

Market and Technology Overview on Emitters for LiDAR Sensors

DVN AM LiDAR Conference 2022 in Wiesbaden



30 NOV.
01 DEC.
2022
FRANKFURT

DVN
Lidar

SAVE THE DATE
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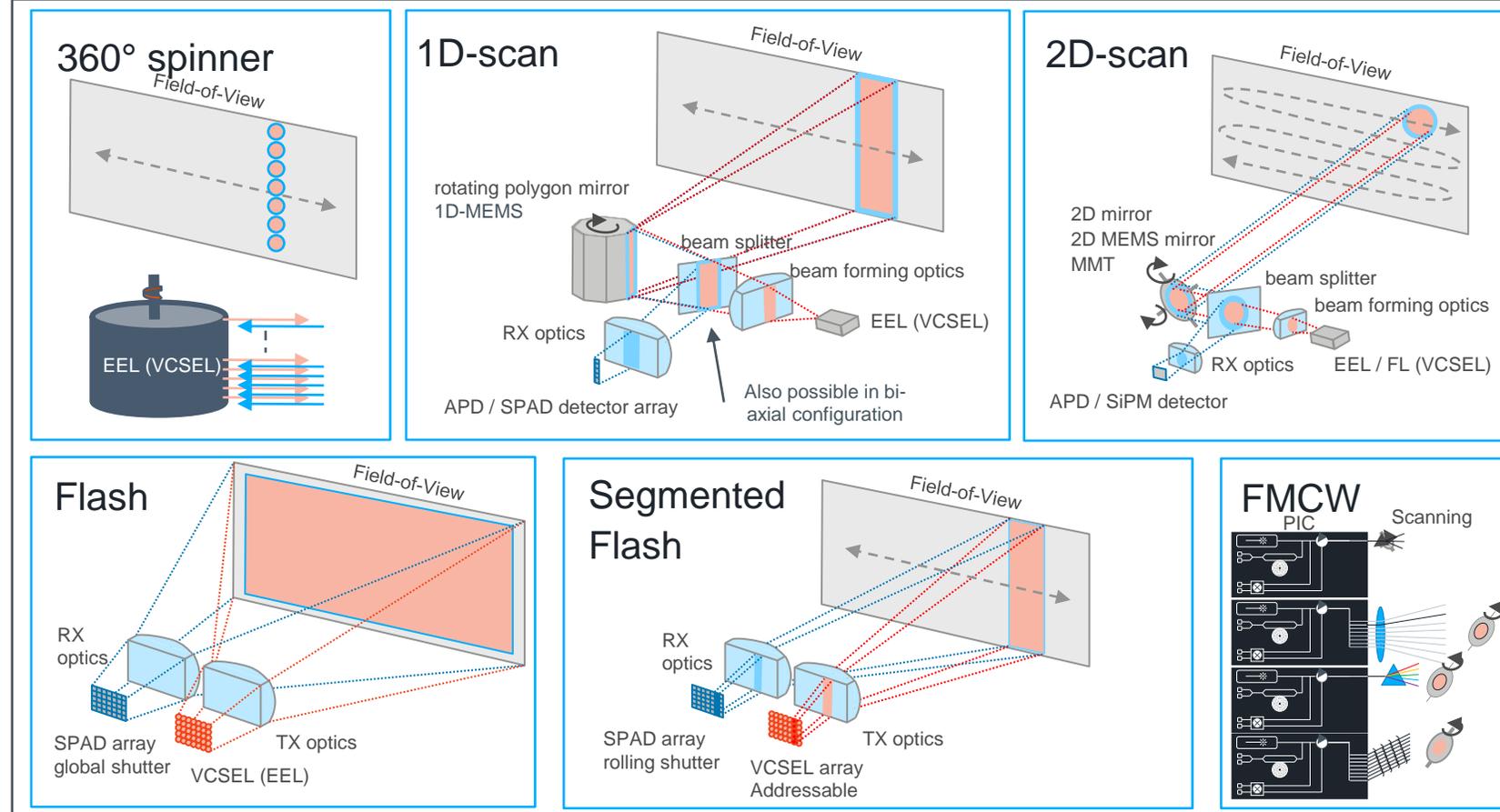
**DVN AUTOMOTIVE
LIDAR CONFERENCE
& EXPO**

