Overview and trends of the different emitter type for LIDAR
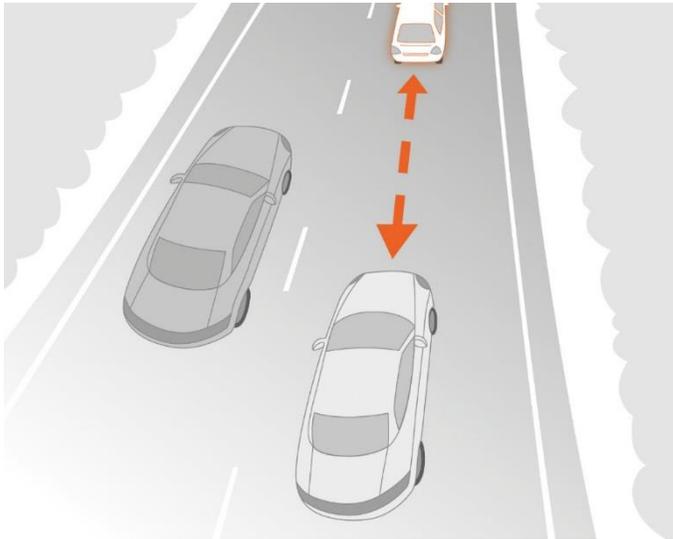
Mergl | 03.12.2019 | DVN – conference (Frankfurt)

Light is OSRAM

OSRAM
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OS is a long-time partner for lasers in the automotive industry

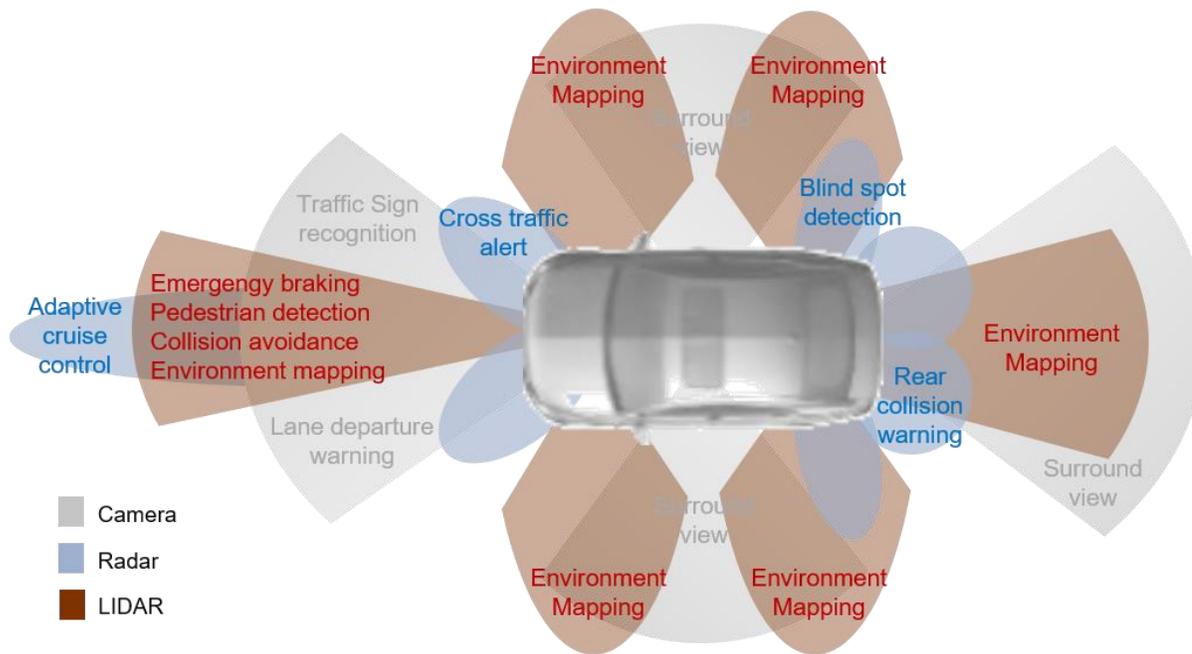## First use of LiDAR since early 2000s

905 nm pulse Laser,
75 W, 20 ns

More than 10 car OEMs use laser based AEB[1] systems with OSRAM´s 905nm laser already today

