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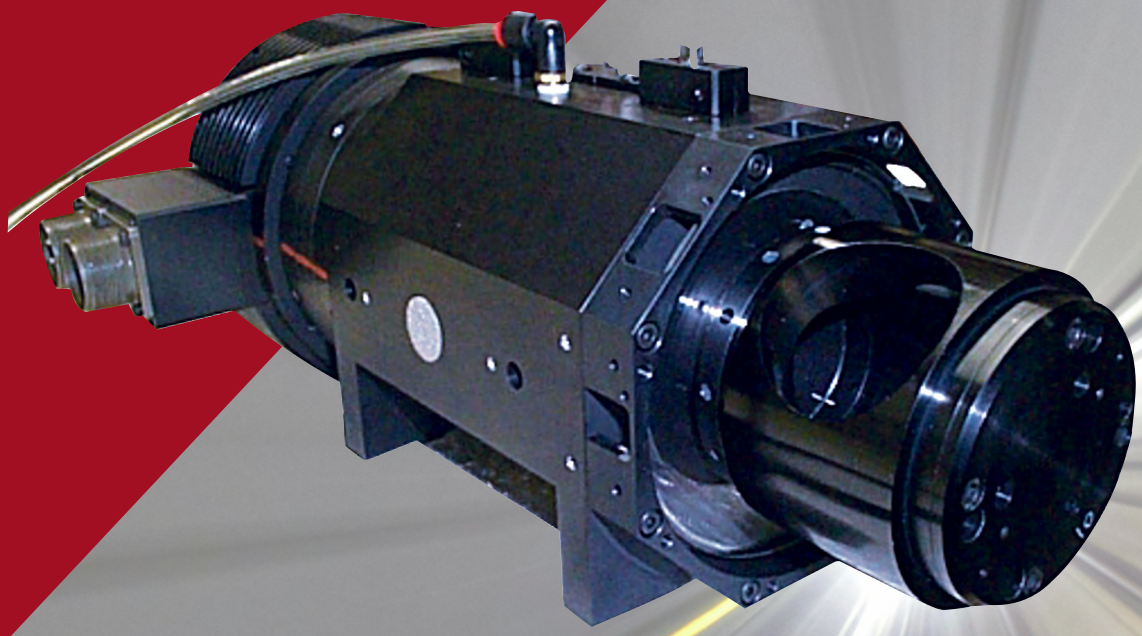
CASE STUDY

Precision Air Bearing Spindle for High-Speed Rail Inspection

How ABTech delivered a custom imaging solution for a leading laser scanning manufacturer in Europe



The Challenges

High-quality, high-speed rail inspection

Project Background

A leading laser scanning manufacturer sought to enhance their rail inspection capabilities across Europe. Their existing system, using ball-bearing spindles, struggled with image clarity due to vibrations and poor synchronization. They turned to ABTech to develop a solution capable of delivering precise, high-quality imagery while enduring the harsh conditions of rail inspection.

Project Challenge

The primary issue was the production of blurry images from the existing spindles used in the imaging system. The scanning heads were not synchronized tightly, and the lack of smooth motion resulted in poor-quality photos. The spindles needed to operate effectively while the train traveled 75 mph, capturing high-resolution images of the rail and its surroundings. The system had to function flawlessly across a wide temperature range, from below freezing to over 100°F, since the train traveled across Europe during the cold winter months.

HIGHLIGHTS

The project aimed to address several critical issues:

- **Image Quality:**
The existing ball bearing spindles produced blurry images due to high levels of vibration.

- **High-Speed Operation:**
The spindles needed to rotate at speeds up to 20,000 RPM while the train traveled at 75 mph.

- **Temperature Extremes:**
The system required reliable operation across a broad temperature range, from below freezing to over 100°F.

- **Vibration and Shock Resistance:**
The spindles had to endure significant vibrations and shocks from train travel.

- **Precision Synchronization:**
The spindles needed to be tightly synchronized to produce seamless 360-degree images.

The Solution

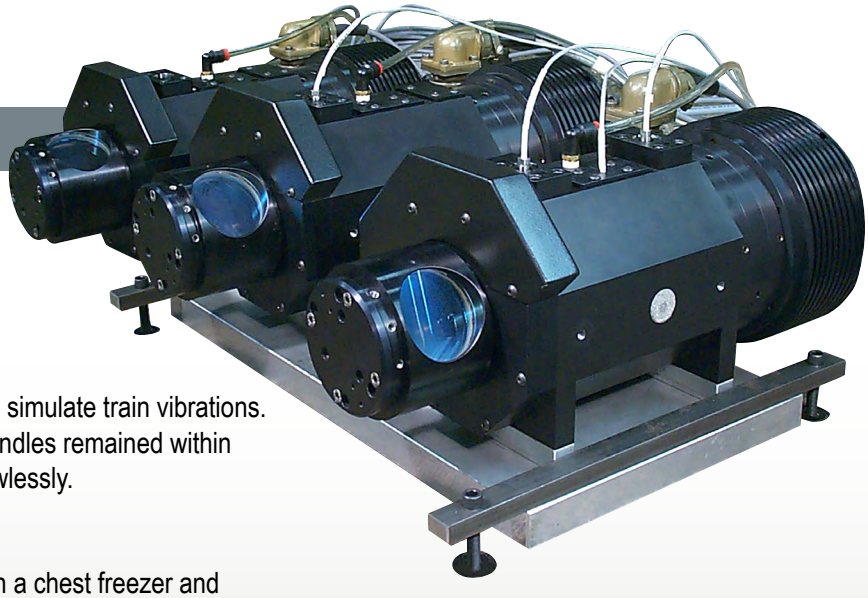
A state-of-the-art, custom-engineered design

