



SWTEST
2026 CONFERENCE

35th
ANNIVERSARY

Optimizing Test Solution for High-Volume Manufacturing of Photonic Devices

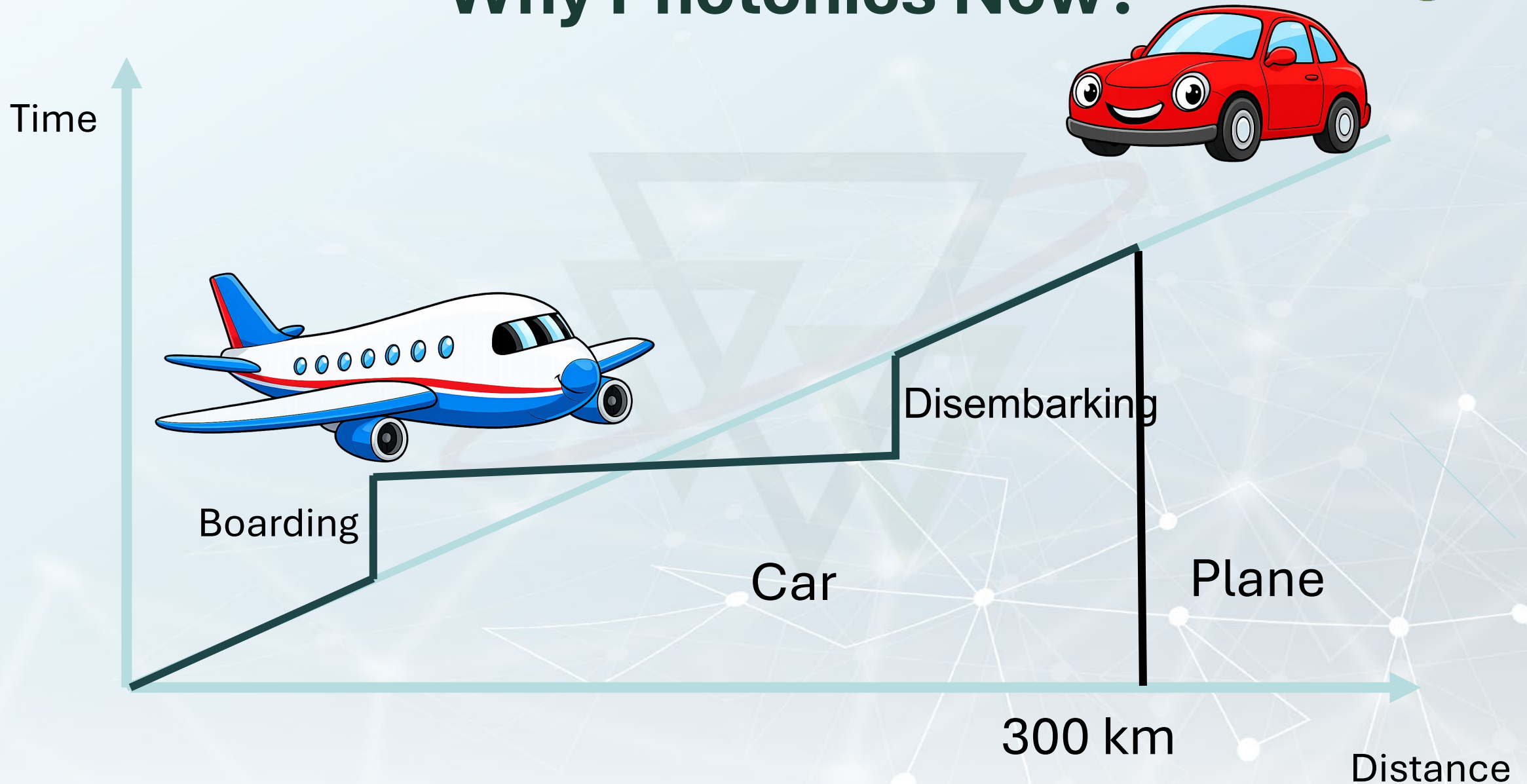
Keystone
photonics

a  **FORMFACTOR™** company

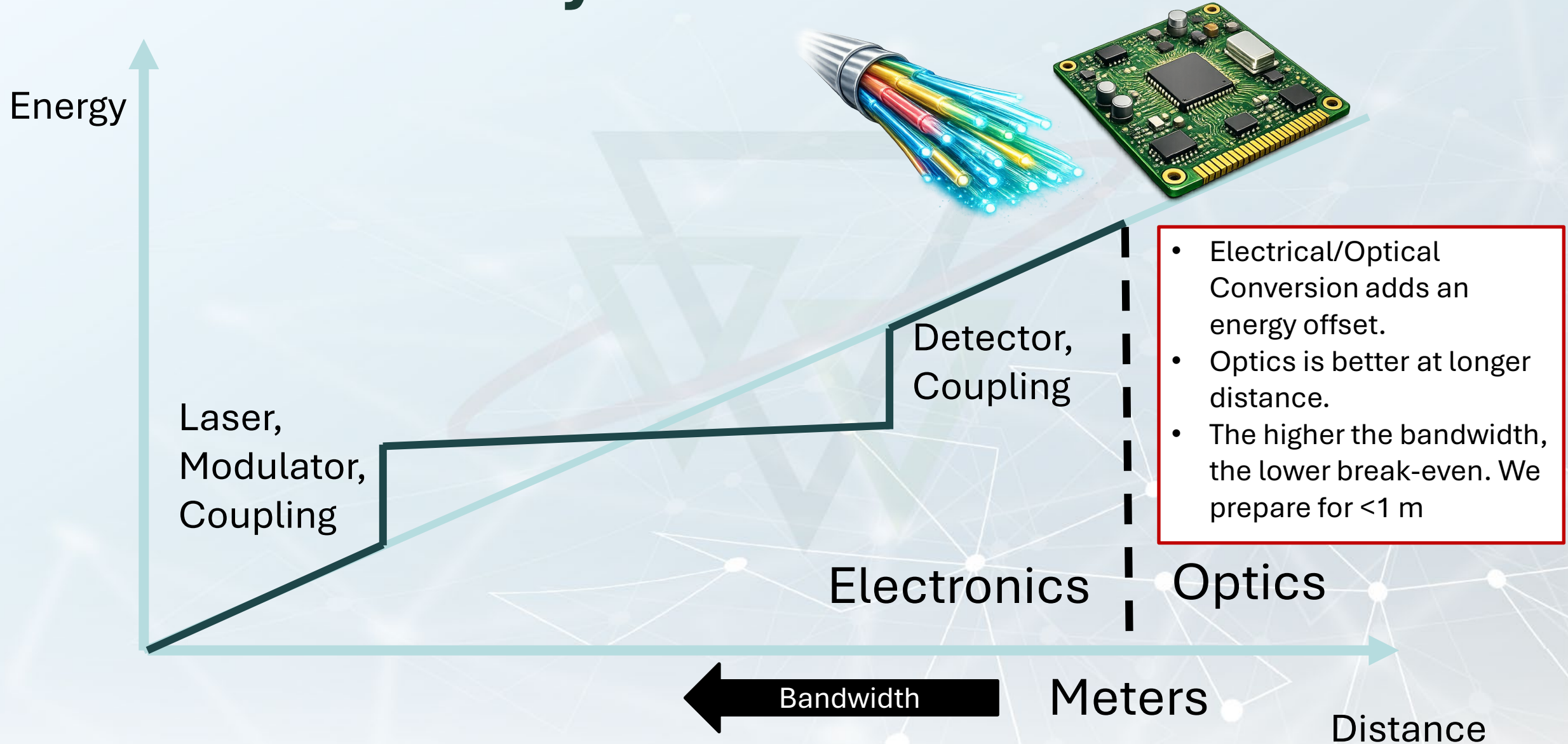
PI

Philipp Dietrich
Keystone Photonics GmbH
Nikta Jalayer
Physik Instrumente

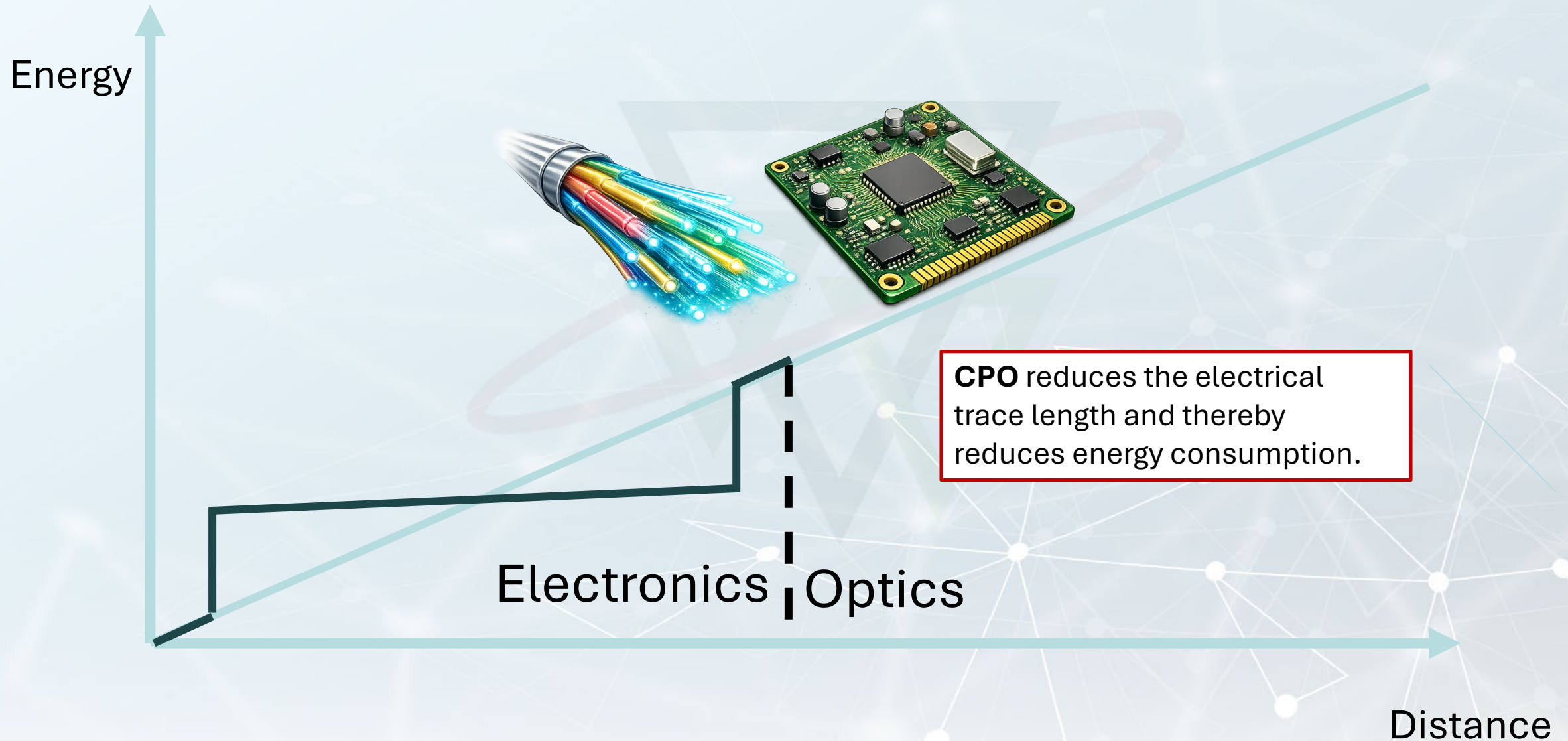
Why Photonics Now?



