



Piezo-Technology & Nanopositioning Overview

Experts for ultra-precise nanopositioning
for semiconductor, microscopy and metrology

About Piezo Nanopositioning

- Introduction - About nanoFAKTUR
- **Piezo Technology** Basics
 - The Making of a Nanopositioning System
- **Applications** and Customized Developments for Semiconductor, Metrology, Photonics and Microscopy
- Summary



About nanoFAKTUR

100+ Years of Experience for piezo positioning systems



Ralf Stamm
Physicist



Klaus Pollak
Mechanical Engineer



Dr. Klaus Müller
Mechanical Engineer



Dr. Cunman Zhang
Electrical Engineer

- Piezo-Technology (Ceramic Material)
- Piezo-Actuators, Lever-Amplification, Flexure Design
- Control-Electronics and Metrology Sensors
- Positioning-Systems

Process Safety

- ISO 9001:2015 Certified

- Fixed processes
- Prescribed standards

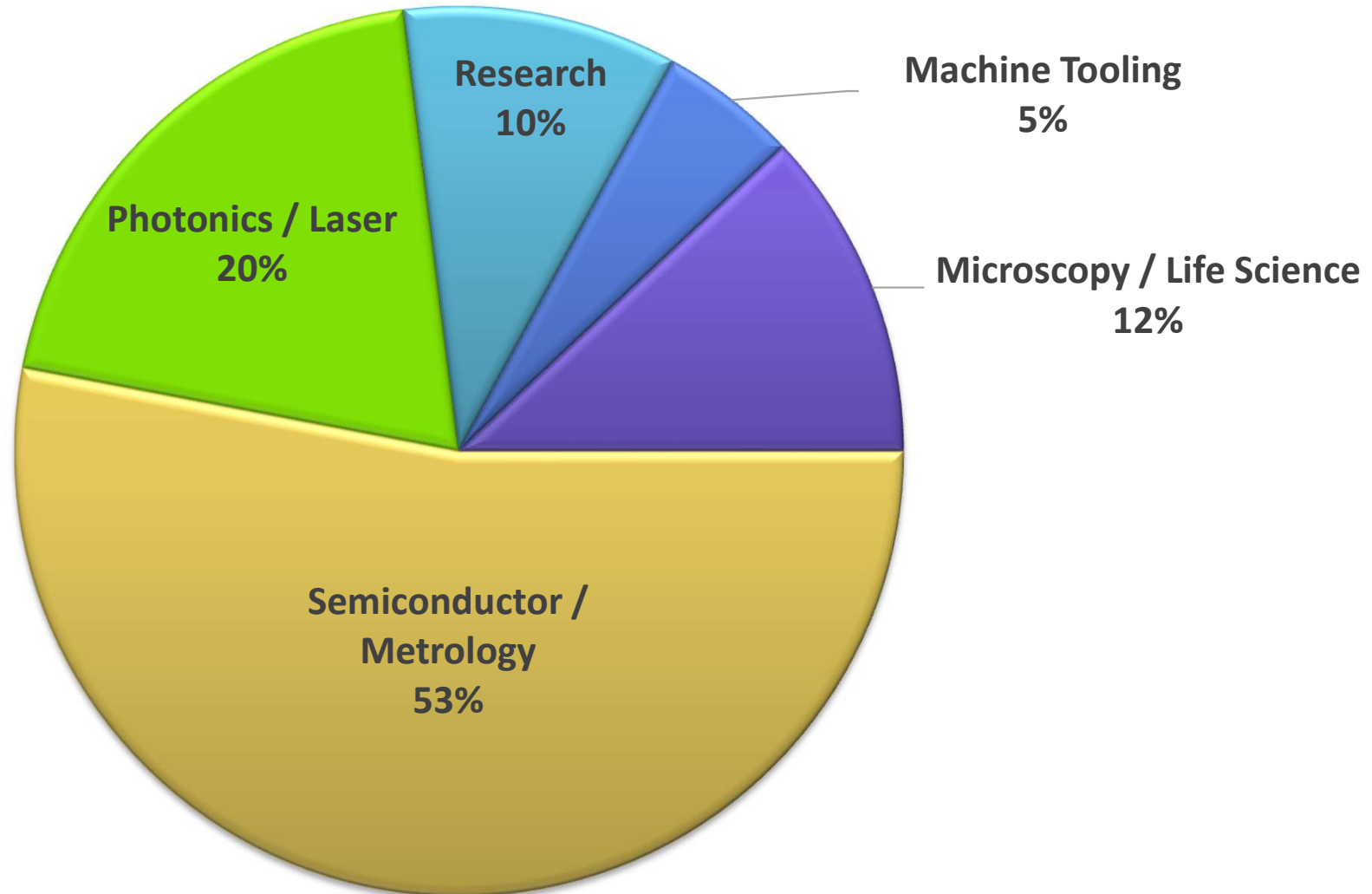


- Global Standard ERP-System



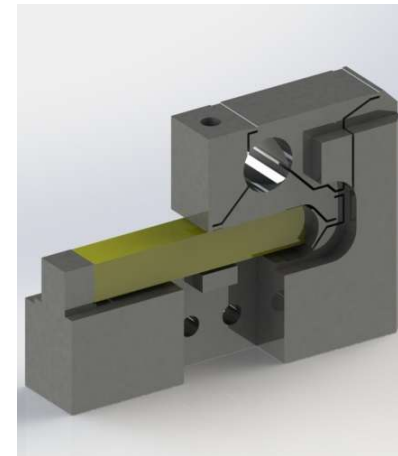
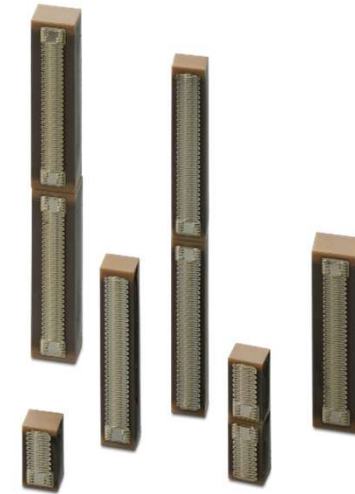
- Frame for all purchasing, parts-lists, material flow
