

FMCW CHIP-SCALE LIDAR DEVELOPED AT CEA-LETI

François Simoens, PhD | Strategic program manager

- › **WHO WE ARE: Optics & Photonics division within CEA-Leti**
- › **WHAT WE DO: Si-Photonics for chip-scale LiDAR**
- › **WHAT WE NEED: Looking for collaboration**

CEA-LETI AT A GLANCE

“3rd Innovative Public Research Organization Worldwide” 2012 -2020

Derwent™
A Clarivate Analytics company



Since **1967**



2,000 people



Patents:

- > 3,000 in portfolio
- 40% under license agreement



Startups:

- 71 created for 20 years (75% in activity)
- 3500 jobs created



Cleanrooms:

- 500 state-of-the-art equipment in 200 & 300 m²
- 10 000 square meters cleanroom



Budget:

- 315 M€
- 85% from R&D contracts

OPTICS & PHOTONICS DIVISION



Image
sensors



Imaging
systems



Display



A lab created in 1978, then a department in 1987
300 researchers, engineers and PhD students



500 patents in portfolio
74 new patents in 2020



70 M€ budget (2020)
90% from external revenue



Optical
sensors



Solid-State
Lighting



Si Photonics

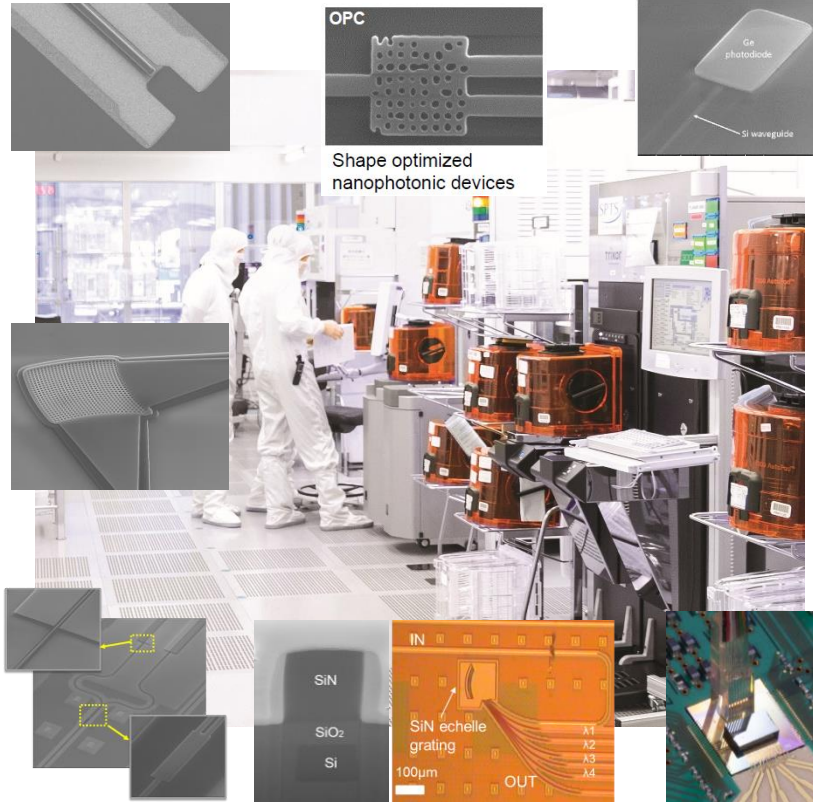
SILICON PHOTONICS

VERSATILE 200MM & 300MM SILICON PHOTONICS PLATFORM

220nm & 310nm photonics SOI
60 nm smallest feature size

III-V on Si lasers

Heterogeneous integration, direct bonding



High-speed Photodiodes

Ge on Si

Fiber to chip coupling

1D & 2D grating coupler. Edge coupler

Optical Phased Array

C-band SM Si WG 0.8-2.1 dB/cm (rib/strip)

