OTIV

UGENT RACING

Technical challenges in autonomous driving

Topics

1. Introduction to OTIV
2. Technical challenges
    a. Dataset creation, pitfalls & localization
    b. Lidars, Lidar point clouds & clustering
    c. Calibration
3. Pizza's & Drinks

Technical challenge: LiDARs

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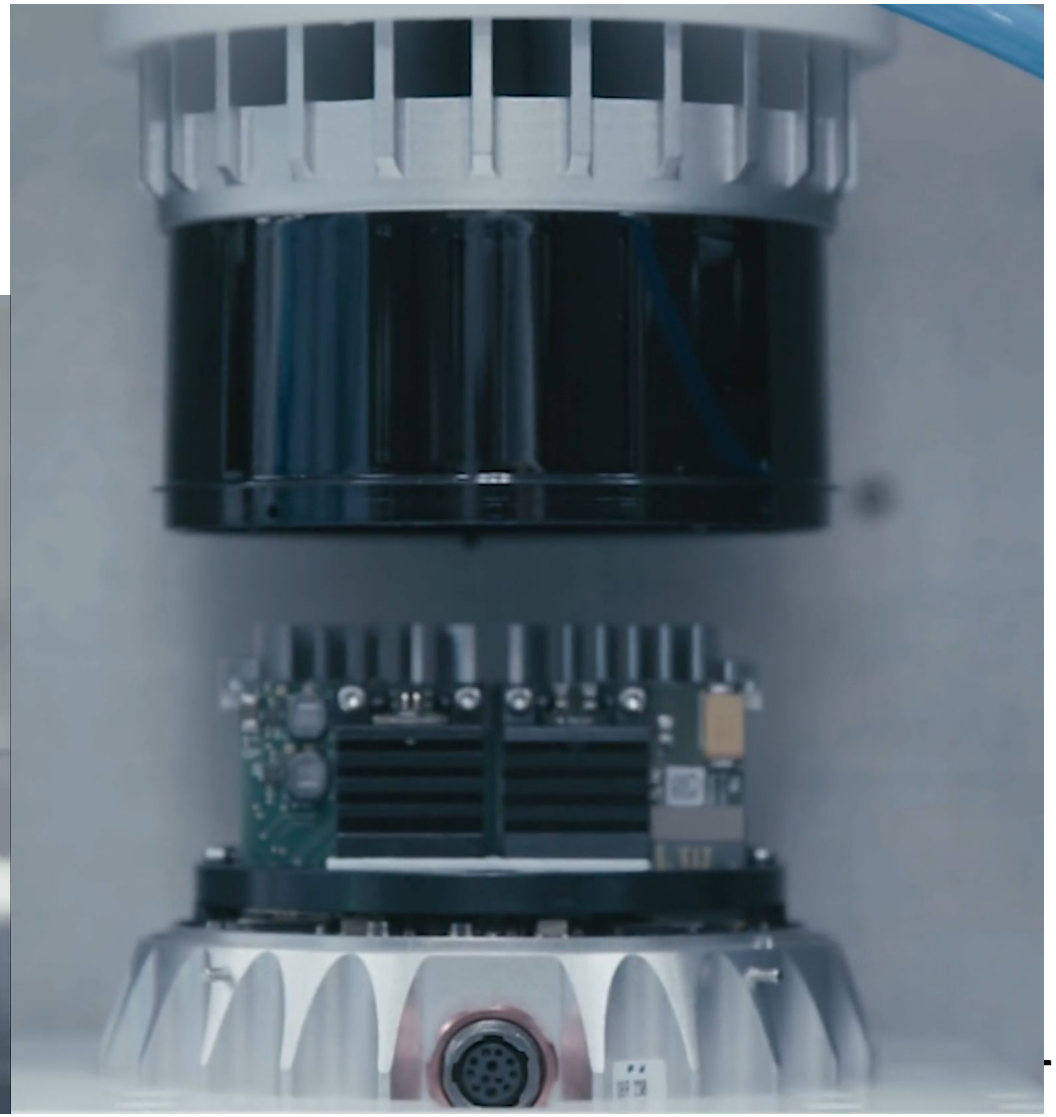
Current tech



Types

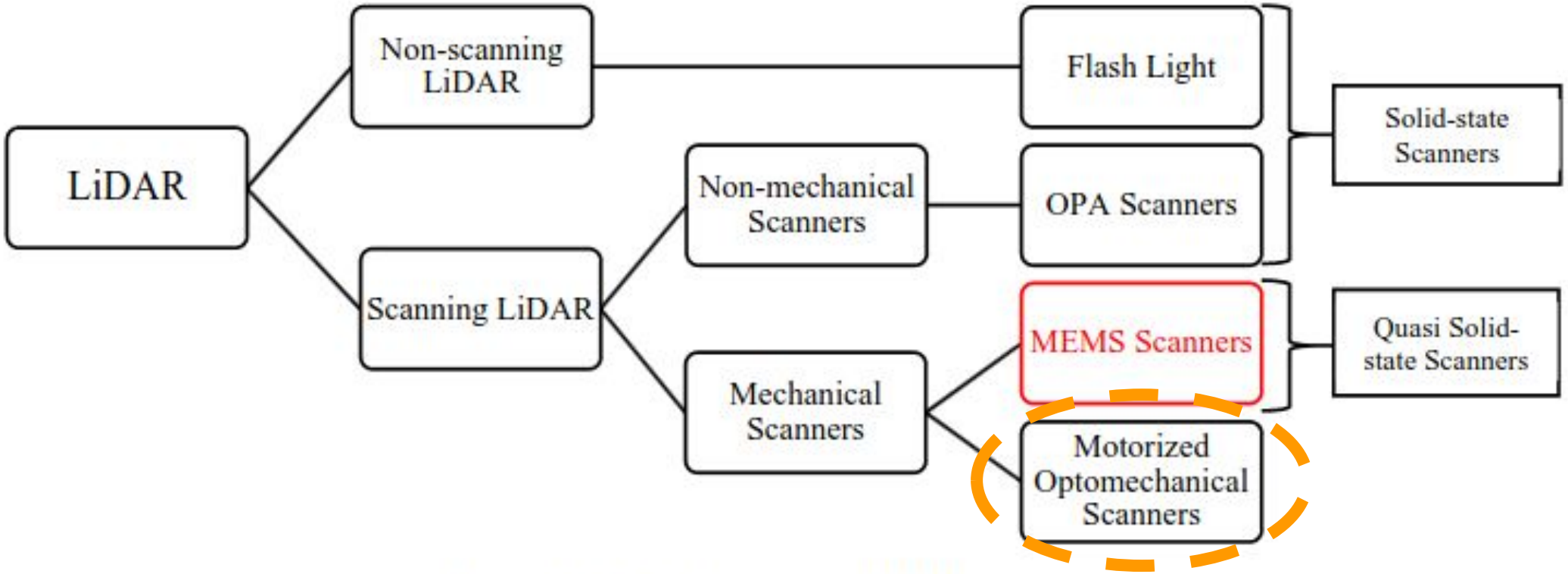


Figure 1. Different types of LiDAR scanners.

MEMS Mirrors for LiDAR: A Review, Micromachines 2020, 11, 456

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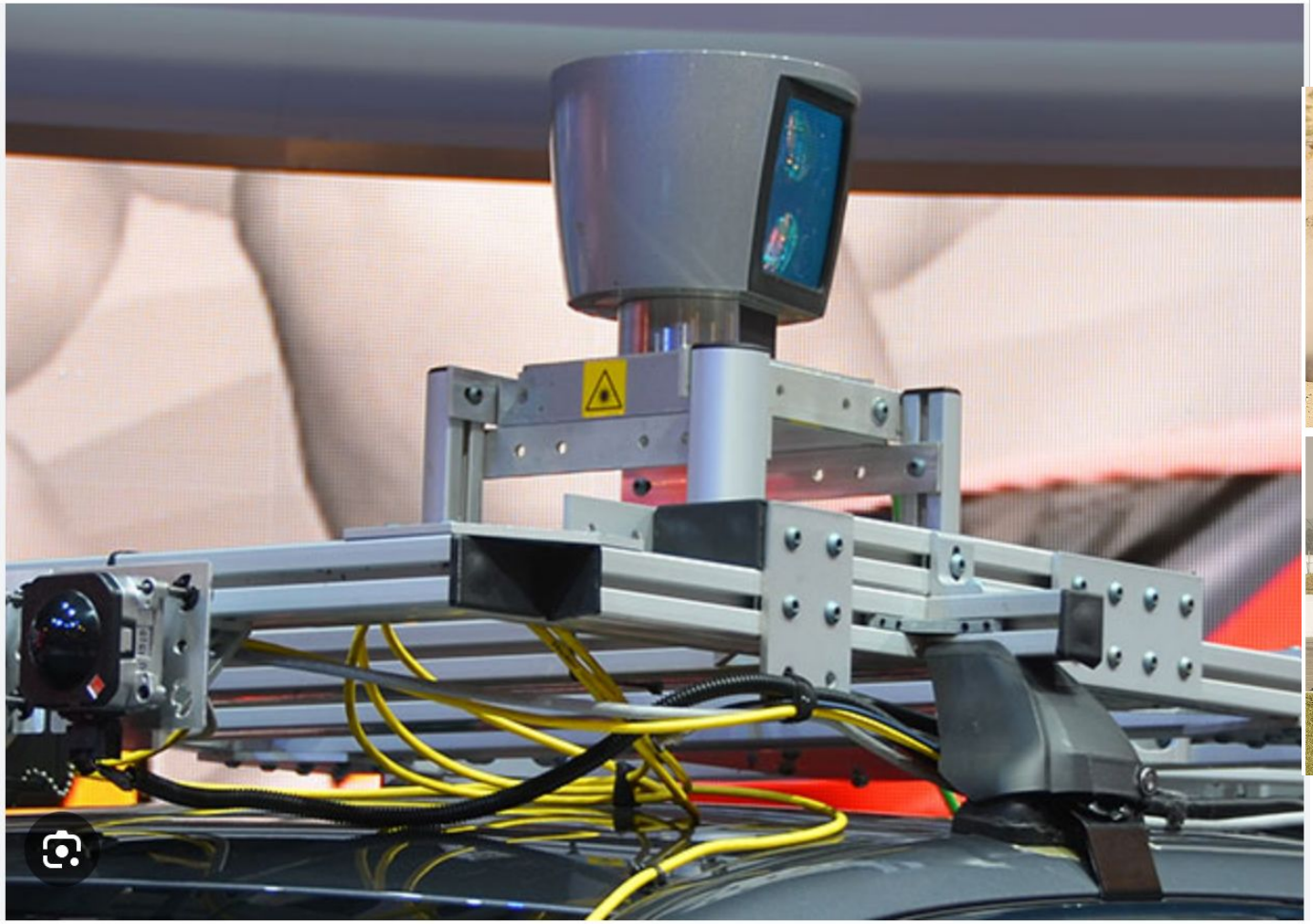
First moves into vehicles: DARPA challenge, early 00's



