

PI nano™ 1x3 XYZ & XY Piezo Stage Systems

Low-Profile, Low-Cost, Nanopositioning Systems for Super-Resolution Microscopy



PI nano™ series nanopositioning stages feature a very low profile of 20 mm (0.8"), a large aperture for 1x3" slides and deliver highly accurate motion with sub-nanometer resolution in up to 3 axes. Slide / petri dish holders optional.

- **Low Profile for Easy Integration: 20 mm (0.8")**
- **Large Aperture for 1x3" Slides. Accessories & Holders Available**
- **All Parts Black Anodized for Minimum Reflections**
- **200µm Standard Travel Range, Longer Ranges Available**
- **Longest Lifetime with Proprietary PICMA® Piezo Technology**
- **Cost Effective due to Low-Cost Piezoresistive Sensors**
- **Compatible w/ Leading Image Acquisition Software Packages**
- **Closed-Loop Control for High Repeatability and Accuracy**
- **Millisecond Step Time, ideal for Super-Resolution Microscopy**
- **Recessed Sample Holders for Maximized Utility**

Long Travel, Low Profile, Optimized for Microscopy

The new PI nano™ XY and PI nano™ XYZ low-profile piezo scanning stages are optimized for easy integration into high-resolution microscopes. They feature a very low profile of 0.8" (20 mm), a large aperture, and long travel ranges of up to

200x200x200 µm with sub-nanometer closed-loop resolution—ideal for leading-edge microscopy and imaging applications.

Longest lifetime is guaranteed by the integrated ceramic-encapsulated PICMA® piezo actuators. Due to the significantly higher humidity resistance, the patented PICMA® design provides up to 10 times longer life than conventional piezo actuators.

Cost Effective Design, High Performance

PI nano™ series piezo positioning stages are designed to provide high performance at minimum cost. For highly-stable, closed loop operation, piezoresistive sensors are applied directly to the moving structure and precisely meas-

ure the displacement of the stage platform. The very high sensitivity of these sensors provides optimum position stability and responsiveness as well as sub-nanometer resolution. A proprietary servo controller significantly improves the motion linearity compared to conventional piezoresistive sensor controllers.

Working Principle / Reliability

Flexures optimized with Finite Element Analysis (FEA) are employed to guide the PI nano™ series stages. FEA techniques give the design the highest possible stiffness in, and perpendicular to, the direction of motion, and to minimize linear and angular runout. Flexures allow extremely high-precision motion, no matter how minute, as they are completely free of play and friction. The award-winning PICMA® piezo drives are more robust than conventional piezo

Ordering Information

P-545.2R7
PI nano™ XY Nanopositioning System, 1x3" Aperture, Slide Holder 200x200 µm, Piezoresistive Sensors, 24 Bit /USB controller.

P-545.3R7
PI nano™ XYZ Nanopositioning System, 1x3" Aperture, Slide Holder 200x200x200 µm, Piezoresistive Sensors, 24 Bit /USB controller.

P-545.2R2
PI nano™ XY Nanopositioning System, 60x60 mm Aperture, 200x200 µm, Piezoresistive Sensors, 24 Bit /USB controller.

P-545.3R2
PI nano™ XYZ Nanopositioning System, 60x60 mm Aperture, 200x200x200 µm, Piezoresistive Sensors, 24 Bit /USB controller.

actuators, featuring superior lifetime and performance in both dynamic and static applications. Because guidance, actuators and sensors are all maintenance-free, these nanopositioning systems achieve outstanding levels of reliability.



Background: The piezo controller is included and comes with a 24-bit resolution USB port as well as ethernet, RS-232 and an analog interface.

Foreground: The optional M-545 manual XY stage provides a stable platform for the PI nano™ piezo stage. R2 piezo stage versions (60x60 mm aperture) shown.

