



HEXAGON
MANUFACTURING INTELLIGENCE



3D Metrology as Enabler for Automated Assembly

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Key Phrases for this 3D Metrology Conference

- *The technology and applications of portable coordinate metrology*
- *3D metrology for advanced manufacturing*
- *Automation and in-process metrology*
- ***Industrial requirements and the future technologies driving 3D metrology development***
- *Augmented reality (upcoming new technology)*
- ***Measurement uncertainty and traceability***

- ***Metrology development adapting to industrial requirements and future technologies***
because very often upcoming or available technologies are there, could be used but it is first necessary to find possible applications and acceptance to adapt from user side before the investments for new developments taking place

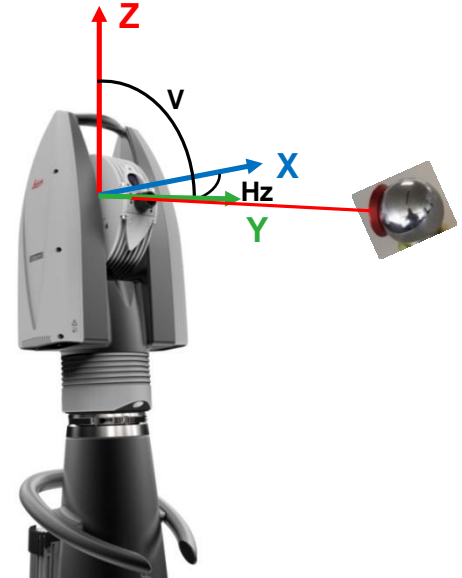
Laser Tracker Solution

- 3D point measurements with Absolute Laser Tracker AT930
- In general identical to Totalstation
- Measurement values
 - Hz – Angle
 - V – Angle
 - • Distance

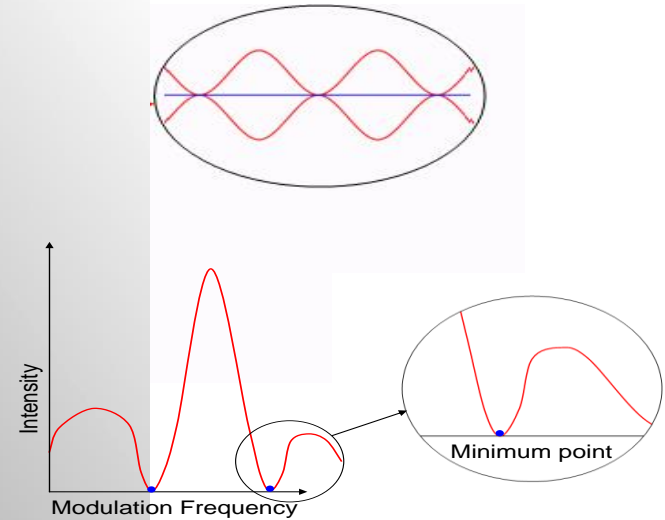
X; Y; Z coordinates

Specific Laser Tracker functionality

- Measurement rate 1000 measurements / seconds
- Measurement during movement
- Distance accuracy in μm -range
- PowerLock functionality



How Does a Laser Tracker Measure?



Result

3D – Coordinats of the measurement points

- To center of reflektors
- Single point measurement
- Points along movement path of reflector



Measurement procedure

- Measurement of reference points
- Local Laser Tracker coordinate-system
- reference points known in object coordinate-system (CAD)
- Transformation
- Measurement in object coordinate-system



3D Measurements (Transformation – Orientation)

