

leti
cea tech

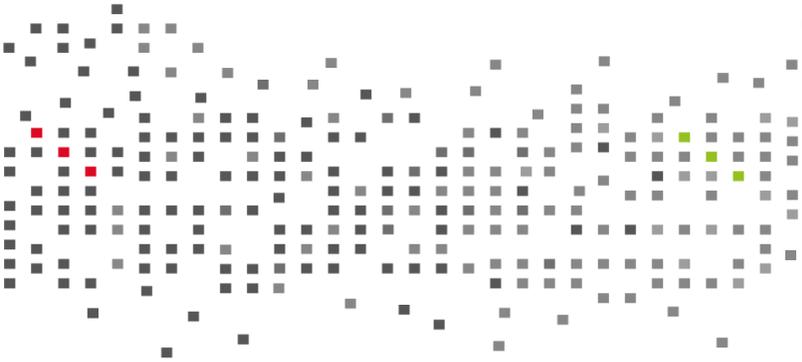
February 5, 2020

Leti Photonics Workshop

W-Hotel, San Francisco

SPIE. PHOTONICS
WEST

Disruptive photonic concepts for new applications & markets

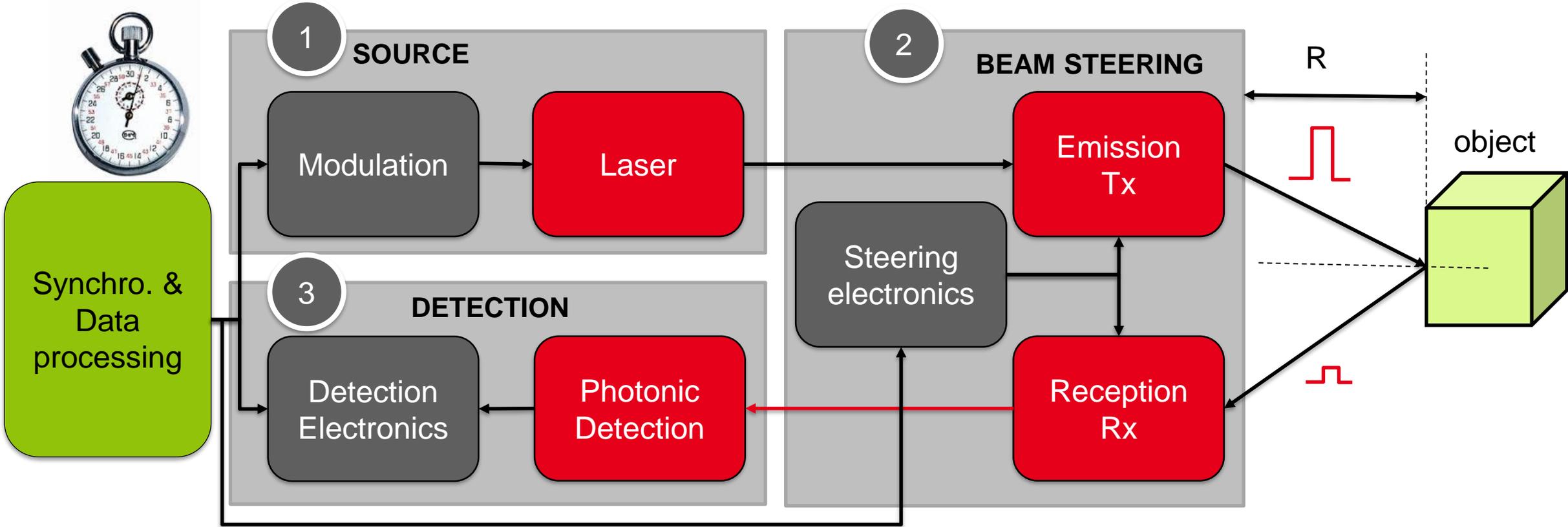


TOWARD MINIATURIZED SOLID-STATE LIDAR

