# MANUFACTURING MADE LIGHT

Solutions for integrated photonics. Built to scale.

20 YEARS

ficonTEC photonics assembly & testing

ficonTEC photonics assembly & testing

PIC INTERNATIONAL CONFERENCE

## Technology developments & equipment concepts for scaling up photonics production for datacentres

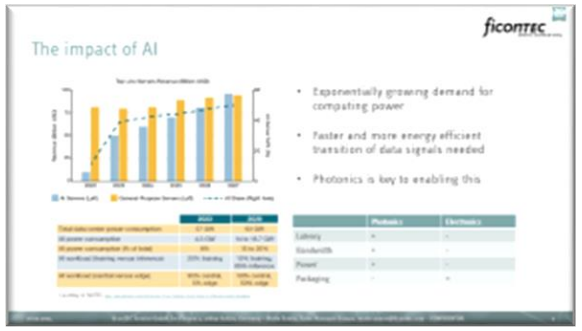
PHOTONICS AUTOMATED ASSEMBLY AND TESTING

FROM LAB TO FAB

ficonTEC

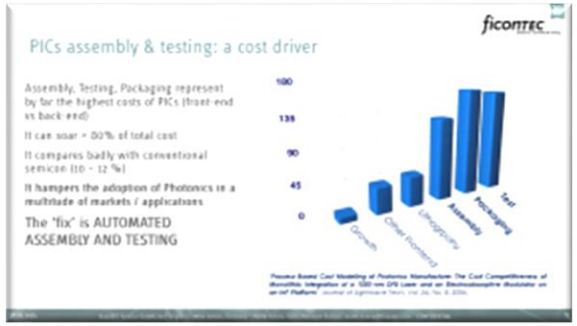
Malte Ennen, Sales Manager Europe

# Outline




The impact of AI

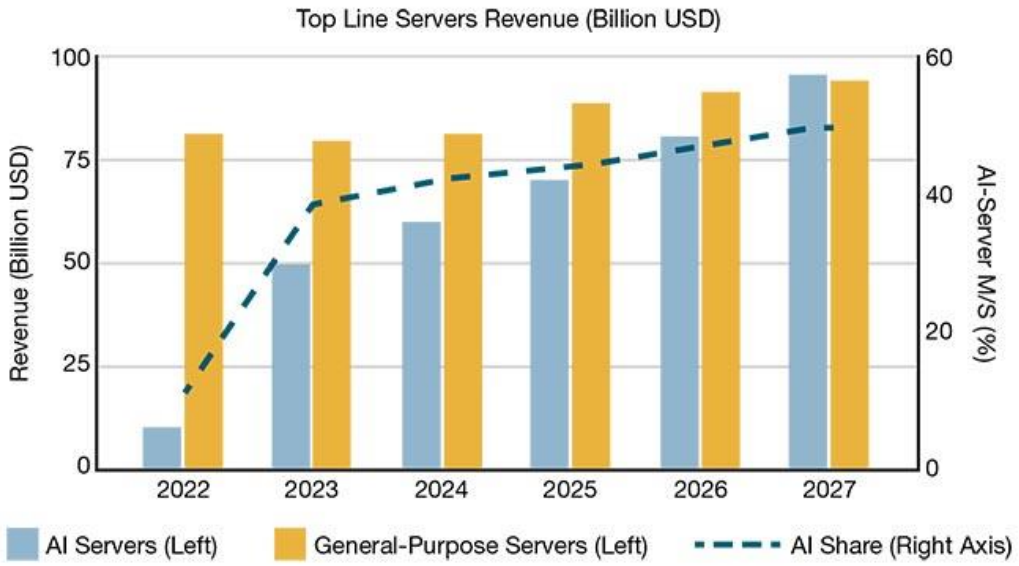
The challenges associated with this





Our solutions

# The impact of AI




- Exponentially growing demand for computing power
- Faster and more energy efficient transition of data signals needed
- Photonics is key to enabling this new revolution of communication

| | 2023 | 2028 |
|---|---|---|
| Total data center power consumption | 57 GW | 93 GW |
| AI power consumption | 4.5 GW | 14 to 18.7 GW |
| AI power consumption (% of total) | 8% | 15 to 20% |
| AI workload (training versus inference) | 20% training | 15% training, 85% inference |
| AI workload (central versus edge) | 95% central, 5% edge | 50% central, 50% edge |

Courtesy of SOITEC https://www.photonics.com/Articles/Has_Silicon_Photonics_Finally_Found_Its_Killer/p5/vo252/i1782/a69704

| | Photonics | Electronics |
|---|---|---|
| Latency | + | - |
| Bandwidth | + | - |
| Power | + | - |
| Packaging | - | + |

