Photonics at IMEC

Dries Van Thourhout, Ghent University & IMEC

Eindhoven, May 2026

Imec receives the world's most advanced High NA EUV system

Imec receives the world's most advanced High NA EUV system

imec

Imec receives the world's most advanced High NA EUV system

Left to right: Peter Vanoppen (ASML), Martin van den Brink (ASML), Luc Van den hove (imec), Matthias Diependaele (Minister President of the Flemish government), Patrick Vandenameele (imec) .

Imec is more than just another R&D hub.

imec

Imec, the leading independent, not-for-profit R&D hub in nano-electronics and digital technologies

Founded in **1984**

Unique ecosystem, collaborating with **600+ industrial partners**

~ $4B invested in **leading-edge semiconductor fabs**

>6,500 employees

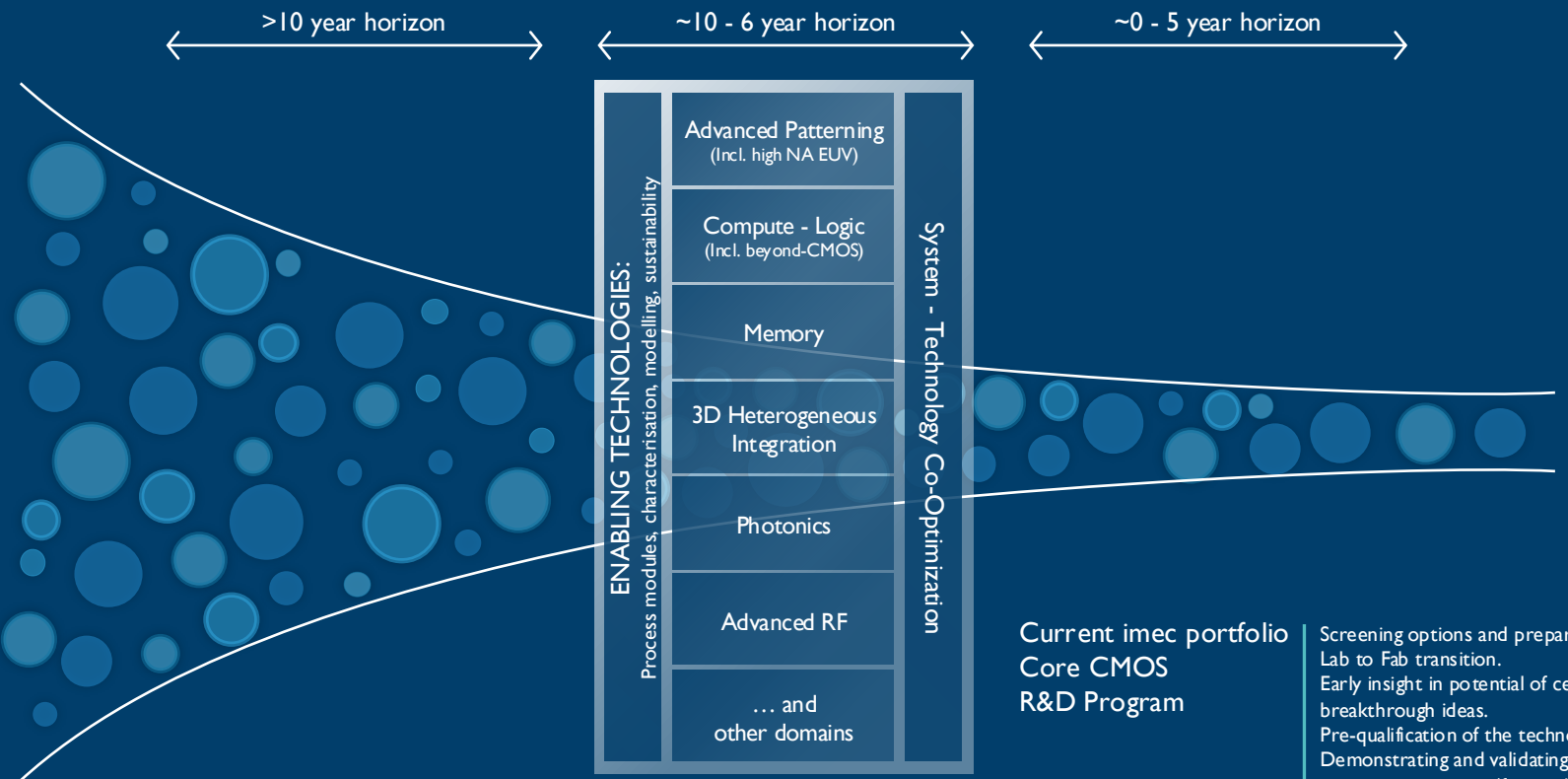
Focus on bridging R&D to manufacturing **for compute & system technologies, health, automotive, industry & consumer, space & defense**

2024: €1B revenue, 187 patent applications, 2627 peer reviewed publications

imec

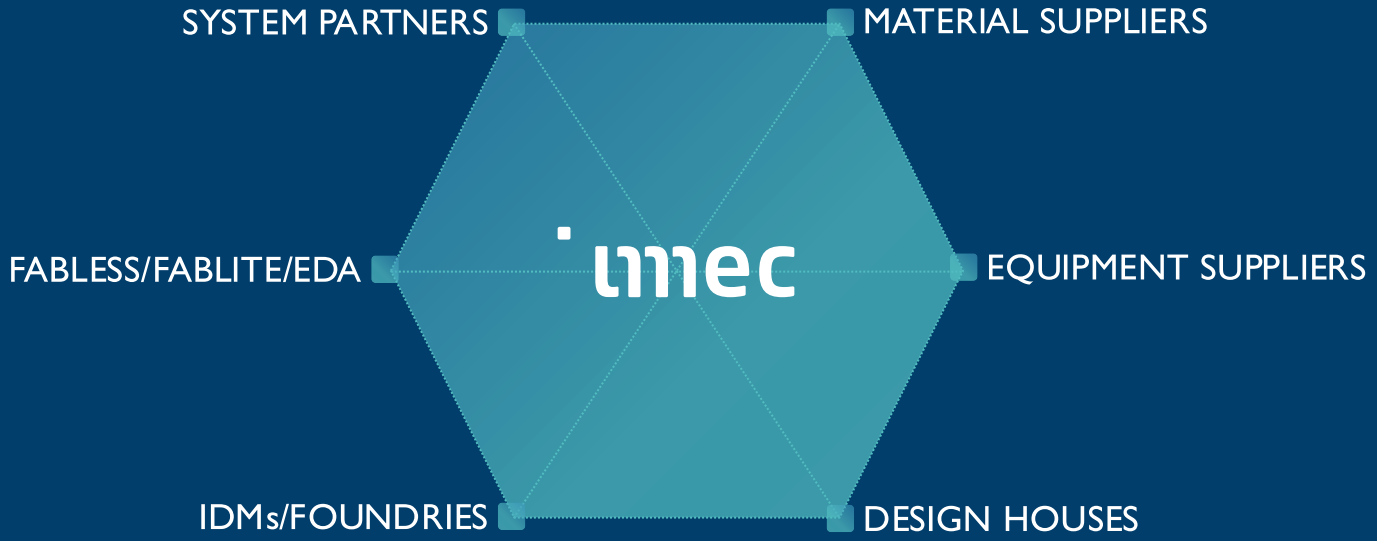

JAPAN
Tokyo
KOREA
Seoul
TAIWAN
Taipei
USA
Michigan
USA
Purdue
GERMANY
Heilbronn
THE NETHERLANDS 3
Eindhoven,
Wageningen, Nijmegen
FRANCE
Paris
QATAR
Doha
USA
San Francisco
BELGIUM 6
Leuven (HQ), Ghent
Antwerp, Brussels, Kortrijk & Genk
USA
San Jose
FINLAND
Helsinki
USA
Boston
ITALY
Napoli
USA
Florida
SPAIN
Malaga
INDIA
Bangalore
UK
Cambridge
R&D
Representative office

R&D Platform



imec

Our global ecosystem of over 600 partners work together in an open innovation model



Multiple research domains at imec

CMOS and beyond CMOS
- Next-generation logic devices
- Novel memory concepts
- Advanced patterning and key process steps
- 3D system integration
- Advanced nano-interconnects
- Neuromorphic computing
- High-speed analog/RF analog

