


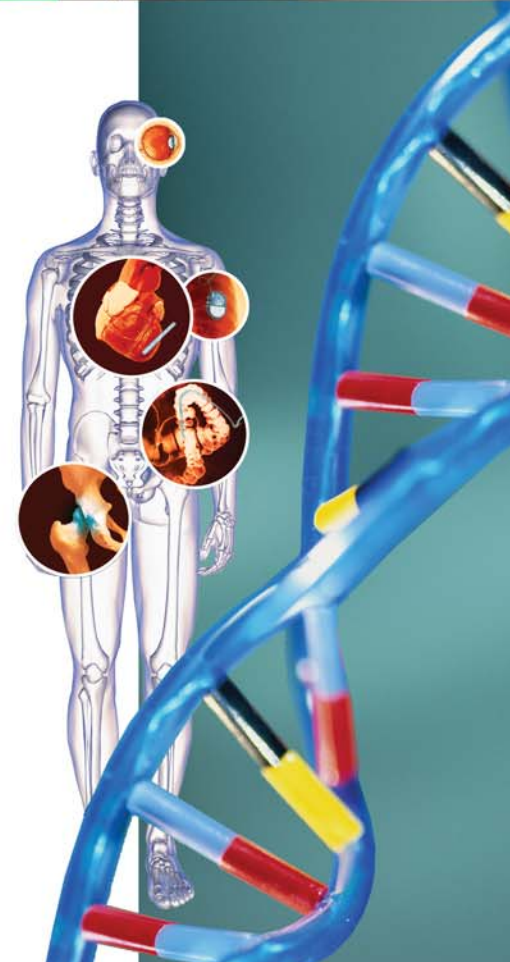
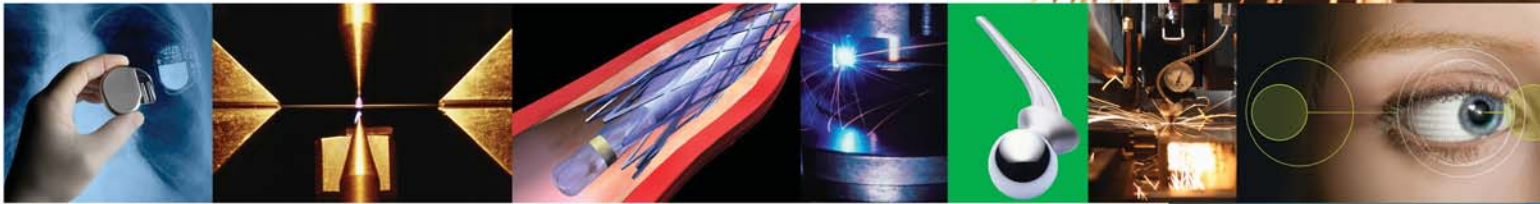


## AUTOMATION SOLUTIONS FOR

-  Laser Processing
-  Medical Device Manufacturing
-  Life Sciences



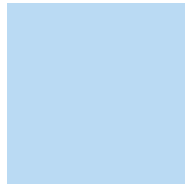
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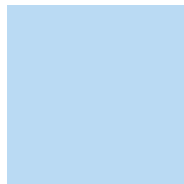
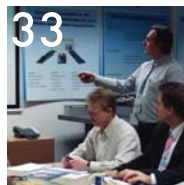
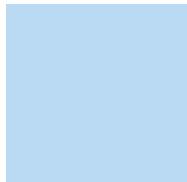
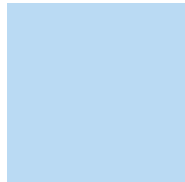
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# AEROTECH SUCCESS IN LASER PROCESSING



For over 35 years, Aerotech has been dedicated to developing solutions for the laser processing industry. We continually enhance our existing product line and invest in new developments to address the most stringent customer requirements. This results in products that offer the highest accuracy, highest throughput, and highest reliability, ultimately leading to the lowest cost of ownership for our customers.

Aerotech's broad range of motion control products means we can provide the optimal solution for your application. Our expertise includes systems for shop floor, R&D, vacuum, and cleanroom environments. Our ability to provide custom-engineered products and systems to end users, integrators, and high volume OEMs is unmatched, and our products deliver quality, performance, flexibility, and the highest return on investment.

Aerotech's focused development has led to our state-of-the-art Automation 3200 motion controller capable of synchronizing 32 axes of motion, with advanced features such as Position Synchronized Output (PSO) for precise laser control, coordinated motion between servomotors and galvos, seamless integration of PLCs, and sophisticated plotting and diagnostic utilities that enable rapid debugging of process and motion parameters.

Coupling these advanced control features with mechanics that are designed for long life and low maintenance in harsh environments provides laser machine manufacturers the means to build the best overall systems in the industry.

## Laser Processes Served:

- Cutting
- Welding
- Marking and engraving
- Drilling
- Ablation
- Micromachining
- Cladding
- Peening

## Lasers in Manufacturing of Medical Devices:

- Stents
- Hypotubes
- Guidewires
- Hermetic sealing of pacemakers and other CRM devices
- Device assembly
- Orthopaedic braces

# SOLUTIONS FOR CYLINDRICAL MATERIAL PROCESSING

Many laser cutting and welding processes require the handling of cylindrical or bar-stock-type materials. Aerotech's extensive line of products includes component-level solutions as well as optimized, combination linear/rotary motion systems designed to automate the handling of these materials. Direct-drive technology coupled with a frictionless rotary union for collet actuation enable speeds in excess of 2000 rpm for high throughput applications. ER collets are available for precision cylindrical gripping applications and a 3-jaw concentric gripper is available for I.D./O.D. and odd form profiles.

## Featuring/Recommendations:

- A3200 controller
- Integrated mechanical packages (LaserTurn™ 1, LaserTurn™ 2, LaserTurn™ 5)
- Direct drive, high-torque rotary axis with integral pneumatic collet adapter or 3-jaw gripper (ACS, ACS-LP)



## LaserTurn™ 1

The LaserTurn 1 cylindrical laser processing platform supports the smallest tube holding capability (100 microns) of the LaserTurn family. A highly repeatable collet assembly allows precision indexing of material to produce continuous patterns in long tubing stock without operator intervention to align the laser cut between successive part feeds. With throughput comparable to the Vasculathe™ and a maximum tube diameter of 8 mm (dry cut), the LaserTurn 1 is ideally suited for high throughput, small diameter tube processing applications.

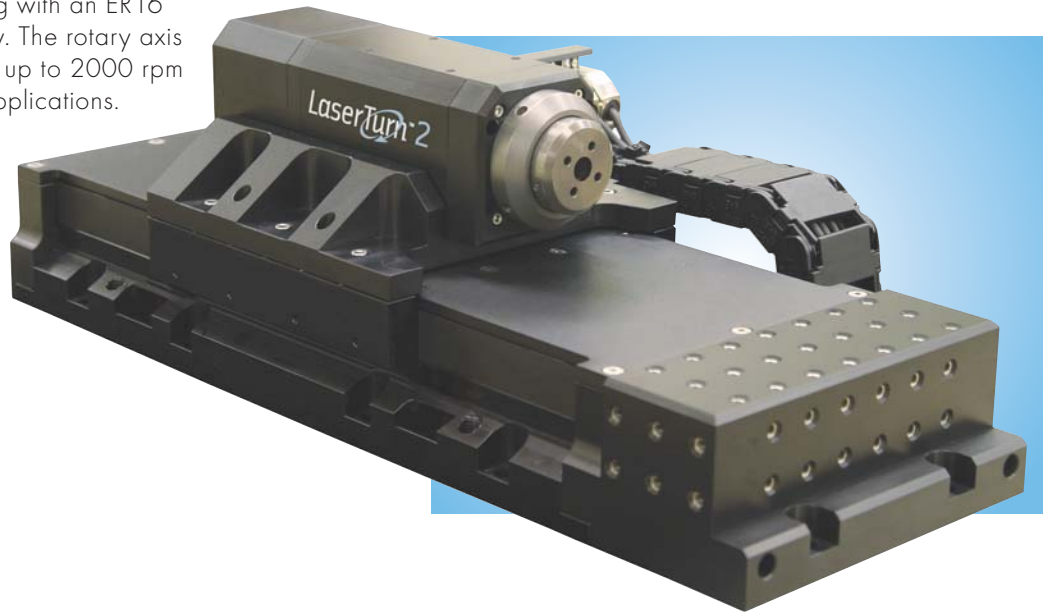
## Precision Components, Mounting, and Gripping Options

The high performance, direct-drive rotary stages used in the LaserTurn product family are available in component form. Multiple precision mounting surfaces ease integration while a large selection of gripping options is available to support a wide range of material profiles.



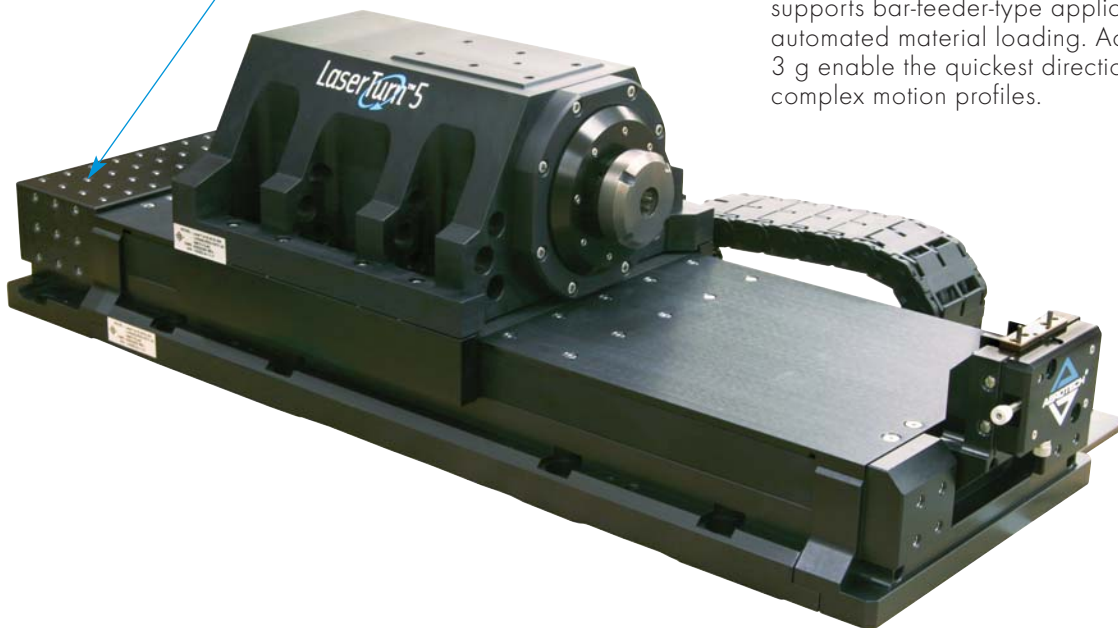
## LaserTurn™ 2

The LaserTurn 2 cylindrical processing platform supports tube diameters up to 10 mm in dry cutting or 5 mm in wet cutting with an ER16 collet-closer assembly. The rotary axis is capable of speeds up to 2000 rpm for high-throughput applications.



