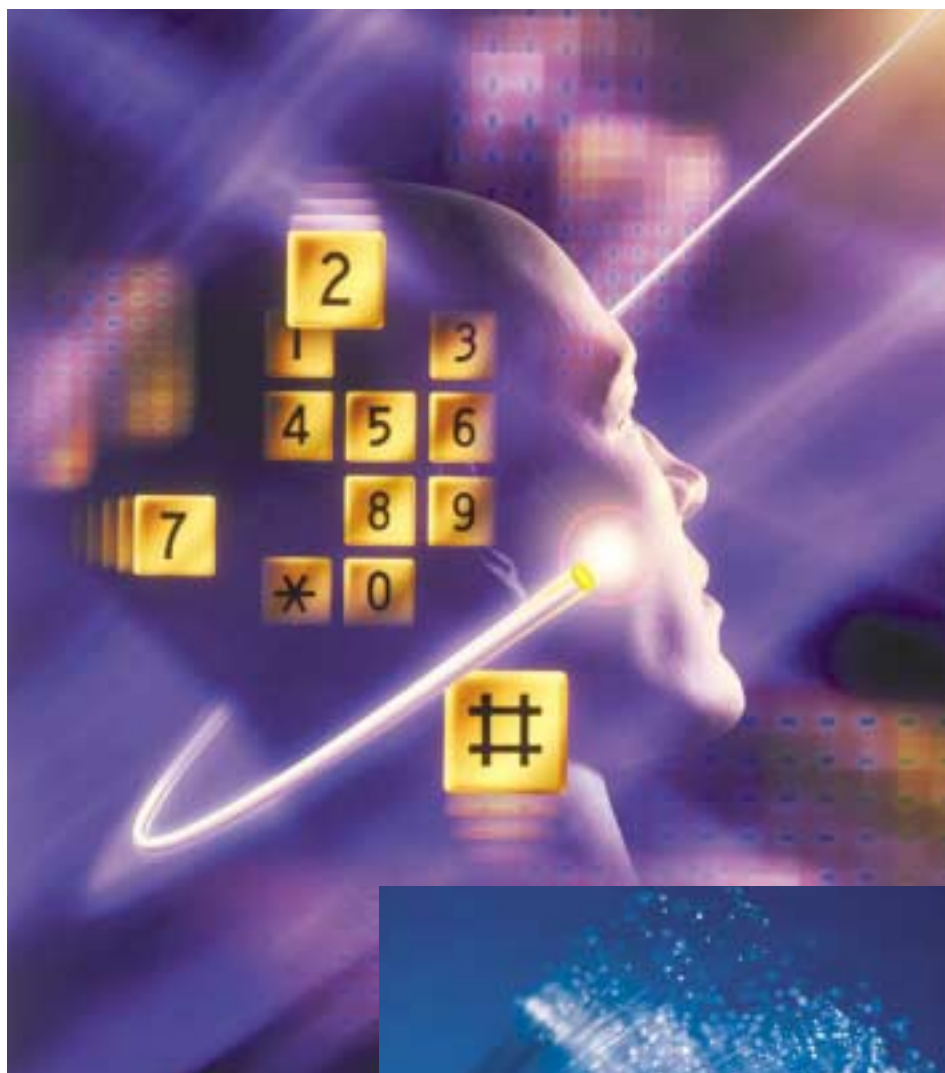


Photonic Automation, Optic Alignment, Precision Mechanics

Photonics Packaging

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



Photonic Alignment / Packaging Precision Mechanics

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

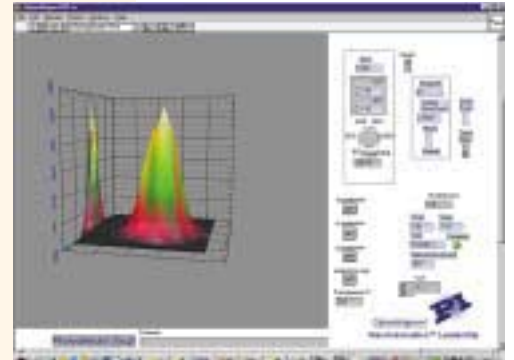


Motorized fiber rotator for polarization-preserving fibers.

Rapid XYZ NanoAligners

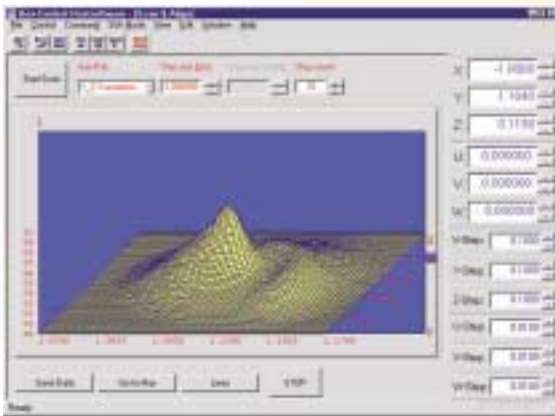


F-130 XYZ rapid-alignment system features 1 nm piezoelectric resolution and 15 mm motorized travel-range in each axis.



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.

5D Serial Kinematics



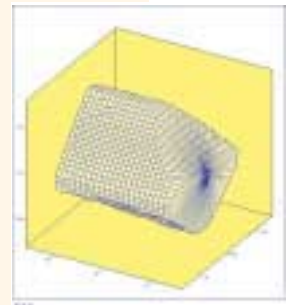
CAD design of a custom 5D coarse/fine alignment system with closed-loop PZT drives.



F-206 HexAlign™ 6D alignment system integrates long-travel, high-precision, six-degree-of-freedom motion and linear/rotary alignment automation. Optional high-speed, $100 \times 100 \times 100 \mu\text{m}$, XYZ PZT alignment module achieves nanometer resolution.

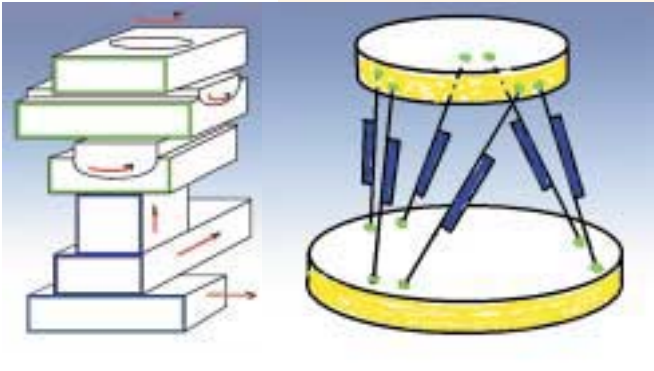
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Workspace



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



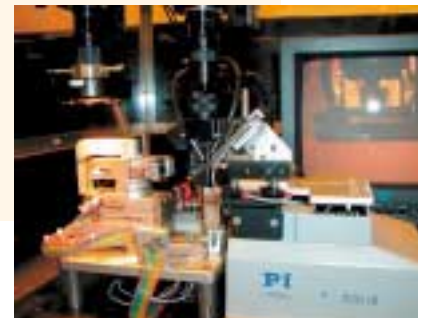
PI's Hexapod controllers perform sophisticated 6-space coordinate transformations and path-planning internally, automatically. This makes the systems very easy to use, as the unit speaks in terms of familiar $X, Y, Z, \theta_x, \theta_y, \theta_z$ coordinates with millimeter and degree units (4-decimal-place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

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.

Integration



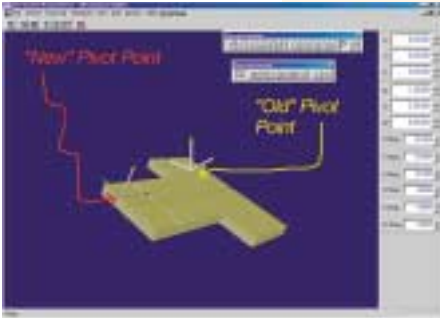
F-206 HexAlign 6-DOF MicroMotion Robot deployed as a photonic alignment subsystem for automated assembly of fiber pigtailed devices. Courtesy of Aries Innovations.

NxN Fiber-Array Alignment



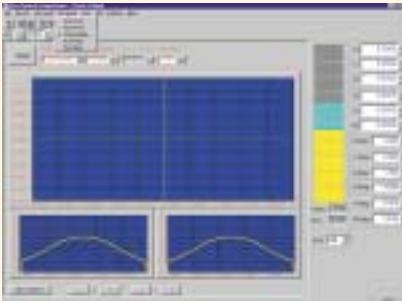
Automated fiber-array alignment software for the F-206 MicroMotion Robot.

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.

...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.

