



# Ultra High Precision Components for semiconductor equipment

● Miniaturized Sensors

● 6-Axis Nanopositioning

● Stage Displacement Measurement

# Where Precision Matters

maximum accuracy for semiconductor equipment

Semiconductor manufacturers face the challenge to produce ever more efficient and dense chips. All involved steps - from production to quality assurance - share one precondition: to ensure highest precision and reliability to maximize the quality output.

Involved devices need to be compatible with extreme conditions such as clean room environments, elevated operating temperatures, or vacuum conditions. attocube's high precision components meet these demands and offer cutting-edge technology for semiconductor applications.

## Lithography Process

- Ultraprecise Position Tracking
- Dynamic Motion Control
- Beam Aperture & Filter Positioning

## Metrology & Inspection

- Laser Beam Adjustment
- Planarity Detection
- Beam Aperture & Filter Positioning

# Motion & Sensing

ultra-precise devices for semiconductor applications

attocube offers ultra precise nanopositioning and interferometric measurement devices, which are compatible with extreme environmental conditions such as high vacuum, clean room environments or elevated operating temperatures.

Years of experience and a dedicated application team guarantees highest levels of consulting competence, a comprehensive on-site installation service and excellent after-sales support for standard products as well as customized OEM solutions.

## Interferometer



- vacuum compatibility down to  $1 \times 10^{-10}$  mbar
- max. operating temperature 150°C
- 0.01 Å resolution
- working distance up to 5 m

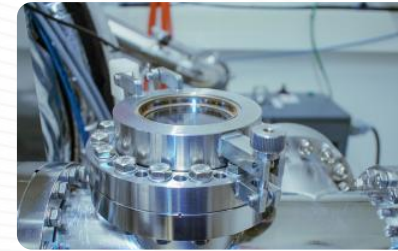
## Nanopositioners



- vacuum compatibility down to  $5 \times 10^{-11}$  mbar
- max. operating temperature 100°C
- motion with nanometer accuracy
- modular positioning system up to 6D

# Services & Certifications

your reliable OEM partner



## Testing Facilities & Quality Assurance

For more than 15 years attocube designs components for extreme environments. Our quality assurance is equipped with test stations for low temperature, ultra-high vacuum and ambient conditions.



## Traceability of Sensing & Motion Components

Thanks to our sensor technology that is traceable to the NIST and to the PTB, we offer systems for Motion & Sensing that are calibrated to international metrology standards.



## Application Development & Expert Support Team

attocube's application team consists of experts with a vast engineering background who help our customers in selecting and integrating motion and sensing components into their systems.