Quantum Computing

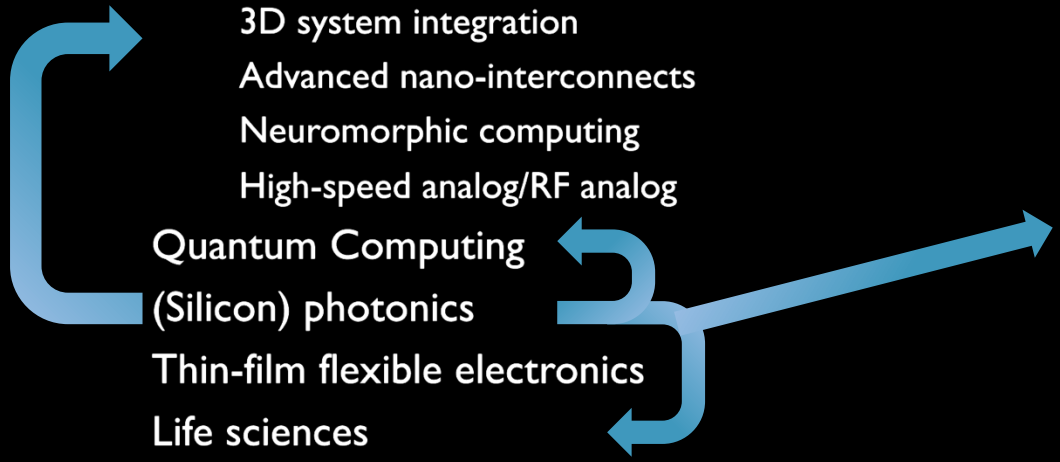
(Silicon) photonics

Thin-film flexible electronics

Life sciences

Wearables

GaN power electronics



Solid state batteries

Photovoltaics

Power to molecules

Sensor solutions for Internet of Things

6G and Wireless Internet of Things communication

Low cost and low power radar sensing systems

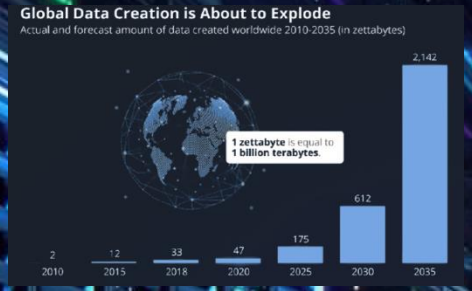
Automotive

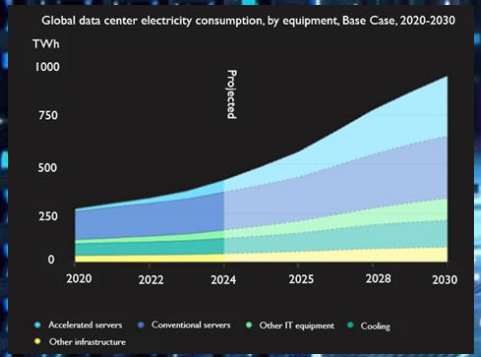
Image sensors and vision systems

Data science and data security

System and IC design

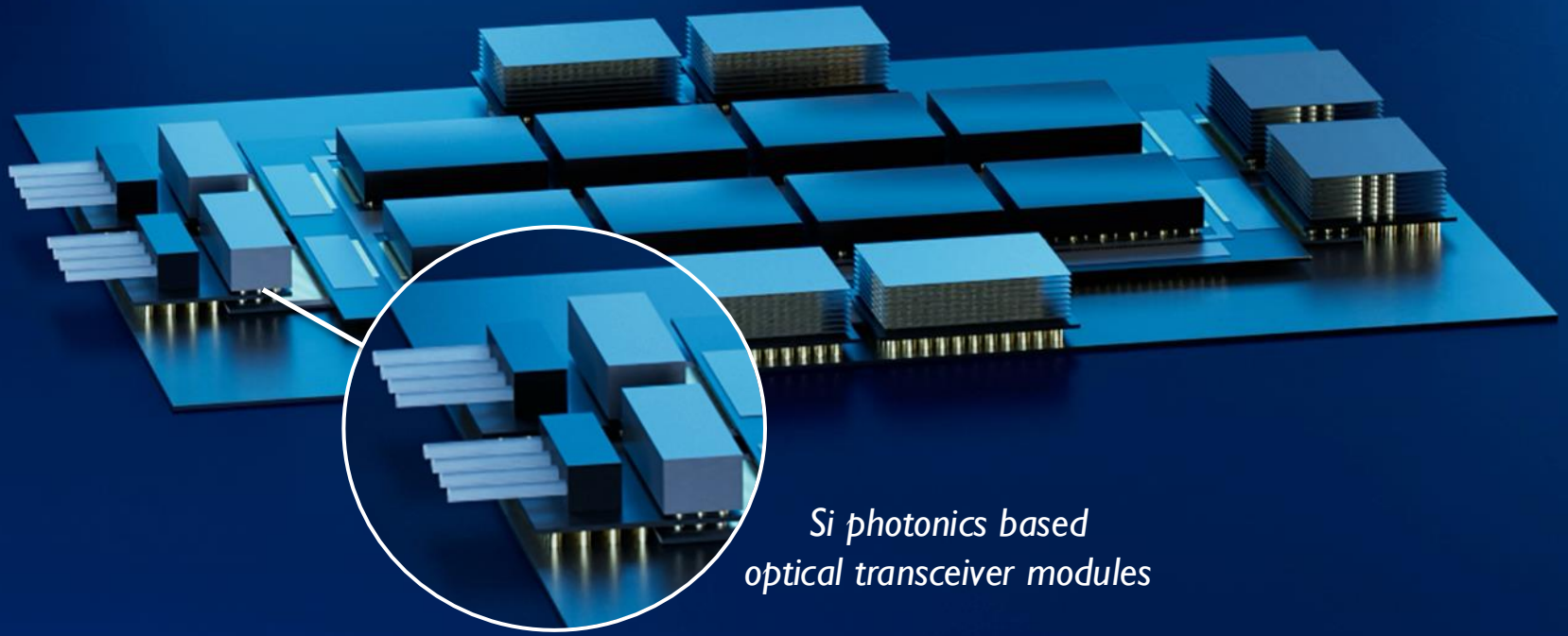
Main driver: AI datacenters demands





- High bandwidth network development: Connectivity BW requirement pushed shift from 800G to 1.6T. Next gen will be 3.2T
- Power efficiency is a key point to address.
- Thermal management and cooling is another challenge to overcome.

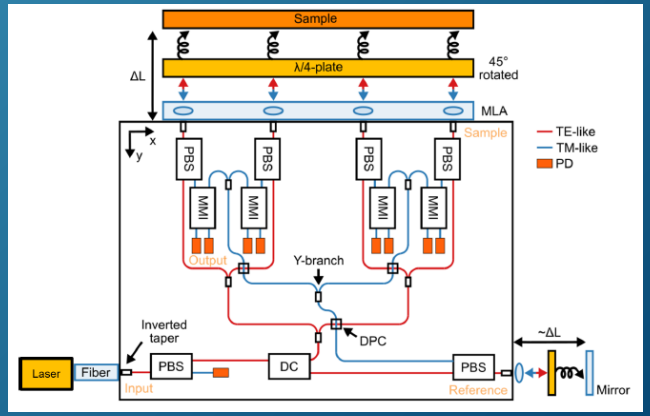
Silicon photonics as key enabling technology for terabit-scale optical interconnects applications



Si photonics based optical transceiver modules

Beyond optical interconnects: Other applications supported by imec photonic platforms

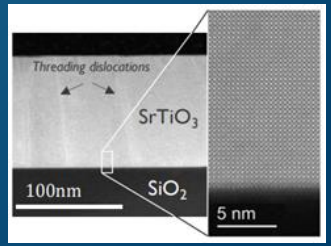
A non-invasive imaging: Optical Coherence Tomography

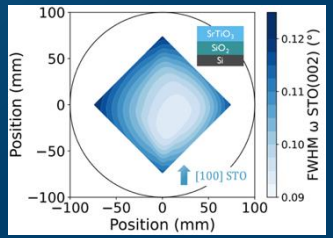


1060 nm devices fabricated in imec's iSiPP platform

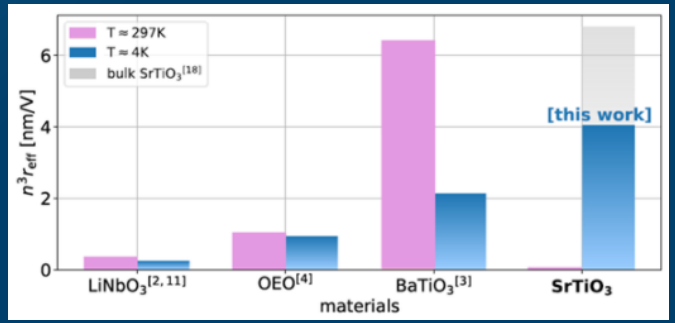
R. Hainberger, et al, SPIE Photonic West, 2024

Material engineering that accelerates the quantum roadmap





Good uniformity over 200mm wafer



Strontium Titanate: Record Pockels coefficient at cryogenic temperatures (for electro-optic devices)

A. Ulrich, et al, Science, 2025

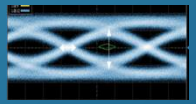
imec's Silicon Photonics Platforms and Heterogenous Integration

