
cea
leti
Leti Photonics Workshop
Photonics applications to boost the microelectronics industry

Frédéric Jung

Consul General of France
in San Francisco

Welcome remarks

Sebastien Dauvé

CEO, CEA-Leti

From Lab to Fab

Bertrand Szelag

Integrated Photonics Program Manager, CEA-Leti

Silicon Photonics: Heightening AI
and Quantum Communications

Vincent Destefanis

Optical Sensors Partnership Manager, CEA-Leti

Towards Ultra-miniature Photonic Sensors:
from Niche to Mainstream

Pierre Castelein

Image Sensors Partnership Manager, CEA-Leti

Advances in FMCW-based Scanless
3D Imaging Systems for Consumer Applications

Michael Pelissier

Multifunctional Display Project Leader, CEA-Leti

On the Use of MicroLED for Multifunctional Display

Michael Tchagaspanian

EVP Strategic Partnerships, CEA-Leti

A Partnership with CEA-Leti:
How Does it Work?

07:00 p.m. – 09:00 p.m.

Networking reception

Supported by the Carnot network of French RTOs

Research for industrial innovation

Frédéric Jung

Consul General of France
in San Francisco

Welcome remarks

Sebastien Dauvé

CEO, CEA-Leti

From Lab to Fab

cea leti

Top 100 Global Innovator 2023

Clarivate™

SILICON VALLEY
AT THE CENTER OF THE FRENCH ALPS

Credit: kevin.s38

#2

INDUSTRIAL HUB

IN FRANCE

GRENOBLE-AREA'S 3 VALLEYS: A DIGITAL INDUSTRIAL ECOSYSTEM

Credit: kevin.s38

CEA-Leti

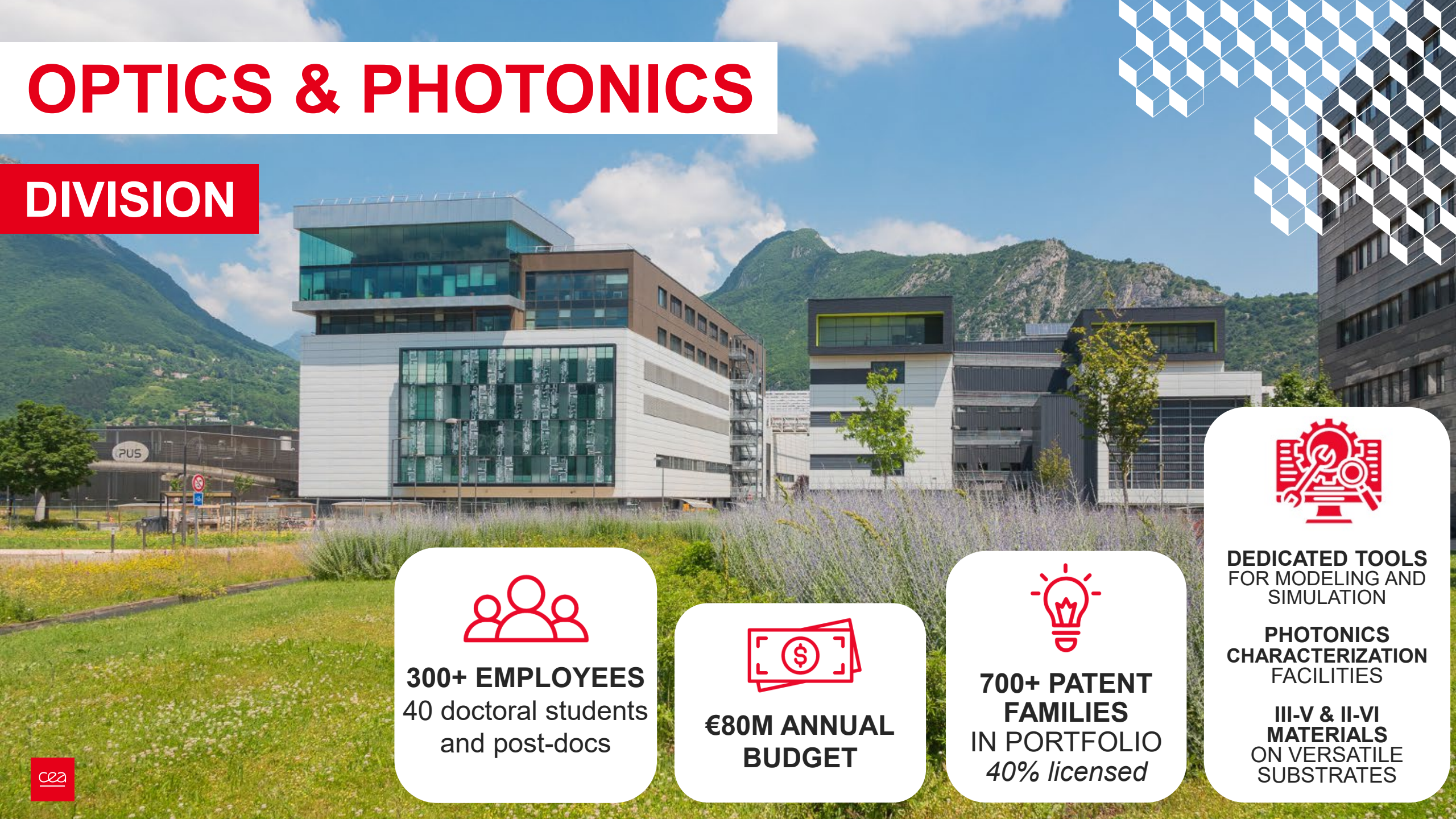
>Founded in 1967
>2 000 people
>4 000 Patents in Portfolio
>350 Industrial Partners
>76 Startups Created
> €400M turnover
85% from R&D contracts

>11 000 m2 cleanrooms
>700 tools

300 mm & 200 & 100 mm
Nanocharacterization Platform
24/7 operations

OPTICS & PHOTONICS

DIVISION



300+ EMPLOYEES
40 doctoral students and post-docs

€80M ANNUAL BUDGET

700+ PATENT FAMILIES
IN PORTFOLIO
40% licensed

DEDICATED TOOLS
FOR MODELING AND SIMULATION

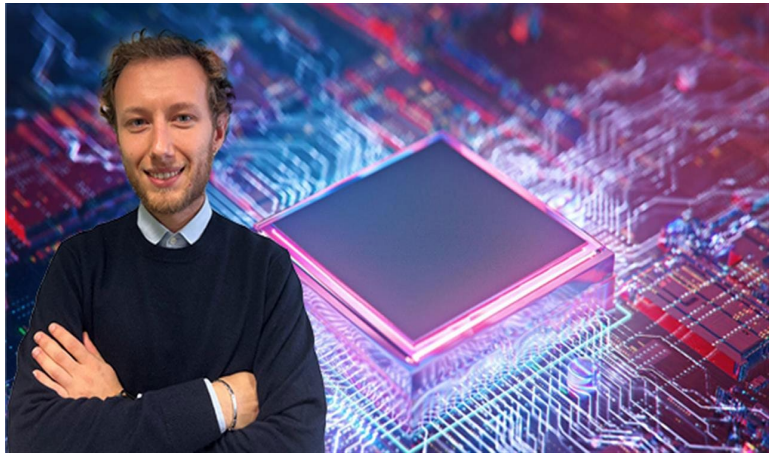
PHOTONICS CHARACTERIZATION
FACILITIES

III-V & II-VI MATERIALS
ON VERSATILE SUBSTRATES

A Few Examples of Recent Achievements

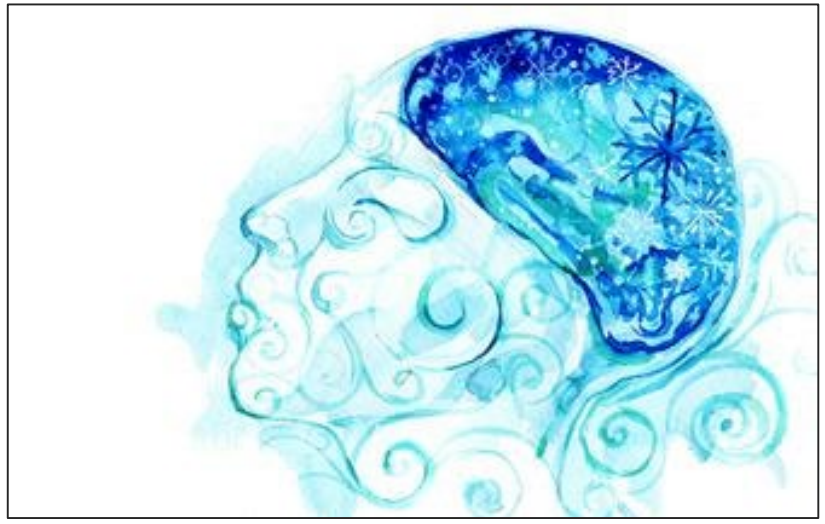
Jean-Michel Hartmann received the Electronics and Photonics Division award at the 243rd electrochemical society conference, Boston

CEA-Leti Reports New Integration & Packaging Gains for Next-Generation LiDAR Steering on Autonomous Vehicles at ECTC



Best Poster @E\PCOS on amorphous chalcogenide materials for highly nonlinear on-chip components

Radiofrequency & silicon photonics for high-performance, low-power, secure data transmission



The Epicool project is investigating the use of optics to cool epileptogenic areas in the brains of epilepsy patients resistant to other treatments

CEA-Leti's recent advances on key AR building blocks, e.g. retinal projection and holography

CEA-Leti's Technological Semiconductor Platform

Merging electronics, photonics and software

200 mm and less	300 mm	wafer
	GAA, FD-SOI, Beyond CMOS	
Embedded memories	Embedded memories	
RF (active and passive devices)	RF (active and passive devices)	
Si PHOTONIC	Si PHOTONIC	
µLED DISPLAY	µLED DISPLAY	
	IMAGERS	
MEMS		
	POWER (Si, GaN, SiC)	
3D	3D	
SUBSTRATES	SUBSTRATES	
II-VI and III-V		

PlatForm for NanoCharacterisation

Characterisation of Advanced Materials and Components Supporting Disruptive Innovation

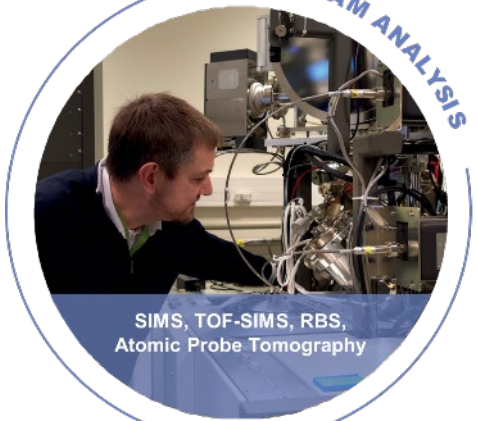
MAGNETIC RESONANCE

Liquid and solid state NMR, DNP

SCANNING PROBE MICROSCOPY

AFM, SSRM, SCM, KFM, Nano-DMA

ION BEAM ANALYSIS

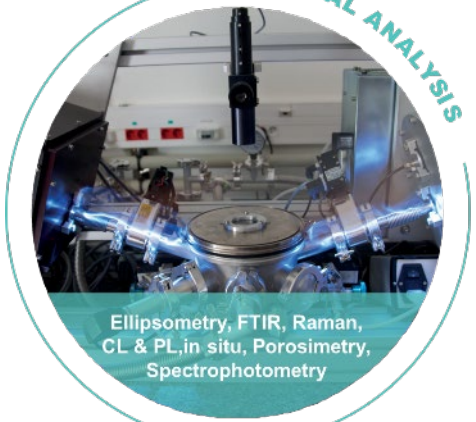


SIMS, TOF-SIMS, RBS, Atomic Probe Tomography

SURFACE ANALYSIS

XPS, HAXPES, XPEEM, Auger nanoprobe, synchrotron

OPTICAL ANALYSIS



Ellipsometry, FTIR, Raman, CL & PL,in situ, Porosimetry, Spectrophotometry

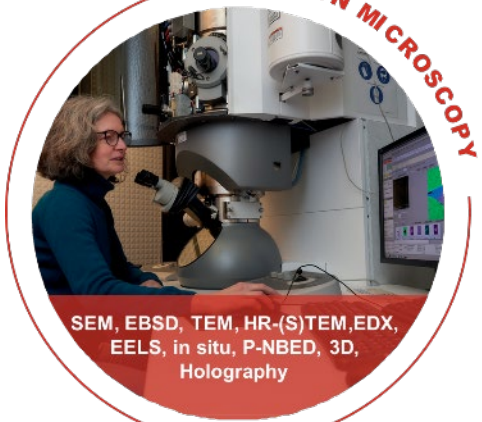
X-RAY ANALYSIS

(HR)XRD, XRR, XRF, SAXS, WAXS, operando, tomography, synchrotron

SAMPLE PREPARATION

FIB (Ga, Xenon), polishing, cleaving, cutting tools, chemistry…

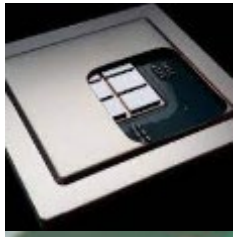
ELECTRON MICROSCOPY



SEM, EBSD, TEM, HR-(S)TEM,EDX, EELS, in situ, P-NBED, 3D, Holography

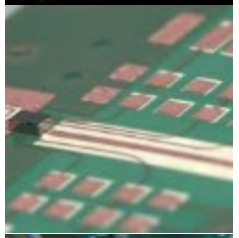
IC DESIGN TEAM AT LETI

› Wide range of fields



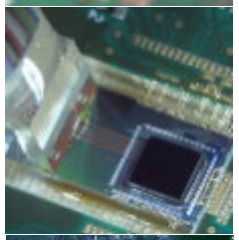
Advanced Digital Circuit

Chiplet approach, In memory computing, ANOC, ONOC, AI …



RF Integrated Circuit Design

5G-6G, mW, Short Range, UWB, Beam Forming …

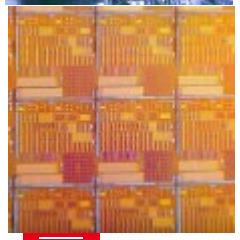


Si Photonics IC

Drivers, Analog Read Out, Data Processing

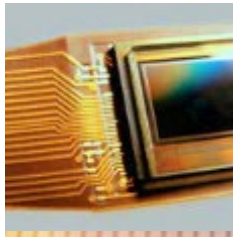
Image Sensor Circuit

Low Noise Read Out, ADC, DAC, Embedded AI



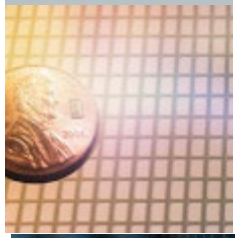
Memory Circuits

In Memory computing, Drivers…



Micro Display Drivers Circuit

Analog/Digital Drivers, Signal processing, Mux



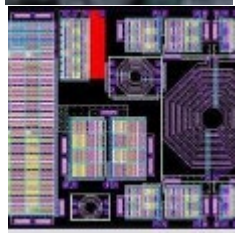
Power Management IC

LDO, Buck Boost, Charge Pump, Power drivers …

Analog Sensor Circuit

Low Noise Read Out, ADC, DAC, Embedded AI

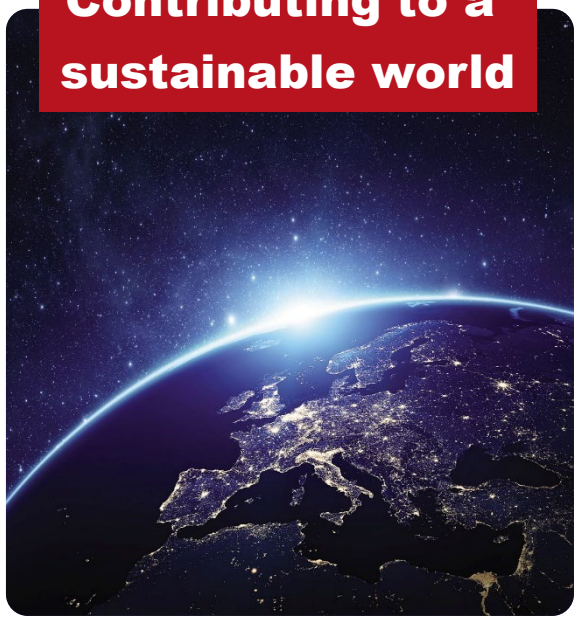
Cybersecurity & Certification



Layout and Masks

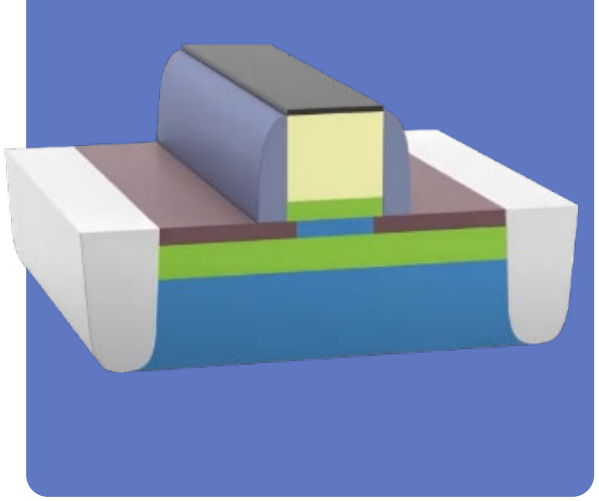
OUR STRATEGY FOR THE FUTURE

Contributing to a sustainable world



Proposing more frugal technologies and processes and training eco-responsible researchers

