U Series Ultra Resolution Positioners (XY/10nm)

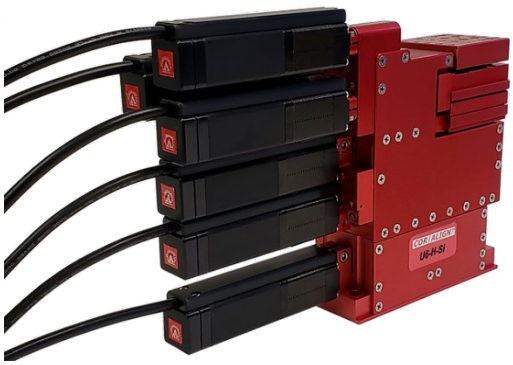
Overview

Luminos U Series Ultra Resolution Positioners utilize the Luminos designed Ultra Precise Linear Stepping Motor Actuator and deliver industry leading 0.1um bi-directional backlash with incremental move capability finer than 10nm resolution on the X and Y axis.

U Series Positioners provide full 2.5mm x 2.5mm x 12.7mm XYZ travel range and offer significant performance improvements compared to Luminos automated I3000 and I6000 positioners which also provide photonics grade alignment with smaller travel ranges.

U Series Positioners represent a significant leap in automation capability, delivering a five fold increase in working resolution (actual minimum movement without lost micro-steps) and an overall speed increase of 12x with a 25x greater motor travel envelope.

U Series Positioners deliver performance that far exceeds SMF-28 Singlemode Fiber Alignment requirements. Using only stepping motor controls, there is no need for closed loop compensation or fine stages and additional controllers. You can also easily align SM waveguides to within 0.01 dB of optimized without backlash compensation.



U6 Ultra XYZ/RYP Positioner

中国区代理商：深圳市谱兆通讯设备有限公司 联系电话：0755-86655448/86655579/86655593
电子邮件：commercial02@pztest.com; info@pztest.com 公司网站：www.pztest.com

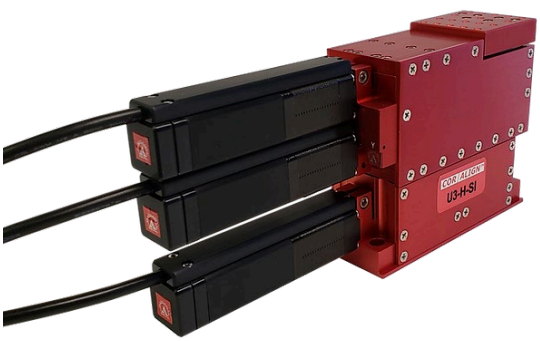
Fiber and Photonics Alignment - No Piezos Required

In the Photonics industry it is generally accepted that Alignment Stages need to resolve to about 1% of beam size or waveguide MFD. For aligning SMF-28 with 10um MFD, a resolution of 100nm is usually acceptable – or was. With the emergence of cutting edge planar photonic devices there is an increasing requirement to align smaller and smaller waveguide structures sometimes as fine as 2um MFD.

It is becoming clear that a new standard of about 20nm resolution is needed for Photonics Positioning Stages. Most major positioning stage manufacturers offer automated alignment systems that employ Coarse + Fine travel stages with multiple levels of controllers, in order to meet Photonics resolution requirements. Many such course travel stages have motor actuators with up to 5-10um of backlash. The use of fine travel piezo stages is therefore not an option, resulting in increased system complexity.

Ultra Low Backlash

Luminos Positioners are unique in industry, delivering consistent micro-stepping performance using a frictionless and inherently time stable in-line configured flexure-based positioning platform, paired with custom open loop stepping motor actuators designed with ample torque margin. Frictionless drive mechanisms are also used to ensure that the actuators operate under uniform preloads. When aligning waveguides, the X & Y axes usually require more than 5X higher resolution than the Z axis. Taking unique advantage of the differing requirements, Luminos stages strategically incorporate patented **Ratio Drive™** mechanisms on the X & Y alignment axes. The XYZ actuators all move 12.5mm however, on Luminos Automated U Series Positioners, the X & Y move their full 2.5mm travel under control of the motor. This results in 5X greater precision in the more critical X & Y axes outputting an incredibly low 0.1um **bi-directional** backlash with 10nm resolution. **Most importantly - no Piezo's required!**

