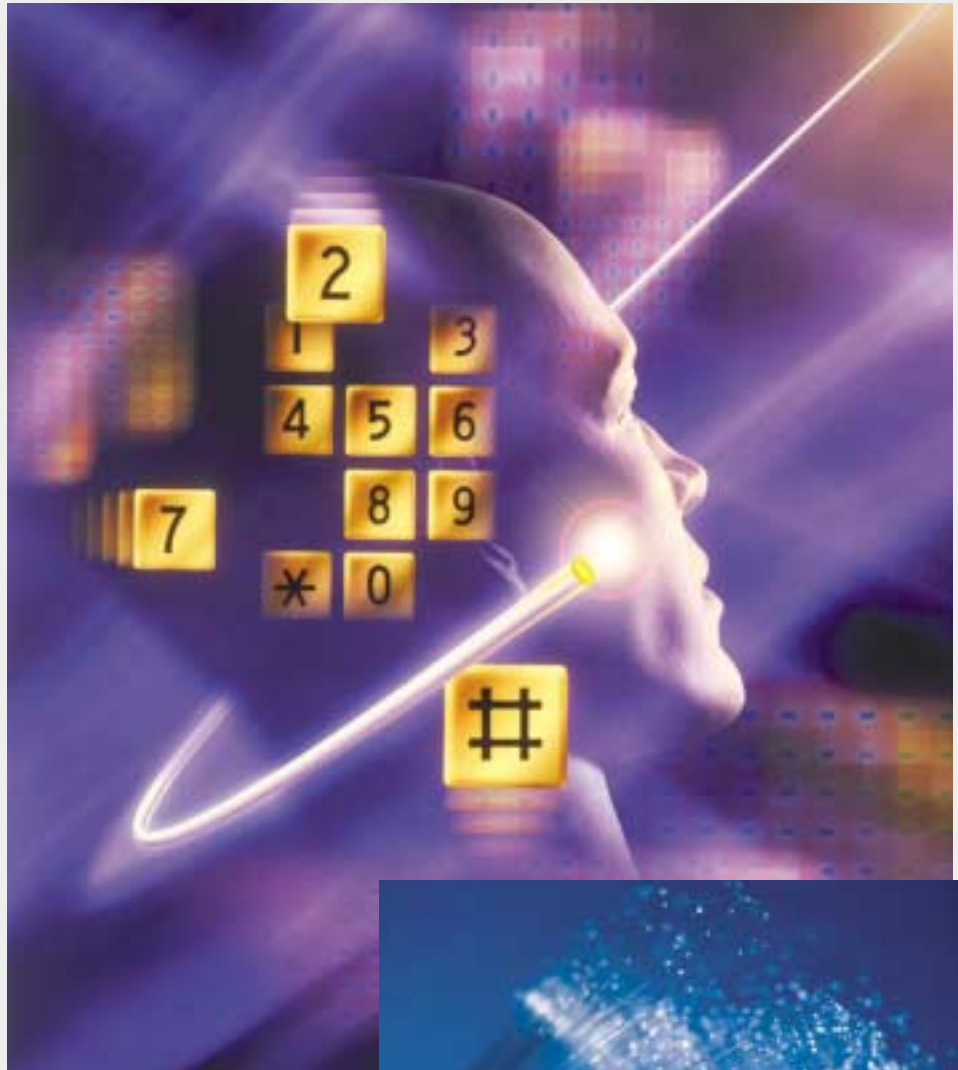


Photonics Alignment Subsystems and NanoMechanisms for Industrial Automation & Development

Applications

- Photonics Alignment & Packaging Automation
- Collimator Alignment
- Fiber-Array Alignment
- Optical Device Testing
- MEMS Positioning/Alignment
- Fiber Alignment
- Laser Tuning
- FBG Writing
- Fiber Stretching
- Beam Switching
- Beam Stabilization
- Micromachining



Photonics Packaging & Alignment Experience

PI provides a great variety of innovative solutions for photonics packaging and alignment automation.

Products range from 6D MicroMotion robots for industrial automation, through ultra-fast piezoelectric scanning modules to modular devices with manual control for laboratory test setups.

Applications include automated angular alignment of collimated fibers or arrays, thin-film WDM add/drops, MEMS switches, planar MEMS cross-connects and multi-channel waveguides.

Additional PI products are available for applications such as writing fiber Bragg gratings (FBGs), fiber stretching, coarse alignment, beam switching, etc.