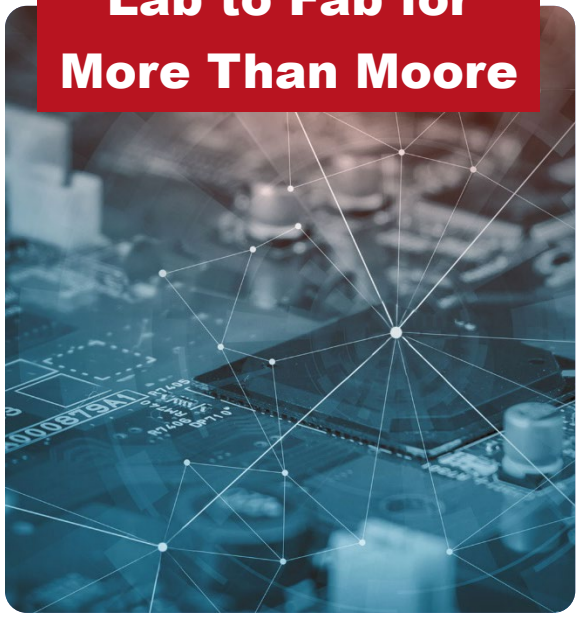
FD-SOI Technology and its applications



Pushing the limits of FD-SOI technology with 10 and 7 nm

Strenghtening and extending the scope of applications

Lab to Fab for More Than Moore

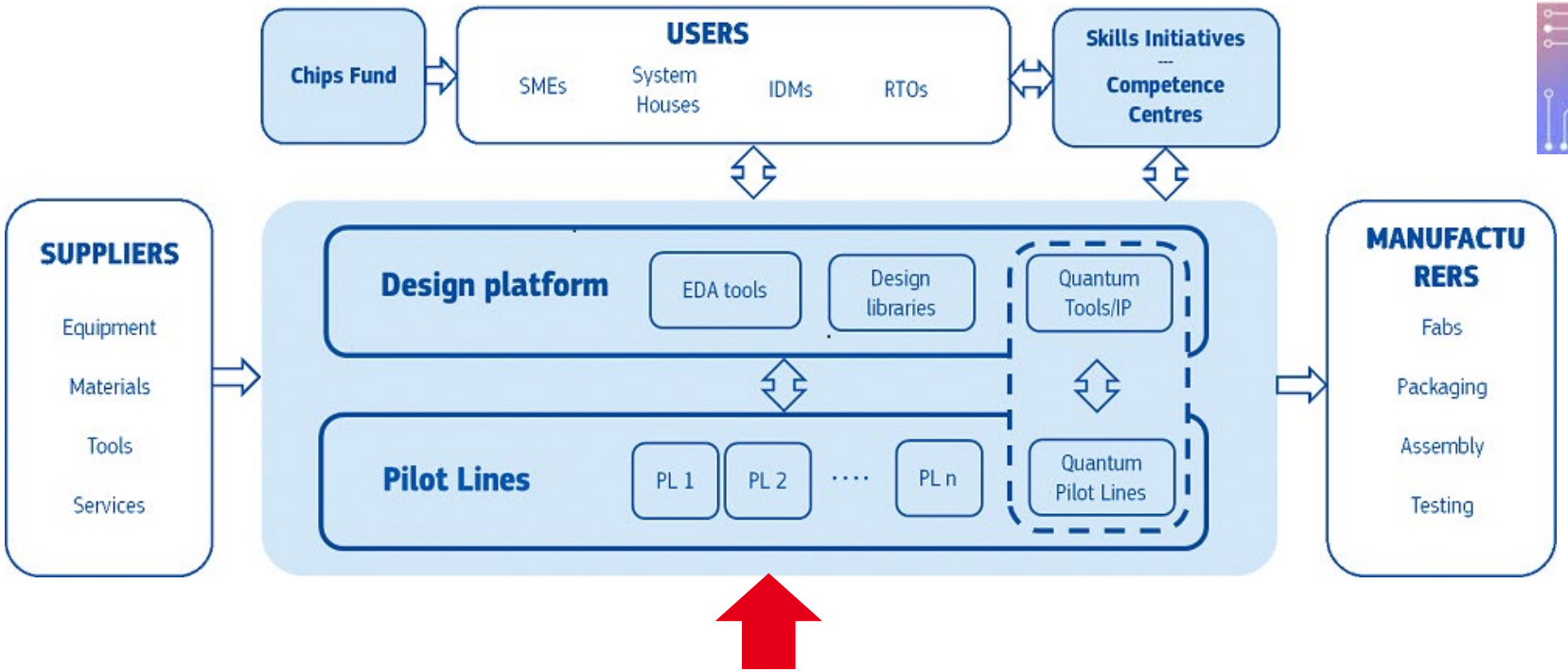


Remaining a leader in innovation in the field of more than moore through win win collaborations and world class facilities

Taking risks to create breakthroughs

Many smart bets based on world class collaborations : quantum computing, edge IA, In Memory Computing, advanced technology for healthcare…

CEA LETI IS ONE OF THE PILLARS OF THE EUROPEAN CHIPS ACT



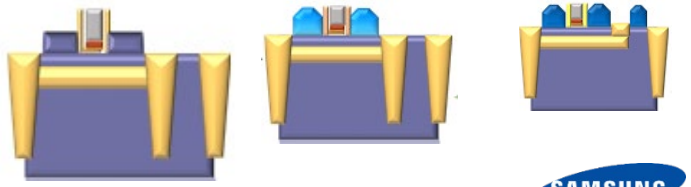
Pilot line
Pilot line on advanced sub 2nm leading-edge system on chip technology
Pilot line on advanced Fully Depleted Silicon On Insulator technologies targeting 7nm
Pilot line on advanced Packaging and Heterogenous Integration
Pilot line on advanced semiconductor devices based on Wide Bandgap materials

FD-SOI Pilot Line for Applications with non-volatile embedded Memories, RF & 3D integration, to ensure European Sovereignty (FAMES)

Greener Electronics FAMes
FD-SOI 10-7nm
NVM RF 3D

FD-SOI industrial offer

28 nm FD-SOI | 22 nm FD-SOI | 18 nm FD-SOI



GlobalFoundries™ SAMSUNG

35 % FAB Dresde

Coopération CEA-Leti-GF

SAMSUNG

Manufacturing partnership GF-ST

150 patents CEA-Leti

FAMES PHASE 1

09/22 – 12/2029

FD-SOI 10 nm & 7 nm, NVM, RF, 3D

- Strain SOI wafers
- Transistors boosters
- MOL/BEOL 64 & 48 nm MP
- Embedded NVM
  MRAM, FeRAM, OxRAM, FeFET
- 3D options
  - *Sequential 3D*
  - *Heterogeneous integration*
- RF Components
  Switches, Filters, passive components
- Process Design Kits
  Provide to all EU partners to test and evaluate the technologies
- Openness of the FAMES Pilot Line to all EU stakeholders

Specific development for key markets

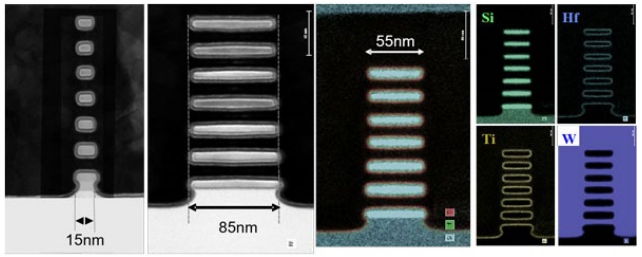
- Computing
  - *Microcontrollers*
  - *MPU*
  - *Trusted IC*
  - *AI/ML chips*
- More-than-Moore
  - *Automotive*
  - *5G/6G chips*
  - *RF connectivity*
  - *Smart sensors*
  - *Smart imagers*
  - *Smart displays*
  - *IoT devices*
  - *Cybersecurity*
  - *Wearables*
- Sovereignty fields
  - *Quantum chips*
  - *CryoCMOS chips*
  - *Trusted IC*
  - *New space components*

FAMES PHASE 2

2028 – 2033

Disruptive technology with 2D materials, IMC, GAA

Gate-All-Around 5-2 nm



- Power efficiency gain of 1000×
- Full FEOL 5 nm
- With non-volatile memory
- In-memory computing
- Using 2D materials

cea
FRANCE 2030
EUROPEAN CHIPS ACT

CEA-Leti building a new cutting-edge semiconductor research facility

anr®

FRANCE 2030

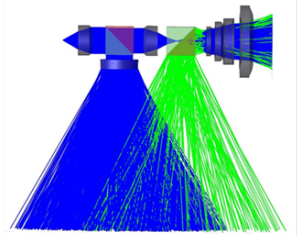
24-month project

2,000 m2
of cleanroom space

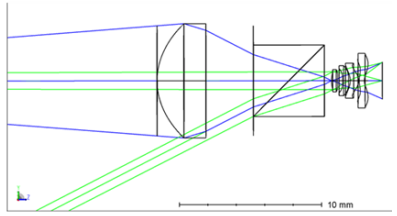
EUV compatible

Meeting the most stringent **environmental** regulations

A few challenges adressing imaging and photonics using FD-SOI

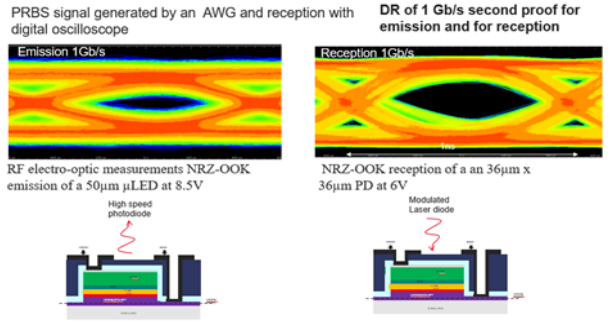


FMCW optical system definition

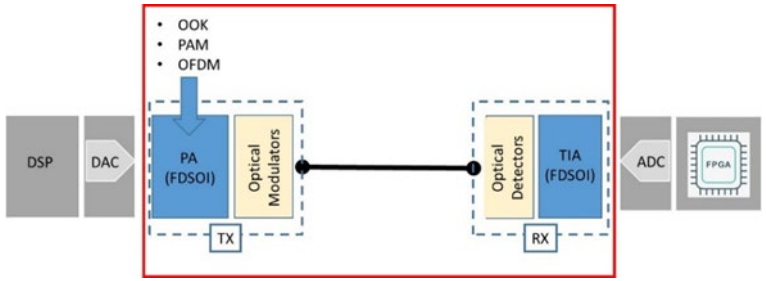


FMCW optical system simulation

FMCW – Depth Imaging Sensor



Multi-channel parallel optical links for sub pj/bit blue light communication based on GaN µLEDs arrays targeting data density up to 20 Tb/s/mm²



Memory Disaggregated Compute Nodes in HPC
Based on FD-SOI optical interconnect targeting low latency

Multifunction DISPLAY based on µLed

CEA-LETI @ Photonics West

We are part of the technical program:

- **19 articles**
- **12 as first speaker**
- **4 invited talks**

Papers dealing with technologies addressing a wide range of applications:

- **Optical communication**
- **IA & machine learning & quantum devices**
- **Bio Sensing & Lidar**
- **Microdisplay & Imaging**


A. Dussaigne

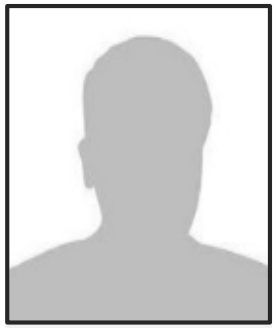

B. Charbonnier


S. Pissot


Q. Wilmart

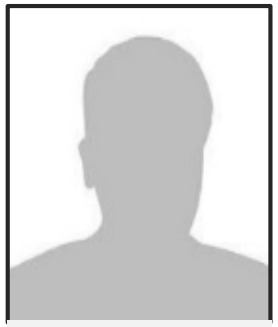

J. Hue


L. Laplatine


A. Cibié


B. Ben Bakir


V. Brisson


S. Litschgi

We are part of the exhibition:

Visit us at booth #5129
in the French Pavilion!

Bertrand Szelag

Integrated Photonics
Program Manager, CEA-Leti

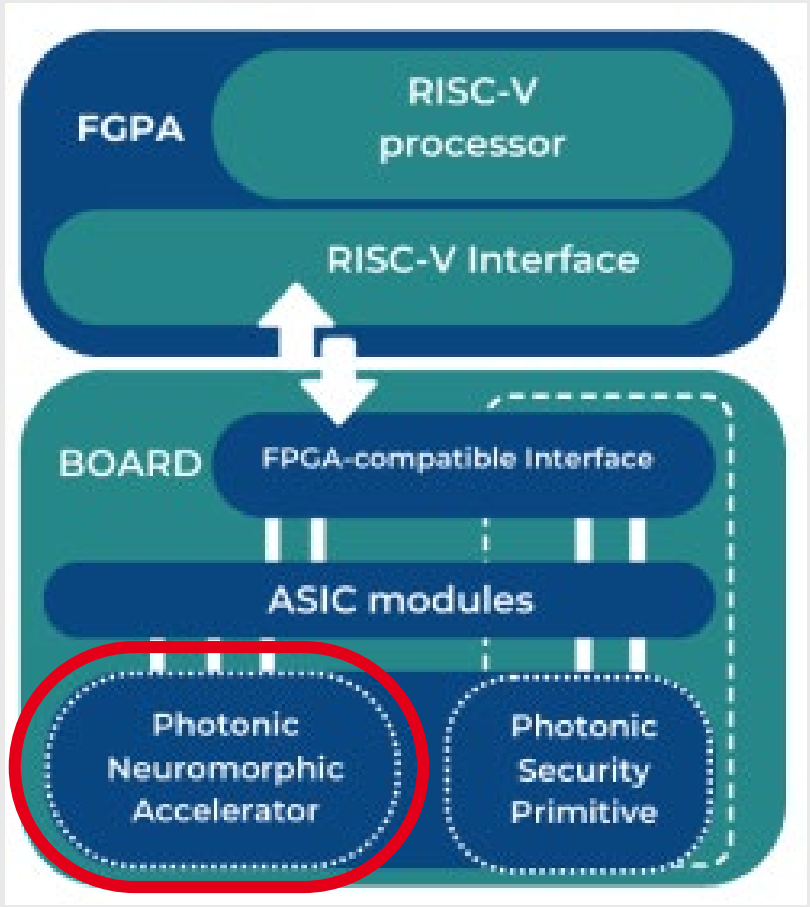
Silicon photonics: Heightening AI and Quantum Communications

“Generative AI models with trillions of parameters are accelerating demand for this platform [silicon photonics I/O]”

Craig Thompson,
VP Business Development,
Networking Business Unit at NVIDIA

Source: Business Wire 2023 article

Next-Generation Energy-efficient Accelerator



Computing platform

Photonic

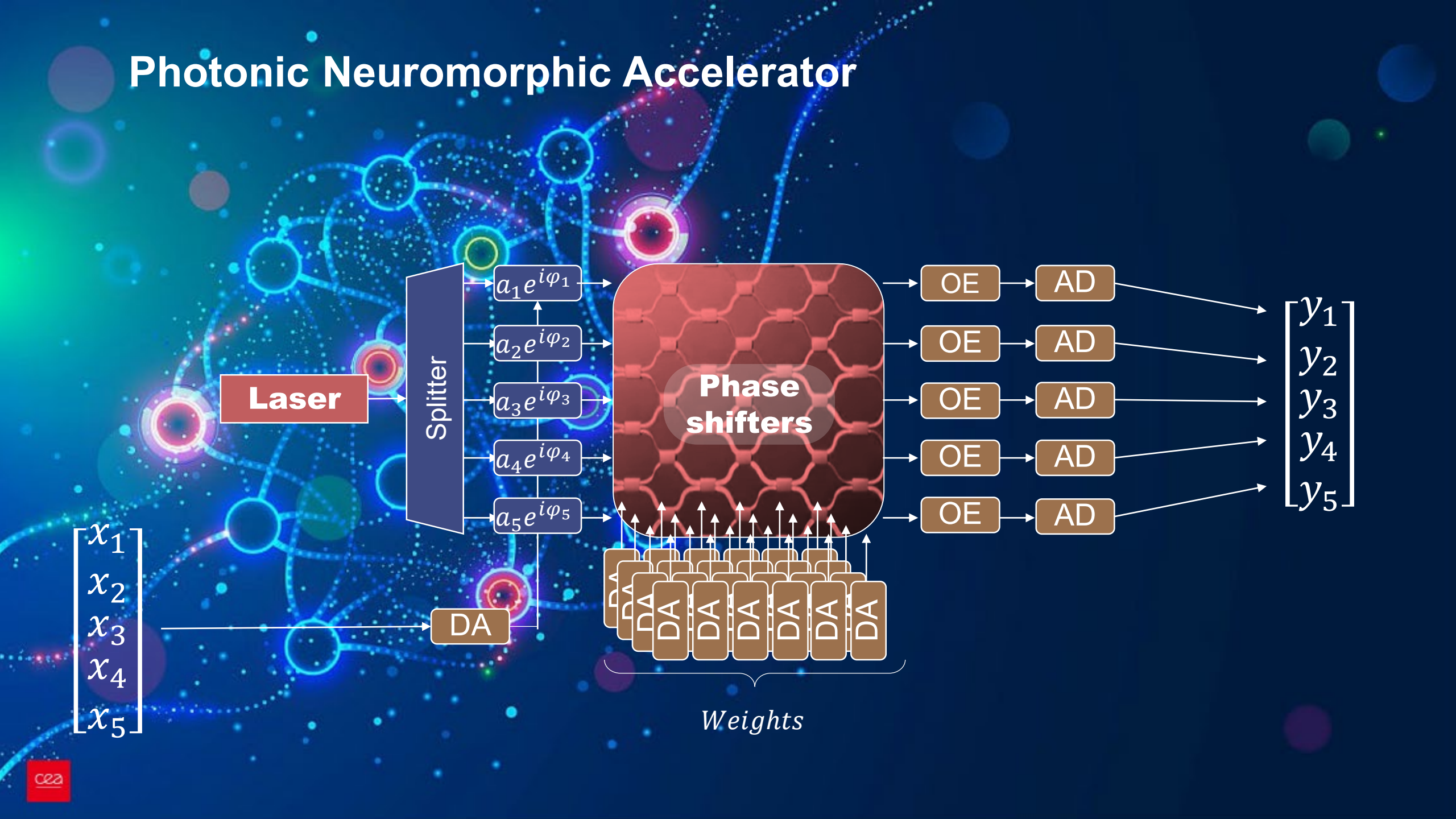
Neuromorphic

Accelerator

- Low latency: < 100 ps
- Low energy per MAC: < 1pJ
- High compute density: > 100 TMAC/s/mm^2

