



Guillaume Basset
Focus Area Manager Photonics

Photonics for Datacenters, EPFL, 05.09.2025

PHOTONICS FOR DATACENTERS AT CSEM



CSEM AT A GLANCE

We are a public-private, non-profit Swiss **technology innovation center**

We enable competitiveness by **developing and transferring world-class technologies to the industrial sector**



1984
FOUNDED



630
SPECIALISTS



107.6
M TURNOVER
in 2023



177
PATENT
FAMILIES



> 50
VENTURES
since 1984

WE ARE 100% INDUSTRY-FOCUSED

Staff with industry experience

Long-term support
(80% of staff on permanent contract)

Processes with built-in confidentiality



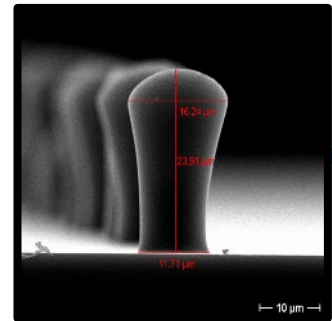
Industrial equipment
(clean rooms, characterization labs)

Proven project management methodology
(300 projects/year)

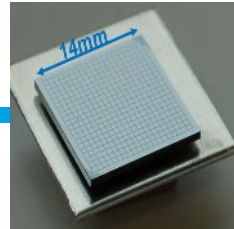
QMS & certifications
(ISO 9001 and 14001,
ISO 13485: Medical devices)

PHOTONICS AT CSEM OVERVIEW

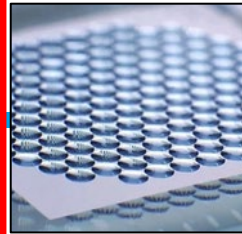
PHOTONICS AT CSEM



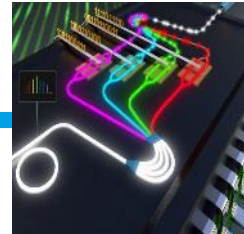
Components



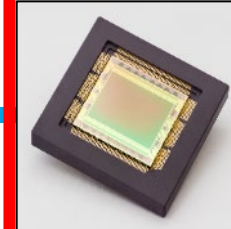
MOEMS



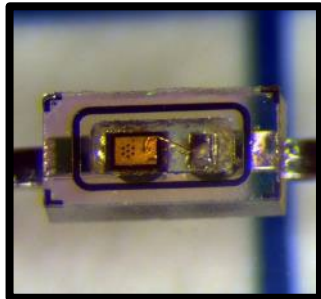
Micro Optics



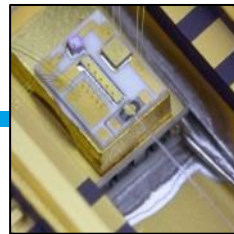
TFLN PICs



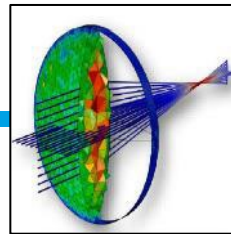
Imaging sensors



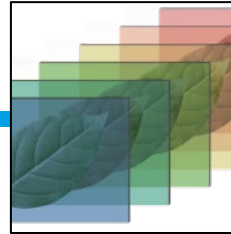
Technologies



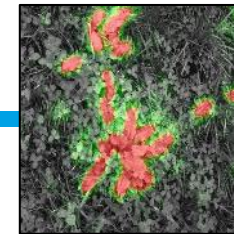
PIC Design,
Testing, Consulting
for Integration



Optical Design:
Zemax, Comsol,
LightTools, FDTD



Metrology & Vision,
Multispectral
Imaging



ML & AI



Systems



Lasers



Cameras




Lidar



Sensing Systems,
Readout Modules

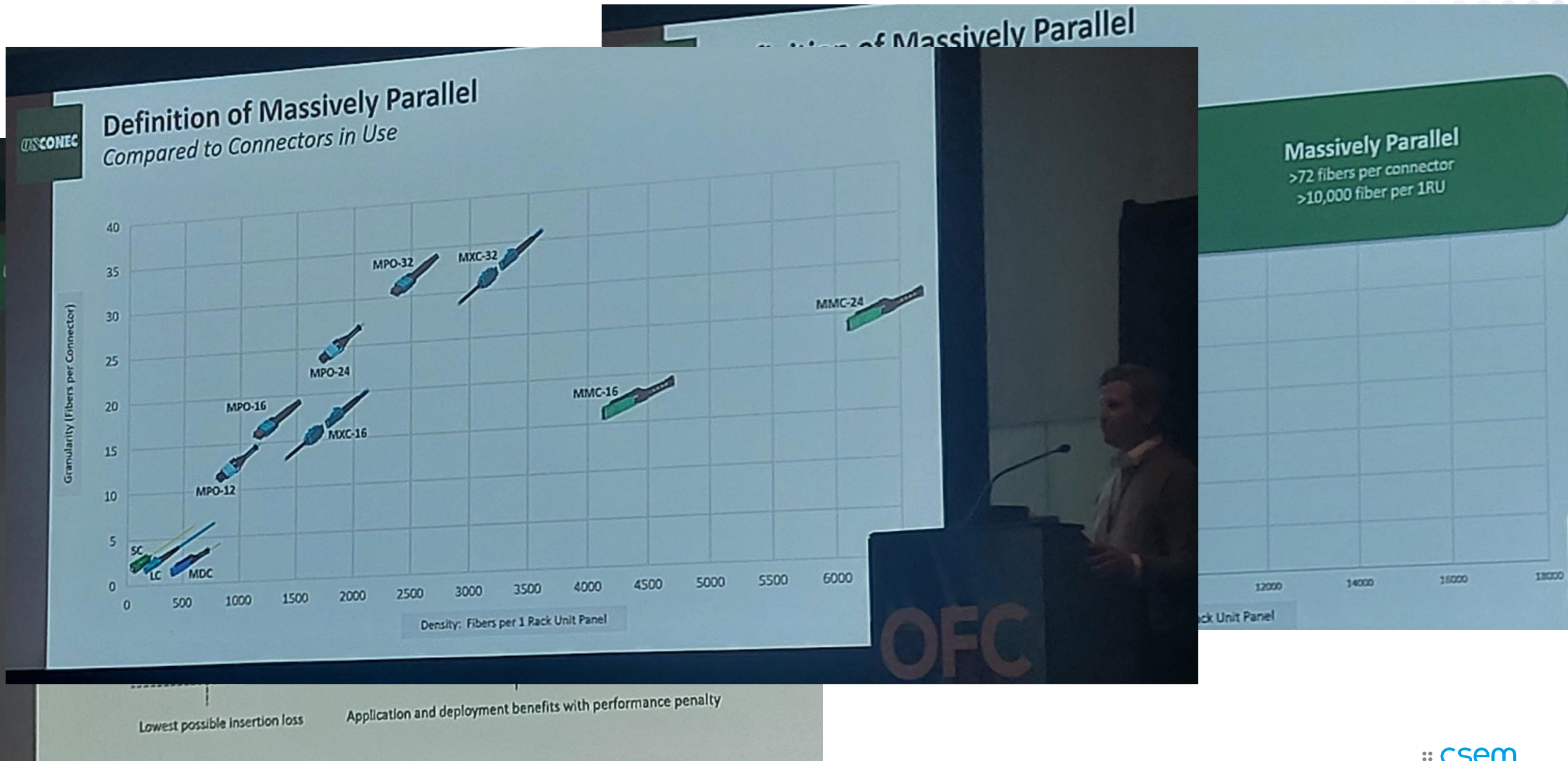
Many industrial
partners & EU/global
Partnerships:



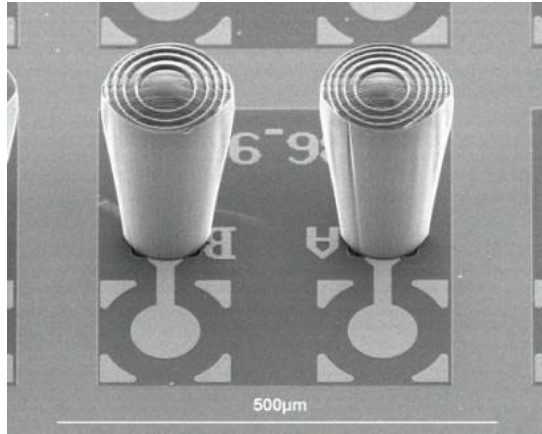


EXPANDED BEAM CONNECTORS FOR DATACOM LARGE FIBER ARRAYS

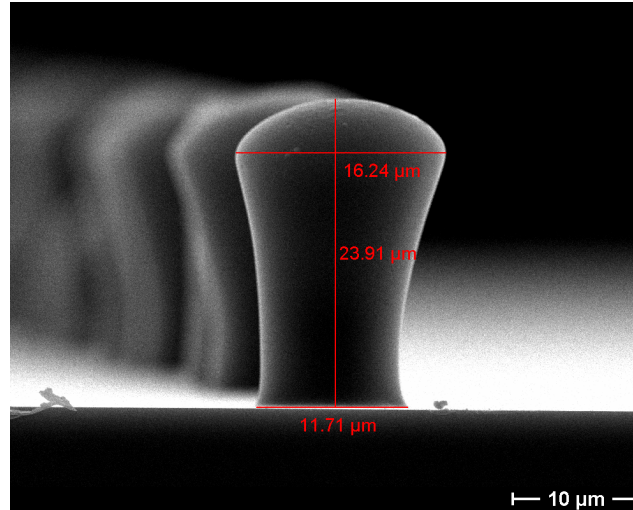
CHALLENGES IN FIBER TO FIBER INTERCONNECTS



