ZEISS Multi Sensor CMMs for Car Body Applications

ZEISS Multi Sensor CMMs for Car Body Applications

More then a Robot – The Hambot

More than a Robot – The Hambot
Trends in Carbody Metrology

Optical sensor for Carbody metrology	▪ Faster to the result. ▪ Surface information (CAD compare) ▪ Digital Twin ▪ Optical sensor on industrial robots
Multi Purpose CMMs	▪ Holistic Approach for measurement: More sensors in one automated Run. ▪ Increasing Flexibility: the application decides about the sensor. ▪ More Metrology in production environment. ▪ Reduction of logistics and transportation costs.
New applications due to Electric Mobility	▪ Short cycle times ▪ Tight tolerances ▪ Critical surfaces (machined aluminum) ▪ Access to the part

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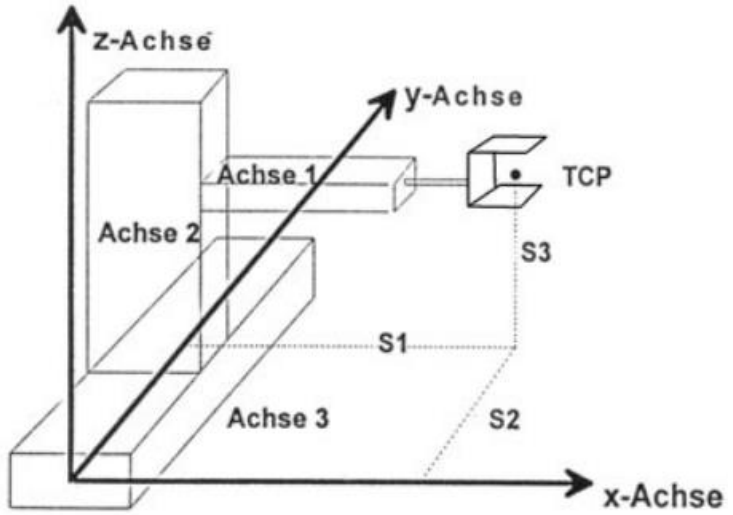
Definition Industrial Robot

Industrial robots are defined by ISO 8373:2012:
An automatically controlled, reprogrammable, multipurpose manipulator programmable in three or more axes, which can be either fixed in place or mobile for use in industrial automation applications

Classification by mechanical structure

- **Linear robots (including cartesian and gantry robots)**
- SCARA robots - Articulated robots
- Parallel robots (delta)
- Cylindrical robots
- Others

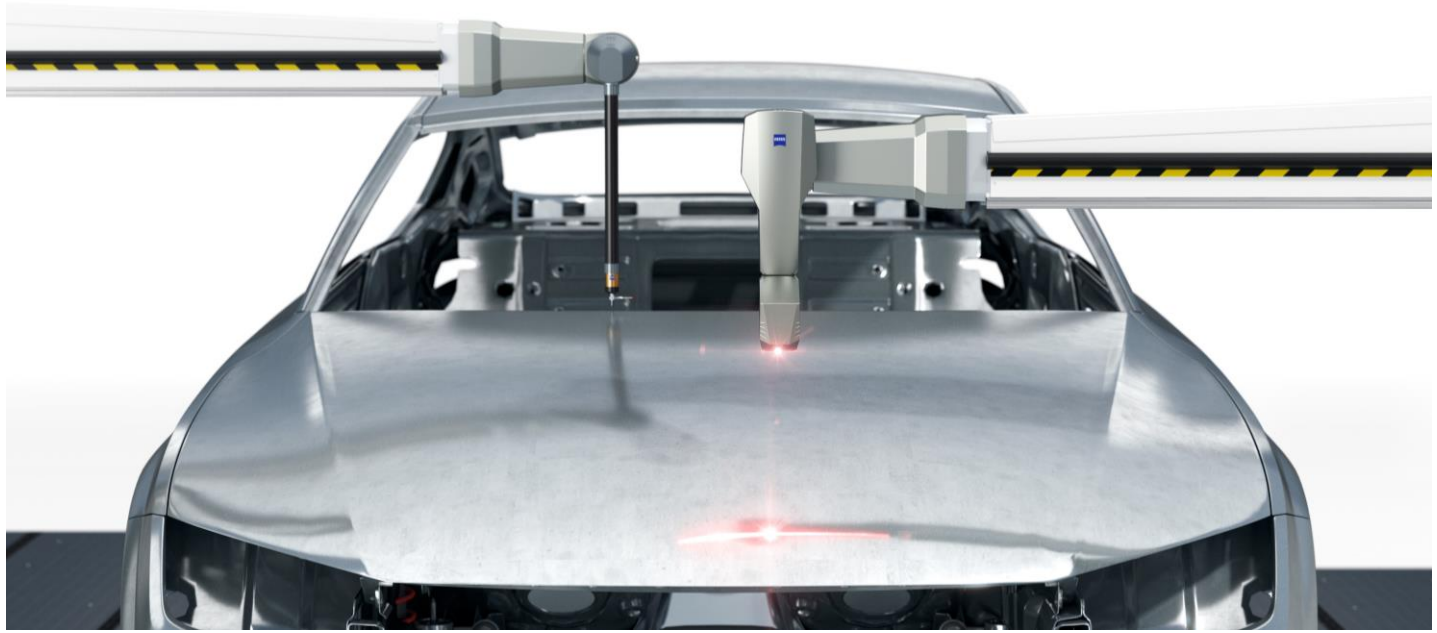


- Horizontal arm CMMs, especially combined with optical sensors are automatically controlled, programmable in more than 3 axis and are therefore robots based on ISO 8373:2012

More than a Robot.
The Hambot.

More than a Robot – The Hambot

ZEISS CALENO – More than a Robot



- CALENO is a cartesian 6-axis robot
- CALENO is a is a robot with an outstanding optical sensor system – EagleEye
- With CALENO you get proven CMM accuracy, a collaborative system and a multi sensor system with automatic sensor change.

This is not possible with an articulating robot.

Therefore, CALENO is more than a robot.

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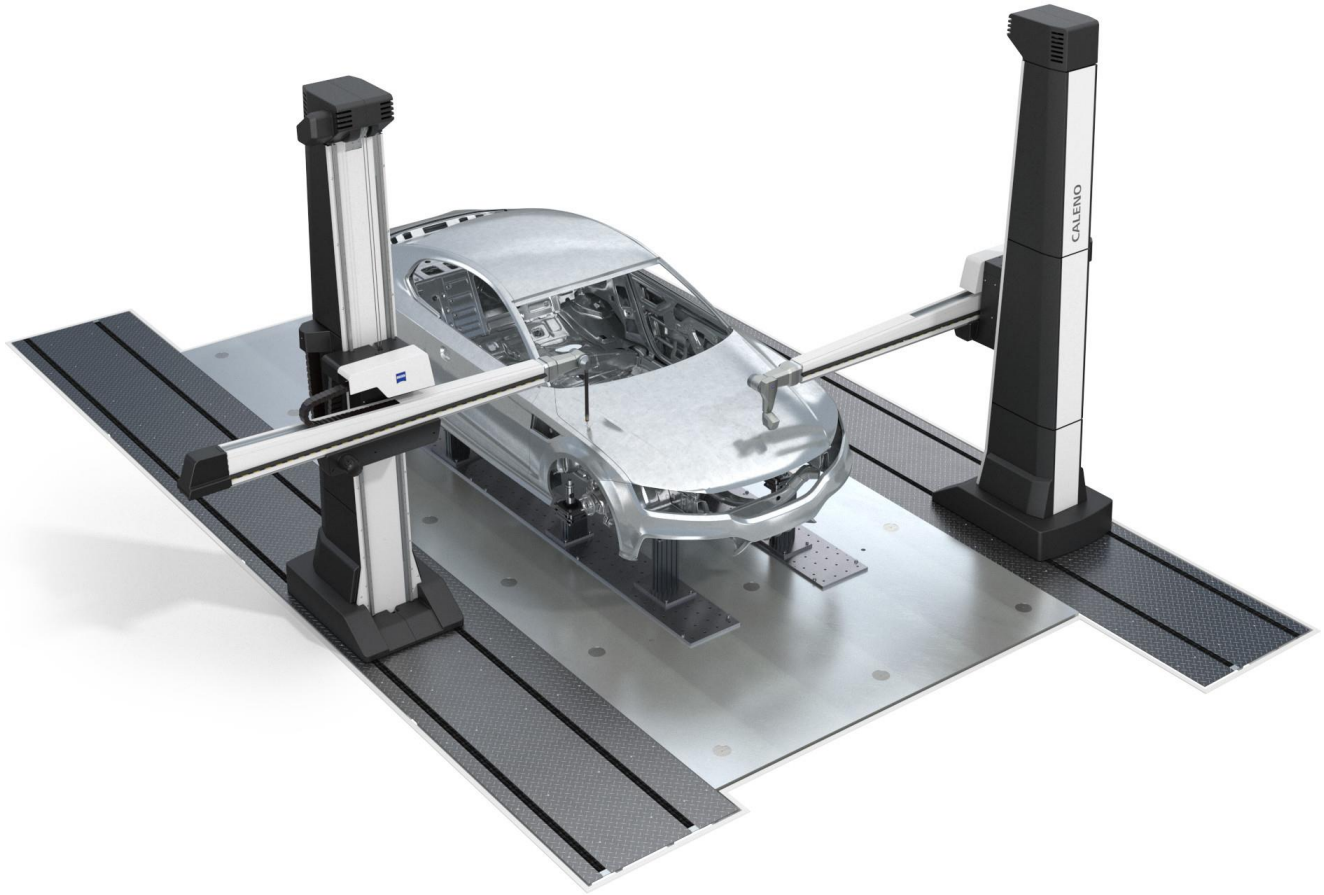
ZEISS CALENO – The Hambot



- The new wording Hambot combines two different needs in metrology
  - The experience with **HAM**, that it is ideal for sheet metal metrology and provides high and absolute accurate measurements
  - The requirement for high productivity, which is linked with the wording ro**bot**
- **Hambot** will be used instead of Horizontal Arm Machine to underline the new class of CMMs with optical sensors.

