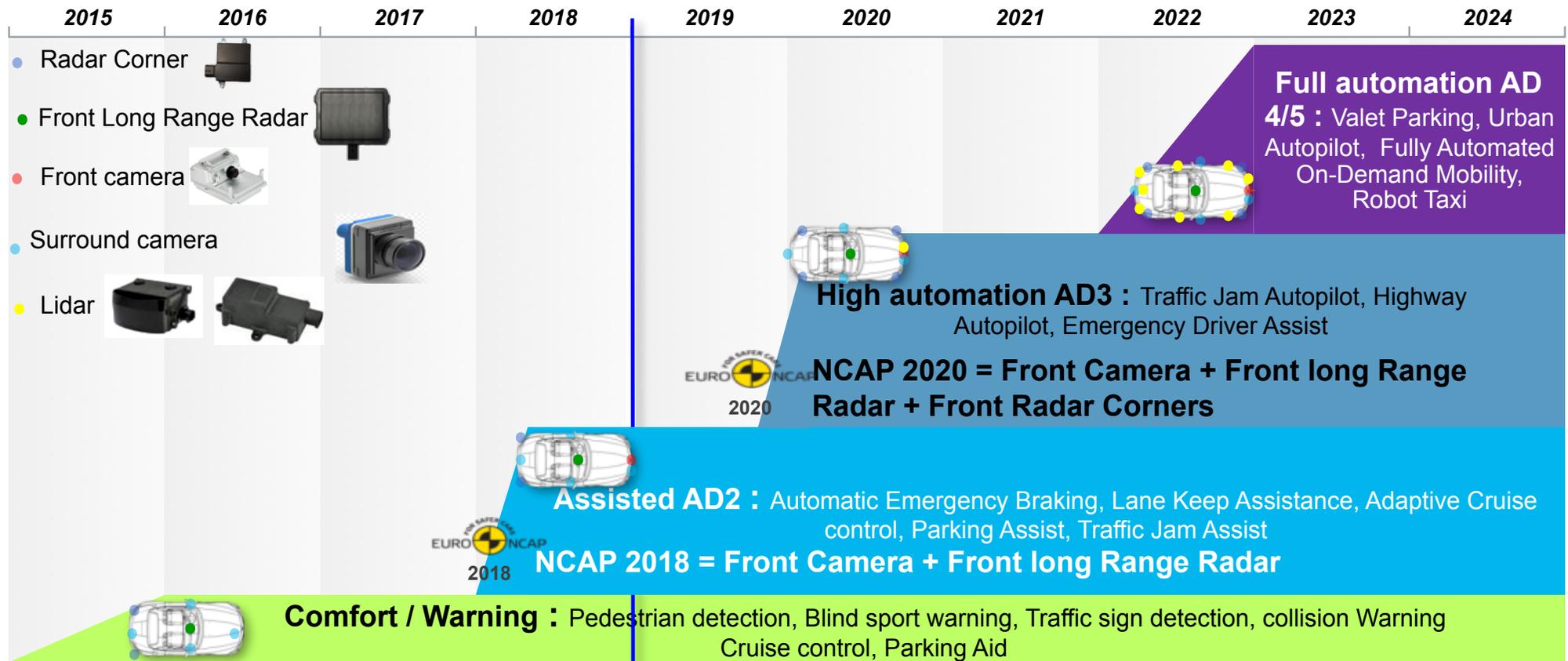# Augmented Visibility with cleaned Lidar Headlamp System
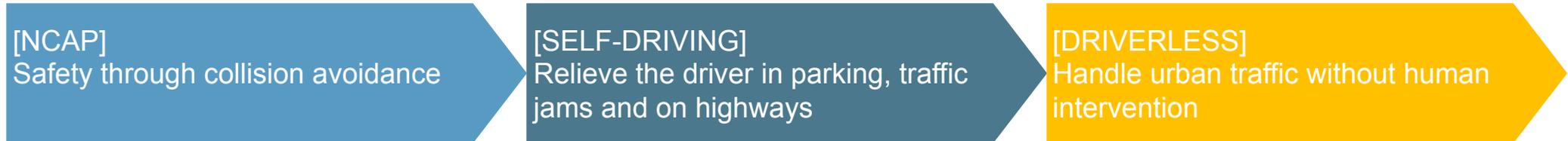
Laurent EVRARD
DVN CONFERENCE ON LIDAR
Frankfurt, November 20th 2018

