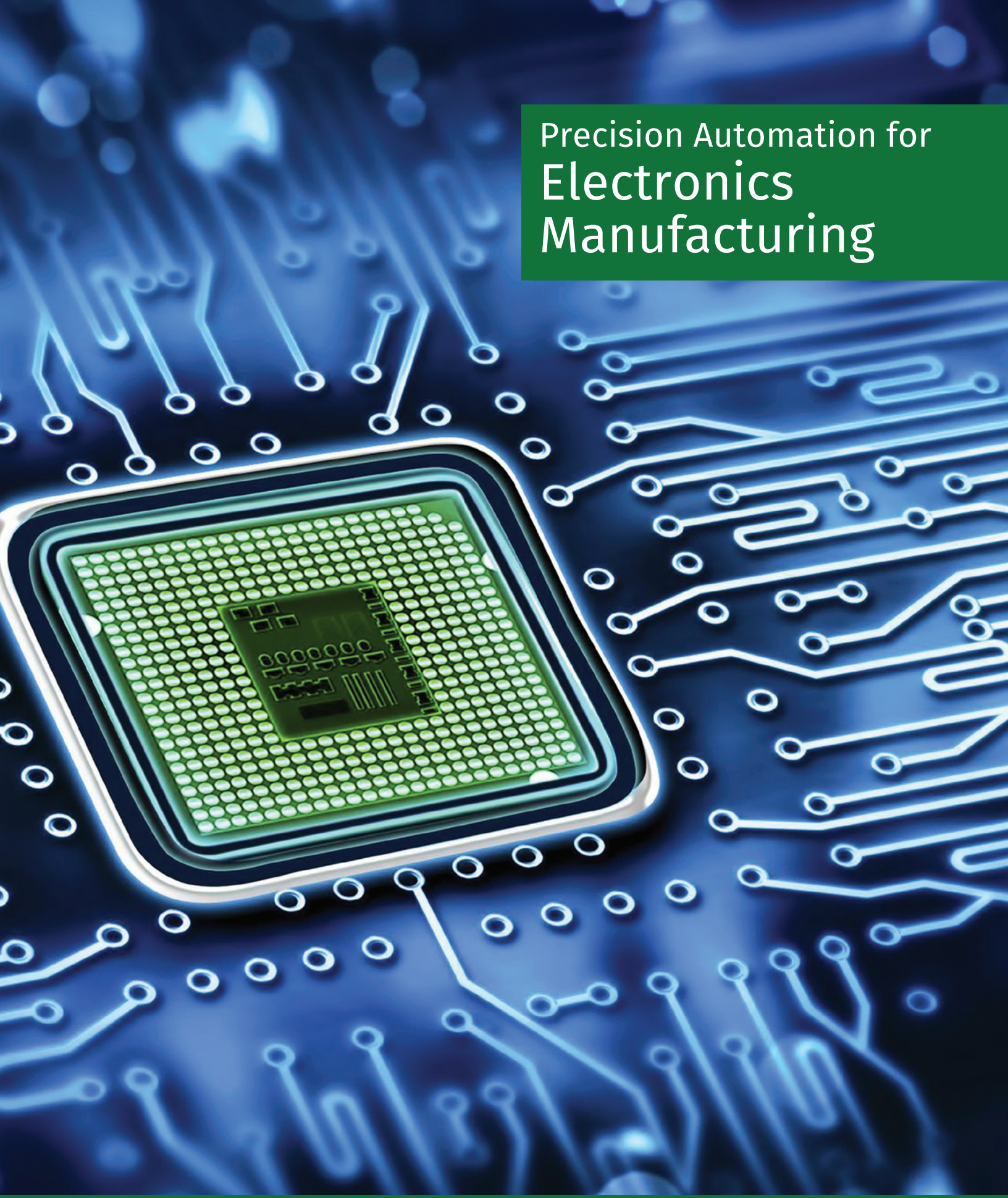


Precision Automation for Electronics Manufacturing

AEROTECH

aerotech.com

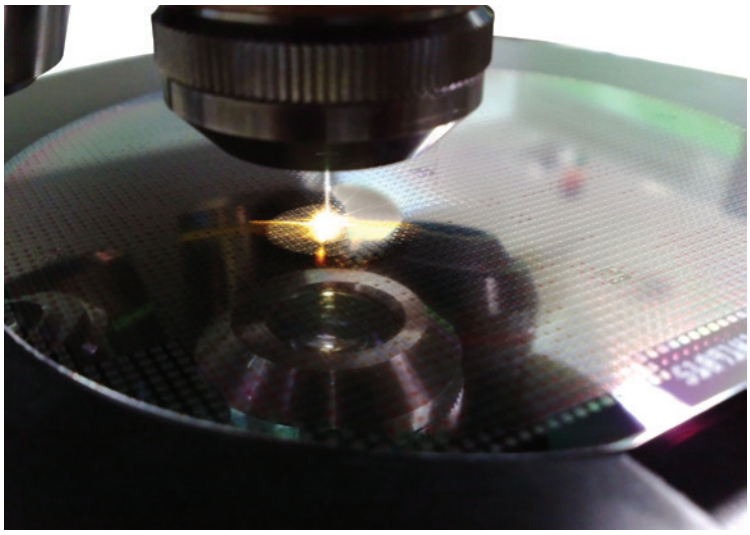
Aerotech Overview

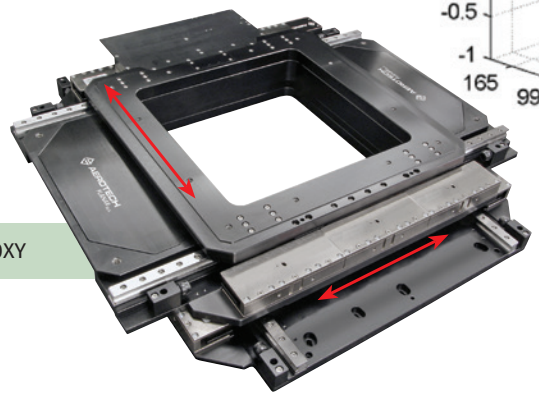
Aerotech has been at the forefront of high-precision motion control since 1970, and provides the precision motion necessary for the advancement of electronics manufacturing processes. Aerotech offers a wide array of products that were developed specifically for electronics manufacturing applications including dispensing, via drilling, flat panel processing, laser-direct imaging, wafer dicing, and semiconductor processes. Whatever motion control your electronics manufacturing application requires, Aerotech is the partner that can make your project a success.

