

Physik Instrumente

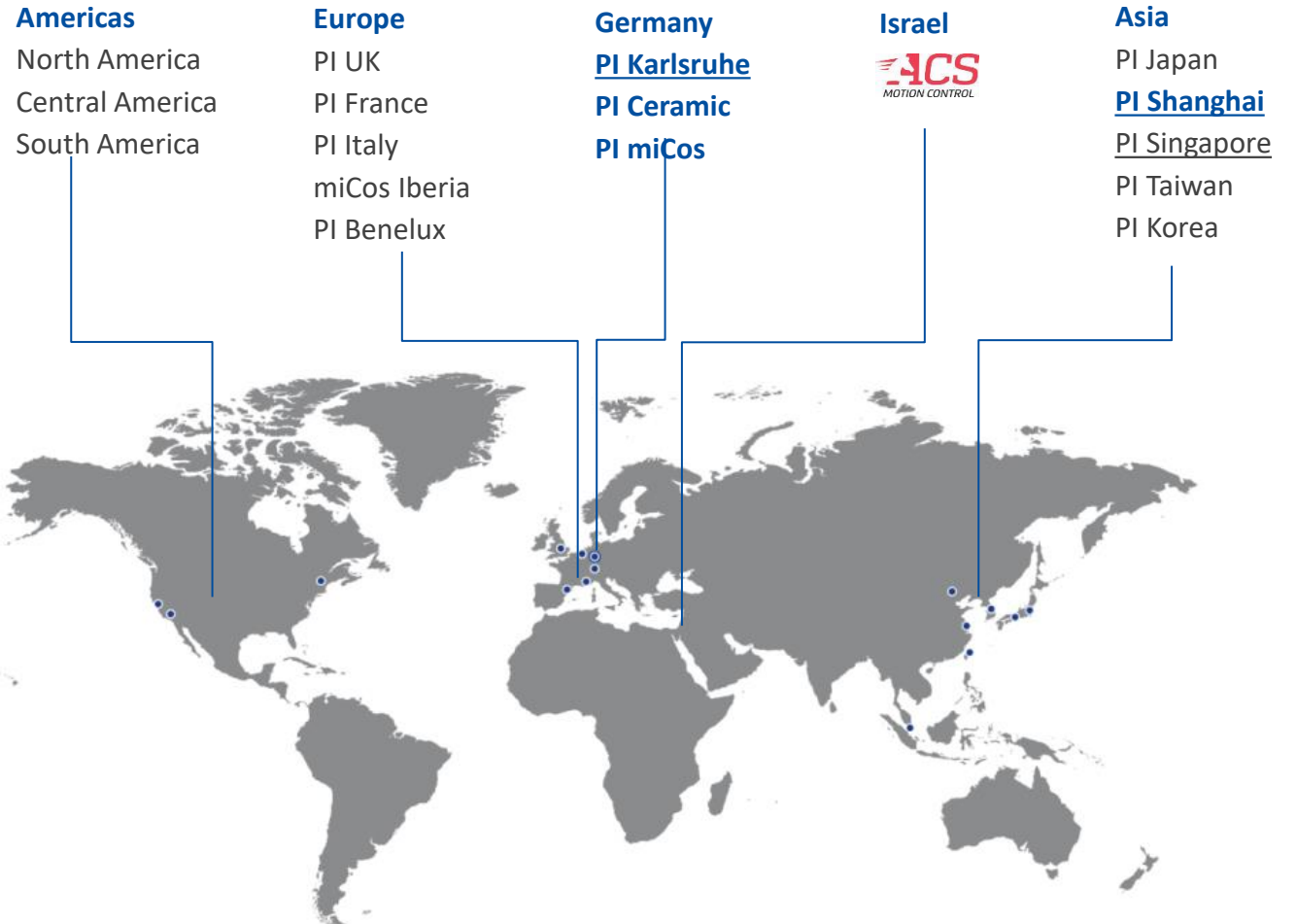
# Key to a Cost-Effective Photonics Manufacturing & Test Strategy