Clemens Hofmann, Senior Principal Engineer LiDAR, ams-OSRAM International GmbH
2022-21-01

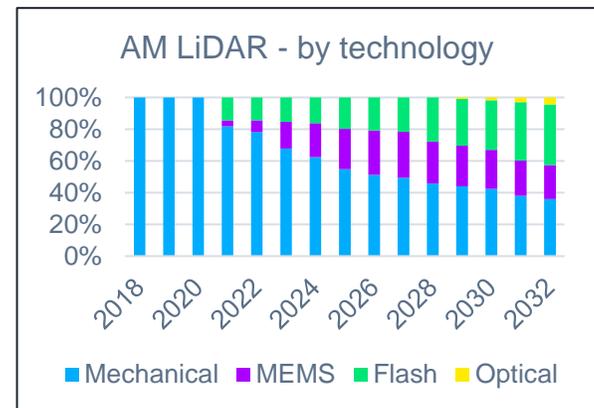
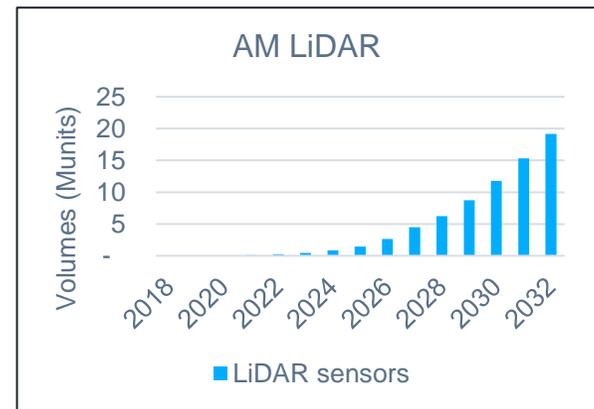
Technology solutions for AM LiDAR

LiDAR solutions with a mechanical scanner will dominate the market, flash is appearing