Electronics Manufacturing Applications

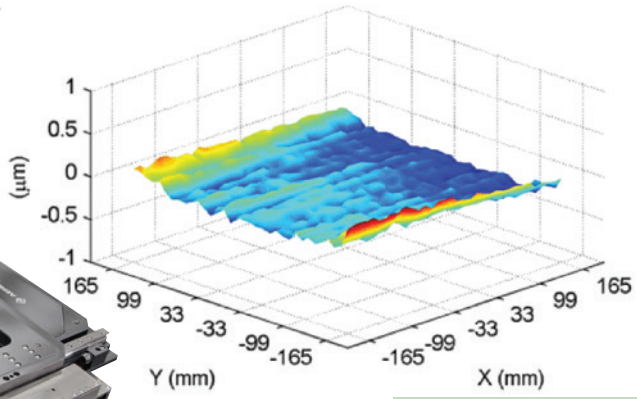
Wafer Dicing

- The Planar$_{DL}$ and Planar$_{DLA}$ are specifically designed and optimized for the requirements of wafer dicing
- The Planar$_{DLA}$ open aperture allows for dual-sided processing
- Linear motors enable high-precision motion with high dynamics: 2 m/s velocities and 2g accelerations
- Design optimized for excellent dynamic geometric performance (straightness ±0.5 µm; flatness ±1.25 µm)
- Clean, robust, low-profile designs allow for easy integration
- Integrated cable and hose management options for additional stages and vacuum chucks





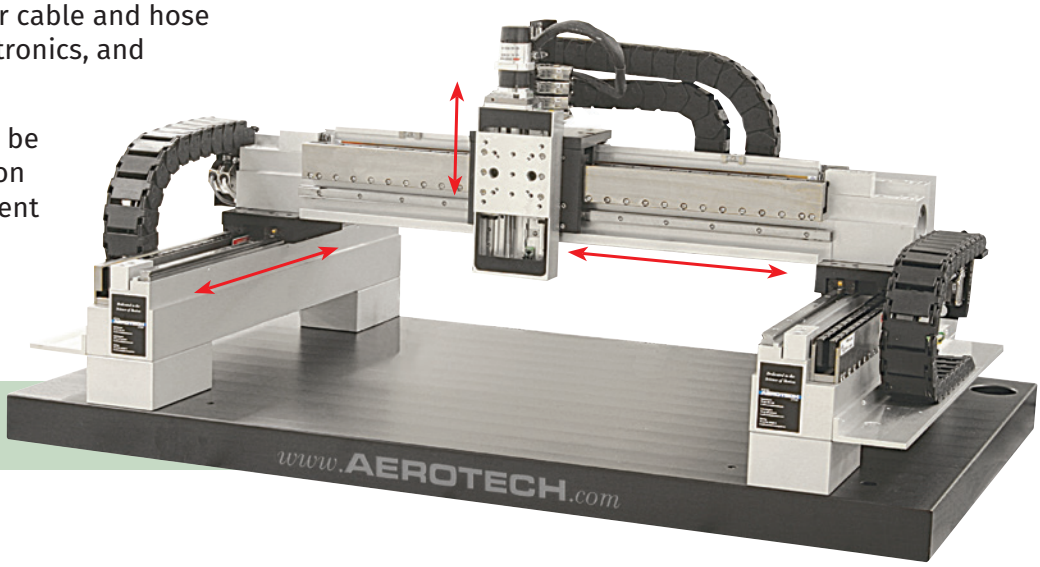
Planar$_{DLA}$-330XY



Planar$_{DLA}$ single-axis accuracy plot

Microelectronics Assembly

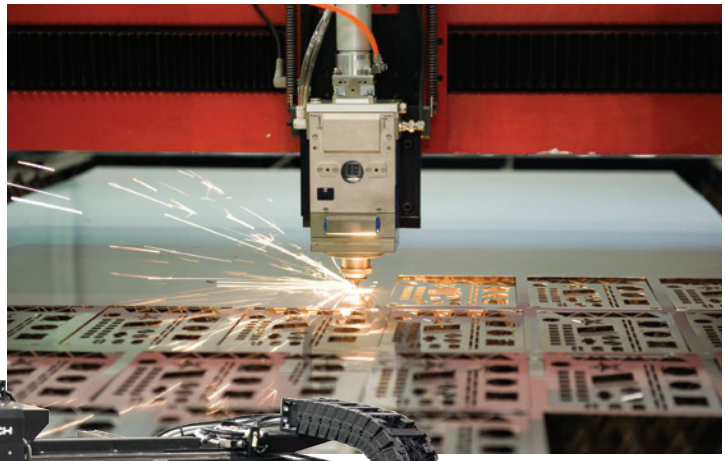
- XY gantry solutions are optimized for rapid, precise pick-and-place electronics assembly, processing, alignment, and inspection
- H and T-style Cartesian gantries are available
- Systems are highly customizable, including travel, Z-axis option, customer cable and hose management, integrated electronics, and additional axes and features
- A3200 controller software can be integrated with 3rd-party vision systems for automatic alignment corrections on the fly