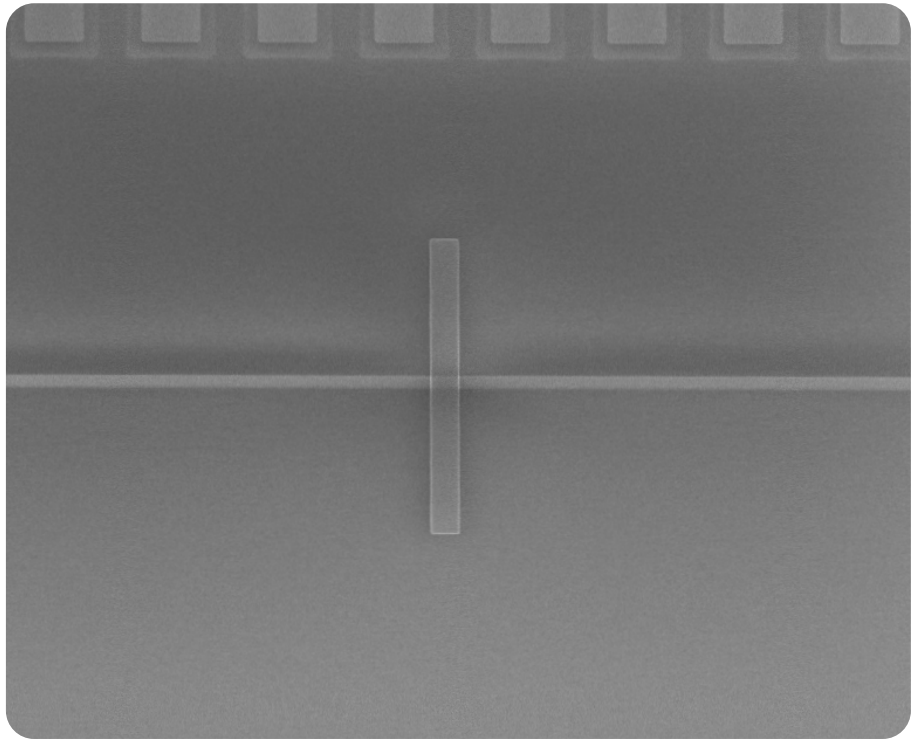
NEUROPULS

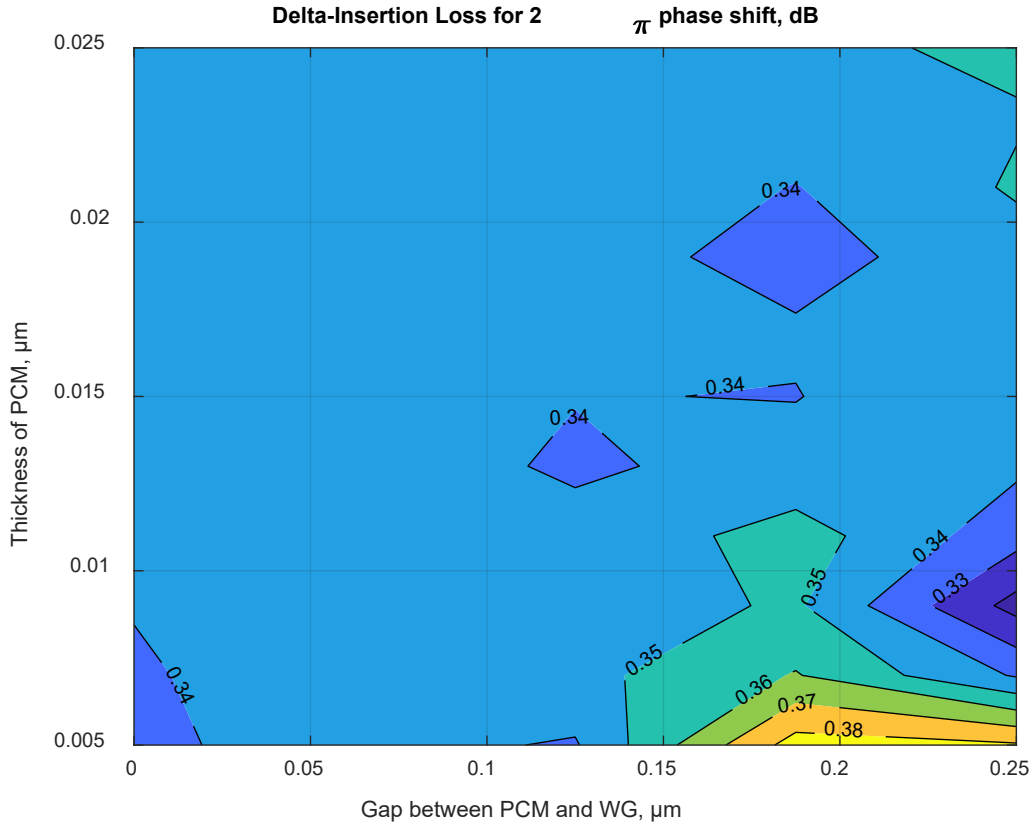
Photonic Neuromorphic Accelerator



Non-volatile Phase Shifters

Based on Phase Change Material





SPIE. PHOTONICS WEST

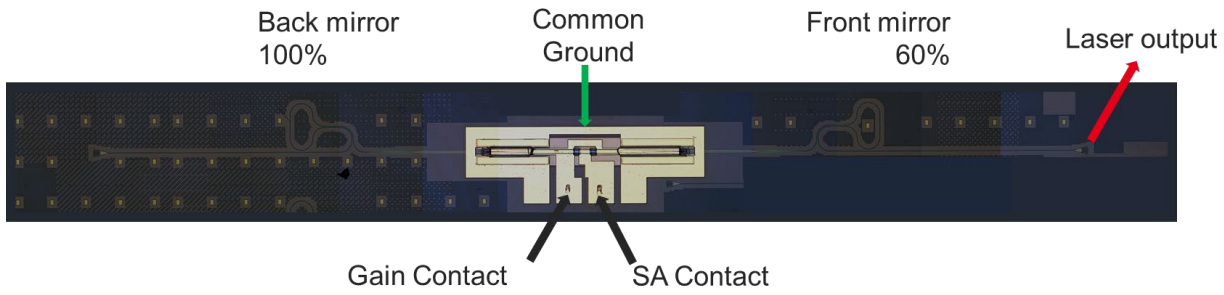
Silicon photonics technology and devices for machine learning , B. Charbonnier et al

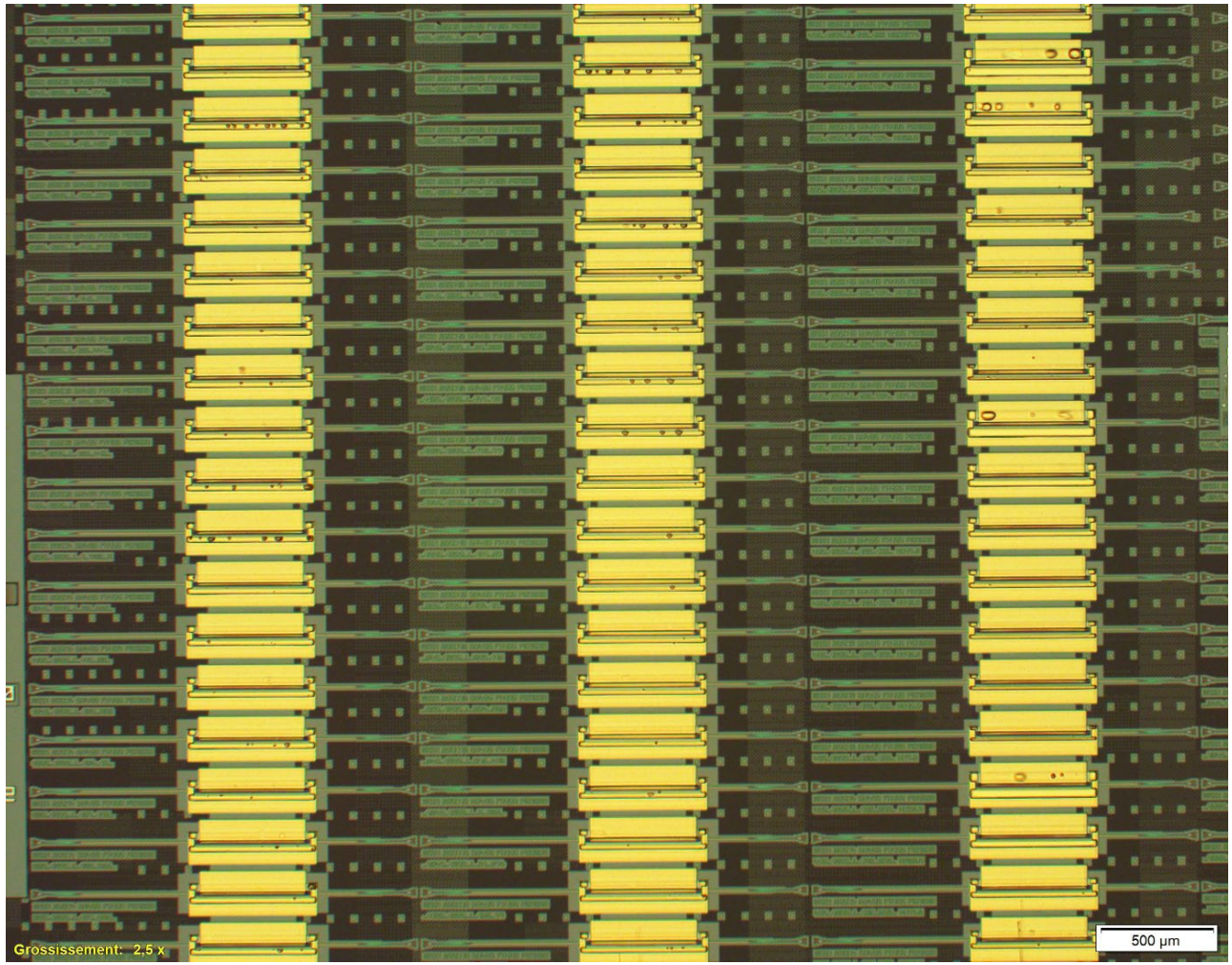
Very low loss

GeSe oPCM with < 0.35dB at 2π phase shift

Photonic Neurons

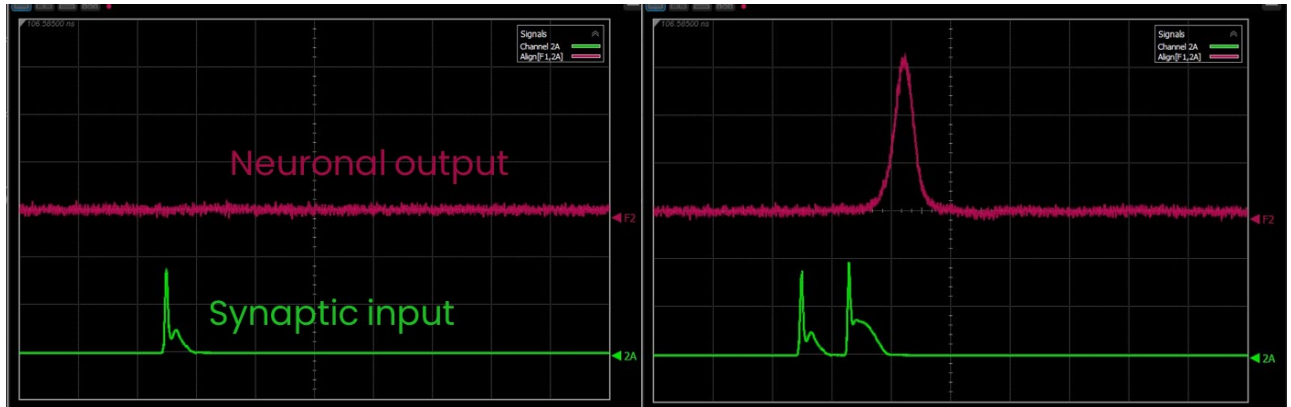
Massively integrated pulsed lasers





Spiking laser

- ***Spikes <10 picosecond***
- ***Neuronal behavior demonstrated!***
- ***Synaptic integration demonstrated!***



“We must remain vigilant about potential misuse of scaled quantum computers which could threaten cryptographic algorithms and secure communications.”

MICROSOFT website

Quantum Cryptography

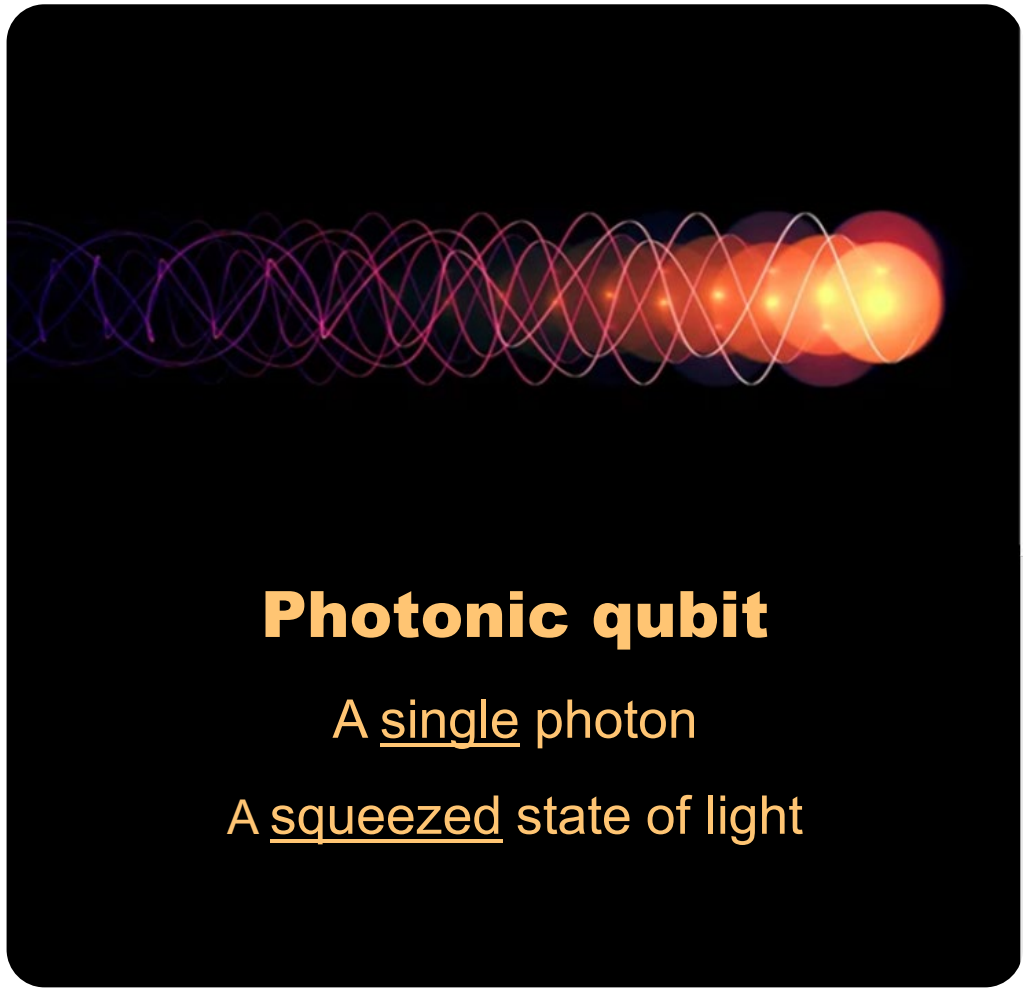
For intrinsic absolute security

Guaranteed by the laws of quantum physics

- Fast & no decoherence
- Excellent carrier

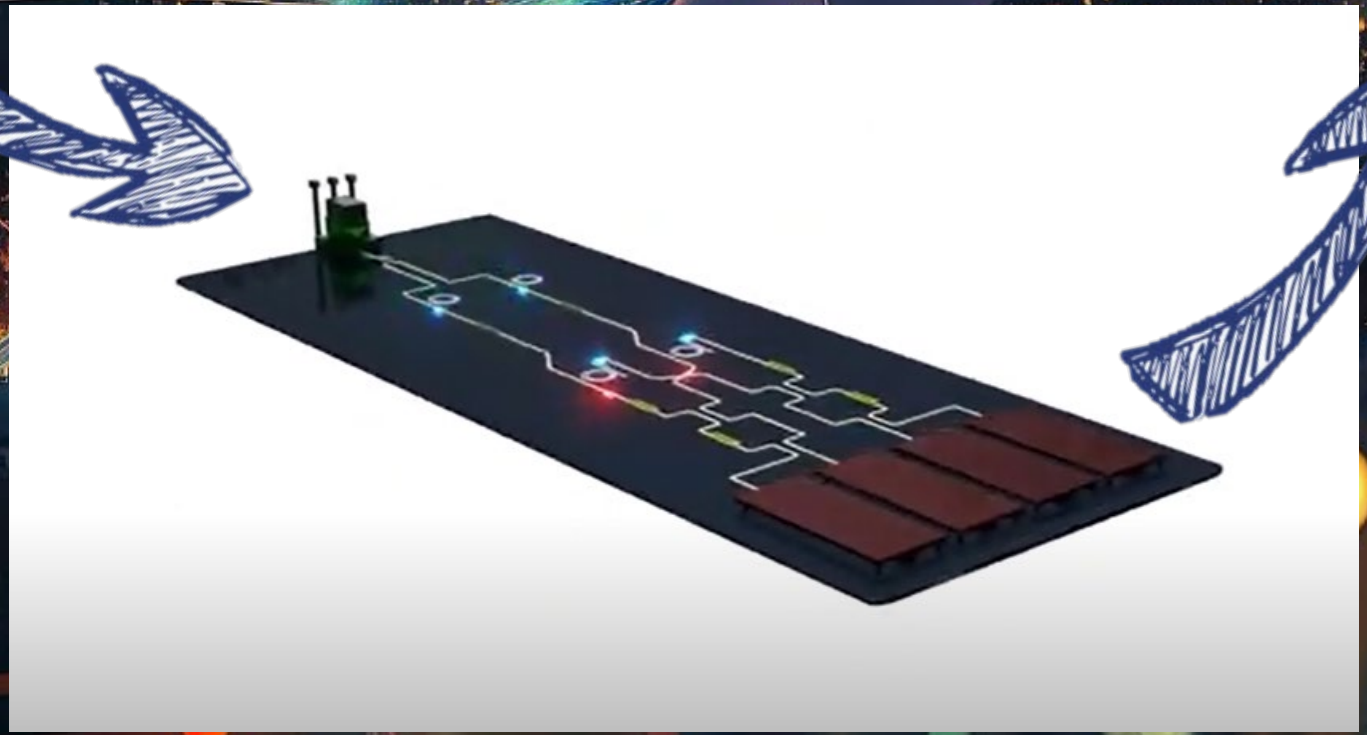
(based on quantum superposition and/or entanglement)

- Over tens of kilometers



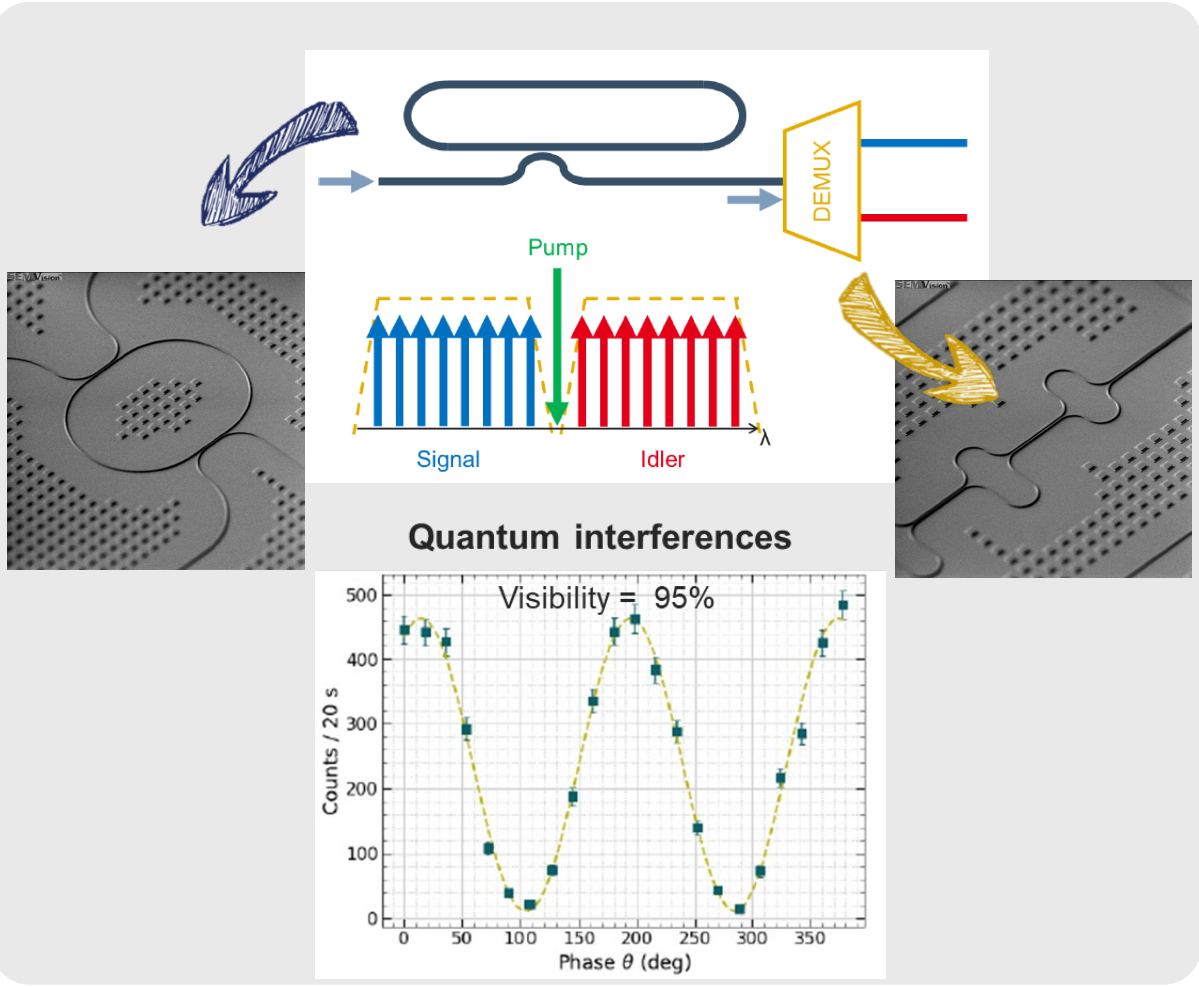
Goal #1 Generate entangled photon pairs at a high rate