MIT and DARPA Pack Lidar Sensor Onto Single Chip - IEEE Spectrum
2004/5/6

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Wired: **An Oral History of the Darpa Grand Challenge**

(I was obsessed with this as a kid)

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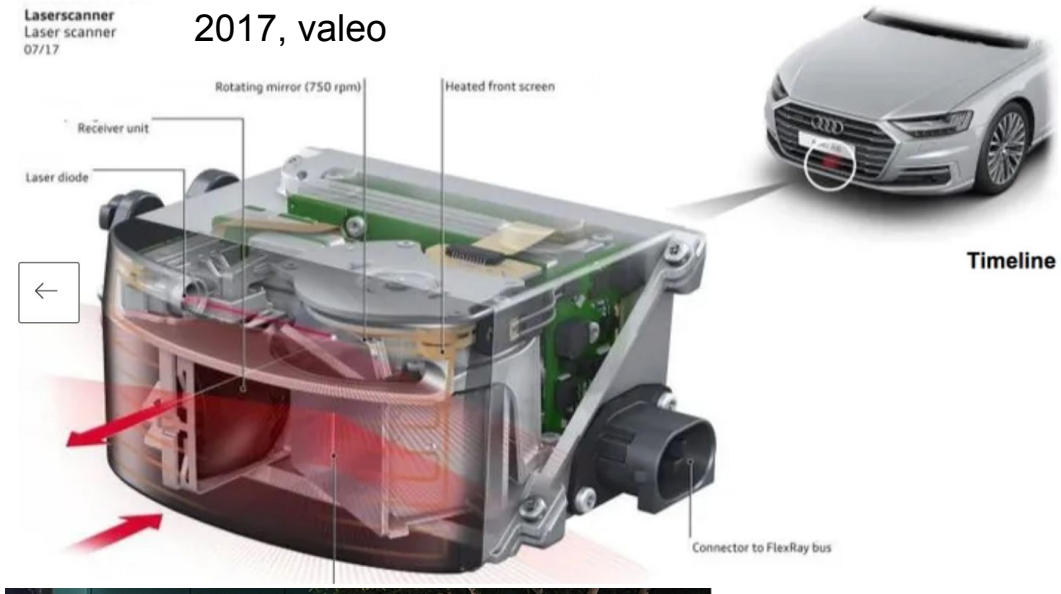
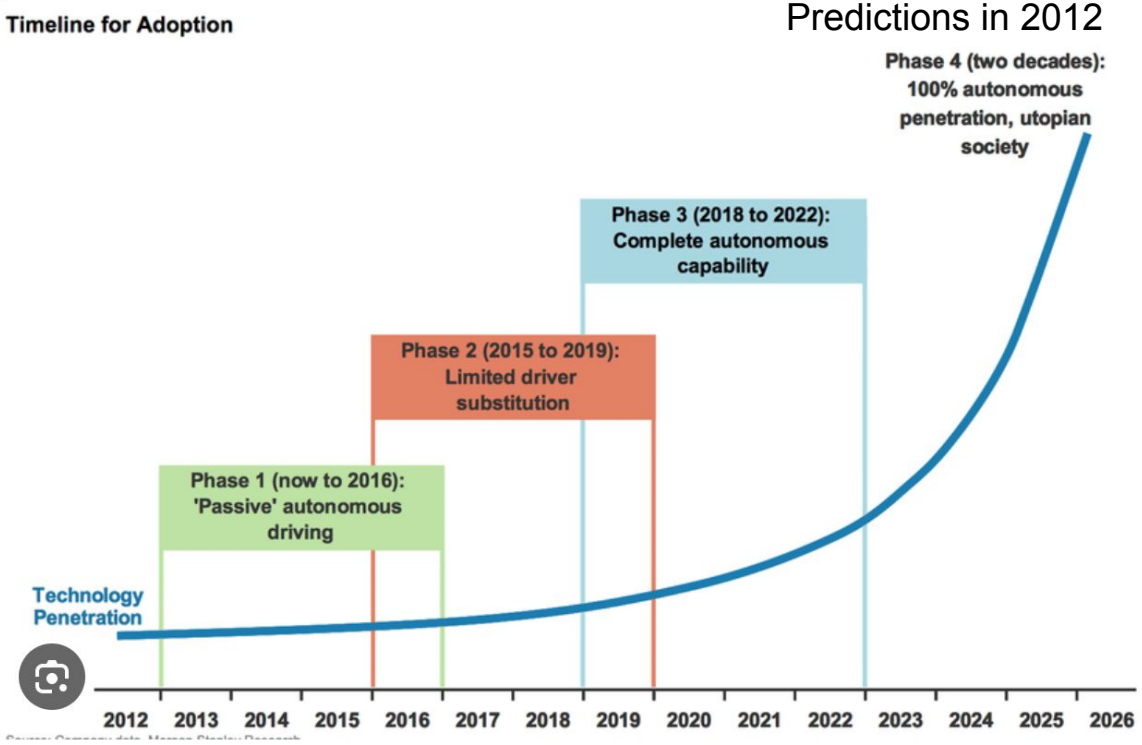
Manufacturers are using scanning LiDAR

But adoption is slower than expected & costs remain high



2017, valeo



Predictions in 2012

Timeline for adoption of autonomous vehicles by Morgan Stanley. | Download Scientific Diagram

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Currently

An alternative to spinning

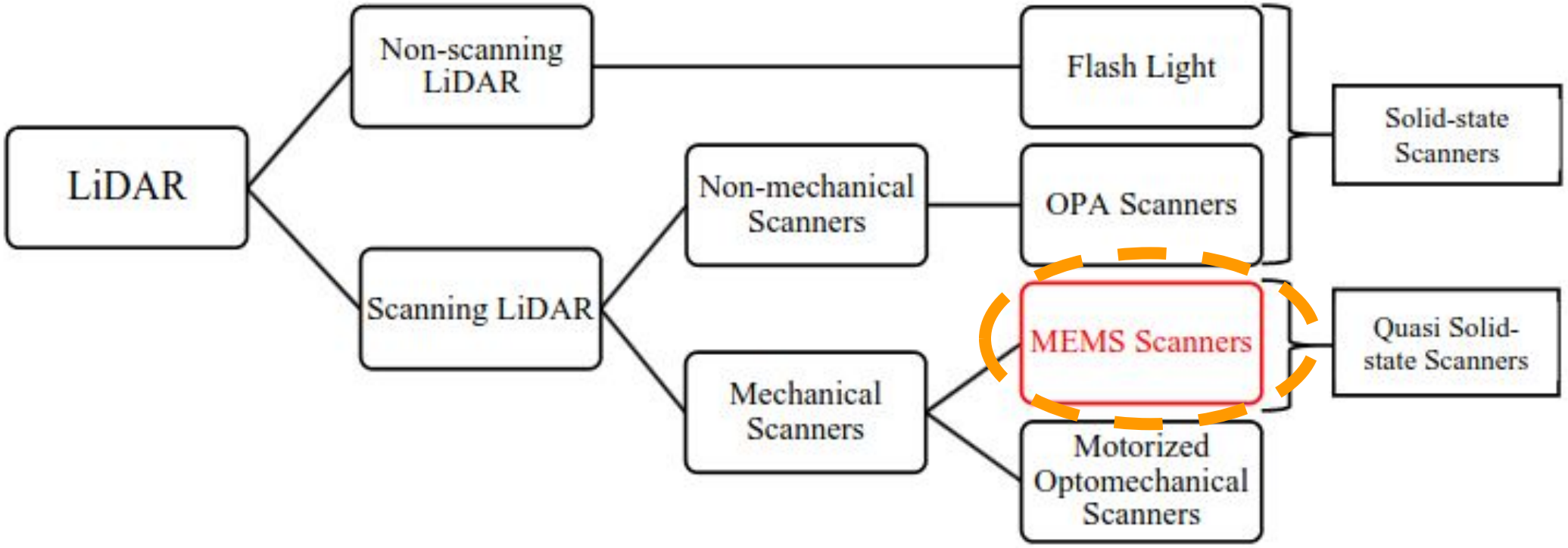
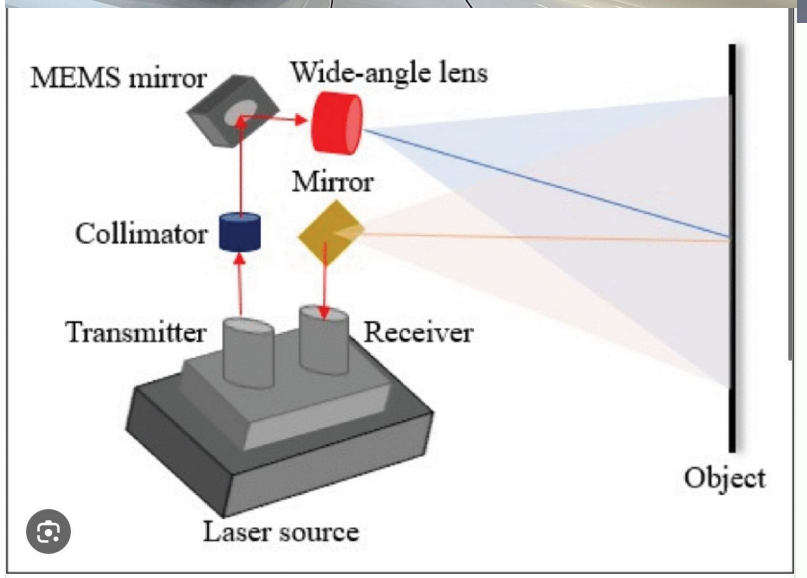
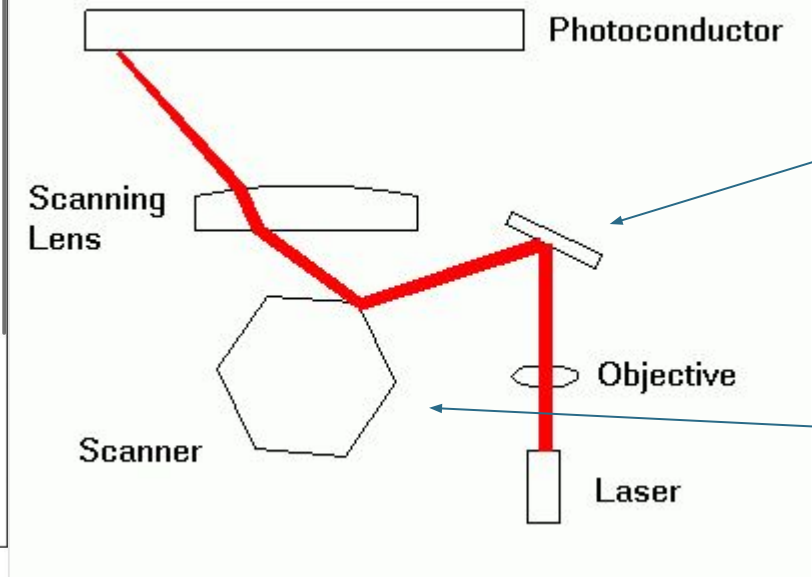


Figure 1. Different types of LiDAR scanners.

