Integrated Photonic Packaging from prototype to production scale-up

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COO & co-founder

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Agenda

- PHIX introduction
- What is needed for volume production?
- How to get there from a PIC design?
- Why has PHIX been successful?

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Who we are

PHIX is a world leading foundry for packaging and assembly of Photonic Integrated Circuits (PICs) and MEMS, supplying components and modules in scalable production volumes.

- Started operations in 2018
- Independent pure play packaging facility
- Specialized in hybrid PIC assembly and fiber array interfacing

Where we're going

New 1800 m² building in 2023

- 600 m² production facilities
- 600 m² auxiliary workspace
- 600 m² room for further growth
- Up to ISO 5 clean room space

New funding

- New €3M investment round for the short term
- €20M from the National Growth Fund for the long term
- Nearly €4M for research projects in 2022 to further technological readiness

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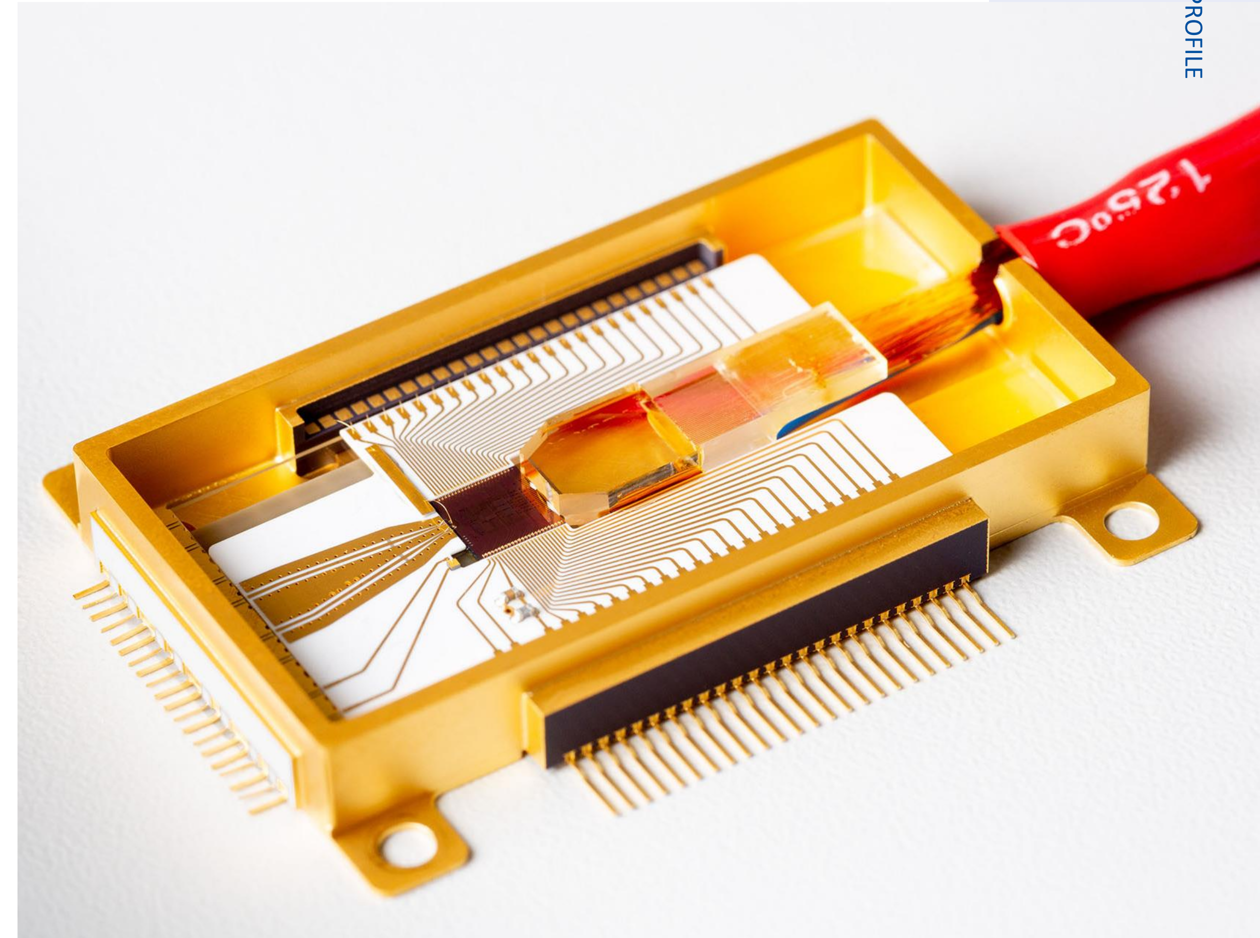
A PIC by itself is not a product!

It needs:

- Optical interconnection (fibers/free-space)
- Electrical interconnection (wire bonds/electronic ICs)
- Thermal management (active/passive)
- Mechanical support (robust package)



How to get from TRL4 to TRL9?

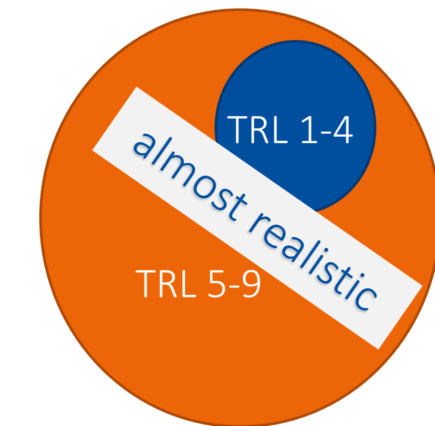
DEPLOYMENT	9	ACTUAL SYSTEM PROVEN IN OPERATIONAL ENVIRONMENT
	8	SYSTEM COMPLETE AND QUALIFIED
	7	SYSTEM PROTOTYPE DEMONSTRATION IN OPERATIONAL ENVIRONMENT
DEVELOPMENT	6	TECHNOLOGY DEMONSTRATED IN RELEVANT ENVIRONMENT
	5	TECHNOLOGY VALIDATED IN RELEVANT ENVIRONMENT
	4	TECHNOLOGY VALIDATED IN LAB
RESEARCH	3	EXPERIMENTAL PROOF OF CONCEPT
	2	TECHNOLOGY CONCEPT FORMULATED
	1	BASIC PRINCIPLES OBSERVED