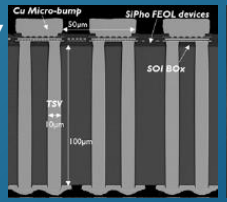
POWERED BY imec

ITF Photonics USA

iSiPP300 (300mm): Beyond 200mm

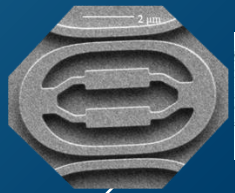
High-Speed TSV
112 Gbps

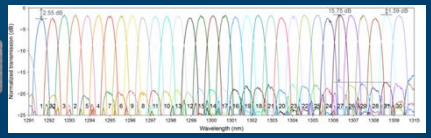




TSV reveal and BSRDL in CMOS fab (imec)

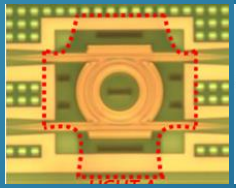
Ultra-Compact Si WDM filters *(193nm immersion)*
(O-band)

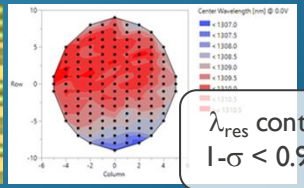




Q. Deng et al, LPR, 2024

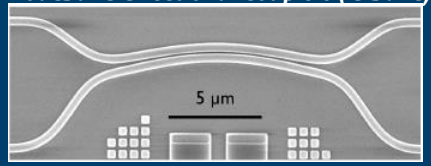
Highly-Uniform Si MRM
(193nm immersion)

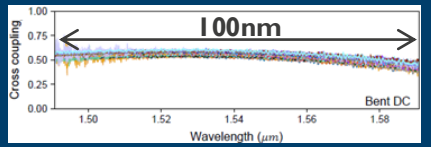




λ_{res} control
1-σ < 0.9nm

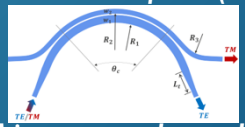
Broadband directional couplers (C-band)



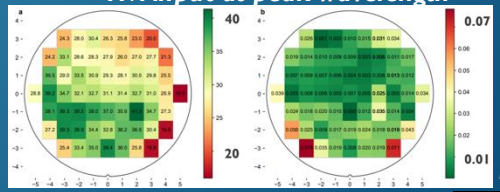


A. Bayoumi, et al, PTL, 2025

Polarization beam splitter (O-band)



TM input at peak wavelength

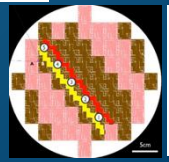


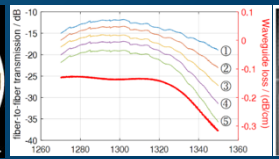
ER ~29 dB **IL ~ 0.019 dB**

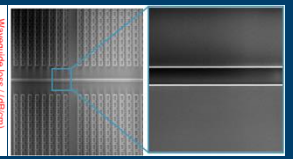
A. Elshazly, et al, 2026

State-of-the-Art Silicon Photonics Platform: CPO driven

O-band
Low loss SiN loss 0.15dB/cm (over 56 cm stitched SiN WG)

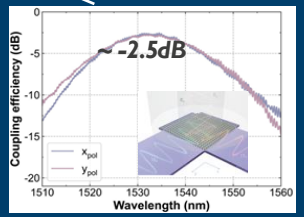


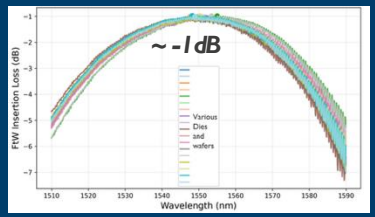




P, Xu et al, OFC 2024

2D Grating Couplers (C-band) **1D Grating Couplers (C-band)**





W. Zhou, et al, Photonics Journal, 2025
(3rd party design demonstrated in imec technology)

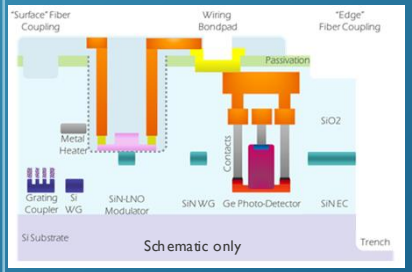
110GHz GeSi EAM as well as Ge based APD are being added in the platform

Roadmap platform: iSiPP400G (200mm), 400G per lane

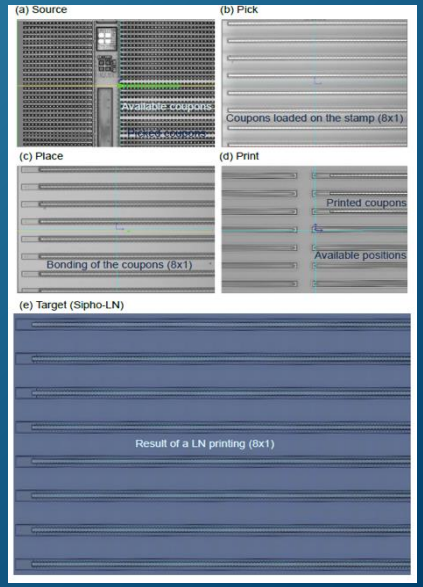
Si Passives, LPCVD SiN, UBM, 4 Level Metal from iSiPP200

+

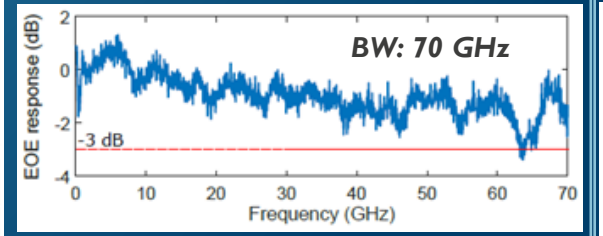
110 GHz Modulator and 110 GHz Ge PD

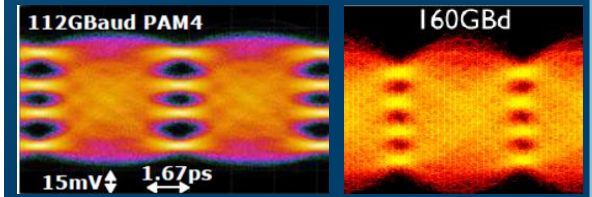


Patterned LNO printed on SiPho wafer

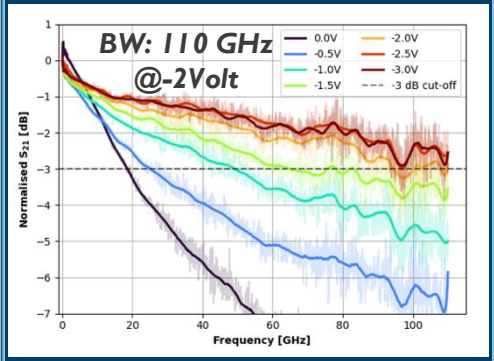


LNO 8 array printing
Alignment accuracy < 500nm





LNO modulator demonstrated in manufacturing flow



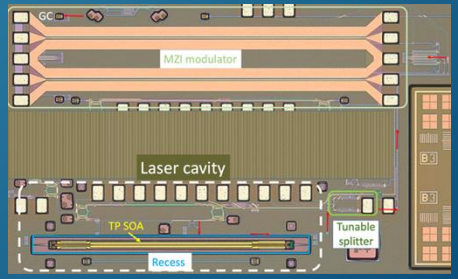
@-2Volt
BW 110 GHz
Responsivity > 0.8 A/W
Dark current <20 nA

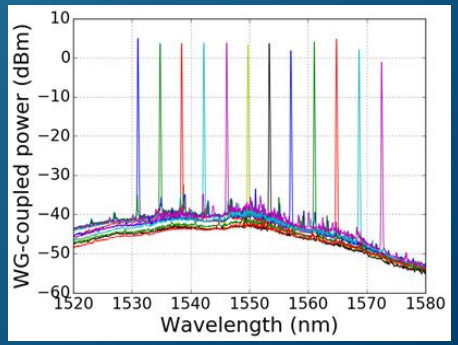
Ge PD of imec fabricated in foundry

OFC Th3F.3 Conor Coughlan

New functionalities: Platform upgrade Supporting III-V devices

SOA Integration (mTP)

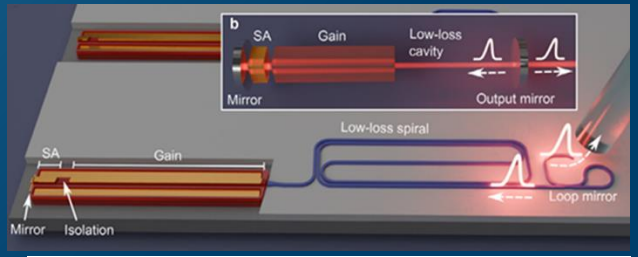


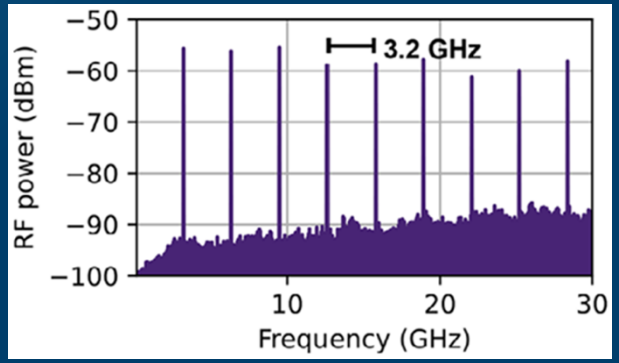


Coarse wavelength tuning

J. Zhang et al, OP Ex 2023

Mode-locked laser Integration (mTP butt coupling)