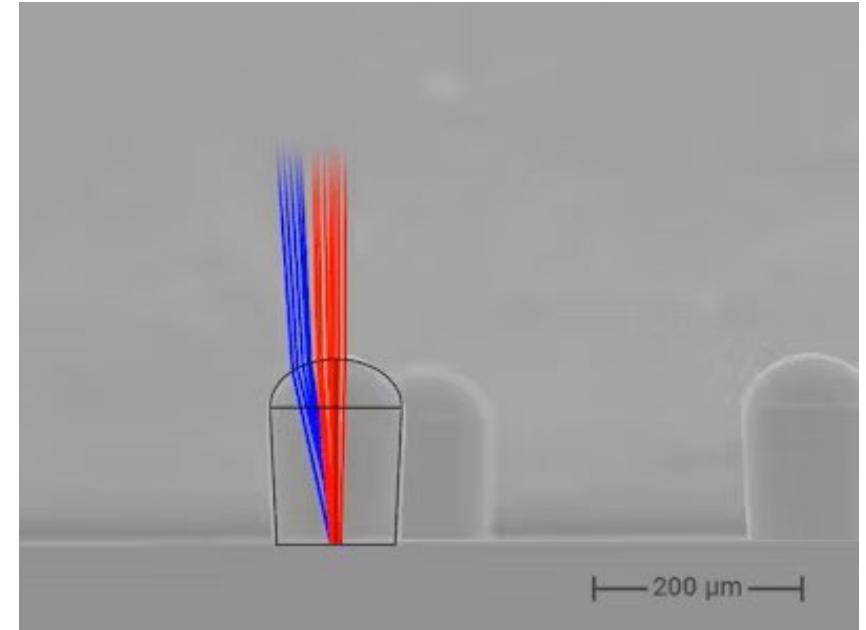
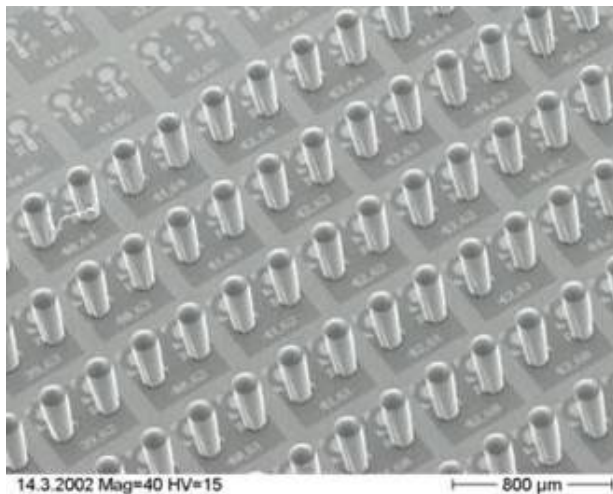
MICRO-OPTICS INTEGRATED ON LIGHT EMITTERS



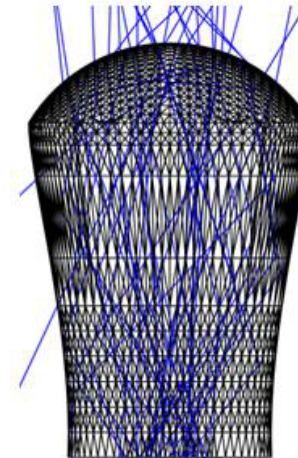
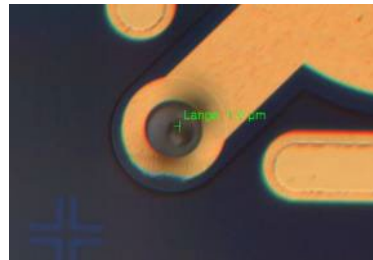
VECSEL beam-shaping



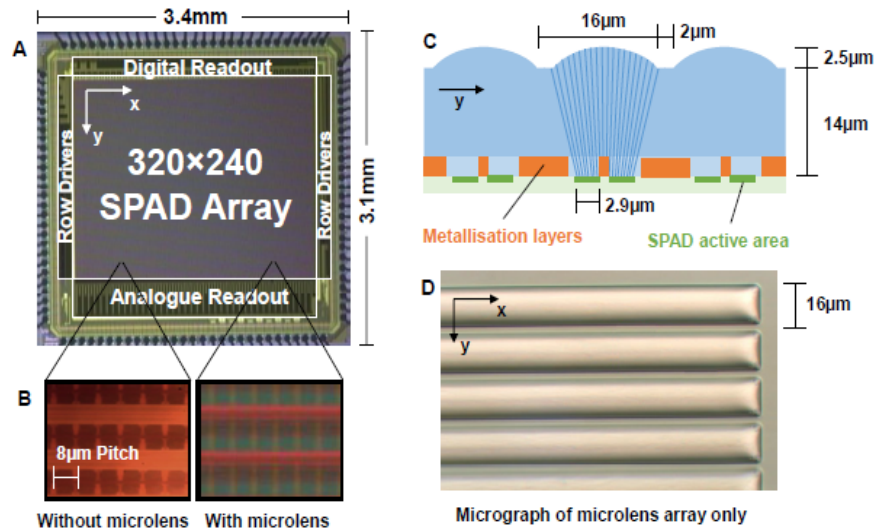
Micro-LEDs beam-shaping



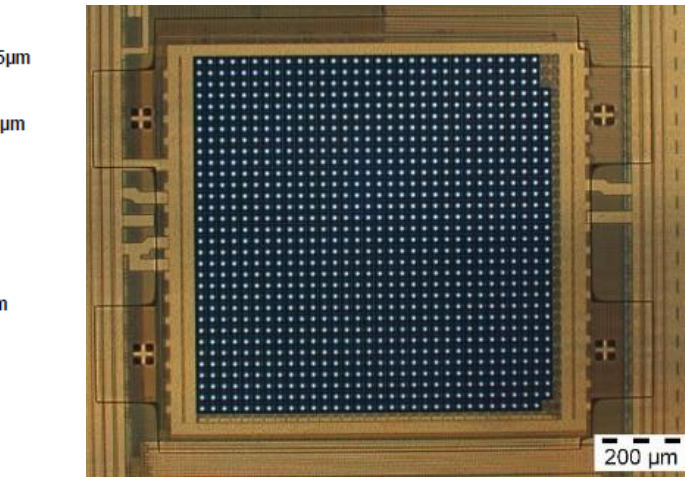
Microlens on PIC C-band grating coupler (1490 and 1610 nm) for beam-shaping / fiber coupling.
Collaboration with IMEC



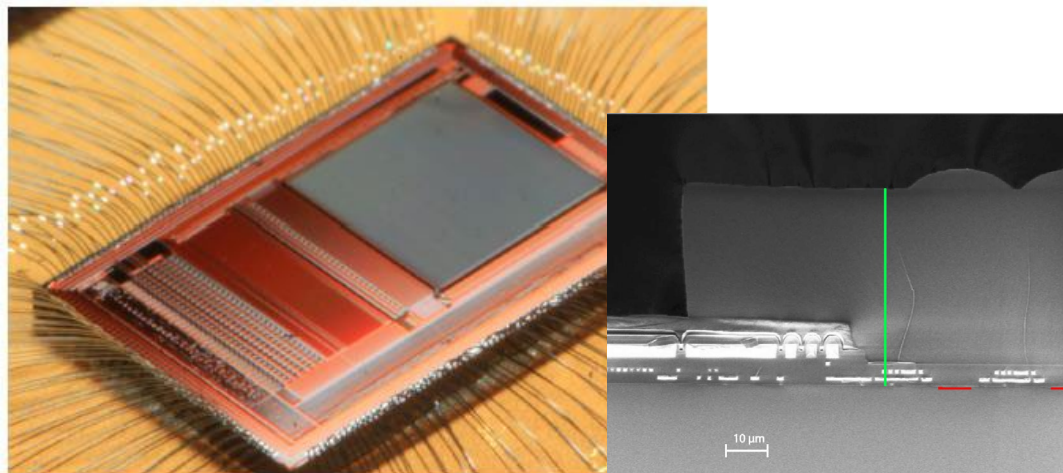
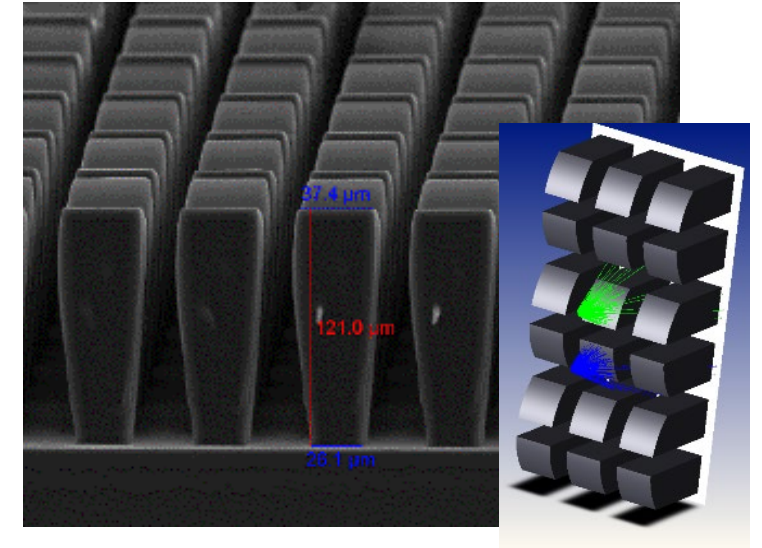
MICRO-OPTICS INTEGRATED ON ADVANCED IMAGERS



