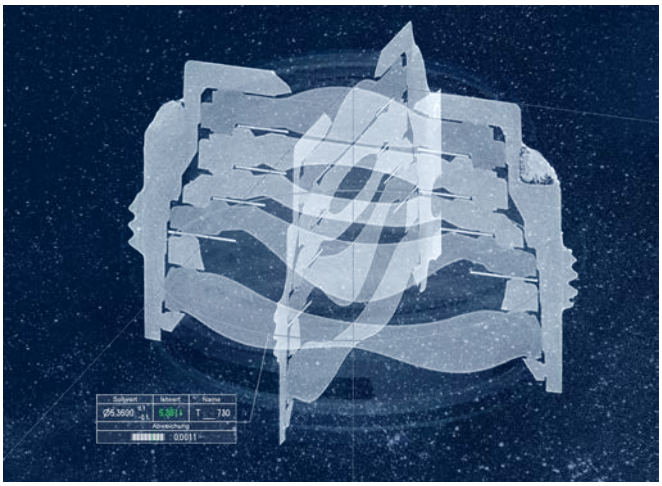
**Dr. Ralf Christoph**
President and owner of
Werth Messtechnik GmbH Giessen

# Content

## News about Multisensor Systems



## Werth Scientific Article



## News about X-ray Computed Tomography




## Werth Case Study

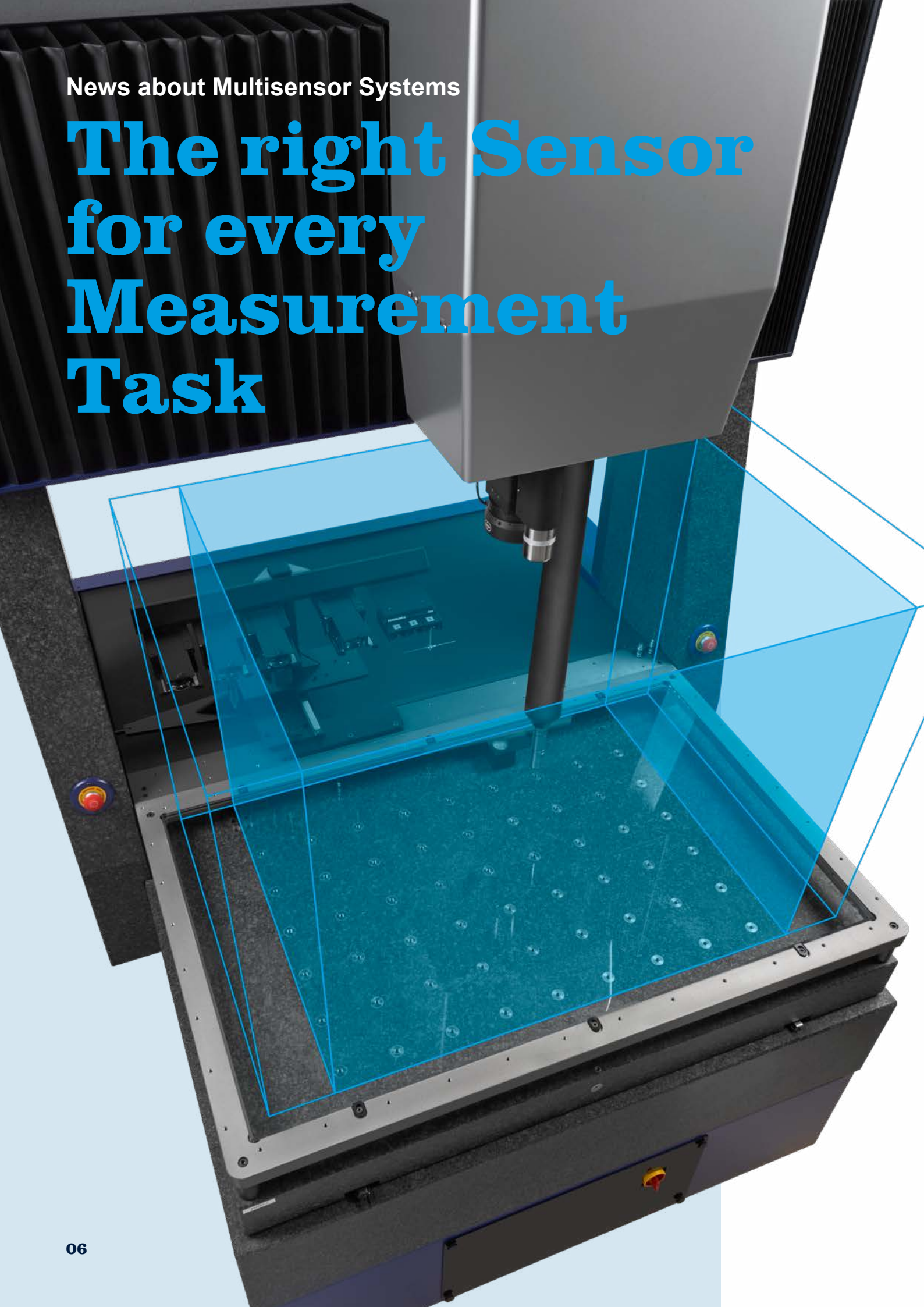


## News about the Werth Group



News about Multisensor Systems

# The right Sensor for every Measurement Task



# The proven Multi-Ram Concept expanded for large Workpieces

Multisensor coordinate measuring machines with several independent sensor axes optimize ease of use. The new ScopeCheck® FB DZ series measuring machine combines large measuring ranges with maximum flexibility and precision.

Werth Messtechnik has expanded the ScopeCheck® FB DZ machine series. The proven multi-ram concept is now available for large workpieces. Different sensors such as the patented Werth Zoom with integrated Werth Laser Probe, the tactile-optical Contour Probe, and conventional scanning probes, can now be used on two independent sensor axes. One ram holds the first sensor in the measurement position, while the other ram is positioned outside the measuring range in the park position. If required, an optional third ram with sensor can be installed. This allows multisensor measurements to be carried out without restriction and avoids collisions.

The ScopeCheck® FB DZ is now available with large measuring ranges from 530 mm × 500 mm × 350 mm to 2130 mm × 1000 mm × 600 mm. The previous maximum measuring range has been nearly doubled with the introduction of the new machine variants. Thus, the FB DZ series is now suitable for relatively large workpieces such as automotive body parts, plastic housings, turned and milled parts, industrial screens, and complete automotive headlights. Depending on the application, the appropriate basic unit can be selected, then tailored with the most suitable sensors. In addition, it is possible to remove the glass table and the transmitted light unit. This feature makes it possible to place or mount particularly heavy objects or devices directly on the granite measuring table.

## Flexibility and economy

Robust mechanical precision guides instead of air bearings make the ScopeCheck® FB DZ ideal for shop floor use. Additionally, the fixed bridge design on a hard stone base ensures the highest accuracy. Accessibility is further improved by a movable measuring table, and four-sided loading. The device series perfectly combines the advantages of conventional tactile, optical, and multisensor coordinate measuring machines.

Multisensor technology enables all measurements to be carried out with a single device. Measurement results of different sensors are available in the same coordinate system with high precision to determine geometric characteristics for the respective workpiece. The characteristics are digitally recorded, allowing for simple data exchanges between different departments or customers with the finished product. Due to the modular design of the devices, retrofitting additional sensors has been made easy so that the machines continue adapting to ever changing measurement tasks.

An important factor in the cost-effectiveness of coordinate measuring machines is measuring time. Time can be significantly reduced by using two independent sensor axes, since sensor changing is no longer necessary. The sensor does not need to be removed from a changing station, but can leave its parking position directly when activated. This arrangement considerably reduces measuring time in multisensor operation.

The ScopeCheck® FB DZ equipped with a large measuring range for multisensor measurements with two sensors (blue), combines the advantages of conventional tactile, optical, and multisensor coordinate measuring machines.

# Chromatic Focus Zoom – The new Multisensor

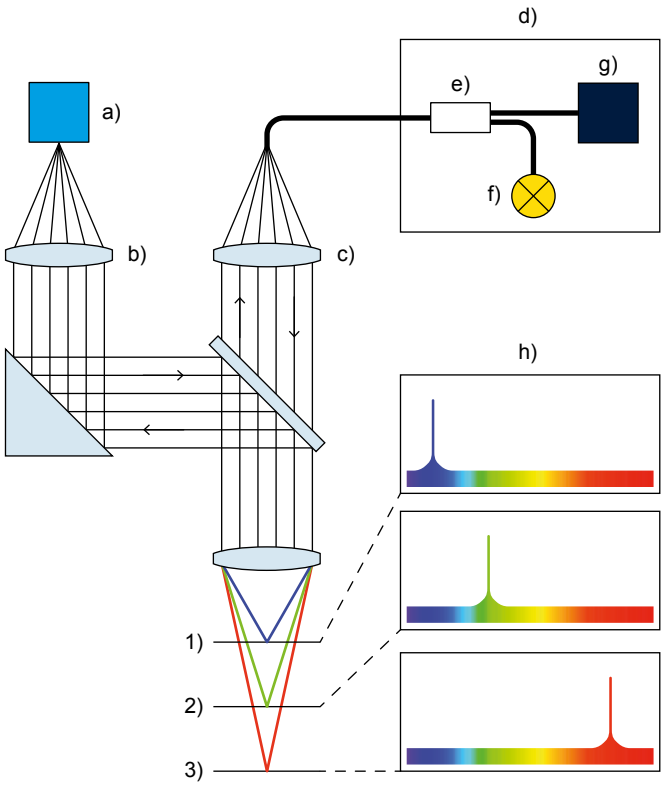
By merging several sensors into a multisensor, costs are reduced and operation is simplified. The new Chromatic Focus Zoom offers high flexibility and accuracy for non-contact measurements without sensor offset in all three spatial directions.

After integrating the Werth Laser Probe (WLP) into the patented Werth Zoom and the Werth Multisensor System, Werth Messtechnik has developed yet another multisensor. For the patented Chromatic Focus Zoom (CFZ), a chromatic distance sensor was combined with a telecentric zoom lens. The zoom enables quality overviews at low magnification and fast measurements “in the image” together with high-precision measurements at high magnification. The CFZ has a zoom that allows the field of view to be changed from approximately 10 mm × 8 mm to a nearly 20 times smaller field of view, while simultaneously increasing the resolution to measure even the finest details. Transmitted light, as well as bright-field and dark-field incident light, enable high-contrast illumination of different types of workpieces. With telecentric lenses, an aperture in the beam path ensures that the image size remains nearly constant within the telecentric range. This feature allows measurement deviations to become negligible if small defocusing goes unnoticed.

Chromatic distance sensors project white light onto the workpiece surface with the aid of a special lens. The distance between the sensor and the workpiece is determined by different focal planes for the different wavelengths of the white light. This sensor principle offers high accuracy in combination with a high degree of independence from the workpiece surface. Even relatively strongly inclined, reflective, and transparent surfaces can be measured reliably. The large measuring range also enables high measuring speeds by utilizing fast scanning without sensor tracking.

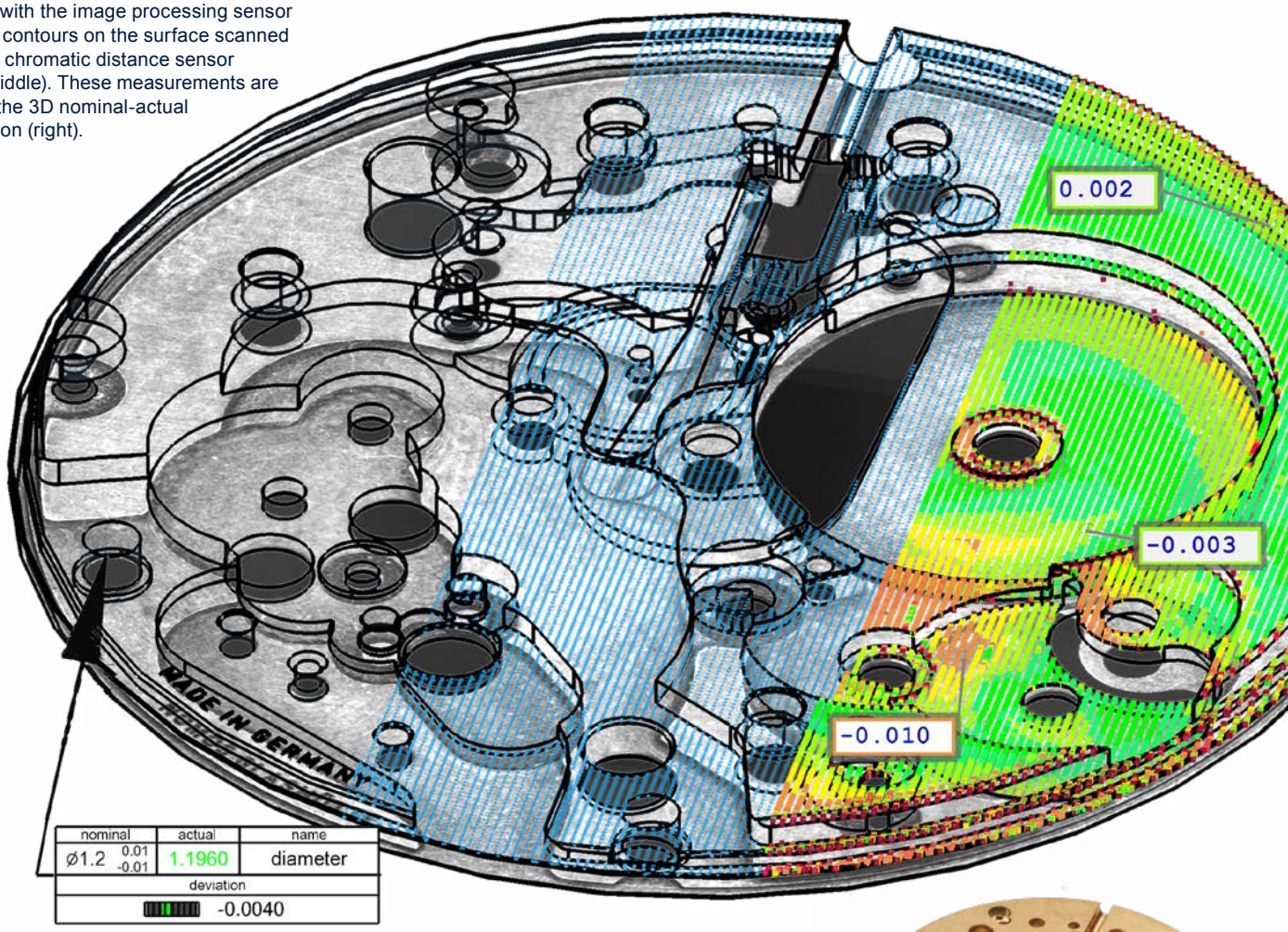
## Combination of Two High-Performance Sensors

With the different sensor principles, the new multisensor has a high degree of flexibility. The image processing sensor is the best sensor for measurements in the plane perpendicular to the optical axis. With the Chromatic Focus Point (CFP) sensor, distance measurements are carried out along the optical axis. The combination of a high-performance image processing sensor and a high-performance distance sensor, enables non-contact measurements with high accuracy and fast measuring speeds in all three spatial directions.