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The Hambot - Overview

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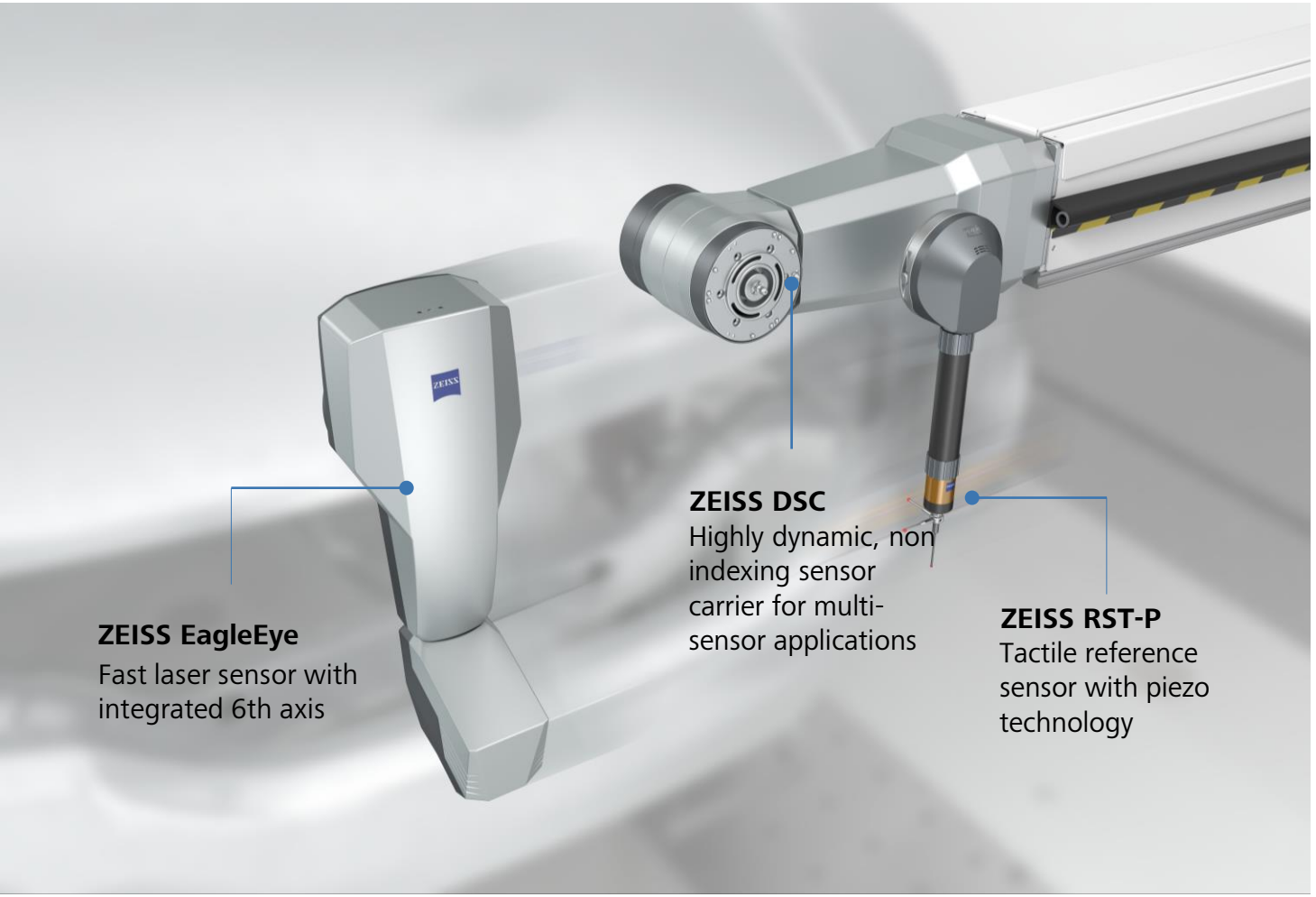
Multi-Sensor System



Multi Sensor System

- With ZEISS EagleEye, geometric elements can be measured and evaluated in record time
- Scanning of free-form geometries for CAD comparison and of geometry elements with the same sensor
- Automatic switch between optical and tactile sensors for features that cannot be optically measured.
- Thermofit extensions with up to 800mm.

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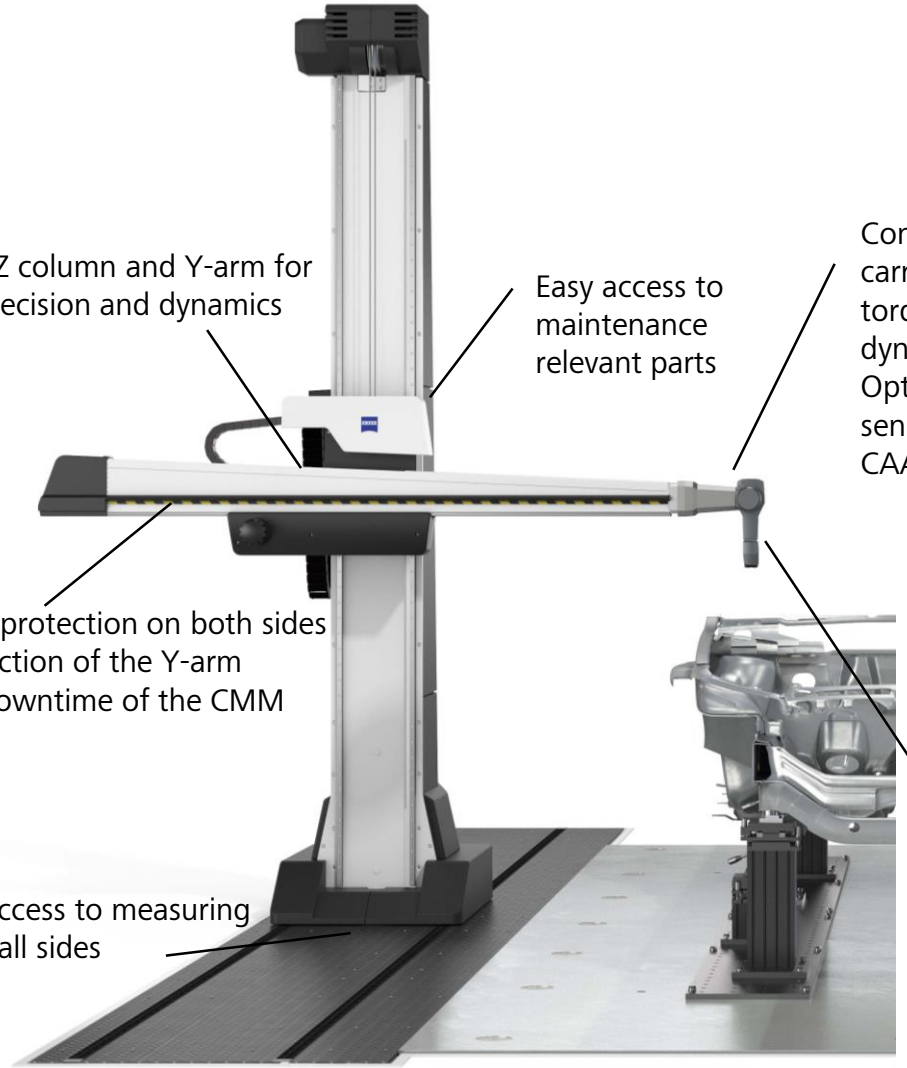
Exceptional Technology - CALENO



Trapezoidal Z column and Y-arm for maximum precision and dynamics

Easy access to maintenance relevant parts

Continuous sensor carrier DSC with high torque and high dynamics
Optional Indexing sensor carrier RDS-C6 CAA

Collision protection on both sides for protection of the Y-arm
Avoids downtime of the CMM

Flush-floor access to measuring range from all sides

ZEISS optical sensor system EagleEye for significant shorter measuring time and CAD compare

Measuring beam with new concept for thermal decoupling of the measuring beam and the foundation

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Exceptional Technology – CALENO T

Full covers made of EPP for excellent thermal isolation

Measuring tables available with optional T-slots or bore pattern for the clamping of fixtures

Inherent stiff measuring plate allows the installation with active damping system

Continuous sensor carrier DSC with high torque and high dynamics
Optional Indexing sensor carrier RDS-C6 CAA

Easy access to maintenance relevant parts

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Safety for the operator and the Hambot

