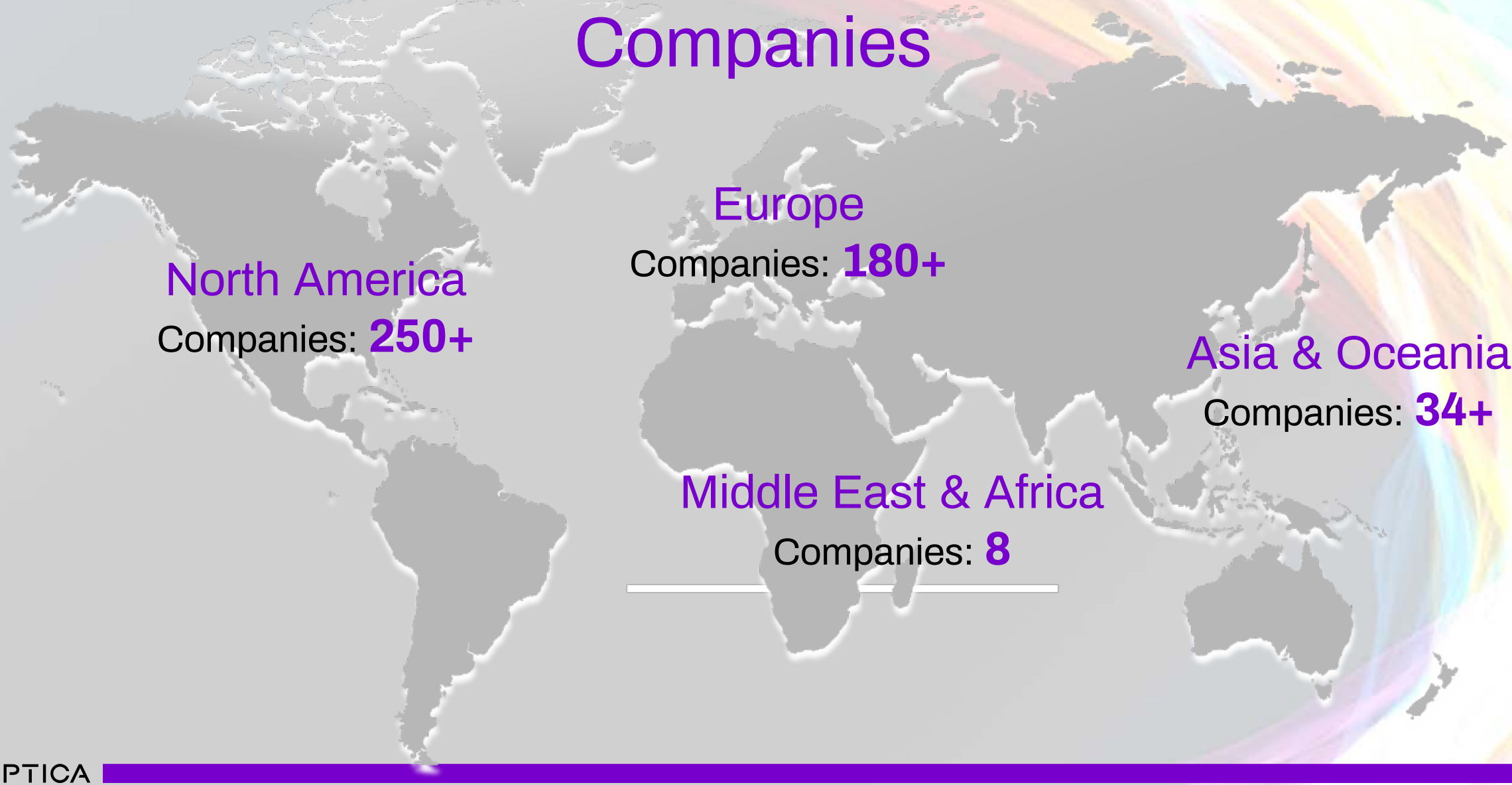
OPTICA
Advancing Optics and Photonics Worldwide

Optica's LiDAR Landscape:
The Findings of our Technology Survey for 2024

Dr. Olga Raz
Technical Director for Optics and Optical Systems

6th DVN Conference on Automotive LiDAR
November 29 – 30, 2023
Wiesbaden, Germany

Global Photonics Industry Network of 500+ Companies



North America

Companies: **250+**

Europe

Companies: **180+**

Asia & Oceania

Companies: **34+**

Middle East & Africa

Companies: **8**

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Optica Industry Pillars:

- ✓ Helicopter view
- ~~✓ Market and trend knowledge~~
- ~~✓ Technical expertise~~
- ✓ Members