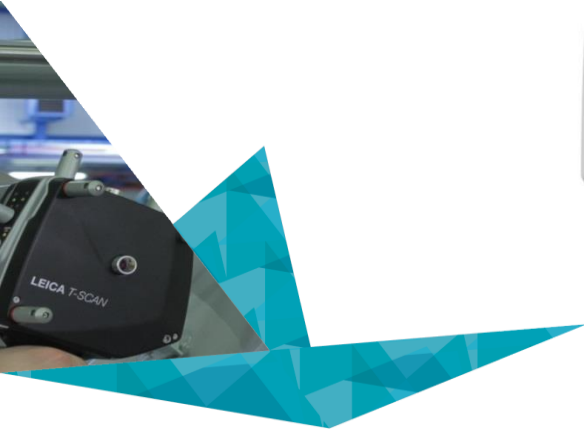
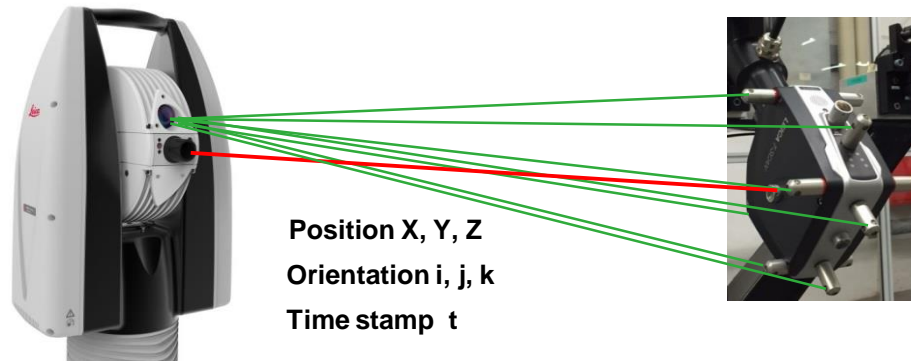


Measurements for referencing
Transformation into objekt-coordinaten-system
3D measurements are restricted to single points

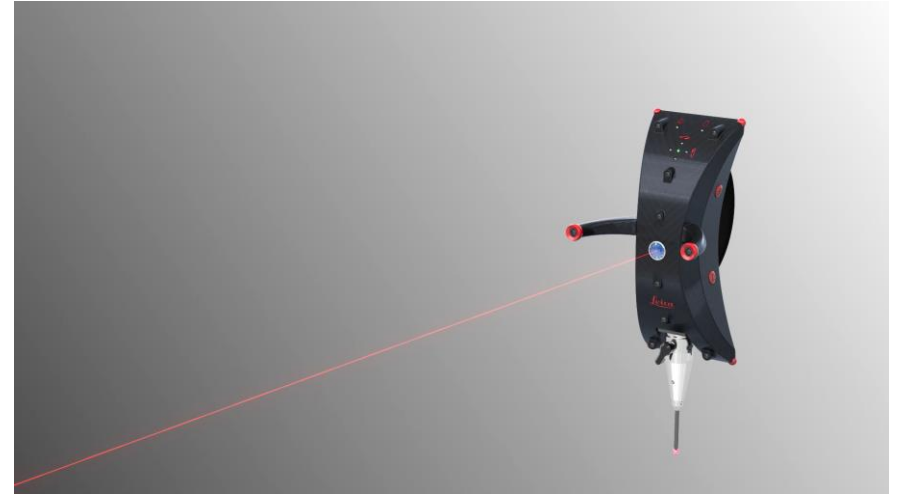


Extension to 6DoF Measurements

- 3D measurements (X; Y; Z) based on Laser Tracker Technology
- **Combination Laser Tracker with Photogrammetry Technology**
- To measure the orientation (i; j; k) in addition
- Result is the measurement of 6 Degree of Freedom (X; Y; Z und i; j; k) with a single measurement
- In addition very precise measurement of the time t



What is 6DoF?



- Integration of photogrammetry and laser trackers
- 6DoF control with laser tracker accuracies
- “Vario-Zoom” optic keeps a typical rotational uncertainties of 0.01° over the full working range
- 1 KHz Real-time capable