Production

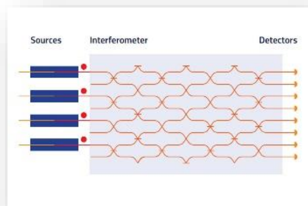
Validation

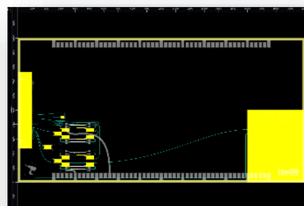
Prototypes

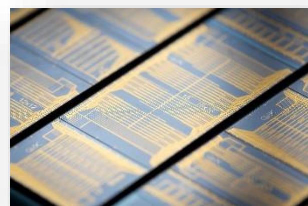
Time/ effort

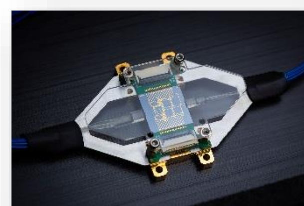


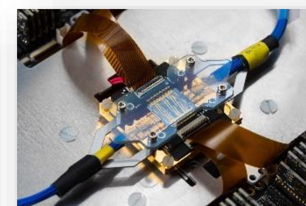
PIC product development chain

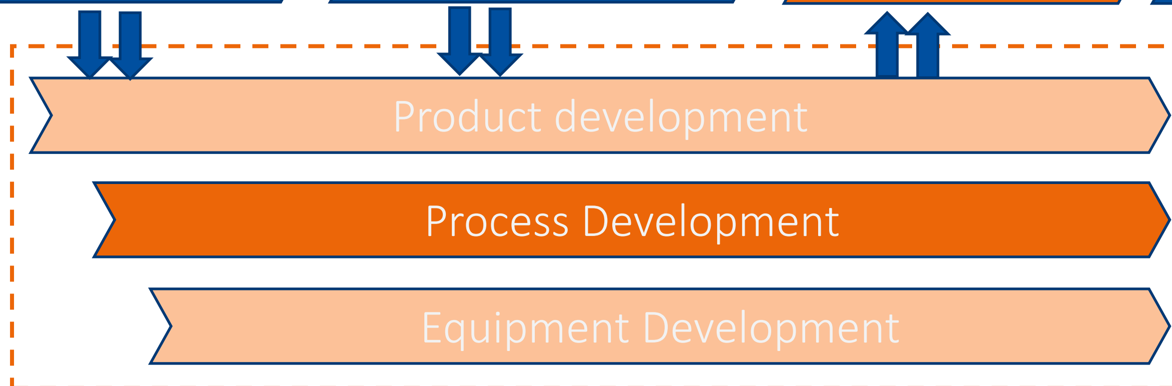








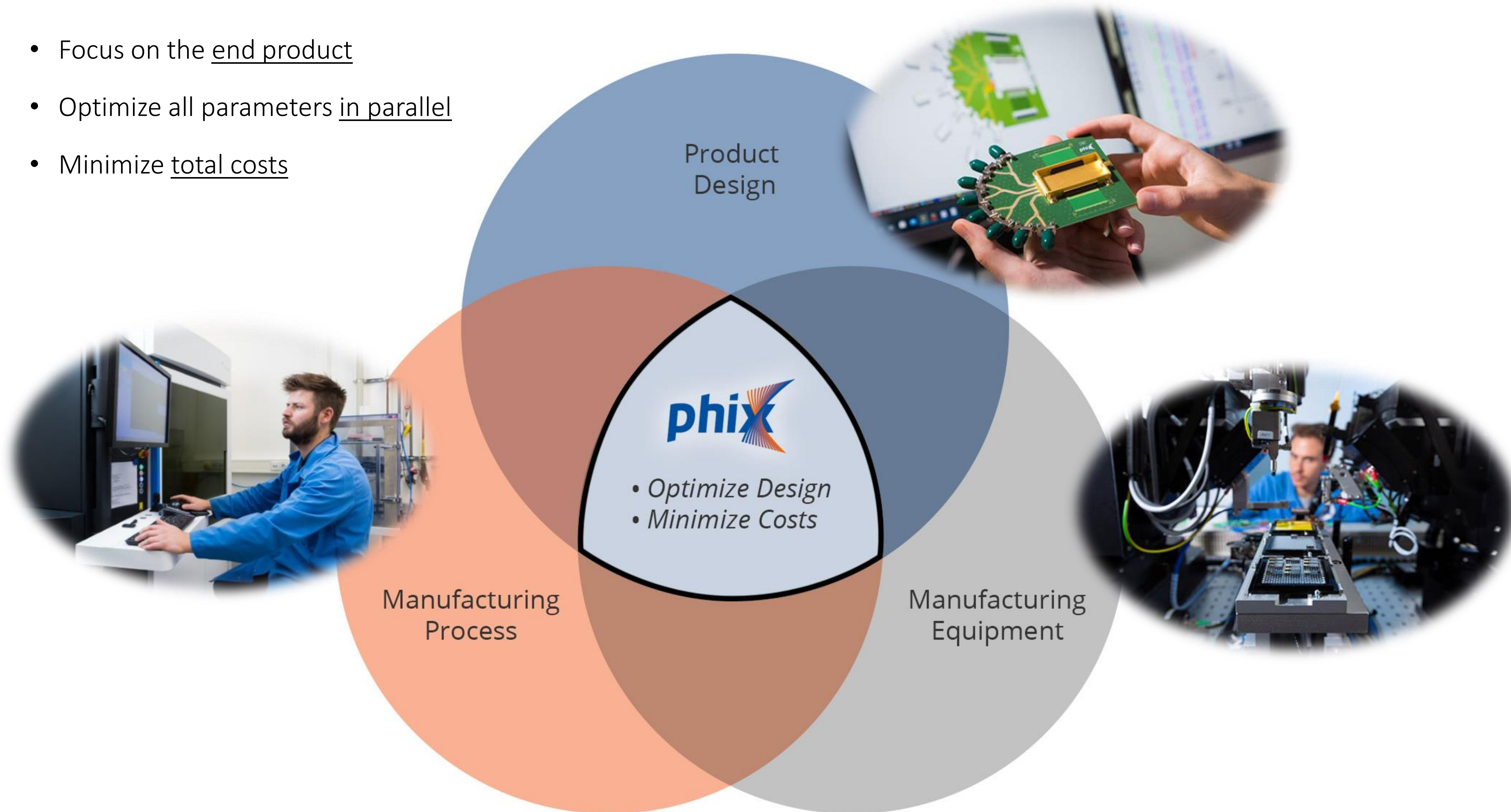




Images courtesy of QuiX Quantum

PHIX Approach to Successful Packaging & Scale-up

- Focus on the end product
- Optimize all parameters in parallel
- Minimize total costs



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Engineering support

Take off quickly

- Benefit from standard package types and building blocks
- Optional standard electrical (DC/RF) fan-out boards
- PIC Design Guidelines documentation and engineering support

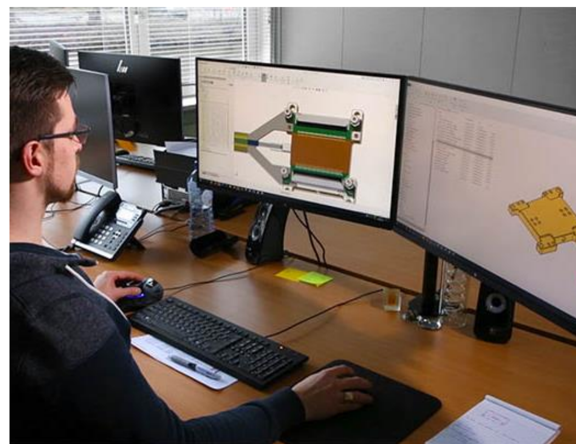
Fly to great heights

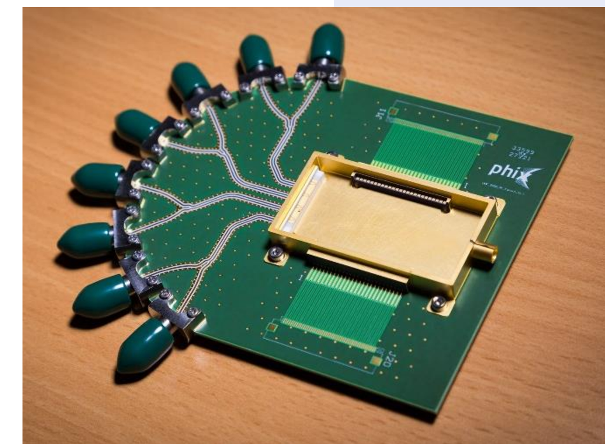
- We help you define a roadmap toward volume manufacturing
- We optimize equipment, processes and the bill of materials with the total costs in mind