The patented multisensor Chromatic Focus Zoom (CFZ): Camera (a) and imaging optics (b) of the image processing sensor (simplified, illumination not shown) are combined with the imaging optics of the Chromatic Focus Point distance sensor (c) via a beam splitter. The measuring head is connected to an evaluation unit (d) via a long optical fiber. It is also connected to the broadband white light source (f) and the spectrometer (g) via a fiber coupler (e). The spectra (h) represents the distance of the object (position 1, 2, and 3) to the measuring head.

High-precision lateral measurements scanned with the image processing sensor (left) and contours on the surface scanned using the chromatic distance sensor (blue – middle). These measurements are used for the 3D nominal-actual comparison (right).




Since positioning is no longer necessary when switching sensors, a quick change from the image processing sensor to the distance sensor is possible. In addition, the sensor offset in all three spatial directions is negligible. Therefore, the entire measuring volume of the coordinate measuring machine is available for combined measurements with both sensors. The compact arrangement of the sensor system minimizes measurement deviations caused by temperature-related changes in sensor offset. As a result, a combined multisensor measurement is more accurate, even under production conditions, than a standard conventional multisensor measuring machine that uses multiple single sensors in different positions.

The CFZ is easy to operate; with the help of image processing, the measuring spot of the CFP can be visualized on the workpiece. The risk of collision is also reduced since the measuring range is not limited by the second sensor, which is conventionally mounted at a distance. In addition, the overall costs are lower because only one sensor has to be purchased instead of two. Also, the required multisensor measuring range can be achieved with a smaller device, saving valuable installation space.

## Wide Range of Applications

The Chromatic Focus Zoom enables both the automatic acquisition of the entire workpiece with Raster Scanning HD, and the imaging of the workpiece surfaces in a 3D measuring point cloud for tasks like flatness measurements. The new sensor is particularly suitable for measurements on glass displays. Markings on the displays can be measured with the image processing sensor and freeform surfaces can be measured with the CFP. Many other measurement tasks in medical technology, automotive engineering, and other industries can be improved with this new sensor. With the patented HD raster scanning, the image processing sensor takes an image of the entire workpiece. Then, the distance and contour measurements are carried out with the CFP.


Contour scanning with V Pro: The effective contour of the tool is measured in relation to the shank without an alignment process

# The Advantages of different Rotary Axes combined in one System

Rotationally symmetrical workpieces and cubic workpieces, can be measured with different views using a rotary axis without reclamping. The workpieces are normally held between centers or with chucks. Reproducible clamping without concentricity deviations (colloquially known as wobble errors) can only be achieved using expensive clamping devices and an additional time-consuming workpiece axis measurement.

For tools with a cylindrical shank, such as ball milling cutters, the Werth V Pro shaft rotation unit offers the perfect solution. By placing the tool in two V-grooves and rotating the workpiece with a friction wheel, concentricity deviations caused by clamping are avoided. This is due to the tool being guided over the shafts cylindrical surface during turning. This approach results in high reproducibility when measuring cutting edges and enveloping contours, which corresponds to the effective contour of the tool during use. In addition, the V Pro does not require a chuck and is therefore more cost-effective. It is easy to handle since almost all shank diameters can be clamped without the need for special collets or endstops.

Measurements of inner contour and pitch deviations with conventional rotary axis and wobble correction by WinWerth®

With a high-quality conventional rotary axis, the indexing accuracy is excellent thanks to the tool being turned directly via the chuck and the encoder systems used. After the workpiece orientation has been measured, the WinWerth® wobble correction helps to precisely measure geometric properties such as the rake, clearance angle of tools, or pitch dimensions. The disadvantage lies in higher acquisition costs and increased measurement efforts, because the wobble error from the workpiece clamping must first be measured for the software correction. The V Pro is ideal for pure run-out or enveloping contour measurements. If pitch measurements must also be performed, conventional rotary axes are required.

Previously, only one rotary axis could be operated at a time on Werth coordinate measuring machines (CMM). Now it is possible to use two different types of rotary axes together on the same CMM. The user can switch between the two axes either in TeachEdit mode on the WinWerth® measuring software or by DMIS command. This feature allows the advantages of both axes to be used. Particularly in tool applications, all geometric properties can be measured automatically on the most suitable axis. For this purpose, the tool is reclamped by operator or robot. For series measurements, it is possible to load both axes in parallel and measure the desired parameters using one measuring sequence. After reclamping, the tools are measured on the other rotary axis. This saves time and energy, since the automatic measurement does not have to be constantly interrupted. The combination of V Pro and a conventional rotary axis is particularly well supported for tool measurements thanks to the Precision Tool Pro software package.

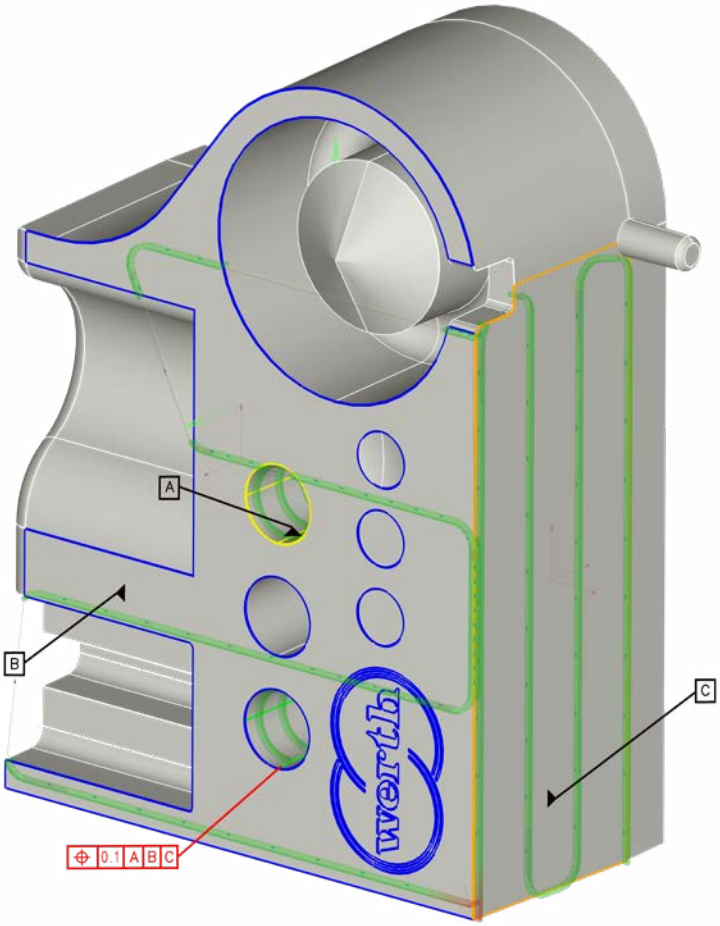
# Automatic generation of Measuring Sequences

CAD models with PMI (Product and Manufacturing Information) data contain dimensions, including tolerances and reference elements. The WinWerth® measuring software offers two variants for creating measuring sequences with PMI support.

In most cases, PMI (Product and Manufacturing Information) data does not contain all the information required to create a complete measuring sequence. This applies to sensor selection or technology parameters, such as zoom magnification or probe tip diameter. Therefore, Werth enables interactive use of PMI data to simplify the creation of measurement sequences. To do this, the user first selects the sensor and the measurement parameters. By selecting the PMI data of a geometric property. the scan path or point distributions on the source elements are automatically generated and can be edited if necessary. Clicking the “Measure” button outputs the geometric property. In this way, the necessary elements are measured and all geometric properties of the workpiece are calculated from the measurement results.

Fully automatic generation of standard measuring sequences is also possible. All parameters for each defined geometric property must be specified in the PMI data before starting a measurement sequence. This includes the sensor to be used (image processing, laser, or probe), the associated sensor parameters (magnification, illumination, or probing method), as well as the information on measurement strategies (point distribution or filters required for scanning). After clicking on “Generate measuring sequence automatically,” a scan path or point distribution is generated on the source element. Then, the elements are measured and all geometric properties of the workpiece are calculated from the results. Lastly, the DMIS measuring sequence created by these steps is saved. If desired, the measuring sequence can be extended or changed by conventional operation.

Measurement sequence generation with PMI data is available for all of the following: the image processing sensor, touch-trigger and measuring probes, the patented Werth Fiber Probe®, Werth Laser Probe, Chromatic Focus Point sensor, Line sensors, and the X-ray tomography sensor. If no CAD models with PMI data are available, the dimensions can be later supplemented by the quality assurance department. Thus the CAD models can be used for a uniform inspection plan design on different measuring devices. Alternatively, the WinWerth® PMI module enables Werth application engineers to store algorithms for measuring customer-specific geometric properties using PMI data. For example, in a customer project, the fully parameterized measurement of tools was realized. Ultimately, PMI data speeds up the creation of measurement sequences and operator errors are minimized.



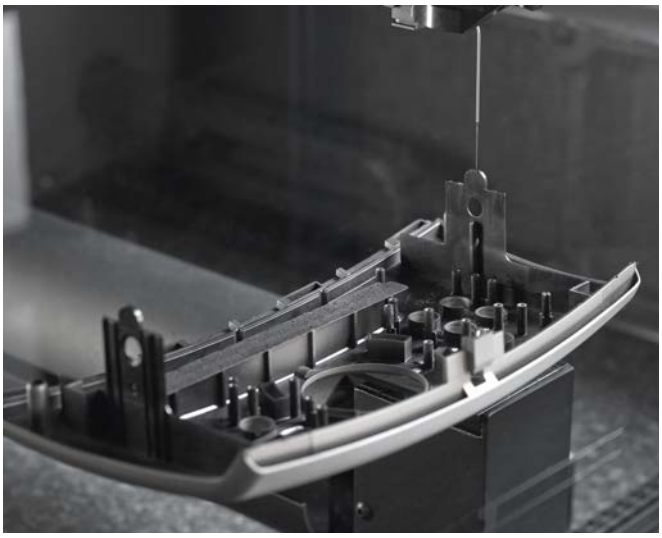

The position deviation measurement of a hole can be seen by simply clicking on the PMI data. The reference elements, hole (A) and two surfaces (B & C) are automatically detected.

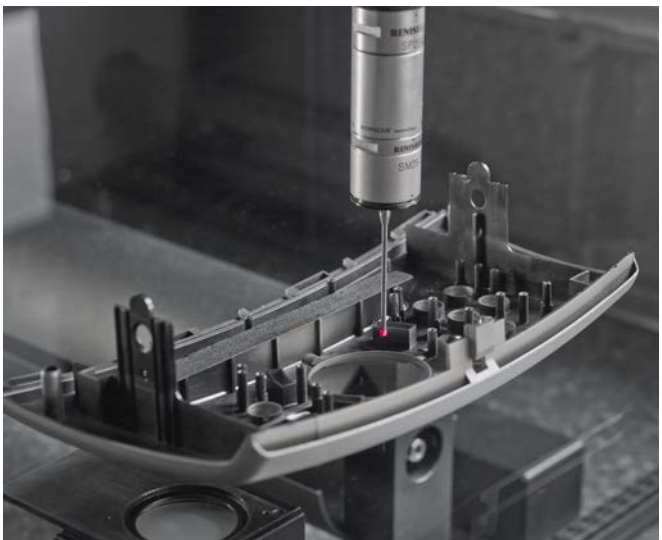
# Werth APR – Automatic recognition of Sensors for reliable Measurements

Multisensor technology increases flexibility in the measuring process. The new Werth APR ensures reliable measurement processes by automatically recognizing the type, position, and correction data of the sensor.

Optical sensors are characterized by the detection of multiple measuring points in a short amount of time. Small and sensitive workpieces can be measured without contact and without clamping; the risk of collision is minimal. Non-contact sensing also eliminates sensor motion around the workpiece, further reducing measurement time. Tactile sensors are often required for three-dimensional and surface independent measurements. A unique tactile sensor is the patented Werth Fiber Probe® (WFP), probably the world's most frequently used micro probe. This tactile optical sensor has a glass sphere as a probing element, which can be as small as 20 µm.

Often, conventional tactile-electrical sensors also require probes with styli of different lengths and diameters. Various geometric properties of the workpiece are usually measured by combining different styli in one measuring sequence. The change racks required for this purpose are normally mounted within the measuring range of the device, thus reducing the usable measuring range. However, with the use of a Werth retraction unit, racks are positioned outside of the measuring range to free up measuring space. A common Probe is the SP25, which is usually combined with the FCR25 change racks. An important prerequisite for trouble-free measuring processes is the correct equipping of the change racks with the various styli. For example, if an excessively long stylus is at the wrong slot, not only can faulty measurements occur, but collisions with the workpiece are far more likely.