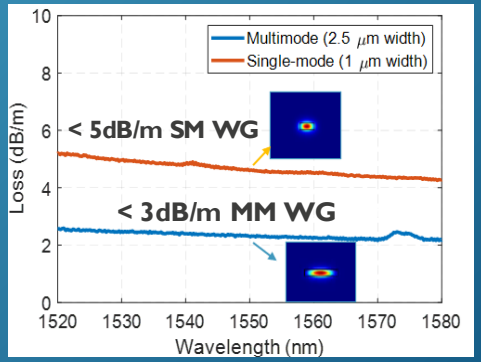
Fundamental RF tone showing an extinction ratio of approximately 50 dB

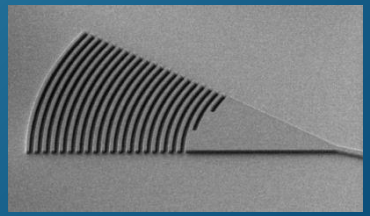
M. Kiewiet et al, LPR 2025

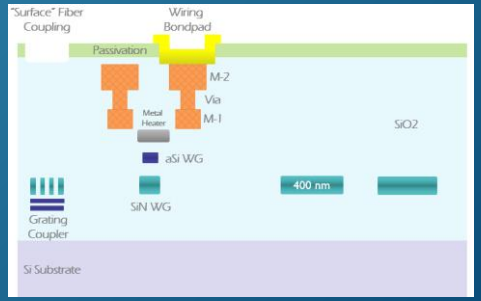
iSiNPP (200mm) platform

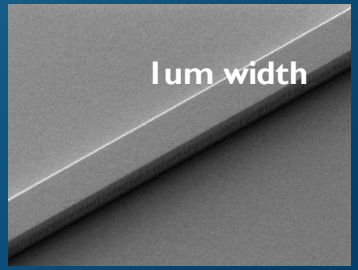
iSiNPP = imec SiN Photonics Platform

Propagation loss, 400nm thick LPCVD SiN



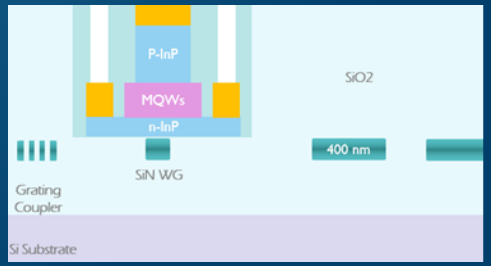


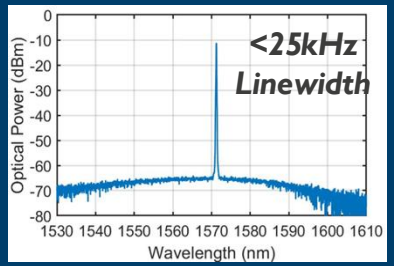


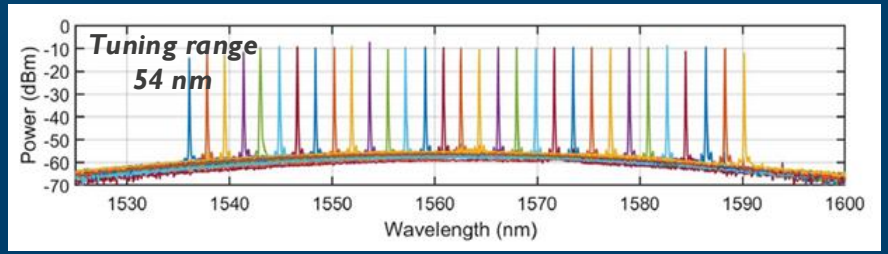


PDK V.1

Narrow linewidth tunable laser on 400nm SiN integrated using Transfer printing







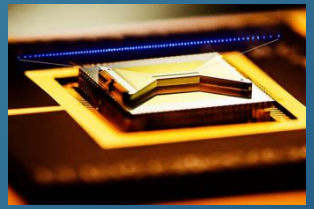
B. Pan et al, Photonics Research, 2024

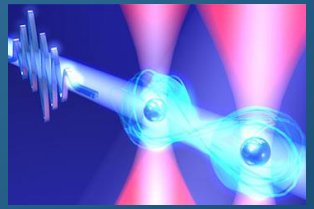
Lower loss SiN WG, LNO modulator and laser integration to come in the next PDK versions

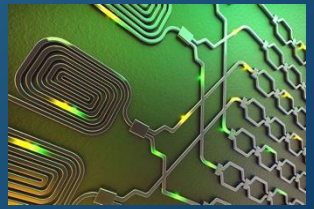
Application domains enabled by imec SiN technologies

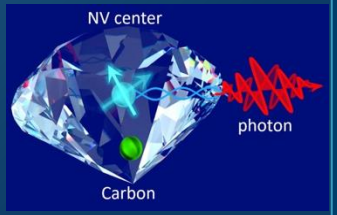
Quantum computing & Sensing

Ions | Atoms | Photons | Color centers









Qubit hardware platforms

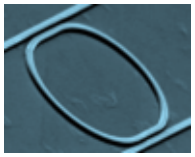
Industry | Consumer

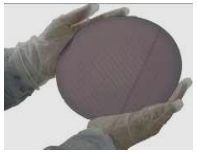
AR/VR | Biosensor

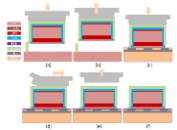
Optical Systems for XR & Health

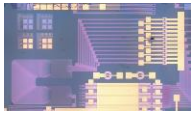
Imec ventures

Photonics Research Group Ghent









Research Group of Ghent University

- Faculty of Engineering and Architecture
- Department of Information Technology (INTEC)
- Associated laboratory of IMEC

Technology Research

- Photonic Integration: Systems on a chip
- on silicon: “Silicon Photonics”
- Enhanced with new materials:
  III-V, ferro-electrics, graphene, …

Applications

- High-speed telecom and datacom
- Sensing for life sciences:
  UV, visible, short-wave IR and Mid-IR
- Optical information processing
- Quantum information

12 Professors
35 Postdocs
70 PhD students
15 Support staff
2 Business Developers

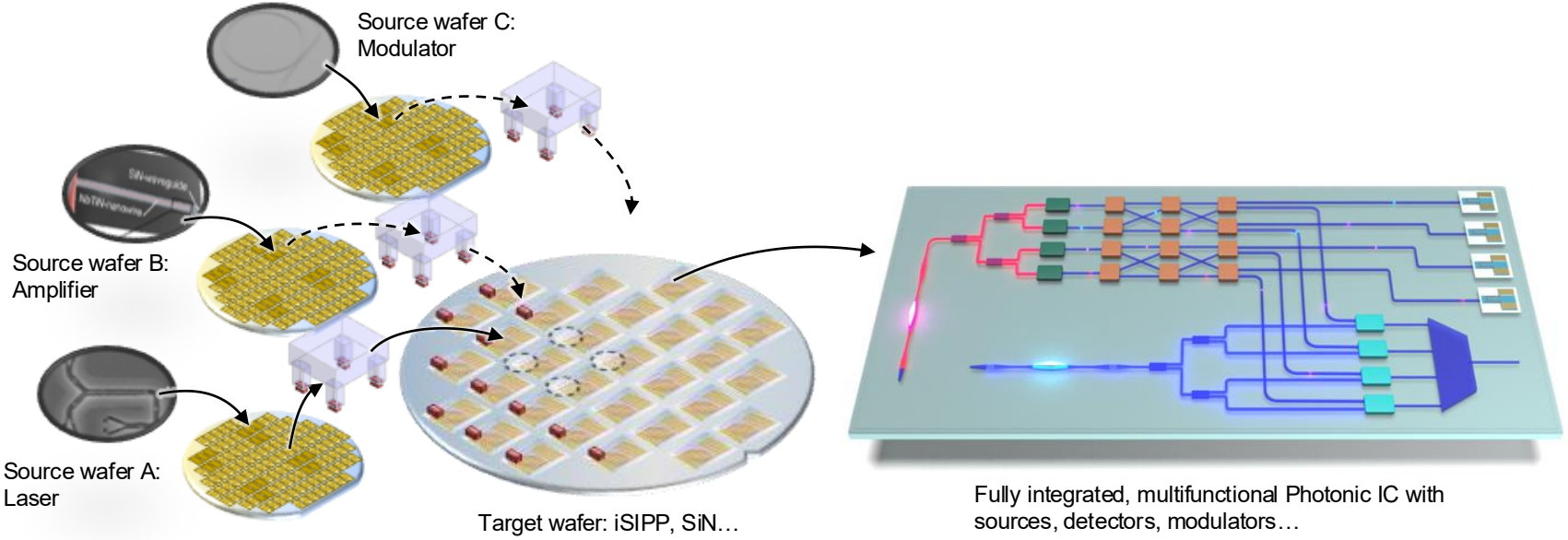
20+ nationalities
9 ERC grantees
7 spin-off companies
50 journal papers/year
Class 100 clean rooms