Currently MEMS dominates in price and certification

Smaller sizes, more resilient and cheaper to manufacture





MEMS mirror: slow, higher power lasers

Polygon scanner: faster

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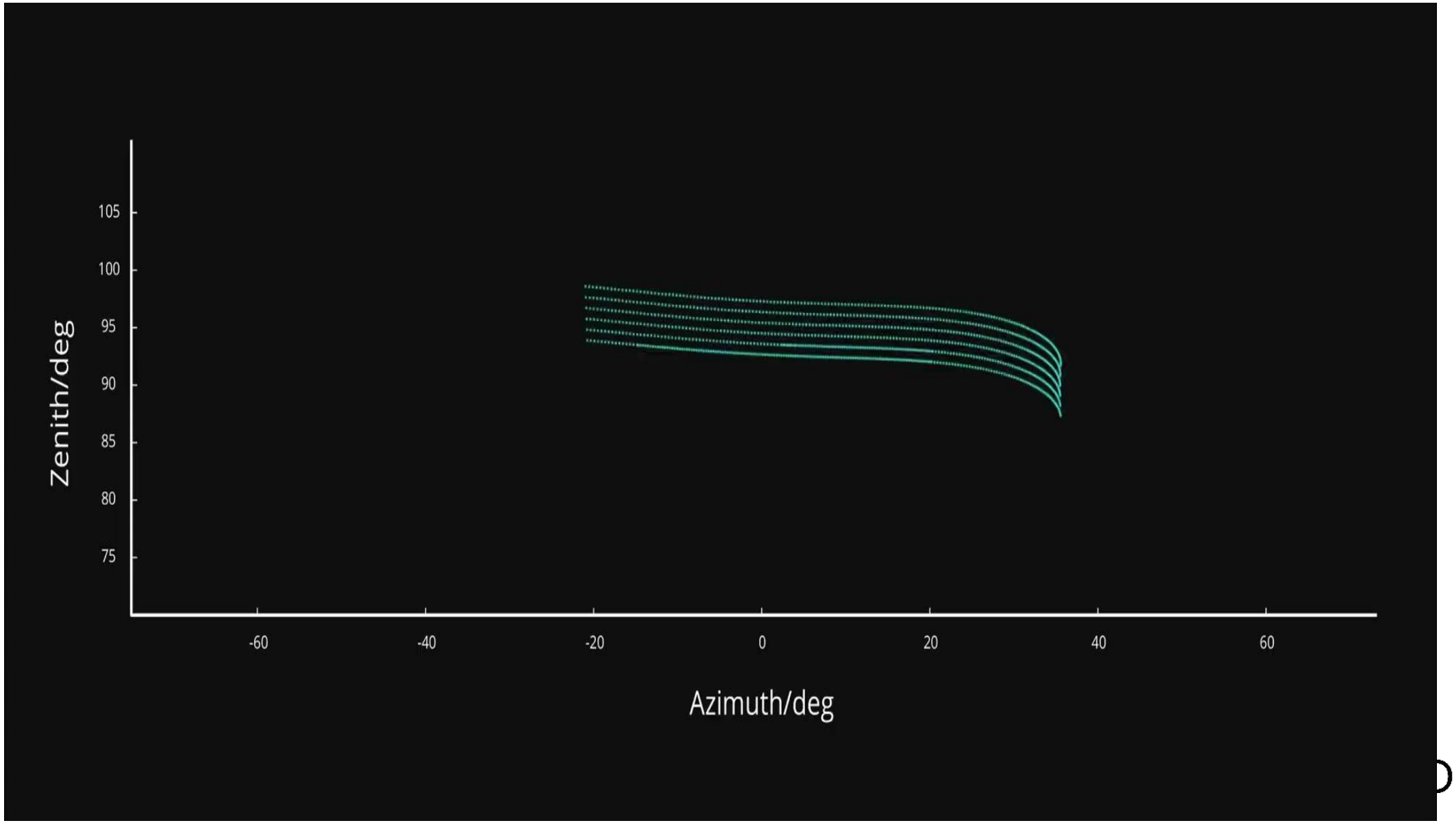
But MEMS has limitations



Key differences

TOF

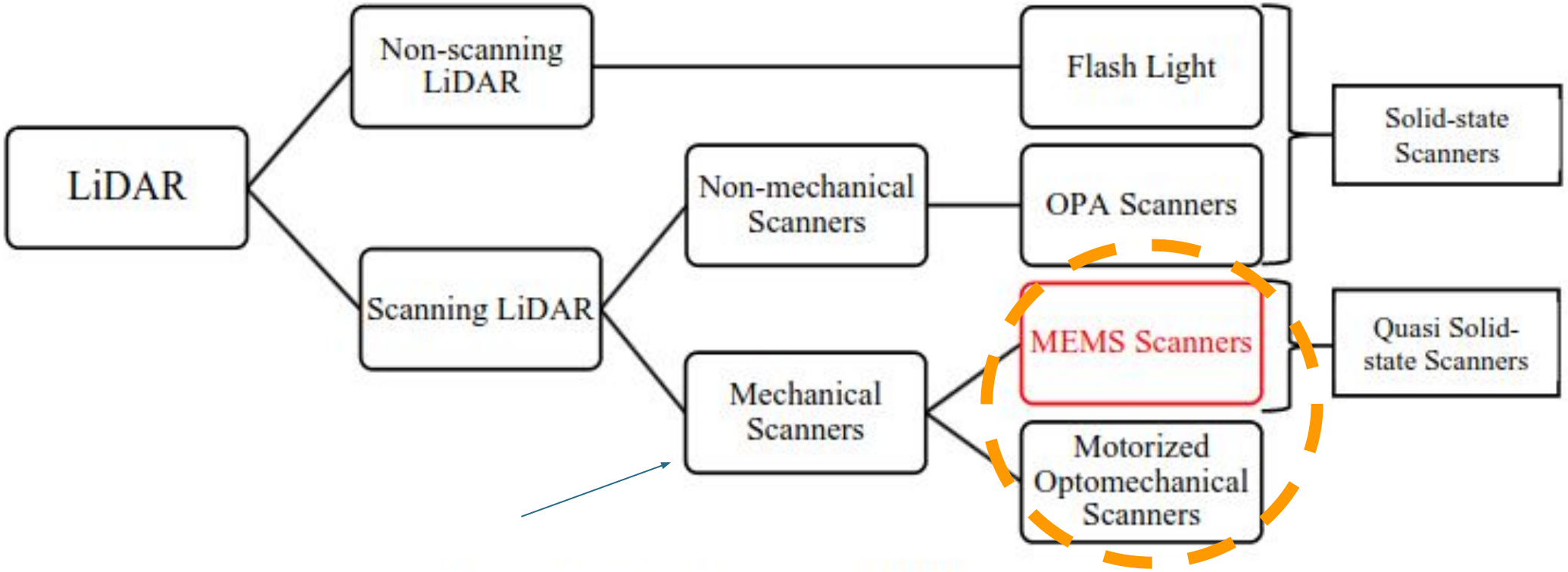
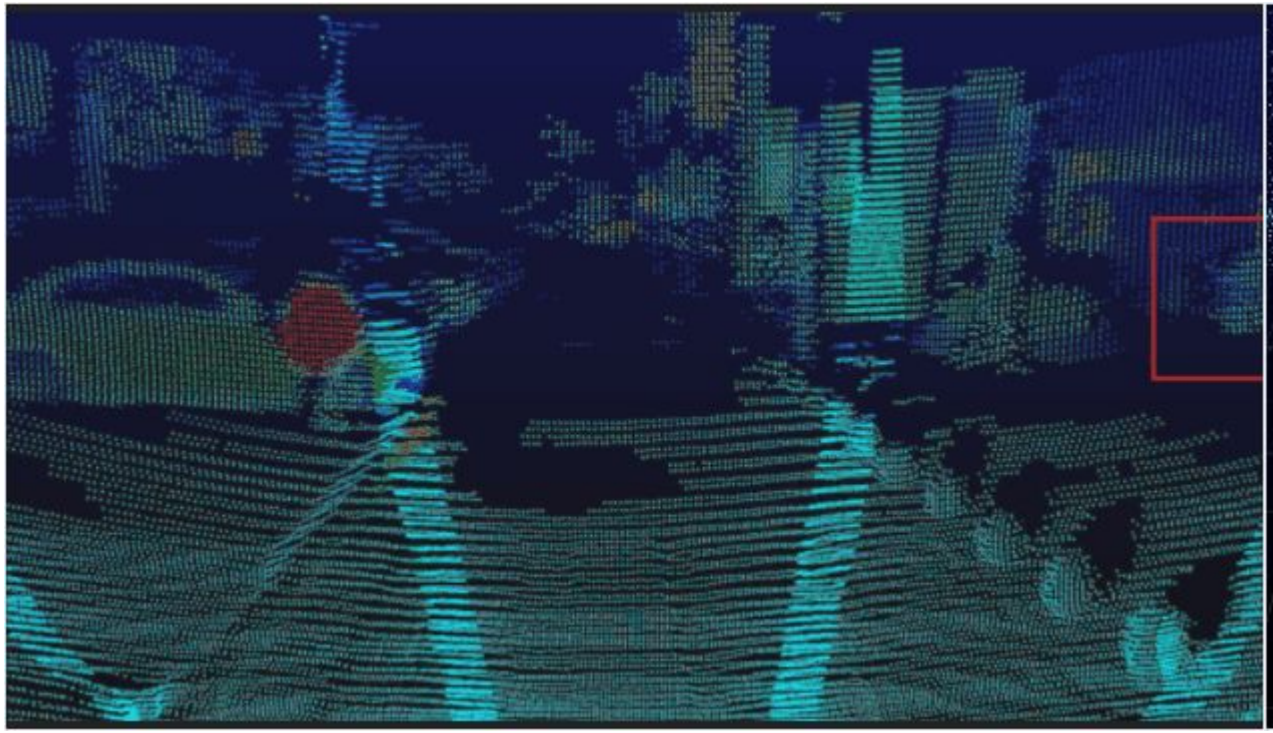


Figure 1. Different types of LiDAR scanners.