phix PHOTONICS ASSEMBLY

Design Guidelines for Photonic Integrated Circuit Packaging

PHIX is a one-stop-shop for the manufacturing of modules powered by photonic integrated circuits (PICs), from design to volume production. This document describes the core design guidelines for PICs that will enable PHIX to package your chip into a high performance and cost-effective module that is suitable for a scale-up to volume manufacturing. It will also help you select the standard package type that best suits your needs.





Design guidelines

- Product and Process development accounts for more than 60% of the packaging costs -> reduce by chip design

- If there is standard packaging solution that the customers can choose from, the packaging costs will decrease

- The smallest chip area does not always result in the lowest cost solution

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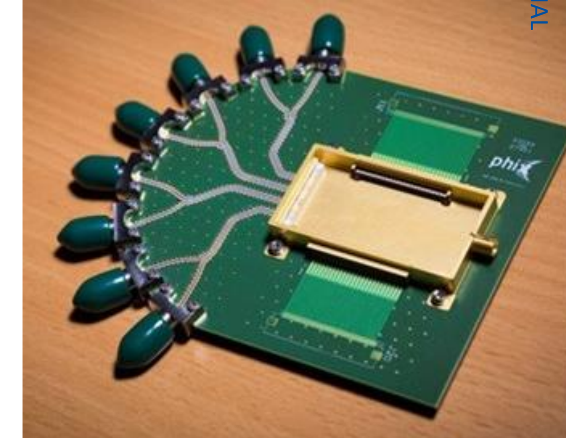
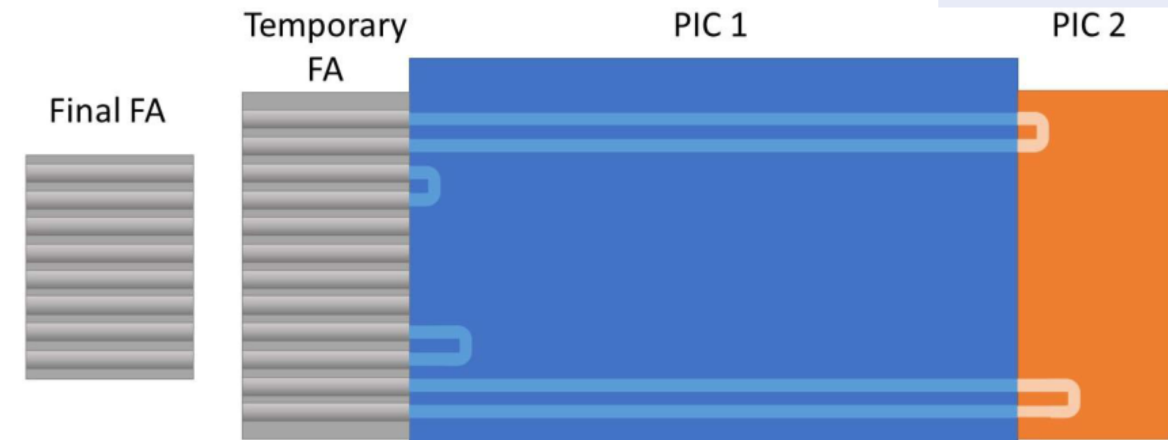
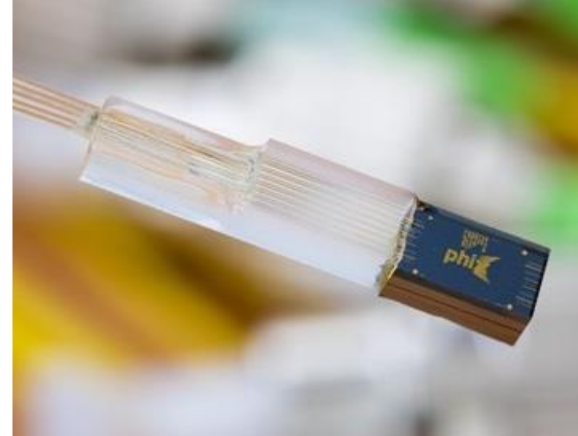
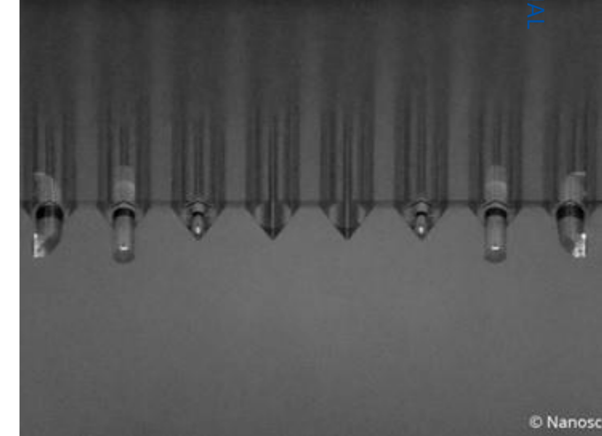


