



PHOTONICS ASSEMBLY

PIC Packaging Scale up Challenges

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Chief Commercial Officer

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WWW.PHIX.COM

Agenda

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

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Who Are We?

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



High Tech Factory at University of Twente where PHIX is currently located

Where we're going: Kennispark Twente

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



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A PIC by itself is not a product!

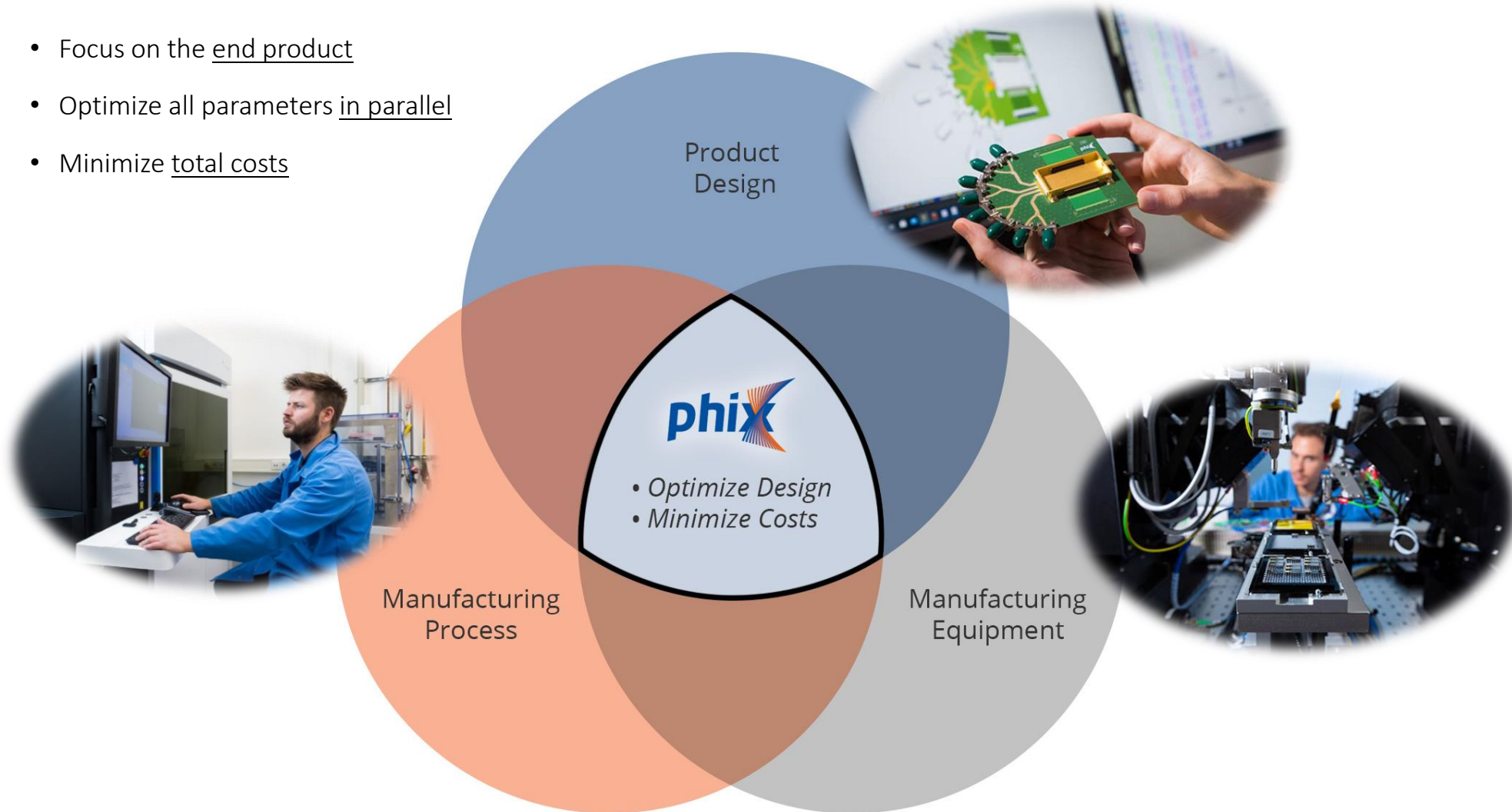
It needs:

- Optical interconnection (fibers/free-space)
- Electrical interconnection (wire bonds/PCBs/electronic ICs)
- Thermal management (active/passive)
- Mechanical support (robustness, sealing)