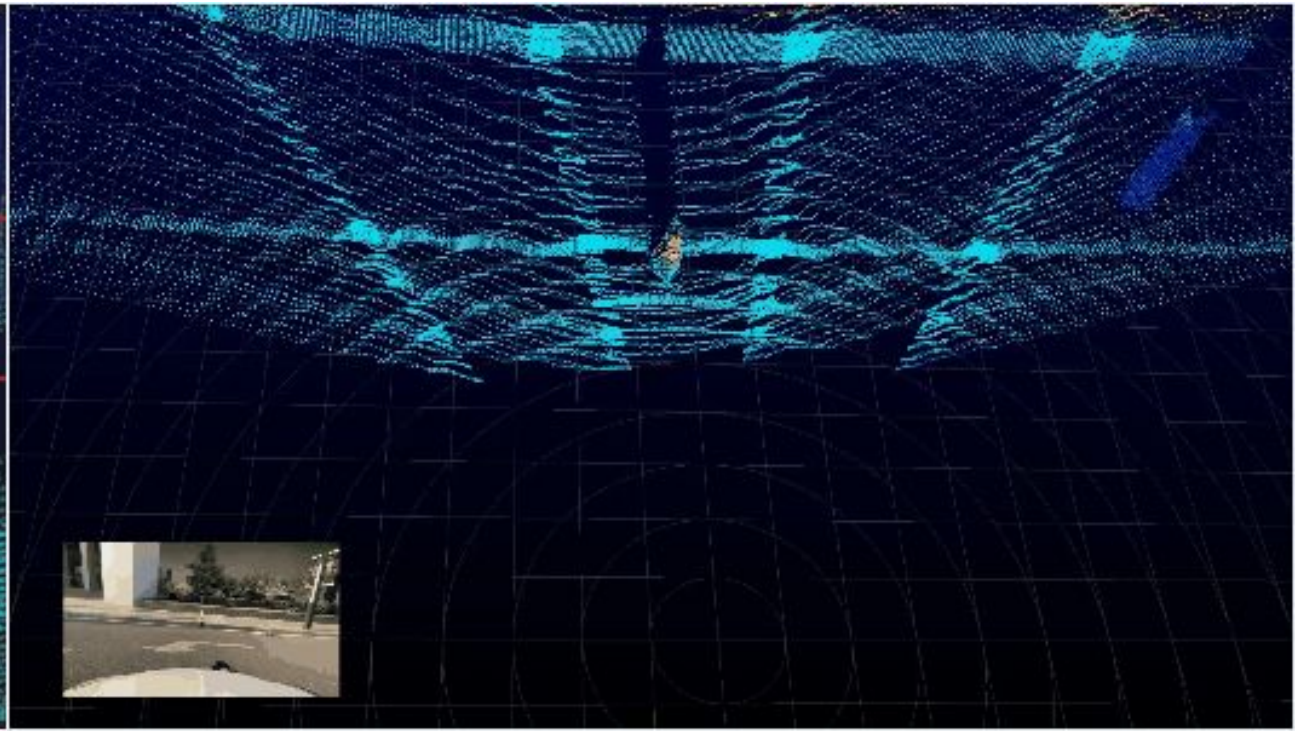
ToF has issues

For MEMS and Rotating - resulting in lower reliability

Point Cloud Defects That 99% of LiDAR Suppliers Won’t Let You Know - robosense.ai



Ghosting



Distortion and missing points at short ranges

Direct from Ouster

New Lidar Firmware v1.12: Retroreflector Fixes, Corrected IMU Axis Directions

Were we are heading

But disputed if it is the future!

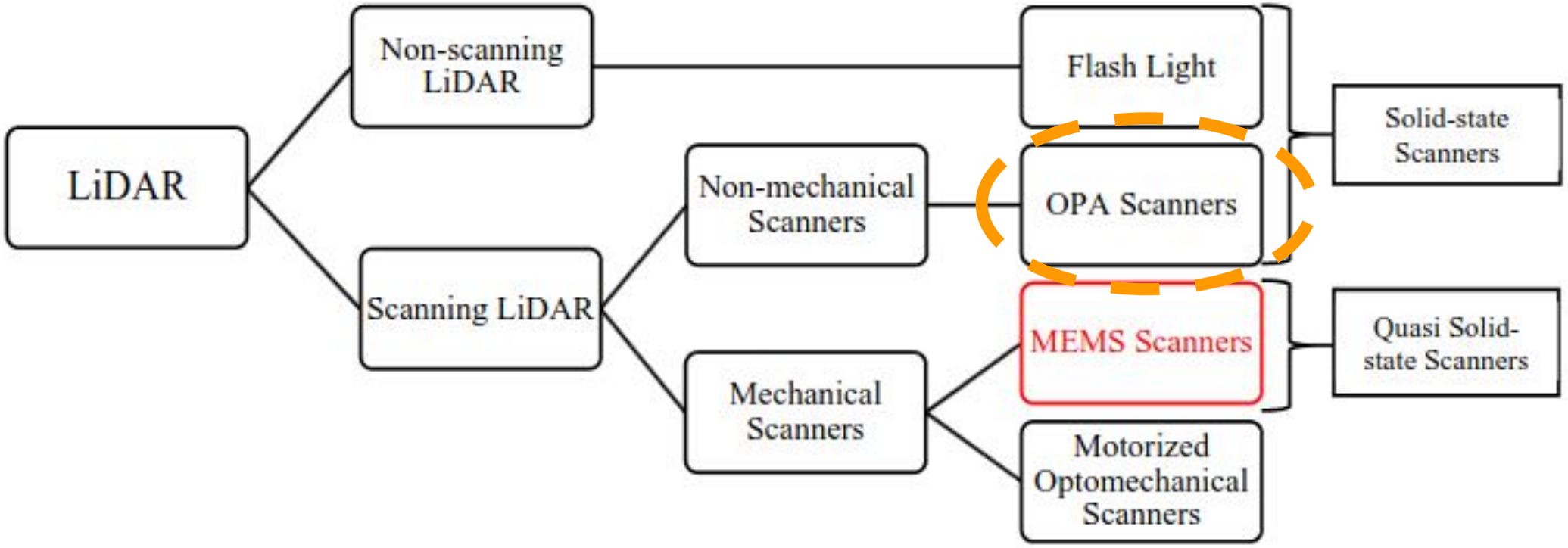
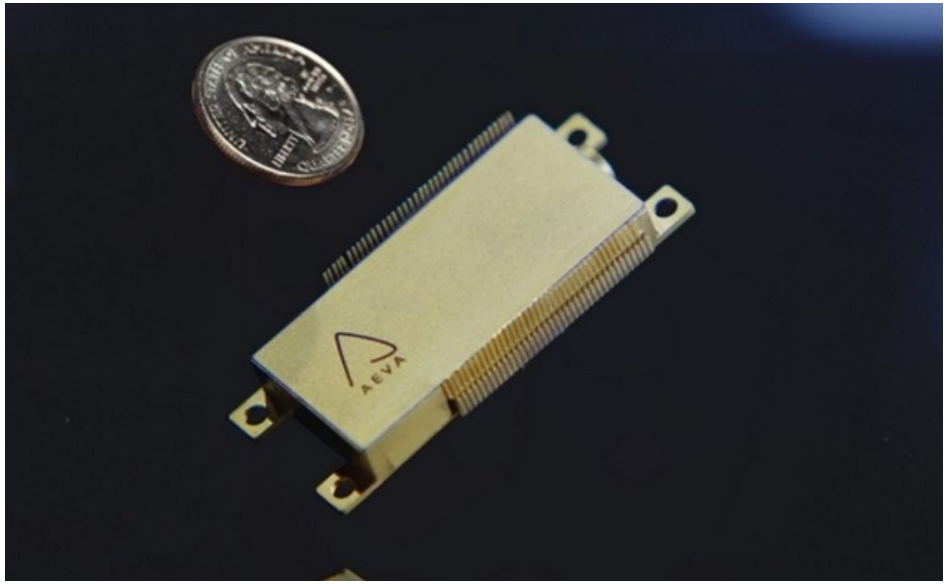
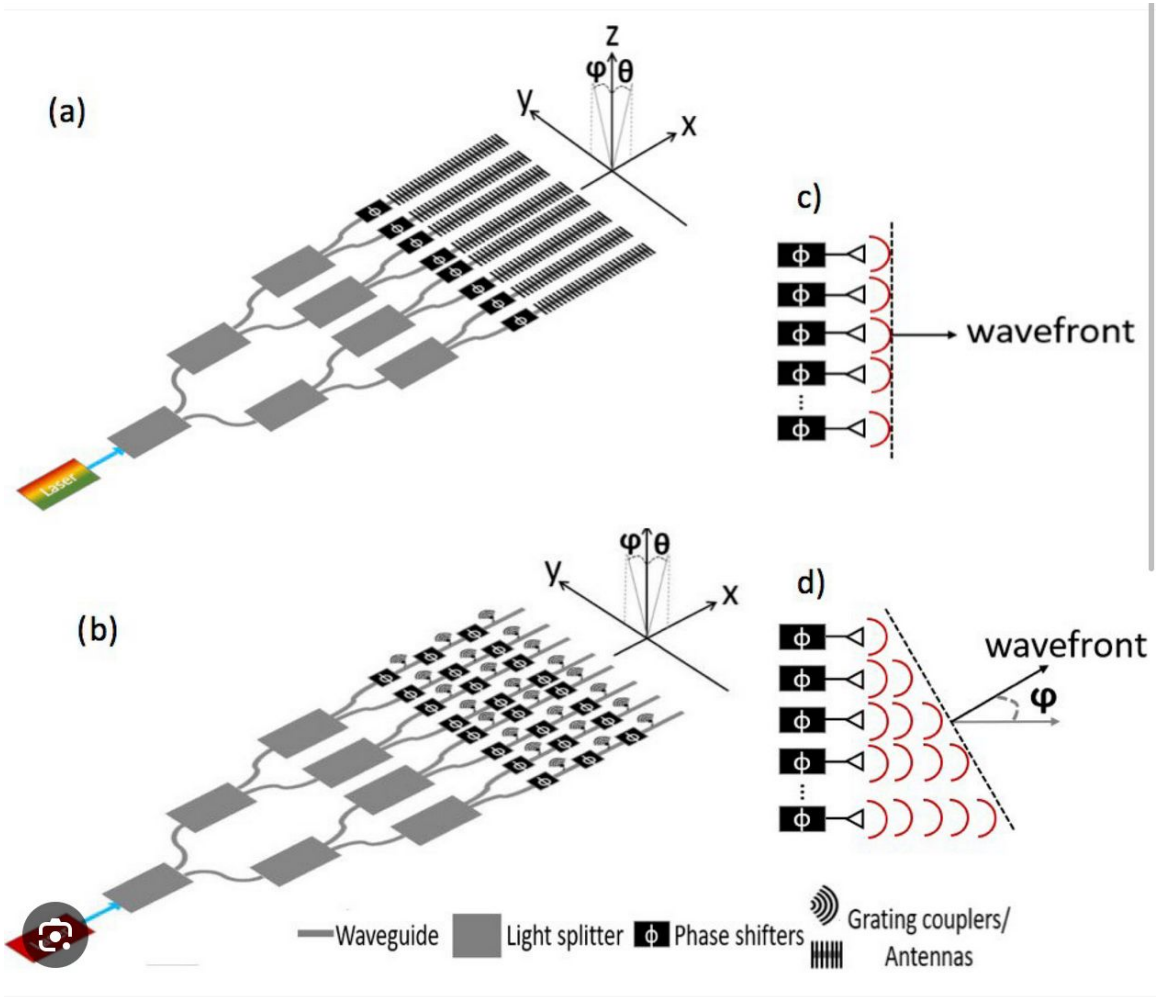


Figure 1. Different types of LiDAR scanners.