Automated Collimator Alignment



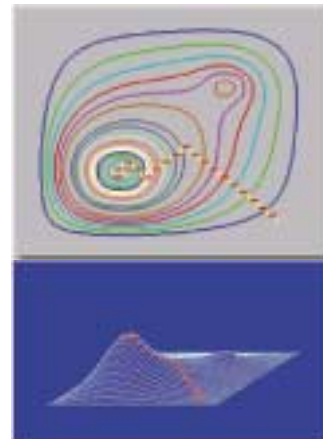
F-206 HexAlign™ Hexapod principle allows motion of platform in all six degrees of freedom. Ideal for angular scans and alignment tasks like those required in **collimator packaging applications**.

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



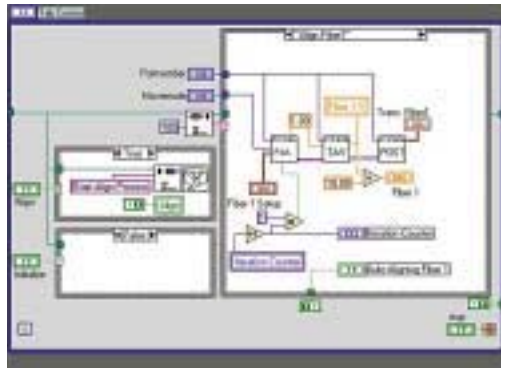
PI provides several automatic alignment routines to quickly find the point of maximum light intensity.

Photonics Packaging Alignment

PZT Actuators
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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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.

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™).

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.

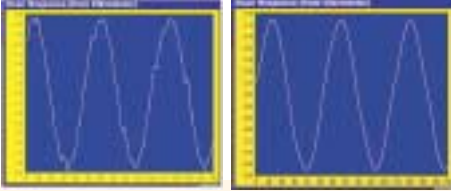
Fiber Stretching/Tuning



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

Photonics Packaging & Alignment Precision Solutions

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

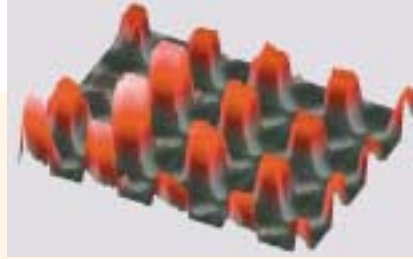
- Higher-resolution gratings
- Finer spectral linewidths
- Higher rejection ratios

FBG Writing



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

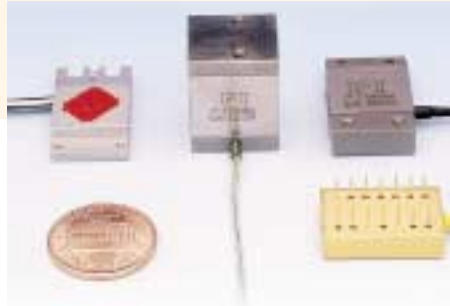
MEMS



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.

F-206

**6 Axis Automatic Photonic Alignment
Robot & Software**

**Ordering
Information**

F-206.IR
HexAlign™ Six-Axis MicroMotion Robot & Alignment System, IR Optical Board

F-206.00
HexAlign™ Six-Axis MicroMotion Robot & Alignment System, vis. Optical Board

F-206.IRD
HexAlign™ Six-Axis MicroMotion Robot & Alignment System, Front Panel Display & Keyboard, IR Optical Board

F-206.00D
HexAlign™ Six-Axis MicroMotion Robot & Alignment System, Front Panel Display & Keyboard, vis. Optical Board

Options & Upgrades (Plug-and-Play, User-Installable)

F-206.00U
Optical Board (vis. range)

F-206.iRU
Optical Board (IR range)

F-206.iiU
2-Channel Photometer Card (IR Range)

F-206.vvU
2-Channel Photometer Card (Vis Range)

F-206.AC8
Upgrade for 2 Additional Motion-Control Channels on F-206 Controller

F-206.i3E
GPIB / IEEE 488 Interface for F-206 Controller

F-206.MHU
Force-Limiting Mounting Platform

F-206.MFU
Mounting Platform with Force Sensors

F-206.NCU
Rapid NanoAlign Upgrade for F-206. Consists of P-611.3SF XYZ NanoAligner, E-760 Controller Board and Alignment Software

F-206.MC6
6D Interactive Control Pad

C-815.MC6
3 m Extension Cable for Interactive Control Pad

M-500.206
Adapter Plate for Mounting F-206 MicroMotion Robots on M-511, M-521 and M-531 Translation Stages (see "Accessories," page 7-82 ff. in the "MicroPositioners" section).

**Custom Designs
for Volume Buyers**

- **Compact, Low-Profile, Six-Axis MicroMotion Robot**
- **PivotAnywhere™ Fully Virtualized Center of Rotation—Pivot About any Point in Space**
- **Automatic Alignment (Transverse and Angular)**
- **Alignment Routines for Collimators and Arrayed Fibers/Components**
- **Digital Controller with Built-in Photometer, or Compatible with External Metrology**
- **High Speed, Fast Settling**
- **No Moving Cables, for Improved Reliability, Easy Setup, Reduced Friction**
- **Automatic Path Planning**
- **Open Source LabView™ Drivers, DLL Libraries...**

6D Alignment

The F-206 HexAlign™ Six-Axis MicroMotion Robot is based on PI's ultra-high-resolution Hexapod technology, developed for aligning optics in astronomical telescopes more than a decade ago. It provides six degrees of freedom, 0.1 μm minimum incremental motion (six-axis move!) and the unique PivotAnywhere™ capability. PivotAnywhere™ allows the user to define the center of rotation (pivot point) anywhere, inside or outside the F-206 workspace envelope, with a single software command.

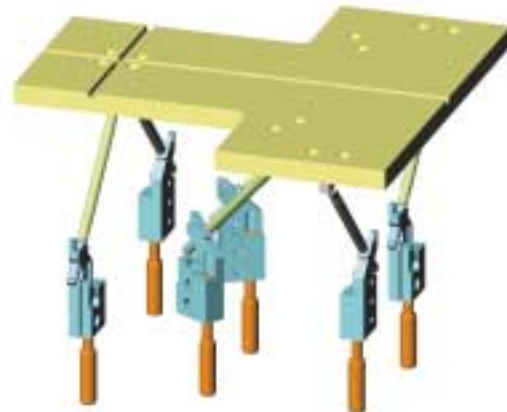


F-206 HexAlign™ System with Digital Controller (figure shows model F-206.00D with display and keyboard). PI's Hexapod controllers perform sophisticated six-space coordinate transformations and path planning internally, automatically. This makes the systems very easy to use, as the unit speaks in terms of familiar X, Y, Z, θ_x , θ_y , θ_z coordinates with millimeter and degree units (4-decimal-place precision).

Compact, Plug & Play

The F-206 is considerably more compact and accurate than conventional multi-axis stage stacks. Its novel parallel kinematics design (see Princi-

ples of Operation, p. 8-9, 8-12) and powerful, all-digital 6D controller has a vector based design to compensate for unwanted motions.



Parallel kinematics of constant-strut-length Hexapod system shows how little mass (basically only the top platform) has to be supported and moved by the six drives. This explains why the F-206 is considerably faster in terms of step-and-settle than standard "stacked" multi-axis systems, where each stage has to support and move it's own platform and the mass of any other stages above it. Also, note that, unlike serial kinematics systems, there are no moving cables to cause friction, tension or torsion to limit accuracy and repeatability.

6 Axis Automatic Photonic Alignment Robot & Software

Application Examples

- Photonics Packaging
- Optical Device Testing
- Collimator Alignment
- Arrayed Component Alignment
- MEMS Positioning/Alignment
- Fiber Alignment
- Micro-Machining
- Micro-Manipulation (Life Sciences)
- Semiconductor Handling Systems
- Microsurgery

Furthermore, orthogonality and crosstalk issues, which are a formidable assembly and service concern for stacked multi-axis units, do not affect parallel-kinematics systems. There are none of the servo-tuning and dynamic setup procedures necessitated by the widely varying effective loads on stages in a stacked assembly. The F-206 is truly a plug-and-play motion system that requires no servo adjustment or tuning. Its operation is fast and crisp, with uniform dynamics, regardless of the direction of motion. Another advantage of the F-206 design is that there are no moving cables to limit repeatability with friction and no cable management issues to be resolved when integrating the unit.

