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Micro-Optics
An Enabling Technology For DATACOM

Dr. Wilfried Noell
Chief Scientist，Focuslight

2024 October 29th

Focuslight Overview

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- Founded in 2007 by Dr. Victor X. Liu, headquartered in Xi'an, China.
- A fast-growing company that develops and manufactures:
  - **High-power diode laser components and materials** (Photon Generation)
  - **Laser optics components** (Photon Control)
  - **Photonics module and system solutions** (Application Solutions) focusing on optical communication, automotive, pan-semiconductor, and medical and health applications.
- A **global photonics foundry** offering process development and manufacturing services to the global photonics community.
- Publicly listed in the Shanghai Stock Exchange (Ticker Symbol: 688167).

Products and Businesses

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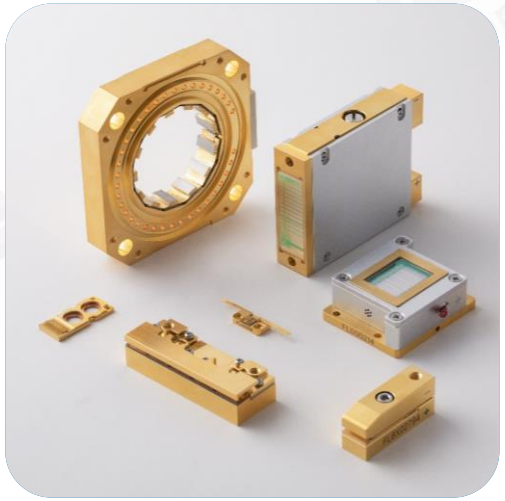

Photon Generation

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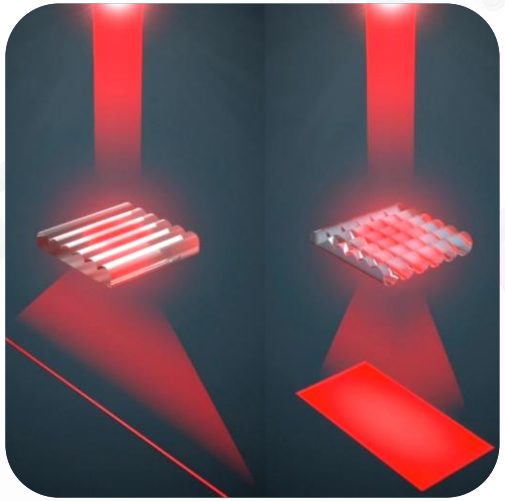

Photon Control

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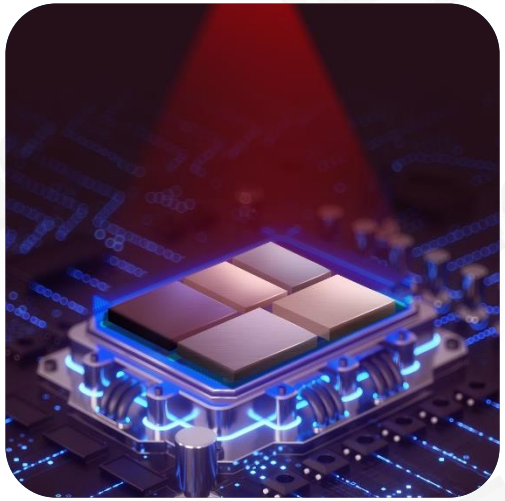

Photonics Application Solutions

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Global Photonics Foundry

From Optical Design to Product

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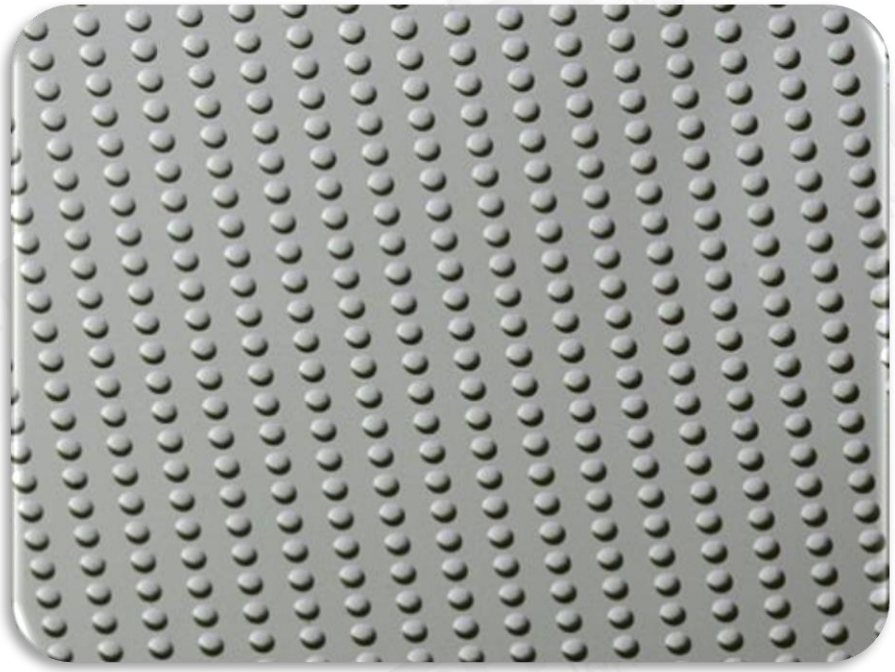
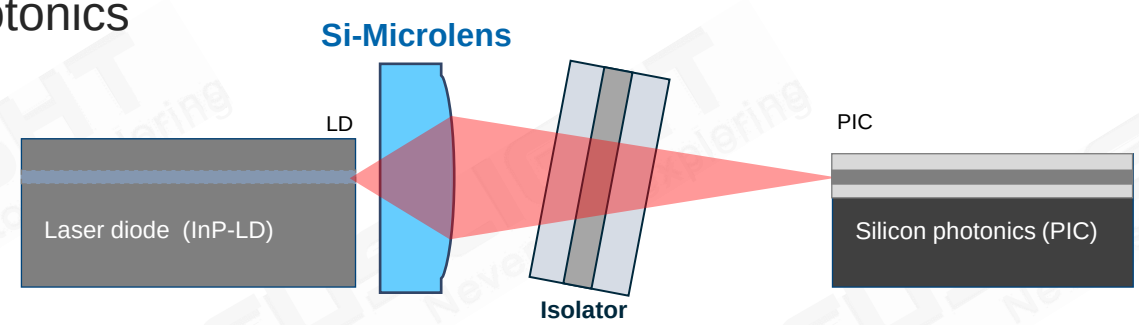
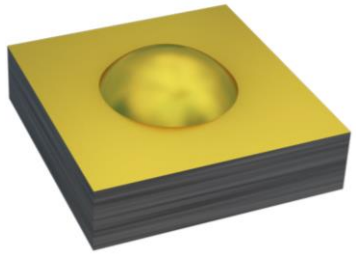
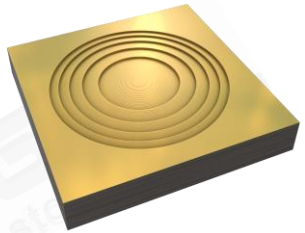
Microlenses for Fibers, LD, PICs, and Silicon Photonics



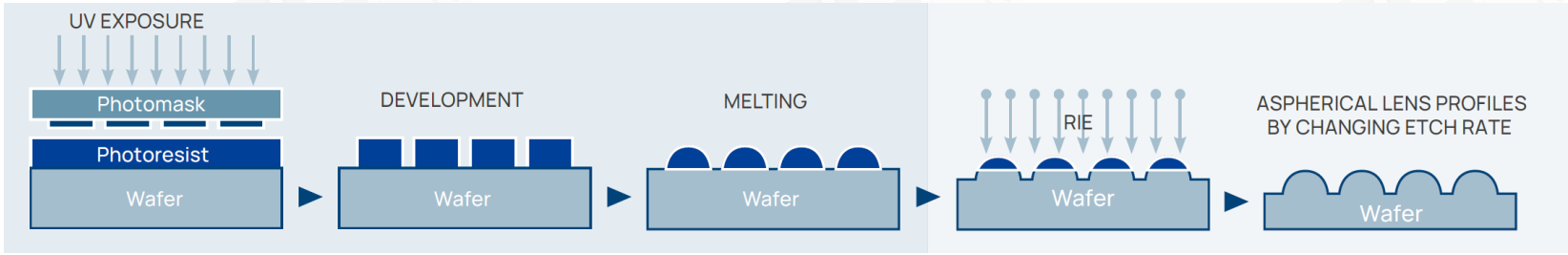






- Ray tracing and physical optics
- Tolerance simulations
- Manufacturing constrains in design flow (DFW)
- Wafer-level manufacturing
- P&P and chip level delivery

