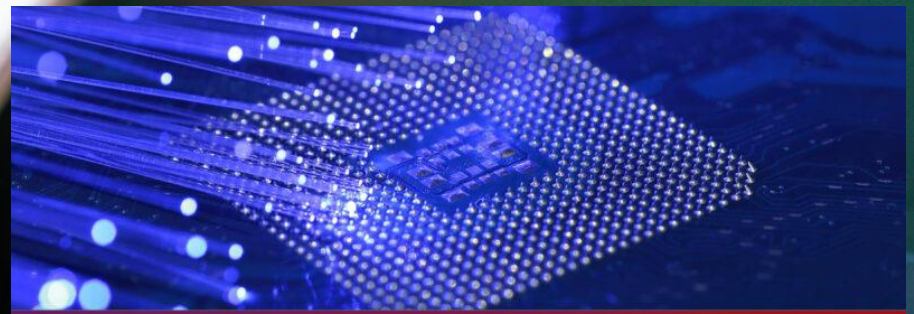

Hamed Sattari
Project Manager – Emerging Micro and Nano Technologies
Technology Manager – LNOI PIC Platform

2023/11/14

ELEVATING LITHIUM NIOBATE ON INSULATOR (LNOI) PICS THROUGH STANDARDIZATION

THREADS

CSEM's LNOI PIC Offerings

Perspective, Need, Next Steps

CSEM AT A GLANCE

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

We enable competitiveness through innovation by developing and transferring world-class technologies to industry

230
INDUSTRIAL CLIENTS / YEAR

203
PATENT FAMILIES

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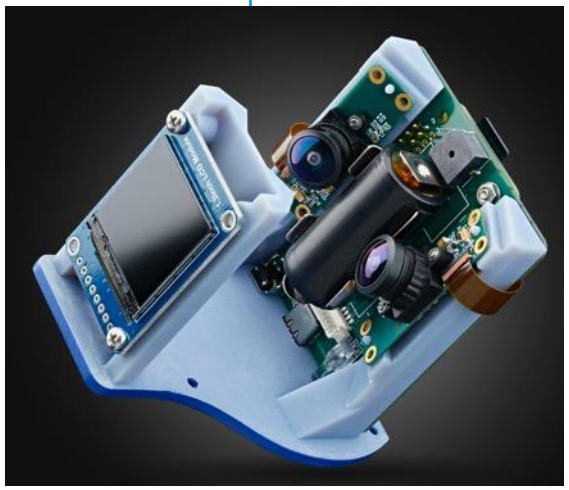
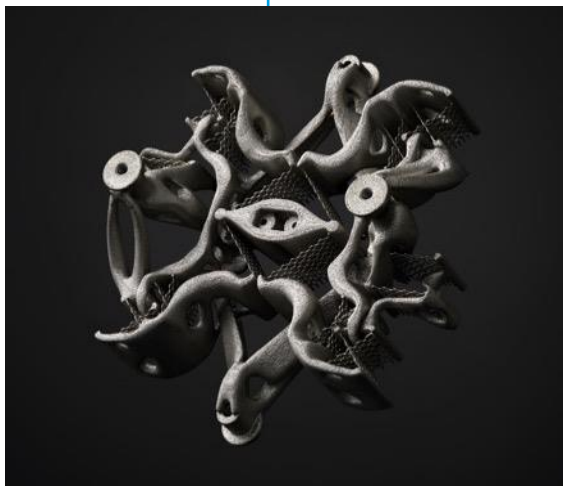
OUR DNA COMES FROM OUR WATCHMAKING ROOTS

Small & precise



Complex



Ultra-low-power

Multidisciplinary

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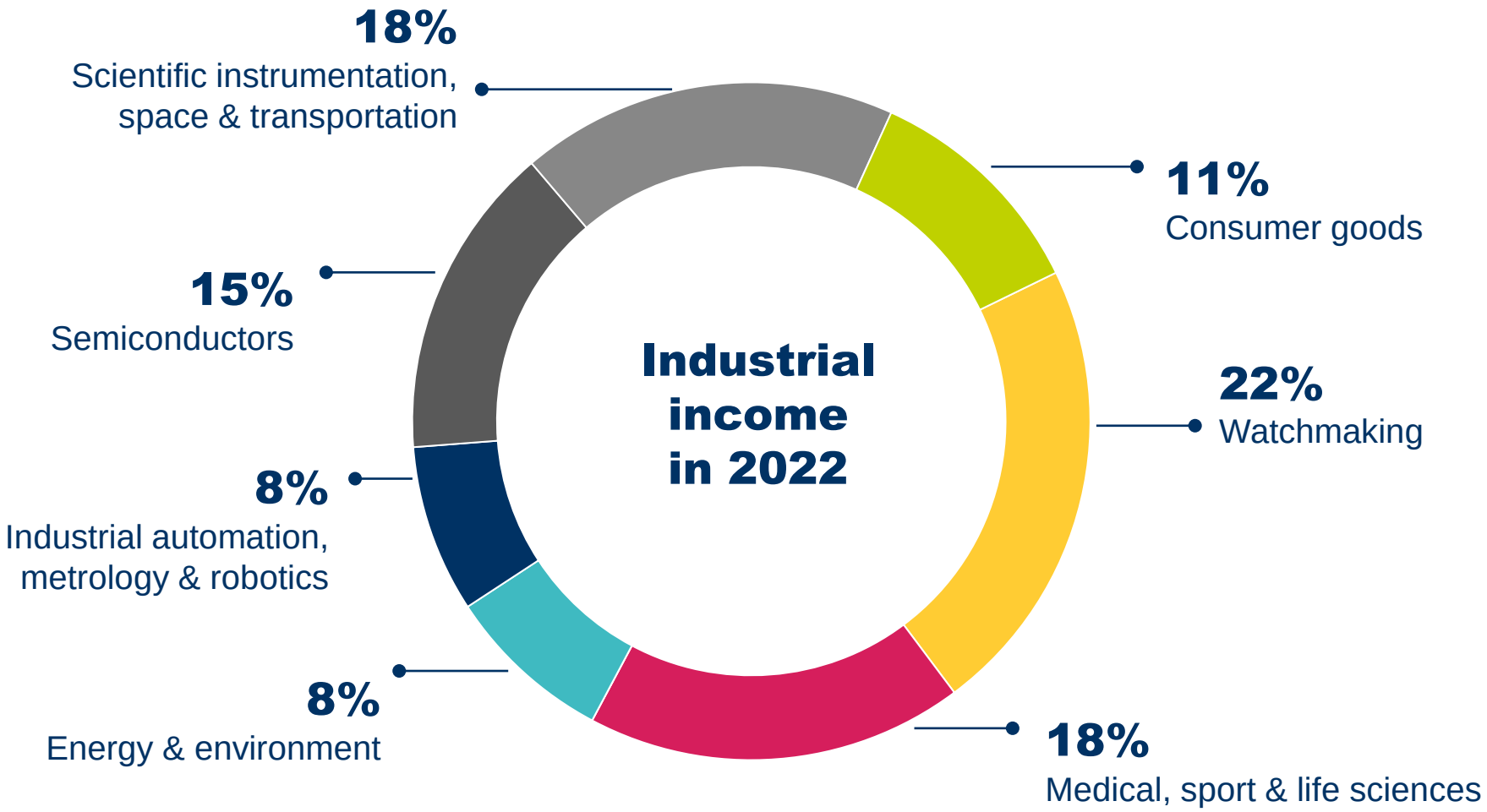
EXPERTISE SERVING SEVERAL MARKETS



