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POWERED BY: AEROTECH | SANTEC | SENKO

A New State-of-the-Art for Multichannel Active Alignments

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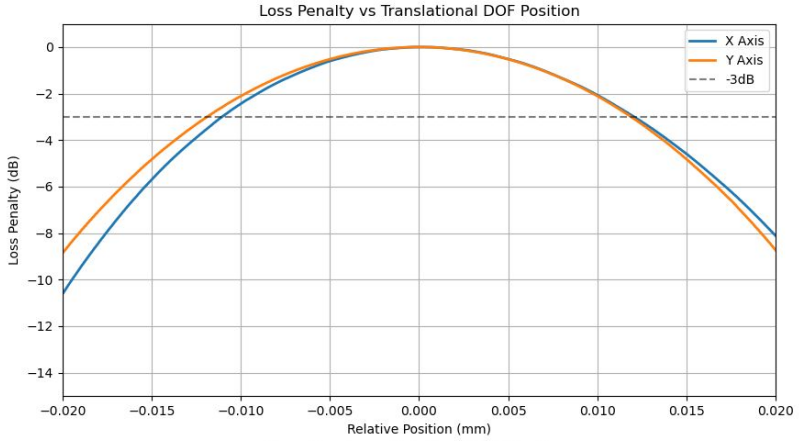
Active Alignment of Arrays

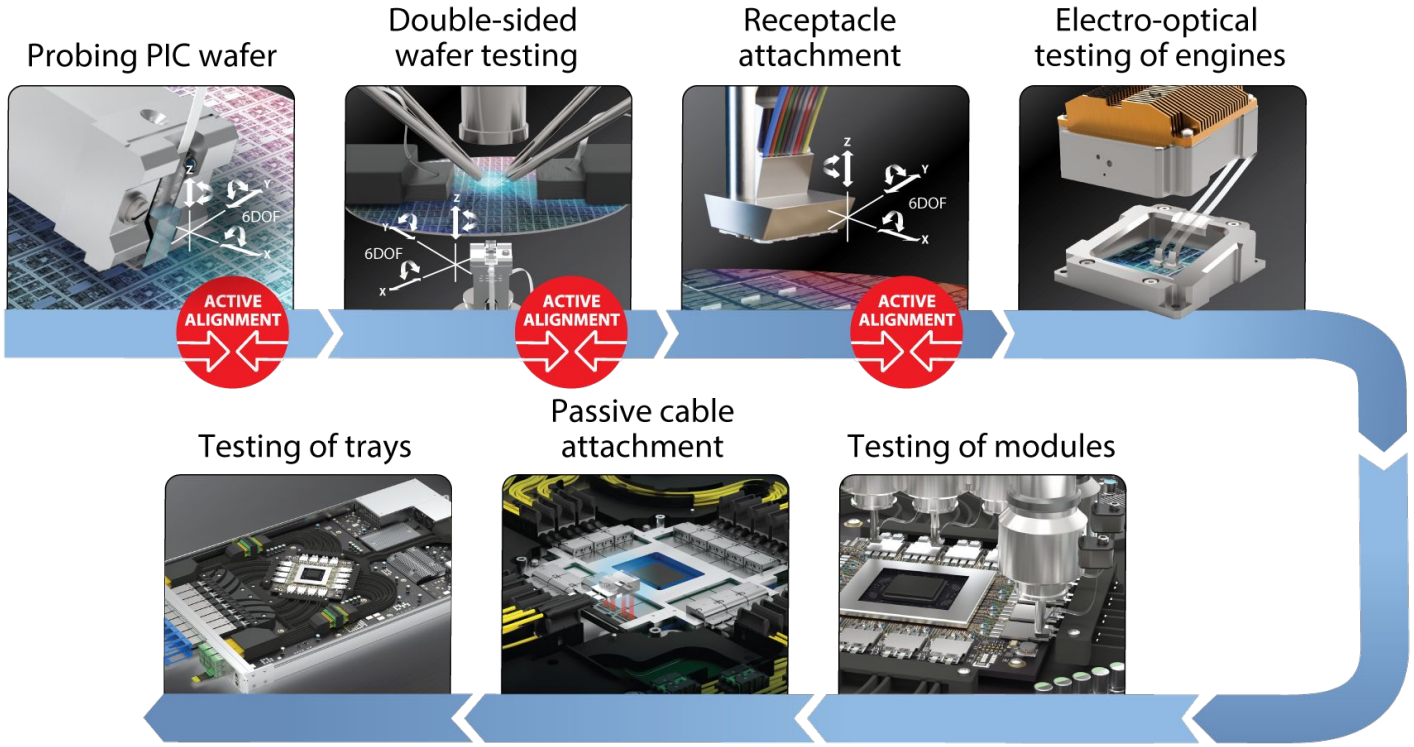
An industry-wide challenge

- **Problem:** Alignments of multichannel optical arrays have complex loss penalties and are sensitive to misalignment in all 6 degrees of freedom.
- **Current state-of-the-art**: Manual processes and alignment algorithms optimize a single channel or couple of channels in few degrees of freedom, causing slow, suboptimal alignments.