5th Leti Workshop San Francisco | François Simoens | 2020/2/5

AS AN INTRODUCTION, THE BASICS

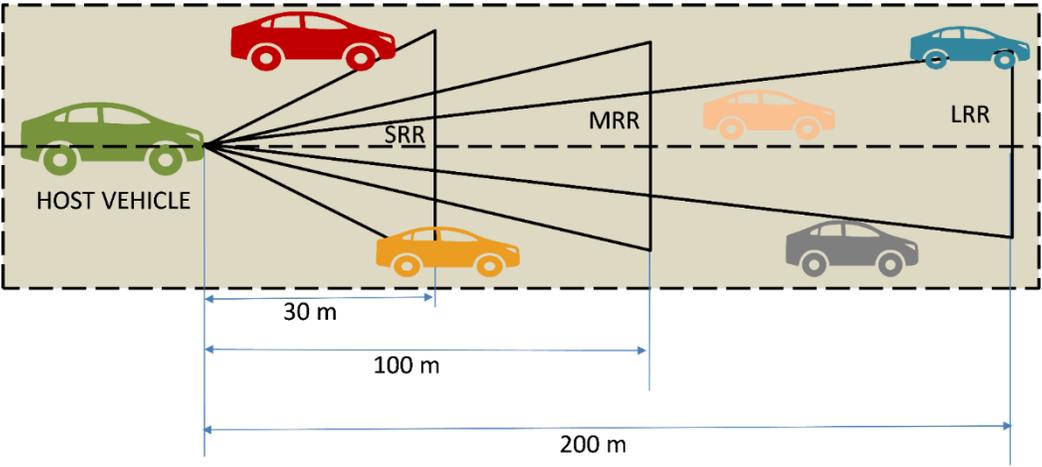
- LIDAR (LIGHT DETECTION AND RANGING) PRINCIPLE



AS AN INTRODUCTION, THE BASICS

- LIDARs ARE SIMILAR TO RADARs

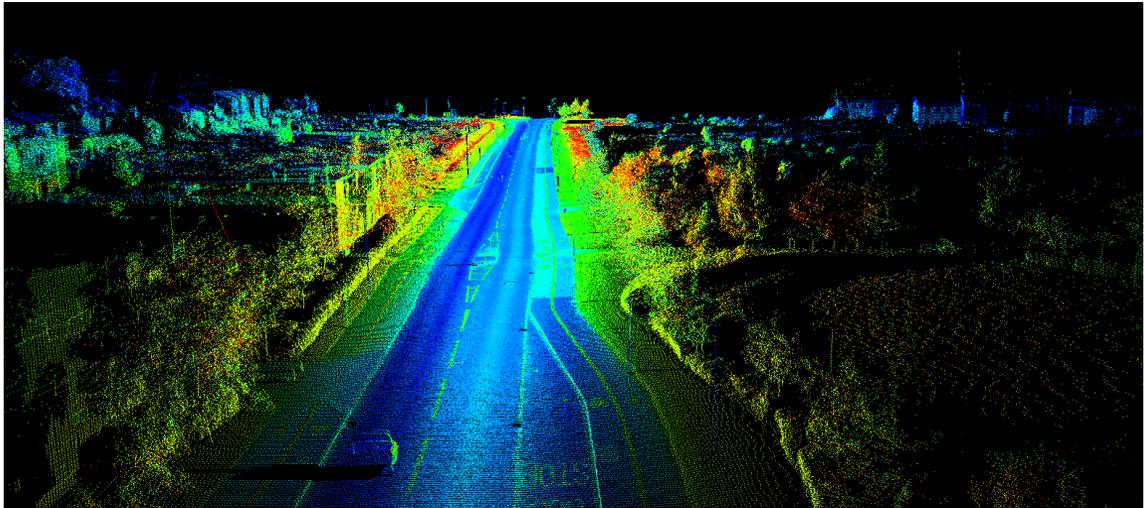
Various types of automotive RADAR sensors