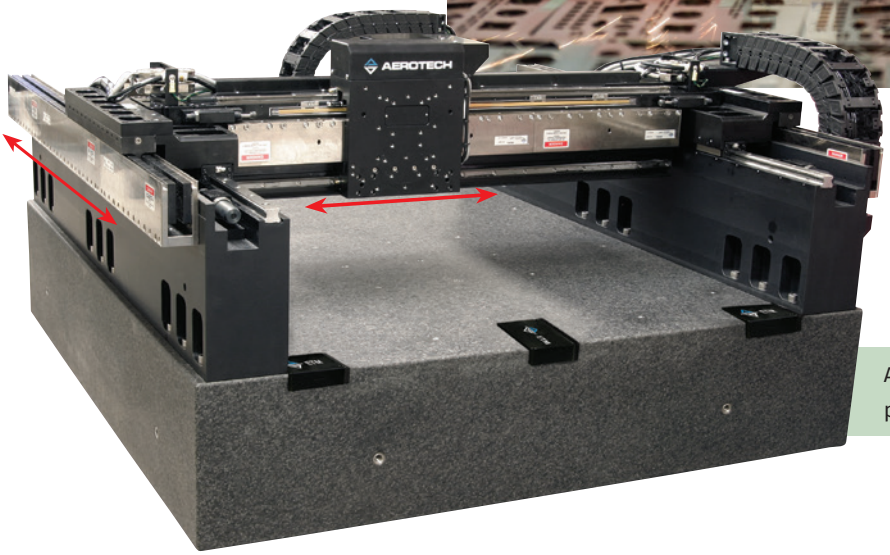


AGS1000 high-throughput, compact gantry

Stencil Cutting

- Aerotech's AGS15000 gantry is designed to address the specific and unique challenges presented by stencil cutting and PCB micromachining
- The planar design improves performance with high dynamic move profiles
- Design is optimized for thermal stability so performance is consistent during high duty-cycle applications
- Custom cable management systems are designed to include various process cables and hoses
- Dual linear motors and linear encoders eliminate yaw errors

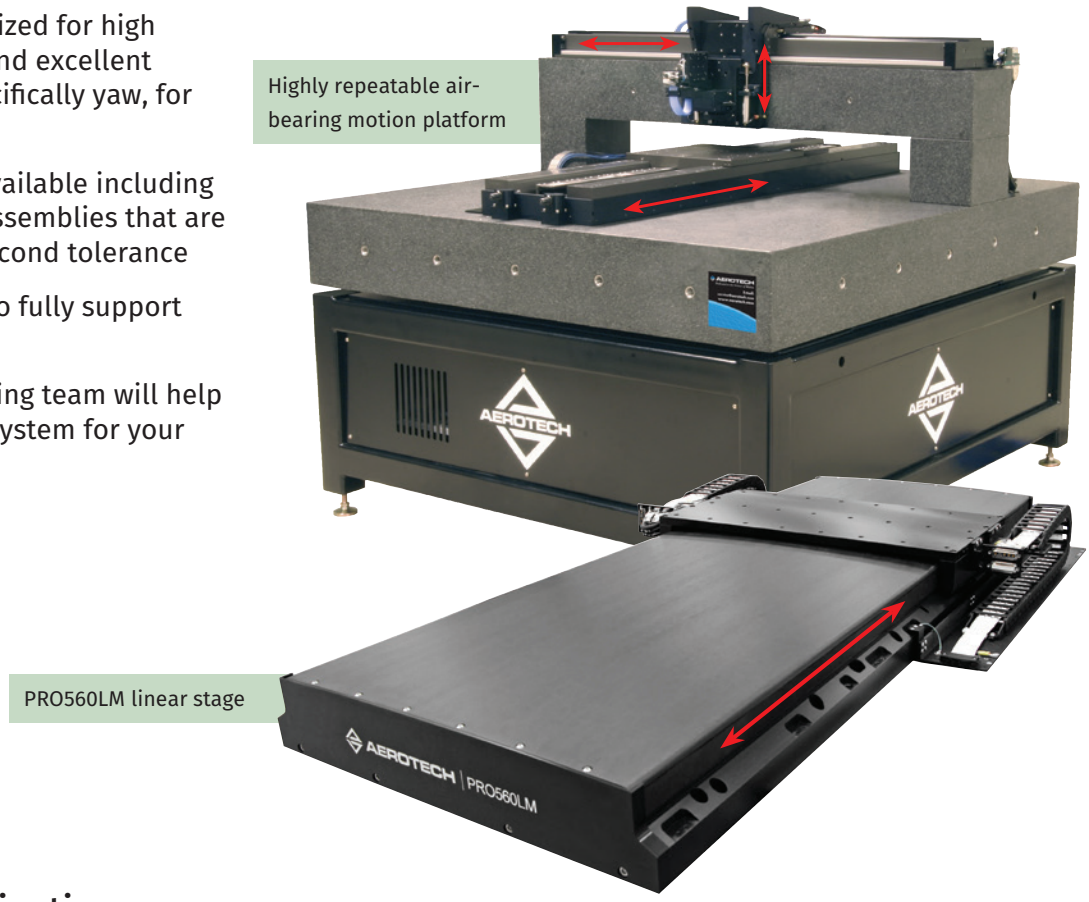




AGS15000 high dynamic-performance gantry

Multi-Head Laser Direct Imaging

- Long-travel stages are optimized for high accuracy, velocity stability, and excellent geometric performance, specifically yaw, for multi-head LDI applications
- Various configurations are available including XY motion and split bridge assemblies that are aligned to single-digit arc-second tolerance
- Wide body stages designed to fully support large panels
- Aerotech's Systems Engineering team will help you design the best motion system for your specific application