Main Applications for Laser Tracker Automation

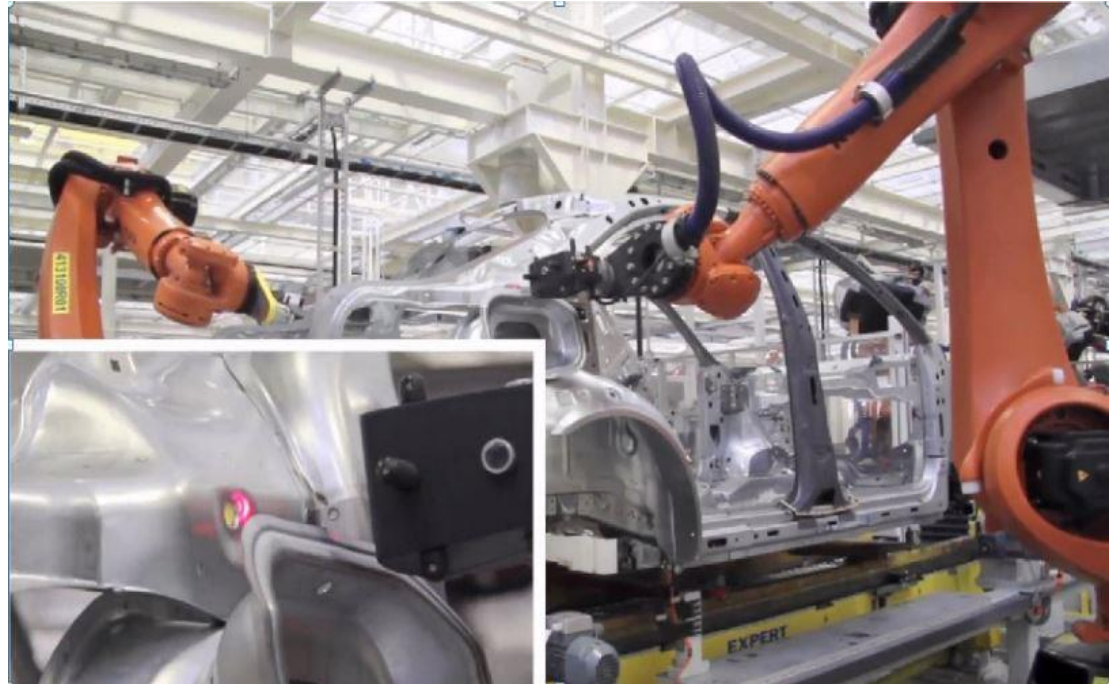
- Inspection
 - Point Cloud scanning with T-Scan
 - Single point measurements with T-Mac
- Robot or machine, calibration or optimization
- Robot or machine guidance with T-Mac
- Real-time control



Inline System at Skoda

Measurement of

- 283 features
- in 53 seconds
- completed after 5 units
- 1000 cars per day

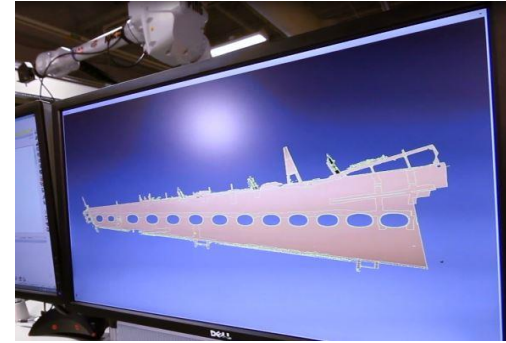


Automated Laser Tracker Solutions

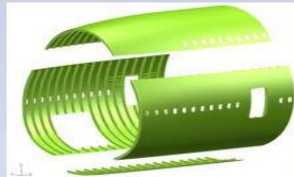
NIAR in US

Large aerospace part inspection

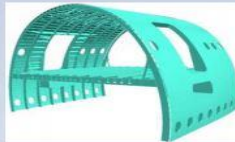
Complete surface measurement in 4 minutes