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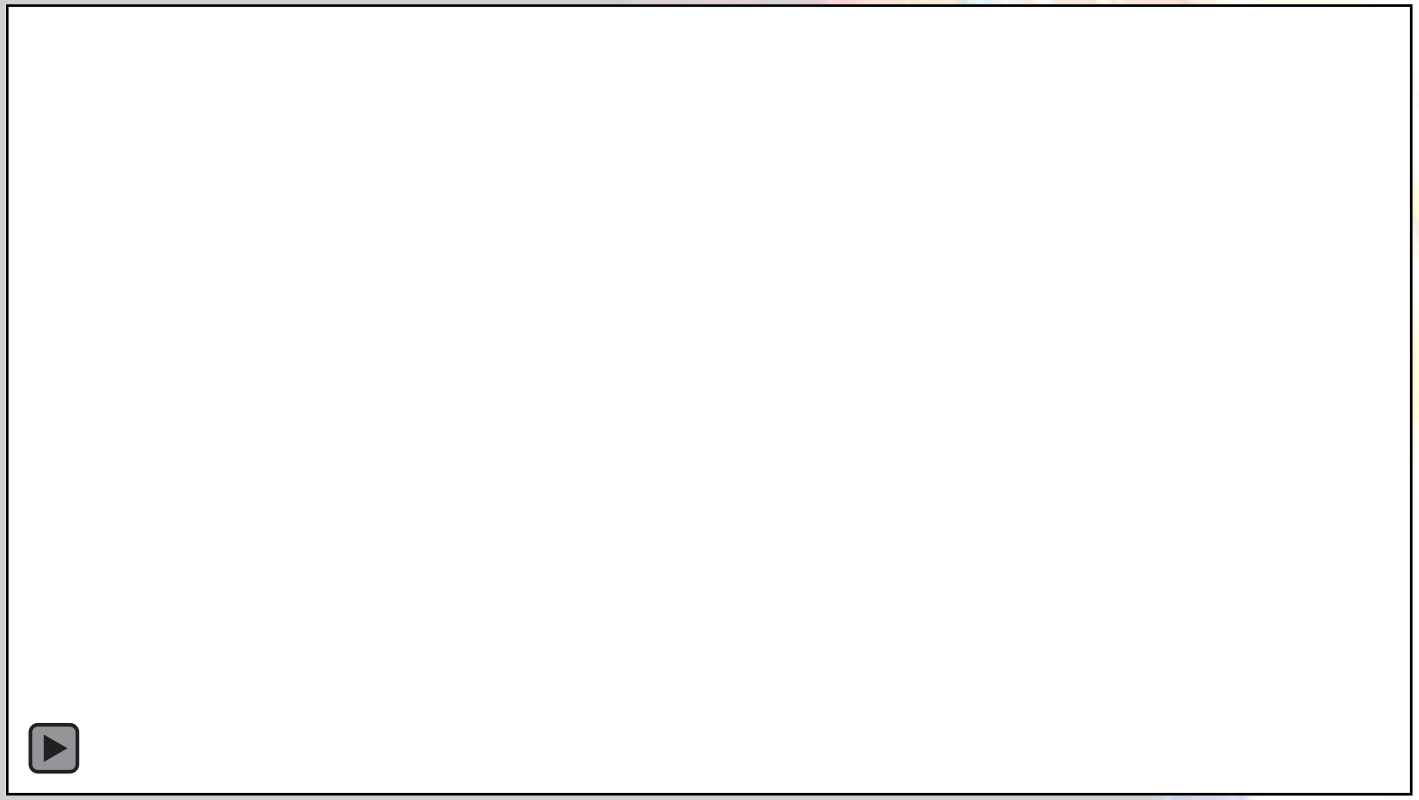
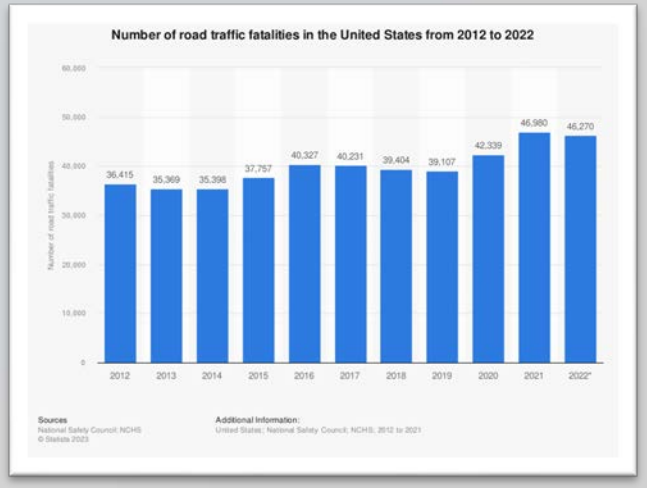
Why?

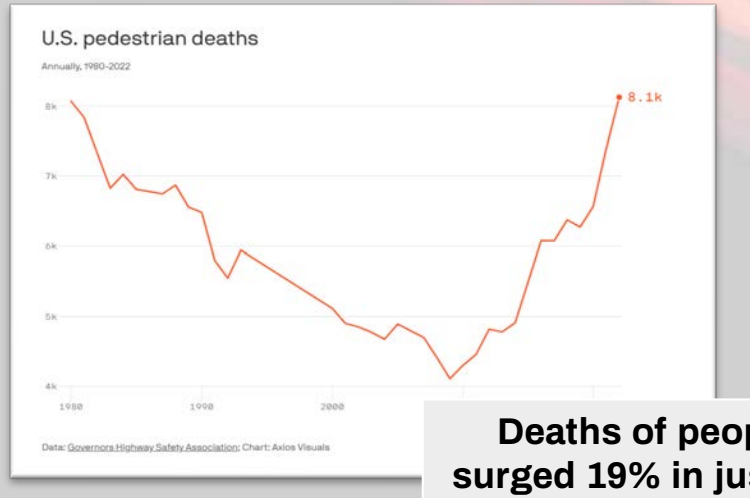
“So we've got the humans, they're paying attention to the road, they can see what's going on ahead of them. Or can they? … So, frankly, humans are terrible drivers. They're really bad. In fact, if you look at the number of miles per incident, that human drives, they're very bad… 35,000 people per year are being killed on highways in this country (2018, USA). Let me put that in perspective for you 35,000 people, that's the equivalent of a B-737 dropping out of the sky every working day. So imagine Monday, a Delta jet drops out, Tuesday - Southwest, Wednesday - United. Who in the room here is going to be getting on an airplane on Thursday? Nobody…”