Goal #2 Detect Photonic qubits with high efficiency



Goal #1 Generate Entangled Photon Pairs at a High Rate

Using integrated photonics



1 GHz generation rate achieved!

By frequency multiplexing

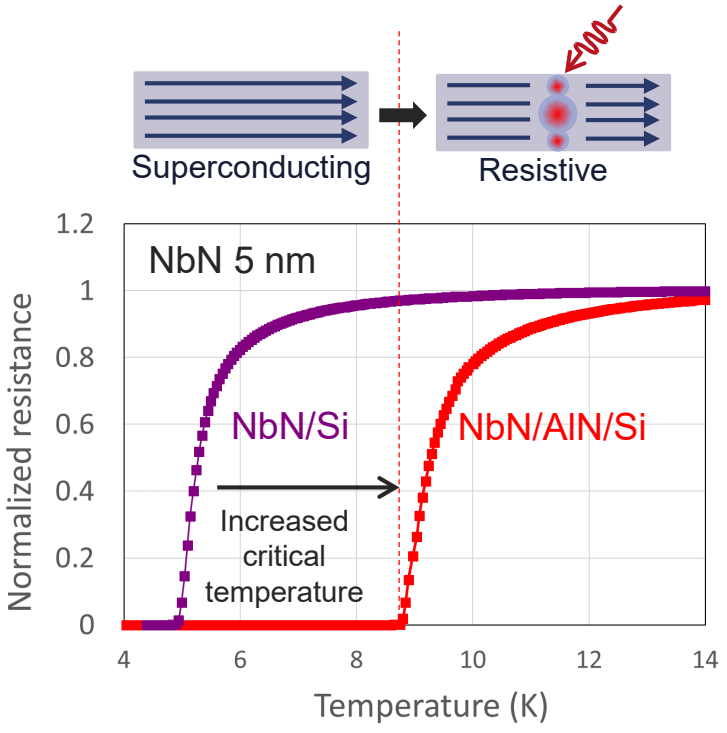
Frequency entanglement demonstrated with:

- Visibility: 95%
- Purity: 96.5%
- Fidelity: 98%

Goal #2 Detect Photonic Qubits with High Efficiency

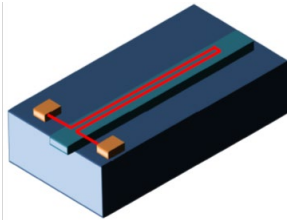
Waveguide-integrated SNSPDs for ultra-high efficiency and low dark counts

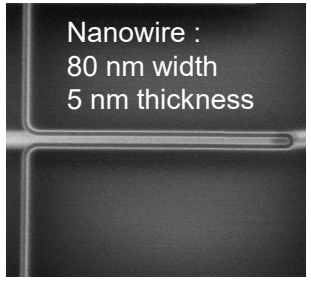
Optimized NbN with AlN buffer layer on 200 mm SOI wafers

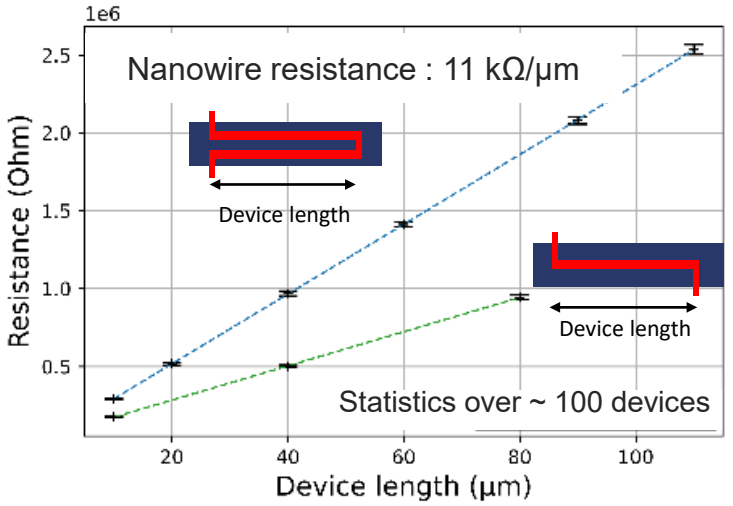


R. Rhazi, S. Olivier et al., Superconductor Science and Technologies 34, 045002, 2021

Excellent electrical uniformity across 200 mm SOI wafers

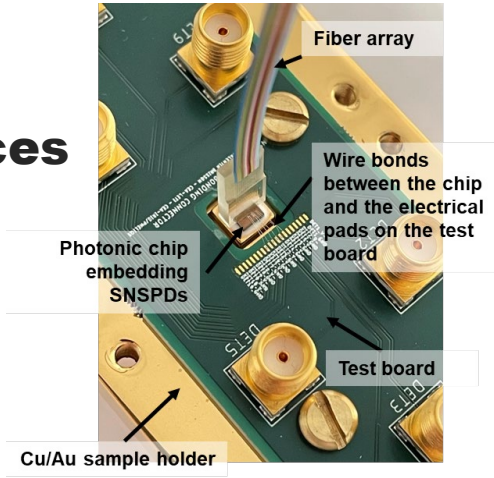


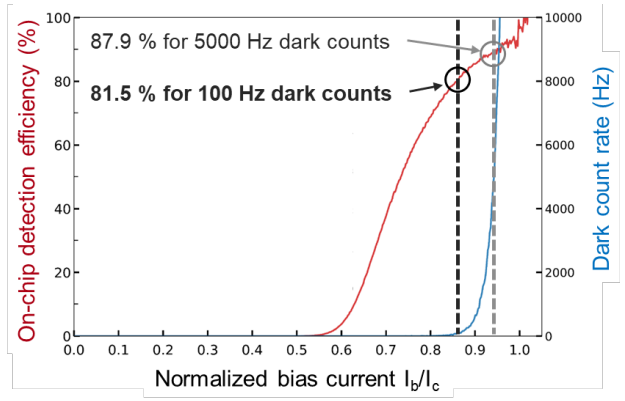




V. Brisson et al., Single Photon Workshop, 2022

Cryogenic detector performances





SPIE. PHOTONICS WEST — **NbN SNSPD integrated on Si, V. Brisson et al**

cea irig

Silicon Photonics

From Design to Prototyping

For your AI

And Quantum Projects

Research for industrial innovation

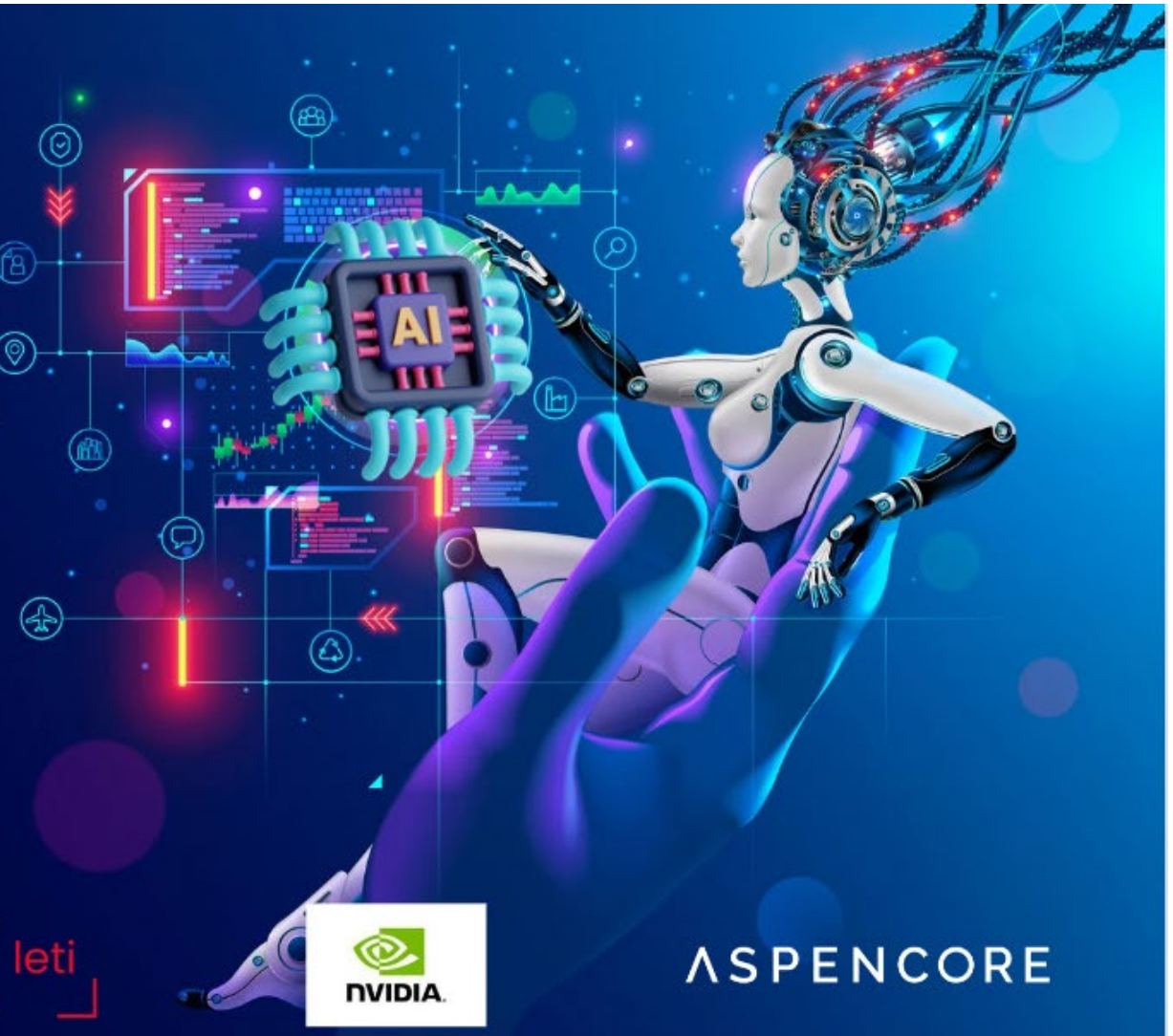
WORKSHOP

“Has Silicon Photonics finally found its killer application?

Date, time & location:

March 27 - 5:00-7:30pm

Hard Rock Hotel San Diego



soitec

cea leti

NVIDIA

ASPENCORE

OFC 2024

More information & registration

INDUSTRIAL PANEL:

cea

NVIDIA

Google

tsmc

JABIL

LIGHTCOUNTING

Vincent Destefanis

Optical Sensors Partnership Manager, CEA-Leti

Towards Ultra-miniature Photonic Sensors: from Niche to Mainstream

From the 1st Sensors to Miniature Chips…

Towards Mainstream

Canaries for Detection of Explosive Gas in Mines (XIXth Century)

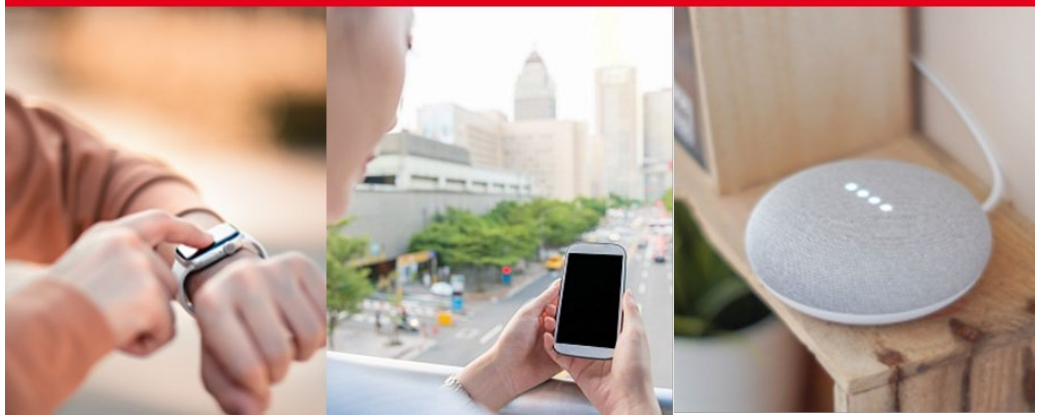
Miniature & Versatile MEMS Sensors

- **MORE SENSITIVE THAN HUMANS**
- **ONLY FED BY BIRD SEEDS & WATER**
- **FEATURING « NON-ARTIFICIAL INTELLIGENCE »**
- **BULK SENSORS DEDICATED TO NICHE APPLICATIONS**

Mainstream Applications

High-volume usecases targeting low manufacturing costs

CONSUMER



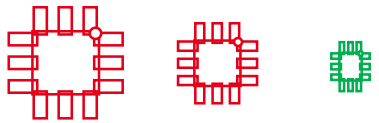
AUTOMOTIVE

MEDICAL

ENVIRONMENT & ENERGY

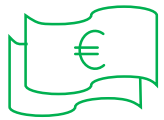
CEA-Leti Main Key Drivers

For the Development of Leading-edge Sensors

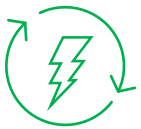


MINIATURIZATION
Small Footprint

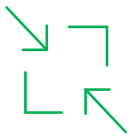
HIGH PERFORMANCE
High Selectivity & Sensitivity



LOW COST
Few € / $



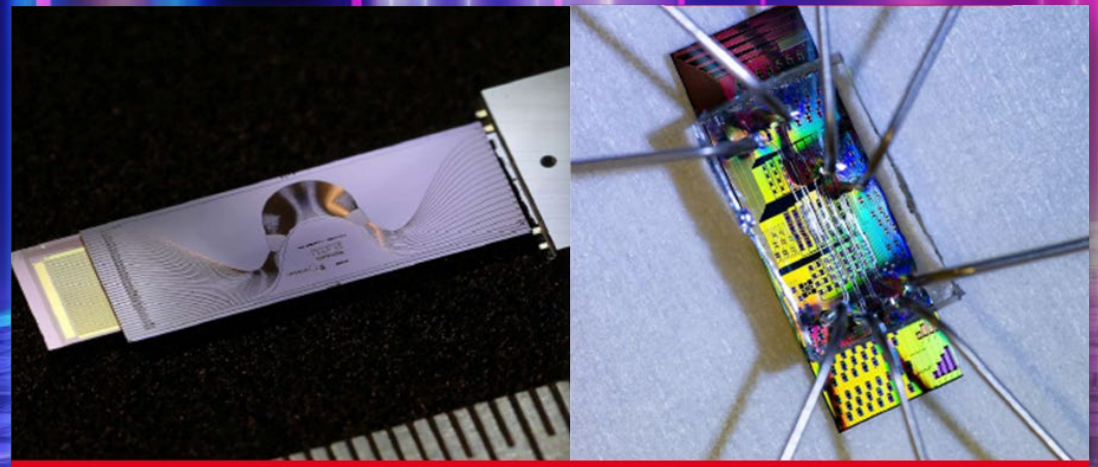
LOW POWER
Few mW



SMART
Artificial Intelligence
Multi-Sensing

CEA-Leti

Main Technological Assets



INNOVATIVE CORE SENSORS
& SENSOR ARCHITECTURES

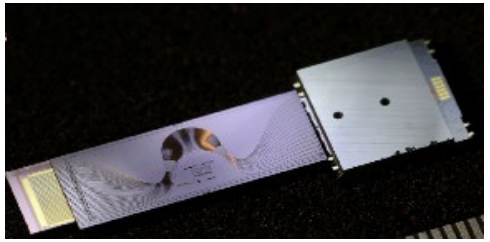
LEADING-EDGE MEMS
& CMOS MANUFACTURING

PHOTONIC INTEGRATED
CIRCUIT PLATFORMS

CEA-Leti Optical Sensing Technologies

For sensing of chemicals and particles of matter

QUANTUM CASCADE LASER PHOTOACOUSTIC

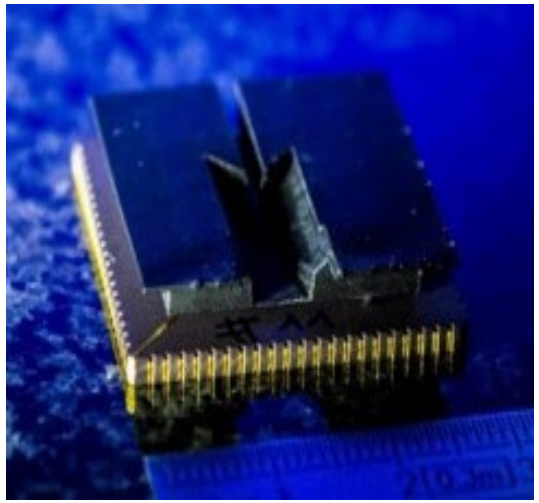


NON- DISPERSIVE INFRARED

MACH ZEHNDER INTERFEROMETRY

Sensing of chemicals into gas or liquids

SCATTERING-IMAGING



Particles of matter sensing

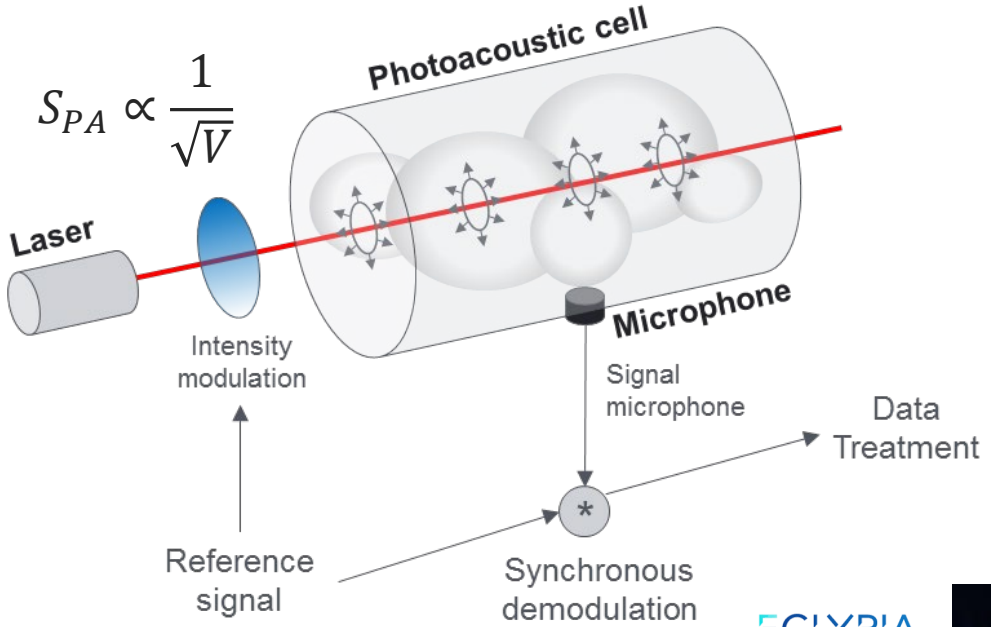
INFRARED IMAGING

Medical Diagnosis

High Chemical Specificity from Infrared Operation!

Highly Selective & Sensitive Technique

Quantum Cascade Photoacoustic Laser



- **Scale-down compatible** < 1 cm^3
- Limit of Detection in the **10 ppm – 10 ppb range**
- **Selective** Detection of Chemicals
- **Multi-Sensing** Capable

Fully-integrated miniature sensor

Wearable Device for Continous Glycemia Monitoring

Ultra-small sensor

High Selectivity & Sensitivity

For Consumer, Medical & Industrial

J.G. Coutard et al., Photonics West 2024, 27th Jan.