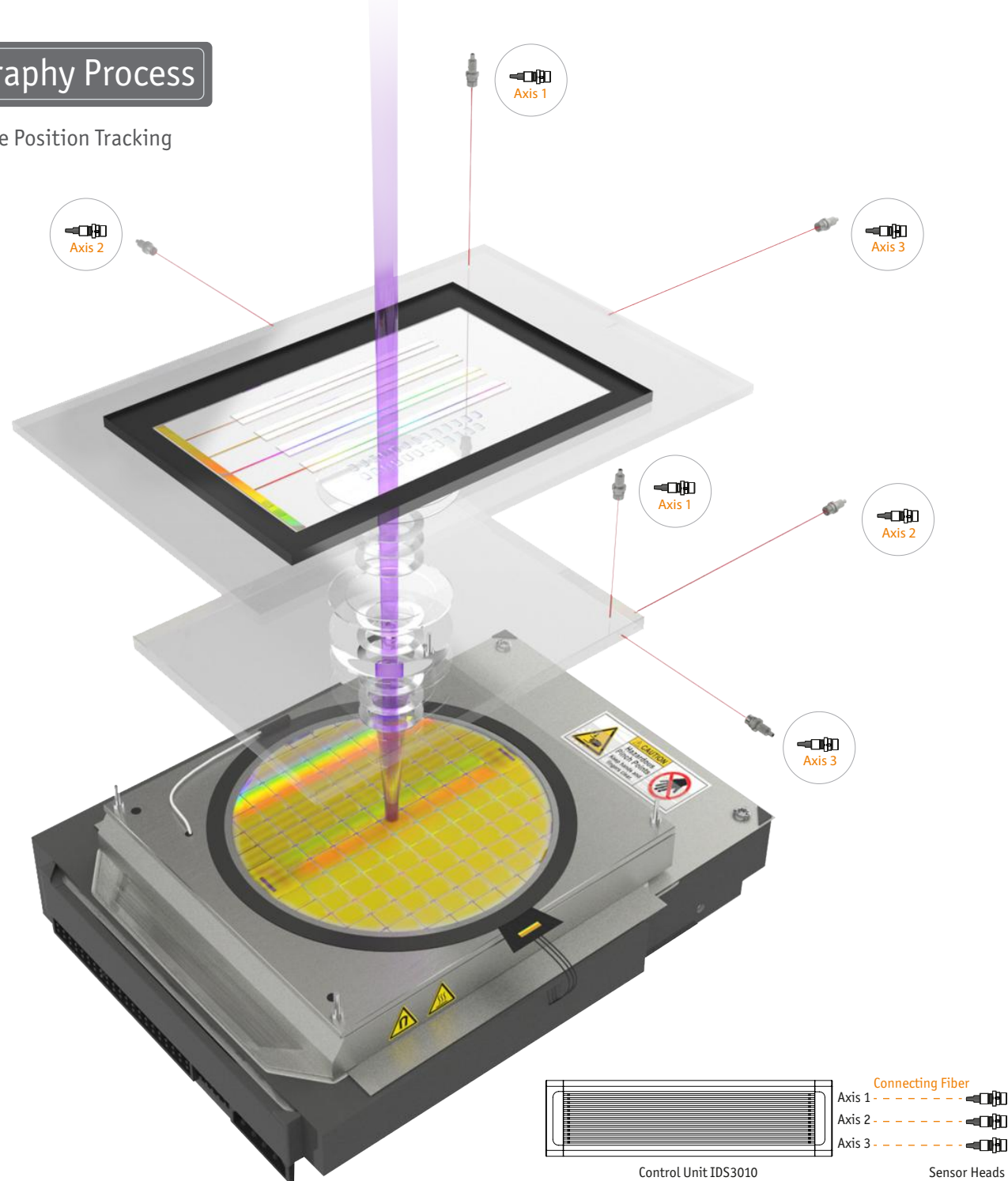
## Lean Production Made in Germany

The complete supply chain is directed towards the lean production organization that enables short delivery times, flexibility and high quality for the production of customized systems as well as high quantities.



# Lithography Process

- Ultraprecise Position Tracking



# Ultraprecise Position Tracking

- Application/Challenge:

During the photolithography process circuit patterns of few nanometers in size are transferred from the photomask (reticle) via various lenses onto the semiconductor wafer. After the photomask pattern is projected to one part of the wafer, the wafer stage is moved and the lithography process is repeated until the whole wafer is covered with the respective patterns.

The ultraprecise position tracking and alignment of measurement frame, optics and wafer stage is key condition to ensure highest quality throughout the lithography process. All components used in this process need to meet the requirements of clean room conditions and - depending on the technology - be capable to perform under vacuum and high temperature environments.

- attocube's Solution:

attocube's laser interferometer IDS3010 with vacuum and high temperature compatible sensor heads can be easily integrated into lithography machines, ensuring the best alignment among the key components with nanometer accuracy, delivering high speed data with up to 10 MHz bandwidth.