# Transition of data center architecture

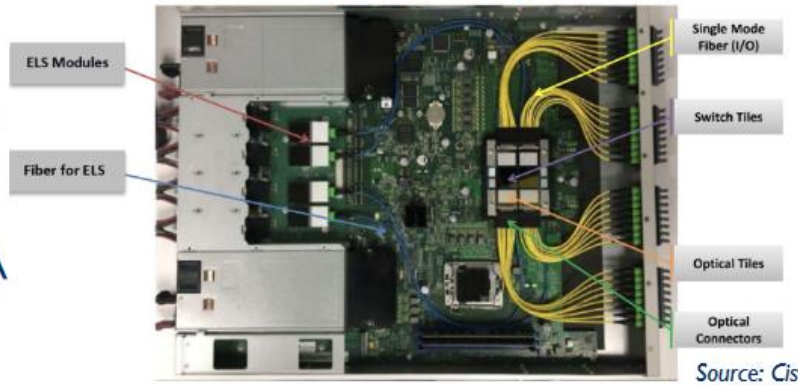
**2019** → **~2028**

**12.8 Tbps**

32x 400G QSFP-DD or OSFP

Evolution toward CPO assembly with pluggable ELS modules on the switch PCBA

**204.8 Tbps**

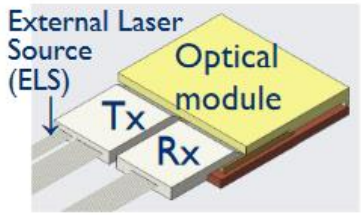


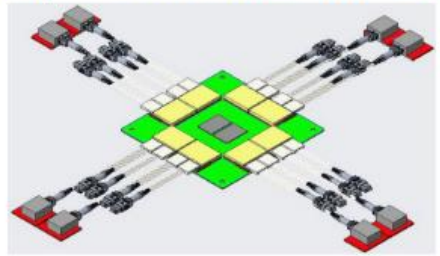

*Source: Cisco*

**QSFP-DD** W: 18.35 mm, L: 89.4 mm and T: 8.5 mm
**OSFP** W: 22.58 mm, L: 107.8 mm and T: 13.0 mm

Evolution toward CPO optical modules

8x optical modules for CPO



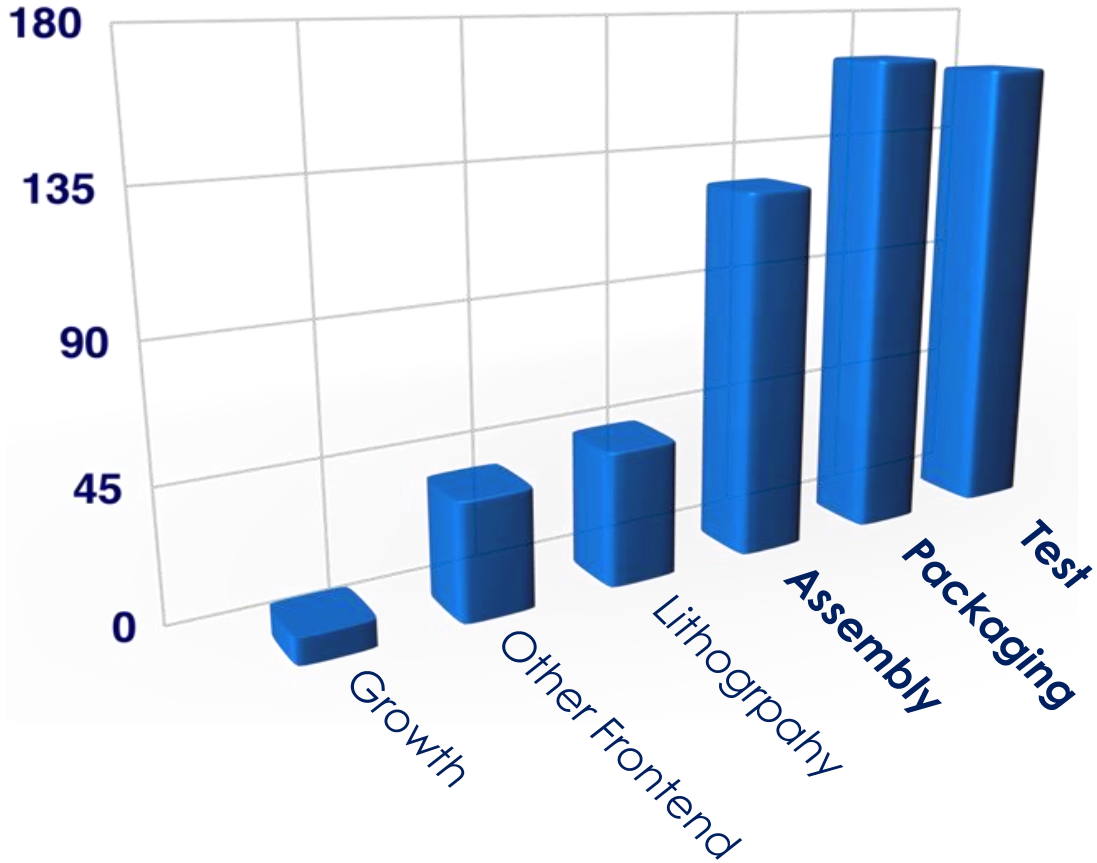
**CPO optical module** W: ~20 mm, L: ~60 mm

Courtesy of Yole

# PICs assembly & testing: a cost driver

- Assembly, Testing, Packaging represent by far the highest costs
- It can soar > 80% of total cost
- It compares badly with conventional semicon (10 – 12 %)
- **It hampers the adoption of Photonics in a multitude of markets**