Manufacturing



Optical Interconnects – From AI to Long-Haul

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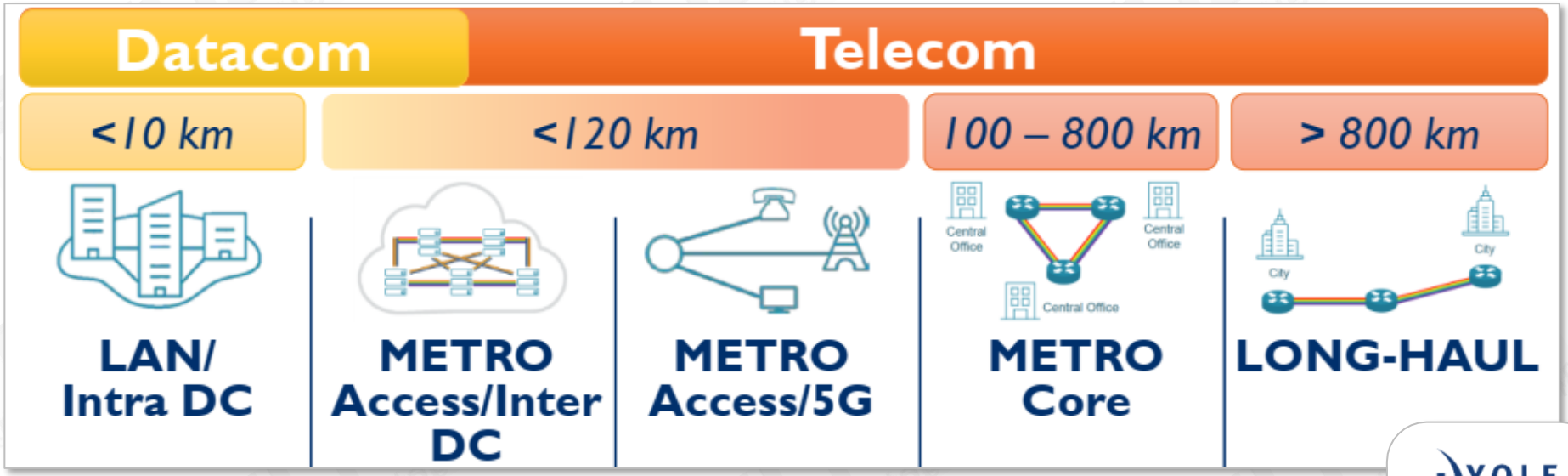
Datacom → AI/LLM Paradigm Shift

AI / LLM Clusters need high speed data rates
→ Challenges for transceivers and component makers!

AI / LLM Clusters



YOLE Développement

850 nm
MMF, IM
VCSEL

1310 nm
SMF, CWDM, OCS
PIC (SiPh, InP, Hybrid, …)
DML, EEL, EML, LPO/LRO/CPO

1550 nm
SMF, DWDM, Coherent
WSS, ROADM, EEL

Datacom & Optical Interconnects

Datacom → AI/LLM Paradigm Shift

2024

AI / LLM Clusters need high speed data rates
→ Challenges for transceivers and component makers!

AI / LLM Clusters

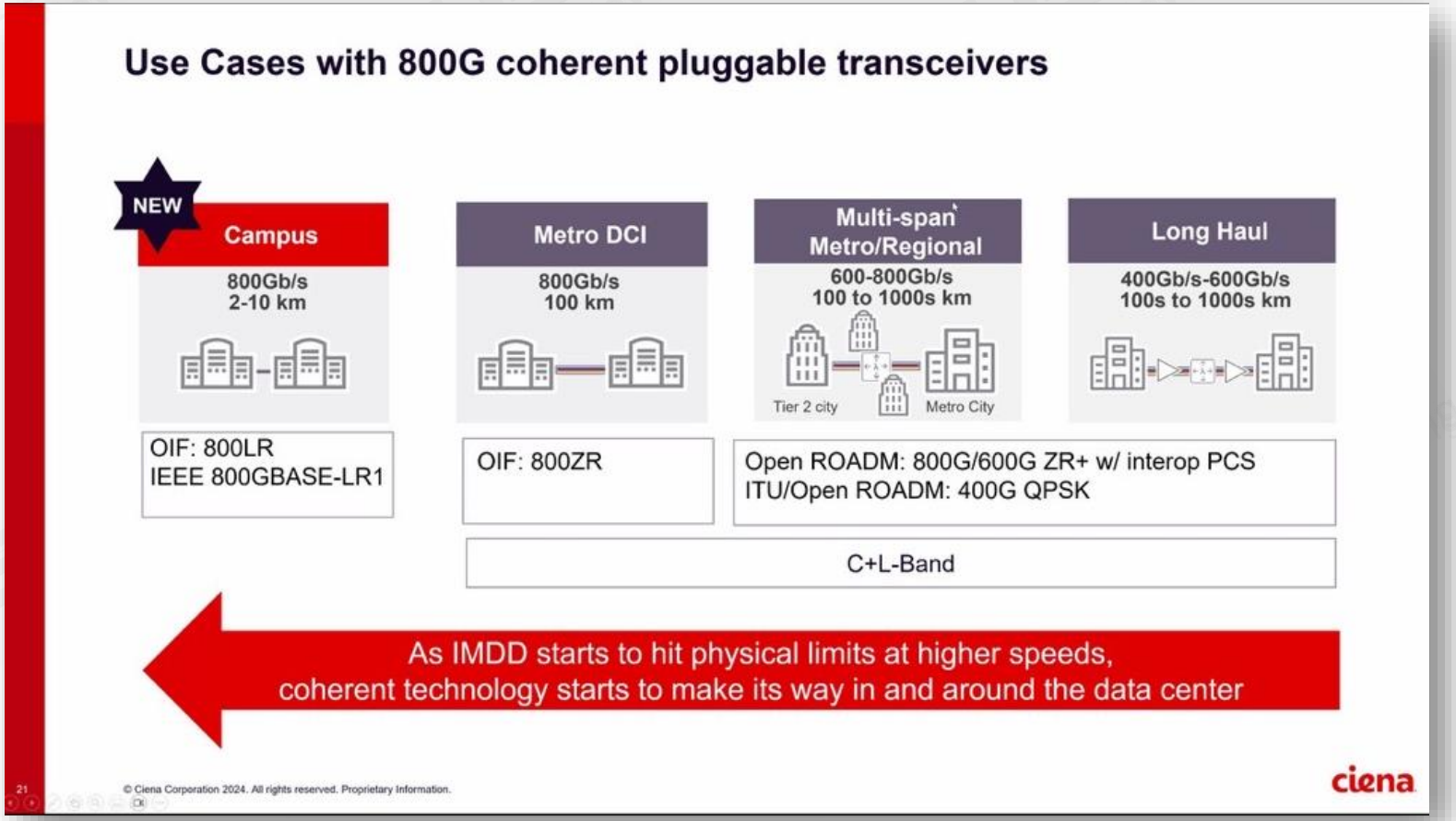
850 nm
MMF, IM
VCSEL

SMF, CWDM, OCS

PIC (SiPh, InP, Hybrid, …)

DML, EEL, EML – 1310 nm
VCSEL – 850 nm

LPO / LRO / CPO



Optical Interconnects – From AI to Long-Haul

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Datacom → AI/LLM Paradigm Shift

AI / LLM Clusters need high speed data rates
→ Challenges for transceivers and component makers!