OS with pioneer role and a proven track record

- \> 10 year of LiDAR Laser supplier to automotive industry

- \> 10 million LiDAR lasers in the field without *chip failures*

- \> 200 Billion km

1) AEB: Auto emergency breaking

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The Future of Autonomous Driving

Environment Mapping

Environment Mapping

Surround view

Blind spot detection

Traffic Sign recognition

Cross traffic alert

Adaptive cruise control

Emergengy braking
Pedestrian detection
Collision avoidance
Environment mapping

Environment Mapping

Rear collision warning

Lane departure warning

Surround view

Environment Mapping

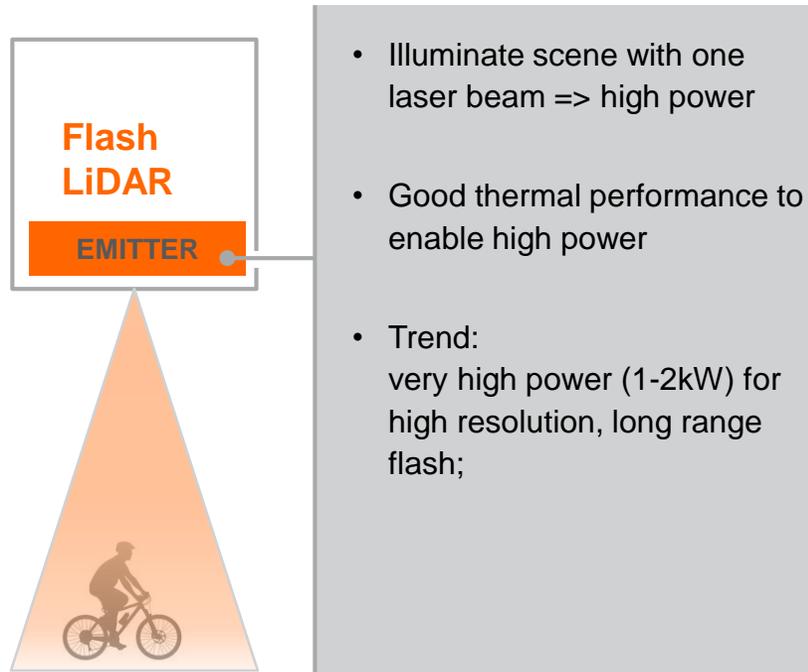Environment Mapping

Surround view

Camera
Radar
LIDAR

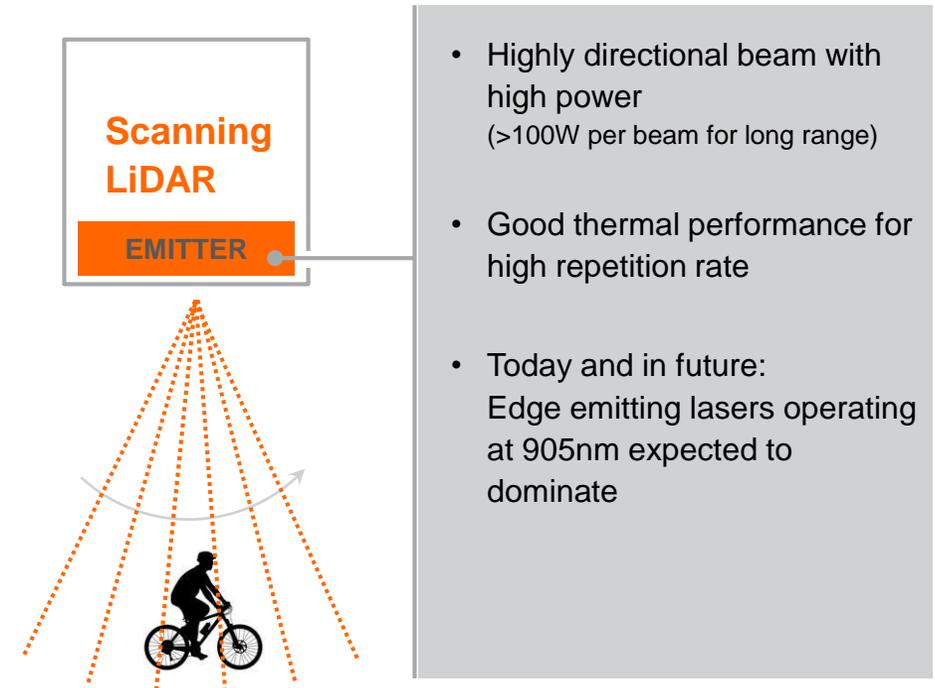Correlation technology ⇔ application is examplary only