Tackling Volume & Cost Limitations of QCL

Quantum Cascade Laser on Si

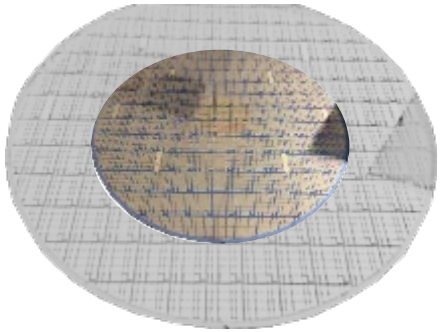
Commercially-Available QCL

III-V manufacturing
Limited volumes
& Low yields

Limitation
to niche markets

~ €1,500 /chip

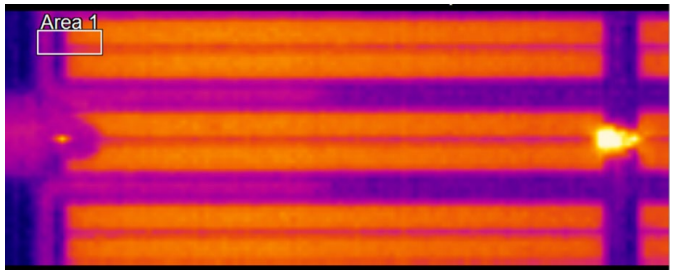
Current LETI solution

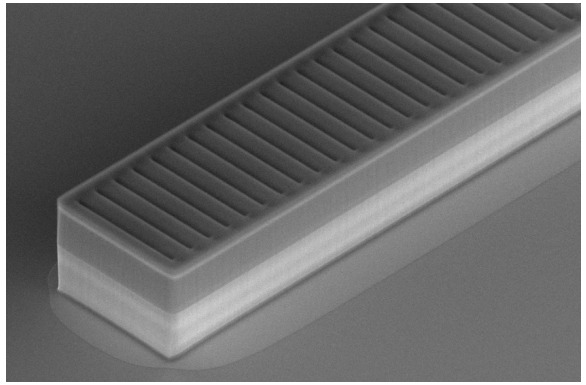


4'' III-V wafer bonding on 200 mm Si wafer (up to 5)

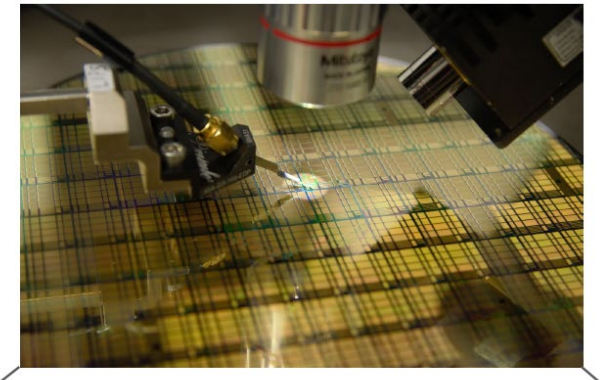
10 000 chips/wafer

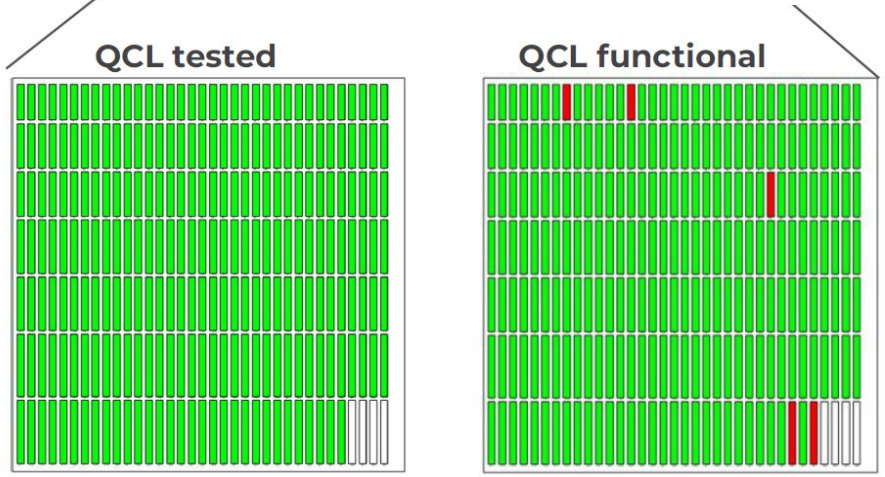
~ €1 – 5/chip*





On Wafer Characterization



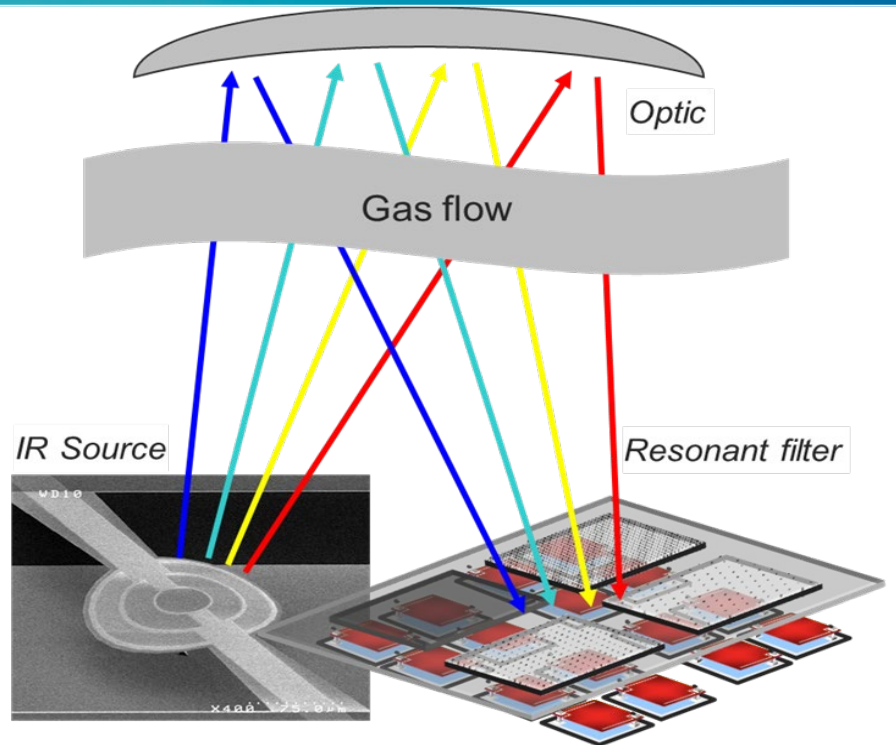


Manufacturing yields > 90%

Ready for Technological Transfer to Industry !

The Best Cost / Performance Trade-off

Non-dispersive Infrared Sensing Technology

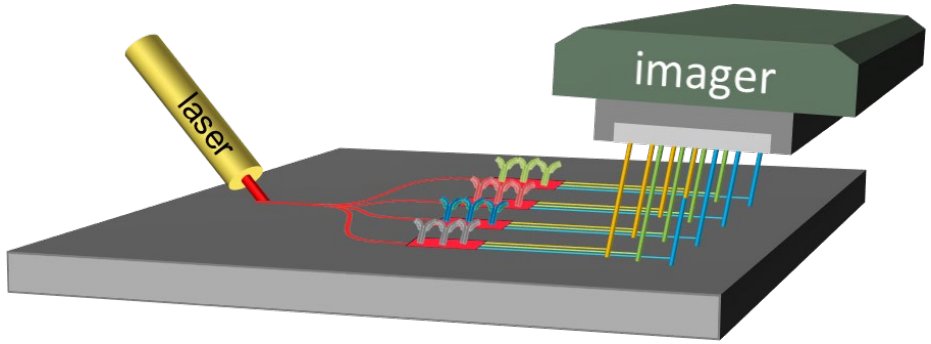


- Ultra-low power: about 2 mW
- Small sensor footprint: 2 cm²
- Limit of Detection ≈ 100 ppm

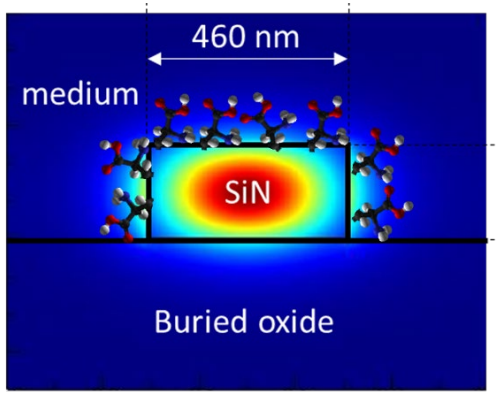
Towards 1 ppm sensors
for industrial & environmental applications

Massively Parallel Biosensing

Mach Zehnder inteferometry



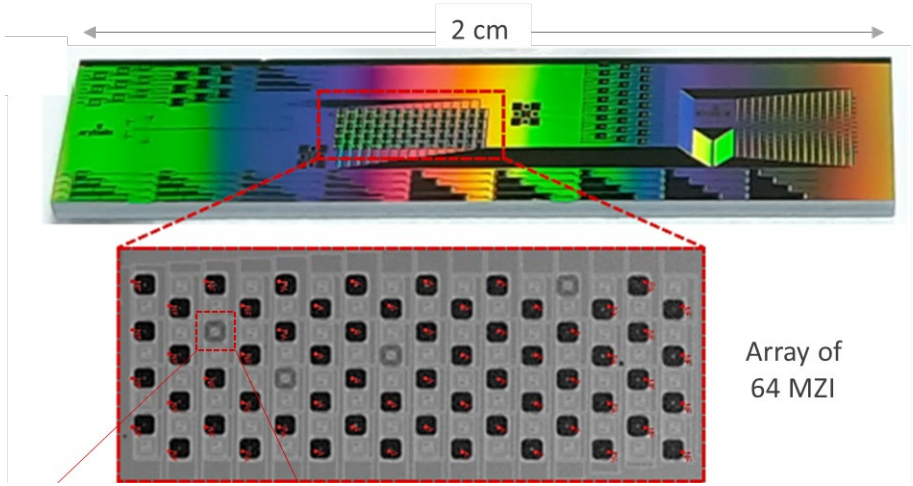
- **Highly selective** from bio-functionalization
- **Fast, automated sensing:** in the min range
- **High sensitivity:** in the ng/mL to µg/mL range
- **Combination of photonics & microfluidics**



Massively Parallel Sensing

Fast, Low Cost & Miniature Technology

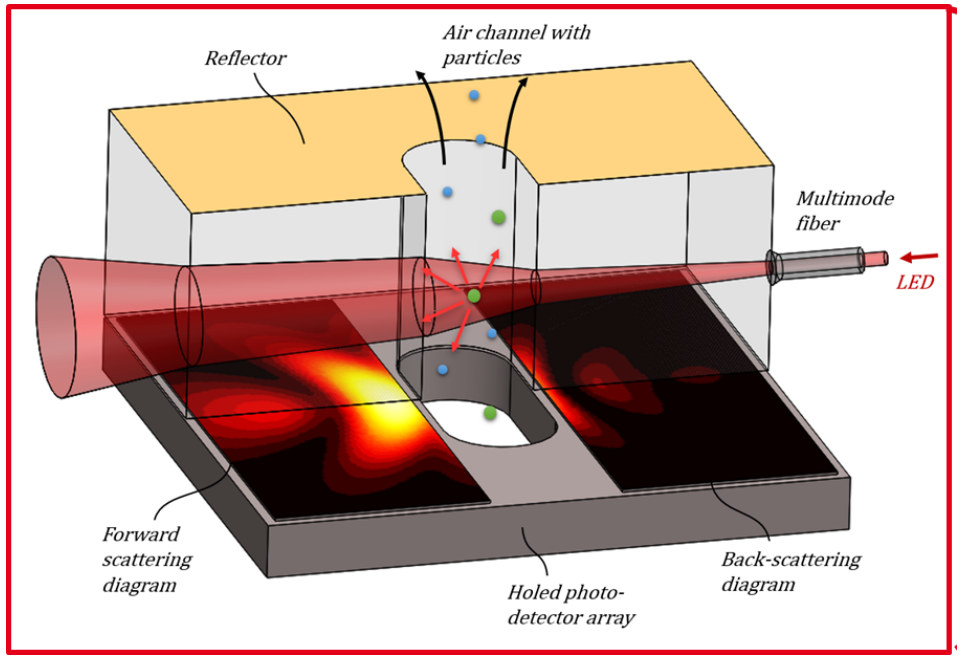
For Digital olfactive & Biosensing Applications

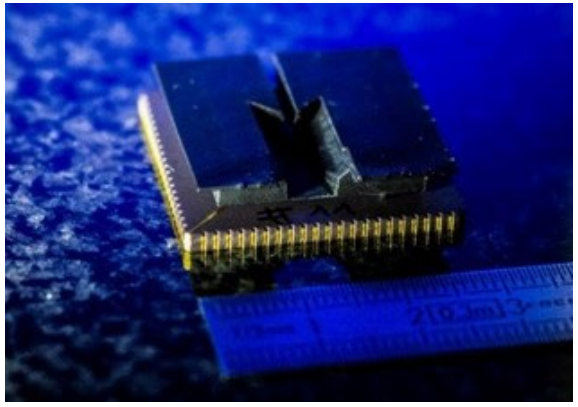


L. Laplatine et al., Photonics West 2024, Paper 12835-41

Smart Sensing of Particles of Matter

From scattering of light





- **Count, Identify & Classify** particles of matter
- **Machine Learning**
- **High resolution** : 1µg/m^3
- Detection of particle diameter **below 1 µm**

Smart Sensing of Particules of Matter

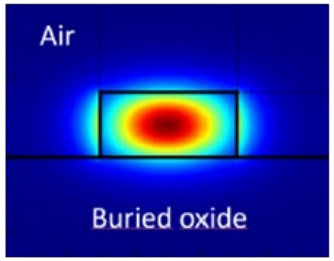
Innovative Sensor Design

For Safety & Environmental Applications

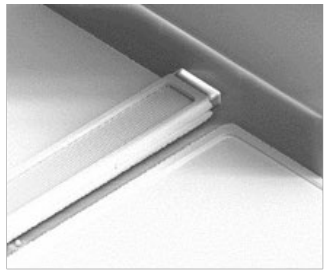
What's next?

Ready to explore disruptive photonic solutions!

Technological photonics building blocks



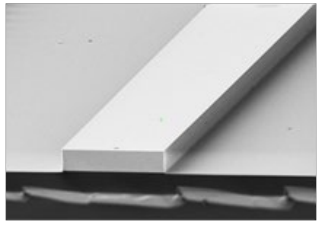
Modeling



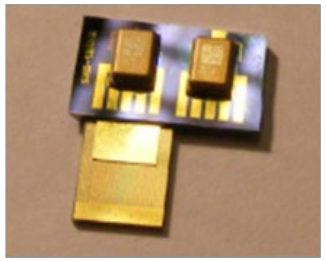
III-V Lasers on Silicon

GeSn Source/Det.

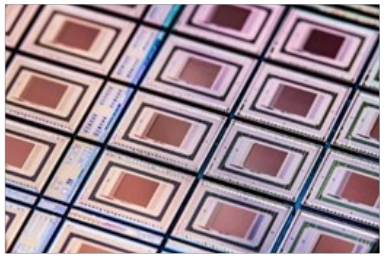
AI / Machine Learning



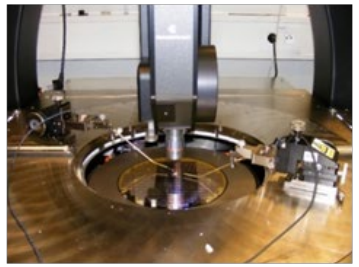
SiN & Ge/SiGe Photonic Integrated Circuits



Photoacoustic Detector



Bolometer Detector



Characterization Methods

Miniature, Affordable and High-Performance Photonic Sensors Targeting Mainstream Applications

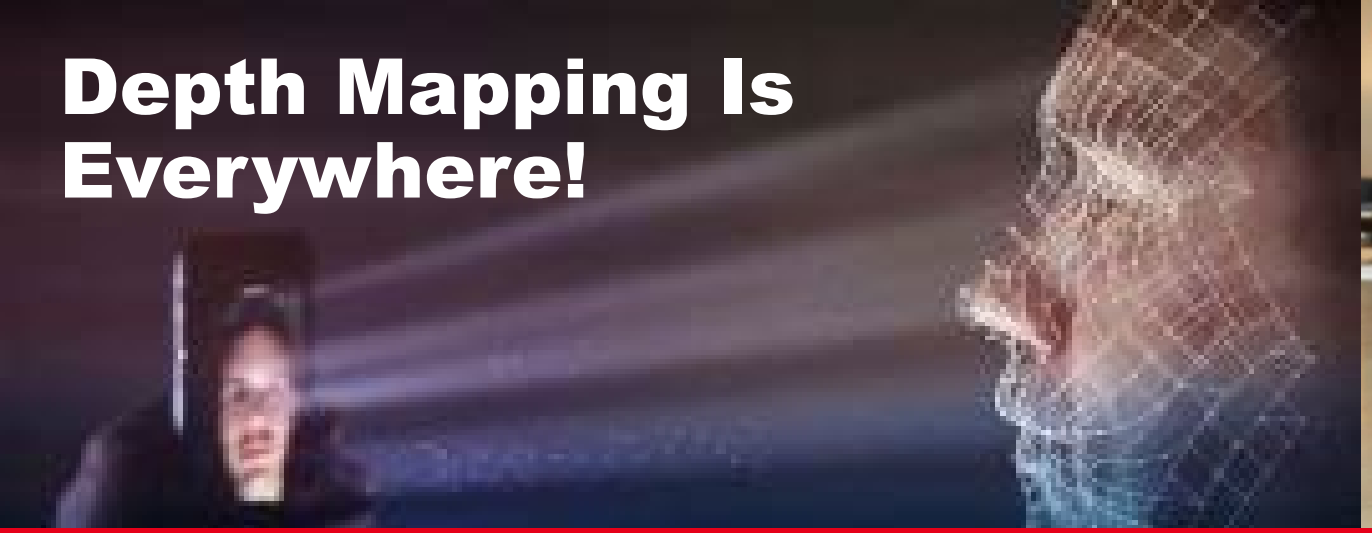
Research for industrial innovation

Pierre Castelein

Image Sensors Partnership Manager, CEA-Leti

Advances in FMCW-based Scanless 3D Imaging Systems for Consumer Applications

Depth Mapping Is Everywhere!