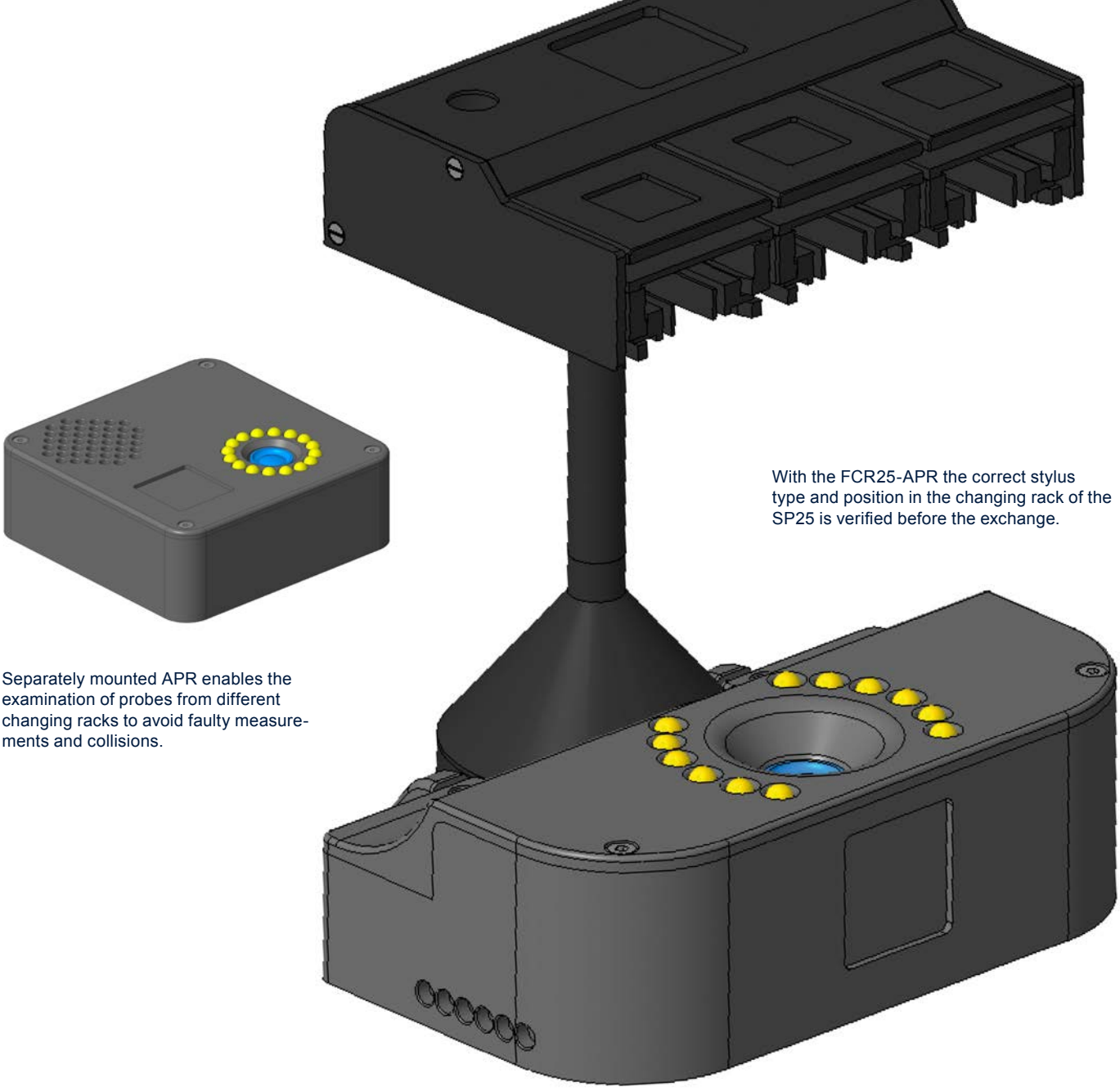




Fast alignment of the workpiece and 3D-contour measurement using the image processing system and the patented Werth Zoom with integrated Werth Laser Probe (above).

Measuring micro geometries with the patented Werth Fiber Probe® (middle).

Scanning of bores with different sizes using conventional probes (below).



With the FCR25-APR the correct stylus type and position in the changing rack of the SP25 is verified before the exchange.

Separately mounted APR enables the examination of probes from different changing racks to avoid faulty measurements and collisions.

## Safety in two versions

The FCR25-APR is a combination of the change rack FCR25 and the new Werth APR (Automatic Probe Recognition). This device automatically detects the stylus with an integrated camera. Each time a stylus is changed, the corresponding changing station, position, and rotational orientation is verified. The new function can be used in TeachEdit mode and for automatic measurements. It can be switched on and off via a pull-down menu in the WinWerth® measurement software.

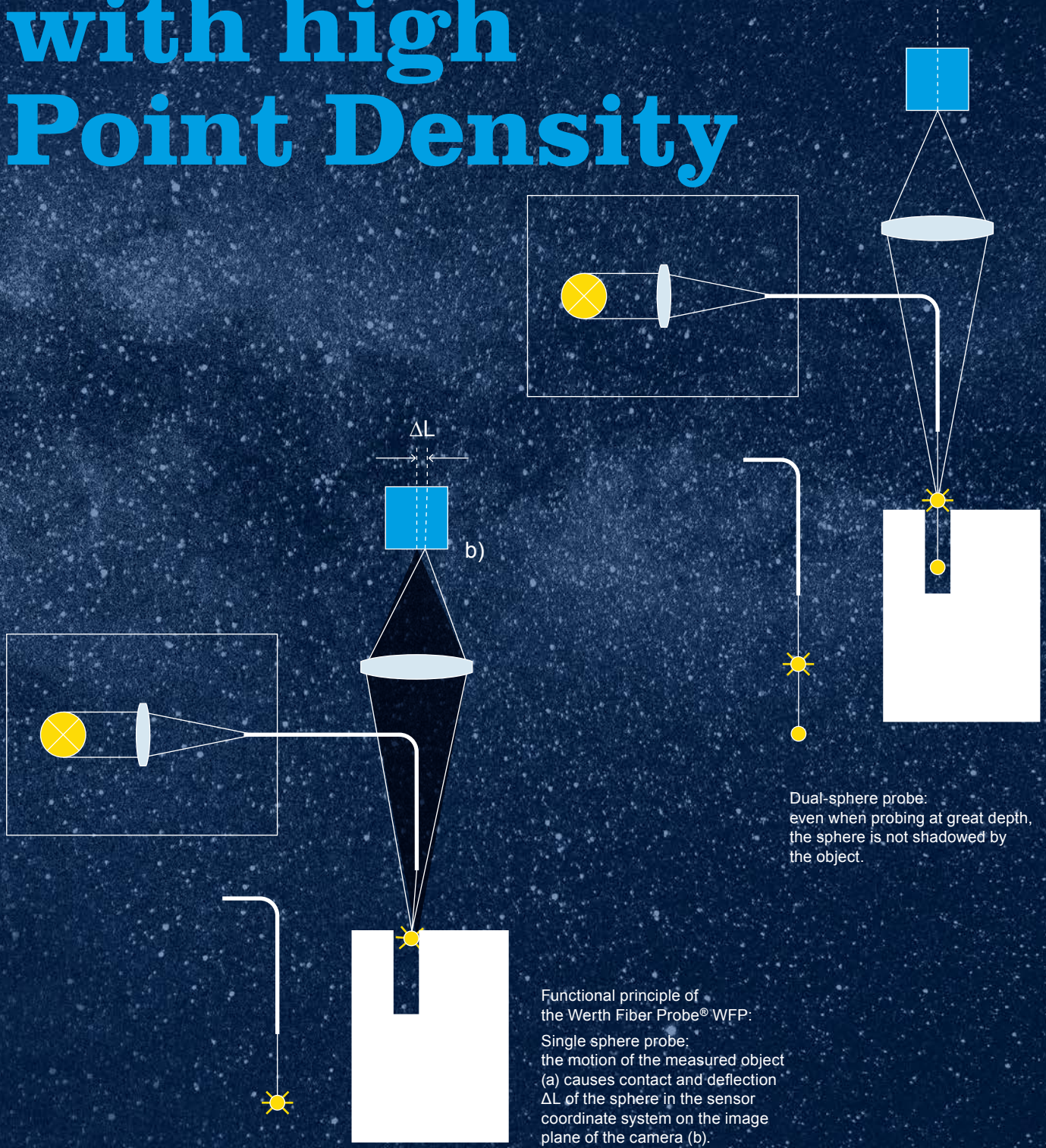
If several change racks are required or if a change rack is already installed, a separate APR module with an integrated camera can be mounted on to the measuring stage. All probes are then positioned in front of the camera for inspection. The separate APR unit will verify after a changing cycle whether the correct stylus or probe has been selected.

The automatic recognition of the sensor configuration ensures reliable measuring processes; operating errors and collisions are nearly impossible. Also, errors caused by similar looking styli are resolved. The Werth APR guarantees a safe selection of styli in the corresponding measuring programs.

The probes are recognized by assigning a QR code in the Scalib calibration program of the WinWerth® measuring software. The existing function “Check probe list” is extended to assign the QR code to calibrated probes.

In the future, the same capability will be available for the various sensors of the Werth Multisensor System. Further operating modes such as guided filling of the changing stations, and automatic sensor sorting in the changing racks are being developed to support the user.

# Complete Measurements with high Point Density




Dual-sphere probe:
even when probing at great depth, the sphere is not shadowed by the object.

Functional principle of the Werth Fiber Probe® WFP:

Single sphere probe:
the motion of the measured object (a) causes contact and deflection ΔL of the sphere in the sensor coordinate system on the image plane of the camera (b).

# High-precision Measurement Technology for the Production of optical functional Surfaces

Due to surface properties, both optical functional surfaces and the tools used to measure them represent a special challenge for metrology. Different sensors are required for different workpieces.

Optical lenses have a wide range of applications. In everyday life we often encounter them as LED (Light-Emitting Diode) lenses, as eyeglass lenses or contact lenses. they are even integrated into smartphone cameras or projectors. Each type of lens has different features; these features vary and require different measurement technology. In the case of LED lenses, such as car headlights, complex geometry is the main measurement focus. The lenses are several centimeters in size and require measurements in the medium accuracy range. Another example is plastic injection molds for contact lenses. These are produced for their manufacture, for which highly reflective tools are made with tolerances around 10 µm. Lenses for smartphones offer completely different complications. They are strongly curved, only a few millimeters in size with tolerances typically 3 µm or less, and are placed into complex assemblies.

## Measuring complex geometries with computed tomography

LED lenses for car headlights are assembled with a light source and reflector. The flatness of the various surfaces and the position of the components in relation to each other are critical for light yield. Since the form deviation of a geometric element can vary greatly in different subareas and short distances, the entire element must be detected with a high point density.

In computed tomography (CT), the workpiece is rotated inside a conical X-ray beam between the X-ray source and detector. During this rotation, radiographic images are taken in order to construct a complete volume model. To determine geometric properties like dimensions, measuring points at material transitions are calculated using a patented subvoxeling method. Because the X-rays penetrate the workpiece, the resulting cloud of measuring points represents internal and external geometries. CT can therefore be used to measure the complete assembly in its fully assembled state. Thus, the installation position of the components in relation to each other can be assessed. Due to the high point density, CT measurements are also useful for measuring form deviations.

## Optical measurement of highly reflective surfaces

Contact lenses, like LED lenses, are measured with CT. Complete measurement is also required for tight tolerance metal tools used to manufacture injection molds. However, solid steel tools are difficult to penetrate, so the accuracy of CT is often insufficient. In addition, the tools are polished. Thus, they have very smooth and highly reflective surfaces, so there is no diffuse reflection. If the light from optical distance sensors hits an ideal reflective surface with too high of a deviation from the perpendicular, it is reflected past the sensor lens. Even with a large aperture, the surface information is lost.

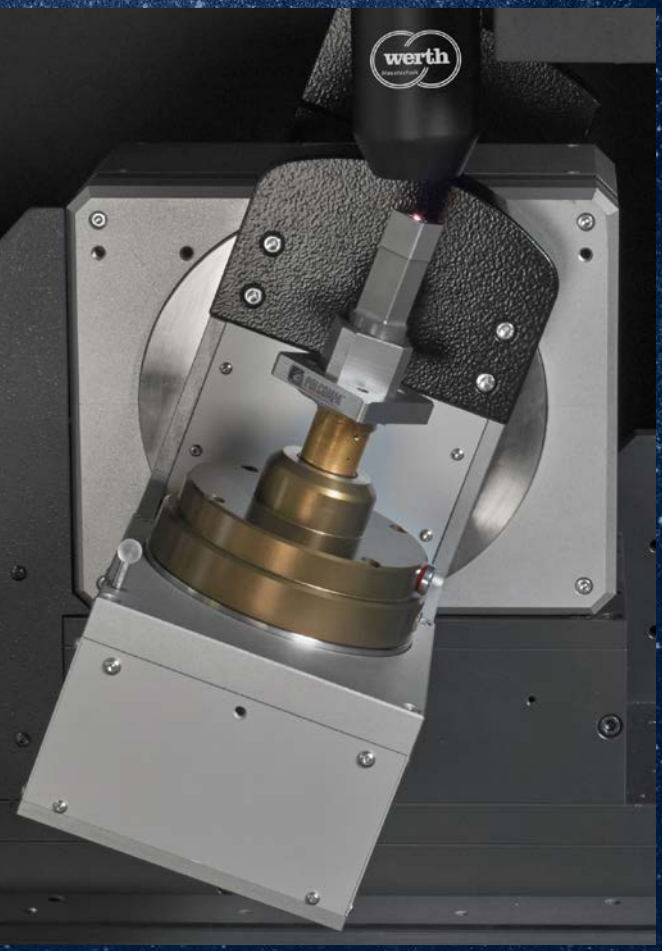
However, the injection mold tools are often rotationally symmetrical turned parts. With the aid of a rotary-tilt axis, the surface normal can be swiveled into the sensor axis. In this way, the entire workpiece surface can be captured by several rotary axis scans at different swivel angles. For this purpose, the Werth VideoCheck® FB DZ 3D coordinate measuring machine can be equipped with a rotary-tilt axis. The stable fixed bridge design ensures high accuracy. With the two independent sensor axes, multisensor measurements are possible without restrictions. This is because the axis that is not in use remains in the parking position outside the measuring range. Thus, optical, tactile, and tactile-optical sensors can be combined in the optimal way for the specific applications.

The Chromatic Focus Line (CFL) Sensor is especially suited for the measurement of highly reflective tools. Neither direct reflection or lack of contrast in highly reflective surfaces is a problem. The imaging optics are deliberately manufactured in such a way that the focal planes of differently colored light are separated according to the desired measuring range. If white light is projected onto the workpiece surface, the distance to the sensor and the position of the measuring point on the workpiece surface, can be determined detecting the wavelength with the highest intensity.

The combination of the CFL and the rotary-tilt axis on the VideoCheck® FB DZ enable high accuracy measurements. Using this machine, the tools used to manufacture injection molds for contact lenses can be measured with tolerances of 10 µm. Another advantage of the CFL is high measuring speed. With a rotation speed of 45° per second, 2000 lines with 200 measuring points each can be recorded. The point density depends on the diameter of the tool. The resulting measurement is a 3D point cloud of the entire tool surface. This point cloud can then be used for dimensional measurements or a nominal-actual comparison.

