The three most important LiDAR facts avoiding integration into headlamps today

03. December 2019, Frankfurt

Johannes Brill

The New… Established… Global player

7th

Largest Independent Automotive Supplier

* Automotive News 2018

14,6B €

Total Sales Turnover

* based on 2018 figures JPY 1.825 B

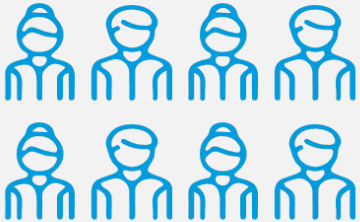
170

Locations Worldwide

* Plant, R&D center, application centers

62.000

Global Employees

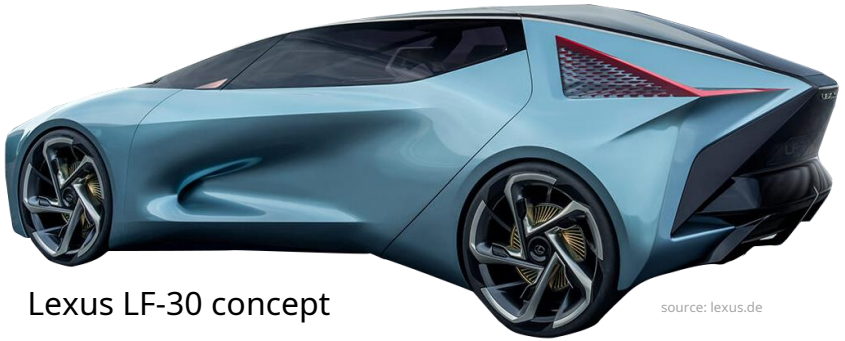


Capabilities Make Us Ready for the Future of Mobility

FUTURE MOBILITY

source: audi.com

Audi AI.CON



Lexus LF-30 concept

source: lexus.de

REALITY 2019

Waymo's self-driving Chrysler Pacifica

source: waymo.com

Uber / Volvo's self-driving XC 90

source: volvocars.com

Mercedes-Benz ESF 2019

source: media.daimler.com

SENSOR INTEGRATION IN LAMPS

Headlamps and rear lamps allow to integrate sensors in an optimized styling.
Lamps hardly influence the shape of the vehicle and give more freedom to generate an aesthetical design.

CES INNOVATION AWARDS 2019 HONOREE

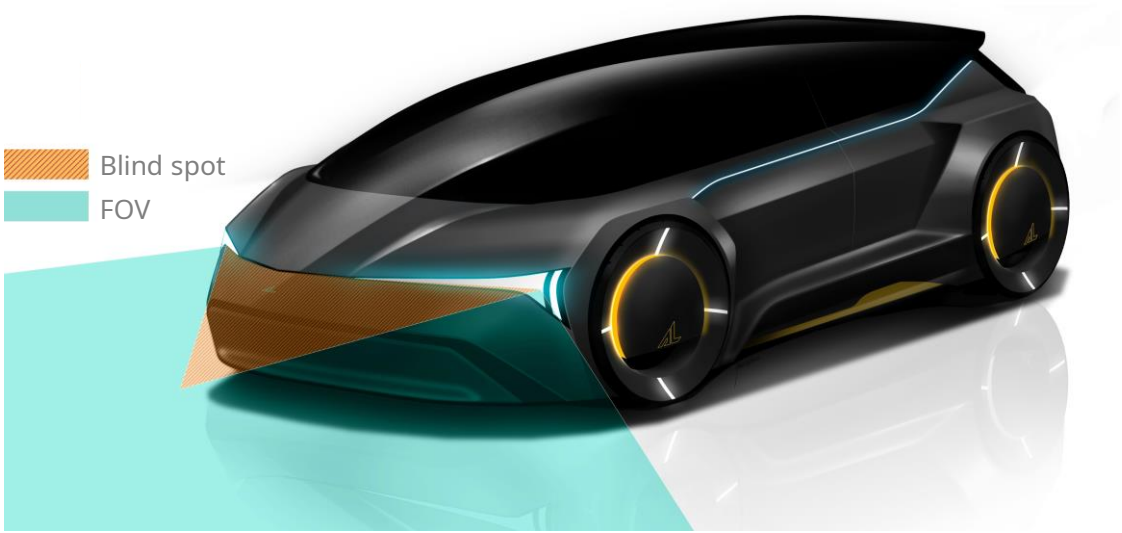
Honoree in the Vehicle Intelligence and Self-Driving Technology category