Value propositions of different technologies (selection)

Camera   Color vision and ability to recognise signs

Radar   Speed detection / darkness

LiDAR   3D capability; high angular resolution / darkness

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Two basic LiDAR technologies

Flash LiDAR

EMITTER

- Illuminate scene with one laser beam => high power

- Good thermal performance to enable high power

- Trend:
  very high power (1-2kW) for high resolution, long range flash;

- The whole FOV is illuminated at once using a wide-angle beam

- No moving parts in the LiDAR module

Scanning LiDAR

EMITTER

- Highly directional beam with high power
  (>100W per beam for long range)

- Good thermal performance for high repetition rate

- Today and in future:
  Edge emitting lasers operating at 905nm expected to dominate

- Scanning, narrow emitter beam which is being moved across the FOV over time

- Mechanical solution or micro-mirrors used for beam steering

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Comparing - Near Infrared IR-A (905nm) vs Near Infrared IR-B (1550nm)

905nm will stay dominant LIDAR wavelength in the market due to superior emitter and detector performance
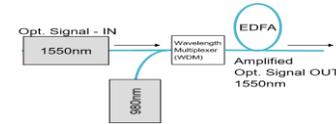
Key Parameter	EEL 905nm	EEL 1550nm	Fiber 1550nm
Laser technology	InGaAs/GaAs	InP / InGaAsP	980nm or 1480nm Pumping / Erbium doped Fiber
Peak Power	+	0	++
Beam quality	+	+	++
Compactness	++	+	0
Operating Temperature range	++	+	0
Cost	++	+	0
Water absorbtion [cm^-1]	+	0	0
Eye safety	+	++	++

Key Parameter	Sensor 905nm	Sensor 1550nm
Detector Technology	Si	InGaAs
Operation Temp. Range	++	+
Detector Noise	++	0
Cost	++	0
Integration of electronics	++	0

0   poor
+   good
++ very good

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Emitter comparison
Edge Emitting Laser vs. Vertical cavity surface emitting Laser

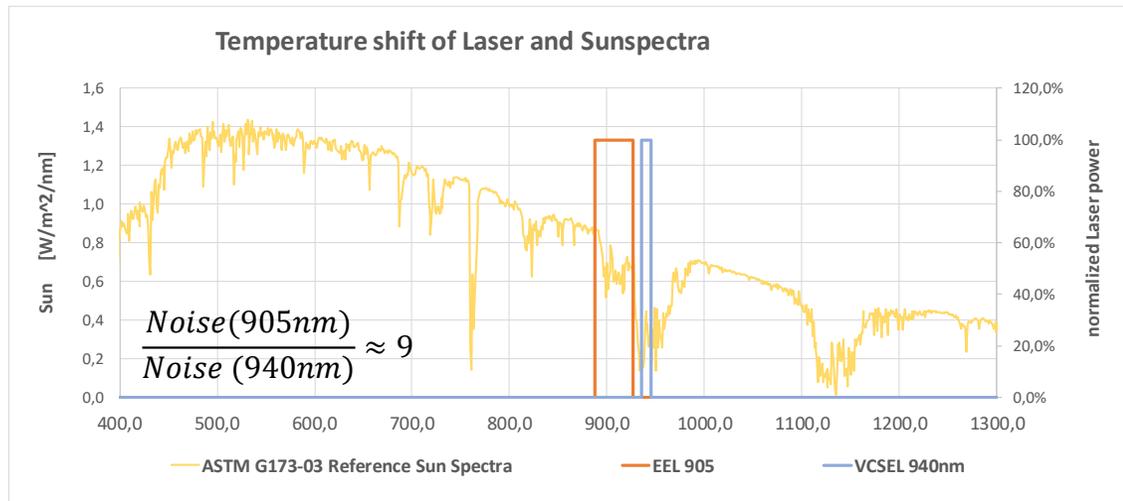**EEL dominate for long range scanning LIDAR due to high power density. VCSEL good alternative for Flash LIDAR**

