

First-Ever Precision Measurement/Loading System for GRIN Optical Thin Film measurement

ABTech Manufacturing creates the first measurement and automatic loading system for ultra-precise, ultra-thin optical films in just 3 months.

Introduction:

When a company develops a unique product, it needs equally innovative measurement systems to monitor consistency and verify the quality. Faced with the need to meet tight specifications for its ultra-thin, high-performance thin films, Peak Nano Optics turned to ABTech in New Hampshire for ABTech's expertise in custom-engineered metrology and precision motion systems.

Peak Nano (www.peaknano.com/optics) has developed optical lenses composed of film layers 10,000 times thinner than a human hair. These nano-layered, gradient, refractive index (GRIN) lenses are significantly lighter than any other, enable more complex performance parameters and are custom-tailored for military, medical and commercial applications.

The company needed a system to precisely measure the refractive index of each film, ensure the films met customer specifications and then load them robotically into sorting bins.

Accurate Measurement, Precision Movement, and Speed

"Nothing like this measurement and automatic loading system existed in the market," says Ken Abbott, owner of ABTech, Inc.

(www.abtechmfg.com). "Accuracy of signal capture and synchronization were Peak Nano's primary concern, but speed of operation was an important second and timely delivery was also essential. Creating that system, especially for incredibly thin, light-weight, closely specified films, required close collaboration with Peak Nano's engineers to understand their needs and come up with a design that would deliver on all their requirements."



Photo 1: Multi-Axis Metrology Platforms

- **C-axis: AT300 air bearing**
- **31" worktable with 4 film stations**
- **B-axis: SP138 air bearing**
- **Optical arm for precise laser path**
- **Laser station: Located under safety hood behind B-axis**
- **Collaborative robot with custom end of arm tooling for loading and unloading film**
- **Full system enclosure to protect from robot and laser**
- **Door sensors and E-stop circuit for protection**
- **Base cabinet and frame with vibration isolation leveling feet**
- **2-axis motion and DAQ controller**
- **Granite surface plate provides stable foundation**

The system is based on ABTech's multi-axis air bearing platform for precision positioning. The 12-inch rotary air bearing table has the ability to jog to multiple locations per sample and is driven with a brushless dc servo motor and optical encoder. Its 90-degree indexing allows it to move continuously without having to return to a neutral position. Six sensors ensure that temperature, pressure and humidity remain constant during the delicate measuring process. The horizontally mounted Air Bearing Spindle is used to sweep a laser beam across the lens being tested and is driven with a brushless dc motor and 2 optical encoders. An absolute encoder is used for servo positioning and a higher resolution relative encoder is used for data capturing of the rotational position.

The measurement cycle for each film is three full sweeps, with the data captured by three photo diodes and the relative encoder. The workstation includes four film stations. The bar-coded films are then scanned so that an Ethernet-controlled robotic arm with a 39-inch (1-meter) reach can place them into sorting bins. A real time and FPGA based controller captures and synchronizes all of the signals related to measurements and motions.

The entire system fits on a single workstation, enclosed in acrylic panels with individual door sensors. It takes up just 55 inches (1.4 meters) by 101 inches (2.5 meters) of floor space.

The system completes every task for each film—pick up, detailed measurement, sorting, and, unloading—in just 10 seconds.

Project Management That Delivers

“Our system enables Peak Nano to verify that their film is manufactured correctly, and it will help them advance GRIN technology even beyond where it is today,” Abbott states. “We had to move into some unknown territory to combine signal capturing, positioning and measurement, careful pickup and unloading, and synchronization in one customized system.”

ABTech built the system using ABTech's own proprietary precision motion and measurement systems, off-the-shelf components (such as the robot) that were used in new ways and Peak Nano's application software. One of the project team's challenges were to identify and bring

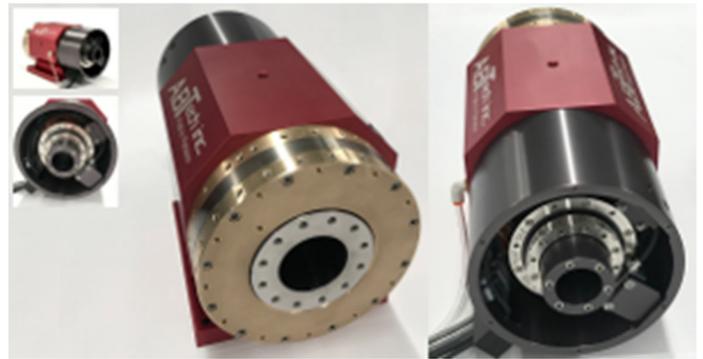


Photo 2: B-axis

- ***B Axis: SP138 Air Bearing Spindle***
- ***Brushless DC servo motor drive***
- ***Dual high-resolution non-contact rotary encoders***
- ***Foot Mount Housing***
- ***1.50" Clear Aperture***
- ***Intended for 0-90 deg rotation /1 second***

