# TRITOP CMM

## Optical 3D Coordinate Measuring Machine

1 x 0.5 x 0.5 m³ Measuring Volume – 0.015 mm Accuracy
10 x 5 x 5 m³ Measuring Volume – 0.2 mm Accuracy

gom

# TRITOP CMM

**Optical 3D Coordinate Measuring Machine**

## Industrial Measurement Technology
### Quality Control and 3D Inspection

The portable TRITOP CMM system measures coordinates of three-dimensional objects quickly and precisely. Measuring tasks that traditionally were performed by tactile 3D coordinate measuring machines can now easily be carried out with the TRITOP CMM system. It does not require any complex, heavy and maintenance-intensive hardware. The measuring machine comes to the object!

As with tactile coordinate measuring machines TRITOP CMM records the coordinates and their orientation in space for any feature of interest:

- Surface points and sections
- Primitives
- Holes, punch holes and edges
- Diameters, lengths, angles …

After the 3D coordinates have been determined, the measurement mathematically is transformed into the coordinate system of the component:

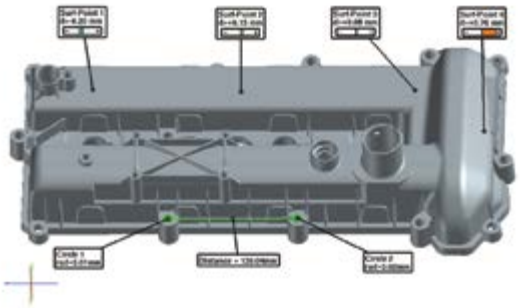
- RPS
- Gage alignment
- Best-fit …

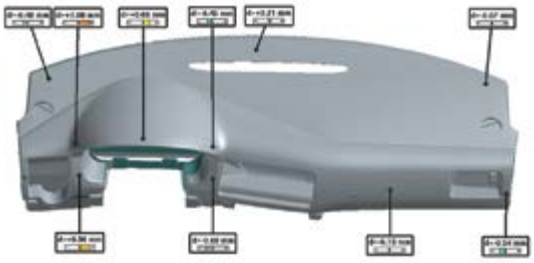
The measured and aligned data is used for various tasks:

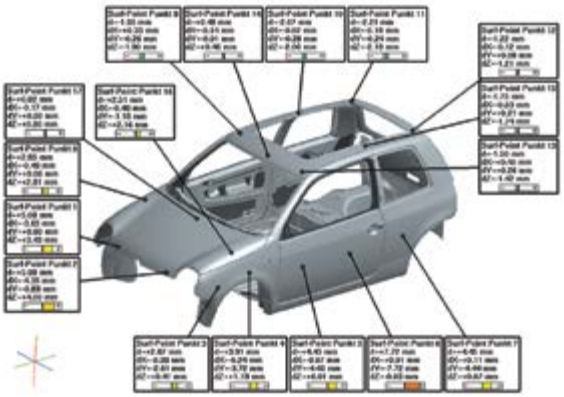
- CAD comparison
- Verification of shape and position tolerances
- Verification of specifications from drawings, files or tables
- Initial measurements

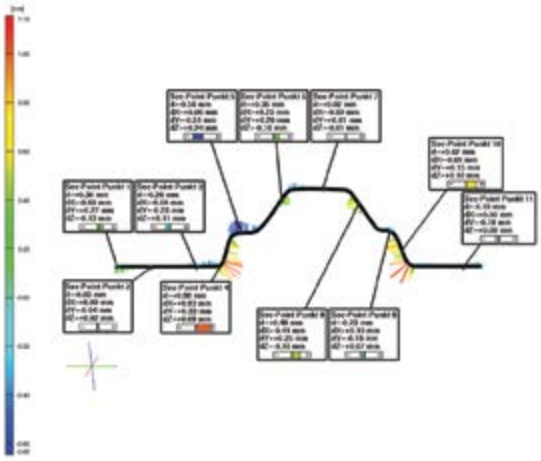
When comparing the measuring data with CAD data (IGES, VDA, STEP, Catia, ProE, UG …), the corresponding measuring reports are created in the familiar formats:

- False-color representation
- Deviation of individual points as labels
- Sections, angles and distances
- Diameters and flatness
- Tables and lists









## Image Processing with Subpixel Accuracy

### The Mouse Pointer Becomes a Touch Probe

The measuring object is recorded with a high-resolution digital camera. The images are automatically evaluated on a notebook using the TRITOP$^{CMM}$ software. With a mathematical adjustment computation, a precise model is automatically calculated from ray intersections, camera positions, lens distortions and object coordinates. The adhesive reference point markers applied to the object and the coded markers and scale bars placed next to the object are included in this computation.

Based on this model and on the digital images, the user performs the actual measurement directly on the notebook screen. He clicks with the mouse pointer on the features to be measured and thus starts a new type of image processing and triangulation algorithms. The software then fits these selected features three-dimensionally in space and automatically decides which images are suitable for the exact coordinate determination.

It only takes seconds to determine features like surface control points, sections, holes etc. without occupying the object any longer.