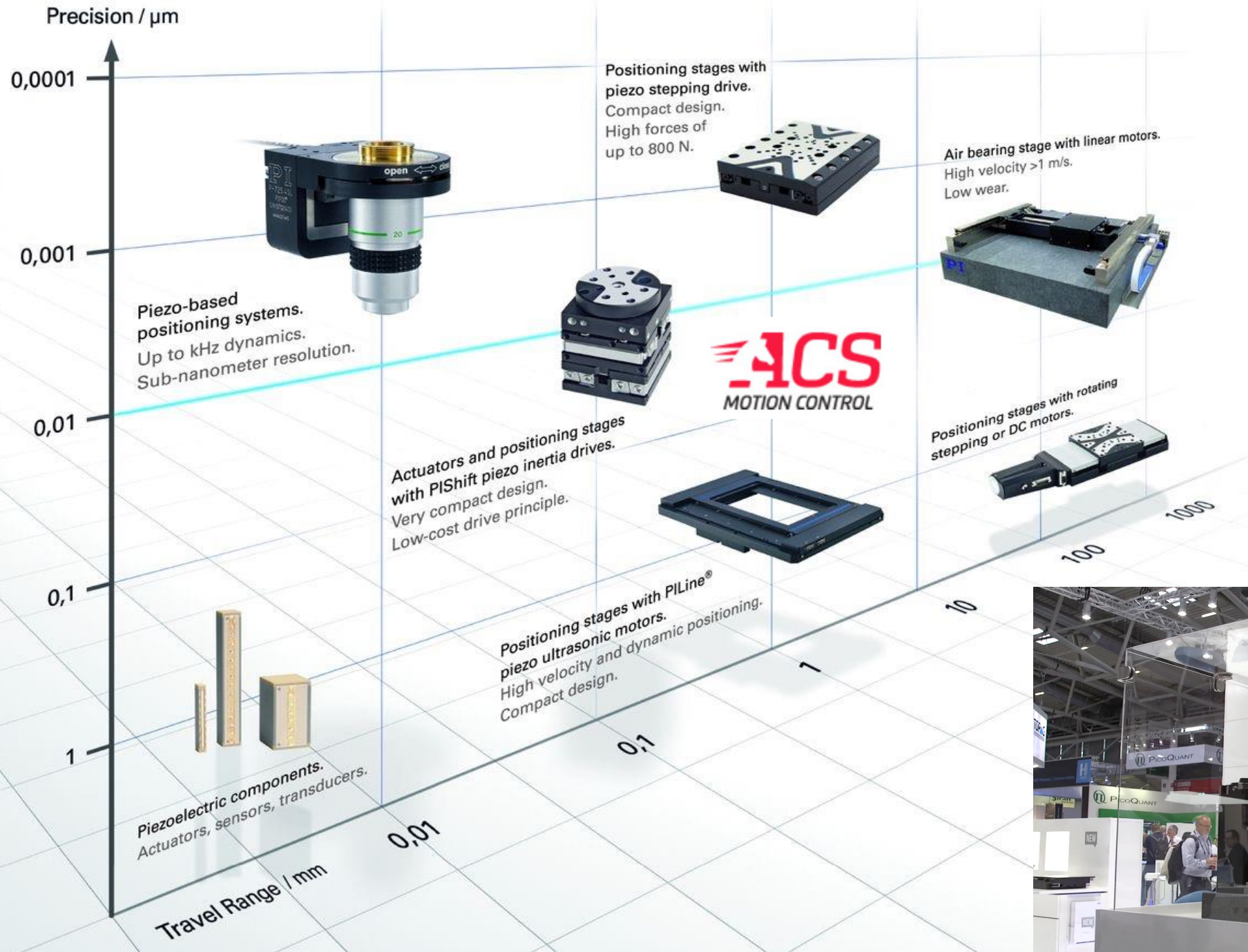
Scott Jordan  
Head of Photonics  
PI

- ~1700 Employees
- 15 Subsidiaries
- Design & Service Centers in USA, Asia, Europe
- >100 man Years of Alignment Expertise
  
- Privately Owned – Not Driven by Quarterly Results
- Focused on Long Term Relationships w/Customers & Suppliers

## The PI Group

**Precision Automation, Nanopositioning, Piezo Technology**

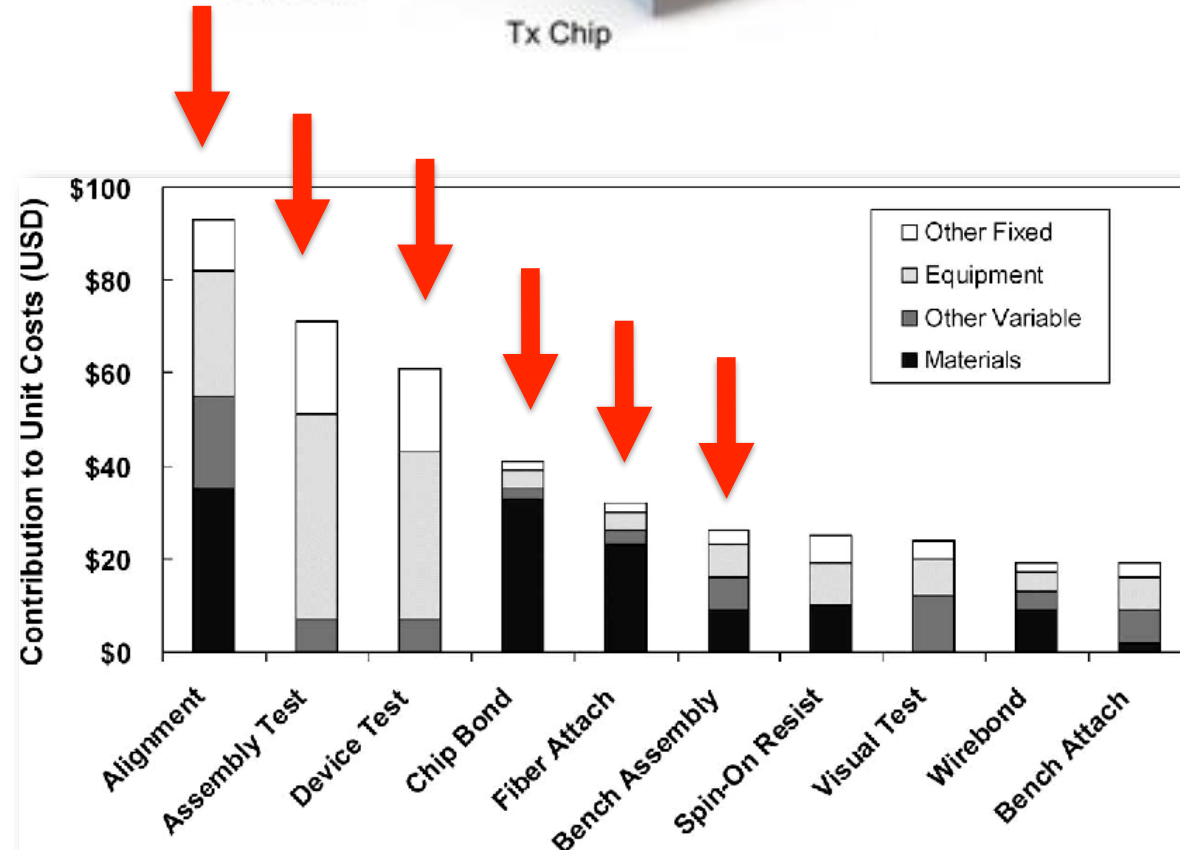
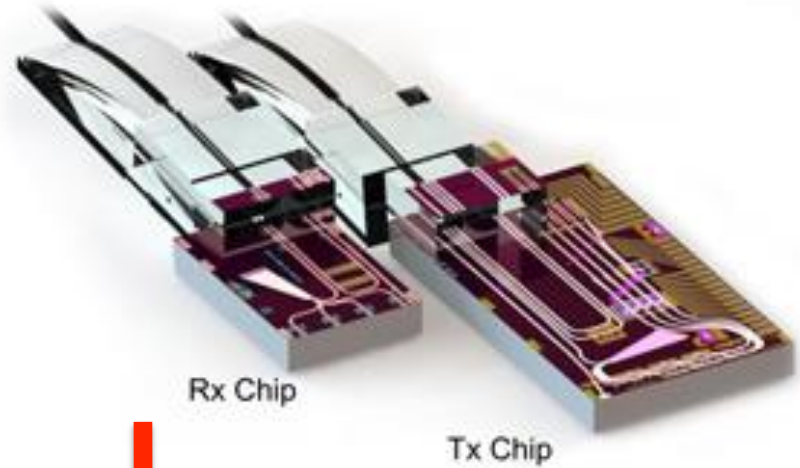