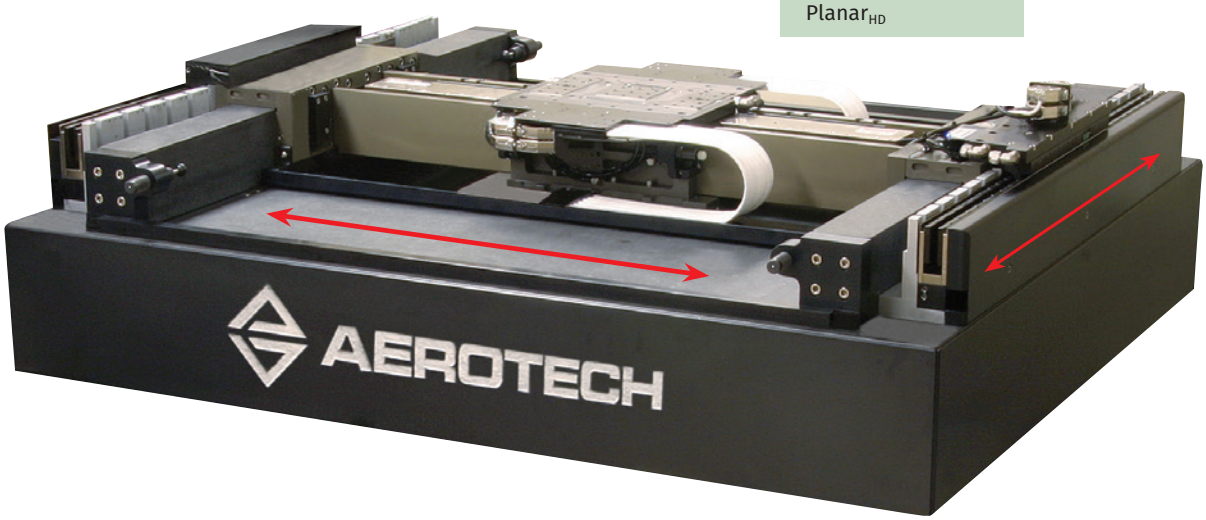


Nanopositioning Applications

- The QNP and QNP_{HD} high-precision piezo stages are optimized for dynamic motion and best-in-class geometric performance
- Standard travels range from 10 µm to 600 µm
- Linearity to 0.007%
- Superior positioning resolution (<1 nm) and linearity with direct metrology sensor
- QFOCUS® QF-46, with up to a 29 mm aperture, enables microscope objective and optics positioning at high speeds with nanometer-level performance

Flat-Panel Processing and Inspection

- Large travel air-bearing XY optimized for flat-panel processing
- <±2 µm accuracy and <±2 µm repeatability at travels larger than 1 m
- Planar air-bearing systems designed for <±3 µm flatness
- Flatness compensation is available with additional Z axis
- Systems include linear motors for high-dynamic motion



Planar$_{HD}$

Via Drilling

- Aerotech's AGV galvo scanners achieve micron-level work-point accuracies at extremely high process speeds
- Infinite Field of View (IFOV) coordinates motion between galvo scanner and servo stage motion, allowing for laser processing of large, uninterrupted areas with no stitching
- Aerotech's CADFusion software easily converts your drawing files to G-code to eliminate significant programming and integration time

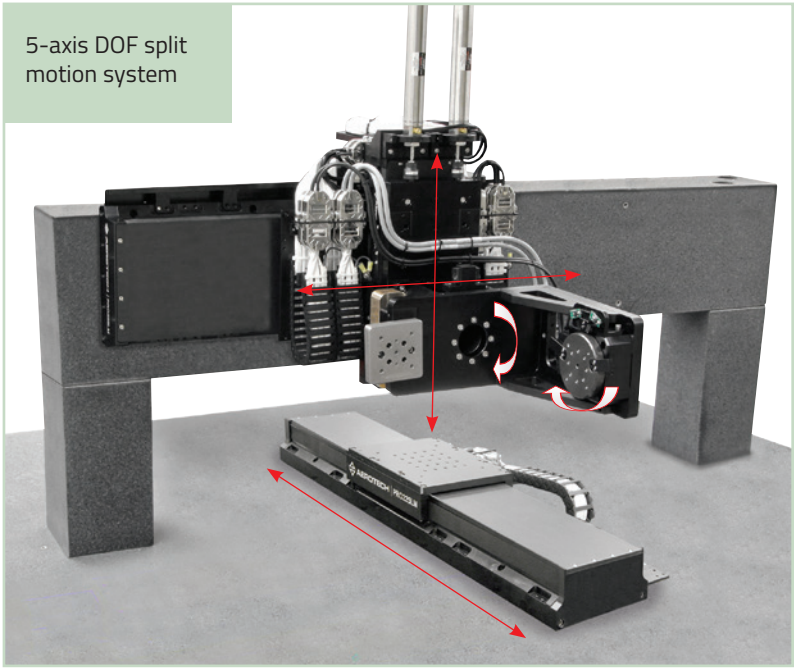
AGV-HPO galvo scanner

AGV-HP galvo scanner

Printed Electronics Applications

Dispensing/ Printed Electronics

- Multi-axis assemblies from 2 to 6+ degrees of freedom are tailored for printing/dispensing along complex contours
- Precision alignments and work-point calibrations reduce 3D stack-up errors at the work point
- Aerotech's Position Synchronized Output (PSO) allows for encoder feedback to be coupled directly to the dispensing head to achieve consistent trigger-based or flow-based deposition and high part quality
- Transformations available with the ROTATION command allow for easy programming of virtual pivot point kinematics