Working Principle

The basic operating principle of the F-206 is related to the Hexapod principle (PI also offers other types of Hexapod MicroMotion robots, e.g. the M-850, p 7-16). Unlike hexapods with variable-length struts ("legs") the F-206 features constant-length struts. This concept provides the following additional advantages over "classical" variable-strut-length Hexapods:

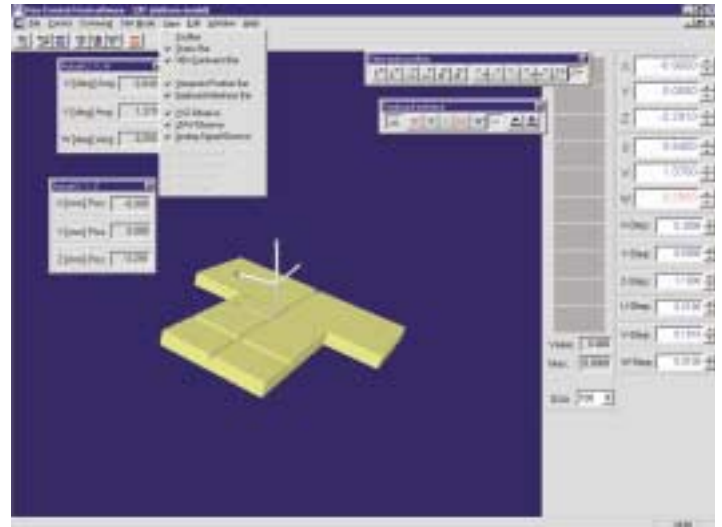
- Reduced size
- Reduced inertia for improved dynamic performance
- Independent, modular, identical drive/strut units, simplifying assembly and service
- All six struts are driven with individual industrial-class servo-motors and encoders

PivotAnywhere™ Virtualized Rotation

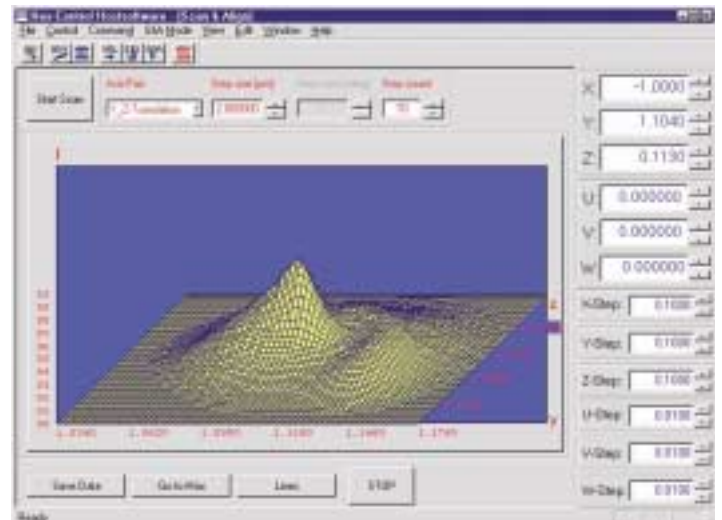
A highly useful feature is the F-206's PivotAnywhere™ fully virtualized rotation capability. Since its motion is not defined by fixed bearings but rather by sophisticated real-time, 6-space control algorithms, you can define any point in space to be the center

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of rotation with a **single software command**. This is ideal for angular alignment of collimators or fibers, since it is easy to set the pivot point to



Hex-Control software: manual operation. 3-D view of F-206 platform in space in reference to origin and pivot point.



HexControl software. Display shows an optical device scan

F-206

6 Axis Automatic Photonic Alignment Robot & Software

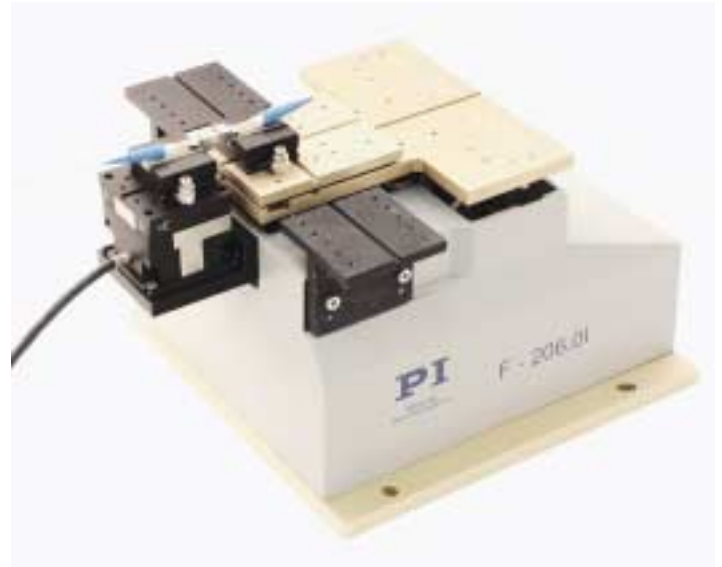
prevent “walking” of the fiber as its tip/tilt orientation is optimized. All commands and operations are high-level, using human-readable units (mm, degrees) and coordinates (X, Y, Z, θ_x , θ_y , θ_z). The F-206 automatically manages its path planning and coordination of its six motors.

Optical Metrology

An integrated photometer card (two, for array alignments, optional) and built-in automatic alignment procedures add to its power in photonics packaging applications.

Software Architecture

Control of the F-206 is facilitated by the controller's software architecture providing a variety of high-level commands for minimized communications overhead & bandwidth.



F-206 HexAlign™ 6D alignment robot combines long-travel, high-precision, six-degree-of-freedom motion and linear/rotary alignment automation. Optional high-speed 100x100x100 μ m, XYZ PZT scanning & alignment module achieves nanometer resolution (see P-611, p. 8-16); F-206.MHU force limiting platform (optional) protects equipment.

Partial Command Listing

MOV X.. Y.. Z.. U.. V.. W
Move to absolute position (units for X, Y, Z: mm, U, V, W: deg).

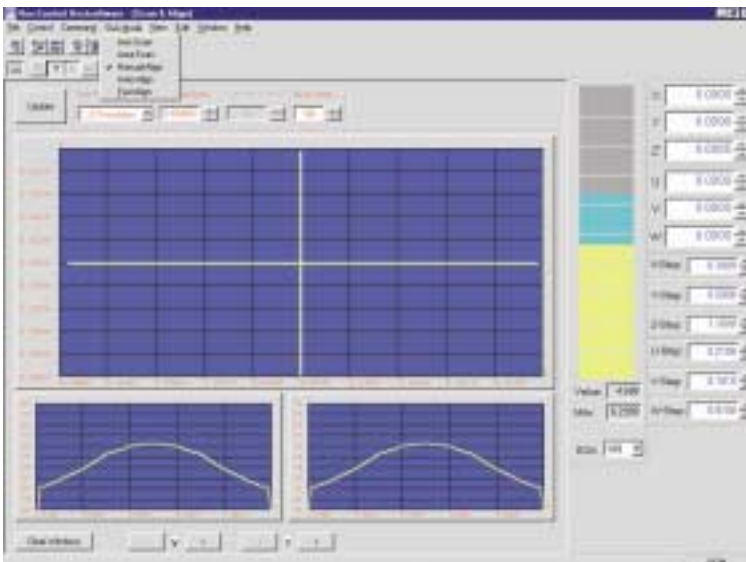
SPI R.. S.. T
Set Pivot Point (with R, S, T in mm).

TAV?
Tell Analog Value: Reports the voltage at the analog input.

FSC [ax][L][S]
Execute two dimensional Fast Scan (XY or XZ). The system stops on exceeding the programmed level [L] of the analog input or integrated photometer.

FSA [ax][L][S]
Fast Scan with Automatic Alignment. On exceeding the Level [L] during the scan, the Automatic Alignment Function is automatically executed.

- Other F-206 features are:**
- Integrated Scan & Automatic Alignment Functions
 - LabView™ Drivers and DLL Libraries
 - Simulation Tools
 - Terminal Software

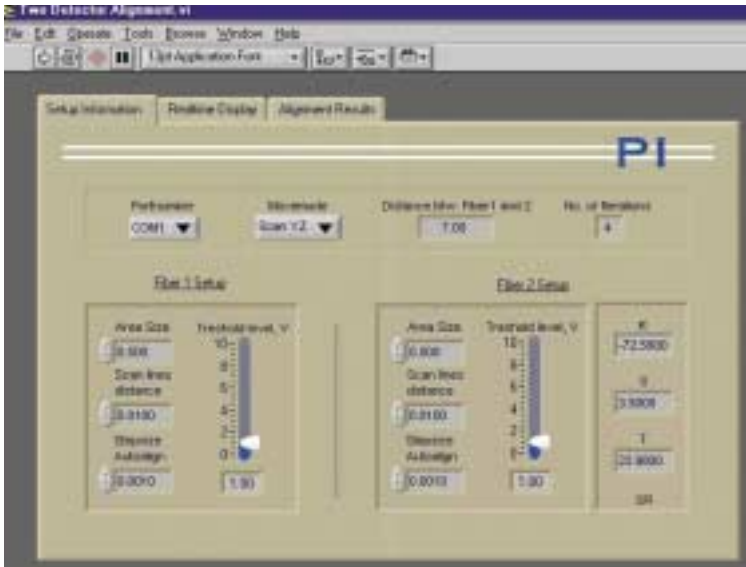


F-206 software even supports manual pre-alignment. The windows show: YZ position, intensity distribution in Y and Z directions and the photometer read-out “thermometer” with peak detector.

