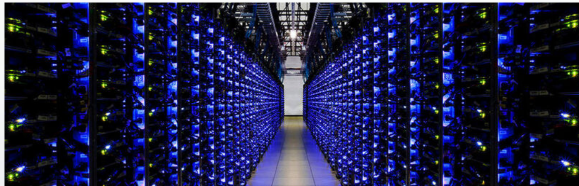
Technology Developments & Equipment Requirements for Scaling Up Photonics Production

Torsten Vahrenkamp & Stefano Concezzi
Presentation generated by Moritz Seyfried

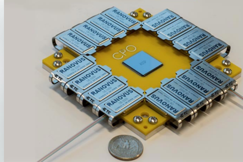
Photonics – It is just everywhere

Telecom/Datacom	LiDAR Development	Bio-Sensing	Quantum Technology



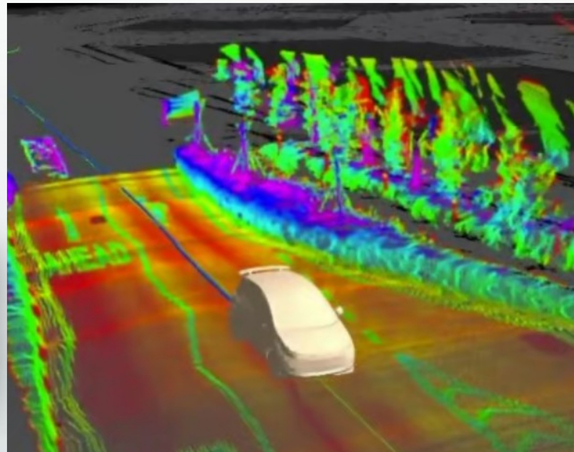
Datacenter, [Credit: google/datacenter]

400G Transceiver module [Credit: Intel]



CPO vision [Credit: Ranovus]

Optical backbone of data centers and telecommunication networks. Pluggable or CPO.

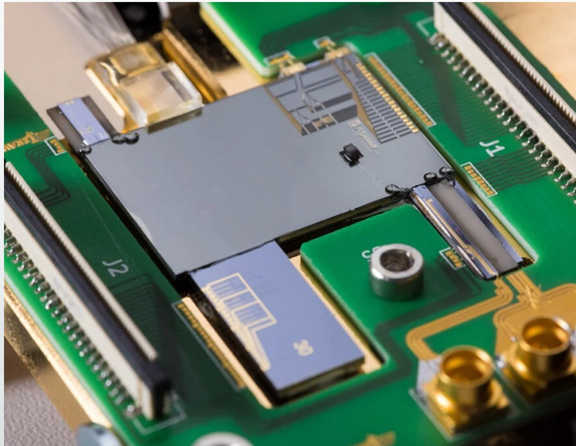
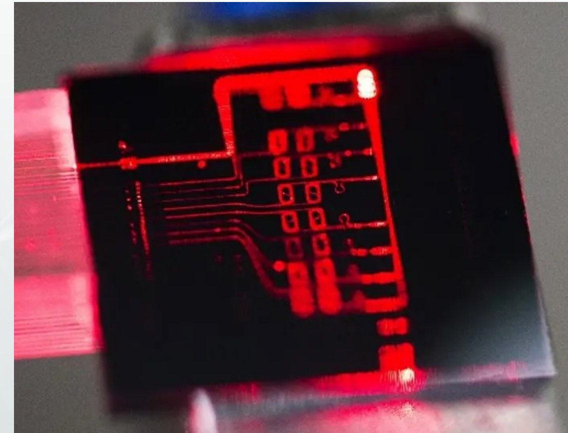


Solid-state-based LiDAR systems, e.g. Intel/Mobileye LiDAR system.

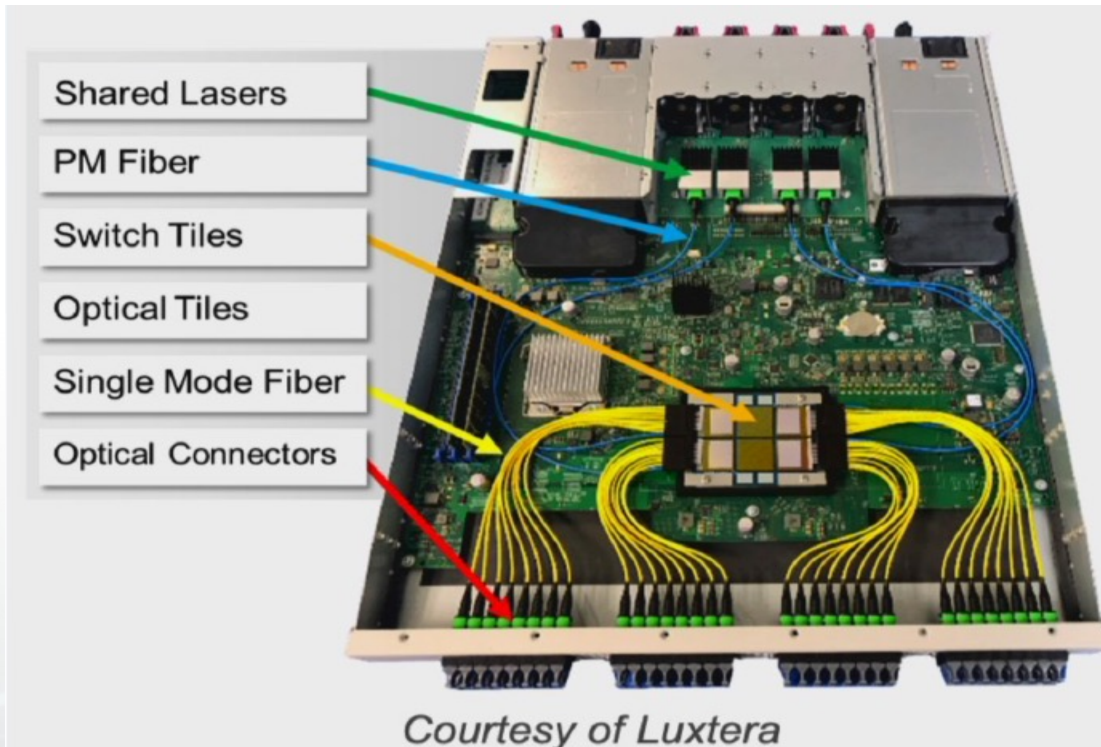
Optical sensing of bio-markers for constant medical monitoring. [Rockley Photonics]

Generation of entangled photons for quantum key distribution. [Quantum Optics Jena]

PICs inside

Telecom/Datacom	LiDAR Development	Bio-Sensing	Quantum Technology
			
PIC-based approach from PHIX/Teraway for high-speed transceiver module.	Solid-state-based LiDAR systems such as e.g. Intel/Mobileye LiDAR system. [Mobileye]	8 MZI building blocks showing waveguides outlining the sensing area to be functionalized. [LioniX]	PIC-based approach for building a large-scale quantum computer. [PsiQuantum]

PIC product assembly



- Known good photonic integrated circuits (PICs)