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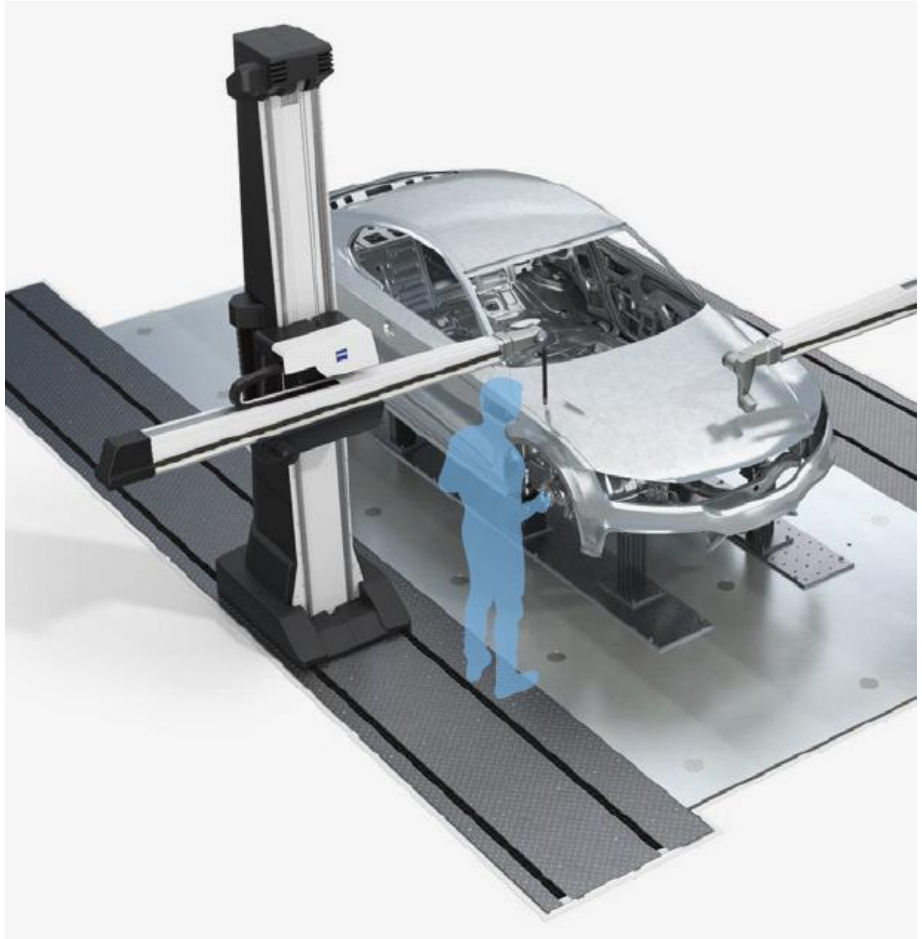
Safety for the Operator

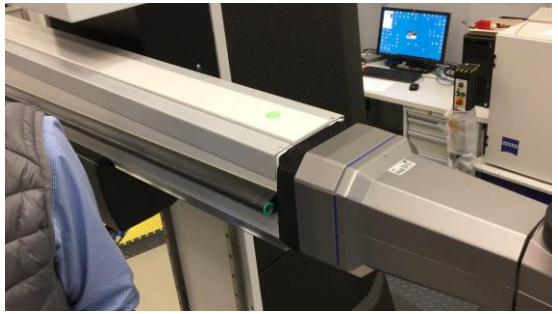


Friction drives, lag detection and over current protection

- The multi layer safety concept will stop the system, if any obstacle is in the travel path to protect the hambot and the operator.

Safety edge at the Y-arm

- ZEISS CALENO has standard sensor strips along the entire length of both sides of the Y-arm. If the narrow elastic tubes are deformed on contact, they will instantaneously shut down.



- Due to the safety features, the operator is allowed to work in the system, whilst measuring
- Risk of damaging is significantly reduced to reduce downtime and repair costs.
- Protects the operator from injury

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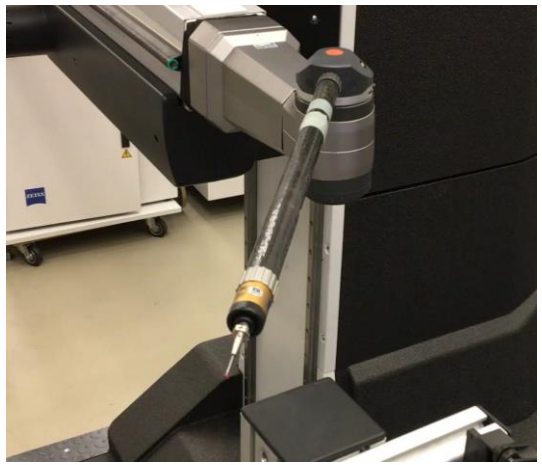
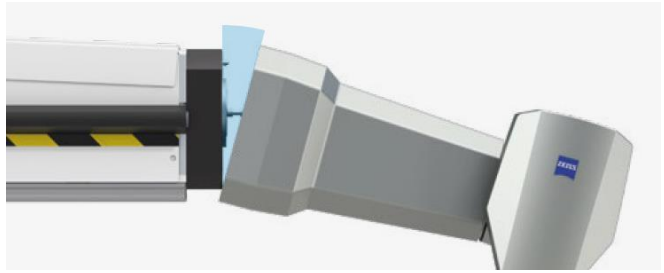
Safety for the sensor system



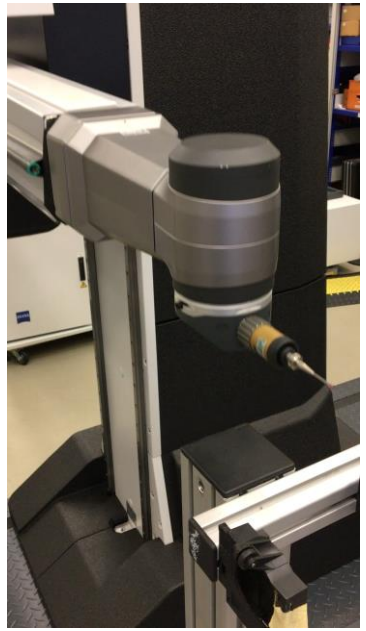
Collision protection for the sensor

- The connection point to the sensor is spring-mounted on the sensor carrier. This protects the sensor from damage in the case of a collision.



Optional collision protection for the ZEISS DSC or RDS-C6

- In addition, CALENO can optionally be delivered with an additional spring-mounted collision between the sensor carrier and the Y-arm.



Protective device on the ZEISS RST-P sensor

- Overtravel protection for ZEISS RST-P To minimize damage by collisions with the stylus. The traverse angle of the stylus on the ZEISS RST-P is an exceptionally large 26 °.

- Maximum protection of the sensor carrier and the sensor system leads to maximum availability of the system and reduced repair costs.

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CALENO/CALENO T – What is new

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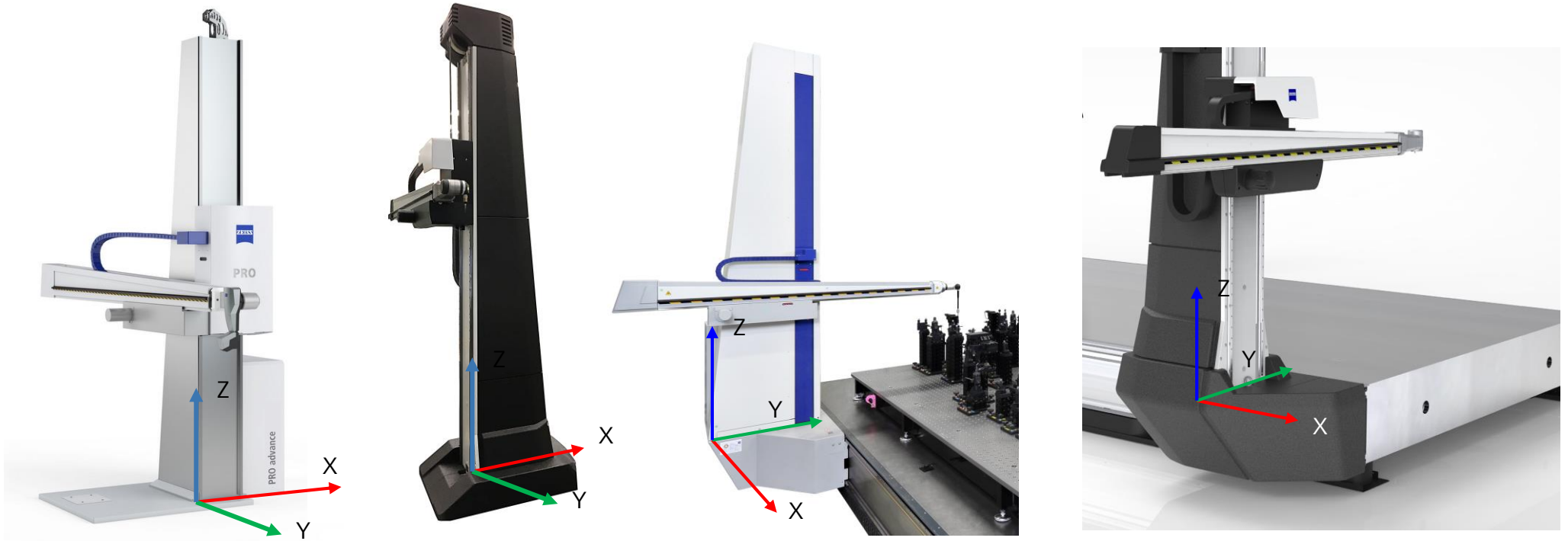
PRO/ CALENO Improvements

- Column turned by 90° for enhanced stiffness



PRO/ CALENO **PRO T/ CALENO T**

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PRO/ CALENO Improvements

PRO

CALENO

- PRO/ PRO T was available with standard, or full covers
- CALENO is always with full covers
  - Enhanced thermal stability
  - New material EPP with excellent thermal isolation