LiDAR Technologies – Scanning / Flash Systems



LiDAR Market Trends

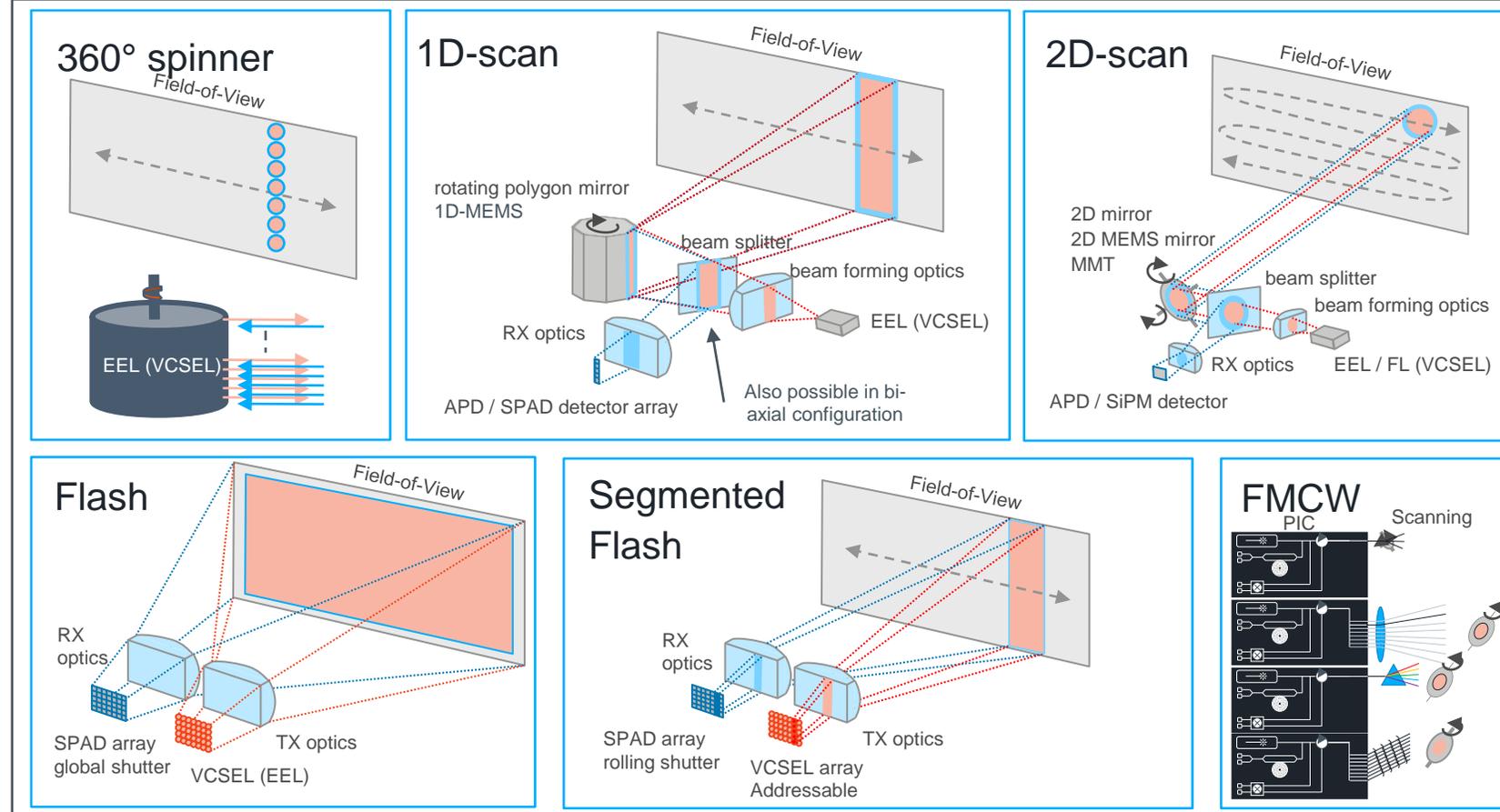


Yole LiDAR report Aug. 2022

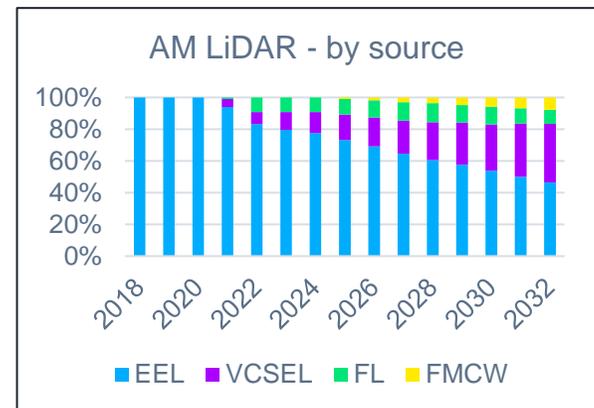
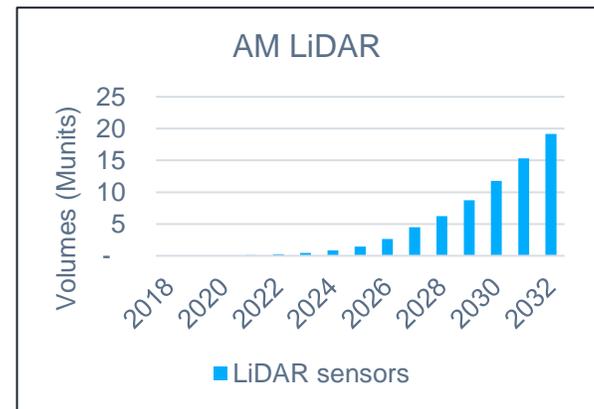
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LiDAR Market Trends