## Measurement of strongly curved surfaces with fiber probe

Cameras in today's smartphones must be able to do one thing above all else; to create impressive and sharable images. Pixel size and number are no longer the main criteria. The imaging optics must meet exceptionally high standards. They must help to take bright and sharp photos, even in poor lighting conditions.




With the help of the rotary-tilt axis, surfaces that are differently oriented can be optimally aligned to the Chromatic Focus Line Sensor and then measured in workpiece coordinates.

Through many years of cooperation, Werth Messtechnik and JiMEAS Technology in Korea have overcome many challenges of measuring smartphone lenses as a complex assembly. The knowledge jointly acquired has resulted in remarkable success and high customer satisfaction at one of the world's largest manufacturers of mobile phones. Continuous improvements in hardware and software in line with customer-driven requirements have helped JiMEAS Technology maintain a technological lead and corresponding competitive advantages.

When measuring lenses, mounts, and housings, fast and precise measurement is important for controlling the production processes. If quality standards are not met, too much scrap will be produced in today's high output speeds. When measuring mounts and housings, the patented Werth Zoom also demonstrates exceptional imaging quality. The MultiRing offers a wide adjustment range of the illumination angle in space by combining a variable working distance with several LED rings, thus delivering maximum flexibility in reflected light measurements.

Miniaturization and precision of the plastic lenses poses an additional challenge for measurement technology. The small, strongly curved smartphone lenses affect optical measuring machines similarly to highly reflective surfaces, such as injection molding tools. Consequently, the optical sensors reach their limits due to the aperture.

With a maximum permissible error of up to (0.15 + L/900) µm, the VideoCheck® UA is probably the most accurate, commercially available, multisensor coordinate measuring machine in the world. This is made possible by special air bearing technology, integrated vibration isolation, and temperature-stable scale systems with 1 nanometer resolution. In the patented Werth Fiber Probe® (WFP), the elastic stylus shaft serves only to position the probing ball, which is as small as 20 µm and has a lateral deflection that is optically measured. The axial deflection of the WFP® 3D is determined by means of a laser distance sensor. The tactile-optical measuring principle reduces the probing forces to a few hundred micronewton, thus avoiding damage to sensitive surfaces.

Result of a computed tomography measurement of an optical system of a smartphone camera consisting of plastic lenses, frames, optical apertures, and housing.


With the WFP® 3D, all parameters of the plastic lenses, including the entire surface geometry, can be measured in a single measuring sequence with manufacturing tolerances down to the sub-micron range. Mainly, the complex forms of the aspherical surfaces and their concentricity are measured. As with the LED lenses, the mounting position of plastic assemblies can also be captured using CT. Thus, the distances between the lenses, gap dimensions, and coaxiality can be measured.

Measuring of sensitive smartphone lenses with the Werth Fiber Probe® 3D

# Fast, accurate and complete Measurement


With a measuring range of about 120 mm, an optional 6-megapixel detector, and fast OnTheFly operation, the TomoScope® XS FOV is ideal for production-related measurement of plastic parts.

# X-ray Computed Tomography at the Price of conventional 3D Coordinate Measuring Machines

Werth presents the “FOV” model, the third model of Werth’s TomoScope® XS product line. The TomoScope® XS family includes Werth’s powerful and compact coordinate measuring machines with X-ray computed tomography. This new model is even less expensive and particularly easy to operate.

As early as 2005, when the first device with X-ray computed tomography (the TomoScope® 200) was developed for coordinate measuring technology, it was important this technology became available to as many users as possible and at attractive prices. In the ensuing years, the trend moved toward more powerful devices that enabled measurements of larger workpieces made of denser materials. In 2017, Werth Messtechnik introduced the TomoScope® XS featuring a compact design with similar capabilities to Werth’s larger machines. Last year, the TomoScope® XS Plus doubled the measurement volume of the TomoScope® XS. The TomoScope® XS FOV (Field Of View) is based on over 15 years of development experience in the field of tomography – Werth now offers X-ray tomography at the price of conventional 3D coordinate measuring machines.

### Fully automatic measurement “in the Image”

Depending on the selectable mounting direction of the detector, the new CTs offer a measuring range of 120 mm diameter or height. The measurements take place in the field of view. The optional 6-megapixel detector enables a very high resolution. OnTheFly mode and the real-time reconstruction of the digital workpiece volume ensure fast measurements.

The TomoScope® XS FOV is fully automated with helpful preset parameters. The operator positions the workpieces on the rotary table and starts the measurement. If desired, some measuring parameters like voltage or pre-filter can be modified by the operator.

### Production-related measurement of plastic workpieces

The TomoScope® XS FOV is ideal for high volume production related measurements of plastic workpieces, for instance workpieces from a packaging industry. Examples are yogurt pots, bottle caps, dowels, or plastic inhaler housings. Several small workpieces, such as lids or plastic gears, can be measured together using suitable fixtures. During evaluation, the software function “Workpiece separation” (see page 25) automatically separates the measurement data. The results are visualized in a user-friendly manner in the WinWerth® 3D graphic window. A color-coded display used to differentiate in and out of tolerance parts is integrated into the measurement report. This provides a quick overview for inline and atline measurements (see page 26).

The TomoScope® XS FOV is a flexible device for fast measurements with X-ray computed tomography. This unit has high availability thanks to the new maintenance-free tubes in monoblock design with 130 kV voltage. It is delivered with a 24-month warranty without shift limitation. The compact design based on the full protection principle allows it to be used almost anywhere. Like all X-ray computed tomography coordinate measuring machines from Werth Messtechnik, the TomoScope® XS FOV fully complies with specifications based on VDI/VDE 2617. The Werth calibration laboratory was first accredited for DAkkS calibration of coordinate measuring machines with X-ray tomography sensor technology according to VDI/VDE 2617 sheet 13.

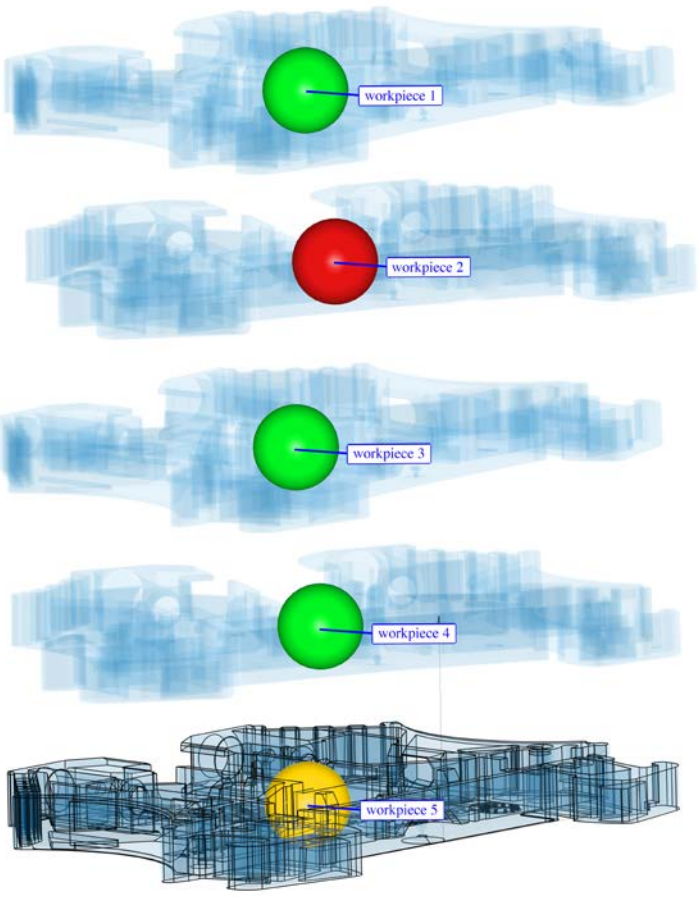
# Multi-Object Measurements perfected

New software functions are available for simultaneous measurements of multiple workpieces. The workpieces can be the same or different. Evaluation of workpiece groups simplifies process control in plastic injection molding.

WinWerth® software enables coordinate measuring machines with X-ray tomography to measure several workpieces at once in a single fixture. Reducing measurement times to just a few seconds per workpiece. The measuring point clouds are automatically separated with the help of the software function "workpiece separation," which can now be easily integrated into offline programming. The position of the individual workpieces is automatically taken from the CAD model of the fixture or from the first measurement. Only the estimated size of the workpieces must be entered into WinWerth®. Small defects such as blowholes or chips, are automatically assigned to their respective workpiece, making it much easier to conduct and resolve inspection tasks.

In addition, a new measuring element called the "workpiece," has been integrated into WinWerth®. This function summarizes multiple workpiece evaluations. The workpiece status ("good," "bad," or "above an intervention limit") can be determined from specific geometric properties. The elements are visualized in the workpiece position as a colored ball within the 3D graphic window. The ball color changes between green, yellow or red depending on the defined tolerance values. Workpieces can also be grouped together. Group information can then be arranged based on vertical or horizontal fixture planes (see page 24). It is possible to calculate geometric properties such as coordinates, angles, radii, or form deviations for "Group" elements. Depending on the requirements minimum, maximum, scatter, mean value, and standard deviation can also be displayed for group geometric properties. In addition, text recognition can be used to assign groups to an automatically-recorded cavity number.

The status of individual workpieces is displayed with colored markings by using the overview display in the 3D graphics and measuring protocol. Further information, such as color-coded deviation displays, can be checked directly by selecting the option in the 3D graphics or protocol. Combining several workpieces into a group also extends statistical evaluation options. For example, mean value and scatter can now be calculated directly in WinWerth® for measurements of critical geometric properties. This is especially important for process control in plastic injection molding. The new functions are also suitable for 2D and 3D measurements with multisensor technology.




By using the new element "Workpiece," workpiece status can be seen at a glance and with the click of a button, various measurement result data can be displayed.

# Control of the Measuring Process via Text Recognition

Text characters, lines, and text blocks can now be recognized with Werth's image processing Optical Character Recognition (OCR) software. This new function is available for all image processing sensors and raster images created with Rasterscanning HD or the Chromatic Focus Probe. It can also be used with the X-ray tomography sensor in combination with the new 3D volume window (see page 22). Additionally, the "Text" element has been integrated into the WinWerth® measurement software. This feature specifies the recognized text and its quality as a percentage. For fast and reliable text recognition, dictionaries can be created that contain only numbers. Over 100 dictionaries are already available for text recognition.

Further, text recognition can also automatically select corresponding measurement programs. Program parameters can be determined during the measurement. In multi-cavity measurements, the corresponding master part can be determined using the nest number on the workpiece. Once the workpiece is identified, the measurement results are assigned to the respective workpiece. The data collected is automatically transferred to the measurement report.

# Burr Detection on the CT Volume

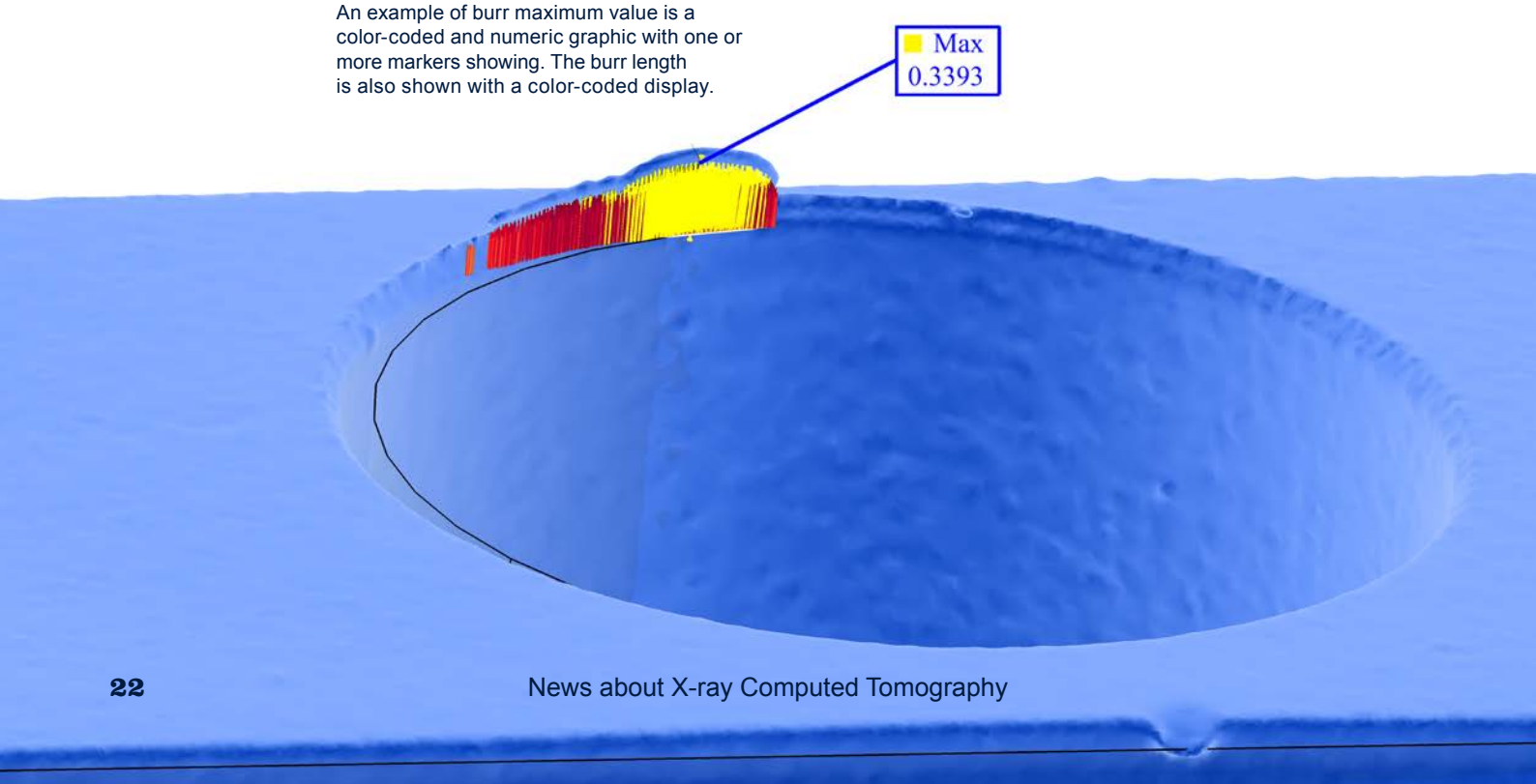
A new function in WinWerth® allows burrs or chips to be automatically detected and fully measured during the measuring process. The display can be color-coded or labeled with analysis markers.