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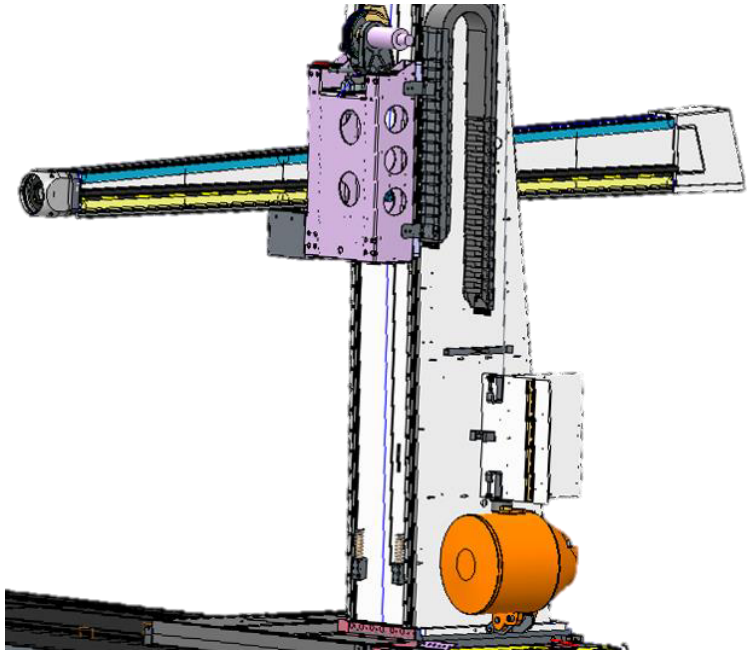
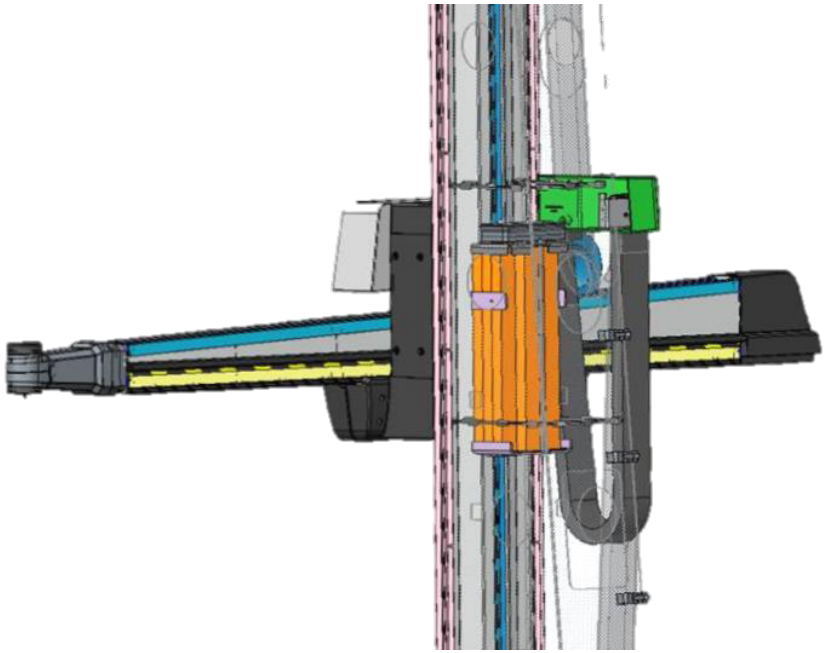
PRO/ CALENO Improvements





- New counter balance system
  - Counter weight instead of balancer
    - Less service costs
    - Improved MTBF

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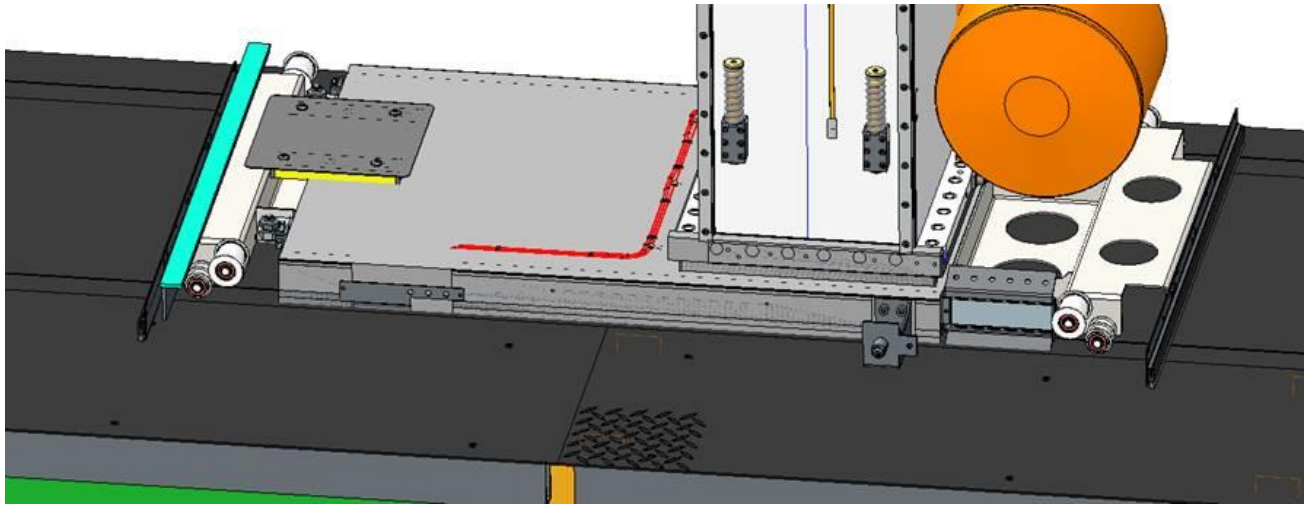
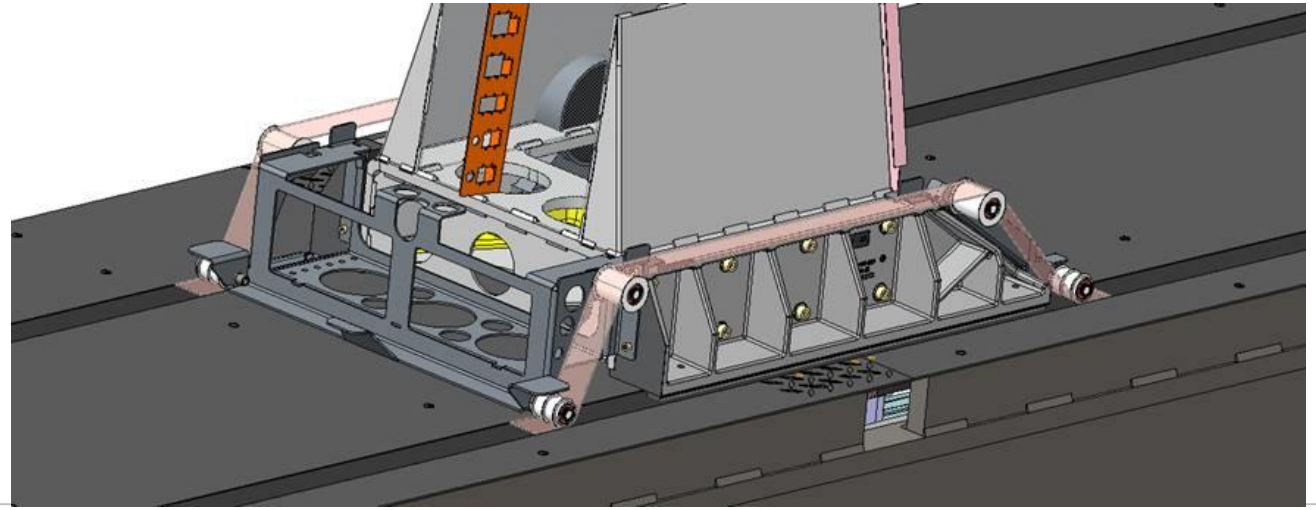
PRO/ CALENO Improvements





- New X-carrier
  - No welded dedicated X-carrier
  - Reduced complexity
  - Standard with gap covers

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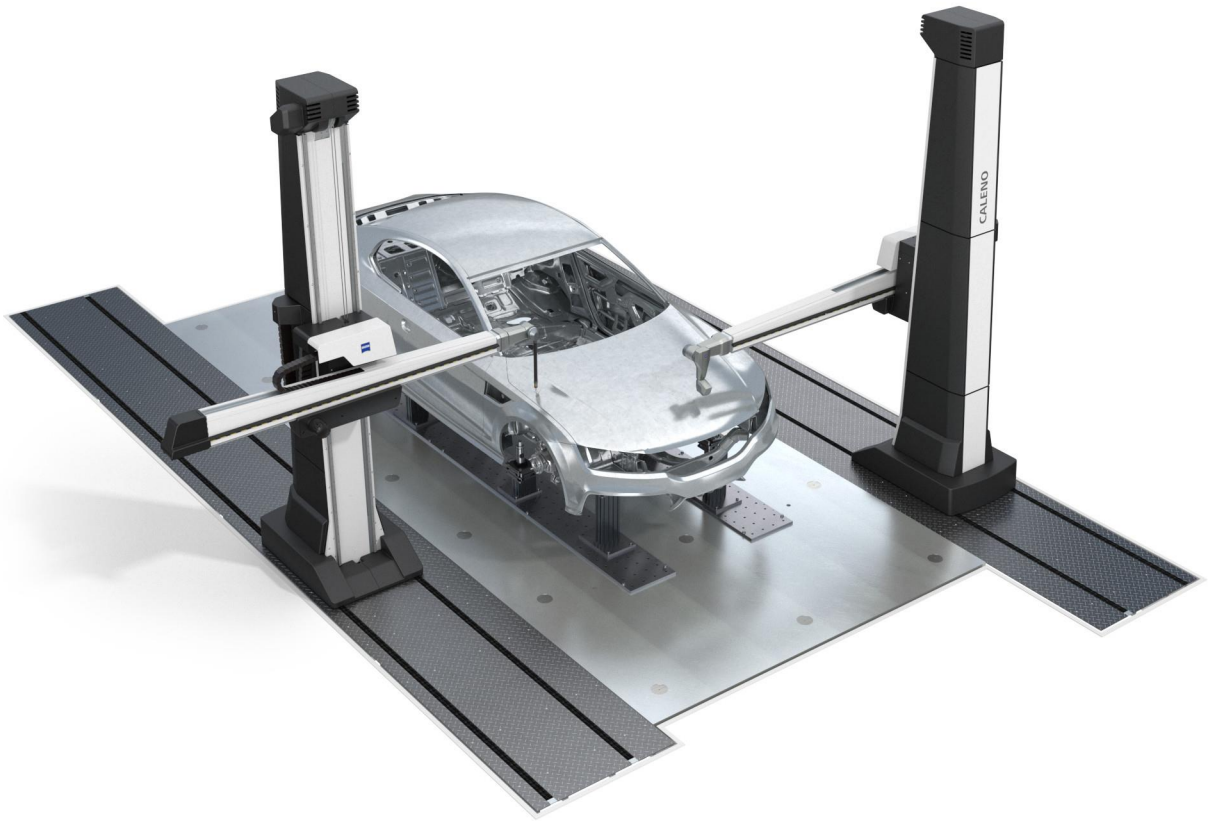
What is new? Summary