A 3D object window shows all measured features and coordinates. In this window, CAD data is imported, best-fit elements like cylinders, cones etc. are created and simple CAD functions like intersections and projections are used. Any combination of elements is possible. The user has direct access to dimensions like distances, angles or diameters.

Deviations to the CAD data are displayed in false-color. Automatic or interactive labels or sections display the numerical values of the deviations. Finally, the measuring reports are exported or directly printed.

## Measuring with Photos

As for all 3D measurements, the object for a TRITOP$^{CMM}$ measurement has to be in a stable and fixed position as well.

Prior to taking photos, the object needs to be prepared:

- Some coded measuring markers are applied to the fixture or directly to the object. These markers are used for the fully automatic evaluation process.
- Scale bars are positioned next to the object. Their dimensions are transferred to the measurement. Two scale bars are used to observe the measuring accuracy.
- Surface points to be measured have to be marked. For this purpose, adhesive points can be used, the thickness of which is precisely known. Another method is to mark points or sections with a pen. Each point or line drawn like this is precisely determined by image processing algorithms.

In order to carry out TRITOP$^{CMM}$ measurements, the object needs to be recorded from various directions with the digital camera. It is not necessary to maintain exact camera positions. A rough scheme of recording positions for certain objects is shown in the user manual.

The camera images are transferred to the notebook fully automatically using a high-speed wireless network or a flash card reader. On the notebook, the complete further evaluation is carried out.

### Idea of the TRITOP$^{CMM}$ Technique

- The system precisely determines the coordinates of each adhesive reference point and each freehand marking. Thus, these coordinates describe a point on the object's surface. As with tactile machines, here as well several individual points are combined to primitives, or the deviation to the nominal surface is directly determined.

### Advantages of the TRITOP$^{CMM}$ Technique

- Complete 3D measuring machine with minimum hardware requirements (2 cases with a total weight of 23 kg)
- The object is not touched during measuring
- Very high accuracy also for large objects
- No wear and tear, no decrease of accuracy
- Easy handling
- Independent of environmental conditions (climatic chamber, open air …)

## Fields of Application

- Inspection of sheet metal parts and car bodies, e. g. in pilot production, process optimizing, tool try-outs, start of series production or during random samples
- Quality control of large objects, e. g. aircraft, ships, wind turbines, etc.
- Verification of plastic parts, e. g. for first article inspection
- Verification and recording of jigs and fixtures
- Measuring of models and prototypes, e. g. vehicle interior and exterior design
- Verification of tubes and wires with respect to their three-dimensional shape
- Measuring trimming edges of two-dimensional sheet metal blanks
- Deformation analysis of car and climatic chamber tests
- Measuring of reference point fields

## The Complete TRITOP$^{CMM}$ System

### Measuring Camera
- Digital camera with high-resolution CCD chip
- Stable and certified lens
- Data transmission via flash card or network
- Flash
- Robust plastic case for camera and notebook

### High-speed Wireless Network
- Fast, wireless 54Mbit/s image transfer
- 64 bit encryption
- Automatic analysis of the measurement images

### Notebook
- High-performance notebook with OpenGL graphics
- Network card and flash card reader
- DVD/CD recorder/reader
- Windows and LINUX installation

### Scale Bars
- Low thermal expansion
- 4 x 1 m and 2 x 0.5 m, screwable (gage block principle)
- Various inserts for different object sizes
- Certified length according to German and American standards
- Coded for automatic identification
- Robust plastic case

### Marker Material
- Coded points on adhesive or magnetic foil
- Adhesive points of various sizes
- Marker pens
- Adapter for threads, setscrews and collar holes

### Software
- Loading of digital color and gray scale images
- Robust orientation of image sets
- Precise online calibration of cameras and lenses
- Bundle adjustment with an unlimited number of unknowns
- Feature and surface oriented image processing
- Macro functionality for process automation
- Mathematical alignment of components
- Nominal/actual comparison with CAD interface
- Primitive module
- Measuring reports in various formats

## System Description

- Non-contact photogrammetry system
- Self-calibrating due to overdetermined systems of equations
- Self-checking due to the use of two scale bars
- Maintenance-free
- Typical measuring time per object: 5 to 60 minutes (depending on the object size)
- Typical number of measuring points per object: 10 to 50,000
- CAD interface (IGES, VDA, STEP, Catia, ProE, UG ...)
- Average length measurement deviation according to VDI/VDE 2634 [µm]: 5 + L/50 (L in mm)
- Temperature range without camera protection: 0° to 50° C
- Temperature range with camera protection: -40° to 100° C
- Humidity: non-condensing
- Case size: 1350 x 260 x 120 mm³ and 470 x 390 x 190 mm³
- Total weight: 23 kg

## GOM

GOM was founded in 1990 as spin-off of the Technical University Braunschweig, Germany. The company owns subsidiaries in Switzerland, France, Great Britain, Italy and Belgium. Worldwide, more than 40 committed and competent partners market GOM products.

GOM focuses on the development of optical 3D measurement technology for industrial use. Efficient measuring instruments are available for numerous applications. The equipment is mainly used in product development and quality assurance.

Today, GOM employs more than 250 people and can rely on the support of their international distributors.

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