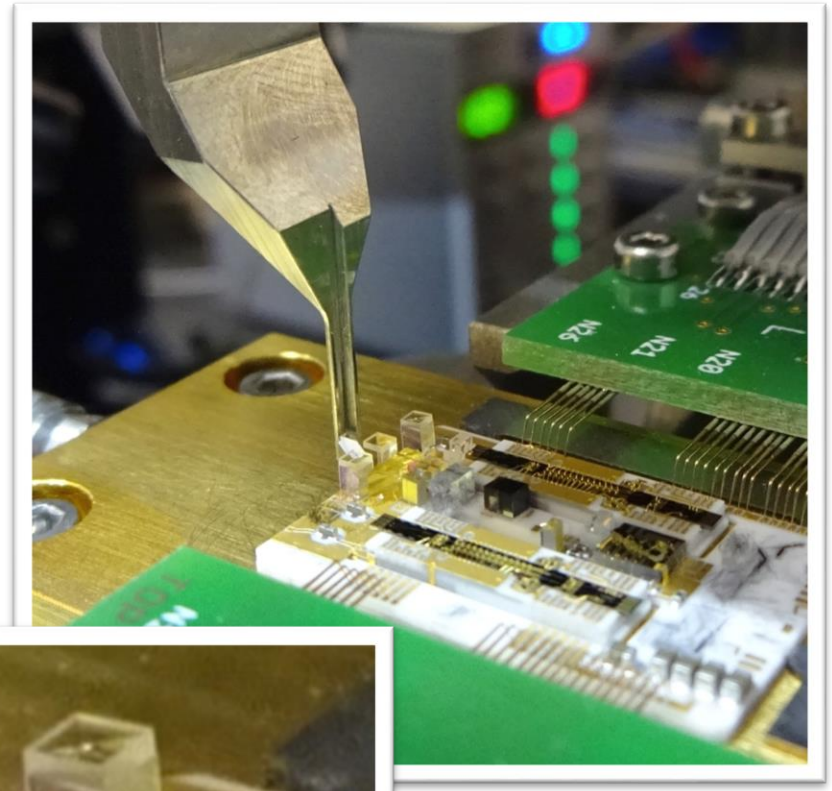
**The 'fix' is AUTOMATED ASSEMBLY AND TESTING**

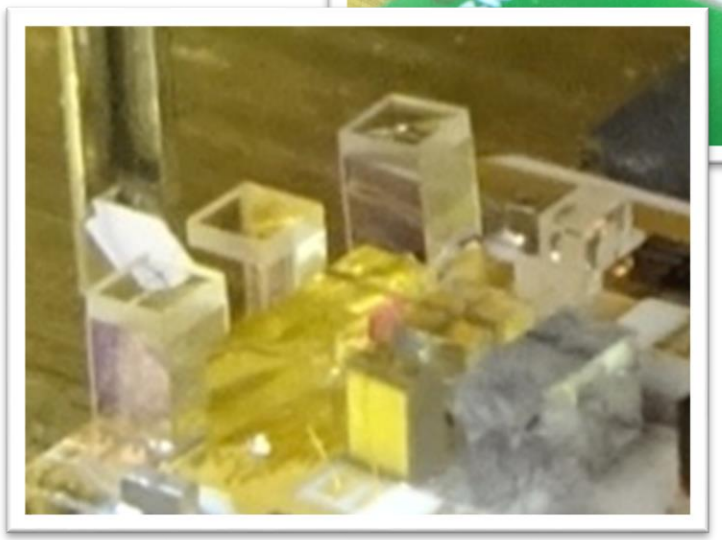



***'Process-Based Cost Modeling of Photonics Manufacture: The Cost Competitiveness of Monolithic Integration of a 1550-nm DFB Laser and an Electroabsorptive Modulator on an InP Platform'***, *Journal of Lightwave Tech, Vol. 24, No. 8, 2006.*

# Flexibility vs speed: a matter of volumes

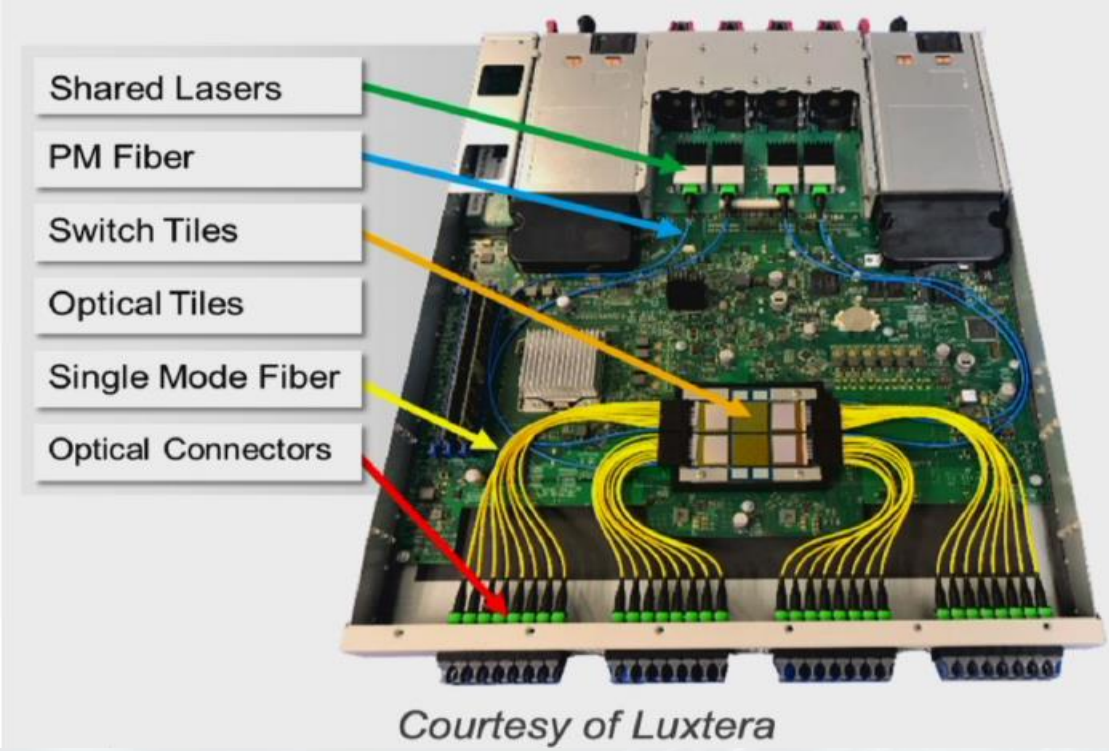
| Numbers | Placement & Alignment | Machine Vision | Testing | Speed |
|---|---|---|---|---|
| Few tens | Manual | Only visual aids | Off-line / absent | Tens of minutes to hours |
| Few hundreds to few thousands | Automated / semi-automated | Automated feature detections and guidance | In line | Few minutes |
| Tens to hundreds of thousands (millions?) | Fully automated | Automated feature detections and guidance | In line | Tens of seconds |