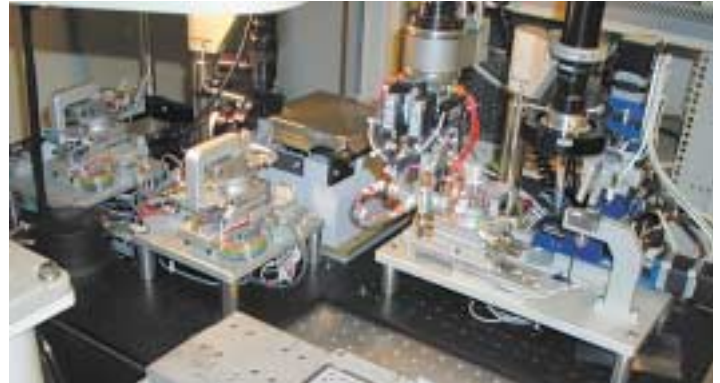
F-206

6 Axis Automatic Photonic Alignment Robot & Software

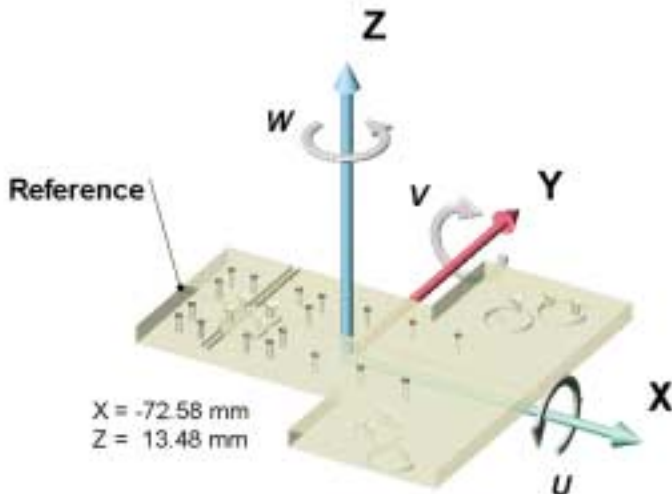
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LabView™ drivers for automated fiber-array alignment are provided with the F-206



F-206 HexAlign 6-DOF MicroMotion robot deployed as a photonics alignment sub-system for automated assembly of fiber pigtailed devices. Courtesy Aries Innovations



F-206 provides ultra-precise motion in all six degrees of freedom with rotation about any point in space (pivot point set by user)

6 Axis Automatic Photonic Alignment Robot & Software

F-206 Controller

- **Digital Six-Axis Servo-Controller (6 Axes, + 2 Axes Optional)**
- **Built-in Photometer Card (2nd Card Optional, for Array Alignment)**
- **Built-In High-Speed Analog Input**
- **Wide-Range Power Supply**
- **Optional Interactive Controls (Front Panel Keyboard/ LCD Display)**
- **Optional Interactive Control Pad with Programmable Step Size**
- **Easy Firmware Update**
- **Optional IEEE 488 Interface**
- **Well-Documented, Compact, High-Level Command Set**

The F-206 HexAlign™ controller performs sophisticated six-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).

Furthermore, the F-206 controller features a 6+2 architecture, with 6 channels dedicated to control the Hexapod platform. The other two channels (optional) are available for control of other PI motorized equipment, e.g. M-500 series long-travel translation stages, rotation stages, or other actuators for flexible automation.

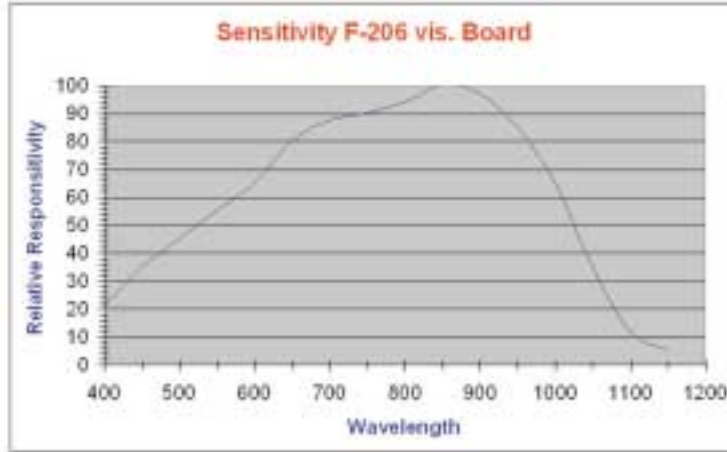


F-206 Controller, rear view, showing optical fiber input, connectors for motor out, analog in (A/D), power out (servo-amplifiers) and optional monitor out.

6 Axis Automatic Photonic Alignment Robot & Software

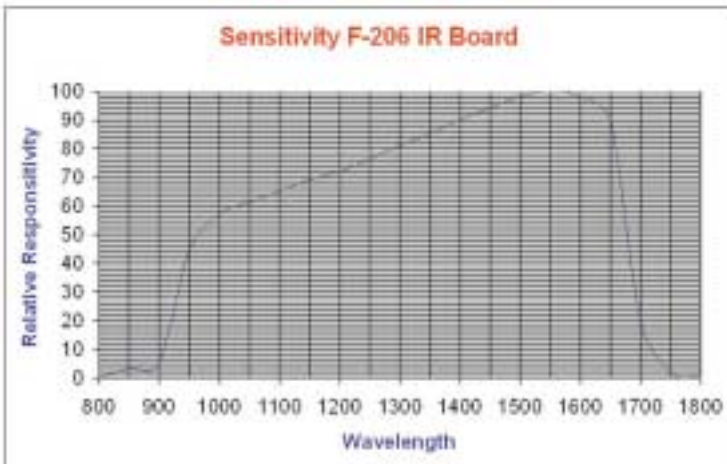
Optical Metrology Boards

Standard F-206 systems come with one optical metrology board installed (model number F-206.iR / F-206.iRD for infrared detector or F-206.00 / F-206.00D for visible-light detector). The system can also be upgraded to operate two optical metrology boards for applications such as fully automated fiber-array alignment. See Ordering Information p. 8-8 for upgrade order codes. Two-channel boards are also available.

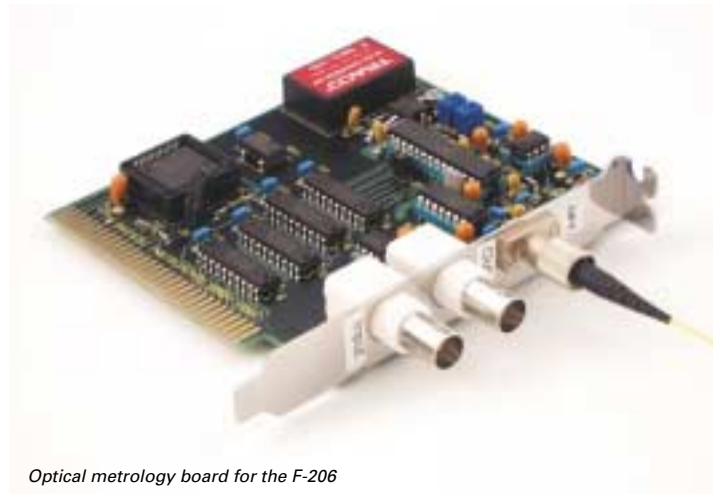


Sensitivity of the visible range photo detector in the F-206 optical metrology board

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Sensitivity of the IR photo detector in the F-206 optical metrology board



Optical metrology board for the F-206

IR and VIS boards for F-206 Controller

Optical power range:	5 nW – 10 mW
Analog input voltage range:	0 – 10 V
A/D resolution:	12-bit
Sample rate:	10 kHz
Bandwidth:	300 Hz (optical input), 10 kHz (voltage input)
Maximum sensitivity at:	880 nm (VIS); 1550 nm (IR)
40%:sensitivity at	480 / 1040 nm (VIS); 850 / 1680 (IR)

6 Axis Automatic Photonic Alignment Robot & Software

F-206.MHU, F-206.MFU Force-Limiting, Force-Sensing Platforms



F-206.MHU Magnetic kinematically clamped force limiting platform

In some applications it may be useful to limit the forces on or from the F-206 platform to protect the mechanics or components mounted on the F-206 from damage. Two platform options are available:

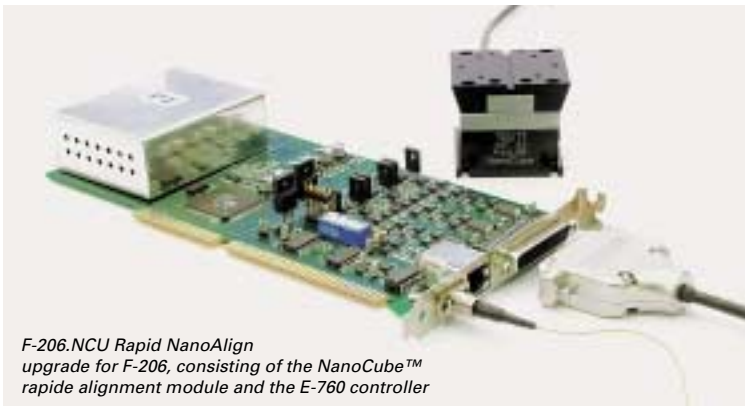
F-206.MHU is a magnetic kinematically clamped add-on plat-

form that is automatically released when a certain force or torque is exceeded. This platform also makes it easy to exchange complete setups mounted on different top plates. Additional top plates are available as part number F-206.TMV.