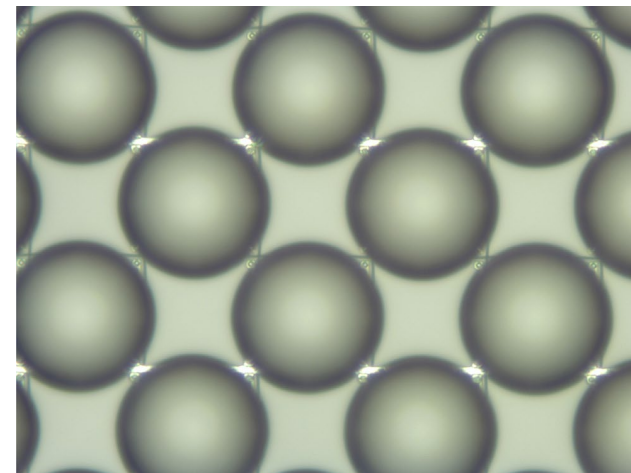
I. Gyongy et al., Optics Express, **26**, 2280-2291 (2018)



I. M. Antolovic et al., Quantum Sensing and Nano Electronics and Photonics XVI, **10926**, 359–365 (2019)



J. Mata Pavia et al., Opt. Express **22**, 4202-4213 (2014)



C. Tripl et al., Nucl. Instrum. Methods Phys. Res., A **1040**, 167216, (2022)

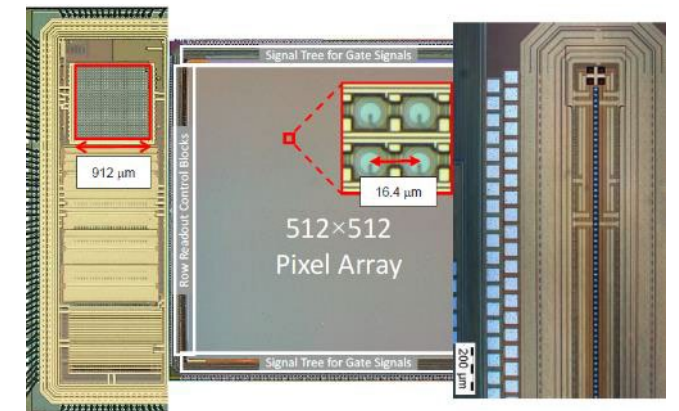


Fig. 1. Micrographs of Piccolo, a 32 × 32 SPAD array with photosensitive area on the top section, highlighted in red (left) [41,42] – see also Fig. 8 (center); SwissSPAD2 512 × 512, a gated SPAD imager with 4 pixels shown in the inset (center, featuring round SPAD active areas in this case) [45]; Detail of LinoSPAD2, a 512 × 1 linear SPAD array with top alignment cross integrated in the metal stack (right).

C. Bruschini et al., Optics Express, **31** (13), 21935-21953 (2023)

SPAD LIGHT CONCENTRATION ON MULTI-PROJECT WAFER/RETICLE → NEED FOR MULTIPLE SAG MLA

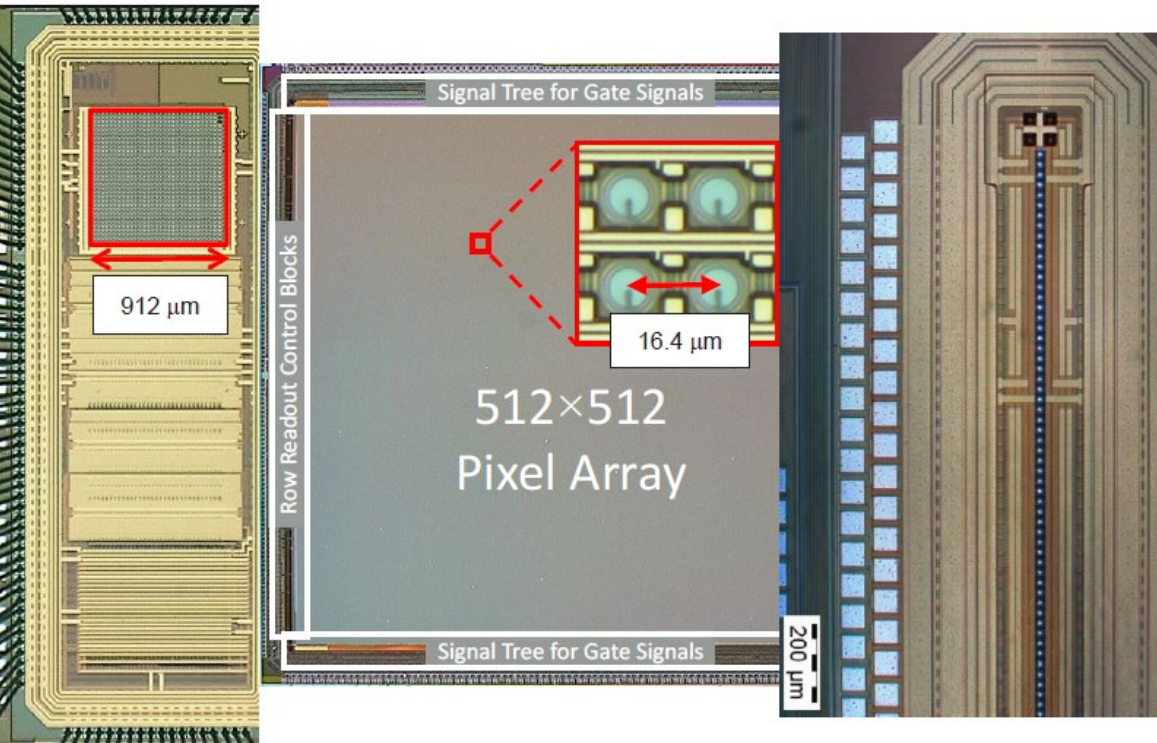
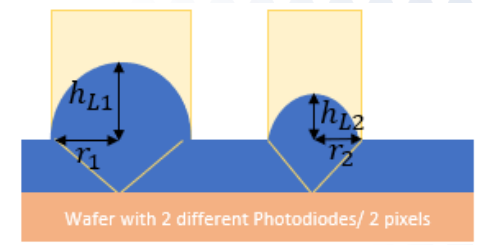
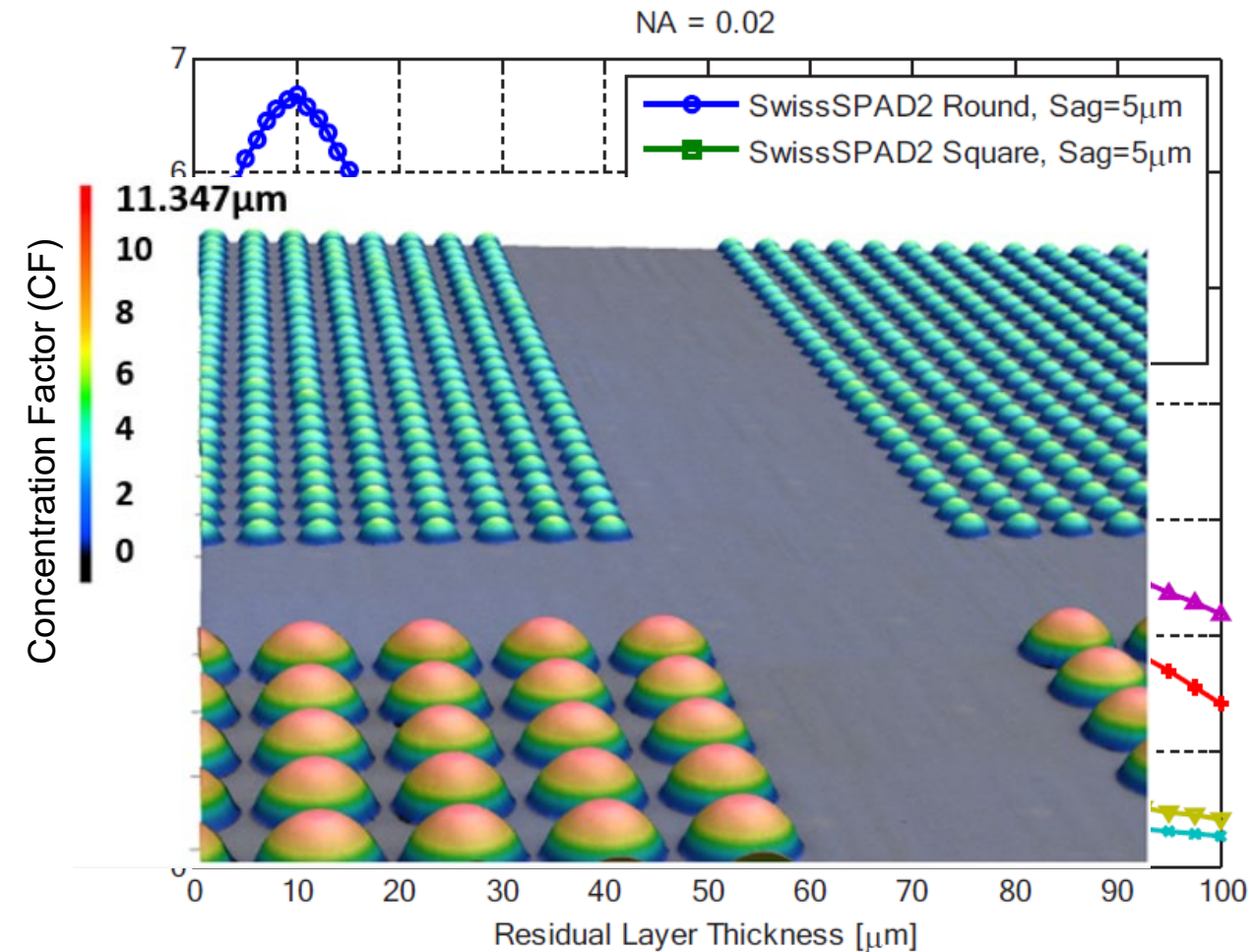