High-speed Modulators

MZM & RRM

Flip chip assembly

With UBM and μ pillars

PECVD SiN

Add-on layer. Rib wg 0.6 dB/cm

Applications

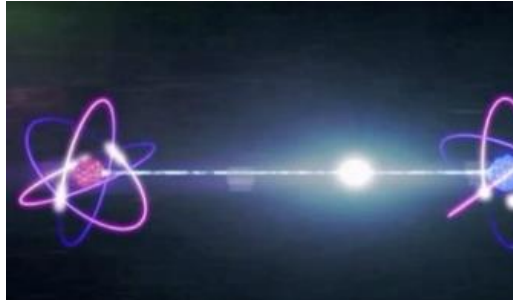
COMMUNICATIONS
TELECOM, DATACOM, 5G



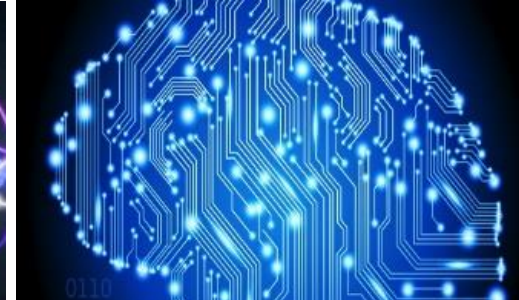
COMPUTING
HPC



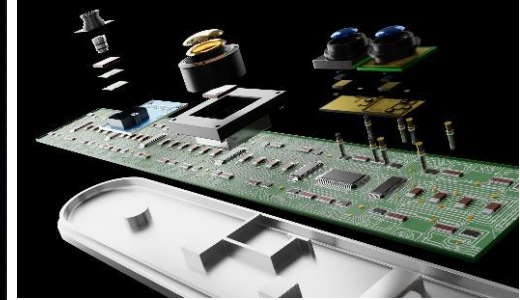
QUANTUM
TECHNOLOGIES



NEUROMORPHIC
& AI



LIDAR
& SENSING

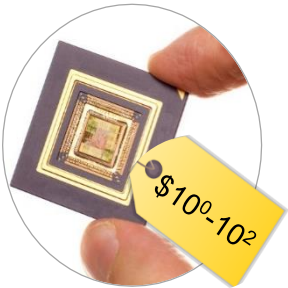


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SILICON PHOTONICS

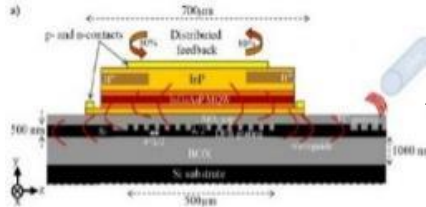
TOWARDS A FMCW LIDAR ON CHIP

LiDAR = Light Detection And Ranging

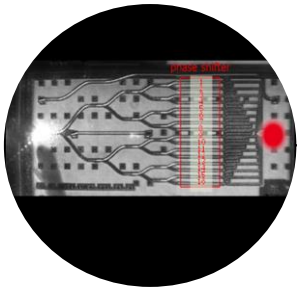


Leti's state-of-the-art integrated silicon photonics platform

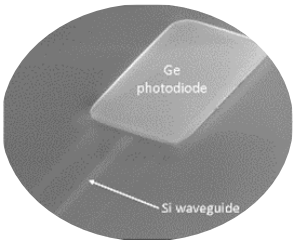
III-V laser
CMOS process
compatible



Integrated **OPA**
(Optical Phased
Array)