AI / LLM Clusters

850 nm
MMF, IM
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1310 nm
SMF, CWDM, OCS
PIC (SiPh, InP, Hybrid, …)
DML, EEL, EML, LPO/LRO/CPO

Cignal AI
Active Insight

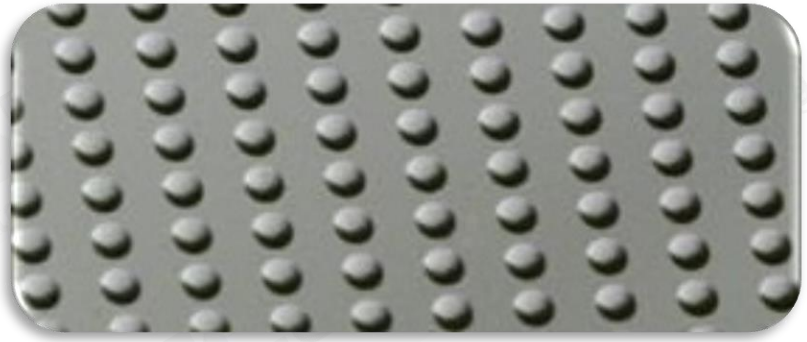
"400GbE and 800GbE shipments reached record levels this quarter [2Q24]… Datacom component revenue surged to nearly $2.5B… "

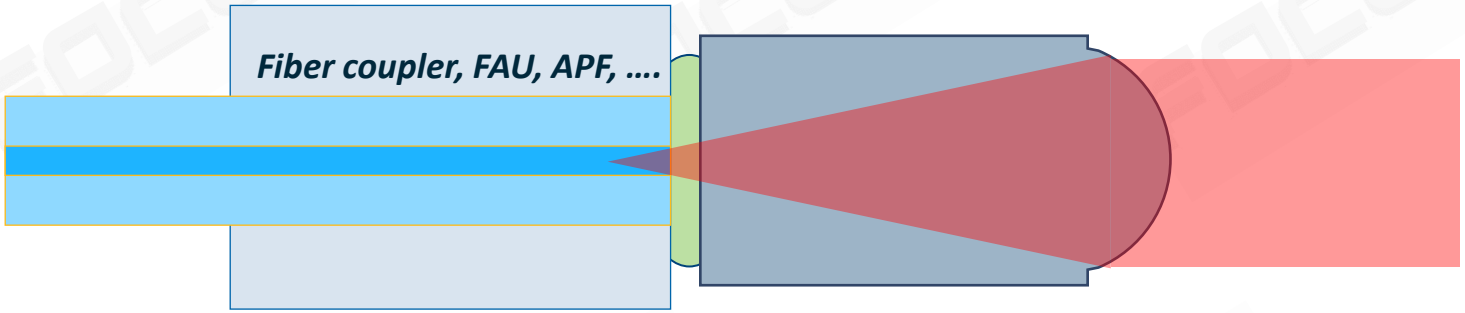
OPTICAL COMPONENTS
REVENUE LEADERBOARD- 2Q24

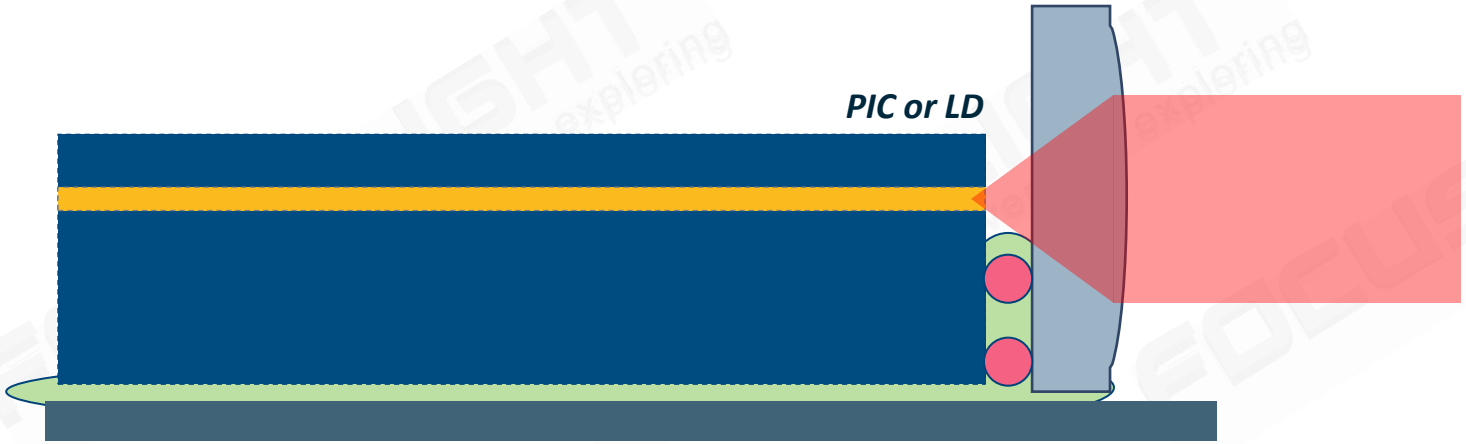
Rank	Telecom	Datacom	Consumer	Industrial
1	MARVELL	INNO LIGHT	COHERENT	COHERENT
2	LUMENTUM	COHERENT	LUMENTUM	IPG PHOTONICS
3	COHERENT	SP SOURCE PHOTONICS		LUMENTUM
4	ACACIA	JABIL		emcore
5	Accelink	eoptolink		

Collimation Microlenses – Silicon and Glass

- Collimation & refocusing
- Sizes from < 0.6 x 0.6 mm to 100 x 100 x 3 mm
- Singlets, 1D and 2D arrays (MLA)







Fused silica lens

- Wafer level, high uniformity
- Sub-µm precision
- No dispersion, low CTE
- Large variety of thicknesses, 0.4 to 3.2 mm
- Combination with fiber array

Silicon lens

- Wafer level, high uniformity
- Sub-µm precision
- Very thin, 0.25 to 1 mm

Datacom & Optical Interconnects

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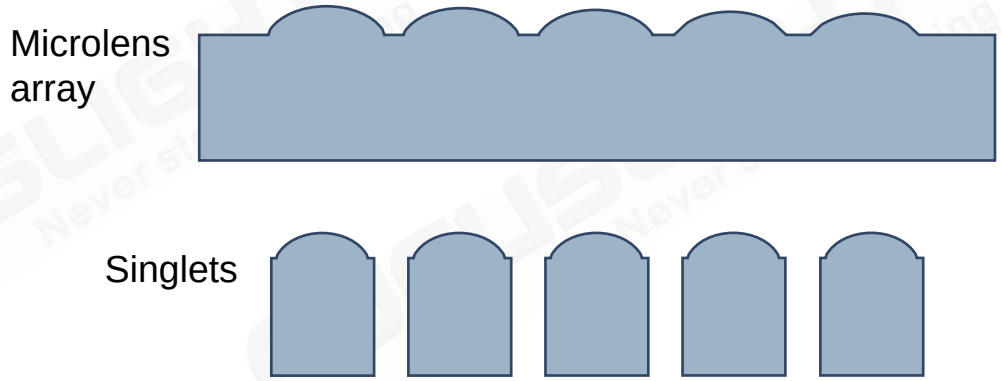
Singlets and Arrays for CWDM and Pluggables