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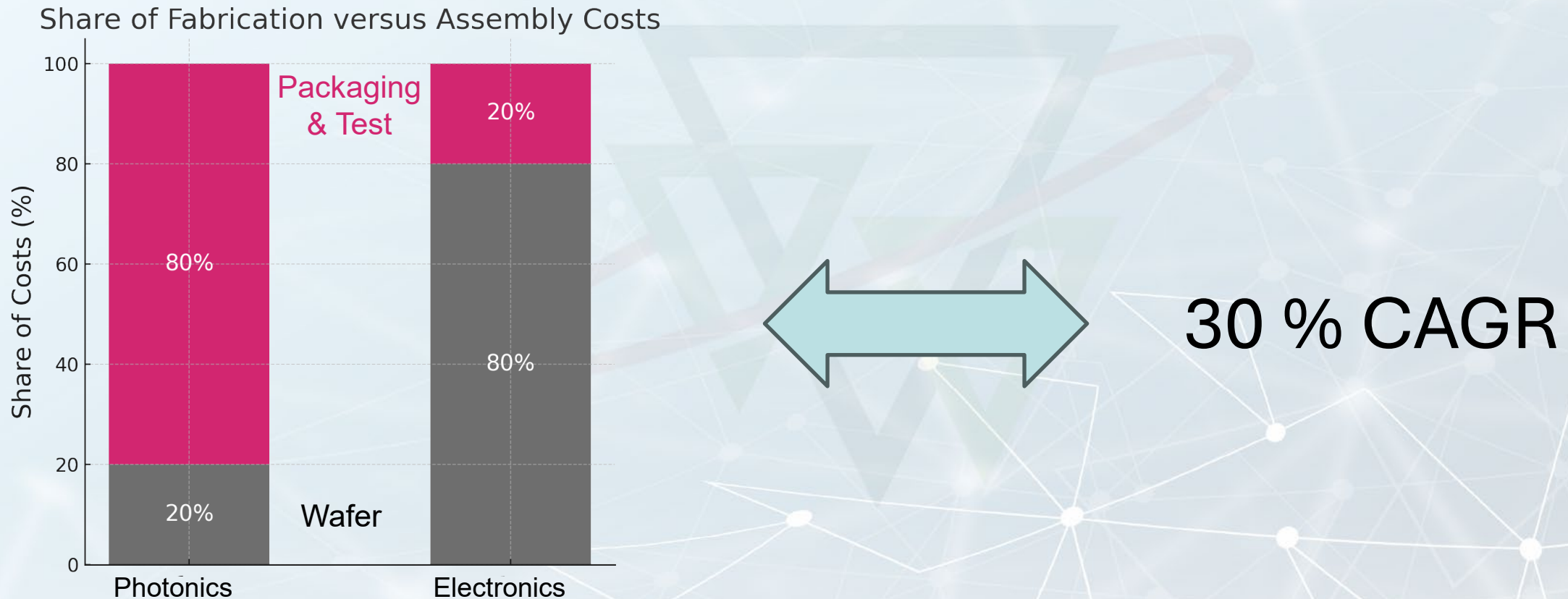


And Co-Packaged Optics?



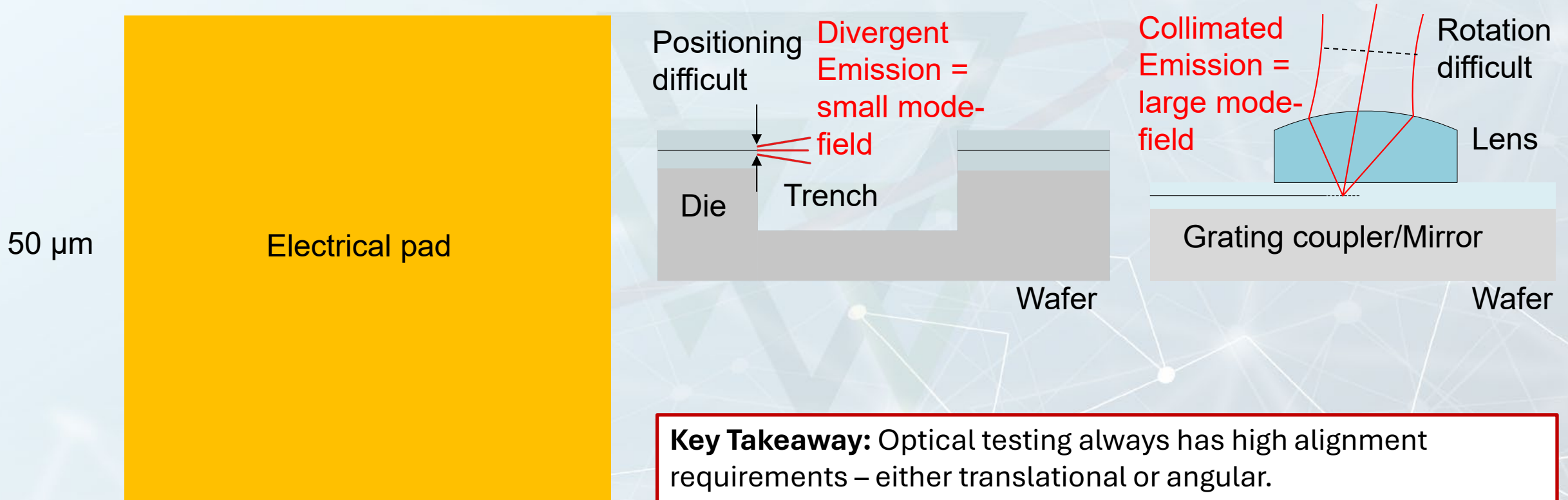
Cost For Test Is Very High

Test (and packaging) The Largest Cost-Drivers in Integrated Photonics



Fuchs et al. 10.1109/JLT.2011.2159260;
 Gregg Barlett, Global Foundries at Global Photonic Economic Forum 2024
https://youtu.be/H0_H9M0i7Og?si=nPdJyWC5KYMoj8TR