5-axis DOF split motion system

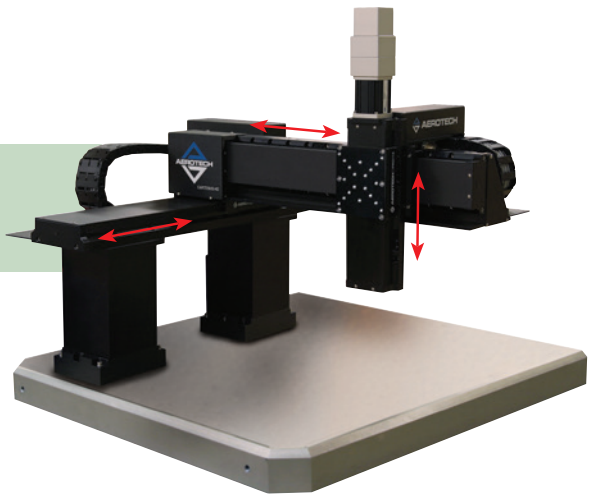
High Throughput Dispensing

- Custom configuration including multiple motion arms for multiple dispense heads that increase the throughput of the process
- Nanometer resolutions and micron-level accuracies and repeatabilities for consistent depositions
- Optimized geometric performance (pitch, roll, and yaw) enables consistent deposition with multiple heads

Quad-head "H-style" Cartesian dispensing system

Material Extrusion/Deposition

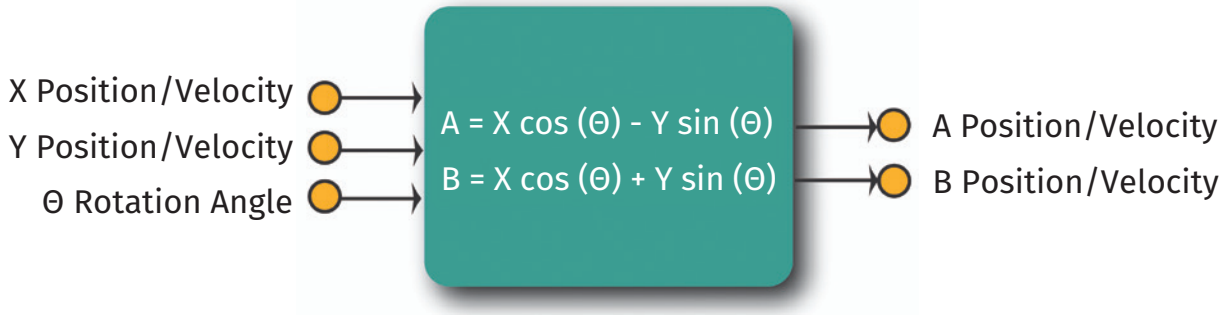
- Gantry configurations allow for overhead tool operation and fixed-part placement
- Systems offered in both "T-style" and "H-style" Cartesian gantries
- Aerotech controls simplify gantry set-up and operations



"T-style" Cartesian system

Real-Time Kinematics for Dispensing Applications

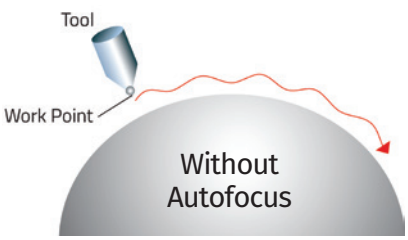
- Aerotech's Automation 3200 (A3200) controller with built-in kinematics capability greatly reduces the complexity of multi-axis dispensing applications
- Motion profiles can be generated directly from a CAD drawing and executed on the controller, greatly reducing programming time and program complexity, while permitting rapid changeover to alternate part profiles
- Motion profiles are programmed in linear/arc segments or points on a cubic spline interpolated path, removing the need for complex post-processing tools to create multi-axis print paths
- Part geometry and dispensing speeds can be optimized on the machine without re-posting the motion profile, increasing productivity
- Programming in part coordinates and executing the kinematics in real-time enables the specification of the point of rotation at run time, greatly simplifying the fixturing requirements with a fixed point of rotation that results from post-processor programs

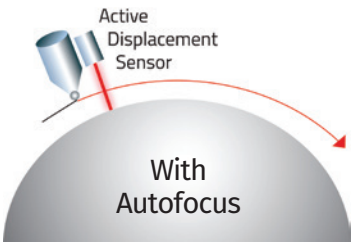


Real-Time Kinematic Transformation

Autofocus

- Maintains constant offsets between tooling and part surface, enabling complex contouring over 3D shapes while maintaining consistent deposition
- Built-in routines allow the user to easily integrate a third-party displacement sensor in order to maintain part offset





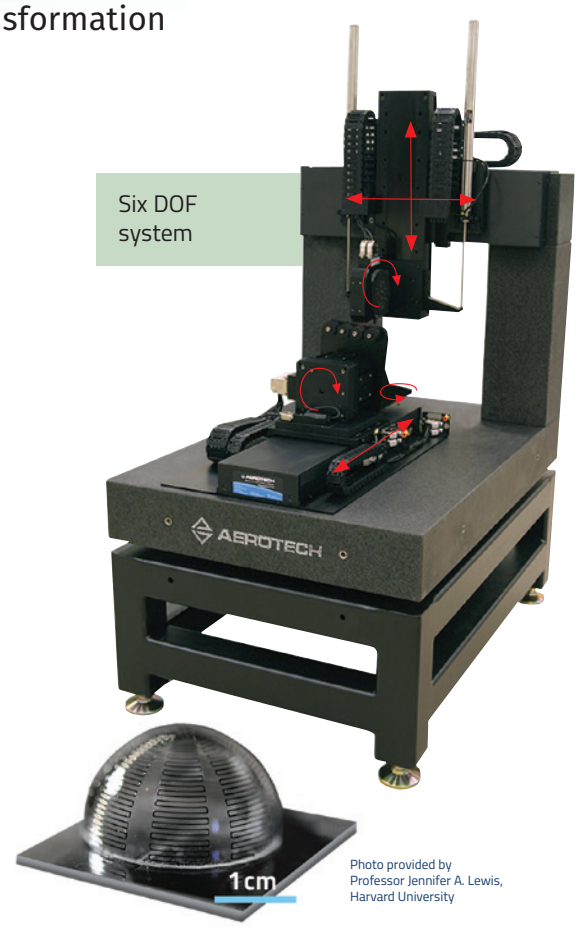
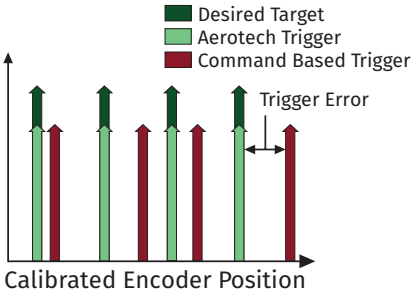