Microlenses

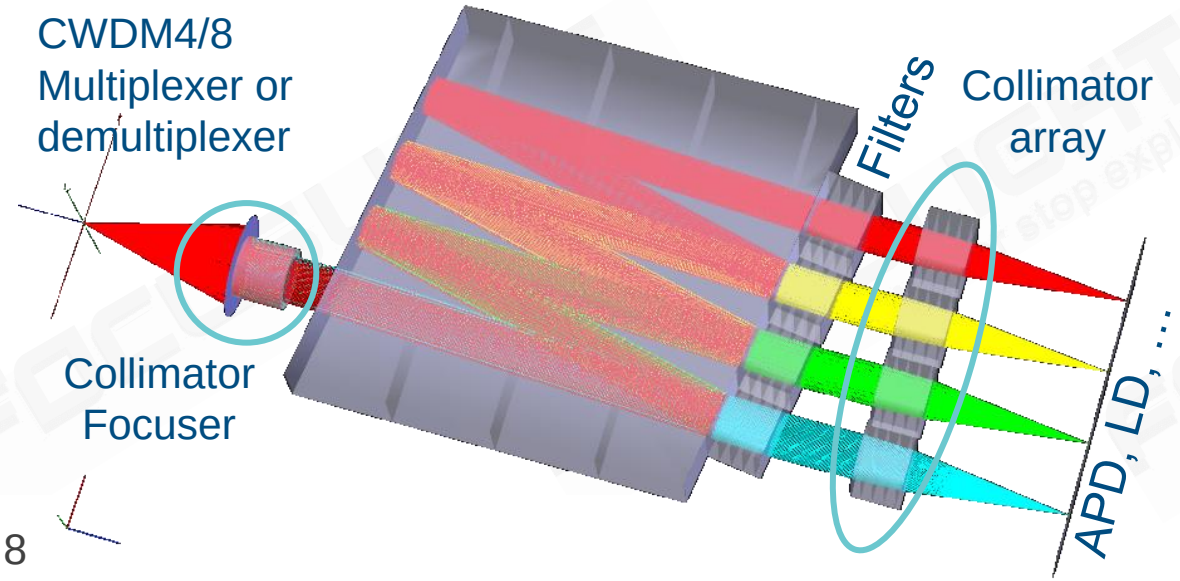
- 1x4, 1x8 to 1xN lens arrays with perfectly aligned lenses
- Singlets < 0.6 x 0.6 x 1 mm³
- Collimation & refocusing
- Large lens aperture for large beam size and long distance

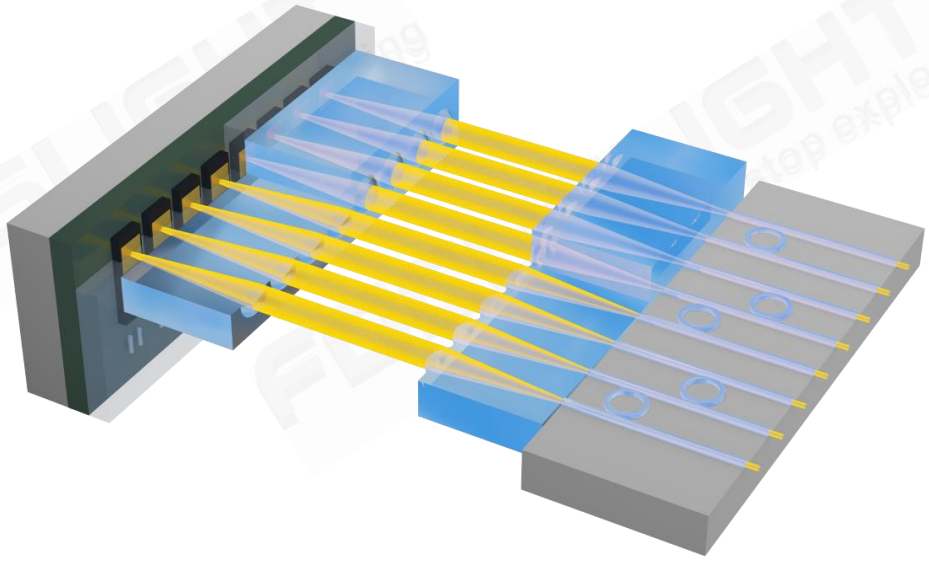


Free-space optics

800G

Micro-Optics for Si-Photonics





Micro-Optics for Silicon Photonics

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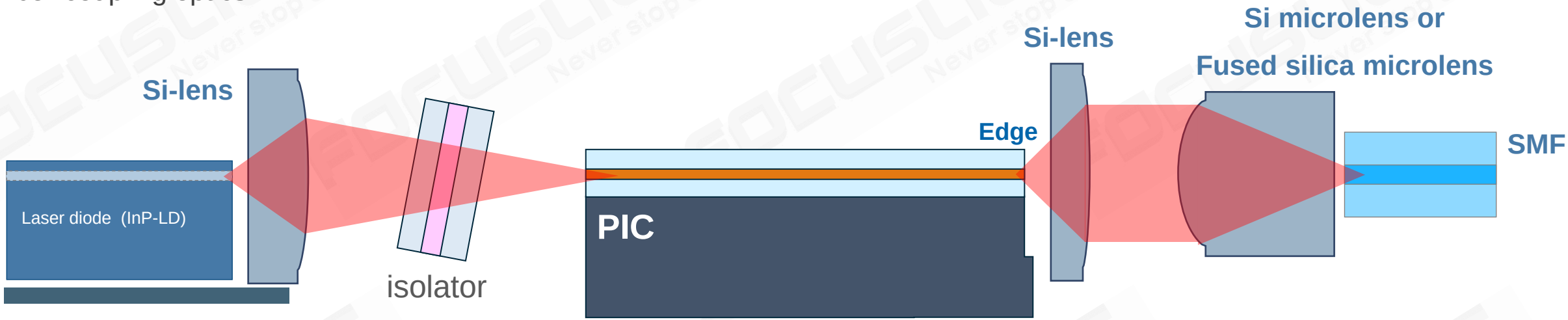
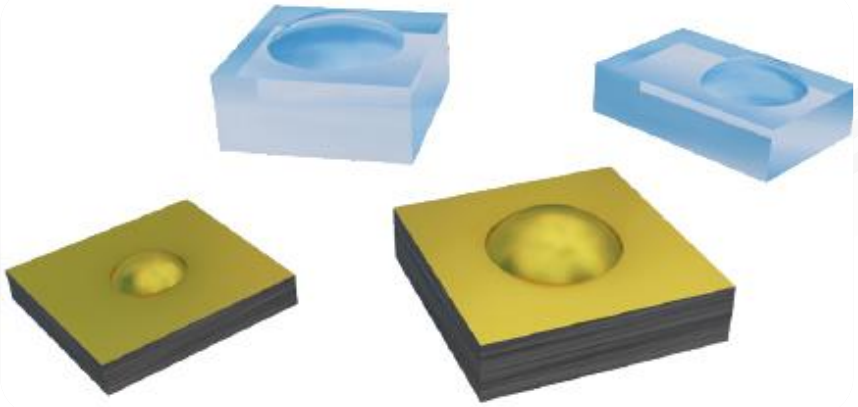
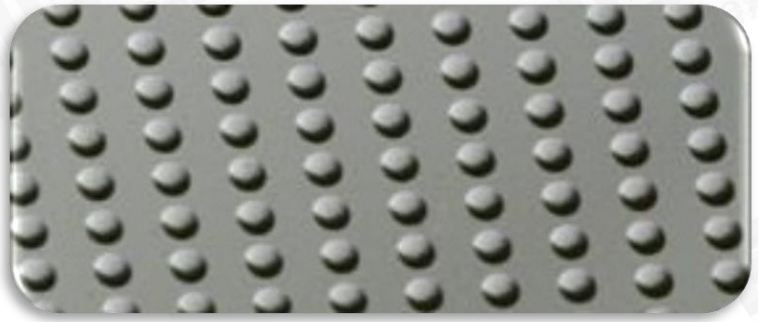
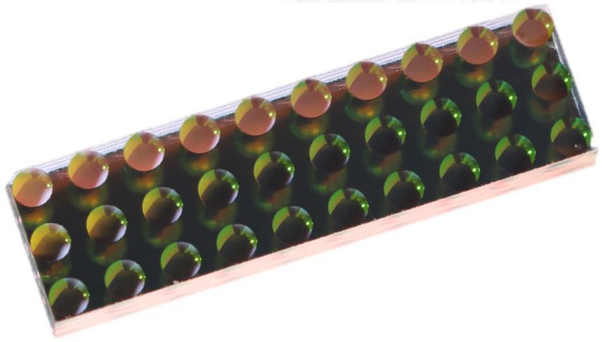
- Collimation optics & re-focusing optics
- Edge coupling microlenses – singlets and arrays
- Fiber-coupling optics