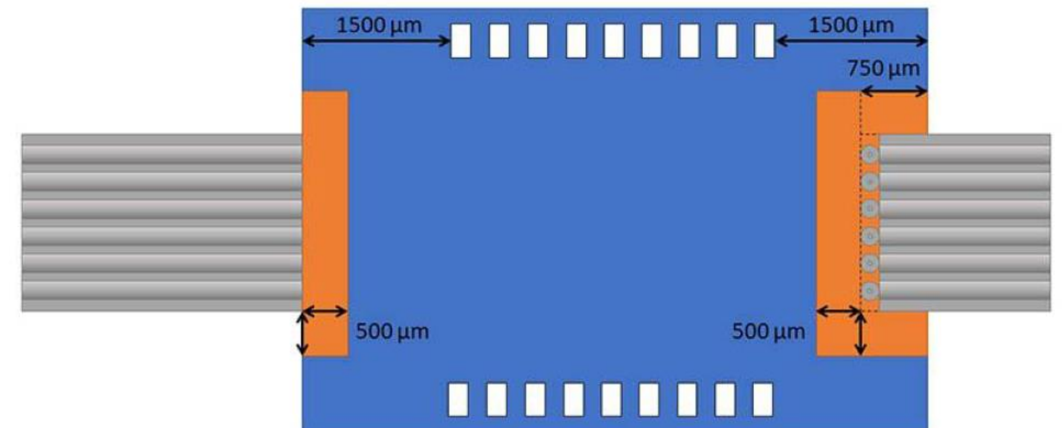


Lower the cost

- Eliminate SSC's and Polarisation Maintaining interfaces where possible
- Have margin in the power budget to allow for manufacturing tolerances