### Optional Tooling Platforms

*The LaserTurn series is available with front- and rear-mounted tooling platforms with optional features such as automated material advance and alignment assemblies.*



## LaserTurn™ 5

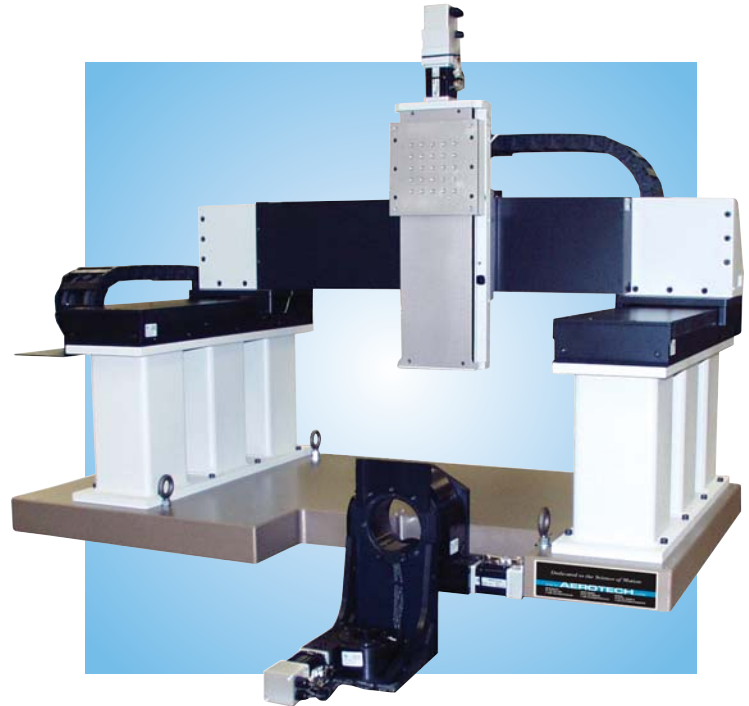
The LaserTurn 5 cylindrical processing platform is available with a 3-jaw concentric gripper for I.D. and O.D. gripping or ER collet chuck for high precision applications. With custom jaws the gripper can hold materials with square or hexagonal profiles. A 12 mm clear aperture supports bar-feeder-type applications for automated material loading. Accelerations up to 3 g enable the quickest direction reversals for complex motion profiles.

# SOLUTIONS FOR 3D LASER CUTTING & WELDING

3D laser cutting and welding applications require a combination of both linear and rotary axis motion to ensure that laser beam delivery is perpendicular to the part at any point during processing. As a complete motion system provider, Aerotech can supply a precision-aligned, multi-axis, articulated system with micron-level rotary axis of intersection and arc-second orthogonality between axes. Systems can be based on split bridge (separate X and Y axes), gantry, remote Z, or any combination in between. All stages are sealed against environmental contamination for use in 24/7 cutting and welding applications.

## Gantry for Offset Welding

This long travel, sealed gantry system features a large offset in the A/B rotary axis assembly to support offset welding applications. The vertical axis can dynamically adjust the focal distance during processing for consistent weld quality.



## Multi-Axis Linear/Rotary Combination

X/Y linear stage configuration with low profile, direct-drive rotary axes. The direct-drive rotary stage at the workpiece (ADRS series) features high-speed rotation (up to 600 rpm) with high resolution (7,000,000 counts/rev after interpolation) for the highest possible performance.



# SOLUTIONS FOR 2D LASER CUTTING & WELDING

Aerotech has a broad range of solutions available for 2D and 2.5D laser cutting and welding applications. Systems can be configured with traditional stacked XY orientations, split axes with the X on the base and Y on a bridge, or full gantry systems with flying optics or fiber-based beam delivery.

## Featuring/Recommendations:

- A3200 controller
- Sealed linear motor stages (ALS5000, ALS25000, ALS1000)

## Ceramic Processing

The ALS5000 coupled with the wide-body ALS5000WB base provides increased roll stiffness for multi-head ceramic processing applications. Low angular errors allow the accurate placement of part features over large areas while the high dynamic stiffness holds tight tolerances on small part features.



## Flat Sheet Processing

Aerotech's latest generation gantry system has been optimized for high-speed laser cutting and welding applications. The low CG of the bridge coupled with dual linear motors/encoders and stiff mounting interfaces have demonstrated micron-level dynamic accuracies on high-speed cutting applications. A large radius cable management system allows integration of fiber-based beam delivery systems while mounting surfaces on the bridge structure enable the attachment of optics for free space laser-beam delivery.

# ADVANCED LASER CONTROL

Laser processing involves precise coordination of several subsystems to produce high-quality parts. While some of this coordination can be accomplished by careful timing of various components, utilizing the advanced features of Aerotech's Automation 3200 motion controller to manage this coordination reduces development time while producing the highest-quality parts.

## Position Synchronized Output (PSO)

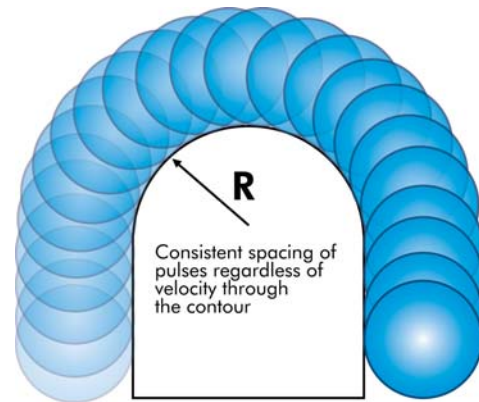
Hermetic welding, micromachining, and ablation require precise control and spacing of laser pulses on the material being processed to provide consistent quality. When using a fixed frequency laser, this is complicated by the need for constant velocity, severely limiting processing speeds when faced with complicated geometries. By utilizing Aerotech's unique Position Synchronized Output (PSO) capability, the laser is fired according to real-time position feedback in 3 dimensions, removing the need for velocity regulation and eliminating the effects of external disturbances, thus increasing both process throughput and quality. When multi-axis PSO is required, the feedback positions are vector processed to exactly synchronize 2D or 3D contours.

PSO functionality includes several easily programmed operation modes, each fully configurable to interface with lasers equipped with externally synchronized control, including CO<sub>2</sub>, YAG, and excimer lasers. Modes of operation include:

- Fixed distance firing
- Windowing
- Array-based firing

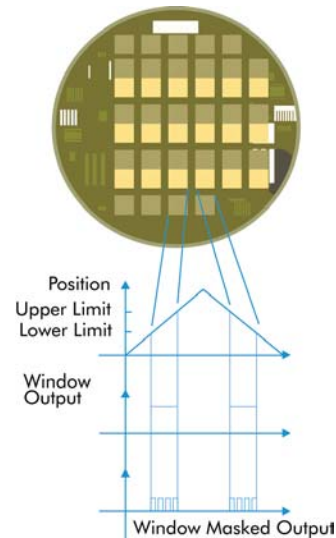
## Fixed Distance Firing

This mode provides single- or multiple-pulse output as a function of one to three axes' position feedback for a fixed distance. This minimizes the heat affected zone (HAZ) from over-processing a material. Applications include cutting, welding, and hole drilling where complex contours require real-time interaction with the laser pulses for dependable consistency. Typical processes include stent manufacturing, hermetic welding, and drilling holes in turbine blades.



## Windowing

In windowing mode, output pulses are restrained inside a user-defined window with the first pulse relative to the edge of the window. Windowing is commonly used when the processing of a part requires the axes to move beyond the part for settling or direction reversal in applications such as flat panel manufacturing or fuel injector drilling.





## Array-Based Firing

Array-based firing provides single- or multiple-pulse output based on process parameters stored in an array based on position. Applications include gray-scale marking of materials where each pixel has differing frequency and power characteristics, and processing of different materials in the same set of motion commands.

## Additional Operational Modes

- Pulse on command
- Single- or multiple-pulse output based on command from a program
- Pulse generator
- Pulse output based on a defined fixed frequency

- Velocity-based analog ramping
- Scaling an analog output as a function of one- to three-axis vector velocity based on a user defined “zero-speed” output voltage and target-speed output voltage

## Application Versatility

In addition to laser control, PSO can be used to trigger any data collection event in applications such as triggering probes or cameras during NDTs (Non-Destructive Tests) and force or flow control systems. The ability to capture data correlating to known pulse spacing along complex contours is ideal for inspection systems such as ultrasonic pulse/echo and through-transmission, eddy current measurements, and X-ray.

## Remote Laser Welding

Welding applications often involve components with intricate patterns that require high throughput processing. Remote laser welding involves scanning a fixed, focused laser beam over a workpiece from a distance. Since minimal setup time is required to position the laser, and the beam may be quickly scanned over a large area with minimal motion, cycle time is significantly reduced.

Utilizing transformation functions in the A3200 controller to transform rotational motion into X/Y Cartesian space allows for simplified programming in linear dimensions or importing from CAD drawings.



## Featuring/Recommendations:

- A3200 controller
- Direct-drive gimbals (AMG and AMG-LP series)

## Benefits of Direct-Drive Gimbals for Remote Laser Welding

- High-accuracy angular position and rate capability
- High axis stiffness for precise pointing
- Direct drive, brushless servomotors result in zero backlash and arc-second accuracy
- Cog-free design for outstanding velocity stability
- Continuous 360° rotation of azimuth and elevation including built-in slip ring

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# SOLUTIONS FOR LASER ABLATION

Ultra-fast lasers and excimer lasers are traditionally used in applications where material ablation is required. Ablation is an athermal process where the photon energy of the light is sufficient to break the chemical bonds at the atomic level, converting the material directly from a solid into a plasma. The time duration of the pulse for ultra-fast lasers is shorter than the heat diffusion time in the material, which results in no thermal damage, recasting, or heat-affected zone. The short pulse duration also produces material removal rates that are quite low (nanometers per pulse) when compared to microsecond-regime IR lasers. This small depth of ablation per pulse can be used to create 3D structures on a nanometer scale.

Excimer lasers also work through an ablation process. However, the beam profile is square or rectangular as opposed to the circular pattern typical of ultra-fast lasers. The excimer beam is passed through a mask that clips the

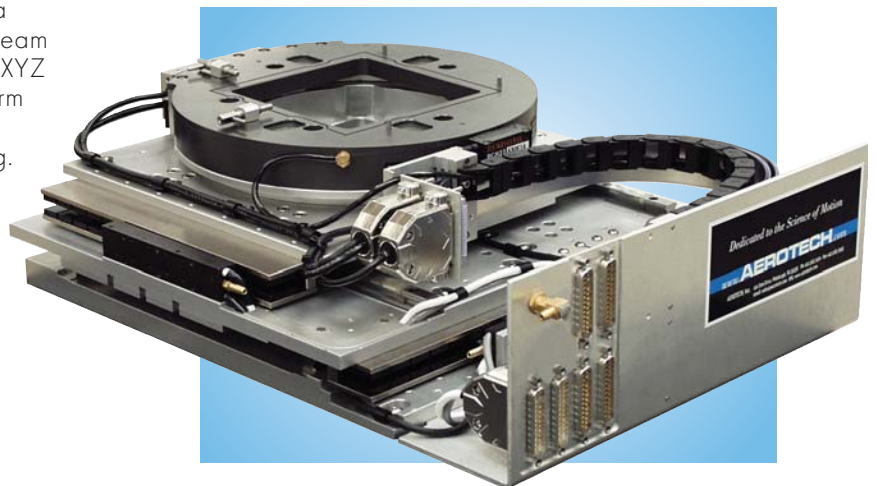
beam energy into a pattern defined by the geometry of the mask. This masking technique makes it easy to ablate complex patterns. Feature sizes projected onto the material through the mask can be adjusted by defocusing the laser, and it is possible to build complex three-dimensional patterns in materials using multiple masks and the defocusing technique.