- **Moving from single/complex/very flexible machines to lines of simpler/dedicated/very fast machines**
- Development of process and approach on a complex system in order to derive the high-volume approach

# Solutions along the value chain




*Courtesy of Luxtera*

- 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**

- Machine concepts for NPI and volume production

→ **Need for holistic product line**

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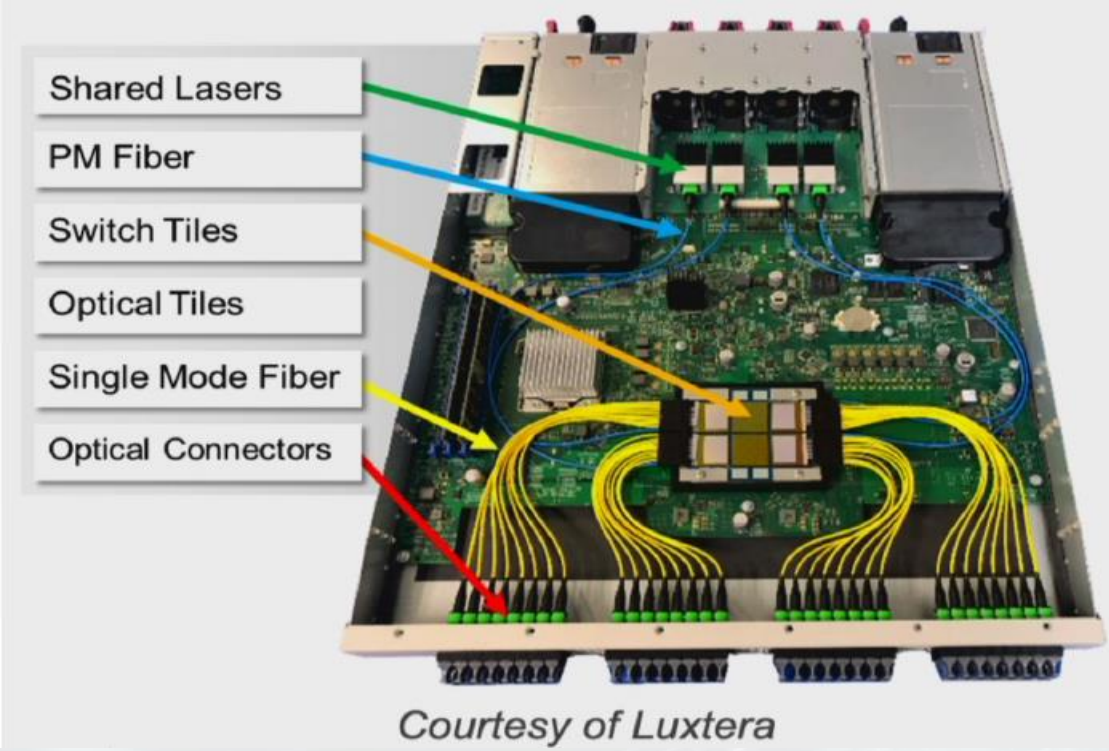