Active Alignment in CPO Testing and Packaging

Future state



Industry Collaboration

Est. December 2024

- **Senko, Santec and Aerotech** established a partnership to develop new technology for aligning high channel count devices, including **algorithms designed specifically for arrays.**
- **Faster alignment times** and **improved signal loss** are achieved through **tighter integration** between motion controller and optical instrumentation.

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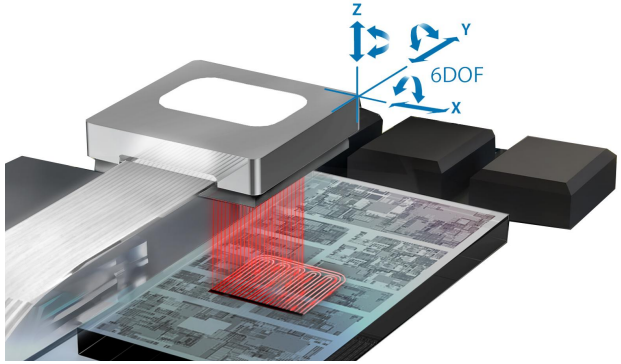

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Company Profiles

AEROTECH

Precision Motion Control

- 55+ years in precision motion
- Stage mechanics, drive electronics and motion control software
- Privately held with 500+ employees globally

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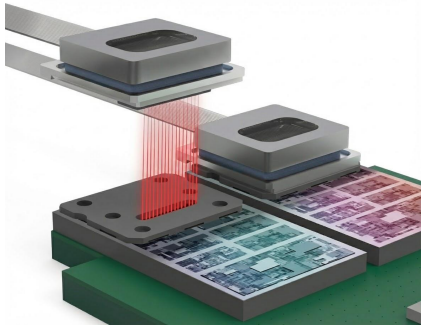

Fiber Optic Communication

- 35+ years and global leader in fiber-optic connectivity
- Detachable CPO connectors
- Small form-factor faceplate and transceiver connectors

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Optical Test Instrumentation

- 45+ years in fiber optic test and measurement
- CPO/PIC characterization tools
- Tunable and high power light sources, OPMs, switches, attenuators

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Photonics alignment architecture

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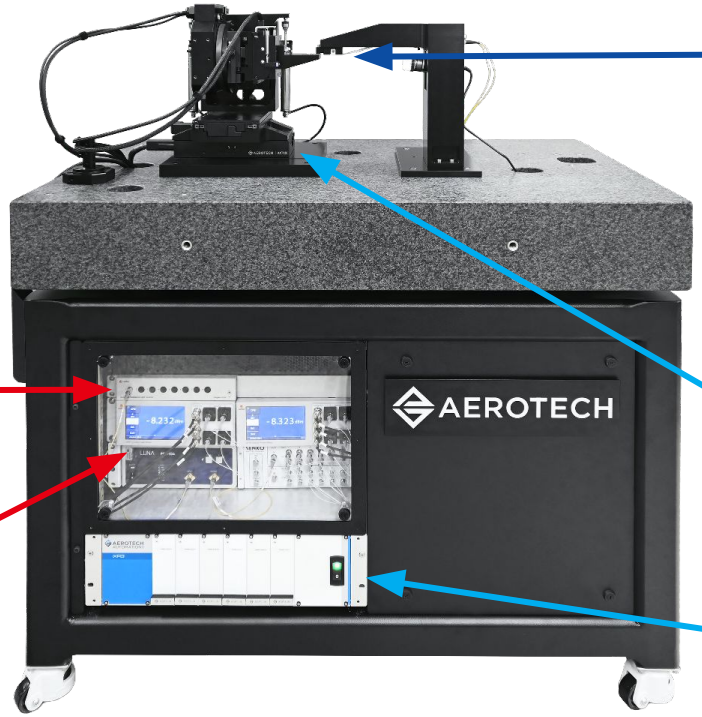