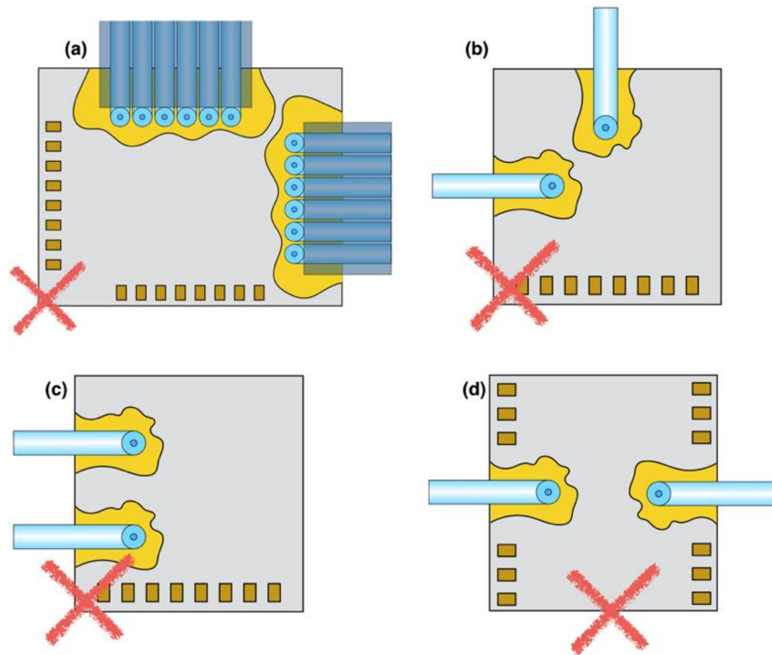


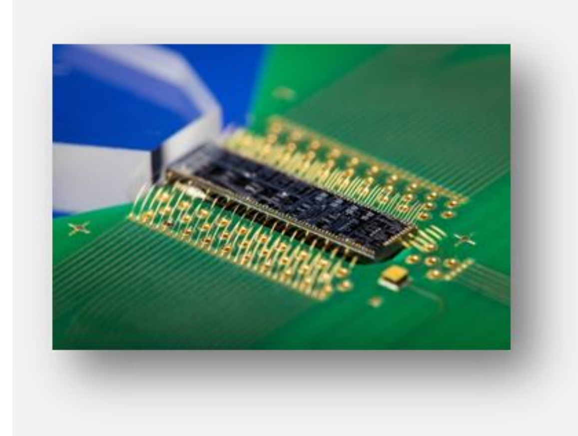


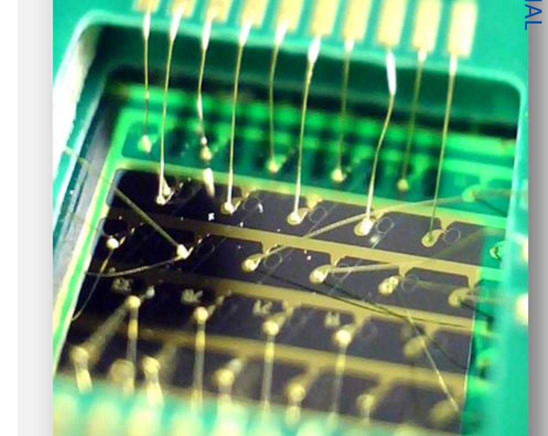


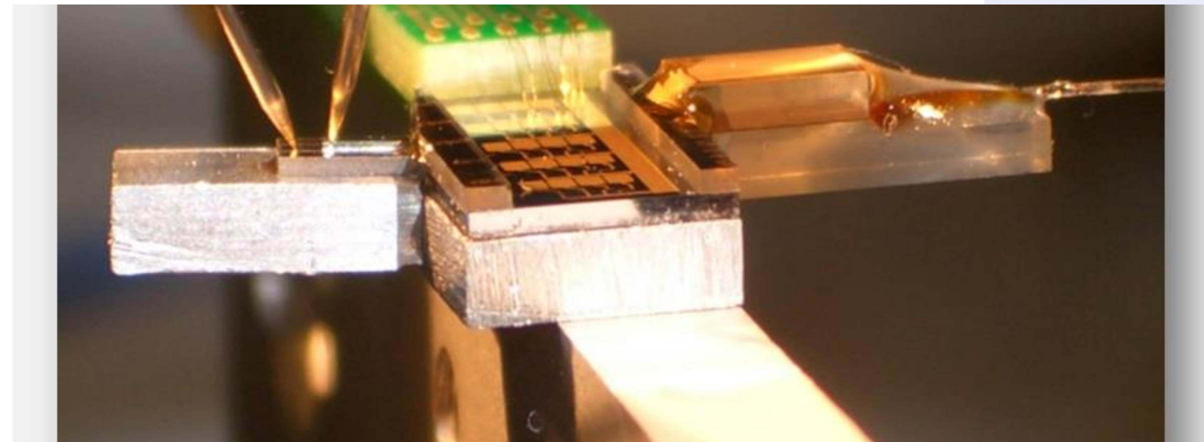
Keep it simple

- A PIC can have denser bond pad configurations then a PCB . Don’t put all the bond pads on a small area if you have the space









Three stages

Characterization / prototype packages

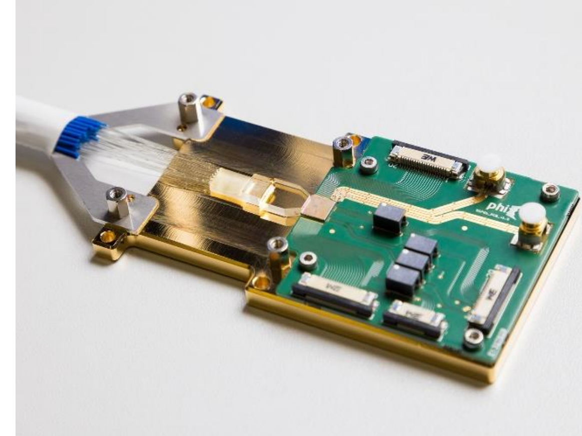
- Chip measurements and system integration tests
- Feasibility studies and system demonstrators
- 1-100 units

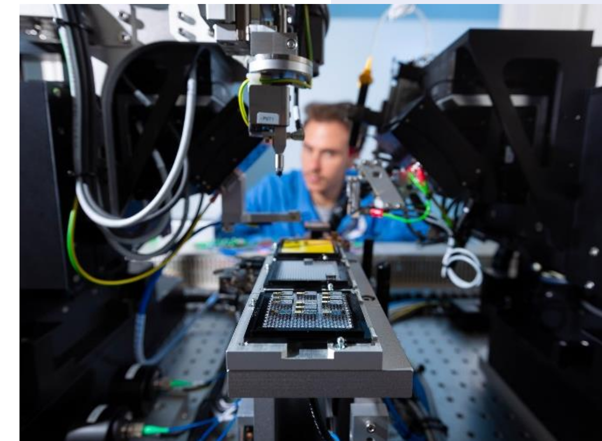
Volume packages

- Optimized for manufacturing and reliability
- Testing to firm acceptance criteria
- 100+ units

Contract manufacturing

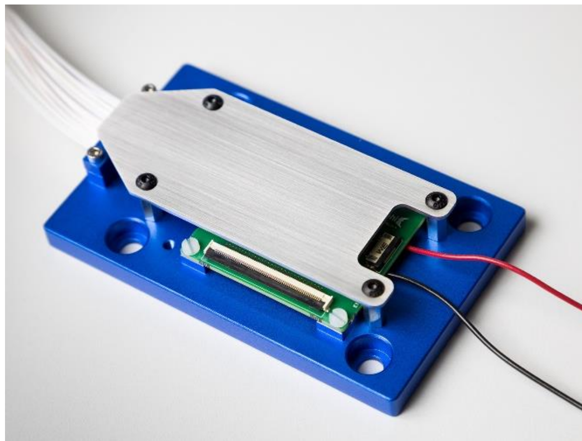
- Providing outsourced or second-sourced component production