Advantages in size and reliability

Also all in silicon -> requires volume to scale





Silicon-Based Optical Phased Array Lidar | Encyclopedia MDPI

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Not everyone agrees

Understanding the magnificent FMCW LiDAR

lidar • Feb 8, 2023

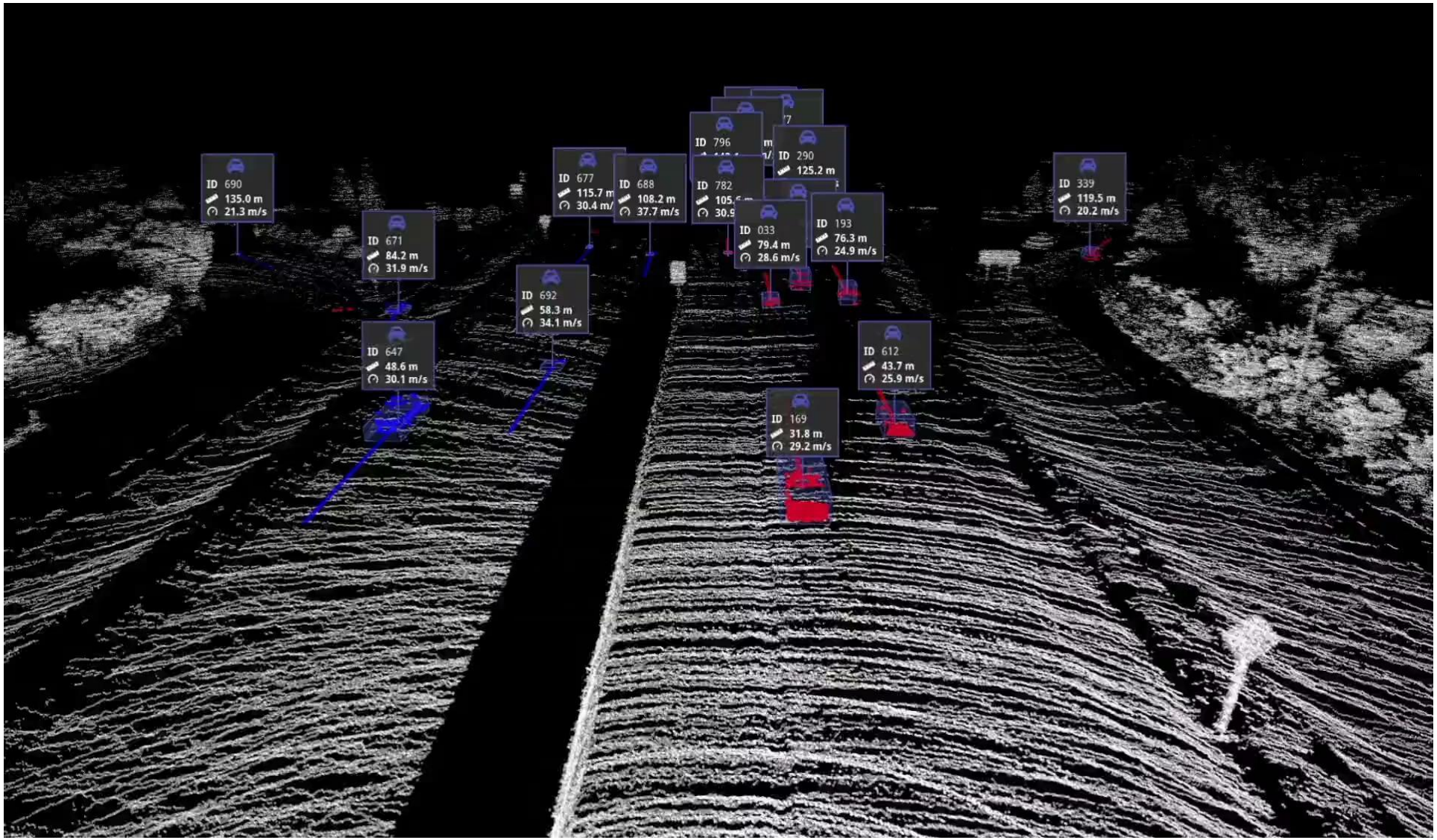
VS

The Odyssey of FMCW

An Epic Introduction to AEye's Latest White Paper *Time of Flight vs. FMCW LiDAR: A Side-by-Side Comparison*

Everyone loves a good myth. From stories told around the campfire to the great classics by Homer or Virgil, myths have endured as a powerful force that has rooted itself in the very fabric of humanity's collective identity. But myths are not just stories. They can be romantic exaggerations of the truth. Just as the Sirens in Homer's *The Odyssey* attempted to lure Odysseus to his doom with their enchanted songs, proponents of Frequency Modulated Continuous Wave (FMCW) LiDAR systems mythologize the value and performance of the technology, leading the autonomous vehicle industry astray and—quite possibly—to shipwreck.

Some nice advantages of FMCW



What about the last category?

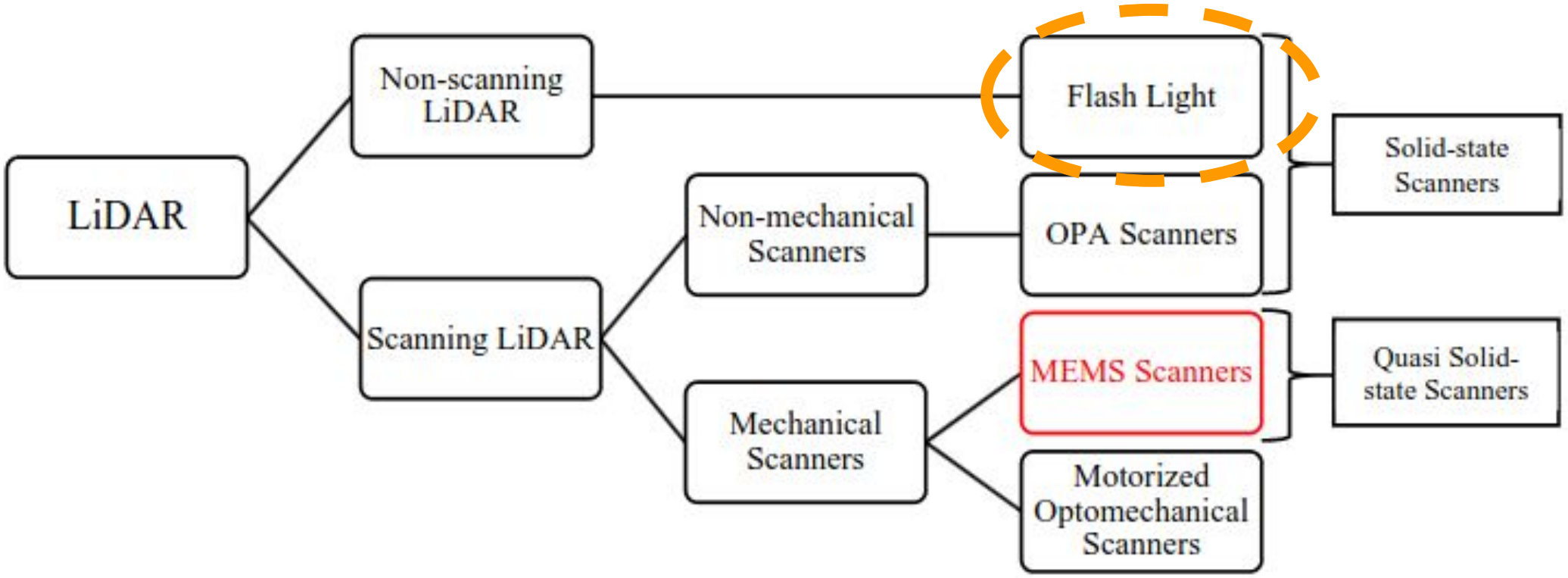
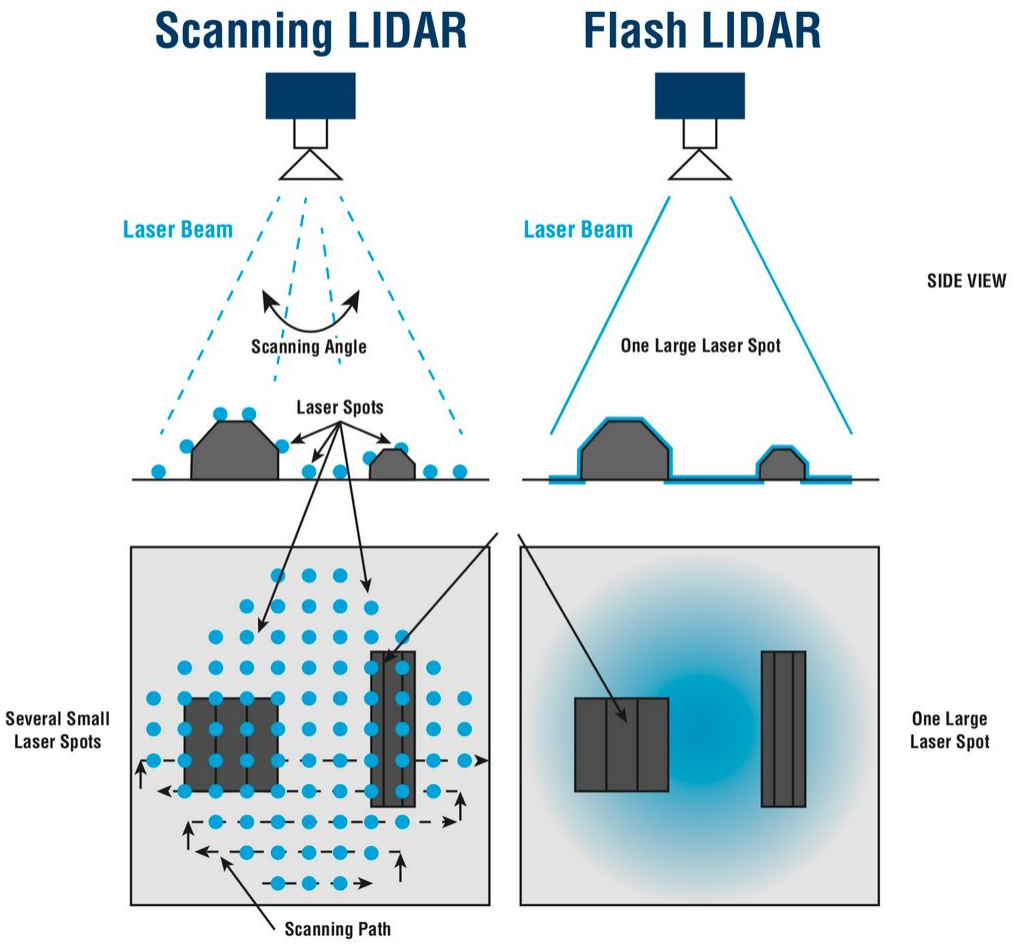


Figure 1. Different types of LiDAR scanners.