- Organizing sales, orders, deliveries, invoicing
- Project Management

Market-Distribution 2025



Portfolio Overview

- Piezo-Technology
 - Materials and Elements
- Piezo-Actuators
 - Piezo-Stacks
 - Encapsulated Piezo-Stacks with Preload
 - Piezo-Levers



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- Nano-Positioning Stages and Systems
 - Multi-Axis Piezo-Stages, 1D to 6D
 - Integrated Displacement-Sensors
 - Advanced Controls Electronics



Linear Stages, TipTilt-, Focus- Positioners, XYZ Scanners



Piezo Controllers and Drivers



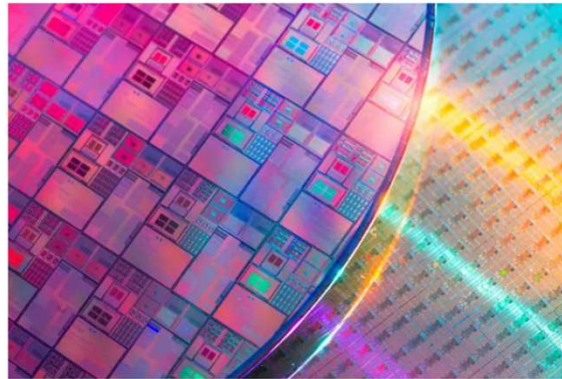
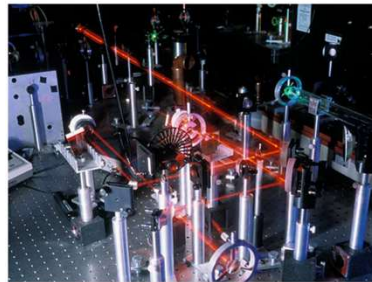
46x56x48,5mm



- Electronics for Piezo open loop or closed loop with SGS, capacitive Sensors or AqB
- **Software and Libraries:**
 - Windows GUI **nFControl**,
 - C# DLL, LabView®, Python®, Linux, EPICs, MicroManager
- **Interfaces and Features:**
 - EtherNET, serial, analog, SPI, (*soon: EtherCAT*)
 - Function generator, Trigger I/Os
 - Dynamic Linearization Algorithm
- Very compact controllers
- OEM customized solutions