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F-206.MFU is similar to F-206.MHU with additional force sensors. The sensor output voltage can be monitored for enhanced safety.

F-206.NCU Rapid NanoAlign Upgrade



F-206.NCU Rapid NanoAlign upgrade for F-206, consisting of the NanoCube™ rapide alignment module and the E-760 controller

For applications where alignment with nanometer-range resolution is required, or where rapid mapping of the entire cross-coupling area is desired, the F-206.NCU Rapid NanoAlign upgrade is recommended. It consists of a

P-611.3SF closed-loop XYZ NanoCube™ alignment module (p. 8-16), the E-760 controller board (p. 6-14), which plugs into the F-206 controller, and special alignment software.

F-206.MC6 6D Interactive Control Pad Upgrade



The F-206.MC6 Interactive 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.

The F-206.MC6 option is a useful addition for simplifying test and setup procedures. It consists of a board that plugs into the F-206 controller and a control pad with six digital “potentiometer” knobs (one for each degree of freedom).

The interactive control pad allows manual step-by-step operation of the platform with a programmable step size. External positioning input (via

the RS-232 interface) can be intermixed with manual positioning input. Both inputs operate on the same position registers of the F-206 controller. The control pad comes with a 3 m cable. A 3 m extension cable is available as part number C-815.MC6.

For Additional Options, see Ordering Information

F-603

Fiber Holders, Objective & Waveguide Holders



Rear (left to right) Microscope Objective Holders: F-603.14, F-603.12 (mounted on P-611.3SF NanoCube™ NanoAlignment System) F-603.11, F-603.13

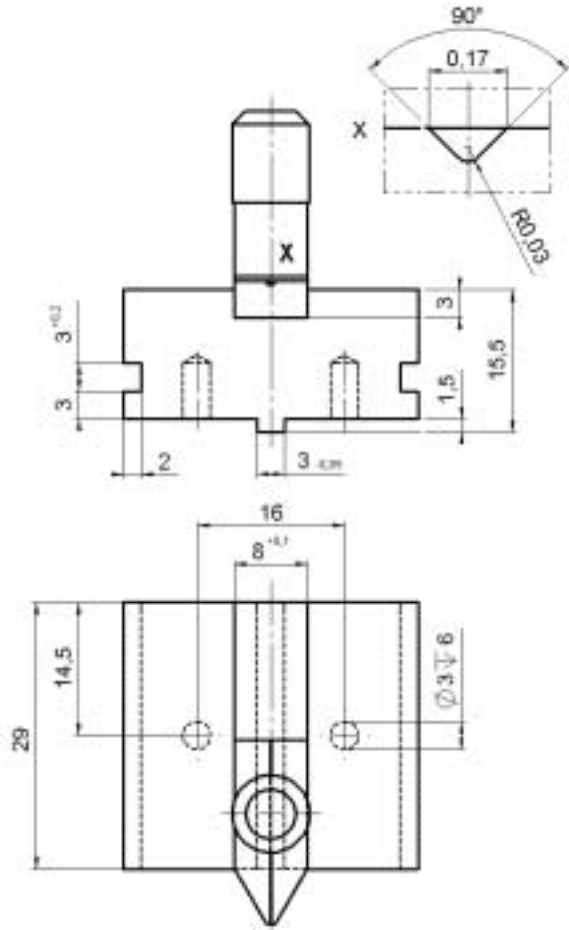
- **Mount on a Variety of PI Alignment Systems**
- **Precision Machined from High-Strength Aluminum**

The F-603 series component holders for fiber optic applications can be combined with the following Micro- & Nano-Positioning systems from PI:

- F-206 6D-Hexapod-Alignment System
- F-130 and F-131 Alignment Systems
- P-611.3OF and P-611.3SF NanoCube™ NanoAligners
- A Variety of Combinations of NanoCubes™ with Other MicroPositioning Systems

All adapters are equipped with a 3-mm-wide tongue that fits in a slot machined into the platform of the positioning system.

M3 capscrews and miniature cleats supplied with each F-603 adapter are used to fasten these accessories quickly.



F-603.60 V-groove fiber holder w/ magnetic clamp

Ordering Information

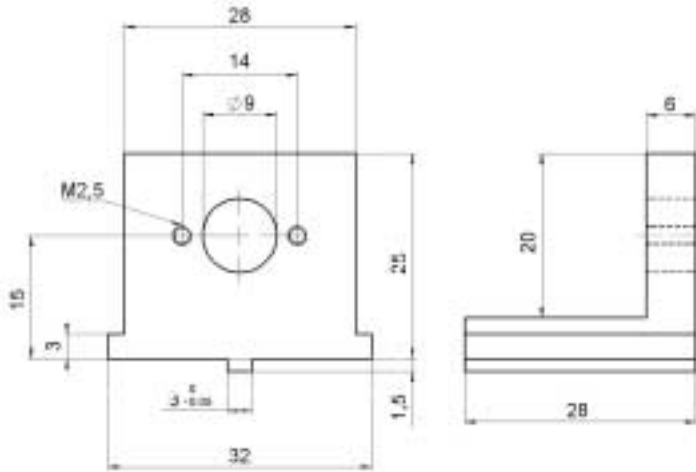
- F-603.11**
Microscope Objective Holder
W0.8x 1/36"
- F-603.12**
Microscope Objective Holder
M19x0.75
- F-603.13**
Microscope Objective Holder
M25x0.75
- F-603.14**
Microscope Objective Holder
M26x0.75
- F-603.20**
Vacuum Waveguide Mount
- F-603.21**
Fiber Holder for FC-Connector
- F-603.22**
Ferrule Holder
- F-603.60**
V-Groove Fiber Holder with Magnetic
Clamp

**Custom Designs
for Volume Buyers**

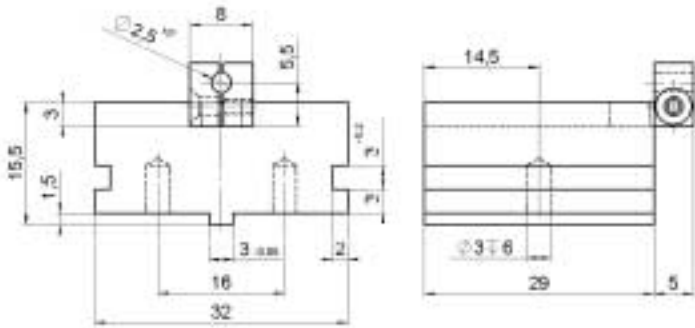
F-603

Fiber Holders, Objective & Waveguide Holders

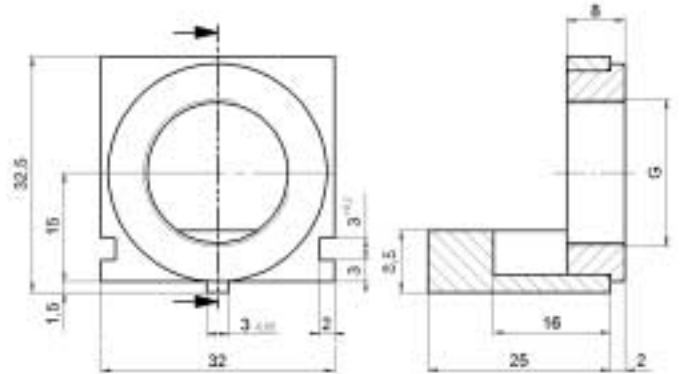
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F-603.21 fiber holder for FC-connector