In plastic injection molding, a burr is created when two molds do not close completely or close with an offset. Some burrs are created because certain moulds can only be manufactured to fit precisely within certain tolerances. Burs can also develop due to wear and tear, and injection parameters that are not optimally set like injection pressure. Burrs cause optical flaws or even functional limitations of workpieces. For this reason, a new function has been integrated into the WinWerth® measuring software. This new feature enables the automatic measurement and display of burrs and chips on plastic or metal workpieces.

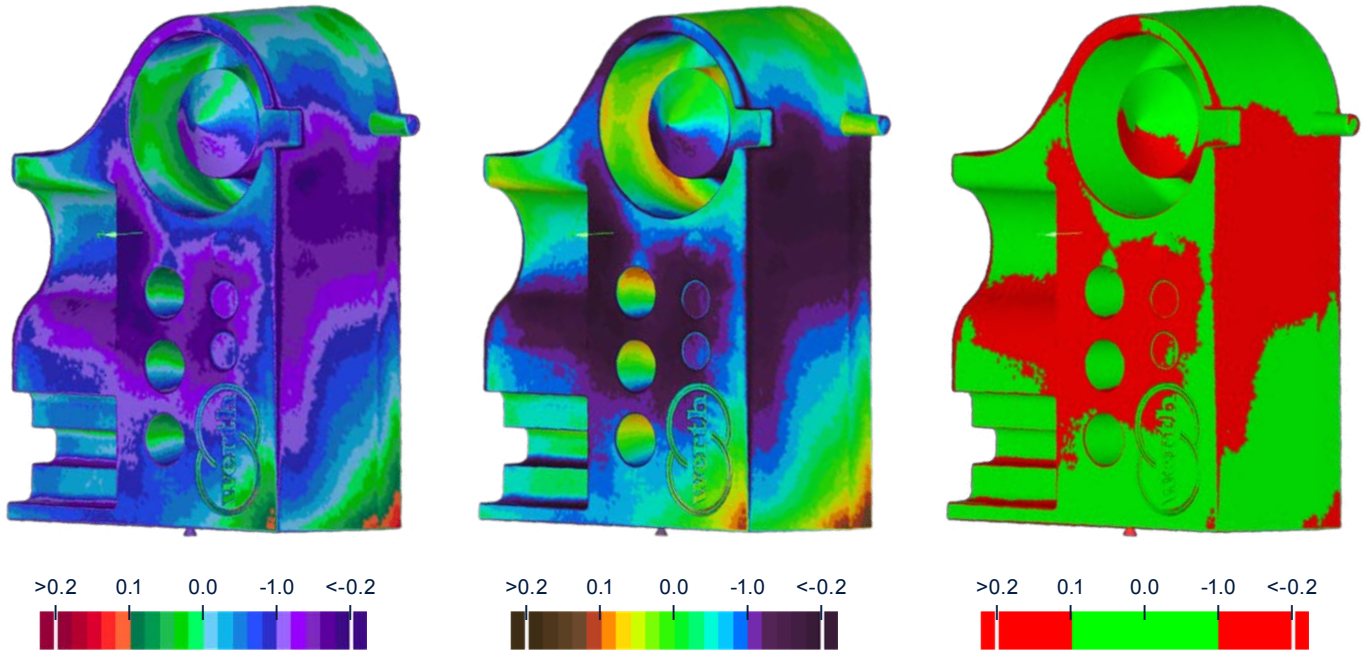
New window functions have been developed to increase the ease of use. Areas that need to be inspected are marked on the workpiece volume generated during computed tomography (CT) measurements. This is accomplished by applying the 2D and 3D windows. These windows are available in multiple shapes. For instance, as a rectangle, polygon, cylinder, or tube window. Additionally, a graphic interface can be used to modify the height, width, depth, diameter, and the rotation angles. Alternatively, it is possible to create windows based on a CAD model. For example, clicking on a line in a CAD model will generate a hose window whose diameter can be adjusted directly in the 3D graphic window. In addition to the burr measurement presented here, these windows can also be used for filtering volumes, cutting out injection points from point clouds (STL format), character recognition, and more.

After the desired windows are set, the operator enters the minimum and maximum burr thickness and the permissible tolerance for burr length. Burrs thinner than the minimum defined burr thickness are not taken into account. The maximum burr thickness is used to differentiate between burr and thin workpiece areas. Burr thickness should be significantly smaller than the thin workpiece areas, but larger than the burrs to be maintained. The result is a color-coded deviation display of the burr and the maximum burr length. In the deviation display, the operator can choose to show only those points where the burr length exceeds the tolerance limits. Using analysis markers, the burr length (along the entire burr) can be displayed numerically. For example, every 0.5 mm a flag is set that contains the maximum local burr length.

An example of burr maximum value is a color-coded and numeric graphic with one or more markers showing. The burr length is also shown with a color-coded display.



# Fast visual Assessment of the Workpiece with extended Color-Coded Deviation Display




In the WinWerth® 3D graphic the color-coded visualization of the deviations can be individually configured.

Left: Werth-standard visualization
Green and Blue – positive and negative in tolerance
Red and Violet – positive and negative out of tolerance

Middle: alternative configuration, continuous color scale

Right: Good-Bad-Evaluation

After a nominal-actual comparison, the deviations of the actual data from the nominal data are displayed in color-coded form. The nominal data can be generated from CAD models or from a master part. Form deviations from calculated geometric elements that are based on actual data can also be displayed in color-coded form. A new feature is the possibility to individualize the color schemes. Standards are stored in the WinWerth® measuring software, which can be modified as desired. Additionally, it is possible to create and save new individual color schemes. The color-coded deviation display can be set and edited directly in the WinWerth® 3D graphic.

The Werth standard display is color-coded according to certain measurement technology aspects. Green and blue areas indicate in tolerance deviations that are above and below the nominal value. A color gradation indicates the size of the deviation from the nominal value. Similarly, red and purple areas indicate deviations outside the tolerances. A newly added feature incorporates two additional color bars for all out-of-tolerance deviations. These bars display deviations beyond the red and violet graded areas of up to 25%, 50%, 75%, or 100% of the tolerance band. This allows for quick and clear identification of workpieces that are clearly outside the desired tolerances. Another feature will only display out of tolerance deviations.

With these new display options, color coding can be adapted to: personal taste; customer requirements; or the usual presentations, of other software products, for example in toolmaking. It is also possible to display deviations within tolerance in green and outside tolerance in red. The use of smooth transitions from red to yellow and green to blue can also be configured.

Another interesting new feature are the analysis markers. These enable quick visual assessments by using flags that are automatically set with alphanumeric information. Analysis markers can be displayed at critical or predefined positions, making it possible to display only the largest deviations inwards and outwards. In addition, the burr length can be displayed at defined intervals along the entire burr, approximately every 0.5 mm. Also, the desired number of markings can be entered so that only the largest deviations are displayed while taking into account a minimum distance.

# Using WinWerth® Scout to access Measurement Results in Production

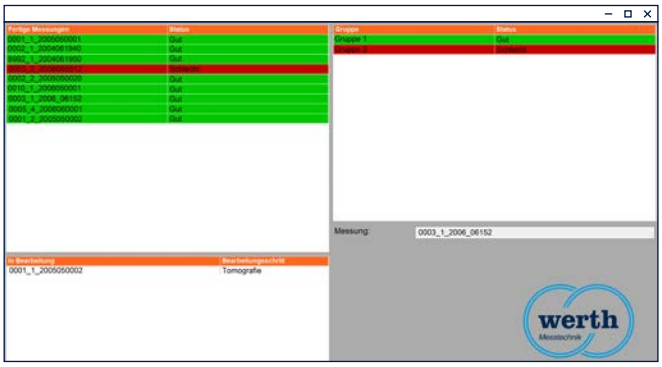
The WinWerth® Scout user interface allows quick and easy access to measurement results in both graphical and tabular forms. It can be used with any Werth coordinate measuring machine. All measurement processes in the company can be viewed, and measurement results from different coordinate measuring machines for the same workpiece can be summarized. With these features, even personnel unfamiliar with the software can quickly gain an overview of the measuring processes and results.

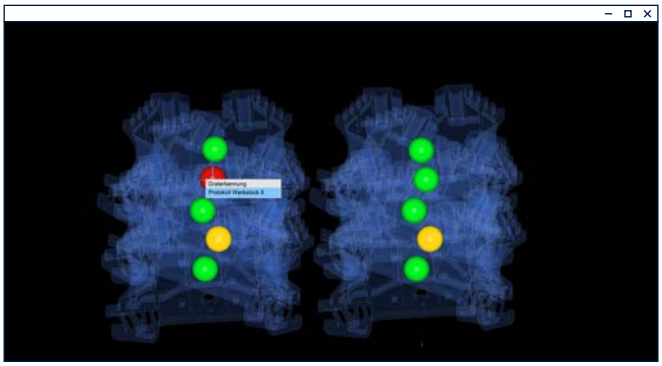
The user interface of WinWerth® Scout is divided into three areas. Measurement jobs that are still being processed are listed. There, next to the identification number of the job, the current status is shown, such as “Job started,” “Tomography,” “Tactile measurement,” or “Evaluation.” Completed orders are automatically moved to another list and are color-coded according to their status: green represents “in tolerance,” yellow for “action limit,” and red for “out of tolerance.”

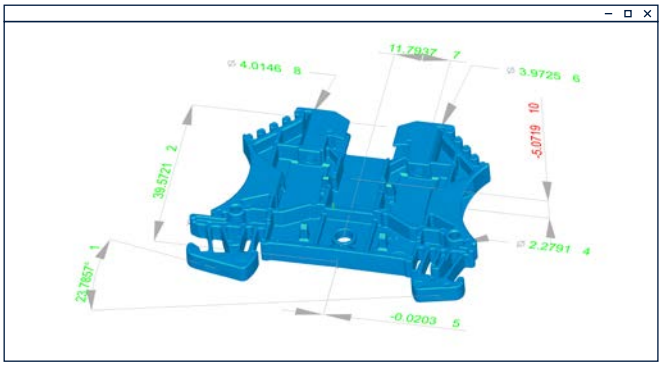
If several workpieces are measured simultaneously, one or more workpiece groups are created. For example, a tomography of workpieces arranged in several planes, one above the other in a fixture (see page 26). Using this feature, the workpieces can be divided into groups using the corresponding planes. If the user clicks on a measuring job in the list of finished measurements, another window opens containing a list of all measured workpiece groups and workpieces. The status of these groups and workpieces are displayed in color. If at least one of the workpieces in the group is outside the tolerances, the entire group is marked in red.

Selecting a group or workpiece in the list will open the WinWerth® 3D Viewer. In the case of workpiece groups, an overview display of the workpiece elements appears (see page 20). A CAD model of the fixture can also be displayed. This allows for quick and easy assignment of workpieces to their position in the fixture. The workpiece elements are displayed as spheres whose color reflects the status of the workpiece, making it easy to see workpiece quality.

Right-clicking the workpiece element of interest opens a selection list with the result representations for the respective workpiece. For example, the operator can select a measurement report with: geometric properties, a measurement point cloud with a graphical representation of the evaluated characteristics, the result of 3D burr detection, or nominal-actual comparisons using a color-coded deviation plot in the WinWerth® 3D-Viewer. For each result, an instance of the 3D Viewer is opened for comparisons. The WinWerth® Scout user interface can also be adapted to customer-specific requirements. Different lists can be displayed as desired.






The list of measuring jobs and workpiece groups (above) shows the summarized measurement result in color-coded form (red – at least one workpiece is out of tolerance). Mouse clicking the overview of the workpiece elements in the WinWerth® 3D-Viewer can be displayed (middle).

Now it is easy to see which workpiece caused the tolerance to be exceeded (red / yellow / green). The access to the measurement results of the respective workpiece is easily done by a mouse click. The measurement report, the color-coded deviation, or 3D representation the geometrical properties can be displayed (below).

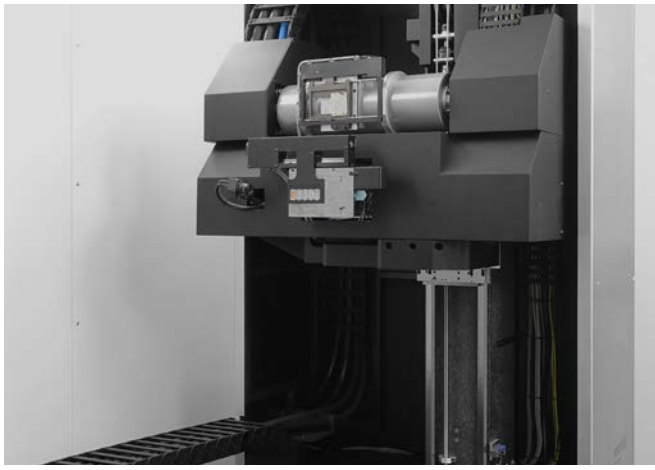
# Multisensor Tomography – Two Measurements with one Result

By using different types of X-ray tubes, it is now possible to measure small details and hard to penetrate areas on the same workpiece.

Until now, coordinate measuring systems with computed tomography (CT) have not been able to measure the same workpiece in the same coordinate system using two different types of X-ray tubes, as usual with sensors of conventional multisensor coordinate measuring machines. When measuring a workpiece or assembly, the reference system can be located on a housing made of aluminum or steel. A small external component, such as a nozzle with a small bore, temperature sensor, or pressure sensor, must be in a specific position relative to it. High tube voltage and power are required for fast tomography scans of materials that are difficult to penetrate, such as thick metals. However, X-ray tubes with these specifications do not have a focal spot small enough for high-resolution measurements.

As a result, Werth now offers two-tube measuring systems for the TomoScope® L, XL, or XL NC machines. These new systems incorporate seamless integration of a second X-ray tube. As a result, a macrofocus measurement and a microfocus measurement can be combined into a single measurement.

This TomoScope® XL NC has a high-performance detector with 400 × 400 pixels and two X-ray tubes.



