

Integrated Photonics Packaging from Research to Pilot Manufacturing

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From Lab to Fab

EU Open Access Pilot Lines



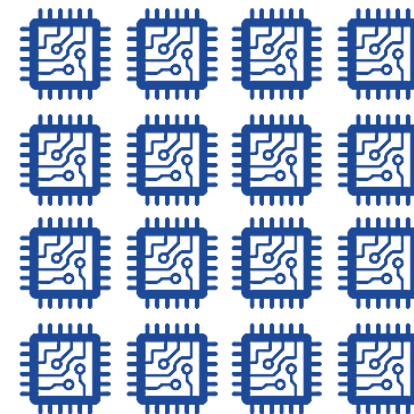
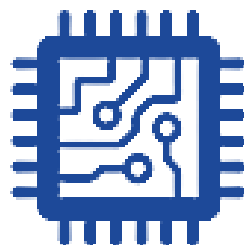
Concept

Research

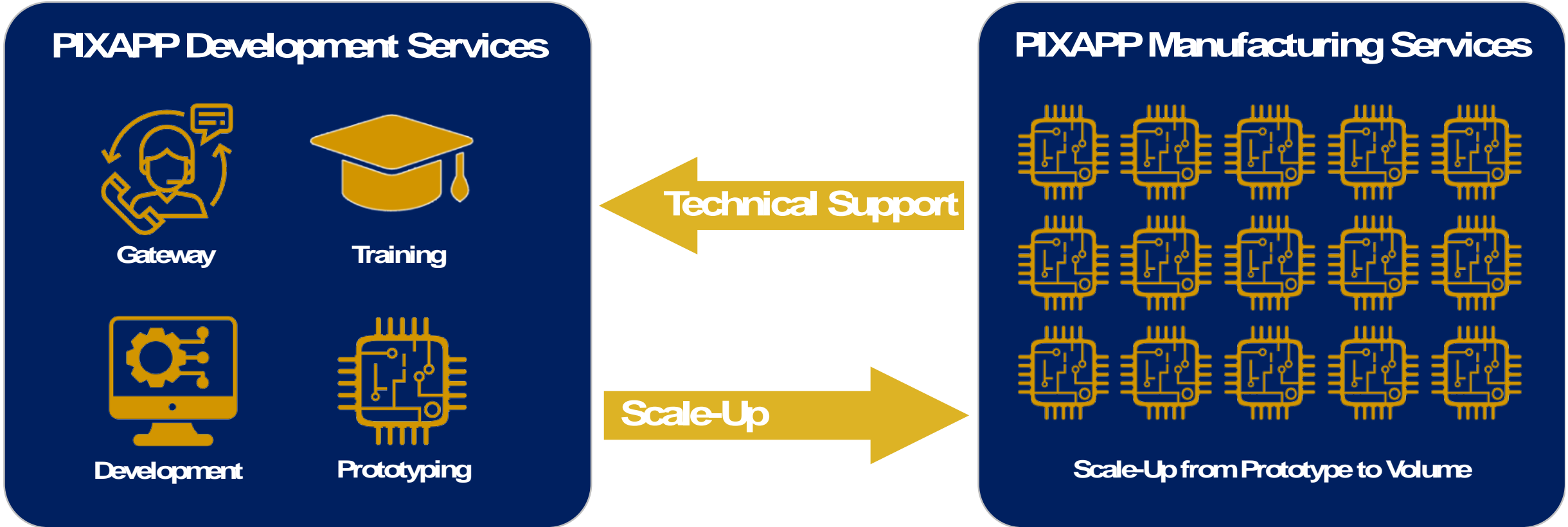
Prototyping

Piloting

Manufacturing



PIXAPP Operation Model



PIXAPP @ Tyndall

fiber pack



fiber pack



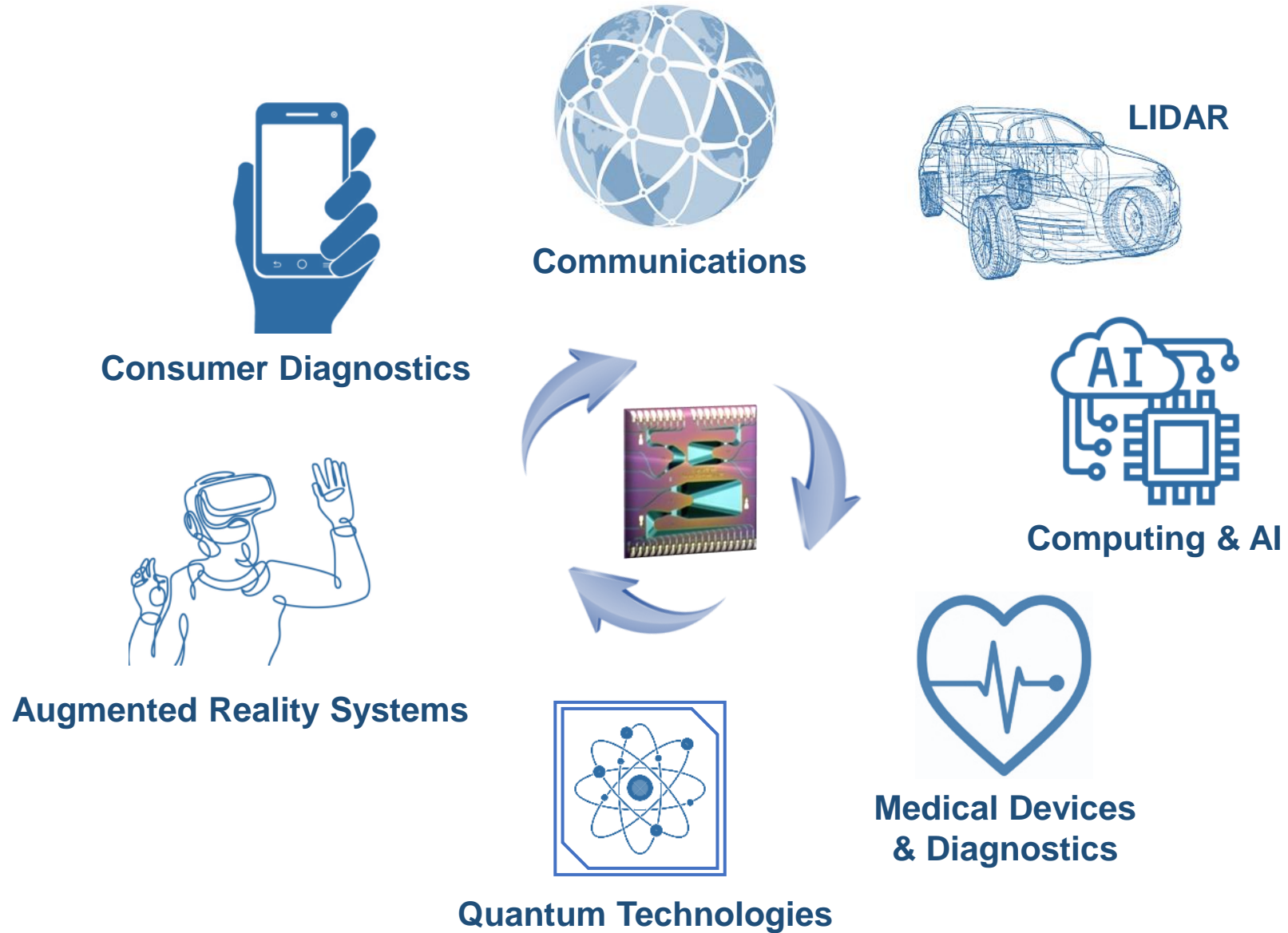
ficontec
photonics assembly & testing
@ Tyndall

ackaging



kage design

Expanding Range of Markets

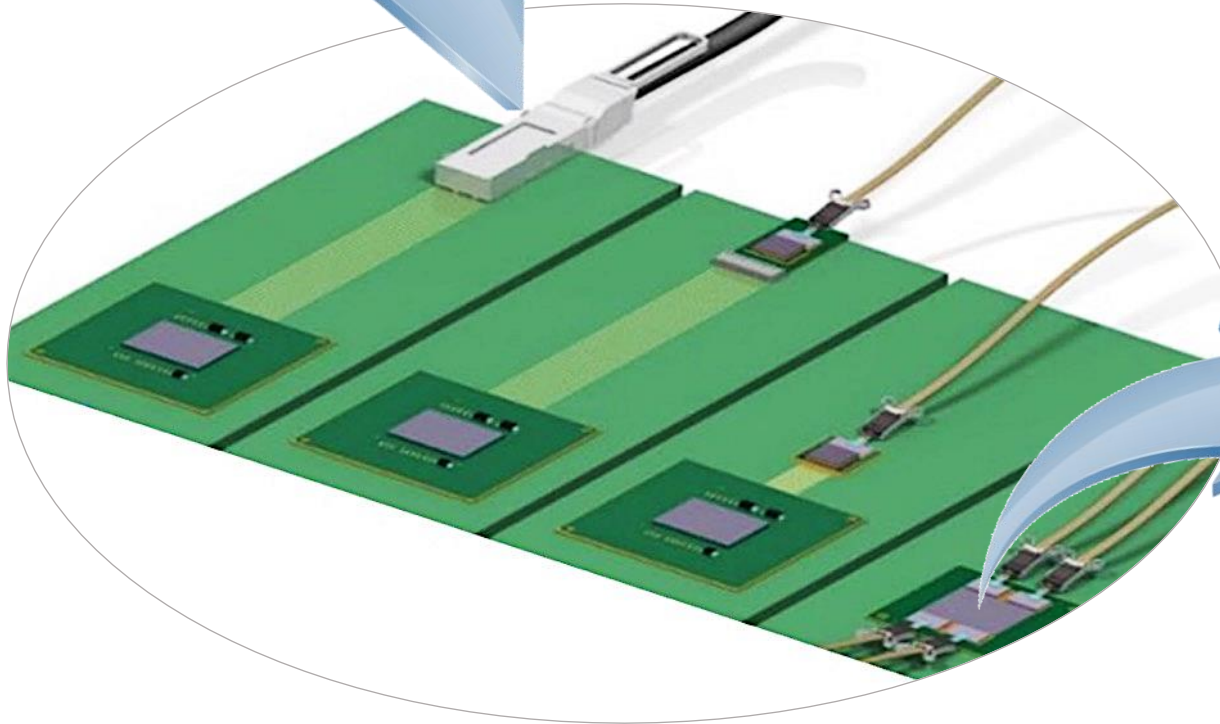


From Pluggable to Co-Packaged Optics

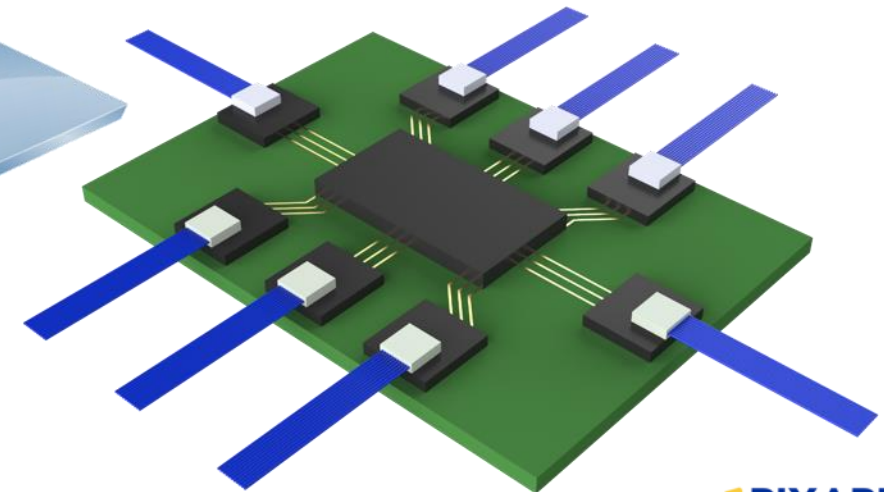
Pluggable Optics



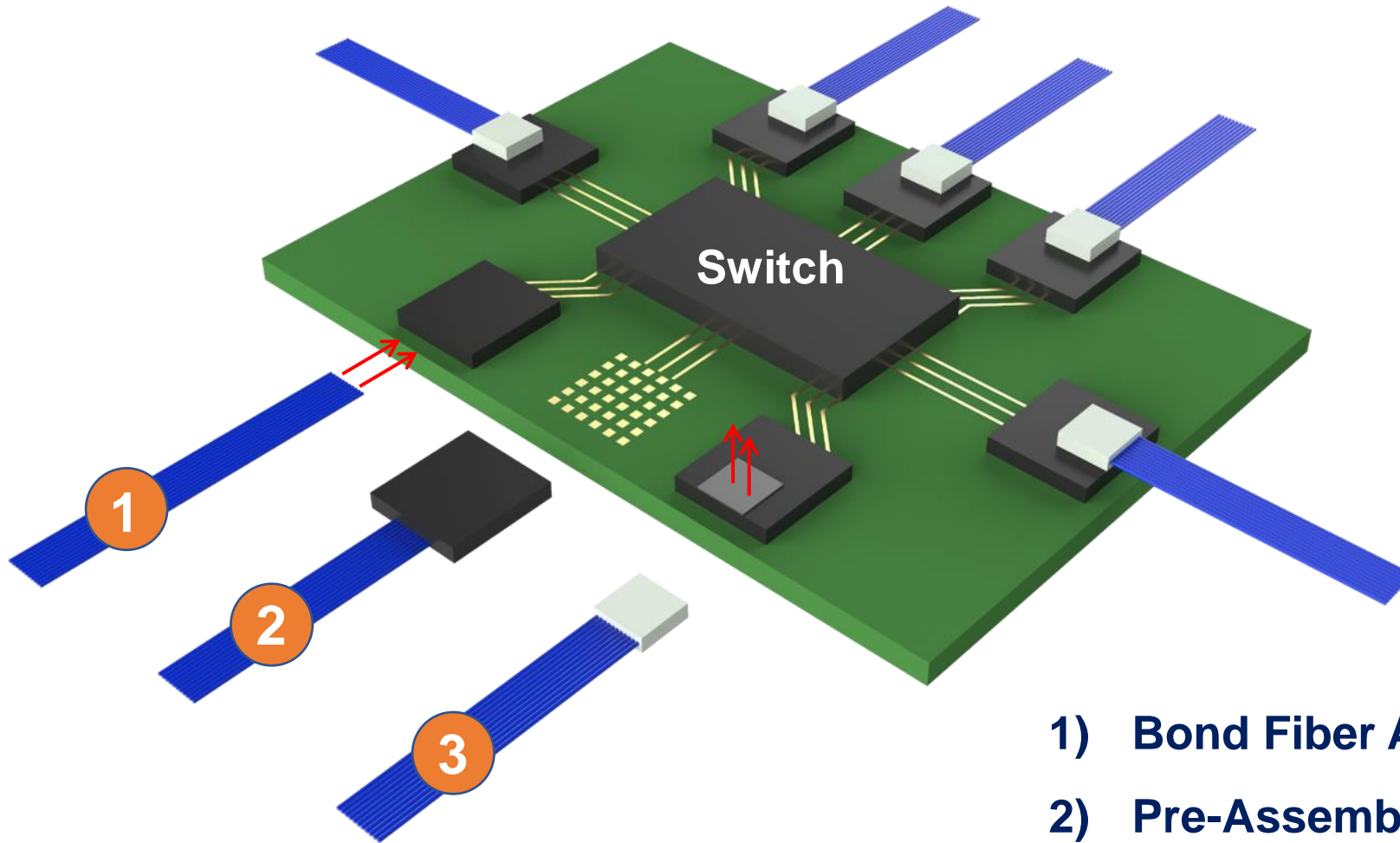
- **Optical Fiber Packaging** (shoreline density)
- **Laser Integration** (external or internal laser)
- **Electrical Packaging** (2.5D integration & interposers)
- **Assembly Sequence** (manufacturing & yield)