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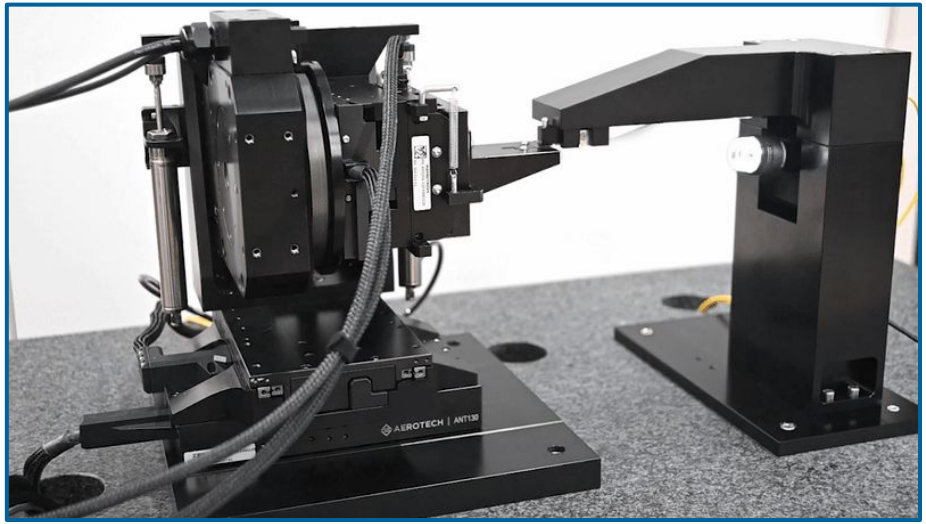
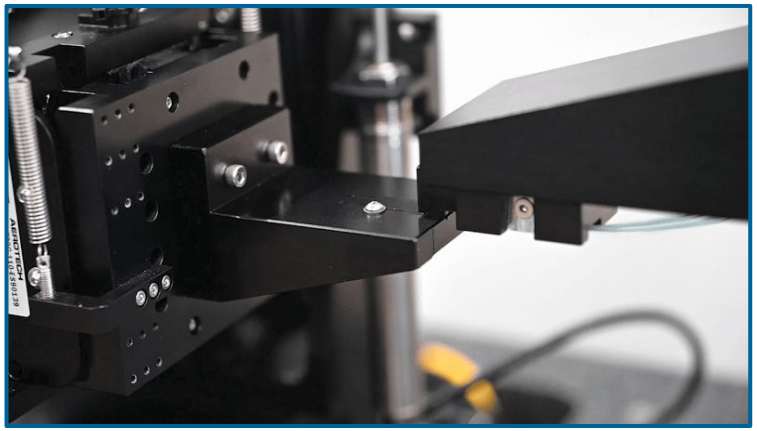
Example load and search routine