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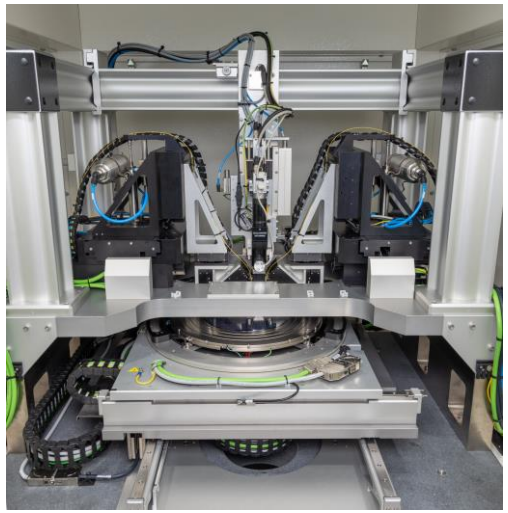
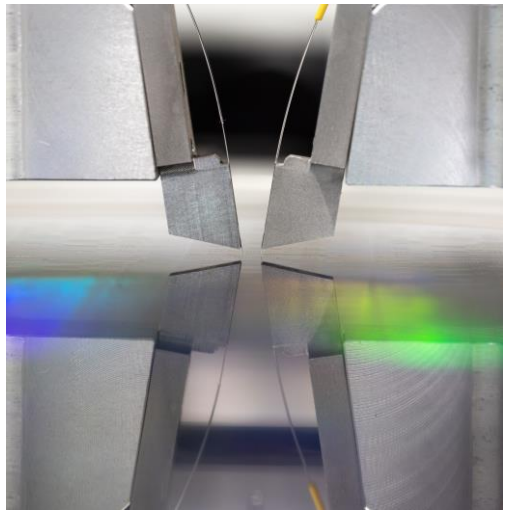
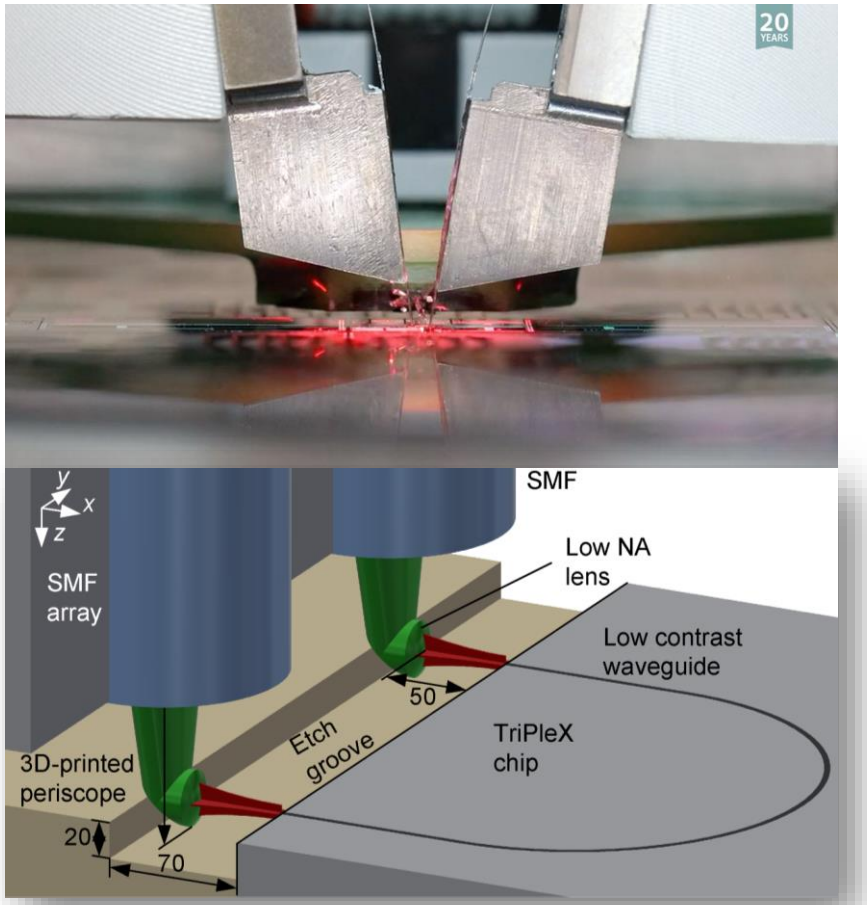
# Electro-optical wafer-level testing