Co-Packaged Optics

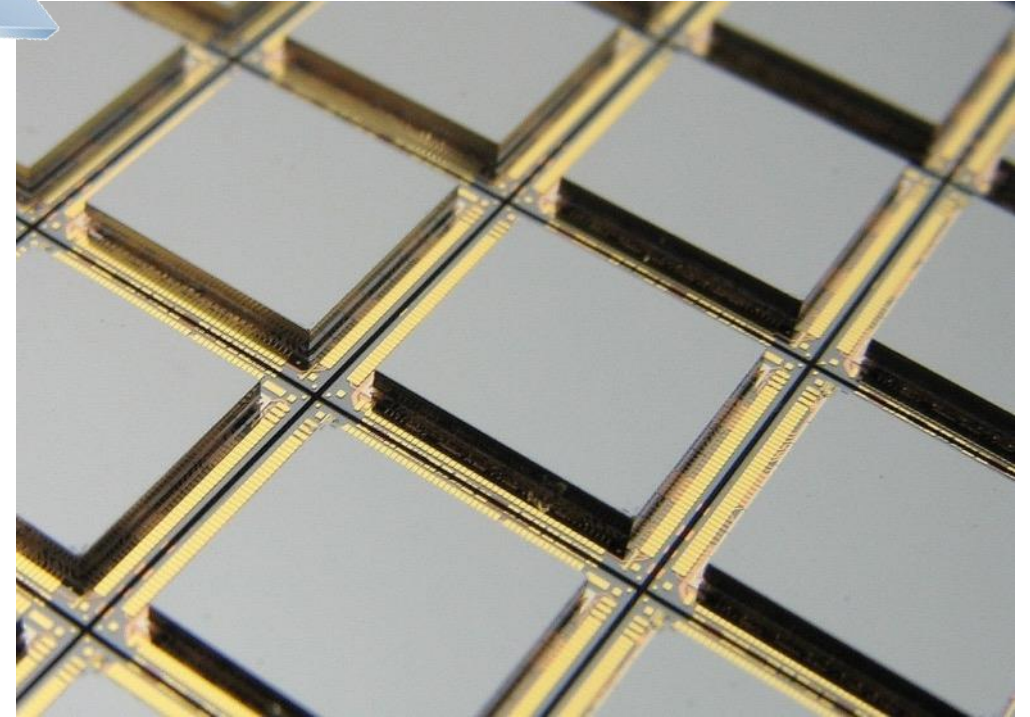
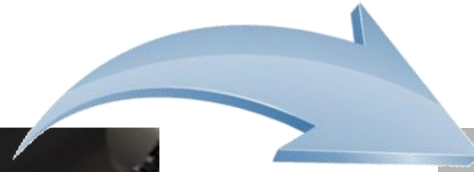
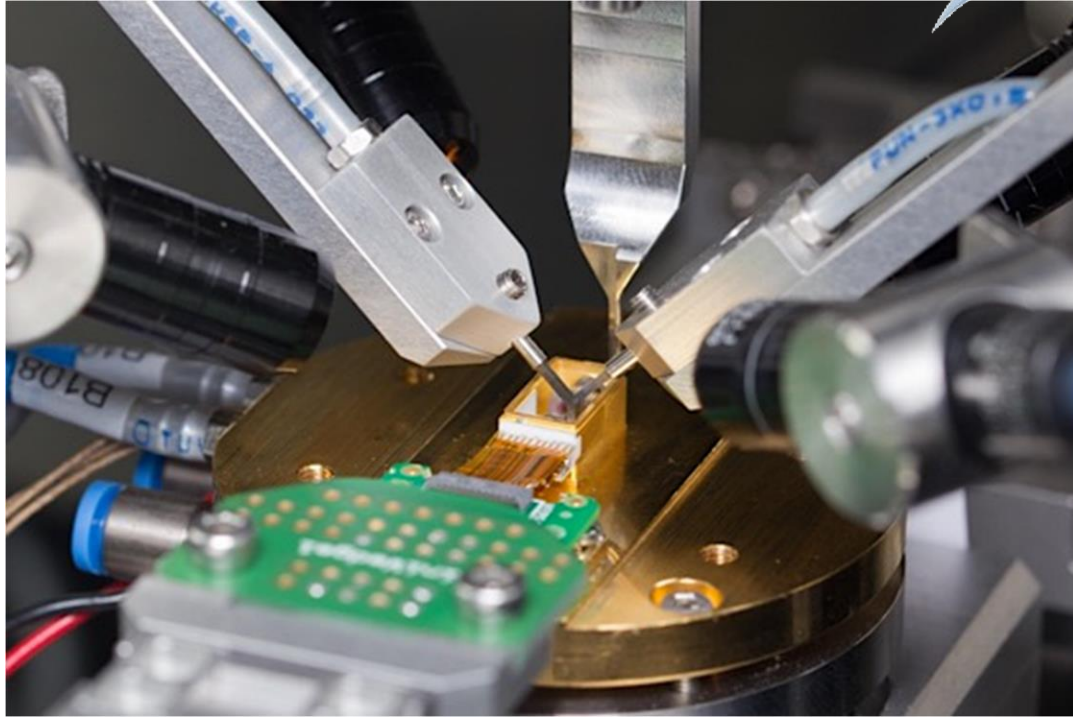


Co-Packaging (Optical Packaging)



- 1) Bond Fiber Array to Photonic Module
- 2) Pre-Assembled Photonic Module
- 3) Pluggable Fiber Array to Photonic Module

Package-Level versus Wafer-Level Manufacturing



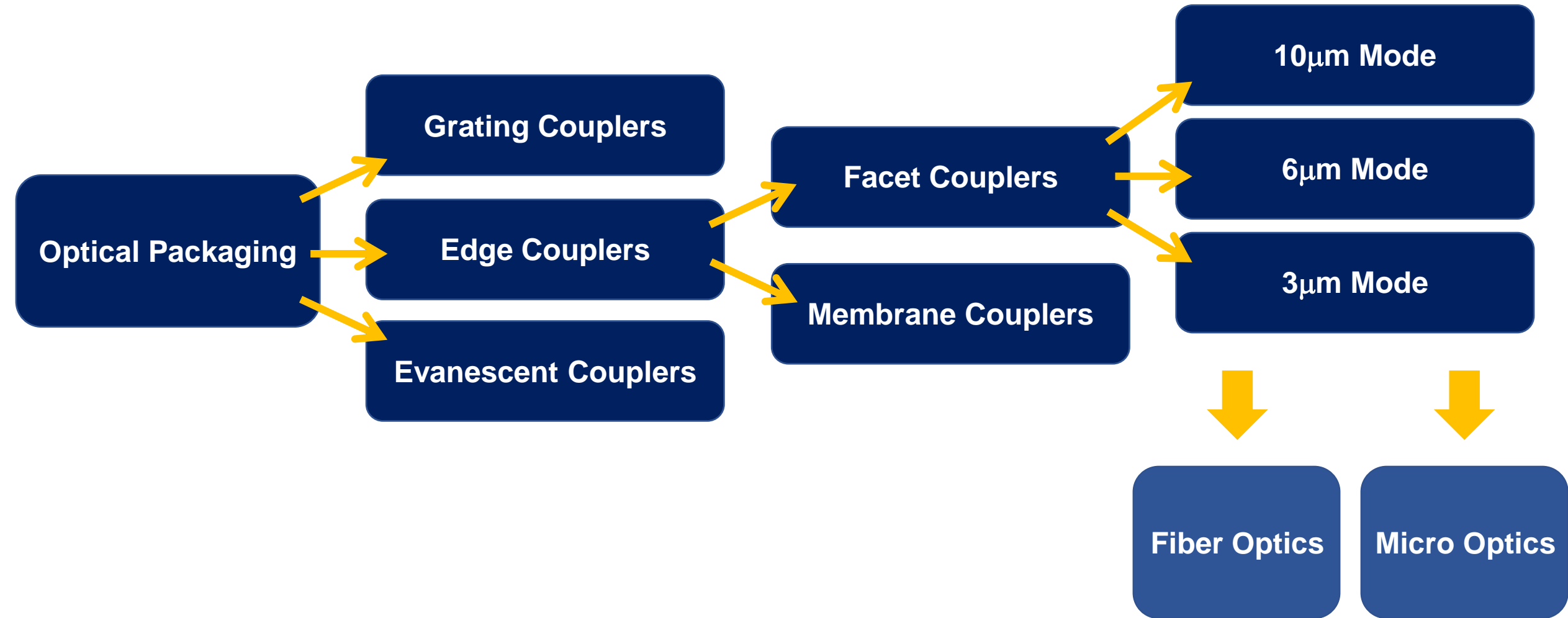
**Photonic Wafer-Level Integration
Packaging and Test Processes**



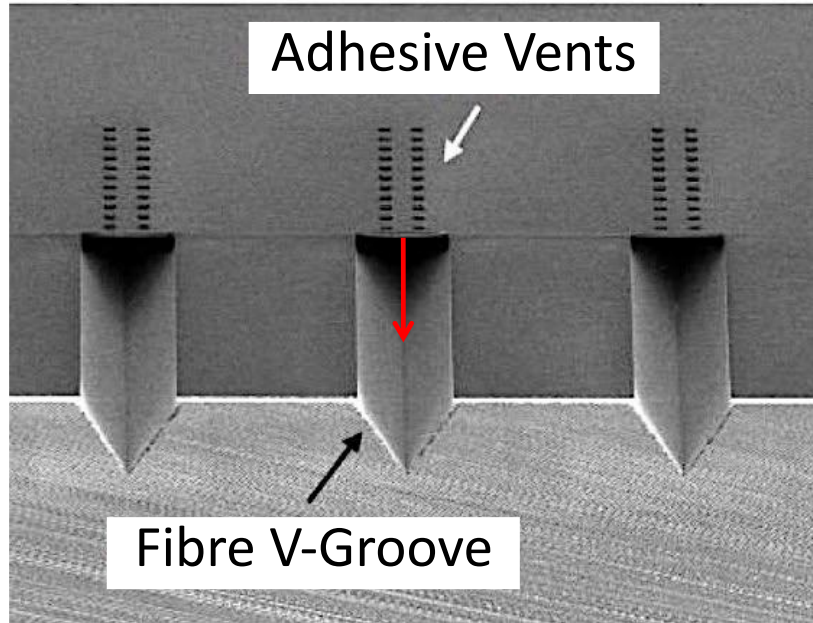
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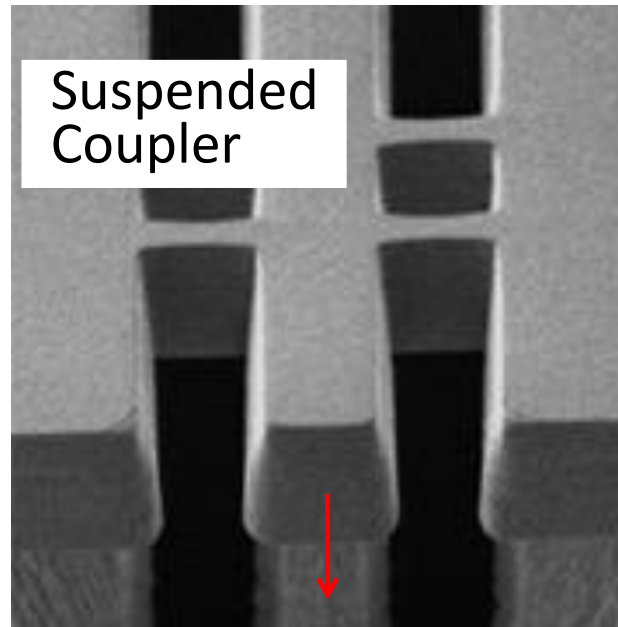
Optical Packaging Challenges