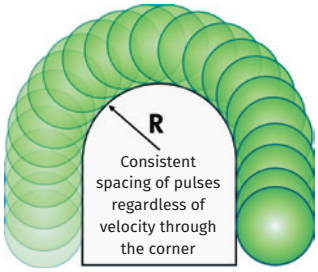
Photo provided by Professor Jennifer A. Lewis, Harvard University

Controller Features for Electronic Manufacturing Applications

Position Synchronized Output (PSO)

- Allows system to trigger a camera, data acquisition, laser firing, or any other process-related equipment based directly on calibrated encoder feedback
- Dramatically reduces unwanted variability in width between laser pulses or other customer processes
- Eliminates need for velocity stability in motion because customer process is triggered based directly on feedback
- Single or multiple pulse output as a function of up to 3 axes' position feedback at up to 16.6 MHz
- Ideal for LCD manufacturing, laser direct imaging, via drilling, wafer dicing, high-precision position-based data acquisition, and various other applications

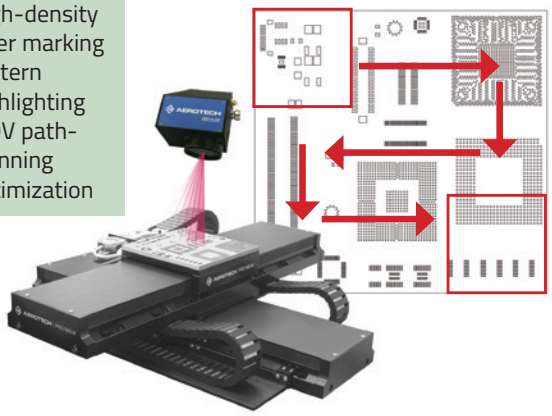




Infinite Field of View (for Galvo Applications)

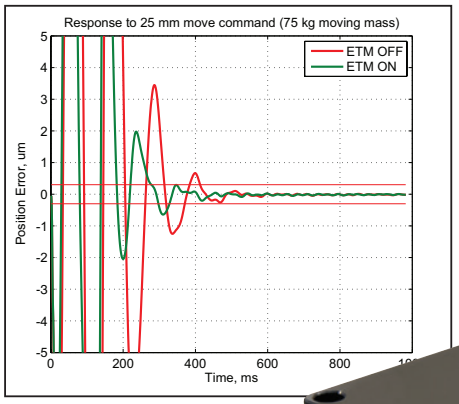
- Aerotech's AGV scanner can achieve micron-level work-point accuracy at extremely high process speeds
- IFOV links the feedback from an AGV galvo to the positioning of XY servo axes, allowing the AGV to interact with the servo stages to process areas larger than the AGV's field of view
- IFOV allows Aerotech's AGV to process large areas in seconds, limited only by the maximum speeds of the servo-stages

High-density laser marking pattern highlighting IFOV path-planning optimization



Enhanced Throughput Module

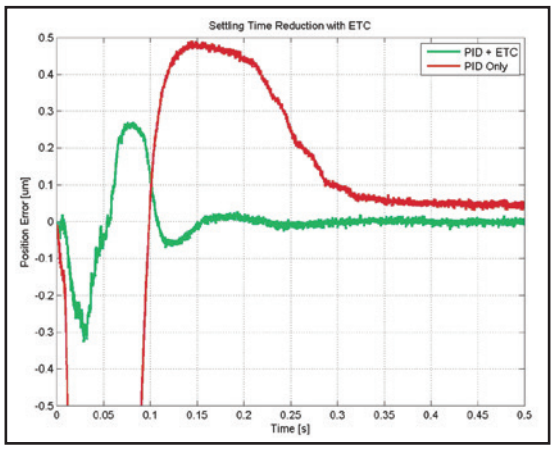
- Significantly improves move-and-settle time and contouring performance, increasing throughput of new and existing machines
- Greatly reduces undesired effects of frame motion on the servo system, providing a low-cost solution for improving productivity



The example plot shows the benefits of the Aerotech Enhanced Throughput Module (ETM). Move-and-settle time for a 75 kg load was reduced by 21% from 414 ms to 328 ms.

Enhanced Tracking Control

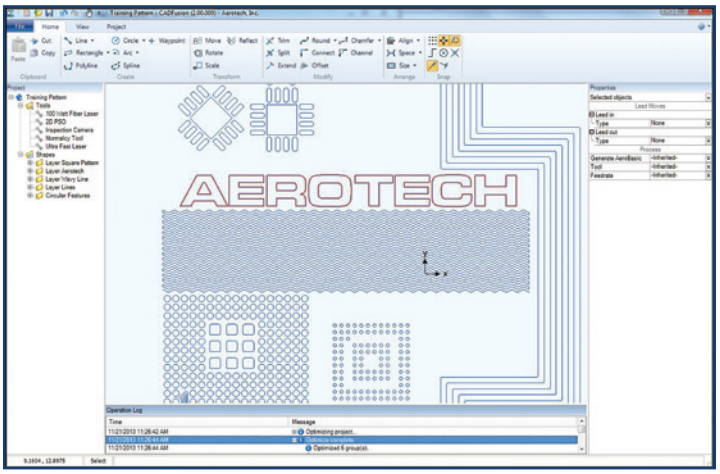
- Aerotech's unique Enhanced Tracking Control (ETC) feature improves move-and-settle times in point-to-point positioning and reduces tracking errors during contoured motion
- ETC is available for both servo stages and AGV galvo scanners
- ETC proactively eliminates the long tail associated with settling to sub-micron tolerances, significantly reducing settling time