## Featuring/Recommendations:

- A3200 controller
- High-performance, linear-motor, open-frame stages (ALS3600)
- Direct drive, open aperture rotary axis (ADRT)
- Direct drive, low-profile rotary axis (ADRS)

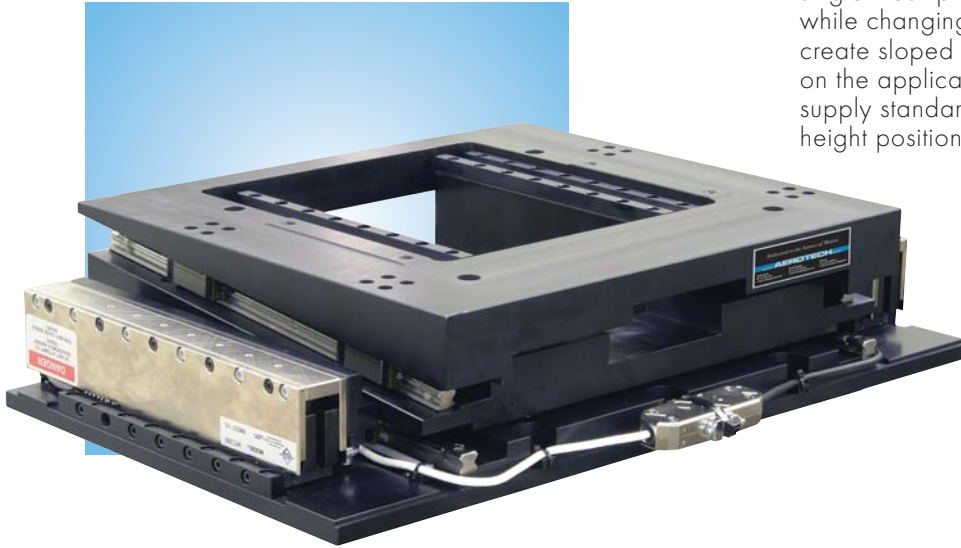
## Mask Alignment Platform

High precision excimer applications that use a masking technique to clip the homogenized beam profile can require precise mask alignment of XYZ and rotary axes. Aerotech's MaskAlign platform utilizes high resolution direct-drive linear and rotary axes for precise, repeatable positioning. Beam projection through the stage set is provided by a 120 mm clear aperture.



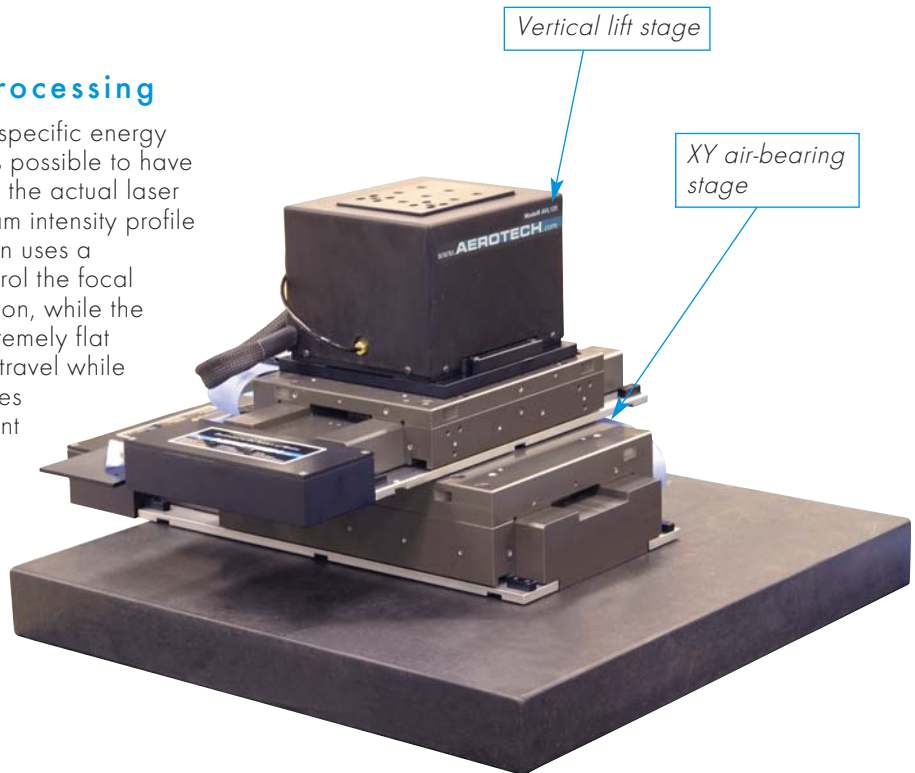
## Custom Large-Profile Z-Lift Stage

Excimer applications can use a defocusing technique to change the aspect ratio of the mask pattern projected onto the part. Different size features can be projected onto the part with a single mask profile. Repetitive firing in position, while changing the focal position, can be used to create sloped 3D surfaces in the material. Based on the application requirements, Aerotech can supply standard and custom solutions for focal height positioning.



## 3D Ultra-Fast Laser Processing

The ablation process occurs at a specific energy threshold for a given material. It is possible to have an ablation spot size smaller than the actual laser spot size by manipulating the beam intensity profile and divergence. The system shown uses a precision vertical lift stage to control the focal position with up to 4.5 nm resolution, while the air-bearing XY stage provides extremely flat motion to maintain focus over full travel while providing extremely small step sizes (10 nm) for the accurate placement of sub-micron part features.

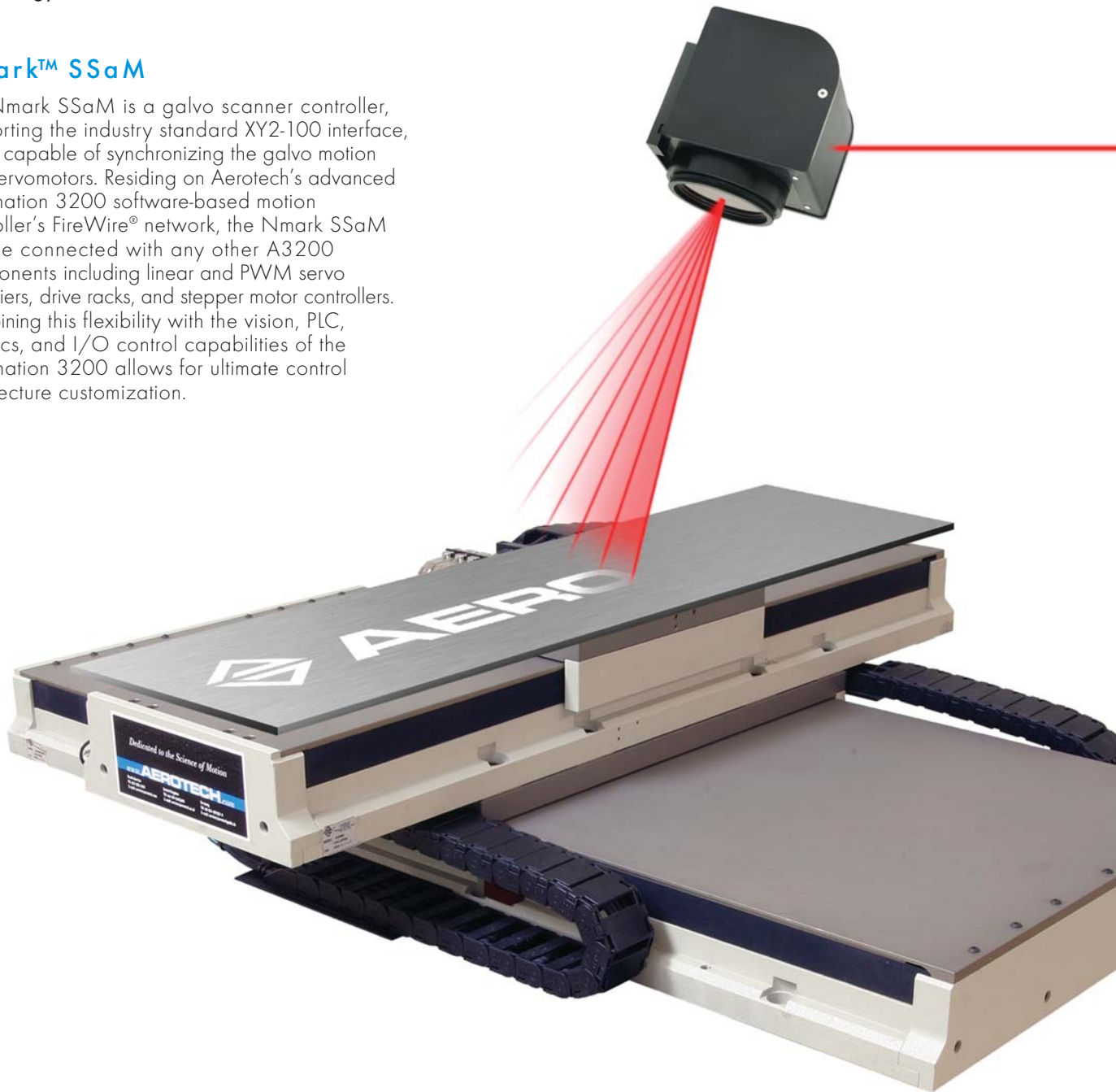


# SOLUTIONS FOR LASER MARKING

Scanheads are excellent devices for quickly marking vectors or graphics, but are limited by the relatively small field of view in which they can process. By coordinating scanner motion with traditional servo axes, the field of view can be significantly expanded while maintaining the quality and throughput expected of scanner technology.