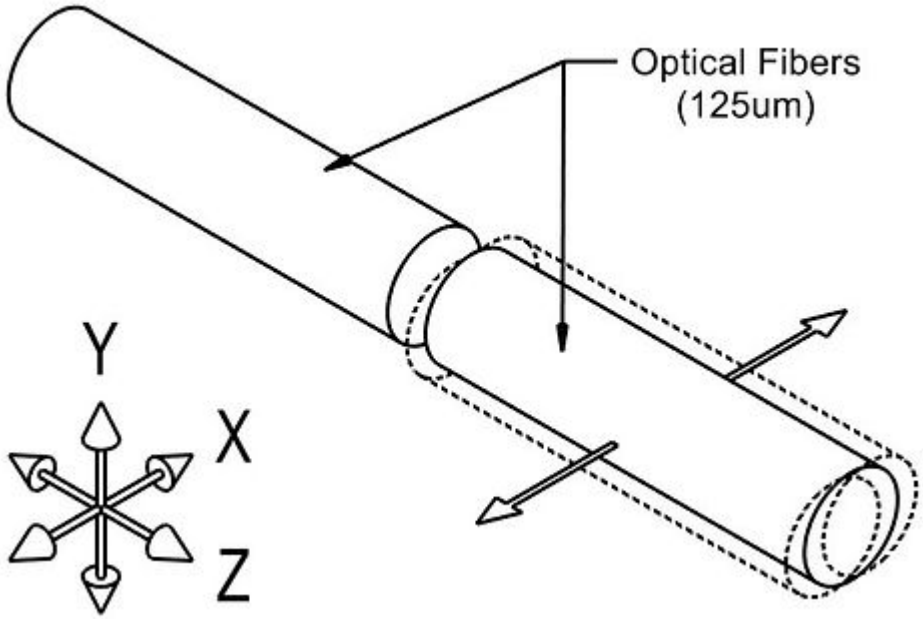


U3 Ultra XYZ Positioner

Photonic Waveguide Alignment

Lateral Alignment Sensitivity

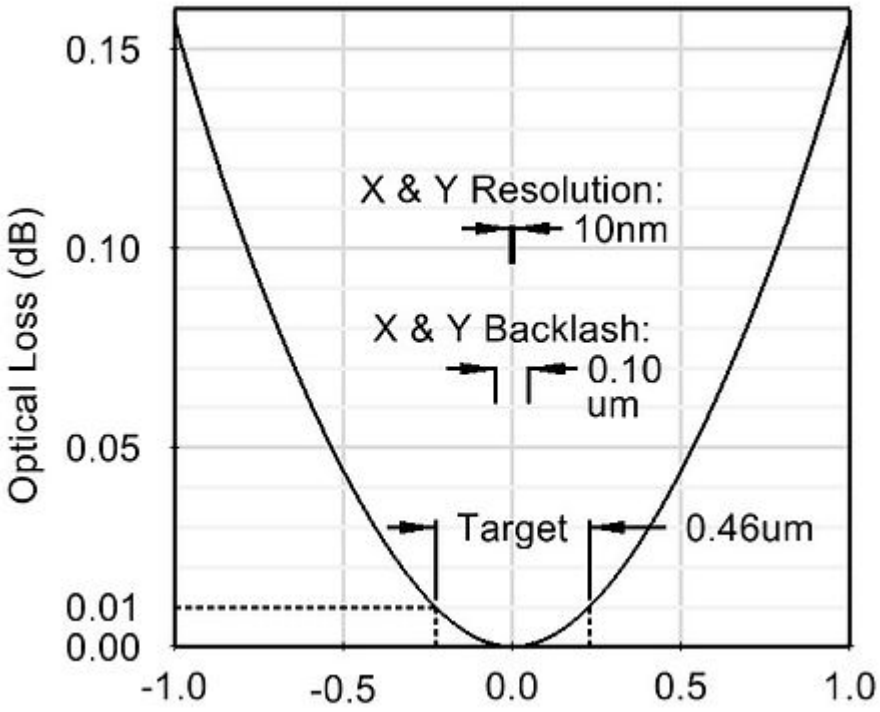
To help understand the level of precision required for aligning photonic waveguides, consider an Industry Benchmark: the SMF-28 single-mode optical fiber with 10um mode field (MFD). Figure #1 depicts how the ends of two optical fiber waveguides would be moved in the X direction to examine Optical Loss vs Lateral Alignment. Typically, one fiber would be connected to a light source and the other to a power meter. The optical loss is equally sensitive to lateral movement in the X and Y directions for SMF-28 which is a round symmetrical waveguide. As industry moves towards advanced planar optical waveguide devices, it becomes more common to see planar waveguides with a 2-3um MFD. It becomes even more important for positioning systems to have margin.



