

Wafer Positioning for Inspection and Metrology

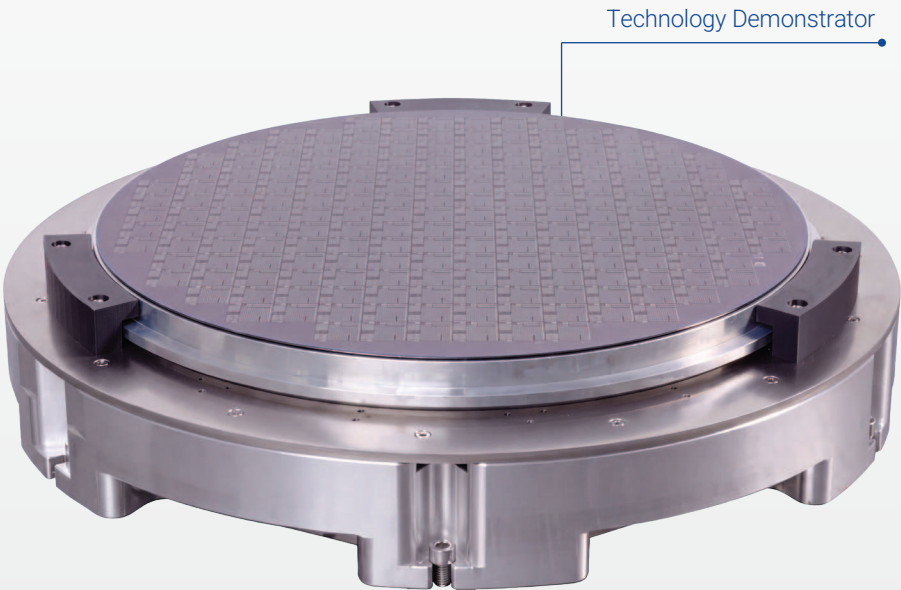


Ultraprecise Theta Positioning for Error-Critical Applications

In ultraprecise theta positioning, axial, radial, and angular error motion can directly affect measurement accuracy. Maintaining the rotor position and plane during continuous rotation is therefore critical for precise and repeatable inspection and metrology. Magnetic levitation enables active control of these degrees of freedom throughout unlimited theta travel, while allowing the rotor dynamics to be adapted to the measurement task

Key MagLev Advantages

- ✓ **Active Rotor Plane Control** — Stabilization of axial position and tip/tilt during rotation
- ✓ **Dynamic Error Compensation** — Active correction of radial, axial, and angular errors
- ✓ **Programmable Stiffness and Damping** — Adaptable rotor dynamics for positioning and measurement



Range of Motion	Dynamic Focus Tracking	In-Position Stability	Payload	Active Plane Stability	Velocity
ΘZ : unlimited* X/Y : $\pm 200 \mu m^*$ ΘXY : $\pm 0.25 mrad^*$	Z : $\pm 600 \mu m^*$	Z : $3 nm^*$	$2^* \dots 25 kg$	Axial error: $< 5 nm$ Non repeat: $< 3 nm RMS$ Tilt error: $< 50 nrad^* p-p$	$> 600 rpm^*$

* Asterisked values represent the performance of the demonstrator shown; additional values indicate achievable performance with different system configurations.

Wafer Positioning for Inspection and Metrology

CHALLENGE

Theta Positioning

Advanced wafer inspection and metrology require extremely low axial, radial and angular error motion during continuous rotation.

Rotor Plane and Axis Stability

Axial runout, radial motion, and tilt directly translate into measurement error, particularly as rotational speed and wafer POI radius increase.

Non-Repeatable Error and Disturbance Sensitivity

Asynchronous error motion, structural vibration, and external disturbances can limit achievable measurement.

Throughput and Settling

Increasing rotational speed alone is insufficient. Acceleration, disturbance recovery, and move-and-settle behaviour determine usable process throughput.

Cleanliness and Services Infrastructure

Mechanical bearings introduce wear and lubricants. Air bearings require air infrastructure and introduce pressure-dependent, airflow, and acoustic behaviour.



SOLUTION

Active Rotor Plane Stabilization

The levitated passive rotor can actively control axial position and tip/tilt during rotation, maintaining the process plane rather than relying solely on passive bearing accuracy.

Multi-DOF Error Correction

Independent actuation provides control over radial, axial, and angular parasitic motion while maintaining continuous theta rotation. Repeatable error components can additionally be characterised and compensated electronically.

Active Disturbance Rejection

Corrective forces and moments can be applied in all directions to suppress vibration, rotor imbalance effects, structural excitation, and process-induced forces.

Programmable Rotor Dynamics

Electronic control enables stiffness and damping to be adapted to the operating condition — for example high dynamics during positioning and high stability during measurement.

Contact-Free, Air-Free Rotation

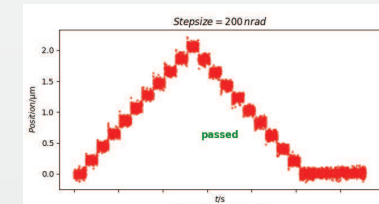
Magnetic levitation eliminates mechanical bearing contact and avoids the compressed air infrastructure. No bearing friction, no lubricant, no bearing wear, and no air-pressure-dependent flying height.



RESULT

The Ultimate Theta Stage

- Precision theta rotation with active control of rotor centre and plane in one contact-free system.
- Reduced dependency on mechanically perfected bearing surfaces and passive spindle accuracy.
- Active correction of axial, radial, and tilt errors can reduce the need for additional compensation mechanisms.
- Programmable stiffness and damping allow the same stage to support both high-dynamic positioning and ultra stable measurement.
- Air-free operation simplifies machine infrastructure and removes pressure-related positioning effects.



Theta Minimum Incremental Motion

Enabling

- **Active control at the process point:** Control focus, height, angular alignment, and fine X/Y positioning during measurement.
- **More measurements per wafer:** Higher inspection coverage without sacrificing throughput while improving precision.
- **Adaptive machine platforms:** Change inspection strategies through software, not stacked mechanics.

LET'S TALK ABOUT YOUR APPLICATION

Discuss your process requirements and the right approach with our experts.

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