230
INDUSTRIAL CLIENTS / YEAR

59%
IN SWITZERLAND

26%
IN EUROPE

10%
IN USA

05%
IN ASIA

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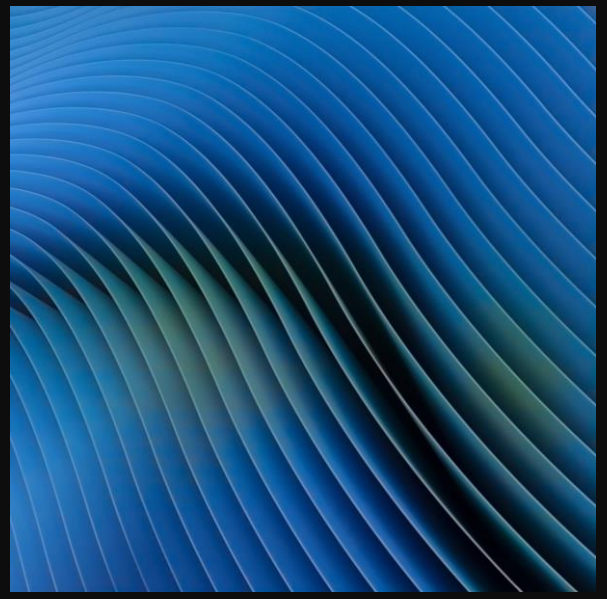
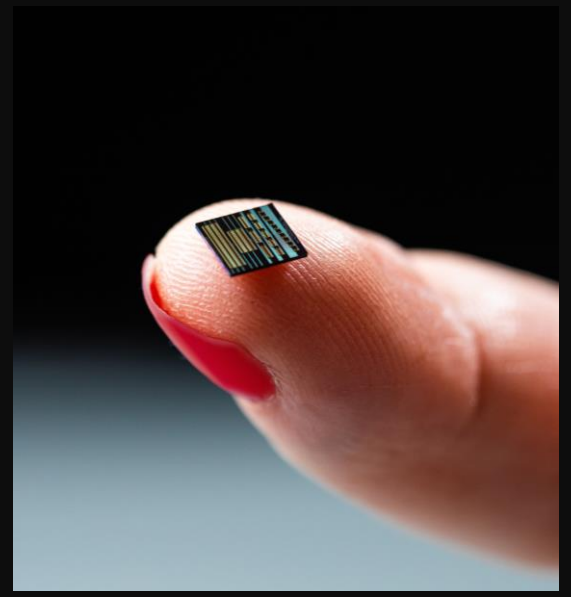
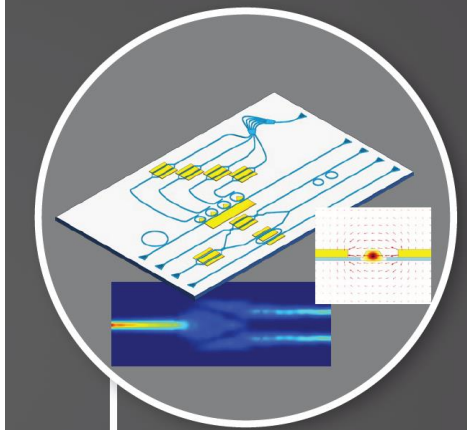
CSEM's LNOI PIC Offerings