Type	SRR	MRR	LRR
Frequency Band	76 -77 GHz	77- 79 GHz	77 – 81 GHz

BUT
PROVIDE 3D IMAGES WITH HIGH RESOLUTION & PRECISION & CAN DETECT VERY SMALL OBJECTS

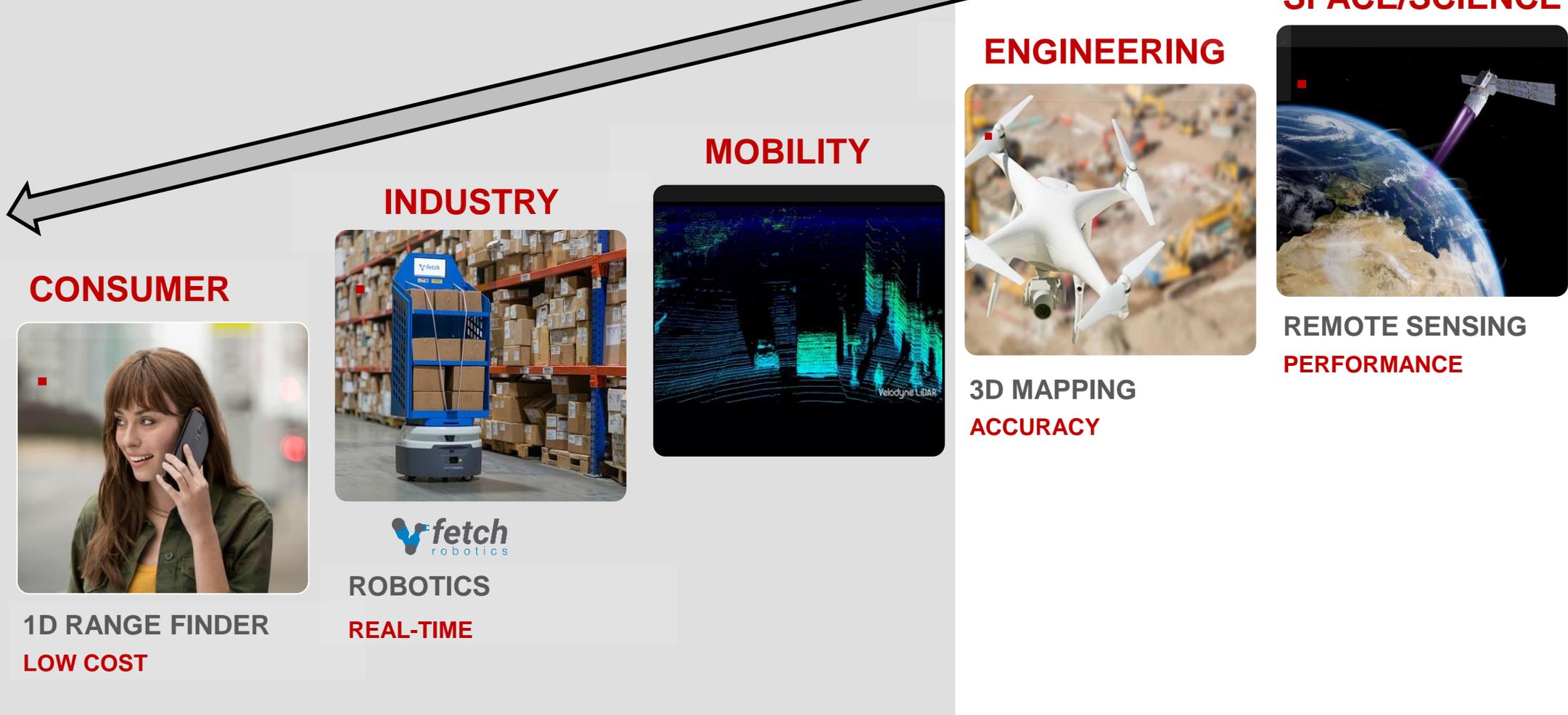
(RF wavelengths = mm range / Optics: 0,25-10µm)



LIDAR MARKET

- PERSPECTIVE OF HIGH GROWTH

COST & SIZE REDUCTION



LIDAR MARKET CHALLENGES

- MANY PLAYERS, MANY TECHNOLOGICAL CHOICES



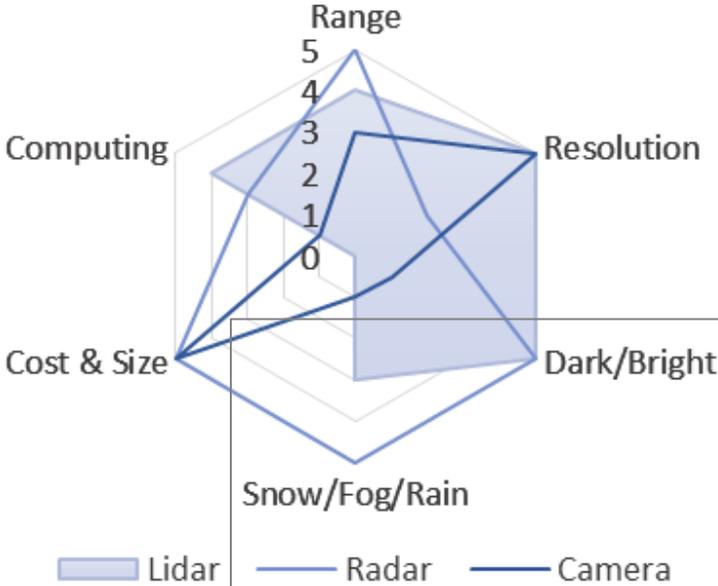
LIDAR MARKET CHALLENGES

- STILL 2 MAJOR OBSTACLES TO LARGE MARKET ADOPTION



Price
 Scalability / Availability
 • Product or Power
Computing
Manufacturability
Maintenance