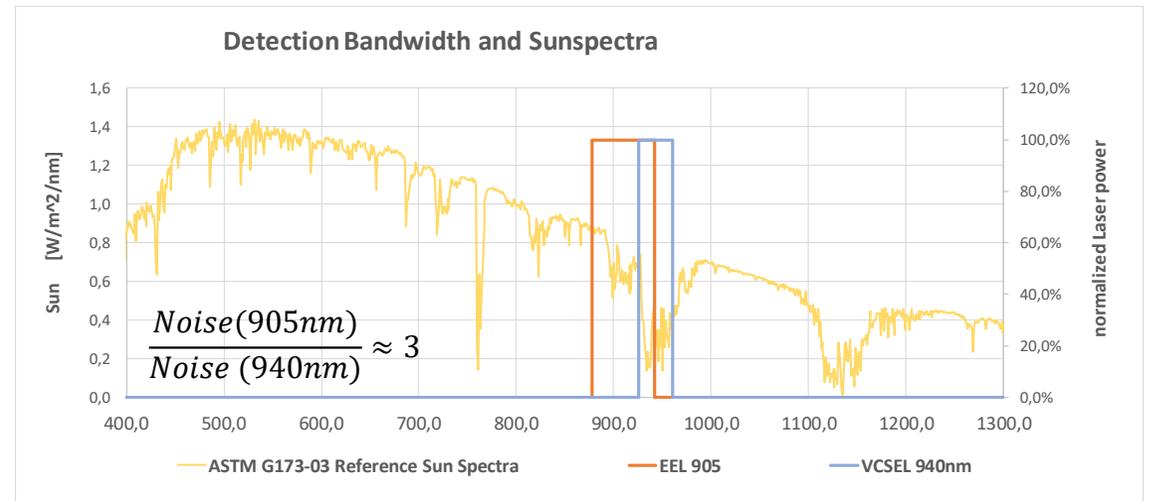| Parameter	EEL	VCSEL
Laser technology	InGaAs/GaAs	InGaAs/GaAs
Wavelength	905nm	850nm, 940nm
Emitting structure	Edge emitting	Surface emitting
Spectral width	± 3 nm	± 3 nm
Optical Power	Scales with Length	Scales with Area
Power density (emitted area)	~60 kW /mm²	~120 W/mm²
Slope efficacy	~3W/A	~1W/A
Radiation Characteristic	Elliptical	Gaussian
	e.g. ± (7° x 25°) design	e.g. ± 20° (design)
Wavelength shift vs. Tj	0.3 nm/K	0.07 nm/K
Temperature Range	-40°C … 105°C	-40°C … 105°C
Rise- and Fall time	< 1 ns	< 1 ns

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Sunspectrum and required detection bandwidth

The bigger Wavelength shift of the EEL905 has lower system influence as expected

Only Laser temperature shift considered

System Detection Bandwidth[2] (temperature, WL binning..)

Temperature shift of Laser and Sunspectra

$$\frac{Noise(905nm)}{Noise(940nm)} \approx 9$$

Legend: ASTM G173-03 Reference Sun Spectra — EEL 905 — VCSEL 940nm

Detection Bandwidth and Sunspectra

$$\frac{Noise(905nm)}{Noise(940nm)} \approx 3$$

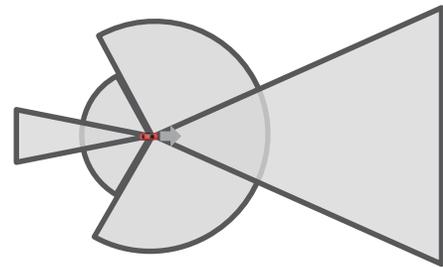Legend: ASTM G173-03 Reference Sun Spectra — EEL 905 — VCSEL 940nm

- Temperature Range of -40°C to 105°C

- Depending on bandwidth we integrate over a given wavelength range of the ASTM reference spectrum -> NOISE