Move to search position



Execute high-dynamic search routines

Collect power level data and send to motion controller in real-time

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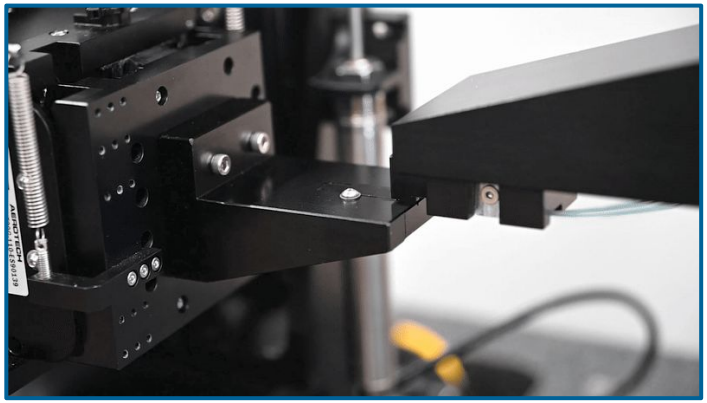
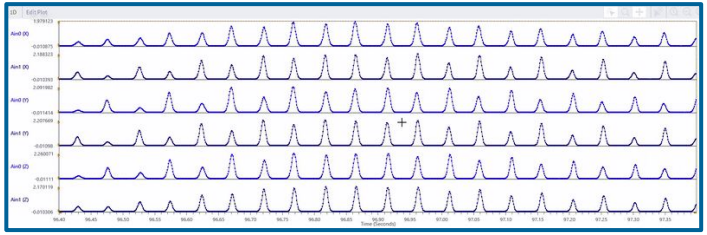
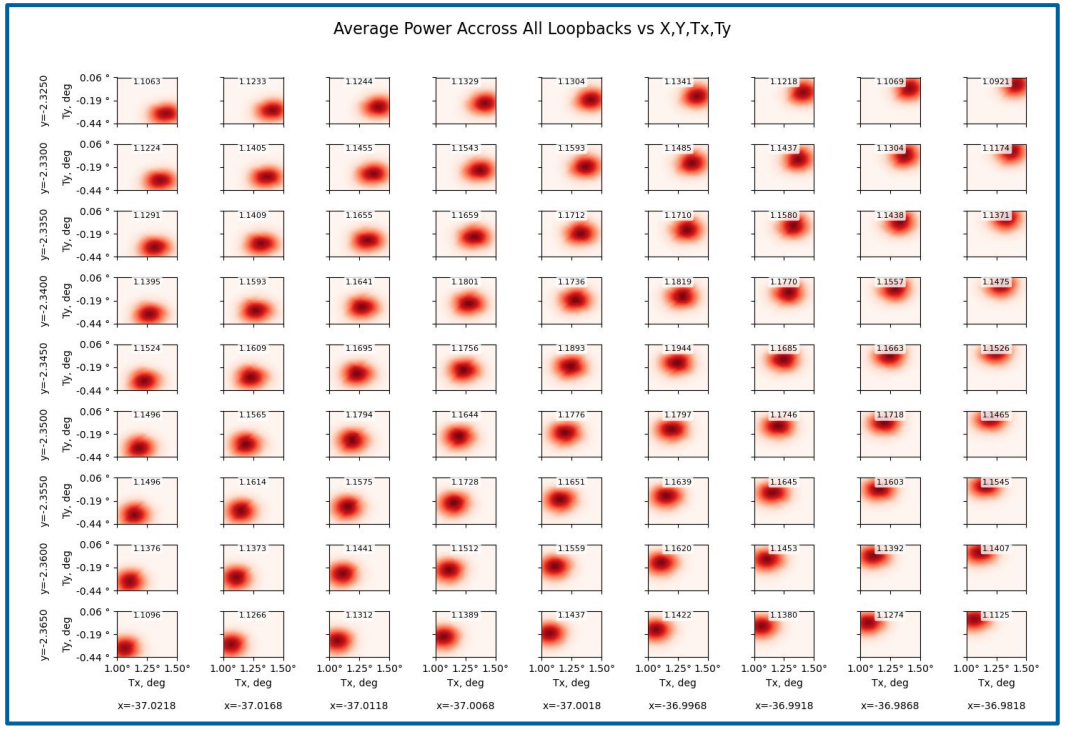
Search space characterization





Live plotted signal during scan



Normalized, average power level (4 DOF)

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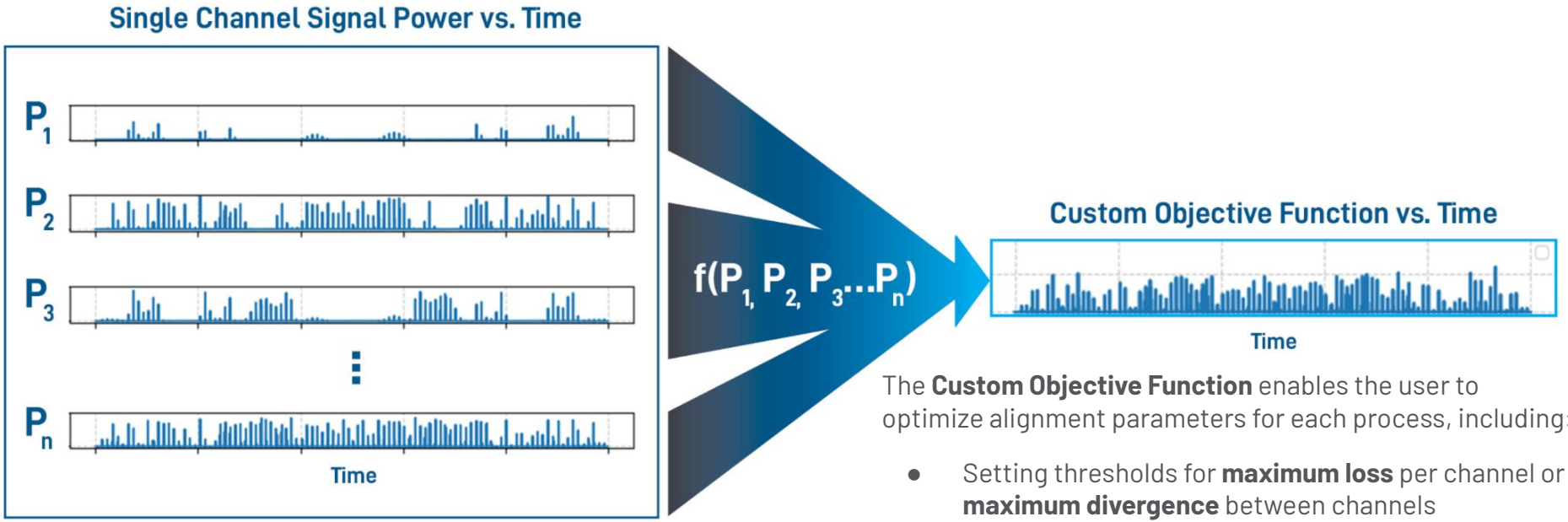
Custom Objective Function