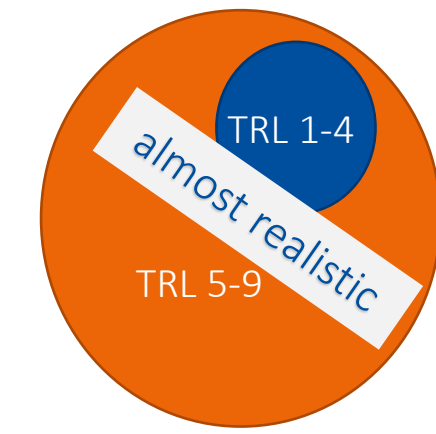
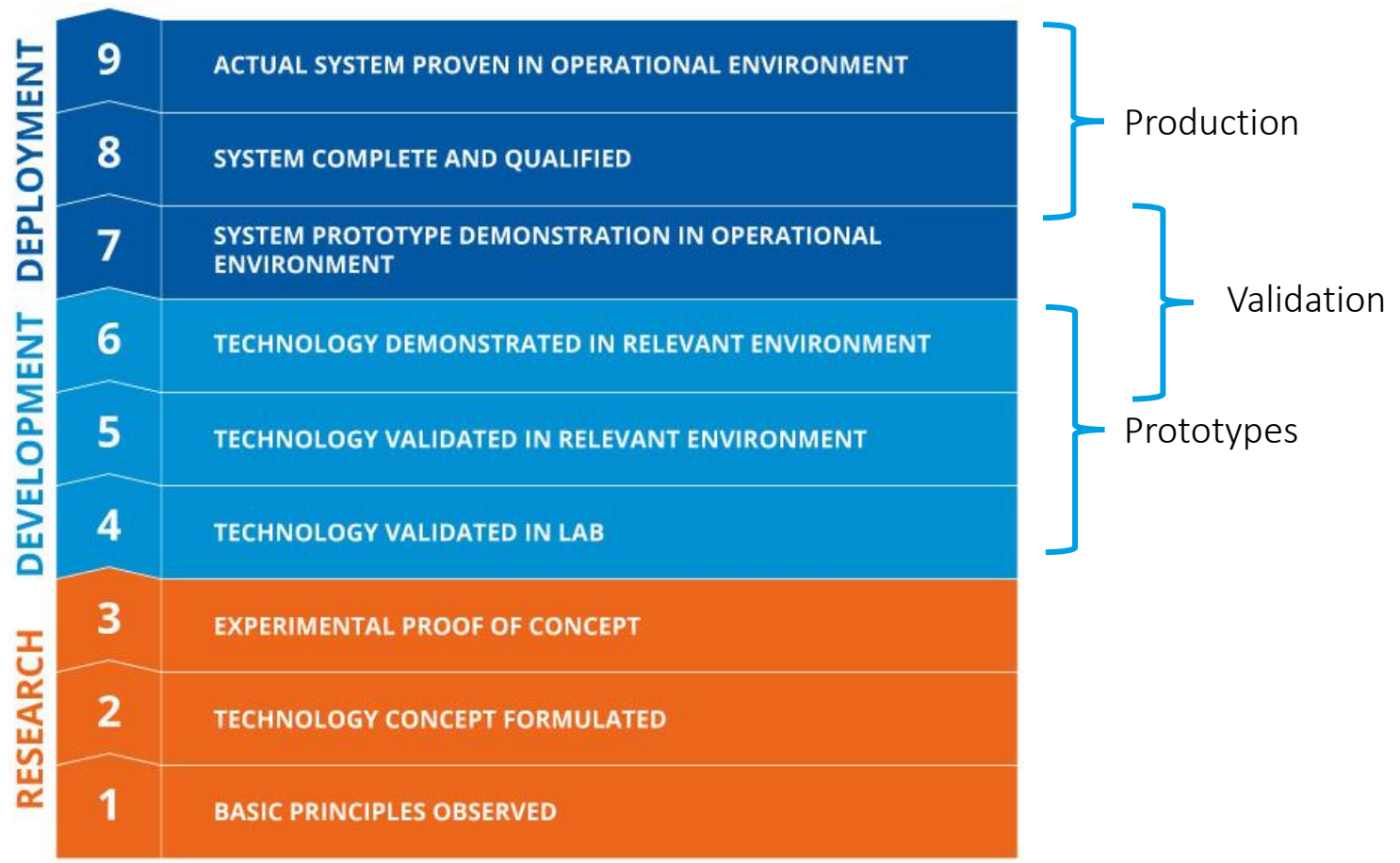
PHIX Approach to Successful Packaging & Scale-up

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



Time/ effort

How to realistically get from TRL4 to TRL9?



Three stages

Characterization / prototype packages

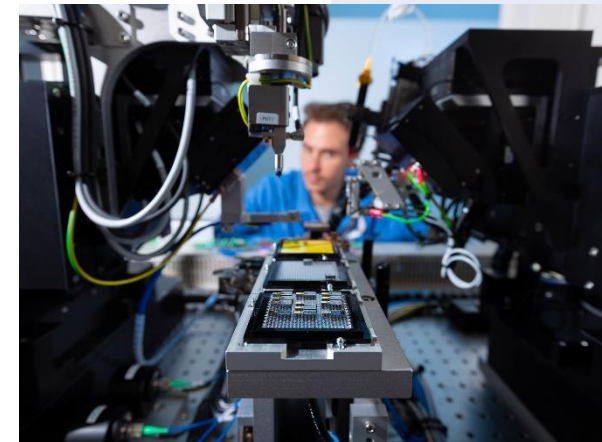
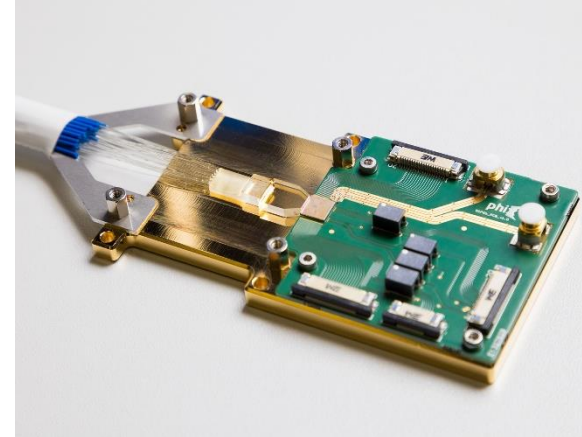
- Chip measurements and system integration tests
- Feasibility studies and system demonstrators
- 1-100 units