POWERED BY imec

Heterogeneous Integration is a Key Technology

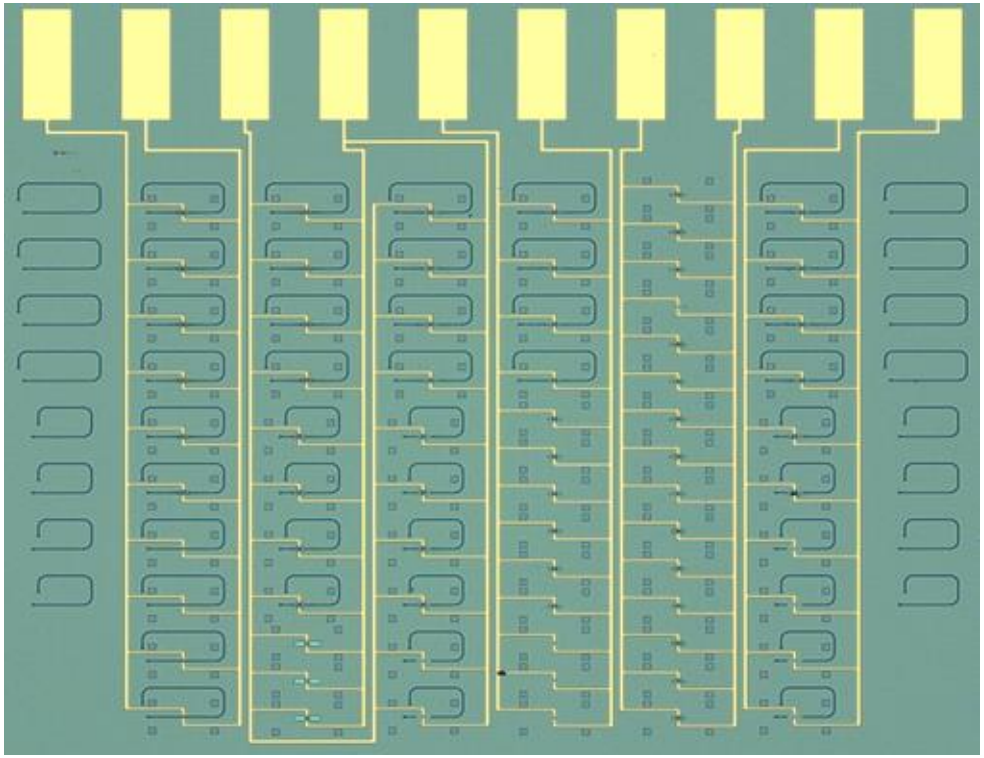
Our Silicon & Silicon Nitride platforms lack key building blocks (lasers, eo-modulators…)

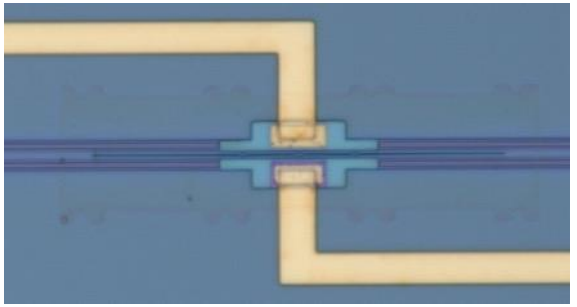
- Our main workhorse: Micro Transfer Printing (mTP)
- Also several other techniques being explored (2D materials, sol-gel deposition of ferro-electrics, III-V epitaxy, liquid crystals…)

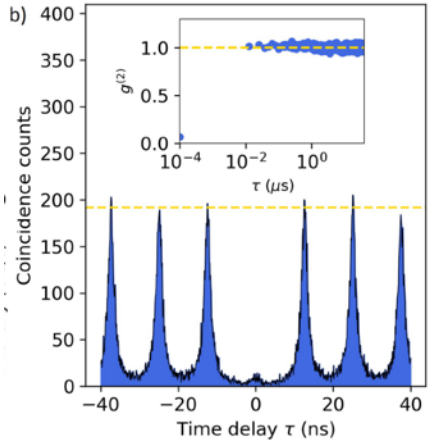


Single Photon Sources integrated on SiN

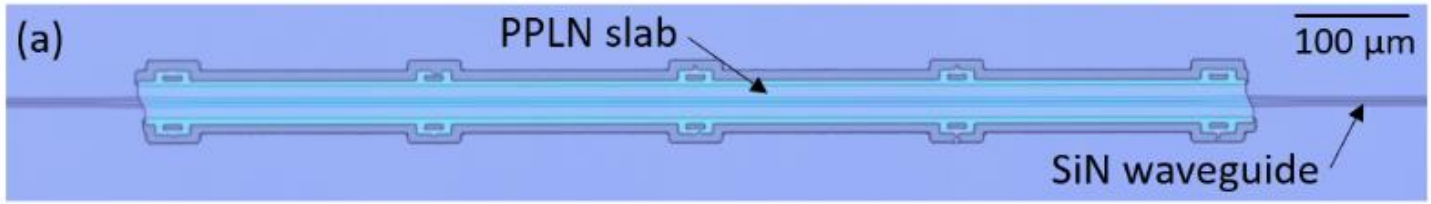
Top view of ±50 sources printed on SiN

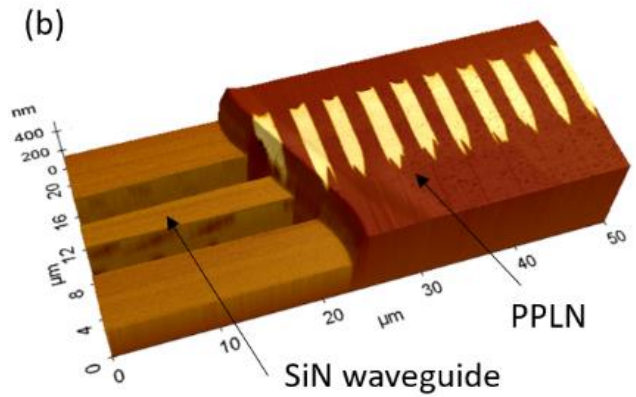


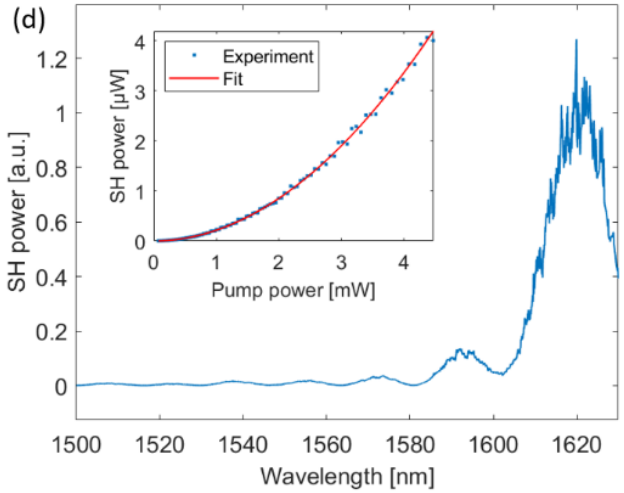




NONLINEAR CONVERSION IN mTP LN







GHENT UNIVERSITY

imec

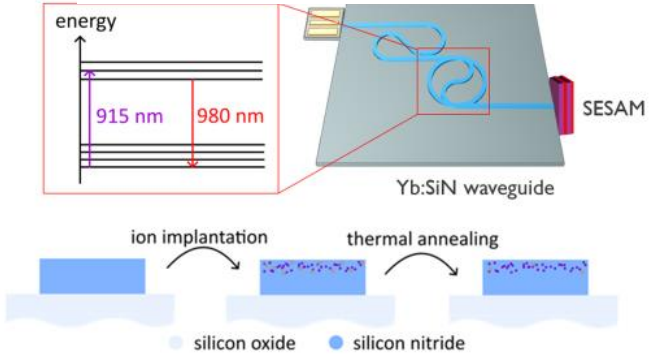
T. Vandekerckhove, … , B. Kuyken, Lasers & Photonics Reviews, 2025