The **Custom Objective Function** enables the user to optimize alignment parameters for each process, including:

- Setting thresholds for **maximum loss** per channel or **maximum divergence** between channels
- **Weighting more critical channels** (such as PM fibers) to prioritize during optimization

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Example Convergence Plot

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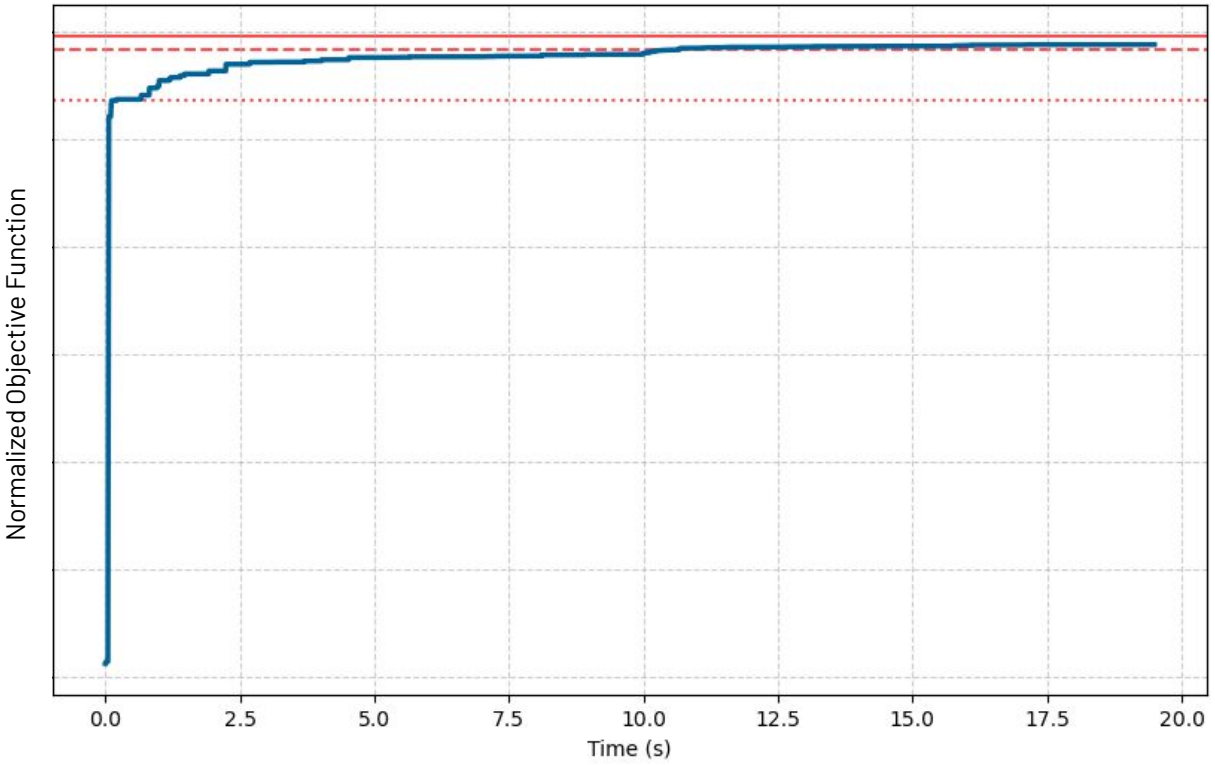
Search parameters:

- Time-limited search
- Objective function defined as average of all channels
- Maximum identified through extended brute force search