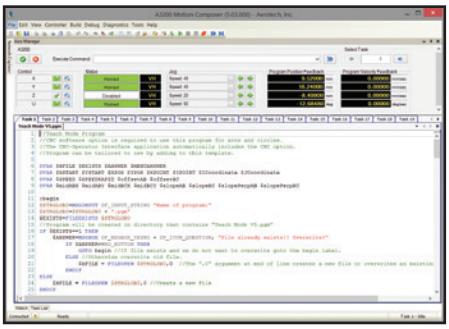
Settling performance with (green) and without (red) ETC

CADFusion CAD to G-Code Software

- Easily imports vector-based drawing files and produces Aerotech compatible motion programs
- Manually or automatically re-shapes tool paths for optimal processing
- Supports advanced Aerotech programming features such as Position Synchronized Output (PSO)
- Extensive drawing tools for part creation and transformation

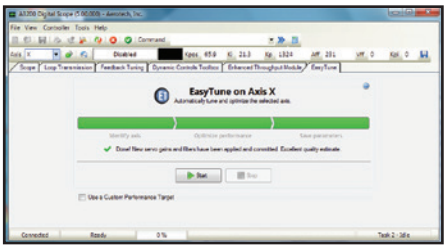


Integrated Development Environment (IDE) Reduces Development Time



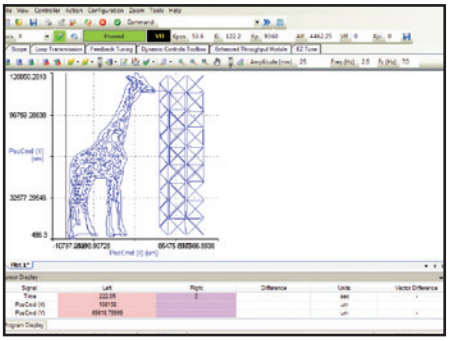
Programming Interface

- Integrated I/O panel
- Debugging features (breakpoint, step-in, etc.)



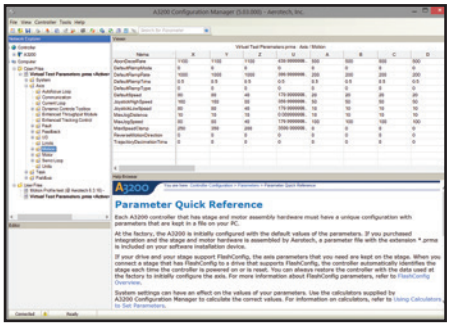
EasyTune™

- One click EasyTune™ to set gains and place filters
- Optimization and performance read-outs



Digital Scope

- 1D and 2D plot capability
- Plot move profiles, I/O, and commands for easy troubleshooting



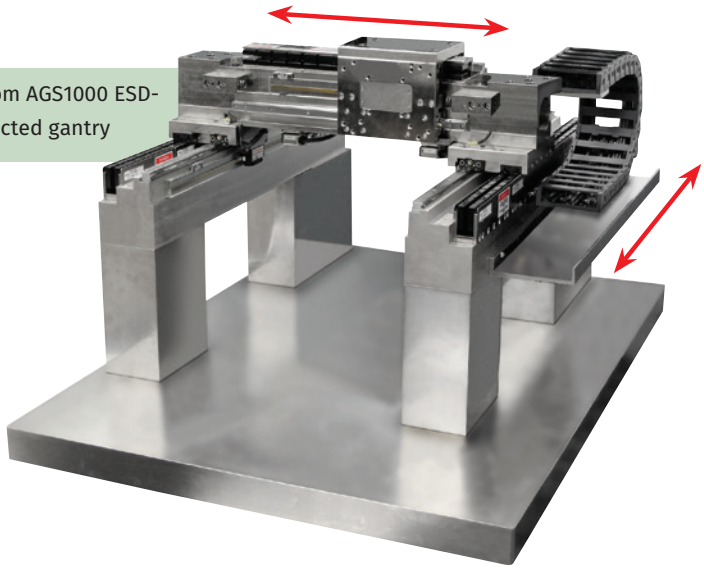
Parameter Editor

- Easy-to-use calculators for system setup
- Integrated HELP files

Aerotech System Capabilities

Electrostatic Discharge Protection

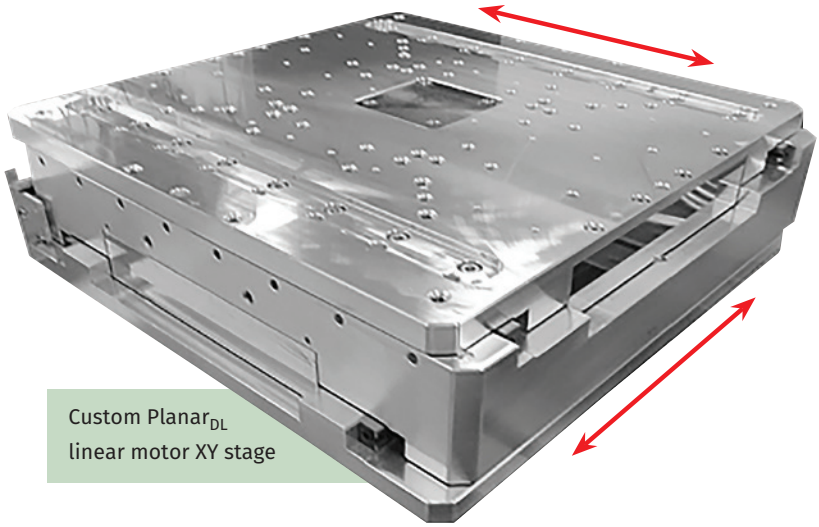
- Electrostatic Discharge (ESD) is a major threat to electronic devices and integrated circuits
- ESD-protected Aerotech systems can be coated in conductive electroless nickel to avoid any charge build-up
- Stages with ESD protection are made with special ESD cable management and all components are tied to common ground to maintain zero potential difference