Solid State Lasers for Metrology and Quantum Systems

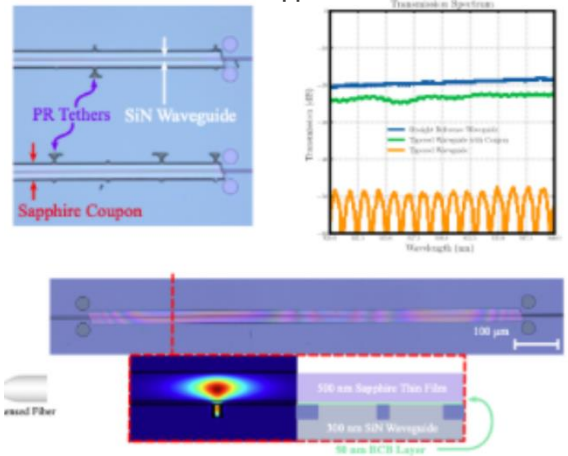
Current on-chip laser technology does not fulfill requirements of future metrology systems

- Solid state nanophotonic gain waveguides can provide unprecedented performance
- Two main approaches:
  - Titanium Sapphire printing on SiN waveguides
  - Rare Earth (RE) doped AlOx or SiN waveguides

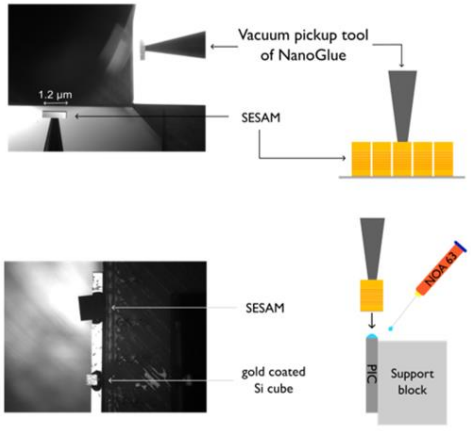
RE implatation for femtoscecond lasers



mTP of Ti:Sapphire on SiN

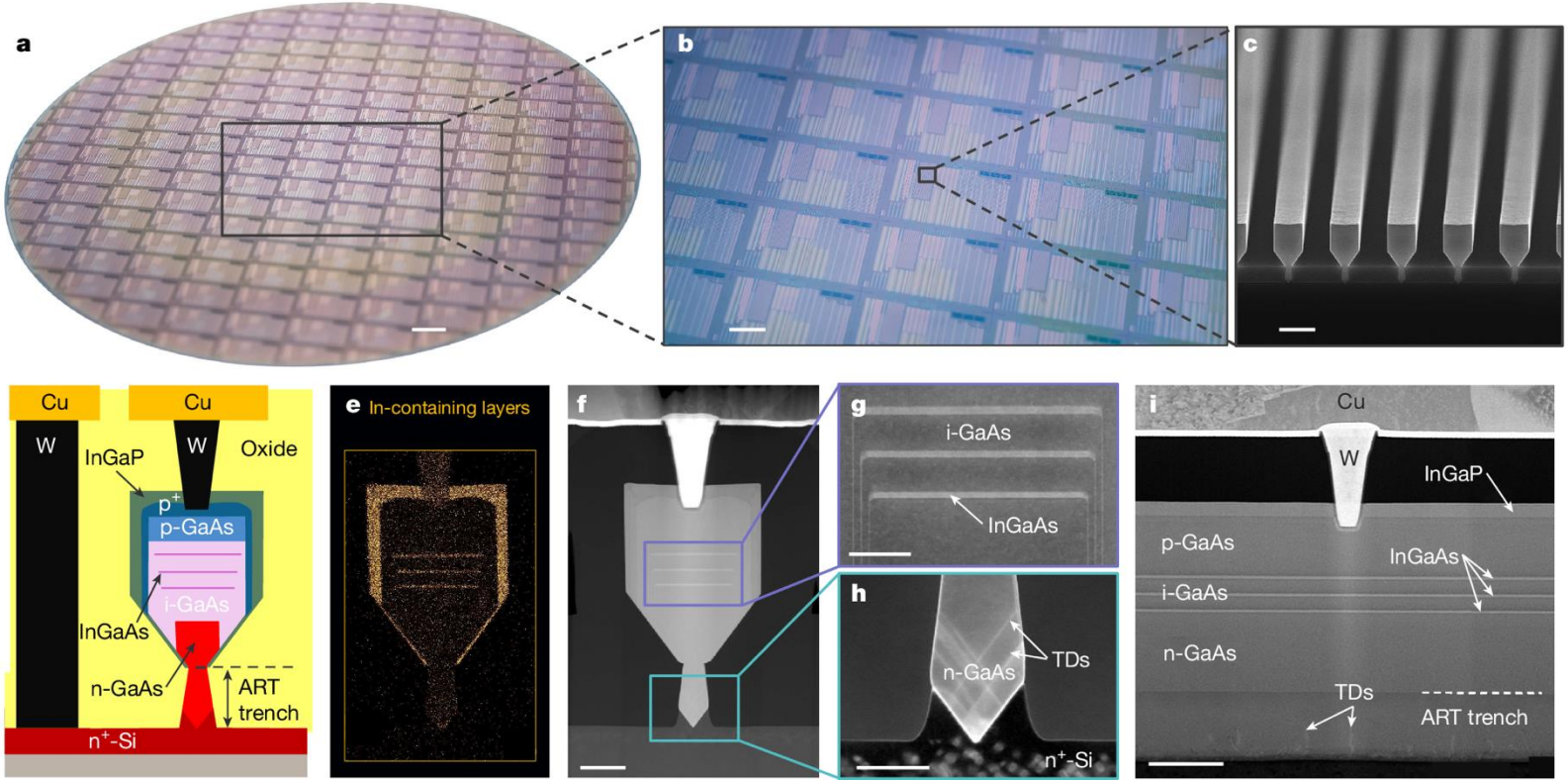


Enabling tech: micro-assembly of SESAM on facet



Kasper.vangasse@ugent.be

Nano-Ridge Lasers Directly Grown on 300mm Silicon

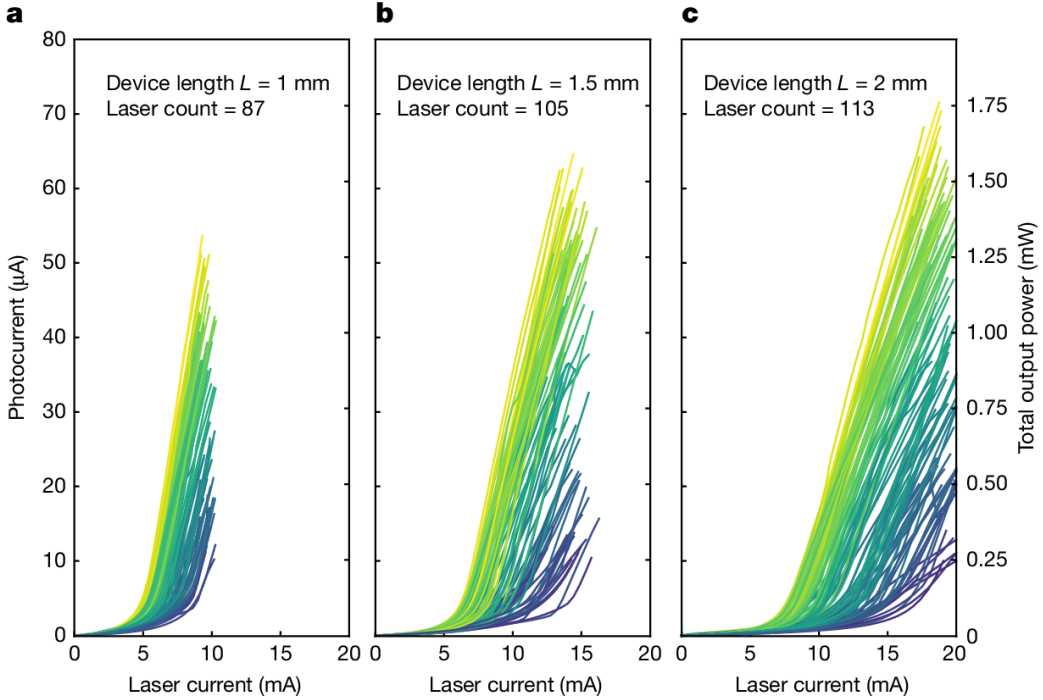


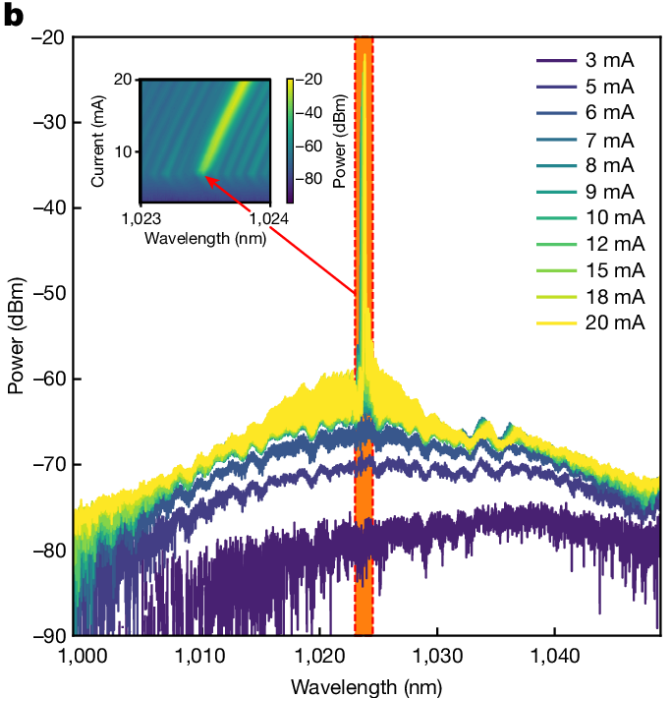
De Koninck, Y., *et al.* GaAs nano-ridge laser diodes fully fabricated in a 300-mm CMOS pilot line. *Nature* **637**, 63–69 (2025). https://doi.org/10.1038/s41586-024-08364-2