- Product:

Displacement Sensor IDS3010



- 10 MHz bandwidth
- 2 m/s target velocity
- real-time

Sensor Heads

- vacuum compatible
- pluggable
- compatible with different targets



# Dynamic Motion Control

## • Challenge:

Reticle and wafer stages need to perform long stroke movements of up to several meters that are both fast and precise. Any measurement device for motion control has to be an order of magnitude more precise and fast than the process itself.

## • attocube's Solution:

attocube's laser interferometer IDS3010 enables metrology tools to achieve the required precision at nanometer range over long distances up to 5 meters with a target velocity of up to 2 m/s.

## • Product:

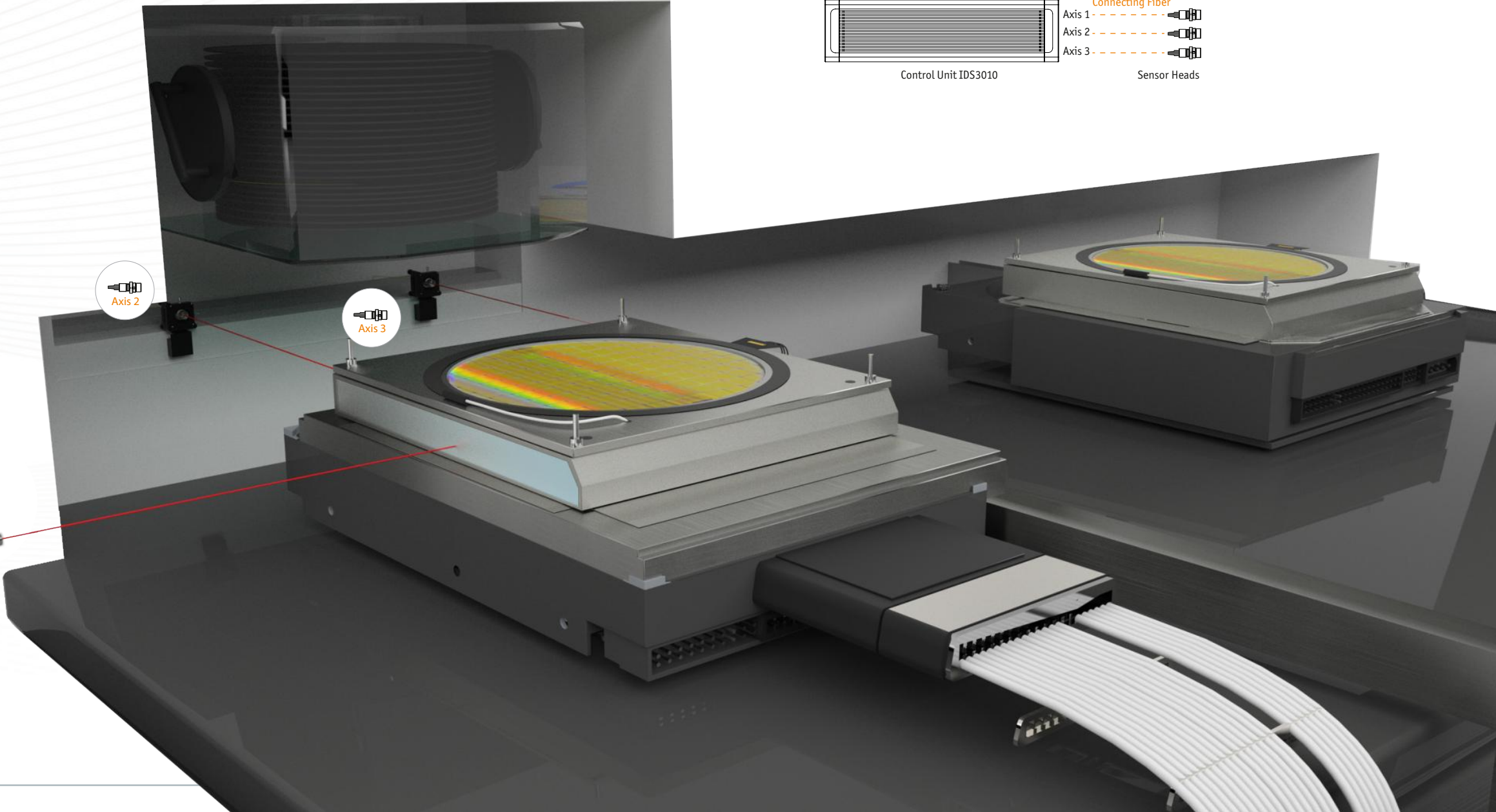
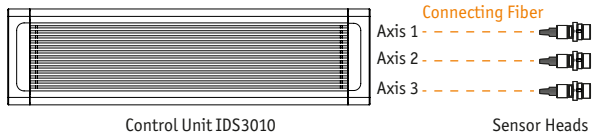
Displacement Sensor IDS3010