High resolution microfocus X-ray tube (down) and high power macrofocus X-ray tube (above)

This is accomplished by using a 450 kV reflection target tube and the Werth 300 kV transmission target tube. For example, the macrofocus measurement can provide high tube voltage and power for measuring dense materials in a short time. However, this method creates a large focal spot of up to 1 mm diameter. Having a large focal spot causes increased X-ray emission at different points within the focal spot. The edge transition in the reconstructed volume from the radiographic images become flatter and blurred, creating low structure resolution. Alternatively, the microfocus measurement with a small focal spot enables high structure resolution, but lower radiographic capability. To combat the complications of the macrofocus measurement technique, a second X-ray tube with a particularly small focal spot for high-resolution measurements can be used.

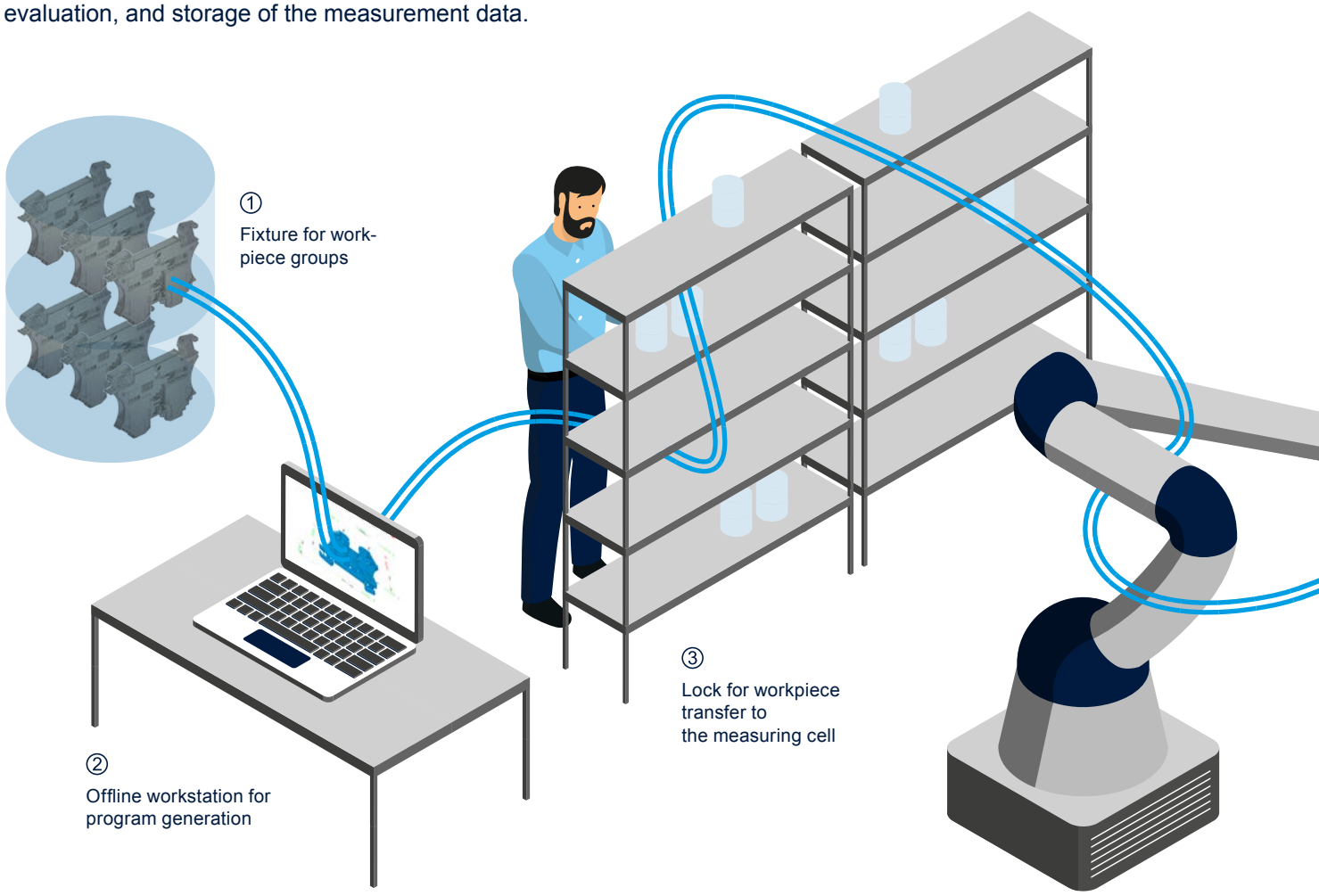
With the aid of WinWerth® measuring software, it is possible to switch automatically between the two different X-ray tubes during the measuring process. When switching over, the exact sensor offset is taken into account so that the measurement results are available in the same coordinate system. It is also possible to use the two tubes separately for measurements on different workpieces. An additional device to complete these measurements is no longer required, saving money, time, and space.

# All TomoScope® Machines now available with “FQ” Version

## Werth expands the possibilities of X-ray tomography for inline and atline measurements by faster algorithms and more convenient multi-object measurements.

The TomoScope® FQ (Fast Qualifier) machine family has been expanded to include smaller machine types such as the TomoScope® XS Plus FQ. The machines are optimized for inline and at-line measurements. A powerful X-ray tube enables short exposure times for each radiographic image. This in combination with OnTheFly mode and real-time reconstruction results in high measurement speeds. A shutter in front of the X-ray tube eliminates the time-consuming on and off switching. This option also reduces wear of the X-ray tube. Further, the requirements for short cycle times are fast, high-resolution detectors, the possibility of robot loading, and time-saving evaluation of measurement data with several computers working in parallel. The machine type is selected according to the required measuring range, resolution, and material of the workpiece. All device types now work with even faster improved algorithms and functions for measurement, evaluation, and storage of the measurement data.

The following is an example of the TomoScope® XS Plus FQ workflow. First, the measuring program is prepared remotely using an offline workstation. Then the QR code (Quick Response) or RFID chip (Radio Frequency Identification) is used to clearly and quickly identify the workpiece or batch. Once the workpiece is identified, the correct measuring and evaluation process assigned to the workpiece can be started. The TomoScope® is loaded automatically by a robot. The uniform software allows task sharing between X-ray tomography and multisensor systems. For workpieces such as valve blocks, housings, and castings; the geometric properties are determined almost every half-minute. A nominal-actual comparison is made with the measuring point cloud of a master part. The workpieces are then inspected for defects such as burrs.

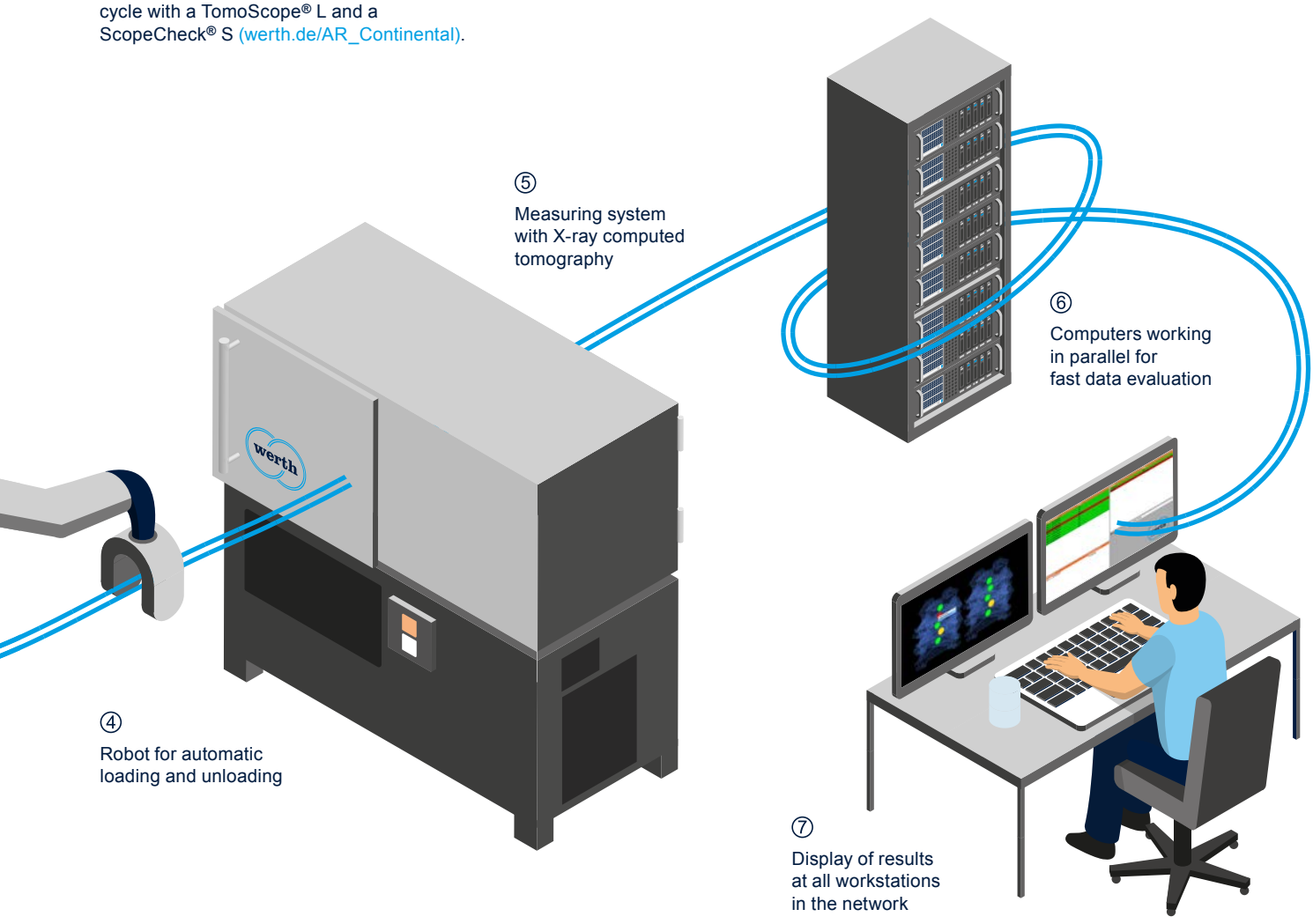


Small measurement objects (such as plastic injection molded parts) can be measured simultaneously in multi-object measurements of, for example 8, 16, 32, or 64 workpieces. This feature further reduces cycle times to a few seconds per workpiece. For such measurements, the Werth transmission tubes provide very good structure resolution even at relatively high power. This allows for defects such as burrs to be reliably detected while retaining fast measuring speeds.

In this inline measuring cell at Continental aluminum workpieces are measured and inspected for defects in the production cycle with a TomoScope® L and a ScopeCheck® S (werth.de/AR_Continental).

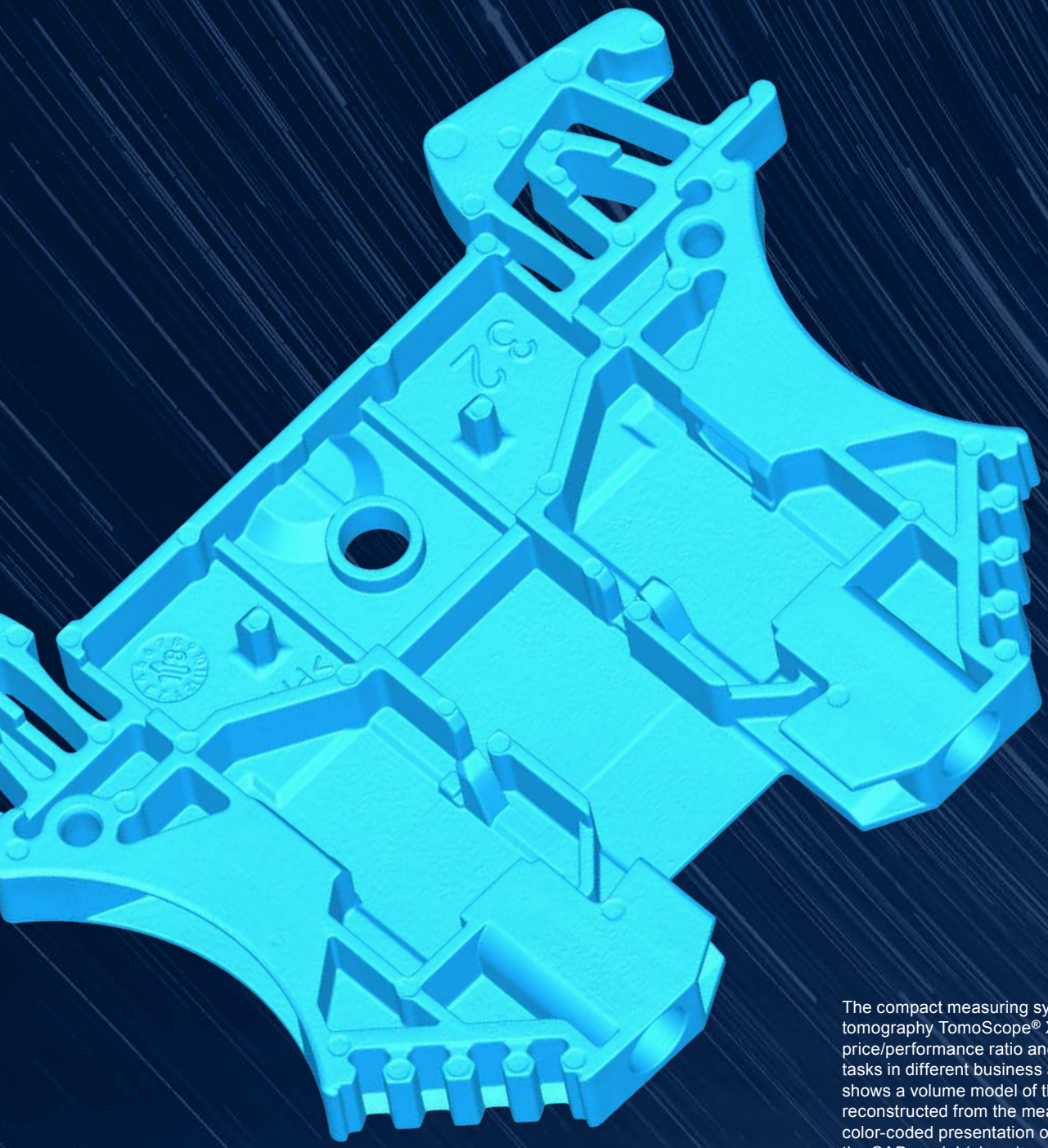
The workpieces can also be grouped into several holding fixtures. For instance, they can be grouped by the design of the injection mold, cavity, plane, sprue, or side. In this case, it is possible to measure the fixtures automatically one after the other using raster tomography and to evaluate the workpieces as a group (see page 20). With raster tomography, radiographic images of the various fixtures are taken one after the other. The total volume is then reconstructed from all of the images in different rotational positions.