Autonomous Driving- Road Map Technology

2015	2016	2017	2018	2019	2020	2021	2022	2023	2024

- Radar Corner
- Front Long Range Radar
- Front camera
- Surround camera
- Lidar

Full automation AD
4/5 : Valet Parking, Urban Autopilot, Fully Automated On-Demand Mobility, Robot Taxi

High automation AD3 : Traffic Jam Autopilot, Highway Autopilot, Emergency Driver Assist

EURO NCAP 2020

NCAP 2020 = Front Camera + Front long Range Radar + Front Radar Corners

Assisted AD2 : Automatic Emergency Braking, Lane Keep Assistance, Adaptive Cruise control, Parking Assist, Traffic Jam Assist

EURO NCAP 2018

NCAP 2018 = Front Camera + Front long Range Radar

Comfort / Warning : Pedestrian detection, Blind sport warning, Traffic sign detection, collision Warning Cruise control, Parking Aid

Main Market Driver (Volumes) is NCAP

Augmented Visibility with
cleaned Lidar Headlamp System

Valeo

Sensor vehicle position evolves with the level of automation

[NCAP]
Safety through collision avoidance

[SELF-DRIVING]
Relieve the driver in parking, traffic jams and on highways

[DRIVERLESS]
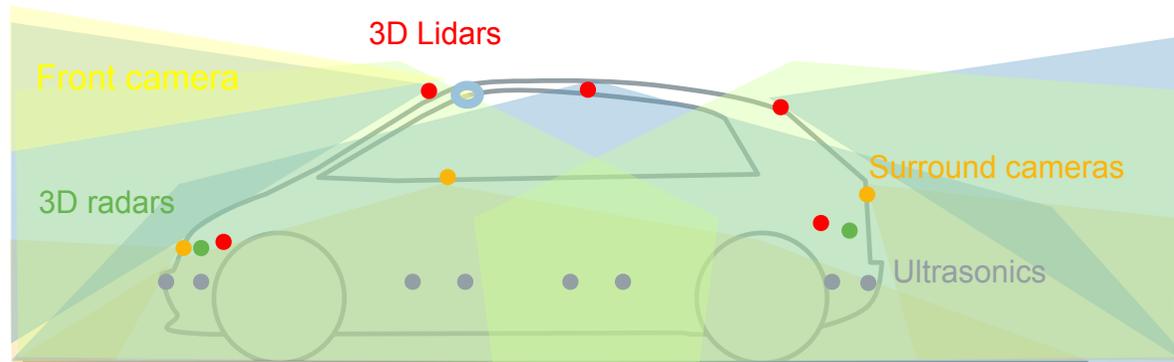Handle urban traffic without human intervention

Front camera

Behind windshield for driver point of view and windshield cleaning

Corner radars

Bumper/Fascia with effects from painting

Headlamps / Taillamps

3D Lidars

Front camera

3D radars

Surround cameras

Ultrasonics

Camera Cocoon

Pod-like position above the waistline

Grill, mirrors and handle/ CHMSL, Headlamps/Taillamps for below waistline

Scala Cocoon

▶ Bumper / Facia (orifices)

▶ Headlamps / Taillamps

Augmented Visibility with
cleaned Lidar Headlamp System

Valeo

Sensors integration into Headlamps: Is there a real need ?

Augmented Visibility with
cleaned Lidar Headlamp System

Valeo

Sensors integration: Is there a real Need ?

It could be...

Augmented Visibility with
cleaned Lidar Headlamp System

Valeo

Styling proposals for lidar integration

LIDAR LOCATION ?