Volume packages

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

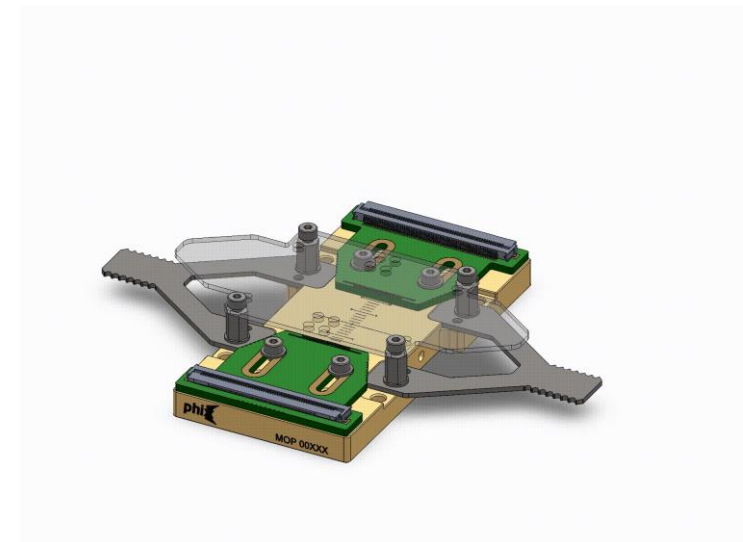
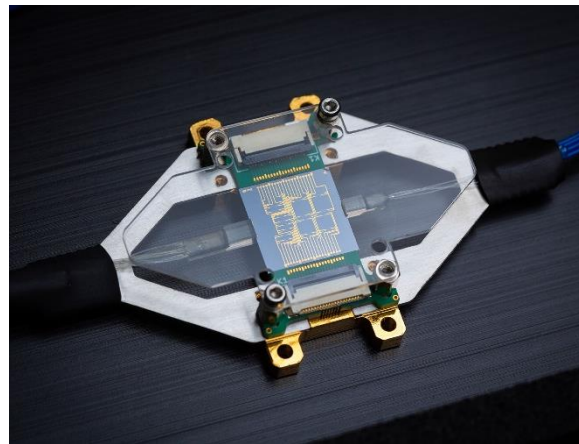
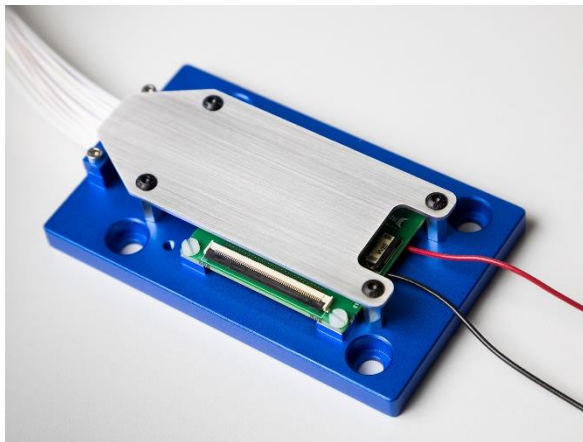
Contract manufacturing

- Providing outsourced or second-sourced component production



Characterization Package

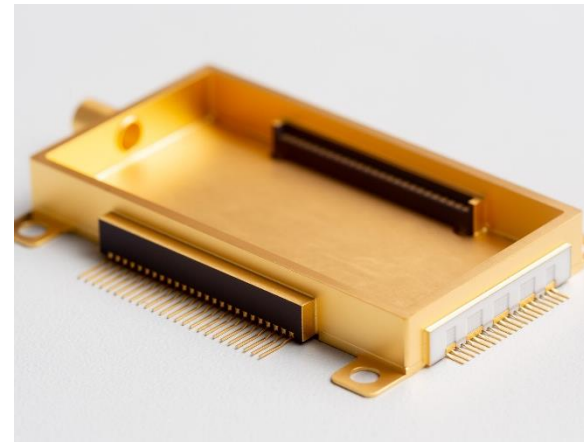
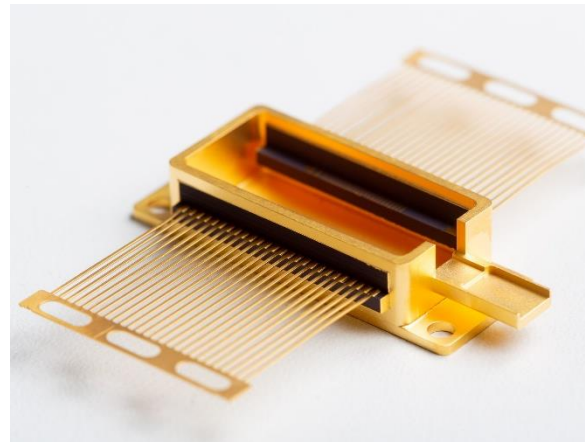
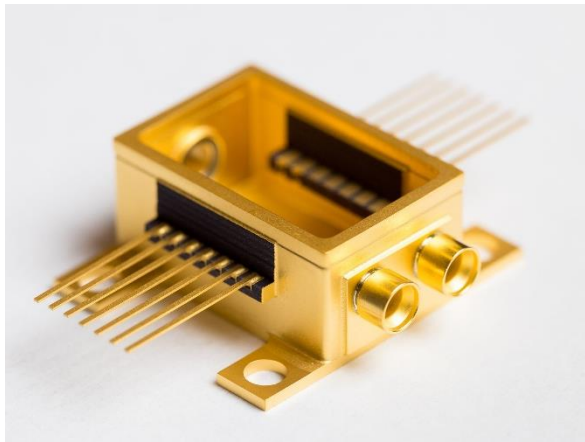
- Chip measurements and system integration tests
- Feasibility studies and system demonstrators
- They provide a housing with electrical connections, optical interfaces, and thermal management
- Open housing allows for easy debugging of the device
- Hybrid assembly of auxiliary chips is also supported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