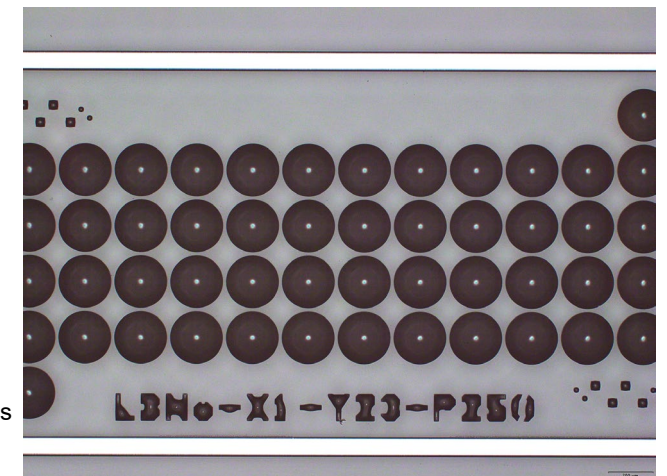
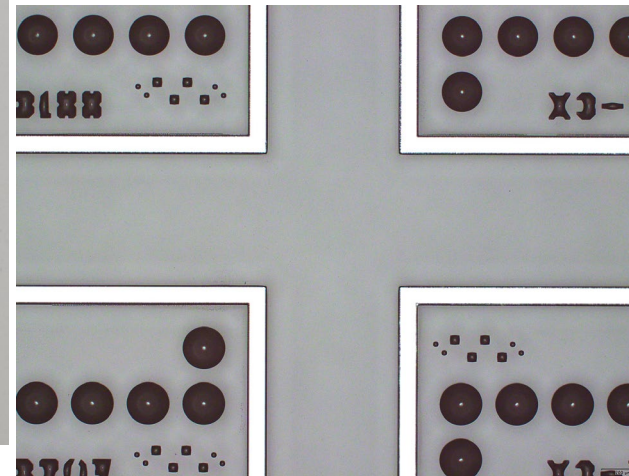
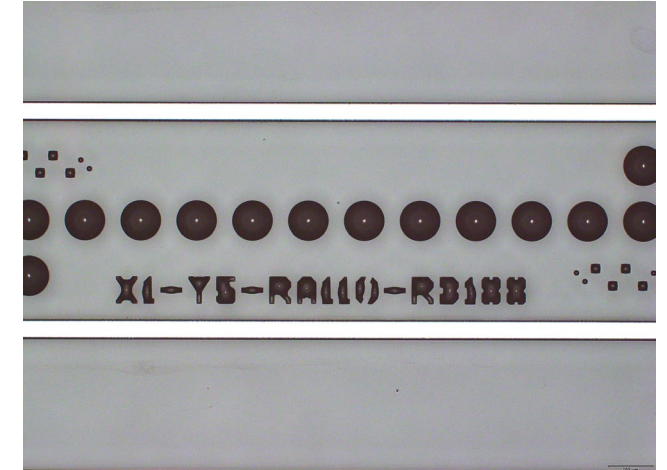
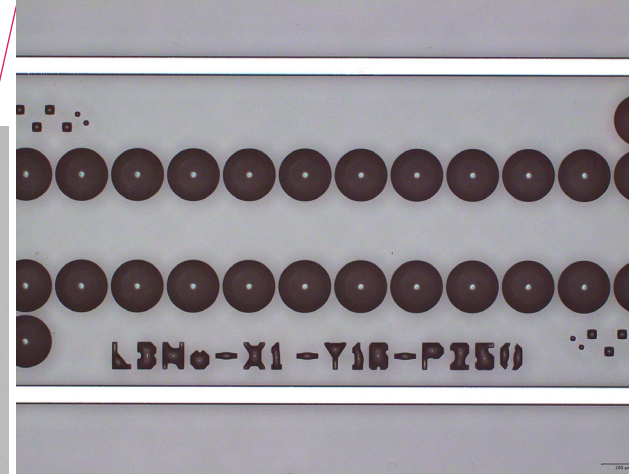
Fig. 1. Micrographs of Piccolo, a 32×32 SPAD array with photosensitive area on the top section, highlighted in red (left) [41,42] – see also Fig. 8 (center); SwissSPAD2 512×512 , a gated SPAD imager with 4 pixels shown in the inset (center, featuring round SPAD active areas in this case) [45]; Detail of LinoSPAD2, a 512×1 linear SPAD array with top alignment cross integrated in the metal stack (right).