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Preliminary Test Results

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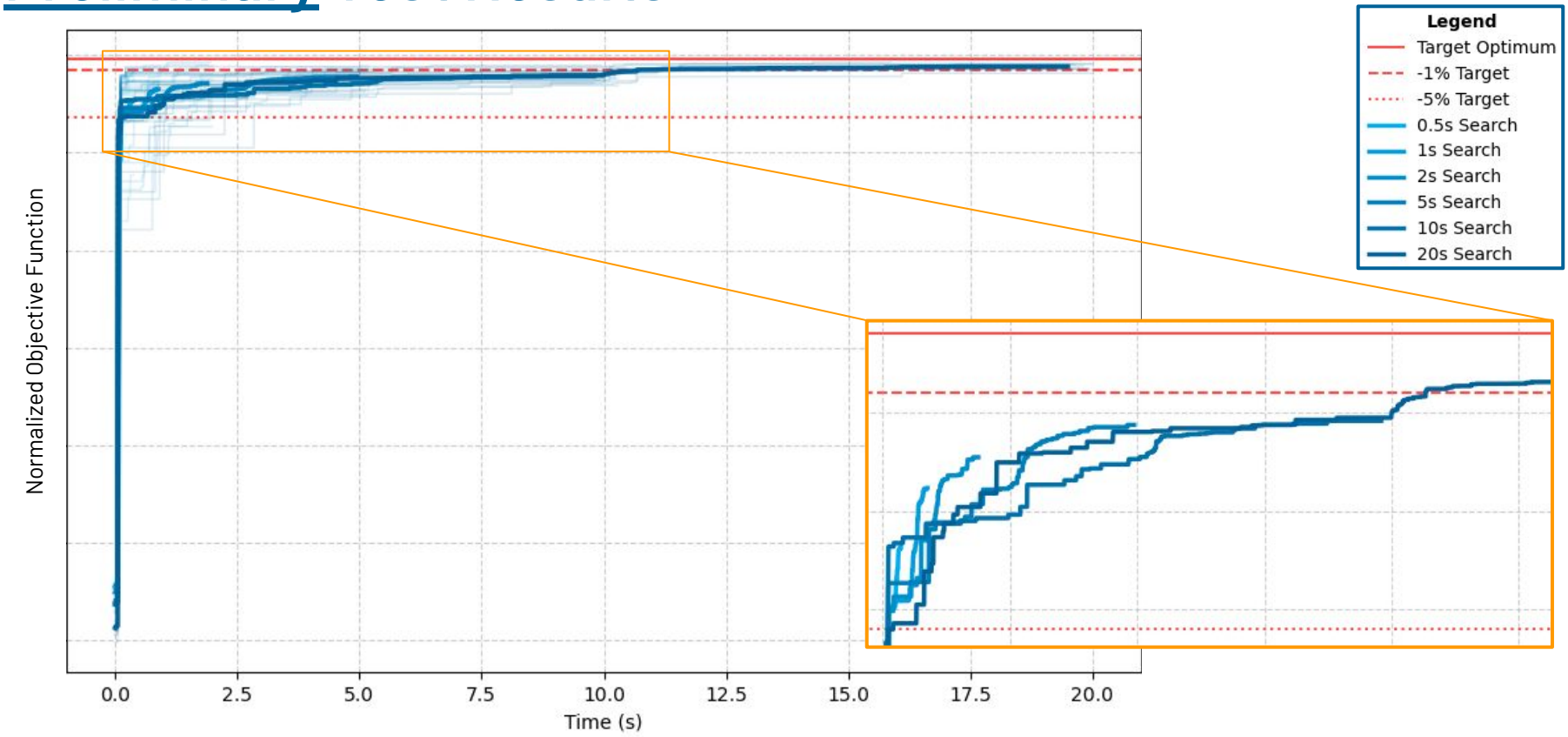

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Preliminary Test Results

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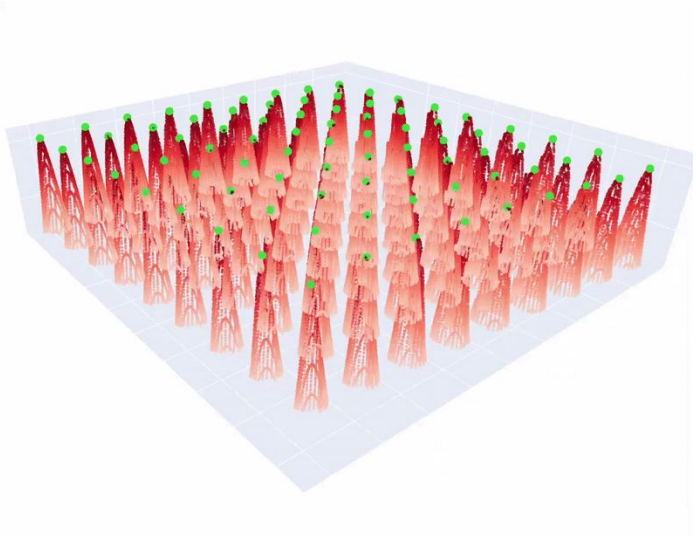
Initial takeaways