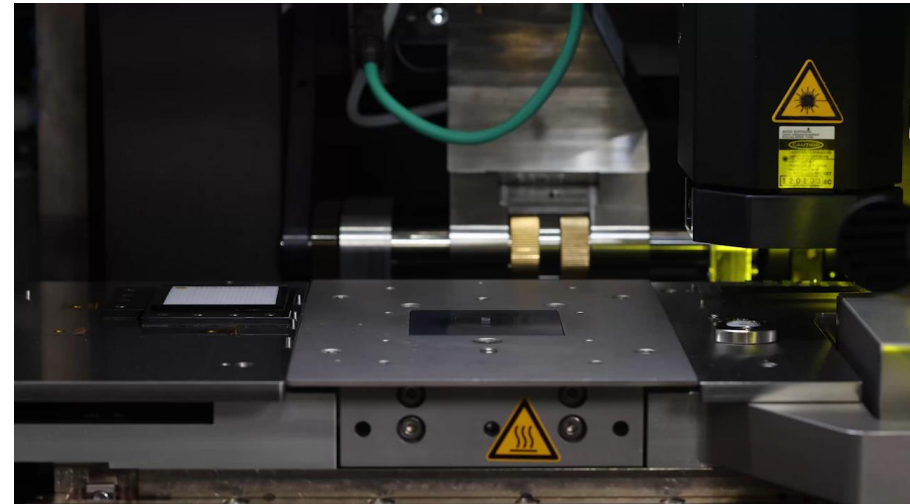
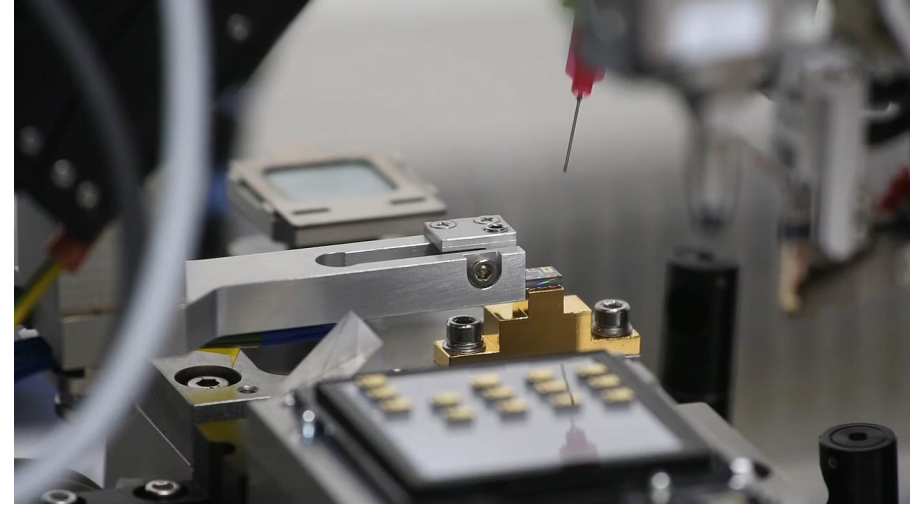
Volume Packaging continued: batch level automation

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...