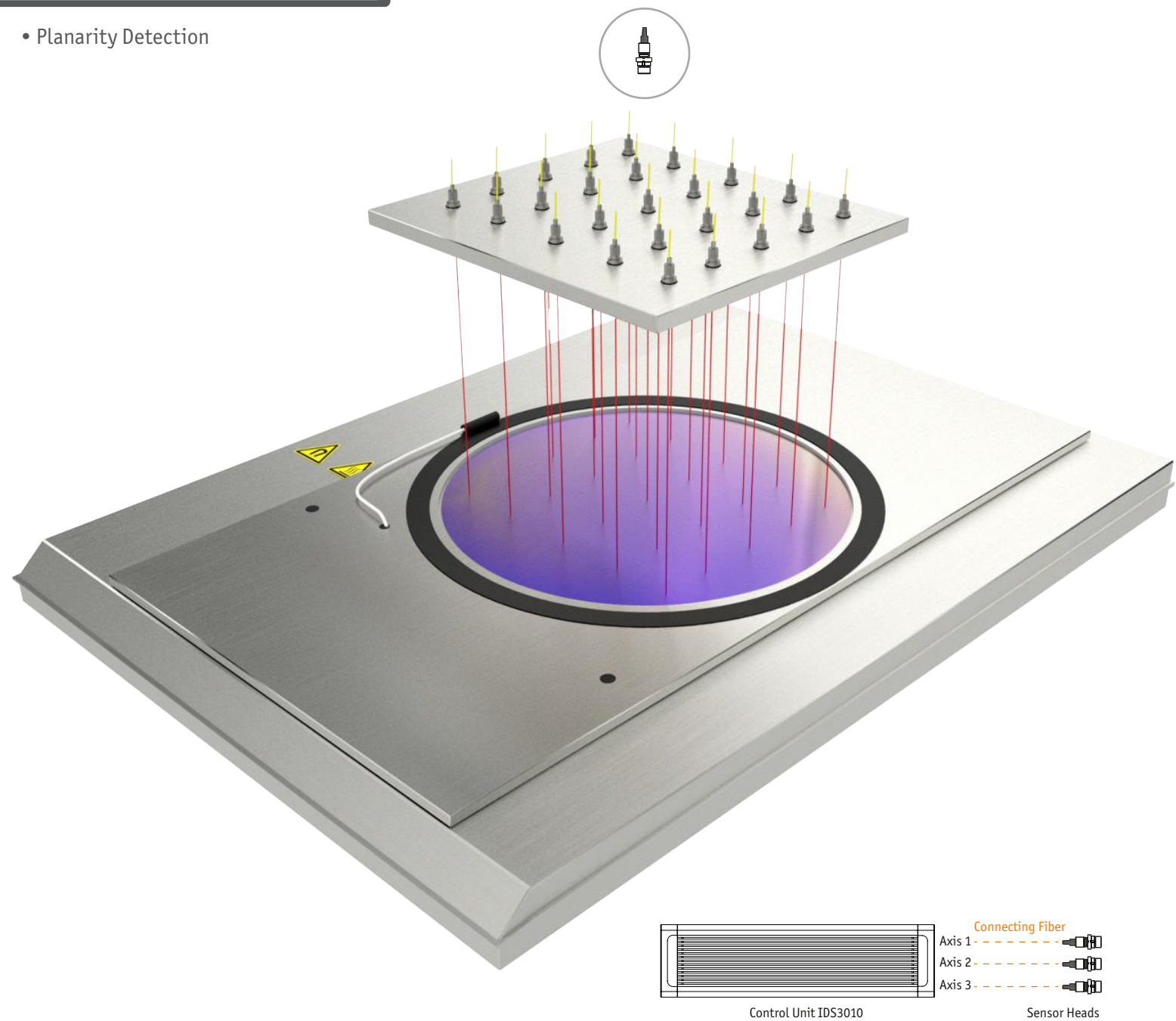
- long distance
- miniaturized sensor heads (1.2 mm)
- application specific design

