



PI News is back

The new PI Nanopositioning News sports a fresh look-and-feel to match our new corporate design. Nanopositioning News will appear regularly to report on new products and events at Physik Instrumente (PI) and PI Ceramic.

We hope it makes for interesting reading.

NEXLINE®

SEMI Acknowledges PI Breakthrough in Nanopositioning Technology

NEXLINE® overcomes the limitations of conventional nanopositioning systems by combining basically unlimited travel ranges with very high mechanical stiffness and responsiveness while providing piezo-class resolution in the sub-nanometer and picometer range. This achievement was recognized by SEMI with the Technology Innovation Showcase (TIS) award, presented at the 2005 Semicon West in San Francisco.

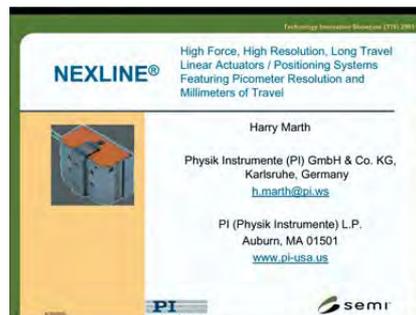
Six-axis parallel-kinematics Hexapod with NEXLINE® high-load actuators for use in strong magnetic fields.



N-215 NEXLINE® High-load actuator, 20 mm travel range with 100 picometer resolution.

The patented NEXLINE® drive technology is based on the highly coordinated, digitally controlled motion of a number of different PZT actuators driven in shear and longitudinal modes. All NEXLINE® components were specially developed and are manufactured in-house at PI and PI Ceramic.

continued on page 7



PI's NEXLINE® presentation in the TIS forum at this year's Semicon West can be viewed on the SEMI website. Shortcut: <http://www.pi.ws/onl/TIS>

Contents

- [High-Performance Nanopositioning for Cost-Sensitive Applications](#)
- [New Modular Nanopositioning Controller for Capacitive-Sensor-Equipped Systems](#)
- [The new M-824 Hexapod – Smaller and Vacuum Compatible](#)
- [M-850 Hexapod Advances Research in Dental Biomechanics](#)
- [Award-Winning PICMA® Piezo Actuator Family Extended](#)
- [Control Ultrasonic Linear Motors Quickly and Precisely](#)
- [Low-Profile Scanning Microscopy Stages](#)
- [NEXLINE® Long-Travel High Force Nanopositioning Actuators](#)
- [M-403 Makes Precision Positioning a Reasonably-Priced Pleasure](#)
- [The New World of Catalogs](#)
- [Moving Day of PI USA West](#)
- [Contact, Tradeshows 2006](#)

High-Performance Nanopositioning Systems for Cost-Sensitive Applications



P-611 family: X, Z, XY, XYZ and XZ stages.

PI has been long recognized as the industry leader in ultra-high-performance nanopositioning systems, continually pushing the limits of technology.

But PI also offers a wide range of compact high-performance systems for cost-sensitive applications.

A family of five stages, based on the successful NanoCube®, is now available for X, Z, XY, XZ, and XYZ positioning, scanning, focusing, and alignment applications.

Special Features at a Glance

- High-performance & low cost
- 100 µm travel range per axis
- 1 nm resolution
- Very compact 44 x 44 mm base

Hybrids: Combination with Motorized Stages

All P-611 series stages can be combined with a variety of manual and motorized micropositioning systems from PI to form long-travel hybrid systems. For more information, see

the M-110 series of mini-translation stages in our catalog at www.pi.ws.

Application Examples

- Alignment, Scanning, Positioning, Nanofocusing in
 - Microscopy, Micromanipulation (life sciences)
 - Semiconductor technology / test systems
 - Photonics, e.g. fiber optics applications
 - Micromachining



P-612 XY scanning stage with aperture.

Scanning Stages with Aperture

The new P-612.2 XY nanopositioning stage was designed for cost-sensitive transmitted-light applications. With a footprint of only 60 x 60 mm, it is the smallest 100 x 100 µm nanopositioning stage featuring a large aperture of 20 x 20 mm.

Ultra-Compact Scanners

Optimized for scanning and imaging applications, the P-714 family of piezo scanners provides highly dynamic XY motion in a package of only 45 x 45 x 6 mm. Learn more about these stages in the next issue of Nanopositioning News, or go online to www.pi.ws.

Microscopy & More

Turn to page 6 to see our latest scanning microscopy XY and Z stages. They come in two flavors: Ultra-high performance, featuring parallel-metrology capacitive sensors, and equipped with strain gauge sensors, for cost-sensitive applications.

Features & Advantages

All components in the above stages are frictionless and not subject to wear. For optimum position stability and responsiveness, the closed-loop versions are equipped with full-bridge strain gauge sensors mounted on the flexure guiding system.