PI's Engineered Systems Group Builds World-Class Automation Platforms

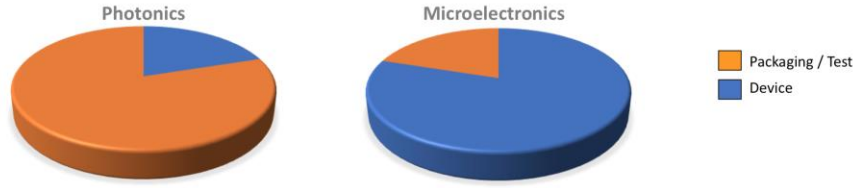


# Alignment: The Repetitive Cost



## Cost breakdown

Packaging cost is a big piece of the pie for Photonics  
 Microelectronic packaging is geared towards low cost



Packaging is key to lower cost of photonics

Leverage the microelectronic industry



Photonics Summit, Cadence, 6th September 2017, San Jose CA

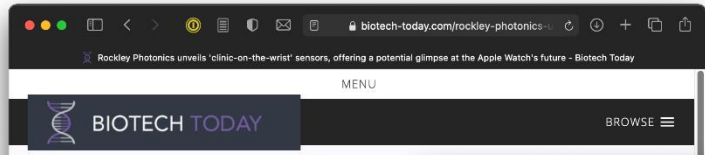


“Automated High-Throughput Assembly for Photonic Packaging”, Barwicz et al, *Photonics Summit*, Cadence, 2017, [https://www.cadence.com/content/dam/cadence-www/global/en\\_US/documents/company/Events/summits/photronics/fortier-2017.pdf](https://www.cadence.com/content/dam/cadence-www/global/en_US/documents/company/Events/summits/photronics/fortier-2017.pdf)

“Process-based cost modeling of photonics manufacture...”, E. Fuchs et al, *J. Lightwave Tech.*, 2006, <https://www.semanticscholar.org/paper/Process-based-cost-modeling-of-photonics-the-cost-a-Fuchs-Bruce/125e24b2e2e7186f0f088526441ee5ce16e6ce42c>

# Observation:

## Silicon Photonics is *not just about the data center anymore*



### Rockley Photonics unveils 'clinic-on-the-wrist' sensors, offering a potential glimpse at the Apple Watch's future

Posted on July 22, 2021 By News Team

Smartwatches are about to get a whole lot smarter. Rockley Photonics has unveiled a health monitoring platform equipped with high-precision sensors that can monitor a range of biomarkers from blood pressure to glucose levels.

Rockley is touting the system as a "clinic on the wrist," since it can monitor a range of biomarkers from blood pressure to glucose levels.

### Aeva Unveils Lidar on a Chip

Aeva says its high-performance lidar will sell for less than US \$500; VW is buying it

BY PHILIP E. ROSS | 11 DEC 2019 | 3 MIN READ

PHOTO: AEA

There are scores of lidar startups. Why read about another one?

### Deloitte's quantum computing leader on the technology's healthcare future

Quantum computing offers significant speed and analytics power and boosts the ability to track and diagnose disease, modernize supply chains and help with drug discovery, says Scott Buchholz.

By Bill Siwicki | August 17, 2021 | 11:44 AM

### Active Optical Cable Market Witness Robust Growth | 3M Company, Amphenol Corporation, Avago Technologies Limited

Published: July 8, 2021 at 4:00 p.m. ET

Scott Buchholz, emerging tech CTO, Deloitte Consulting

### Active Optical Cable Market Witness Robust Growth | 3M Company, Amphenol Corporation, Avago Technologies Limited

Published: July 8, 2021 at 4:00 p.m. ET

The MarketWatch News Department was not involved in the creation of this content.