Sensor Heads

- travel ranges up to 5 m
- 2 m/s target velocity
- low electric noise level







# Planarity Detection

## • Challenge:

During the lithography and metrology processes the wafer is exposed to extreme environments, fast motions and multi-dimensional forces. These could cause elastic or plastic deformation of the wafer which influences the wafers planarity. Uneven wafers reduce the accuracy of lithography processes and distract results of metrology analyses. For example the movement of wafer stages working with

magnetic levitation deforms in direction perpendicular to the flat surface of the plate. The operating status of the wafer stage motor influences the level of deformation. To optimize the operation mode of wafer stages and therefore reduce the wafer deformation during lithography process, a nano-precise and contactless detection of wafer deformation is required.

## • attocube's Solution:

attocube's laser interferometer IDS3010 is capable of measuring directly on the wafer or on mirrors to capture deformations in nanometer range. The miniaturized design of the sensor heads allows to measure the deformation at several places on the same wafer to detect more-dimensional deformations. It can be used under extreme environmental conditions such as vacuum or other harsh environments.

## • Product:

### Displacement Sensor IDS3010



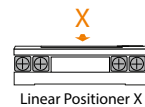
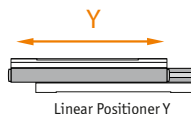
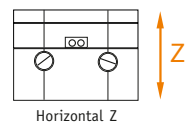
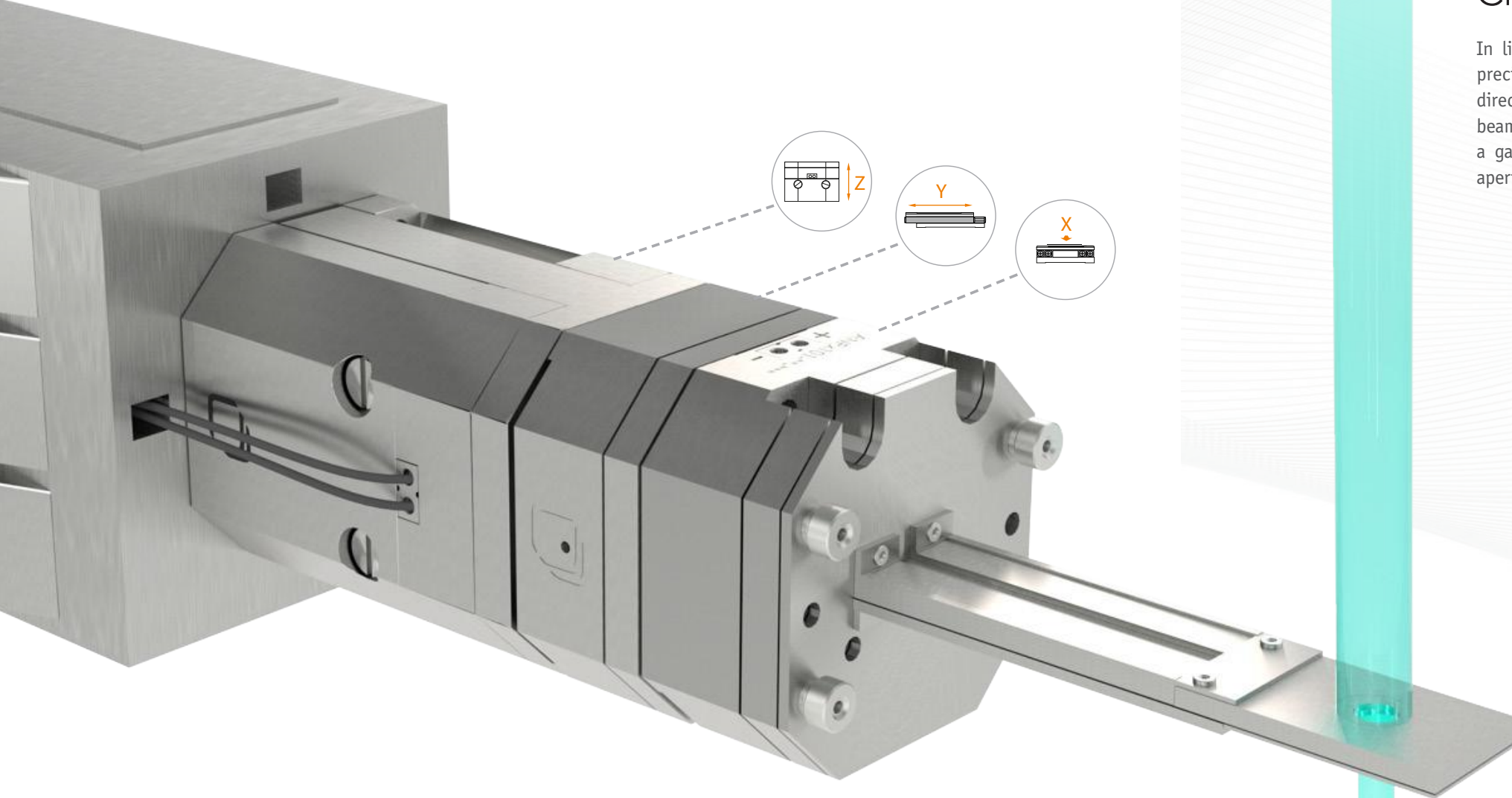
• Certified accuracy in nanometer range

### Sensor Heads

- vacuum compatible
- pluggable