C. Bruschini et al., Optics Express, **31** (13), 21935-21953 (2023)

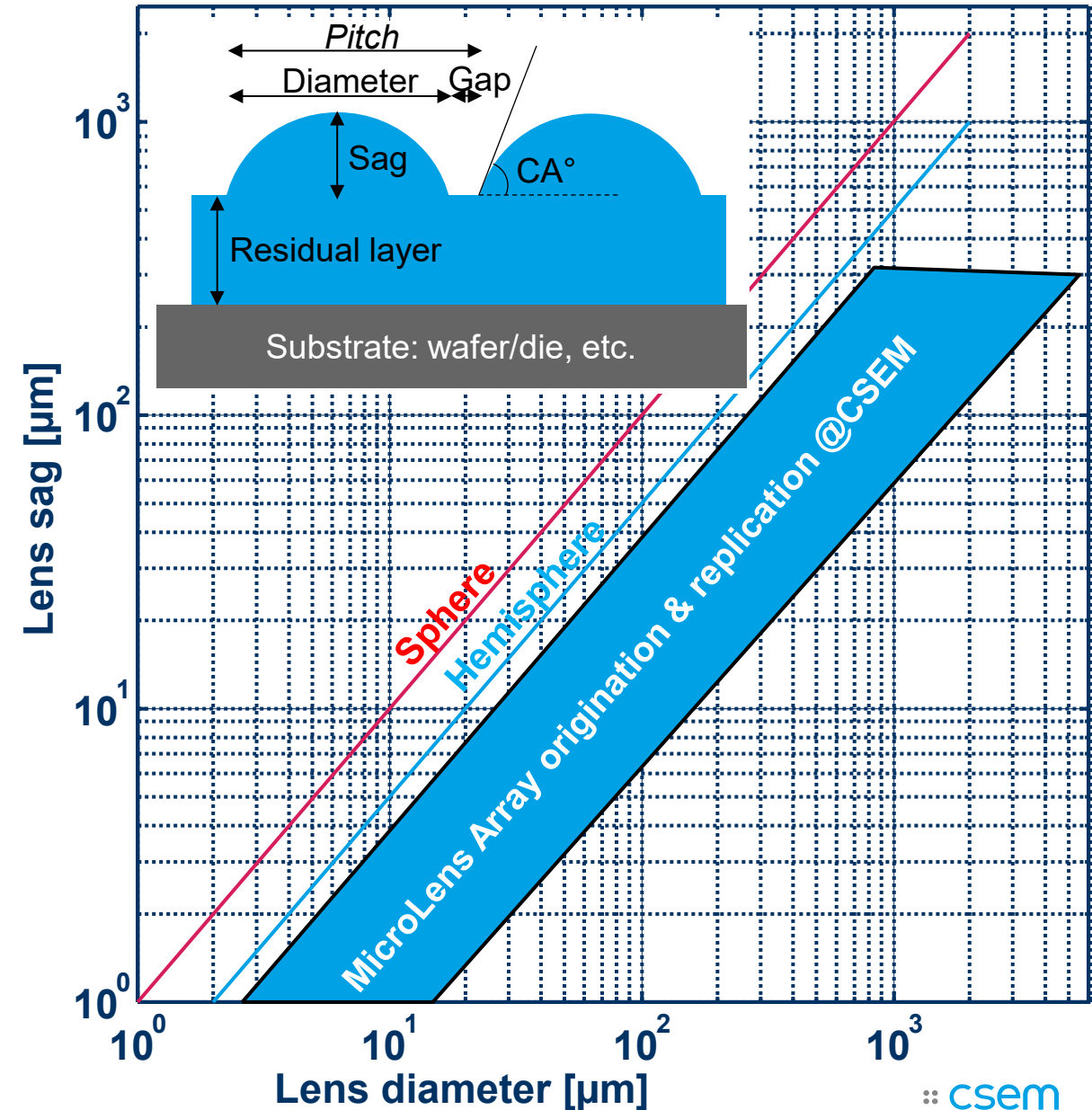
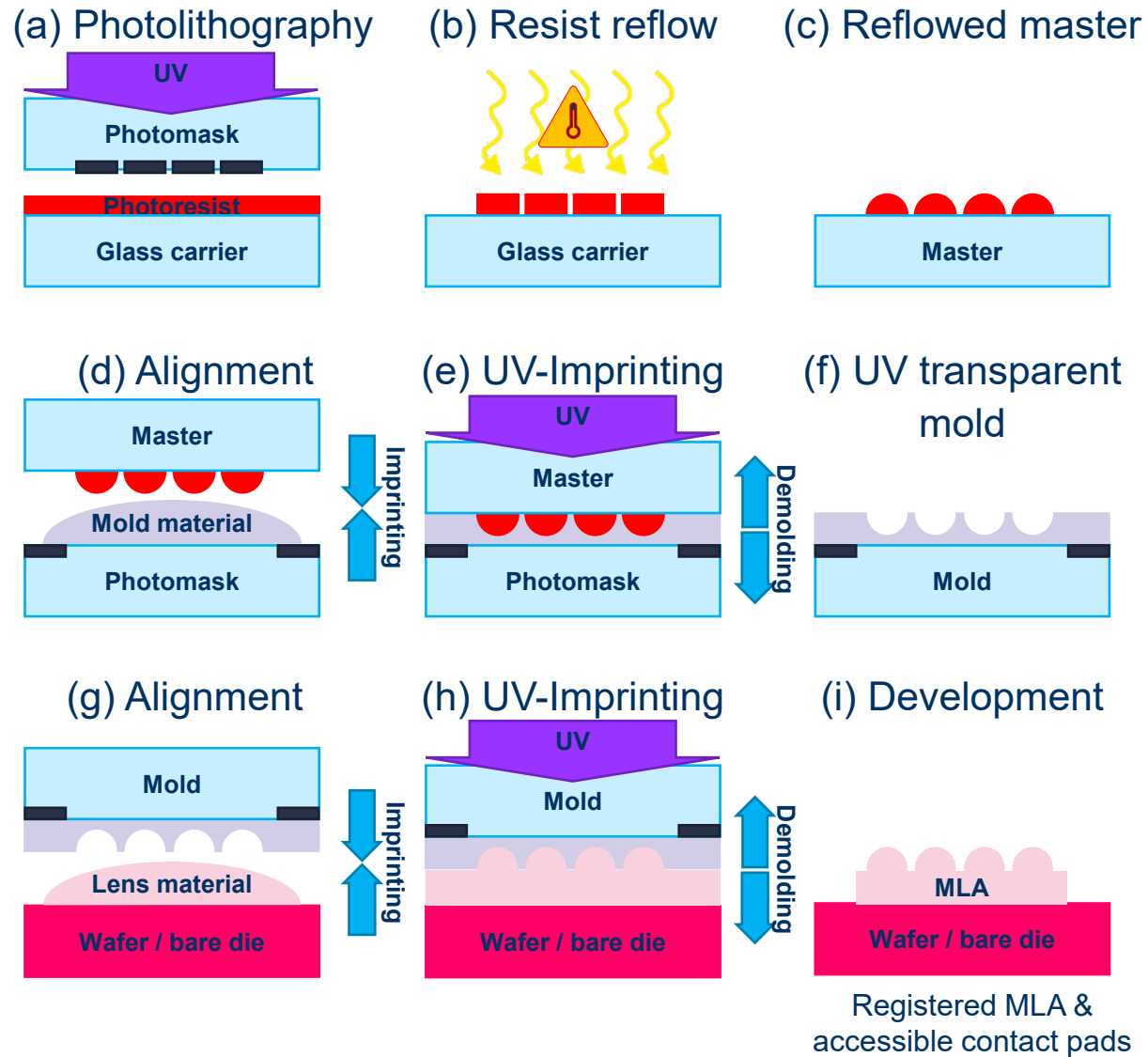
<https://www.csem.ch/en/tailored-services/mla-foundry-services/>

FABRICATION OF WAFER-SCALE DATACOM FIBRE TO FIBRE EXPANDED BEAM CONNECTORS



A connector comprises from 12 to several tens of fibers channels
Each wafer comprises hundreds to thousands of multi-fiber connector's expanded beam micro-optics
All manufacturing and metrology at wafer scale before dicing and integration in ferrules/sockets
Key design improvement: Optical stability over a wide temperature range

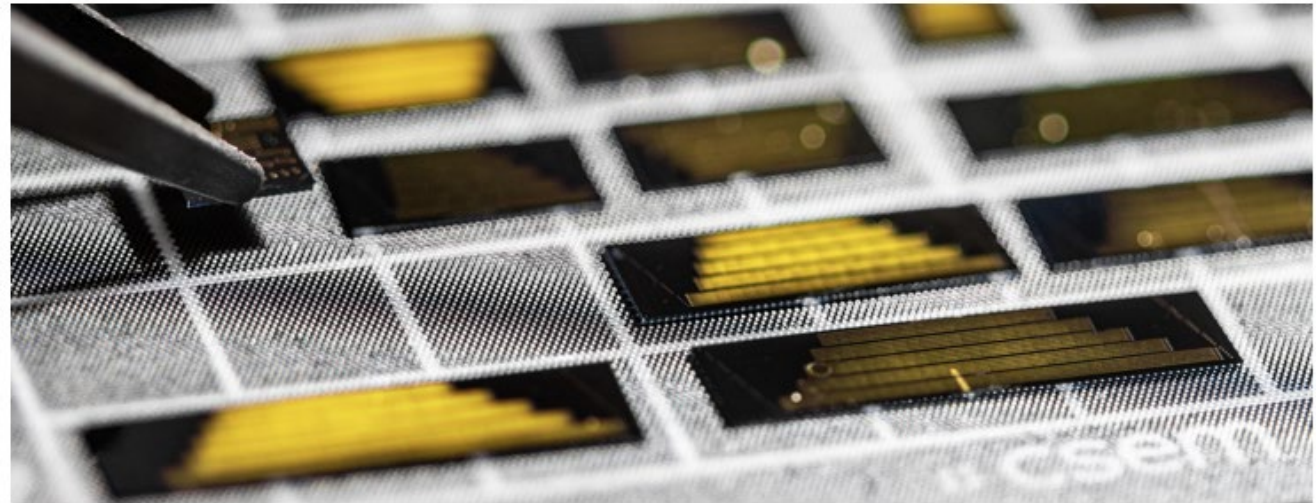
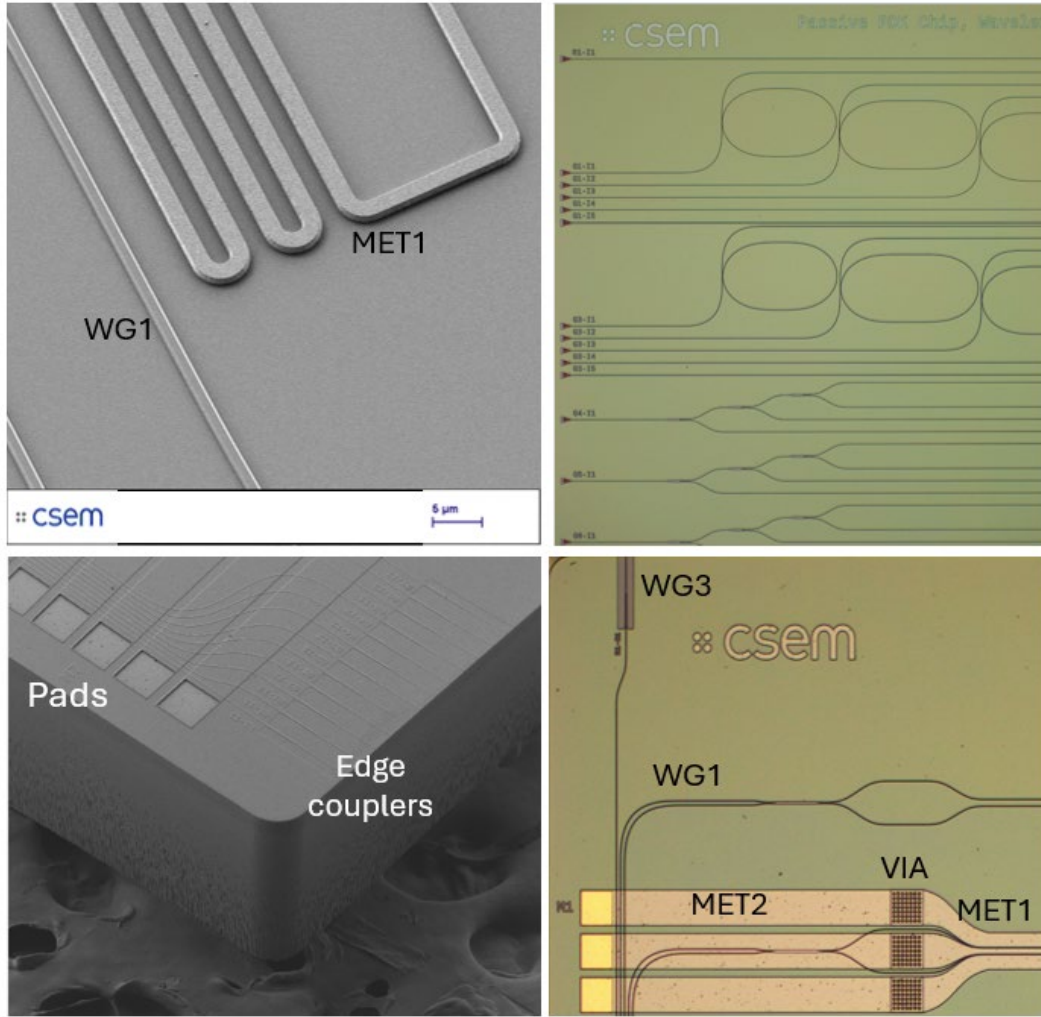
SPHERICAL MICROLENSES FULL PROCESS FLOW