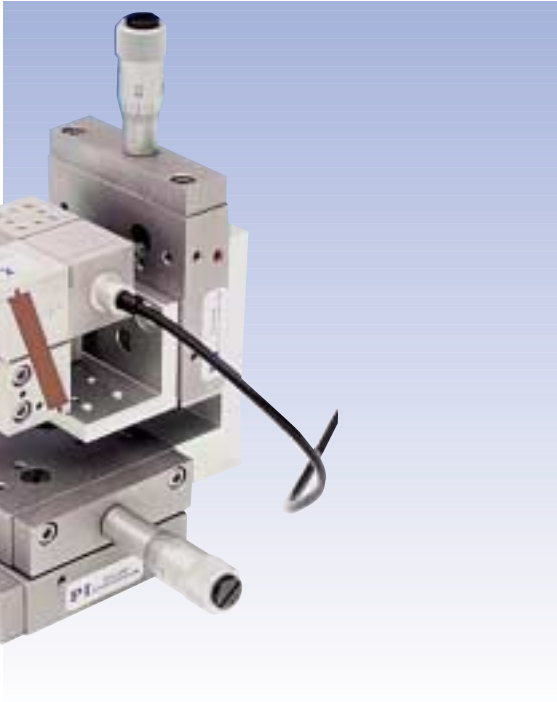
F-603.22 ferrule-holder



F-603.11 microscope objective holder W0.8 x 1/26"
F-603.12 microscope objective holder M19 x 0.75
F-603.13 microscope objective holder M25 x 0.75
F-603.14 microscope objective holder M26 x 0.75

F-110

XYZ Manual / Piezoelectric Photonic Alignment Positioner



F-110 Photonics Alignment System

- **PZT Drives with Sub-Nanometer Resolution**
- **Precision Mechanics with Crossed Roller Bearings**
- **18 x 18 x 18 mm Travel Range**
- **50 x 50 x 50 µm PZT Fine-Travel Range**
- **Optional Motor Drives**

The F-110 photonics alignment system is an ideal solution for applications where a coarse operating position can be set manually and an ultra-high-resolution alignment process (tracking, scanning etc. with sub-nm resolution) is started from that position.

High-Resolution Piezo Drives

The F-110 is based on the M-105.30 XYZ translation stage, (see page 7-24) and the P-282.20 XYZ piezo NanoPositioner (see page 2-25). The advantage of the piezoelectric fine adjustment is based on its extremely high resolution, responsiveness and electrical controllability. If used with an external optical power meter and control software, the F-110 can be used as automatic aligner or scanner with a range of 50 x 50 x 50 µm.

The E-463 piezo amplifier (p. 6-28) is recommended as driving system. It comes with an analog high-speed interface (0 to 10 V). For digital control with a computer, the E-500 modular PZT control system with E-507 amplifier modules (p. 6-35) and optional E-516.i3 computer interface (p. 6-37) is available.

Application Examples

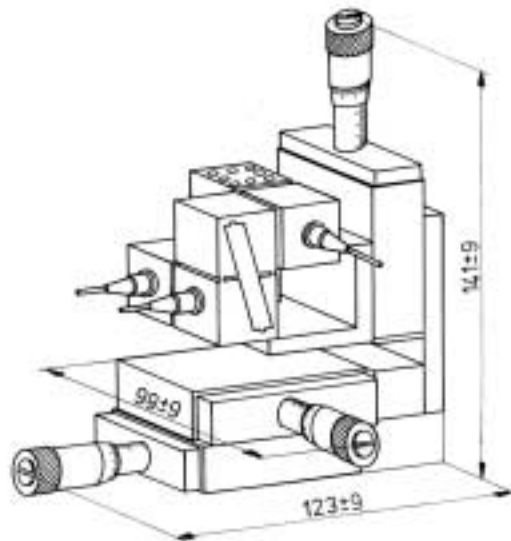
- Photonics packaging
- Optical device testing
- Fiber alignment
- Micro-manipulation (life sciences)

Ordering Information

F-110.00
XYZ Piezoelectric Photonics Alignment System, 18 mm, 50 µm

F-010.00
Fiber Holder with Magnet

Custom Designs for Volume Buyers



F-110 dimensions (in mm)

F-110

XYZ Manual / Piezoelectric Photonic Alignment Positioner

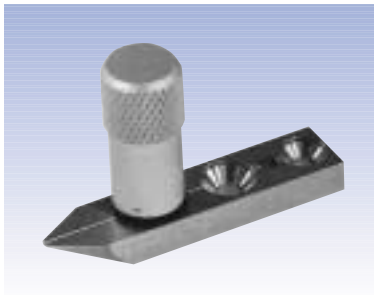
Optional Motor Drives

Motor-drive upgrades for the F-110 are also available, (M-231 and M-232 Mike drives, see page 7-70 ff.). For fully automated alignment tasks, the new F-130, integrated motorized/ piezoelectric alignment system featuring closed-loop piezo drives is recommended (see page 8-18).

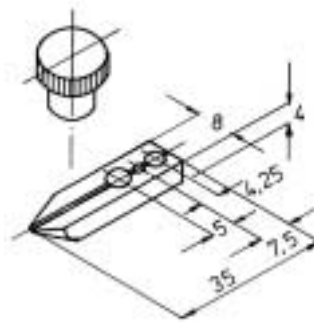
Related Products

The M-105.3P XYZ stage with PiezoMike drives (replacing the manual micrometers). It is modular and can also be configured with only one or two PiezoMike high-resolution drives. The M-105.3BA translation stage, basic unit without drives (p. 7-24).

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F-010 V-groove fiber holder with magnetic clamp



F-010 dimensions (in mm)



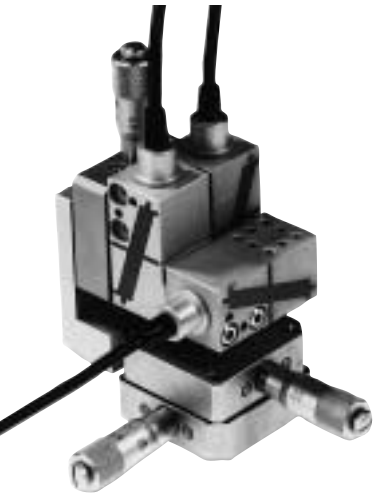
Example of F-110-related photonics alignment systems. XYZ unit on left consists of an M-105.3BA XYZ translation stage with three M-231 DC Mike Drive upgrades and M-009.20 mounting bracket with F-010 V-groove fiber holder. XYZ unit on right consists of an M-105.3BA XYZ translation stage with three P-854 PiezoMike™ upgrades and M-009.20 mounting bracket with F-010 V-groove fiber holder

Technical Data

Models	F-110.00	Units
Axes	X, Y, Z	
Travel range (manual)	18	mm
Piezo fine-travel range (0 to -1000 V)	50	µm
Resolution (piezoelectric)	0.5	nm
Resolution (micrometer drive)	1	µm
Max. load (Z-axis)	50	N
Mechanical positioning system	M-105.30, s. p. 7-24	
Piezoelectric positioning system	P-282.20, s. p. 2-25	
Weight	1.1	kg
Recommended amplifier/controller	E-463, E-500 w/ 3 x E-507	

F-111

Compact Manual / Piezoelectric Photonic Alignment Positioner



- **PZT Drives with Sub-Nanometer Resolution**
- **Precision Mechanics with Crossed Roller Bearings**
- **6 x 6 x 6 mm Travel Range**
- **30 x 30 x 30 μm PZT Fine Travel Range**

The F-111 photonics alignment system is an ideal solution for applications where a coarse “operating” position can be set manually and an ultra-high-resolution alignment process (tracking, scanning etc. with sub-nm resolution) is started from that position.

High-Resolution Piezo Drives

The F-111 is based on the M-313.00 XYZ translation stage (see page 7-20) and the P-282.10 XYZ piezo NanoPositioner (see page 2-25). The advantage of the piezoelectric fine adjustment is based on its extremely high resolution, responsiveness and electrical controllability. If used with an external optical power meter and control software, the F-111 can be used as automatic aligner or scanner with a range of 30 x 30 x 30 μm.

The E-463 piezo amplifier (p. 6-28) is recommended as driving system. It comes with an analog high-speed interface (0 to 10 V). For **digital control with a computer**, the E-500 modular PZT control system with E-507 amplifier modules (p. 6-35) and optional E-516.i3 computer interface (p. 6-37) is available.

For **motorized alignment**, please refer to the new F-130, integrated motorized/piezoelectric alignment system featuring closed-loop piezo drives (see page 8-18).

Related Products

The M-313.80 XYZ (see page 7-20) stage with PiezoMike drives (replaces the manual micrometers). It is modular and can also be configured with only one or two PiezoMike high-resolution drives.



Example of an F-111-related photonics alignment system. M-313.80 XYZ stage with PiezoMike drives, 30 μm fine motion range, M-318.20 mounting bracket and F-010 V-groove fiber holder.