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Technology solutions for AM LiDAR

1550nm will remain niche market during the coming years due to high cost and technological hurdles

SWIR (1550nm) Technology Comparison – SWIR EEL / Fibre Laser / FMCW

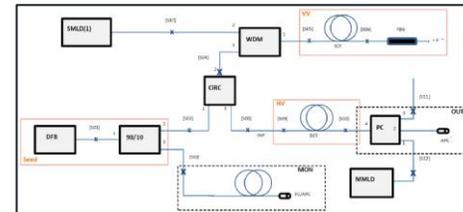
SWIR EEL

- not efficient enough to allow meaningful eye-safety limited LiDAR system, no penetration expected



Fibre laser

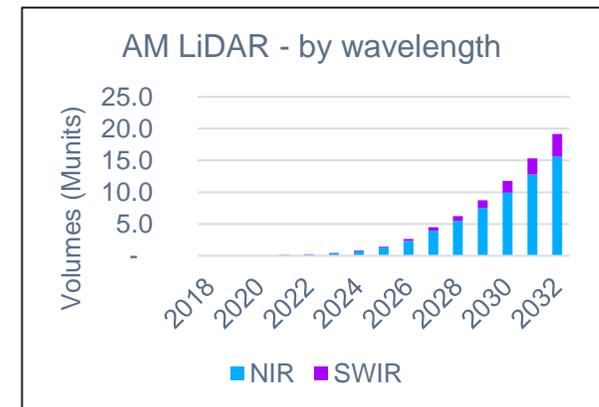
- market share is getting lower, as high cost forces it into cost-insensitive niche markets



LinkedIn

- Fiber Laser specs: 300 @ 10%, 1000m max, 128° x 28° @ 0.05° x 0.075°, 10Hz
- Resolution: 40cm height @ 300m, 1.3m @ 1000m
- Energy: assuming 2ns, 2kW, 10% → 400W energy consumption

LiDAR Market Trends



Yole LiDAR report Aug. 2022

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SWIR EEL

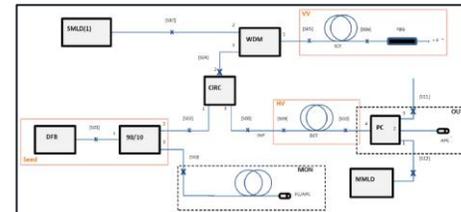
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Fibre laser

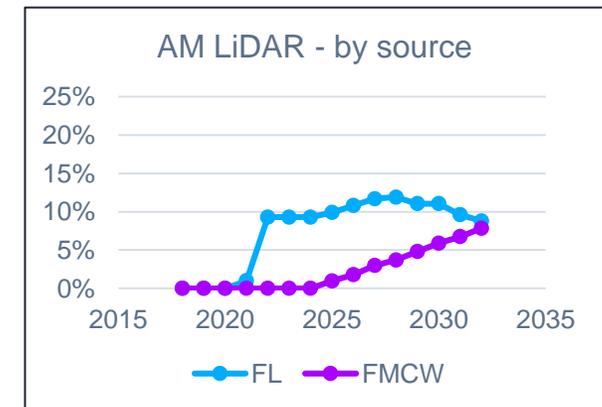
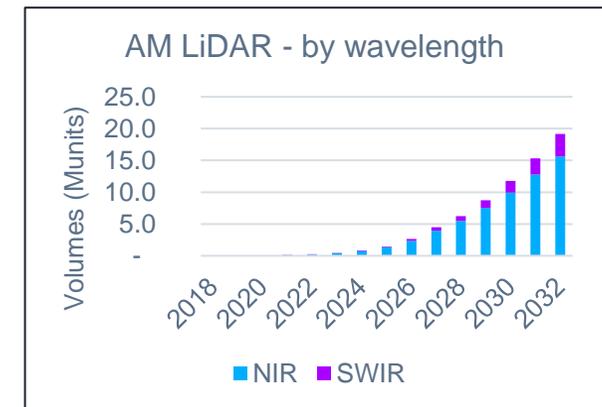
- market share is getting lower, as high cost forces it into cost-insensitive niche markets