PHOTONIC INTEGRATED CIRCUITS
THIN FILM LITHIUM NIOBATE
VERY HIGH SPEED EO MODULATORS

CSEM'S TFLN PIC PLATFORM – OPEN ACCESS FOUNDRY



<https://www.csem.ch/en/tailored-services/tfln-foundry-services/>

CSEM'S TFLN PIC PLATFORM – OPEN ACCESS

- ❑ Reliable high-yield wafer-scale fabrication process

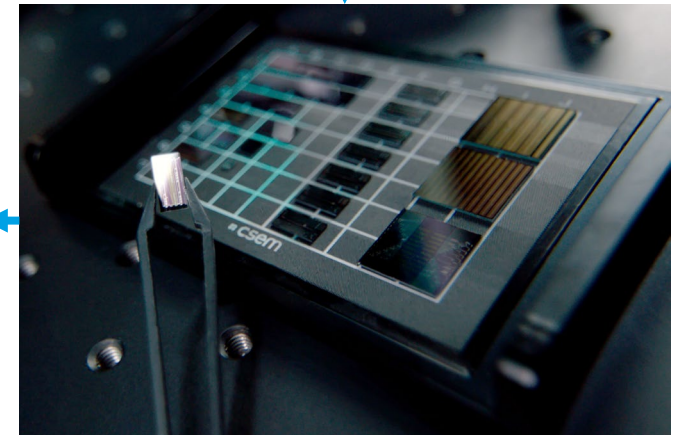
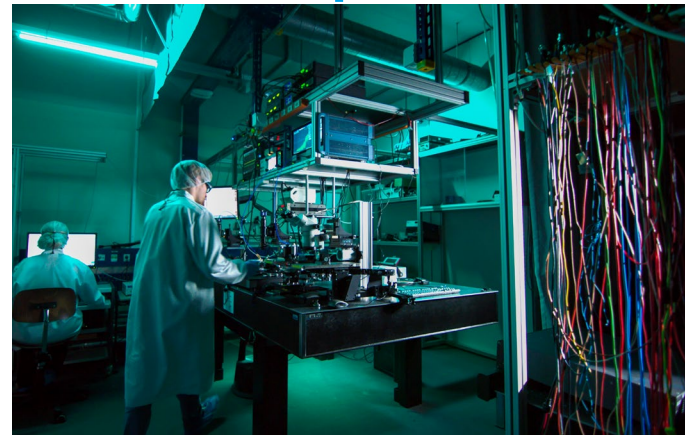
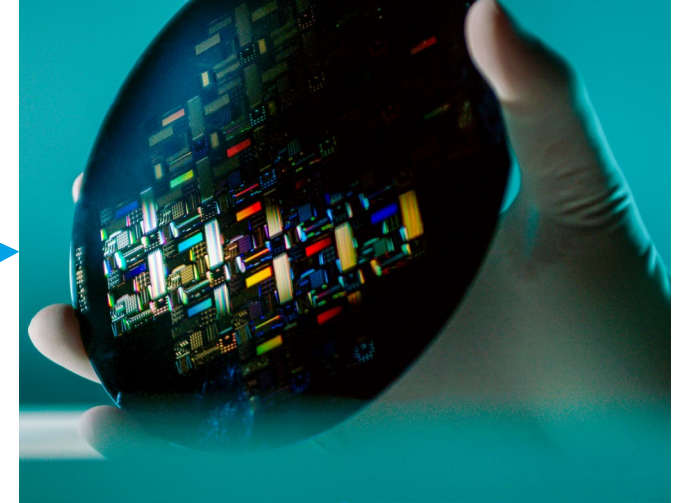
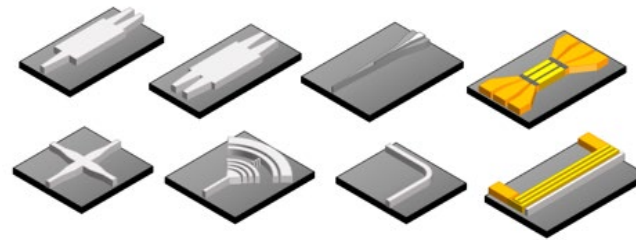
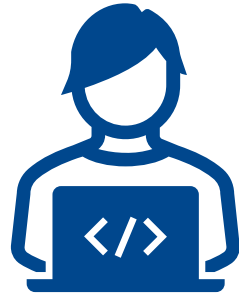
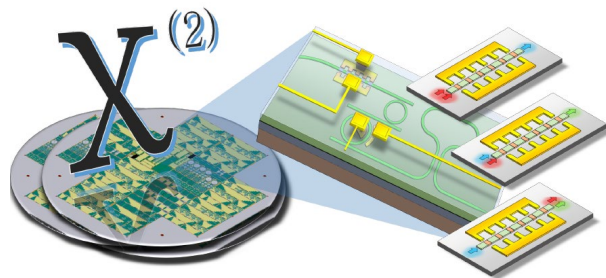
- ❑ Process Design Kits

 - ✓ C-band

 - O-band

 - ⌚ 780 nm

 - ⌚ PPLN as a BB



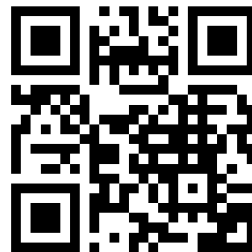


Technology Transfer



F O U N D R Y

Production-Grade Thin-Film Lithium Niobate Photonic Chips



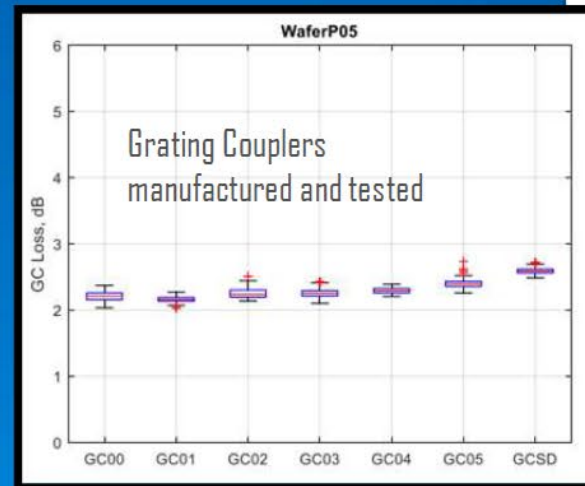
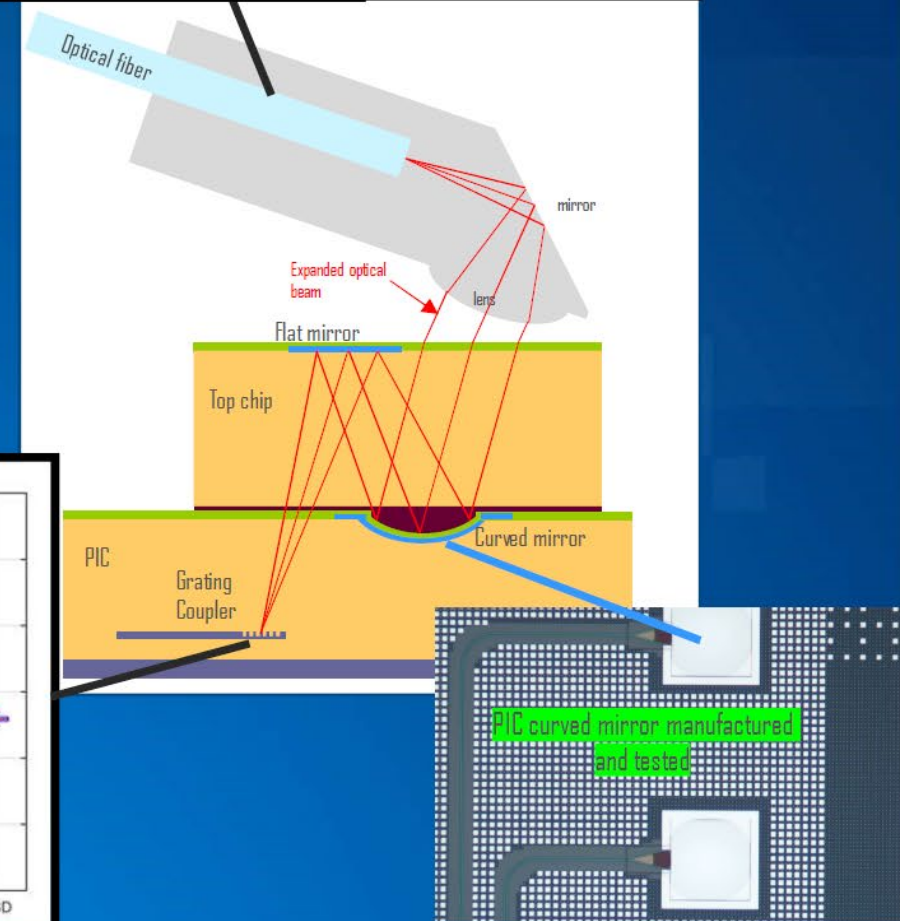
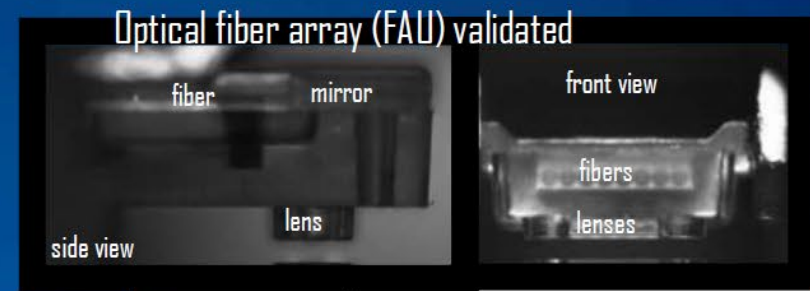
foundry@ccraft.com