Reliability is assured by the use of award-winning PICMA® piezo drives (see article on page 6). Exceptional guiding precision is provided by FEA-modeled, wire-EDM-cut flexures.



New Modular Nanopositioning Controller for Capacitive-Sensor-Equipped Systems

Capacitive sensors are the metrology system of choice for the most demanding applications. The new E-621.CR module is a very cost-effective controller for capacitive-sensor-equipped nanopositioning stages such as

the successful PIHera® or PIFOC® series. Up to 4 (12) units can be plugged into the E-501.621 (E-500.621) chassis for multi-axis applications. The module features high-speed analog and RS-232 interfaces, with a networking feature off the RS-232 interface.

E-621 Features:

- Integrated 20-bit, high-speed RS-232 interface (networks up to 12)
- High-speed analog interface
- Integrated low-noise amplifier
- Integrated servo-controller with a notch filter for higher bandwidth



The New M-824 Hexapod—Smaller and Vacuum Compatible



M-824 6DOF micropositioning system—vacuum model.

Application Examples

- Micromachining
- Micromanipulation
- Life sciences
- X-ray diffraction measurements
- Semiconductor handling systems
- Tool control for precision machining & manufacturing

Compact Innovation

For the last 15 years, PI has been the global leader in high-precision hexapod positioning technology.

The new M-824 Hexapod was developed for space-critical 6D positioning and alignment applications. Its low profile—only 188 mm—has been made possible by the folded-drive-train design, a parallel drive shaft / motor configuration.

The platform can travel up to 45 mm in each linear axis and up to 25 degrees in each rotation axis. The design resolution of each individual strut is 7 nm. The minimum linear incremental motion of the Hexapod is 300 nm and it achieves a repeatability of $\pm 0.5 \mu\text{m}$. Most importantly, the high-g geared design is self-locking to 10 kg and provides very high position stability devoid of servo-dithering issues that plague some other designs.

Vacuum Designs

Because many of today's demanding positioning tasks are performed in a vacuum, PI provides a variety of high- and ultra-high-vacuum compatible micropositioning and nanopositioning products. The new M-824 Hexapod is available for atmospheric pressure as well as for pressures down to 10^{-6} hPa (model number M-824.3VG).

Special Features at a Glance

- Vacuum compatible
- 10 kg load capacity
- Travel ranges to 45 mm, rotation to 25 degrees
- 7 nm actuator resolution
- Minimum incremental motion to 300 nm
- Repeatability $\pm 0.5 \mu\text{m}$
- Very compact design



The interferometer test shows the highly repeatable minimum incremental motion of 500 nm.

M-850 Hexapod Advances Research in Dental Biomechanics

From Christoph Bourauel and Ludger Keilig—Department for Orthodontics at the Rheinischen Friedrich-Wilhelms-Universität, Bonn.

Dental biomechanics deals with the interactions between dental materials, treatment instruments or dentures and the reaction of teeth, biological tissues, etc. to mechanical stresses. A wide spectrum of force systems occur here with masticatory forces exerting loads to 380 N and torques to several Nm.

At the same time, movements of several orders of magnitude are involved: orthodontic equipment can change the position of teeth by up to several mm, whereas—during mastication—teeth are deflected by less than 100 μm and implants by as little as a few microns or less. These combinations of small forces with large deflections, on the one hand, and large forces and extremely small deflections on the other, represent a challenge with respect to the biomechanical metrology.

To deal with this challenge, the Dental Clinic of the University of Bonn designed the HexMeS (Hexapod Measuring System) based on the M-850.50 Hexapod. The ability to move in 6 degrees of freedom and the combination of small dimensions, very high stiffness and resolution of less than 1 μm (1 arcsec) were the key reasons for choosing the M-850 system.

HexMeS also features two 6-component force/torque sensors for the Hexapod with measuring ranges of 12 N (120 Nmm) and 130 N (10 Nm) respectively and an optical detection system equipped with 3 CCD cameras.