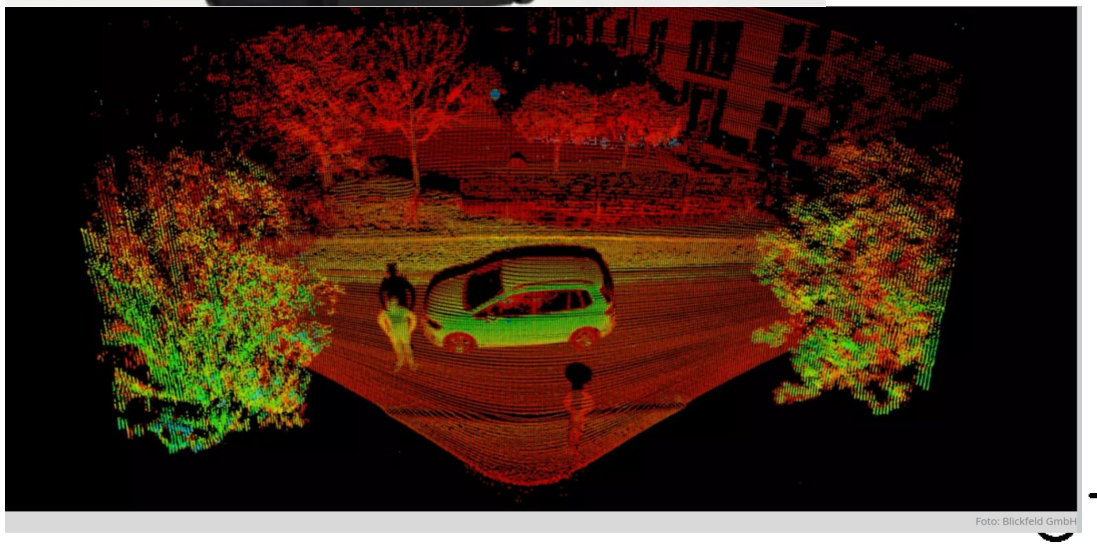
Flash lidar has limitations

But was a potential competitor to MEMS



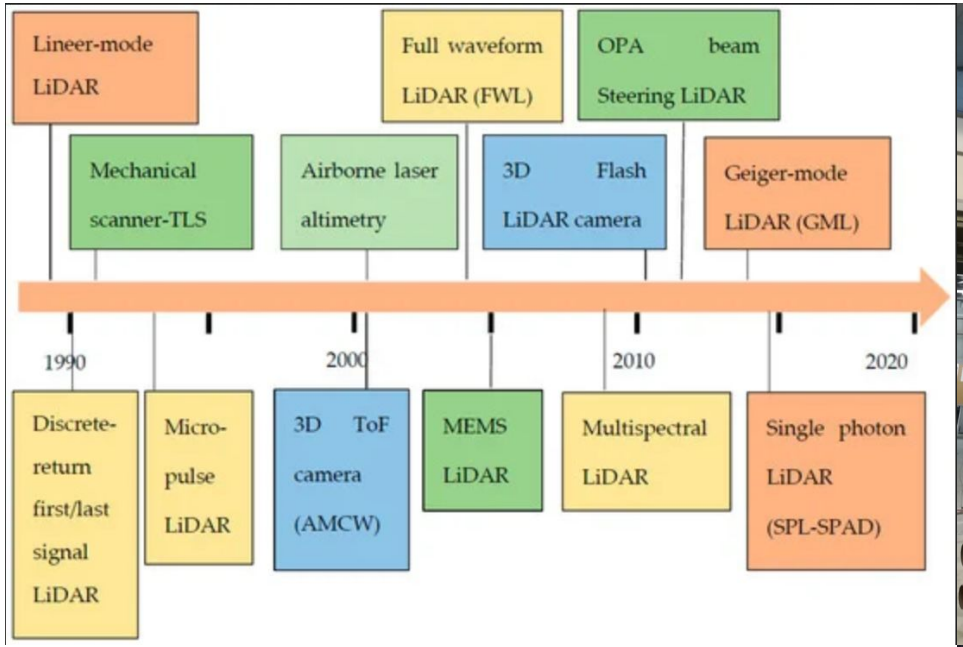
Advanced scientific concepts

Still strong potential for robotics & short ranges

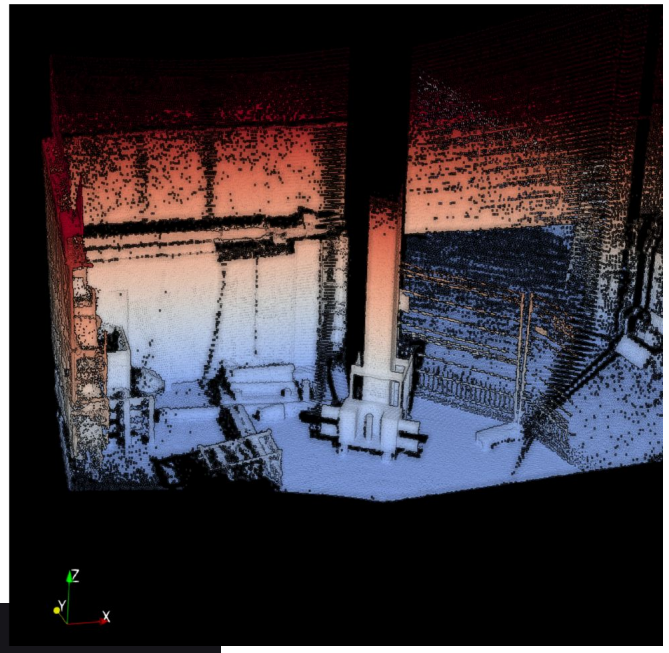


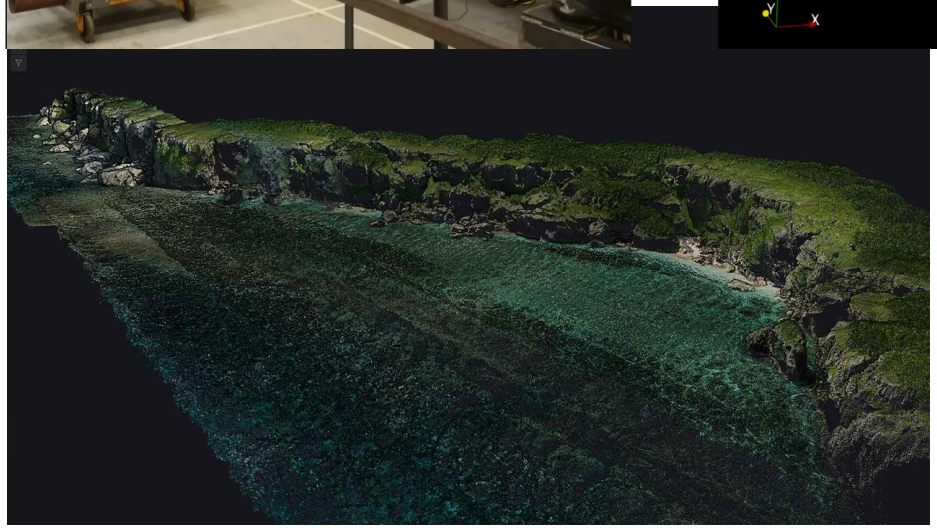
There’s a lot more detail to learn about

Space, aerial, micro industrial LiDAR and related technologies



Review of Scanning and Pixel Array-Based LiDAR Point-Cloud Measurement Techniques to Capture 3D Shape or Motion





Robotics and underwater

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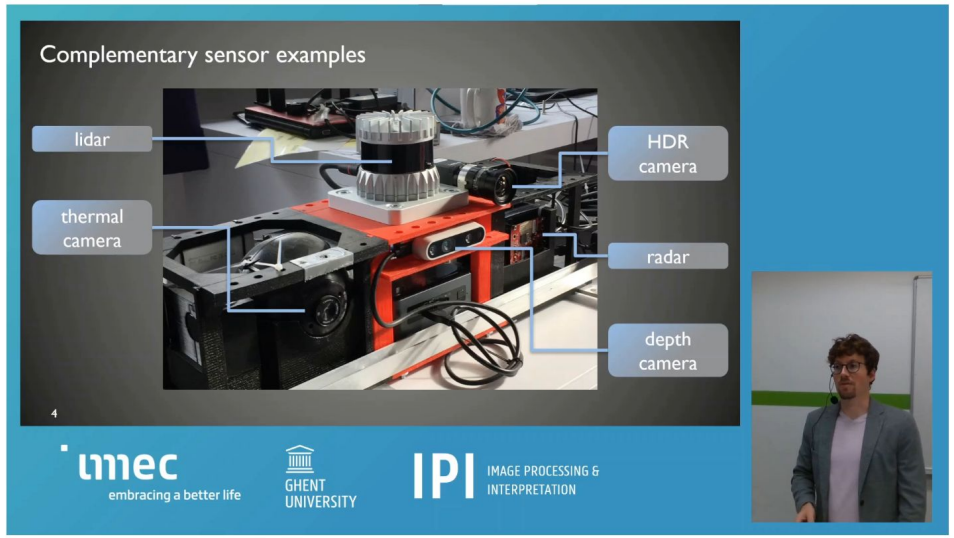
Pointcloud uses

UGhent has research into camera radar and camera lidar fusion, both early and late

Watch IPI researcher David Van Hamme talk about Cooperative sensor fusion for detection and tracking



Great resource https://ipi.ugent.be/research/auto_vehicles/

GHENT UNIVERSITY | FACULTY OF ENGINEERING AND ARCHITECTURE | IPI BACK TO MAIN PAGE

Sensor Fusion and Object Tracking

Spatio-Temporal Consistency for Semi-supervised Learning Using 3D Radar Cubes

Wei-Yu Lee[1], Martin Dimitrievski[1], Ljubomir Jovanov[1] and Wilfried Philips[1]

***Abstract*— Radar has been employed as a key component of perception modules for more than two decades. However, radar image labelling requires expert knowledge. At the same time, it is much more time-consuming than for general RGB images, which impedes further developments of radar.**

In order to alleviate the high-cost annotation problem in radar datasets, we present a novel, semi-supervised deep learning method based on the spatio-temporal consistency. This way we explore the potential of unlabeled radar frames to enhance performance. We utilize the consecutive radar frames from different timeline directions to encourage the model to learn the target motion. Moreover, the proposed self-weighted mechanism avoids over-fitting on certain predominant targets, by exploiting the supervised classification loss dynamically.

We evaluate the proposed method on semantic segmentation and Vulnerable Road Users (VRUs) detection problems. The quantitative results compare favourably to the state-of-the-art and demonstrate the effectiveness of the proposed concepts. The ablation studies also show the effectiveness of the proposed components.