Applications

- Photonics (PIC alignment, SiPh Wafer Probing)
- Semiconductor Inspection, Lithography
- Metrology (WLI, AFM)
- Super Resolution Microscopy
- Cell spectroscopy
- Dispensing

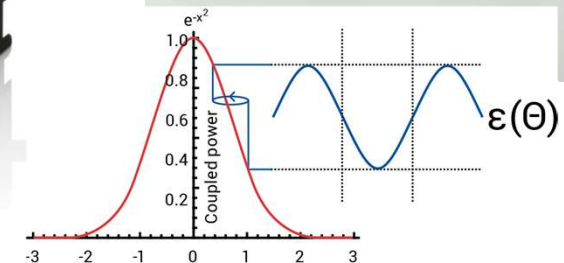
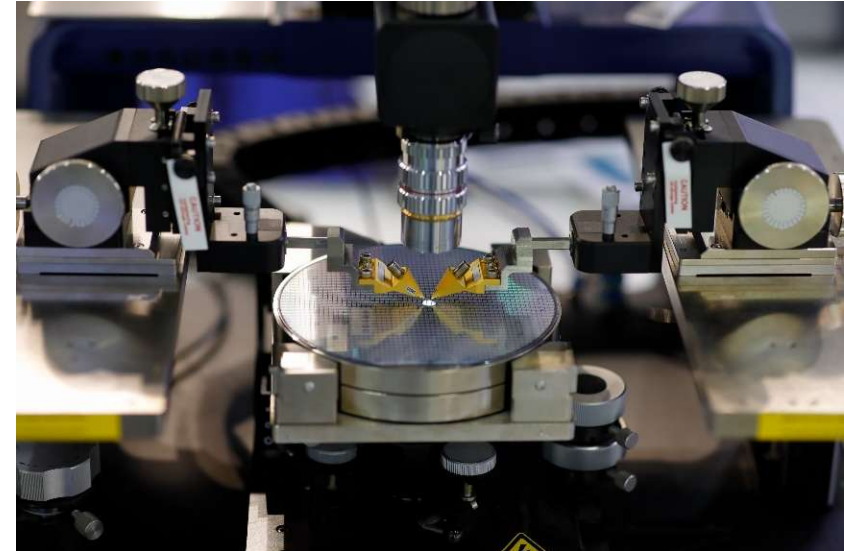


Electro-Optical Wafer Probing in PIC & Silicon Photonics Manufacturing

- Time for optical I/O alignment dominates testing cost & throughput

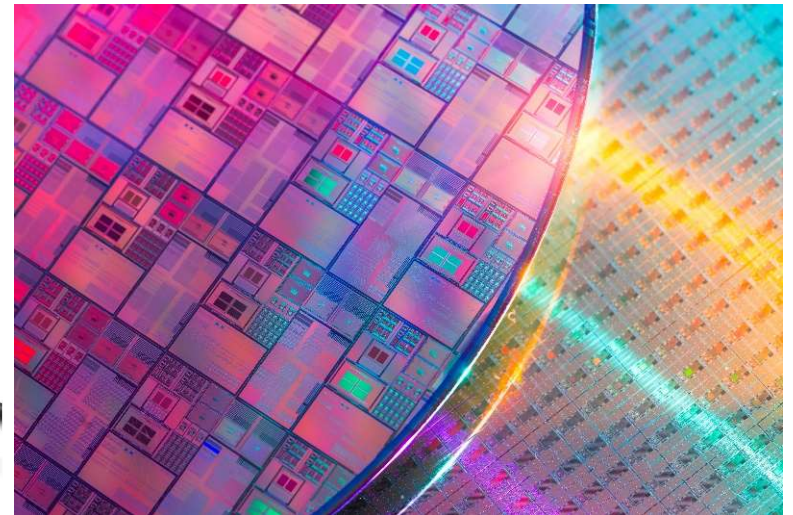
Piezo systems provide:

- high-speed scanning
 - autonomous fast alignment algorithms
 - at nanometer resolution
-
- Higher Throughput and higher yield in fiber array units (FAUs) alignment reduce cost per unit, enabling scalability for high-volume PIC manufacturing
- Product example:** C3S-D00100 | EBD-120330
100x100x100 μm , high bandwidth, fast alignment



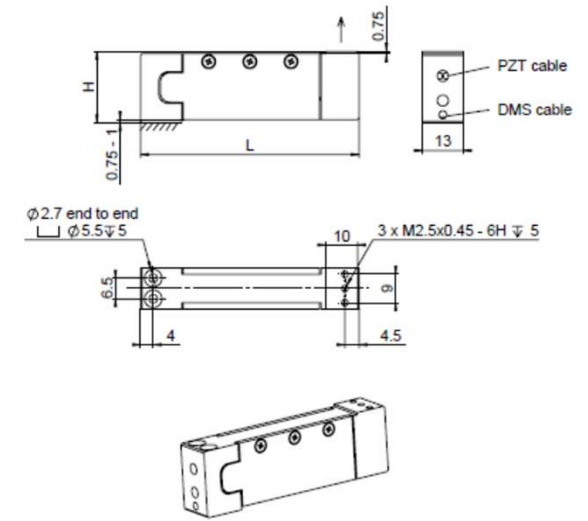
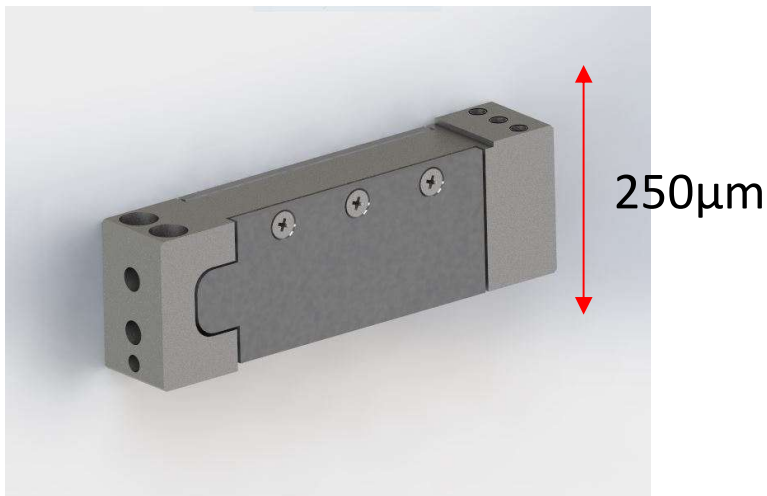
Wafer Inspection

- High stiffness and high position stability
- Zero drift (e.g. over 2minutes)
- Capacitive sensors with high linearity for absolute accuracy of 0.02%
- e.g. 3 axes stages
- Z/Tip/Tilt or XYRotZ