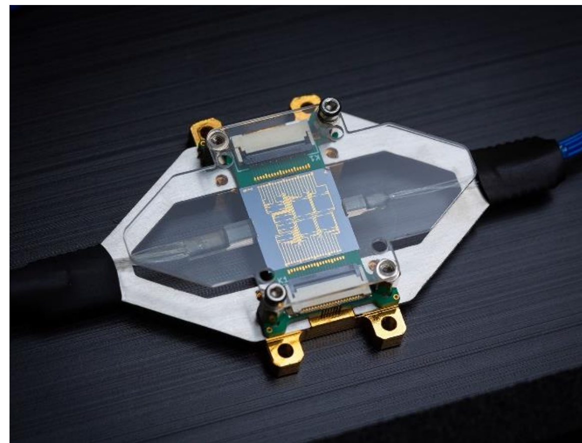


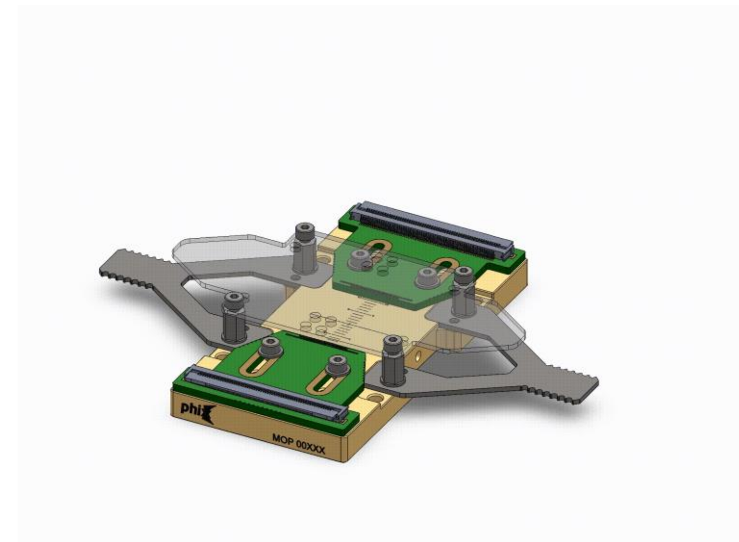


Characterization Package

- Chip measurements and system integration tests
- Feasibility studies and system demonstrators
- They provide a housing with electrical connections, optical interfaces, and thermal management
- Open housing allows for easy debugging of the device
- Hybrid assembly of auxiliary chips is also supported
- 1-100 units



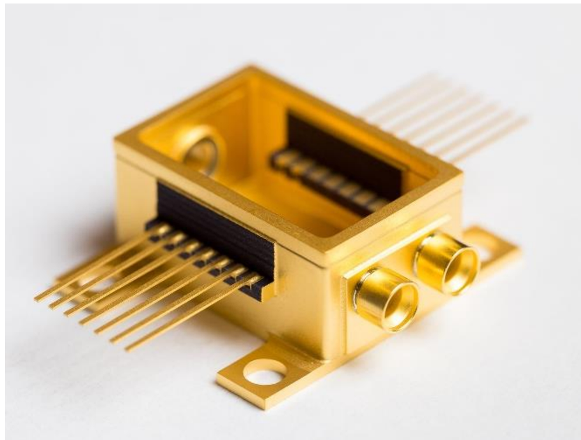


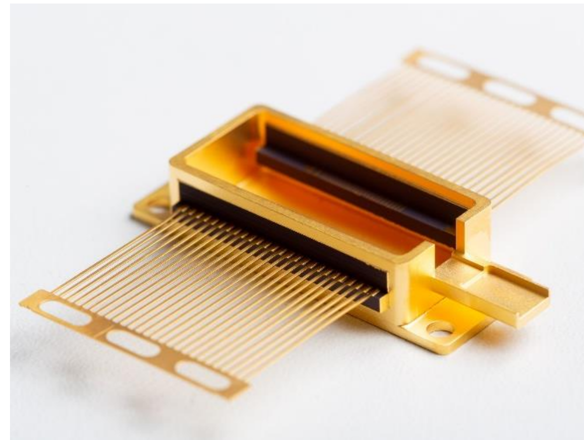


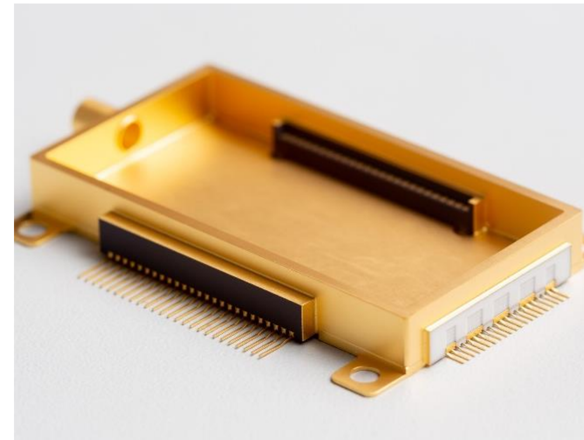
Examples of PHIX characterization packages

Volume Packaging

- Optimized for manufacturing and reliability
- Testing to firm module acceptance criteria
- All major material platforms, such as Silicon Photonics, SiN, InP, PLC, BTO, LiNbO3, are supported
- Can co-package multiple PIC technologies into one product
- 100+ units







Examples of PHIX standard packages for volume manufacturing

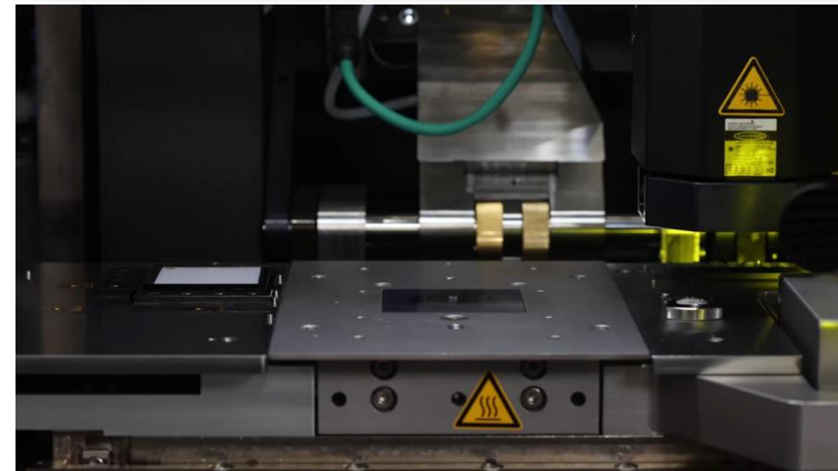
Volume packaging and contract manufacturing