- ▶ 6 years of experience on industrial scale tools
- ▶ Tested, derisked PDK, continuously growing
- ▶ MPW and dedicated RUNs → 2025
- ▶ Roadmap to High-volume production

FIBER ARRAY TO PIC CONNECTIVITY

OAK project: optical IO interface

- What:
 - Demo an alternative low-loss PIC-to-fiber interface with an out-of-plane expanded and collimated beam approach
 - Scope: Photonic IC (PIC) + Fiber assembly unit (FAU)
- Motivation: cheaper, denser co-package photonics
 - Reduced manufacturing complexity → lower total cost of ownership
 - More robust to foreign materials, easier → lower total cost of ownership
 - Denser/array-like PIC Optical IOs → improved performance
- Leti is building all the building blocks for a narrow-band. Demo Q1'23.
- Next Steps:
 - Explore wide-band applications



OAK seeds the next generation of pluggable optical IO for superior manufacturability, higher IO density

TSMC COUPE-GC

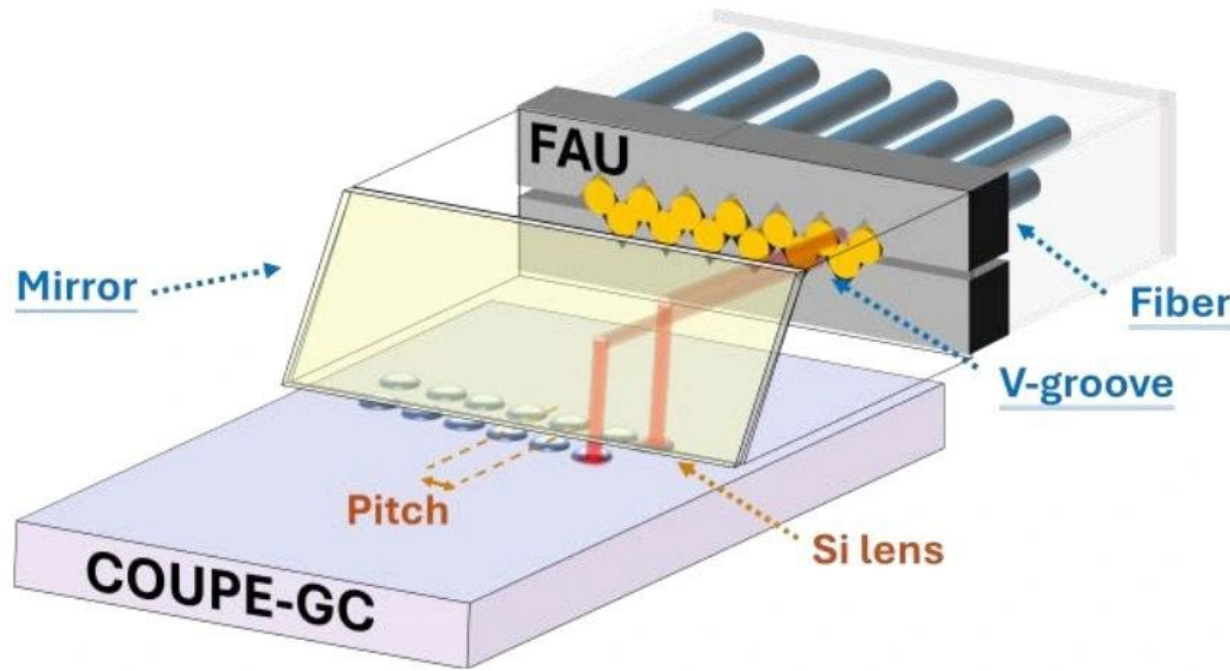


Fig. 4 Schematic diagram for COUPE-GC with FAU. The FAU typically includes critical optical components such as the V-groove mirror, and optical fibers.

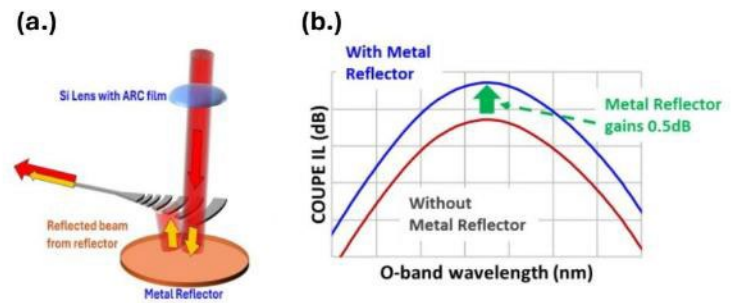


Fig. 5 (a) The structure of COUPE-GC, with the metal reflector placed beneath the GC. (b) Simulation results indicate the metal reflector provide an 0.5 dB IL gain in COUPE-GC.

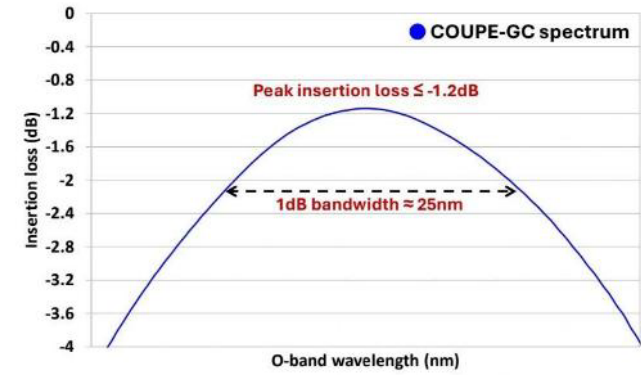


Fig. 6 COUPE-GC spectrum shows that peak insertion loss is less than -1.2 dB and 1 dB bandwidth is around 25 nm, credits to the

TSMC SiPh + COUPE: 1 Platform 2 Schemes Supports both GC and EC

COUPE Platform
(Compact Universal Photonics Engine)

Hybrid Bonding

Si Carrier

EIC

PIC

substack

SEMI VISION

Grating Coupler (GC)

Si Carrier

EIC

PIC

Micro lens

Si WG

Reflection

Edging Coupler (EC)