→ **Need for electro-optical (wafer-level) testing**

- Integration of laser source

→ **Need for high-precision die bonding**

- Fiber array assembly and alignment

→ **Need for fiber interconnect**

- Reliable machine for volume production

→ **Need for line systems and machine learning**

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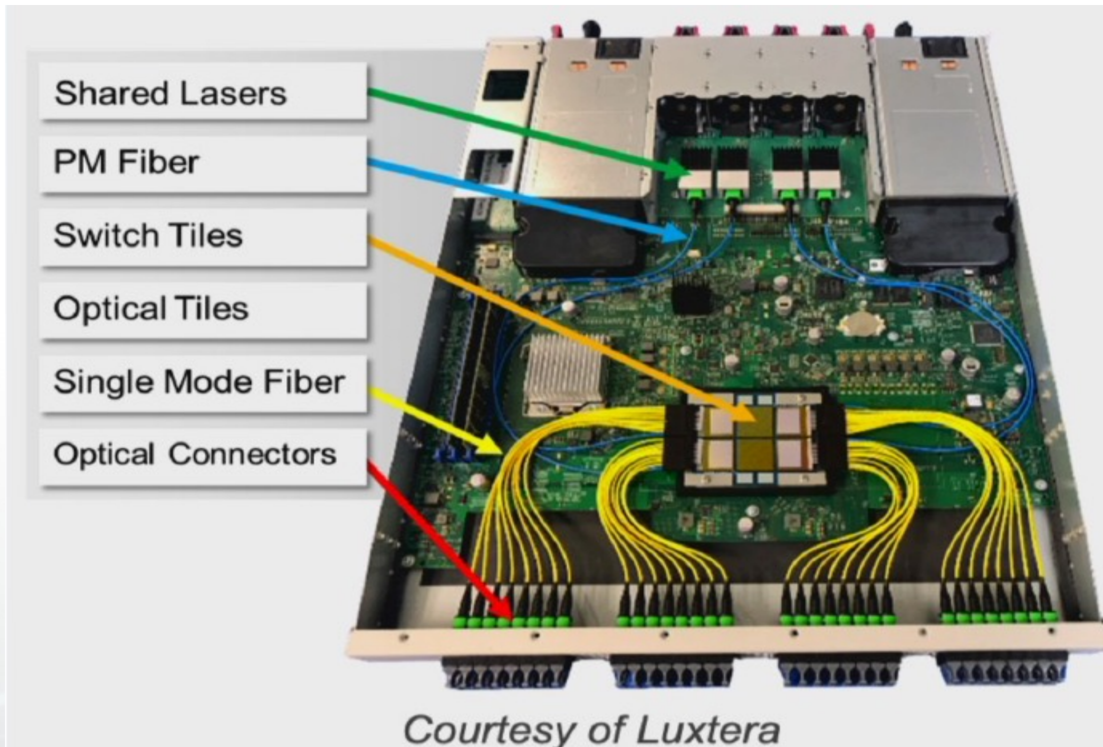
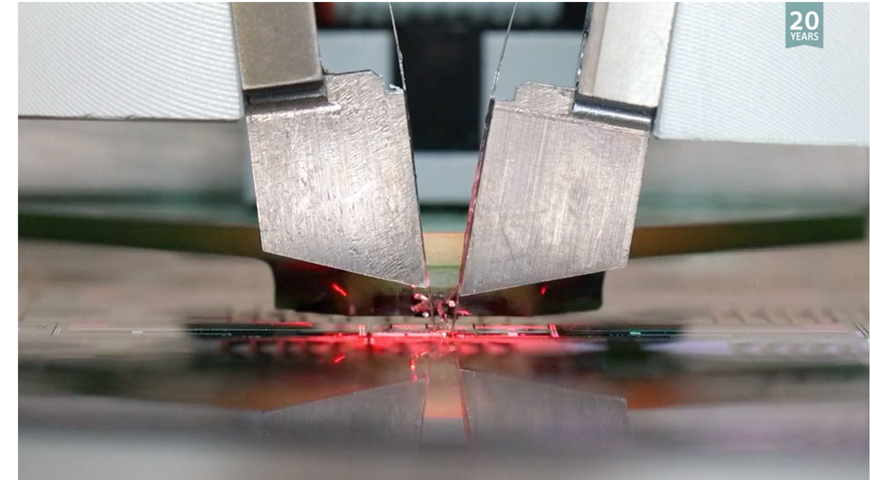