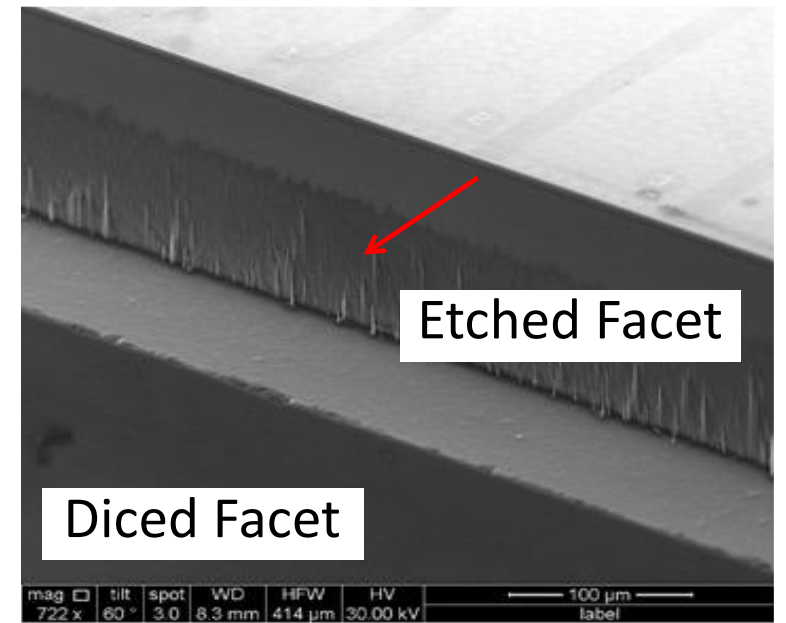
Silicon Edge Couplers



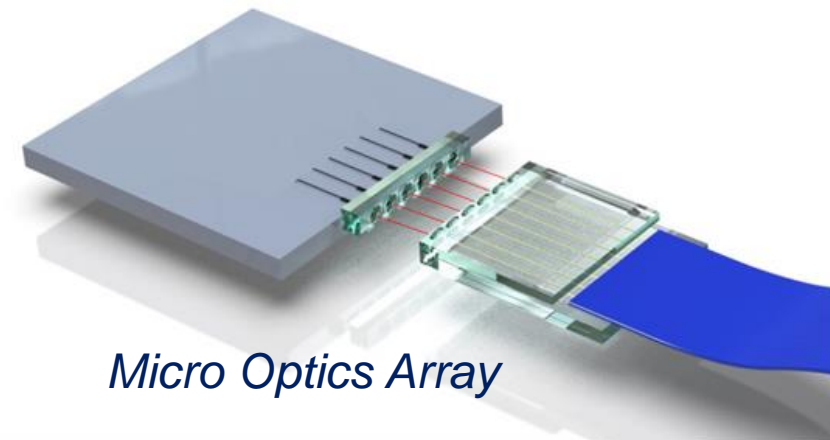
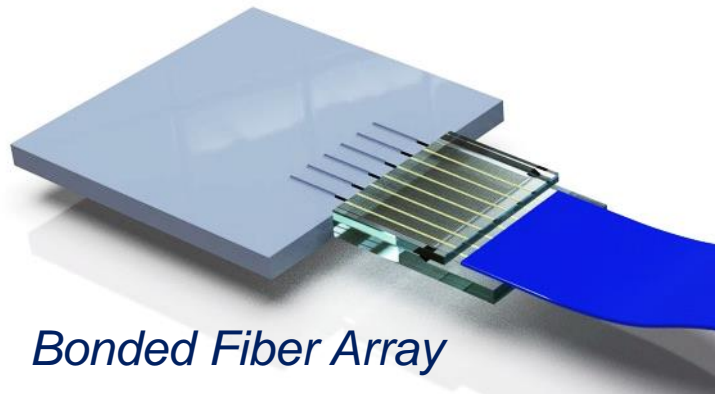
GlobalFoundries™



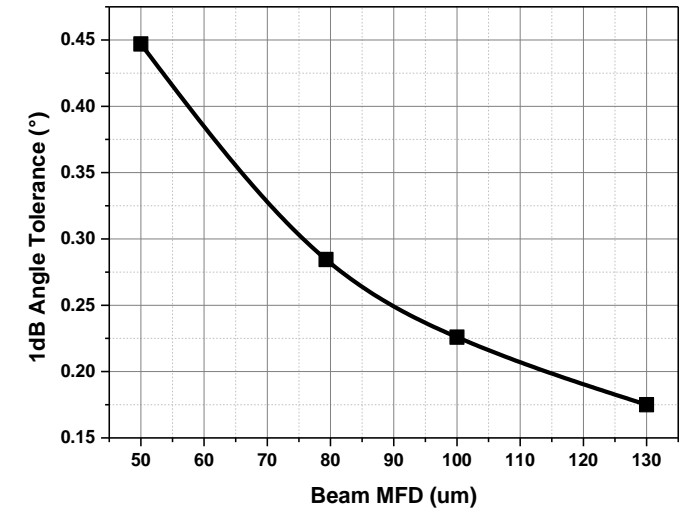
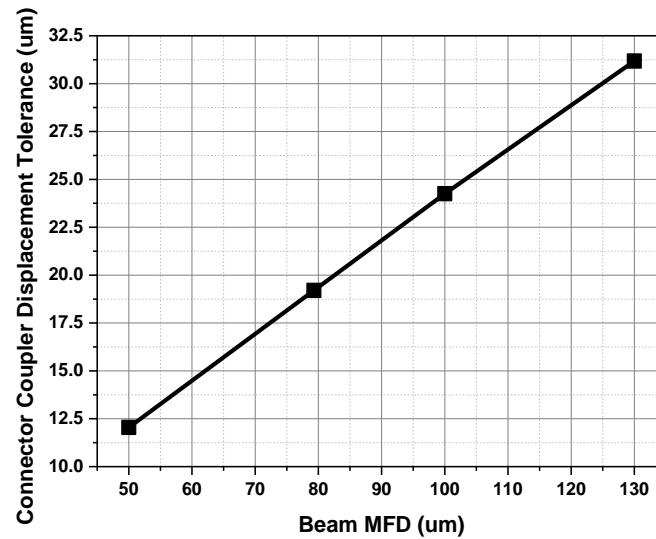
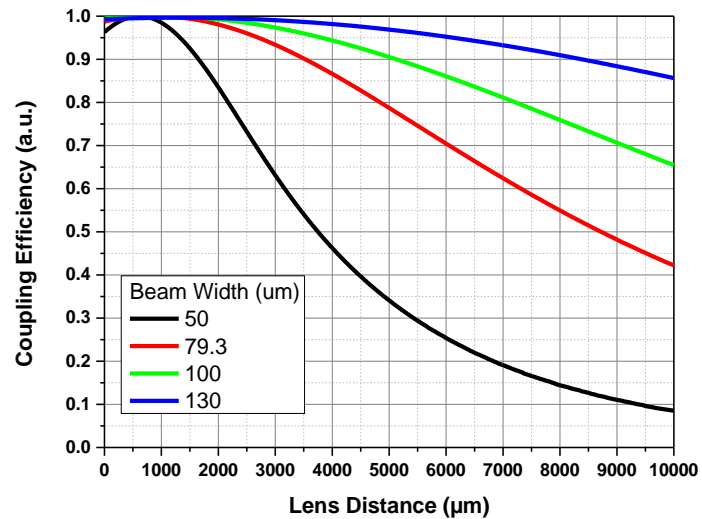
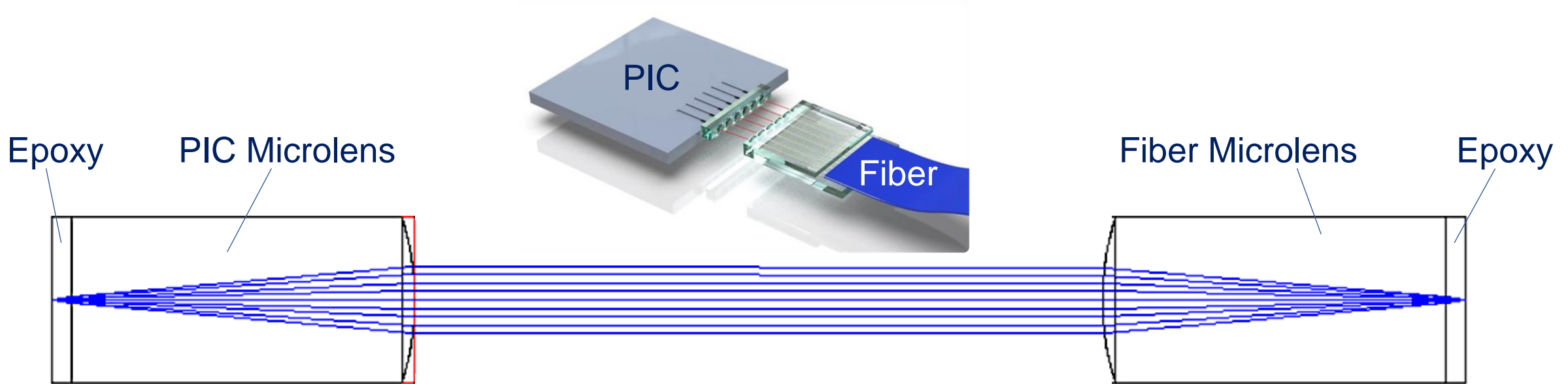
amf
ADVANCED
MICRO
FOUNDRY