Application Examples

- Photonics packaging
- Optical device testing
- Fiber alignment
- Micro-manipulation (life sciences)

Ordering Information

F-111.00
XYZ Piezoelectric Photonics Alignment System, 6 mm, 30 μm

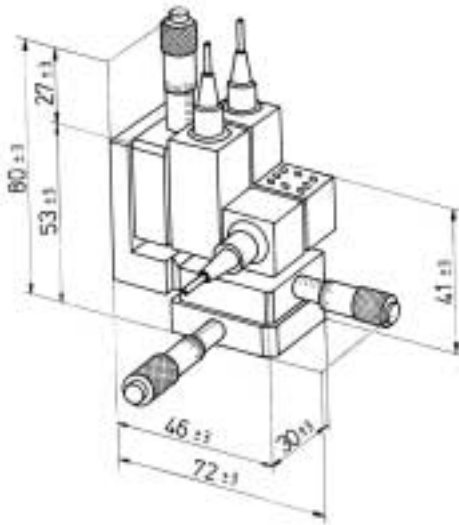
F-010.00
Fiber Holder with Magnet

Custom Designs for Volume Buyers

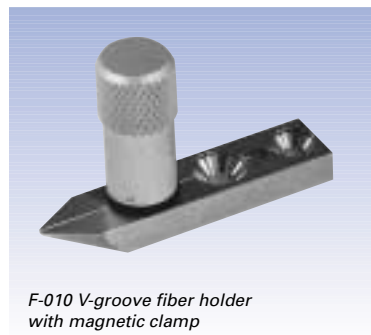
F-111

Compact Manual / Piezoelectric Photonic Alignment System

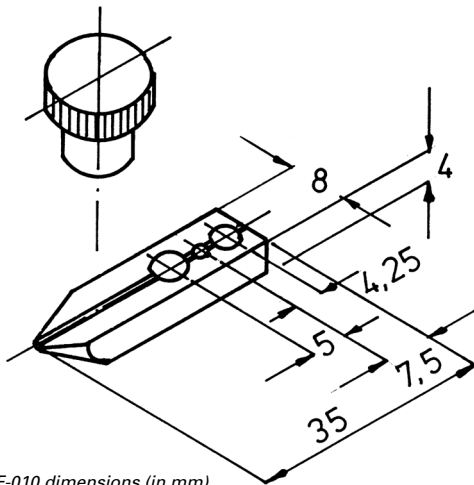
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F-111 dimensions (in mm)



F-010 V-groove fiber holder with magnetic clamp



F-010 dimensions (in mm)

Technical Data

Models	F-111.00	Units
Axes	X, Y, Z	
Travel range (manual)	6	mm
Piezo fine travel range (0 to 1000 V)	30	µm
Resolution (piezoelectric)	0.3	nm
Resolution (micrometer drive)	1	µm
Max. load (Z-axis)	20	N
Mechanical positioning system	M-313.00, s. p. 7-20	
Piezoelectric positioning system	P-282.10, s. p. 2-25	
Weight	0.4	kg
Recommended amplifier/controller	E-463, E-500 w/ 3 x E-507	

F-140

**XYZ Motorized & Piezoelectric
Photonic Alignment Automation Positioner**

**Application
Examples**

- Photonics packaging
- Optical device testing
- MEMS positioning/alignment
- Fiber alignment
- Micromachining
- Micromanipulation (life sciences)
- Semiconductor test systems
- For non-photonics applications
see the M-126, p. 7-32

- **25 mm Motorized Travel**
- **1 nm Resolution**
- **Closed-Loop Piezo Drives Available**

F-140 are compact computer-controllable XYZ alignment and positioning systems combining the advantages of ultra-high-resolution piezo drives with the long travel range of motorized stages.

They are based on the M-126 micropositioning stages (p. 7-32) and the P-611 Rapid Piezo NanoAlignment units (page 8-16).

The F-140 is available in 4 different versions, with DC-motor "coarse" drives and open- and closed-loop piezoelectric "fine" drives.

The motor drives provide 0.1 and 0.2 μm minimum incremental motion over a travel range of 25 mm. The piezo fine drives feature a 100 μm travel range in X, Y and Z, with zero-stiction, zero-friction flexure guiding systems and 1 nm resolution.

The C-880 multi-axis automation platform (page 9-6) is recommended as driving system.

**Ordering
Information**

F-140.SPD

XYZ Alignment System, 25 mm, 100 μm , ActiveDrive Motor/Encoder, C/L Piezo

F-140.SDG

XYZ Alignment System, 25 mm, 100 μm , DC Motor Gearhead/Encoder, C/L Piezo

F-140.OPD

XYZ Alignment System 25 mm, 100 μm , ActiveDrive Motor/Encoder, O/L Piezo

F-140.ODG

XYZ Alignment System, 25 mm, 100 μm , DC Motor Gearhead/Encoder, O/L Piezo

**Custom Designs
for Volume Buyers**

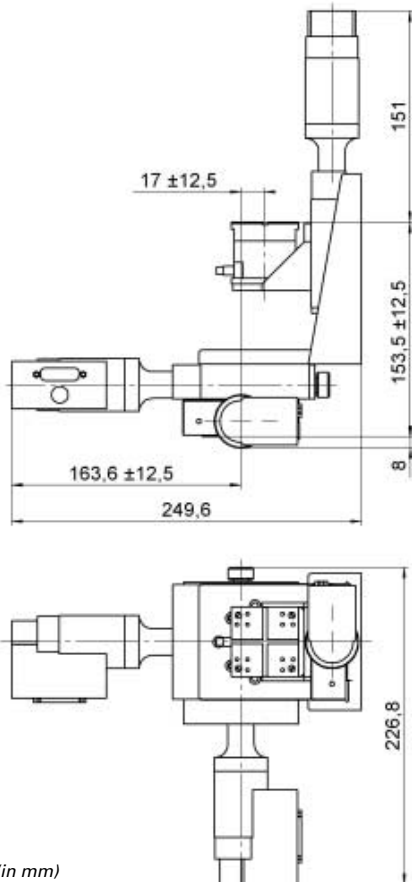


F-140.SPD XYZ Alignment System, 25 x 25 x 25 mm, 1 nm resolution, with optional F-603.22 ferrule holder.

F-140

XYZ Motorized & Piezoelectric Photonic Alignment Systems

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F-140 dimension (in mm)

The C-880 Multi-axis automation platform is recommended as controller for the F-140.



Technical Data

Models	F-140.SPD	F-140.SDG	F-140.OPD	F-140.ODG	Units	Notes see p. 7-96
Key features	ActiveDrive closed-loop DC motors, closed-loop PZT drives	DC motor gearhead/ encoders, closed-loop PZT drives	ActiveDrive closed-loop DC motors, open-loop PZT drives	DC motor gearhead/ encoders, open-loop PZT drives		
Active axes	X,Y,Z	X,Y,Z	X,Y,Z	X,Y,Z		
Motorized travel range (XYZ)	25	25	25	25	mm	
Piezo travel range (XYZ)	100	100	100	100	µm	
Design resolution (motor)	0.125	0.0085	0.125	0.0085	µm	A3
Min. incremental motion (motor)	0.2	0.1	0.2	0.1	µm	A4
Closed-loop / open-loop resolution (PZT)	2/1	2/1	- / 1	- / 1	nm	
Motorized stage	M-126.PD	M-126.DG	M-126.PD	M-126.DG		see p. 7-32
PZT drive	P-611.3SF	P-611.3SF	P-611.3OF	P-611.3OF		see p. 8-16
Material	Al	Al	Al	Al		L
Recommended controllers (see page 9-6)	C-880	C-880	C-880	C-880		

**F-130
F-131**

Small XYZ Motorized / Piezoelectric Photonic Alignment Automation Positioner



F-130.3SD XYZ Alignment System, 1 nm resolution, with optional F-603.22 ferrule holder (see p. 8-26).

Application Examples

- Photonics packaging
- Optical device testing
- MEMS positioning/alignment
- Fiber alignment
- Micromachining
- Micromanipulation (life sciences)
- Semiconductor test systems

- Up to 15 mm Travel
- 1 nm Resolution
- Closed-Loop Piezo Drives Available
- Stepper- & DC-Motor Drives

F-130 are compact computer-controllable XYZ alignment and positioning systems combining the advantages of ultra-high-resolution piezo drives with the long travel range of motorized stages.

They are based on the M-110/ M-111 micropositioning stages (p. 7-30) and the P-611 rapid piezo NanoAlignment units (page 8-16).

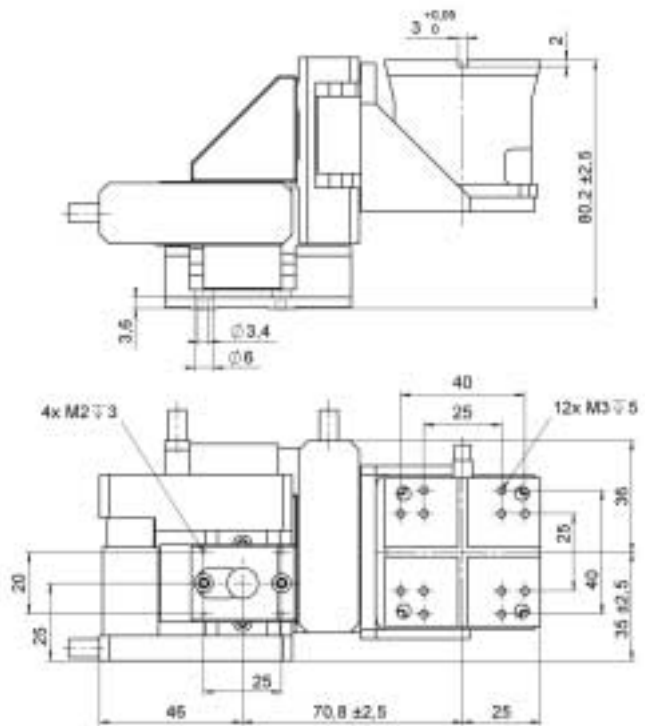
The F-130 / F-131 is available in 8 different versions, with stepper- and DC-motor coarse

drives, and open- and closed-loop piezoelectric fine drives. (see Ordering Information).