Testing Electronics vs Photonics

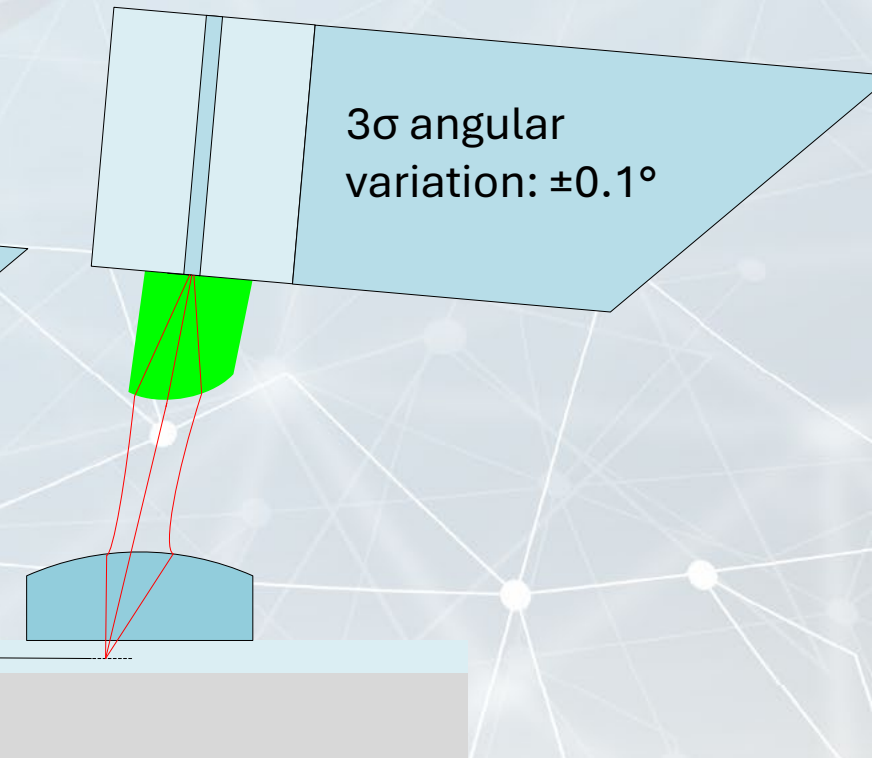
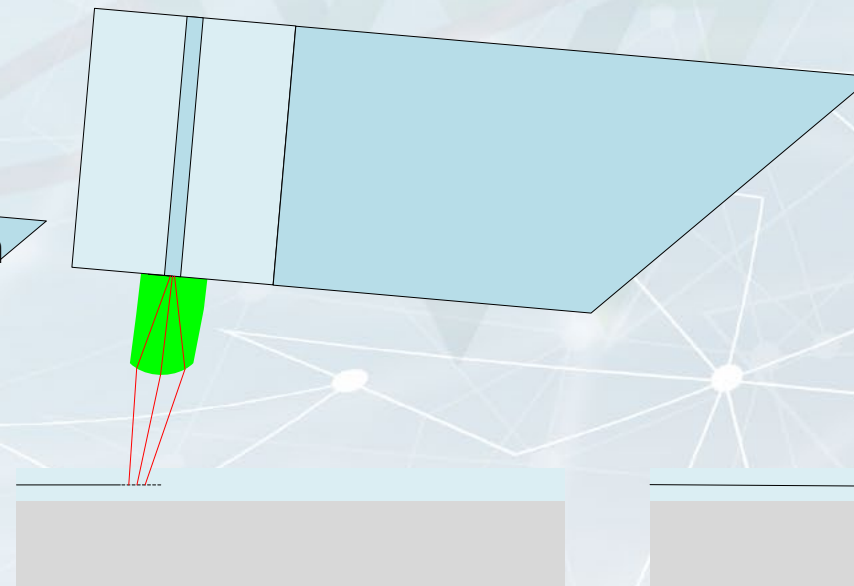
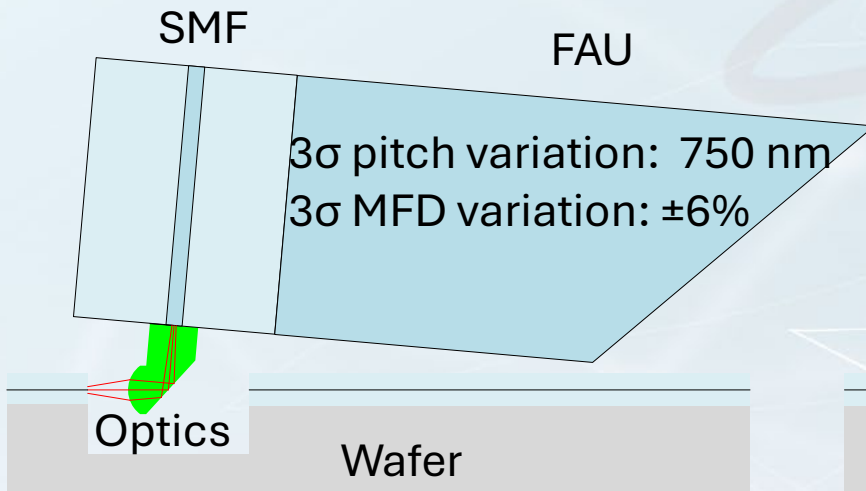


Insertions at Wafer Level

Trench (INS 1)

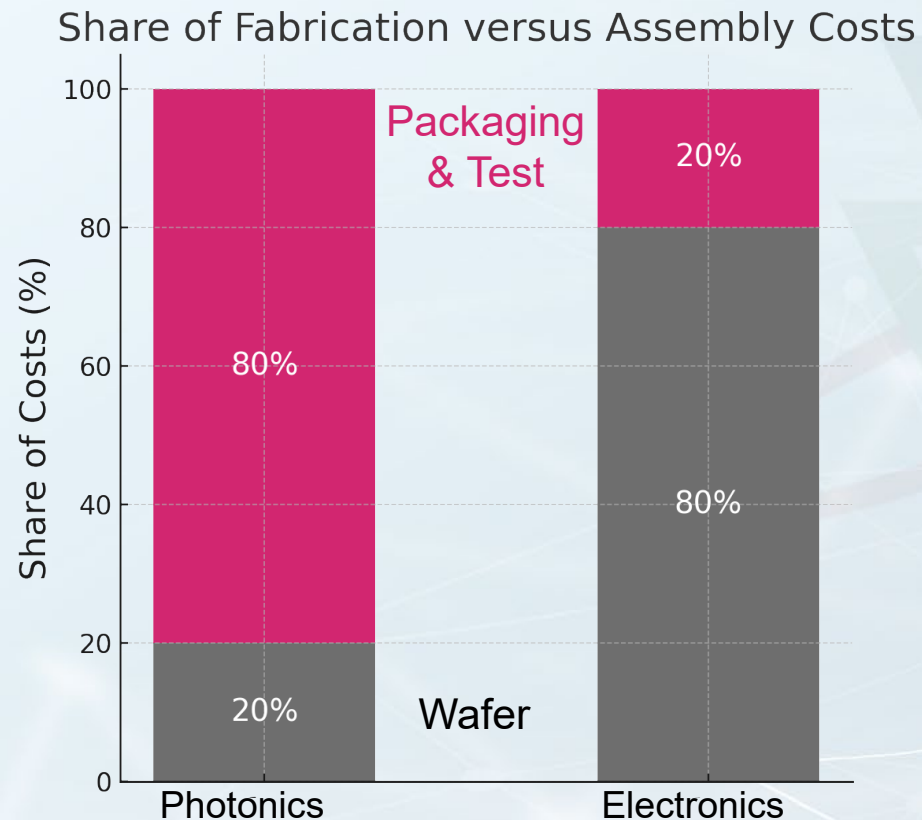
Grating (INS 1)

Collimated (INS 2 and later)

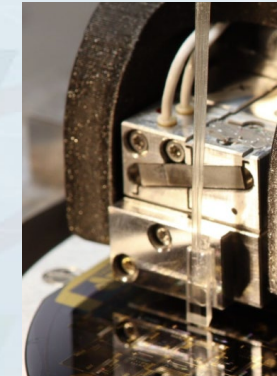


Cost of Test

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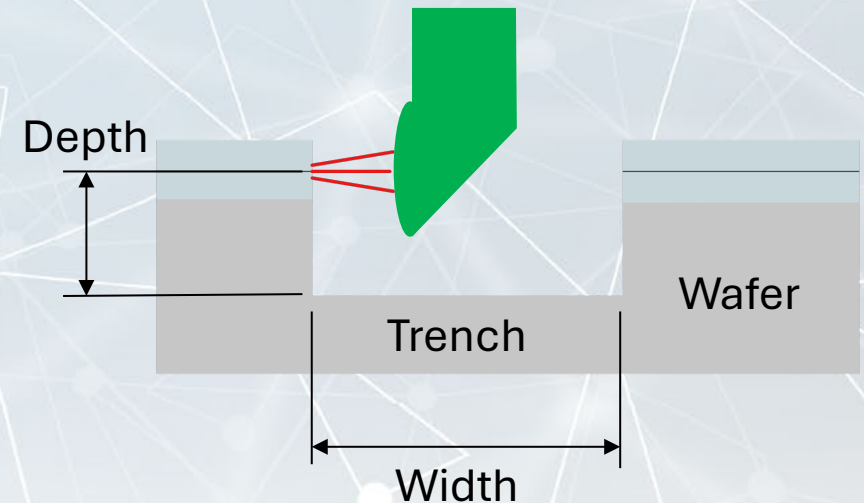


Industry Challenge 1:
Serial process



Alignment Engine

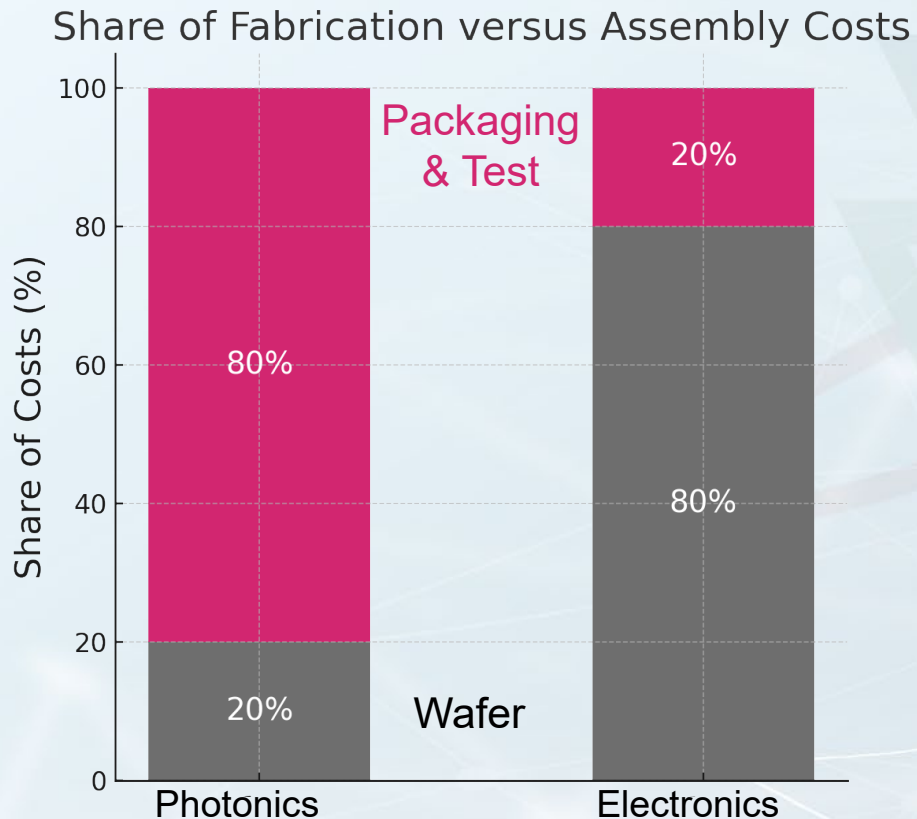
Industry Challenge 2:
Design For Test (DFT)
is expensive