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



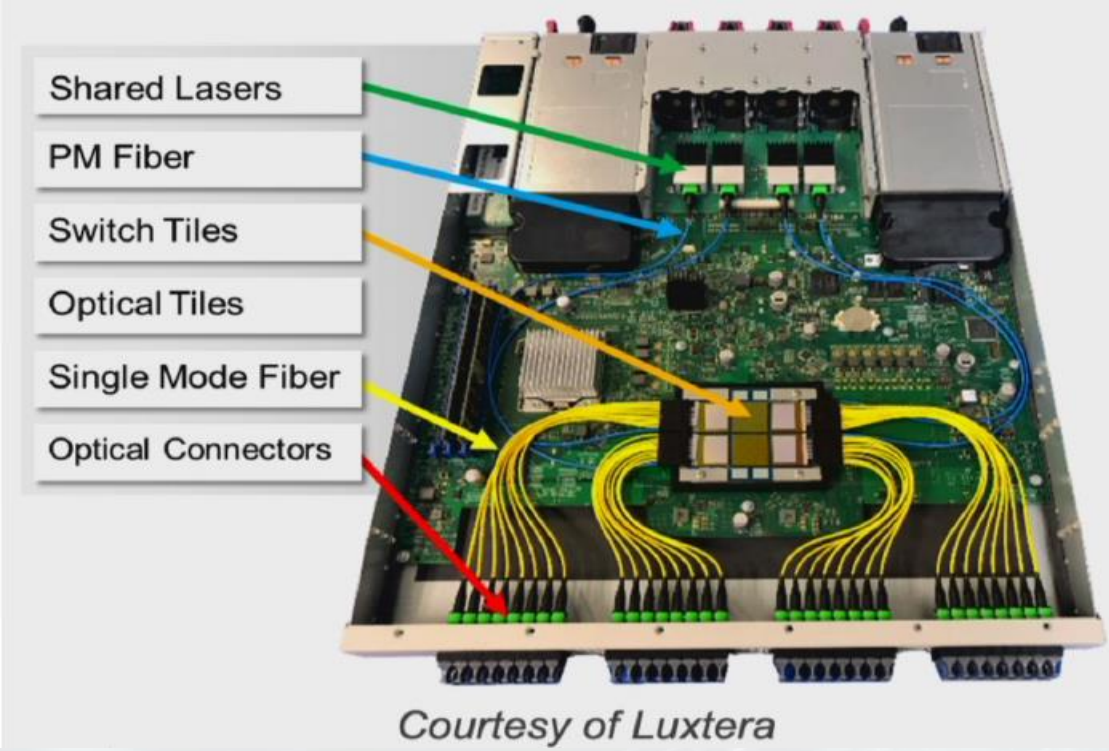
Wafer table






Optical alignment

# Solutions along the value chain

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## Assemblyline

# Through-silicon Align-&-attach with IR

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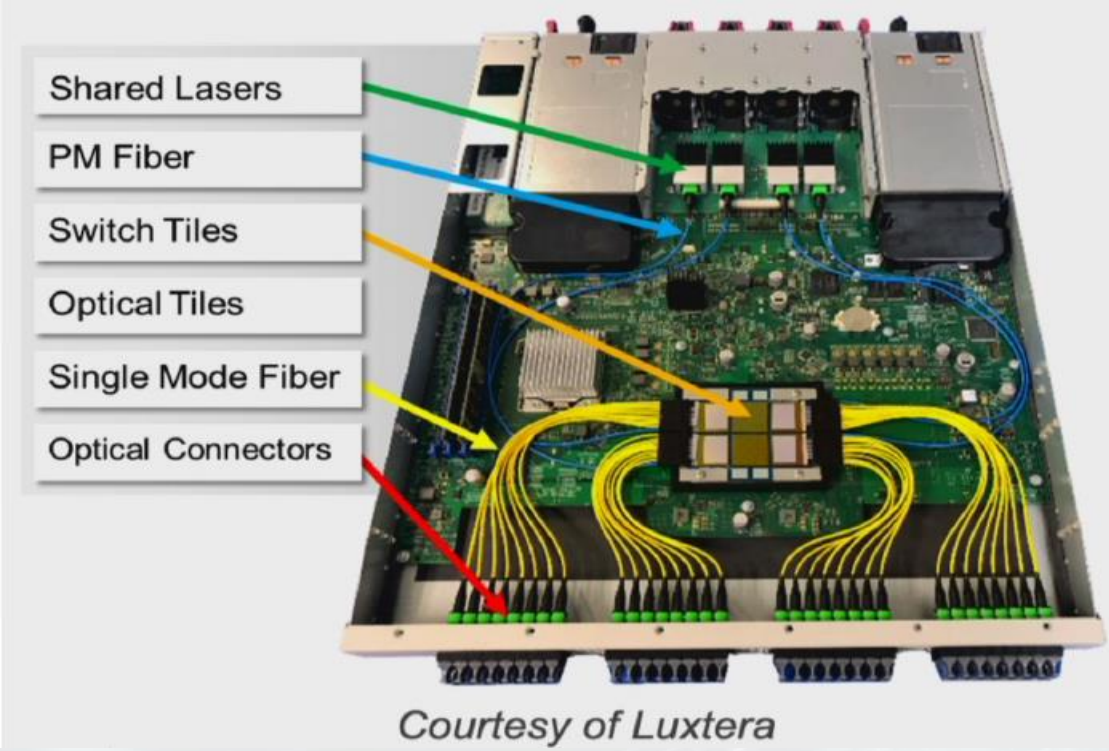


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photonics assembly & testing

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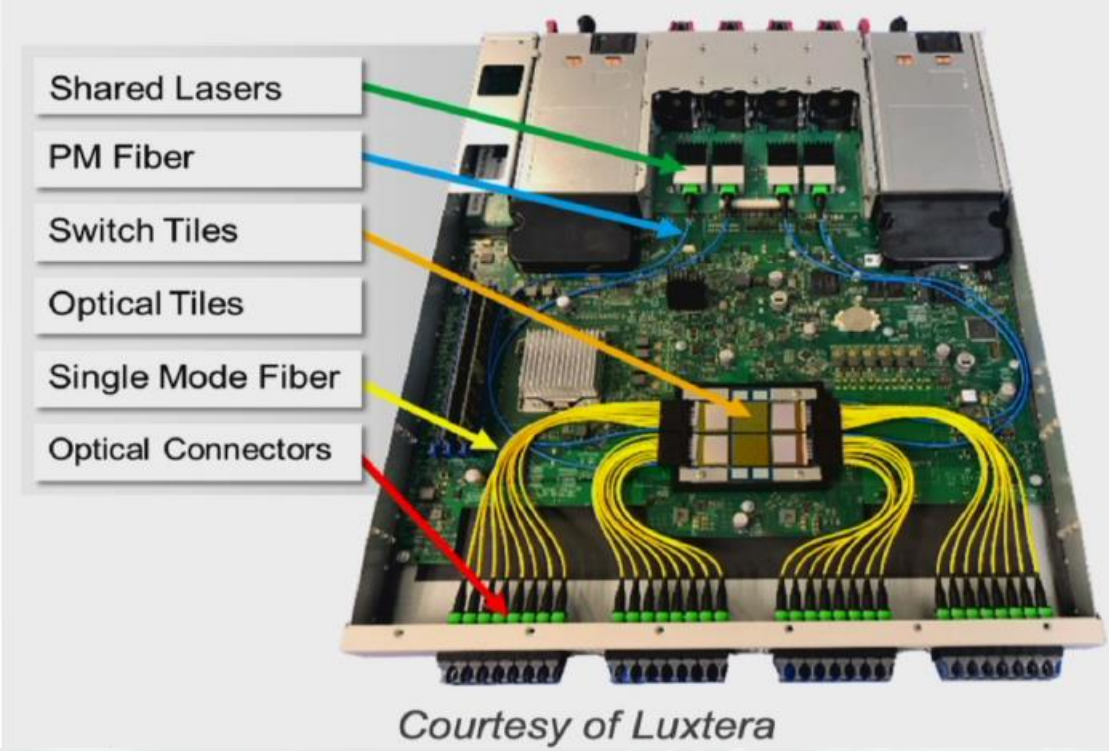