Form factor
 • Size
 • Mass



Performances

- Range
- Angular resolution (H / V)
- Spatial resolution
- Spatial accuracy – any ‘blooming’ artifacts etc...
- Scan rate / frame rate (per sec, in Hz)
- Range repeatability
- **Immunity to other LiDARs**

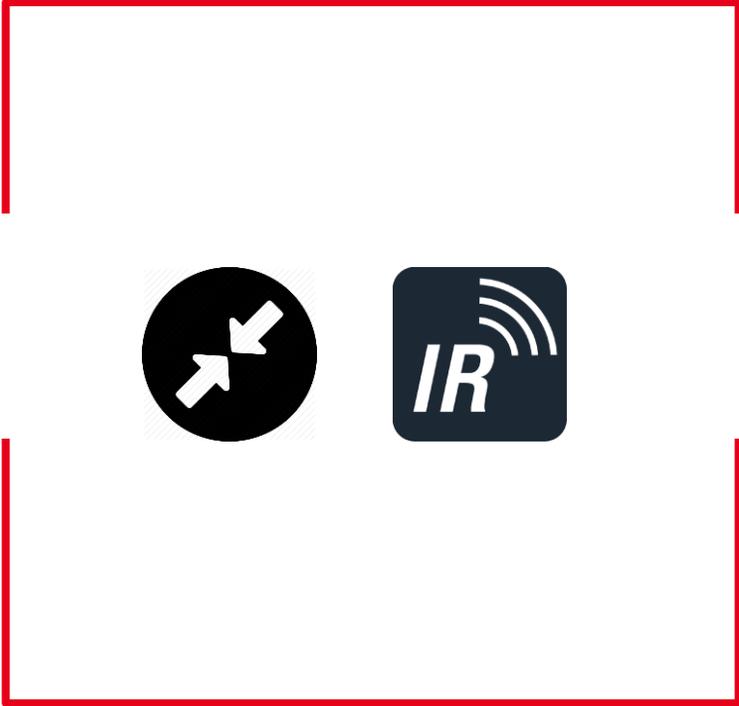
Environmental conditions

- Environment variability (temperature range, peak sun, fog-snow-rain...)
- Functionality amidst window obstruction
- Quality reliability
 - Shock : Vibe / Jitter
 - Thermal range & cycling
 - Corrosion