- CALENO is a fully new developed Hambot (horizontal arm CMM)
  - New designed X-axis as a welded structure with integrated thermal decoupling
  - New Y/Z tower with trapezoid shaped axis and linear ball bearing in all axis
  - New counterbalance system for the column
  - New full covers as standard for improved thermal isolation, environmental protection and modern design
  - New non indexing sensor carrier DSC

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Articulation

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Indexing sensor carrier RDS-C6 CAA

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Indexing sensor carrier RDS-C6 CAA - Summary

Sensor carrier RDS-C6 CAA
- Indexing articulating probe holder

- CAA-calibration
  - For short calibration time
  - For maximum uptime of the CMM
- Step width of only 2,5°
- Position repeatability ±1”
- Maximum extension 400mm
  - For excellent accessibility even on complex parts
- Safety
  - Spring loaded probe plate with mechanical fall arrester
- Sensors
  - Touch trigger probes:
  - RST-P, TP6 und TP20
  - Optical sensor system FalconEye

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Non Indexing Swivel Head DSC

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Non Indexing Swivel Head DSC – Improvements CSC - DSC

Customer benefit

- Higher data rates for future optical sensor systems.
- Improved reliability.
- New, attractive design

Innovation

- New, improved bearings.
- Slip rings for A axis, n X 360°
- B axis ± 137,5°

Replacement for CSC and CSC-U2

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Non Indexing Swivel Head DSC – Differences CSC - DSC

DSC – non indexing probe holder

- Improved performance compared to indexing swivel head
  - XYZ movement and rotation at the same time
- Improved safety, due to additional collision protection of the probe plates
- If extensions longer than 400mm are required, e.g. truck cabins
- For the optical sensor system EagleEye with6th axis
- Passive probe changer for reduced costs and improved reliability
  - Additional ports can be added
- Replaces the CSC

CSC probe changer with 4 ports

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Touch Trigger Probes

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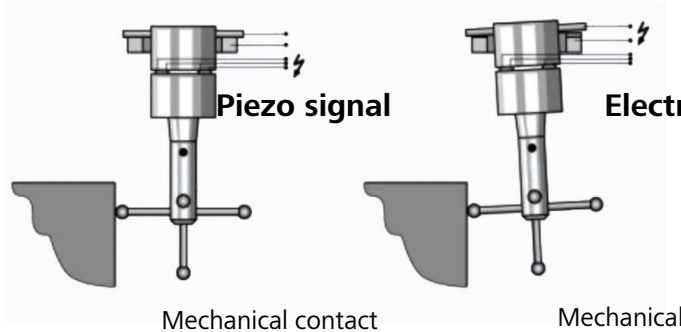
Touch Trigger Probes Zeiss

RST-P Piezo Probe

- Dual principle of probing
  - first force-free Piezo probe impulse
  - then mechanical deflection
- Better reproducibility than Renishaw touch trigger probes
- Robust
  - Overtravel 26°
  - MTBF more than 5 million trigger

- Optimum universal probe due to
  - Stylus weight up to 10g
  - Stylus length up to 90mm
- Temperature stabilized invar body



Mechanical contact closed

Probe force at moment of contact <0.01N

Mechanical contact opened

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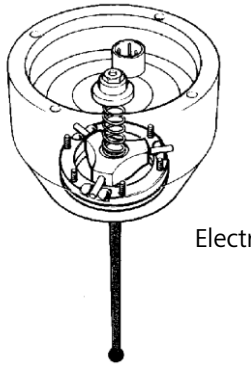
Touch Trigger Probes Renishaw

TP6

- Universal probe, if customer requests Renishaw
- More over travel than TP20
- Cheapest touch trigger probe
- Trigger force can be adjusted

TP20

- Stylus modules can be changed
- Small diameter
- Different probe modules available
- Standard delivery with one module medium force and one high force
- Due to the risk of false trigger, low force should not be used



Electromechanical switch

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Comparison Trigger Probes

	RST-P	TP6	TP20
Principle of function	Piezo	Electro mechanical switch	Electro mechanical switch
Trigger force in the moment of data capture X/Y	<0,01 N	0,11 - 0,3 N with stylus L=20mm	0,08N/ 0,25N/ 0,4N with stylus L=10mm
Trigger force in the moment of data capture Z	<0,01 N	??	0,75N/ 1,9N/ 3,2N
Max. possible stylus length	90 mm	50 mm	50 mm (high force)
Max acceptable stylus mass	10 g	5 g	5 g (high force)
Reproducibility	0,3 µm	0,35 µm	0,35 µm
Stylus length at specification	20 mm	20 mm	10 mm
Durability/ no. of trigger	> 5 Mio	> 1 Mio	> 1 Mio
Over travel X/Y	± 26°	± 22°	± 14°
Over travel Z	8 mm	5,5 mm	4 mm/ 3,7 mm/ 2,4 mm

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Optical Sensor System EagleEye

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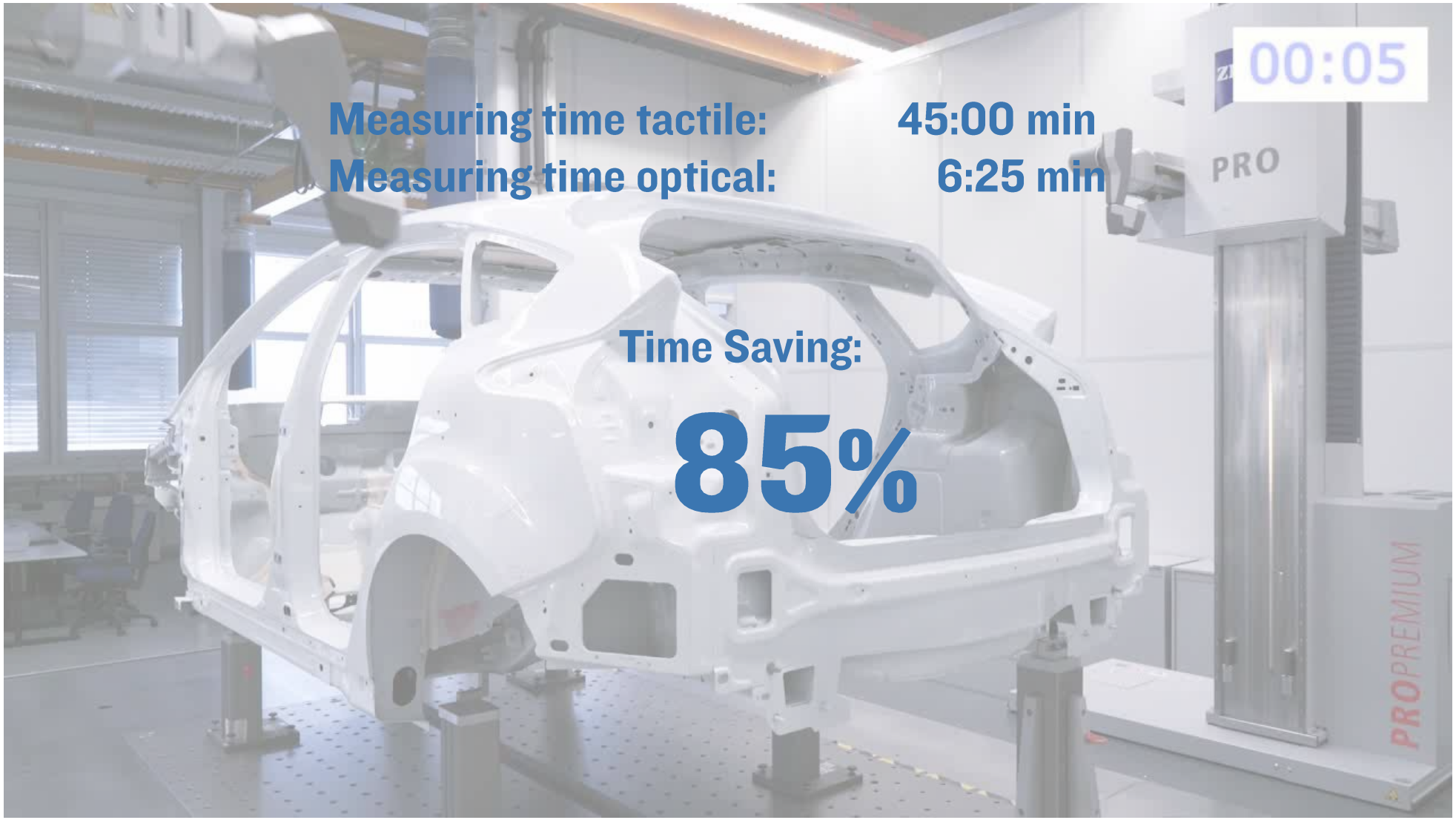
Productivity improvement with the EagleEye system



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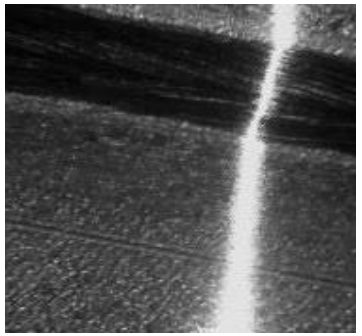
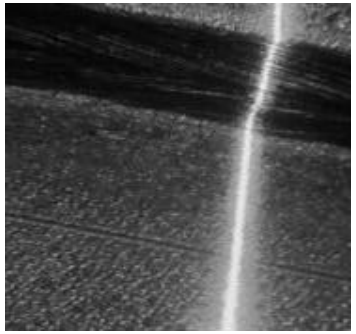
Ease of use

- **Ease of use**
  - **by new camera technology**
    - **Very high dynamic range**