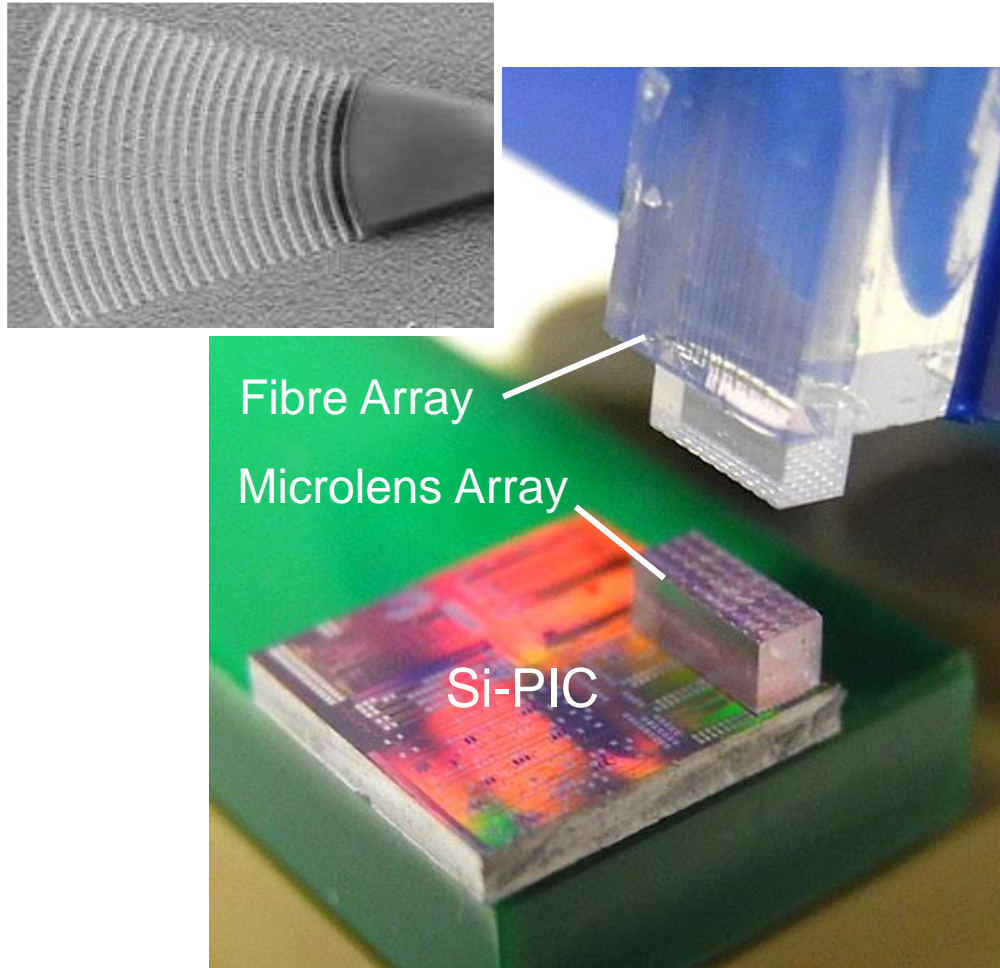
AIM
photonics



Pluggable Optical Fiber Packaging



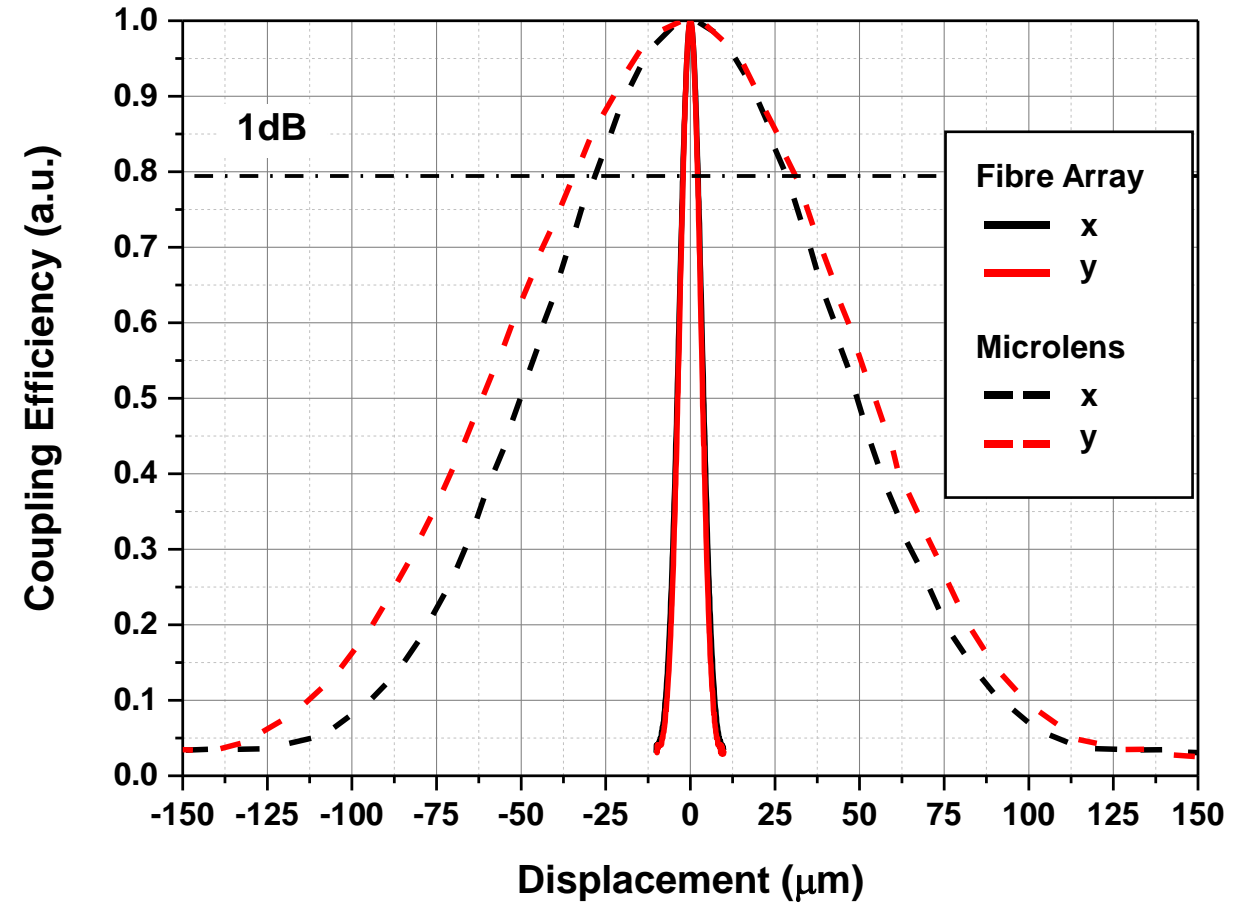
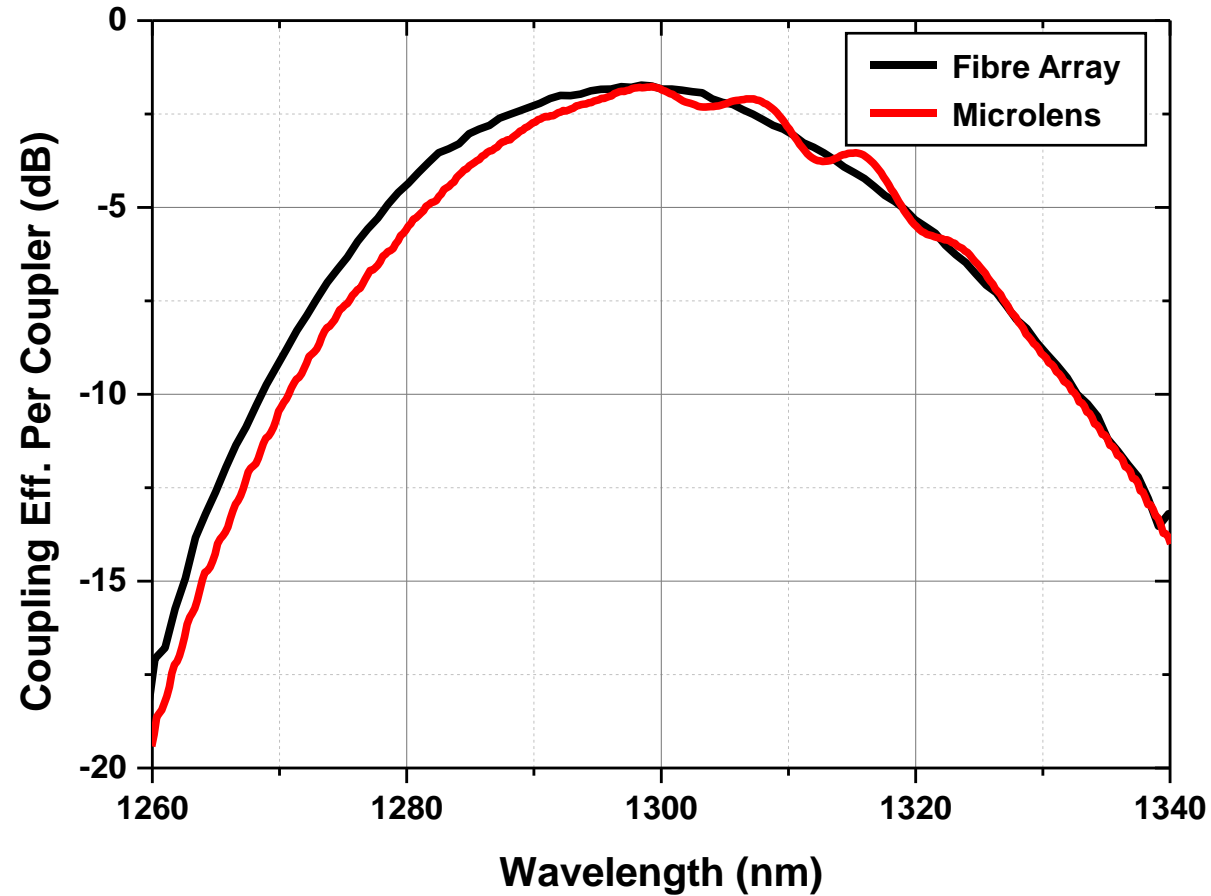
Pluggable Optical Fiber Packaging (Grating Couplers)



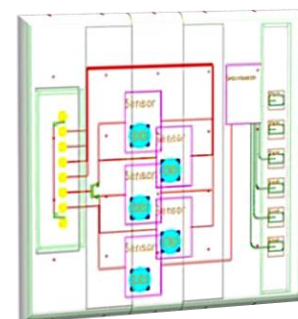
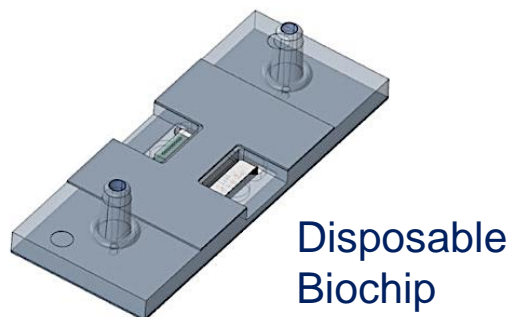
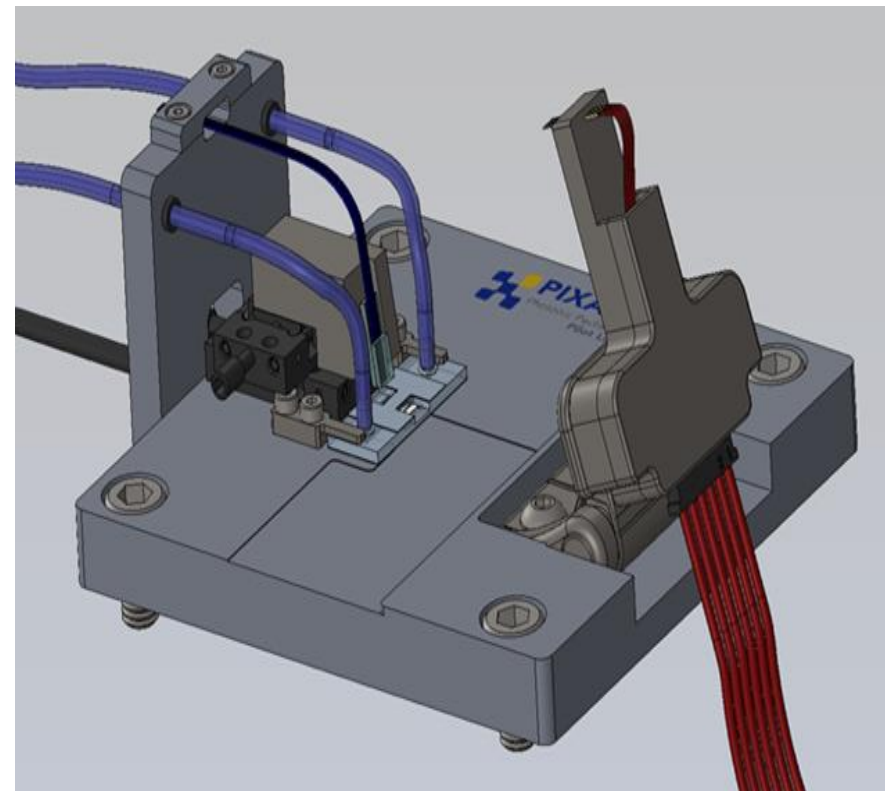
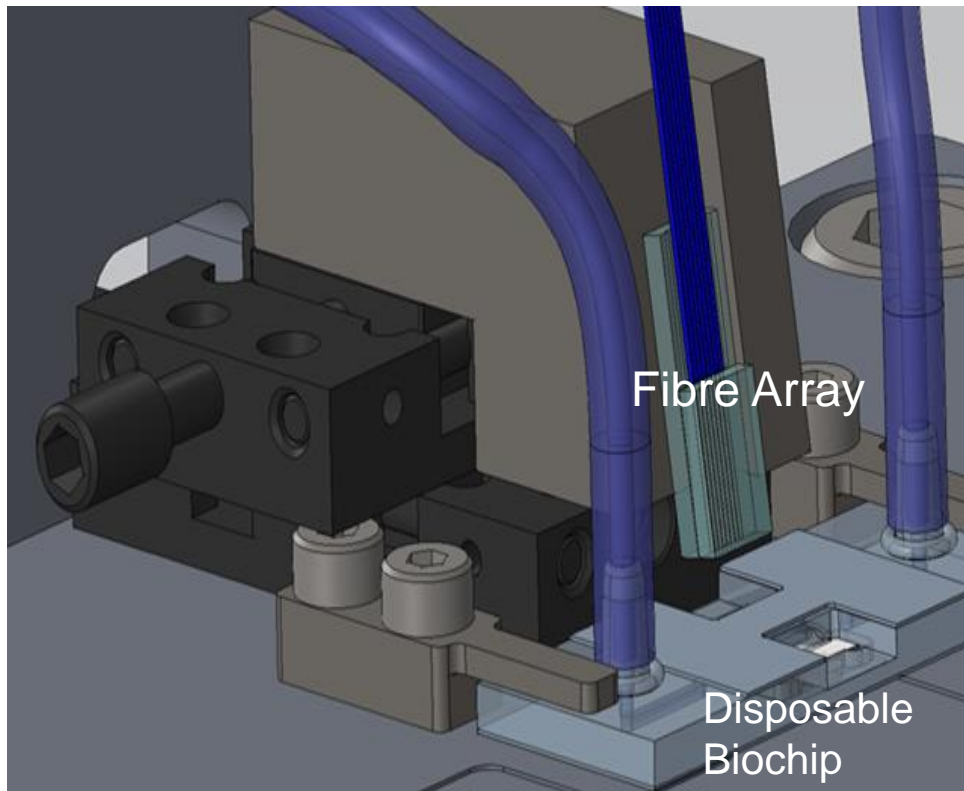
'Pluggable single-mode fiber-array-to-PIC coupling using micro-lenses', IEEE Photon. Tech. Letters, Sept 2017.



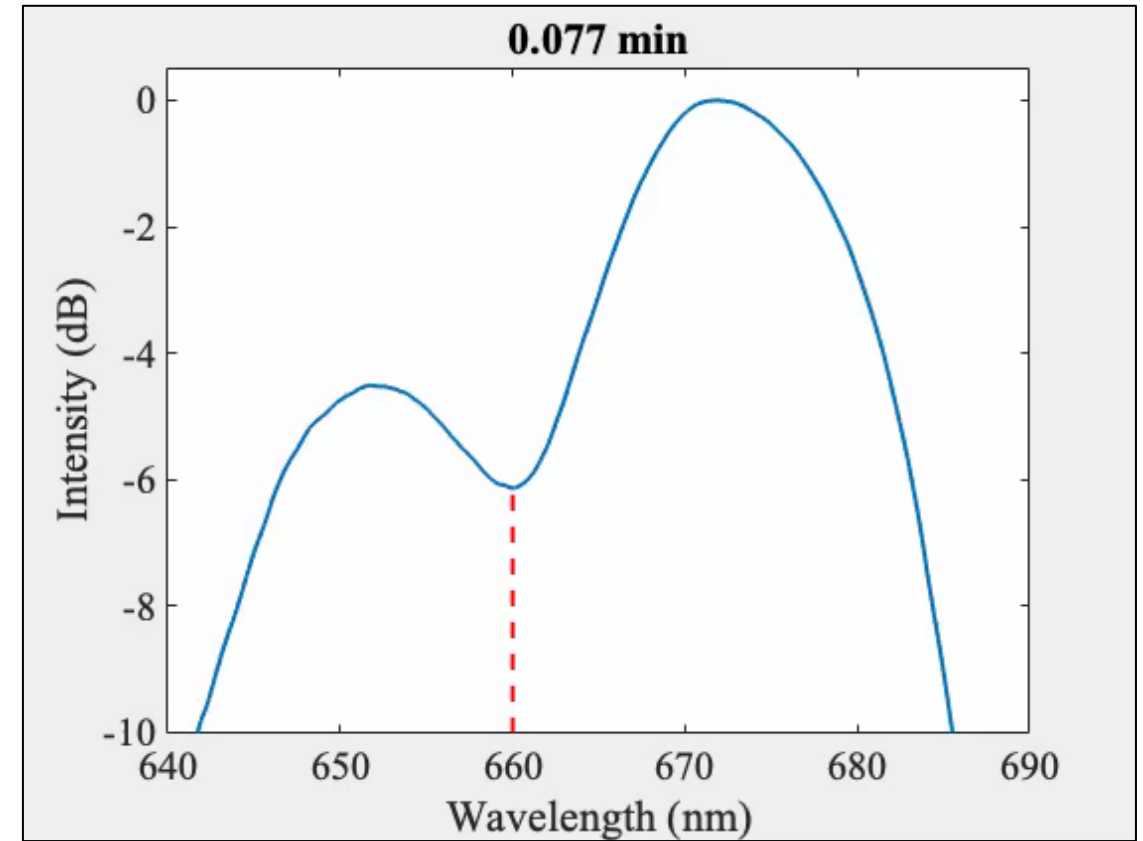
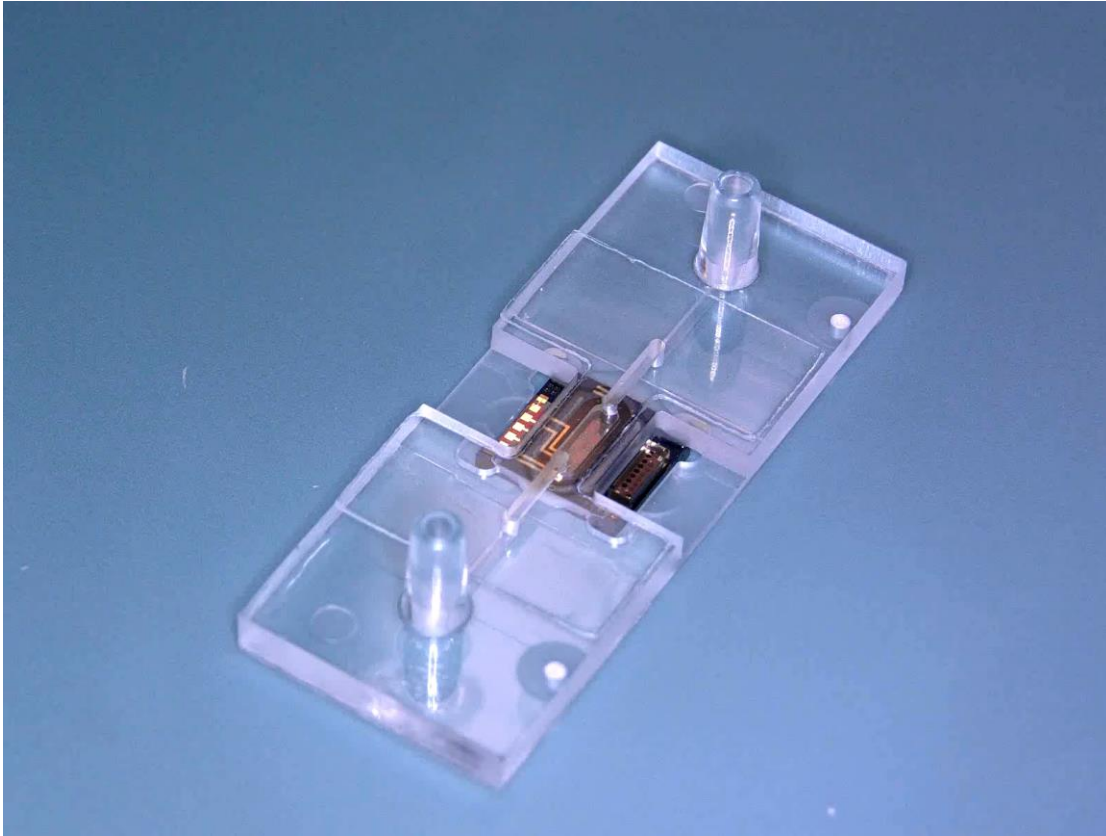
Pluggable Optical Fiber Packaging (Grating Couplers)