Integration in headlamps

Integration in rear lamps

BENEFITS FOR INTEGRATION

In addition to aesthetical design reasons there are technical reasons for integration. Sensors will naturally migrate to the corners - one of the best sensor location for front/side Field Of View (FOV).



- AESTHETICAL INTEGRATION
- FIELD OF VIEW
- THERMAL MANAGEMENT
- LEVELLING
- CLEANING SYSTEM
- HEATING SYSTEM FOR LENS
- PRECALIBRATION SENSORS

MILESTONES OF LIGHTING TECHNOLOGIES

1987

Projector Type headlamp with aspheric inner lenses and reflector surfaces

2005

AFS (HID) with **Infrared Emitter** (source H7) with ANV (Active Night Vision)

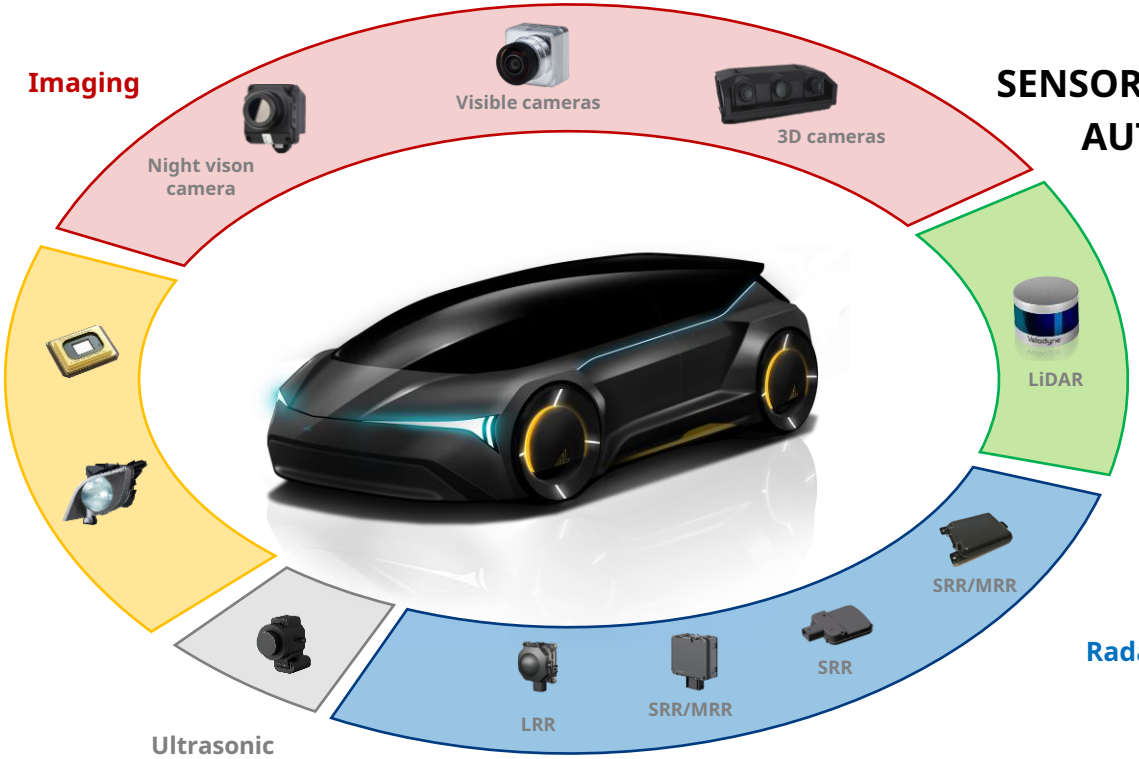
2013

Camera-controlled **All-LED** headlamp with ANV in **IRED**-technology

2018

First **High Resolution** Projector headlamp with DLP-technology and **IRED**-technology