Application Examples

- Super-resolution microscopy
- 3D Imaging
- Laser technology
- Mask / wafer positioning
- Interferometry
- Metrology
- Biotechnology
- Micromanipulation

Technical Data

Model	Plnano XY	Plnano XYZ	Units	Tolerance
Active axes	X, Y	X, Y, Z		
Motion and positioning				
Integrated sensor	Piezoresistive	Piezoresistive		
Closed-loop travel	200 x 200	200 x 200 x 200	µm	
*Resolution	<1	<1	nm	typ.
Linearity	+/- 0.1	+/- 0.1	%	typ.
Repeatability	<5	<5	nm	typ.
Mechanical properties				
Push/pull force capacity in motion direction	100 / 30	100 / 30	N	Max.
Max. payload	500	500	g	Max.
Drive properties				
Ceramic type	PICMA® P-885	PICMA® P-885		
Electrical capacitance per axis	6	6 (X, Y), 12 (Z)	µF	±20%
Miscellaneous				
Recommended operating temperature range	20 to 30	20 to 30	°C	
Material	Aluminum	Aluminum		
Mass	1	1.2	kg	±5%
Cable length	1.7	1.7	m	±10 mm
Sensor / voltage connection	Sub-D 25	Sub-D 25		

Objective Scanners & Mirrors

Z/Tip/Tilt Stages

XY/XYZ Stages

6-Axis Stages

Actuators / Linear Motors

Piezo Controllers

News & Applications

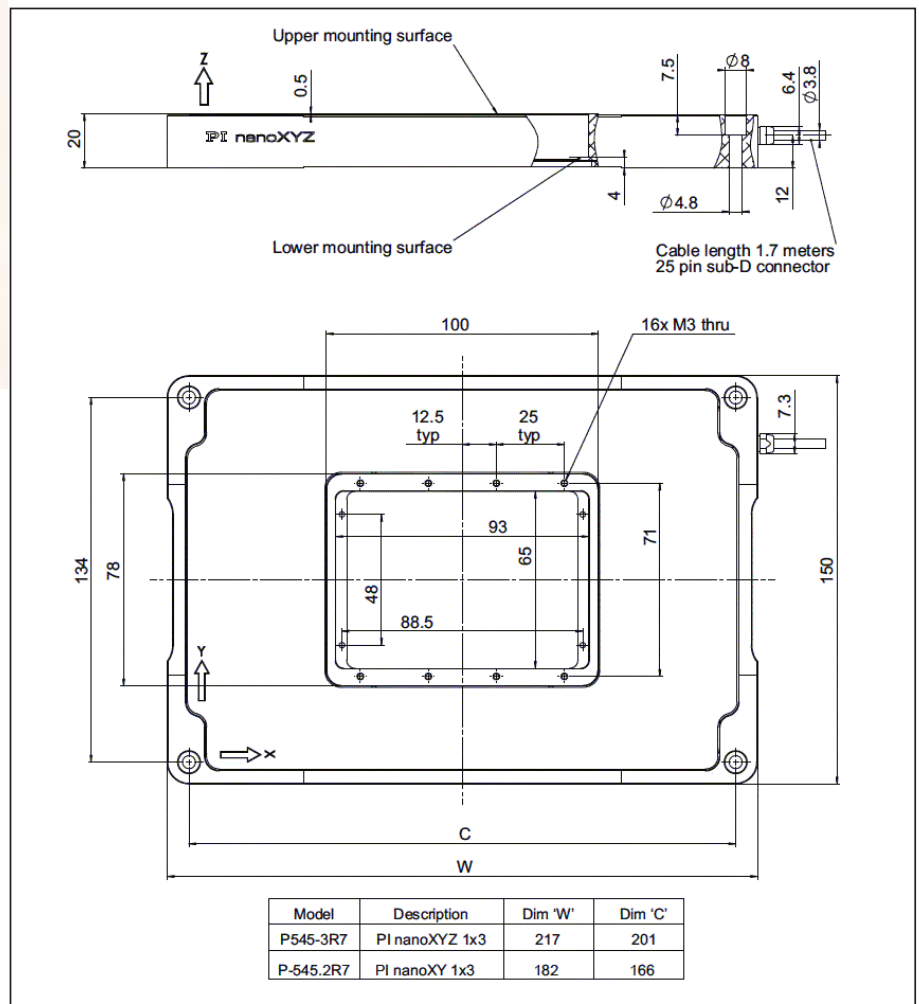
*Resolution of PI Piezo Nanopositioners is not limited by friction or stiction. Value given is noise equivalent motion measured with interferometer.