imec

Waferscale Characterisation of Nano-Ridge Laser

Low threshold and single mode lasing

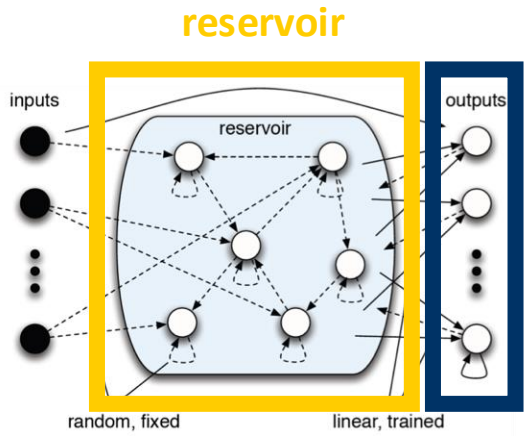




De Koninck, Y., *et al.* GaAs nano-ridge laser diodes fully fabricated in a 300-mm CMOS pilot line. *Nature* **637**, 63–69 (2025). https://doi.org/10.1038/s41586-024-08364-2

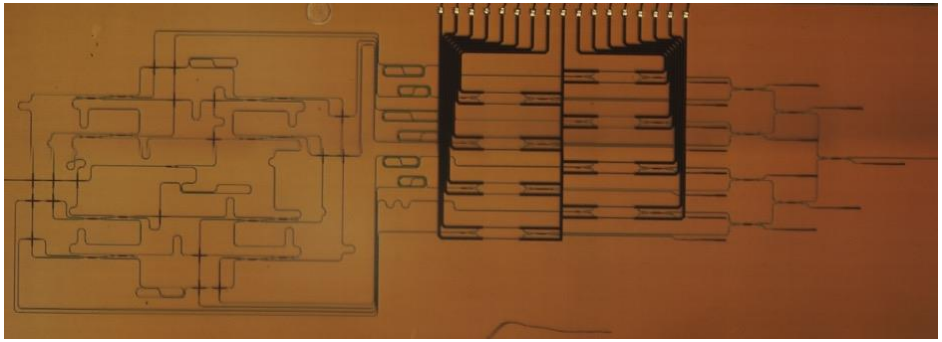
imec

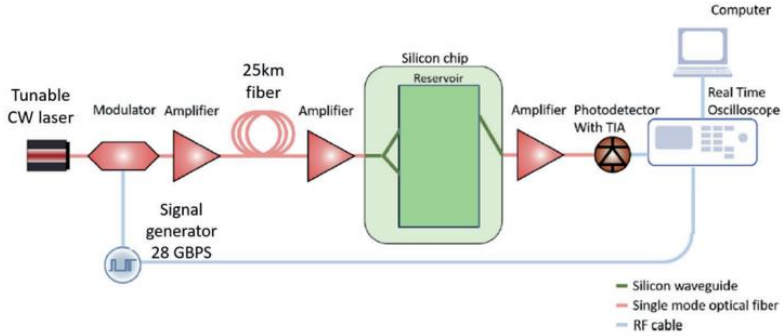
Reservoir Computing: a paradigm from the field of machine learning



- Do not train the recurrent network, only train the linear readout
- Apply to dedicated cases, with input naturally in optical domain, high bandwidt

Example: Real-time equalisation of highly nonlinear telecom links





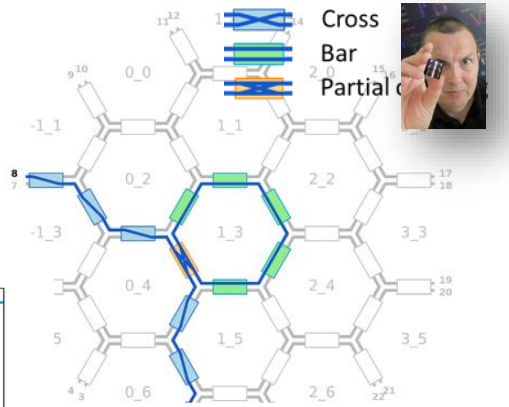
Accepted Nature Photonics, see https://arxiv.org/abs/2503.19911

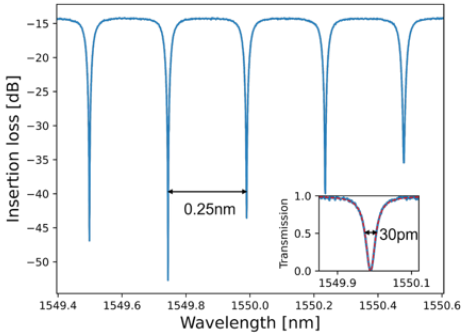
imec

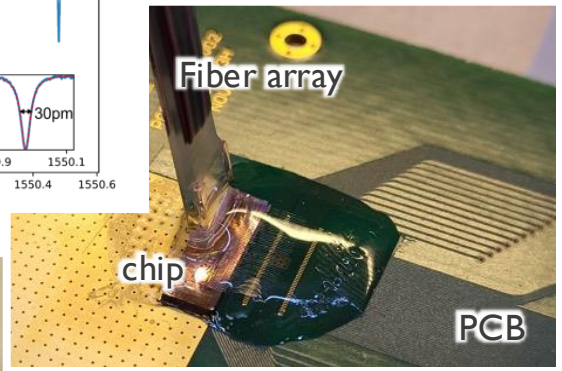
Programmable Photonics

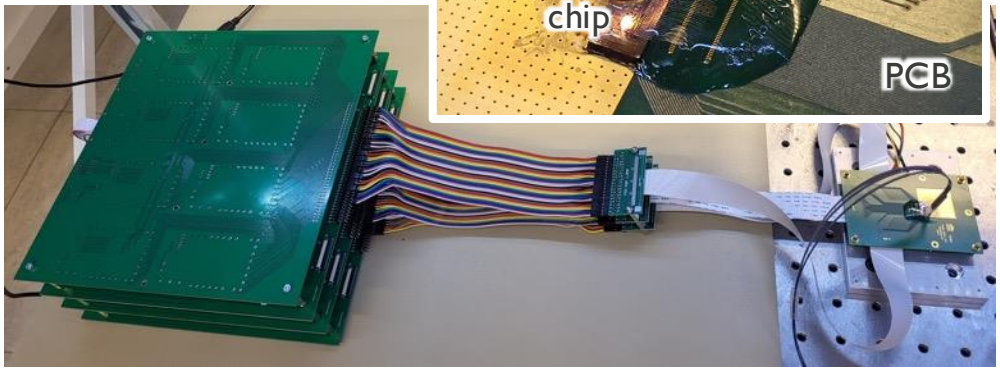
PICs where the flow of light can be electronically programmed

- Enable routing and filtering functions and accelerate rapid prototyping
- Starting from imec's standard iSIPP platform
- Technological developments
  - Better optical gates / phase shifters (MEMS, LC)
  - Scaling of the waveguide mesh, combining with microwave functions
  - Driver electronics (with IDlabs)
- Software and algorithms
  - Calibration, configuration and control
  - User interaction
- Commercialization
  - Developing business cases for programmable photonics
  - Setting up a spin-off company







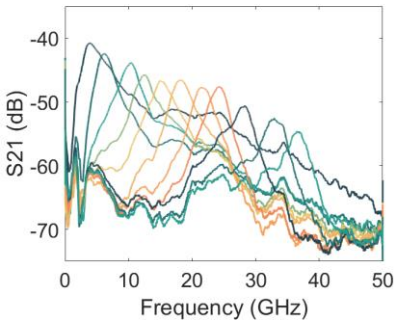


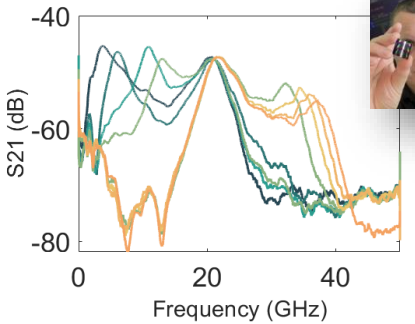
Y. Zhang, Lasers & Photonics Reviews, doi:10.1002/lpor.202502270 (2026)