FMCW

- Technical and financial hurdles for FMCW very high, leading to expected delay in introduction
- Scanning is complicated and time-consuming: a high parallelization will be required (emitter & sensor) to reach sufficient resolution
- Cost pressure will require a full Si-integration, as parallelization will be unfeasible expensive otherwise



LiDAR Market Trends



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SWIR EEL

- not efficient enough to allow meaningful eye-safety limited LiDAR system, no penetration expected

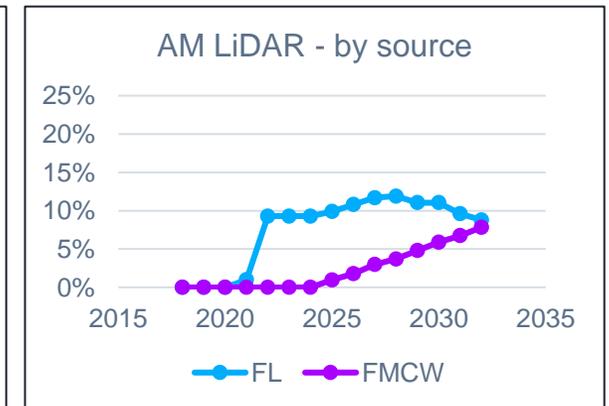
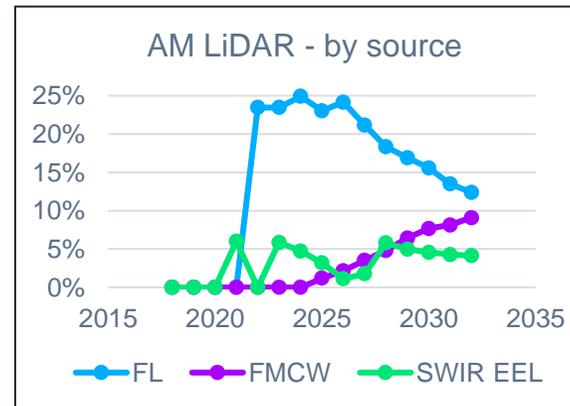
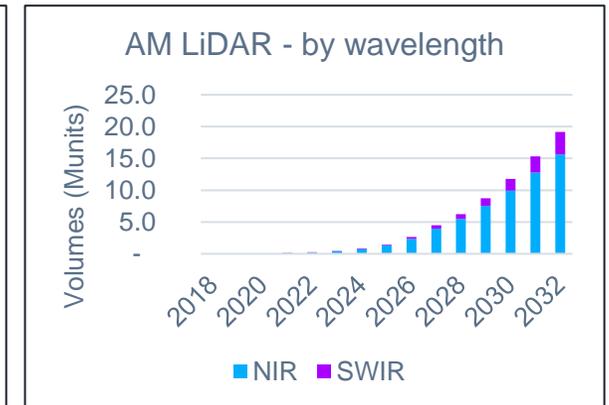
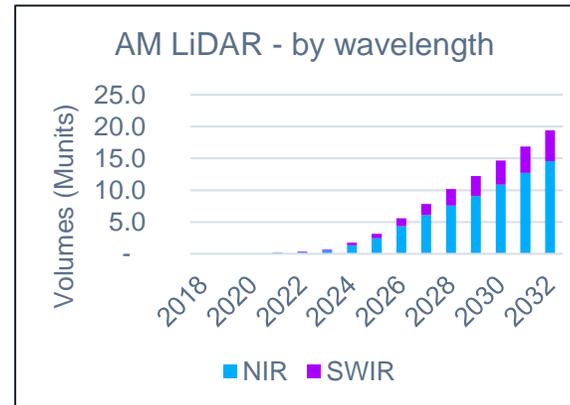
Fibre laser