A380 Inspection PAG Nordenham



Sektion 13



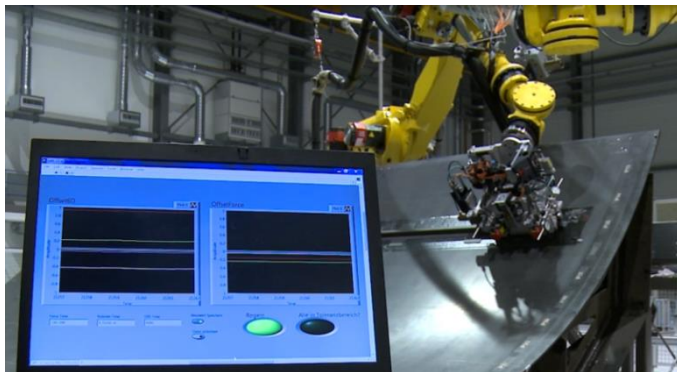
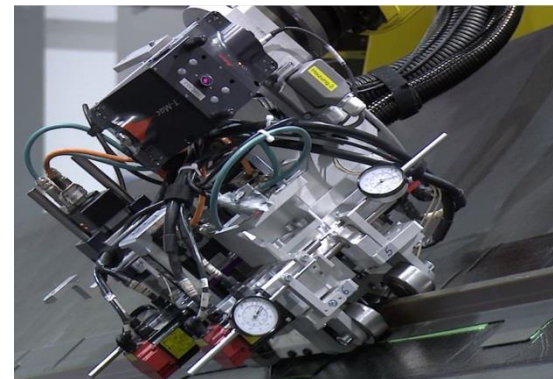
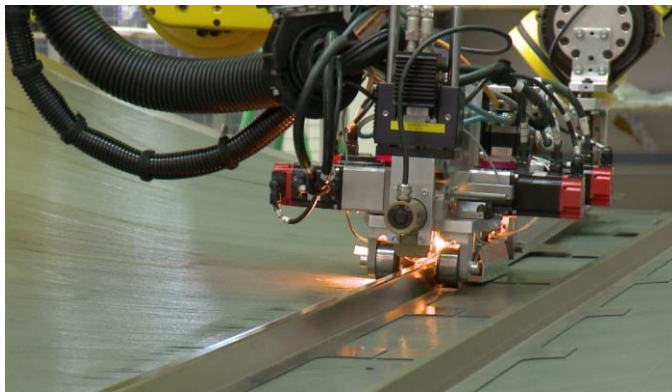
Sektion 15



Sektion 18



Applications to Guide and Control Devices

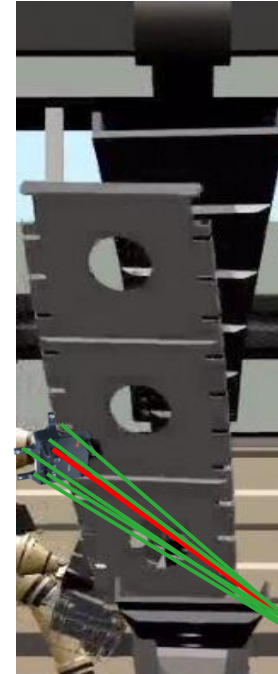


Automated Assembly – Next Step