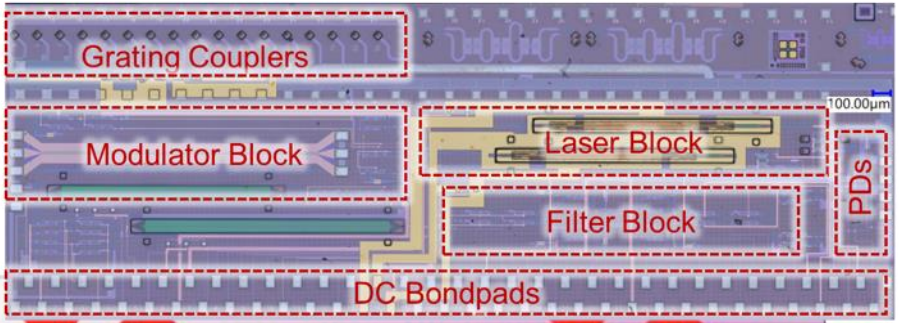
Microwave Photonics

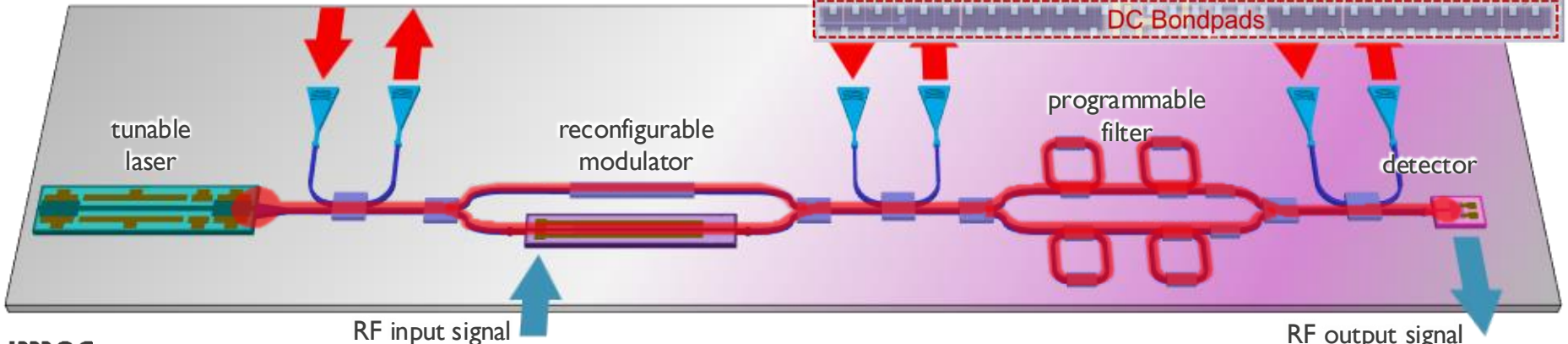
(in collaboration with IDlab)

- Programmable Microwave Signal Processor
  - optical and microwave filtering
  - frequency multiplyer
  - opto-electronic oscillator
- Programmable Beamforming Networks









imec

Hong Deng, Nature Comms. 2025, doi:10.1038/s41467-025-60100-

Student opportunities

How can imec boost your academic journey?

Through an imec **PhD** program - 4 years

Join a vibrant community of over 800 PhD students from 40+ countries, all working on groundbreaking research that shapes the future.

Through an imec **research internship** - 3-18 months

Are you ready to gain hands-on experience in the world's leading research center? We welcome students from across the globe.

More info? www.imec-int.com/studentopportunities

imec

Interested in joining IMEC ?

https://www.imec-int.com/en/careers

- Joining as a PhD-student:
  - Some dedicated topics available directly on website
  - Limited PhD-call open: June 22nd till july 8th,
  - Full PhD-call: mid to end October 2026
- Also options for internships at different levels
- Joining as a postdoc or permanent position
  - https://www.imec-int.com/en/work-at-imec/job-opportunities?type=career&query=photonics&page=1

- Vacancies Photonics Research Group Ghent:
  - https://www.photonics.intec.ugent.be/vacancies/default.asp

Master of Science

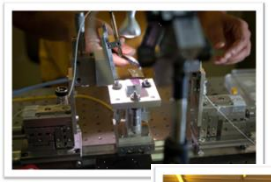
PHOTONICS ENGINEERING

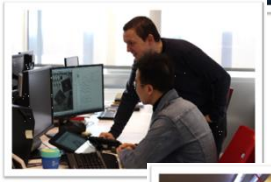
GHENT UNIVERSITY

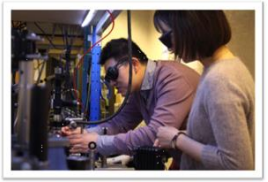
VUB VRIJE UNIVERSITEIT BRUSSEL

Opleidingsprogramma

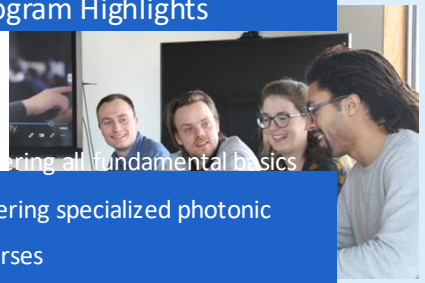
Plichtvakken	ECTS	Year	Sem
Optical Materials	6	1	1
Microphotonics	6	1	1
Lasers	4	1	1
Mathematics in Photonics	4	1	1
Optical Communication Systems	6	1	2
Sensors and Microsystem Electronics	6	1	2
Physics of Semiconductor Technologies and Devices	4	1	2
Laboratories in Photonics Research	6	1	2
Recent Trends in Photonics	4	2	1
Master Dissertation	30	2	1 + 2
Keuze: Advanced Photonics Cluster			
Minstens 20 ECTS, to be taken up in Year 1 and/or 2			
Keuze: Engineering Cluster			
Minstens 10 ECTS, to be taken up in Year 1 and/or 2 Clusters: Electronics & Information Technology | Physics & Materials | Life Sciences			
Business & Entrepreneurship Module			
Minstens 6 ECTS			
Totaal	120		







Program Highlights



...ering all fundamental basics

Offering specialized photonic courses

Offering a secondary engineering

Eligibility criteria

- bachelor degree in a related field (electroni physics, ...)
- B2 English proficiency

€ 5321,40 / year

Application deadlines

- before April 1 – for students who need visa
- before June 1 – for students who don't need visa

Exchange & Internship Possibilities

www.studyphotonics.com

Master of Science

SILICON PHOTONICS

GHENT UNIVERSITY

Program Structure

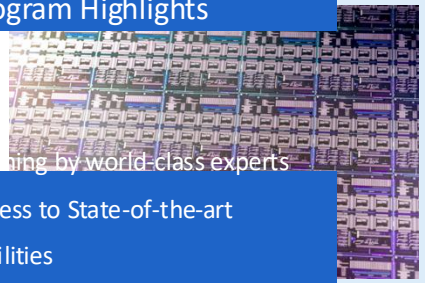
Compulsory: Core Photonics Courses	ECTS	Sem
Photonic Integrated Circuits: from Concept to Application	8	1 + 2
Theory of Photonic Integrated Devices	6	1
Integrated Lasers	4	1
Materials for Photonic Integrated Circuits	4	1
Electronics for Photonic Integrated Circuits	4	1
Processing and Packaging Technologies for Photonic Integration	4	2
Master Dissertation	18	1 + 2
Electives: Advanced Photonics Courses		
In total 12 ECTS, to be taken up in sem 1 and/or 2: select 3 out of the list below: • Quantum Optics • Non-linear Optics • Optical Communication and Information Processing • Integrated Photonic (Bio)Sensing • Micro- and Nanophotonic Semiconductor Devices • Technological Processes for Photonics and Electronics: Laboratory		
Professional Development		
Guest lectures by industrial partners (Ligentec, Sentea, HP Labs, Indigo, Luceda Photonics, …), company visits to imec and PhotonDelta, ePIXfab training activities, …		
Total	60	

Covering all key stages of PIC development

- Concept/Idea
- Modelling
- Simulation
- Design
- Fabrication
- Characterization
- Measurements
- Integration at system level

+ Covering all current main application areas

Program Highlights



…ing by world-class experts

Access to State-of-the-art Facilities

Focus on Professional

Eligibility criteria

- master degree in a related field
- B2 English proficiency

€ 3809 / year

Application deadlines

- before April 1 – for students who need visa
- before June 1 – for students who don't need visa

Flexible study paths for Working students

www.siliconphotonics.eu

embracing a better life