Integrated Si-Ge
photodiodes



SYSTEM

Optical source

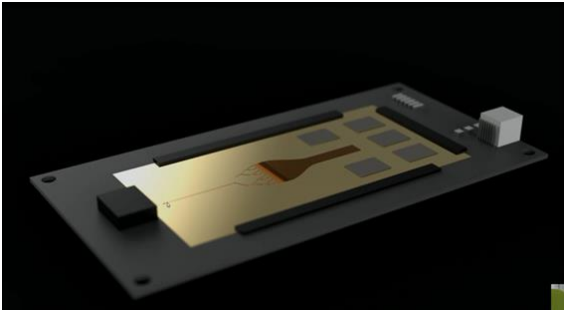
Beam steering

Optics

Photodetection

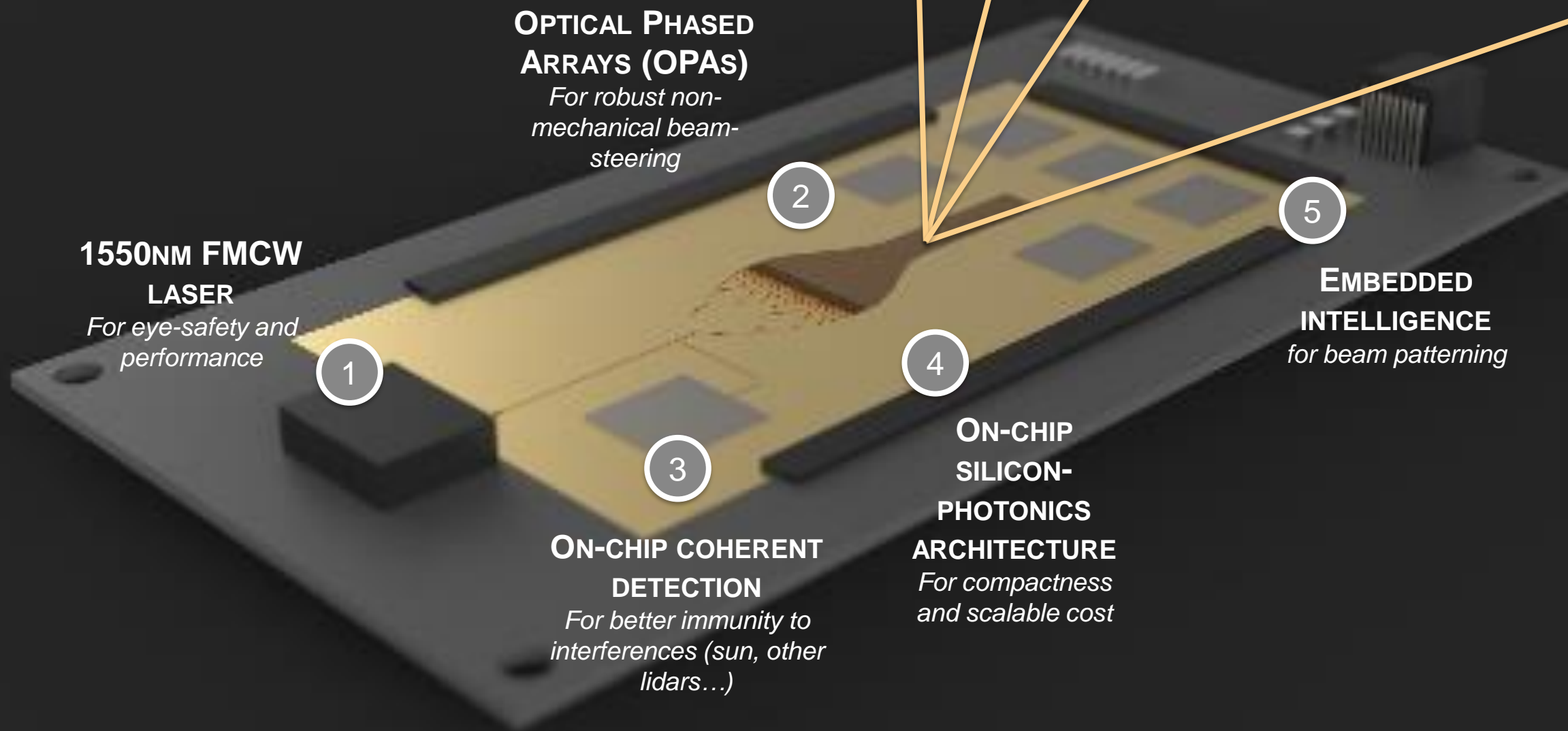
System integration

Data processing



Co-design Hardware & software

ALL-SILICON LIDAR SOLUTION DEVELOPED AT CEA-LETI



SILICON PHOTONICS-BASED LIDAR

RECENT RESULTS VALIDATING SUBSYSTEMS & ASSEMBLY

DESIGN

FABRICATION PLATFORM

INTEGRATION

TESTING

- **2D beam steering** with Optical Phased Arrays

N A Tyler et al. Optics Express, Feb. 2019.

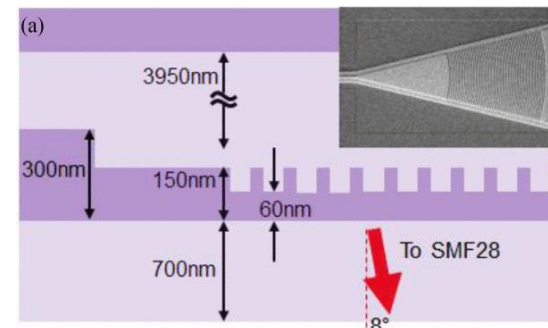
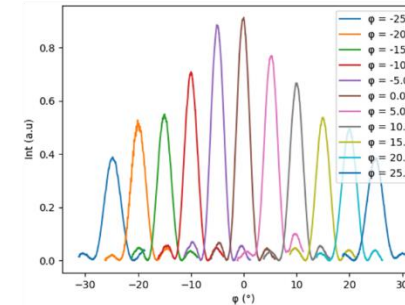
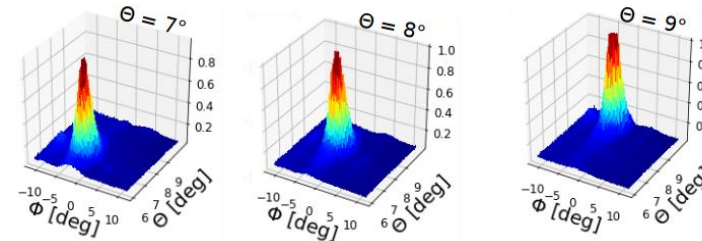
Tyler, N A, et al. CPMT Symposium BEST PAPER AWARD

- **1,000x faster calibration** than previously used algorithms





Sylvain Guerber et al., SPIE Photonics, 2021

- **All-Si & hybrid SiN/Si backside fiber grating couplers** with peak coupling efficiency to SMF : -2.8 dB and -3,2 dB

D Fowler et al., Journal of Lightwave Technology, 2021



ASSETS OF CEA-LETI FMCW LIDAR ON-CHIP

- > IR coherent Detection  > High performance – Immunity wrt sunlight & cross-talk – Direct range + velocity
- > Optical Phased Arrays  > Reliability (no moving part)
- > 3D integration  > High miniaturization
- > Full-silicon compatibility  > Affordable high volume scaling



FORTHCOMING TRANSFER TO A SPIN-OFF

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COLLABORATION IS KEY

We are looking for :

- Laser sources, chip / module manufacturers
- Advanced photonics and electronics packaging compatible with high volume and high throughput
- Optical and electronic test bench manufacturers

Thank you for your attention



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