- By monitoring 8 channels simultaneously, 5-DOF alignment positions within **< 0.1 dB are achieved in a few seconds**, with < 0.01 dB achieved for longer searches.
- Depending on application requirements, **alignment time can be optimized to meet signal level thresholds** to maintain yield.
- Alignments using a similar characterization approach but only monitoring a **single loopback** resulted in objective function scores that were up to **12% worse** than multichannel monitoring.



Normalized power level averaged across all 8 channels (4 DOF)

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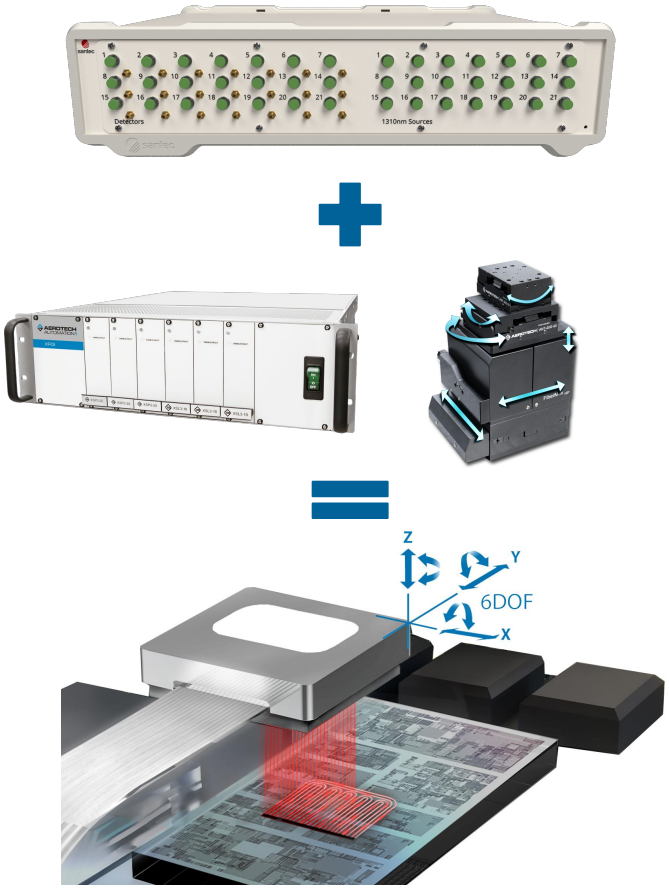
Simplified integration

- **Pre-defined interfaces** between motion control and optical instrumentation reduce system design time
- Devices can be configured and **tested as integrated platform** to streamline setup
- **Customizable parameters** and configurations to fit wide variety of test and assembly processes



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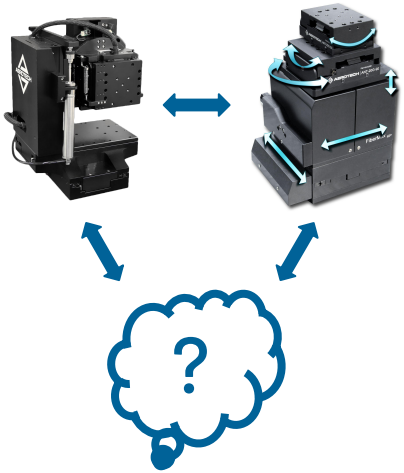
Adaptable, application-specific configurations and interfaces