TOWARD MINIATURIZED AGILE SOLID-STATE LIDAR

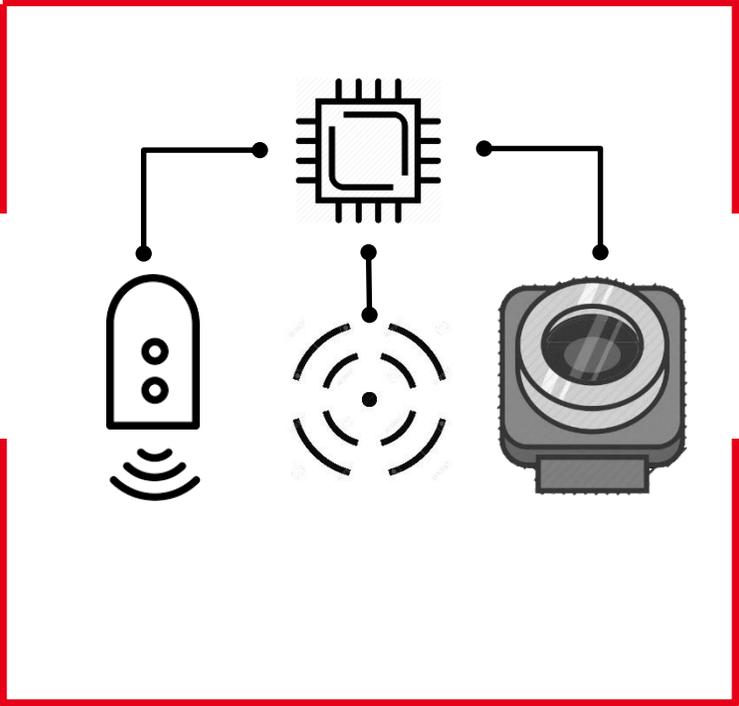
- FUTURE LIDAR

Chip-scale IR LiDAR



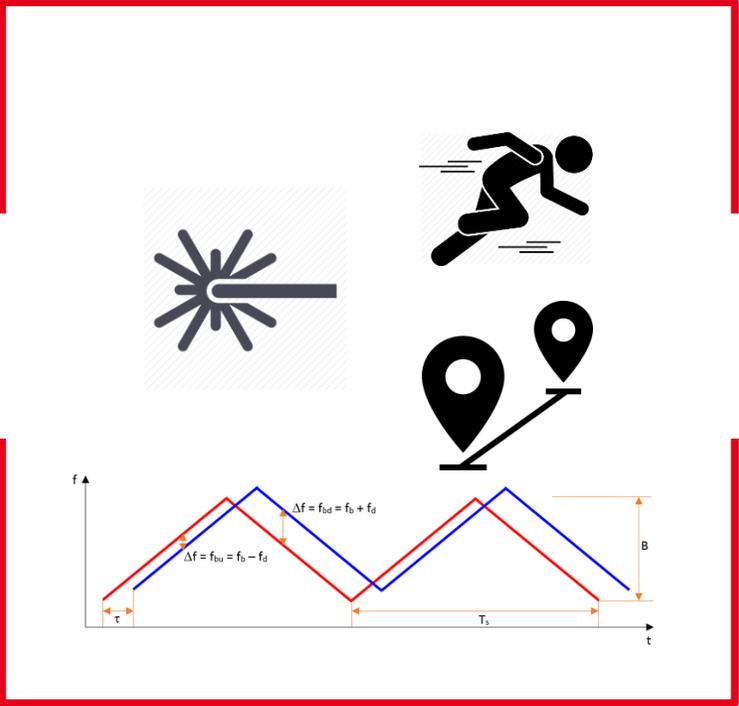
Miniaturized & low cost

Agile



Photons where they are needed with the help of embedded processing

Coherent detection



Minimal multi-user interference
Better immunity / background light
Range and velocity