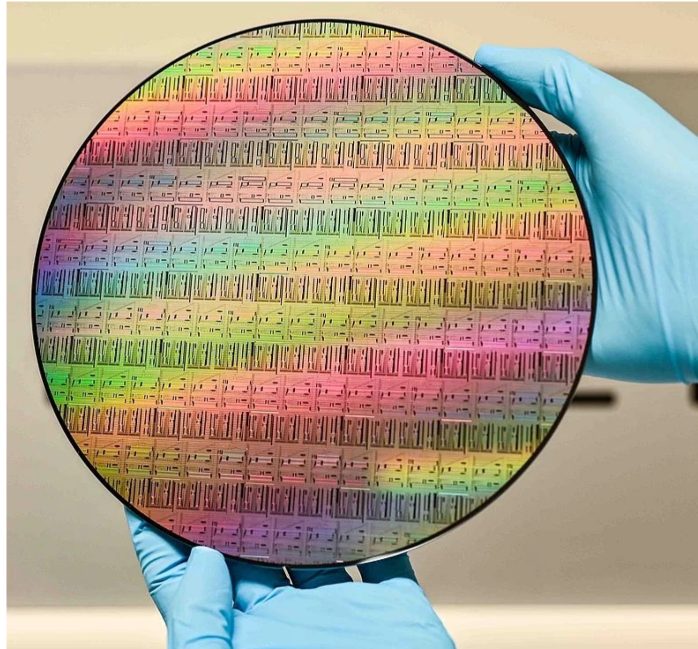
Courtesy of Luxtera

ficonTEC photonics assembly & testing

Electro-optical wafer-level testing

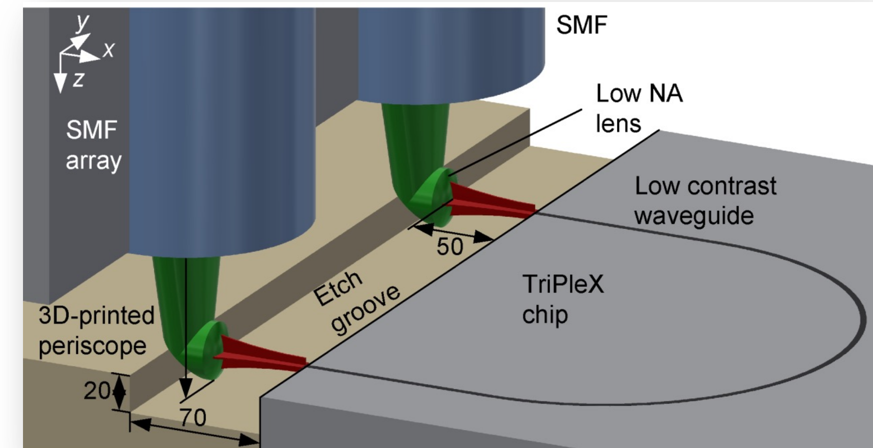
Grating coupling





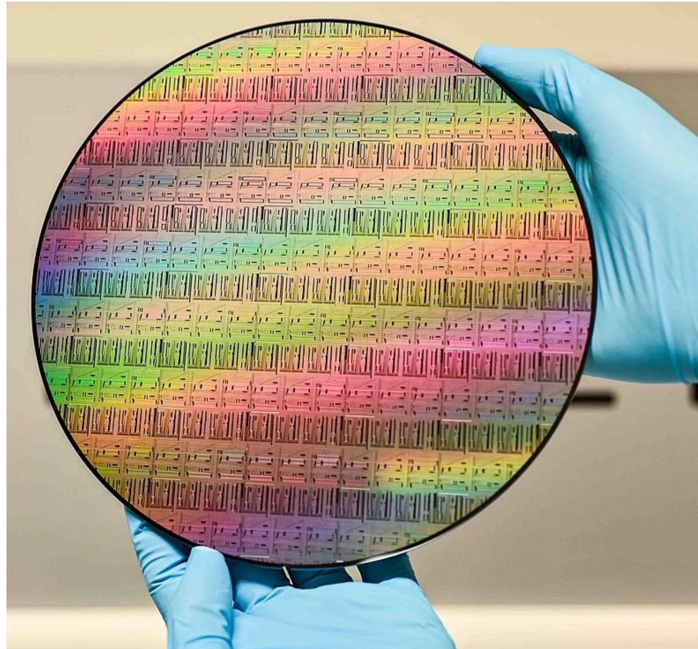
Electro-optical wafer-level tester for verification of PIC functionality

Edge coupling



Pictures from google search

Electro-optical wafer-level testing



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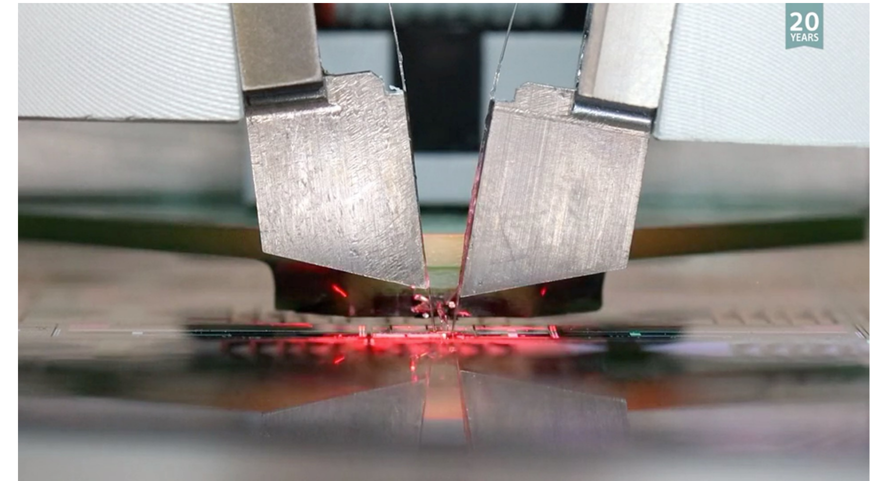

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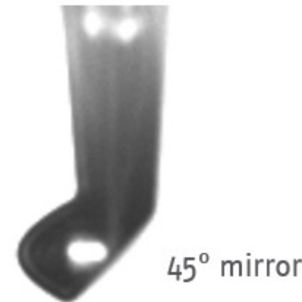

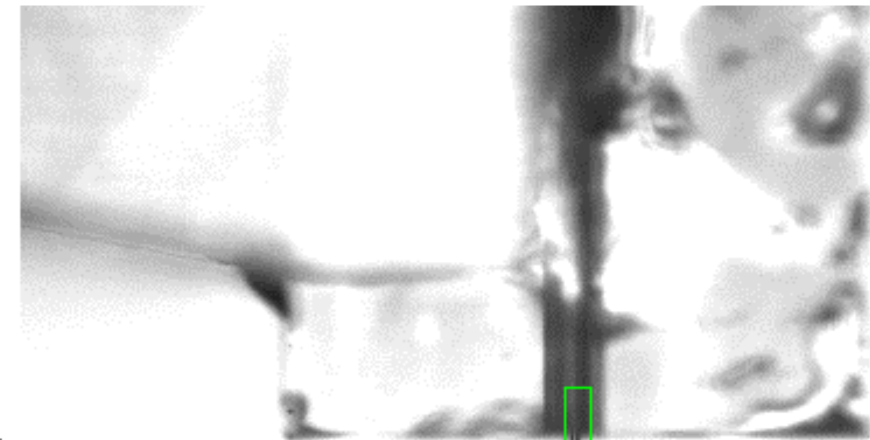

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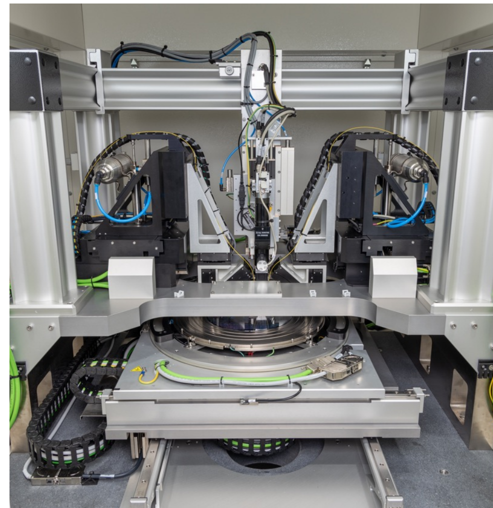
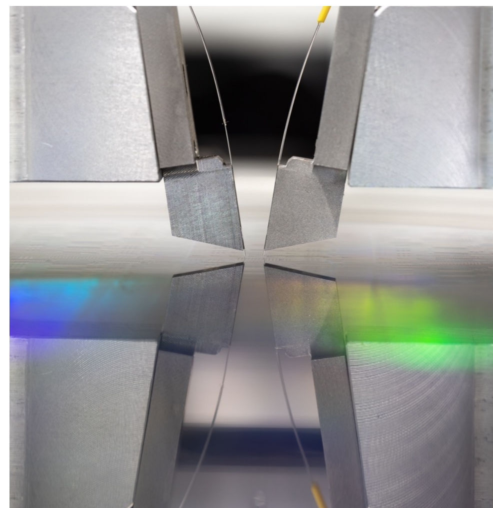
ficonTEC photonics assembly & testing

