

# optical metrology.

SURFACE INSPECTION  
IMAGE ANALYSIS SOFTWARE  
2D AND 3D MEASUREMENTS  
ACCURATE ALIGNMENT



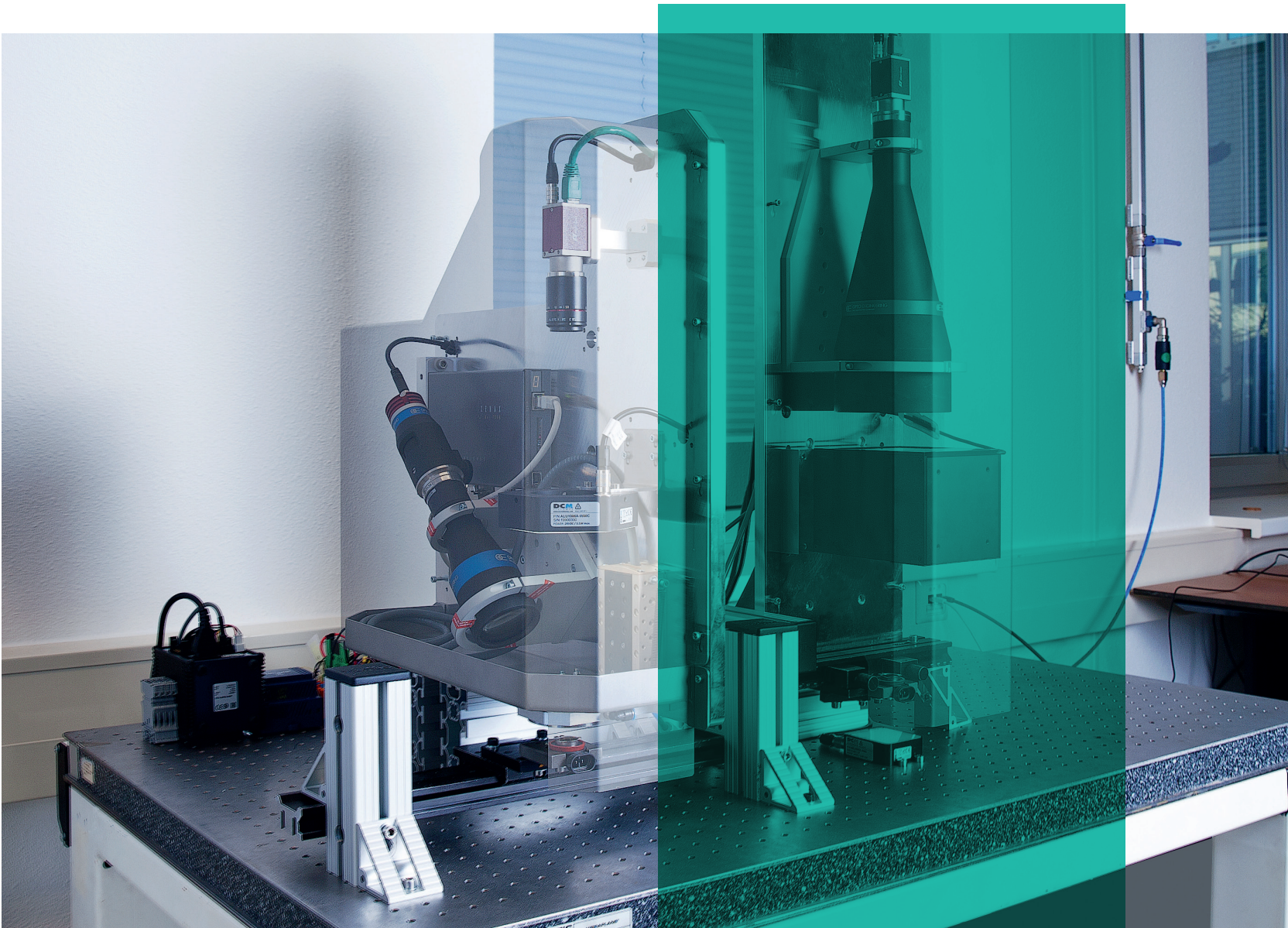
FOCAL

## SURFACE INSPECTION

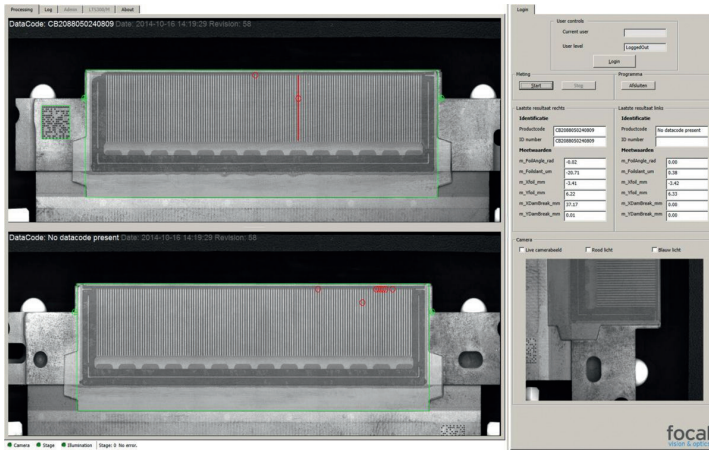
Our task was to automate the entire inspection of light bulb sockets within a cycle time of just under one second. The new vision system had to be able to carry out twenty control measurements; it had to check whether the spring was in place, the type of wing ring, the flatness of the wings, whether there were any burrs on the wing ring, if the rubber ring was contaminated/damaged, etc.

The new system is fitted with two cameras which take up to five shots. We built a system that comprises standard components such as cameras, optics and pattern projector, and designed the custom mirror and the system's mechanical suspension.

Developing the software that included system control, image processing and the user interface proved to be the biggest challenge. The system analyses five images per second to decide whether a part is approved or rejected. The vision system was programmed, using the Halcon library for image processing, so it could reach the necessary speed as well as high levels of reliability. According to the principles of six sigma, the number of erroneous ratings may not be greater than thirty PPM.



# INSPECTION



Wafer inspection and chip inspection require bespoke image hardware and analysis methods. Demcon Focal is specialized in designing the bespoke inspection hardware and accompanying data analysis software, including deep learning and neural network combinations for recognition purposes.

We have developed our own generic software platform, which can interface with most camera brands and protocols and can be connected to a variety of PLC systems. The platform handles the complex vision algorithms that are tailored to the customers' needs. The platform allows logging of images, data and events in various format. Overall this platform reduced the image software development time drastically.

# IMAGE ANALYSIS SOFTWARE

For the Royal Dutch Mint we developed, build and installed a machine for high speed automatic surface inspection of coins. We developed a complex, model-based vision algorithm, which could be trained using the system itself. Ultimately, the system was able to detect a wide variety of stains in real time and to make a judgment - approval or rejection - with 100% reliability.

Demcon Focal is specialized in designing data analysis software, including deep learning and neural network combinations for recognition purposes.

We are specialized in pre-trained deep learning networks for automated feature extractions including a two-step network layer which the customer can create and train themselves, without having knowledge of deep learning or neural networks. We also offer the generation of synthetic data that can be used to train the neural network. This will reduce the NRE inspection module cost drastically when introducing new designs.