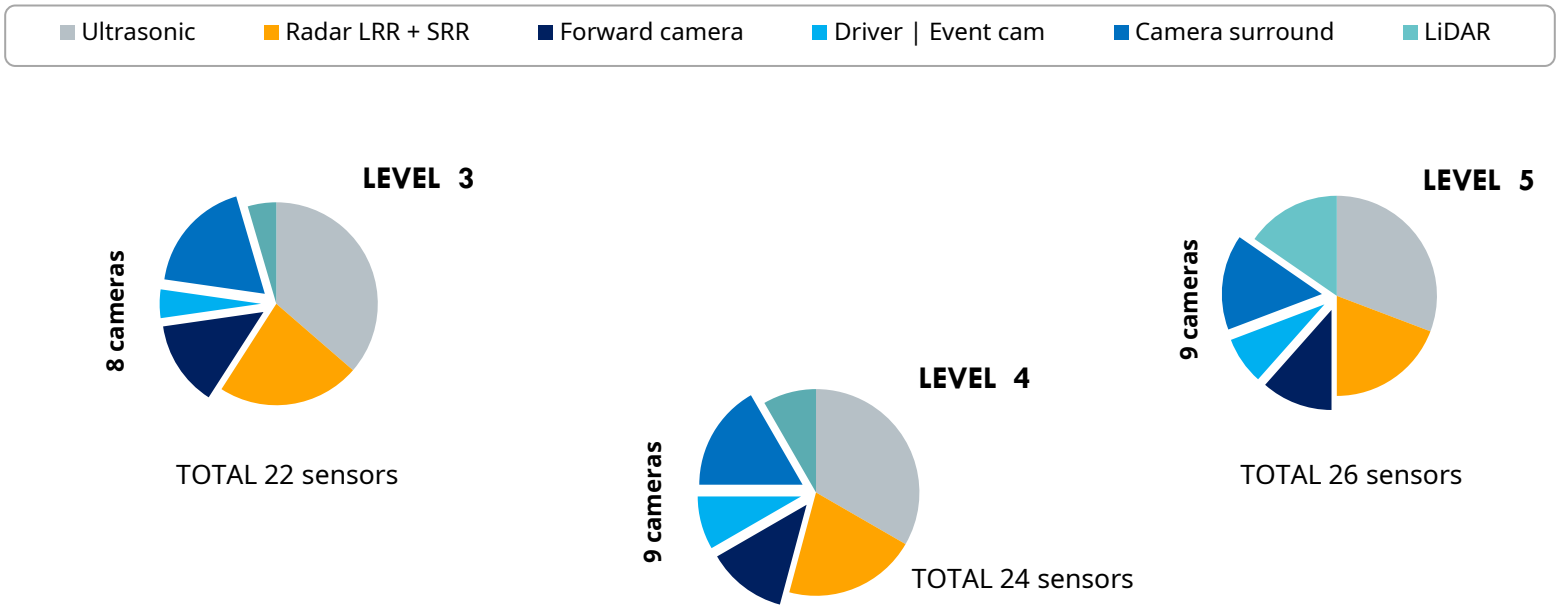
DOES AUTONOMOUS DRIVING NEED GOOD LIGHTING ?



source: Yole LiDAR Report, 2018

DOES AUTONOMOUS DRIVING NEED GOOD LIGHTING ?

SENSOR MODULE NUMBER FOR EACH AUTOMATION LEVEL



Cameras remain an important sensor for AD / ADAS and is the main sensor use for Advanced Front Lighting Systems

LIDAR INTEGRATION

VALIDATION 03

Thermal restrictions of the headlamp.

OPTICAL PATH 02

Influences of the headlamp outer lens on the performance of the LiDAR.

DIMENSIONS 01

Evaluation of the sizes of recent light modules vs. selected Long Range LiDAR modules.