Electro-optical wafer-level testing

Electro-optical wafer-level tester for verification of PIC functionality

Wafer table



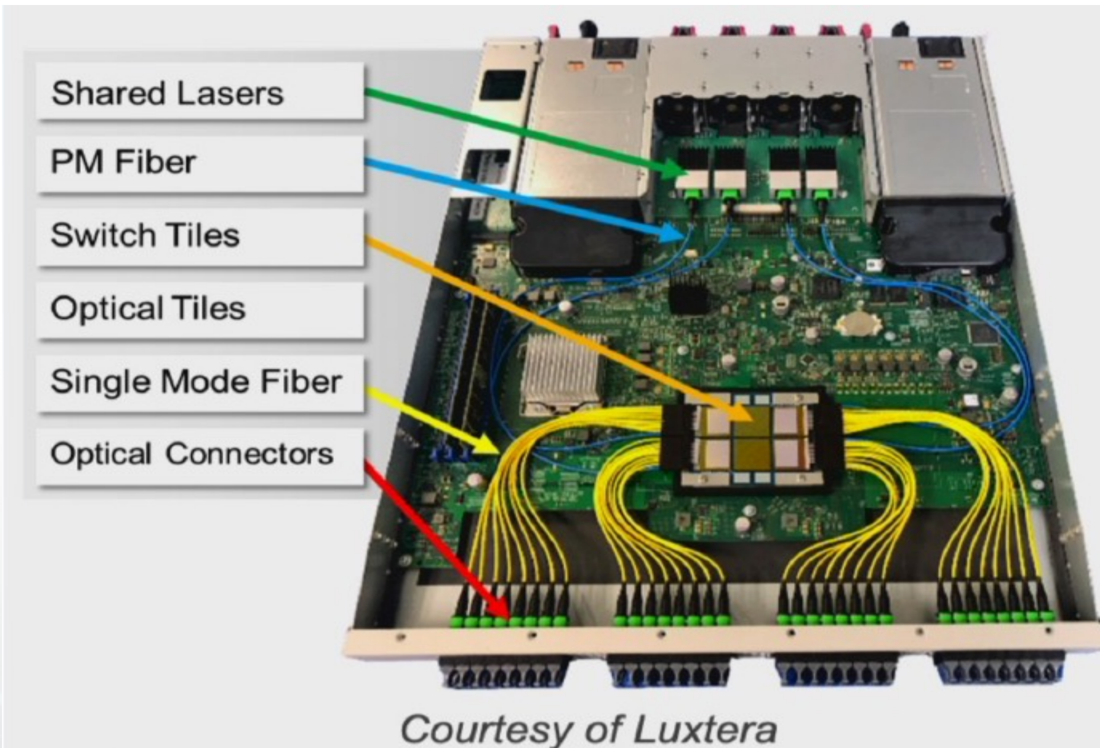


Optical alignment

Next-generation wafer-level tester:

- Throughput requirements
- Interaction with available tester
- RF requirements
- Measurement equipment
- Data handling
- ....

PIC product assembly



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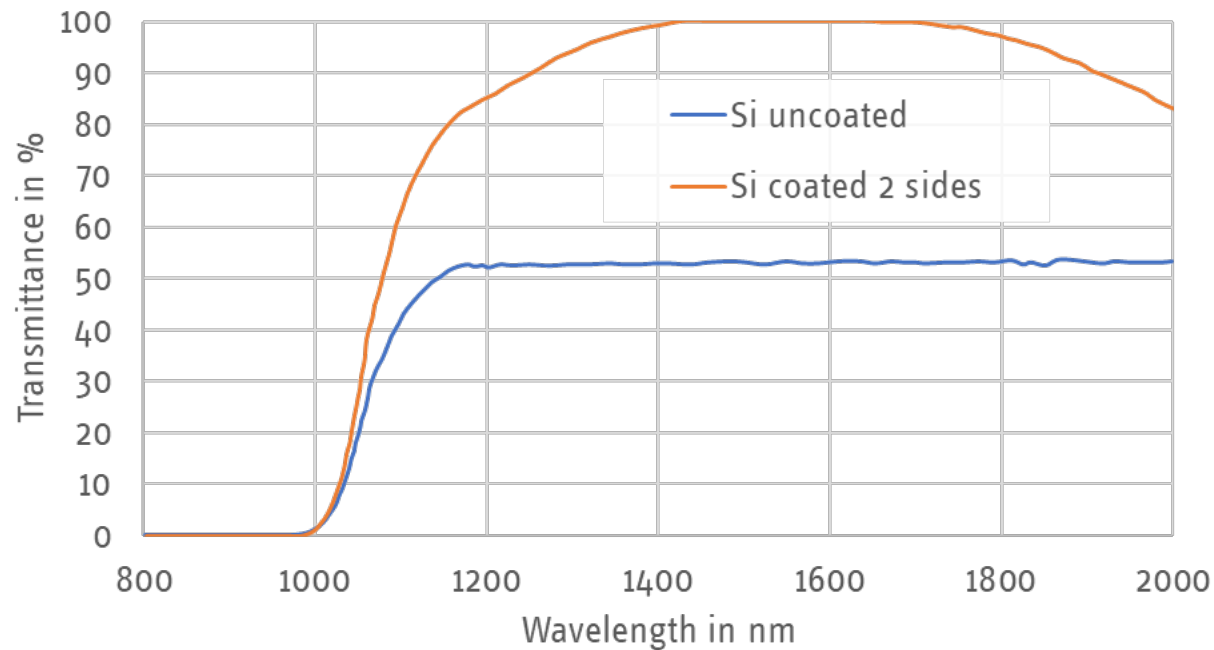
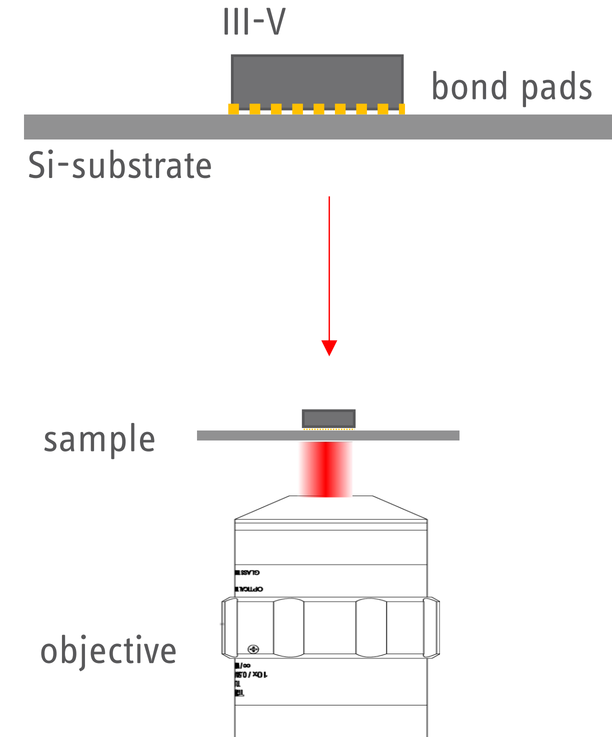
High-precision die bonding