- Compatible to different surfaces (wafers, mirrors, polished metal...)



- Accurate Beam Aperture & Filter Positioning



# Beam Aperture & Filter Positioning

## • Challenge:

In lithography and metrology processes, the precise alignment and filtering of the beam is directly related to the wafer's quality. The laser beam produces photons that are collected via a gathering mirror and directed via different apertures to hit, e.g. the reflection mask.

## • attocube's Solution:

attocube's nanopositioners are designed to operate with low particle generation at high temperatures and vacuum with nanometer precision. These features make them the perfect choice for reliable aperture control under extreme conditions.

## • Product:

### Nanopositioners

- nanometer precision
- UHV compatibility up to  $5e^{-11}$  mbar
- coarse & fine movement





# Laser Beam Adjustment

## • Challenge:

During the metrology process in the wafers production the light or laser beam path have to be precisely and continuously adjusted to perform the relevant controls over the whole wafer surface in order to detect imperfections and provide certain results on the wafer's quality. There are different kind of inspections: Un-patterned wafer inspection where the goal is to identify particles and pattern defects and link

those to a specify position on the wafer. Patterned wafer inspection which identifies geometry imperfections via the comparison with a "golden" dye and lastly the reticle inspection which helps to identify single defects on a wafer reticle. This last inspection is usually performed by using UV illumination.