KEEPING THE HORIZONTALITY

CREATING STYLING EXTENSIONS

Augmented Visibility with
cleaned Lidar Headlamp System

Valeo

Radar integration - Styling 2 choices

Augmented Visibility with
cleaned Lidar Headlamp System

Valeo

Radar integration - Styling 2 choices

Augmented Visibility with
cleaned Lidar Headlamp System

Valeo

Radar integration - Styling synthesis
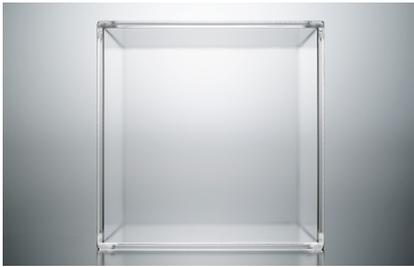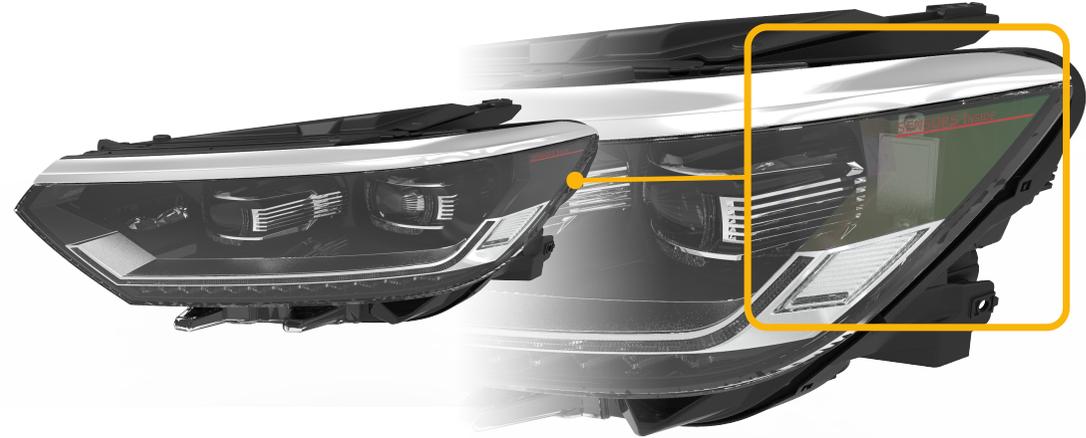
MAKES THE TECHNOLOGY TRANSPARENT

STYLING 2 CHOICES !

MAKES THE TECHNOLOGY PART OF THE DESIGN

Invisible

Visible

STANDARDIZATION IMPACTS

Augmented Visibility with
cleaned Lidar Headlamp System

Valeo

Field of view

▶ Width increased due to side position (tilted Lidar)

▶ Blind central area very close from the standard central integration (+10 cm)

▶ Bezels design to consider Lidar FOV (145° on Scala)

Detection range

▶ Lamp outer lens reduces detection range by 10%

▶ Protection glass from Lidar can be removed in some cases to compensate

Distortion due to outer lens

▶ Increases with incidence angle

▶ Neutral lens to be studied, in line with the sensor

Parasite light from lighting/signaling functions:

▶ Limited effects thanks to integration and wavelengths differences

▶ Taken into account in system calibration

1 / 1.1 m

Lidar blind zone
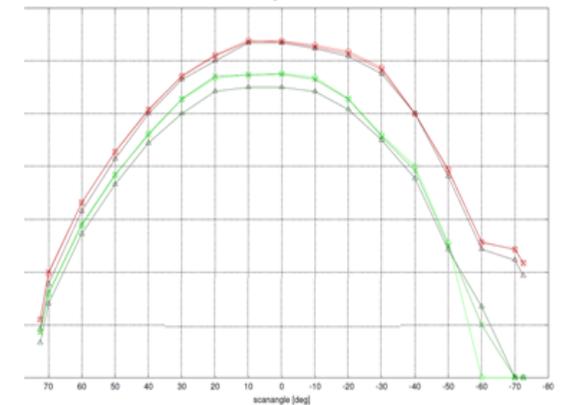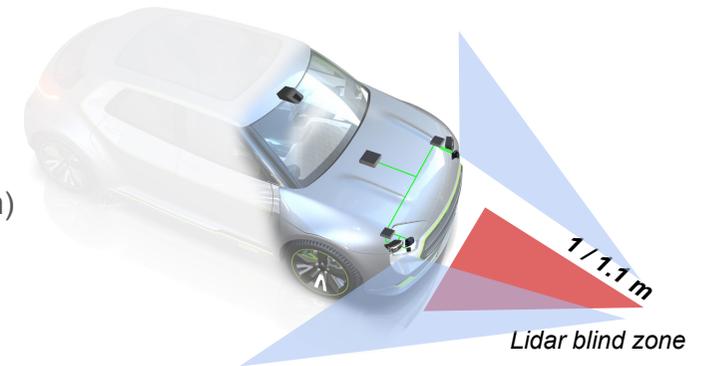
Detection distance – Scala in lamp