Engineering support



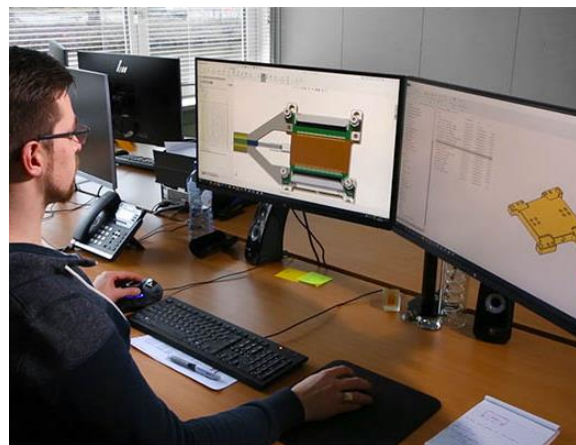
Take off quickly

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



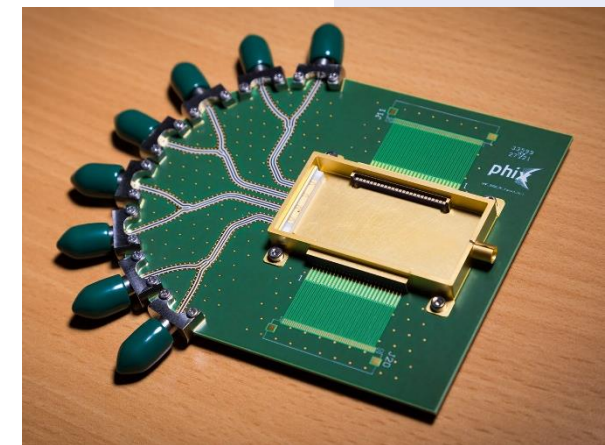
Fly to great heights

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



Design Guidelines for Photonic Integrated Circuit Packaging

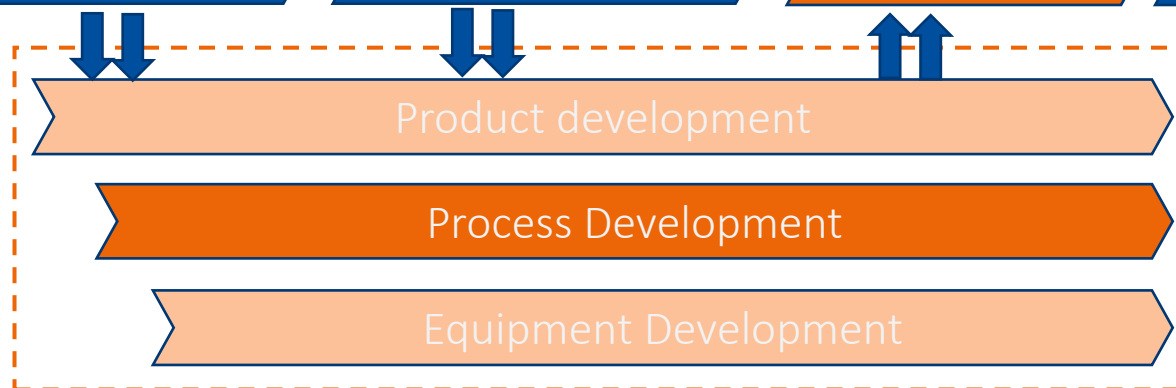
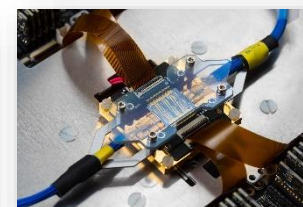
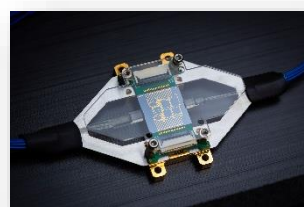
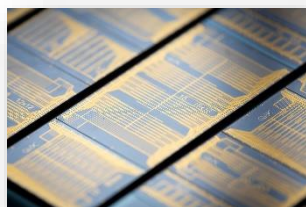
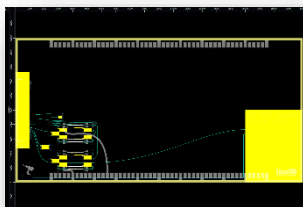
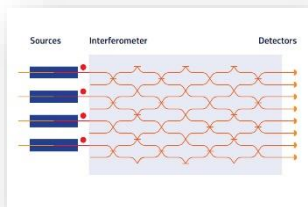
PHIX is a one-stop-shop for the manufacturing of modules powered by photonic integrated circuits (PICs), from design to volume production. This document describes the core design guidelines for PICs that will enable PHIX to package your chip into a high performance and cost-effective module that is suitable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



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PIC product value chain



Images courtesy of QuiX Quantum

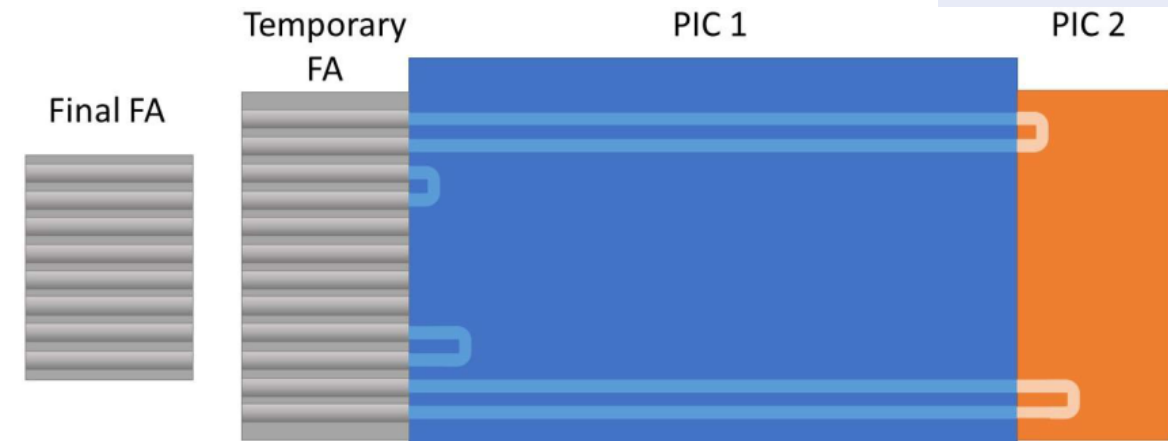
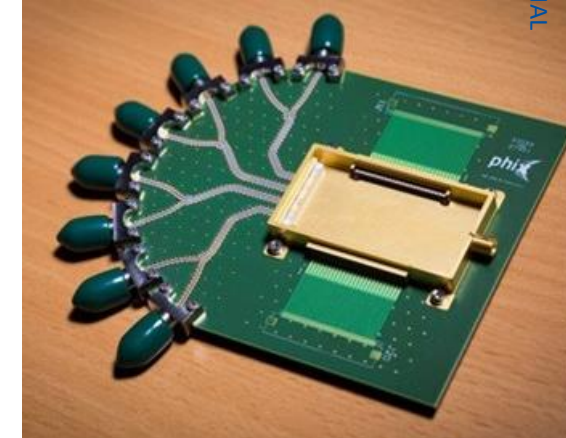
Design rules / guidelines and standardisation