The motor drives provide better than 0.1 μm resolution over a travel range of 5 and 15 mm. The piezo fine drives feature a 100 μm travel range in X, Y and Z, with zero-stiction, zero-friction flexure guiding systems and 1 nm resolution.

Several fiber, waveguide and optics adapters are available from PI (e.g. model F-603.60, see "Fiber, Objective and Wave guide Holders", page 8-26).

The C-880 multi-axis automation platform (page 9-6) is recommended as controller.



F-130.3xx, dimensions (in mm)

Ordering Information

F-130.3SD

XYZ Alignment System, 5 mm,
100 µm, DC Motor/Encoder,
C/L Piezo

F-130.3SS

XYZ Alignment System, 5 mm,
100 µm, Stepper Motor, C/L Piezo

F-130.3OD

XYZ Alignment System 5 mm,
100 µm, DC Motor/Encoder,
O/L Piezo

F-130.3OS

XYZ Alignment System, 5 mm,
100 µm, Stepper Motor, O/L Piezo

F-131.3SD

XYZ Alignment System, 15 mm,
100 µm, DC Motor/Encoder,
C/L Piezo

F-131.3SS

XYZ Alignment System, 15 mm,
100 µm, Stepper Motor, C/L Piezo

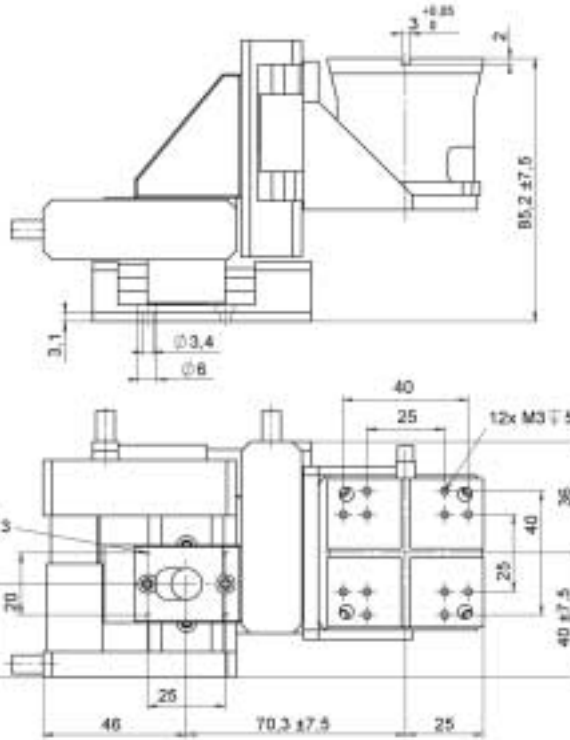
F-131.3OD

XYZ Alignment System, 15 mm,
100 µm, DC Motor/Encoder, O/L Piezo

F-131.3OS

XYZ Alignment System, 15 mm,
100 µm, Stepper Motor, O/L Piezo

Custom Designs for Volume Buyers



F-131.3xx, dimensions (in mm)

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The C-880 Multi-axis automation platform is recommended as controller for the F-130/F-131.



Technical Data

Models	F-130.3SD	F-130.3SS	F-130.3OD	F-130.3OS	F-131.3SD	F-131.3SS	F-131.3OD	F-131.3OS	Units	Notes see p. 7-96
Key features	Closed-loop DC motors, closed-loop PZT drives	Stepper motors, closed-loop PZT drives	Closed-loop DC motors, open-loop PZT drives	Stepper motors, open-loop PZT drives	Closed-loop DC motors, closed-loop PZT drives	Stepper motors, closed-loop PZT drives	Closed-loop DC motors, open-loop PZT drives	Stepper motors, open-loop PZT drives		
Active axes	X,Y,Z	X,Y,Z	X,Y,Z	X,Y,Z	X,Y,Z	X,Y,Z	X,Y,Z	X,Y,Z		
Motorized travel range (XYZ)	5	5	5	5	15	15	15	15	mm	
Piezo travel range (XYZ)	100	100	100	100	100	100	100	100	µm	
Design resolution (motor)	0.007	0.006	0.007	0.006	0.007	0.006	0.007	0.006	µm	A3
Min. incremental motion (motor)	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	µm	A4
Closed-loop / open-loop resolution (PZT)	2/1	2/1	- / 1	- / 1	2/1	2/1	- / 1	- / 1	nm	
Motorized stage	M-110.3DG	M-110.32S	M-110.3DG	M-110.32S	M-111.3DG	M-111.32S	M-111.3DG	M-111.32S		see p. 7-30
PZT drive	P-611.3SF	P-611.3SF	P-611.3OF	P-611.3OF	P-611.3SF	P-611.3SF	P-611.3OF	P-611.3OF		see p. 8-16
Material	Al	Al	Al	Al	Al	Al	Al	Al		L
Recommended controller (see page 9-6)	C-880		C-880		C-880		C-880			

P-611.30F
P-611.3SF*

NanoCube™ XYZ Rapid Photonic Nano Alignment Scanner

Application Examples

- Photonics packaging
- Optical device testing
- MEMS positioning/alignment
- Fiber alignment
- Micromachining
- Micromanipulation (life sciences)
- Semiconductor test systems

Ordering Information

P-611.3SF

NanoCube™ XYZ NanoAlignment Stage, 100 x 100 x 100 μm, Closed-Loop, Fiber Adapter Interface

P-611.30F

NanoCube™ XYZ NanoAlignment Stage, 100 x 100 x 100 μm, Open-Loop, Fiber Adapter Interface

Recommended Controllers

E-760, E-664

Custom Designs

for Volume Buyers

- **Ideal for Fiber Alignment and Photonics Packaging Applications**
- **Optional E-760 Controller Card with Built-In Optical Metrology**
- **100 x 100 x 100 μm Travel Range, Ultra-Compact Package!**
- **1 nm Resolution**
- **Closed- and Open-Loop Versions**
- **Precision Trajectory Control**
- **Fast Scanning and Settling**
- **Large Variety of Controllers**

The P-611.30F and P-611.3SF NanoCube™ NanoAlignment systems are based on PI's vast experience with ultra-high-precision piezo scanning systems (see section PZT flexure NanoPositioners) and photonics packaging applications. They combine a 100 x 100 x 100 μm XYZ positioning and scanning range with a zero stiction/friction wire-EDM-cut guiding system in an extremely compact package. NanoCube™ systems provide motion with nanometer-scale resolution and settling times of only a few milliseconds.

Open- & Closed-Loop Models

Open- and closed-loop versions are offered to suit your application. Several fiber, waveguide and optics adapters are available for mounting on the NanoCube™ (e.g. model F-603.60, see "Fiber, Objective and Waveguide Holders" page 8-26). NanoCubes™ are also available in a slightly different package without the fiber

adapter interface, see the P-611 article on page 2-36 in the "Flexure NanoPositioners" section.

Automatic Alignment

NanoCube™ can be operated with a special controller card (model E-760, p. 6-14) featuring built-in optical metrology and search functionality for automatic alignment tasks. A variety of other rackmount and bench-top controllers is also available.

NanoCubes™ can be easily combined with a number of automated or manual PI MicroPositioning systems, from single axis stages to 6-degree-of-freedom micromanipulators.

Working Principle

P-611 NanoPositioners are equipped with low-voltage piezoelectric drives (0 to 100 V) integrated into a sophisticated flexure guiding system. The force exerted by the piezo drive pushes a multi-flexure parallelogram via an integrated motion amplifier. The wire-EDM-cut flexures are FEA modeled (finite element analysis) for zero stiction and friction, ultra-high resolution and exceptional guiding precision. Integrated position feedback sensors provide nanometer-scale resolution and stability in closed-loop operation (with PI control electronics).



P-611 NanoCube™, XYZ Compact NanoAlignment System, 100 x 100 x 100 μm travel range, 1 nm resolution, shown with optional F-603.22 ferrule holder.

Notes

*For versions without the fiber adapter interface see the P-611 article on page 2-36 in the "Flexure NanoPositioners" section.