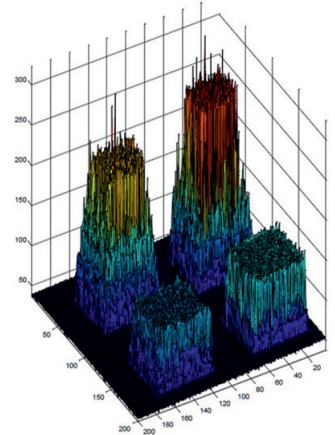
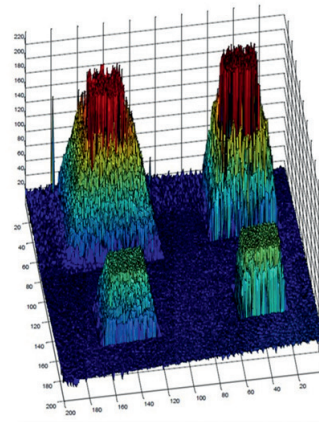
## 2D AND 3D MEASUREMENTS

Metrology system: in-line depth measurement

Within the H2020 project ADALAM, a novel depth sensor was successfully integrated into a laser micromachining system. This new sensor allows the machine to get feedback on the actual machined depth, which is used to automatically adapt the micromachining process.

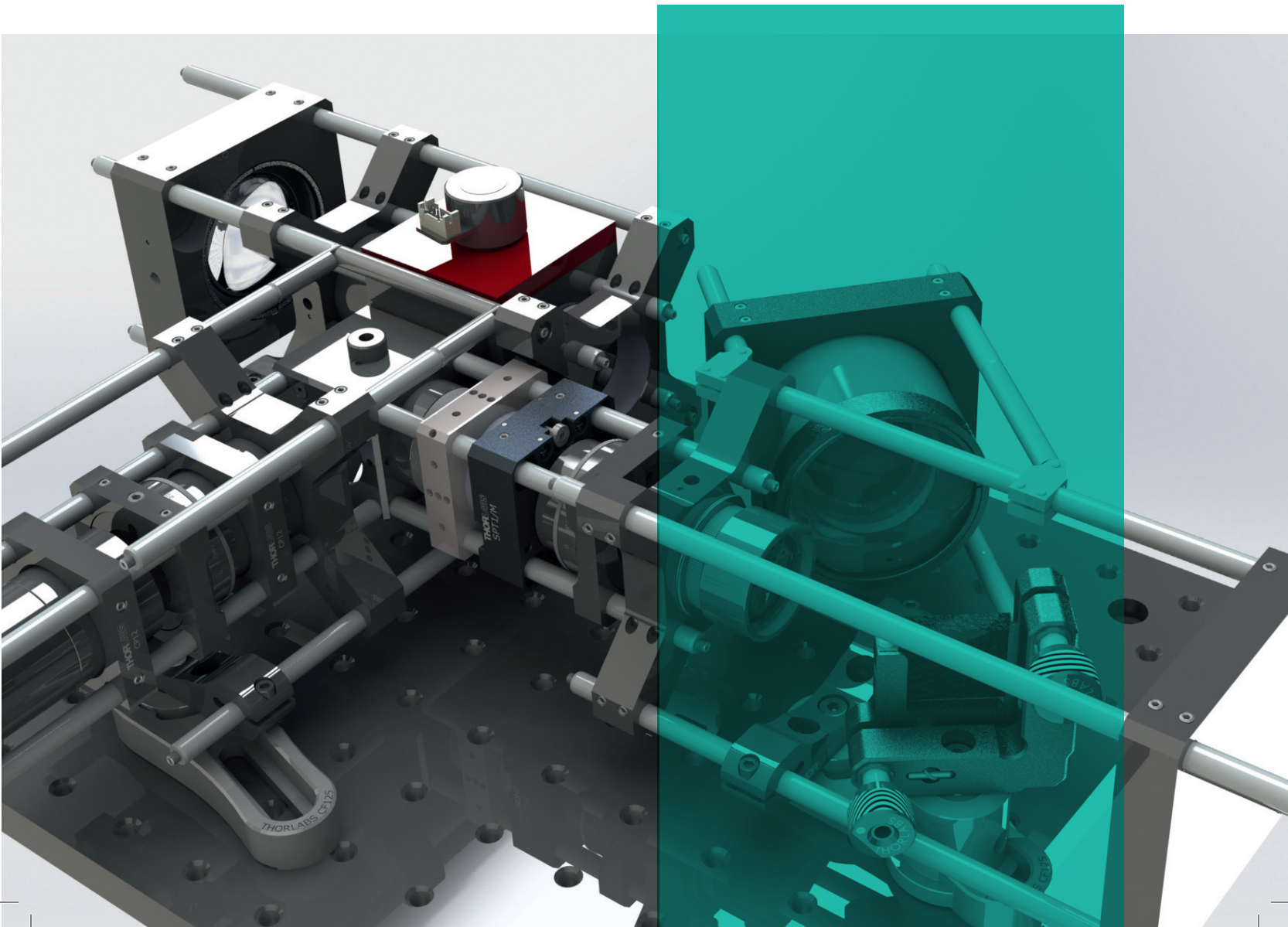
Typical specifications that have been achieved:

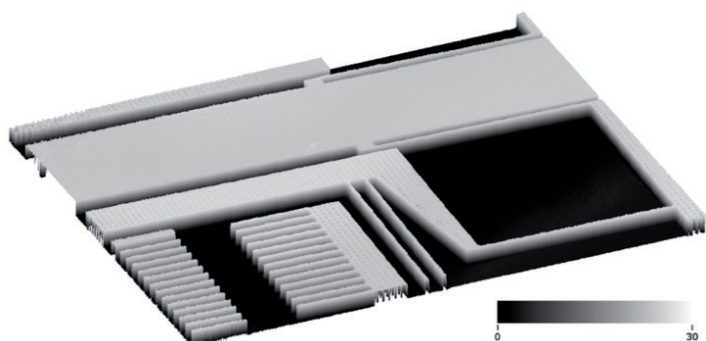
- The measurement reproducibility is  $\pm 1.5 \mu\text{m}$ ,
- The measurement range is  $900 \mu\text{m}$ .
- The exposure time at the darkest spot is near  $1 \text{ ms}$



European  
Commission

Horizon 2020  
European Union funding  
for Research & Innovation





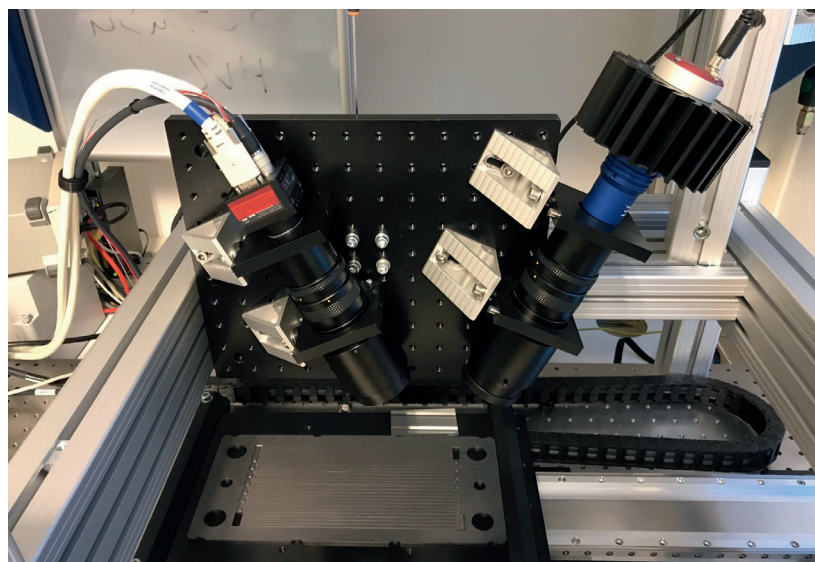
### Metrology system: Surface measurements