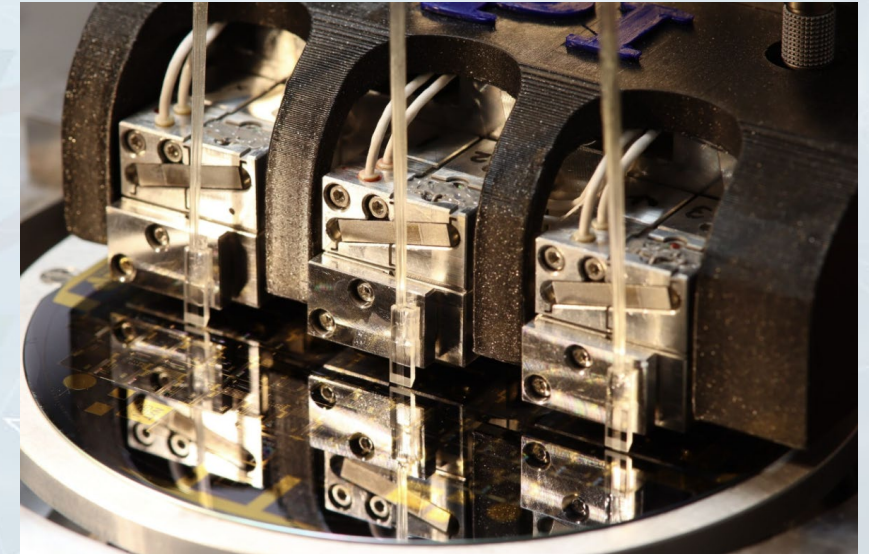
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Keystone and PI Solution

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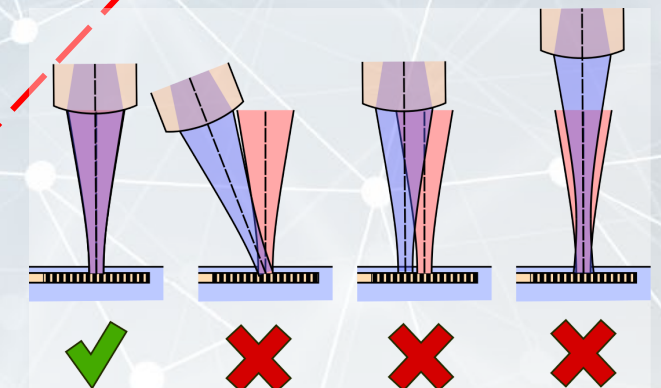
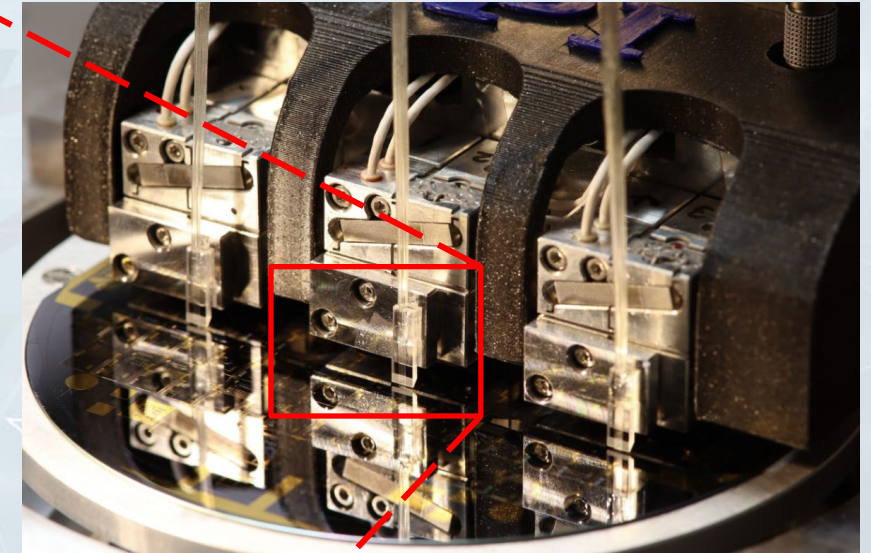
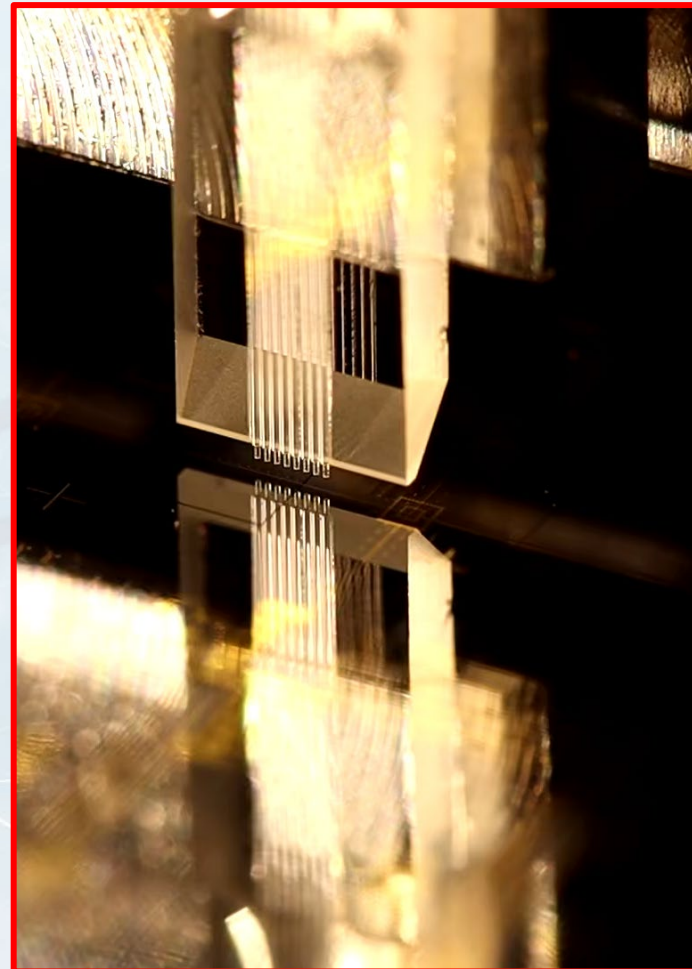
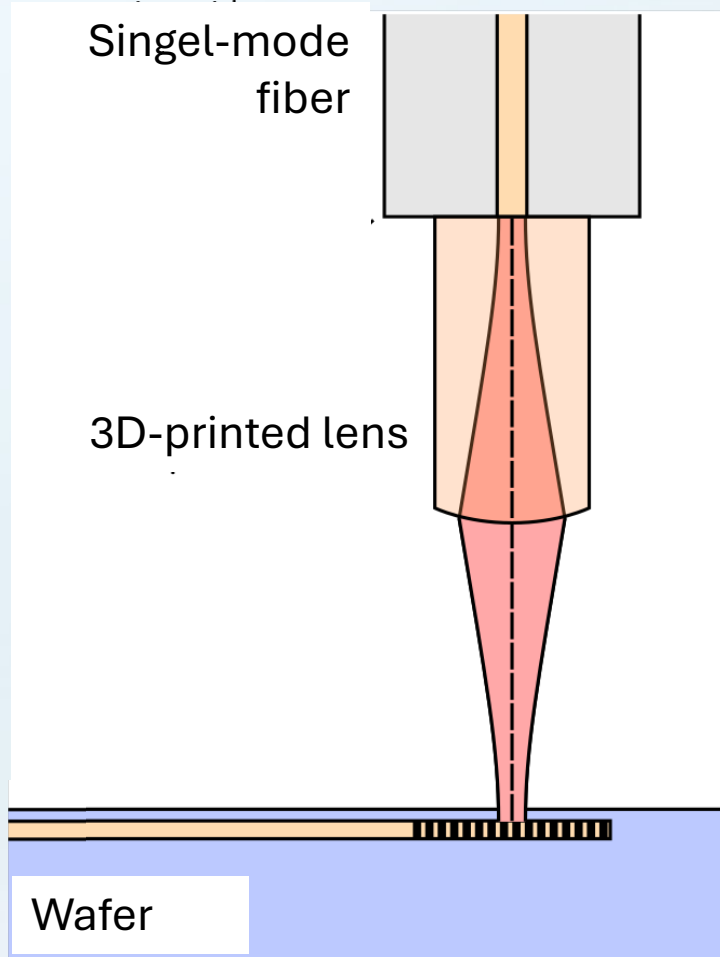