Optical Loss vs. Lateral X or Y Alignment
Figure #1

Figure #2 shows a plot of the Optical Loss vs Lateral Alignment of SMF-28 optical fibers within the range of +/- 1um of ideal alignment. Most optical power meters have a typical 0.01 dB resolution which can be seen to correspond to a target X displacement range of 0.46um. If a positioning stage were to have less than 0.46um bi-directional backlash, then it becomes possible to write optimization software that does not need to rely heavily on backlash compensation. It also becomes possible to design a positioning system that does not have to switch between coarse and fine movement controls. The majority of actuators on the market that can meet the Figure #2 Target are complex closed loop units with encoders

or compound stepping motor actuators often with additional Piezo fine stages built in. Luminos stages offer many strategic advantages. Luminos U Series Ultra Positioners deliver a positioning stage architecture unique to the market. Luminos offers the only stages that can deliver 0.1um bidirectional backlash on X & Y with simple incremental stepping motor controls. Photonics waveguide alignment without requiring the use of Piezos or encoders. A simplified approach to meeting and exceeding the requirements of photonics waveguide alignment systems. In fact, Figure #2 shows there is margin in accuracy for going far beyond the requirements of aligning SMF-28.

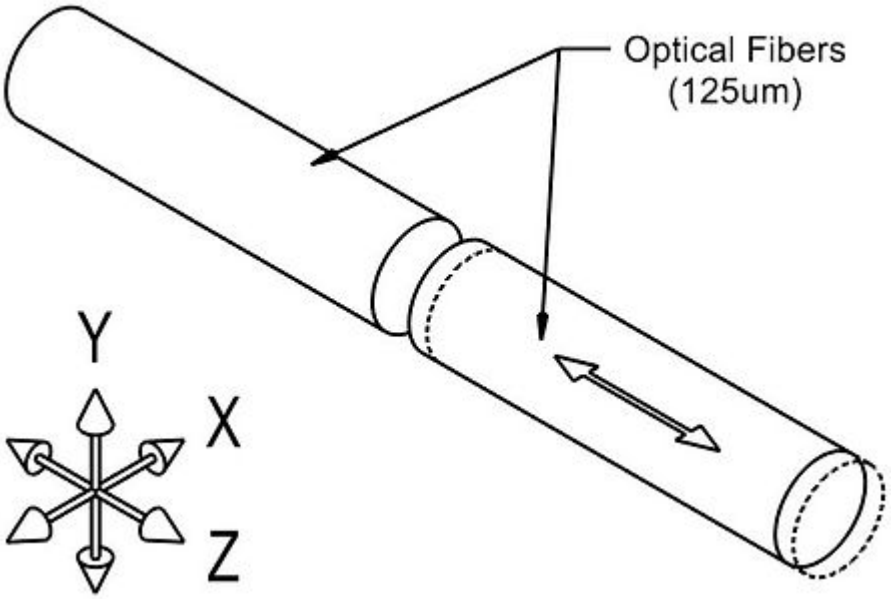


Optical Loss vs. Lateral Alignment

Figure #2

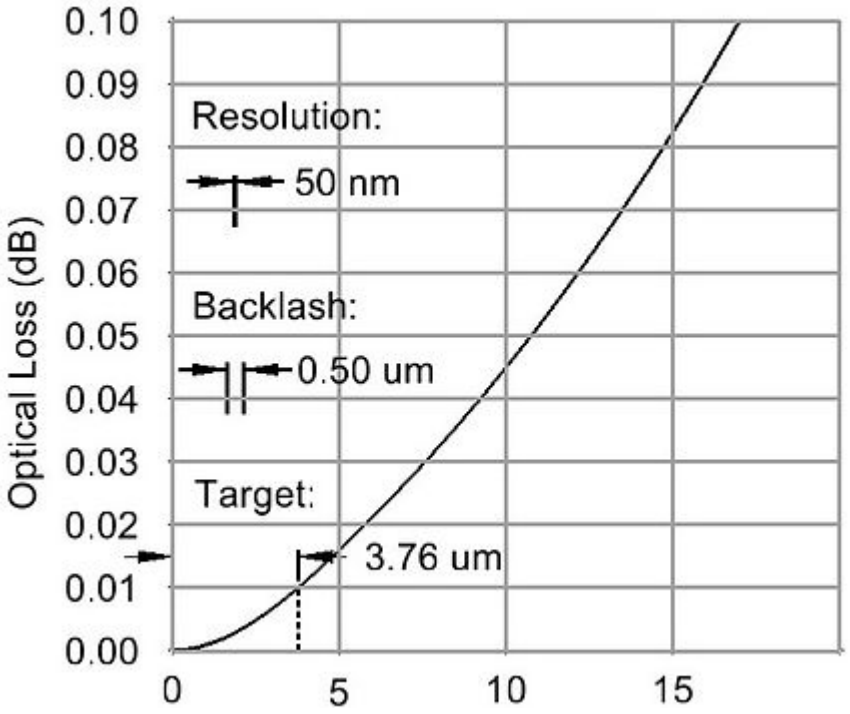
Axial Alignment Sensitivity

Figure #3 depicts how the ends of two optical fibers would bemoved to examine Optical Loss vs Axial Alignment. lt isassumed that the optical fibers are in idealX&Yalignmentand only theZ gap spacing is varying. The loss measurementsshown in Figure #2 & Figure #4 were taken with indexmatching fluid between the ends of the optical fibers toeliminate Fresnelinterference effects



Optical Loss vs. Axial Alignment
Figure #3

In Figure #4, Optical Loss vs. Axial Gap Size, optical loss is observed to be far less sensitive to axial movement than to lateral movement, as seen in Figure #2. The difference in target size for a 0.01dB offset is measured as 3.76um vs 0.46um. This differing alignment sensitivity can be significant in low NA optical waveguides and is uniquely taken advantage of with Luminos **Ratio Drive™**, incorporating highly engineered frictionless flexure drive mechanisms within the X & Y axes of all Luminos stages. Another strategic benefit of Luminos **Ratio Drive™** is increased stability. When the motor actuators warm slightly, any resulting thermally induced change in position is also reduced by the same Ratio. As a result, Luminos stages are inherently more stable than comparable direct driven stages and are reputed by customers to maintain very stable alignment while idling for long periods of time even many days.