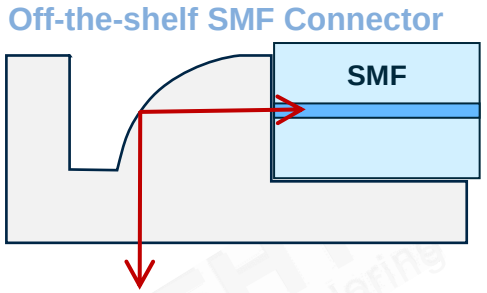


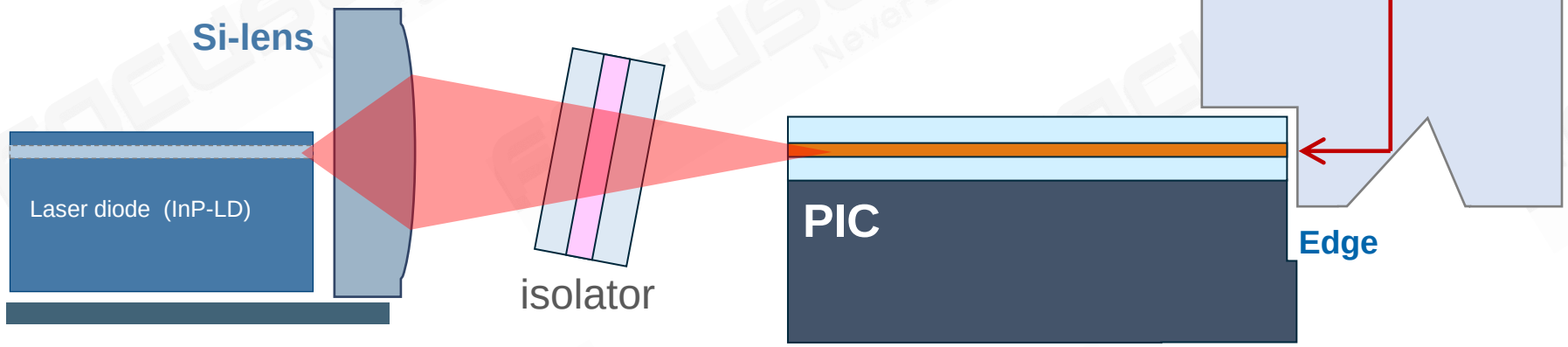


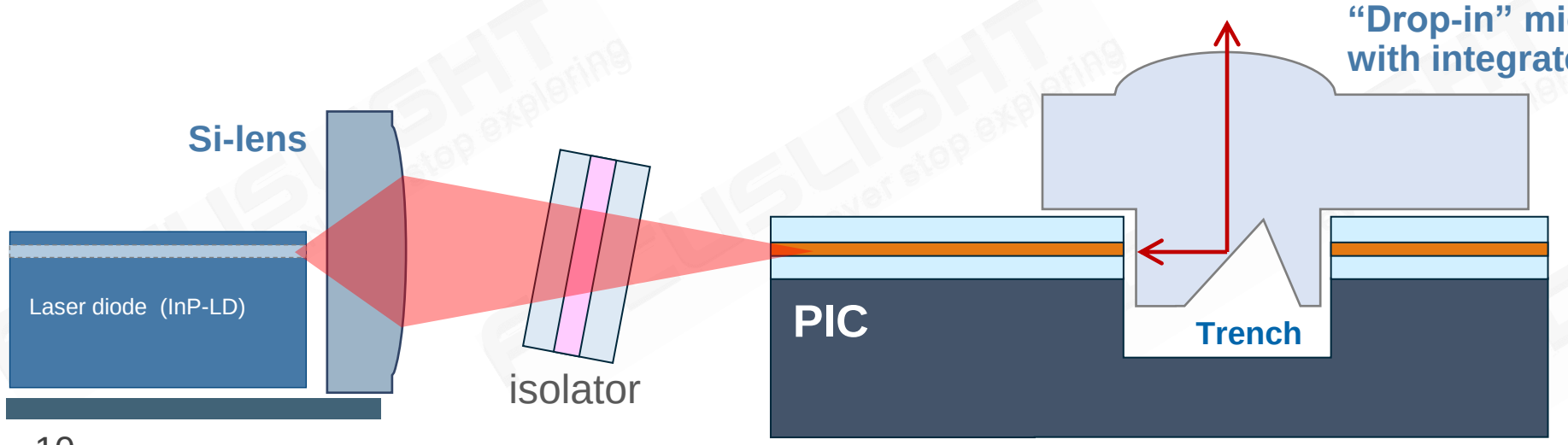


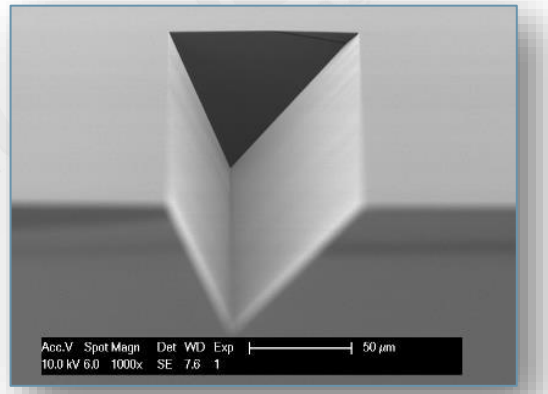
Next Generation Microprisms for PICs

- Collimation optics & re-focusing optics
- Microprism with microlens array for edge coupling
- “Drop-In Prism” → Chip-to-wafer technology → In development

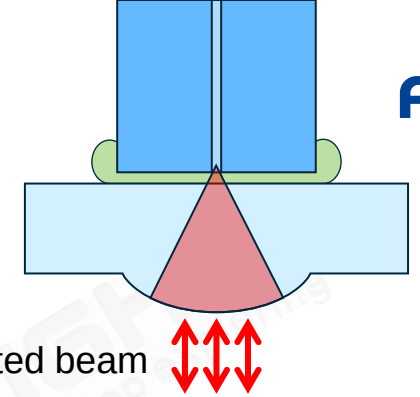




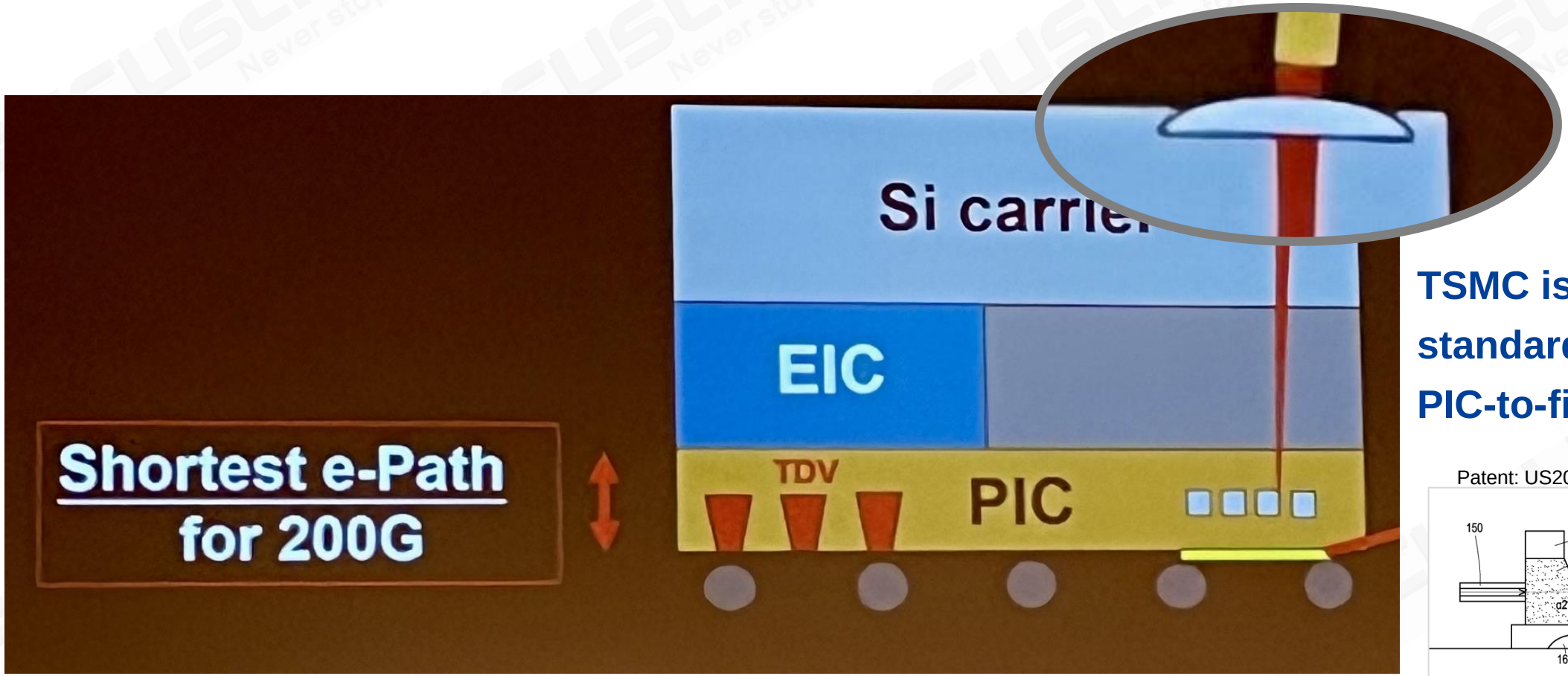




TSMC’s Co-Packaged Optics “Standard”