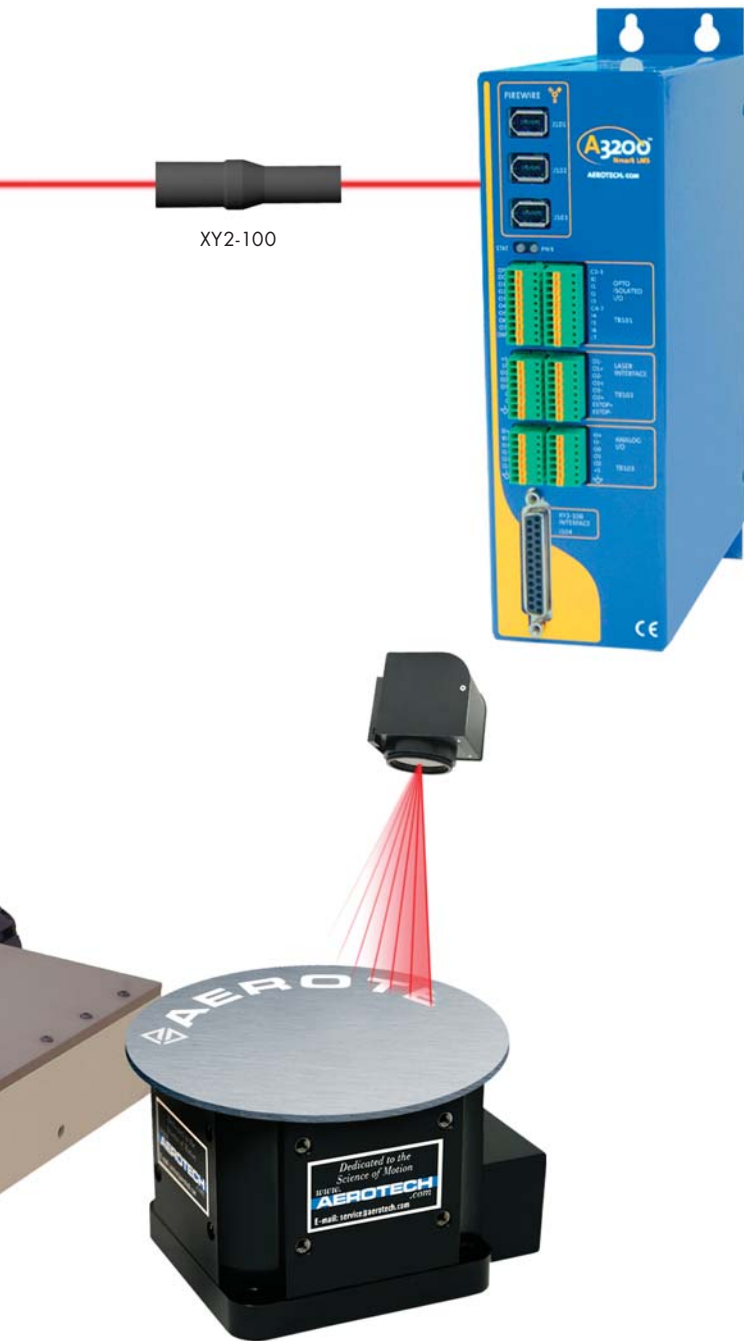
## Nmark™ SSaM

The Nmark SSaM is a galvo scanner controller, supporting the industry standard XY2-100 interface, that is capable of synchronizing the galvo motion with servomotors. Residing on Aerotech's advanced Automation 3200 software-based motion controller's FireWire® network, the Nmark SSaM can be connected with any other A3200 components including linear and PWM servo amplifiers, drive racks, and stepper motor controllers. Combining this flexibility with the vision, PLC, robotics, and I/O control capabilities of the Automation 3200 allows for ultimate control architecture customization.



## Stretched Vector

Scanners are commonly used in vector-type laser cutting, welding, marking, sealing, and ablation applications that require the process to be completed in a single pass of the laser. Coordinating vector movement with servo motion vastly expands this working field and effective vector length, allowing for a wider range of products to be processed, fully utilizing the advantages of scanner technology.



## BroadMark Graphic

Many applications require raster-type scanning of the laser for bar codes, bitmaps, and scribing. When the object being processed is larger than the scanhead's field of view, it is common to stitch several exposures together. This can result in discontinuities in the image due to angular errors in aligning each exposure, reducing image quality and the range of applications suitable for this technology. With the Nmark SSaM's BroadMark functionality, linear and rotary servo motion can be coordinated with the galvo mirrors so that the entire raster scan is completed in one continuous pass, eliminating these angular errors.

### Nmark SSaM Features:

- Multi-vendor scanner support with industry standard XY2-100 interface, with support for up to three axes of clock and direction stepper motors, two galvo mirrors, and a third axis for dynamic focus control. Additional features include first pulse suppression, first pulse delay, on-the-fly marking, image transformation, and a full complement of opto-isolated digital and analog I/O.
- Scanner and servo motion is programmed in industry standard RS-274 G-code language along with AeroBASIC™ command extensions for laser and IO control. With all major CAD/CAM vendors supporting RS-274 output, users have a direct conversion path from CAD data to galvo and scanner motion.

# SOLUTIONS FOR LASER DRILLING APPLICATIONS

Nd:Yag and Q-Switched lasers are typically used in laser drilling applications. Laser drilling is usually accomplished by one of two methods: either with percussion laser drilling or trepanning the beam. While percussion drilling is often a faster process, trepanning the beam results in a lower heat affected zone and allows for complex hole geometries. In both cases, precise contouring of the motion axes is required to maintain tolerances.

## Featuring/Recommendations:

- A3200 controller
- High-performance linear motor stages (ALS5000/ALS5000WB)
- Direct drive, high-torque rotary tilt axis (ADRT)
- Direct drive, low-profile rotary axis (ADRS)

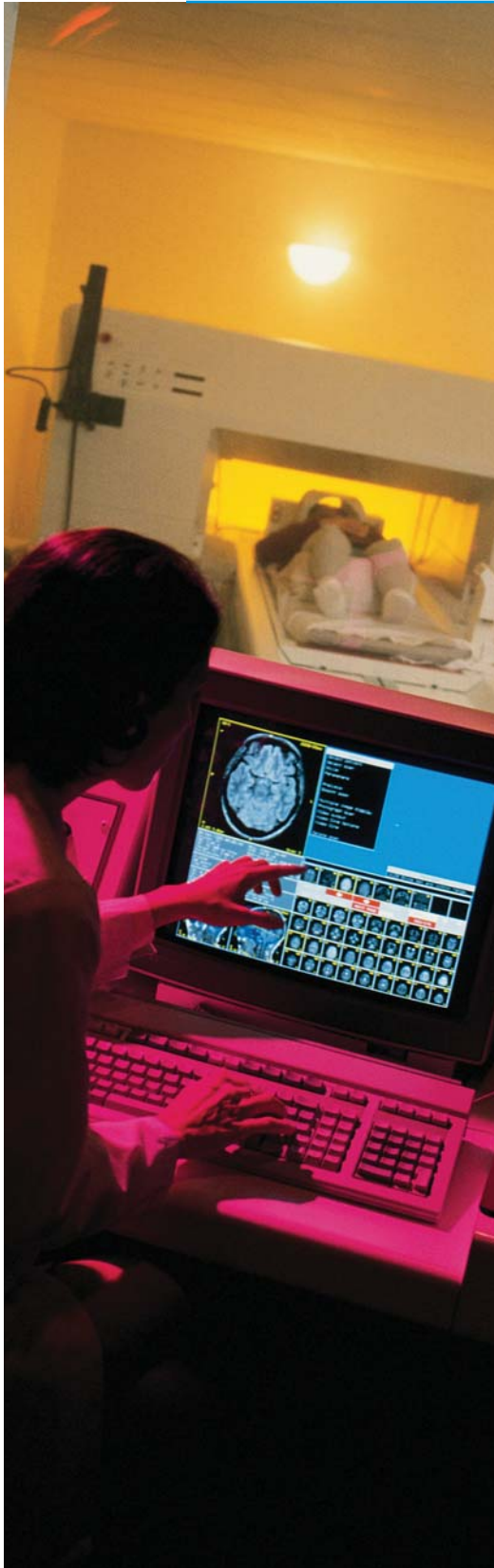
## 5/6-Axis Laser Drilling

Five- and six-axis motion assemblies composed of high resolution direct-drive axes allow accurate drilling of deep aspect-ratio holes in components such as fuel injectors, which require precise positioning of parts in three-dimensional space. High performance, wide body, linear-motor stages ensure cantilever load effects are mitigated while maintaining micron-level accuracy. Two axis, direct-drive rotary assemblies position to arc seconds of accuracy, allowing for precise contouring of the part.



ALS5000WB  
wide body, linear  
motor stage

# AEROTECH SUCCESS IN THE MEDICAL INDUSTRY



Advancements in core technologies such as electronics, software, and imaging have continued to drive the development of new medical devices and diagnostic procedures. The growing complexity of these devices and stringent FDA validation procedures require precision automation components and systems to ensure consistent, repeatable results. Likewise, the costs associated with supporting the infrastructure and integration of these systems into specialized cleanroom manufacturing environments require solutions with the highest possible output per square foot of production space while limiting maintenance and downtime.

Aerotech is uniquely positioned to meet the stringent requirements of this industry. Our standard motion products can be configured to meet most automation requirements with proven reliability demonstrated by over 35 years of sales into the medical field. Application specific optimized solutions, such as our stent cutting and hermetic sealing solutions, are available that can demonstrate up to a 5x improvement in throughput over conventional approaches, providing a lower total cost of ownership and maximizing your return on investment.

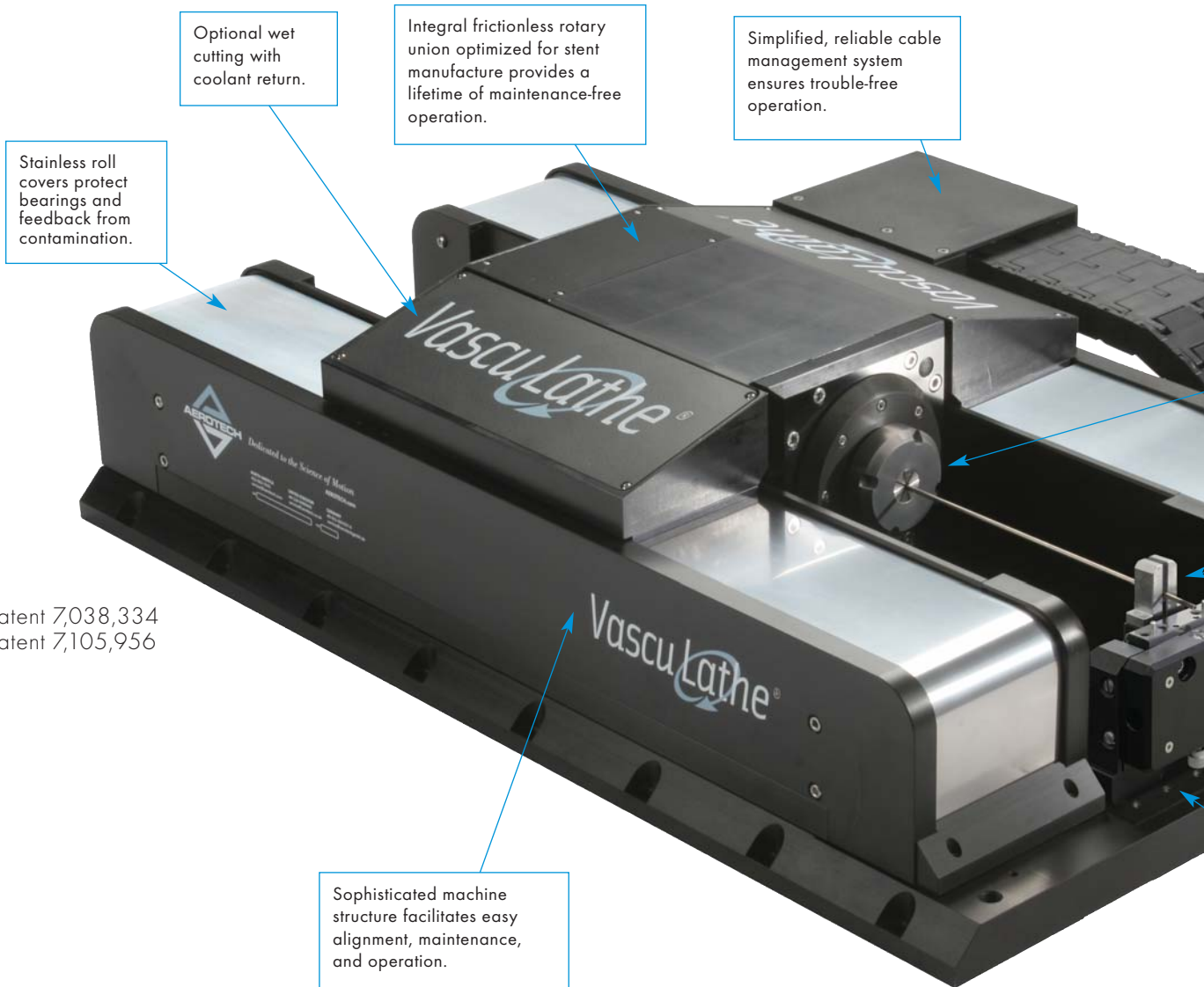
## Applications served:

- Stent cutting
- Cardiac pacemaker, defibrillator, and neuro-stimulation seam welding systems
- Guidewire, catheter, and hypotube manufacturing
- DNA sequencing
- CAT scanners
- Proteomics
- Haptic mills
- Blood sequencing
- Patient and X-ray source positioning
- Magnetic resonance scanners
- Oncology
- Surgical staples
- Intraocular and contact lens manufacturing
- Retinal inspection

# SOLUTIONS FOR STENT MANUFACTURING

VascuLathe® represents a revolutionary approach to satisfying the demanding requirements of stent manufacturing applications. The fully integrated motion system couples automated material handling functionality with high performance direct-drive linear and rotary motion capability. The integral linear-rotary design increases throughput by 2 to 5 times when compared to traditional screw-based or other manufacturing approaches, while still maintaining submicron tolerances on tight part geometries.

The increased throughput gives much needed flexibility in the extremely competitive stent-manufacturing environment. The higher throughput of the VascuLathe implies that fewer machines are required to produce an equivalent number of stents when compared to traditional manufacturing approaches, resulting in lower total labor costs and reduced floor space requirements. Alternatively, the VascuLathe can be used to meet increased and varied product demand within the existing manufacturing space, saving the costs associated with facility expansion.



U.S. Patent 7,038,334  
U.S. Patent 7,105,956





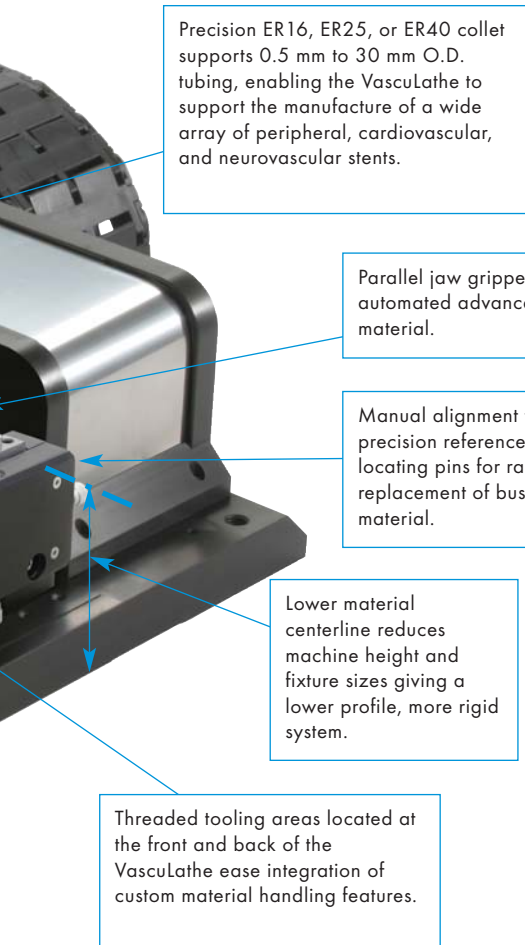
Highly advanced drive technology results in superior surface finish.

Future-proof software-only control and network architecture (FireWire®).

Special software programs to assist in product changeover.

## A3200<sup>®</sup> Digital Automation Platform

The Vasculathe features Aerotech's Automation 3200 controller (A3200), a 100% digital automation platform. The A3200's advanced control architecture has special path planning functionality that automatically adjusts the cutting speed to minimize path errors in tight stent geometry, maintaining form quality throughout the part. Sophisticated laser control functions automatically adjust the laser power and rep rate to minimize the heat-affected zone of the material as a function of the cutting speed. Specialized drive electronics are optimized for the frequent direction reversals encountered in a typical stent profile and help to further minimize following error. Advanced plotting and diagnostic tools display axis performance in real time and process monitoring functions report peak position error, path cut length, and stent cut time at the completion of each part, providing an instantaneous measure of part quality on a piece-by-piece basis.



Precision ER16, ER25, or ER40 collet supports 0.5 mm to 30 mm O.D. tubing, enabling the Vasculathe to support the manufacture of a wide array of peripheral, cardiovascular, and neurovascular stents.

Parallel jaw gripper for automated advance of tubing material.

Manual alignment fixture with precision reference surface and locating pins for rapid replacement of bushing material.

Lower material centerline reduces machine height and fixture sizes giving a lower profile, more rigid system.

Threaded tooling areas located at the front and back of the Vasculathe ease integration of custom material handling features.

# SOLUTIONS FOR GUIDEWIRES, CATHETERS, CANNULAE, HYPOTUBES, AND ENDOSCOPES

Many medical devices and diagnostic tools are fabricated from tubular materials that can have multiple features integrated along their length. For example, a hypotube may have a skive or slot on the distal end to facilitate the placement of components such as balloon catheters, and will have a spiral or interlaced pattern cut along the length for flexibility and directional control when inserted into the body. Endoscopes have intersecting, welded, cylindrical features for camera and control ports and irrigation features for clear viewing through the device. All of these products require precise angular positioning and velocity control during the manufacturing process to ensure consistent, repeatable performance of the finished component.

## Featuring/Recommendations:

- A3200 or Ensemble motion controller
- Rotary axes with integral pneumatic collet adapters and 3-jaw grippers (ACS, ACS-LP)

## Low Profile, Direct-Drive Rotary Stages Feature ER Collets

Aerotech manufactures direct-drive rotary stages with automated material handling features for ease of integration into new and existing systems. Air-activated ER collets can grip tube diameters from 0.2 mm to 30 mm and can be used to position hypotubes, cannulae, and other medical devices for laser and mechanical forming processes.



## 3-Jaw Grippers

A 3-jaw parallel gripper for I.D. or O.D. gripping is offered, and includes a clear aperture for product feed-through. Optional jaw travel ranges are available to suit different material sizes and peak gripping force requirements. Custom jaw profiles can be created to grip hexagonal and other non-round profiles, or to set the material depth of grip.



# HERMETIC SEAM WELDING

The ever-shrinking geometries of electronic components, coupled with advances in battery technology, have led to the development of a large array of implantable medical devices for heart rhythm management (pacemakers, defibrillators) and chronic pain relief (neuro-stimulation). These products share a common packaging technique that consists of a titanium half-shell enclosure joined together with a hermetic seam weld. The integrity of the weld is crucial to ensure the long-term reliability of the device and to protect the patient from contamination. Traditional approaches to the welding process have utilized standard rotary and linear motion devices coupled with

complicated post-processing software to create the weld path. Aerotech's HermeSys is a holistic design that optimizes all aspects of the hermetic seam-welding process. Specialized mechanics are used to accurately position the device during the welding process. Onboard kinematics allows the programming of weld geometry in part space for rapid optimization of process parameters on the machine (no post-processing required). And, finally, a reference design is available for an automated material handling system to ensure that the part load/unload cycle can keep pace with the optimized welding process.

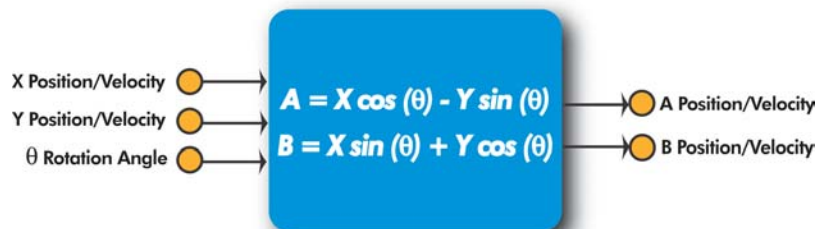


## HermeSys™ Hermetic Seam Welding System

The HermeSys features a purpose-designed mechanical structure that is substantially stiffer than component-level solutions. The increased stiffness allows high acceleration with minimal following error, a critical requirement for holding tolerance during the multiple direction changes and rapid start/stop of the linear and rotary axes during the welding process.

### Real-Time Kinematics

Real-time kinematics removes the need for complex post-processing tools to create multi-axis laser weld paths. The weld profile is programmed in linear/arc segments or points on a cubic spline interpolated path. Part geometry and welding speeds can be optimized on the machine without re-posting the weld profile.



Real-Time Kinematic Transformation

# SOLUTIONS FOR INTRAOCULAR AND CONTACT LENS MANUFACTURING

Intraocular and contact lens manufacturing require precise speed control, high radial and axial stiffness, and minimum runout of the tooling for precise manufacturing of lenses. Aerotech's LENS GEN<sup>®</sup> system was designed to produce superior quality IOLs, contact lenses, and molds with minimal setup, offering a highly reliable, completely sealed design.

## Featuring/Recommendations:

- A3200 or Ensemble multi-axis motion controller
- High performance linear motor stage (ALS5000)
- High performance, direct drive, air-bearing rotary stage

## LENS GEN<sup>®</sup> Two-Axis Optical Lathe

The LENS GEN<sup>®</sup> two-axis lathe produces aspherical and spherical IOLs and contact lenses faster and with unsurpassed surface finish and accuracy. The high performance air-bearing spindle that is rigidly mounted to the Z-axis stage requires no water cooling and offers infinitely variable speed control. An LVDT probe system verifies lens blank placement before lathing, preventing any mishap due to incorrect arbor insertion or other factors. Linear axes are available with either high precision crossed-roller bearings or air bearings for smooth, stiff, and accurate operation. Brushless linear servomotors drive the stages, avoiding accuracy limiting effects such as backlash and hysteresis associated with lead or ball-screw-driven stages. Both the linear and rotary stages are completely sealed to protect the bearings, increasing stage life and reducing maintenance costs. The natural granite machine base provides both high rigidity and excellent thermal stability. Passive vibration isolation elements isolate the base from its fabricated steel frame.