- Product and Process development accounts for more than 60% of the packaging costs -> eliminate by chip design
- If there is standard packaging solution that the customers can choose from, the packaging costs will decrease
- The smallest used chip does not perse result in the lowest cost solution



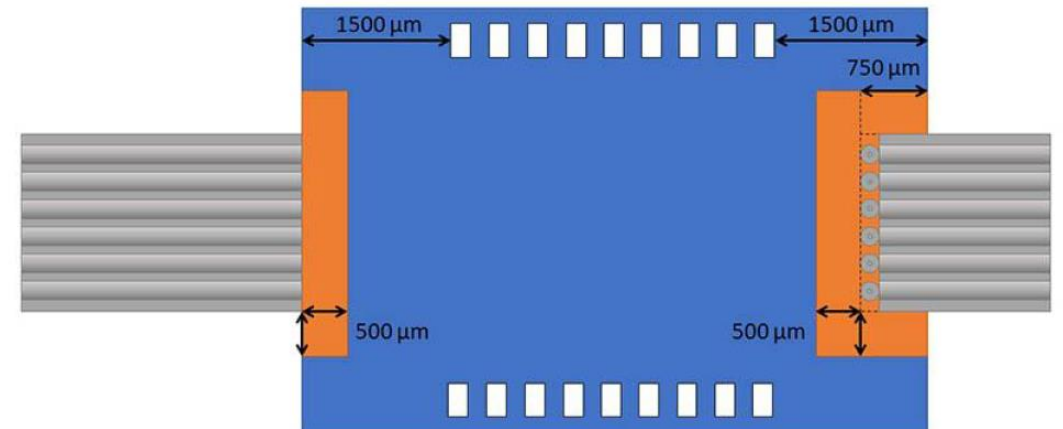
