



*Global Manufacturer of Innovative Ultra Precision Machining Solutions*

# *Freeform® TL1000*



*The Largest 5-Axis  
Ultra Precision Machine*

**AMETEK®**  
ULTRA PRECISION TECHNOLOGIES

[www.precitech.com](http://www.precitech.com)

Whether you need to manufacture a freeform part today or want the flexibility for future market requirements, **the Freeform® TL 1000 is precisely the machine you need.**

Precitech has added our 500 mm X axis to the field proven Freeform TL platform, increasing flexibility and precision. The result is the largest commercially available ultra precision freeform machining system - the Freeform TL 1000.

Customers can diamond turn, micro-mill, micro-grind, and groove non-rotationally symmetric surfaces on a one-meter platform.

Since 1962 we have delivered complete ultra precision solutions and maintain an installed base of over 1,500 systems worldwide. We continue to define the state-of-the-art, enhancing accuracy, productivity, and ease of use.

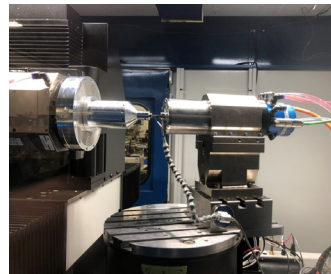


Standard lathe enclosure also available. Temperature control room with easy access doors and roof panel for crane access. Shown in a full temperature controlled room for maximum precision.

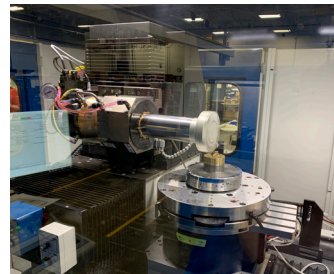


Work envelope. Granite risers used to elevate the X axis, minimizing ABBE offset errors

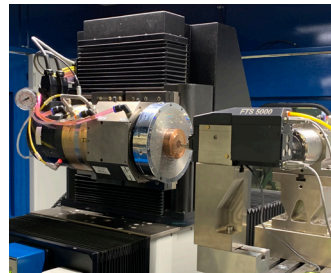
## Flexibility



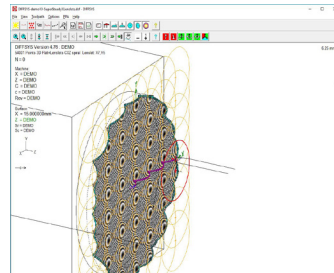
Local spiral milling using 80k rpm Levicon air bearing spindle



Raster milling (flycutting) of an F-theta lens using the HS-150 workholding spindle



Cutting a lens array with the FTS 5000 fast tool servo

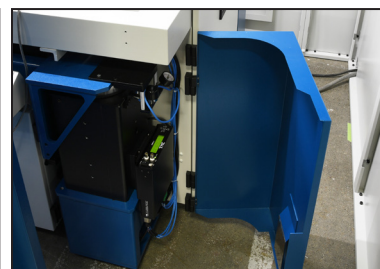


DIFFSYS tool path generation software included with every machine

## Available Options



Available with Praecis air shower for up to ±0.01°C temperature control accuracy



Available PEPS II-VX active on-machine vibration cancellation and leveling

## Key Specifications

Turning performance	Surface roughness < 1.5 nm Sa Form accuracy < 0.125 µm P-V (tested and measured on one surface upon request)
Milling performance	Surface roughness < 10 nm Sa (< 3 nm is achievable with optimum material and cutting conditions) Form accuracy < 0.2 µm P-V
Swing capacity	1000 mm dia. maximum 530 to 680 mm dia. over B axis depending on configuration (can be expanded upon request)

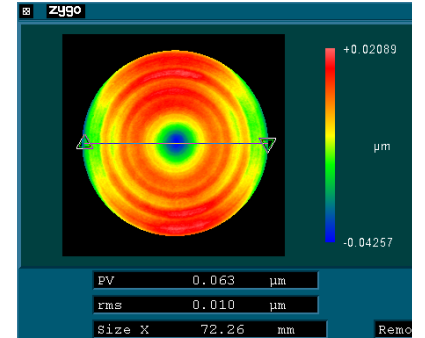
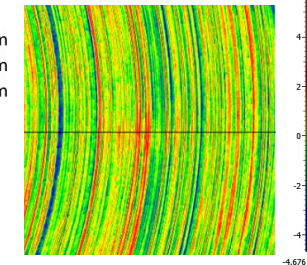
## Features and Benefits