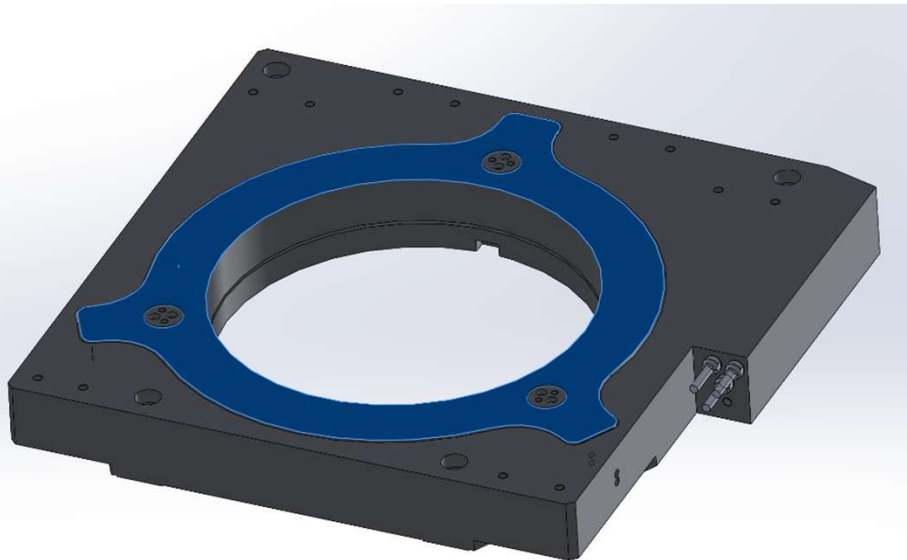


Piezo Lever Amplified Actuators for System Integration

Product	PPa Piezo-Lever					
Product-Number	PPa-b00100	PPa-b00250	PPa-b00500	PPa-b01000	Unit	Tolerance
Displacement (-45..180 V)	130	310	580	1100	μm	$\pm 10\%$
Displacement, closed loop	100	250	500	1000	μm	$\pm 10\%$
Resolution, open loop	0.2	0.3	0.5	1	nm	typ.
Resolution, closed loop	2	6	12	25	nm	typ.
Linearity, closed loop	0.1		0.2		%	typ.
Repeatability	7	10	30	60	nm	typ.
Push/Pull	50/20		30/15		N	max.
Lateral Force	40		30		N	max.
Stiffness	0.85	0.5	0.22	0.11	N/ μm	$\pm 10\%$
Resonance, unloaded	850	630	340	210	Hz	$\pm 10\%$



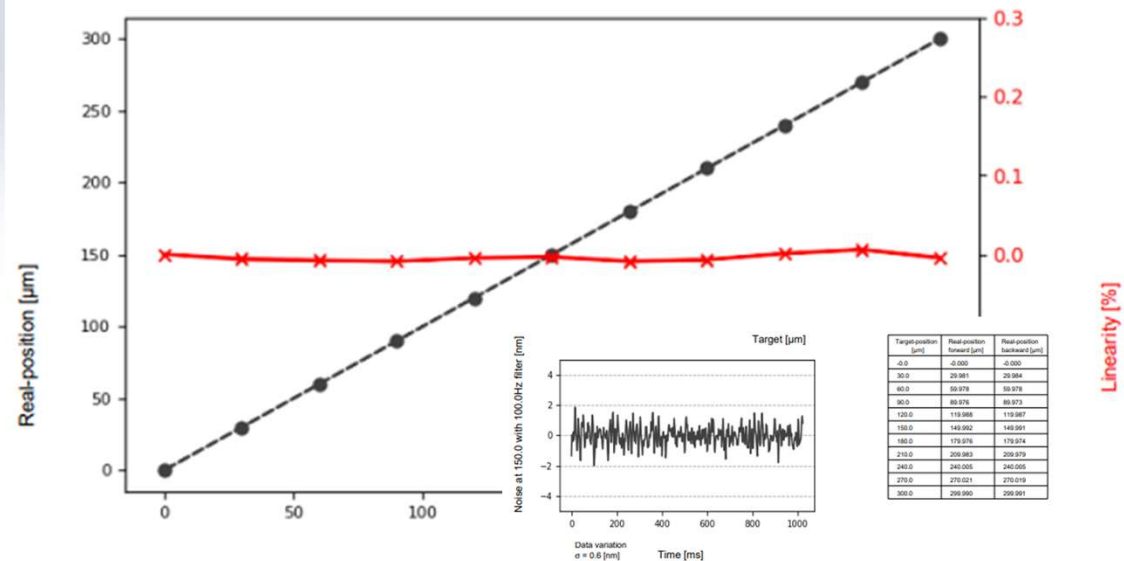
High linearity Z-TipTilt stage for Metrology for Wafer and Optics



nanoFaktur measurement protocol

Test equipment: SIOS interferometer SP 5000 TR

Channel 3: Closed-loop range: 0.0 .. 300.0 μm
Piezo-voltage range: -45.0 .. 180.0 V
Open-loop range: 405.5 μm