6-DOF MicroMotion Robots



Family of HexAlign™ industrial 6D MicroMotion Robots. PI has over a decade experience with sub-micron-resolution 6D Hexapod designs.

Fiber Rotators

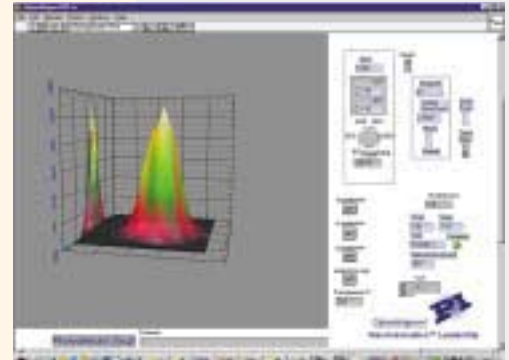


Motorized fiber rotator for polarization-preserving fibers.

Rapid XYZ NanoAligners

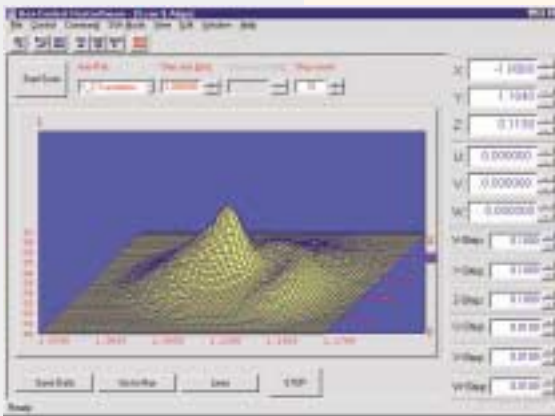


F-130 XYZ rapid-alignment system features 1 nm piezoelectric resolution and 15 mm motorized travel-range in each axis.



Closed-loop industrial piezoelectric modules such as the NanoCube™ allow rapid mapping of the entire coupling cross-section, eliminating spurious lock-on to local maxima.

Control Software



HexControl software. Display shows an optical device scan.

Switching/Aligning



PZT bender actuators can be used in fast switching applications.

Modular PZT Aligners



Modular manual and piezoelectric aligners.

PZT Actuators
PZT Flexure NanoPositioners
PZT Active Optics / Steering Mirrors
Tutorial: Piezoelectrics...
Capacitive Position Sensors
PZT Control Electronics
MicroPositioners / Hexapod Systems
Photonics Alignment & Packaging Systems
Motor Controllers
Index

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6D Parallel Kinematics

5D Serial Kinematics

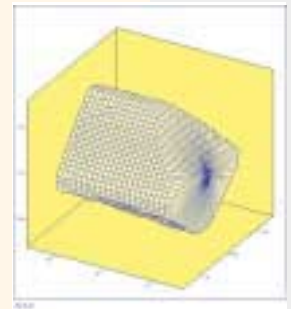


CAD design of a custom 5D coarse/fine alignment system with closed-loop PZT drives.



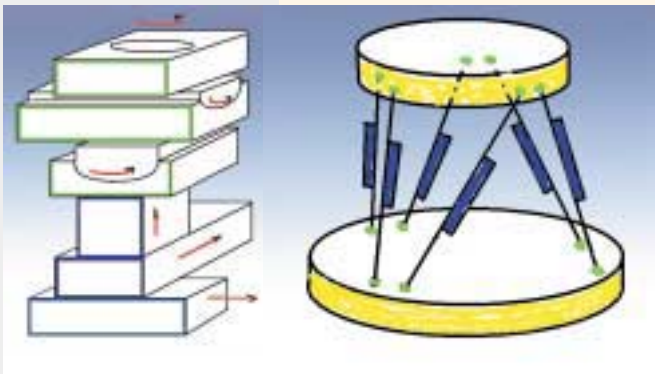
F-206 HexAlign™ 6D alignment system integrates long-travel, high-precision, six-degree-of-freedom motion and linear/rotary alignment automation. Optional high-speed, 100 x 100 x 100 μm, XYZ PZT alignment module achieves nanometer resolution.

Workspace



Example of F-206 6D workspace

Serial vs. Parallel Kinematics



Stacked "serial" kinematics 6D alignment system vs. Hexapod "parallel" kinematics system designs clearly show advantages of the Hexapod, such as minimized size and inertia for highest **responsiveness and throughput**. Also note: **no moving cables** means better reliability and repeatability.