# SOLUTIONS FOR DNA, DRUG DISCOVERY, AND PROTEOMICS

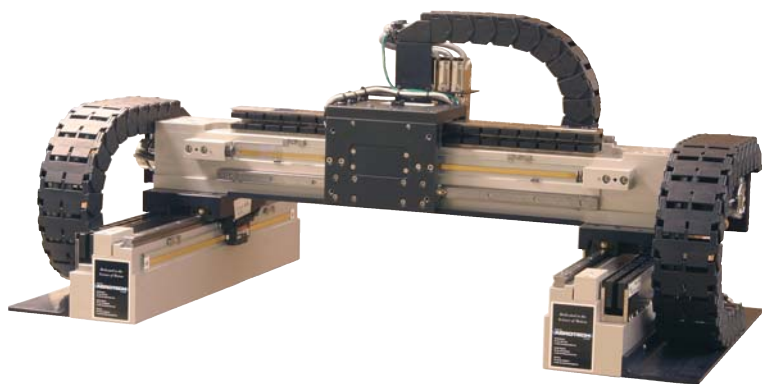
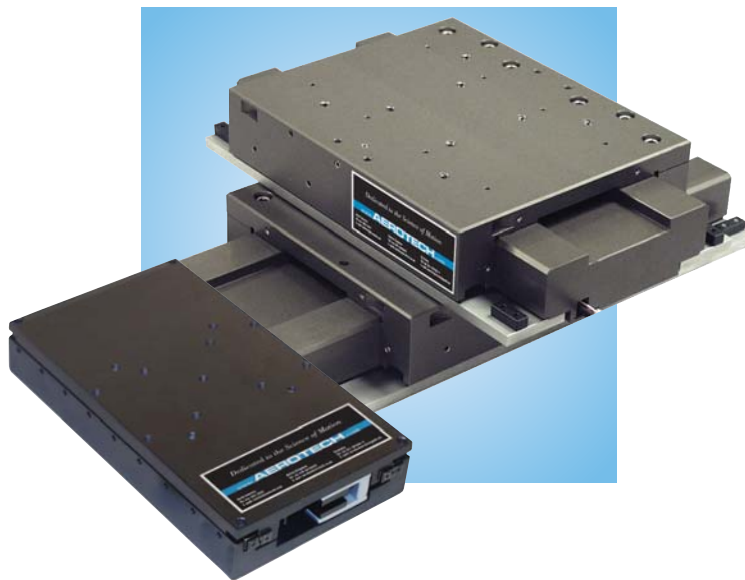
Historically, DNA and other reactive-agent-based analysis procedures have used low-end positioning devices such as stepper motors and belt drives to distribute solutions into low-density well plates. As the industry has progressed to higher density plates with smaller sample sizes, more sophisticated motion control technology has been required to increase the efficiency and reduce the costs of the test procedure. Likewise, newer luminance analysis tools with extremely sensitive detector technology have placed more stringent requirements on the motion platform in terms of positioning accuracy, velocity stability, and flatness of travel. As a single-source manufacturer of high-end motion control equipment, Aerotech is uniquely positioned to provide solutions for the latest generation of lab automation tools.

## Featuring/Recommendations:

- A3200 controller
- Linear motor gantries (AGS1000)
- Low-profile, linear motor, mechanical and air-bearing stages (ABL1000, ALS130)

## ABL1000 and ALS130 Linear Stages

Aerotech's ABL1000 air-bearing stages and ALS130 series crossed-roller mechanical-bearing stages are well-suited for applications requiring excellent velocity control, positioning accuracy, and in-position stability. Micron-level flatness of travel also makes these stages ideal for applications that are sensitive to depth of focus.



## Linear Motor Gantries

Aerotech's AGS series gantries have the throughput and accuracy to handle high throughput, high density well-plate screening applications. Linear motor technology and direct-drive motors ensure a long, maintenance-free operational lifetime.

# SOLUTIONS FOR DEVICE ASSEMBLY

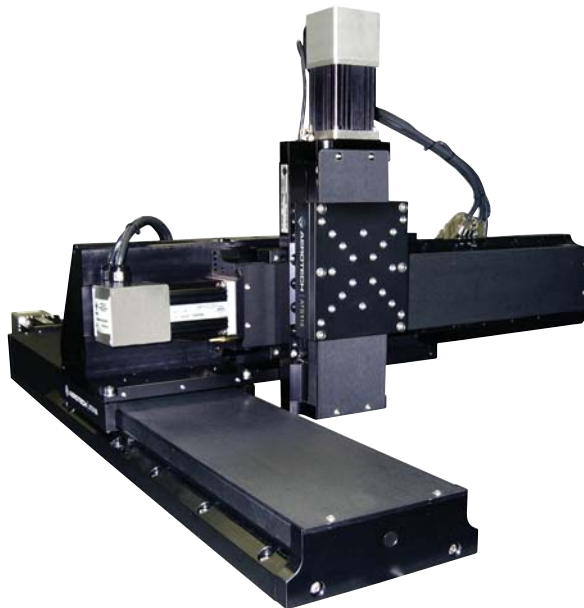
Aerotech has manufactured gantries for a variety of applications, including pick-and-place machines, automated assembly, vision inspection, dispensing stations, and packaging. These solutions can be fully customized to meet unique demands and process variations. Dual brushless servomotors and dual noncontact linear encoders on the lower axis provide the highest accuracy and highest throughput solutions.

## AGS10000 Linear Motor Gantry

With velocities up to 3 m/s and accelerations up to 3 g, the AGS10000 is designed for speed. The optimized cable management system with provisions for customer cables was designed for long life, while the robust mechanical structure was designed for high servo bandwidth, with optional risers and an integral controller and drive chassis. The Z and theta axes are customizable for your application. The fully flexible configuration options allow for wide variations in part size and orientation, providing a highly versatile gantry solution.

## Featuring/Recommendations:

- A3200 controller
- High performance, linear motor gantry (AGS10000)
- Linear ball-screw focusing axis (ATS1000)



## Component Cartesian Gantry

Component gantry assembly solutions are optimized for aligning components or for rapid pick and place assembly. With travels up to 600 mm by 600 mm and an optional vertical axis, these gantries are fully scalable to meet your application requirements. Built with precision ball screws and brushless rotary servomotors, maintenance-free operation is assured, resulting in the lowest cost of ownership to assemble your products.

# COMPONENT SOLUTIONS FOR MEDICAL DEVICE MANUFACTURING

Many complex medical devices require a variety of motors and other motion components for an array of tasks. Reliability and ease of integration are key to effectively

building the highest quality machines as required in the medical industry. Aerotech offers a wide range of standard motors that can be selected to best fit your application.

## Slotless, Brushless Rotary Motors

- Standard NEMA sizes for easy integration and retrofitting
- Advanced slotless design yields superior velocity and position control
- Brushless technology provides maintenance-free use and delivers higher accelerations than brush motors

## Frameless Torque Motors

- Five frame sizes to fit most applications
- Frameless design for easy integration into OEM machines
- Slotless stator and high-pole-count rotor provide zero cogging for exceptional velocity and position control
- Up to 116 N-m of peak torque and 29 N-m of continuous torque



## Brushless Linear Motors

- Advanced design yields 49% greater continuous output than comparative models
- Zero-cogging allows smooth velocity and position control
- Symmetrical mounting pattern allows tracks to be mounted end-to-end for unlimited travel
- Optional air cooling for greater rms force
- Up to 3820 N of peak force and 955 N of continuous force

## Brushless Rotary Motors

- Standard NEMA sizes for easy integration and retrofitting
- Wide range of torques cover a variety of applications (0.7 - 95 N-m)
- Advanced 8-pole design matched with skewed stator minimizes torque ripple and cogging for smoother velocity control
- Rugged construction ideal for 24/7 production applications
- Optional IP65 through IP67 construction allows use in harsh environments

# AEROTECH SUCCESS IN ADVANCED MOTION CONTROLS

## Motion Control at its Finest

Around the globe and 24 hours a day, Aerotech's state-of-the-art single- and multi-axis motion controllers are used in a variety of applications, from research and development, to calibration and testing, to 24/7 production manufacturing and more. These servo and stepper controllers solve simple and complex motion tasks with easy-to-use, highly flexible interfaces. By combining our controls expertise with outstanding positioning mechanics, Aerotech delivers the finest system solutions available with the least amount of customer risk. We offer several different innovative digital control architectures, from PC-based FireWire® controllers to stand-alone systems with Ethernet, USB, or GPIB interfaces, so our customers can get synchronized motion solutions that match their needs.

### Innovation

In addition to a standard suite of features, our controls include important interfaces for: high-speed, 3D vector-based position synchronized outputs (PSO) for highly accurate position-based event triggering; rapid position latching for precise event-based position capture; and unique handling of motion relating to laser processing, including acceleration limiting, cutter compensation, and 3D error correction.

### Simplicity

Our control software provides a library of easy-to-use commands for initializing the system, commanding incremental or absolute position motion, velocity motion, fault trapping, error handling, and synchronized and asynchronous I/O. These functions can be multitasking or a single process thread. Motion commands can simultaneously command many axes to move together or independently. Concurrent with the motion application, our controllers process numerous fault and error checking routines so the customer remains focused on the motion process and not the system housekeeping tasks. Our software is compatible with RS-274 G-code, C++, .NET, or LabVIEW®. Numerous canned functions and programming examples for scanning, tracking, and point-to-point motion can be immediately integrated by customers for rapid program development.

### Flexibility

Aerotech controllers feature interfaces for brush and brushless servomotors including sinusoidal commutation, as well as stepper motors. Standard encoder interfaces include TTL quadrature inputs, analog sinusoidal encoder inputs, and resolver and inductosyn inputs for magnetic encoding where optical encoders are impractical. We have many onboard I/O channels controlled from single or multiple I/O commands. These I/O are easily combined with Opto 22™ modules for a large variety of DC, AC, and switch closure capabilities. Opto-coupling I/O protects the controls from over-voltage or over-current damage. I/O can be expanded by additional controllers or with Ethernet I/O modules. Aerotech designed and manufactured linear and PWM amplifiers feature high power outputs with low electrical noise, and minimum crossover distortion and dead time. They provide fast reaction motion capability while minimizing electrical noise. We manufacture our own linear and rotary motors to complement our amplifiers, eliminating problems of component compatibility and wiring.

Our expertise in all facets of the motion system - controls, drives, motors, and mechanics - allows us to understand and optimize the total system solution better than any other manufacturer. Call us today to assist you with your application.



Automation 3200







# STAND-ALONE, SINGLE-AXIS CONTROLLER

Aerotech's Soloist™ single-axis digital servo controller combines advanced software architecture (.NET) with a power supply, an amplifier, and a position controller in a single package. The flexibility and scalability of the

Soloist™ make it the ideal controller for both small and large applications on the production floor and in laboratory applications.