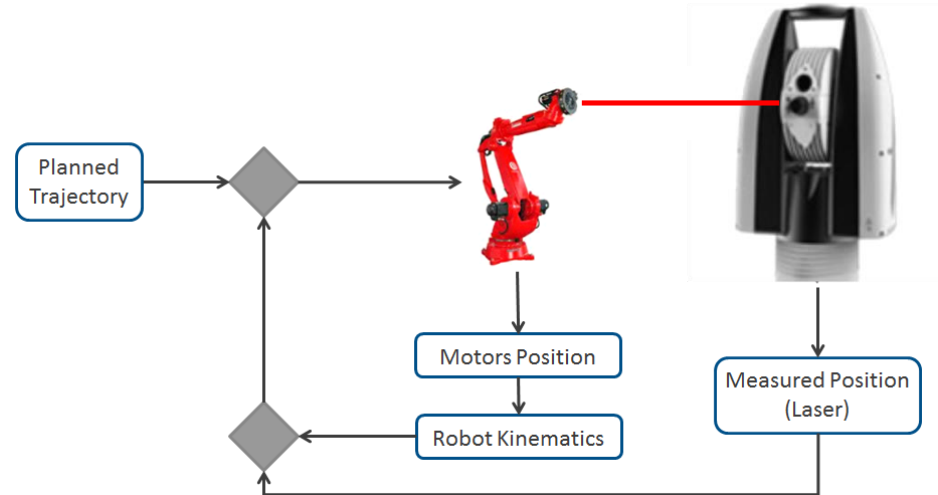
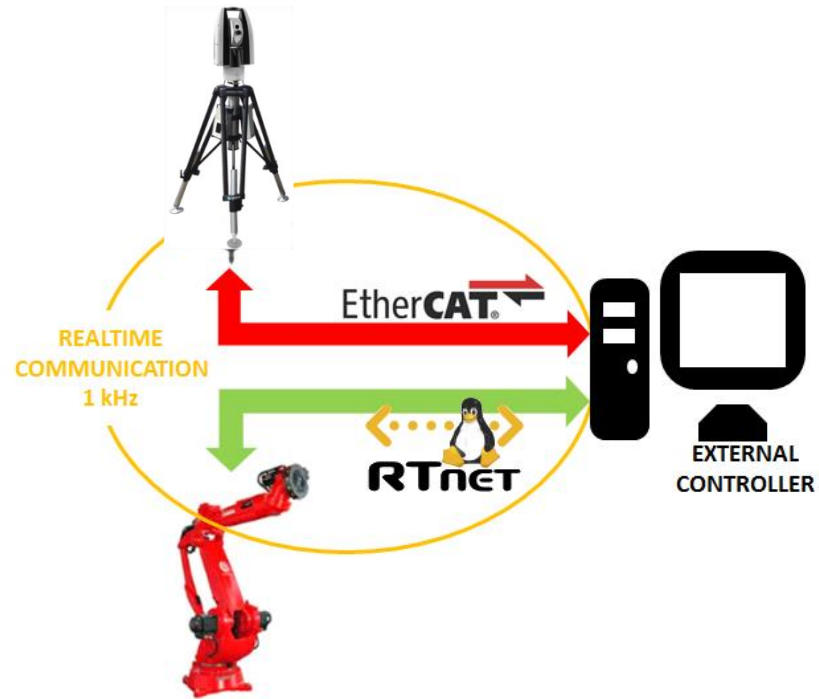
- Support Assembly Process
 - Inspect the part which should be assembled
 - Provide a T-Mac type sensor at the transport tool
 - Measure relation of the part to the transport tool
 - Measure neighbour part where it should be joint
 - Guide the tool to the nominal location