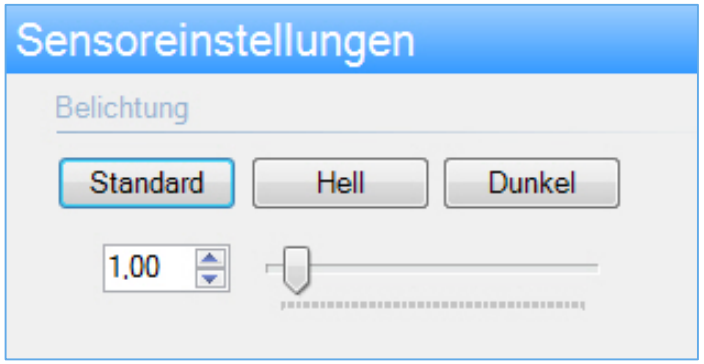


Without LinLog



With LinLog

  - **Easy scanning of different materials**



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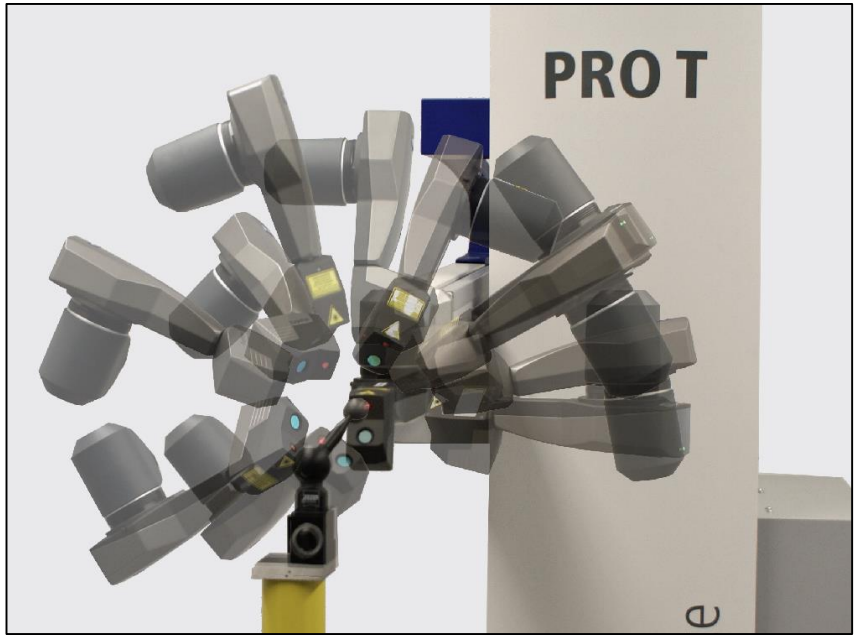
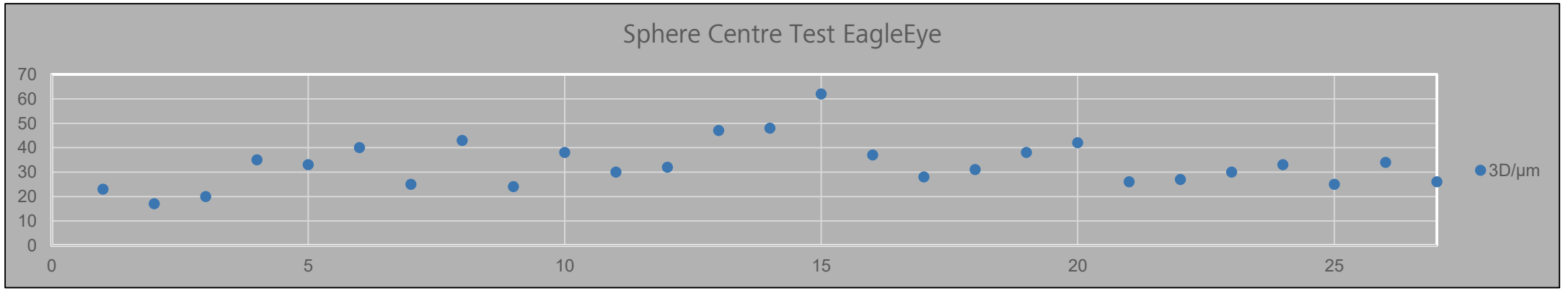
Accuracy

- **Sensor accuracy: 20µm[1]**
- **System accuracy: < 70µm[2]**





1 The accuracy of the sensor is defined as the maximum deviation of the X or Y center point of a sphere, measured in the measuring area of the sensor

2 Sphere center test on PRO premium 16/25. 29 angular positions of A-/ B- and C-axis

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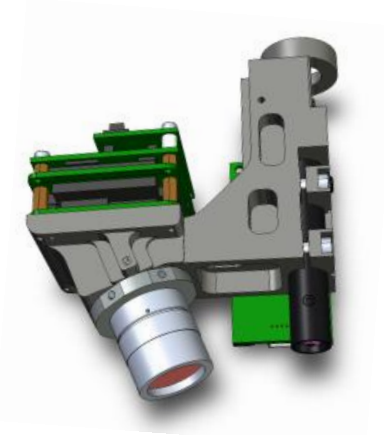
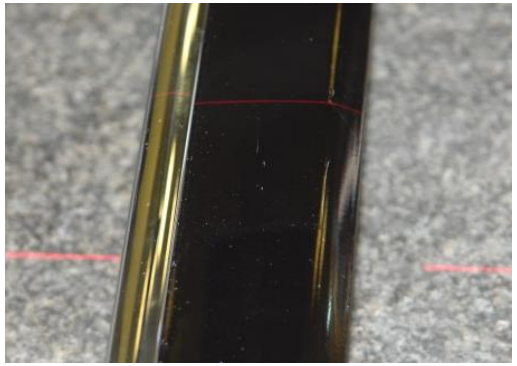
Robustness

- **Mechanically robust system without moving parts**



- **Body out of aluminum**
  - **Sensor**
  - **C-axis**

- **No spikes, even at critical geometries and materials**
  - **Due to LinLog Technology**



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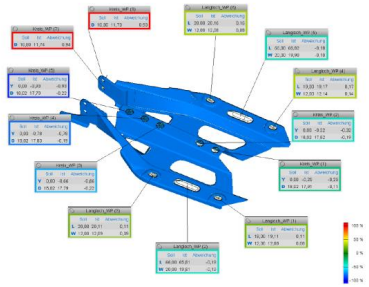
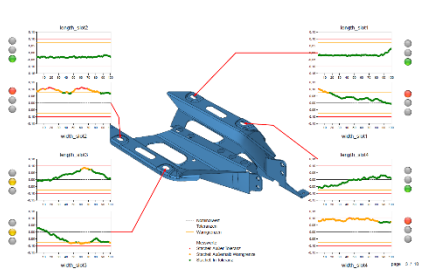
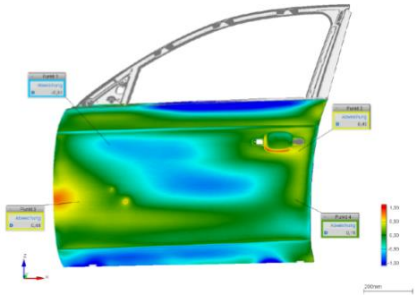
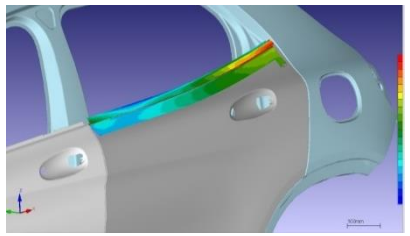
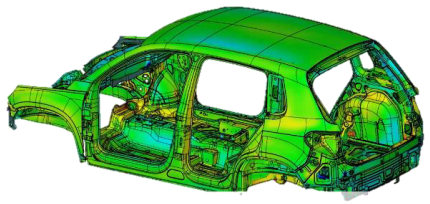
Description of the Application/ differentiation

				
Feature Analysis	Feature Serial Measurement	CAD Compare outer shell	CAD Compare problem analysis	Complete Scan for virtual Meisterbock
Individual features are measured in order to detect and correct problems. Feature measurement during product startup.	Process control based on test features and functional dimensions. Statistical evaluation of the results. Samples from the current series.	Essentially, the visible surfaces in the area of the outer skin are detected. There is no requirement to detect the inside of the components, or the structural areas.	A typical problem analysis with optical metrology is shown in the picture above. It is e.g. for leak tests in the area of the doors. For this purpose, only the information in this subarea is needed.	All components are recorded completely, ie inside and outside, in order to carry out virtual analyzes and simulations of the components to each other. For this, the deformations must be simulated by the dead weight of the components for the virtual masterbuck.