## Advanced software architecture reduces development time and eases maintenance

- Development environment for .NET (C#) or Windows® (C++)
- Virtual instruments for the LabVIEW® environment
- Positioning modes include indexing, homing, velocity profiling, freerun, and CAM tables
- Autotuning makes servo tuning fast and simple
- File storage folder for parameters, programs, maintenance data, etc.
- Multitasking operating system
- Advanced data logging capabilities

## Scalable design suitable for large axis-count web applications or stand-alone operation

- Digital drive in models up to 30 Apk
- Six programmable inputs (two high speed); four programmable outputs
- ESTOP input
- Dual encoder inputs for master/slave applications or dual-loop control
- Optional AUX power, encoder multiplier, single-axis PSO, integral or external shunt
- Expansion board with 16 digital inputs, 16 digital outputs, one analog input, one analog output, and brake relay

## Industry standard interfaces (Ethernet/USB/RS-232) make connectivity quick and cost-effective

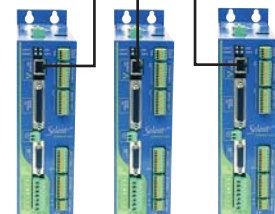
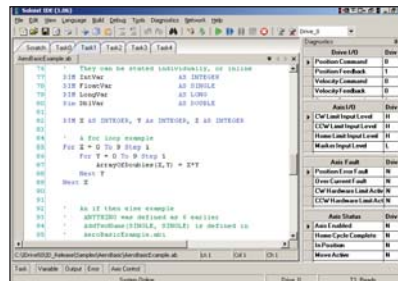
- Multi-axis configuration through Ethernet up to 1024 axes
- MODBUS over Ethernet master/slave capabilities
- Status, development, and commands can be performed via Ethernet or locally through USB
- General purpose RS-232 serial port



Soloist™ MP

Soloist™ CP

Soloist™ CL



Soloist™

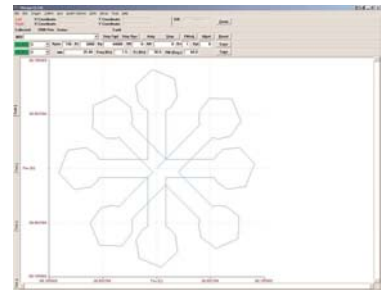
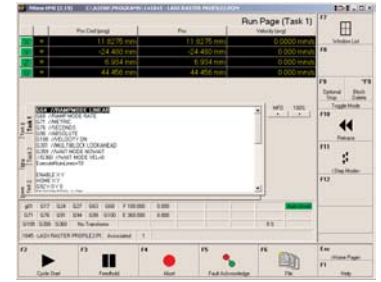


# DIGITAL AUTOMATION PLATFORM

## The Intelligent 32-Axis Motion, Vision, PLC, Robotics, & I/O Platform

### A3200 ADVANTAGES

- Higher throughput due to high performance control, network, and high-power drives
- Higher quality output (accuracy and precision) due to fully digital drive and advanced servo algorithms
- Faster startup and changeover results from fully integrated motion platform, easy-to-use setup tools, and extensive diagnostics
- Lower startup and lifecycle cost due to lower component count and reduced engineering time
- Higher reliability due to fewer components
- Simplified integration as all major automation components are bundled into one platform
- User interface flexibility due to local or remote processing
- "Future Proof" architecture built on commercially available PCs running Windows® 2000/XP operating systems



**FireWire® (IEEE-1394) INDUSTRY STANDARD, HIGH-PERFORMANCE COMMUNICATION NETWORK**

### EXTENSIVE I/O CAPABILITY

All Automation 3200 drives and drive racks are available with an integrated 10/100 Base-T Ethernet interface, permitting interaction with third-party I/O boards and PLCs.

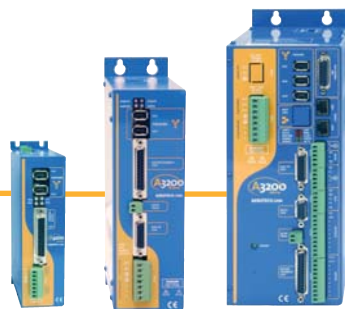
Analog and Discrete I/O



Ethernet I/O Expansion

### EASILY INSTALLED DIGITAL DRIVES FROM 10 A to 150 A

From highly compact, cost-optimized designs to self-contained, plug and play models, Aerotech has the drive for any application.

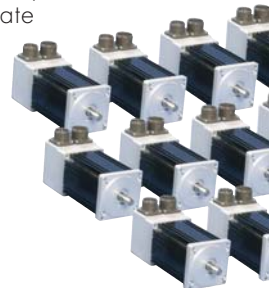


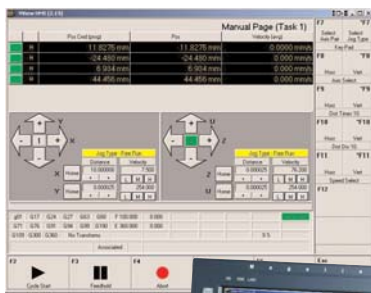
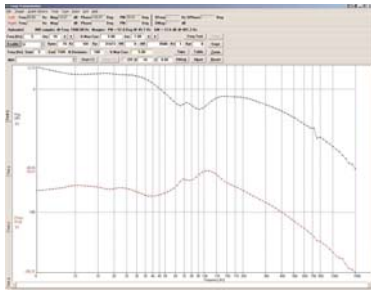
### Distributed Motion Control

Motion control is performed at the drive level.

### DIGITAL DRIVE features

- PWM or linear
- Integrated 10/100 Base-T Ethernet
- Onboard x65536 encoder multiplication
- Resolver or inductosyn feedback
- 20 kHz position, velocity, and current-loop sample rate
- Integral power supply
- Sinusoidal commutation
- Local I/O ports





## ROBUST, HIGH-PERFORMANCE MOTION ENGINE CAPABILITIES

- Point-to-point motion
- Interpolated motion
- Velocity profiling
- Look-ahead
- Electronically geared motion
- Cutter compensation
- CNC functionality
- Electronic CAM profiling
- Position synchronized output
- Fast position capture
- High-speed registration
- Gantry mode
- Motor control
- Dual loop control
- Axis calibration
- Orthogonality correction
- 3D error mapping
- Helical interpolation
- Autotuning
- Coordinate transformations
- Normalcy, parts rotation, mirroring, and retrace
- Cubic spline fitting
- Kinematics

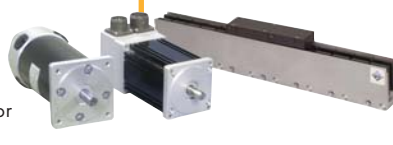
### Motion Controller

Motion generation and synchronization are centralized at the PC. Motion execution is decentralized at the drives. A3200 operates on any standard desktop or industrial PC. Servo loops are closed on the drive.

Npaq® 6-Axis Drive Rack



Any Brush or Brushless Servomotor



### RETROFIT TO EXISTING MOTORS & DRIVES

Use as an integrated system or interface to existing motors and drives in a cost-effective retrofit.

Nservo



Any Servo Amplifier

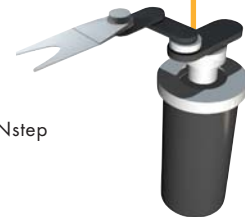
Nstep



Any Stepper Drive



Any Stepper Motor



Robotics



Vision



# INTELLIGENT NETWORKED DRIVES

Aerotech Ndrive® series digital servo amplifiers, Automation 3200 controller, and linear and rotary servomotors are perfectly matched to provide the ideal solution for your motion control application. Available models include the Ndrive HP, Ndrive HL, Ndrive CP, Ndrive MP, and Npaq®. Additional solutions are the integrated Nsys console, Nservo, and Nstep interfaces.

## Available features and options (all options not necessarily available on all models):

- Easy networking via industry standard FireWire® interface
- Digital current, velocity, and position loops for improved motion stability
- Drive brushless and DC brush-type servomotors, as well as stepping motors
- Input voltage range from 10-320 VDC or 7-240 VAC
- Bus voltage from 10-320 VDC
- Output current 10-150 A peak (5-75 A continuous)
- 20 kHz PWM or linear output
- Dedicated ESTOP input and optional brake
- Up to 3 axes of Position Synchronized Output
- Up to 16 in/16 out expansion board with analog in/out (optional Ethernet for additional I/O)
- Integrated hardware or software multiplier
- CE compliant



**Ndrive MP**  
"Micro-sized" drive saves space and reduces cost



**Ndrive CP**  
Compact drive minimizes integration time



**Ndrive HP**  
High performance drive for demanding applications



**Ndrive HL**  
High powered linear drive for ultimate performance

## Cost-Effective Machine Retrofits with Nservo and Nstep:

- Extend the life of your capital investment by retrofitting your existing amplifiers and drives to interface with the A3200 controller
- Retrofit older Aerotech or third-party servo, analog, or stepper drives
- Nservo and Nstep each support up to 4 axes of control
- FireWire® enabled for easy networking



**Nstep**  
Interface older stepper drives to the A3200 controller



**Nservo**  
Interface older servo or analog amplifiers to the A3200 controller



**Nsys**  
Integrated console containing computer, controller, I/O, and customer supplied product



**Npaq®**  
Highly integrated six-axis drive chassis

## MULTI-AXIS MOTION CONTROLLER

The Ensemble™ is Aerotech's next-generation multi-axis controller for moderate- to high-performance applications with high-speed communication through 10/100 Base T Ethernet or USB interfaces. It offers easy-to-use, affordable multi-axis motion programming for laboratory experimentation, production testing, or advanced OEM automated manufacturing systems.

### Ensemble™ Epaq and Drives

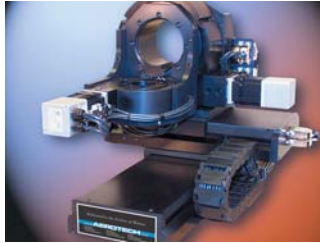
- Up to 10 axes of coordinated motion
- Multiple 10-axis systems can be controlled by a single PC via Ethernet or USB
- Controller architecture capable of coordinating motion of up to five independent tasks
- Capable of driving and controlling linear or rotary brushless, DC brush servo, and microstepping motors
- Complete motion capabilities include: point-to-point, linear and circular interpolation, electronic gearing, velocity profiling
- Program in AeroBASIC™ with the IDE, Microsoft .NET including C#, VB.NET®, Managed C++, or LabVIEW® over Ethernet or USB from Windows® 2000 or Windows® XP
- Remote ASCII interface provided for Windows® or non-Windows® programs (including Linux) to command the Epaq through standard Ethernet, RS-232 port, and optional IEEE-488
- Advanced Windows®-based remote diagnostics, tuning, and programming interface software
- Axis jogging/control with optional joystick
- Epaq is available in rackmount or desktop versions



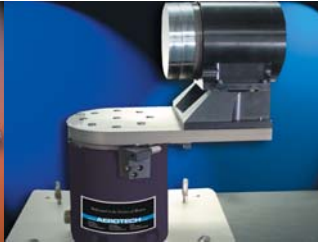
Ensemble™ Family (left to right): MP, CP, CL, Epaq

# ENGINEERED SYSTEMS

Aerotech engineers and manufactures specialty high-performance subsystems. Our highly-trained staff of experienced software and hardware engineers enables our customers to get to production readiness faster. Aerotech provides real-time collaborative support – either at your facility, at our facility, or on the web.