DIMENSIONS WE DEAL WITH

INTEGRATION

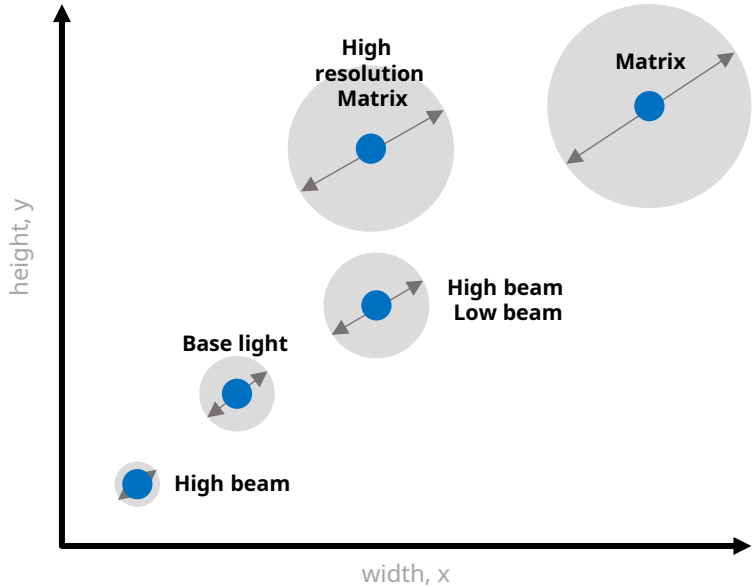
01

LIGHT MODULES

Size of current light modules and the corresponding power consumption

Legend
- module size
- power consumption

SIZES OF RECENT LIGHT MODULES



DIMENSIONING OF LIGHT MODULES

Matrix Light module

SIZE DOES MATTER !

INTEGRATION

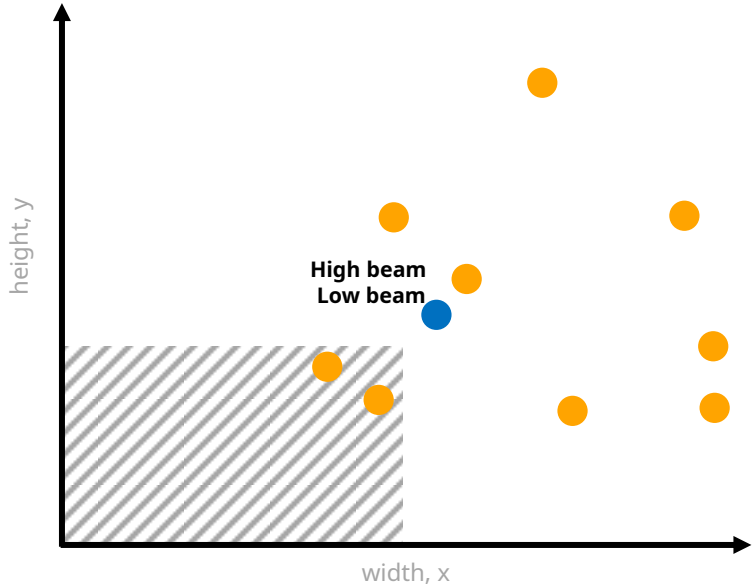
01

LiDAR MODULES

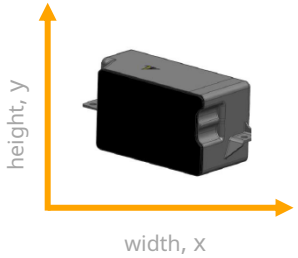
Size of selected Long Range (LR) LiDAR modules