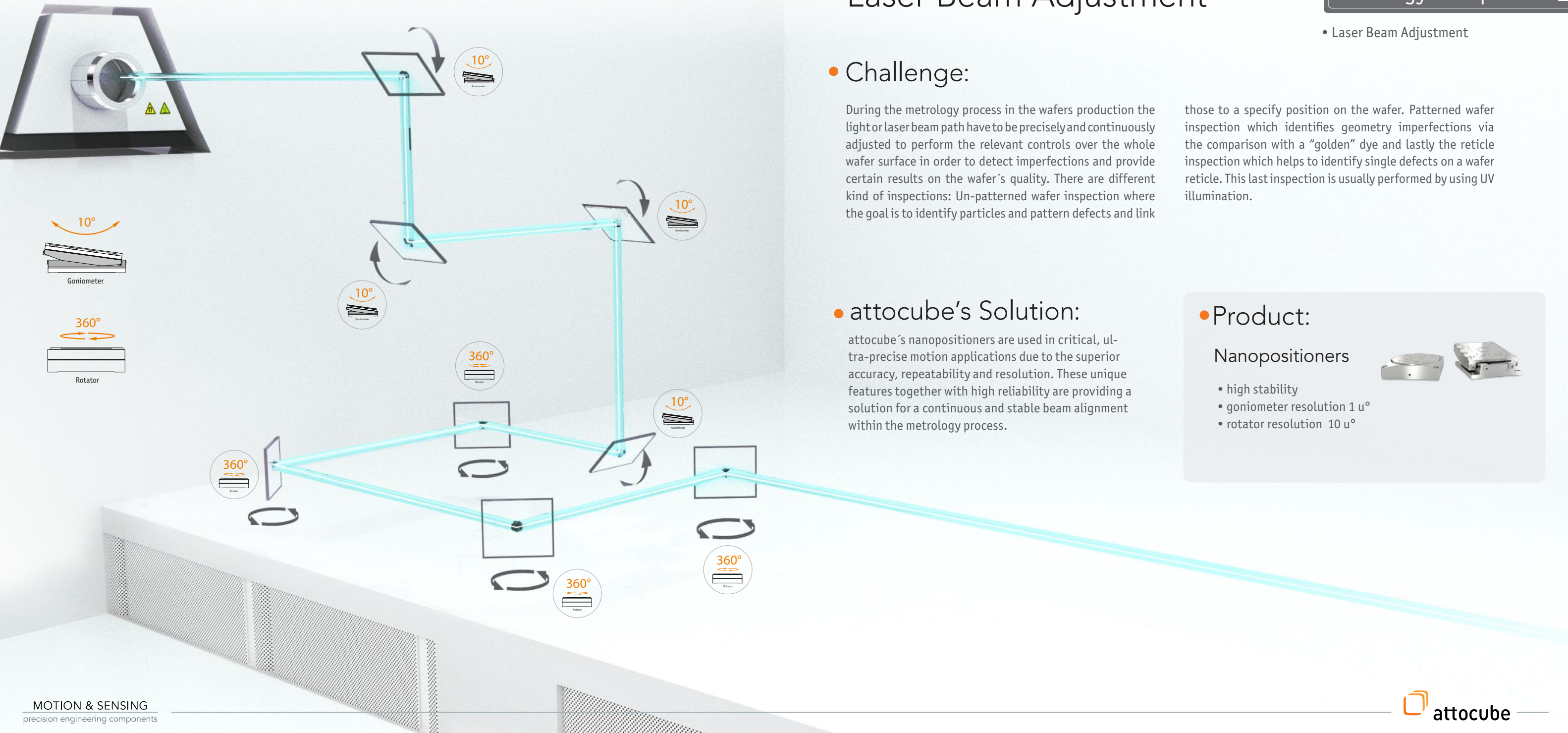
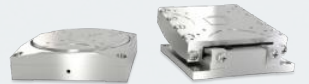
## • attocube's Solution:

attocube's nanopositioners are used in critical, ultra-precise motion applications due to the superior accuracy, repeatability and resolution. These unique features together with high reliability are providing a solution for a continuous and stable beam alignment within the metrology process.