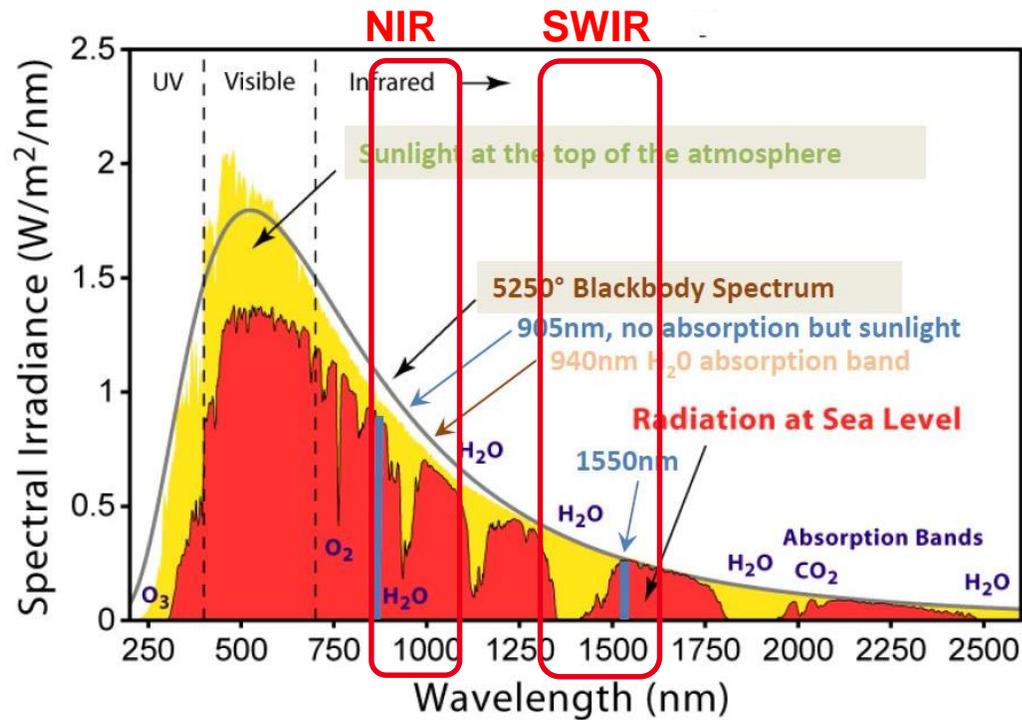


Chip-scale IR LiDAR

HIGHER POWER → MORE SENSITIVE

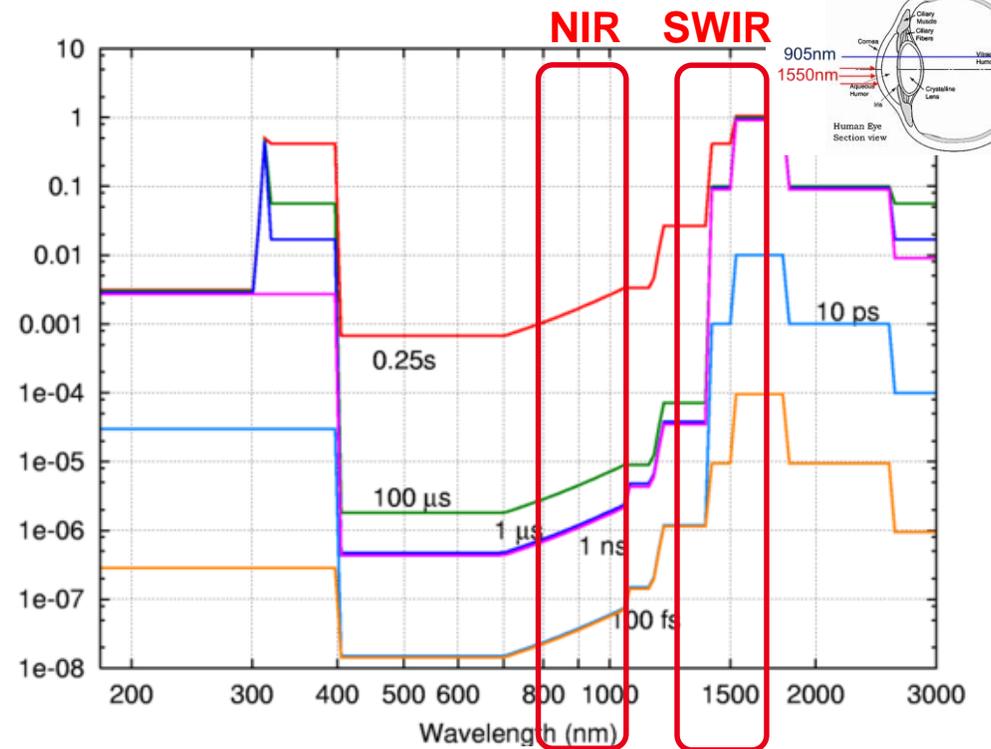
SWIR (>1μm) COMPARED TO NIR (<1μm)

3X LOWER AVERAGE SOLAR IRRADIANCE



40X HIGHER EYE SAFETY OPTICAL OUTPUT POWER LIMIT

Maximum power exposure MPE as energy density versus wavelength for various exposure times (pulse durations)



(IEC 60825-1:2014) European standard [EN 207](#)