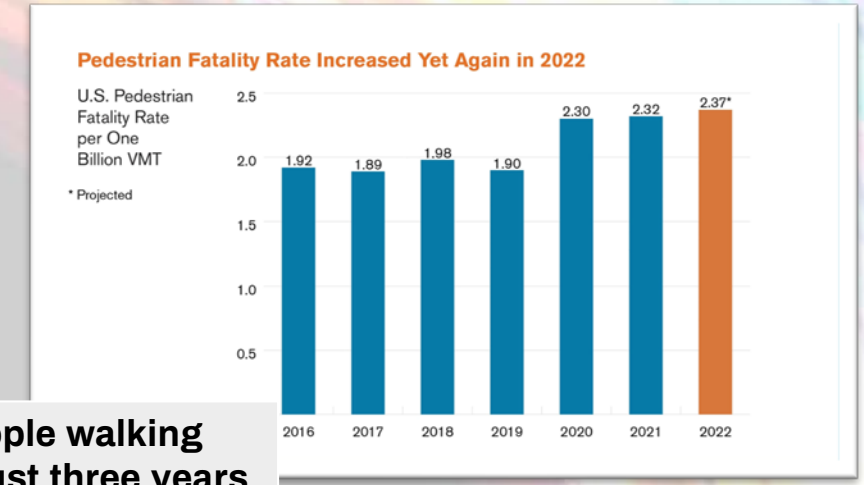


Road accident statistics

USA

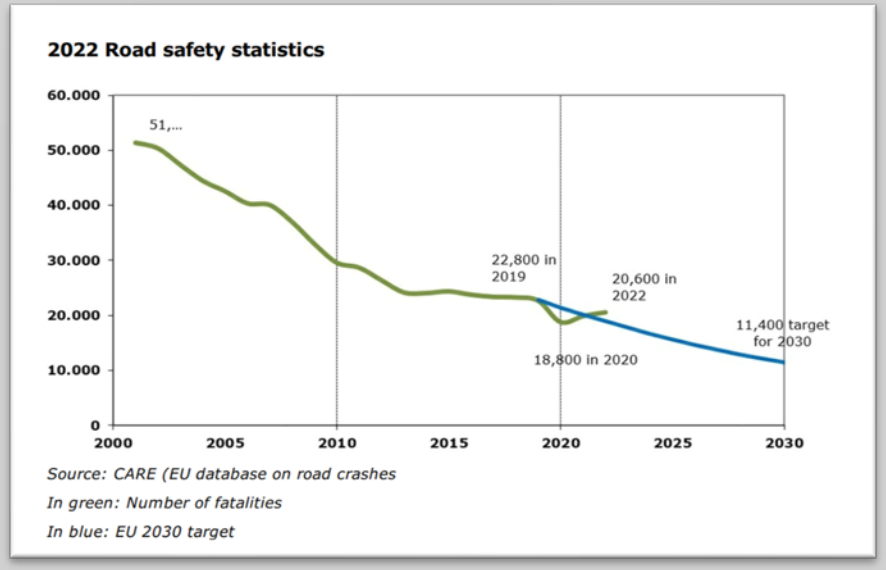


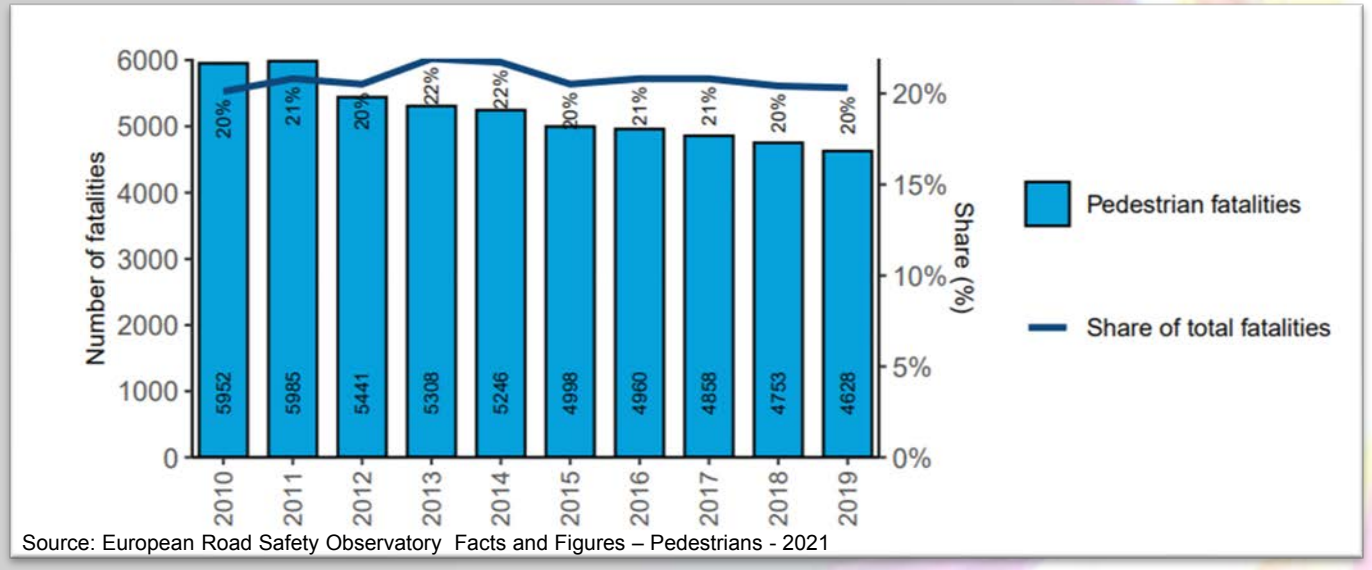




Deaths of people walking surged 19% in just three years

EU





Source: European Road Safety Observatory Facts and Figures – Pedestrians - 2021

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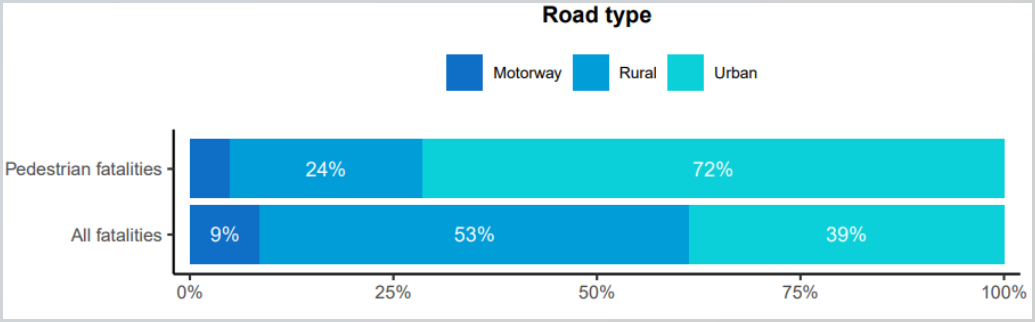
Road accident statistics EU



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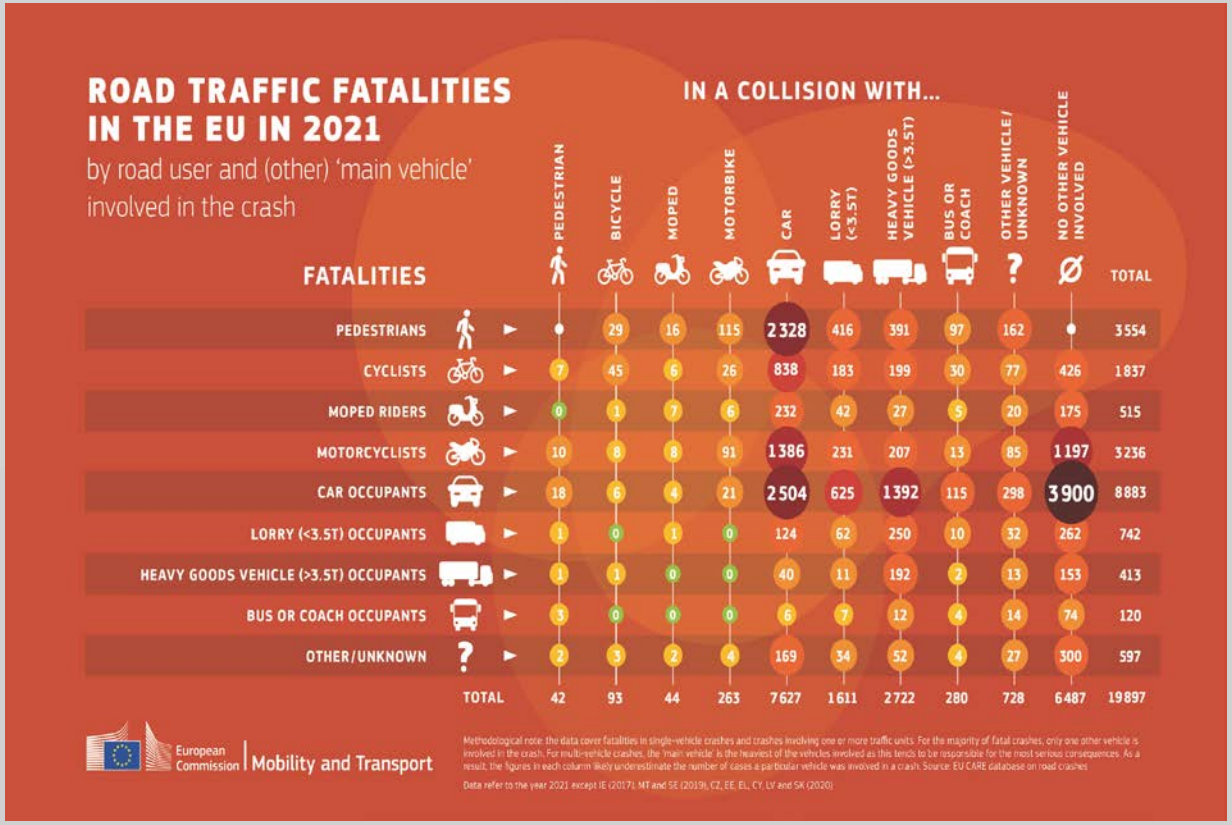