Pluggable Optical Fiber Packaging (Biosensor)



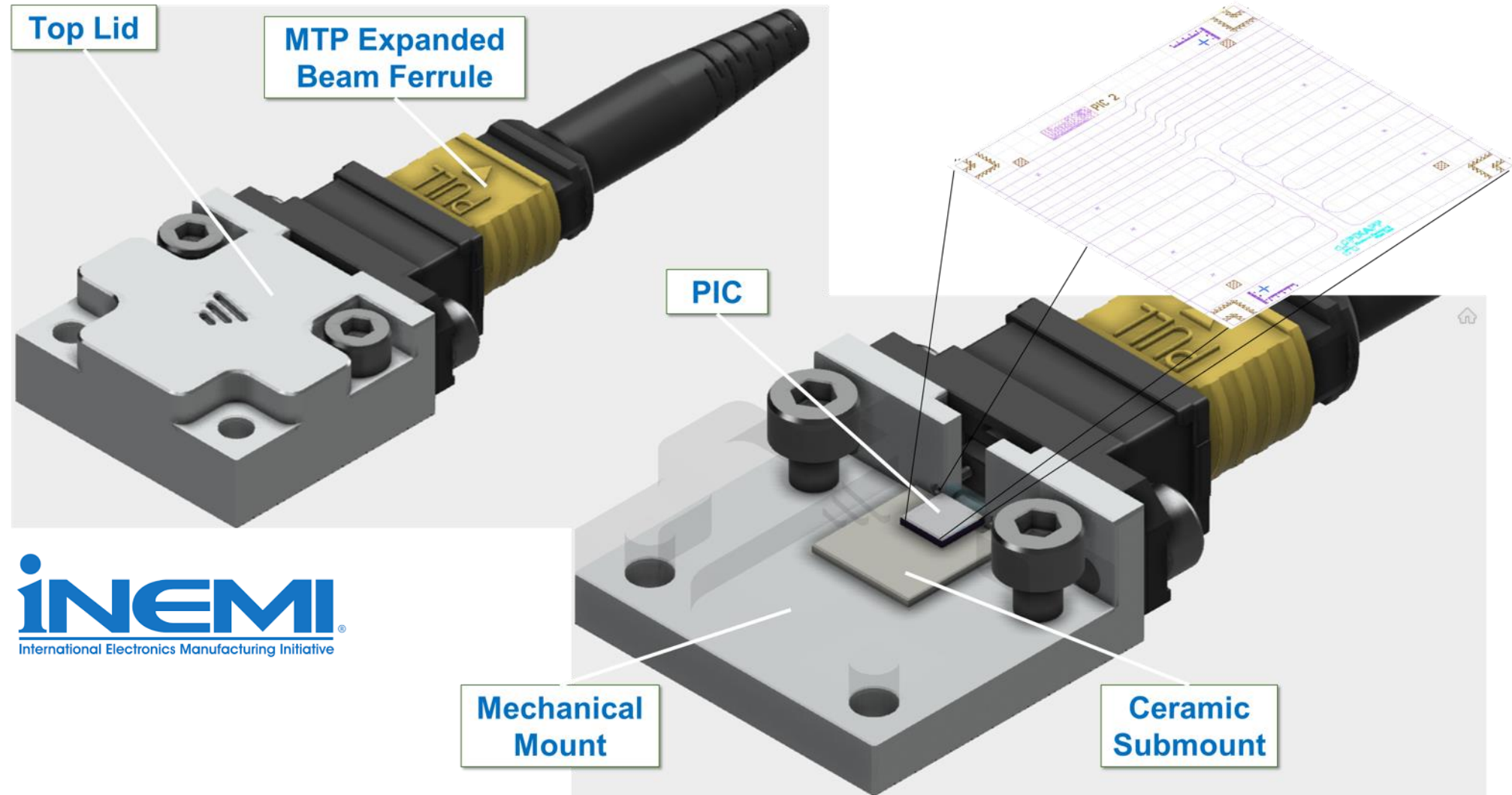
Pluggable Optical Fiber Packaging (Grating Couplers)



PIXAPP Biomedical Demonstrator

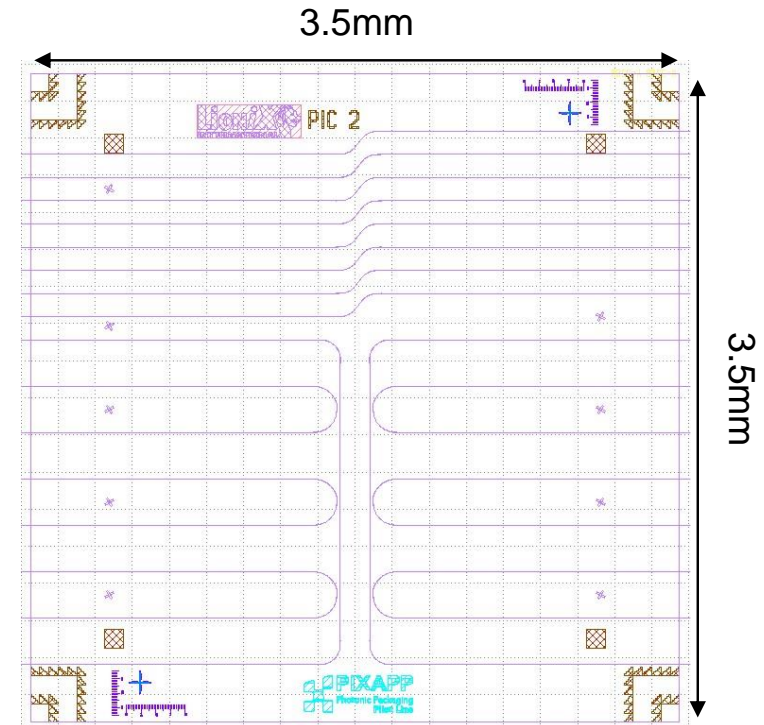
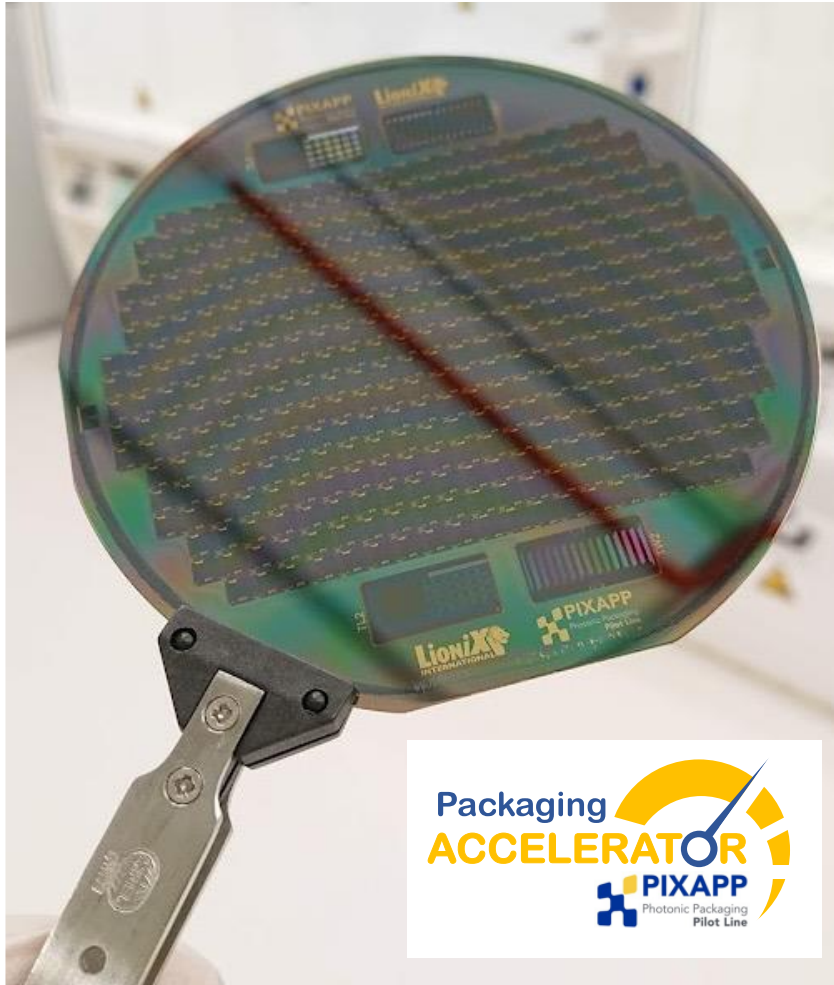


Pluggable Optical Fiber Packaging (Edge Couplers)

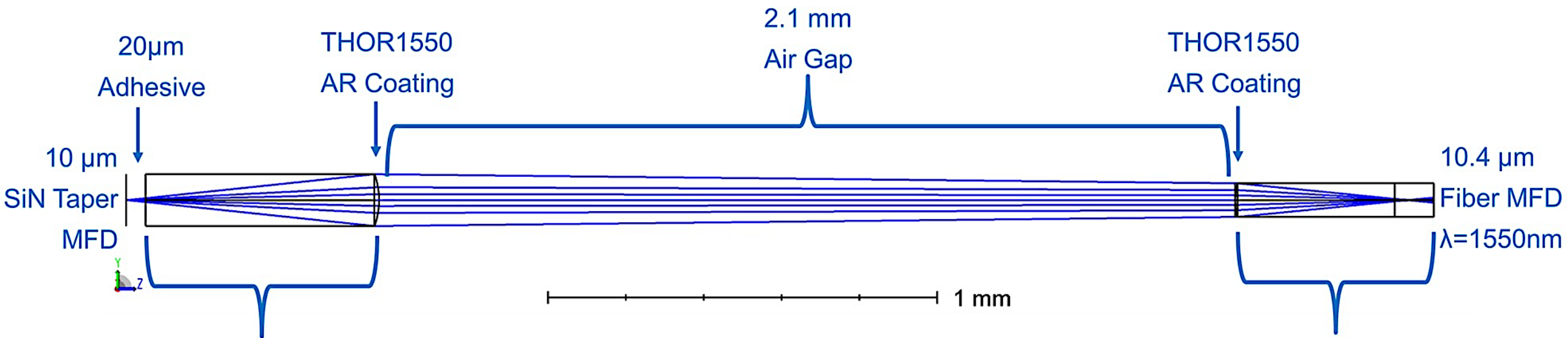


iNEMI
International Electronics Manufacturing Initiative

Pluggable Optical Fiber Packaging (Edge Couplers)



Pluggable Optical Fiber Packaging (Edge Couplers)