Manufacturing scale-up of:

- Hybrid tunable lasers
- LiDAR modules
- MEMS-based mass flow sensors

Automated processes for:

- Wire bonding
- Flip chip assembly
- Hybrid PIC edge coupling
- Fiber assembly
- Fiber attachment
- Epoxy dispensing
- and more…



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PHIX value proposition

Independent packaging foundry

Quality

Low scale-up cost

Speed

Flexibility

Design engineering support

- One-stop shop
- Easy start-up
- Max. performance at min. cost

Technological excellence

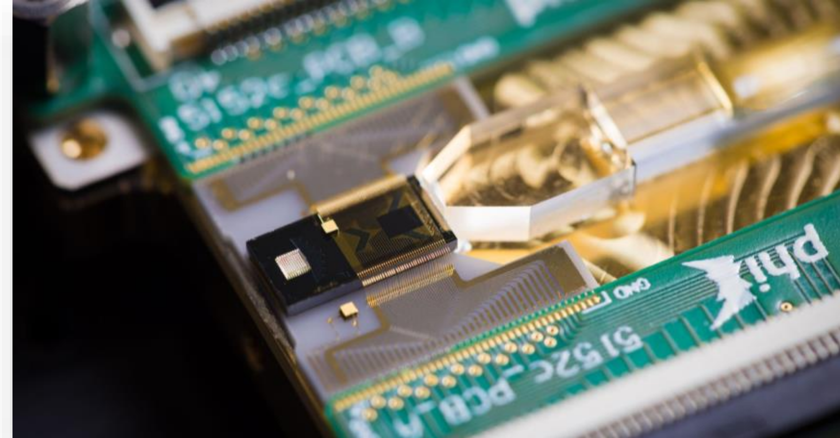
- Allround
- Harness the full power of PICs
- Low losses

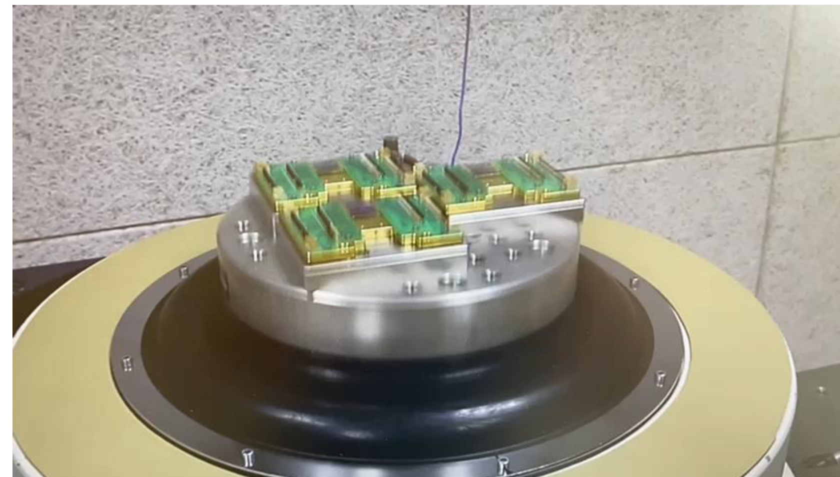
European based

- Connected
- Unique position
- Well-funded
- Trustworthy

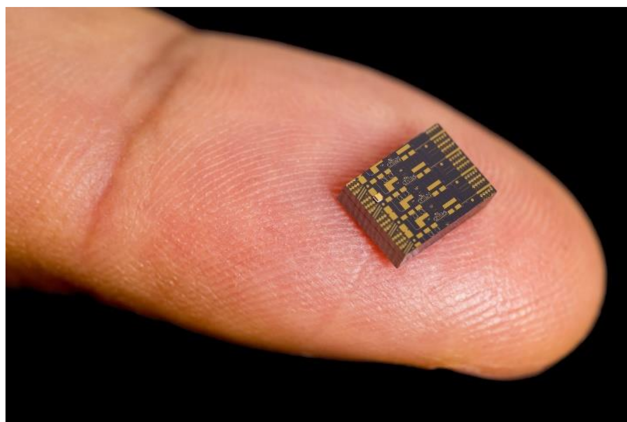
Key takeaways

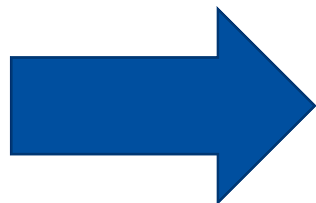
- Packaging of a PIC is a product development process
- Optimize product design, assembly process and assembly equipment in parallel
- Characterization package concept enables decoupling chip validation process from product validation process
- Standard packages available for initial product release
- Photonics does not scale similar as electronics