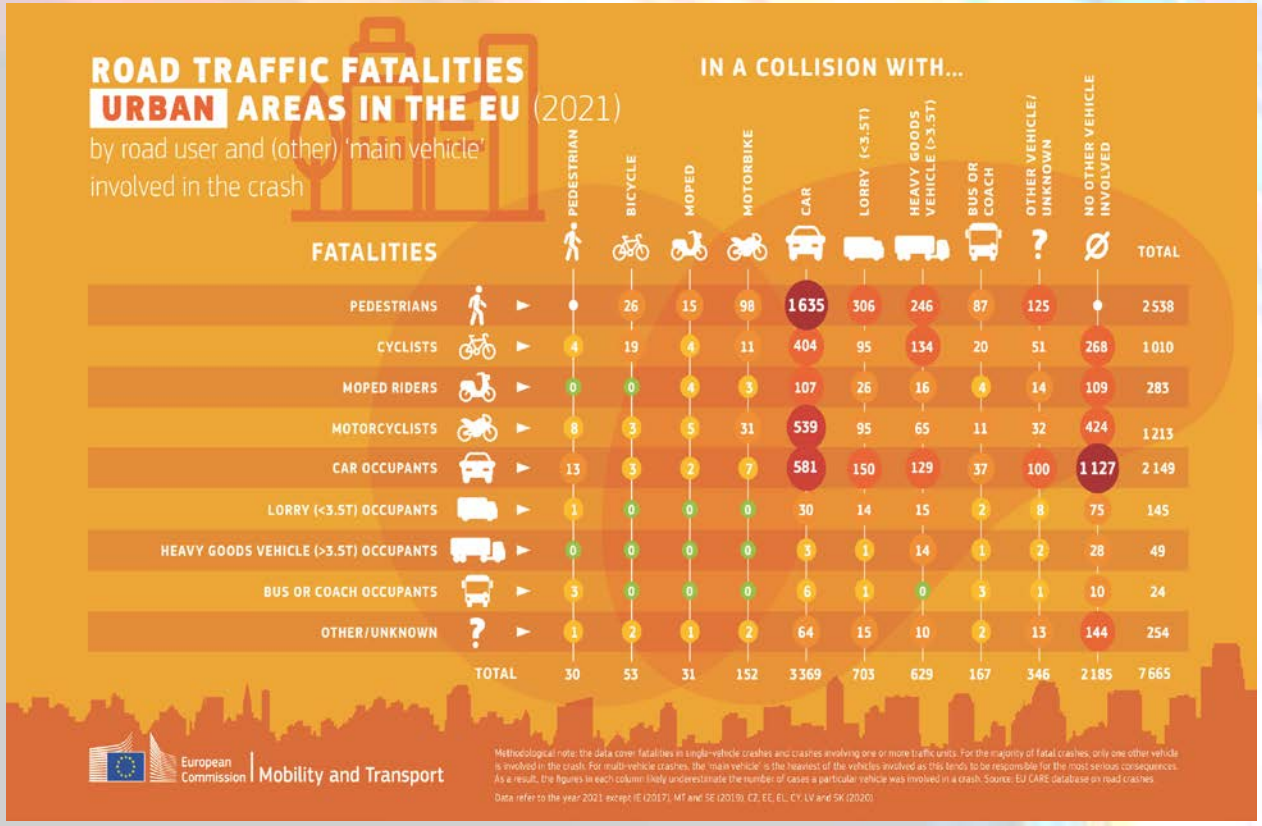

The EU and UN's target is to halve the number of road deaths by 2030.

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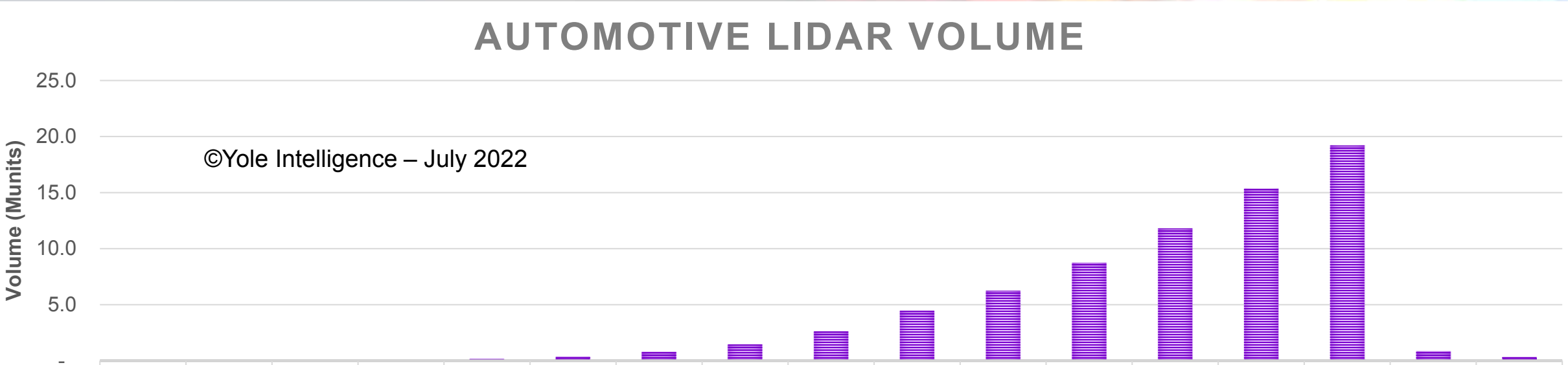
A difficult gap to jump



	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	CAGR 22-27	CAGR 27-32
Total	0.0	0.0	0.0	0.1	0.2	0.4	0.8	1.5	2.6	4.5	6.2	8.7	11.8	15.3	19.2	87.1%	33.9%

- ✓ The volume of LiDAR is expected to remain under the one-million-unit mark until 2024, as LiDAR are only integrated in high-end cars.

Optica LiDAR Ecosystem Survey:

~ 20 members in components & systems

Questions asked:

1. Describe the top three challenges LiDAR technology faces at the present day in your opinion

2. Key quantitative advantages offered by your technology

3. Suggest the top three areas of improvement or disruptive technologies your company expects to positively impact LiDAR ecosystem

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The top three challenges

1. Cost → Price vs. Performance

“…current LiDARs offer high performance and very high cost, or too little capability at acceptable costs, so customers have to pick the "right now" solution versus a solution they really want.”