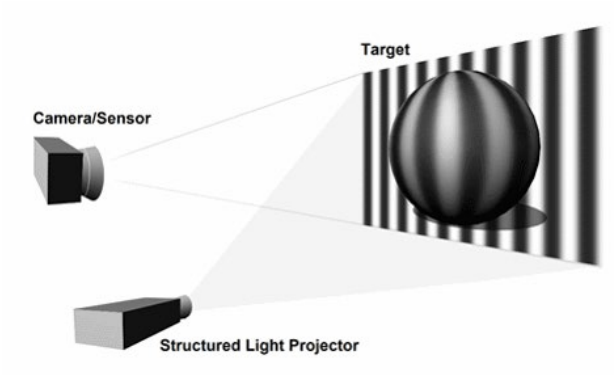


“Global Depth Sensing Market is expected to reach US $15B by 2033, rising at a CAGR of 8.2%.”

source: Persistence Market Research

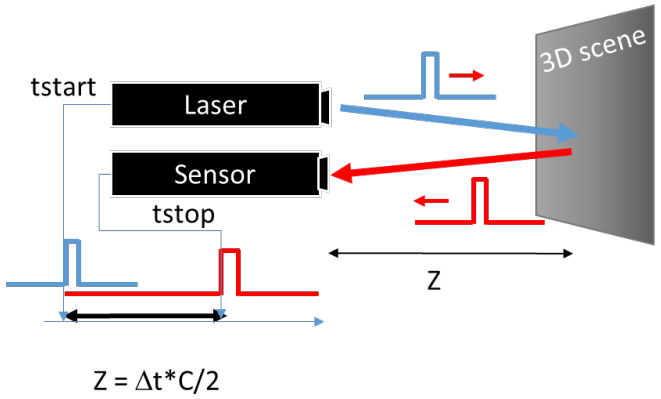
Commercial Depth Mapping Sensors

Structured light



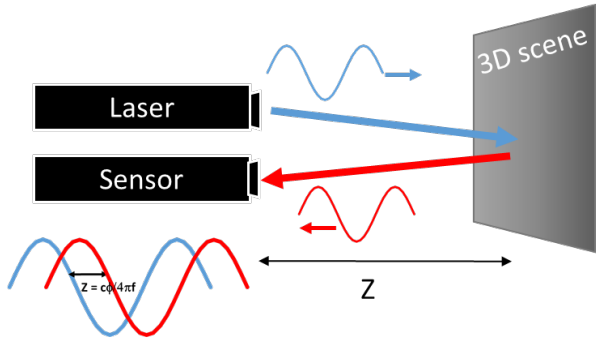
Global shutter

Direct ToF



SPAD

Indirect ToF

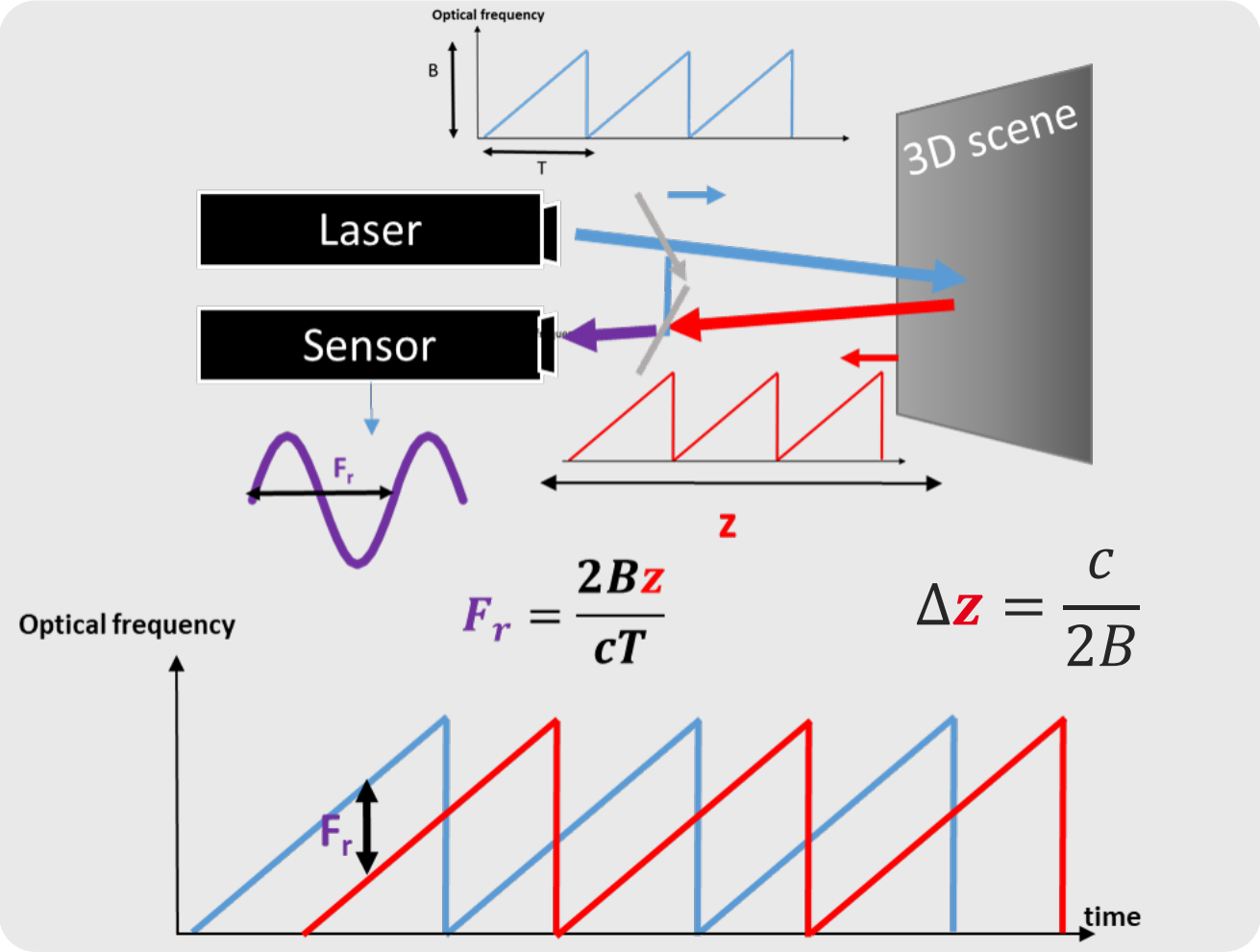


Lock-in pixels

distance — spatial definition — consumption

Frequency Modulated Continuous Wave (FMCW)

A game changer for 3D imaging?



High-depth resolution

Depth and speed measurement

Higher immunity to background light

Complex signal processing

3D mapping at video rate

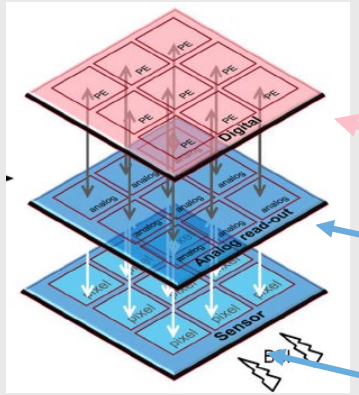
Towards Scanless 3D FMCW-based Imaging

Advanced CIS foundry nodes open the path to compact Imagers for scanless depth and speed imaging at video rate

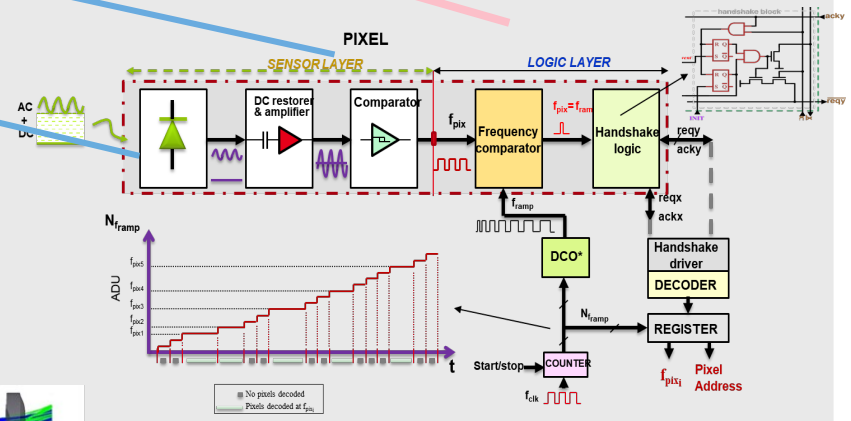
- ***Targeted performances:***
  - ***High spatial resolution:*** *~ Mpix , <5µm pitch*
  - ***Depth resolution:*** ***~****cm resolution at several meters and 50 Fps*
  - *High FoV: ~ 60°*
  - *Low power consumption: ~ 100mW*

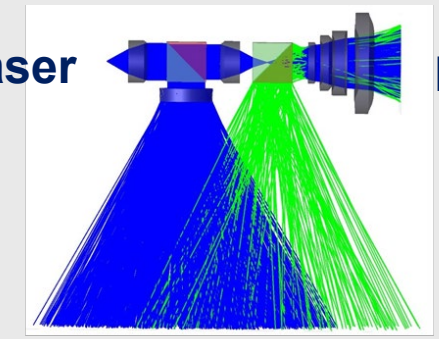
- ***Small footprint***

12 patents



Typical architecture of the Stacked FMCW Imager



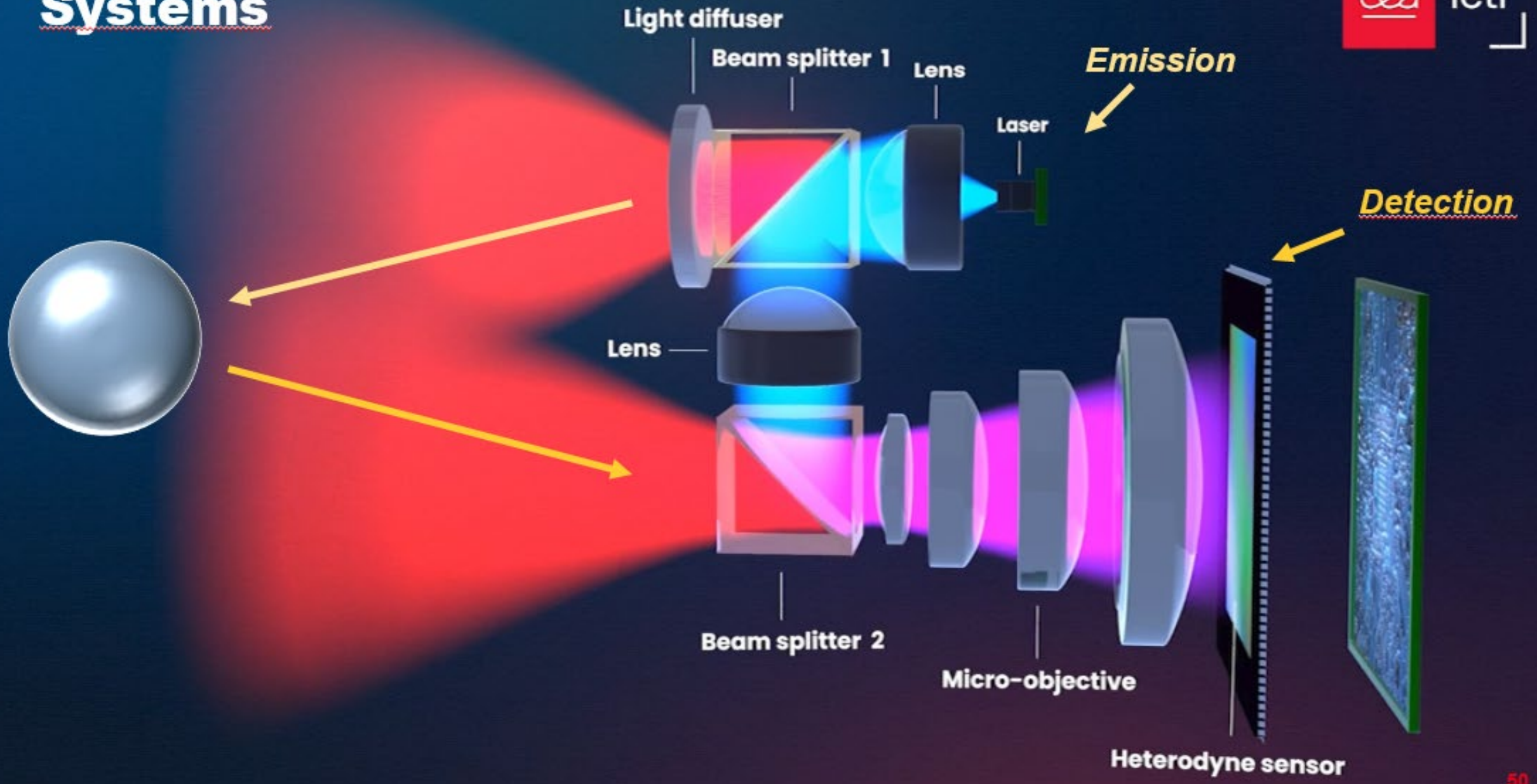


3D scene

A Daami and al, "Free space 3D FMCW imaging system: towards consumer application", https://doi.org/10.1117/12.2577103

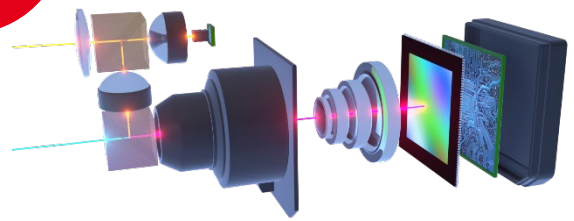
L. Frey and al , "Three dimensional FMCW scanless imaging: optical challenges and solutions" , https://doi.org/10.1117/12.2578121

Towards Compact FMCW-based 3D Imaging Systems



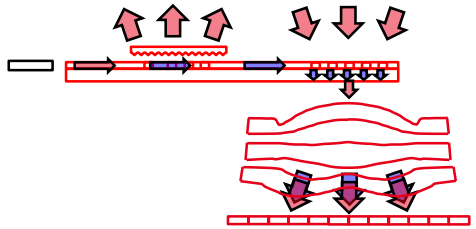
Roadmap for FMCW-based Scanless 3D Imagers at Leti

01



FIRST FMCW-BASED 3D IMAGING DEMONSTRATOR IN VISIBLE RANGE

02



2ND GENERATION WITH INTEGRATED OPTICS

For higher compactness

03

EXTENSION TO SWIR RANGE FOR LONG DISTANCES AND HIGH-END APPLICATIONS

Based on SWIR materials (typically III-V, Ge)

CEA-Leti Preparing the Next Generation of FMCW-based Depth/Speed Imagers for Consumer, AR/VR, Industrial and High-end Applications

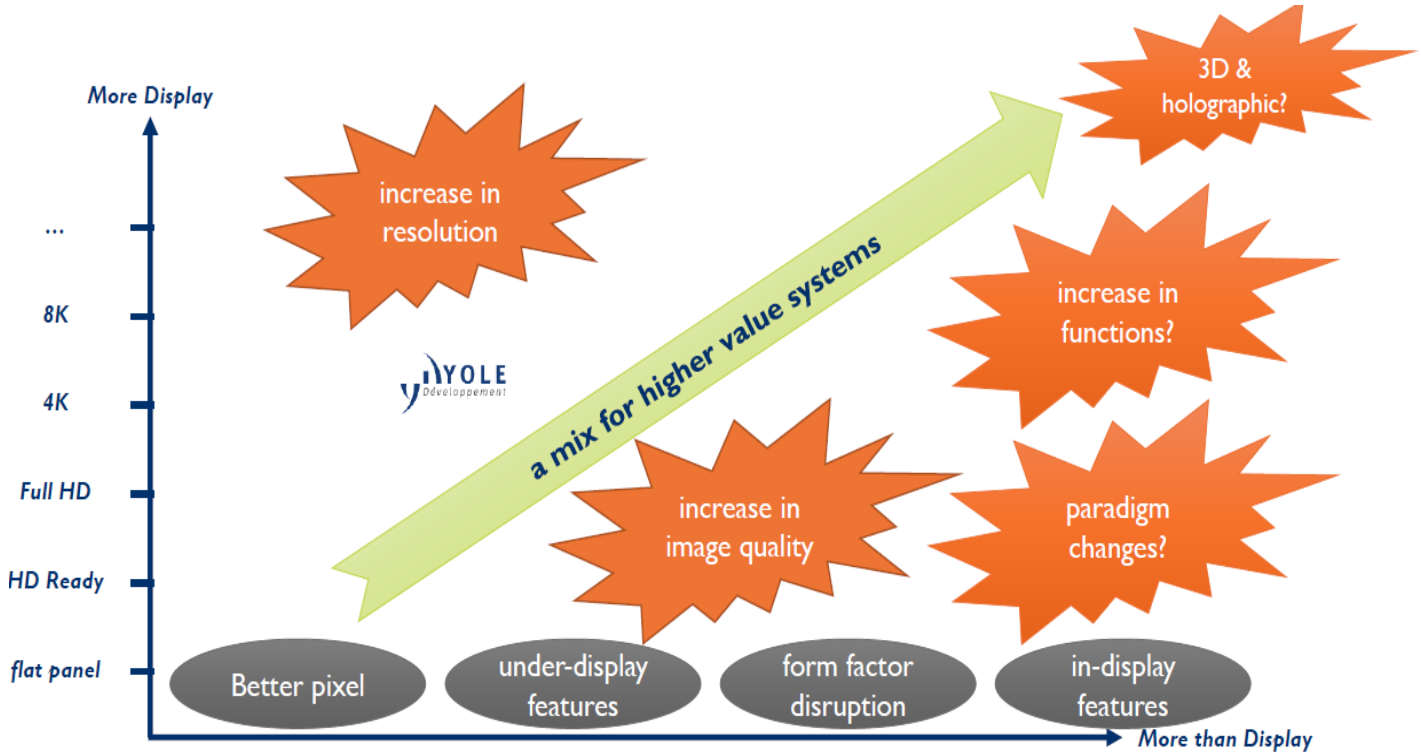
Be part of the adventure!

Research for industrial innovation

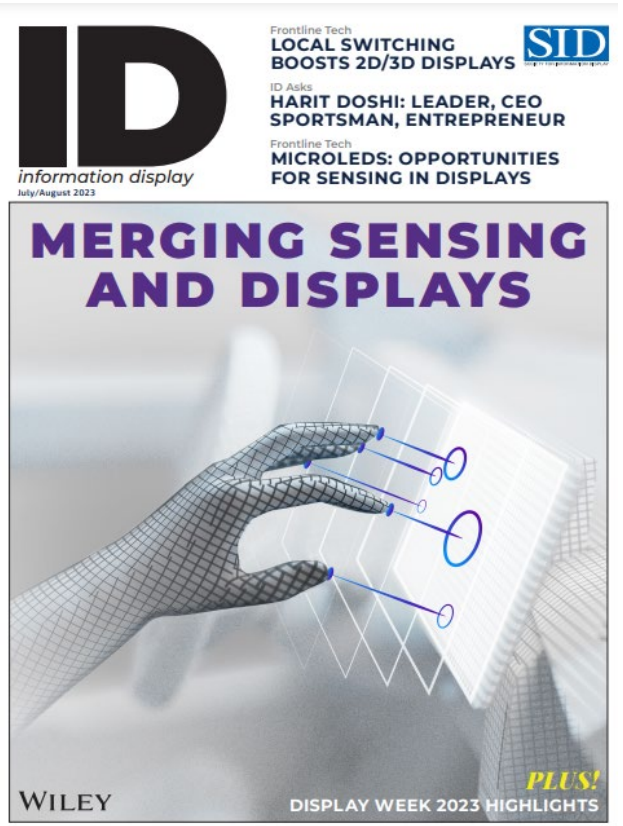
Michael Pelissier
Multifunctional Display
Project Leader, CEA-Leti

On the Use of MicroLED
for Multifunctional Display

From « More Display » to « More than Display »