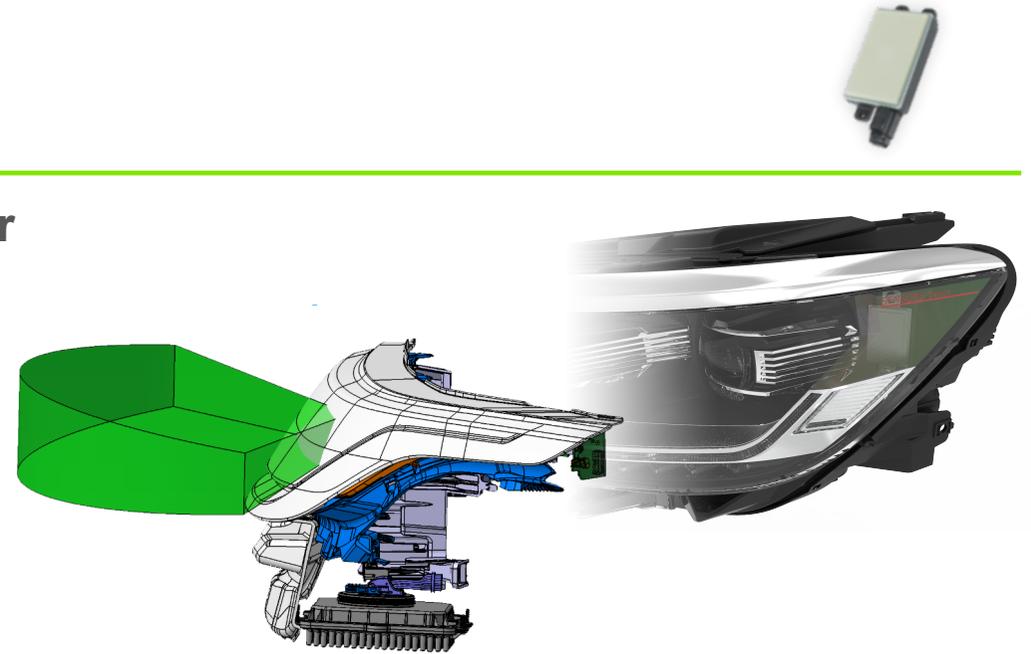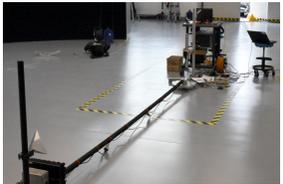Augmented Visibility with
cleaned Lidar Headlamp System

Radar Integration - Performances impacts

Metalized bezel to be avoided in front of Radar

Radar FOV to be also considered

Transmission test (with Arc Test tool)

- ▶ On axis loss about 1.1 db
- ▶ Off axis, worst case : 4.1 db
- ▶ Comparison with bumper:
  - – Non metalized painting: 0.75 db
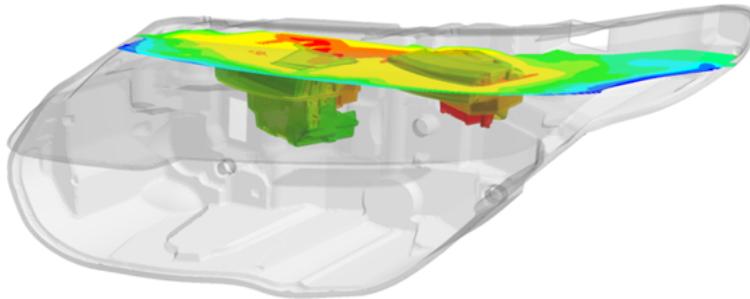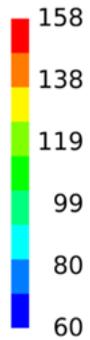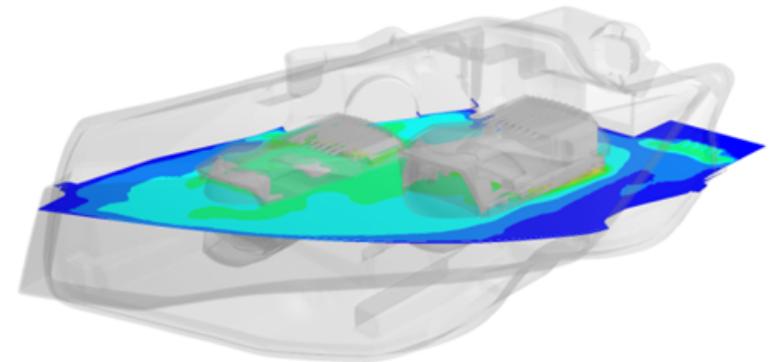 - – Metalized painting : 7 db
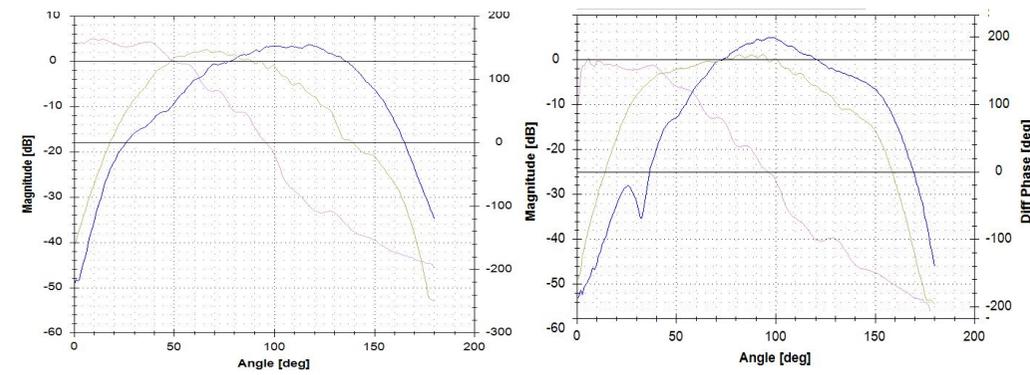
Radar measurement without/with PC lens