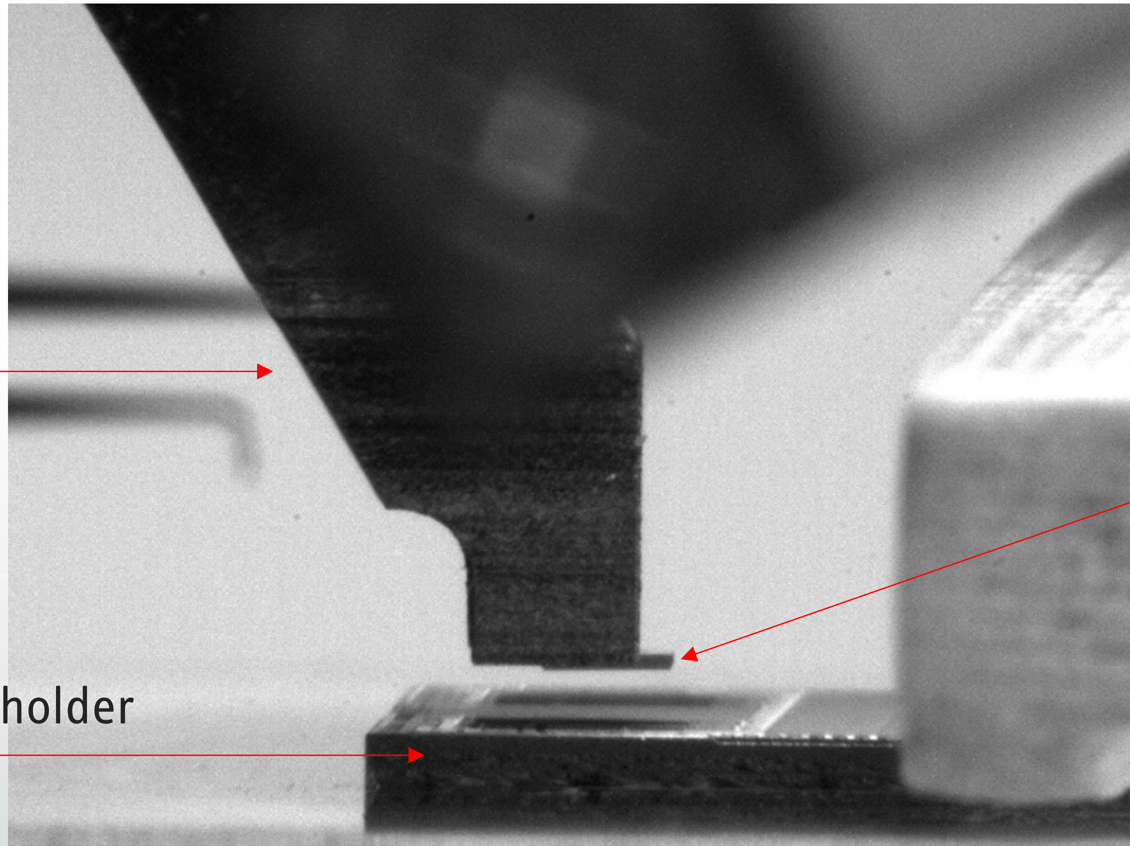


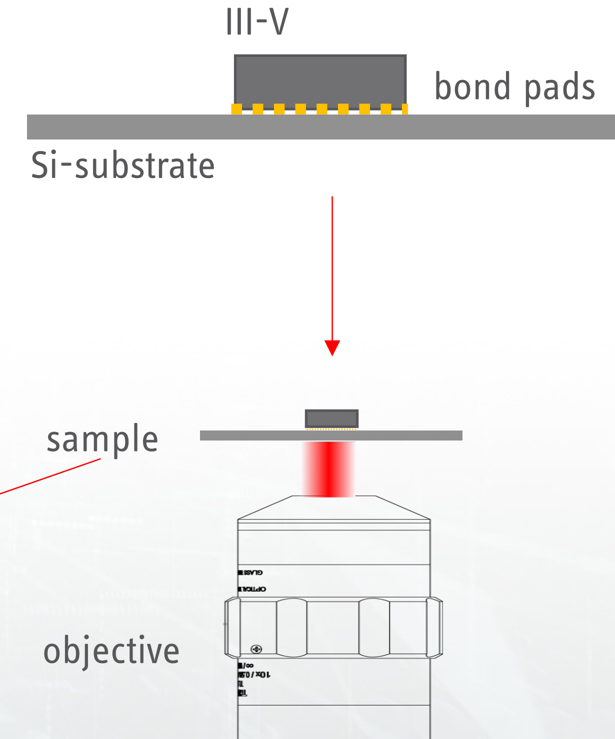


High-precision die bonding

Pick-up tool on high-accuracy 6-axis aligner

SiP fixed on the holder





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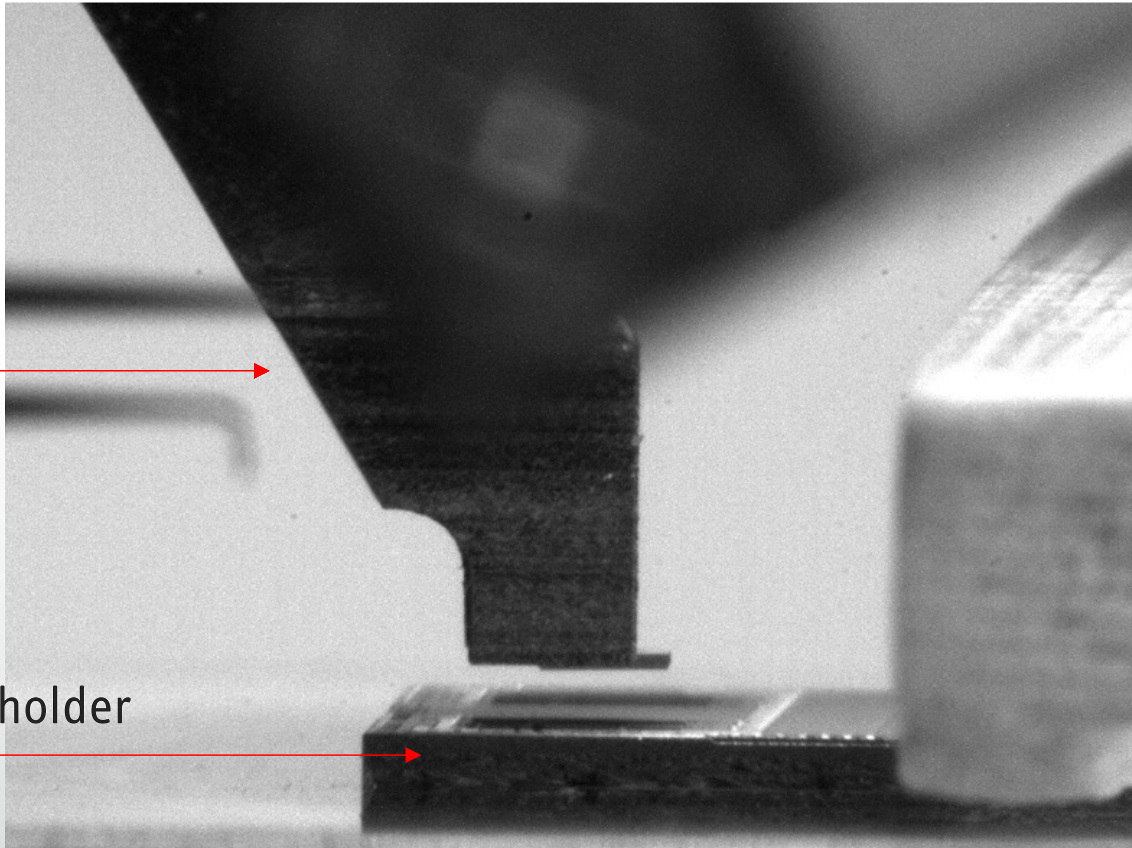
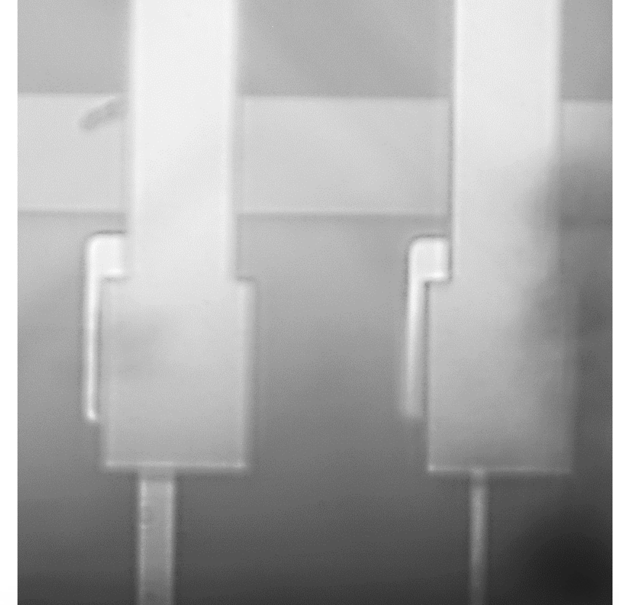
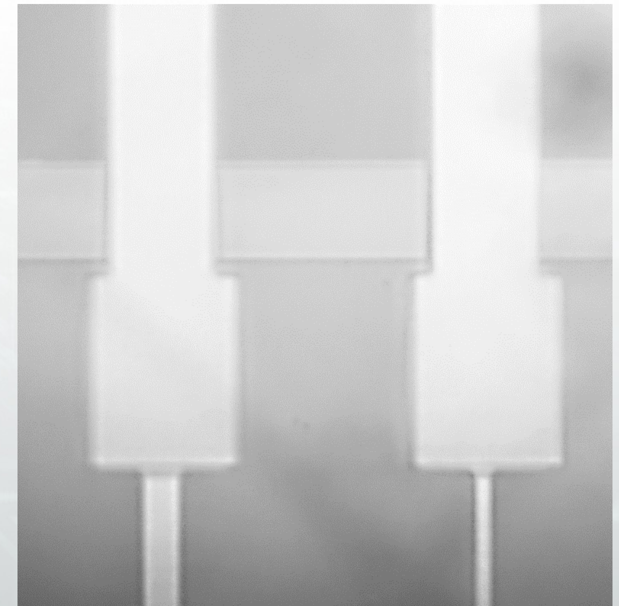