- market share is getting lower, as high cost forces it into cost-insensitive niche markets

FMCW

- Technical and financial hurdles for FMCW very high, leading to expected delay in introduction towards 2030+
- Scanning is complicated and time-consuming: a high parallelization will be required (emitter & sensor) to reach sufficient resolution
- Cost pressure will require a full Si-integration, as parallelization will be unfeasible expensive otherwise

LiDAR Market Trends



2021

Yole LiDAR report Sep. 2021

2022

Yole LiDAR report Aug. 2022

Technology solutions for AM LiDAR

NIR EEL + VCSEL solutions dominate the LiDAR space

NIR (850/905/940nm) Technology Comparison – EEL / VCSEL

Technology: EEL versus VCSEL

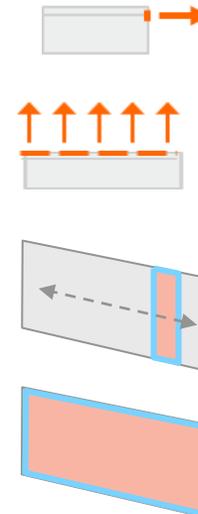
- EEL: Higher power density implies smaller emitter optics for scanning LiDAR
- EEL: Polarization enables coaxial system designs with higher efficiency
- VCSEL: Narrow spectral linewidth enables smallest bandpass for VCSEL.

Technology: Flash versus Scanning

- Scan: Larger optical aperture per detector pixel for same size gives higher SNR
- Scan: Resolution not limited by 2D SPAD pixel count
 - Short Range LiDAR: $160^\circ \times 90^\circ @ 0.4^\circ \rightarrow 400 \times 225$ pixel
 - Sony IMX459: 192×56 pixel
- Flash: No moving parts for global and rolling shutter flash systems

Use cases

- NIR EEL and VCSEL rely on mature technology, proven in the market
- TJP / HWP: EEL are most suitable light sources for long range scanning LiDAR systems
- Parking / Urban: flash VCSEL or scanning EEL are a good match for short range LiDAR