Advanced Laser Machining



Discrete Part Milling Machine



Rapid Prototyping



Advanced Pick-Place-Inspect Station



Ion Beam Profiling in Vacuum



Precision Optical Production



High-Precision Air Bearings



Liquid-Cooled, Vacuum-Prepped System



High Volume Production Inspection Station



4-Axis Coordinate Measuring Machine



Electronic Inspection



High-Speed Optical Indexer



Patterned Media Inspection



Printhead Inspection Station



High-Accuracy Laser Machining



Optical Lens Fabricating

# AEROTECH ONLINE

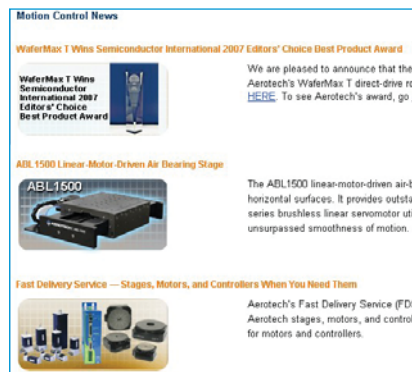
Aerotech's website at **www.aerotech.com** is your comprehensive resource for all Aerotech information worldwide. Our product information is very thorough and better than having a catalog. Each product section comes with all the information available in print and includes downloadable 2D and 3D models. Register for our e-newsletter *In Motion* to receive news on all of the current activities at Aerotech.

## Select your Market

Our "select a market" feature details market-specific automation solutions from Aerotech.

## Product Navigation

Easy-to-use product navigation intuitively and quickly guides you through our broad product range.



## Current Product and Company News

The most current product and company news is featured prominently on our home page.

## Worldwide Sales Office Locator

Use our worldwide sales office locator to quickly find an Aerotech office near you.

## Customer Service

Our customer service center provides contact information for Aerotech customer service worldwide. Also included are details on our training programs, software and product manual downloads, and an FAQ section.



# WORLDWIDE TRAINING & SUPPORT

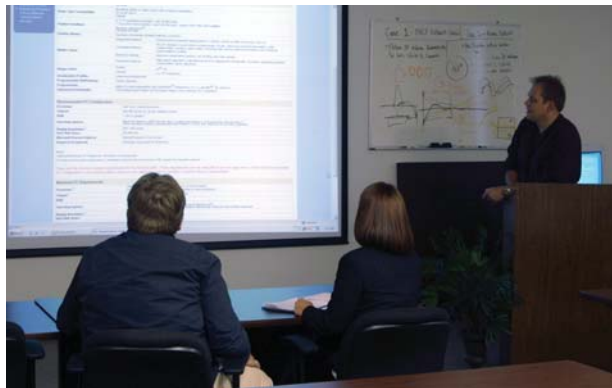
Aerotech offers comprehensive worldwide training and customer service either at customer facilities or at one of our Aerotech training centers.

## Our Training Program Features:

- Standard and customized courses
- Hands-on training with Aerotech positioning systems
- Interactive training with experienced instructors
- Comfortable, spacious facilities



Aerotech Ltd (United Kingdom)



Aerotech Inc (U.S.A.)



Aerotech GmbH (Germany)

## Installation and Start up (Commissioning)

Aerotech offers startup and commissioning services to minimize startup times, reduce cost, and accelerate time-to-production. By combining our product knowledge with your process and application expertise, new systems and applications can be completed faster and at a reduced overall cost.

## Engineering Support

Aerotech provides complete engineering support for our products, including onsite support and maintenance, and remote support via phone, fax, website, and/or WebEx<sup>®</sup> software. As a manufacturer staffed by engineers, we understand the unacceptability of downtime.

## Training

Aerotech training classes are designed to help our customers realize the full potential of our products. By demonstrating all of a product's features and how to use them, customers have been able to reduce startup time and quickly optimize their applications. Aerotech's classes have been developed, and continually upgraded, using feedback from our customers.

Aerotech has over 35 years of expertise in designing motion control and positioning systems and components with an unsurpassed track record of reliability. When you make the choice to purchase from Aerotech, we urge you to learn how to get the most from your new Aerotech products. Aerotech provides both onsite (your facility) and/or in-house (our facility) training for our customers' convenience.

# AEROTECH AT A GLANCE



Corporate Headquarters • Pittsburgh, PA • USA



Aerotech UK



Aerotech Germany



Aerotech Japan

## High Volume Manufacturing



Over 100,000 axes installed worldwide

## Worldwide Service and Support



Worldwide startup service and on-site training



Fully equipped on-site training facilities



## Technically Superior Components

Highest performance brushless linear and rotary motors



ADRT rotary stages



ALS1000 linear motor stage



Ndrive®



A3200



Npaq®

Award-winning Automation 3200

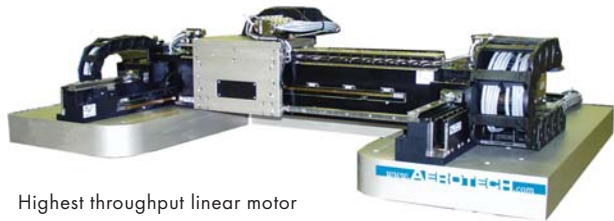
1-32 axis motion, vision, PLC, robotics, and I/O platform

## High Performance Sub-Assemblies

Award-winning FiberMax® 6-axis nanopositioner



LaserTurn™ 5 high-speed cylindrical laser cutting system



Highest throughput linear motor Cartesian gantry systems

## Best-in-Class Sub-Systems



Highly integrated motion sub-systems with machine frame, display, and packaged electronics



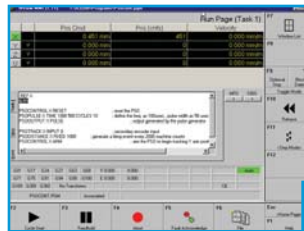
Custom-engineered, vacuum, and cleanroom compatible systems



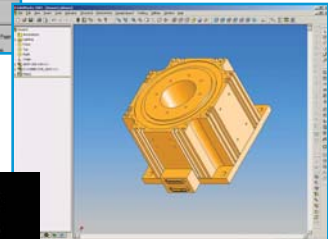
Production-proven, large format air-bearing systems for flat panel and semiconductor applications

## Comprehensive Technical Support Services

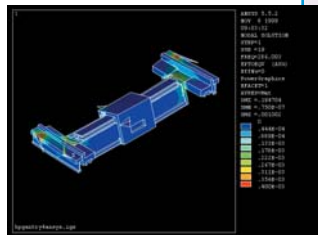
Custom software application support



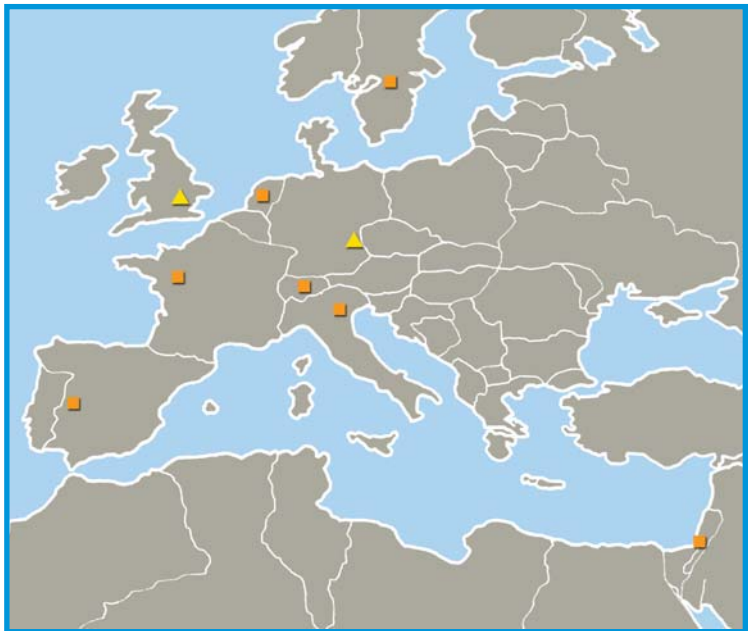
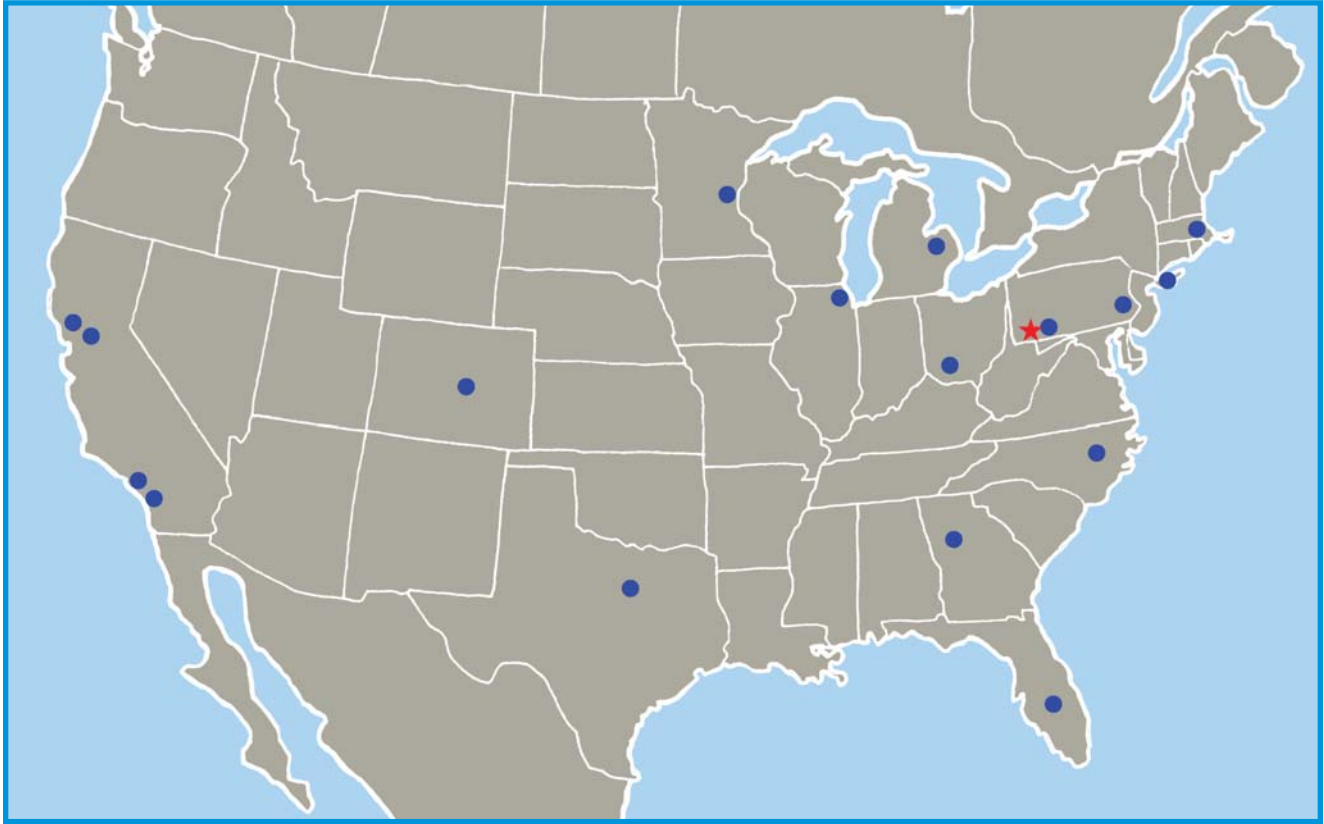
3D models to facilitate faster and more accurate system layout



Advanced analytical techniques for optimization of system geometry



## Aerotech's Worldwide Sales and Service Locations



★ - Aerotech Headquarters   ● - Direct Field Sales Office   ▲ - Aerotech Subsidiary   ■ - Representative