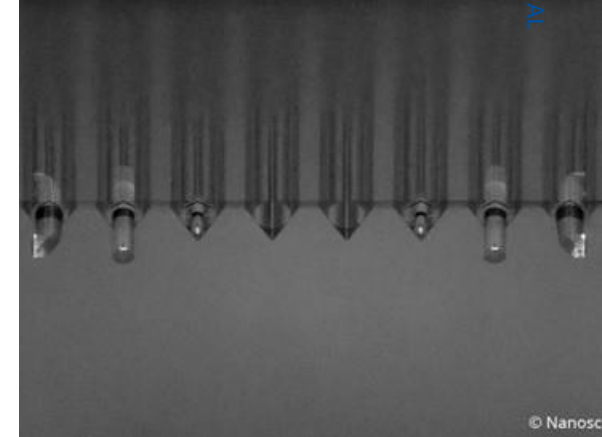
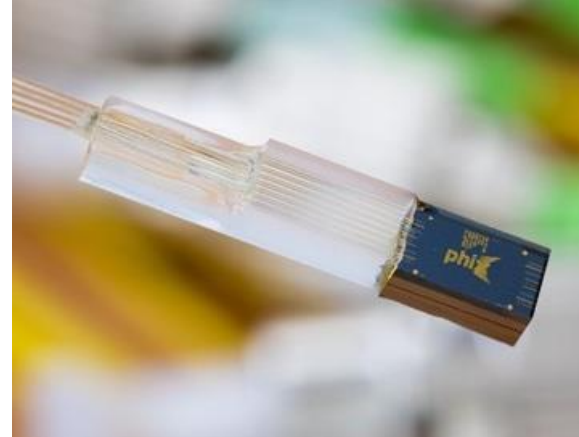
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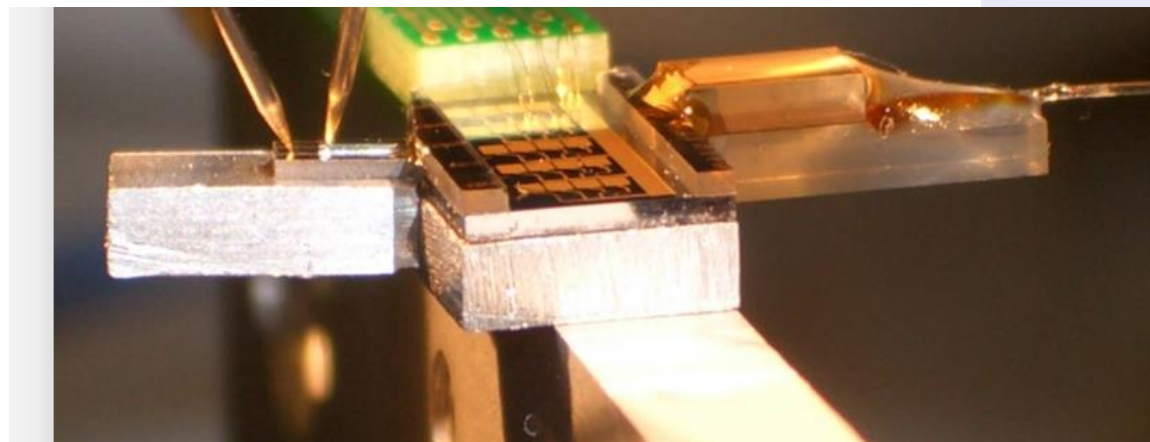
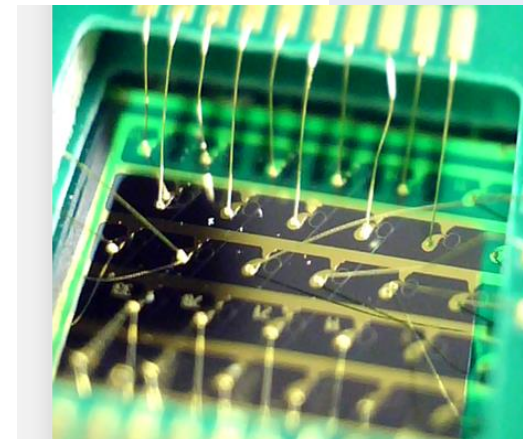
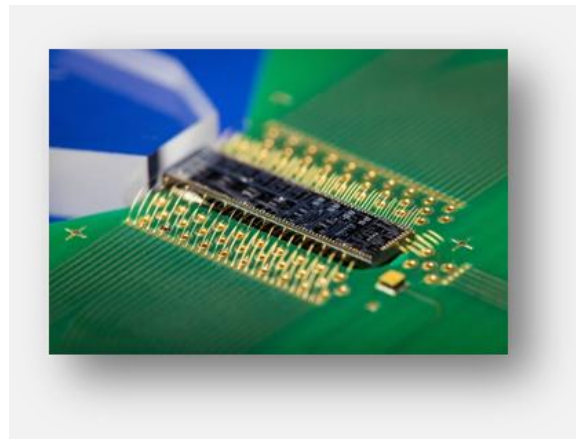
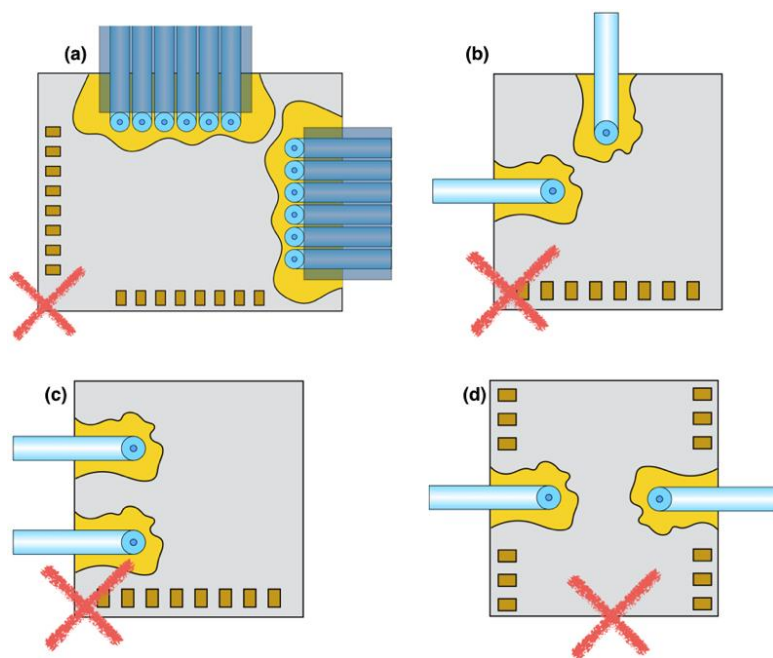
Lower the cost