LiDAR Market Trends

AM LiDAR - by wavelength



AM NIR LiDAR - by source



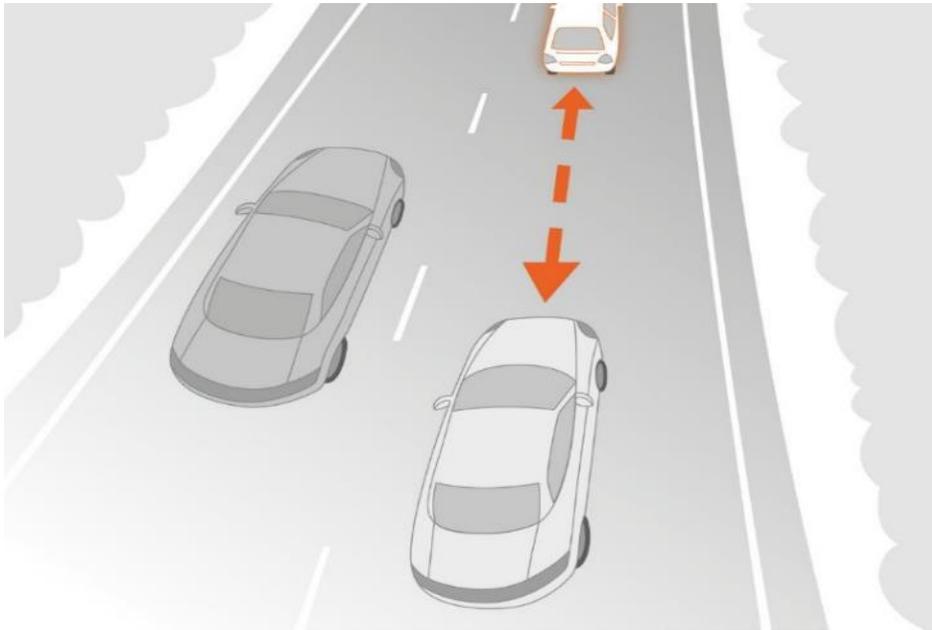
Yole LiDAR report Aug. 2022

ams OSRAM EEL for LiDAR – Track Record

OS has been at the forefront of developing the LiDAR market for over a decade

Short-range-LiDAR – Cam System

First use of LiDAR since early 2000s




905 nm pulse Laser,
75 W, 20 ns

>10 car models use laser based AEB¹ systems with OSRAM's 905nm laser already today

Pioneer role and a proven track record

>10 Mio

LiDAR lasers in the field (~ 200 billion km) without *chip failures*

>200 BN

Kilometers covered in autonomous driving with OS lasers

>€ 200 Mio

In cumulative LiDAR sales thus far

EEL Market Leader



- ✓ ams OSRAM is the leader in EEL technology for LiDAR with a high market share
- ✓ Industry leading product portfolio and reliability
- ✓ Automotive as part of our DNA

ams OSRAM EEL for LiDAR – Edge Emitting Lasers

ams OSRAM has technology leadership in NIR EEL for LiDAR Application

AM EEL Package Product Portfolio

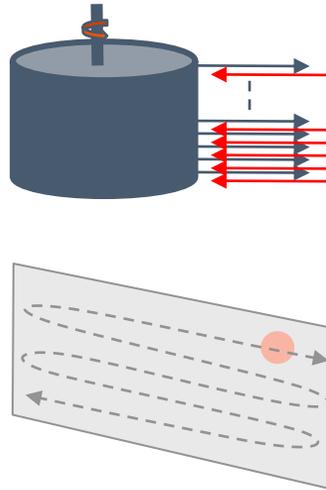
65W / 125W



AEC-Q102 qualified

small size of bare die facilitates compact form factor and higher number of lines

Small Etendue enables 2D MEMS scanning

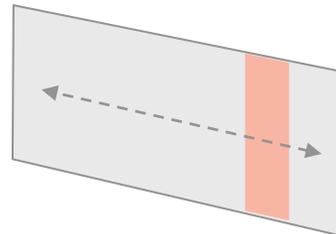


500W and beyond

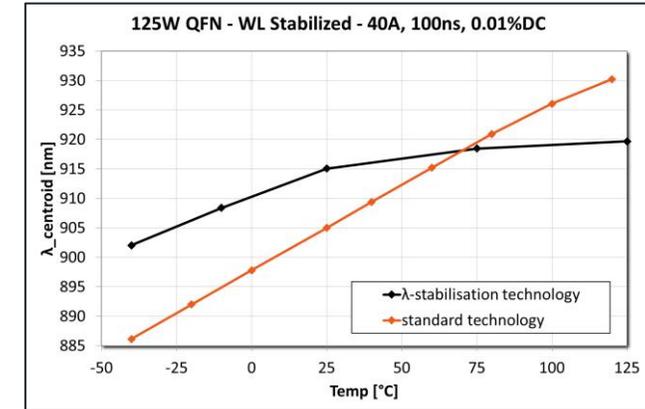


AEC-Q102 qualified

High power needed for 1D-scanning



EEL Technology Roadmap



Wavelength stabilization

- Strongly reduced shift over temperature (0°C - 105°C Ta)
- ams OSRAM simulation and market feedback suggest that this can lead up to ~40% range increase due to higher SNR