SUSS Lens Array #18-00997

<https://shop.suss-microoptics.com/collections/couplers-collimators-1>

Fused Silica

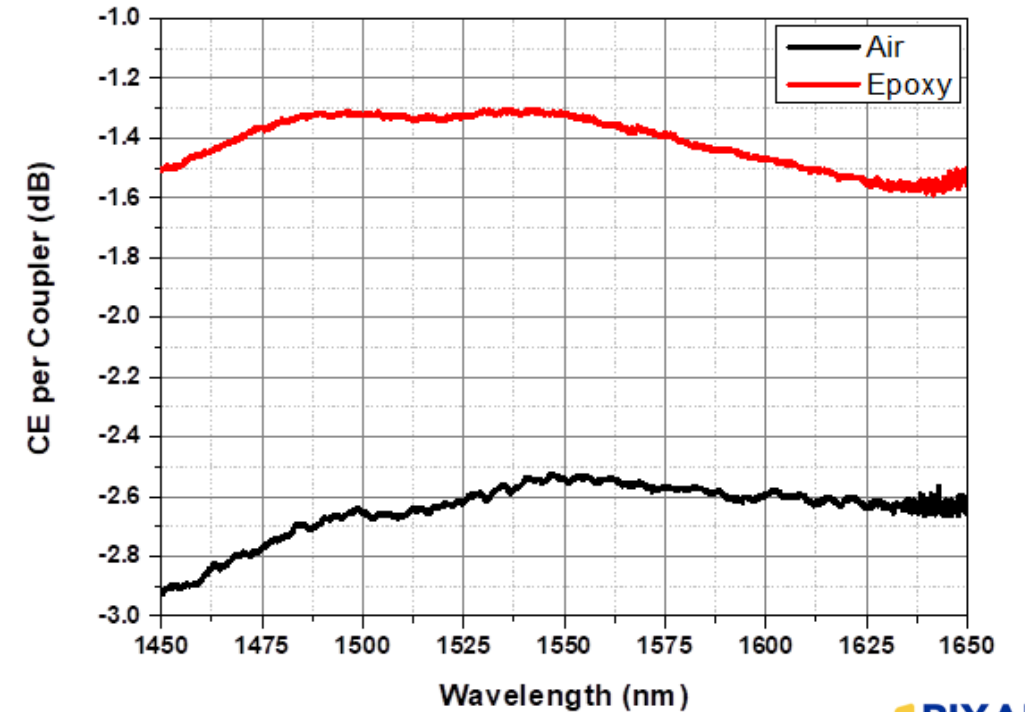
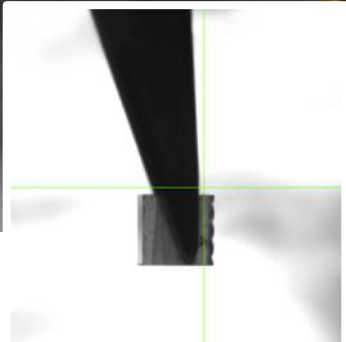
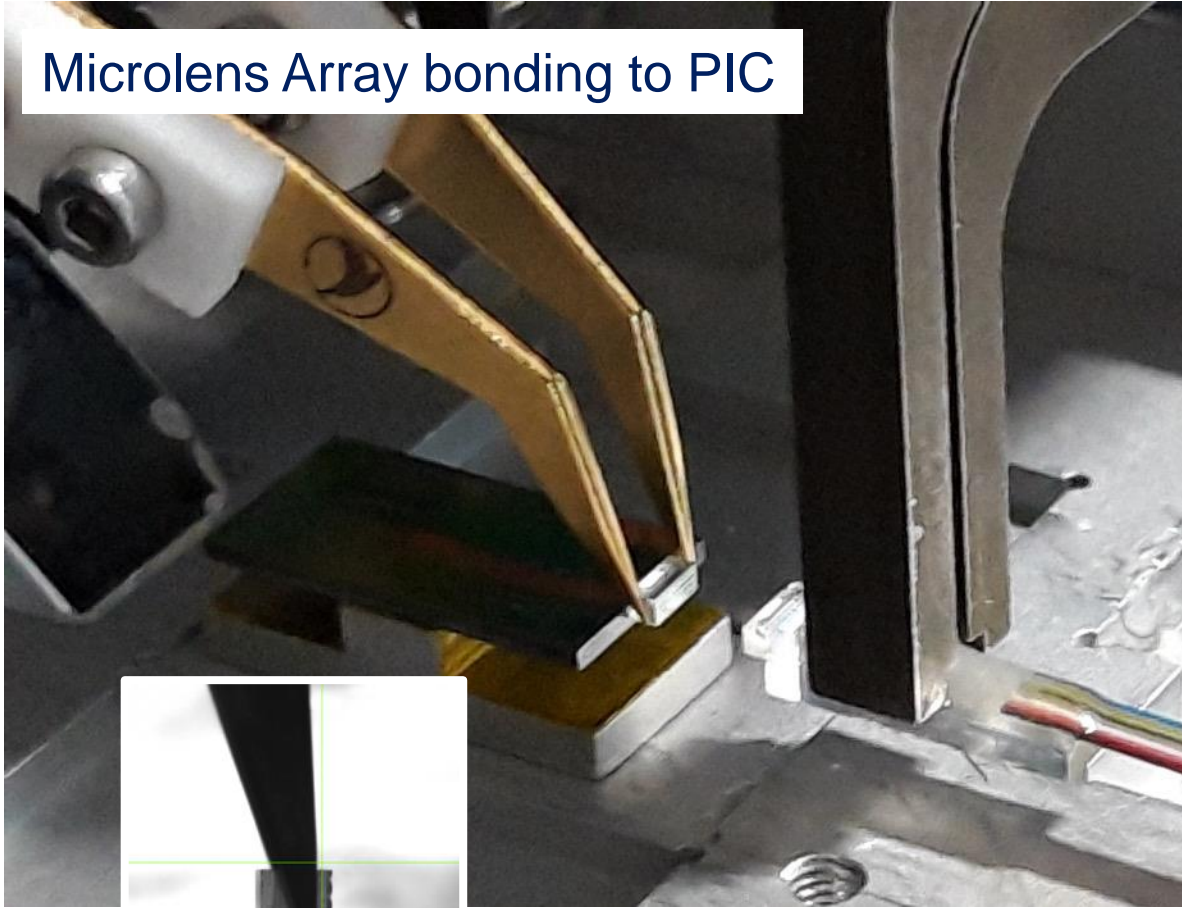
Thickness=0.6mm

Radius of Curvature=0.192mm

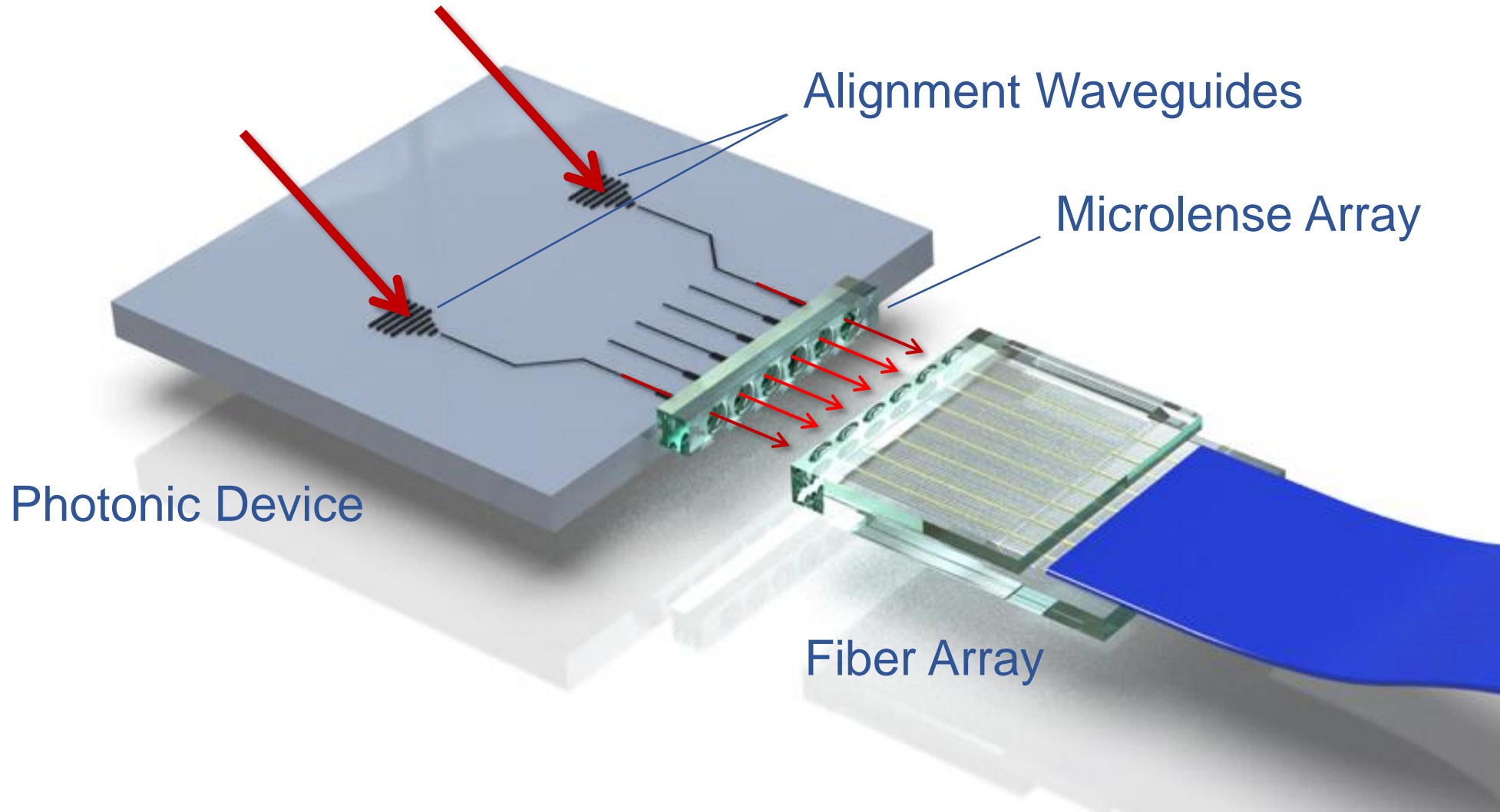
**MT Expanded
Beam Ferrule**

Pluggable Optical Fiber Packaging (Edge Couplers)

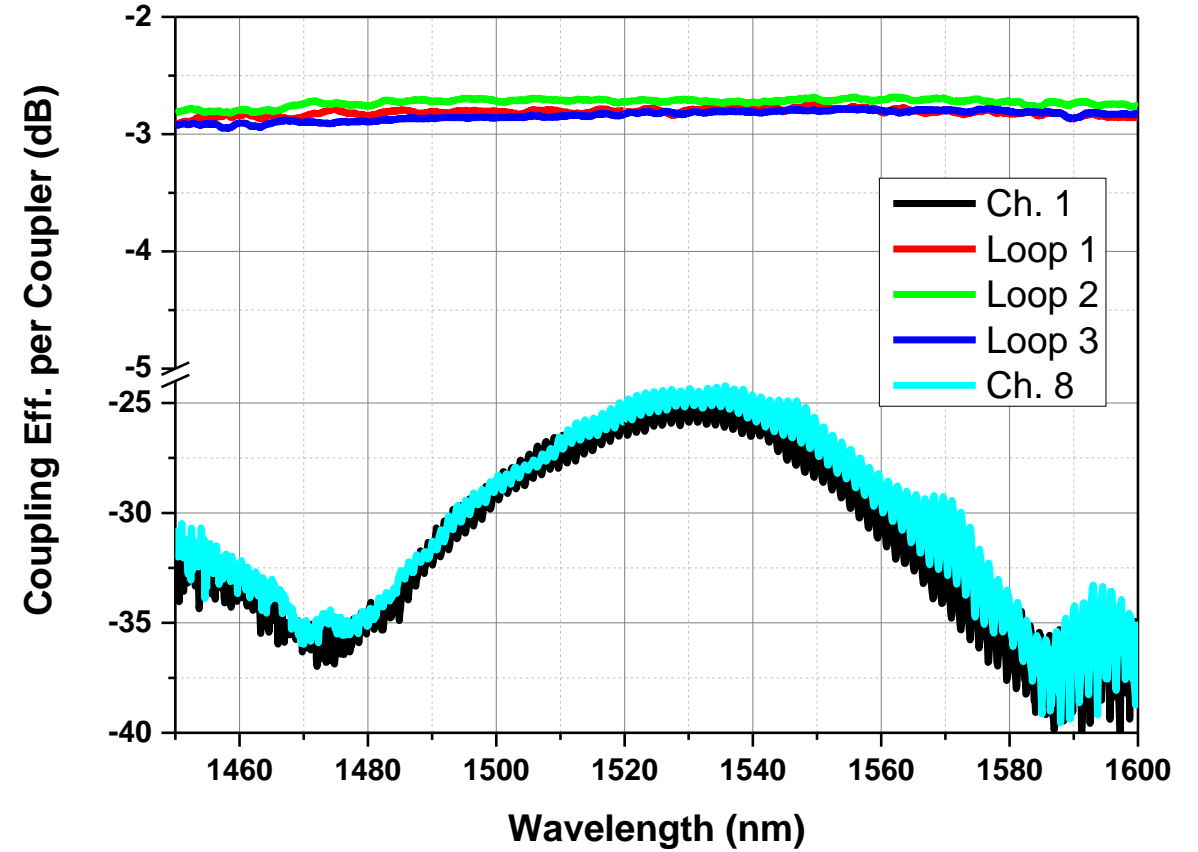
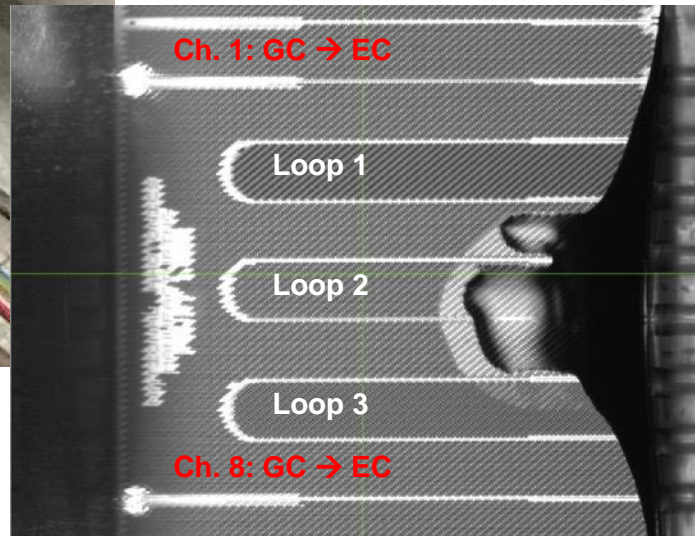
MicroLens Array bonding to PIC



Pluggable Optical Fiber Packaging (New Design Rule)