Jul 08, 2021 (AB Digital via COMTEX) -- Active Optical Cable Market By Technology (InfiniBand, Ethernet, HDMI, DisplayPort, USB, and Others), Connector Type (QSFP, CXP, CDFP, CFP, SFP, and Others), and Application

### Bill Gates, Neo, Gigafund backing Luminous in photonics supercomputer moonshot

Kirsten Korosec

@kirstenkorosec / 6:52 AM PDT • June 4, 2019

Image Credits: Lightwave Laboratory at Princeton University

Luminous Computing, a one-year-old startup, is aiming to build a photonics chip that will handle workloads needed for AI at the speed of light. It's a moonshot and yet, the young company already has a number of high-profile investors willing to bet on the prospect.

million in a seed round led by Bill Luke Nosek and Steve Oskoui of

What this means:  
Fasten your seatbelts

**SILICON PHOTONICS TRANSCEIVERS IN HIGH VOLUME**  
**OVER 3M UNITS SHIPPED, MORE THAN 2M UNIT RUN RATE**

**100G PSM4 QSFP**      **100G CWDM4 QSFP**

- Up to 2 km reach on parallel single mode fiber
- Fully MSA compliant

**In volume production**

- 500m, 2 km and 10km reach on duplex single mode fiber
- Fully MSA compliant
- Extended temp -40 to 85°C

**In volume production**

4 fibers for 100G      Single fiber for 100G

2 km      2 km

On-die hybrid lasers      Single die CWDM4 transmitter

Intel

Apple Watch surpasses 100m sales – and it's growing faster than ever

Why the Apple Watch could soon hit 350 million sales

Global Consumer Active Optical Cable Market is Expected to Account for USD 405.06 million by 2027

Global Consumer Active Optical Cable Market, By Region

Year	North America	Europe	Asia Pacific	South America	Middle East and Africa
2020	Low	Low	Low	Low	Low
2021	Low	Low	Low	Low	Low
2022	Low	Low	Low	Low	Low
2023	Low	Low	Low	Low	Low
2024	Low	Low	Low	Low	Low
2025	Low	Low	Low	Low	Low
2026	Low	Low	Low	Low	Low
2027	Low	Low	Low	Low	Low

DMCA Protected © Data Bridge Market Research- All Rights Reserved. Source: Data Bridge Market Research Market Analysis Study 2020

Connected cars report: 125 million vehicles by 2022, 5G coming

Connected cars report: 125 million vehicles by 2022, 5G coming

The global market for connected cars is expected to grow by 270 percent by

Data Bridge Market Research

## These are Early Days

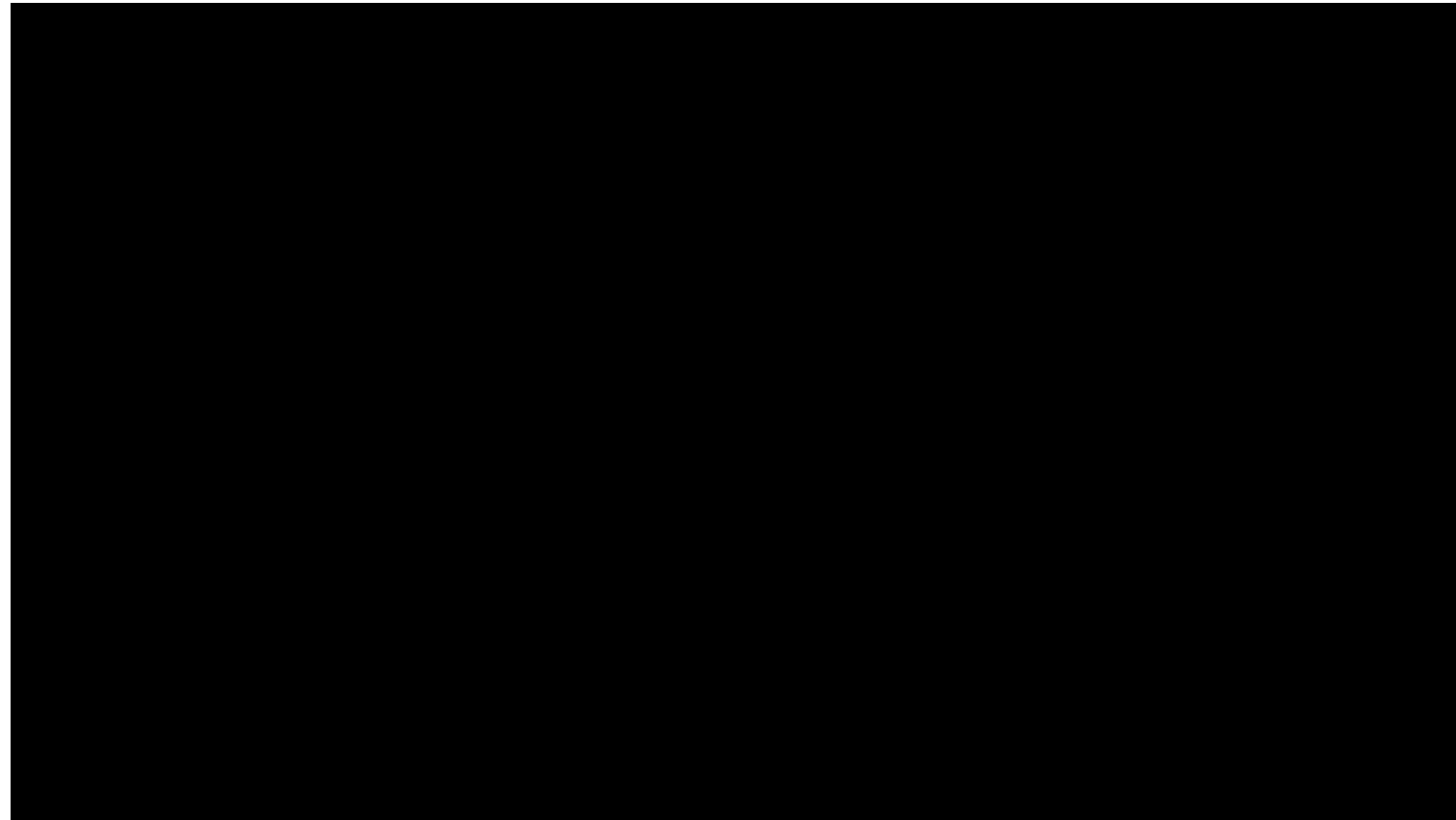
Parallels to 1980s chip industry:

- Ecosystem just being born
- Custom equipment
- In-house and captive integrators

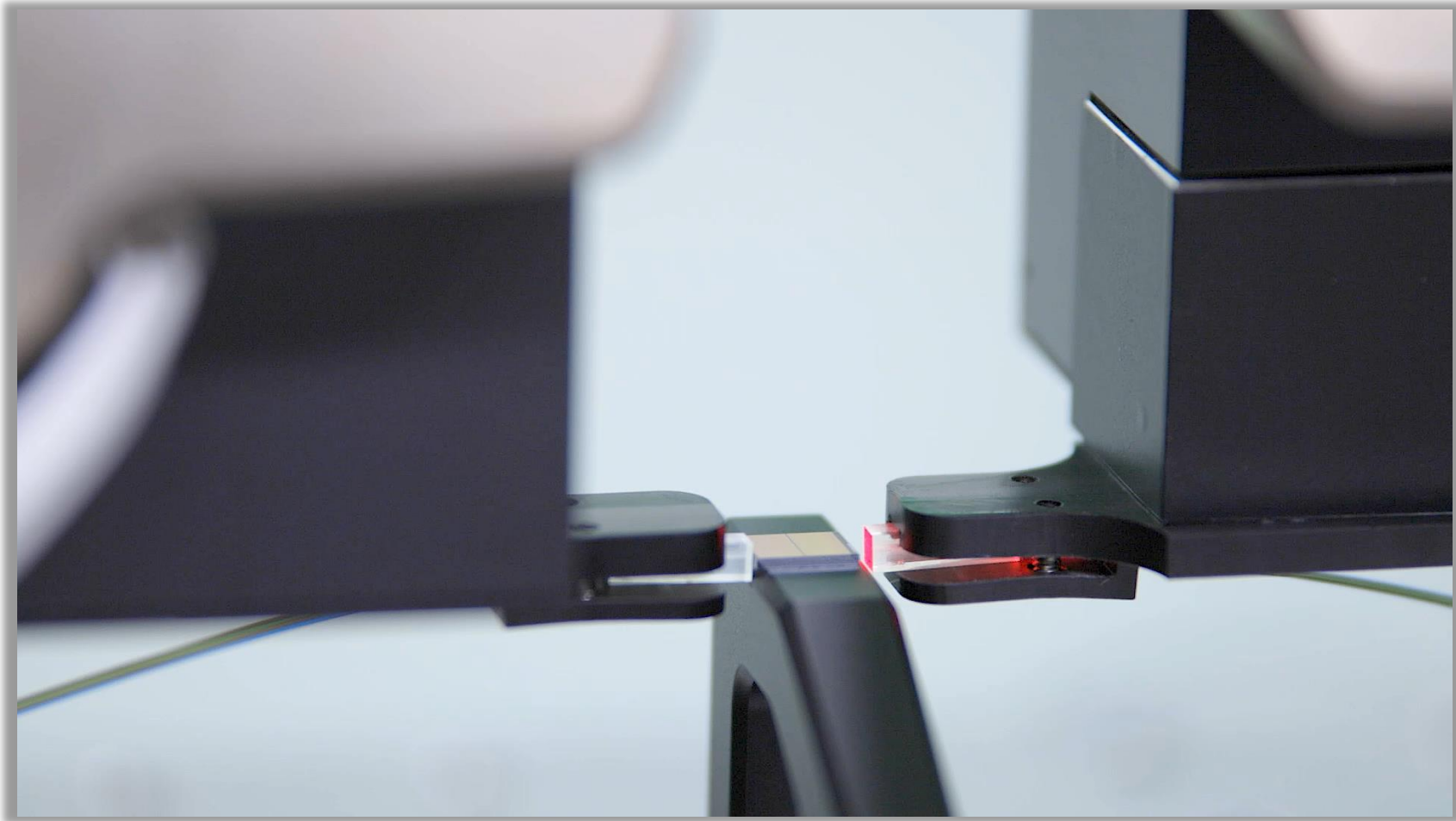


**Fast forward to today:**

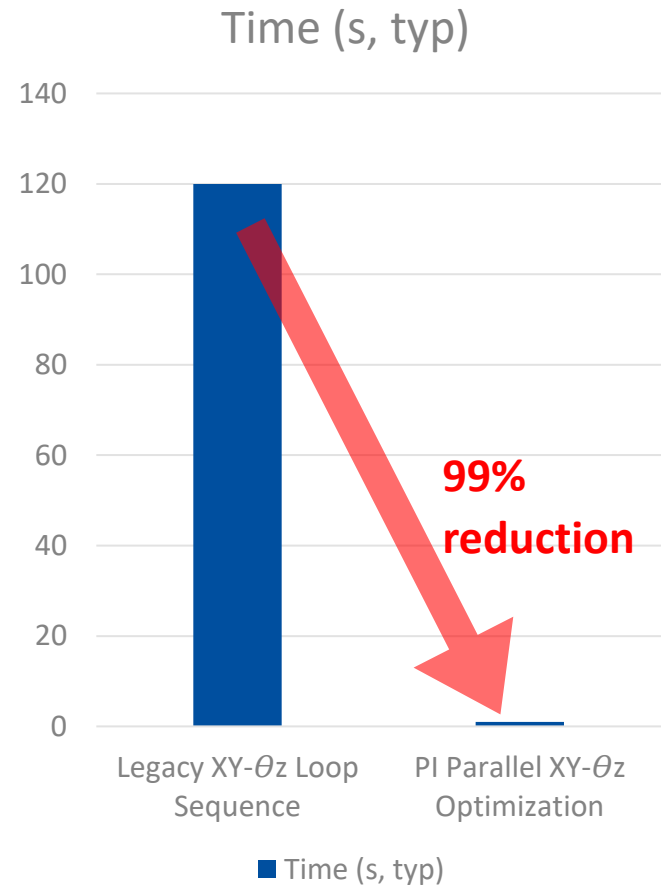
- You can build a fab by writing POs



Excerpted from <https://www.chiphistory.org/128-an-intel-wafer-fab-cleanroom-circa-1980>