THIN FILM LITHIUM NIOBATE ON INSULATOR (LNOI) PIC PLATFORM

OPEN ACCESS FOUNDRY SERVICE OFFERINGS



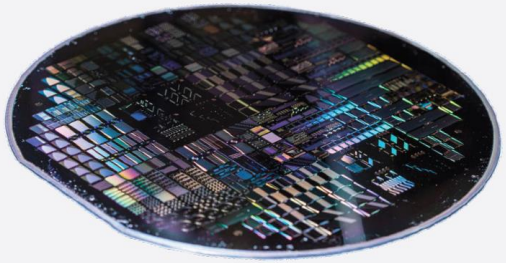
Design

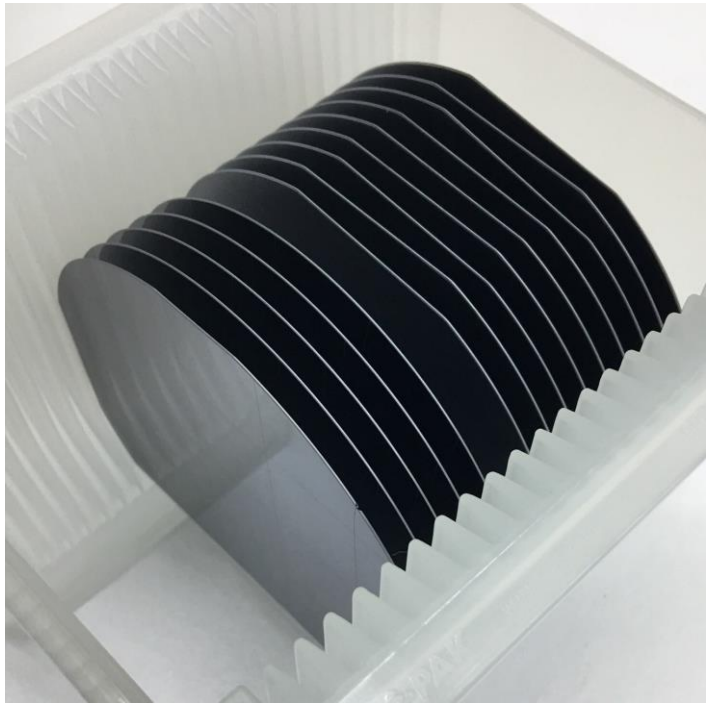
Fabrication

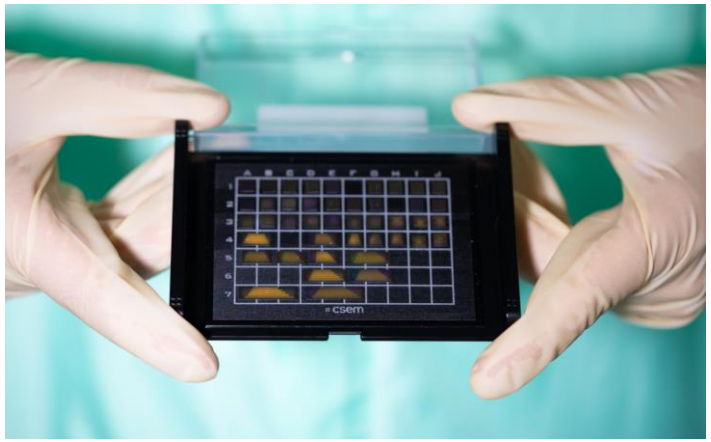
Testing

CSEM foundry service

- Affordable cost
- Library of standardized building blocks
- Expert check
- Design rule check







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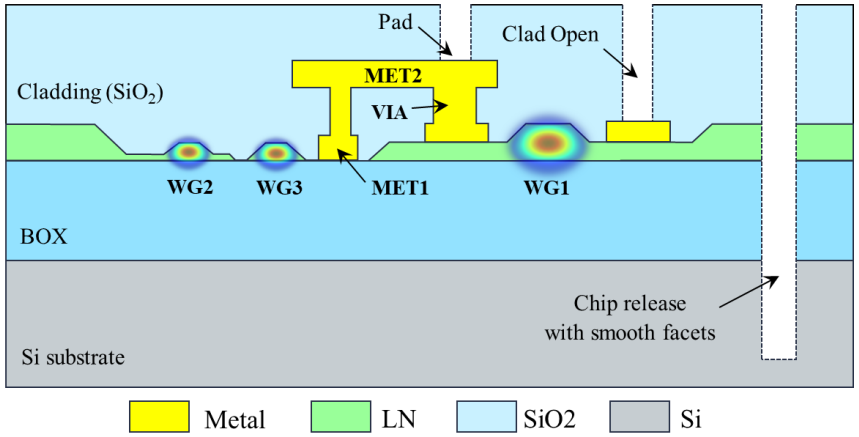
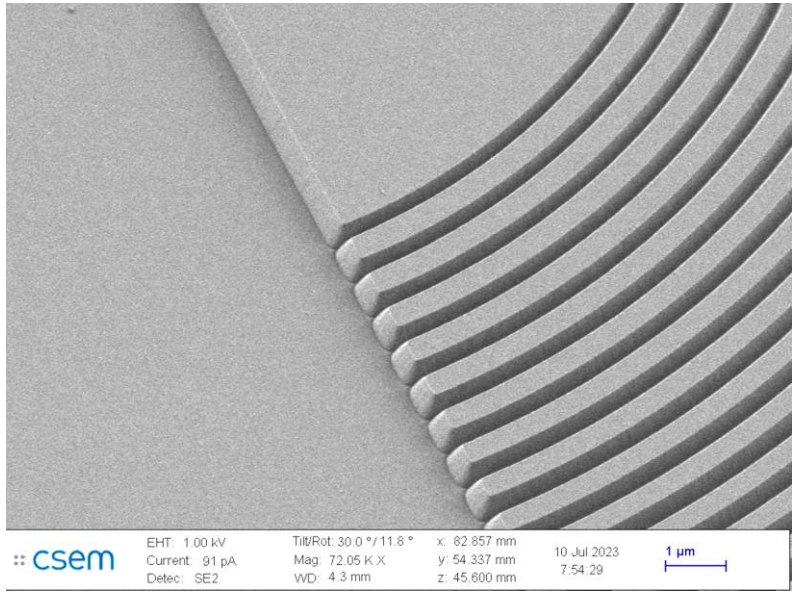
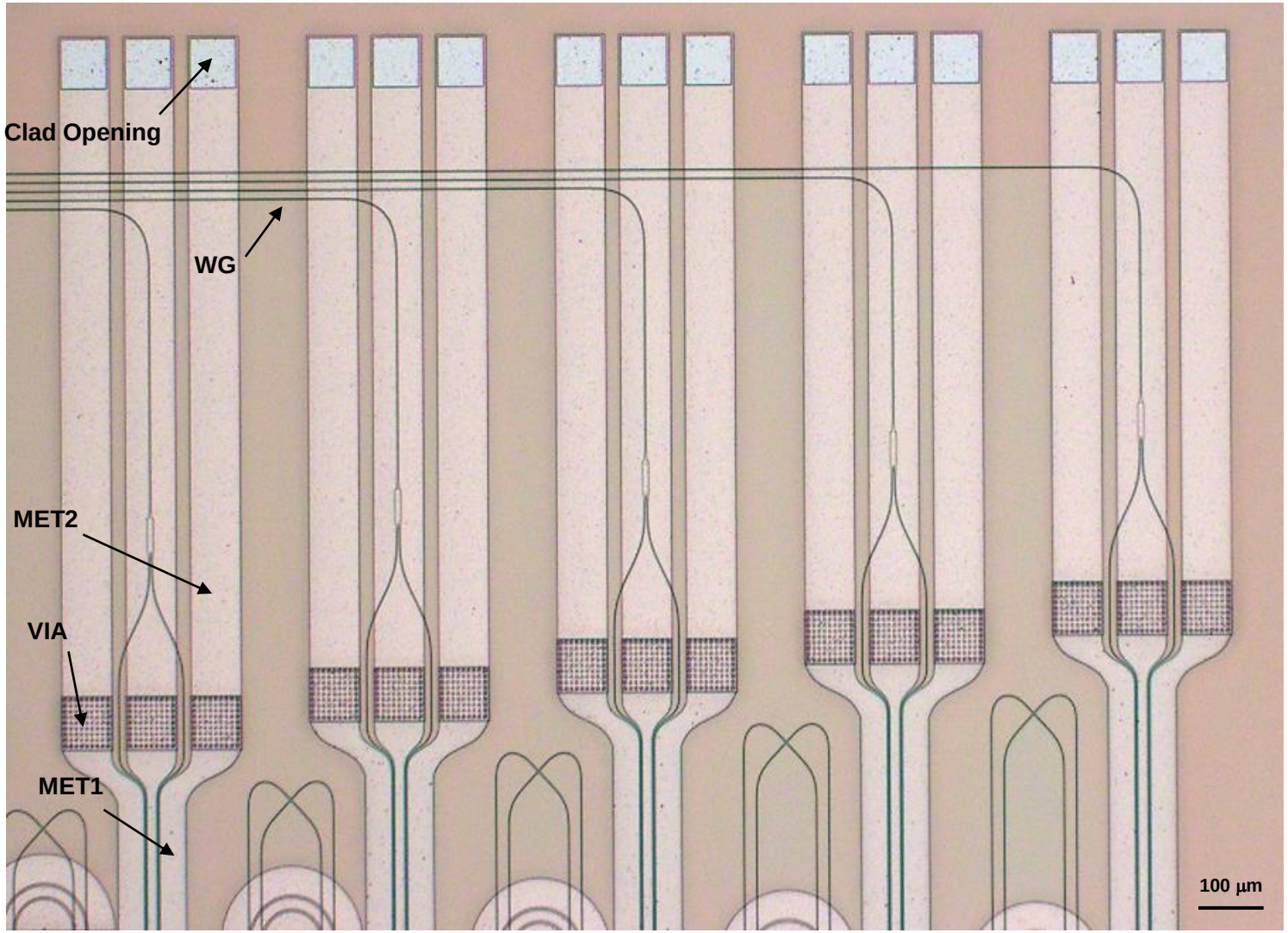
CSEM LNOI PIC PLATFORM TECHNOLOGY