2. Complexity and size

“… For the LiDAR technology as a whole, many want to go from mechanical-driven LiDAR concepts to solid state, meaning no moving parts that would improve LiDAR's reliability and potentially make the LiDAR systems more compact..”

3. Reliability

“… Automotive reliability is very challenging to achieve. OEM wants the LiDAR system to perform reliability under harsh conditions (105°C and high humidity conditions), which requires specific packaging to qualify for standards such as AEC..”

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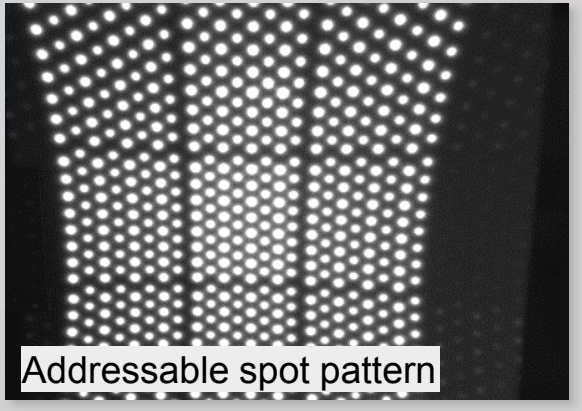
Member's solutions: Learning from much simpler consumer LiDAR

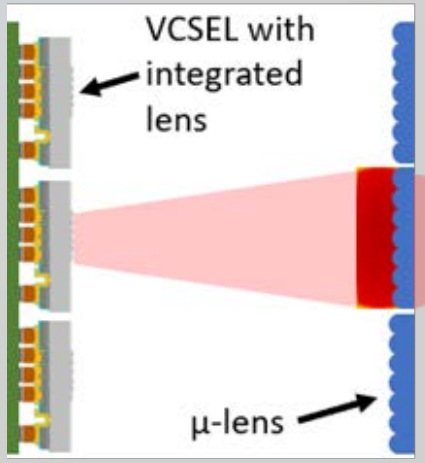

Smartphone LiDAR


Addressable spot pattern

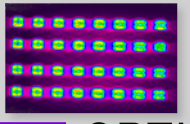
VCSEL way: All solid-state, addressable

- ✓ No mechanics, less assembly → reduced cost, enhanced reliability
- ✓ Address groups or lines → dynamic resolution, performance
- ✓ LiDAR in smartphones can boost an alternative approach based on VCSELs → cost savings

Scaling from consumer towards automotive LiDAR

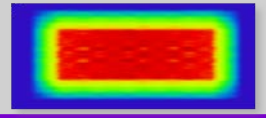


VCSEL chip



Spot pattern by µ-optics

Uniform illumination



- ✓ **ViBO (VCSEL integrated Backside Optics) chip with integrated lenses for uniform illumination**
- ✓ Each point illuminated by all VCSELs (redundancy)
- ✓ Conserved brightness by integrated µ-lenses

- ✓ **µ-optics in the uniform plane generates the spot pattern**
- ✓ flexibility in design by separate µ-optics

- ✓ **Spot plane is imaged onto the scene**
- ✓ 1 small chip = 1 addressable segment

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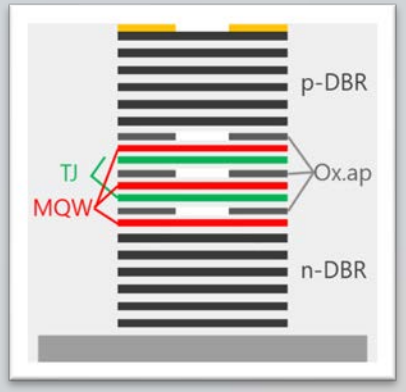
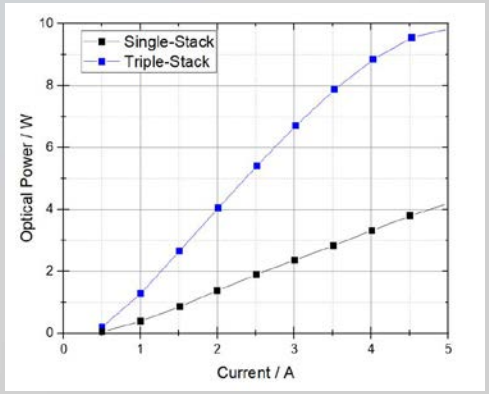
Dr. Holger Mönch | TRUMPF Photonic Components

TRUMPF

Increasing VCSEL power by stacked junctions

Option for ViBO as well as for standard VCSELs



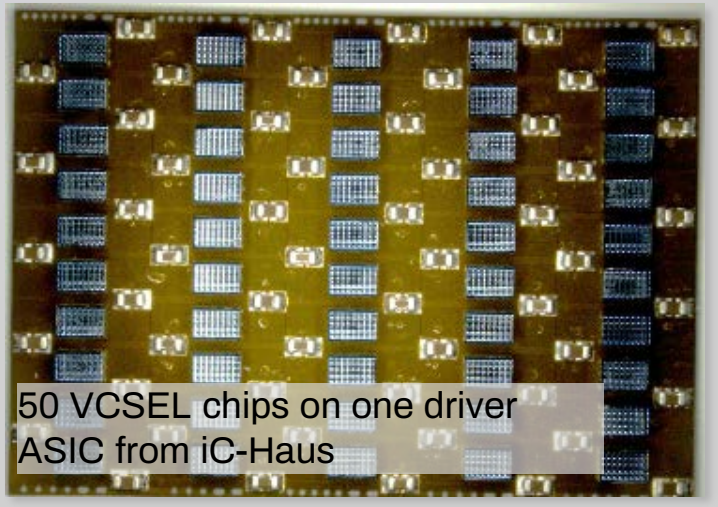


Generating multiple photons by one injected electron →

- ✓ 3x higher slope efficiency
- ✓ → 3x more output power in Pulsed
- ✓ → 2x more output power in CW

Segmented automotive LiDAR

How to build a huge point cloud in a reliable manner



50 VCSEL chips on one driver ASIC from iC-Haus

10 mm

- ✓ 50 small chips on one driver iso one giant chip
  - ✓ <1 mm² VCSELs flip-chip on Si-driver
  - ✓ Reduced thermo-mechanical stress
  - ✓ Saves GaAs area
  - ✓ Many VCSELs per zone (redundancy)
  - ✓ Independent optimization of light pattern and chip
- ✓ **System concept fulfills all requirements for automotive LIDAR with range > 100 m**

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Dr. Holger Mönch | TRUMPF Photonic Components