## PI's Novel Parallel Multi-DOF Optimization





# Partnering with Pioneers

Example: Improving Silicon Photonics process-economics with automated, multi-DOF optimization



Excerpted from <https://www.TinyURL.com/new-FF-video>

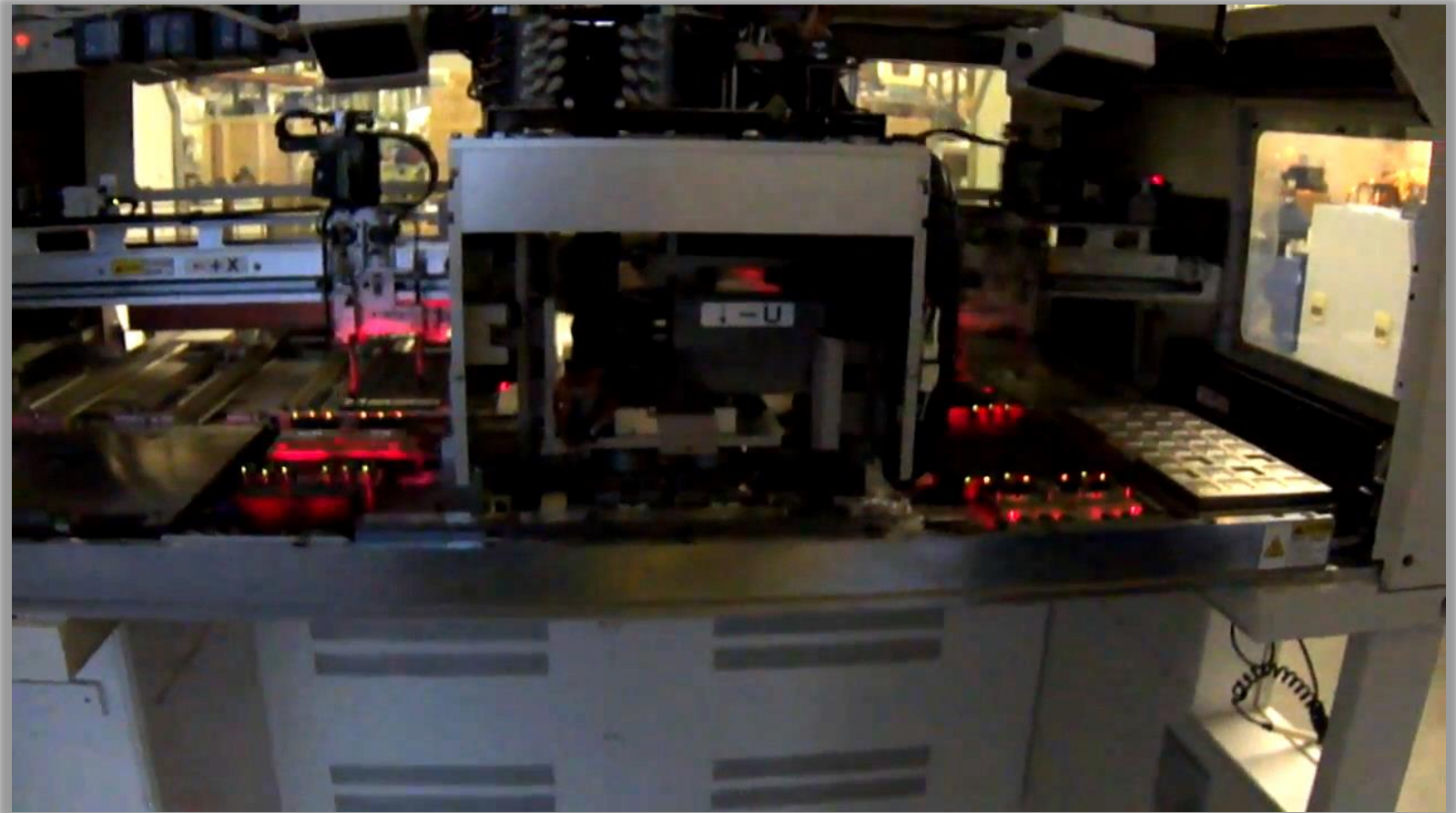


[Automated Assembly Equipment solutions by Etteplan | Etteplan](#)