Custom AGS1000 ESD-protected gantry

Cleanroom and Vacuum-Ready Systems

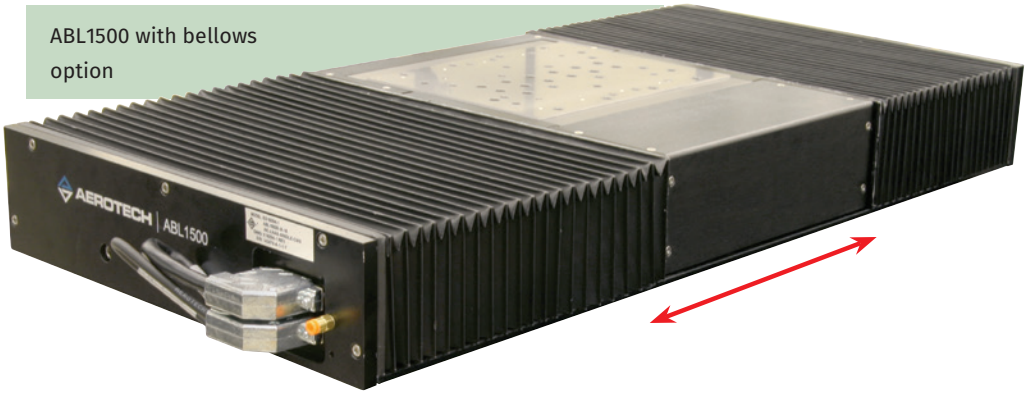
- Extensive cleanroom capabilities on-site at Aerotech's factory, down to ISO Class 5 (Class 100) areas
- Systems can be designed with all cleanroom-safe components including cable management, stainless-steel hardware, cleanroom lubricants, and other features
- Aerotech's cleanroom systems are assembled in our cleanroom and undergo an optional ultrasonic wipedown before being packed, purged, and sealed



Custom Planar$_{DL}$ linear motor XY stage

Environmentally Sealed Systems

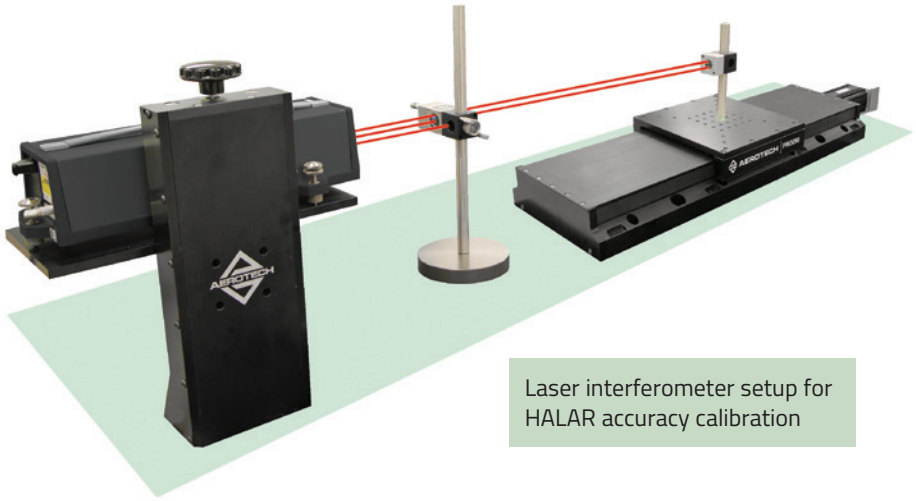
- Aerotech offers systems designed to work in harsh production environments
- Sealing options available for various standard and custom systems
- Systems are designed to be protected from process debris



ABL1500 with bellows option

Metrology Measurement

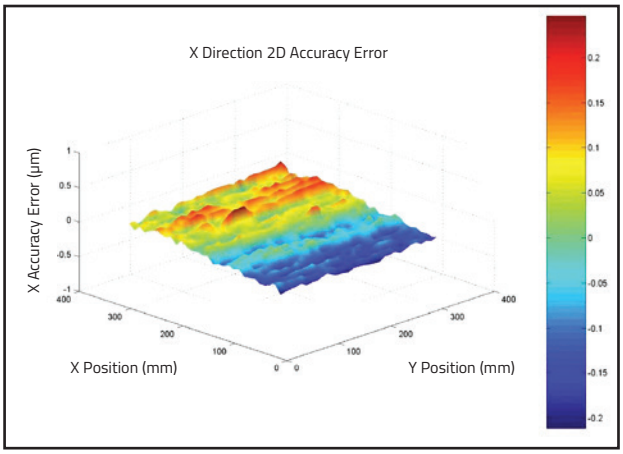
- Aerotech has extensive metrology capabilities that allow for precision measurements:
  - Interferometry for linear errors
  - Collimation for angular errors
  - Capacitance setups for rotary errors and minimum incremental motion measurements
  - Dynamic tests for motion process testing



Laser interferometer setup for HALAR accuracy calibration

Error Mapping and Calibration

- The controller compensates for errors of the motion system by making a lookup table of the measured error motions, and then the trajectory generation is modified by the controller to eliminate the measured errors
- Calibration is performed at the work point to minimize errors at the process point for best results
- Offered in both 1D, 2D, and 2.5D
- Available for both linear and rotary motion errors



Errors shown on a 2D calibration map

Precision Alignments

- Capabilities include multi-axis alignments of linear and rotary stage assemblies:
  - Perpendicularity between axes
  - Axes of intersection for rotaries
- Performed using precision granite surfaces and telescoping techniques

Aerotech Worldwide

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China ▪ India ▪ Japan ▪ Taiwan ▪ Thailand

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