Augmented Visibility with
cleaned Lidar Headlamp System

Valeo

Thermal effects

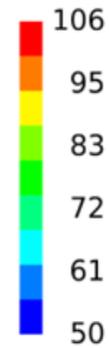## Both Lighting modules, Drivers and Sensors generate heat and are sensitive to temperature

▶ Sensors: Typical T°max. = 85°C

▶ LED Lighting modules still generate heat
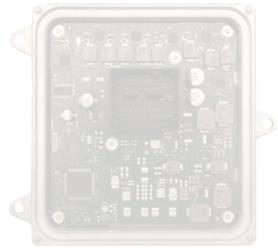

Styling highly impacted by thermal mapping

LED DRIVER

LIGHTING MODULES
(Beam + HD)

**STRONG SYNERGY BETWEEN EE ARCHITECTURE FOR
HIGH DEFINITION LIGHTING AND SENSORS INTEGRATION**

SENSORS

PICTURE CONTROL MODULE
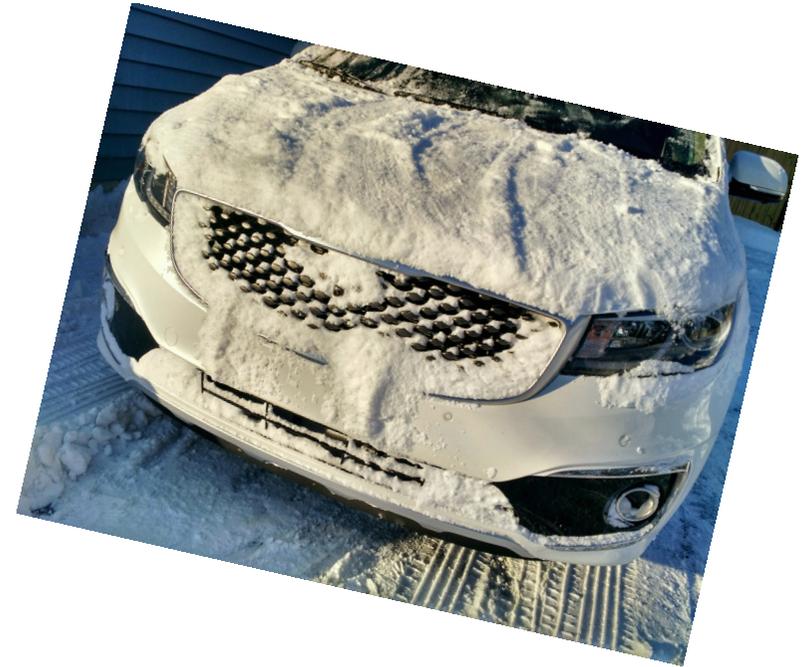Including Lidar/Radar ECU