Experience



PI's first ultra-high-resolution 6D Hexapod positioning system was introduced for optical alignment in astronomical telescopes a decade ago.

Coordinate Transformation: Internal, Automatic

Added Ultra-Fine Motion

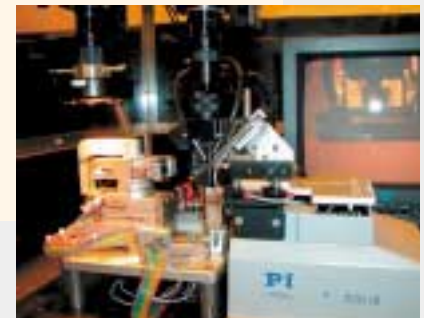


NanoCube™ industrial XYZ high-speed piezo alignment module with controller card featuring optical metrology and search functionality. The controller card and NanoCube™ module can be integrated in the F-206 6D alignment system for enhanced versatility.



PI's Hexapod controllers perform sophisticated 6-space coordinate transformations and path-planning internally, automatically. This makes the systems very easy to use, as the unit speaks in terms of familiar X, Y, Z, θ_x , θ_y , θ_z coordinates with millimeter and degree units (4-decimal-place precision).

Integration



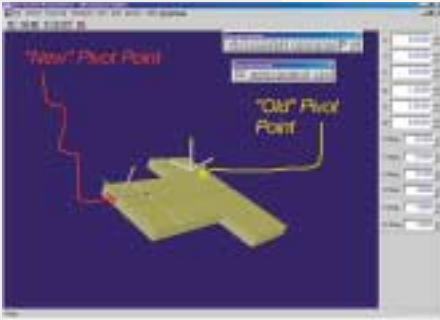
F-206 HexAlign 6-DOF MicroMotion Robot deployed as a photonic alignment subsystem for automated assembly of fiber pigtailed devices. Courtesy of Aries Innovations.

NxN Fiber-Array Alignment



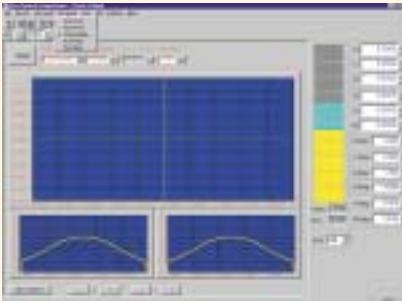
Automated fiber-array alignment software for the F-206 MicroMotion Robot.

Fully Virtualized Center of Rotation



Automatic software coordinate transformation allows the center of rotation to be placed **instantly** anywhere in space, such as at the tip of a fiber, the beam waist of a laser diode, the focal point of a lens, the surface of a thin-film filter, or the optical axis of an array channel.

"Pre-Align...



F-206 software even supports manual pre-alignment. The windows show: YZ position, intensity distribution in Y and Z directions and the photometer read-out "thermometer" with peak detector.

Why Can PI Provide Superior Solutions?

- Broadest range of architectures for industrial alignment and positioning.
- Sophisticated, modular, rapid-alignment automation technologies.
- Unique throughput-optimization technologies.
- 30 years experience in designing ultra-high-precision mechanics and controls.
- More than 10 years experience in fiber and photonic device handling for industrial automation.
- Easy-to-use / easy-to-integrate software, DLLs, LabView™ support, built-in scan & align routines.

Automated Collimator Alignment



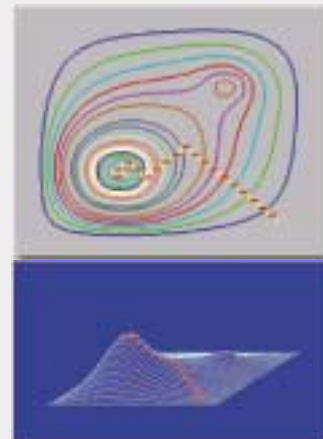
F-206 HexAlign™ Hexapod principle allows motion of platform in all six degrees of freedom. Ideal for angular scans and alignment tasks like those required in **collimator packaging applications**.

6D Controller with Scan & Align Functions



F-206 HexAlign™ controller features built-in optical metrology and a variety of automatic scan & alignment functions.

Alignment Routines



PI provides several automatic alignment routines to quickly find the point of maximum light intensity.