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Software

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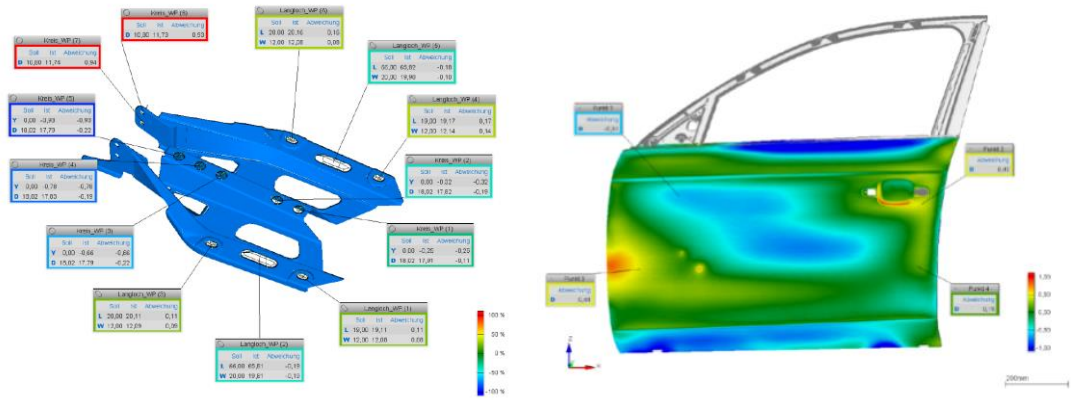
ZEISS CALIGO - The software for freeform surfaces and features



02 Benefits // Highlights

- Easy to use software
- Path-in/Path-out
- Efficient software architecture for processing large data quantity
- Efficient change management
- Integrated simulation functions for off-line programming
- Collision protection by using automatic travel paths
- Including ZEISS PiWeb reporting (professional report creation)

01 Main application // description

- Efficient tool for testing and inspection freeform surfaces and standard geometries in car body construction
- Allow meaningful conclusions of car body reports
- Sectional view and 3D intersection curves
- Statistic analyses for processes and production means
- Management dashboards

03 Installation locations // facilities

Facilities of automotive manufactures and suppliers:

- Individual parts, assembly (geometries, features, surfaces)
- Body construction (geometries, features, surfaces)
- Client/server installation is embedded in existing IT infrastructure

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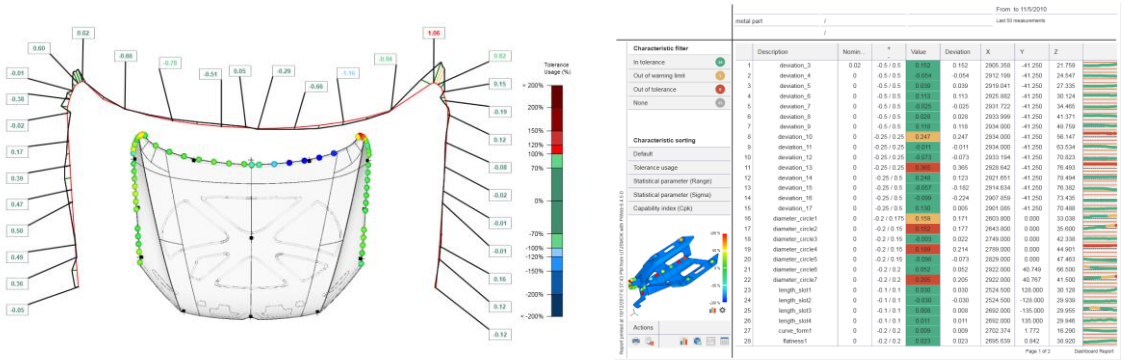
ZEISS PiWeb - Quality data management



01 Main application // description

- Interactive reports for complex data
- Allow meaningful conclusions of car body reports
- Sectional view and 3D intersection curves
- Statistic analyses for processes and production means
- Management dashboards

02 Benefits // Highlights

- Central data store with global data availability
- Tools for in-line data, fast creation of reports with large data
- User specific reports for QA and in-line
  (e.g. tool manufacturing, assembly, final assembly, management)
- Fast and intuitive handling and creation reports with drag and drop

03 Installation locations // facilities

Facilities of automotive manufactures and suppliers:

- Individual parts, assembly (geometries, features, surfaces)
- Body construction (geometries, features, surfaces)
- Paint shop (gap-and-flush measurement after painting)
- Final assembly (gap-and-flush measurements for fully assembled vehicles)
- Client/server installation is embedded in existing IT infrastructure

ZEISS Multi Sensor CMMs for Car Body Applications

Applications

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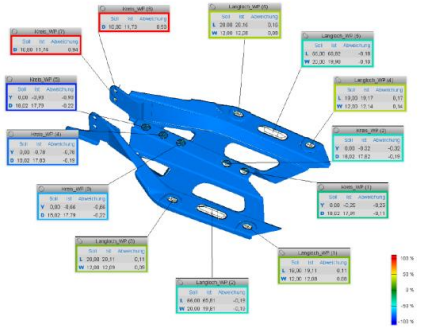
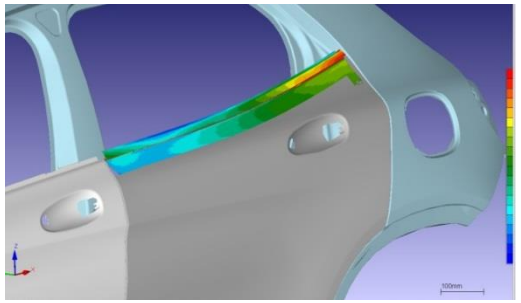
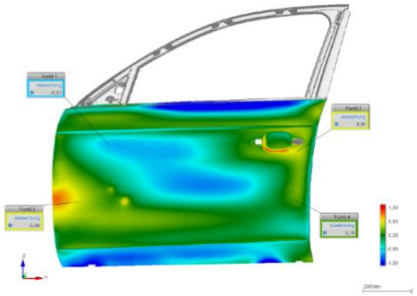
Analysis of press parts, assemblies and BIW







In which phase is being measured?

- Part qualification for start up phase of production
- Fast analysis in the series

What will be measured?

- Press parts, hanging parts, up to the complete body-in-white.

How will be measured?

- Fast, tactile and optical feature measurement
- CAD compare for problem analysis.
- Digitization

How to create the measuring programs?

- Offline, with simulation for the start up phase
- Direct at the CMM for problem analysis

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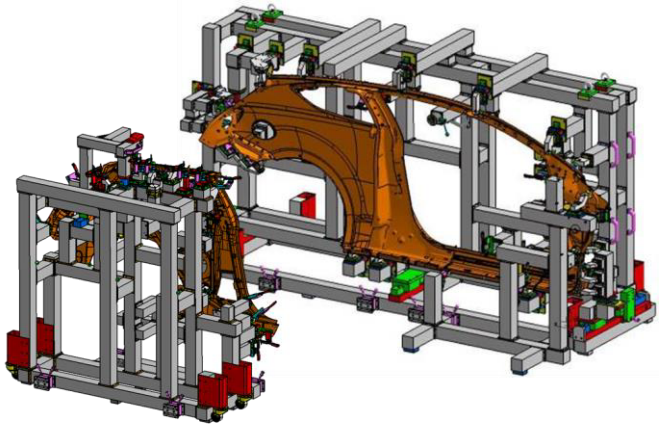
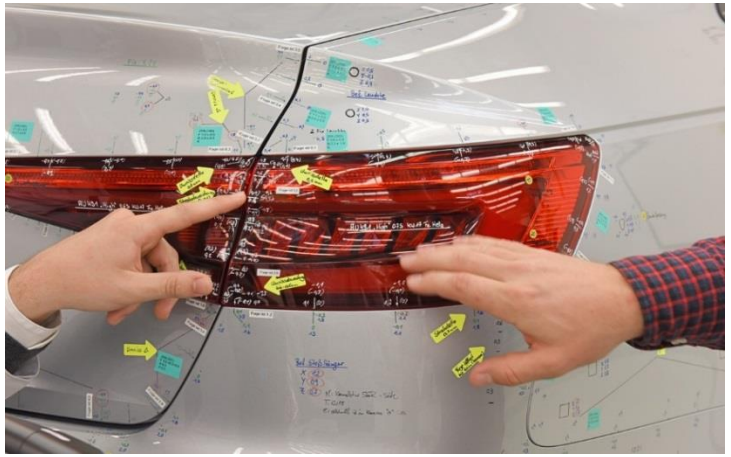
Meisterbock analysis and finished car analysis





In which phase is being measured?

- Part qualification for start up phase of production
- Fast analysis in the series

What will be measured?

- Verification of the dimension of the individual components.
- Verification and analysis of quality, flush&gap, optics, haptics, function and assemblies capability.

How will be measured?

- If necessary, tolerances, construction and design issues can be discussed on the Meisterbock with parts, data and reports

How to create the measuring programs?

- Direct at the CMM for problem analysis

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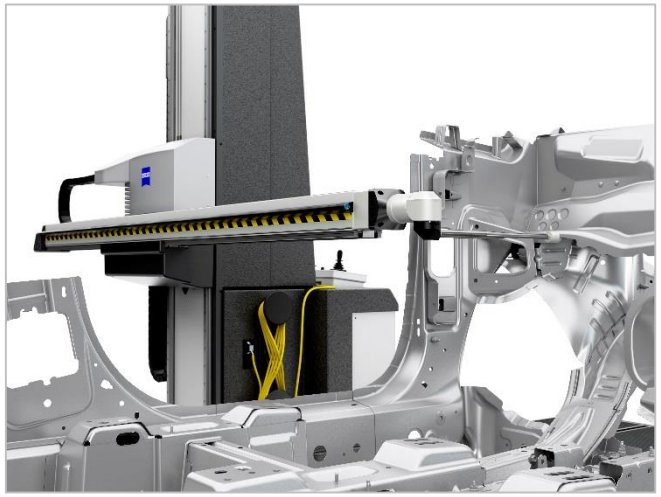
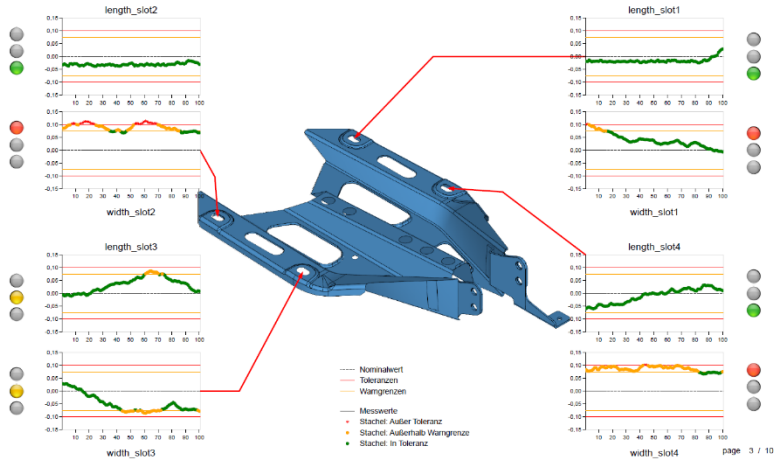
Serial measurement BIW





In which phase is being measured?

- Fast process control in serial production

What will be measured?

- Body-in-white and hanging parts

How will be measured?