Improvement:

➔ real-time feedback loop



Moving to 7DoF

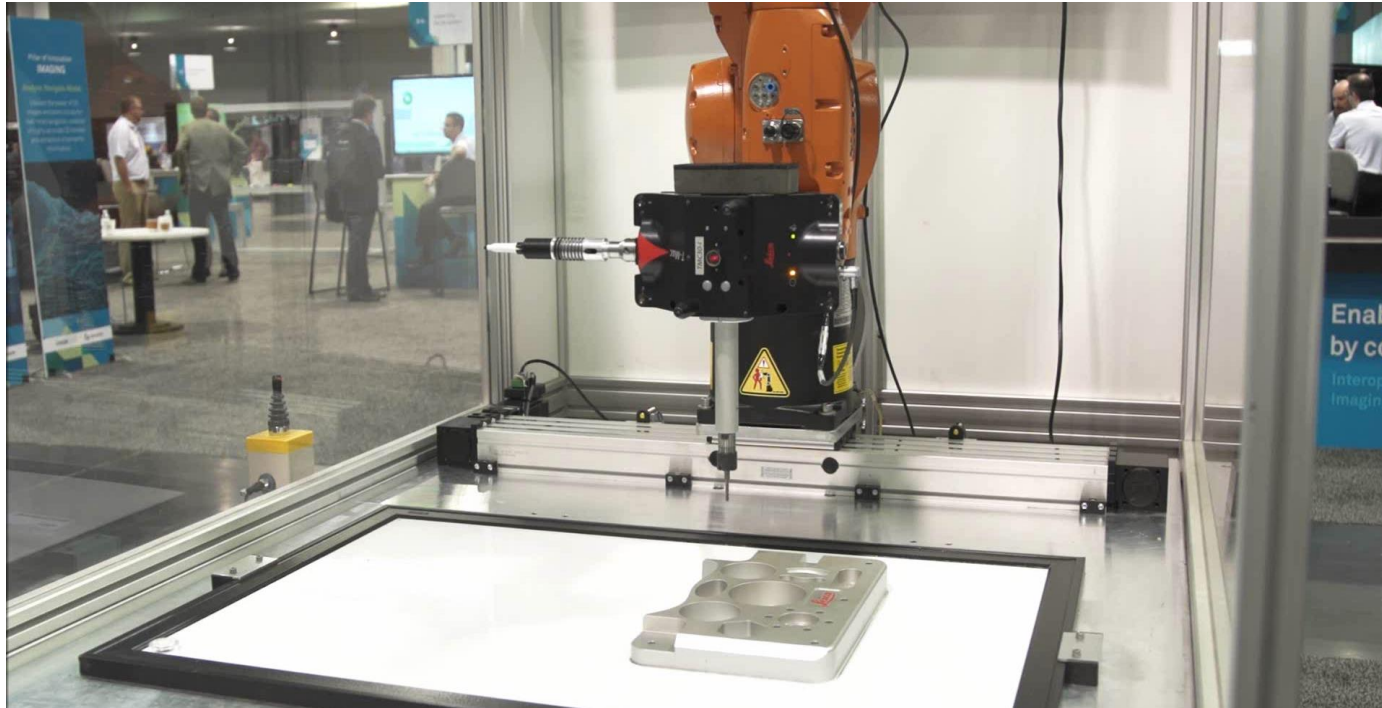


Building MegaROB

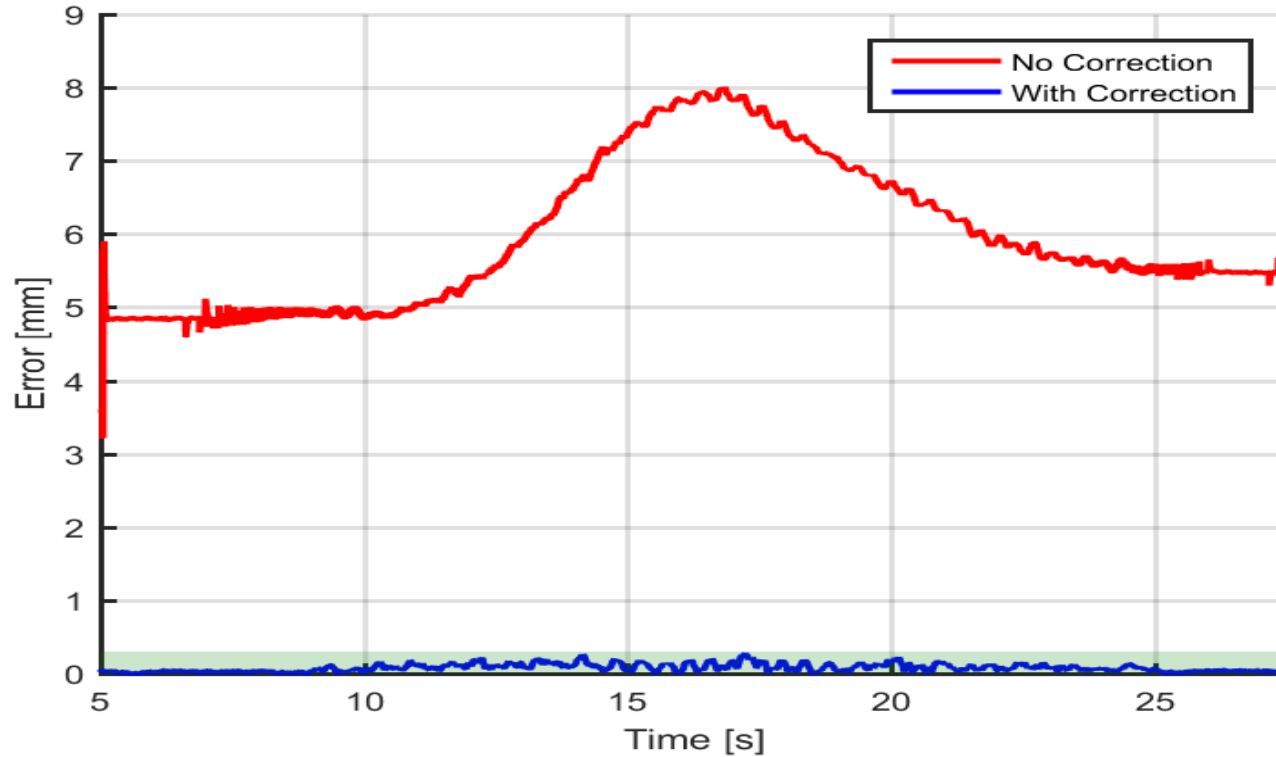
- Development of a platform:
 - Flexible
 - Sustainable
 - automated
- High Accuracy manufacturing operations
- Complex parts. Medium and large size (>10m)
- Using:
 - Industrial Robotics
 - Laser tracker
- Assembled on a crane