Multi-DOF Positioners



Split DOF Positioners

Flexible Stage Mechanics

Flexible APIs + I/O

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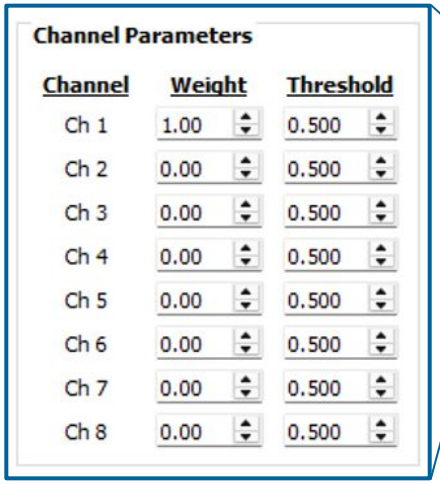
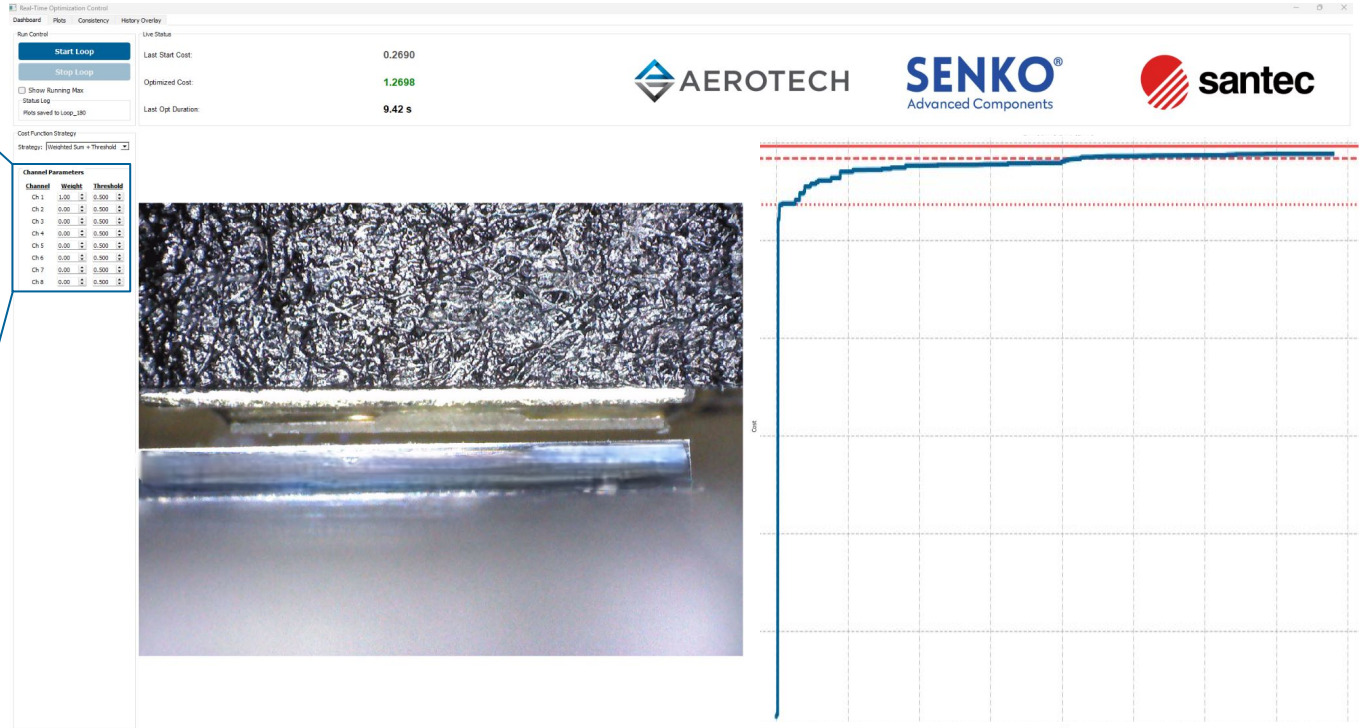
Example Python GUI





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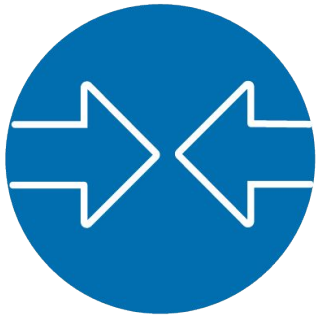
A new state-of-the-art for multichannel photonic alignment

- By utilizing simultaneous multichannel signal monitoring and customizable objective functions, this new, adaptable architecture **significantly enhances active alignment for photonic test and assembly processes**:

Alignment Speed
Throughput dramatically increased



Coupling Efficiency
Signal loss significantly improved

Integration Simplicity
Startup challenges reduced or eliminated

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View live demos of PICAlign at Aerotech's booth (5207) at OFC 2026!

OFC

Mar. 17 – 19 in Los Angeles, CA

- **Aerotech – #5207**
- **Santec – #1029**
- **SENKO – #1139 + #5536**

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