The P-545 piezo stage can be mounted on the optional M-545 manual XY stage. This high-stability stage is recommended as a basis for the piezo stage, especially when the highest step-and-settle performance is required. It is available for Olympus, Nikon, Zeiss and Leica microscopes and can also be upgraded with motorized micrometers.



M-545.2 Microscope stage. The high stability and autolocking feature of M-545 provides significant advantages over other microscope stage designs when using fast piezo scanning stages.



P-545 Plnano™ Trak High-Speed Piezo Tracking Stage

Fastest XYZ Microscope Stage to Enable use of Full Turret Motion



Plnano™ series nanopositioning stages feature a very low profile of 0.8" (20mm) and use a full slide mounted at the bottom. They deliver very fast and highly accurate motion with sub-nanometer resolution in up to 3 axes.

- **Ultra Fast: < 5msec Response Time:**
Ideal for Tracking Applications
- **Low Profile for Easy Integration: 20 mm (0.8")**
- **Full Slide Mounted at Bottom:**
Turret can Rotate w/o Moving Objective in and out
- **Up to 70 x 70 x 50 μm Travel Range**
- **10X Longer Lifetime due to**
Proprietary PICMA® Piezo Technology
- **Cost Effective due to Low-Cost Piezoresistive Sensors**
- **Compatible w/ Leading Image Acquisition Software**
- **Closed-Loop Control for High Repeatability and Accuracy**
- **Sub-Nanometer Resolution and Millisecond Step Time,**
ideal for Super-Resolution Microscopy
- **High Power Controller Included**
- **Optional Long Travel Piezomotor / Manual Stage**

High Speed Long Travel, Low Profile, Ideal for Single Molecule Tracking

The new Plnano™ XY and XYZ high-speed piezo scanning stages are optimized for easy integration into high resolution microscopes. They feature a very low profile of 0.8" (20 mm), a large aperture, and extremely fast response with subnanometer closed-loop resolution— ideal for leading-edge particle tracking and microscopy applications. Longest lifetime is guaranteed by the integrated ceramic encapsulated PICMA® piezo actuators. Due to the significantly higher humidity resistance, the patented PICMA® design provides up to 10 times longer life than conventional piezo actuators.

Cost Effective Design, High Performance

Plnano™ series piezo positioning systems are designed to provide high performance at minimum cost. The system consists of the mechanics and an advanced controller optimized for the piezo stages. For highly stable, closed loop operation, piezoresistive sensors are applied directly to the moving structure and precisely measure the displacement of the stage platform. The very high sensitivity of these sensors provides optimum position stability and responsiveness as well as sub-nanometer resolution. The proprietary servo controller significantly improves the motion linearity compared to conventional piezoresistive sensor controllers.

Working Principle / Reliability

Flexures optimized with Finite Element Analysis (FEA) are employed to guide the Plnano™ series stages. FEA techniques give the design the highest possible stiffness in, and perpendicular to, the direction of motion, and to minimize linear and angular runout. Flexures allow extremely high-precision motion, no matter how minute, as they are completely free of play and friction. The award-winning PICMA® piezo drives are more robust than conventional piezo actuators, featuring superior lifetime and performance in both dynamic and static applications. Because guidance, actuators and sensors are all maintenance-free, these nanopositioning systems achieve outstanding levels of reliability:

Ordering Information

P-545.2D7
Plnano™ Trak XY High-Speed Piezo Tracking Stage with large Aperture, 70x70 μm, Piezoresistive Sensors, with High Power Piezo Controller

P-545.3D7
Plnano™ Trak XYZ High-Speed Piezo Tracking Stage with large Aperture, 70x70x50 μm, Piezoresistive, Sensors, with High Power Piezo Controller

Ask about custom designs!