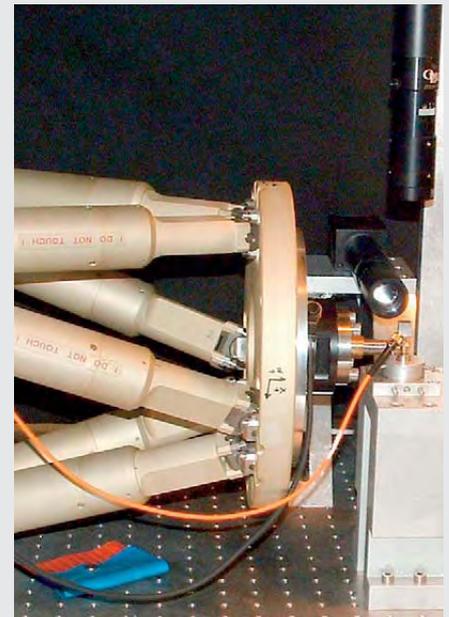
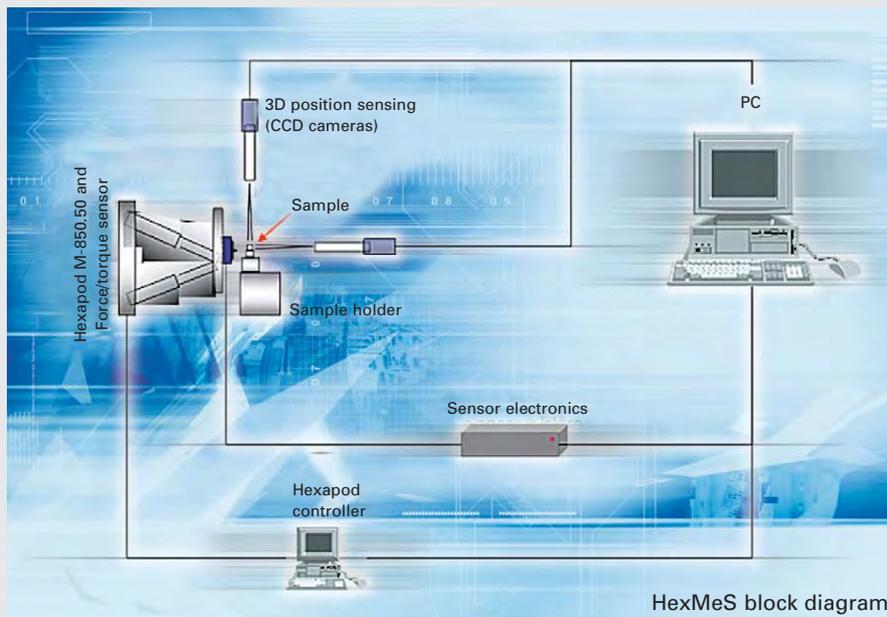
Because of its high stiffness (100 N/ μm), sample deflections can usually be calculated directly from the Hexapod motion.

For high-load testing—simulations of mastication in the 100 N range—the optical portion of the HexMeS is used. It resolves sample deflections to 0.7 μm / 0.2 arcsec.

The M-850-based HexMeS currently represents one of the most flexible measuring systems in the field of dental biomechanics. Its efficiency and the broad spectrum of its application have been demonstrated in a whole series of experimental investigations into dental implants, telescope crowns and orthodontic prostheses.



Load testing of a double crown.



Award-Winning PICMA® Piezo Actuator Family Extended



The award-winning PICMA® multilayer actuators come in 19 different sizes.

The award-winning, ceramic-encapsulated PICMA® multilayer piezo actuator family has grown one more time. In addition to the 2 x 3, 3 x 3, 5 x 5, 10 x 10 cross sections, 7 x 7 mm versions are now available. They come in both 18 and 36 mm lengths, providing 15 µm and 30 µm displacements, respectively. For most applications, this cross-section represents a good compromise between high load capacity and low electrical capacitance.

PICMA® actuators now form the basis of PI's rapid nanopositioning systems and are also supplied to OEM customers. PICMA® ceramic-encapsulated actuators are far superior to con-

ventional polymer-coated multilayer actuators. Lifetime, resistance to humidity, vacuum compatibility, temperature stability and operating temperature range have all been significantly improved.



The innovative PICMA® technology was honored with the Photonics Circle of Excellence Award in the course of the 2005 Photonics West Show.

Control Ultrasonic Linear Motors Quickly and Precisely

The C-865 is the first controller specially developed for PLine® piezo linear motors. In combination with the PLine® M-663 micro-translation stage, it forms an extremely compact, high-precision and rapid positioning system for linear travel ranges of up to 20 mm. Owing to the high servorate and dynamic parameter switch-

ing, the C-865 controller can provide extremely crisp step and settling behavior.

PLine® Facts:

- Compact & cost-effective
- 0.1 µm resolution
- <10 ms step-and-settle time
- Up to 500 mm/s



C-865 Controller with M-663 PLine® stage.

Low-Profile Scanning Microscopy Stages

The P-540 nanopositioning stage family features the lowest profile of any capacitive-sensor-equipped XY scanning stage in the industry. Yet its 16.5 mm profile does not come at the cost of performance, because the precision components previously in a

profile height of 30 mm were redesigned to fit into the new, slimmer stages.

The lower profile is especially beneficial when integrating the stages into a microscope. The enlarged 80 x 80 mm aperture means that specimen slides or petri dishes with suitable adapters can be inserted directly into the stage opening.

high-resolution, high-speed), 100 x 100 µm and 200 x 200 µm or as a Z-tip-tilt stage with 100 µm travel range for aligning the focal plane in microscopy. It goes without saying that the P-540 nanopositioning systems use the award-winning PICMA® actuators.