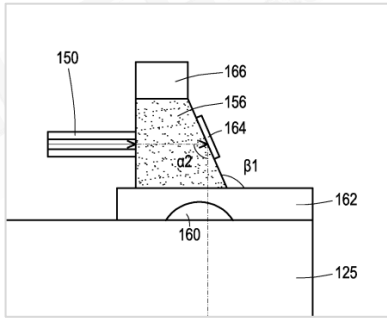
Matching micro-optics
For external & pluggable fiber arrays (FAU)



TSMC at PIC Summit Europe 2023

TSMC is (effectively) standardizing the PIC-to-fiber interface

Patent: US2024192456A1



Datacom & Optical Interconnects

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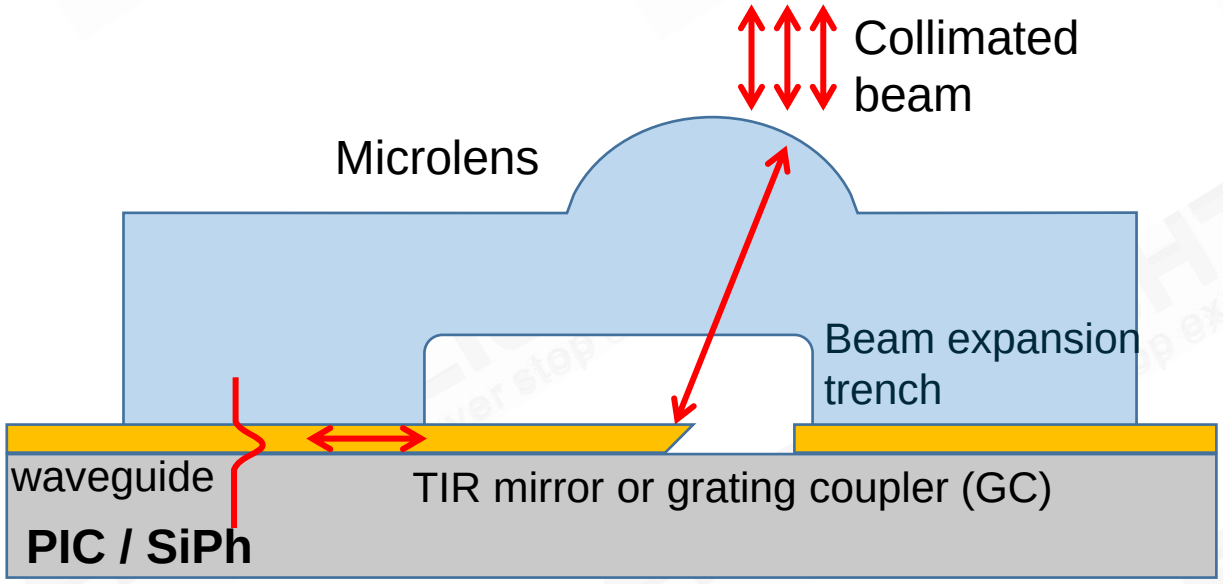
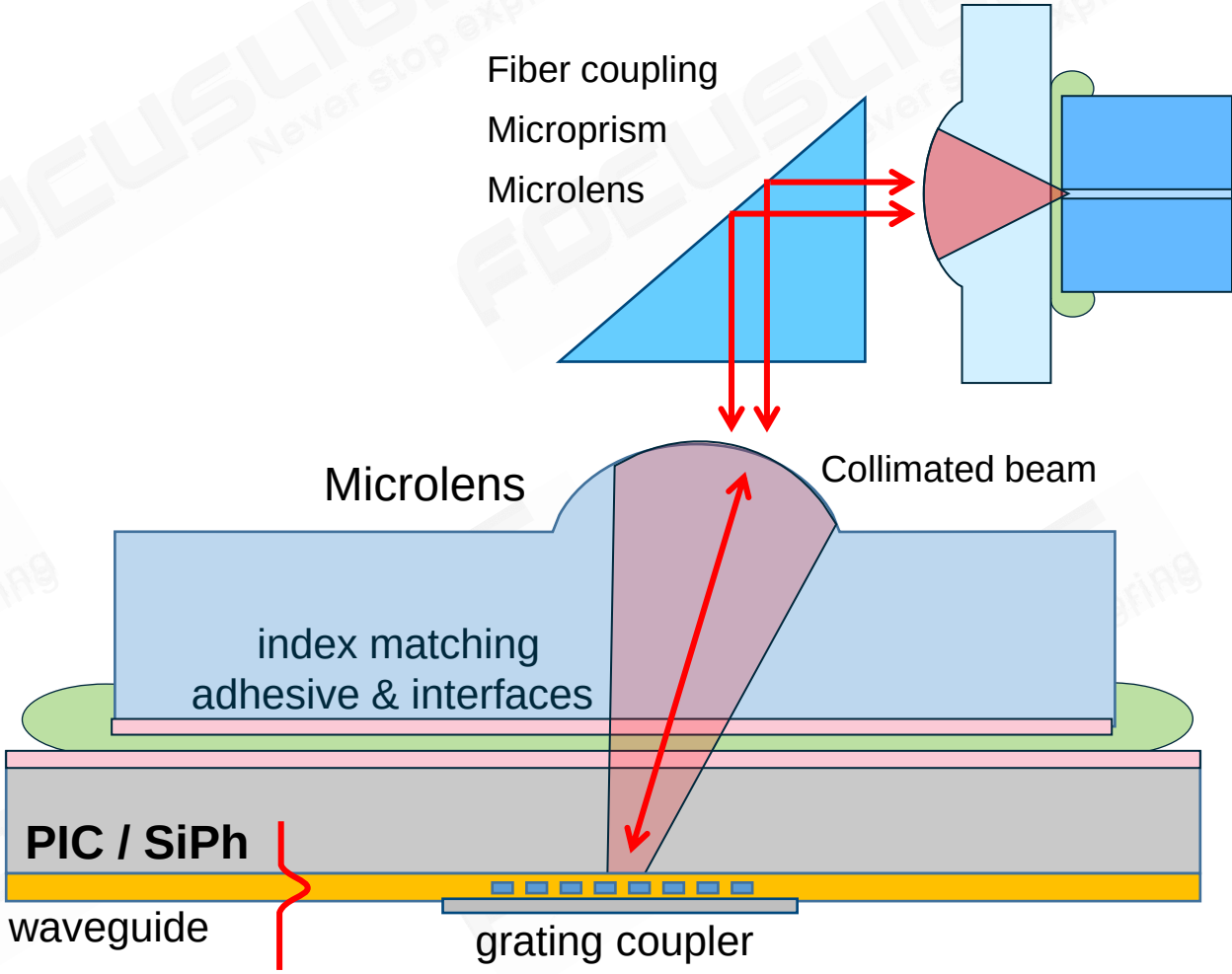
Microlenses for Silicon Photonics with Grating Couplers