Application improvements

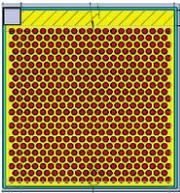
- Wavelength stability and higher power enables higher **range**
- Higher number of junctions allows easier **driver** design
- Smaller aperture enables higher **resolution** or smaller optics

ams OSRAM EEL for LiDAR – Vertical Cavity Surface Emitting Lasers

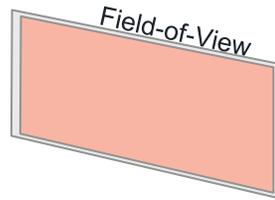
ams OSRAM has technology leadership in NIR EEL for LiDAR Application

AM VCSEL Package Product Portfolio

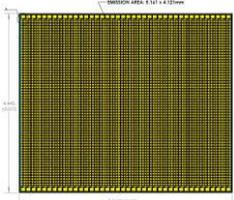
Global shutter



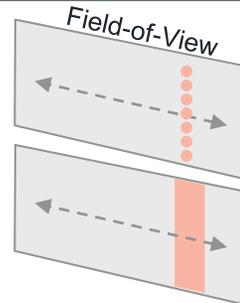
- Pairing with Global Shutter SPAD receivers
- Higher power densities allow smaller chip or longer range



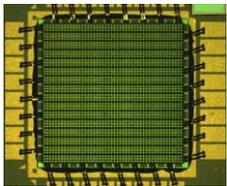
1D Addressable



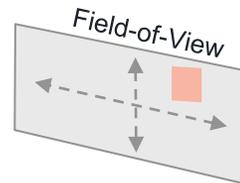
- Matched with rolling shutter SPAD receivers (row, column)
- Two design concepts:
 - 1:1 pixel relationship
 - Homogeneous line



2D Addressable



- Matched with rolling shutter SPAD receivers (sections)
- Increased # of segments vs 1D addressable VCSEL



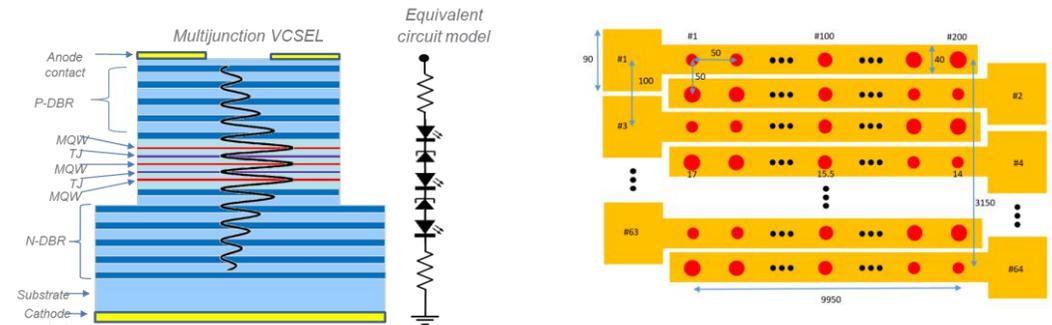
VCSEL Technology Roadmap

Power density

- increase number of junctions
- increase aperture fill factor

Segmentation

- optimize VCSEL-SPAD match in system



Summary

Key take aways

- **Scanning:** LiDAR solutions with a mechanical scanner will dominate the market, flash is appearing
- **Lightsource:** LiDAR solutions with an EEL will dominate the market, VCSEL is appearing
- **Wavelength:** NIR solutions will dominate the LiDAR space. 1550nm will remain niche market.

- Standardisation of LiDAR test method would make objective comparison of LiDAR sensors easier
- SPAD pixel count needs to increase to allow useful use cases in AM LiDAR

- **ams-OSRAM** has been at the forefront of developing the LiDAR market for over a decade and is well positioned to continue to do so

Sensing is life

ami OSRAM