Solution 1:
Parallelized
Simultaneous
Multi-site Array
Alignment



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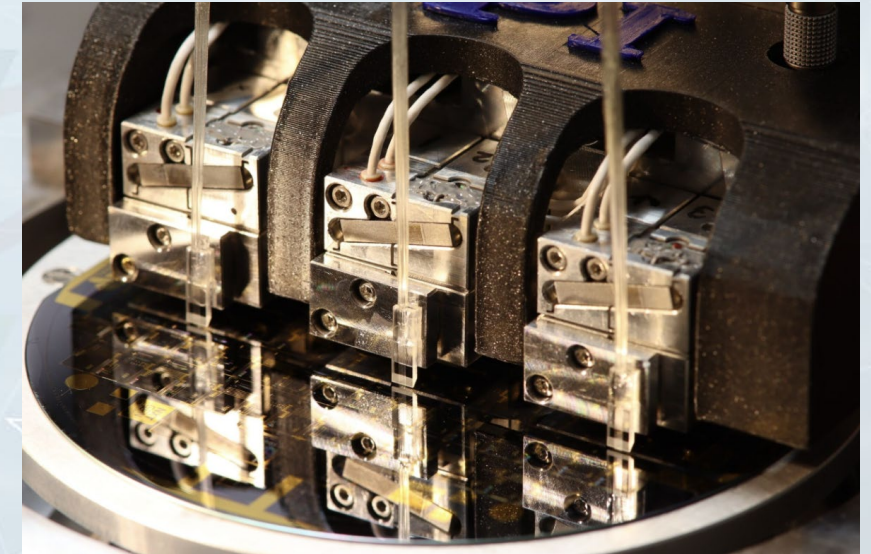
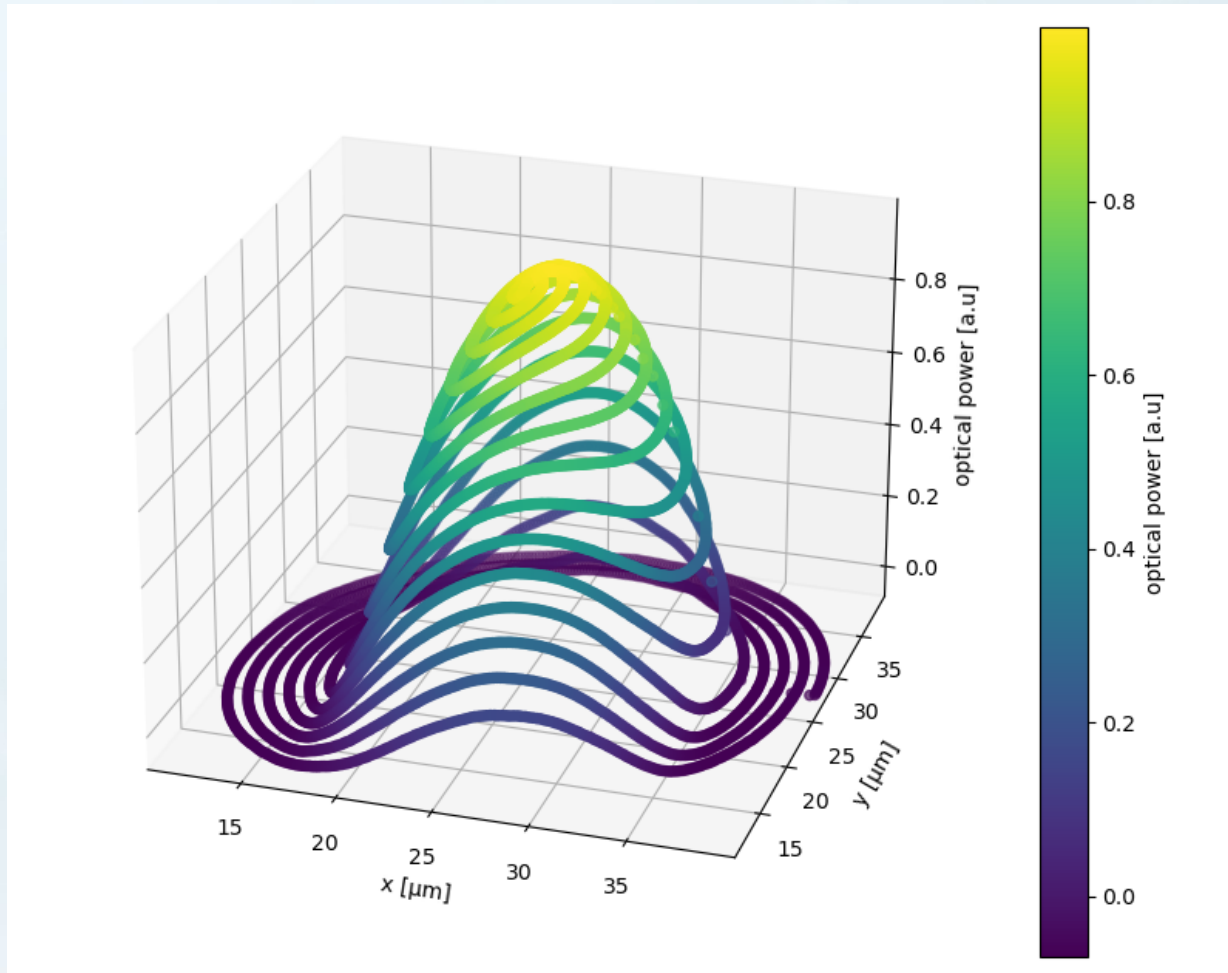
Keystone and PI Approach



Performance of Piezo Aligner Engines

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Scan area: 30 μm by 30 μm
Optimized Alignment: $\leq \sim 100$ ms



Performance of Piezo Aligner Engines

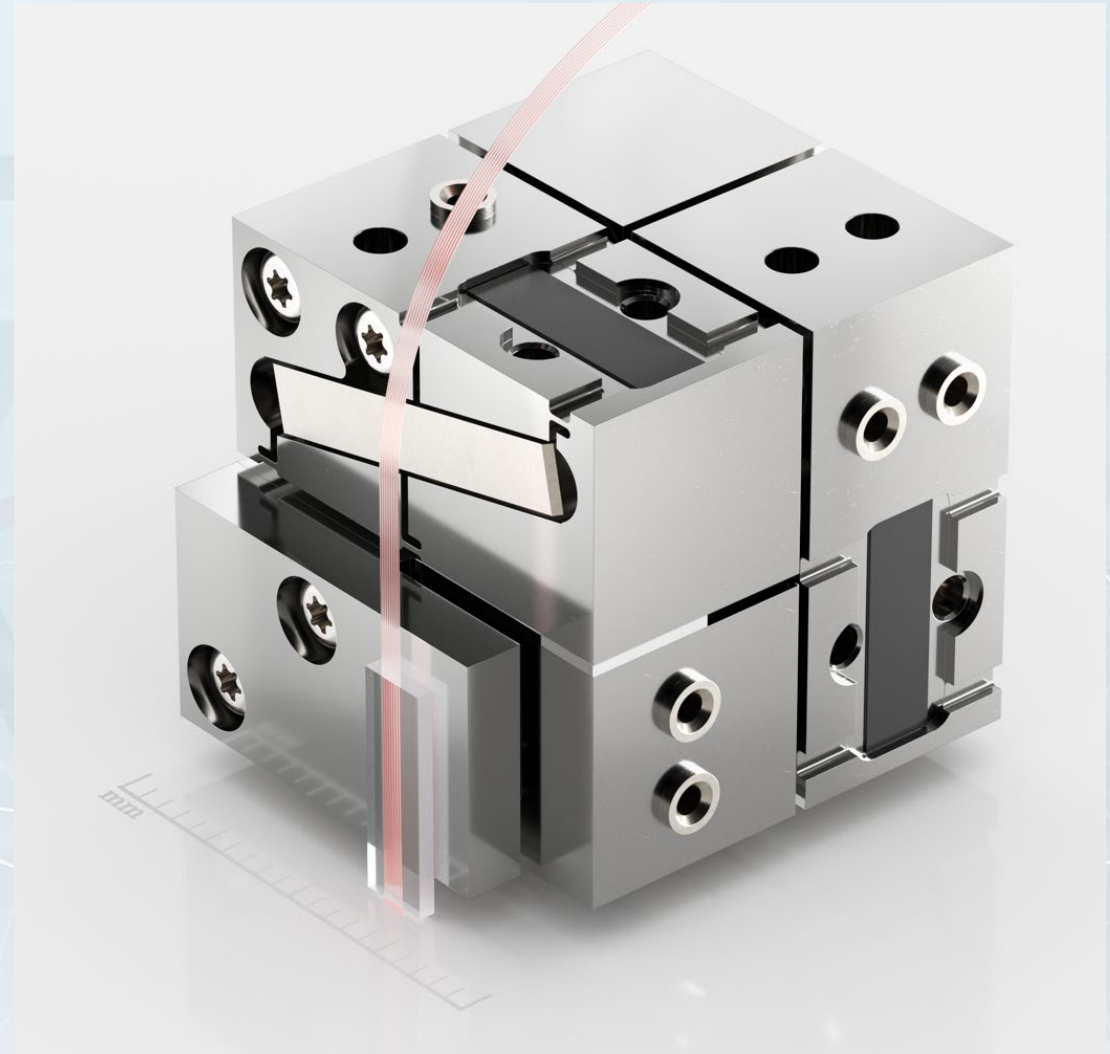
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Averaged Linear

- Bidirectional Accuracy: **114.53 nm**
- Unidirectional Repeatability: **±9.73 nm**
- Travel: **65.50 μm**
- Linearity: **18.95 nm**

Averaged Rotational

- Bidirectional Accuracy: **2.65 μrad**
- Unidirectional Repeatability: **0.45 μrad**
- Travel: **6.35 mrad**
- Linearity: **4.34 μrad**