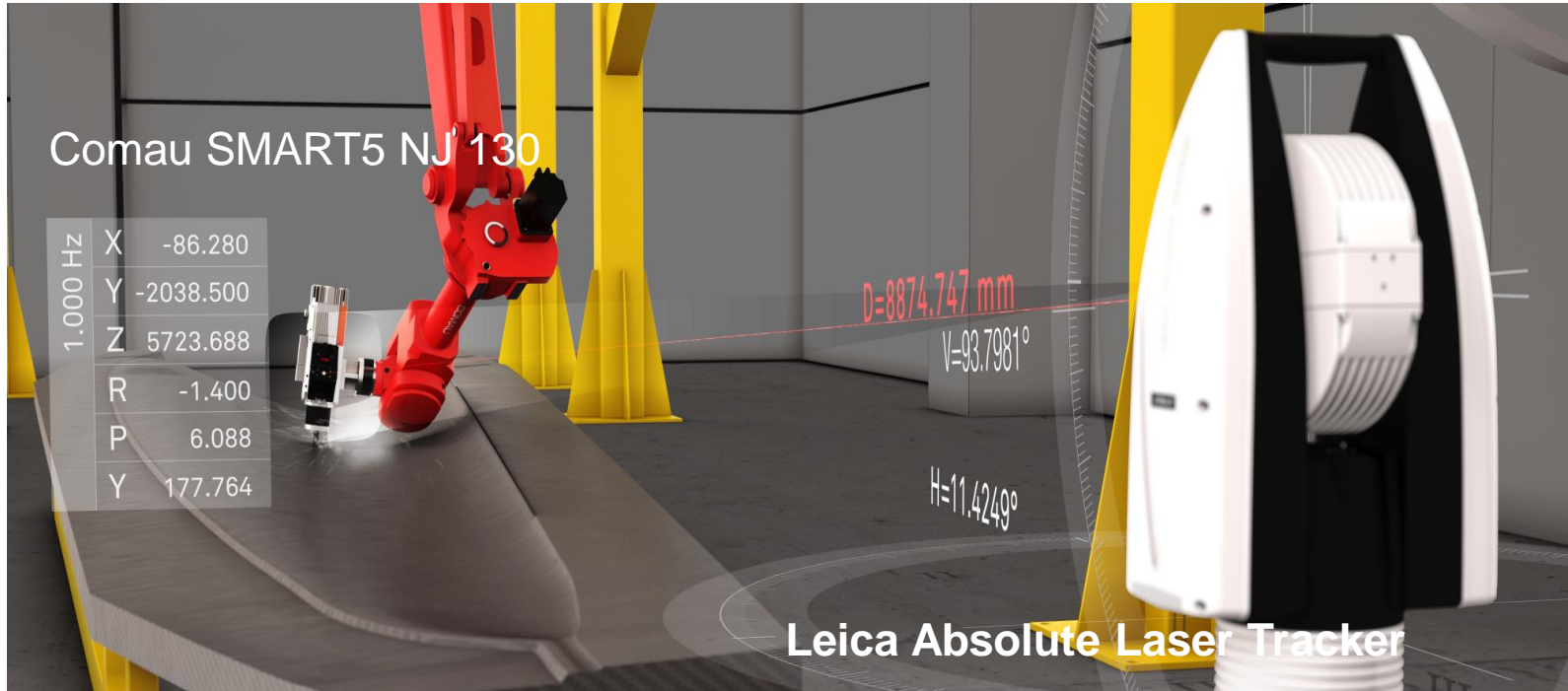
Integrated 7DoF machine control




Results



Main Elements – Machine, Laser Tracker & T-Mac



A photograph of a white industrial robot arm, the AT960, mounted on a black base. The robot is positioned in a factory setting with a white wall and a window in the background. The image is framed by a large, stylized teal geometric shape that resembles a large triangle or a stylized 'A' on the left side of the page.