Si Carrier

EIC

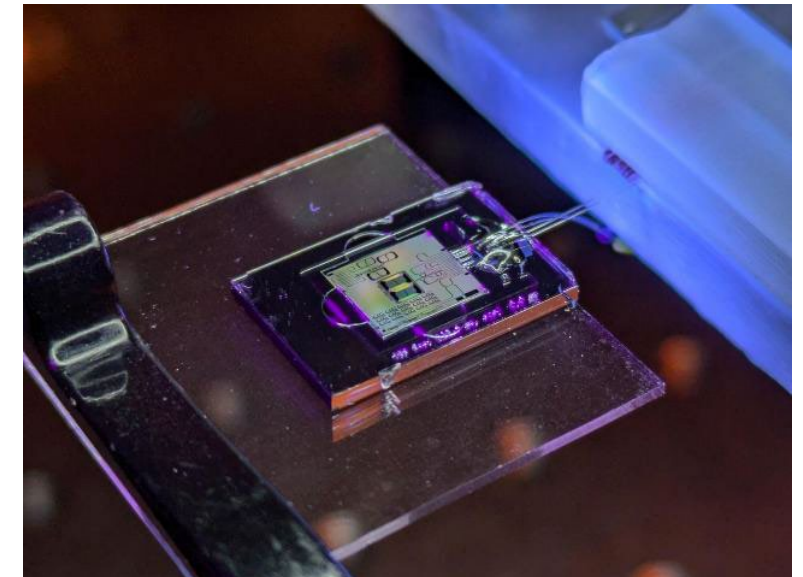
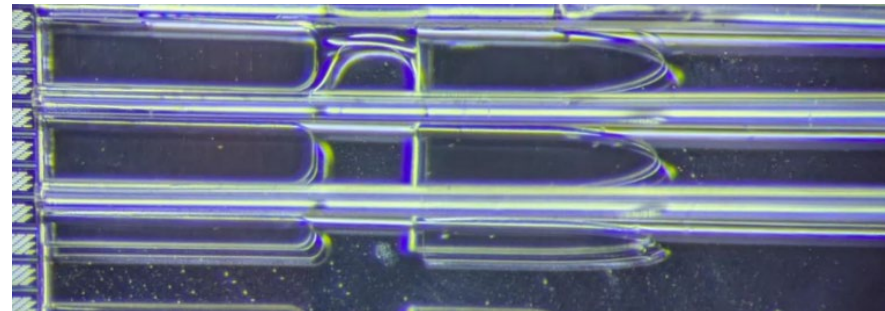
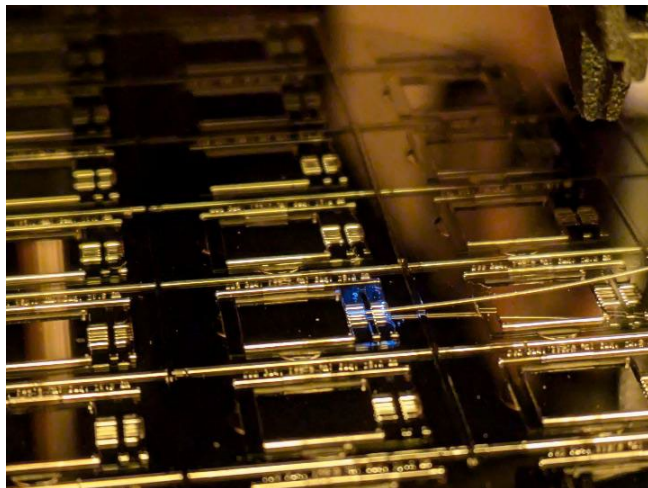
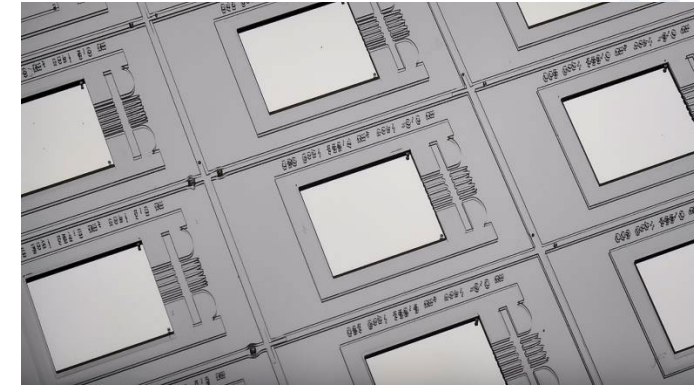
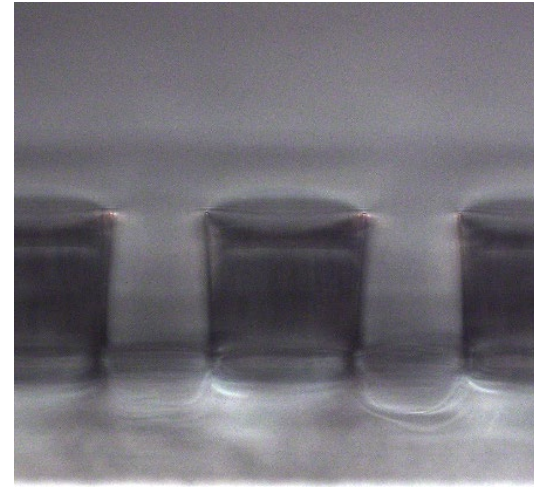
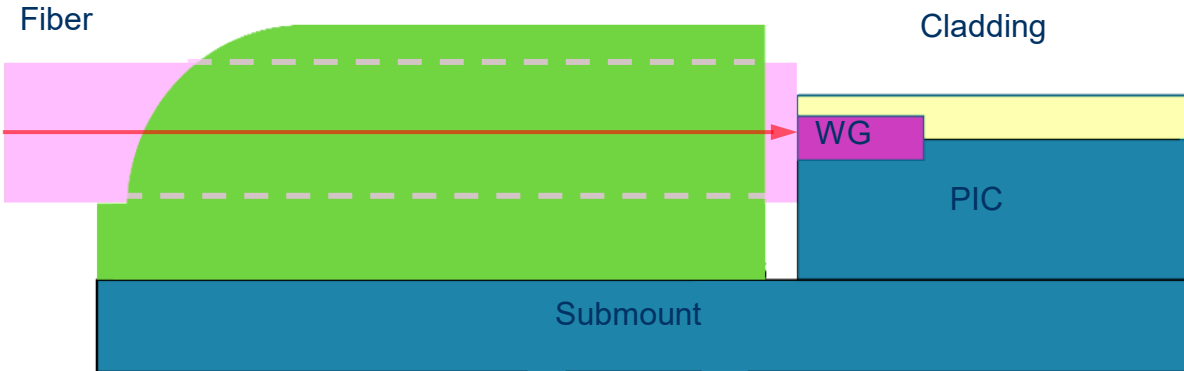
PIC

Si WG

Micro lens

PIC TO FIBER PASSIVE ALIGNMENT – GC OR EDGE

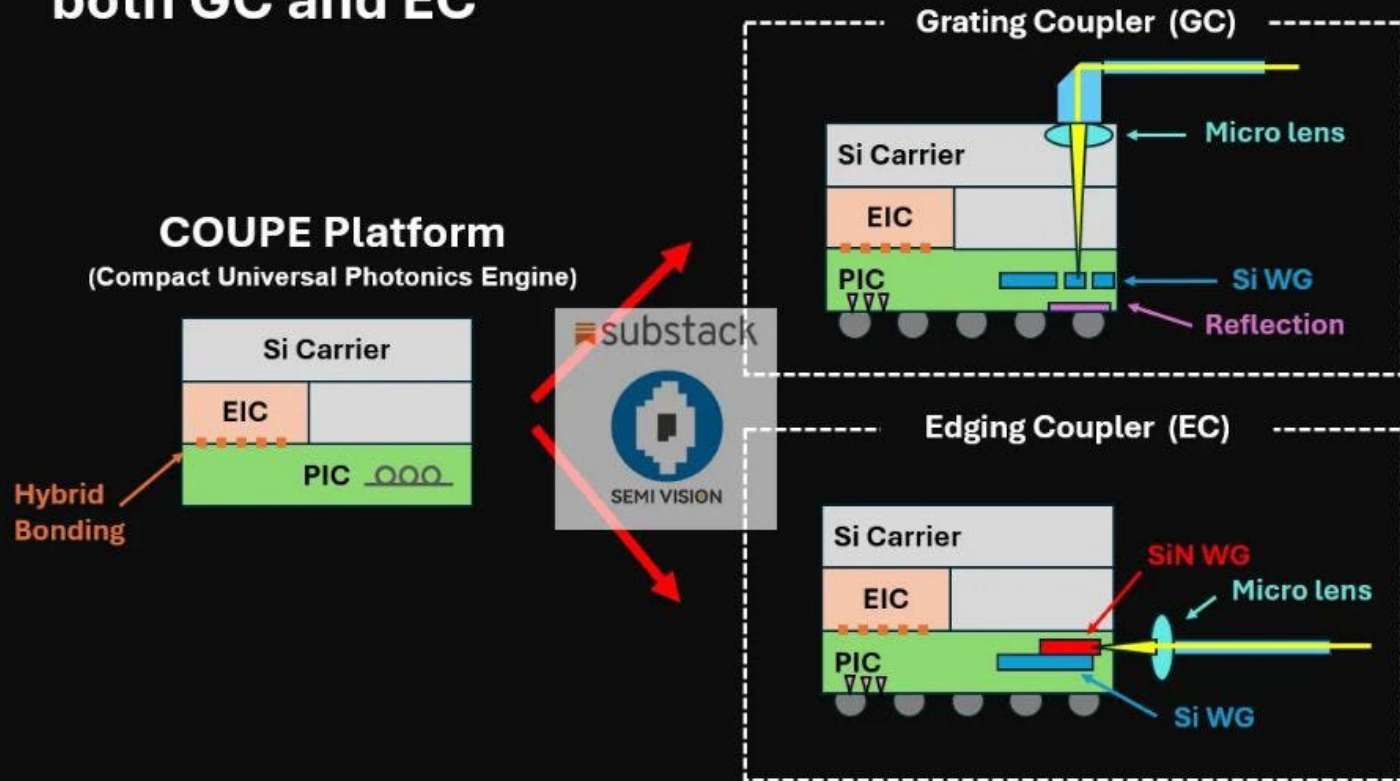
Passive Alignment Structures



Processing by wafer-scale imprinting on submount wafer
Alignment structures for passive fiber alignment or faster active alignment

FIBER TO PIC CONNECTIVITY (EDGE) FOR CPO GEN 2

TSMC SiPh + COUPE: 1 Platform 2 Schemes Supports both GC and EC



On a journey towards a European wafer-scale solution, edge coupling based with expanded beam for high robustness, high efficiency and high fiber density

LOOKING FORWARD TO THE DISCUSSIONS

Guillaume Basset - guillaume.basset@csem.ch

<https://www.csem.ch/en/technical-focus/photonics/micro-nano-optics/>

<https://www.csem.ch/en/tailored-services/mla-foundry-services/>

<https://www.csem.ch/en/tailored-services/tfln-foundry-services/>