Demo Performance of Piezo Aligner Engines

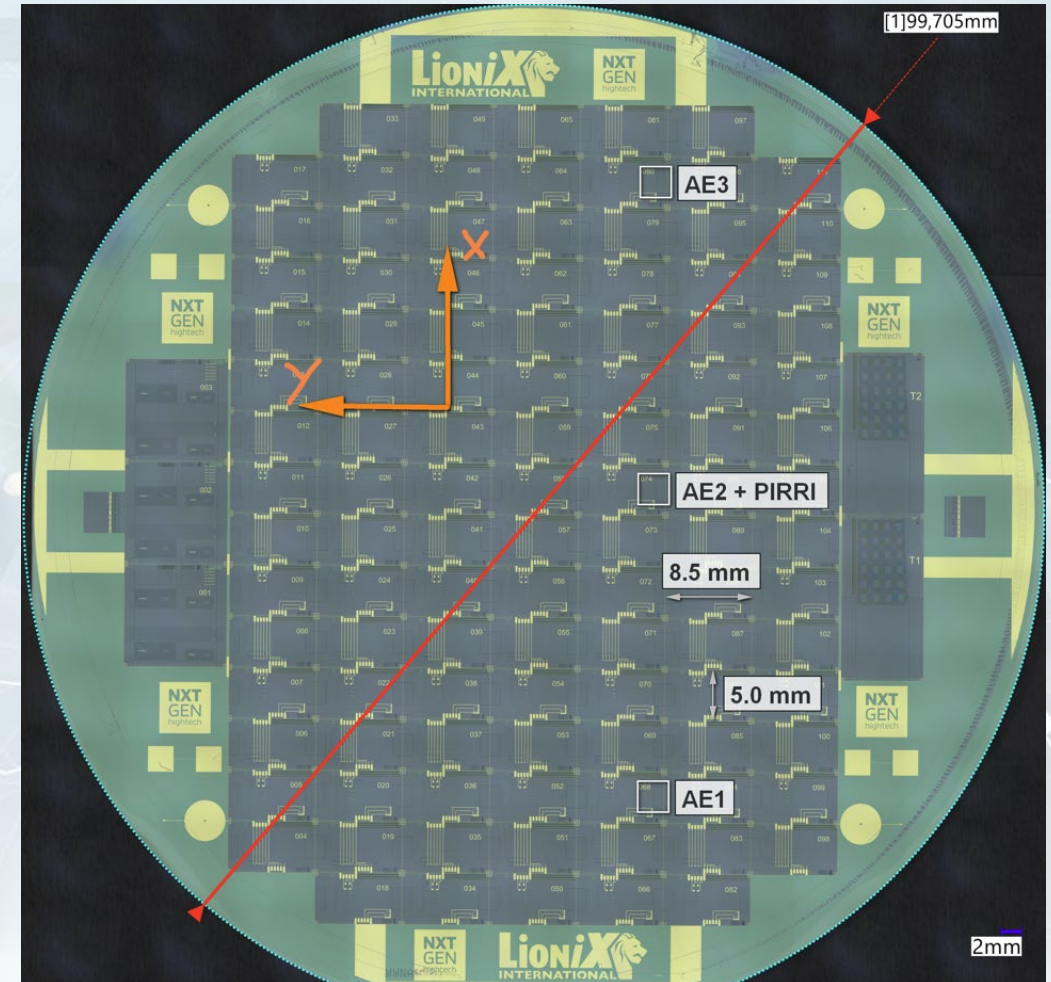
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- Demo Functionalities and Properties Coverage at Photonics West 2025
- HVM test showcase
- Live active alignment
- Parallel action
- Test site(s) stepping
- “Test Head” set-up

LioniX Wafer

- 4“ SiN
- Multiple dies
- Electronic and photonic structures
- Surface coupling

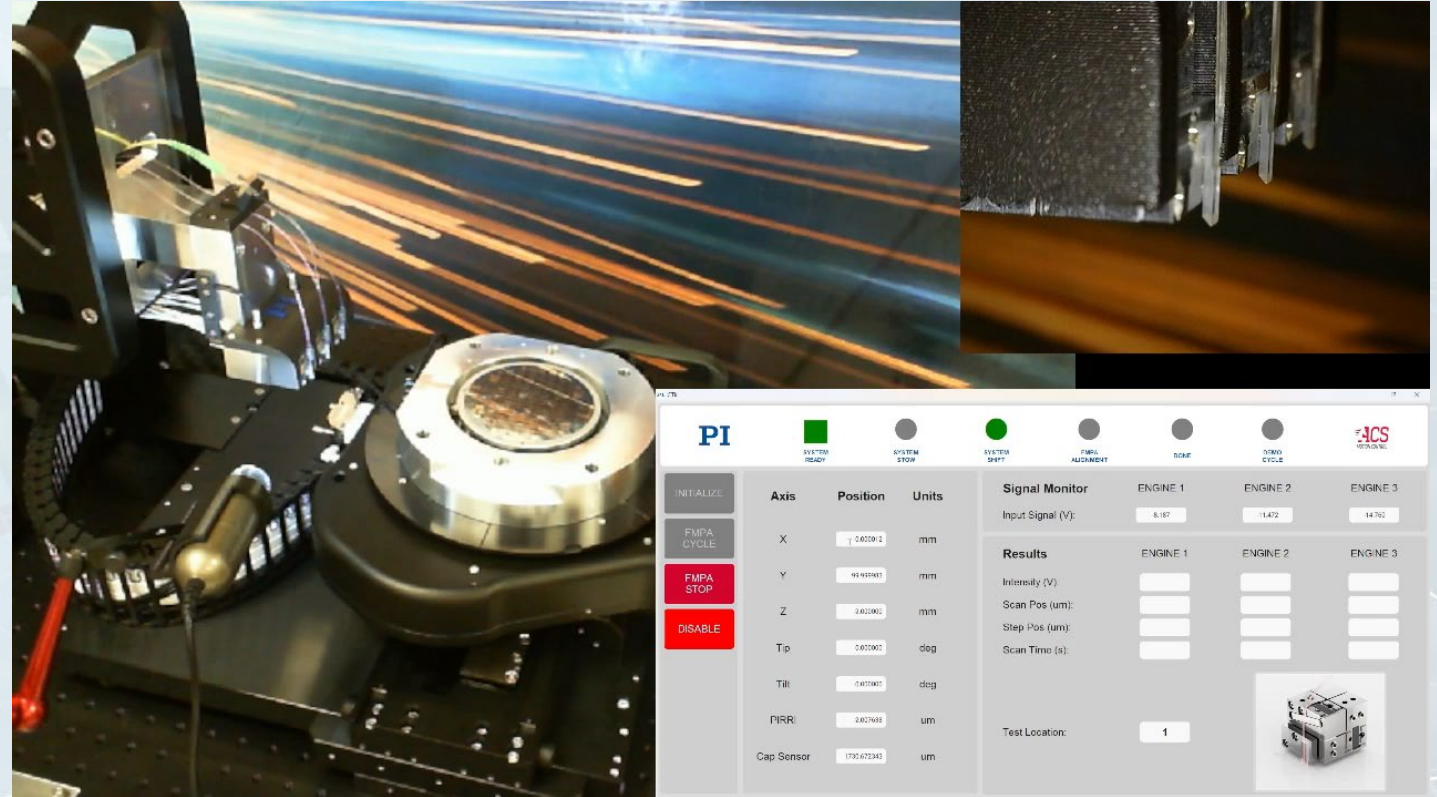
LioniX
INTERNATIONAL



Simultaneous Multi-Site Array Alignment

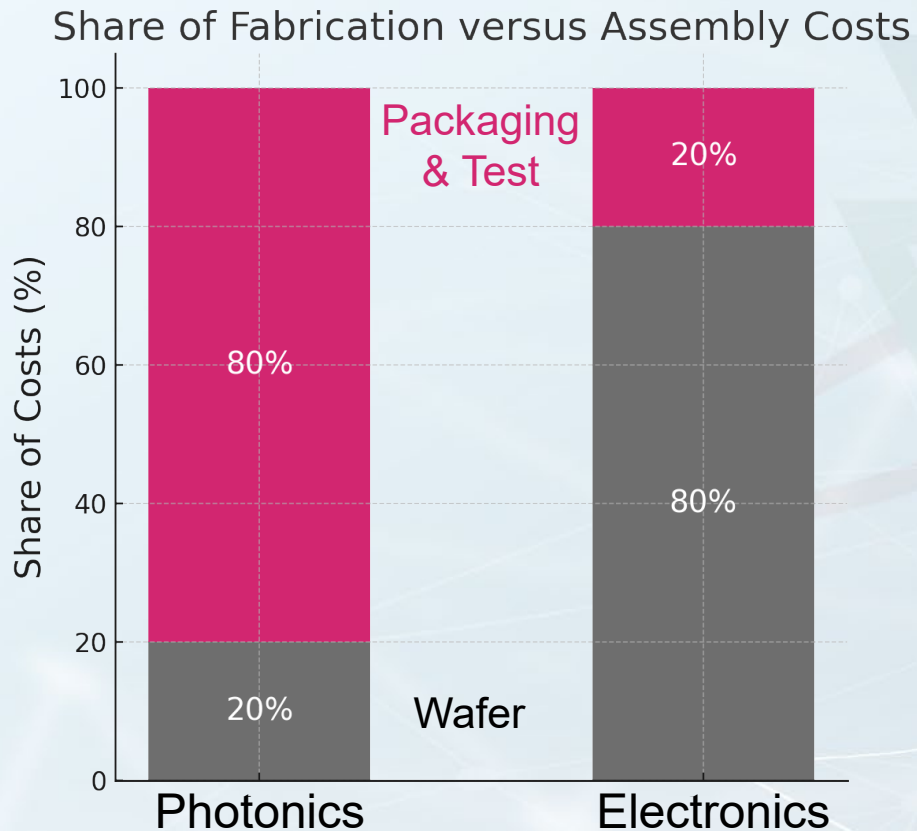
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- Live demonstration of piezo aligner engines running multiple wafer-level array alignments simultaneously
- 4 Degrees of Freedom Photonic Alignment Engines
- Alignment times in the 100ms range
- Parallel Multi-Site Array Alignment