Application Examples

- Biotechnology
- Microscopy
- Scanning microscopy
- Confocal microscopy
- Semiconductor testing
- Handling

Preliminary Specs

Models	Plnano™ XY	Plnano™ XYZ	Units	Tolerance
Active axes	X,Y X,Y,Z			
Integrated sensor	Piezoresistive P	iezoresistive		
Closed-loop travel	70 x70	70 x70x50	μm	
*Resolution	<1 <1		Nm	typ.
Linearity	+/-0.1 +/-0.	1	%	typ.
Repeatability	<5 <5		Nm	typ.
Push/pull force capacity in motion direction	100 / 30	100 / 30		max.
Max. payload	500 50	0	g	max.
Drive properties				
Ceramic type	PICMA®	PICMA®		
Recommended operating temp. range	20 to 30	20 to 30	°C	
Material	Aluminum	Aluminum		
Mass	1 1.2		kg	±5%
Cable length	2 2		m	±10 mm

*Resolution of PI Piezo Nanopositioners is not limited by friction or stiction. Value given is noise equivalent motion measured with interferometer

P-545 PInano™ Cap Super-Stability XY / XYZ Piezo Stages

Capacitive Feedback for Highest Stability & Linearity: Ideal for SR-Microscopy



PInano™ Cap super stability piezo XYZ stage, 200 μm. These capacitive-sensor-equipped stages provide higher stability and linearity than PR sensor stages. Very low profile of 0.8" (20mm), full slide mounted at the bottom.

- **Capacitive Direct Metrology Sensors: Higher Linearity, Stability and Accuracy than PR-Sensor Versions**
- **Closed Loop USB Controller (24 Bit Resolution) & Software Included**
- **Low Profile for Easy Integration: 20 mm (0.8")**
- **Bottom Slide Mount: No Interference with Turret Rotation**
- **200 μm Travel Range per Axis**
- **10X Longer Lifetime with Proprietary Piezo Technology**
- **Compatible w/ Leading Image Acquisition Software**
- **Sub-Nanometer Resolution and Millisecond Step Time,**
- **Ideal for Super-Resolution Microscopy**
- **Optional Long Travel Piezomotor / Manual Stage**

High Stability and Linearity Optimized for High-Resolution Microscopes

The new PInano™ Cap XY and XYZ capacitive sensor piezo stages are optimized for easy integration into high resolution optical microscopes. They feature a very low profile of 0.8" (20 mm), a large aperture, and extremely fast response with subnanometer closed-loop resolution—ideal for leading-edge microscopy and imaging applications. The stage design permits a full slide to be mounted at bottom allowing the turret to be rotated without moving the objective in and out. Longest lifetime is guaranteed by the integrated ceramic encapsulated PICMA® piezo actuators. Due to the significantly higher humidity resistance, the patented PICMA® design provides up to 10 times longer life than conventional piezo actuators.

High Performance, Yet Cost Effective

PInano™ Cap series piezo stages provide even higher performance than their piezoresistive (PR) sensor equipped cousins. Systems consist of the piezo mechanics, an advanced controller optimized for capacitive feedback and software. For the highest linearity and stability, these stages are based on direct measuring, non-contact capacitive sensors, a principle free of Johnson noise. RF excitation circuitry in the controller further reduces sensitivity to external noise sources or DC voltage drift of electronic components that can limit the long term stability of DC signal excited sensors such as film and PR strain gauges. The proprietary servo design improves the motion linearity compared to conventional piezo controllers.

Stage Working Principle / Reliability

Flexures optimized with Finite Element Analysis (FEA) are employed to guide the PInano™ series stages. FEA techniques give the design the highest possible stiffness in, and perpendicular to, the direction of motion, and to minimize linear and angular runout. Flexures allow extremely high-precision motion, no matter how minute, as they are completely free of play and friction. The award-winning PICMA® piezo drives are more robust than conventional piezo actuators, featuring superior lifetime and performance in both dynamic and static applications. Because guidance, actuators and sensors are all maintenance-free, these nanopositioning systems achieve outstanding levels of reliability:

Ordering Information

P-545.2C7

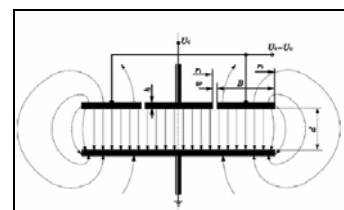
PInano™ Cap XY Piezo Stage with large Aperture, 200x200μm, Capacitive direct Metrology Sensors, with USB Controller

P-545.3C7

PInano™ Cap XYZ Piezo Stage with large Aperture, 200x200x200μm, Capacitive direct Metrology Sensors, with USB Controller

Application Examples

- Biotechnology
- SR-Microscopy
- Scanning microscopy
- Confocal microscopy
- Sample Positioning



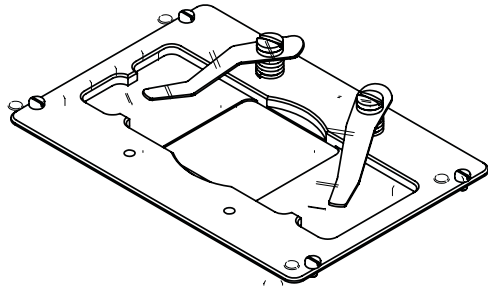
Non-contact capacitive position sensors measure directly and provide higher linearity and long term stability compared to piezoresistive or film sensors that infer position information from strain.

Models	PInano™ XY	PInano™ XYZ	Units	Tolerance
Active axes	X,Y	X,Y,Z		
Integrated sensor	Capacitive C	apacitive		
Closed-loop travel	200x200	200x200x200	μm	
*Resolution	<1 <1 n		m	1 σ
Linearity	+/-0.05 +/-0.	05 %		typ.
Repeatability	<5 <5 nm			typ.
Push/pull force capacity in motion direction	100 / 30	100 / 30		max.
Max. payload	500 50	0 g		max.
Ceramic type	PICMA® PICMA®			
Recommended operating temperature range	20 to 30	20 to 30	°C	
Material	Aluminum Aluminum			
Mass 1		1.2	kg	±5%
Cable length	2 2	m		±10 mm

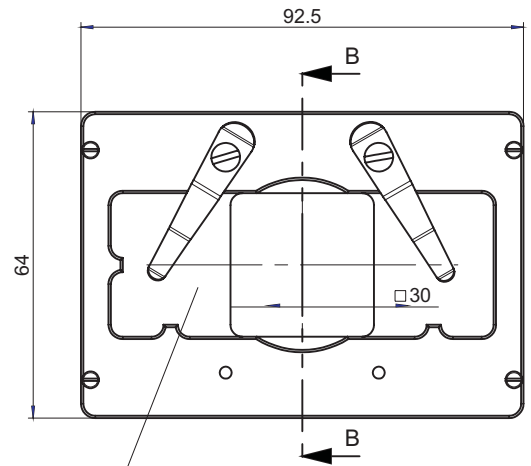
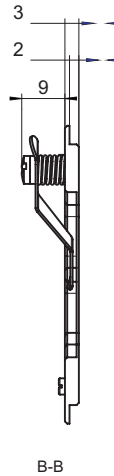
*Resolution of PI Piezo Nanopositioners is not limited by friction or stiction. Value given is noise equivalent motion measured with interferometer