- ▶ **Industry leading swing and load capacity**
- ▶ **Part cutting results comparable to commercially available small frame machines**
- ▶ **Flexibility to produce freeform geometries with 3 linear and 2 rotary CNC axes**
- ▶ **5 Axis freedom with 3 axis performance**  
Y axis and spindle designed for maximum thermal stability
- ▶ **Thermally controlled enclosure options insure accuracy during long cutting-time parts**
- ▶ **Reduced sensitivity to vibration enabled by its integral TMC MaxDamp® isolation system**
- ▶ **Capability to produce large and small parts**  
auxiliary spindle mount to the X axis

## Without Compromise

### XZ Diamond Turning Results

zygo  
Sa 0.919 nm  
Sq 1.162 nm  
Sz 10.426 nm

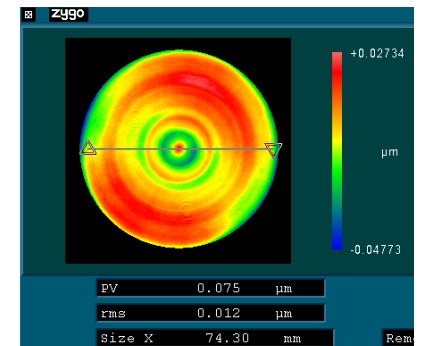
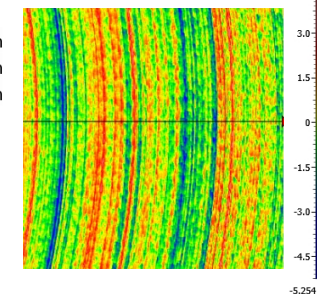


XZ Surface finish: 0.9 nm Sa  
YZ Surface finish: 0.9 nm Sa  
Material: 12.7 mm OD  
Nickel phosphorus plated steel  
Spindle speed: 3,000 rpm  
Feedrate: 5 mm/min

XZ Form accuracy: 63 nm PV  
YZ Form accuracy: 75 nm PV  
Material: 76.2 mm OD aluminum  
Spindle speed: 3,000 rpm  
Feedrate: 10 mm/min

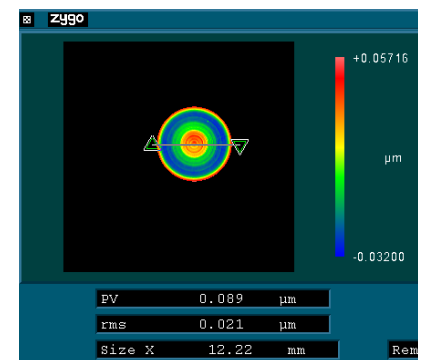
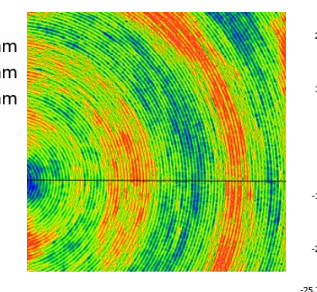
### YZ Diamond Turning Results

zygo  
Sa 0.960 nm  
Sq 1.208 nm  
Sz 9.980 nm



### XZC Milling Results

zygo  
Sa 5.565 nm  
Sq 6.868 nm  
Sz 52.106 nm



Surface finish: 5.5 nm Sa  
Material: 12.7 mm OD  
Nickel phosphorus plated steel  
Spindle speed: 3,000 rpm  
Feedrate: 5 mm/min

Form Accuracy: 89 nm Sa  
Material: 12.7 mm OD  
Nickel phosphorus plated steel  
Spindle speed: 3,000 rpm  
Feedrate: 5 mm/min

Machine Base and Control	Description
Machine base	Sealed natural granite base provides exceptional long term machine tool stability
Machine type	Ultra precision five axis CNC contouring machine
Vibration isolation	Self leveling dual chamber pneumatic isolation system (Optional PEPS® II-VX active vibration cancellation available)
Control system	UPx™ machine tool control operating system with UPx Data Store and Windows sub systems
Operating system	QNX real time operating system with 64 bit floating point decimal precision
Programming resolution	0.01 nm linear / 0.0000001° rotary
File transfers	USB, CD-ROM, Ethernet
Turning performance	Surface Finish < 1.5 nm Sa, Form Accuracy < 0.125 µm P-V tested and measured on one surface upon request (All measurements according to ISO Standard 4287)
Milling performance	Milling surface roughness under 10 nm Sa   Milling form accuracy < 0.2 µm P-V (< 3 nm is achievable with optimum material and cutting conditions)