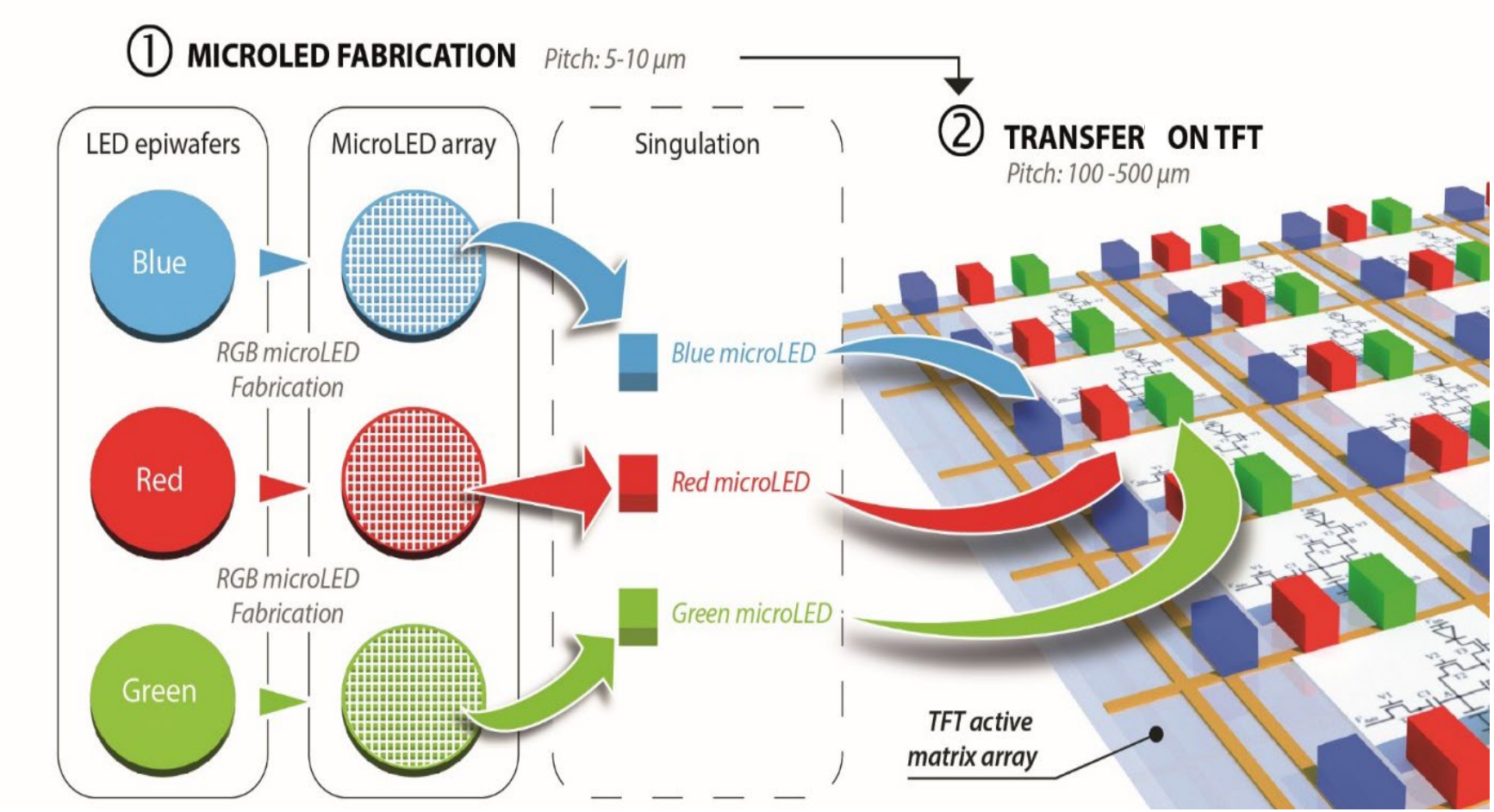
📖 Source : Yole Report, 2019 Next-generation HMI in Displays



Innovating by integrating more functions under or within the display

How to Make a MicroLED Display (I)

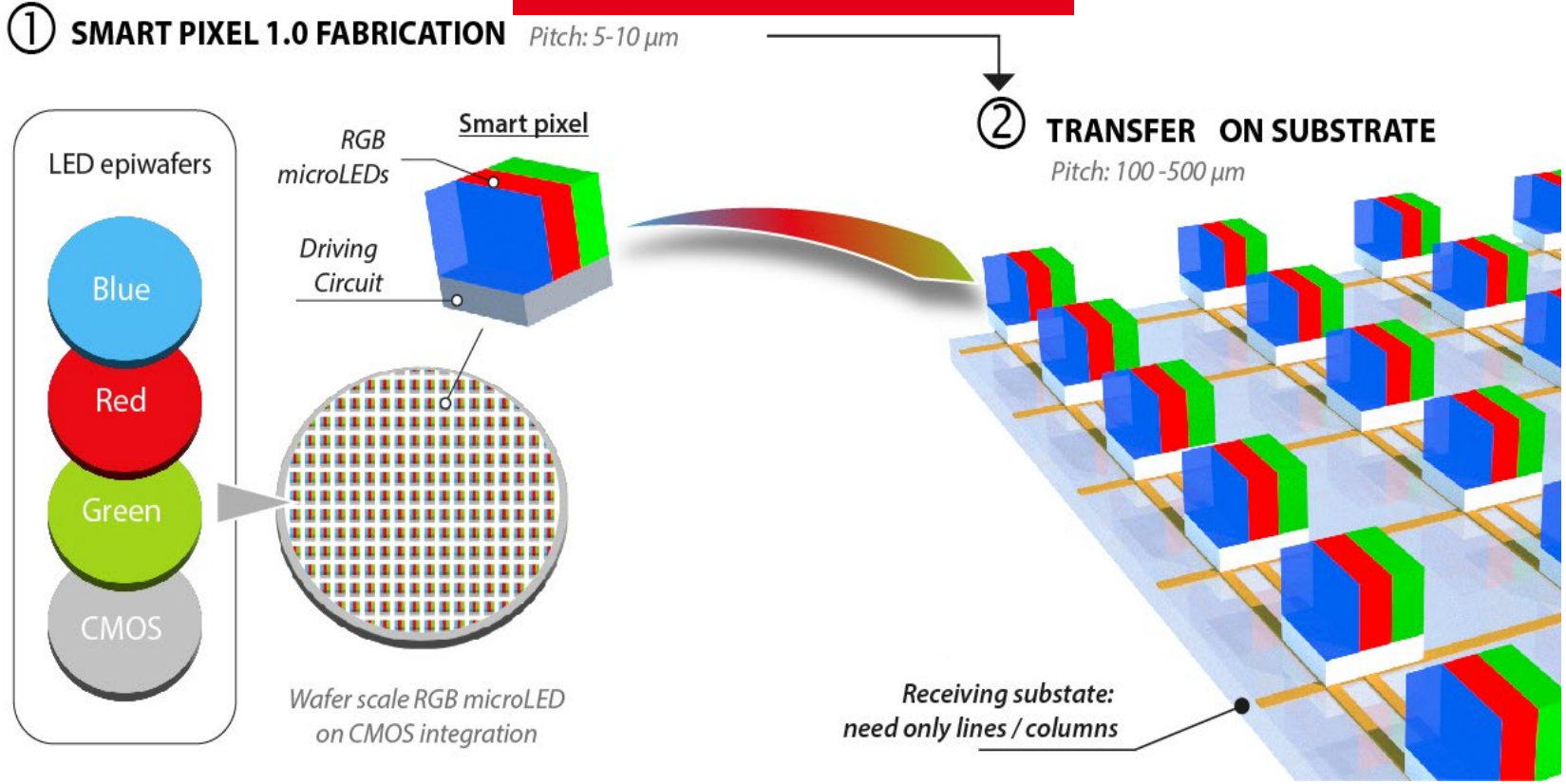
Classical Method



Source : CEA-Leti [TE23]

How to Make a MicroLED Display (II)

CEA-LETI Smart-Pixel



Smart-Pixel solution enables to drive microLED with CMOS

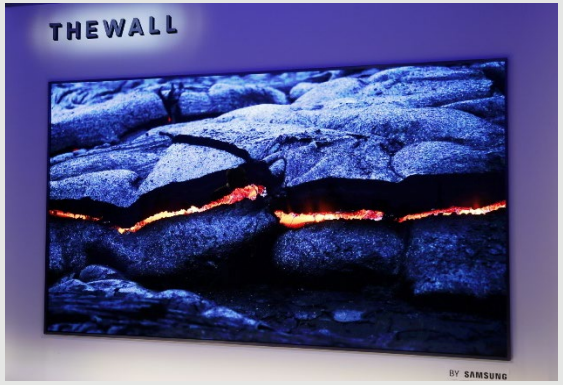
- Simplify the pixel transfer to the backplane for large display
- Overcome TFT limitation to drive high current
- Enable tailored driving mode for microLED (PWM) and compensation method

Why MicroLED Technology?

AR/MR

wearable

TV / Monitor



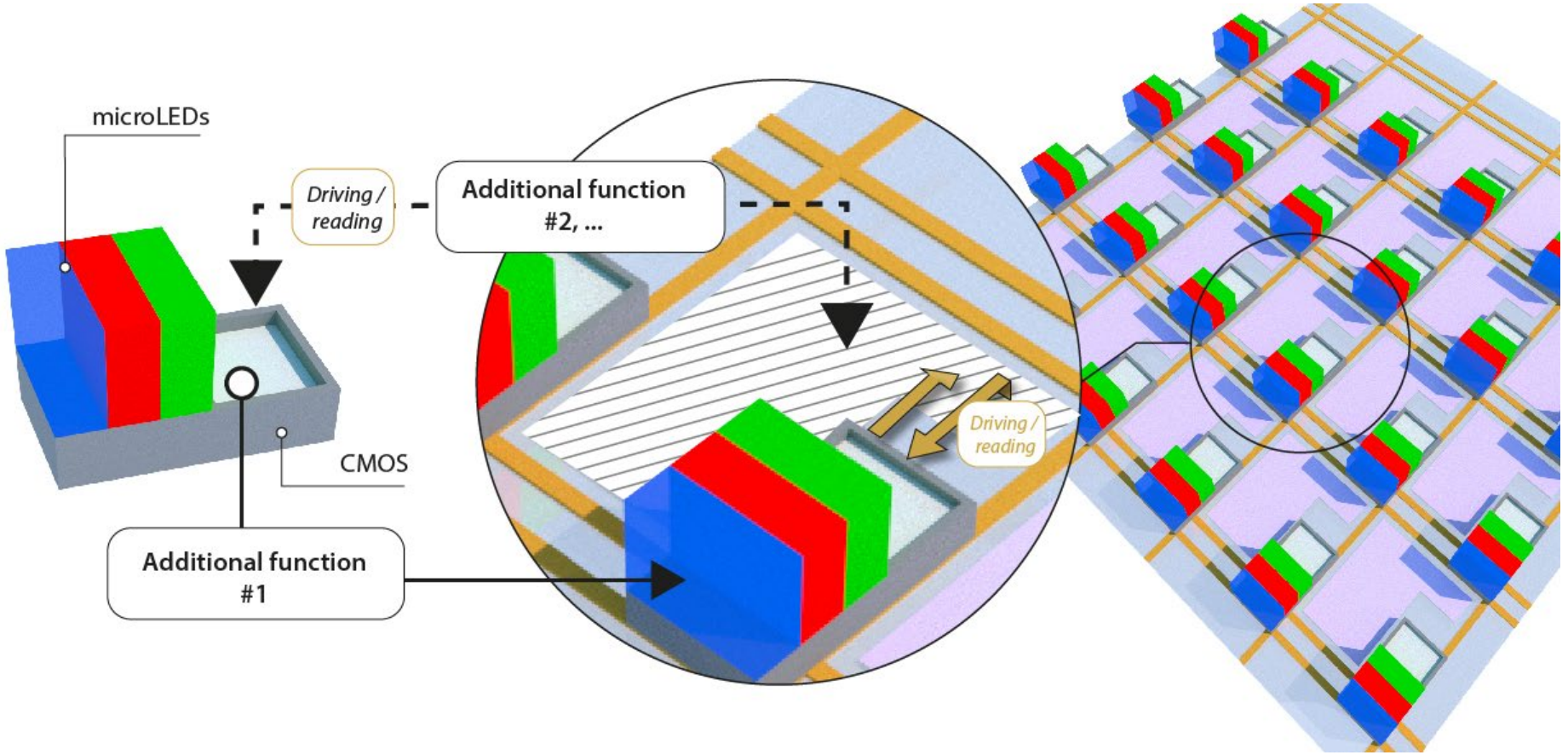
📖 Samsung , CES 2018

- Higher brightness
- Better color/contrast
- Size
- Robustness

📖 Samsung at CES 2024, Photo by Sam Rutherford/Engadget

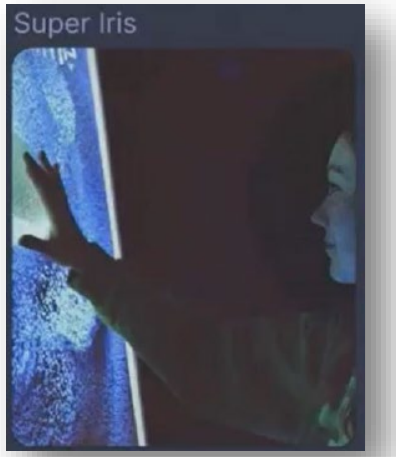
High brightness of microLED paves the way to novel applications.

On the Opportunity of MicroLED for Multifunctional Display

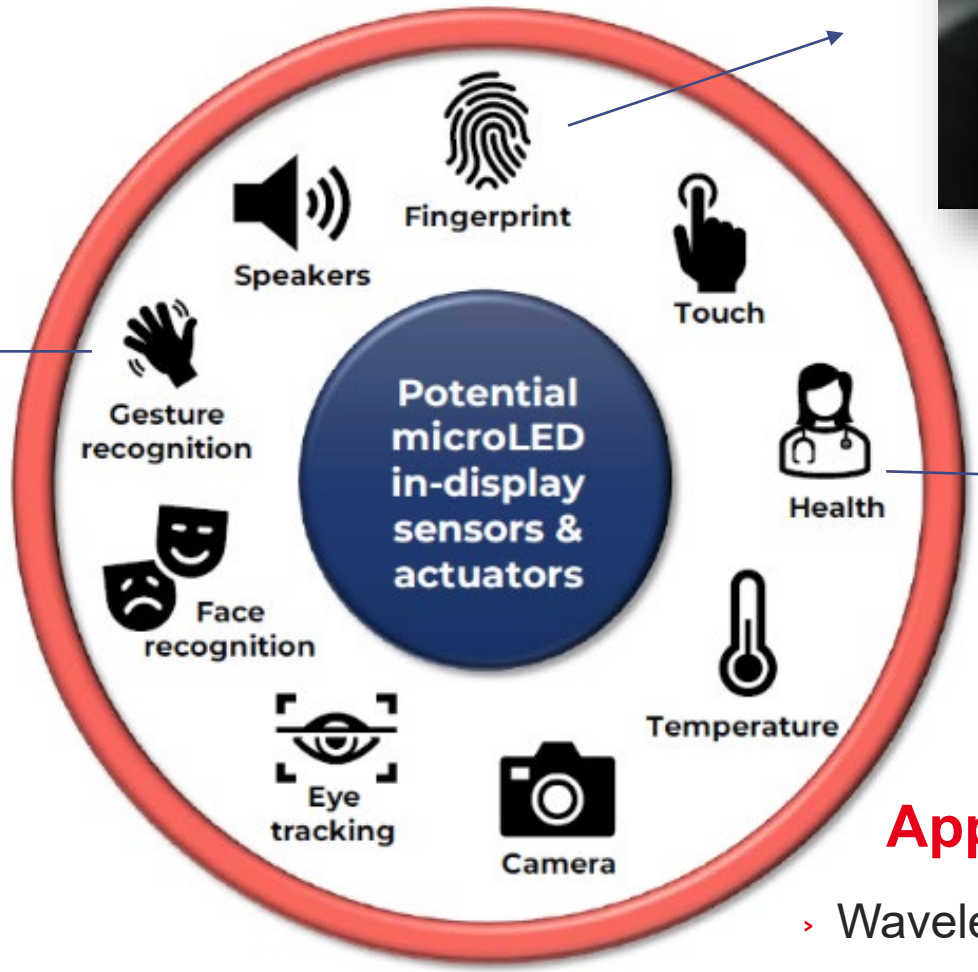


The free space within the pixel enables embedding additional functions either on the CMOS or within the inter-pixel area.

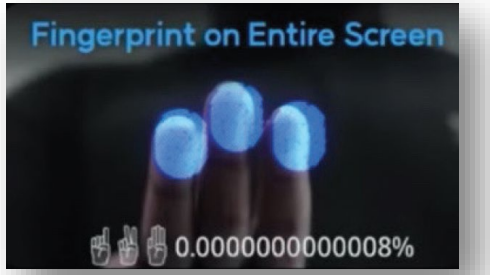
Multifunctional Display: Why Exactly?



Source : Embodme



Yole, MicroLED 2022



Source :Samsung, SID-2023

Applications drive key parameters:

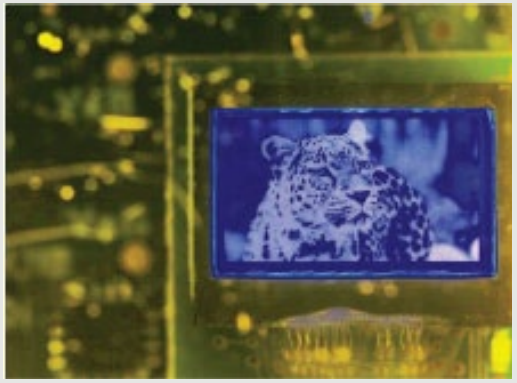
- Wavelength Range : From Visible to SWIR
- Sensor Pixel Resolution
- Benefits from distributed sensing over wide area.

Our focus: Embedded Optical Sensors

CEA-Leti Technology Development Relevant for Multifunctional Display

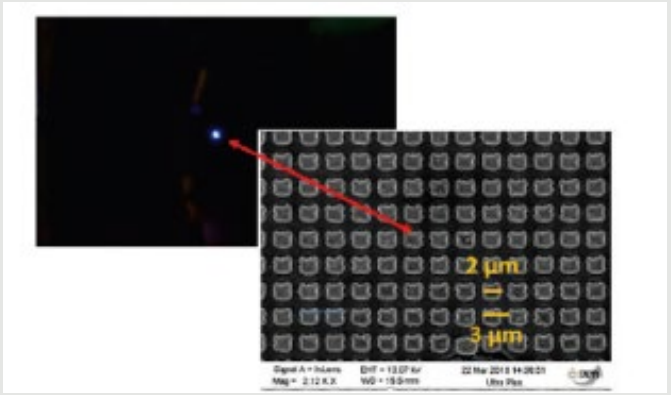
- MicroLED: TCAD simulation; microLED GaN fabrication; POC realization — CEA-Leti [CI24,LI24,DU24]
- Sensor: Inorganic photo-detector and Organic technology development — CEA-Leti [DM23,MU23, Du23]
- Integration on CMOS, D2W, W2W, hybrid, direct bonding

microLED bonded with microtubes: 10 µm

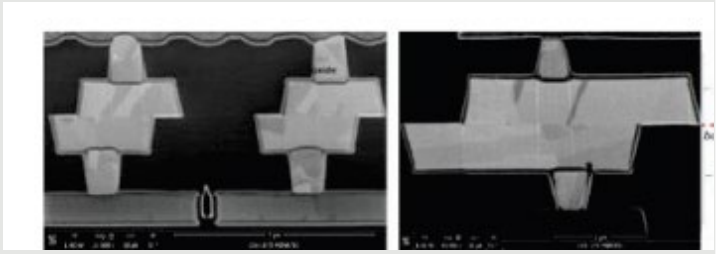


CEA-Leti [TE222]

microLED with direct metal bonding: <5 µm



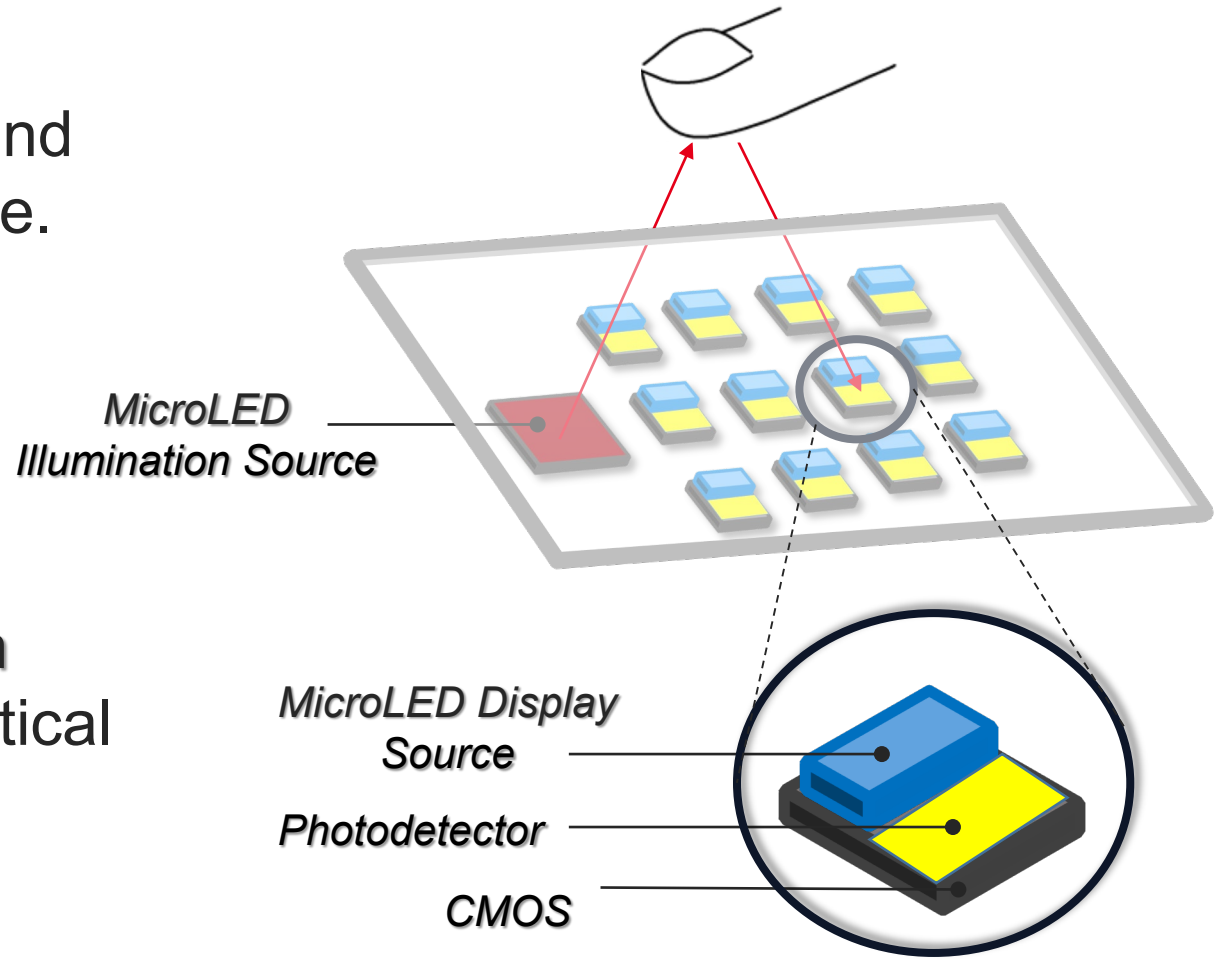
microLED with hybrid bonding: <5 µm



- Large patent portfolio on microLED technology, its related integration and smart-pixel solution.