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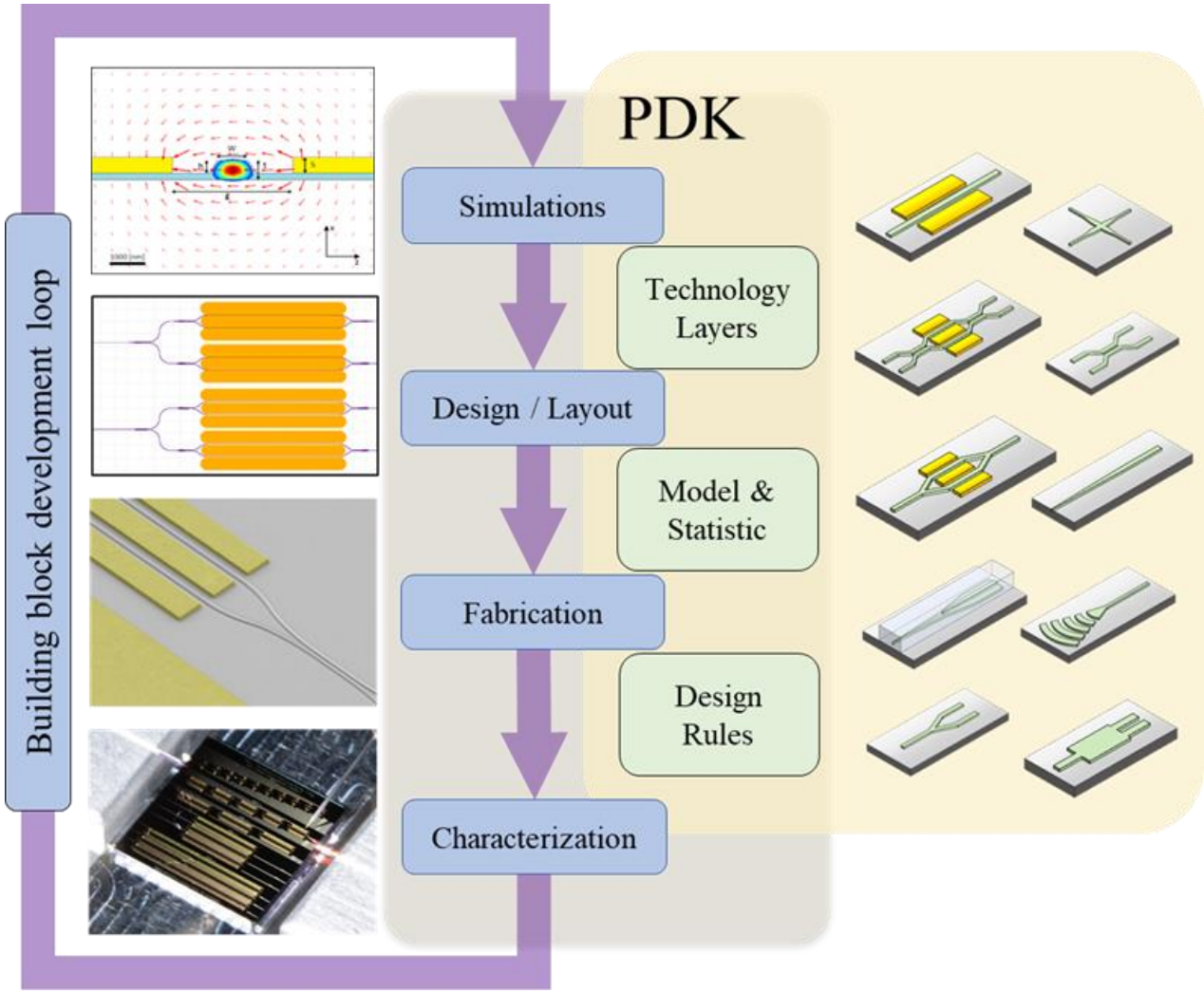
TOWARDS STANDARDIZATION