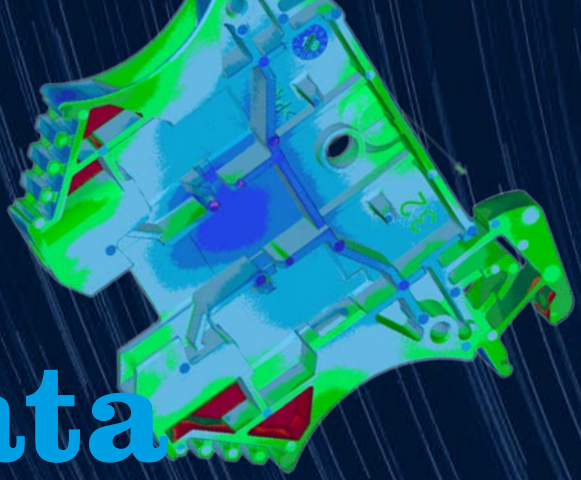
With the WinWerth® Scout user interface, a list of measured workpieces or workpiece batches can be viewed at all workstations in the network. Scout provides a quick overview of the measurement results. Workpieces or workpiece batches that lie outside the tolerances are marked with color. The evaluation options in the WinWerth® measurement software have been expanded (see page 20 ff.). All results can now be called up by mouse click via Scout.



Werth Case Study

# Complete Data Sets in record Time





The compact measuring system with computed tomography TomoScope® XS offers a good price/performance ratio and is used for various tasks in different business areas. The picture shows a volume model of the workpiece, reconstructed from the measuring data and a color-coded presentation of the deviation from the CAD model (above).

# A compact CT System replaces conventional 3D Coordinate Measuring Technology

Computed tomography has found its way into the process workshop at Weidmüller, in Detmold. With the TomoScope® XS, the measurement technicians qualify plastic connector components up to the point of readiness for series production, creating initial sample test reports, monitoring measurement strategies of other measuring devices and much more. Compared to conventional methods, the CT device is many times faster.

Weidmüller stands for the best connections in industrial connectivity. The company, headquartered in Detmold, Germany, supplies products, solutions, and services for the transmission of power, signals, or data, including a wide variety of plug and cable connectors. In view of Industry 4.0 and increasing digitalization, developments are progressing at a rapid pace throughout the entire product range. It is therefore crucial to implement innovative ideas consistently, and as quickly as possible. In order to guarantee the accustomed high safety and quality standards, Weidmüller constantly adapts its corporate structures to the requirements.

### Weidmüller – partner in industrial connectivity

Weidmüller was founded in 1850. Today the company supports customers and partners around the world with products, solutions, and services in the industrial environment of energy, signals, and data. Weidmüller has production facilities, sales companies, and representatives in more than 80 countries. In 2017, the company had around 4,700 employees and generated sales of 740 million euros.

Two years ago, the central measuring room was assigned to the process workshop, which belongs to the Industrial Solutions division, where new product developments are qualified up to series production. Olaf Despang, head of the central measuring room, explains: “Whereas we used to test components exclusively for drawing conformity, the immediate proximity to the Try-out-process now enables us to measure the injection-molded prototypes immediately and incorporate the results into the qualification process. We no longer differentiate between good and bad, and we also provide analyses that accelerate the improvement process of the tool and thus lead to faster readiness for series production.”

### CT delivers an exact digital image of the test specimen

For about seven years now, measurements have been carried out in Weidmüller’s central measuring room using high-quality 3D multisensor coordinate measuring technology. In the case of X-ray computed tomography (CT), which is mainly associated with the field of medicine, the measuring technology uses various rotational positions to scan the respective workpiece. The measuring software calculates a three-dimensional workpiece from thousands of 2D images. Compared to conventional sensors, CT provides a very dense point cloud that includes all external and internal geometries 1:1.


Detlef Ferger (left), executive vice president sales at Werth Messtechnik, was able to offer Rauf Özden (center) and Metin Aclan, the perfect solution for the tasks in the central measuring room of the process workshop.

Metrology engineer (M.Sc.) Rauf Özden, a team member of the central measuring room, has been working with this technology for years: “In another department, there is a CT device that we were able to use for our purposes on a service basis. However, this device is mainly designed for inspection tasks, i.e. for non-destructive material testing such as blowhole and crack detection, and therefore is often not accurate enough for metrology tasks.”

In 2017, the decision was made to invest in a 3D coordinate measuring machine with CT sensor technology, which should enable a variety of productivity improvements. For example, it should deliver a higher degree of automation in the acquisition and evaluation of measurement data, faster graphical evaluation of functional areas (without the often present ambiguities of dimensioning in technical product drawings), and non-destructive testing in the volume of the workpieces, for example for blowholes and cracks.

Rauf Özden was involved in the selection process. He explains: “The basic requirement was that the device be suitable for a large part of our product range. In addition, it had to provide precise measurement data, to comply with national and international standards, and to be within our rather tight budget.” The team from the central measurement room subjected five devices from different suppliers to a utility value analysis. The clear winner was the TomoScope® XS from Werth Messtechnik GmbH, Giessen. It met all the technical requirements and also scored points for its small footprint and best price/performance ratio.

## Compact CT unit for a large area of use

The TomoScope® XS was launched at the beginning of 2017. Werth succeeded in developing a compact CT with high performance. The development team benefited a wealth of experience. Nearly 20 years ago, the Giessen-based measuring equipment manufacturer had launched the TomoScope® 200, the world’s first CT device designed specifically for coordinate measuring technology, which could be optionally upgraded to a multisensor device. Over the years Werth expanded the product range of the CT types, special measuring methods and software tools. The compact TomoScope® XS opens up a broad field of metrological applications for computed tomography. The core element is the transmission tube, the first of its kind in monoblock design, which needs almost no maintenance and achieves a small focal spot even at high tube power. This approach allows fast measurements with high resolution. Metrology engineer (M.Sc.) Metin Aclan, mainly responsible for operating the CT device installed in the central measuring room, since May 2018, confirms this: “An average scan takes us about two to three minutes.” The TomoScope®’s new OnThe-Fly-CT mode is also responsible for the short measuring time. Here, continuous rotation of the device axis avoids the pauses that otherwise occur when positioning the workpiece and so reduces measuring time by a factor of 10.

## Versatile in use

Within just six months the TomoScope® XS has succeeded in pushing conventional 3D-coordinate measuring methods into the background. According to Aclan, around 90 percent of all plastic parts are now tomographed. His colleague Rauf Özden adds: “This saves us around 75 percent of the work that we previously had to do, which means that the investment should pay for itself in a very short time.”

The CT compact device is suitable for a large part of Weidmüller’s product range; among other things, the metrology engineers qualify plastic connector components up to readiness for series production. Picture: Weidmüller

Rauf Özden is one of the nine employees who are currently checking the digital twins generated by the TomoScope® XS in various ways. The time savings are particularly evident in the most important tasks, for example when it comes to supporting the correction process of the molding tool until it is ready for series production.

For this purpose, a digital twin of the prototype is created in the CT and compared with the 3D CAD model. Özden, who carries out such analyses, is very enthusiastic about the color-coded representation of this nominal-actual comparison: “You don’t have to be a

metrology engineer to see what the workpiece actually looks like and where the deviations from the nominal contour lie. A picture like this says more than 1,000 measured values. This has also led to rapid acceptance of the new technology beyond the measuring room." With the help of CT, approval can be given after the first correction loop in the majority of cases.

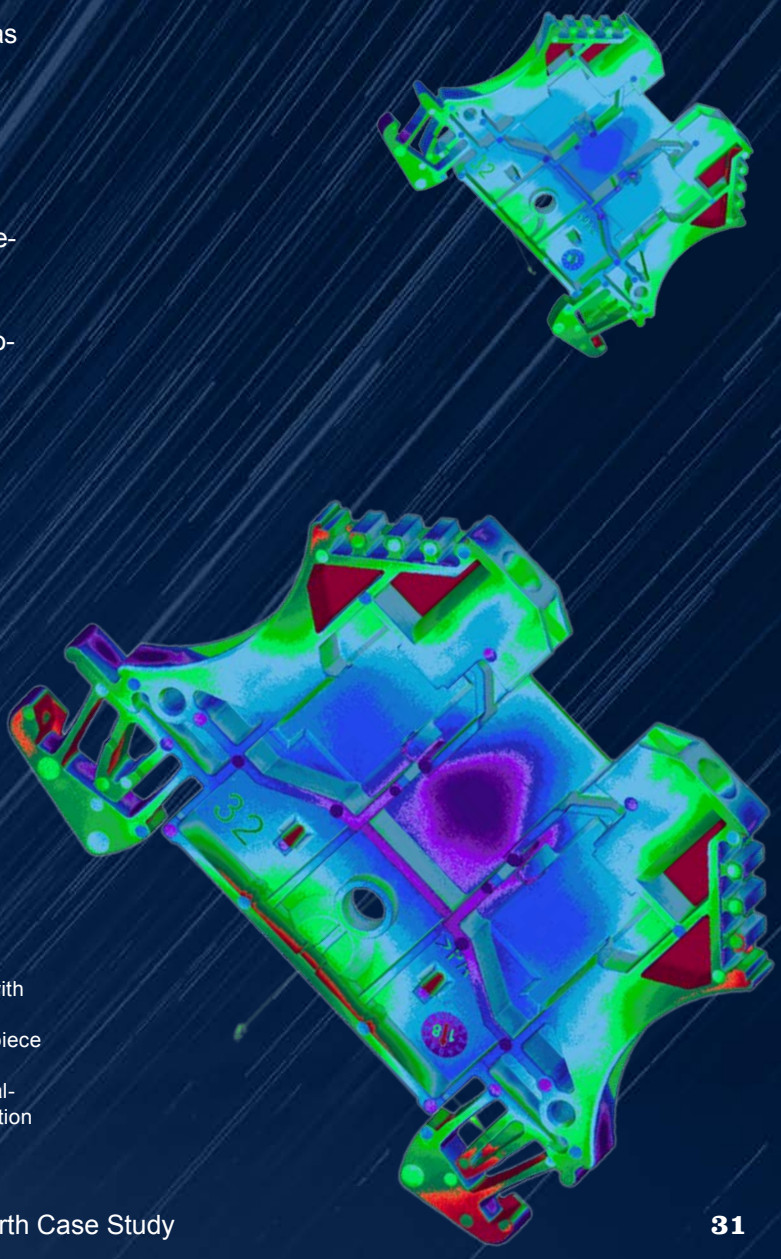
In the central measuring room, nobody wants to miss the TomoScope® XS. It shows its strengths in many fields of application. Connector components can now be measured in an assembled state, so that the functional areas can be clearly identified. "The toolmakers thus find out which corrections have priority for the function of the parts," explains Özden. "If design drawings contain ambiguities, we can use the function of a component that is now obvious to us to determine the appropriate measurement strategy. For important test dimensions, this capability must be transferable to the series measurement during production with conventional sensors so that the measurement results are also reproducible there."

Another typical application where a lot of time can be saved with the TomoScope® XS is the initial sample inspection. The central measuring room now only has to allow for three days instead of three weeks. More and more fields of application are opening up. For example, product developers are even coming with their 3D printed parts to have the geometric quality checked. In addition, employees in the complaints department ask for help if they are stuck in the troubleshooting process. Rheologists also use the new possibilities to compare their simulations of flow and deformation behavior with the injection-molded prototypes.

## Ideas for the future

Rauf Özden is sure that computed tomography is only at the beginning its career at Weidmüller. In the future he would like to examine metal parts, where the maximum X-ray voltage of 130 kV is currently insufficient. However, the TomoScope® XS is also available with an X-ray voltage of 160 kV, and the power increase can be easily retrofitted on site. Unfortunately, for solid metal parts, the specialists still have to resort to more powerful equipment from service partners.

Özden also sees the possibility of using the TomoScope® XS in series production in the future: "It is easy to operate, robust and needs only low maintenance – ideal to measure workpieces directly on the shopfloor. Using it, signs of tool breakage and burr formation can be detected easier and faster than with a microscope."



Modern Coordinate measuring machines with computed tomography sensor technology provide a complete digital twin of the workpiece in a short time. This is suitable both for dimensional measurements and for nominal-actual comparisons with color-coded deviation display. Picture: Weidmüller

News about the Werth Group

# Unbureaucratic and Creative

# Foreign Representatives introduce themselves – Werth Inc.

After Werth Messtechnik entered the U.S. market through a sales representative in 1994, the company opened its official North American sales and service center. The service center was established in 2003 in the colonial town of Old Saybrook, Connecticut. The location is conveniently situated between Boston and New York, allowing for easy access to both metro areas' international airports. The office location is also accessible to the regional airports in Hartford and Providence. The demonstration center ● in Old Saybrook is equipped with nearly the entire product portfolio of Werth Messtechnik GmbH. This provides the opportunity to carry out product demonstrations and training, for both customers and employees. Werth Inc. started out with two employees, but quickly added application, sales and service engineers, regional sales representatives, and a general office worker. In 2014, the company opened a West Coast branch with a demonstration center ● in Silicon Valley, about two hours south of San Francisco by car. This was followed by the addition of several regional service centers ◉ in South Carolina, Ohio, and Colorado.

## Long travel times for service

Several hundred Werth coordinate measuring machines have now been installed in the USA. Most installations have occurred in the economic centers of the Northeast, the industrialized Midwest, the Rocky Mountain region of Colorado, Utah, and California. However, Werth Inc. also has customers in more remote locations such as the upper peninsula of Michigan and the island of Puerto Rico. The "Lower 48" (the states excluding Alaska and Hawaii) represents a land mass of 7.6 million square kilometers, that is 21 times larger than Germany. This geography results on occasion in bossiness travel times of up to 18 hours by plane and car. Thanks to the decentralized service, Werth Inc. manages to answer most service requests within the same day and to be on site at short notice despite the long distances. The team, which is now established nationwide, initially consisted of two immigrants trained by Werth in Germany. Customers appreciate Werth's unbureaucratic and creative approach to solving their problems.