Optical Loss vs. Axial Gap Size SMF28 @ 1550nm (9/125μm fiber)
Index Matched

Figure #4

Specifications

Travel		
Axis	U Actuator Travel	Output Travel
Z - focus	12.7mm (0.50")	12.7mm (0.5")
Y - vertical	12.7mm (0.50")	2.5mm (0.1")
X - lateral	12.7mm (0.50")	2.5mm (0.1")
Roll	12.0 mm (0.47")	±1.5 degrees
Yaw	6.0 mm (0.24")	±1.5 degrees
Pitch	6.0 mm (0.24")	±1.5 degrees

Resolution				
Axis	Resolution	Full Steps	µ-Steps	Comments
Z	50nm (2µ-inch)	4,167	266666	Resolution at the output of the positioning stage is based on the micro-stepping controller operating at 64µ-steps/full step. One full step = 0.00012" [3.048 µm] at the actuator. One µ-Step = 1.875 µ-inch [47.6 nm] at the Z output. At the X and Y output, consistent 10nm movements are delivered.
Y	10nm (0.4µ-inch)	4,167	266666	
X	10nm (0.4µ-inch)	4,167	266666	
Roll	0.043 arc sec	3,937	251968	
Yaw	0.086 arc sec	1,968	125952	
Pitch	0.086 arc sec	1,968	125952	

Stage Configuration & Arc Error Motion			
Axis	Flexure Type	Drive Type	Arc Error
Z	Dual	Direct Drive	None - True Linear Motion
Y	Single	5x Ratio Drive™	Max 30µm - Arc Error in Z only
X	Single	5x Ratio Drive™	Max 30µm - Arc Error in Z only
Roll	Single	Rotational	Max 35µm
Yaw	Dual	Rotational	None
Pitch	Dual	Rotational	None

Linear Stiffness		
Along Axis	Stiffness	Comments
Z	130 kN/m	measured at the rotation center
Y	95 kN/m	
X	40 kN/m	

Torsional Stiffness		
About Axis	Stiffness	Comments
Z - roll	75Nm/rad	measured at the rotation center
Y - yaw	100Nm/rad	
X - pitch	130Nm/rad	

Maximum Load		
Static Load	Transient Load	Comments
2.2 lbs (1 kg)	10 lbs (4.5 kg)	Stage must be protected from shock loading during transport and usage

Physical Properties		
Characteristics	Specifications	Comments
Construction	Aluminum	6061 & 7075 - T6 anodized
Weight	1.5 kg	Approximate
Body Dimensions	5.79" x 1.75" x 5.19"	LxWxH excluding micrometers
Mounting Height	5.19"	Base to top of mounting plate
Mounting Configuration	0.26" diameter holes	1.00" x 4.00" centers (compatible with1.00" grid optical tables, units mount on 2" intervals with 0.25" allowance for routing of cables, etc.
Coincident Rotation Center	1/2"	Above top of mounting plate
	1"	Out from end of mounting plate