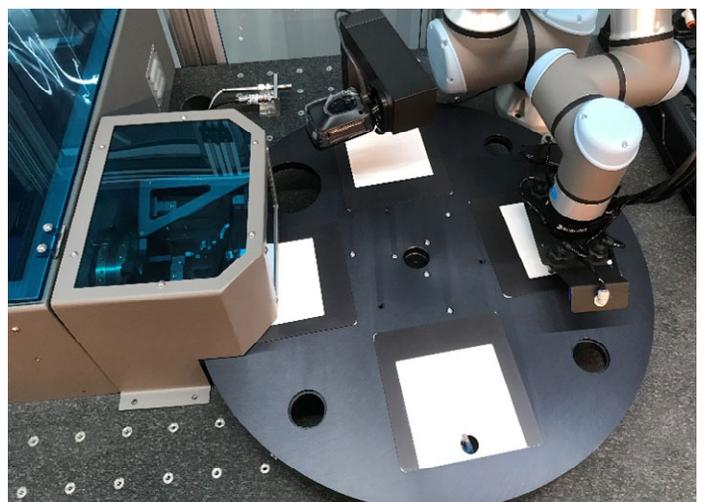


Photo 3: C-axis

- ***AT300-A2- 12" Rotary Air Bearing with Direct Drive***
- ***Top Flange housing design (recessed into granite)***
- ***90-degree indexing (+/-1 cm)***
- ***Ability to course jog to multiple locations per sample***
- ***31" worktable with film pockets***
- ***High resolution non-contact rotary encoder***

together all the pieces, evaluate and test them for this custom purpose and learn the new technologies involved, at the same time ensuring that the completed system would be accurate and fast enough to meet Peak Nano's needs.

ABTech was uniquely qualified to deliver on all counts. The system was ready for customer approval and delivery in just three months.

"We're experienced project managers for custom builds," says Abbott. "We are experts in measurement and motion technology. We also know how to select, evaluate and apply the right combination of custom and standard components and how to develop accurate test procedures. When any customer arrives to check out a custom build, we're confident that it does what it is supposed to do. "That's why our customers choose us."

Look to ABTech, Inc. for custom built motion control systems, air bearing, hydrostatic, or mechanical precision motion components.

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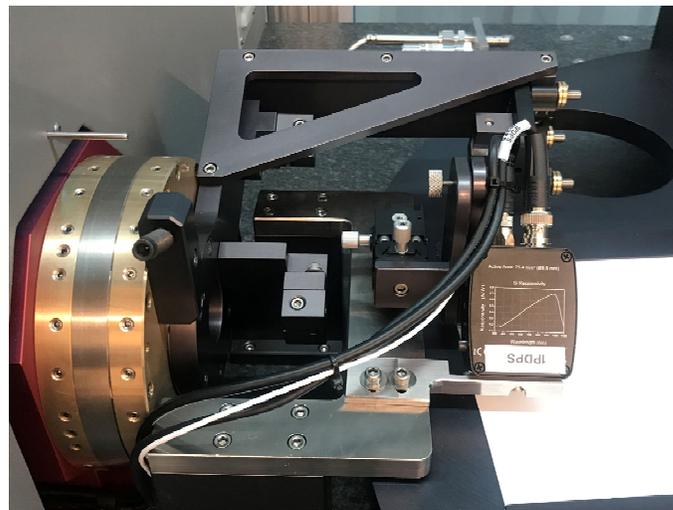


Photo 4: Optical arm

- **Attached to B-axis shaft**
- **Precision ground aluminum for improved measurement speed while maintaining stability**
- **Fine adjust and locking mounts for prism alignment**

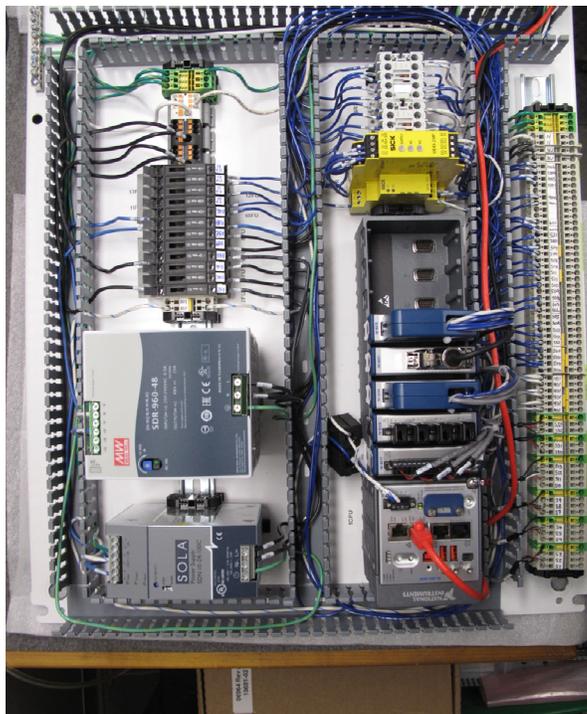


Photo 5: Electrical

- **National Instruments 8-Slot cRio Chassis**
 - **FPGA and Real-Time programming**
 - **Labview Firmware (developed by ABTech)**
 - **Synchronized data capture of B-Axis Encoders and 3 Photodiodes at 1MHz**
 - **Non-Synchronized capture of temp, pressure, RH and other sensors**
- **Galil 4-Axis motion controller w/ amplifiers**
- **Internal transformer and communication Interface for Robot Controller**
- **Fully integrated safety enclosure and E-Stop system**
- **Ethernet communication to all devices**