Collimation Optics plus 90° turn

- Front- or Backside
- Off-axis microlens for tilted beam (0 to 10°)
- Beam expansion inside either air or microlens
- Typically, active alignment



e.g. US9348099B2 patent



Packaging of Micro-Optics

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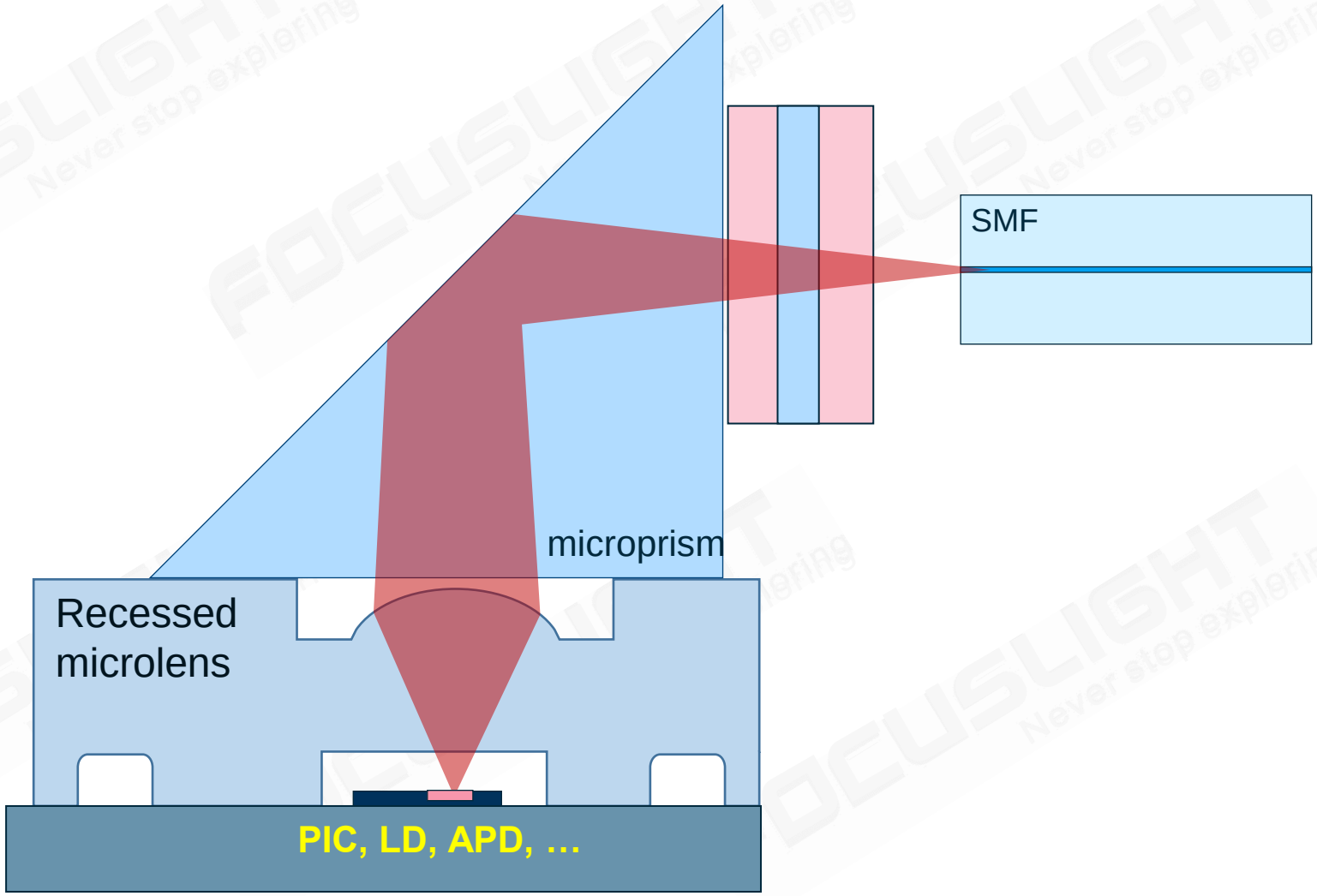
Recessed Microlenses for Stacking Optics – Packaging

Stacking

- Microprisms
- FACs & SACs
- Isolators
- Silicon photonics (PIC)

Advantages

- Flat and dust-free area for vacuum gripper
- Flat base for microprisms & isolators
- Defined gap between lens and prism
- Large lens arrays with
  Sub-200nm position accuracy
- Scalable volume production



Micro-Optics for 2D Grating Coupler Arrays

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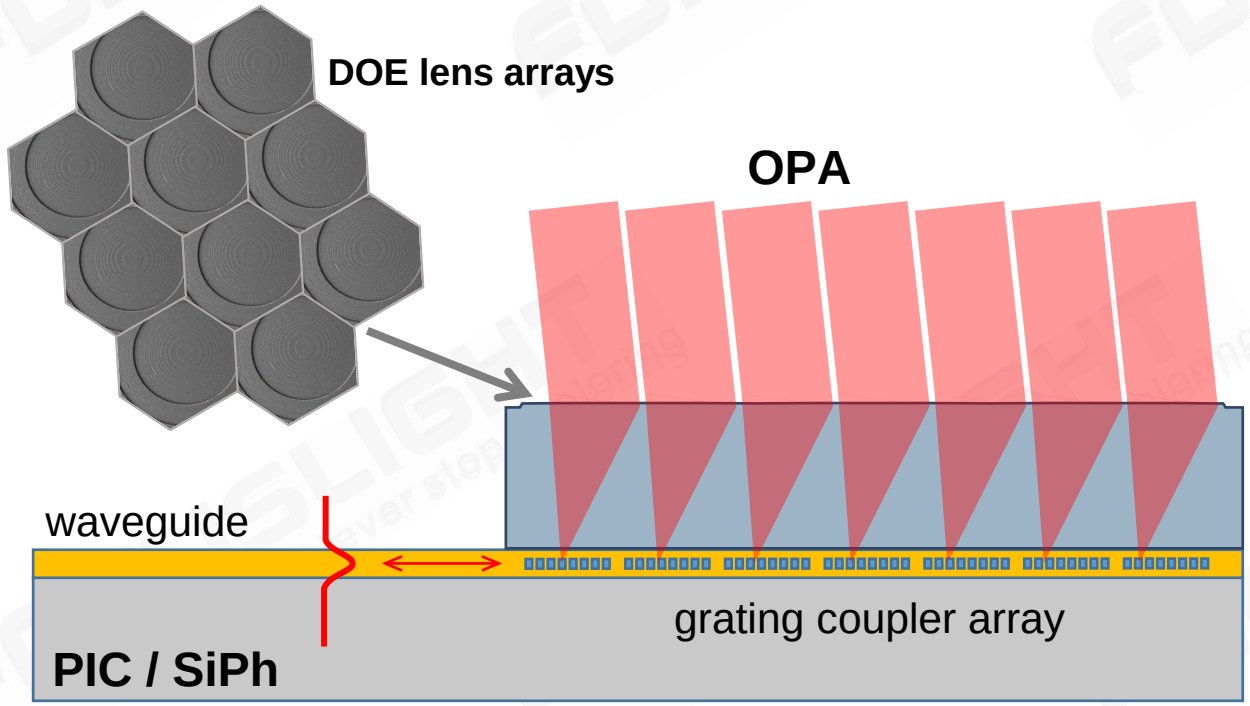
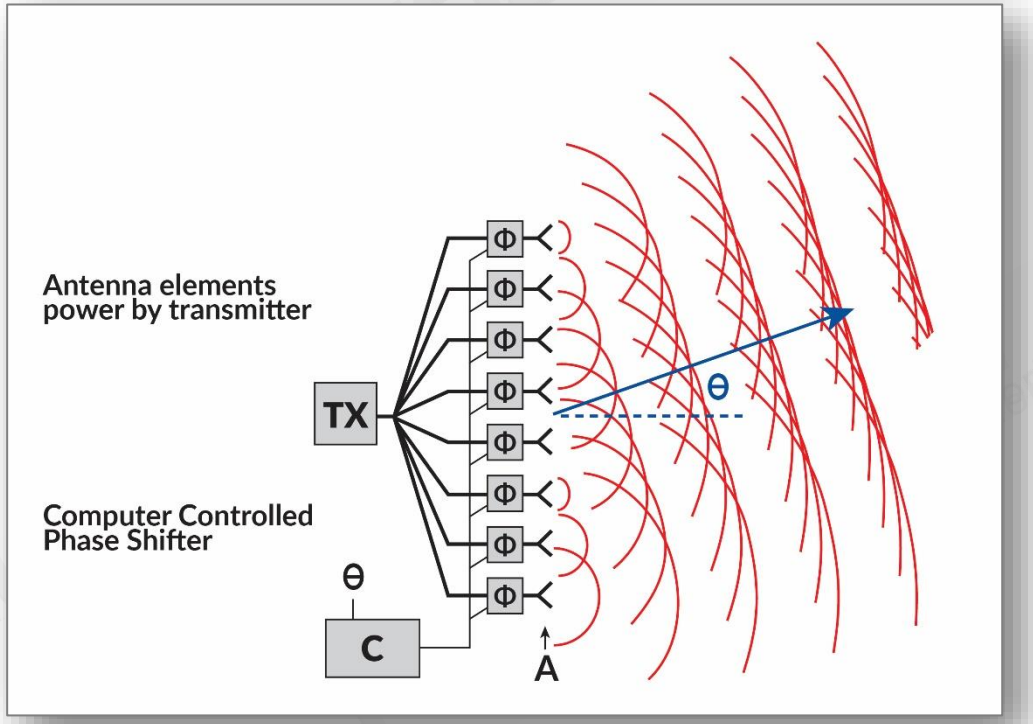
- High density micro-/nano-optics
- Extremely high uniformity in lens parameters across large arrays
- High fill-factor microlens arrays
- Off-axis lenses for tilted beams