C-Band Building Blocks (version 2023)

Building Block	Performance
Waveguide	Propagation loss: 1 dB/cm single mode, < 0.2 dB/cm multimode
MMI (1x2, 2x2)	Insertion loss < 0.2 dB, 3dB BW > 60nm
Directional Coupler	Insertion loss < 0.2 dB, 3dB BW > 30nm
Waveguide Crossing	Insertion loss < 0.1 dB, Crosstalk < 30 dB
Grating Couplers	Coupling loss: 5 dB, 3dB BW > 30 nm
Edge couplers	Coupling loss: 3 dB, 3dB BW > 70 nm
EO modulaors	V_{π},L < 3 V.cm, BW > 45 GHz

✓ Pcell for customized components

In the pipeline:

- Thermal phase shifters → early 2024
- Polarization controllers → early 2024
- PPLN for SHG → late 2024
- **780 nm PDK** → early 2024

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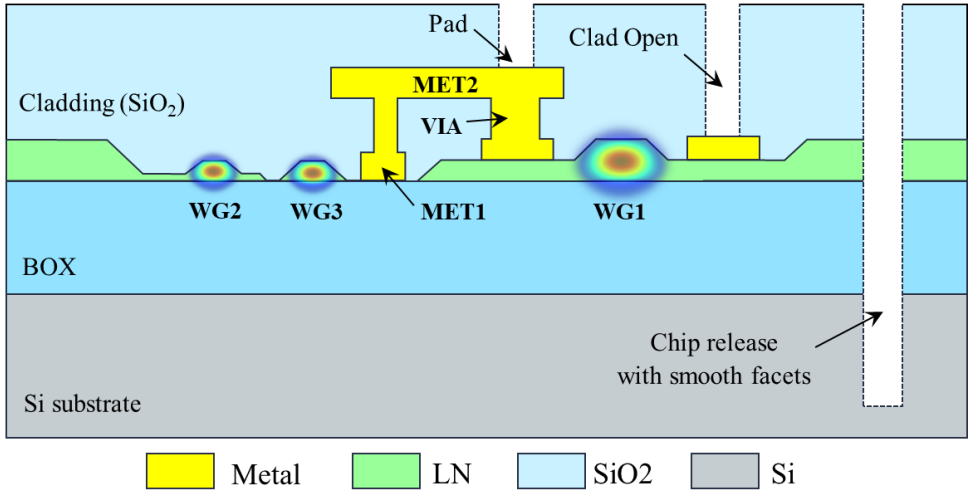
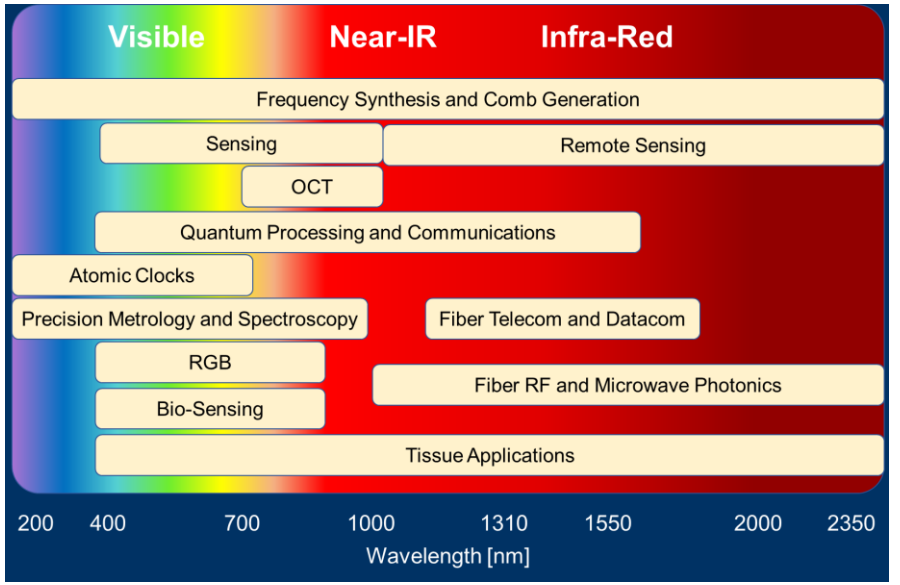
CSEM LNOI PIC PLATFORM OFFERINGS

Service	Technology Features	Deliverables and the options		Order criteria
MPW RUNs	• Full stack: 3 waveguide and 2 Metal layers • 2 RUNs per year	• Design consultation • DRC report • Inspection pack	• Custom chip size from 5x5 mm2 up to 10x30 mm2	• Minimum order 100 mm2
Dedicated RUNs	• Customized stack: from 1 WG to a full stack • Flexible starting date;	• Minimum 100 (5x5 mm2) chips per Wafer • DRC report, Inspection pack	• Customized chip size and shape • Flexible design rules	• Minimum order of 4 wafers
Simulation and Design	• Passives and Actives BBs • From visible to IR	• EME, FDTD, FEM • Layout, DRC, final GDS file	• Design consultation • Design report	• Order minimum 1 month before the design submission deadline
Testing	• Passive and Actives (DC, RF) • Telecom C-Band, 780 nm band	• Automated setup, dedicated lab	• Insertion loss, EO bandwidth, Statistic • Characterization report	• Limited offer depending on the available resources
Demo Chips	• Full stack • Only Passive • Only Active	• Chips with only one type BB • PDK chips with only passive BBs • PDK chips with only active BBs	• Trial evaluation of the platform • Practice electrical and optical interfacing • Practice packaging and reliability tests	• Minimum order of 1 chip • Pricing based on the availability and the stack complexity