- Direct measurement of geometrical features with optical or tactile sensor.

How to create the measuring programs?

- Central creation of measuring programs, or at offline stations in the measuring room.

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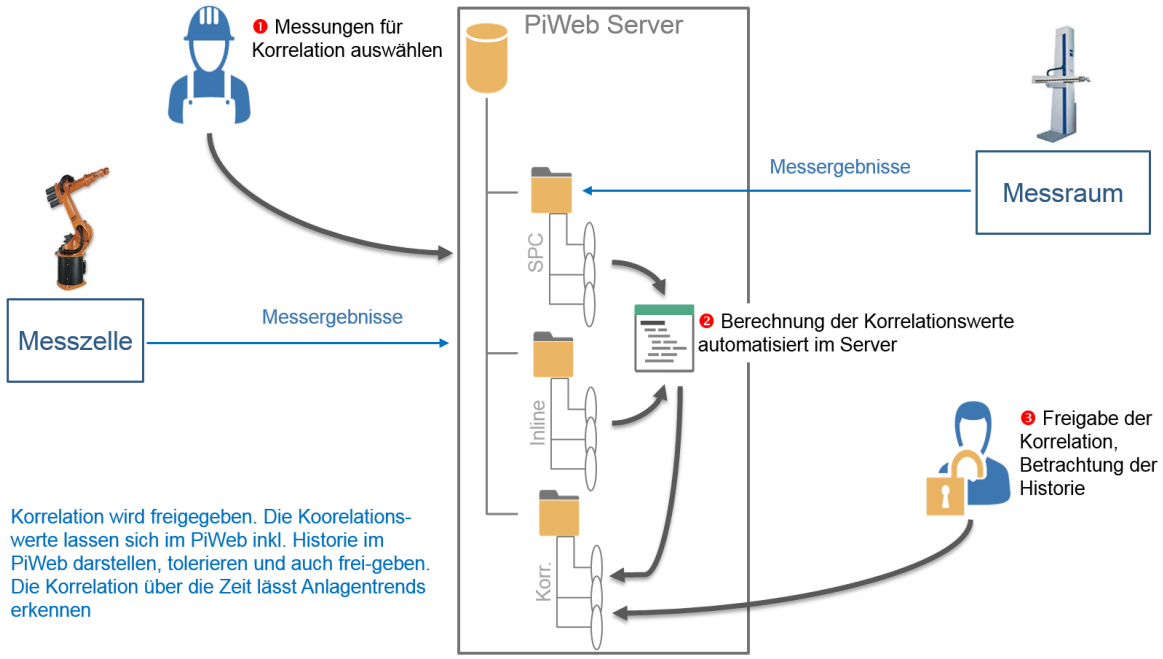
Serial measurement BIW – Correlation for Inline Measurement



In which phase is being measured?

- Correlation for inline measurement

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- Body-in-white and hanging parts

How will be measured?

- Direct measurement of geometrical features with optical or tactile sensor .

How to create the measuring programs?

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ZEISS Multi Sensor CMMs for Car Body Applications

Portfolio Overview

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Portfolio Overview

Performance CMMs

Premium CMMs

Flush to floor

CALENO RDS C6-CAA

CALENO DSC

CALENO DSC
with optical sensor system EagleEye,
Option HA and HP

Table version

CALENO T RDS C6-CAA

CALENO T DSC

CALENO T DSC
with optical sensor system
EagleEye,
Option HA and HP

Upgrade concept of CALENO T and CALENO up to highest specification

Speed, better accuracy sensor carrier, optical sensor

Application

Performance

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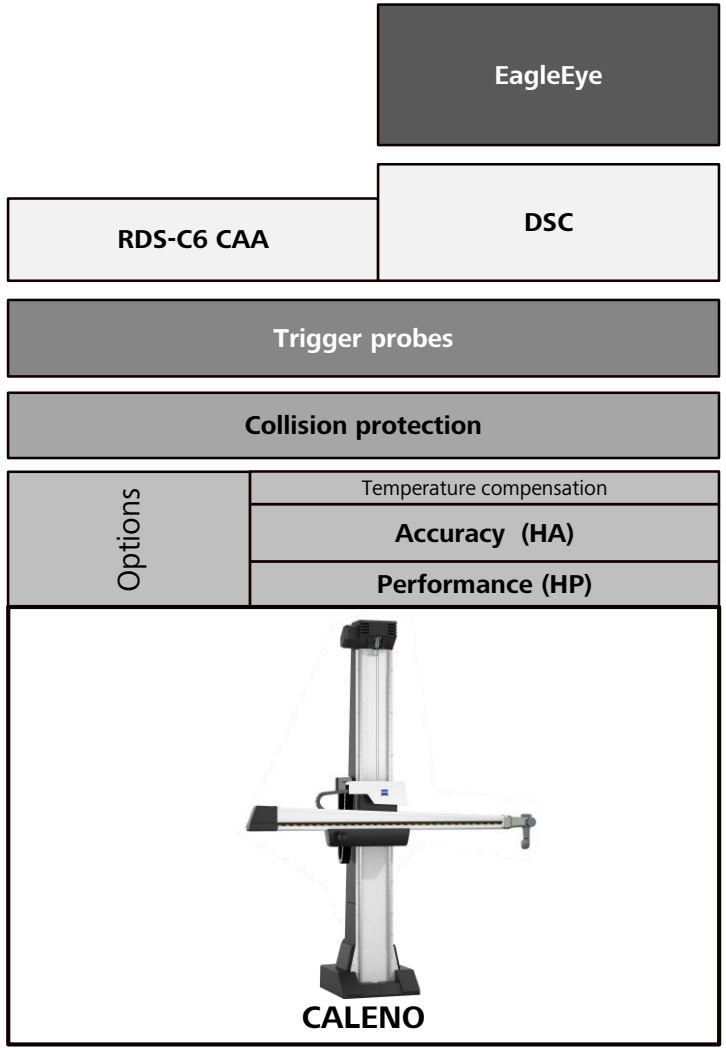
The platform strategy



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The platform strategy

	CALENO / CALENO T
Accuracy for 16/25	27+L/80≤70
Option High accuracy	18+L/125≤50
Measuring range X	3.000 - 25.000
Measuring range Y	1200[1], 1600, 1800[2]
Measuring range Z	2100, 2500, 3000[2]
Max acceleration	1000mm/s²
Option performance	1500mm/s²
Max. Travel speed without light barrier	260mm/s
Max. Travel speed with light barrier	866mm/s[3]
Sensor Carrier	RDS-C6, indexing 2,5°/ DSC, continuous
Max. probe extension RDS (indexing)	400mm
Max. probe extension CSC (continuous)	800mm
Tactile probes	TP6/ TP20/ RST-P
Optical sensor CSC	EagleEye
Covers	Full covers

ZEISS Multi Sensor CMMs for Car Body Applications

Summary

10

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Summary

- Modular platform concept of the CALENO / CALENO For an optimized adaption of the CMM to the customer needs
  - The CMM can be upgraded with modules like high speed and high accuracy
- Flexible installation
  - Flush to floor with CALENO
  - Side mounted table version CALENO T
- Highest precision and highest productivity
- Robust and service-friendly
- RDS C6 – CAA, DSC
  - the benchmark for indexing and continuous articulating heads
- Machine and operator safety
- Maximum flexibility of the measuring range
- Technology from one source: ZEISS

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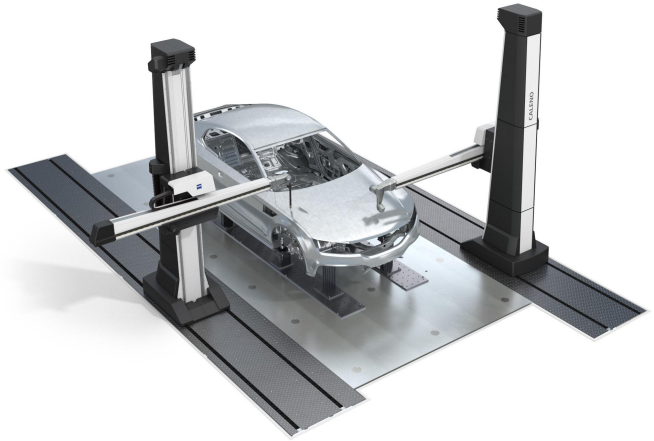
Solutions



CALENO RDS-C6 CAA Duplex

Typical for OEMs with small and medium quantities or pure analysis systems

- Analysis
- Process control series and correlation – low and mid volume
- Meisterbock CMMs
- Finished car analysis

CALENO T Single/ Duplex

Typical for 1st Tier

- Analysis of press parts and hanging parts
- Serial measurement, e.g., battery trays in production environment

CALENO DSC Duplex

Typical for big OEMs

- Analysis
- Process control series and correlation – high volume
- Meisterbock CMMs
- Finished car analysis

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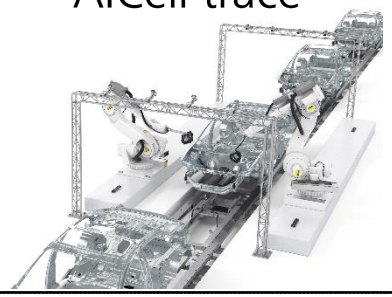
Hambot und Scanbox: Differentiation of the two measuring systems Inline/Atline/Offline

		Strength: **Metrology** Feature extraction	**Strength: Digital Twin** Full part scanning
Inline 01	Measuring of individual modules and full part digitization of assembled parts and complete bodies // e.g. 54 sec.	AICell trace 	ATOS Inline
Atline 02	Complete optical scans for CAD comparison e.g. of attachments // within 10 to 15 min..	Hambot – CALENO 	ATOS ScanBox
Offline 03	Precise analysis of any carbody part. Highly precise and optically efficient. // from a few min. to hrs.	Hambot – CALENO 	ATOS ScanBox

Process control

Metrology & Digital Twin

Seeing beyond