Linear Hydrostatic Slideways	Description
Type	Hydrostatic bearing slideways with symmetrical linear motor placement and liquid cooling
Travel	X axis: 500 mm (19.7 in.) Vertical Y axis: 150 mm (5.9 in.) Z axis: 300 mm (11.8 in.)
Maximum feedrate	3000 mm/minute (118 in./minute)
Drive system	Linear motors used on all three linear axes
Position feedback resolution	0.008 nm for all three linear axes
Straightness horizontal / vertical	X axis: 0.5 µm (20 µin.) over full travel / 0.75 µm (30 µin.) over full travel Y axis: 0.5 µm (20 µin.) over full travel both directions, 0.3 µm over the central 100 mm Z axis: 0.5 µm (20 µin.) over full travel / 0.75 µm (30 µin.) over full travel
X,Z Pitch / Roll motion	2.0 arc-sec
Y Pitch / Yaw motion	2.0 arc-sec
X, Z Vertical / Horizontal stiffness	438 N/µm (2,500,000 lbs per in.) both directions
Y axis stiffness in the X and Z direction	263 N/µm (1,500,000 lbs per in.) both directions
Y axis working load capacity	91 kg (200 lbs)
Hydrostatic oil supply system	Hydro-7 Smart Servo Control, low pulsation pump, optional thermal control

Workholding Air Bearing Spindle	High Performance HS150 Spindle (3 year warranty)
Spindle air bearing type	Slot type thrust bearing
Materials	Steel shaft / Bronze journal
Standard swing capacity	1000 mm max.   530 mm dia. over the B axis
Ultimate load capacity (@ spindle nose)	136 kg (300 lbs.) @ 100 PSI / 204 kg (450 lbs) @ 150 PSI (load capacity with Y axis locked down)
Axial stiffness	230 N/µm (1,314,000 lbs/in.)
Radial stiffness	130 N/µm (743,600 lbs/in.)
Motion accuracy	Axial/Radial ≤ 15 nm (0.6 µin.)
Thermal control	Liquid cooled chiller +/- 0.1°C accuracy
C-axis feedback resolution	0.010 arc-sec 16,200 line encoder (0.018 arc-sec 9,000 line encoder available on request)
C-axis positioning accuracy	± 1 arc-sec
C-axis max speed	2,000 RPM (4,000 RPM with 9,000 line encoder)
Workholding spindle max speed	10,000 RPM

Rotary B-axis	HydroRound II Rotary B-axis with Hydrolock
Type	Patented self compensated oil hydrostatic bearing, Bi-conic, integral brushless DC motor
Load capacity	454 kg (1000 lbs)
Tabletop size	381 mm (15 in.) diameter
Maximum speed	3,600° per minute
Hydrolock holding torque	> 108 N-m / 80 ft-lbs
Feedback resolution	0.003 arc-sec
Positioning accuracy	± 0.1 arc-sec
Radial error motion	0.10 µm (4.0 µin.) @ tool height (6.9 in. above table top), can be improved with optional error mapping
Axial error motion	0.10 µm (4 µin.)
Coning error	1.0 nm/mm (1.0 µin./in.)
Radial stiffness	525 N/µm (3,000,000 lbs/in)
Axial stiffness	875 N/µm (5,000,000 lbs/in)
Moment stiffness	17 N-m/µrad (150 in.-lbs/µrad)

Optional Milling / Grinding Spindles	SP75FF Spindle	Levicron High Speed Milling Spindle
Air supply pressure	690 kPa (100 PSI)	610 kPa (88 PSI)
Air consumption	50 lpm (1.7 SCFM)	70 lpm (2.5 SCFM)
Radial load capacity	32 kg (70 lbs) ultimate load capacity	29 kg (65 lbs) ultimate load capacity
Axial stiffness	70 N/µm (400,000 lbs/in.)	50 N/µm (285,000 lbs/in.)
Radial stiffness	22 N/µm (125,000 lbs/in.)	35 N/µm (200,000 lbs/in.)
Axial error motion	Under 0.05 µm (2 µin.)	< 30 nm asynchronous
Radial Error motion	Under 0.05 µm (2 µin.)	< 30 nm asynchronous
Maximum speed	15,000 RPM	80,000 RPM (stiffness increases 50% with 60k RPM model)

Facility Requirements	Freeform® TL 1000
Power	208 or 230 VAC - 1 phase - 50/60 Hz - 4.5 KVA
Compressed air supply	Typical: 14 scfm at 100 psig, filtered to 50 µm and dry to 10° C dew point
Machine size	3505 mm x 3442 mm x 2670 mm (138 in. x 136 in. x 105 in.) (approximate with freestanding room, not including control pendant or auxiliary equipment)