0,6nm noise

Download software and manuals: www.nanoFaktur.com/support Password: nFSoftw

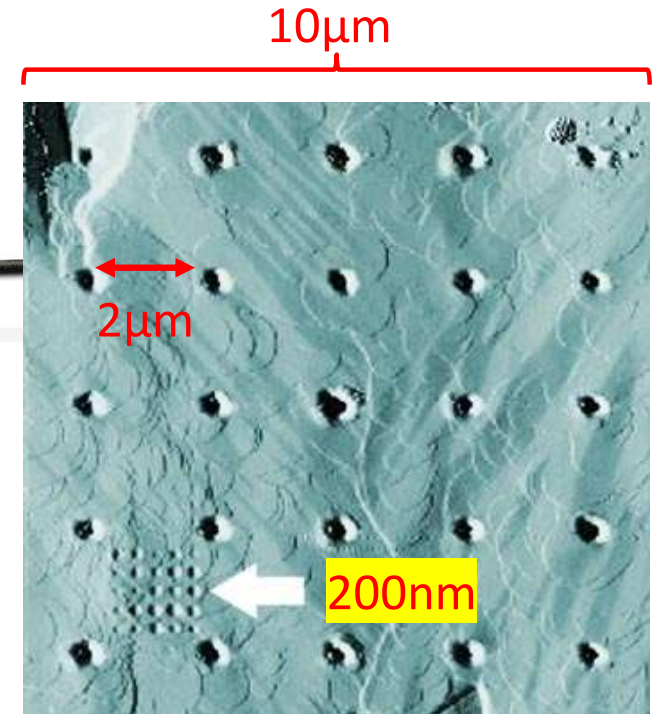
AFM Atomic Force Microscopy



XYZ Piezostages (300x300x300 μ m)
Super low Out-of-Plane motion



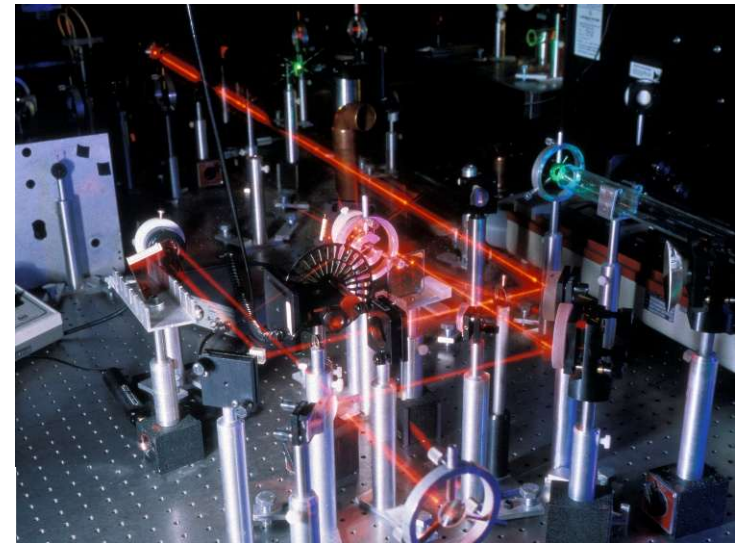
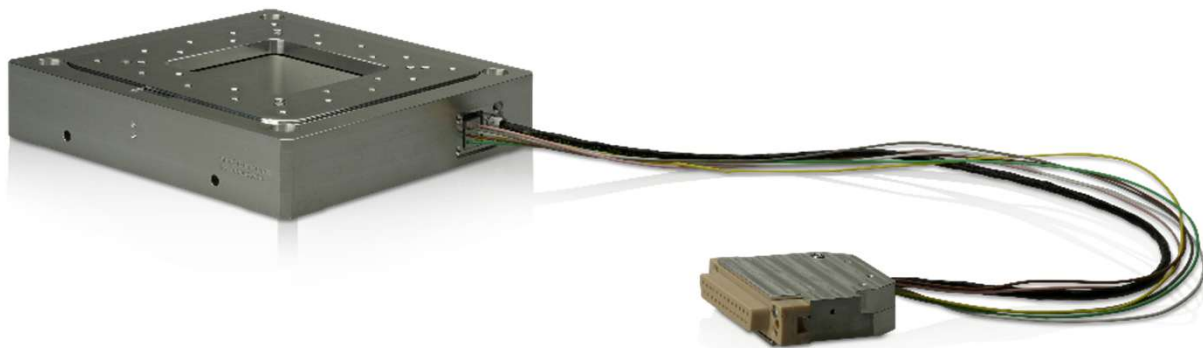
Z-Focus Positioner
500 μ m travel



- TappingMode™ image of **indentation patterns** on Parafilm® acquired with a MultiMode® AFM.
- Patterns were produced using LiftMode®.