## • Product:

### Nanopositioners

- high stability
- goniometer resolution 1  $\mu^\circ$
- rotator resolution 10  $\mu^\circ$





# Displacement Measuring Interferometer

## ultra-precise sensor for semiconductor applications

The continuous increase of ultra precise motion control in the semiconductor equipment makes the IDS3010 (Interferometric Displacement Sensor) the perfect choice for industrial manufacturers in the industry. attocube's laser interferometer provides miniaturized sensor heads, suitable

for harsh environment with extreme accuracy and resolution down to pico-meter level. This is the outstanding combination for easy integration within semiconductor machines thanks to a broad spectrum of digital and analog real-time interfaces and protocols to deliver simple transmission of position data.



Control Unit IDS3010

### Fast, precise & powerful

- data capturing rate of 10 MHz
- measurements with target velocities of up to 2 m/s
- working distances up to 5 m
- 1 pm resolution

### Compact & robust sensor heads

- smallest diameter 1.2 mm
- pluggable or clamped
- vacuum compatibility up to  $5e^{-11}$  mbar
- temperatures up to 150°C

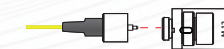


Sensor Heads



#### Mounting

- cylinder or metric thread from 1.2 mm diameter to M15.5 x0.5 metric thread



#### Fiber connection

- clamped on fiber or pluggable FC/PC



#### Optics type

- focusing, divergent or collimating



#### Customization

- dedicated focal length

### Adaptable modules & components

#### Options for accessing the IDS via computer

- Measurement Software WAVE
- Webserver
- DLLs (C, C#, Labview, Matlab)



#### Realtime output-signals:

- Sin/cos
- HSSL
- Linear analog
- AquadB
- BiSS-C



# Ultraprecise Nanopositioners

piezo based nanopositioners for ultra clean environment



Due to the need of highest accuracy in the semiconductor market, attocube combines its superior precision positioning technology with unrivaled compact and low-particle generating design to fit in any high complex system.

Moreover attocube's nanopositioners offer flexible stacking for motion with multiple degrees of freedom suitable for a wide range of extreme environments.

## Extreme Environments

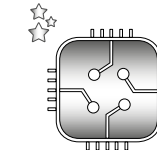
attocube's nano drives meet the challenge of precise positioning systems, reliably working under extreme environmental conditions. Suitable models are available for high temperature, high and ultra high vacuum.

Every positioner is tested in it's mentioned environment to ensure reliable functionality in any critical situation.



### UHV Pressure

- down to  $5 \times 10^{-11}$  mbar



### Clean Room

- low particle generation



### High Temperature

- up to 100°C

## Compact, precise, & powerful

attocube's positioners employ a powerful and precise nano drive in a compact frame for easy integration into customer setups.



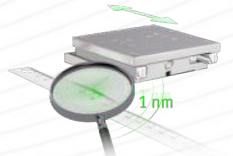
### Footprint

- from 15 x 15 mm<sup>2</sup>



### Dynamic Force

- up to 8 N



### Resolution

- down to 1 nm

## Flexible positioning

attocube's positioners can be stacked to multi-axis devices with up to 6 degrees of freedom.



### Rotation



### Goniometer



### Linear Positioner



(c) 2019, attocube systems AG - Germany. attocube systems and the logo are trademarks of attocube systems AG. Registered and/or otherwise protected in various countries where attocube systems products are sold or distributed. Other brands and names are the property of their respective owners.

attocube systems AG | Eglfinger Weg 2 | 85540 Haar | Germany  
Tel.: +49 89 420 797 - 0 | [info@attocube.com](mailto:info@attocube.com)  
[www.attocube.com](http://www.attocube.com)