LIDAR Technologies
Different LiDAR systems may require different light sources

High Power VCSEL is under evaluation at OSRAM OS

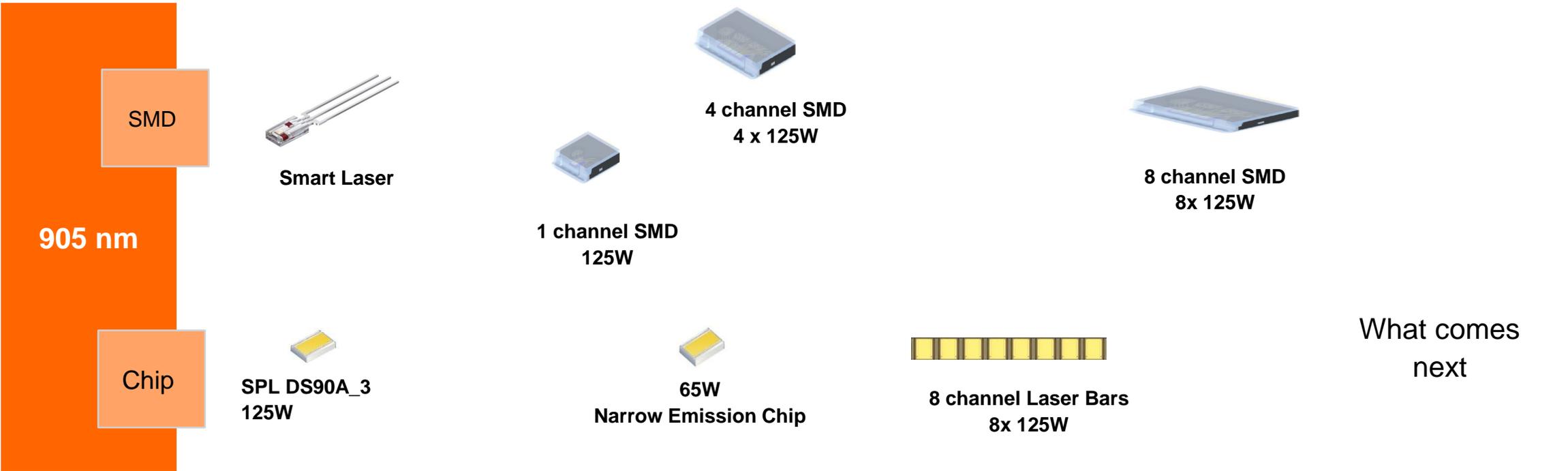|	Short Range 0 m – 40 m City Traffic, Autobahn lane change	Mid Range 1 m – 90 m City Traffic, Country Road crossing Autobahn rear view	Long Range 1 m – 200 m (250m) Autobahn, long distance view
Flash LiDAR	EEL VCSEL	EEL VCSEL (high power)	EEL VCSEL (high power)
MEMs LiDAR	EEL VCSEL	EEL VCSEL (high power)	EEL VCSEL (high power)
Mechanical Scanning LiDAR	EEL VCSEL	EEL VCSEL (high power)	EEL VCSEL (high power)

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Portfolio Development: EEL for LiDAR

Today

Future

905 nm

SMD

Chip

Smart Laser

1 channel SMD
125W

4 channel SMD
4 x 125W

8 channel SMD
8x 125W

SPL DS90A_3
125W

65W
Narrow Emission Chip

8 channel Laser Bars
8x 125W

What comes next

In Mass Production today …

… and Future concepts

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Portfolio Investment

VCSEL

Today   **Future**

Consumer   **Automotive interior**   **LIDAR**

BIDOS
PLPVQ 940A

0.6 W

BIDOS
PLPVCQ 850
PLPVCQ 940

2 W

BIDOS
PLPVEC2 850
PLPVDC2 940

3-4 W

BIDOS
PLPVCQ 940A_P
PLPVCQ 940B_P

2 W

BIDOS
Automotive

4W
FOV (h x v) 120° x 90°
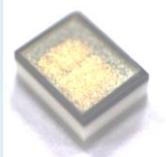
BIDOS
Automotive

3 W
FOV (h x v) 47° x 35°

VCSEL array concepts
For LIDAR

Multichip arrays, Multichanel

Single chip solutions

What comes next

- In Production

- Samples available 2020
- Automotive release Q4 2020

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Thank you.

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