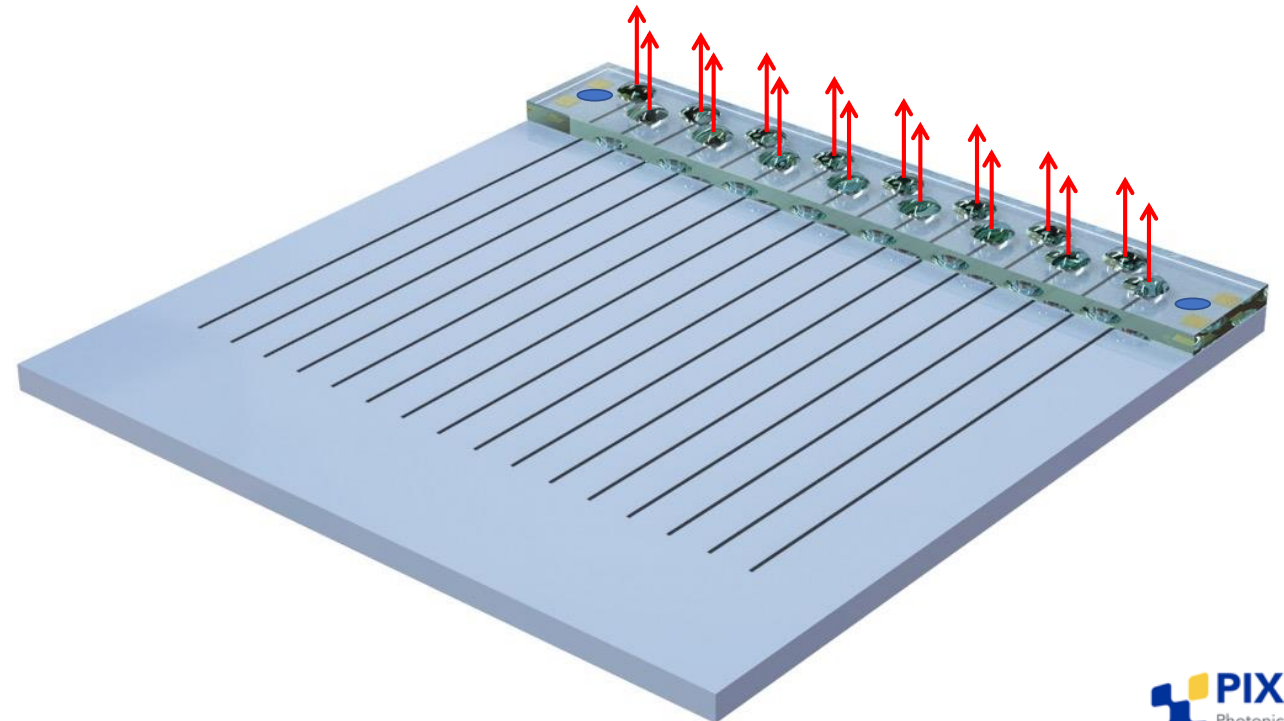
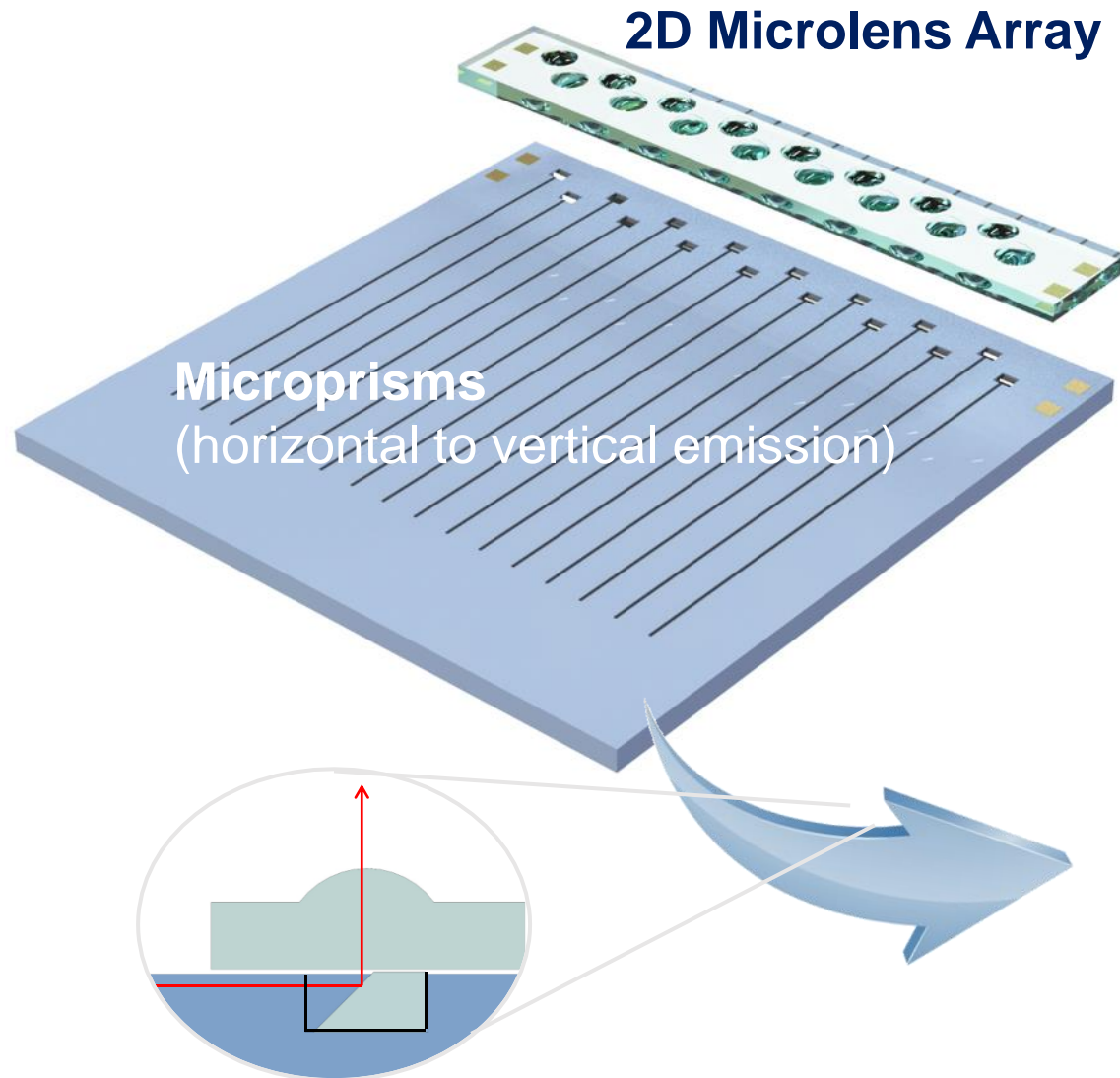


Pluggable Optical Fiber Packaging (New Design Rule)

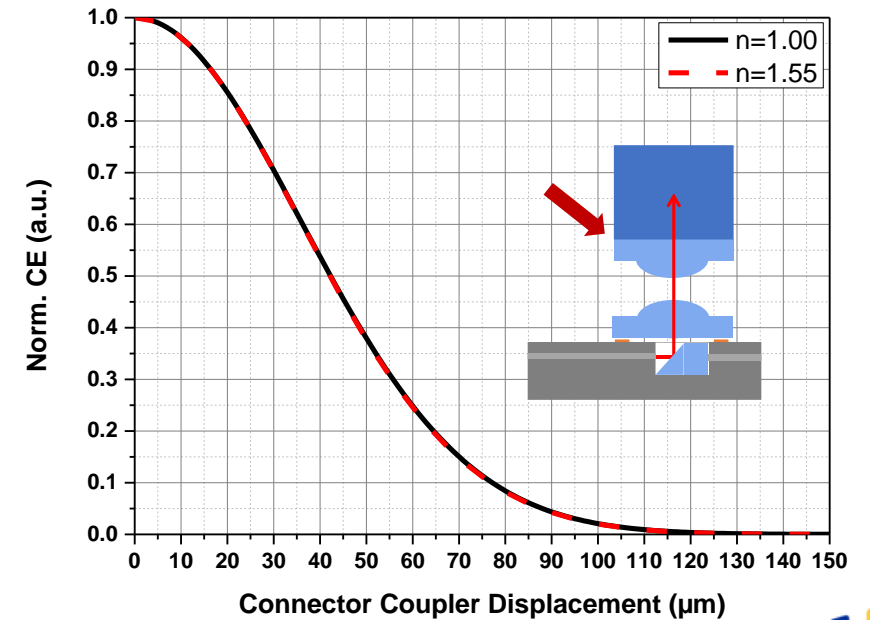
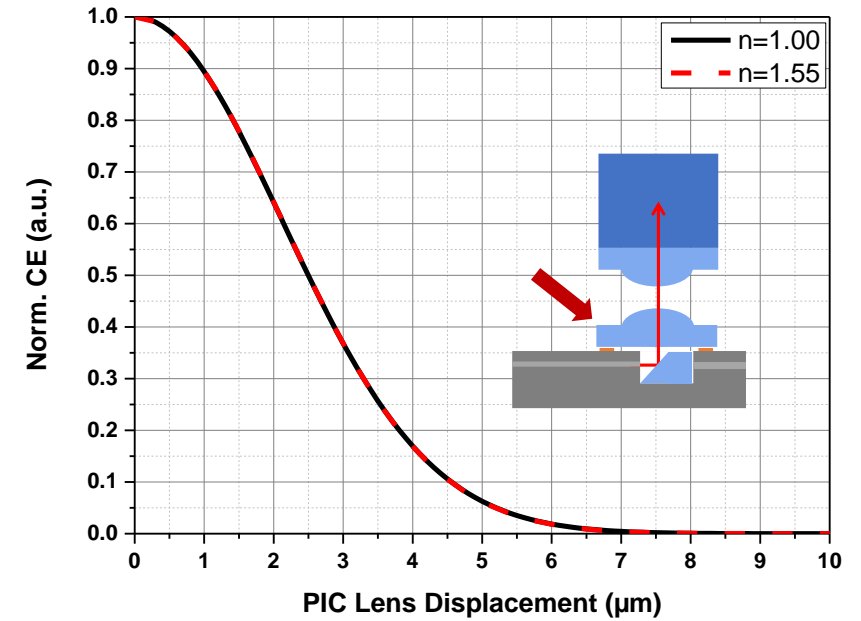
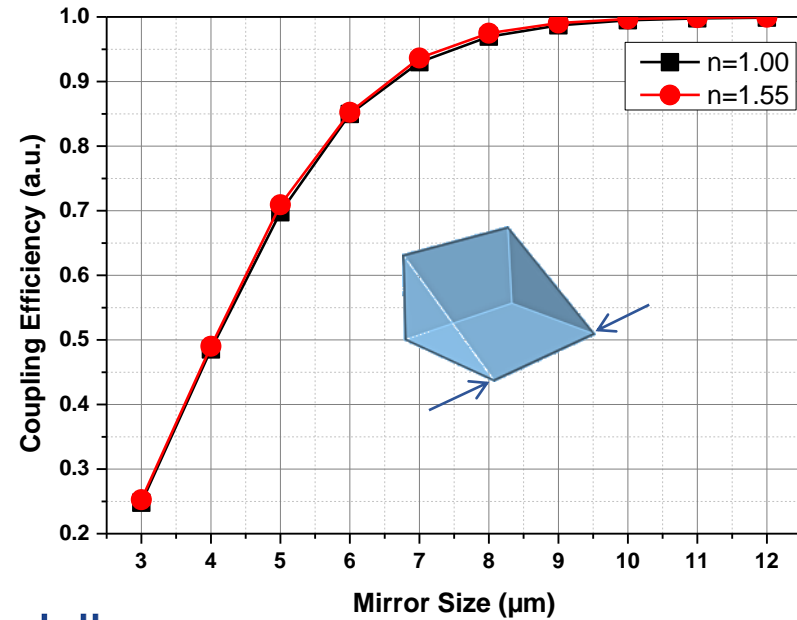
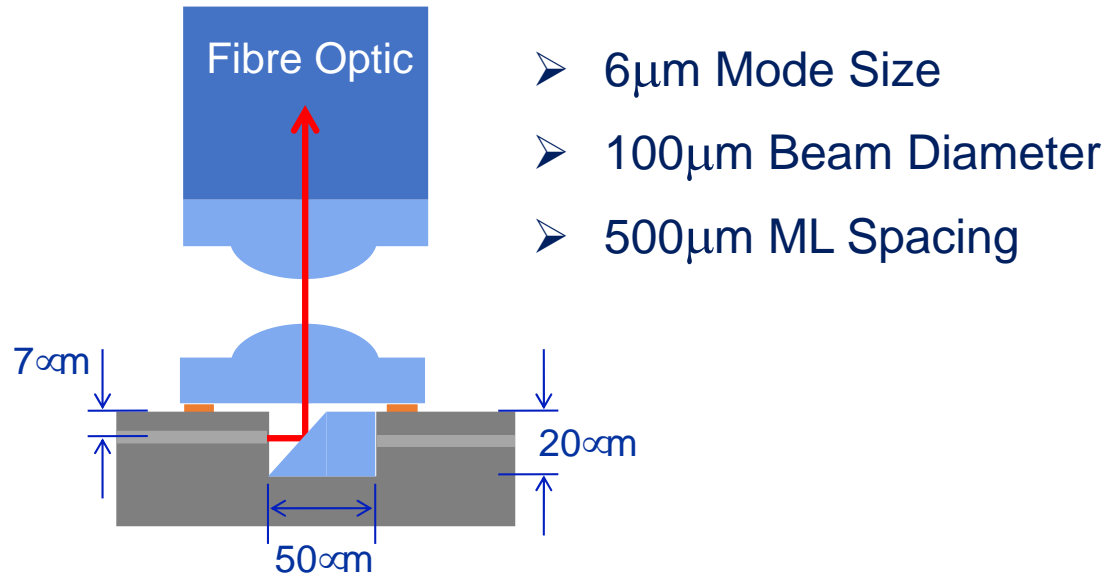