TRUMPF

Member's solution: Improving power & sensitivity for long-range LiDAR

Future Devices: Sources

- ✓ 4/5 stack EEL → long-range LiDAR concepts
- ✓ 4 Stack 160W @35% E/O

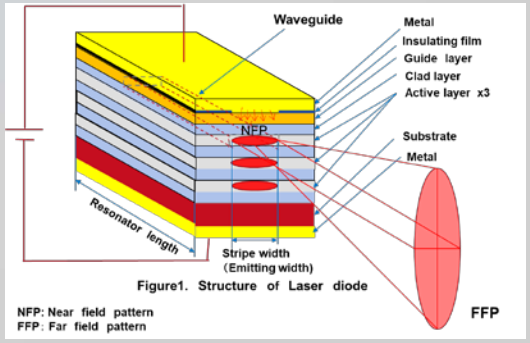
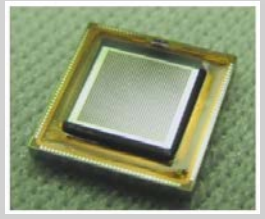


Figure1. Structure of Laser diode

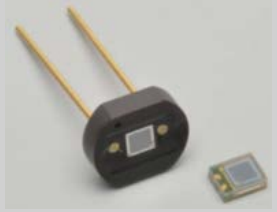
NFP: Near field pattern
FFP: Far field pattern

Future Devices: Detectors

SPPC (SPAD)



MPPC (or SiPM)



- ✓ High sensitivity
- ✓ Low noise
- ✓ Low cross talk
- ✓ 1D & 2D arrays with integrated ASIC

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HAMAMATSU

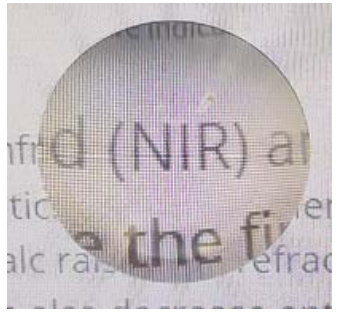
PHOTON IS OUR BUSINESS

Member's solution: Novel Optics for more powerful 3D depth imaging

Roadmap to higher refractive indices

- ✓ Current solutions 1.72 index at 1550 nm
- ✓ Demonstrated Polycalc versions > 2.0 index

50% Greater Magnification
vs. Identical 33 mm Diameter Lens



Polymer
1.5 index

Polycalc
~1.72 index @1550 nm

Benefits of Polycalc optics:

- ✓ Widen field-of-view by 40% and double the detection range
- ✓ Stable to 200°C+
- ✓ Wafer scalable → reduced costs
- ✓ Compatible with CMOS

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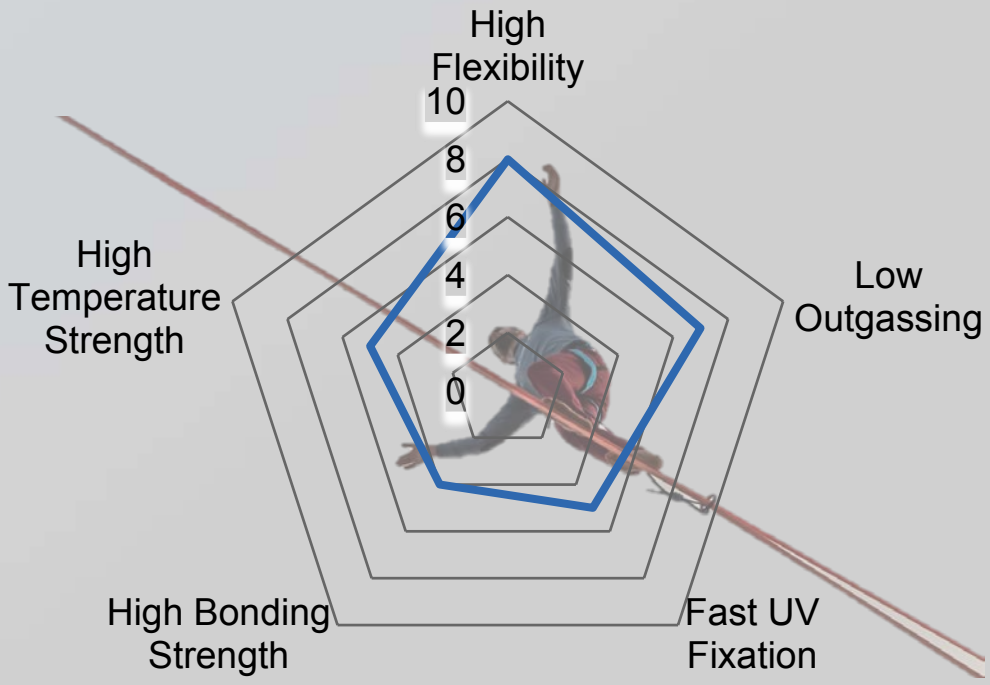
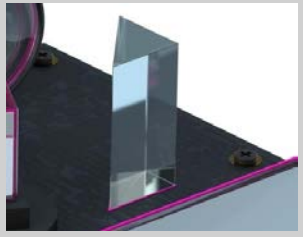
For a strategic partnership, email CEO & Co-Founder Jay Liebowitz jay@norcontech.com

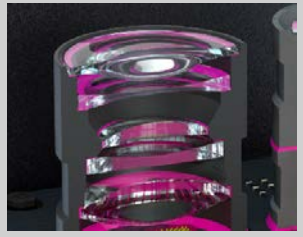
Member's solution: Bonding for improving reliability & reducing costs