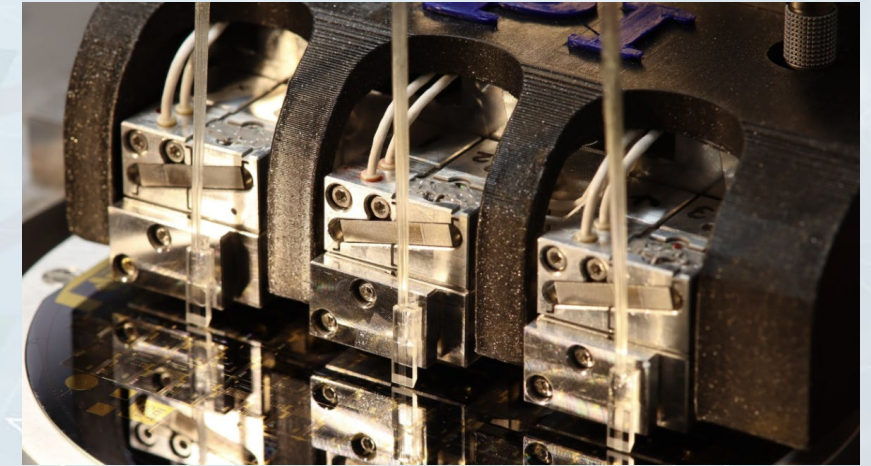


Cost of Test

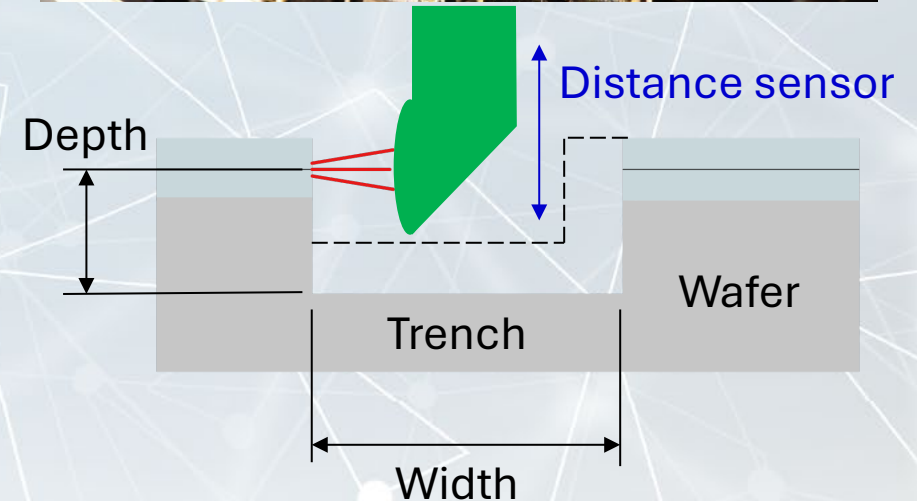
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Solution 1:
Parallelized
Simultaneous
Multi-site Array
Alignment

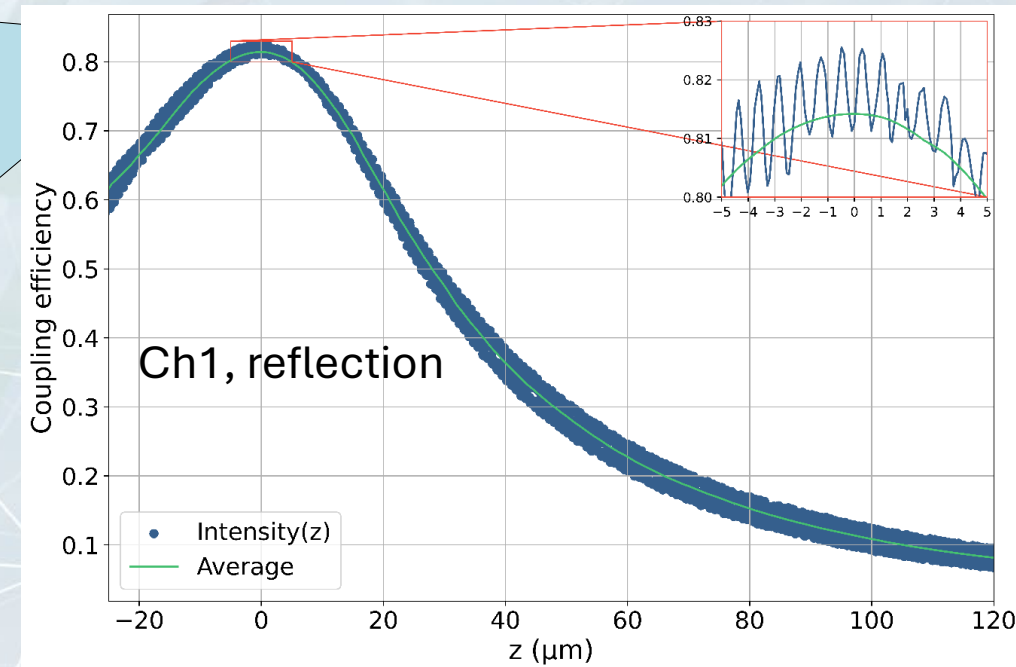
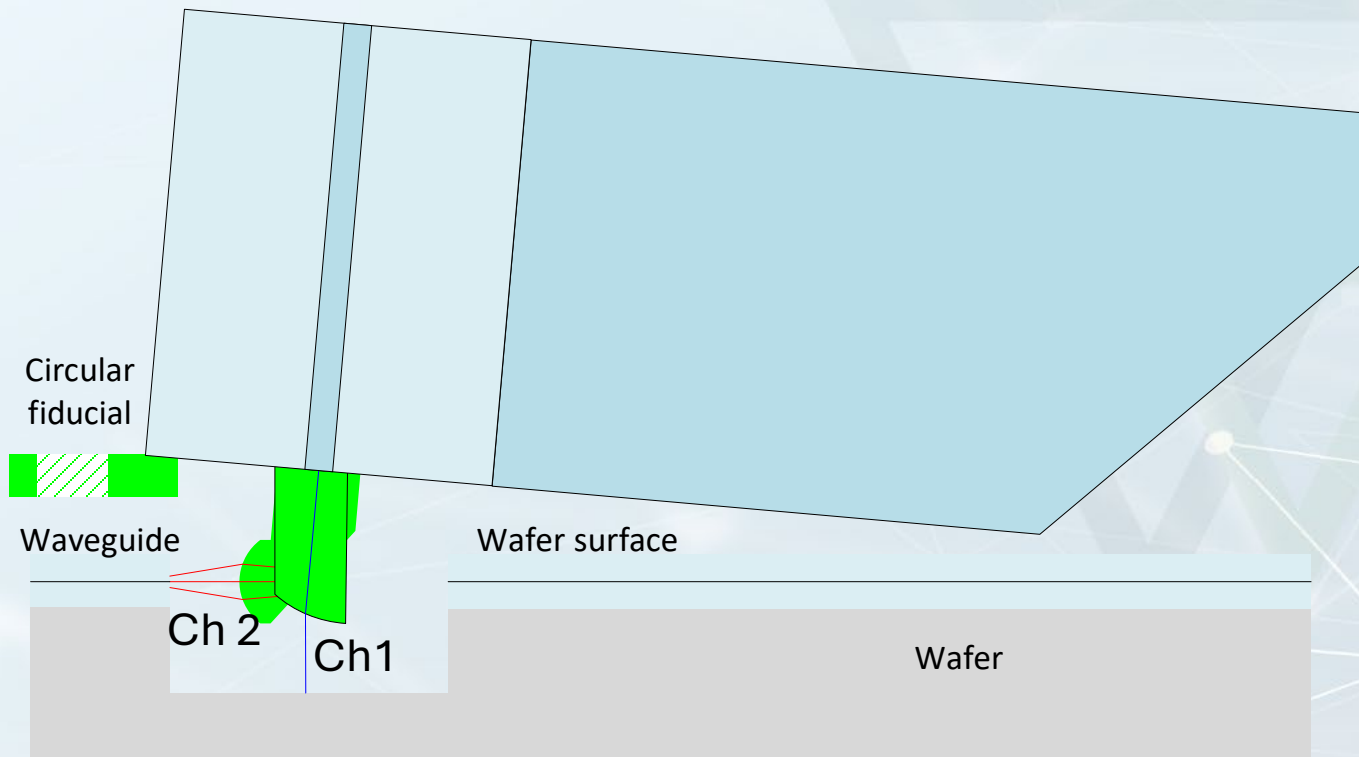