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# From development to volume production

PHOTONICS AUTOMATED ASSEMBLY AND TESTING

FROM LAB TO FAB

Fully automatic production line consisting of feeding system, active and passive assembly cells, end of line test and laser marking

Fully automatic production system:
1 Input feeder; 1 Assembly system;
1 Output feeder

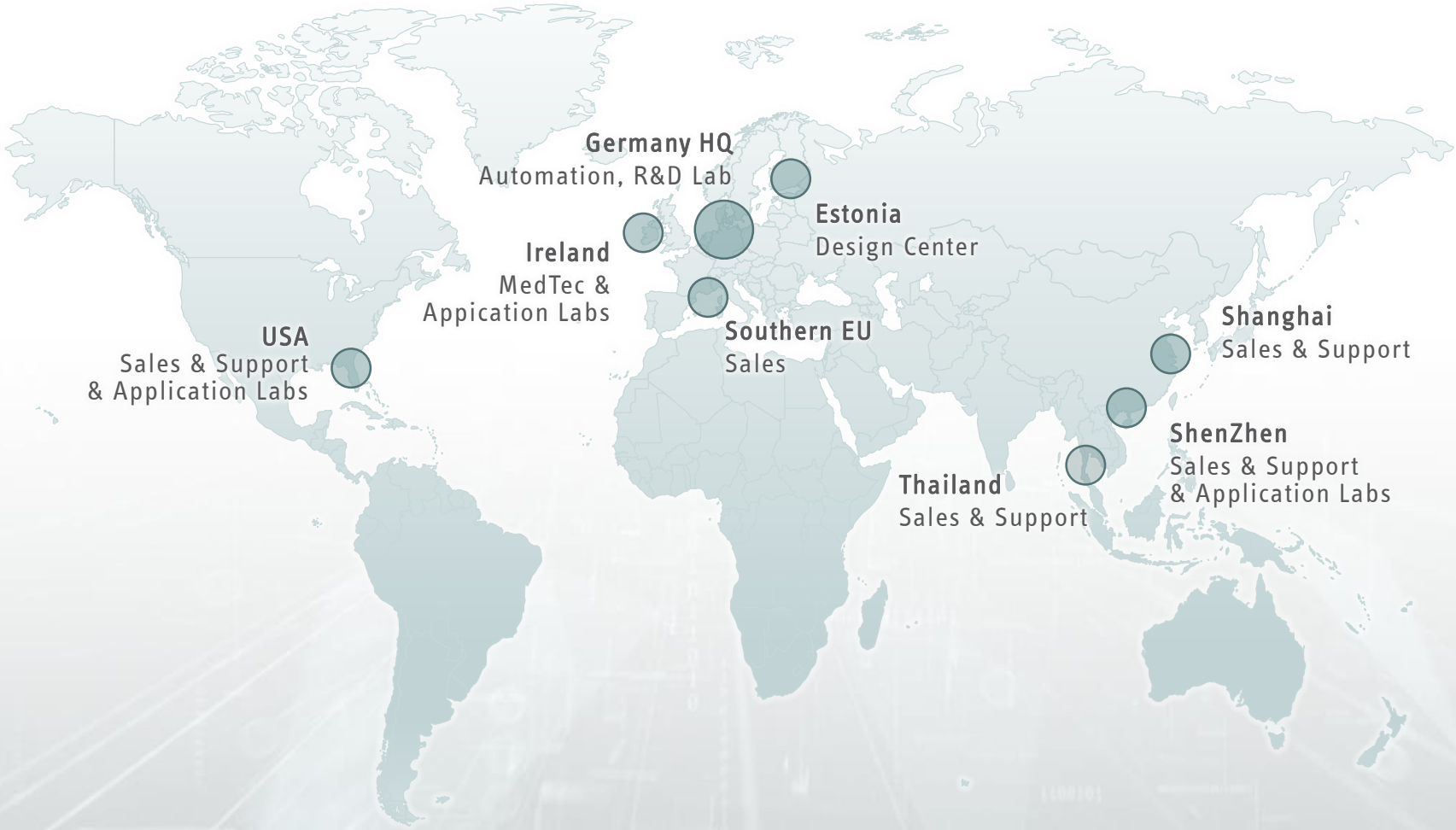
Production system for development with production capacity

Lab systems (with production capability)

# Key takeaways

- Assembly & Test are (and will remain) the cost driver for photonic products
- Product and machine development are interconnected and influence each other
- Automated assembly steps for most process steps for data center devices available
- Last decade mainly focused on improving individual assembly machine performance
- This decade will focus on increasingly higher levels of automation