LiDAR optics bonding

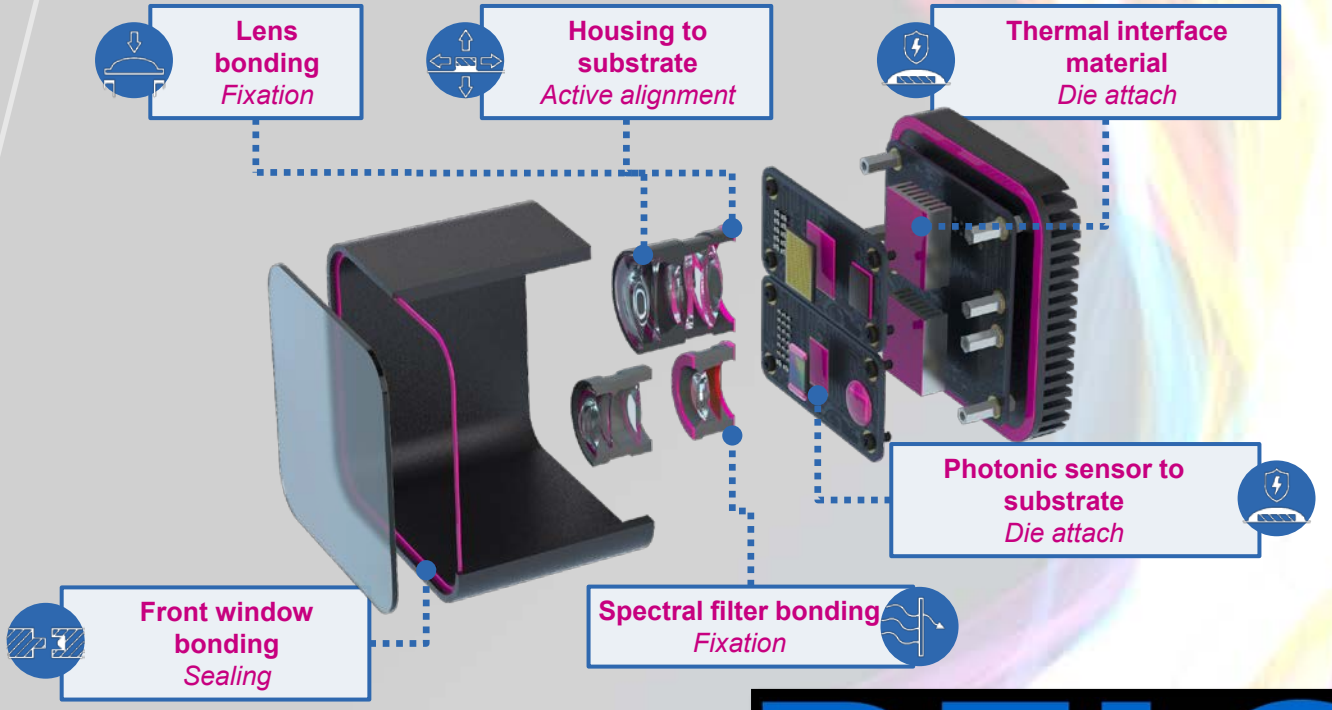
Finding the right balance between mutual dependent requirements







- Cost- and time-efficient
- High-volume manufacturing
- Miniaturization
- Reliability



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Dr. Michael Greisel | DELO

Member's solution: Adoption of FMCW LiDAR through Chip Integration

✓ silicon photonics integration platform offers a cost-effective solution by integrating all the high-performance components needed into a **single silicon chip**

SiLC's Eyeonic™ Vision Sensor aims to enable mass migration from 3D TOF solutions to state-of-the-art 4D FMCW technology

Optical power to enable >1Km range

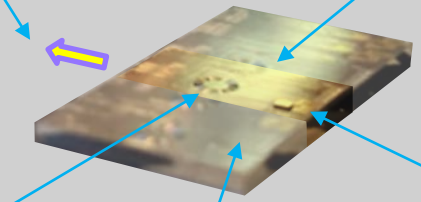
SiLC can put >10X higher optical power (1W) on air due to its unique waveguide structure

Ultra low loss enables power efficiency

Lower loss means better signal to noise ratio

SiLC can integrate meters of waveguides needed to implement high performance laser linearization circuits to achieve ~100X better laser performance

Single Chip FMCW Integration



Higher receiver gain

2X Higher Quantum Efficiency

Significantly better performance of Ge PDs enables better signal to noise ratio and significantly higher coherent gain

Lower noise means better SNR

Lower Noise & Cross-talk

Enhances signal-to-noise ratio (SNR) and significantly higher dynamic range to image at longer distances

Enabling on chip laser and optical amplifier

Lower Back Reflection

Control of back reflection on the chip to better than -45dB

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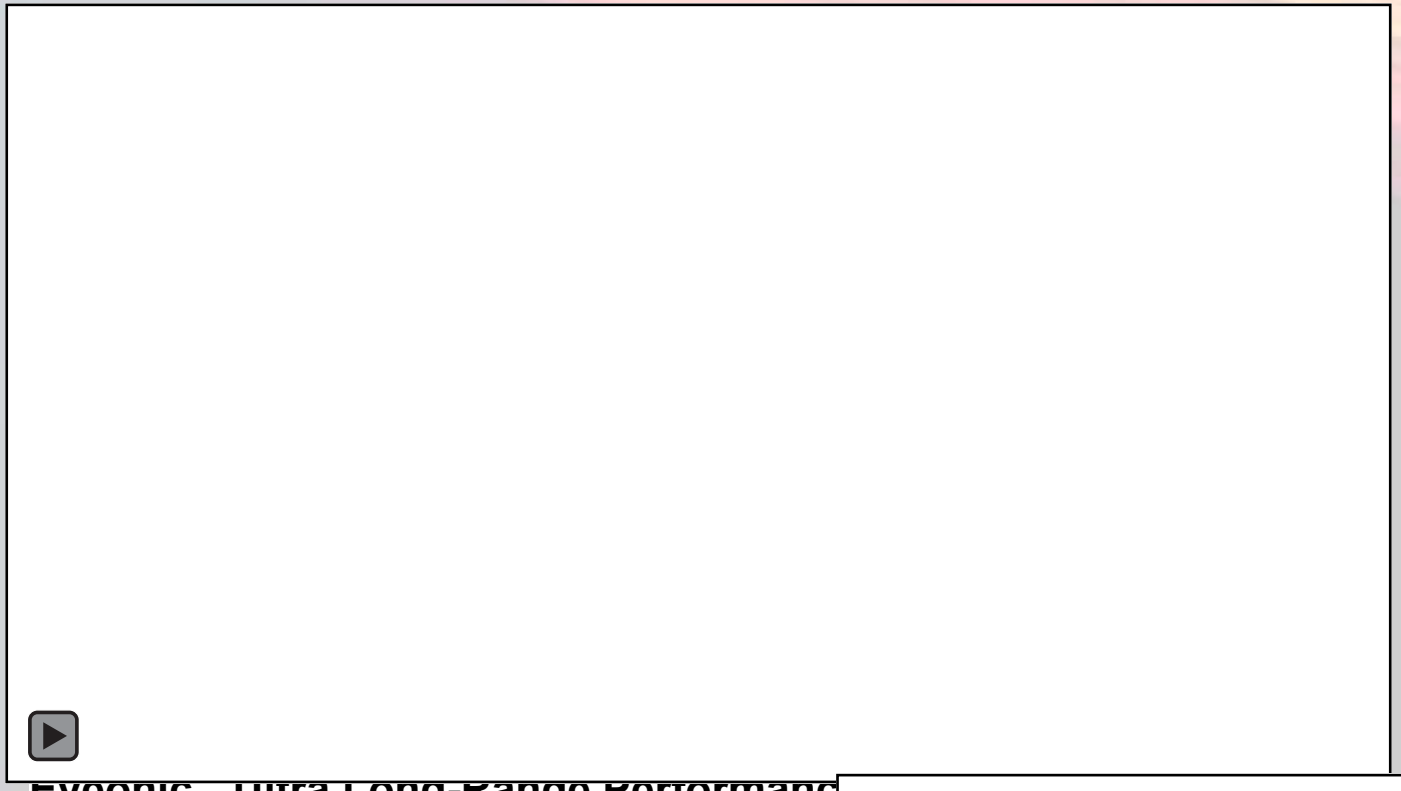
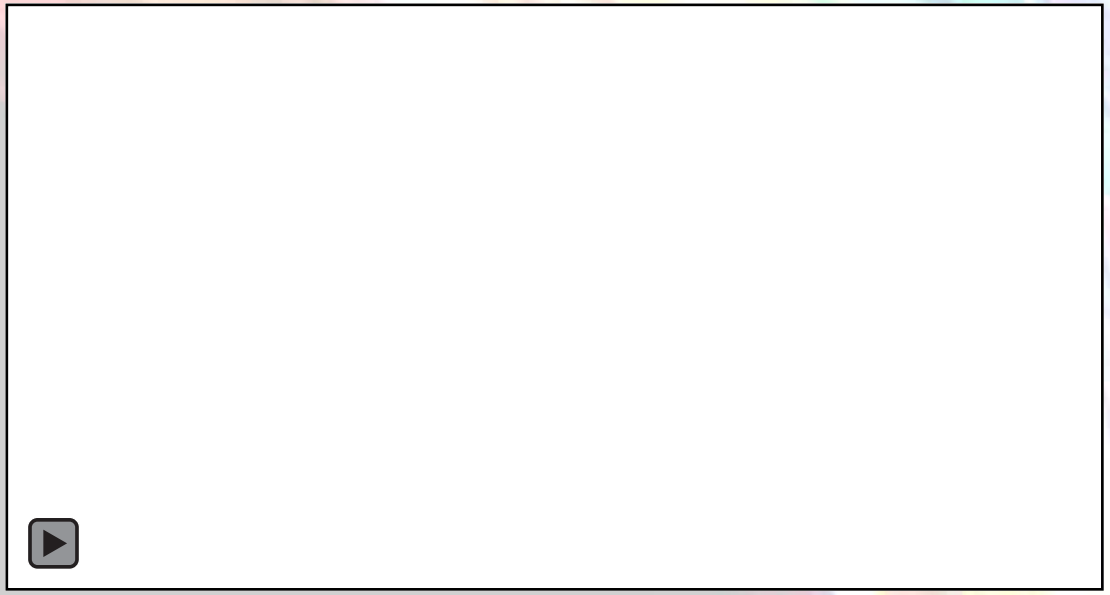
Ralf Muenster, VP of Business Development & Marketing, ralf@silc.com