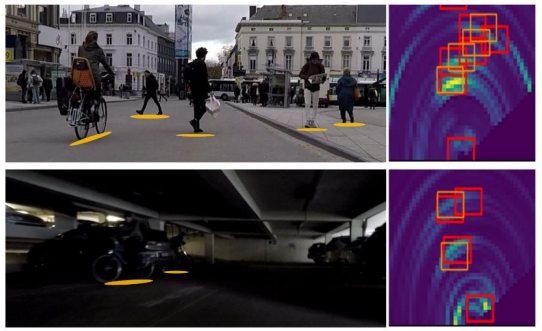
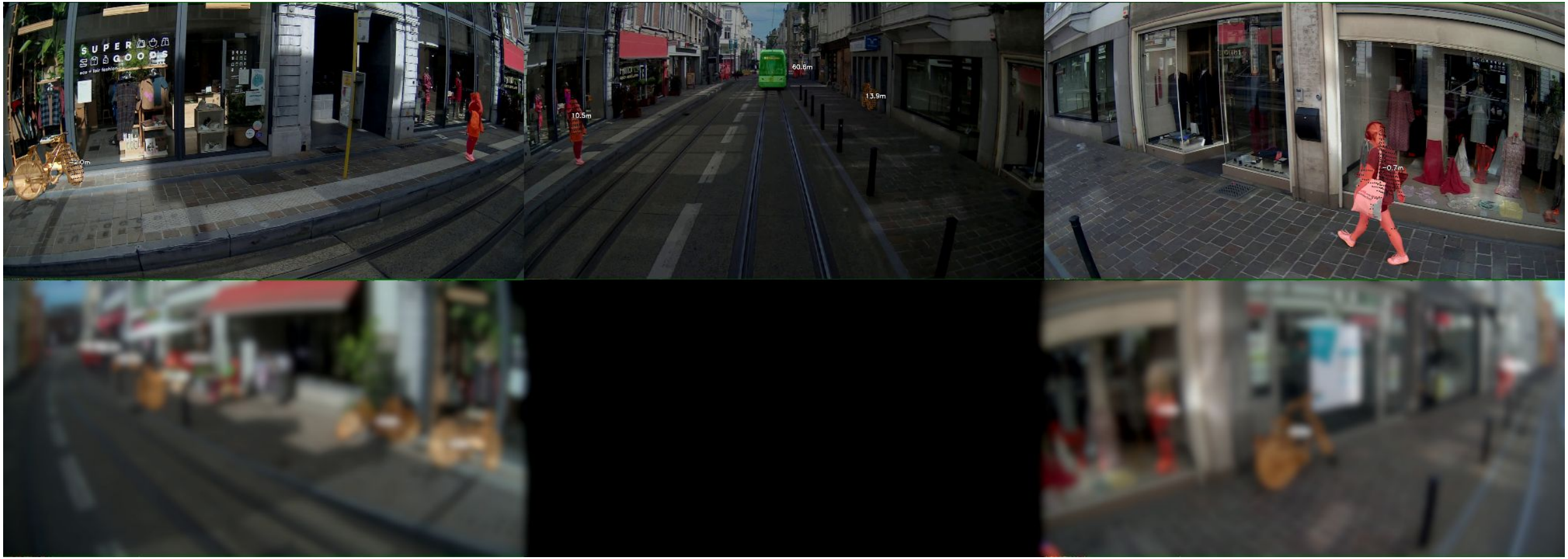


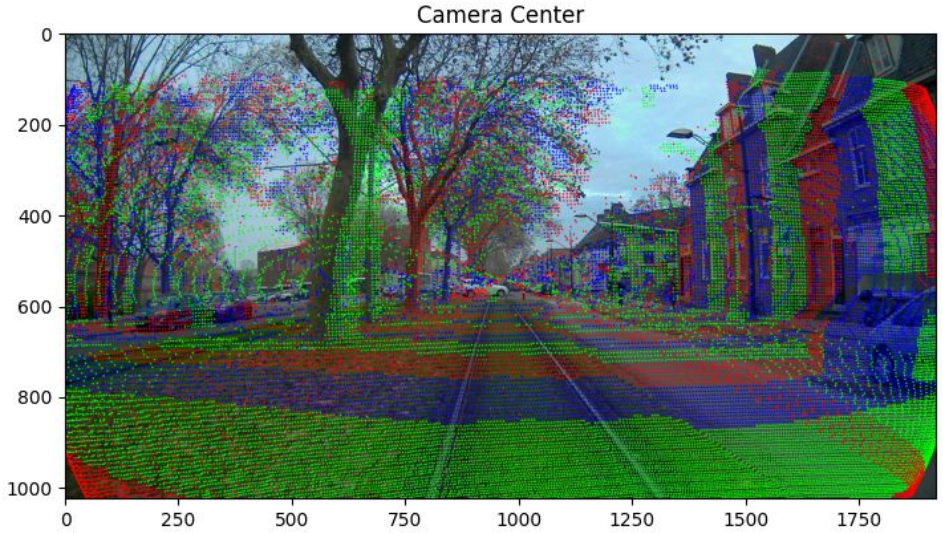
Fig. 1. An example of the radar scan and the synchronized camera image in different light condition. Orange and red bounding boxes represent the ground truth targets and results predicted by our proposed method. The radar scans have been visualized in Cartesian coordinates for comparison with the images.

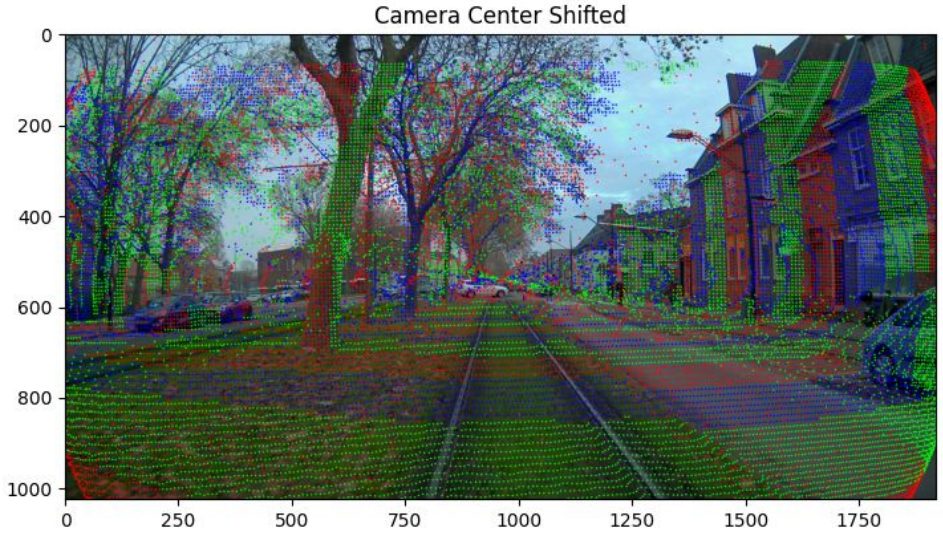
Internal examples

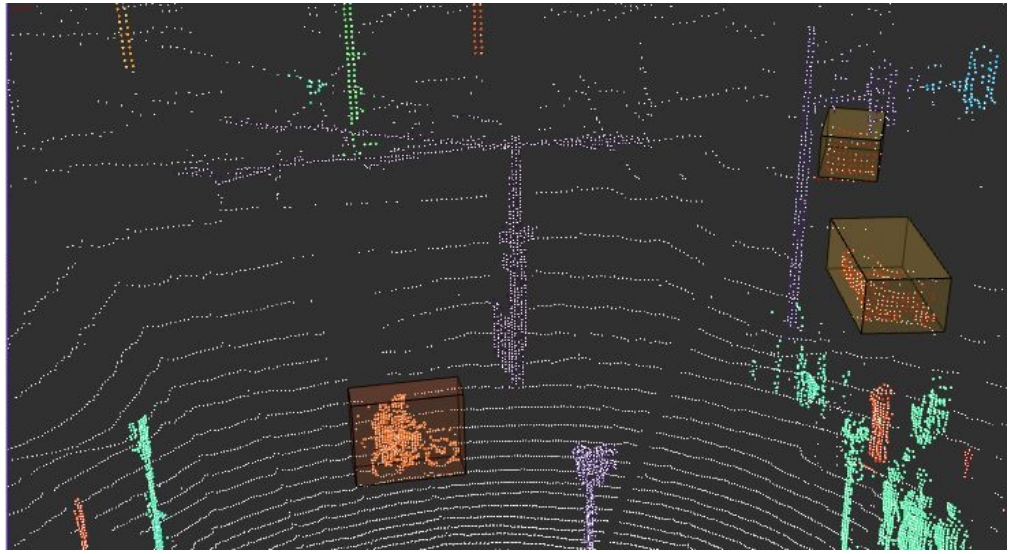


Compensating movement & clustering

Intern work - looking for people to help on LiDARS!