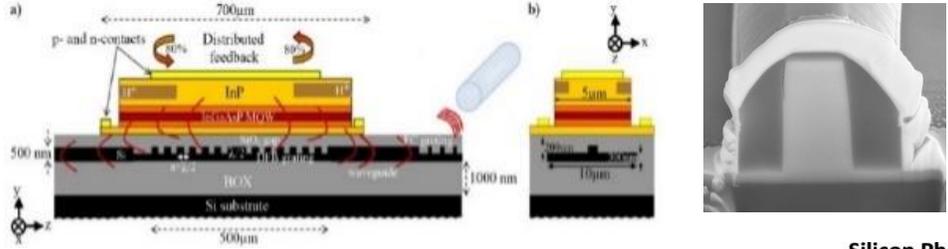


Chip-scale IR LiDAR

LOW-COST, MINIATURIZED, SCALABLE

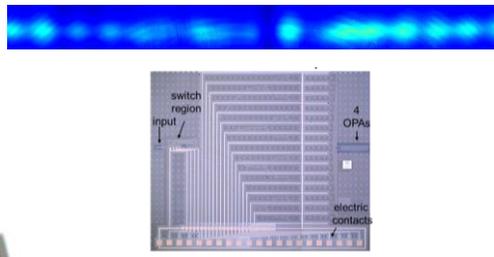
3D HETEROGENEOUS INTEGRATION OF SILICON PHOTONICS AND CMOS CHIPS

CMOS-COMPATIBLE HYBRID III-V ON SI LASER

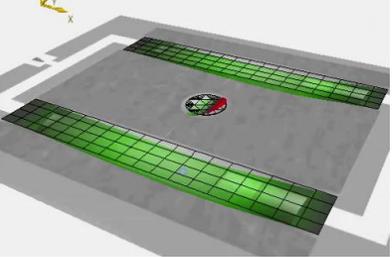


BEAM STEERING

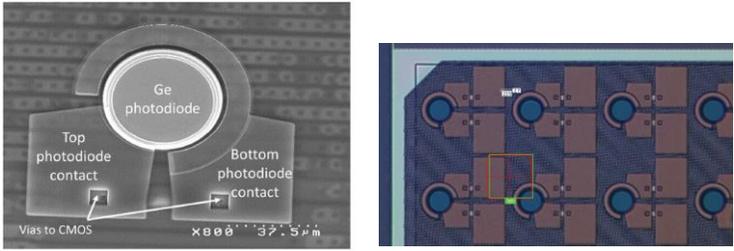
OPTICAL PHASED ARRAY



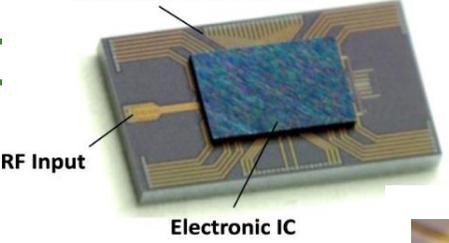
MEMS μMIRROR



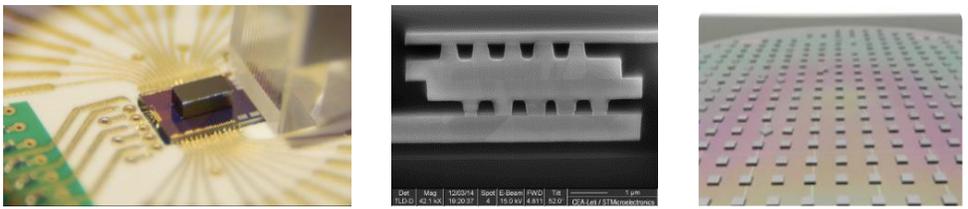
SIGE PHOTODETECTORS



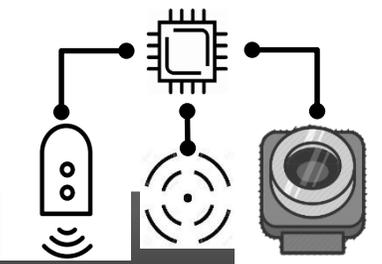
Silicon Photonic Device



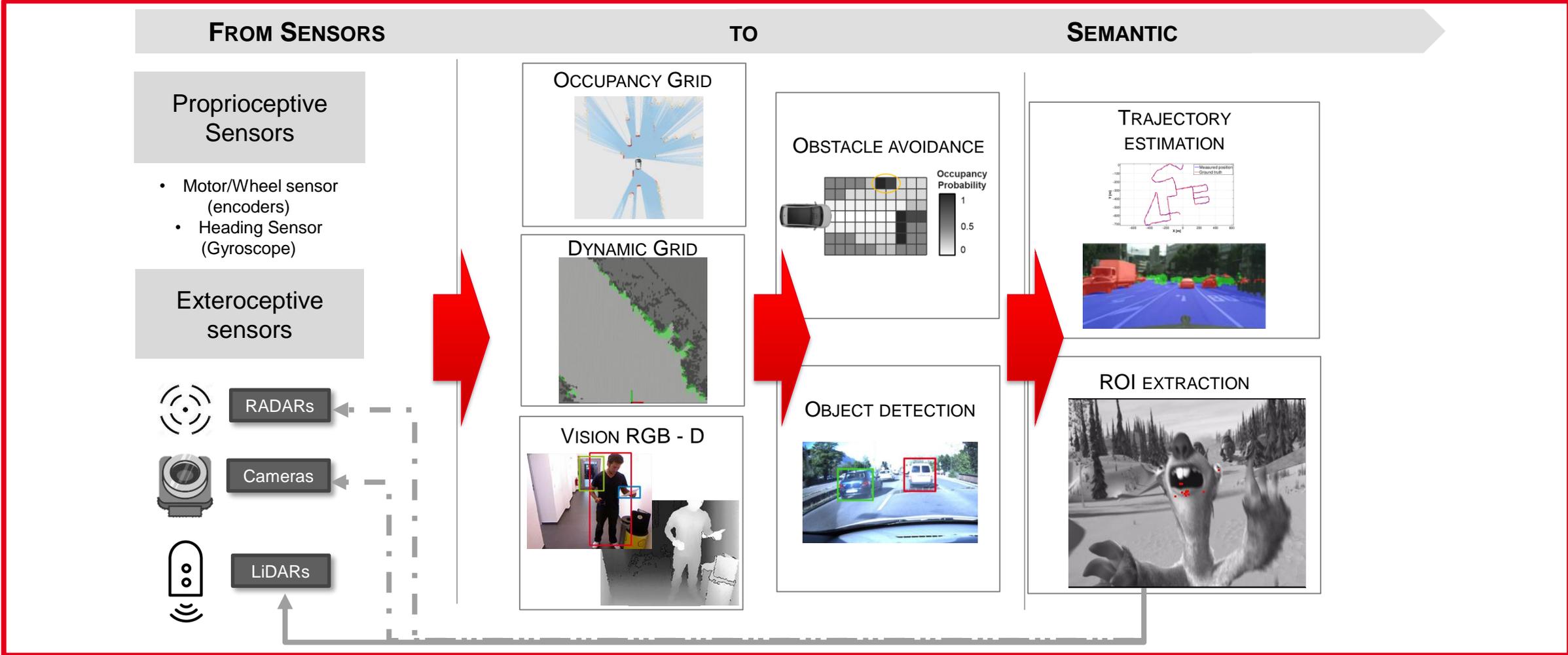
HETEROGENEOUS INTEGRATION & 3D ASSEMBLY



TOWARD MINIATURIZED AGILE SOLID-STATE LIDAR



Agile **EFFICIENT USE OF PHOTONS**



CONCLUSION

- CONVERGENCE BETWEEN SILICON PHOTONICS & ELECTRONICS
- GREAT OPPORTUNITY FOR 3RD GENERATION LIDARS

PHOTONICS

LOW COST TECHNOLOGIES & INTEGRATED ON CHIP

ELECTRONICS

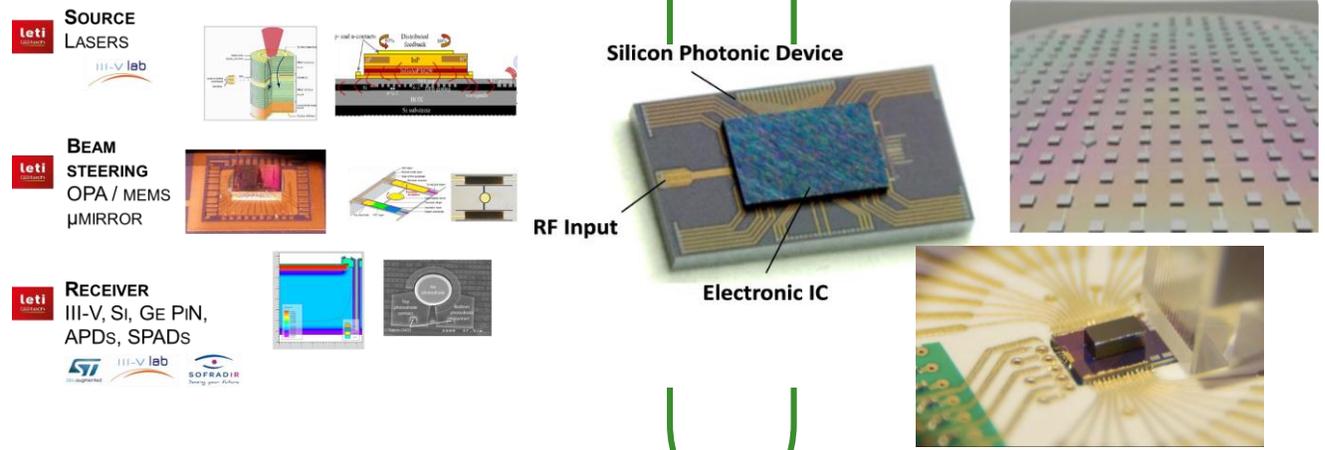
HETEROGENEOUS INTEGRATION & 3D ASSEMBLY WITH ELECTRONICS

SOFTWARE

OPERATION DERIVED FROM DATA FUSION & AI

LOW-COST AND MINIATURIZED

SMART



Object fusion

Monitored objects limited by computing power

Fault detection issues

Objective : Object recognition

Algorithm : AI, learning based on a finite list of objects...

Sensor : Image

Map fusion

Every location, obstacles & free space, is monitored

Objective : Construction of a map model of the environment

Algorithm : Fusion approaches, filtering, localization...

Sensor : Distance...

**Thank you
for your
attention**

**See Leti's demonstrators at booth 857A
France Pavilion (South Hall)**

**And welcome in
Grenoble in June >>**



The banner features a background of a hand reaching out, overlaid with a colorful, wavy digital pattern. In the top left corner is the Leti logo. The main text is enclosed in a red-bordered box, and a red ribbon at the bottom contains the slogan. At the very bottom, a list of technology areas is displayed.

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DAYS**
JUNE 22-26, 2020
GRENOBLE, FRANCE

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