# Partnering with Pioneers

Example: Chip Tester Change Kit with embedded alignment



# Large-format applications: PCBs, Trays, Carriers...



YouTube:



*Unacknowledged!*

...Meeting an ~~unfilled~~ need

Test and assembly are back-end processes.

Who cares about super cleanliness in back end processes?

...Photonic chips do!

# New: Air Bearing Fast Alignment Engines



*Super cleanliness*

*Zero maintenance, Zero wear*

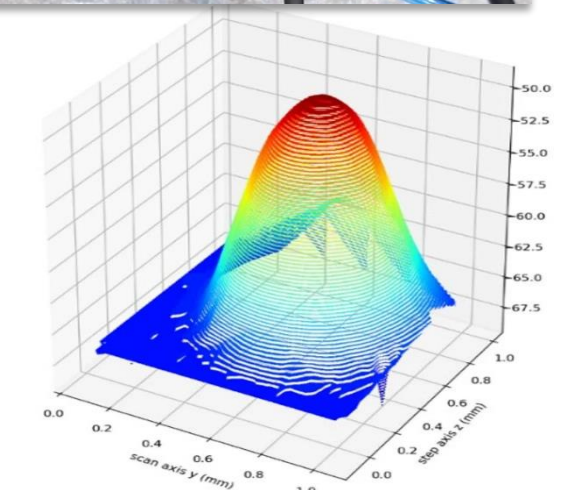
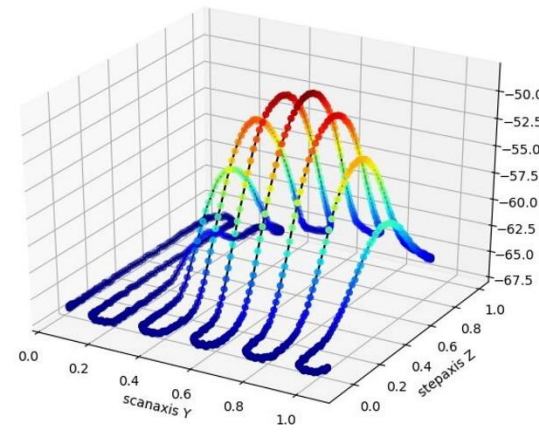
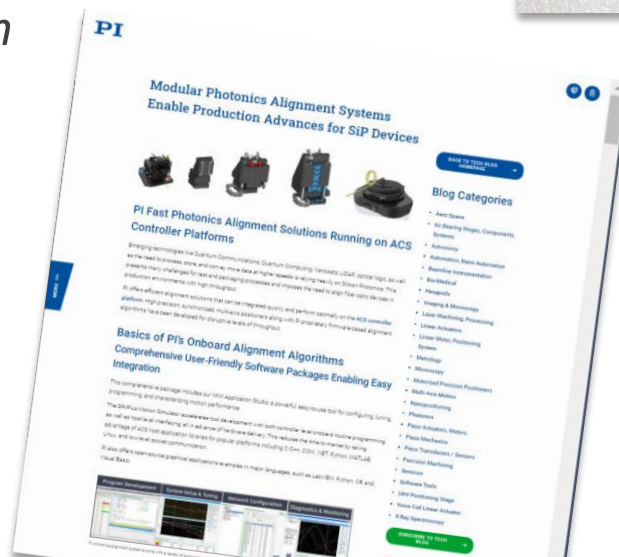
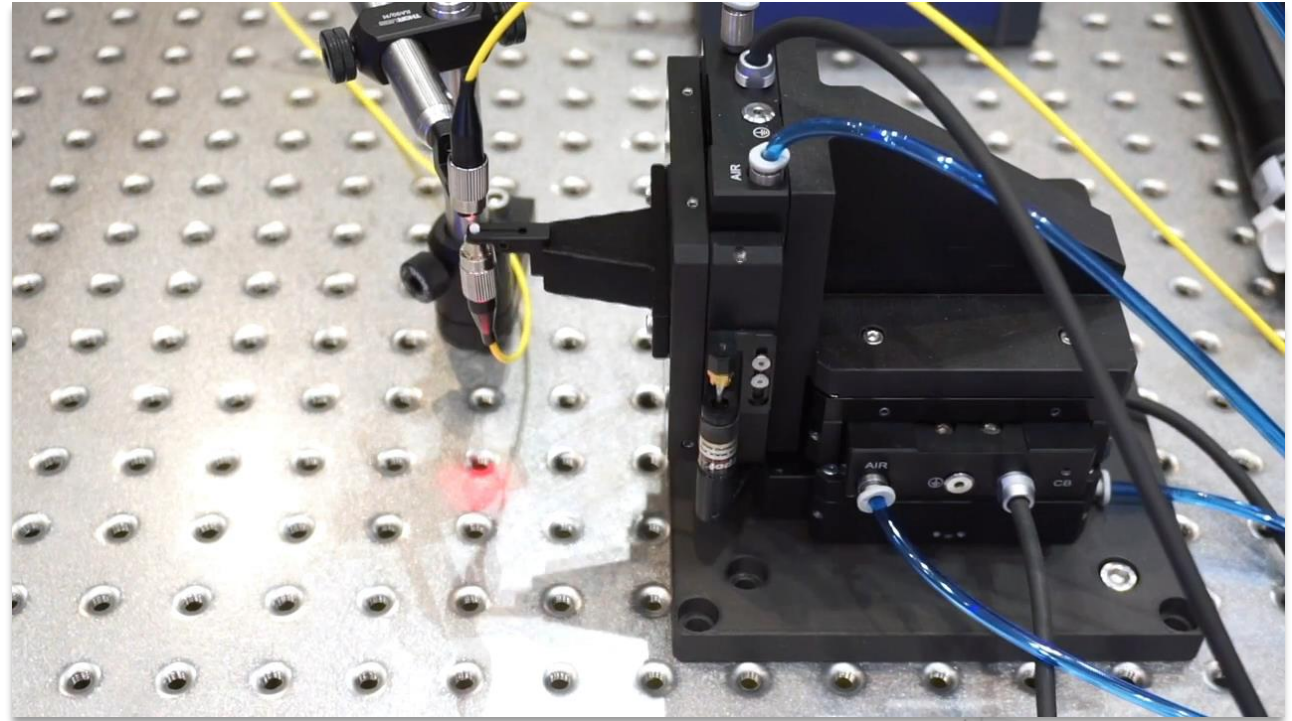
*Highest MTBF*