P-545.xR7 Sample Holder Accessories

P-545.SH3
Slide Holder



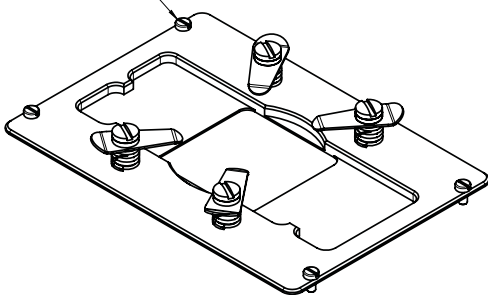
P-545.SH3



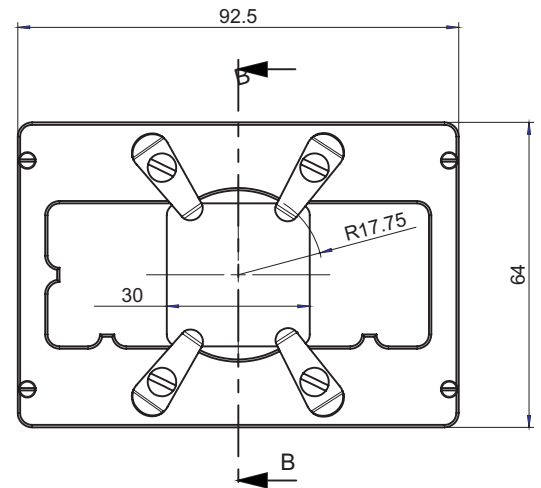
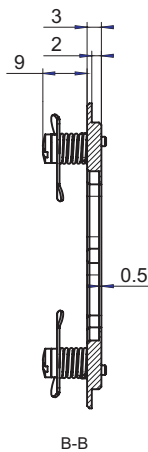
Opening for Standard Microscope Slide
25mm x 75mm or 1 inch x 3 inch

P545.PD3
Petri Dish Holder

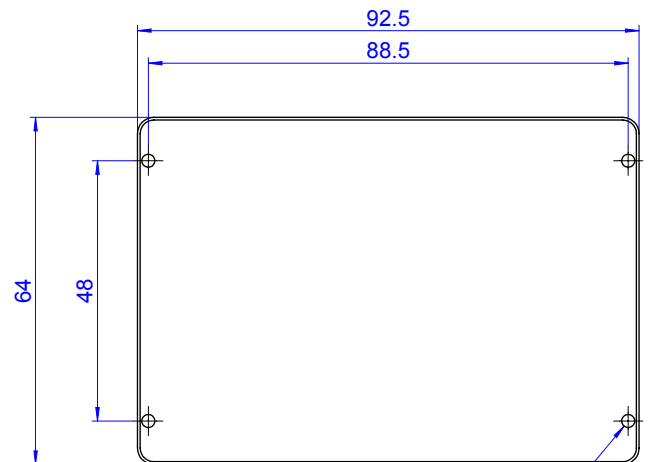
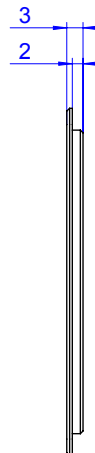
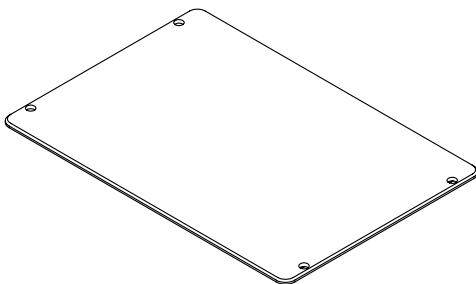
M2 x 3mm Screw