Quantum defects, Optical Tweezers, Quantum Computing

- XYZ Piezo Nanopositioning Stage with Capacitive Sensor, Parallel-Metrology
- UHV vacuum compatible 10^{-9} mbar
- L3C-D10300 + EBC-120



Summary

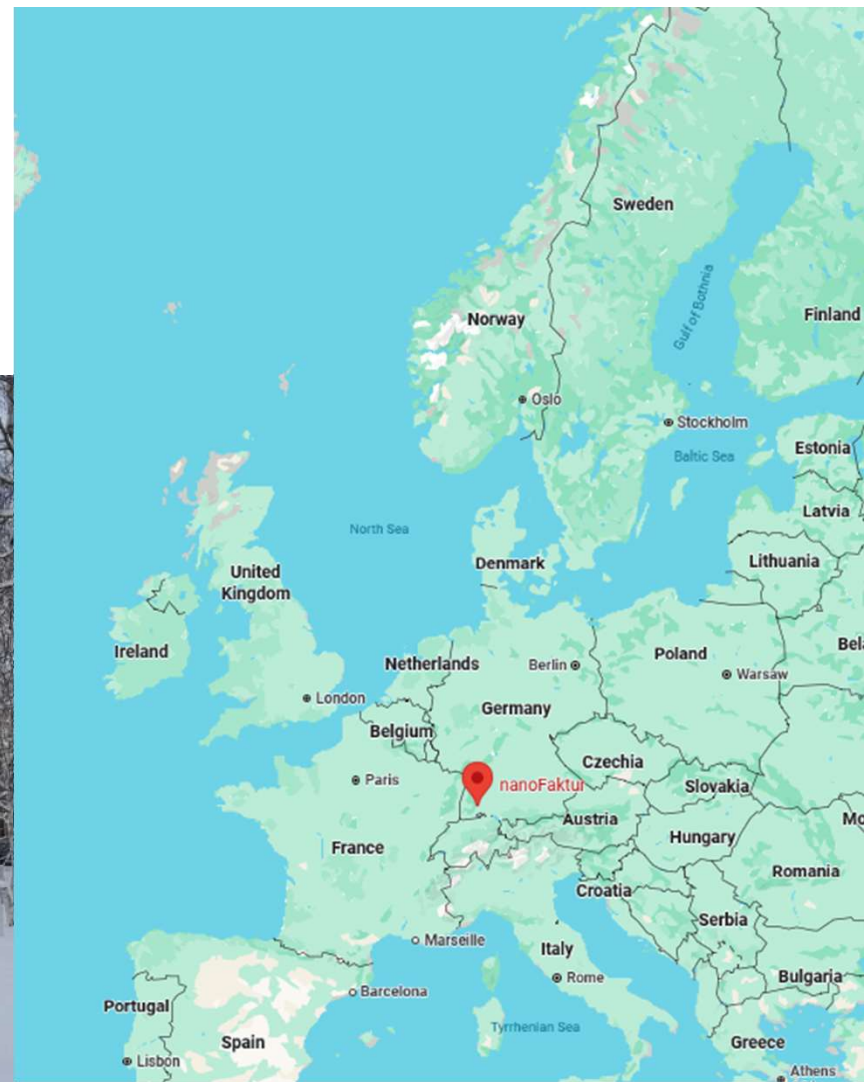
- 100+ years of expertise in piezo positioning systems for OEMs
- Superior piezo performance:
 - Doubled stroke for more travel range, compact designs, fast step-and-settle, high stiffness, and robustness for harsh environments
- Broad portfolio of standard mechanics and electronics
- Agile and extensive R&D and customization for new designs, from low to high OEM volumes
- Direct engineer access: no sales layers, faster support, quicker prototyping, and shorter lead times



Thank you!



Black Forest
~750m above sea level



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