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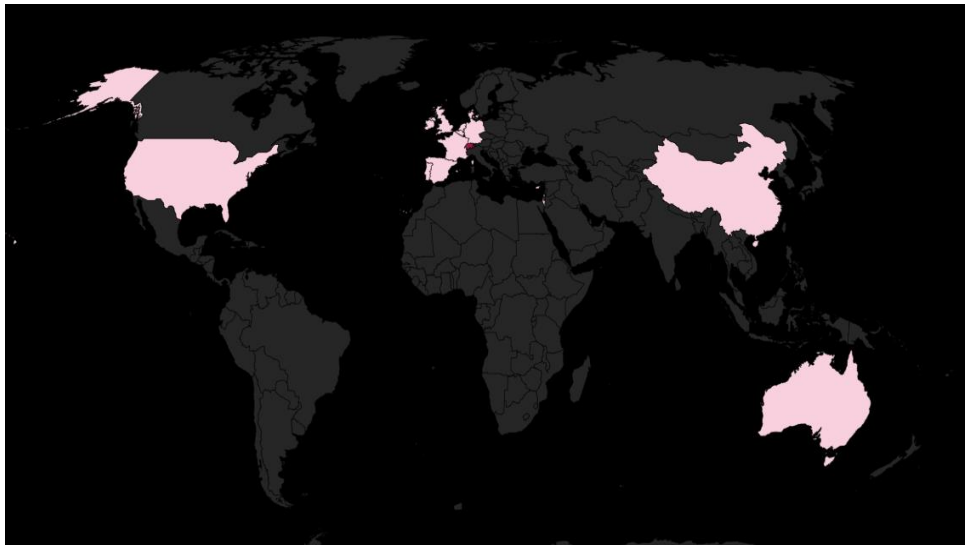
CSEM LNOI PIC PLATFORM MPW SERVICE

MPW RUN ID - Technology	Design Submission Deadline	Expected Shipping Date	Status
2021_RUN1 – 1 WG, 1 MET	Early evaluation	Early evaluation	Delivered
2021_RUN2 – 2 WG, 1 MET	15/04/2022	31/10/2022	Delivered
2022_RUN1 – 2 WG, 2 MET	15/02/2023	30/09/2023	Delivered
Dent Blanche – 2 WG, 2 MET	15/11/2022	31/03/2023	Delivered
Eiger – 3 WG, 2 MET	28/02/2023	30/09/2023	Delivered
Finsteraarhorn – 3 WG, 2 MET	30/09/2023	30/04/2024	Ongoing
Grand Combin – 3 WG, 2 MET	22/12/2023	31/07/2024	Accepting designs
Hockenhorn – 3 WG, 2 MET	31/04/2024	31/10/2024	Accepting designs





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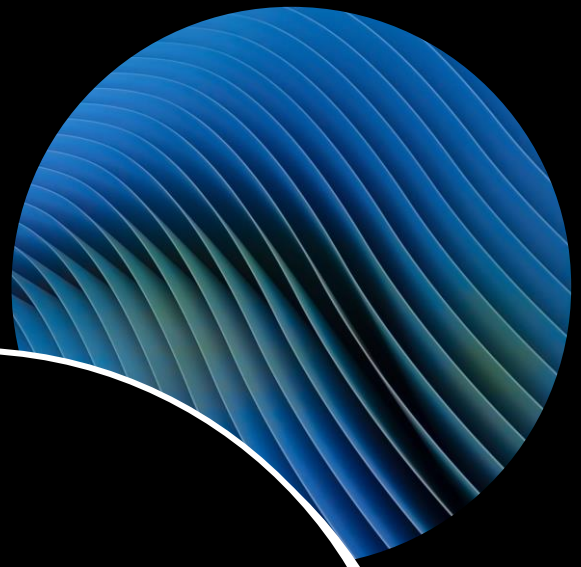
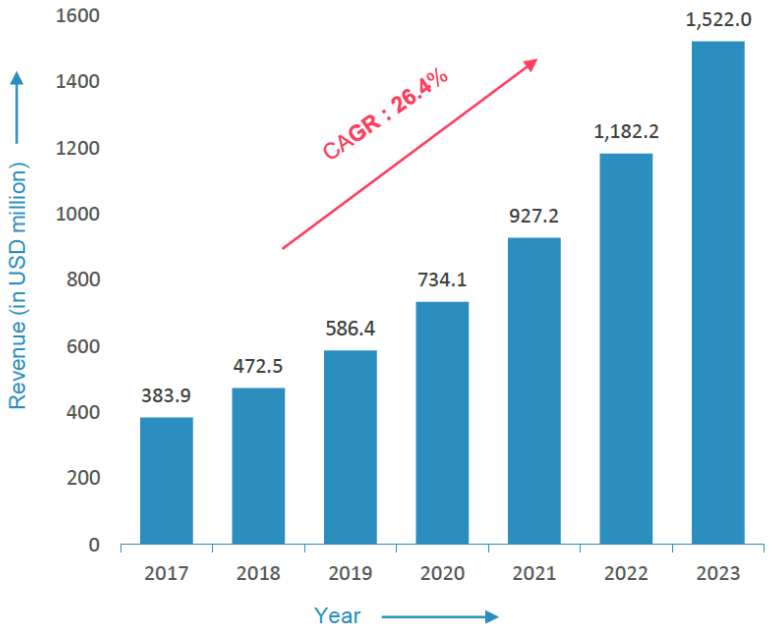


Perspective, Need, Next Steps

PERSPECTIVE: CURRENT MARKET; DRIVES FOR FUTURE

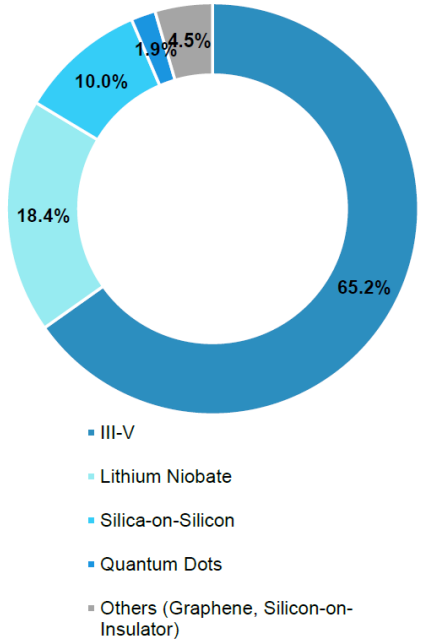
- PIC is a fast-growing market

Photonic Integrated Circuit Market: Revenue in USD million, Global, 2017-2023



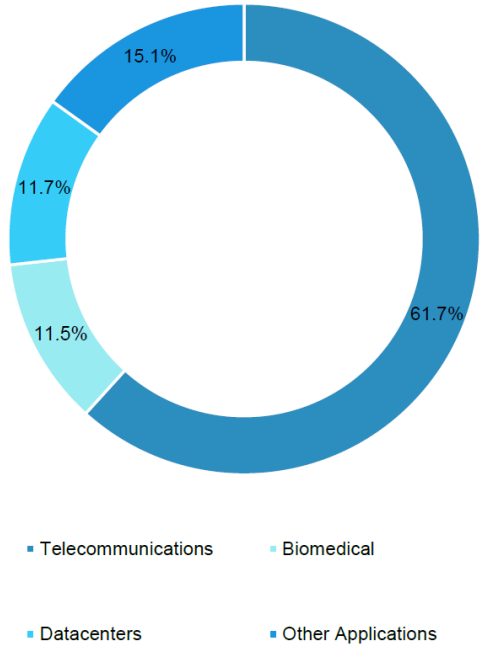
- And is divided between different materials