## TomoScope® XS promotes the Werth brand name

Werth Inc. faces the challenges of this large country every day with four different US time zones (covering the "Lower 48") and a six-hour time difference with its headquarters in Germany. Just within the first year of its launch, Werth Inc. sold about 20 units. The company tripled its sales between 2016 and 2019 and was named the most successful subsidiary of the Werth Group two years in a row. In recent years, the introduction of the TomoScope® XS promoted the Werth brand name in the United States and created a rapidly increasing demand for Werth machines. In order to ensure customer satisfaction and to process all orders promptly; specialists from Giessen were temporarily dispatched to support the training of American colleagues and the training of customers.


The Werth Inc. sales team with computed tomography systems and multisensor measuring machines at the trade fair IMTS in Chicago (above)

The service team during a training and experience exchange in Werth's Old Saybrook, CT demonstration center (down)


# Field Service CT

### What are you doing, Mr. Hemelik?

I am checking the maximum permissible error for length measurement of a TomoScope® XS Plus with a calibrated multi-sphere distance standard. After initial setup at the Werth factory, the specifications for the TomoScope® XS Plus are checked again during the installation and commissioning of the machine at the customer's site. We want to ensure that the machine is in perfect condition after transport. Once the machine is verified, the in-house results are recorded and the test report from our factory inspection is given to the customer.

William Hemelik with the TomoScope® XS Plus (above)

Placing a multi-sphere calibration standard on the rotary table (down)

### What is your background?

In September 2005, I started my apprenticeship as a mechatronics technician at Werth. I worked on various multisensor coordinate measuring machines until 2018. A possible future in the service field was already mentioned during my job interview. Due to my previous experience, additional training in the field of X-ray tomography was the logical next step for me. The combination of mechanics, electronics, and computer science provided the best preparation for the versatile work our service department performs. Even today, I benefit from the tips I received from my experienced colleagues who also completed their apprenticeship at Werth and those who have worked for the company for many years.

### What do you enjoy most about your work?

Back when I started, the variety in service was attractive and continues to be so today. I enjoy activities such as the installation of new equipment, hardware and software updates, maintenance, and calibration. I also like the changing workplaces because it allows me to become more insightful about different high-tech manufacturing processes. It is also exciting to see how multisensor technology is developing, like how new sensors and functions are constantly being added. And how X-ray tomography is revolutionizing quality assurance, like in plastic injection molding.

# Assembly of the Werth Zoom

**What are you doing in the picture, Mr. Rohrbach?**

I am assembling our patented Werth Zoom. At the beginning, I check that the components are cleaned and prepared for assembly. Then I assemble the subassemblies, align the optics, and glue them with a special adhesive to safely prevent dealignment later. Next, the basic zoom body with the mounts and spindles are connected. Finally, I complete the unit with the motor, bright-field incident light illumination, our standard sensor interface Werth multisensor system, and the camera.

**What is your background?**

In the 1970s, the industrial landscape in our region was very diverse. As a young person I had a lot of choices when looking for an industrial training institution. I visited several companies and then decided on Werth. Until the early 1990s, Werth had an extremely high vertical range of manufacturing with about 100 employees at the time. Almost all components were manufactured in-house, from turned and milled parts to lenses, prisms, and mirrors. After my apprenticeship as a mechanic, I worked in production, then as a warehouse clerk.

Starting in the mid-1990s, Werth reduced its vertical range of manufacturing, relying more and more on the excellent supplier structure in the surrounding area. New assembly workplaces were created and the workforce was gradually expanded. During my previous job in measuring stage assembly, my clean and precise working methods were noticed. I was then offered the job of zoom assembly in our sensor production.

**What do you enjoy most about your work?**

To date, I have built as many as 2,000 zooms and mastered many challenges. One time I was not able to fixe a problem with a shadow in the bright-field reflected light illumination. was unsure of myself, but it turned out that my colleagues in the design department had updated the drawings and forgot to communicate the change. My honor was saved!

Furthermore, the cooperation and camaraderie among co-workers at Werth is excellent. We have had barbeques in addition to the official Werth summer and Christmas celebrations since the 1970's.


Jürgen Rohrbach, since August 1973 with Werth Messtechnik: "Assembly of a Werth Zoom is high precision work"

# Training in Coordinate Measuring Technology at Werth

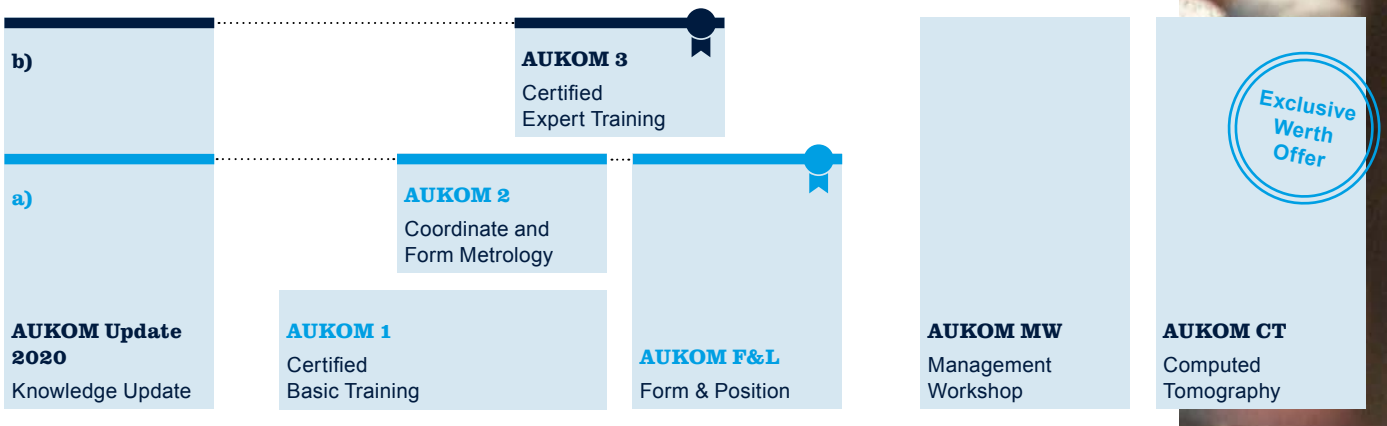
The certified AUKOM trainers from Werth impart specialist knowledge with the expertise of the leading manufacturer of coordinate measuring machines integrating optical sensors, X-ray computed tomography, and multisensor technology.

The non-profit association AUKOM (Training Coordinate Measuring Technology) e. V. offers manufacturer-neutral basic training for coordinate measuring technicians. This program fills the demand for advanced information on coordinate measuring machines. Since there are not many available outlets to learning material covering coordinate metrology with optical sensors, X-ray tomography, and multisensor technology; an AUKOM training program was created under the leadership of Werth Messtechnik. With its experienced AUKOM trainers, Werth offers all AUKOM courses: AUKOM Level 1, 2, and 3, Form & Position, computed tomography, the Management Workshop, and the AUKOM Update 2020. The courses AUKOM 1, Form & Position, Update 2020, and computed tomography can now be completed online and will be available until further notice.

Under the banner “AUKOM 2020,” all of the training content for measurement technicians has been revised and is being actively shaped by Werth. The course “AUKOM Update 2020” contains all new material for previously trained AUKOM technicians. This course is designed so that technicians can stay up to date with the latest state of the art technology.

The update also allows participants to become certified as an “AUKOM Measurement Technician,” as well as a “Inspection Process Designer/AUKOM Expert.” The topics from AUKOM 3 were brought forward into AUKOM 2 and the topics for the Inspection Process Designer are featured in AUKOM 3. To qualify as an AUKOM Measurement Technician, you must successfully complete the courses: AUKOM level 1 and 2, as well as Form & Position. To qualify as an Inspection Process Designer, you must complete: AUKOM level 1, 2, and 3, as well as Form & Position.

In order to attract a wider circle of participants, the material from the separate course on computed tomography (CT) was integrated into the AUKOM Level 1–3 courses, with reduced detail. However, as the first supplier of coordinate measuring machines with computed tomography, Werth, continues to offer a dedicated AUKOM course on CT. The purpose of this is to impart specialized knowledge directly from the industry’s top expert. Looking ahead, under the banner “AUKOM 2025,” new additional topics will be integrated into the existing courses and a new course on surface metrology will be developed.



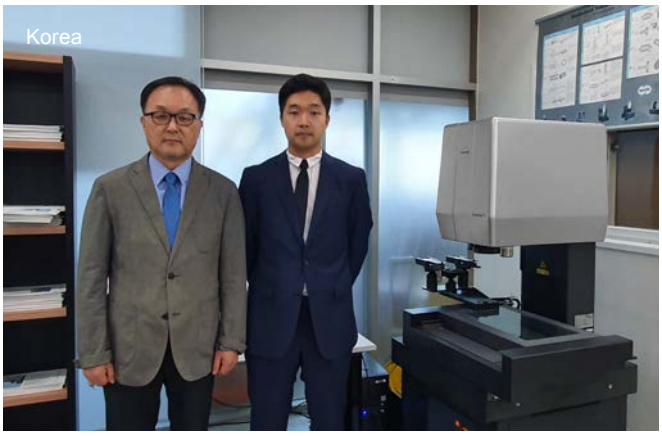

AUKOM
Training System

# Become an AUKOM Measurement Technician or Inspection Process Designer now!

**AUKOM 2025**
Surface Metrology

Future Topics

# News in Brief



### Promotion of Science and Technology

Technology Day is held annually in Giessen, Germany. Its purpose is to educate customers from all over the country about trends and developments in multisensor coordinate measuring technology and X-ray tomography. Technology Day 2019 consisted of informative technical presentations from research and development as well as interesting user reports. Attendees also had the opportunity to carry out test measurements on their own individual workpieces. Christoph Egloff, from the “Scanlabor” in Coesfeld, remarked about Technology Day, “Thanks to the open atmosphere, we were able to gain good insights into the operating procedure, production, and quality control of the measuring systems.”

In addition, Arno Fink (left), Chairman of the Board of Trustees of the Dr.-Ing. Siegfried Werth Foundation, presented awards for outstanding scientific work in the field of non-contact dimensional metrology to (from left): B. Eng. Henrik Sprankel, Dr. Klaus Bergner, and Dr. Joscha Maier.

### 20 Years of Werth in Korea and Taiwan

Since the end of the 1990s, the Asian market has been an essential source of business success for Werth Messtechnik GmbH. During that time, our first contacts with several sales representatives were made. These contacts successfully represent the Werth name in their respective countries to this day.

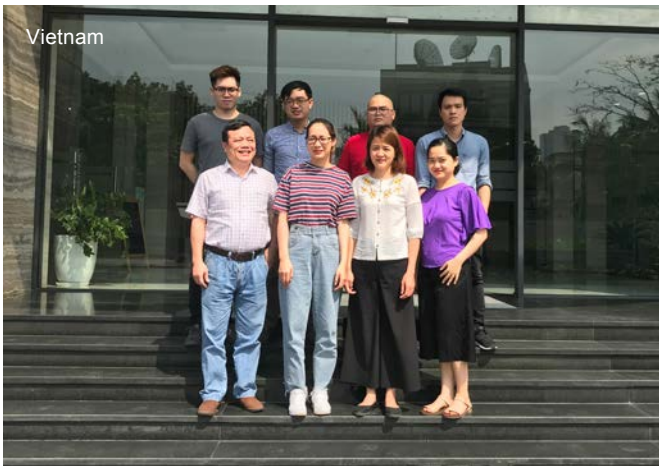
In Taiwan, Werth is represented by the Full Bright Industrial Supply Center with company founder Mike Chen (left) and sales manager Danny Lee. The company is experiencing an increasing demand for Werth coordinate measuring machines as the global requirements for manufacturing quality continues to rise. Their customers come from diverse industries including optical, medical, electronics, and automotive.

JiMEAS Technology Corp. located in Seoul, South Korea, was founded in 1997 by J. J. Ji (here with his son, Gyoon Chul Ji). In 2003, JiMEAS also started a cooperative alliance with HanYang University for the development of sensor technology. Subsequently, two tactile sensors and various software processes were presented, some of which are now patented. Furthermore, Werth and JiMEAS were particularly successful in several projects for measuring smartphone cameras (see page 15 f.).


Italy


Austria

Mexico


Vietnam

## Werth Austria Opens a New Demonstration Center

To meet increasing demand, Werth Messtechnik Österreich GmbH opened a new sales and application center in Vienna as a base for activities in Austria. The facilities are equipped with multisensor and X-ray tomography coordinate measuring machines. The Vienna location is easily accessible by car and train; it's also a short drive from the Vienna International Airport. In combination with a de-centralized service team, Werth's Austrian demonstration center is now open for serving customers throughout the country. An opening ceremony with live music and a supporting program was held in November 2019, attracting many visitors. Over the course of the event, interesting lectures were held by experts from Werth, users from throughout industry, and the research community.

## New Partner in Mexico

Earlier this year, we announced a new international partner for Werth sales and service activities in Mexico. Metrología e Ingeniería Avanzada S.A. de C.V. was founded in 2006 and its headquarters are located in San Nicolas de los Garza, Mexico. The company is accredited to ISO/IEC 17025:2017 and offers metrological consulting, training, contract measurement, and equipment sales.

## Werth Italy Expands

In order to meet increased demand in the Italian market, Werth Italia S.r.l. moved to Casorate Sempione in May. The new facility is equipped with a demonstration center, a larger floor area of 300 sqm, and is conveniently located near the Milan Malpensa International Airport. Managing Director Sandro Telasi is excited to share customer experiences with the new ScopeCheck® FB DZ, which has been added to the demonstration center. Naturally, Werth Italy provides installation and commissioning of equipment, training, and machine support for customers throughout Italy. In addition to training courses and demonstrations of the various coordinate measuring machines, Werth Italy also offers contract measurements and the creation of customer-specific measuring programs.

## New Partner in Vietnam

NITECH Co Ltd was founded in 2017 and specializes in the distribution of 3D precision measurement equipment, 3D printers, and related services. Managing Director Hoang Anh (back row, second from right) and his team work in Hanoi, Vietnam. The company also has an office in Ho Chi Minh City, the country's largest city. Starting in 2020, the ten-member team will take over sales, marketing, and services for Werth's 3D coordinate measuring machines in Vietnam.

# Coordinate Measuring Machines with Optics, Computed Tomography and Multisensor Systems

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