CEA-Leti Development Axes on Multifunctional Display

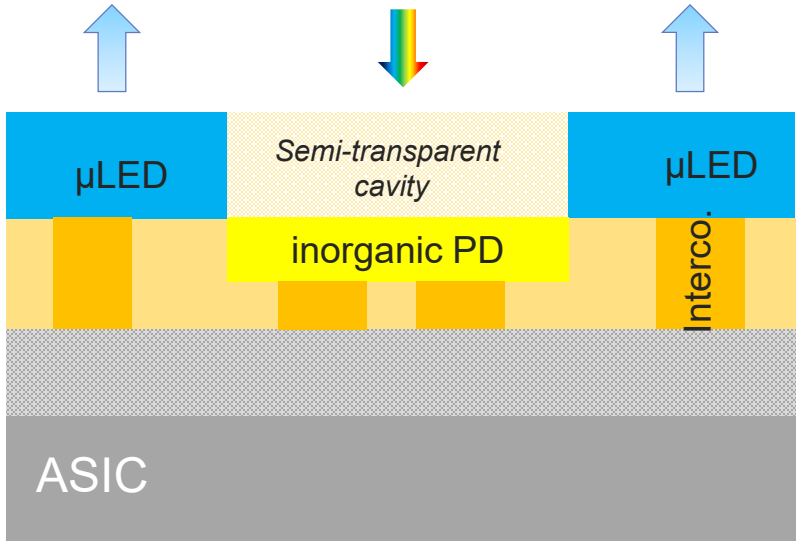
- Co-integration between microLEDs and organic photodetectors in visible range.
- Extension to NIR/SWIR range.
- Investigation of optimal CMOS design (source & read-out) in presence of optical crosstalk.



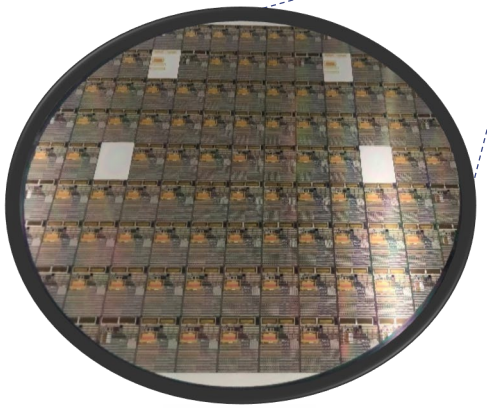
Monolithic Co-integration of MicroLED & Photodetector

CEA-Leti is developing optimal co-integration solution

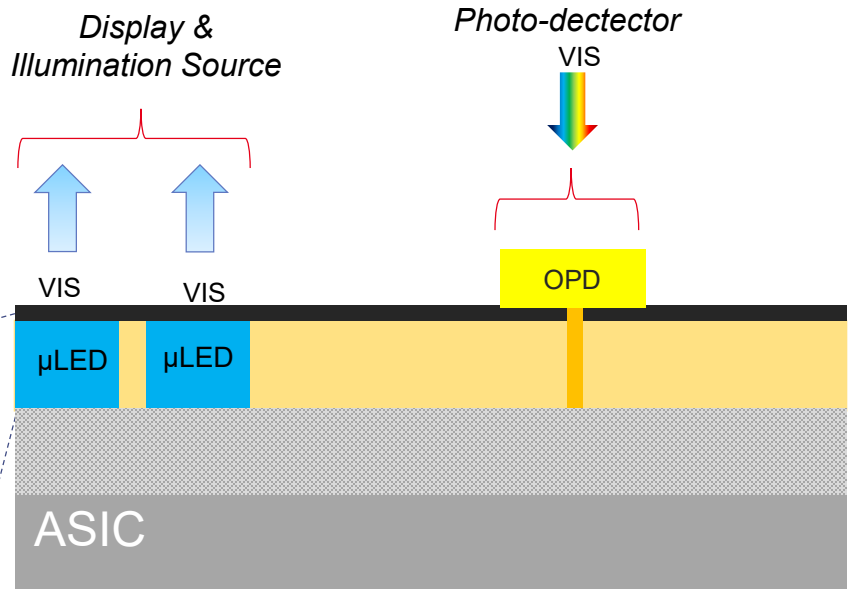
MicroLED & inorganic PD



- 2 wafer-to-wafer bonding
- Semi-transparent cavity
- Vias and interconnection management



MicroLED & organic PD



- 1 wafer-to-wafer bonding
- Organic layer deposit

CEA-Leti is well positioned to develop multifunctional display solutions:

Know-how related to microLED technology

Co-integration capability with multiple types of photo-detector

CMOS ASIC design

Research for industrial innovation

Acknowledgement & References

SPIE. PHOTONICS WEST 2024

- [CI24] A. Cibie, P. Lemaitre et al. "*Parallel Communication with InGaN/GaN Micro-LEDs using a CMOS Compatible Approach*", Photonics West 2024
- [LI24] S. Litschgi et al., "*Influence of Quantum Well Thickness on Carrier Diffusion Length in InGaN Quantum Wells Grown on Sapphire, Freestanding GaN and Si*", Photonics West 2024
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- [TE23] F Templier, " *MicroLED Technology: A Unique Opportunity Toward "More Than Displays*"; Information Display -07-2023
- [TE22] F.Templier, et al, "*Challenges and Solutions for the Fabrication of CMOS-driven Microled Displays*" International Display Workshops, 2022

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- [DM23] De Martino, C Ballot et al., "*Monolithic integration of small pitch hybrid LED-OLED bicolor array on 8" Si for pure color applications*", Light-Emitting Devices, Materials, and Applications XXVII, PC124410X

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- [MU23] Munshi, B Racine et al "2.85-Gb/s Organic Light Communication with a 459-MHz micro-OLED." IEEE Photonics Technology Letters, 2023.
- [Du23] Durlin, Q., Aliane, A., André, et al « *Fabrication and characterisation of the PiN Ge photodiode with poly-crystalline Si : P as n-type region* ». Opto-Electronics Review, 31.

cea

Michael Tchagaspanian

EVP Strategic Partnerships,
CEA-Leti

A Partnership with CEA-Leti:
How Does It Work?

Boosting Technological Innovation and its Impact on Society and Environment

Telecommunications

Nanocharacterization

Design

Photonics

Cyber-physical Systems

2,000 talented people

350 industrial partners

75+ startups created

4,000 patents in portfolio

Cleanrooms (200 & 300 mm)

Cybersecurity

Power electronics

Micro-nanotechnologies for Health

Microsystems

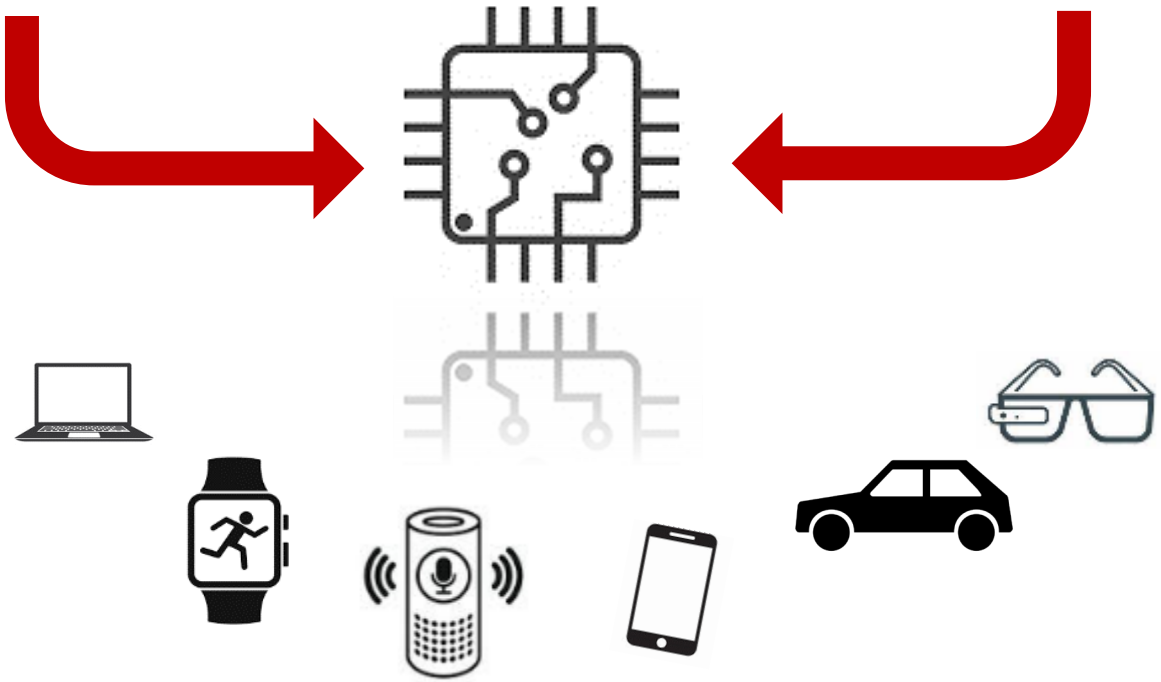
Clinatec

LEVERAGING TWO CORE SKILLS

Make your device unique and innovative

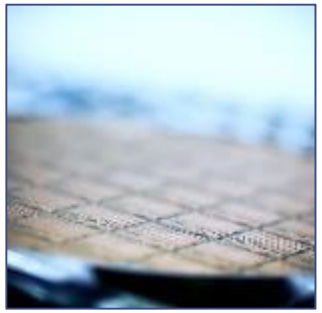
Semiconductor Technologies and Engineering Process

Integrated Circuit & Architecture Engineering Design

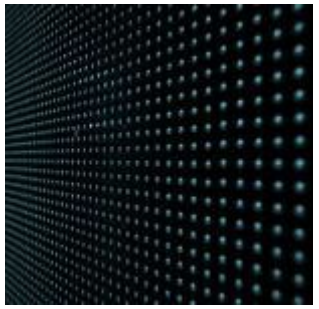


Relevant for yield and volume production

Make Your Solution Unique!



Materials



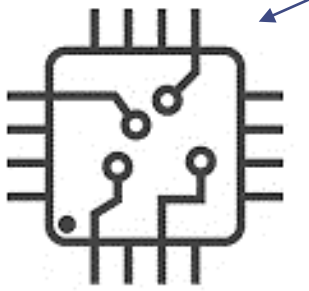
Foundry Process

Components & Devices

Functions Architectures

Make your device unique and innovative

MEMS
ACOUSTICS
SI PHOTONIC
NEW MATERIALS
FLEXIBLE ELECTRONICS
KNN AIN PZT
VCSEL QCL
PMUT CMUT
GYROSCOPE
µLED
RADAR
ACCELERO
BLOOD PRESSURE
PRESSURE SENSOR
GLYCEMIA
HAPTIC FEEDBACK
HEALTH MONITORING

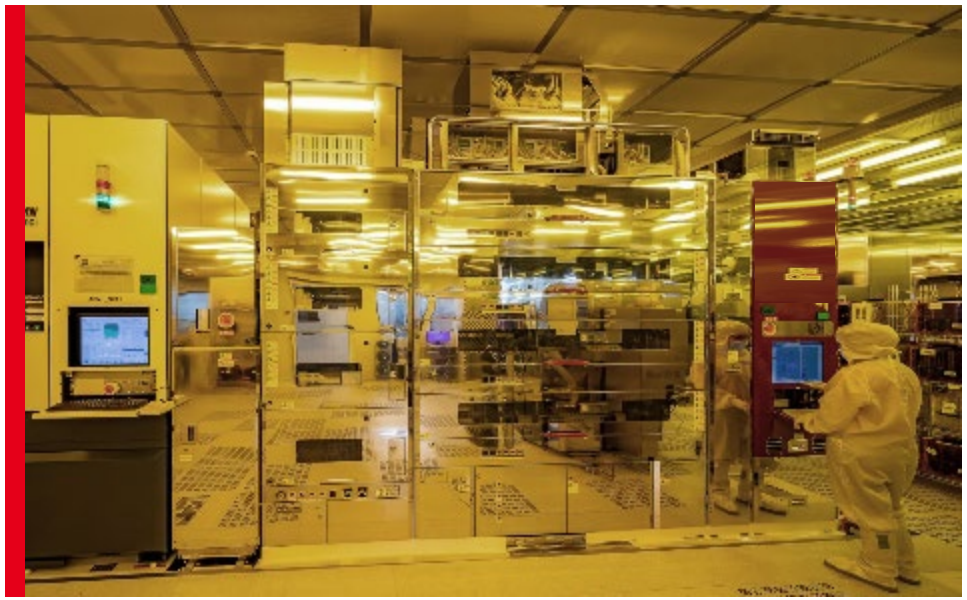


Relevant for yield and volume production

UWB
RF DEVICE
RF PA
GaN SiC
RADAR
RFIC
SMART IMAGE SENSORS
GEOLOCATION
POWER DEVICE
IN MEMORY COMPUTING
FDSOI RFSOI PSOI
DATACOM
NEUROMORPHIC
µDISPLAY
GAS SENSOR
PHOTOACOUSTIC
3D-IC PACKAGING

World-class Infrastructures & Platforms

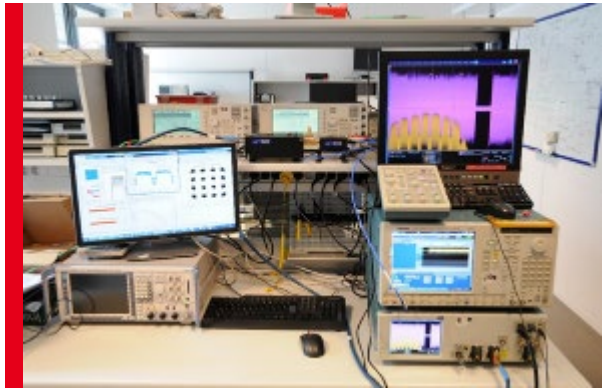
RF Facilities



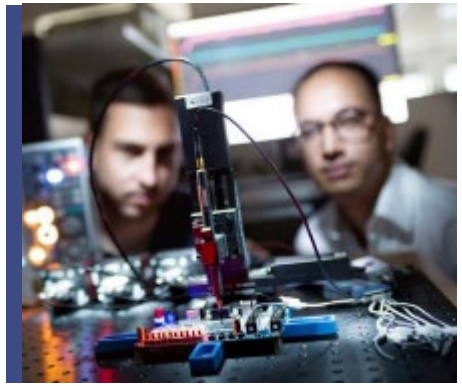
200 & 300mm Cleanrooms

Nano-biotechnology

Clinatec



Hardware in the Loop
for Sensor and RF



CybersecurityL

IC Design

Nanocharacterization

Main Technological Baselines

300 mm		1	NW GAA / BEYOND CMOS / FDSOI
200 mm	300 mm	2	EMBEDDED MEMORIES
200 mm	300 mm	3	RF (active and passive devices)
200 mm	300 mm	4	Si PHOTONICS
200 mm	300 mm	5	µLED DISPLAY
300 mm		6	IMAGERS
200 mm		7	MEMS
200 mm	300 mm	8	POWER (Si, GaN, SiC)
200 mm	300 mm	9	3D-IC
200 mm	300 mm	10	SUBSTRATES
200 mm		11	II-VI and III-V

RF data communications
antennas, filters, RF IC

Low-power processing
non-volatile memories,
FD-SOI, 3D IC packaging

Sensors
NEMS for inertial measurment unit
and acoustic, image sensors

Display
using organic and GaN microLED

How Does it Work?

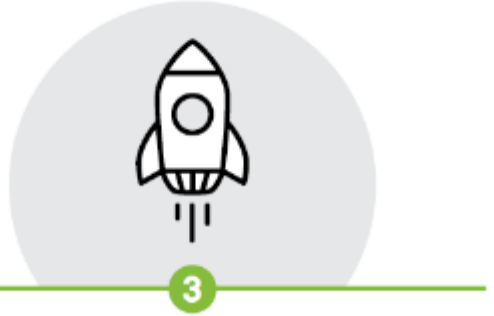
- ✓ **Exclusivity** makes your solution unique
- ✓ Benefit from CEA-Leti IP **to accelerate** your time to market
- ✓ Proven **ecosystem** e.g. foundries for production

1

Innovation from CEA-Leti
Innovative breakthroughs
to create high-value product

2

Prototyping
Proof of concept and prototyping
capability taking into account
the partner production constraints to
ensure fast technology transfer
and reduced time to market.



3

Mass market / Growth
Smooth transfer to go mass market
Partnerships with foundries

Development Program

CEA-Leti's activities at SPIE Photonics West

Upcoming Events

Leti Photonics Workshop	Leti Innovation Days	Leti Semicon Workshop
January 31, 2024 San Francisco *During Photonics West*	**June 25-27, 2024** Grenoble	**July 2024** San Francisco *During Semicon West*

Stay tuned! Follow us on social media @CEA-Leti


cea leti
Leti Innovation Days
Innovate, integrate, elevate:
your lab-to-fab fast track
June 25-27, 2024 | Grenoble, France
leti-innovation-days.com