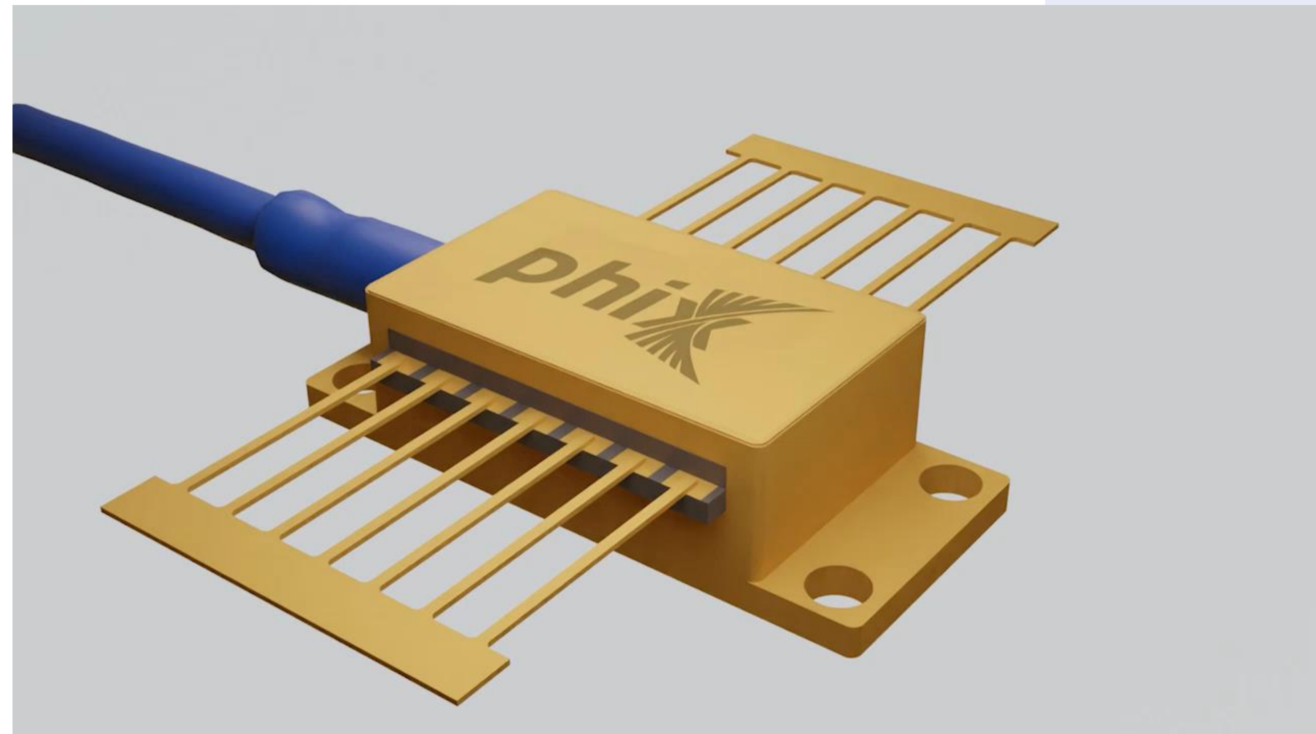




Questions?







Back-up slides

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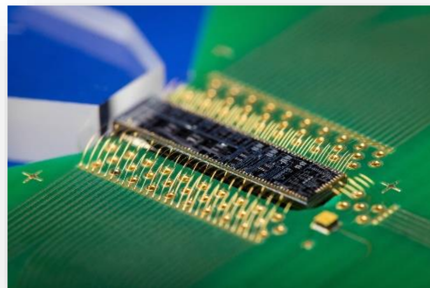
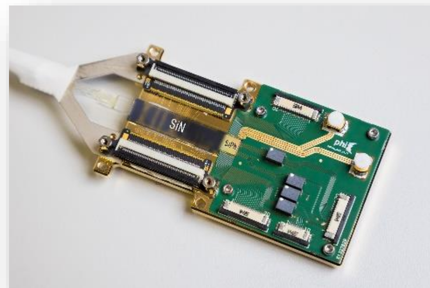
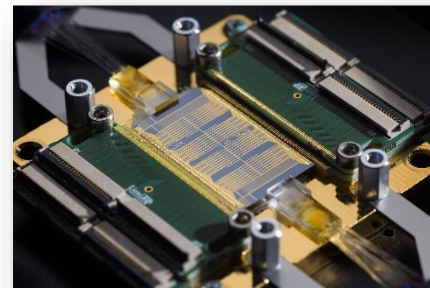
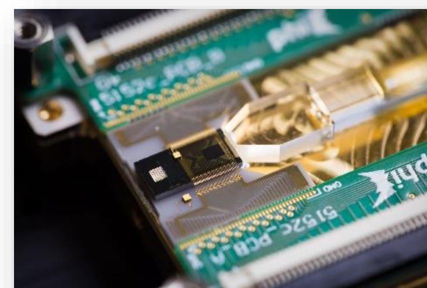
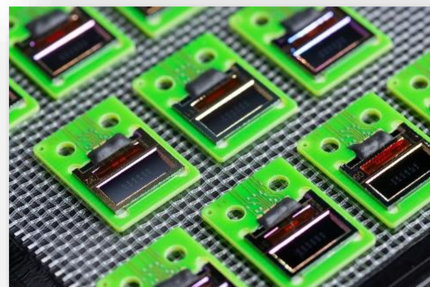
Product examples

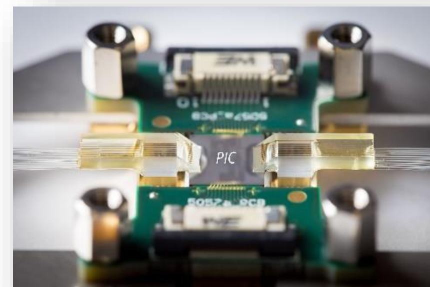


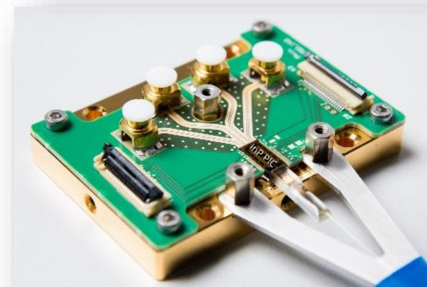


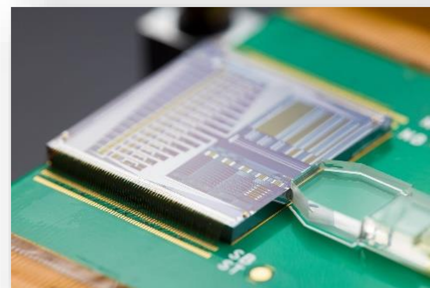


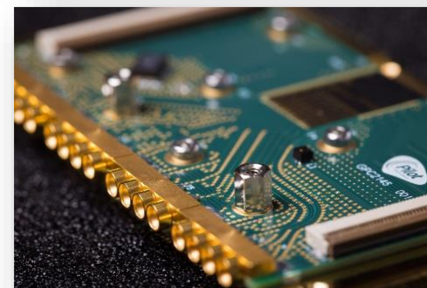












SiN

SiPh

PIC

InP PIC