Legend
- module size LiDAR
- light module size

SIZES OF SELECTED LR LIDAR MODULES



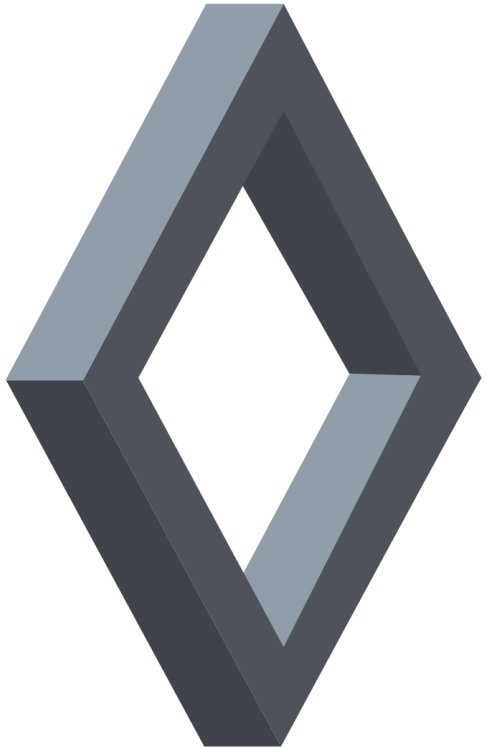
DIMENSIONING OF LR LiDAR MODULES



Long range LiDAR

01

CONCLUSION
DIMENSIONS



Limited space in the headlamp

Reduce LiDAR size

Reduce number of lighting modules

Extension of headlamp

IMPACT OF THE OUTER LENS

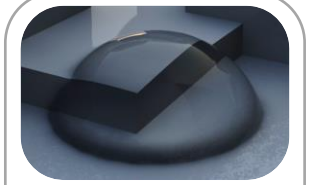
INTEGRATION

02

OUTER LENS DESIGN

Optical distortions caused by the outer lens

OPTICAL DISTORTION

	Fresnel reflection losses	Beam deflection	Beam distortion
			
effect	reduction of light intensity/ power	change of beam direction	change of beam profile
prevention	incident angle	angle between inner and outer surface	angle between inner and outer surface

source: wikipedia CC BY-SA 3.0 (author Nico2panama)