Solution 2:
Integrated
Metrology



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Integrated distance sensor



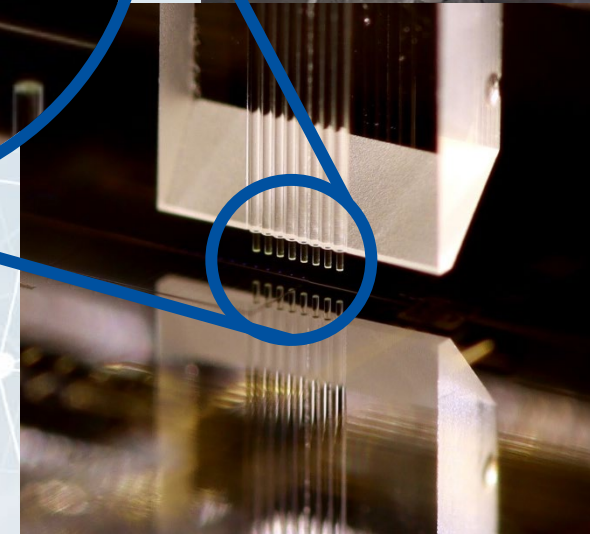
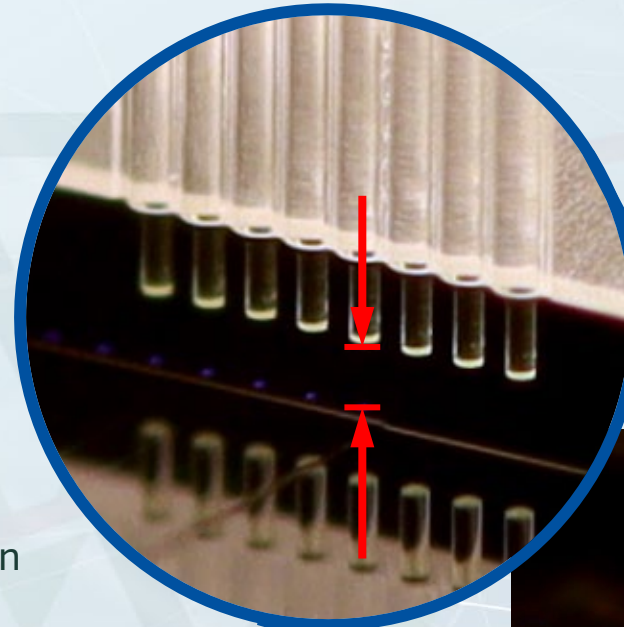
Absolute Optical Distance Sensor

Industry Challenges:

- Maintaining precise fly-height is critical to prevent probe-to-device collisions
- Stringent footprint constraints within test and prober systems

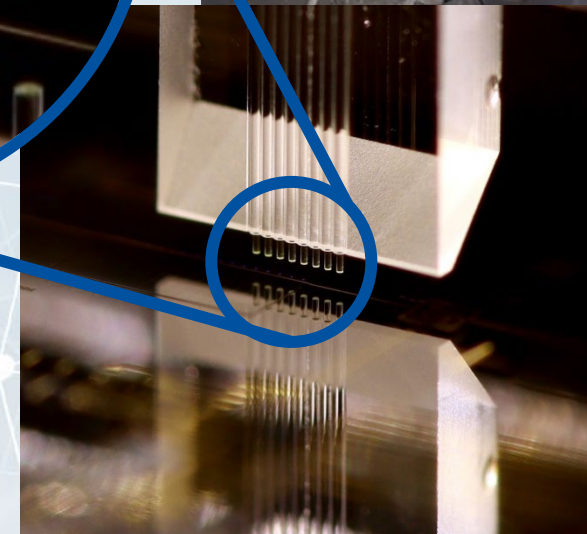
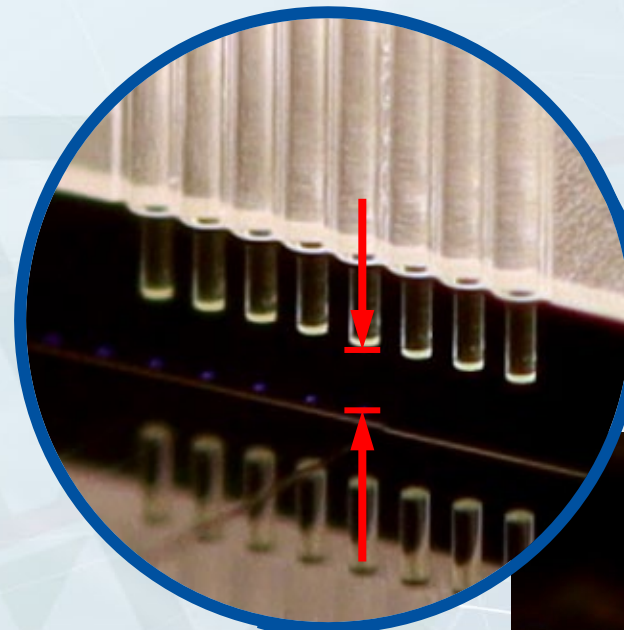
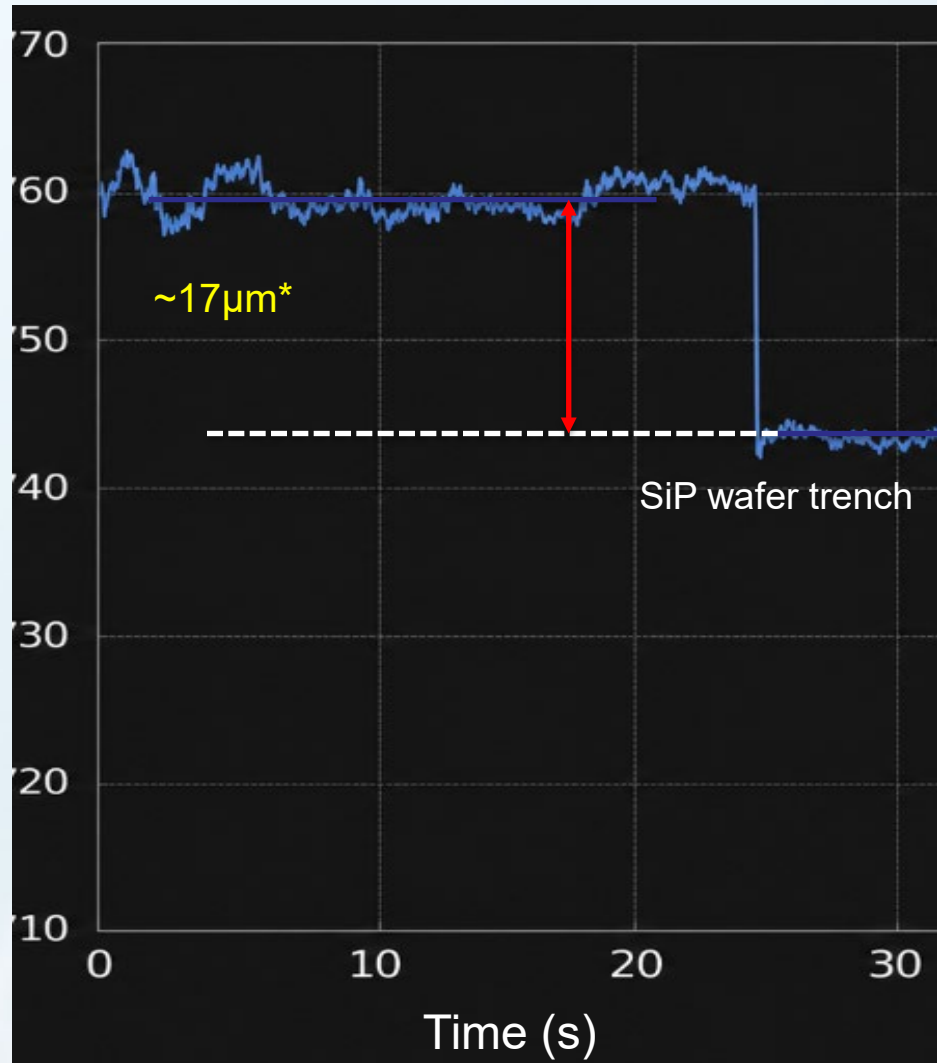
Technology Advantages:

- Enables seamless integration of distance sensing within the FAU
- Near-Zero impact on test interface hardware design
- Provides absolute distance measurement for enhanced process control
- Supports reliable trench and topography detection
- Improves alignment robustness and operational safety
- Facilitates higher throughput through automated height management



Absolute Optical Distance Sensor

Height (μm)



Conclusion

Industry Challenge

- High test cost driven by throughput bottlenecks and stringent alignment requirements

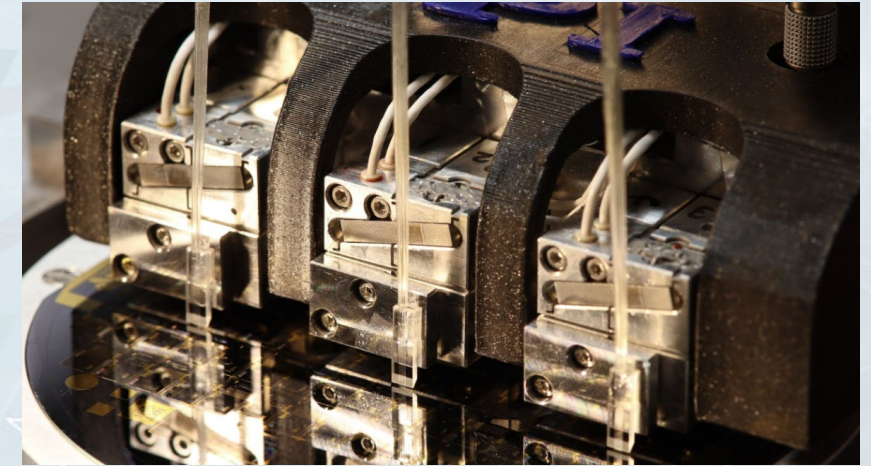
Keystone and PI Solution Strategy:

- Parallelized alignment for increased throughput
- Integrated metrology to relax DFT requirements
- Closed-loop automation for improved yield and repeatability

Business Impact

- Reduced cost of test
- Increased manufacturing scalability
- Faster time-to-volume production
- Improved return on capital equipment investment

**Solution 1:
Parallelized
Simultaneous
Multi-site
Array
Alignment**



**Solution 2:
Integrated
Metrology**