Result – New Product

AT960 – 7 DoF

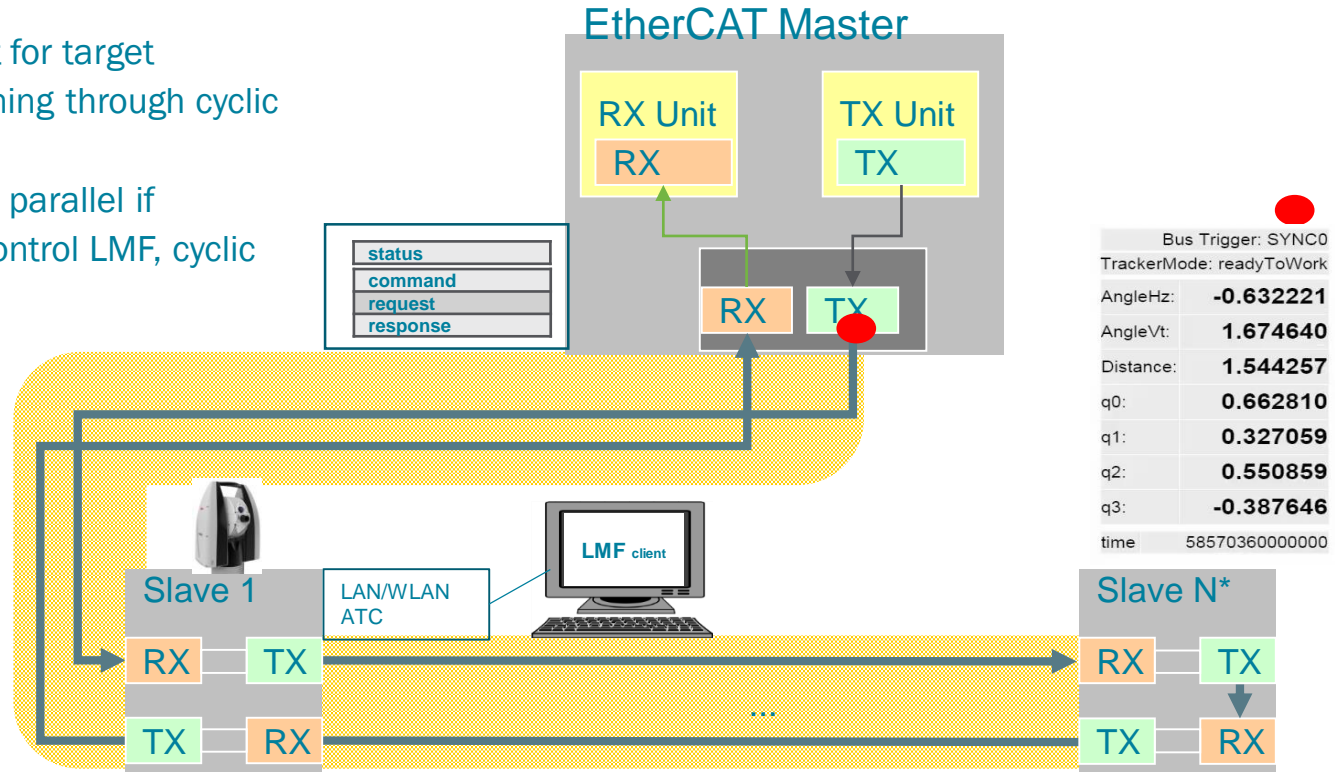
7DoF - RTFP Industrial Ethernet – Key features



- Flexible: Implemented as EtherCAT Slave, (Masters can be implemented as a software solution on any Ethernet MAC*)
- Cyclic 7DoF measurement Data and states up to 1kHz
- Command interface over EtherCAT (LMF control in parallel)
- Several Triggering options (free running, Sync0, external), EtherCAT Distributed Clock support
- Tracker Pilot page for settings and configuration
- Simple wiring and set-up

Cyclic data - Command interface

- Basic command set for target selection or positioning through cyclic data
- LMF can be used in parallel if required (Tracker Control LMF, cyclic data RTFP)



Possible application sectors



Aircraft industry



Renewable energy



Transportation





Questions?