EXTERIOR ENVIRONMENT

**As field test of Autonomous vehicles are extending…
real life constraints are appearing.**

Augmented Visibility with
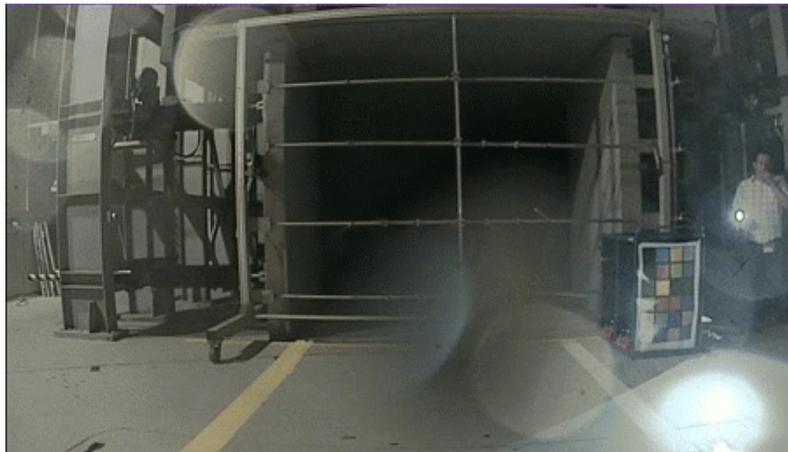cleaned Lidar Headlamp System

Valeo

Without Cleaning

With Cleaning

Example under rain, and by night

Without Cleaning

With Cleaning

Augmented Visibility with
cleaned Lidar Headlamp System

Define needs "Sensorwise" : Logic behind proposal

Type / Location	Needs				2nd priority			1st priority
	Quantity of dirt received by the sensor	Sensitivity to dirt	Safety	Opening Angle of the cam	Recommended type I (based on dirt quantity and sensitivity to dirt, see chart hereunder)	Recommended type II (based on angle)	If sensor cleaning is judge needed, what is the logical Minimum equipment	Recommended type III (based on investment in the sensor, see hereunder)
Front Windshield monocam	-	--	++	Narrow				
Front Windshield multicam	-	--	--	Narrow				
Front Grid Cross traffic alert	--	++	-	Wide	Fix	Telescopic		
Front Grid 360 cam	--	--	++	Wide	Telescopic + dry	Telescopic	Telescopic	
Front Grid IR cam	--	++	-	Narrow	Fix	Fix		Fix
Front Grid mechanical Lidar	--	--	--	Wide	Telescopic	Telescopic		Telescopic
Headlamp front SSL	--	--	--	Narrow	Telescopic	Fix		Telescopic
Right or Left SSL (Headlamp or others)	-	--	--	Narrow	Telescopic	Fix		Telescopic
Right or Left CMS (Mirror)	++	++	-	Medium	Nothing	Telescopic	Telescopic	
Right or Left 360 cam (Mirror)	++	++	++	Wide	Nothing	Telescopic	Telescopic	
Rear Retrovision (licence plate)	-	++	-	Medium	Nothing	Telescopic		
Rear Park cam (licence plate)	-	++	++	Medium but low vision field	Nothing	Fix	Telescopic	
Rear mechanical lidar (bumper)	--	--	--	Wide	Telescopic	Telescopic	Telescopic	Telescopic
Rear CMS Retrovision sharkfin	++	++	-	Medium	Nothing	Telescopic	Telescopic	
Rear Retrovision CHMSL	+	++	-	Medium	Nothing	Telescopic	Telescopic	
Rear Retrovision under backlight	+	++	-	Medium				

Techno vs needs

A minimal proposal of equipment.

Augmented Visibility with
cleaned Lidar Headlamp System

Define needs "Profilewise" : What is cleaning what ?

Nozzle

Blowing

Wiping

Centricam

Focus on Integration for the future

Solid-state Lidar

Headlamp

Cleaning

We are convinced that future of the Sensors Integration will belong to those who master Lighting, Sensors and Cleaning.

COMPLETE SYSTEM

VEHICLE ARCHITECTURE

**Complete system approach with
Sensing, Cleaning and Lighting**

ENVIRONMENT FACTORS

INBOARD SENSORS

LIGHTING MODULES

Thank you for your attention