Hybrid Photonic Integrated Circuit Market: Revenue Share, By Type of Raw Material, Global, 2017



- And across several application areas

Photonic Integrated Circuits Market: Revenue Share, By Application, Global, 2017



Source:
Global Photonics Integrated Circuits Market report (EPIC)

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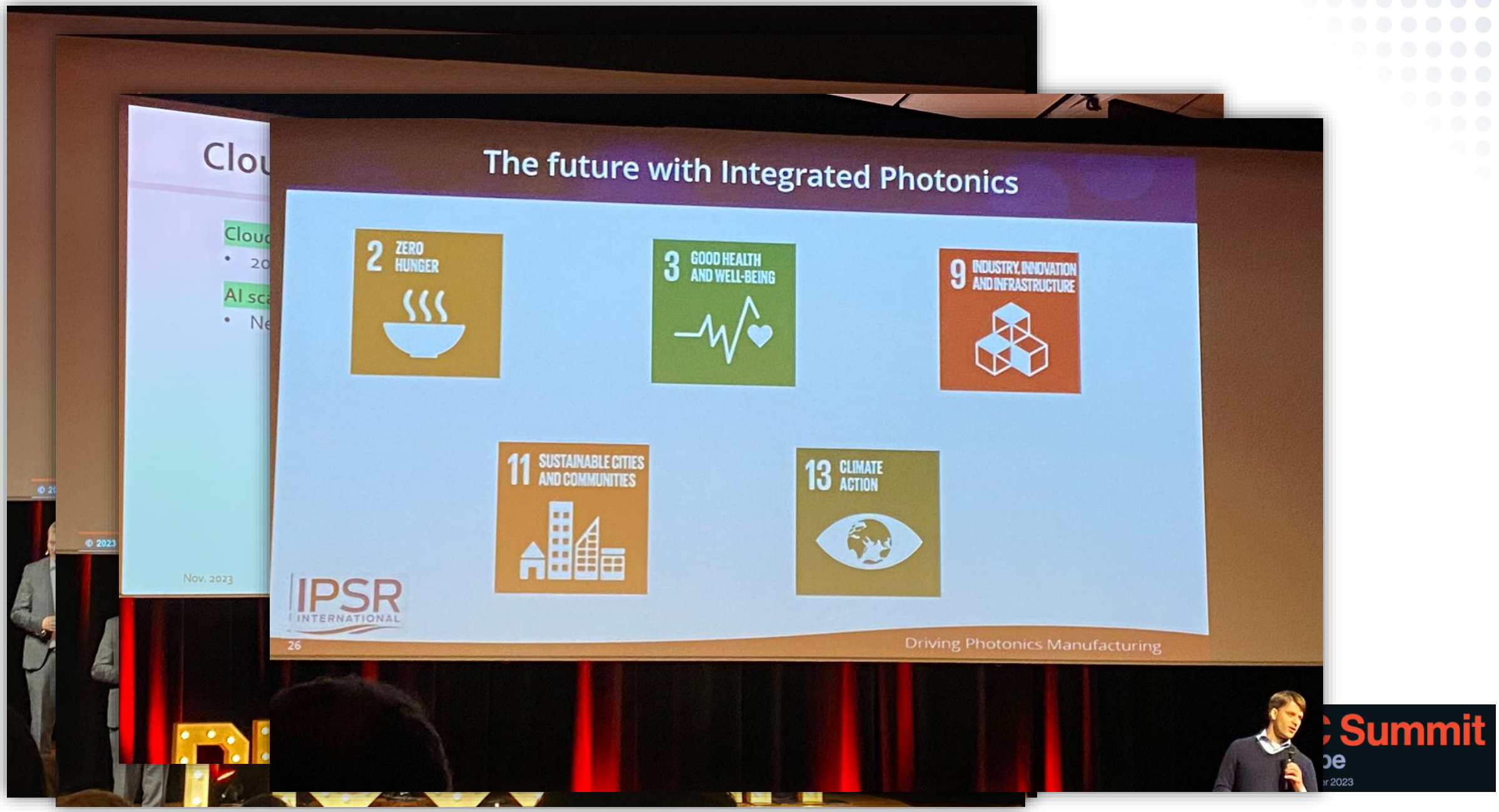
The future with Integrated Photonics
2 ZERO HUNGER
3 GOOD HEALTH AND WELL-BEING
9 INDUSTRY, INNOVATION AND INFRASTRUCTURE
11 SUSTAINABLE CITIES AND COMMUNITIES
13 CLIMATE ACTION
IPSR INTERNATIONAL
26
Driving Photonics Manufacturing
Nov. 2023
Summit