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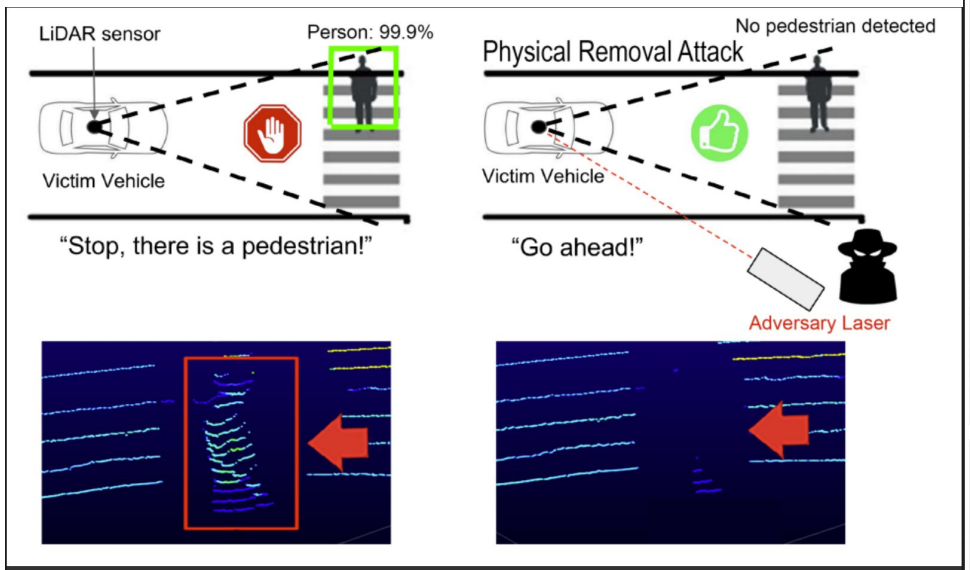
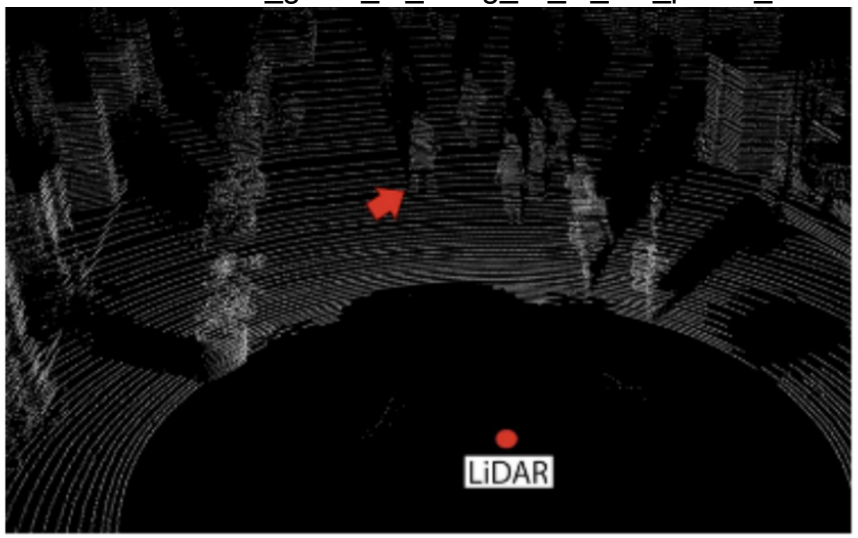
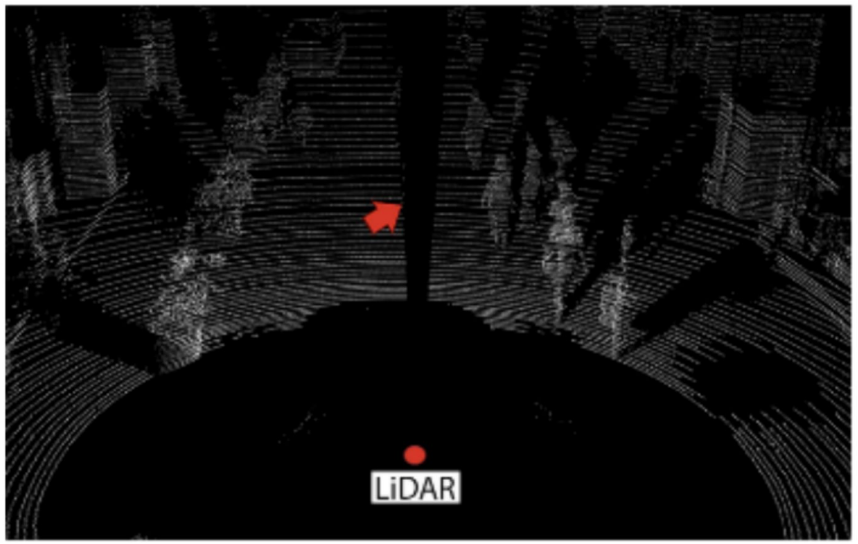
How LiDAR, fusion and the outside world interact

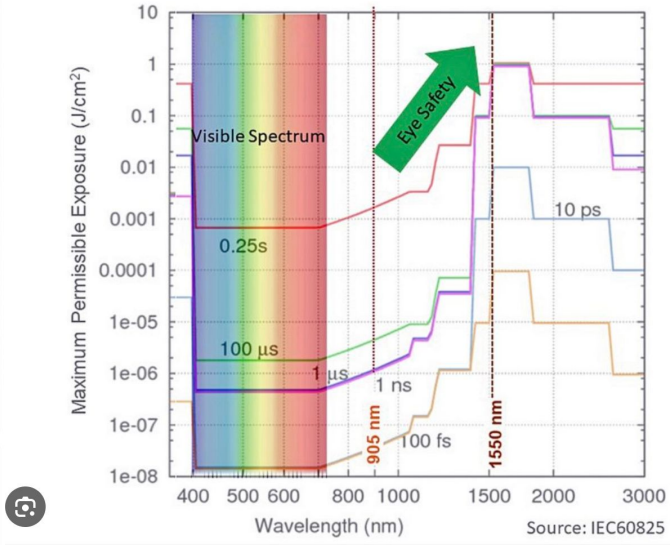
Spoofing lidar: https://hackaday.com/2022/11/22/spoofing-lidar-could-blind-autonomous-vehicles-to-obstacles/
Laws & certification:
https://assets.publishing.service.gov.uk/media/6093f6bfe90e0726f7b69caf/A_guide_to_using_AI_in_the_public_sector__Mobile_version__V2.pdf
https://wayve.ai/thinking/e2e-embodied-ai-solves-the-long



Using a laser to send false echoes back to a LiDAR sensor on an autonomous vehicle can be used to hide objects from its field of view. Credit: Research paper, Cao, Yulong and Bhupathiraju, S. Hrushikesh and Naghavi, Pirouz and Sugawara, Takeshi and Mao, Z. Morley and Rampazzi, Sara







The best tips and guide on lidar eye safety - Photonics report Visit ›

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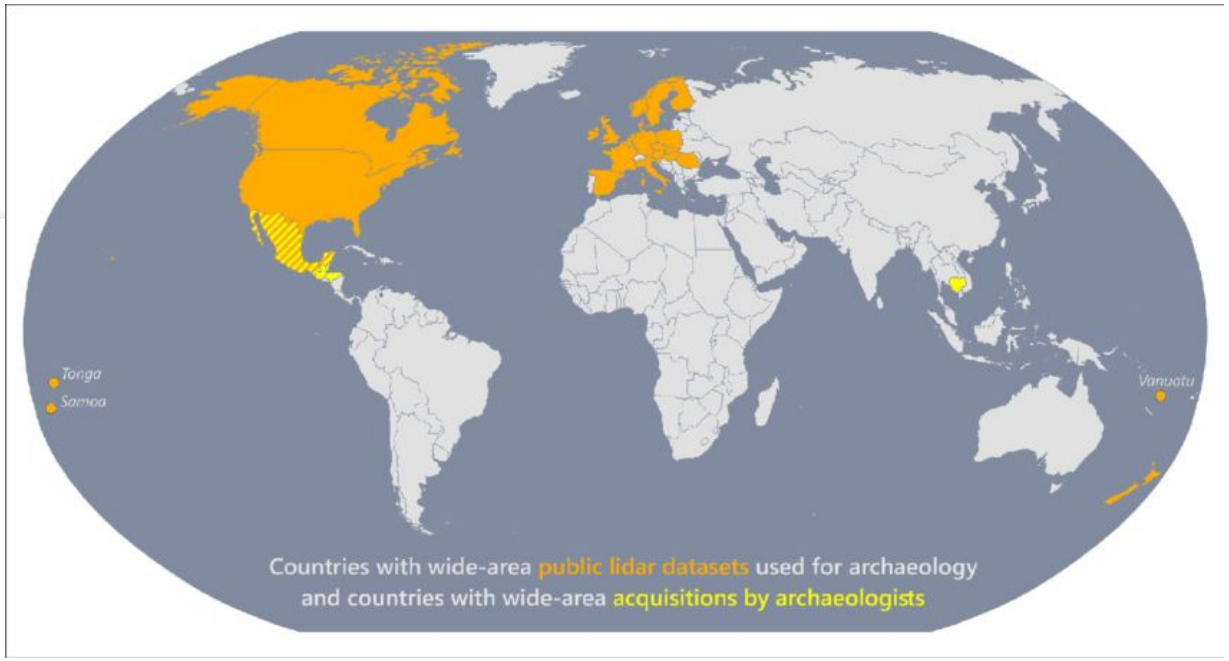
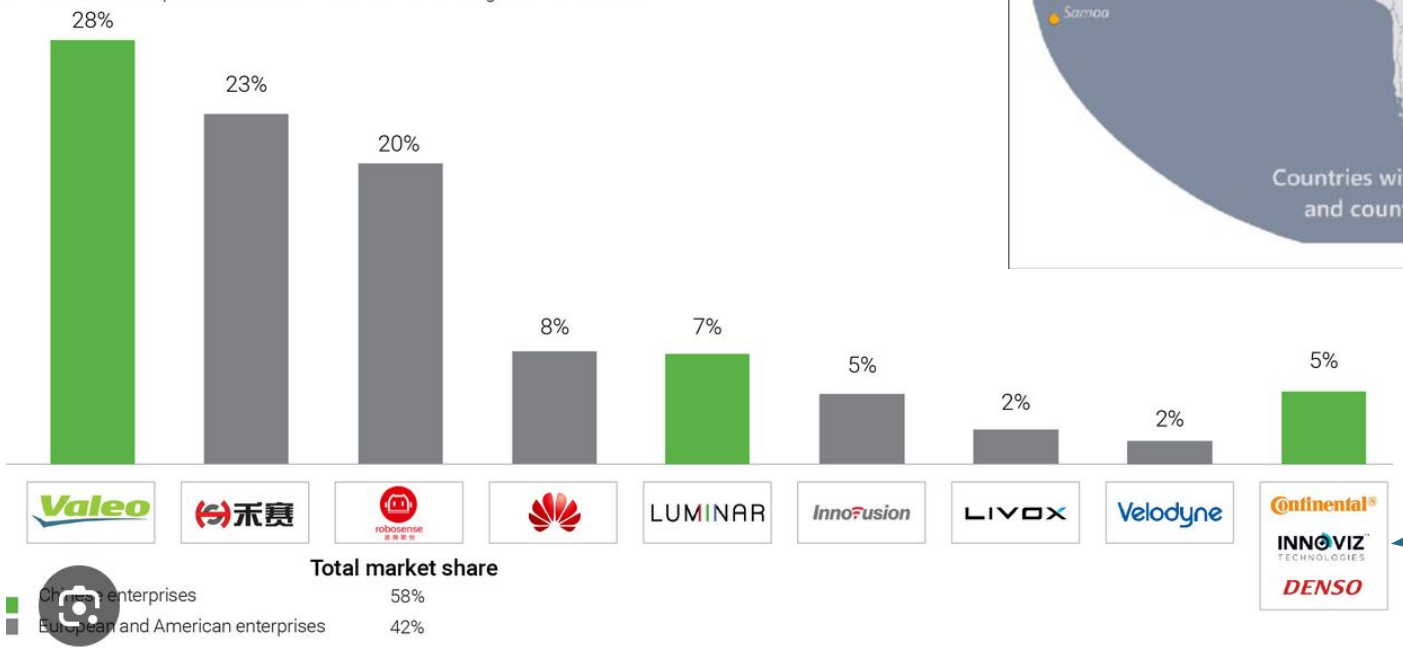
LiDAR and (Geo)politics



AlixPartners Insights

FIGURE 2: **GLOBAL AUTOMOTIVE LIDAR MARKET SHARE DISTRIBUTION IN 2022**

Chinese LiDAR companies account for more than half of the global market share



Source: Yole; AlixPartners analysis

Now SEYOND

China's Proposed Export Ban on LiDAR Technology: What Impact Will It Have on the Automotive Industry?, Steve Dyer,...

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Let’s build the future of automation in rail