The stages are equipped with parallel-metrology capacitive sensors for the highest performance. Strain-gauge-sensor-equipped versions are also available for cost-sensitive applications.

P-541.2DD low-profile, direct-drive piezo scanning stage.



This new series of stages is available either as an XY system with travel ranges of 45 x 45 µm (direct drive,

Continuation of page 1

NEXLINE® Long-Travel High Force Nanopositioning Actuators

NEXLINE® provides motion in two operational modes: A high-resolution, high-speed analog mode and an incremental mode which theoretically has an unlimited travel range. This combination allows positioning heavy objects over long travel ranges with nanometer accuracy. This is used, for example, to improve the resolution of wafer steppers in semiconductor lithography.



N-215 High-force NEXLINE® actuator.

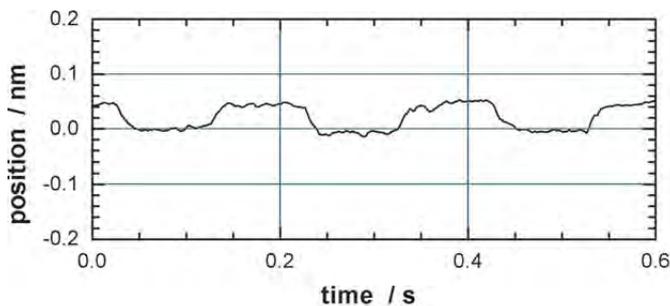
NEXLINE® drives can hold a stable position to nanometer level in power-off mode. They provide significant advantages wherever high loads must be positioned with very high precision, and perhaps given small dynamic adjustments (active vibration control).

NEXLINE® drives can be used with external position feedback as well as internal position sensors, such as capacitive or incremental sensors. It is thus possible to execute analog-mode motion with a stroke of a few microns at a resolution of <math><0.1</math> nanometer and incremental-mode motion with step sizes to 6 μm over a few tens of millimeters travel range.

Features and Advantages:

- High stiffness & load capacity
- High dynamics in analog mode for rapid corrective motion
- High service life because leakage currents caused by offset voltages are avoided
- Optional high guiding accuracy thanks to flexures

N-110 NEXLINE® OEM actuator with 3 mm travel range and a holding force of 50 N.



50 picometer steps with a NEXLINE® drive, measured with external ultra-high-resolution capacitive sensor. This performance provides a big safety margin for next generation nanotechnology applications.

M-403 Makes Precision Positioning a Reasonably-Priced Pleasure

The M-403 series of micropositioning stages provide high positioning performance for cost-sensitive applications. This is achieved by means of a highly modular design and optimized manufacturing processes. At present we can offer a travel range of 100 mm; versions with 25 to 200 mm will follow. The modular principle offers various motor types from stepper motors through to the proven

ActiveDrive™, as well as different types of drivescrews and basic profiles.



The M-403 translation stage with 100 mm travel range.

The New World of Catalogs

You will find everything you need to know about nanopositioning and micropositioning products and applications in the new 500-page, hardbound PI catalog. It is the most comprehensive reference book on the fundamentals of nanopositioning and micropositioning technology yet. The 500-page publication presents PI's state-of-the-art products, technologies and applications in 11 well-organized sections. In addition to standard products, a variety of custom designs are shown.

The new 40-page "Piezoceramic Materials and Components" catalog from PI Ceramic provides help in the correct choice of a suitable piezo transducer for applications in micropositioning technology and sensorics. The comprehensive overview, in conjunction with a compact section covering theory and applications, provides ideal support for the user. Have a look; you are

sure to find something to suit your application needs.



Moving Day for PI USA West

The PI USA West Coast office will move from Tustin, CA to its new location in Irvine, CA by the end of 2005. The new location will offer more space for offices and applications labs.

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Tradeshows 2006

January	21. – 22.	Biomedical Optics (BIOS), San Jose (USA)	
	24. – 26.	Photonics West, San Jose (USA)	
	31. – 2. Feb.	MD&M West, Anaheim (USA)	
February	01.	Simtec, Toulouse (F)	
	15. – 16.	IPOT, Birmingham (UK)	
	18. – 22.	BioPhysical Society, Salt Lake City (USA)	
March	07. – 09.	OFC, Anaheim (USA)	
	13. – 15.	APS March Meeting, Baltimore (USA)	
	30.	Simtec, Grenoble (F)	
	22. – 23.	Technologies HI-TECH 2006, Tel Aviv (IL)	
April	09. – 12.	Focus on Microscopy, Perth (AUS)	
	26.	Simtec, Bordeaux (F) Congress of Electronics (Italy)	

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