Wafer-Level Optical Packaging & Testing

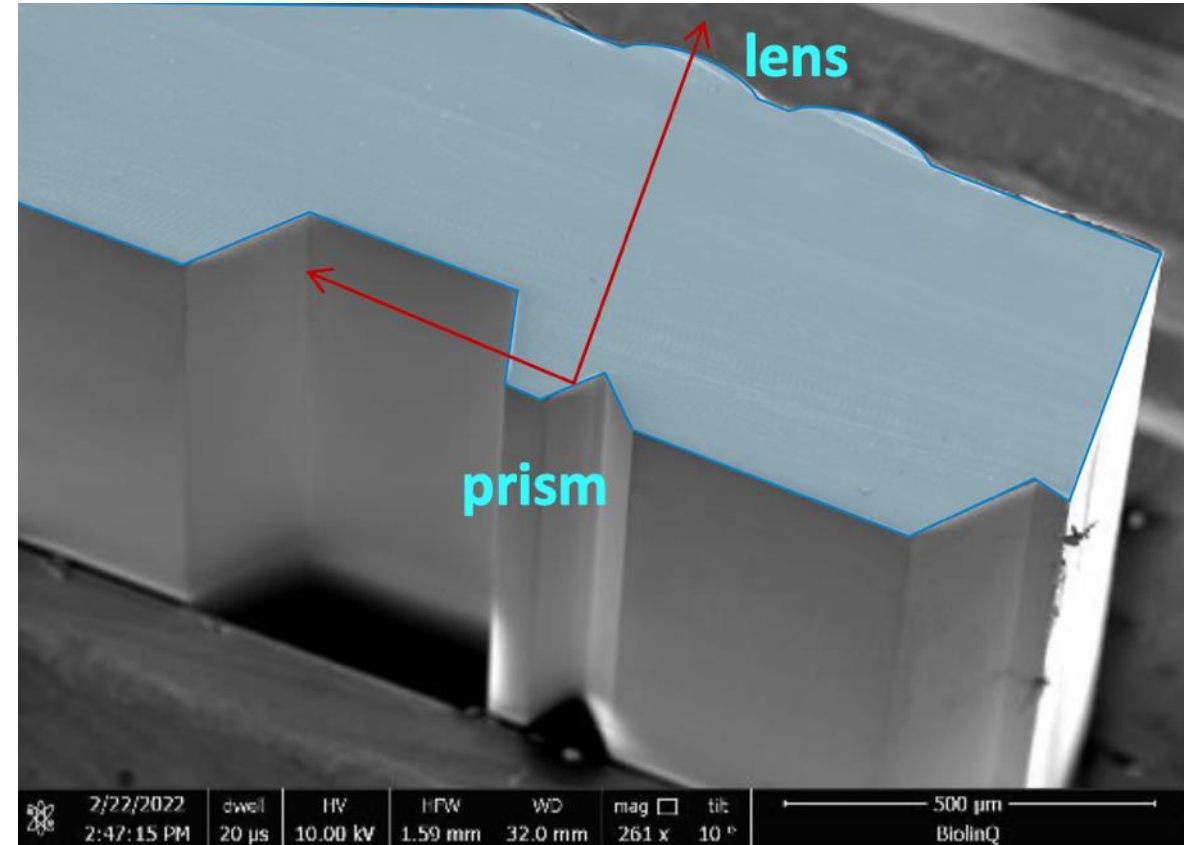
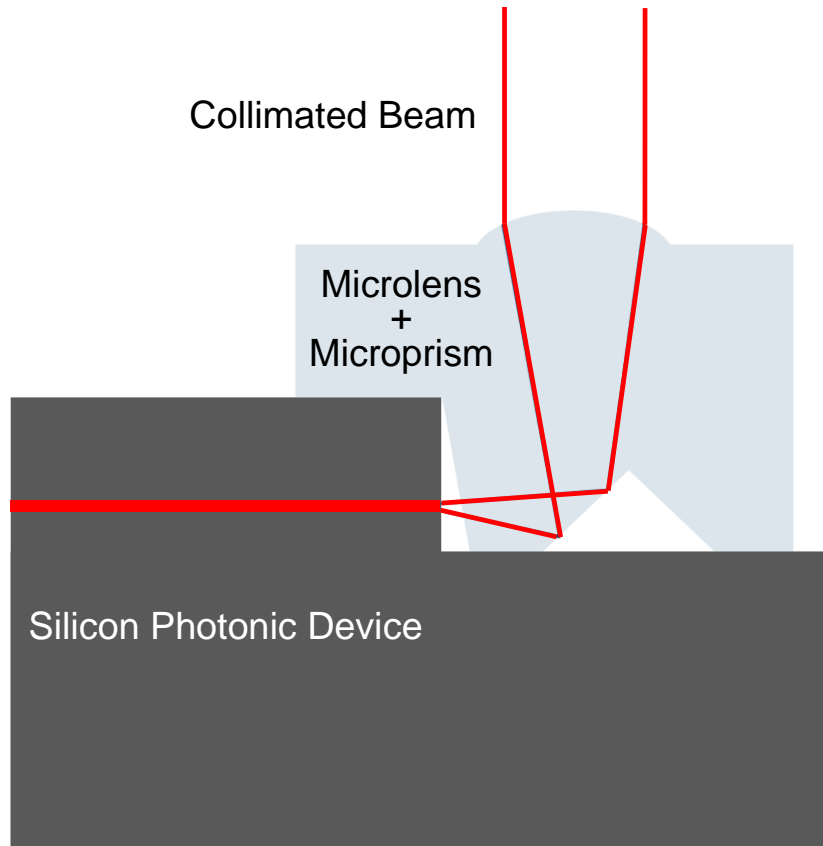
- **Heterogeneous Micro Optic Integration (μ TP)**
- **Shoreline Density (2D array)**
- **Packaging** (improved machine vision process)
- **Solder Bonding** (reflow compatible)
- **Device Singulation** (no facet treatment/polishing)
- **Wafer-Level Process** (lower packaging & test cost)



Wafer-Level Optical Packaging & Testing



Wafer-Level Optical Packaging & Testing



Photonic Wafer-Level Integration
Packaging and Test Processes



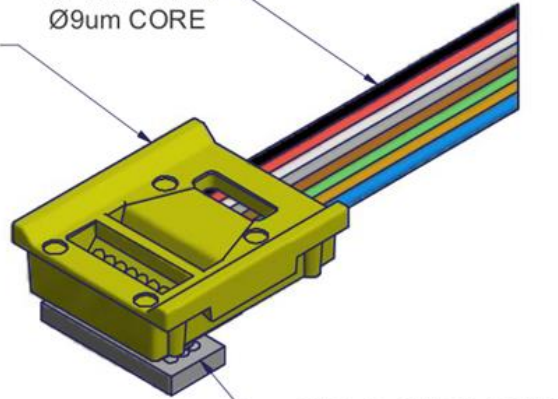
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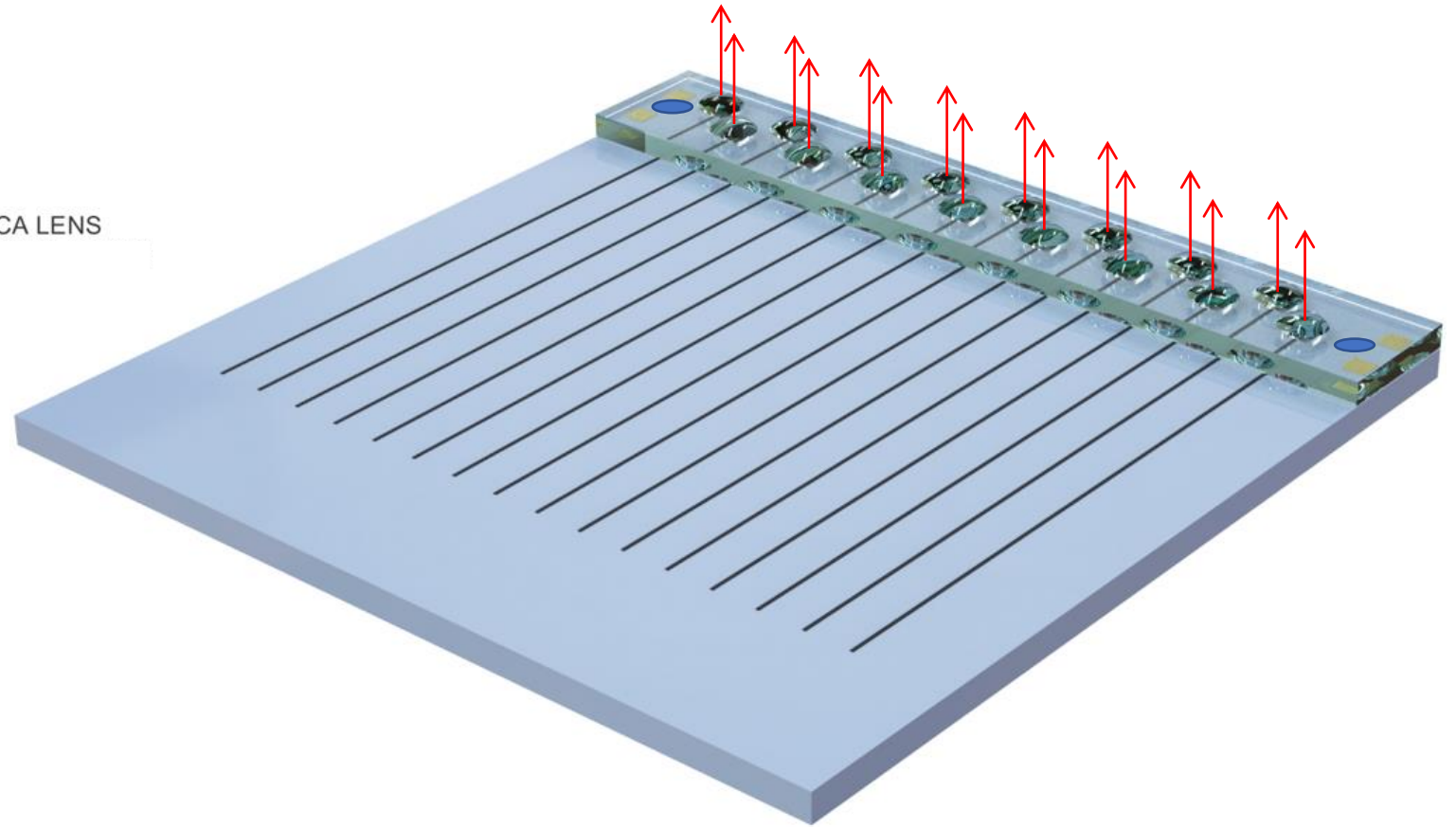
Wafer-Level Optical Packaging & Testing

USCONEC
SM PRIZM LIGHT TURN

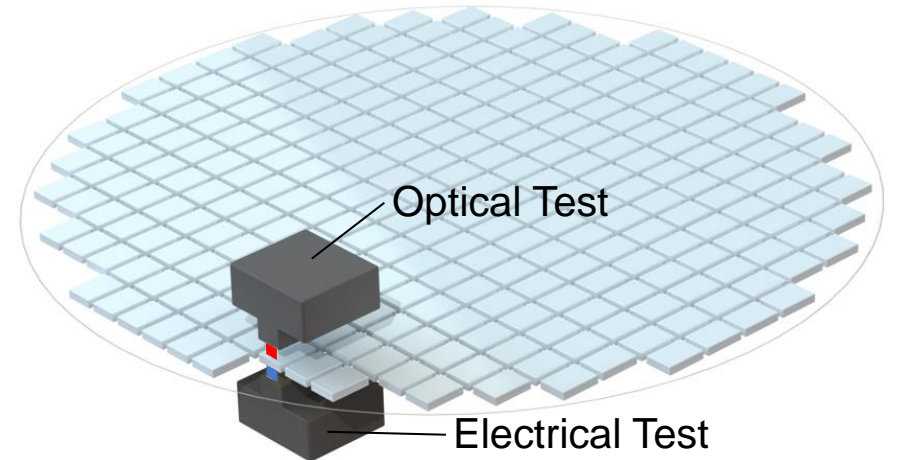
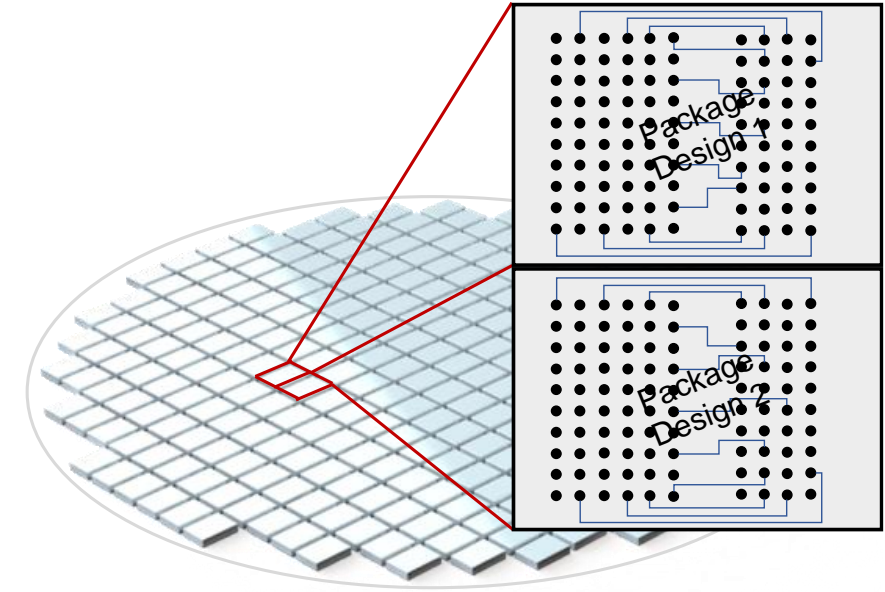
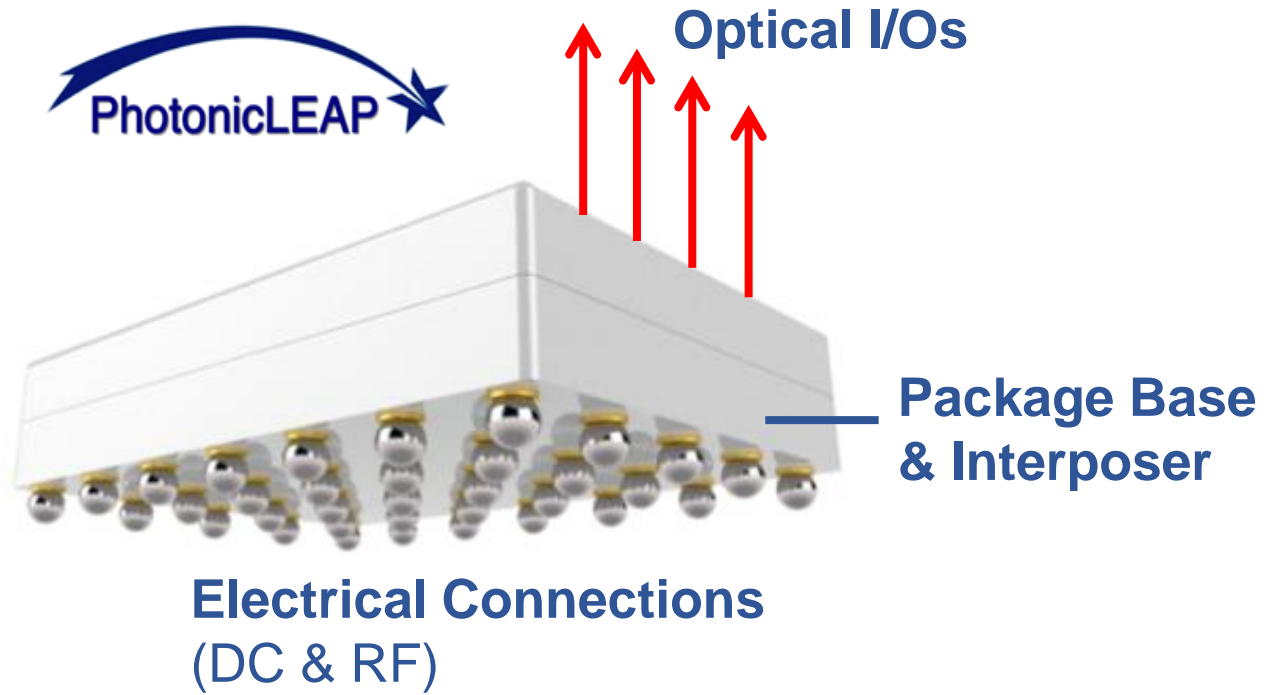
8F SM FIBER
Ø9µm CORE



FUSED SILICA LENS



Wafer-Level (Surface Mount) Photonic Packaging



Summary

- Move from package-level to **wafer-level** assembly processes
- **Bonding optical fibers** to edge of photonic device is challenging & limits possibilities
- **Micro Optics** enable free space, pluggable fibre connectors and wafer-level assembly
- Surface coupling enables **higher shoreline densities** (2D arrays)
- Surface coupling enables **high throughput manufacturing**
- Surface coupling enables **electronic style** packaging and test processes

PhotonHub Europe Workshop



Integrated Photonics Design, Fabrication & Packaging
Basel, September 20th, 2022

(See ECOC or PhotonHub websites)



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