ABTech had several spindle designs to choose from, but the unique challenges of the application required customization. The team designed and engineered a state-of-the-art high-speed air bearing spindle system to meet the demands of the project. The solution included:

1. Custom Engineering:
An all-aluminum, hard-coated design was selected for uniform thermal expansion and contraction. Capacitance probes monitored radial and axial air gaps in real time, with automatic shutdown in place if deflection limits were exceeded. Existing encoders did not meet the required clear aperture, accuracy, resolution, or speed. ABTech developed a custom encoder with a precision disc and dual-channel optical read heads, tailored to the specific needs of the application.

2. Spindle Configuration:
Three spindles were equipped with 45-degree fold mirrors epoxied into aluminum housings and balanced as complete assemblies to minimize vibration.The spindles were precisely synchronized to create a continuous 360-degree composite image.

3. System Design and Features:
The spindles and all associated equipment for image storage were housed in a specially designed train car. A conveyor system enabled the spindles to extend outside the car during imaging for optimal data capture.The spindles operated at 18,000 RPM, capturing images every 10 cm (3.93 inches) along the rail.



TESTING AND VALIDATION

ABTech conducted rigorous testing to ensure the system met all performance criteria:

- **Vibration Testing:**
  Spindles were tested on a shaker table to simulate train vibrations. Real-time monitoring ensured that the spindles remained within operational tolerances and performed flawlessly.

- **Temperature Testing:**
  • Freezer Testing: Spindles were placed in a chest freezer and exposed to freezing temperatures overnight, then turned on and operated at full speed of 20,000 RPMs.

  • High-Temperature Testing: Additional tests in high-temperature conditions confirmed reliable operation from 32°F to over 100°F.

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Results & Impact

Experience, customization make the difference

The ABTech high-speed air bearing spindle system successfully addressed all project challenges:

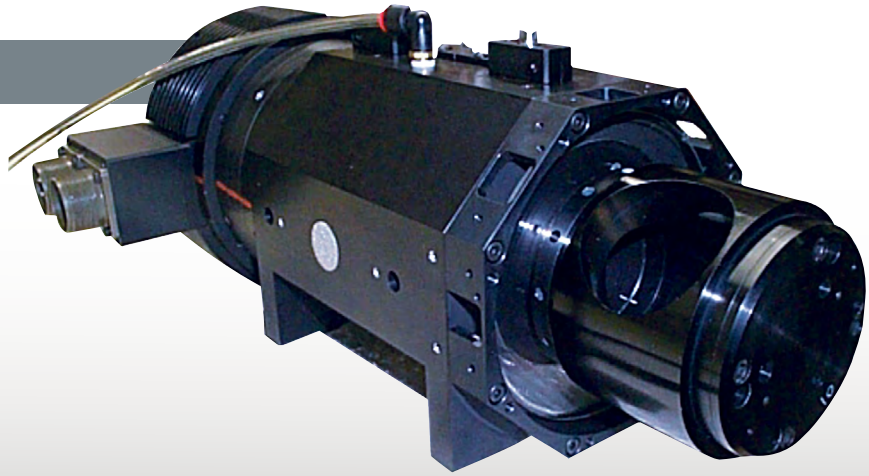
• Enhanced Image Quality:
The new spindles provided clear, high-resolution images, overcoming the blurriness of the previous system.

• Reliable Performance:
The system operated effectively across extreme temperatures and high vibrations, demonstrating resilience and precision.

• Seamless Integration:
The 360-degree imaging capability delivered comprehensive and continuous views of rail infrastructure, including bridges, tracks, and tunnels.

CONSTRUCTION & DESIGN

The spindles featured an all-aluminum, hard-coated design to ensure uniform thermal expansion and contraction. 45-degree mirror assemblies were precisely balanced to achieve superior vibration control and image clarity. The integration of capacitance probes allowed for continuous monitoring and adjustment, ensuring the spindles remained within operational tolerances.



Conclusion

ABTech's innovative approach and commitment to customization delivered a cutting-edge solution that transformed rail inspection capabilities. By leveraging advanced air bearing technology and custom engineering, ABTech not only resolved the technical challenges but also set a new standard for high-speed rail inspection. This project underscores ABTech's role as a leader in precision spindle technology and custom solutions for demanding applications.

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ABTech specializes in high-precision air bearing motion systems. We offer custom designed and manufactured products to suit even the most complex industry needs.

Do you have a process that could be enhanced by a custom air bearing spindle? Reach out to ABTech today.

Contact a Precision Motion Expert