SiP fixed on the holder

Before
alignment





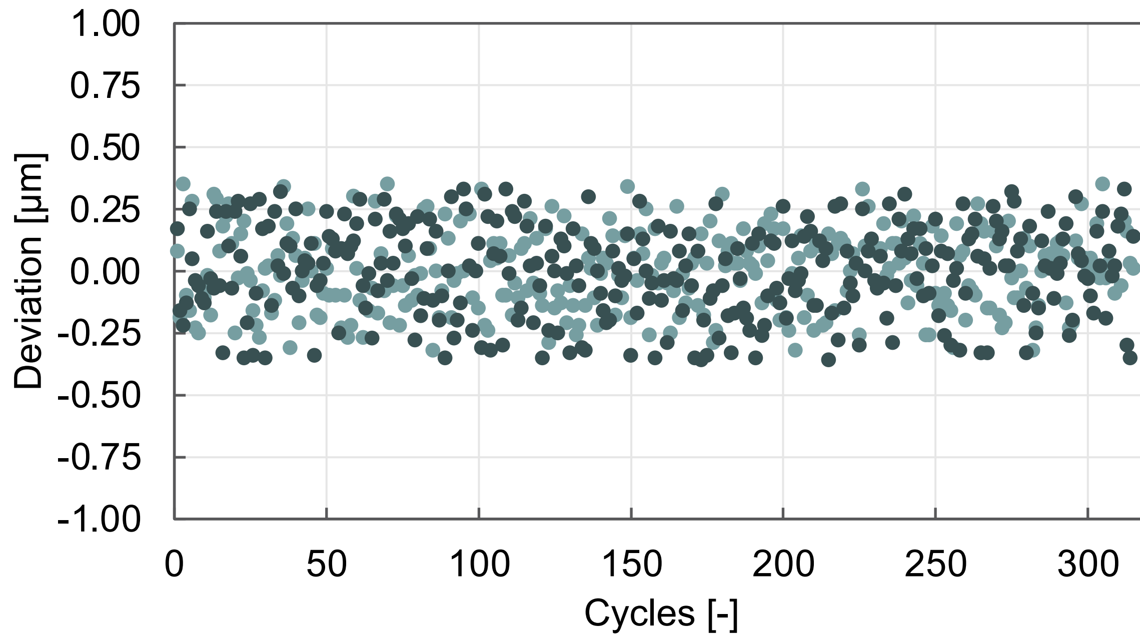
After
alignment

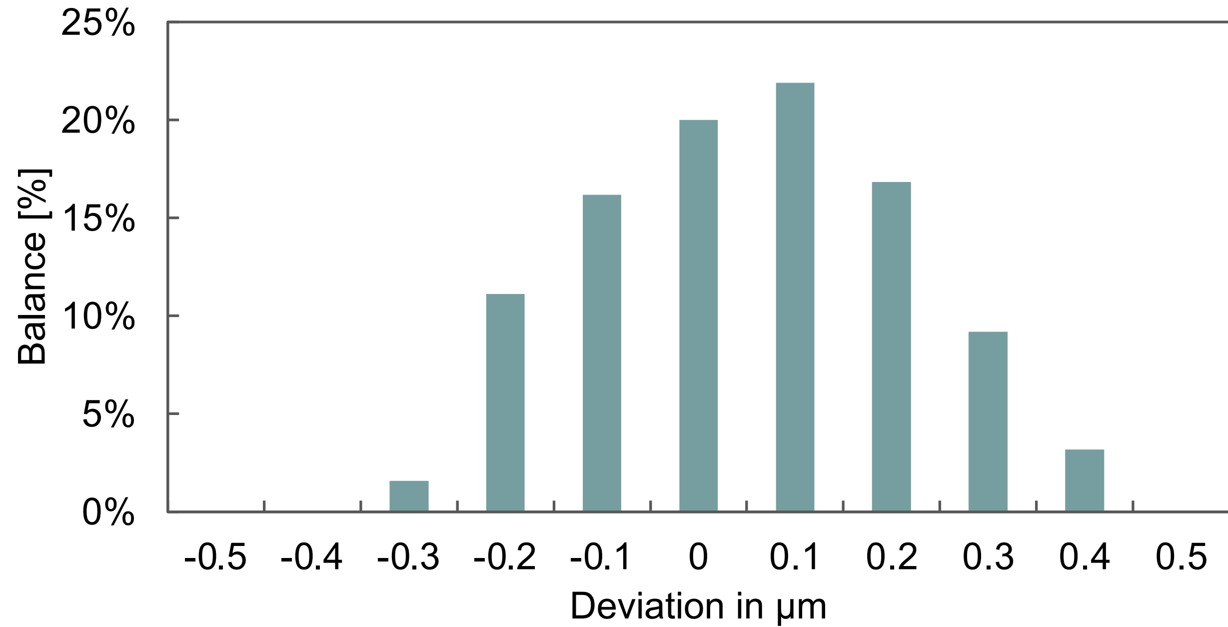
ASSEMBLYLINE

Through-silicon Align-&-attach with IR

High-precision die bonding

ficonTEC photonics assembly & testing





Alignment accuracy:

- In xy-direction → **3σ = +/- 0.22 µm**

Can be combined with localized through-silicon laser soldering

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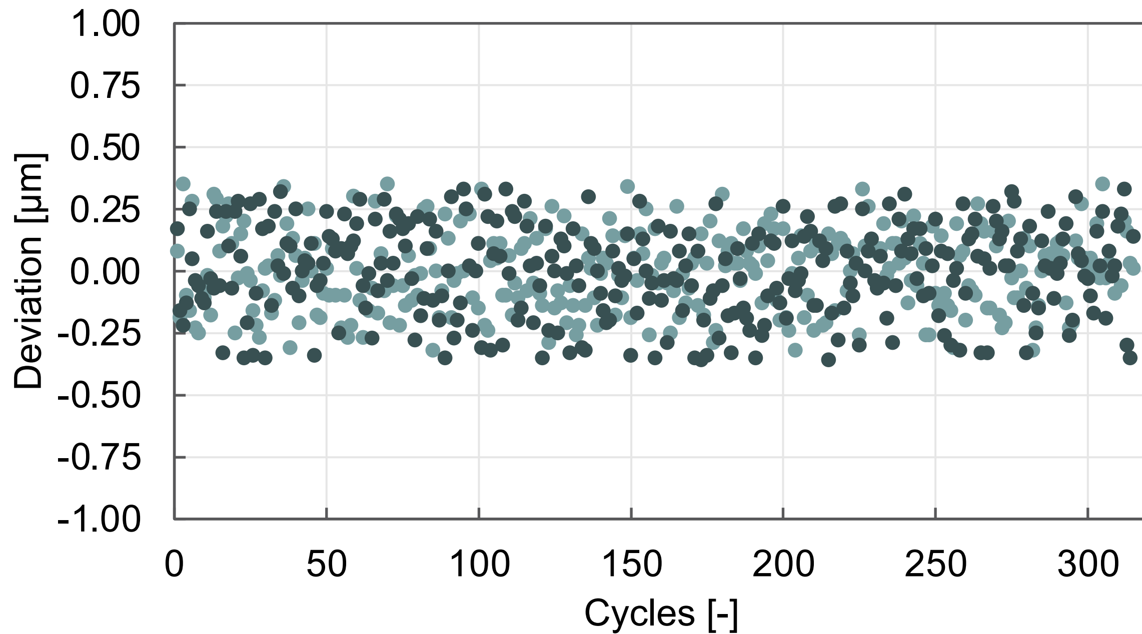
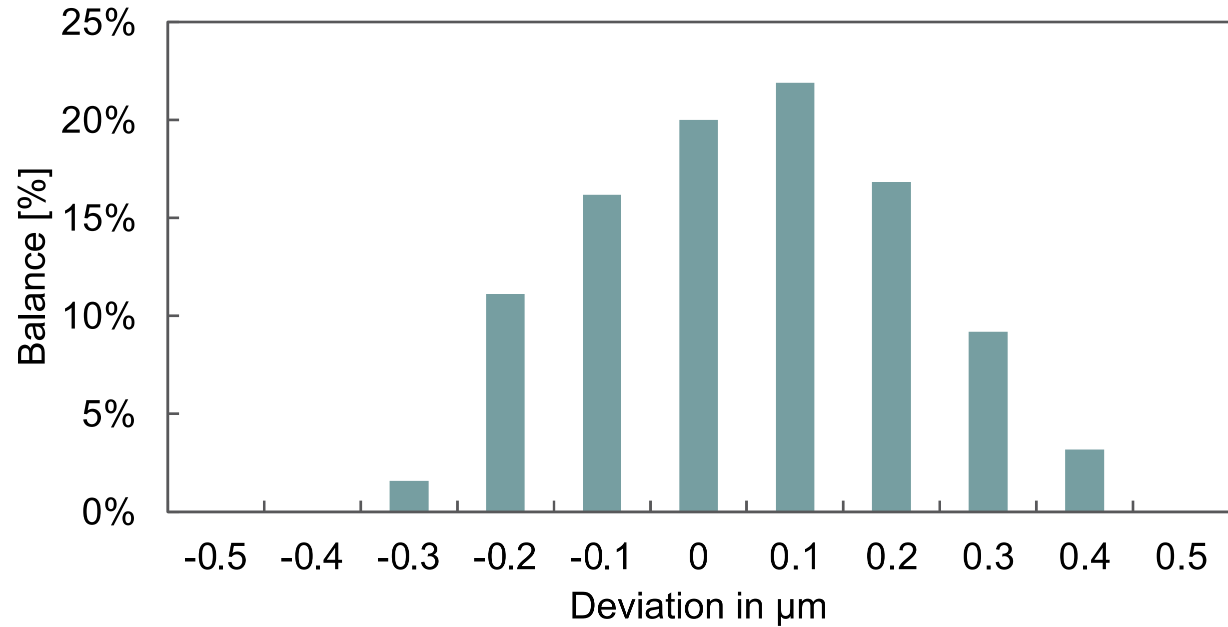
High-precision die bonding





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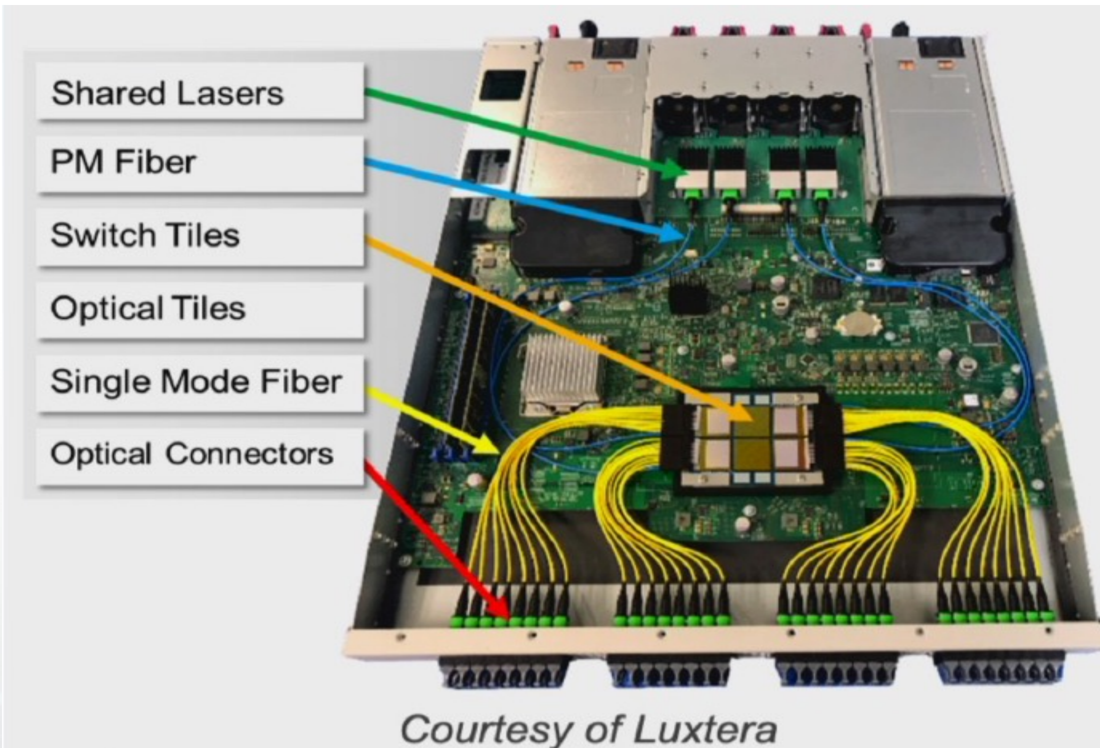
Wafer-level option available early this year !