- 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 than a PCB . Don't put all the bond pads on a small area if you have the space



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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

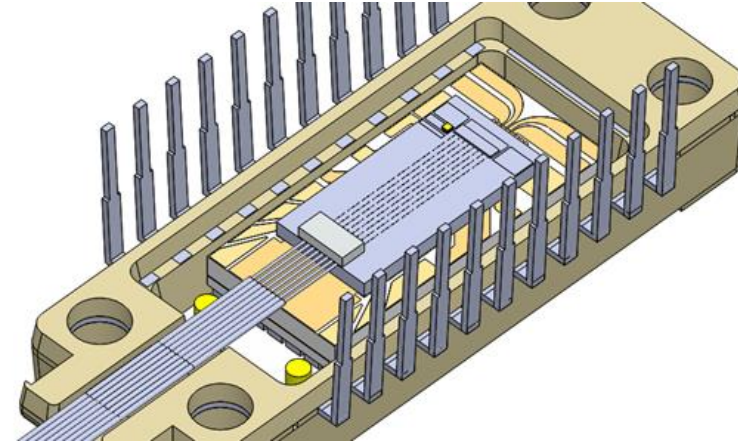
European based

- Connected
- Unique position
- Well-funded
- Trustworthy

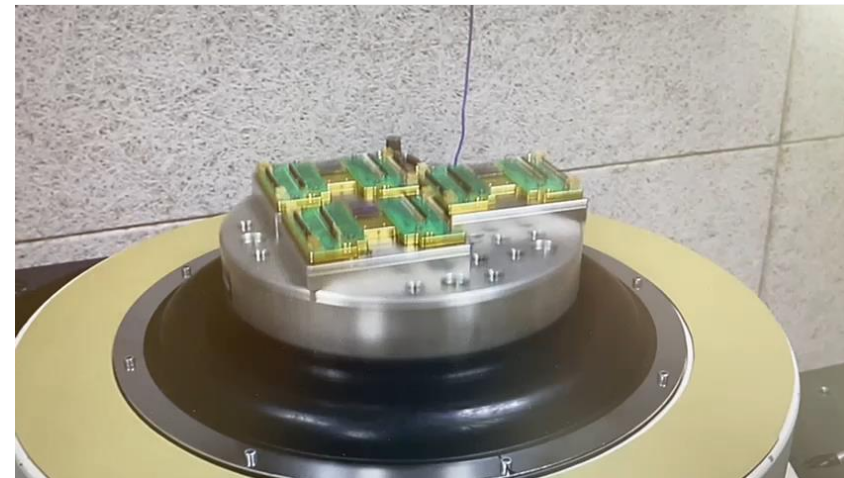


Take aways

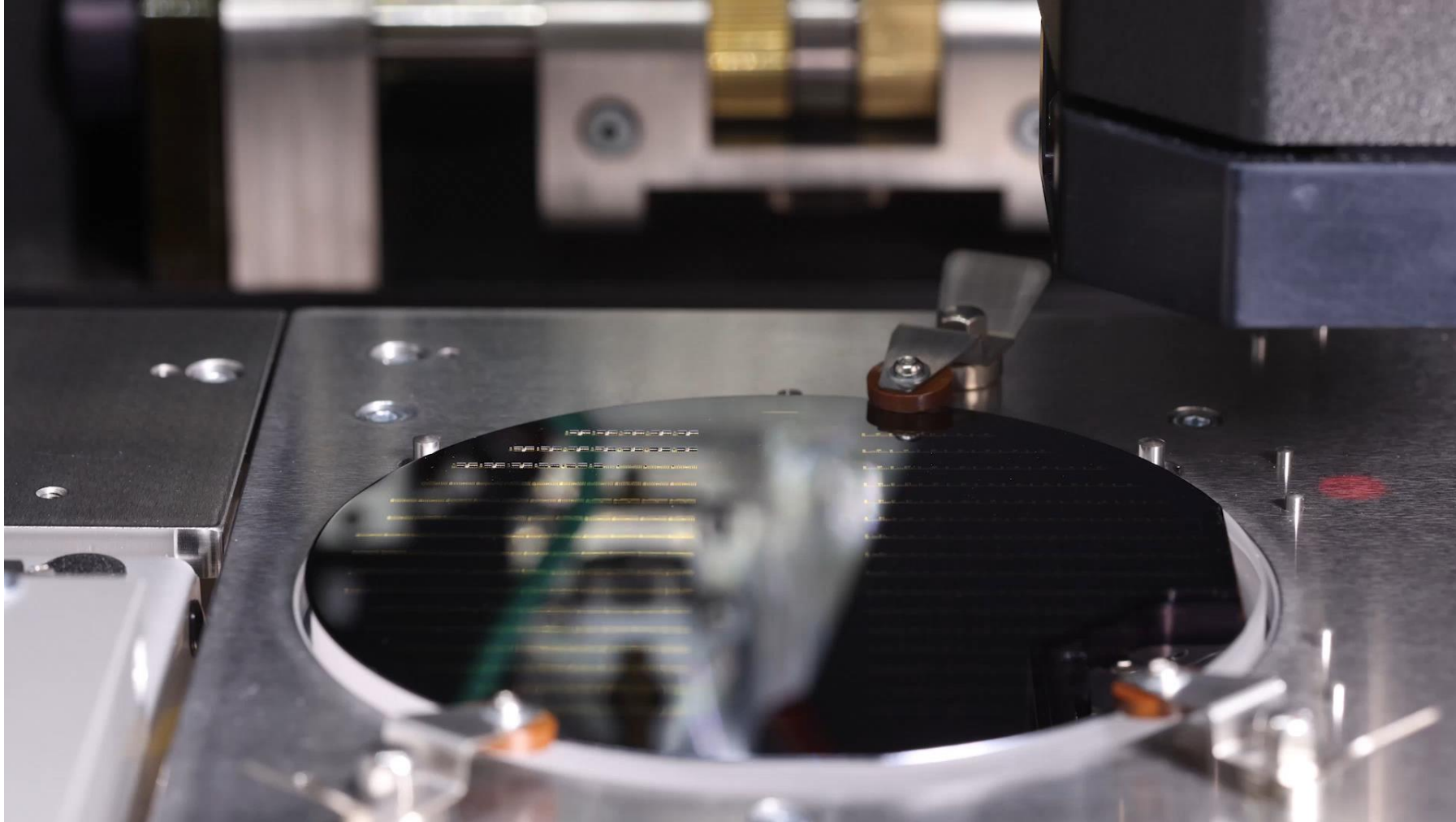
- Packaging roadmap from prototype to qualified volume product
- Free design review before tape out
- Reuse of existing designs / knowledge
- Chip interfacing (SSC, UHNA, SM, PM, Isolator)
- New processes like 2 photon absorption printing, silver sintering, copper pillar
- Photonics does not scale similar as electronics
 - Lack of on chip serializers
 - Optical connections
 - Hermetic feedthrough
 - Automatability
- Be realistic, in volume, TRL, timing it is quickly overestimated



Injection moulded leadframe for fiber optics: Courtesy RJR Technologies



Questions?





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PIC Packaging Scale up Challenges

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