IMPACT OF THE OUTER LENS

INTEGRATION

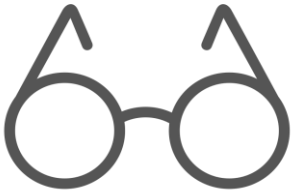
02

LIGHT MODULES

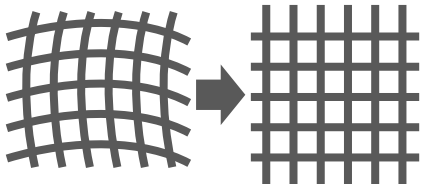
Impact of outer lens on

Outer lens
=
STYLING ELEMENT

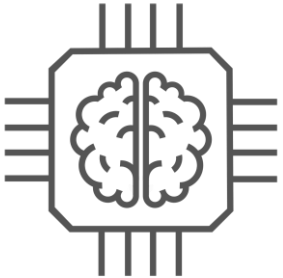
CORRECTION OF OUTER LENS



OPTICAL



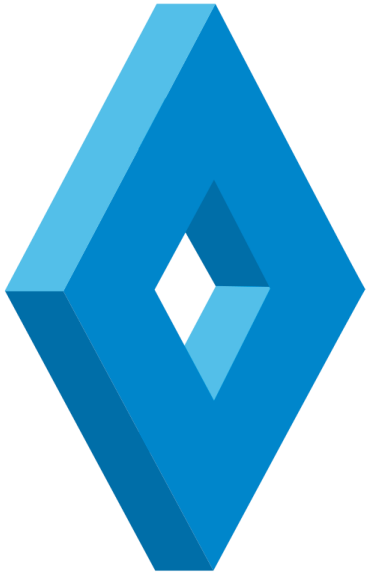
SOFTWARE



INTELLIGENT
SELF-LEARNING SYSTEM

02

CONCLUSION
OPTICAL PATH



3D-shaped outer lens = Influence on the performance

Adaption of styling

Correction optical

Correction by software

VALIDATION

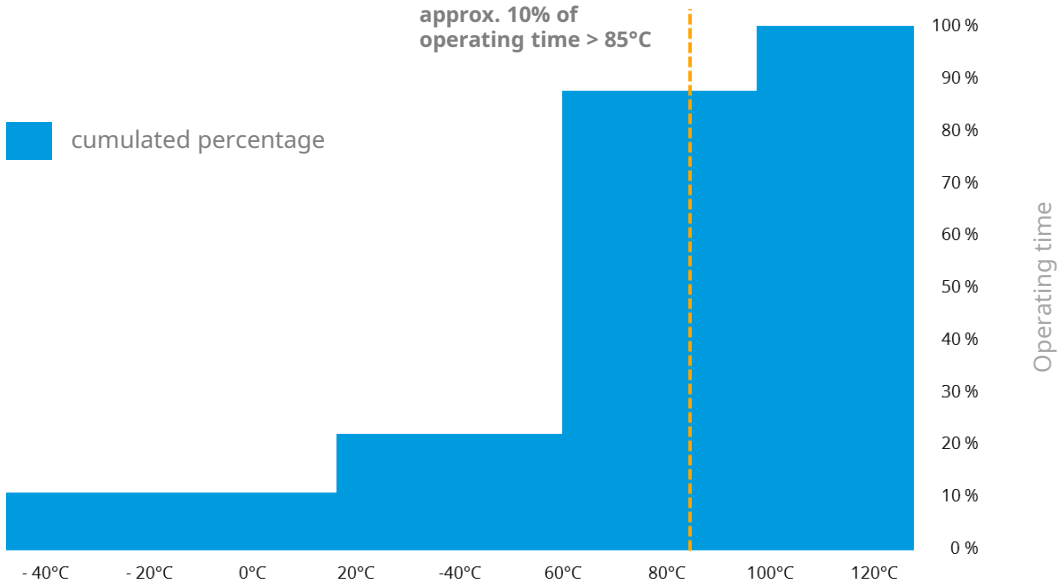
INTEGRATION

03

MISSION PROFILES

Define mission profiles for the entire system.

TEMPERATURE MISSION PROFILE



VALIDATION

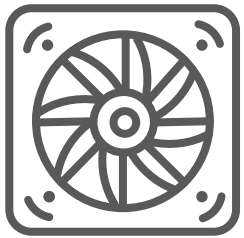
INTEGRATION

03

THERMAL MANAGEMENT

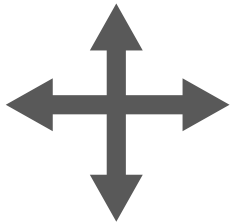
Guarantee the operation of the sensitive components.

OPTIMIZE ENERGY BUDGET



COOLING SYSTEM

DIM LIGHTING



TUNABLE LIDAR LIGHT DISTRIBUTION

PREDICTIVE THERMAL MANAGEMENT

03

CONCLUSION
VALIDATION

Keep power consumption manageable to ensure acceptable temperatures

Define mission profiles

Dim light / Predictive TM

Adapt LiDAR light distribution

SMART CORNER™ BENEFITS AND VALUE

Modularity and Sensor Integration Enables Efficiency for the OEM "Plug and Play"

ADAS/AD Sensors

Radar
Lidar
Camera
FIR camera
...open architecture and/or local data fusion

Cleaning & Heating

Washer system
Heating system
Protective Coatings

Advanced Lighting System

Savings

Brackets
Wire harnesses
Installation time OEM
Space
Weight

SENSOR APPROACH OF AUTOMOTIVE LIGHTING

We will develop or integrate any sensor combination required to support the OEM AD/ADAS strategy.

LiDAR

Development of next generation Solid State LiDAR in **modular approach** through partnerships

OTHER SENSORS

source: Yole – Radar and Wireless for Automotive Market and Technology Trends 2019

Provided by partners or as imposed part

STAND ALONE UNIT ⇔ **SMART CORNER™**

AUTOMOTIVE LIGHTING | MARELLI

Thank you!

SMALLER SYSTEMS
‘Limited space‘

SMARTER SYSTEMS
‚Intelligent or self-learning‘

SUSTAINABLE SYSTEMS
‘Optimizing energy budget‘