PIC product assembly



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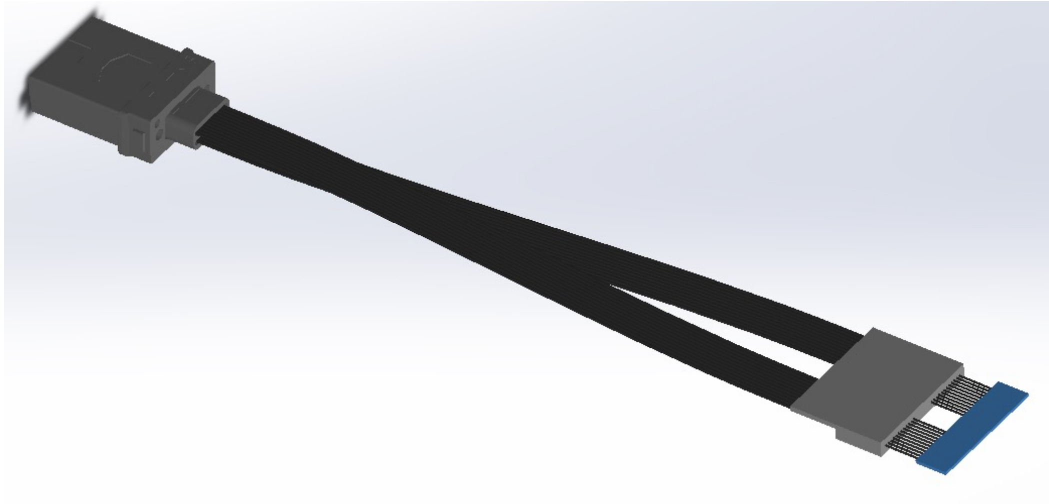
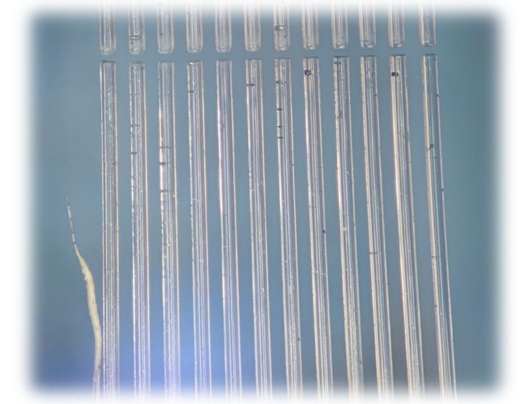
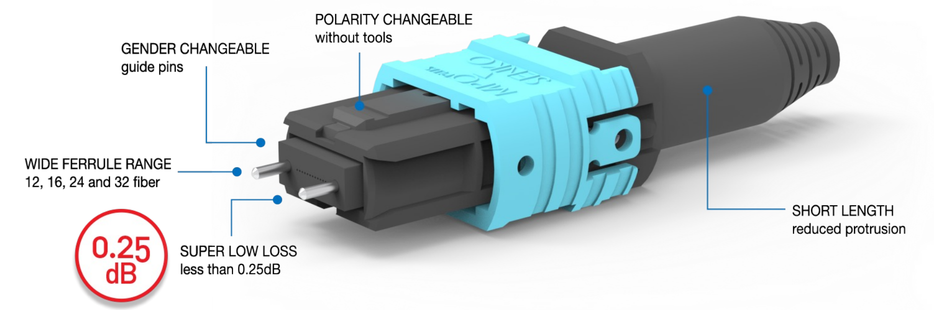
Fiber interconnects



Fiber interconnect from chip to connector

Fiber preparation





www.senko.com

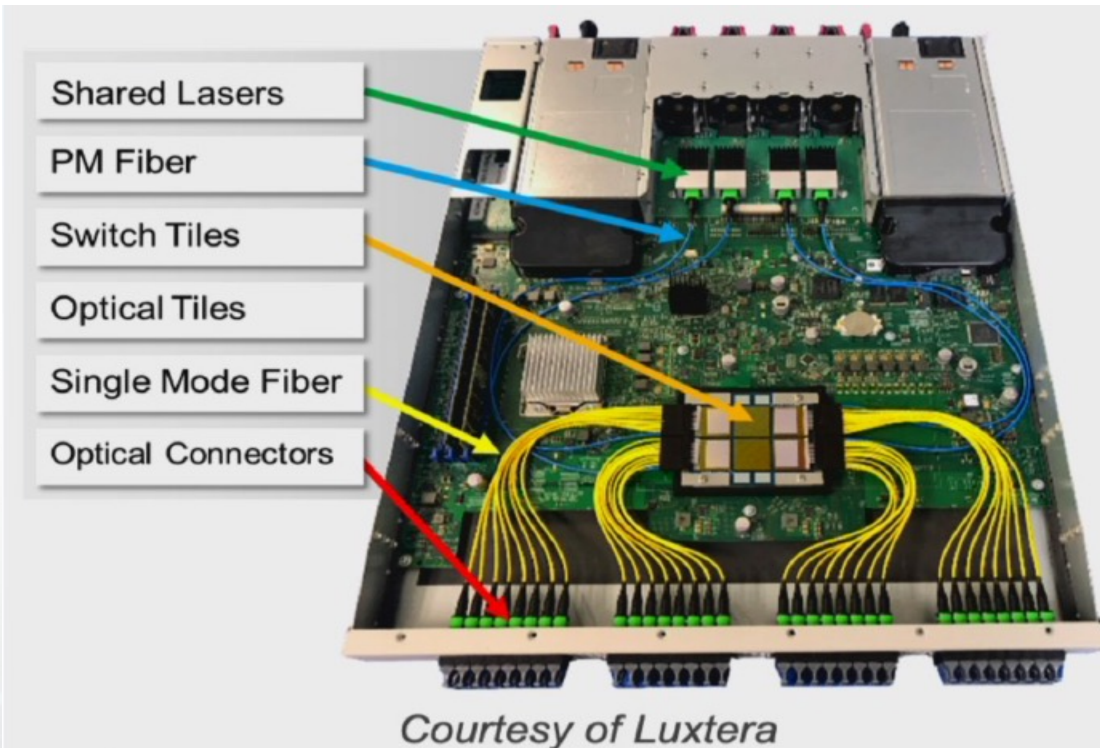
Plug mounting

ficonTEC

photonics assembly & testing

PIC product assembly

ficonTEC photonics assembly & testing 20 YEARS



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Line systems

Air purity optical detector sensor for a German Tier 1

Mass production site in Thailand with over 150 machines, incl. automatic module handling (cassette to cassette)

Machine learning

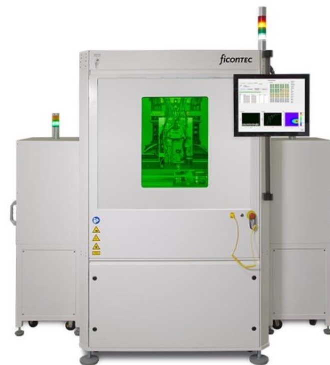
KPI tracking

AI/ML for process optimization

Assembly line

Required solutions

Wafer-level testing + High-precision die bonding + Fiber interconnects + Machine learning



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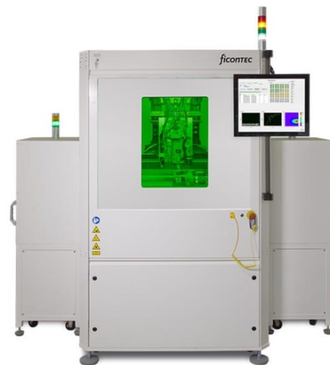

Conclusions

- Assembly & Test are (and will remain) the cost driver for photonic products
- Automated assembly steps for most process steps available
- Last decade mainly focussed on improving individual assembly machine performance
- This decade will focus on increasingly higher levels of automation

Thank you!

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