P545.PD3



P-545.PP3 Blank Plate



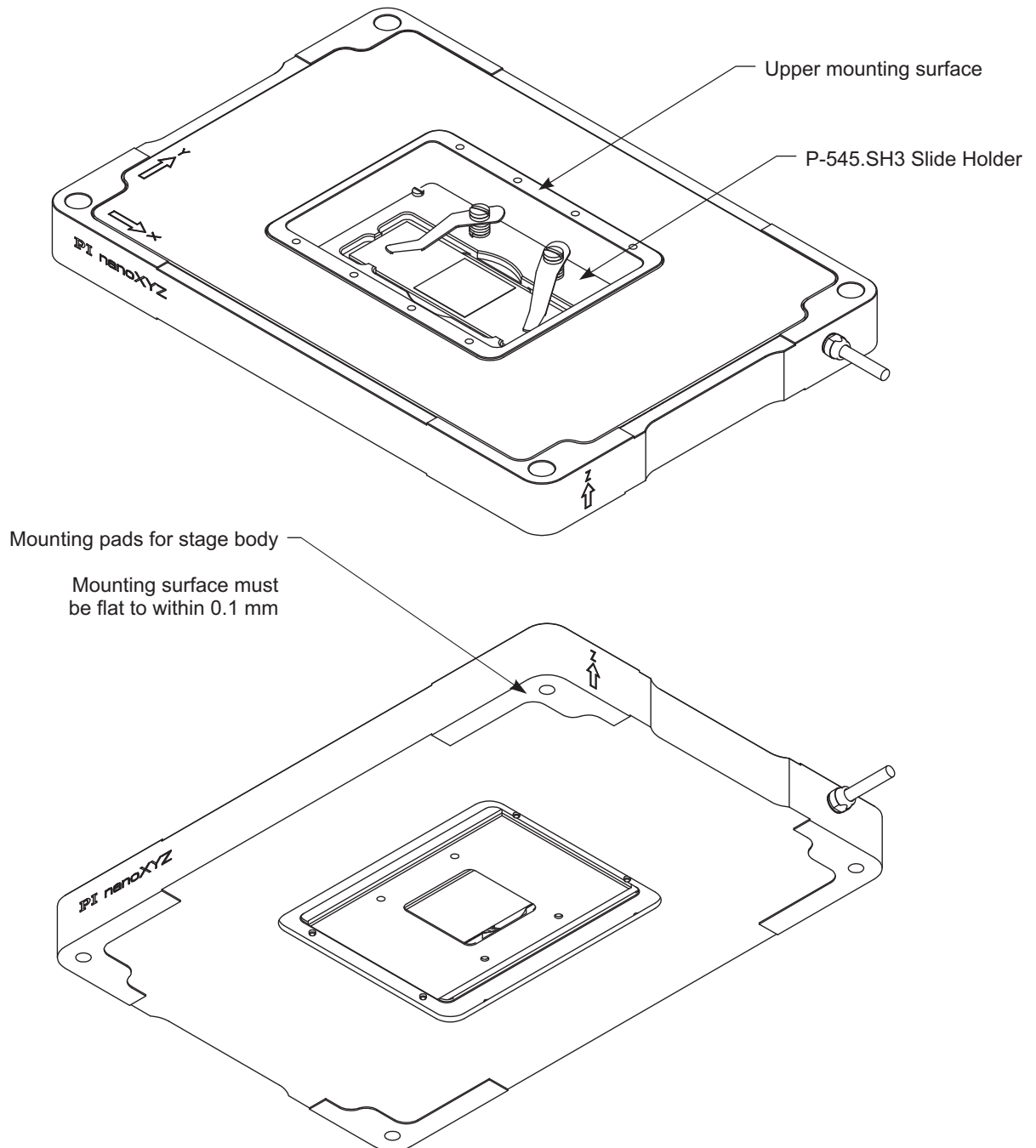
4 x \varnothing 2.4 THRU ALL

P545.xR7 Mounting

P-545 Stages have two mounting surfaces. The primary surface is on the top of the stage and protrudes from 0.5 mm from the body of the stage.

A secondary mounting surface is provided on the bottom of the stage. This surface allows mounting closer to the bottom surface of the stage body which can be useful in some applications, such as microscopy.

The planar dimensions and mounting hole pattern are identical. The applicable dimensions are shown in the diagram on the previous page.



Optional High-Stability Manual Microscope Stage as Basis for Piezo Stage

PI has designed the P-545 stage to be easily integrated to commercial microscopes through the use of the M-545 stage. M-545 stages are available for Nikon, Olympus, Zeiss and Leica inverted microscopes. These stages mount directly to the microscope base and accept the P-545.3R and P-545.2R as well as several other PI stages. The M-545 stages can be manually driven through micrometers or using PI's precision motorized actuators. Contact your PI sales representative for details.

When used in a microscope application, the focal plane for the microscope is located near the bottom of the stage. It is for this reason that the stage has a lower mounting surface. The figure below shows the nominal location of the focal plane. Vertical travel of the objective varies based on the microscope used.

A series of accessories is available from PI to assist with mounting a sample holder to the stage. The P-545.SH1 is available to hold standard 1"x 3" (25mm x 75mm) microscope slides and the P-545.PD1 is offered for holding 35mm Petri Dishes.