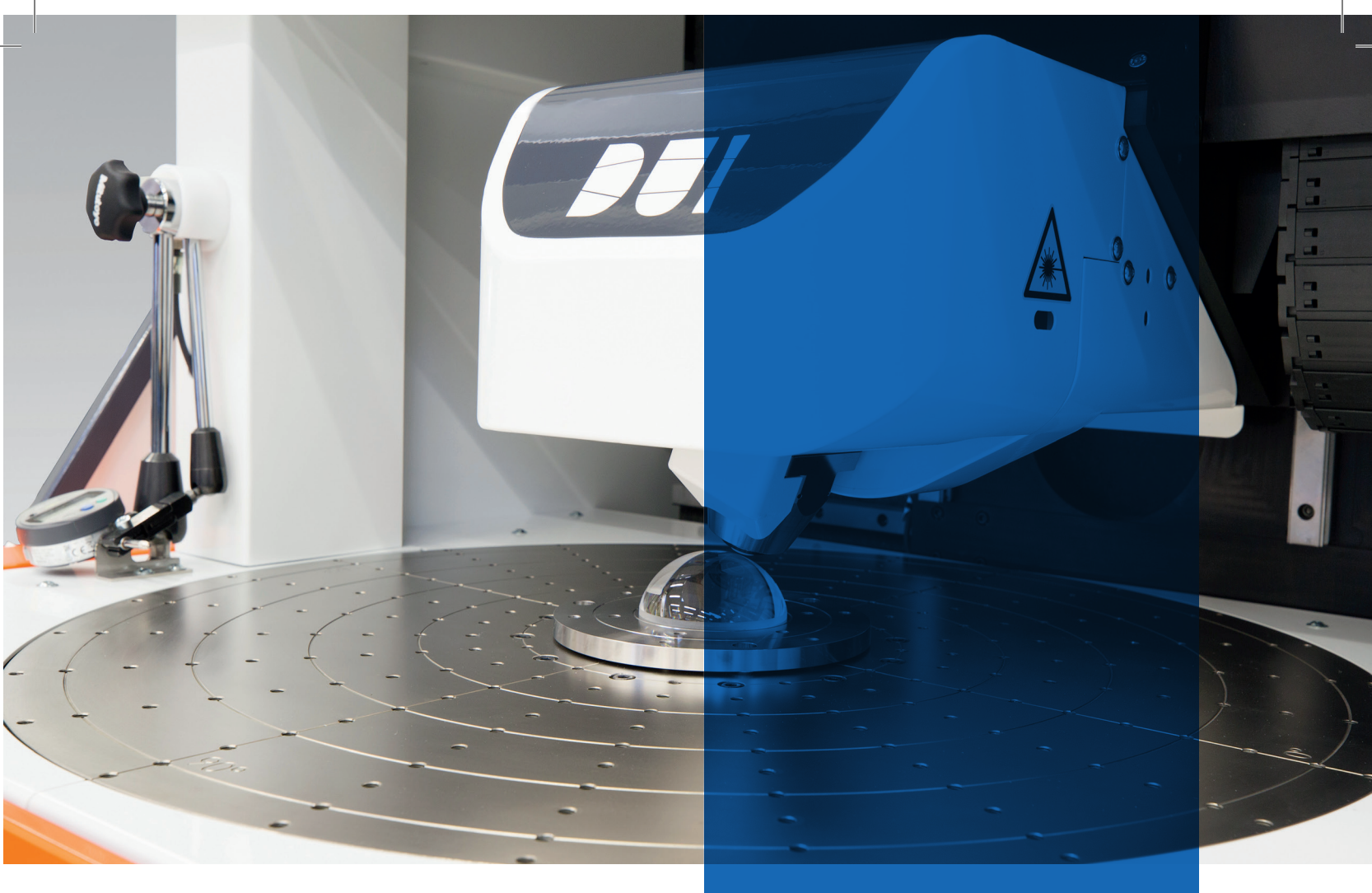
For surface measurements in sub-mm and sub- $\mu$  range for complex shape inspection tasks in industrial environment and medical domain, Demcon realized different interferometry layouts such as Michelson, Mach-Zehnder and Linnik. This technology is suitable for, can be used for, height profile of MEMS chip structures, fiber facet quality inspection and full field OCT measurements.