Eyeonic Ultra Long-Range Performanc

Next moves:

- ✓ Low-cost effective solid-state beam steering
- ✓ Already 16 channels, more to come

Ralf Muenster, VP of Business Development & Marketing, ralf@silc.com

The top three areas of improvement

1. Next-generation detectors and sources for 905 nm, 940 nm & 1550 nm

"…with higher sensitivity & power to enable better performance in terms of both range and resolution"

2. Solid-state beam steering

"…for a smaller footprint and lower solution cost"

3. Integration

"… detectors and sources integrated with electronics such as custom ASIC or TIA to reduce the complexity of LiDAR concepts and improve its reliability and performance… Next-generation PIC (Photonic Integrated Circuit) designs. "

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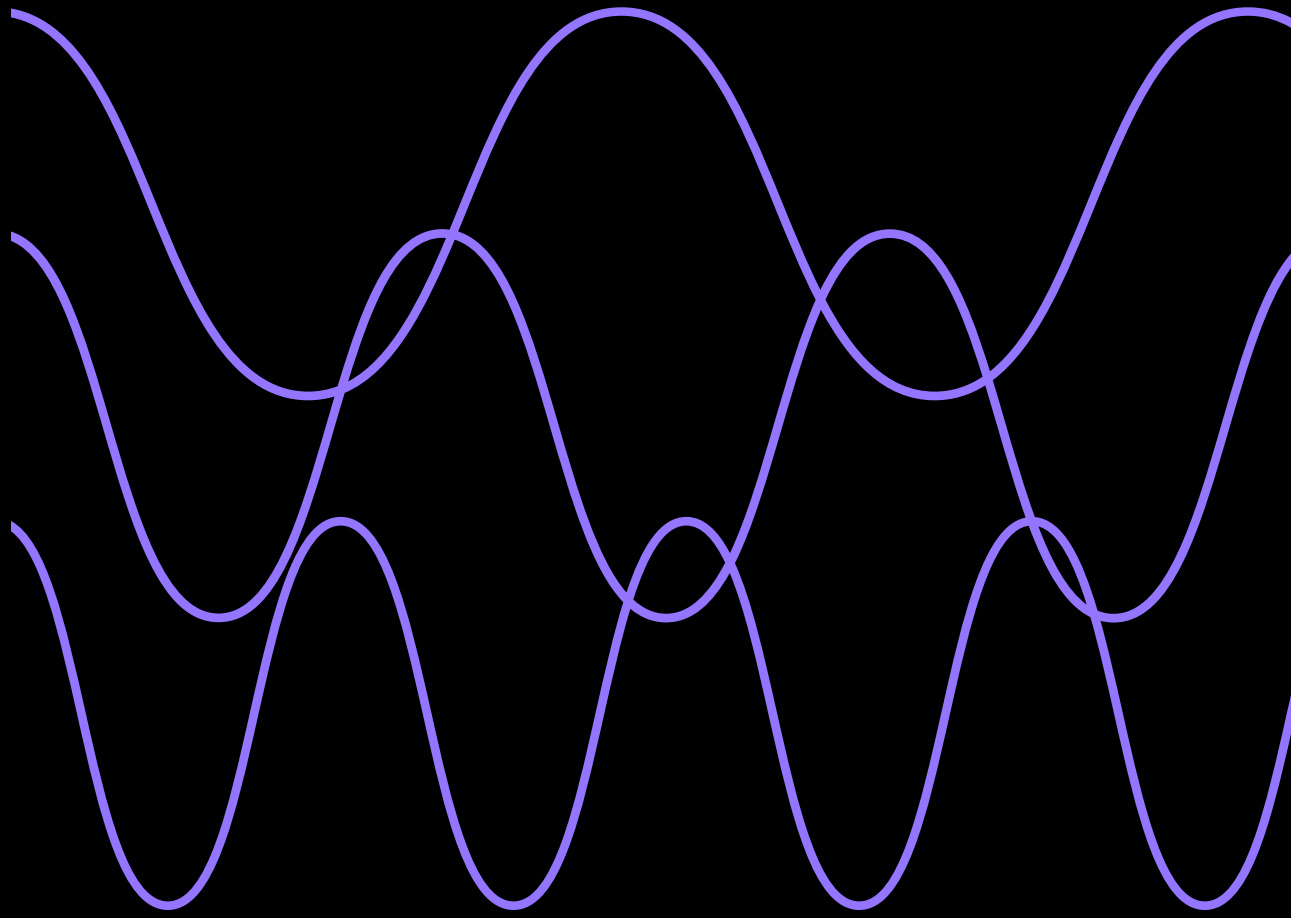
Thank you



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