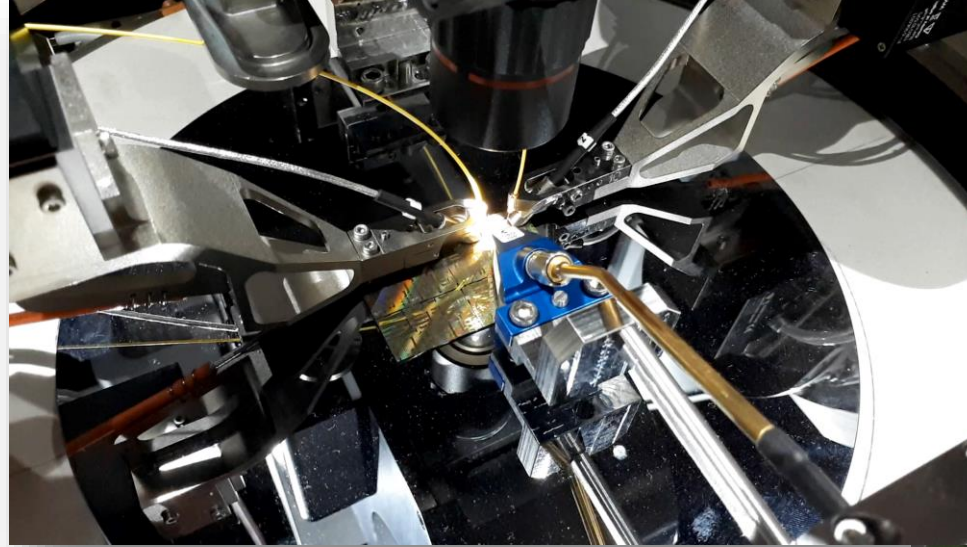
## *Fast Area Scan*

- First light acquisition*
- Profiling & characterization*

## *Parallel Gradient Search*

- Fast Optimization*
- Real-time tracking across multiple DOFs*
- Drift compensation*
- Lock-on*





# Physik Instrumente

Keep in touch! [ScottJ@pi-usa.us](mailto:ScottJ@pi-usa.us)

## PI USA HQ

16 Albert St  
Auburn, MA, 01501

Email [info@pi-usa.us](mailto:info@pi-usa.us)

Visit us: [www.pi-usa.us](http://www.pi-usa.us)

## PI Germany HQ

Auf der Roemerstrasse 1  
76228 Karlsruhe, Germany

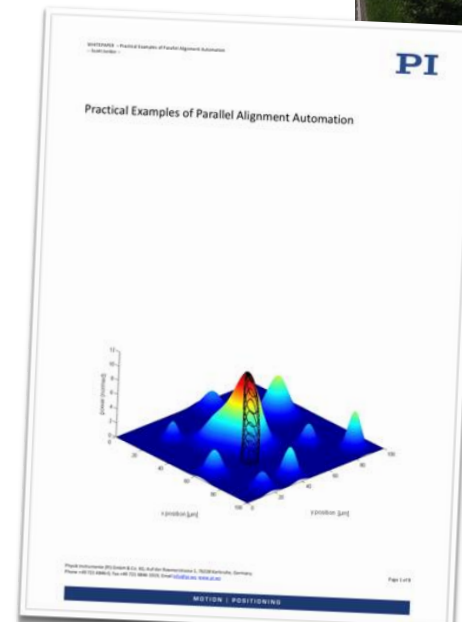
Email [info@pi.ws](mailto:info@pi.ws)

Visit us: [www.pi.ws](http://www.pi.ws)

WeChat



LinkedIn



Ask for a free Tech Note  
on Parallelism in  
Optimization

© 2023 Physik Instrumente (PI) GmbH & Co. KG  
Using these texts, images and drawings is only allowed with  
consent of PI and by indicating the source.