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PERSPECTIVE: STRATEGIC TECHNOLOGY

micro-chip manufacturing

Strategic Technology

Sovereignty

Imminent need,
not a luxury

Global competition

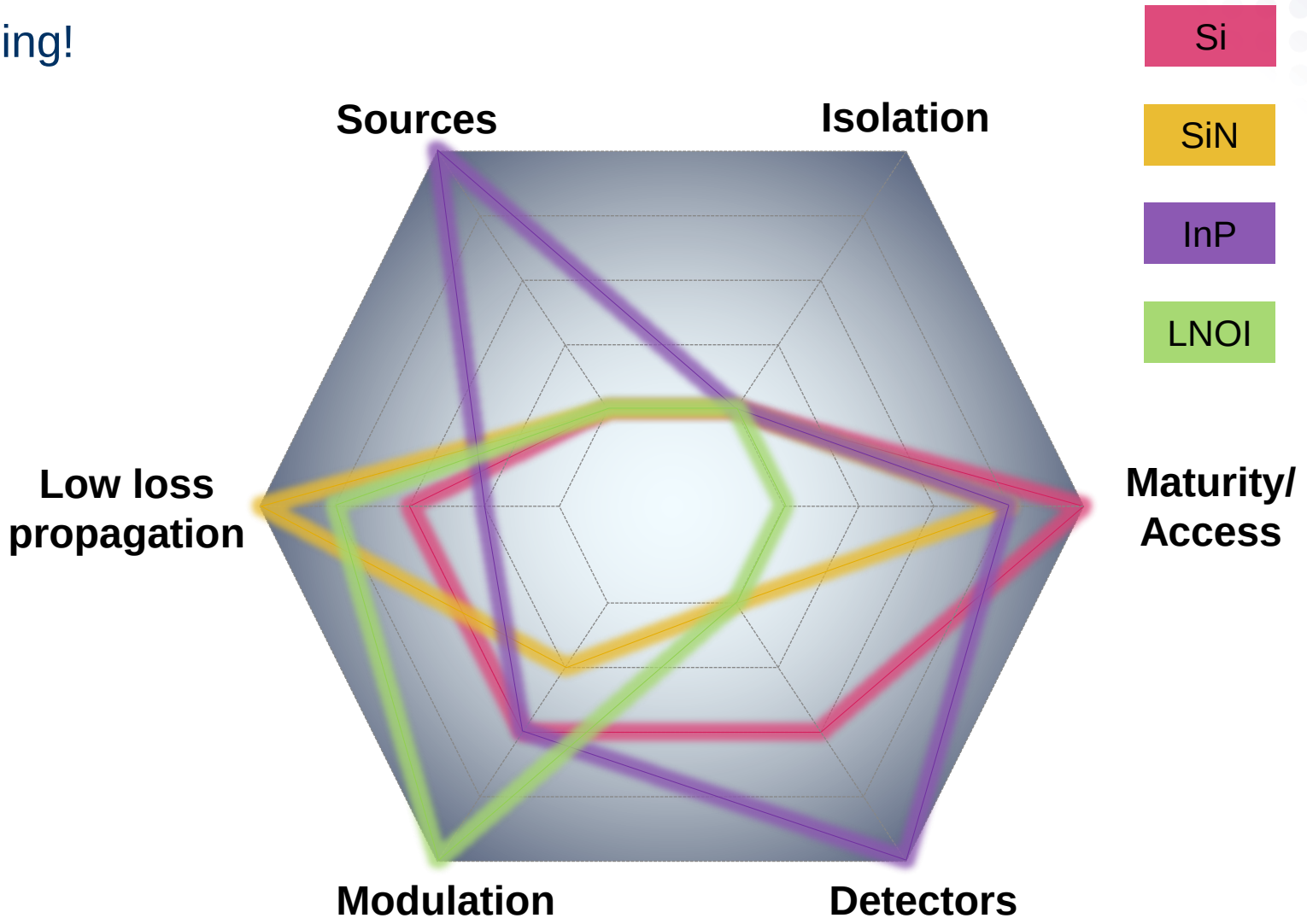
ARE PICS READY TO ADDRESS THE NEEDS?!

Need for Components to Generate, Manipulate, Transport, and Detect light

No single material can do everything!

PIC Systems

- Optical interfacing
- CMOS integration
- Power consumption
- Form factor



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NEED IS EVERYWHERE!

- Chip manufacturing is a key capability
- Max is made by Mix
- It is time to Act

Compact

Power-efficient

Cost-effective

Scalable

- Current market
- Emerging needs
- New markets

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PERSPECTIVE: PICS VALUE CHAIN: AN EXAMPLE

ELENA
Lithium Niobate PICs for Europe

- LNOI PIC Foundry, PDK
- Supply chain for LNOI PICs

PATTERN

- Hybrid/Heterogeneous integration
- ADK
- Supply chain for hybrid PICs

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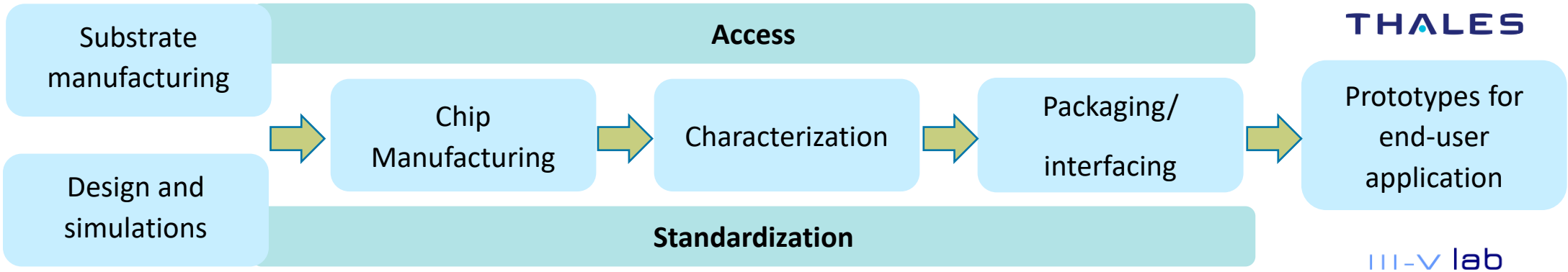

VPIphotonics DESIGN AUTOMATION csem THALES vanguard AUTOMATION III-V lab

ETH zürich UCL phix Rosenberger

LUCEDA PHOTONICS

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FROM PLATFORM STANDARDIZATION TO THE APPLICATION

Focus Area

- Chip manufacturing
- Hybrid/Heterogeneous Integration
- Work together

Challenges

- Optical interfacing
- CMOS integration
- Power consumption
- Form factor

FACING A CHALLENGE?

LET'S TACKLE IT TOGETHER!

A big Thanks to the LNOI PICs team at CSEM

FNSNF
Fonds national suisse
Schweizerischer Nationalfonds
Fondo nazionale svizzero
Swiss National Science Foundation
Innosuisse
BRIDGE
HORIZON 2020
Horizon Europe
European Commission


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FACING THE CHALLENGES OF OUR TIME