Optical Phase Array (OPA) for Beam Steering



https://www.eetimes.com/quanergy-optimizes-optical-phased-array-lidar/#genecy-interstitial-ad
https://go.abiresearch.com/lp-demystifying-lidar-iot-and-automotive-applications

Micro-Optics With Easy-Assembly Features

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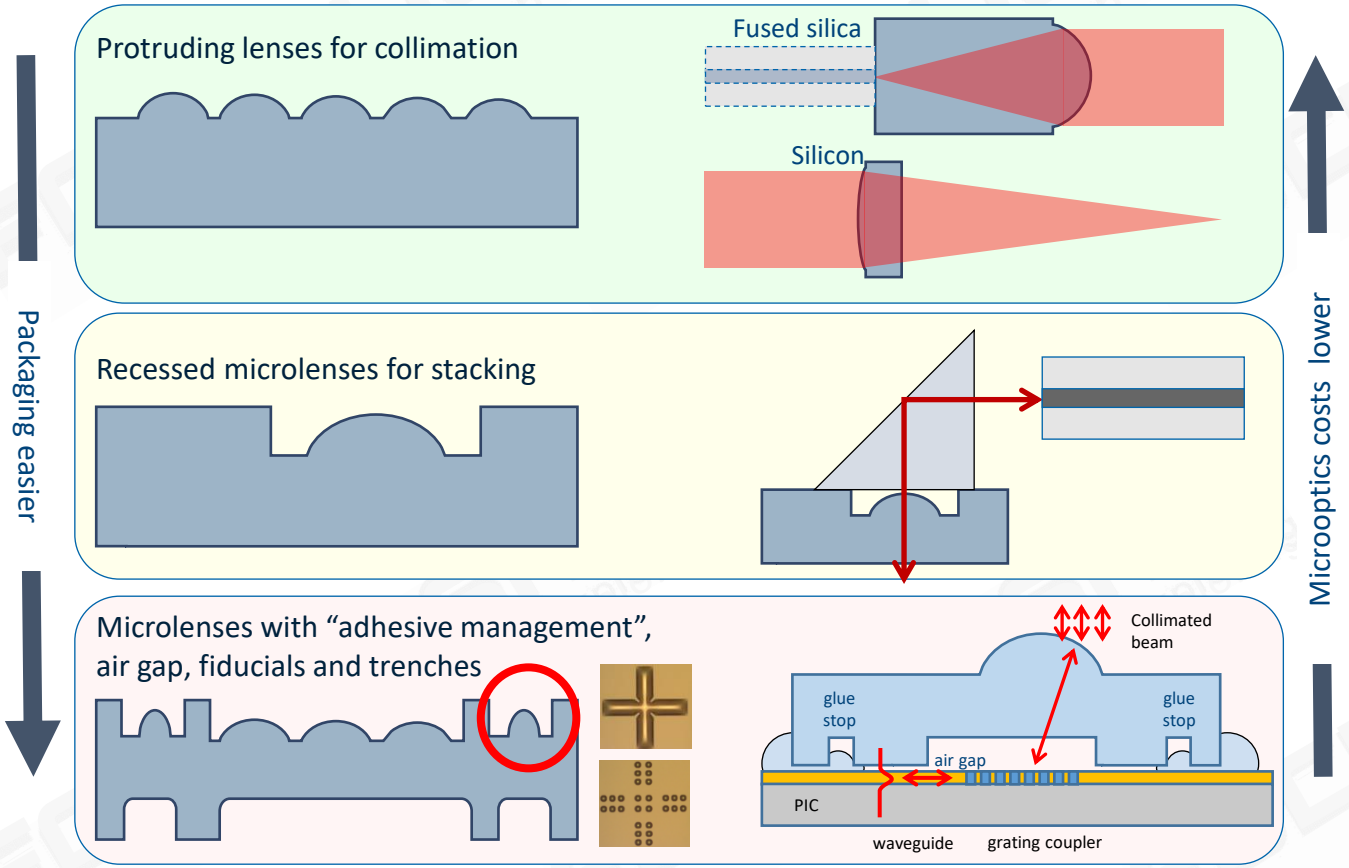
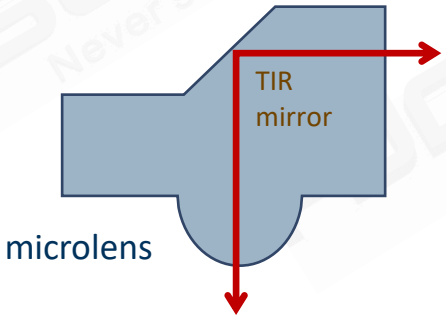
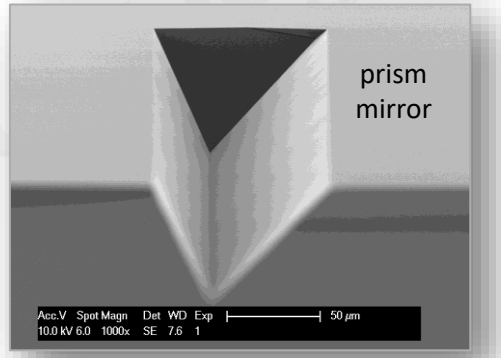
Micro-OPTICS for PICs, datacom, LIDAR and fiber optics

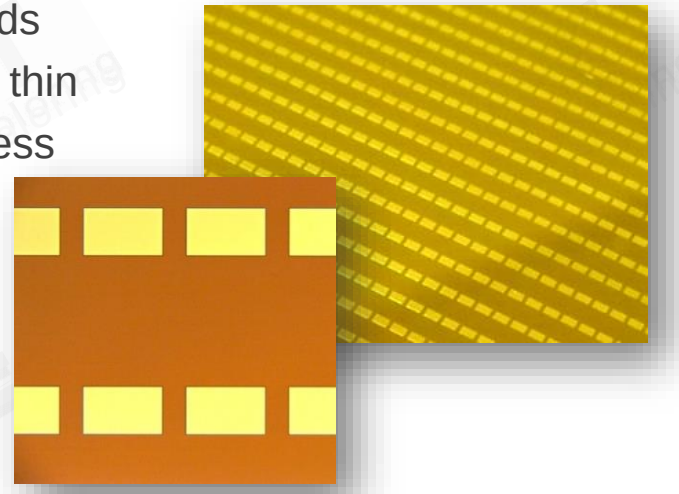


- **Special Features**
- Integrated prisms
- For high level integration





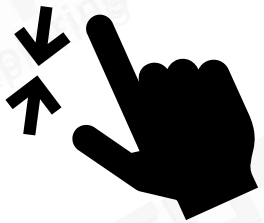
- AuSn solder pads
- Less than 3 µm thin
- For reflow process



Major Advantages

▪ Custom solutions	→ We offer **quick & precise solutions**
▪ Wafer-level production	→ **High volume, high reproducibility**
▪ Microtechnology	→ **Sub-µm precision**
▪ Functional testing	→ **Wafer-level** handling
▪ Large lens arrays	→ **Unique** optical performance and parallelization






THANK YOU

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