# Global Sales & Service



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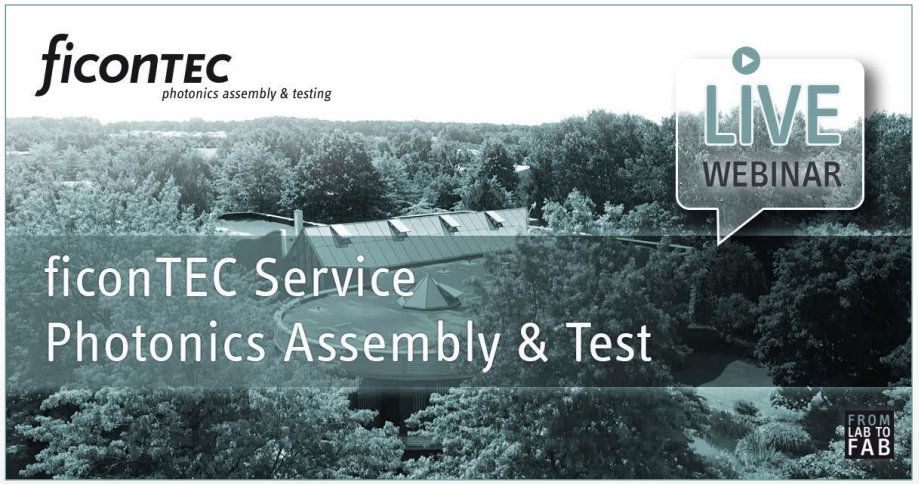
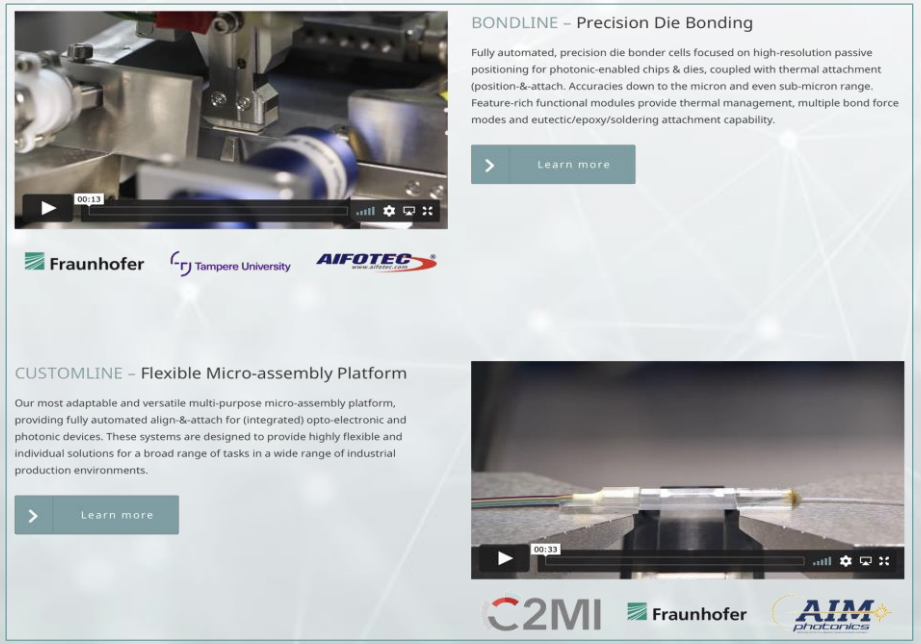
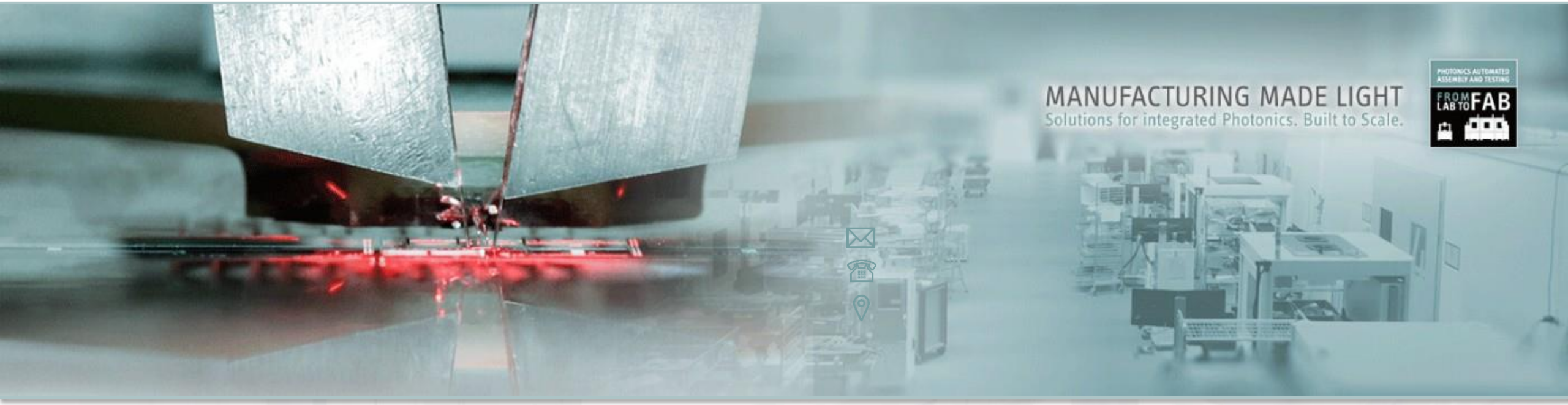
- Locations & Contacts








BLOG

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