...by Wire"



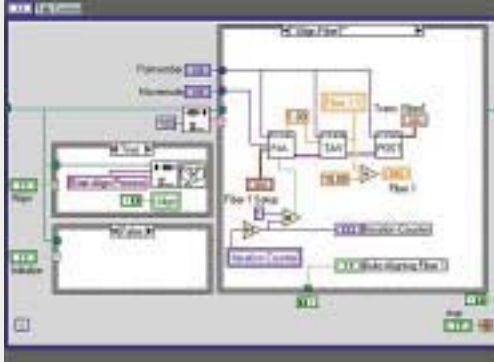
The Hexapod 6D manual control pad upgrade allows fully independent manual moves in each hexapod axis with software-feedback and variable step size. Works similar to fly-by-wire control in aircraft.

Photonics Packaging & Alignment Experience (continued)

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LabView™ Support



LabView™ drivers, including complete scan-and-align routines are available to support your automation processes.

2D Rotary Alignment



Custom θ_x, θ_y alignment system.

Modular Solutions



Modular 6x6x6 mm XYZ Micro-Aligners featuring ultra-high-resolution PZT drives.



Motorized actuator upgrade featuring < 50 nm resolution.



Precision manual aligners with crossed roller bearings provide excellent stability and minimum crosstalk.



Manual 18x18x18 mm XYZ micro-positioner, with 50x50x50 μm XYZ piezoelectric fine motion and sub-nanometer resolution.

High-Resolution Actuators



Variety of closed-loop motor actuators, 10 to 50 mm travel range, ballscrew and leadscrew drives, < 50 nm resolution for automation/upgrades.

IntelliStages™



Long-travel translation stages are available in a variety of form factors and travel ranges. Features include **Direct Output Metrology** (linear scales) and integrated motion controllers/drivers (IntelliStages™).

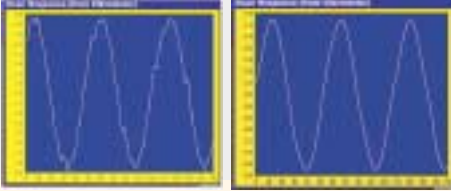
Fiber Stretching/Tuning



PZT tubes can be used for tuning applications (e.g. fiber stretching).

Photonics Packaging & Alignment Experience (continued)

InputShaping™



Left: Resonances excited in fixture on/around PZT NanoScanning stage can limit quality and/or speed of dithering process.

Right: Same PZT NanoScanning stage, same dithering frequency, same fixturing but control with PI's exclusive InputShaping™ technology providing

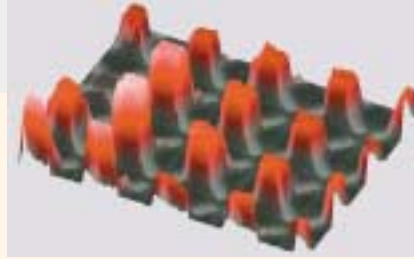
- Higher-resolution gratings
- Finer spectral linewidths
- Higher rejection ratios

FBG Writing



PI provides a variety of NanoScanning stages for **FBG writing** and other precise positioning and scanning processes.

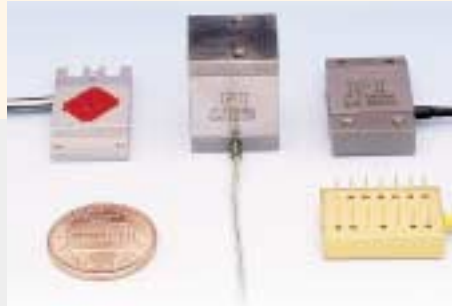
MEMS



PI precision alignment solutions are ideal for MEMS testing & production. The above "motion picture" was acquired with the Polytec Laser Scanning Vibrometer.

(MEMS device supplied courtesy of Computer Optics, Inc.)

Laser Tuning



Sub-nanometer-resolution open- and closed-loop PZT translation stages provide ultra-precise trajectory control and are ideal for tuning applications.

Beam Steering/Switching



Ultra-fast PZT beam-steering platforms provide high bandwidth and accuracy in steering, stabilization and switching applications.

Fabry-Perot Filters



Through-hole mirror shifters providing sub-nanometer resolution can be used in Fabry-Perot filters.



The F-200, PI's first fiber alignment system featuring sub-nm resolution PZT drives, was developed in the mid-1980's.