### Metrology system: triangulation based topography measurement of PEM bipolar plate

Fuel cells are a promising technology for alternative energy supply of mobile and stationary applications. Because of their high system complexity, small changes in materials, manufacturing processes or assembly can lead to significant changes in performance and lifetime. Hence, the need for accurate quality control concepts is of high importance for securing reliable products and for cost effective production of high-end products. Demcon Focal has developed within an Interreg-Rocket project a cost effective bipolar plate inspection system for PEM based plates, to allow 100% in-line inspection. We combine our optics and vision know-how to optimize the triangulation measurement method for these low reflective surfaces. Typical specifications that have been achieved are:

- 100% inspection of bipolar plate:
  - Thickness
  - Warpage
  - Dimensions
- Inspection time: 30 seconds
- Repeatability: 1  $\mu$ m
- Accuracy: 5  $\mu$ m
- Surface: 20x25 cm<sup>2</sup>
- Range: 5 mm





## NMF-PLATFORM – FREEFORM OPTICS MEASUREMENTS

Manufacturing of freeform optical lenses and mirrors cannot be done without a proper measurement system. The Nanomefos design has, due to an ingenious mechatronic design, a state-of-the-art solution for measuring freeform optics. It is a contactless and high-speed metrology system with interferometer accuracy and with coordinate measuring machine versatility.

Demcon, a specialist in all relevant disciplines, like metrology, optics, mechatronics and data analysis, has modernized and industrialized the Nanomefos, resulting into the NMF600 S.

In a relative short time a redesign of the TNO prototype has been made, including the software. The focus was on the costprice, reliability, design-for-manufacturing and user convenience.

Typical specifications that have been achieved:

- Accuracy < 15 nm
- Volume Ø 600 mm x 125 mm
- Flat to freeform
- Convex to concave
- Probe with 5 mm range
- Acceptance angle of 7°

## HIGH PRECISION (SUB- $\mu\text{m}$ ) MEASUREMENTS

Accurate pre-alignment of wafers is key for each individual processing step. Contactless wafer edge measurement requires a dedicated vision system. Demcon Focal has developed an image based measurement system that is capable of detecting statically and dynamically the edge of the wafer with respect to the gripper and wafer marker. Using custom optical design we were able to image the gripper marker, the wafer marker and the wafer edge into one image.

This resulted into sub-micron accuracy in all three dimensions with extended depth of focus and a flat field. One of the key enablers for such performance is the use of custom optical and opto-mechanical designs for imaging and through-the-lens illumination in combination with vision algorithms.

- Up to 6mm out-of-focus, precision  $XY < 1\mu\text{m}$
- Up to 12mm out of focus, precision  $XY < 2\mu\text{m}$
- 24mm field-of-view with TTL illumination



## imagine tomorrow. challenge today.

Demcon Focal is part of the international Demcon group and is specialized in design, engineering and assembly of bespoke opto-mechatronic (sub-) systems, for high technological markets like semicon, bio-medical, life science, aerospace, industrial manufacturing and others. Often these systems are used in applications where accuracy, stability and rapid movement or exploitation in extreme environments is required.

Demcon Focal achieves customized design and engineering in a multidisciplinary approach, entailing optical, vision, data, electronic, software, mechanical and system engineering. Activities include high-level requirement engineering, concept optical design, prototyping, detailed engineering, system integration, manufacturing and testing activities.

Demcon Focal also performs specialized volume production that requires trained engineers, dedicated equipment and clean environment. We can offer system service and support and have production facilities available for complex optical modules.

Institutenweg 25  
7521 PH Enschede  
The Netherlands

Kanaaldijk 29  
5683 CR Best  
The Netherlands

Delftechpark 23  
2628 XJ Delft  
The Netherlands

Blauwborgje 31  
9747 AC Groningen  
The Netherlands

Wilhelm-Schickard-Straße 6  
48149 Münster  
Germany

25 International Business Park  
#03-60A Singapore 609916

[www.demcon.com](http://www.demcon.com)  
[www.demcon.com/focal](http://www.demcon.com/focal)



FOCAL