ADAS sensor Integrated ADB

1. Benefits of ADAS Convergence
2. MOBIS ADB System
3. Sensor Integrated Lamp

2021. 4. 19
MOBIS SZ
Cho, Yeonggi (Jason)

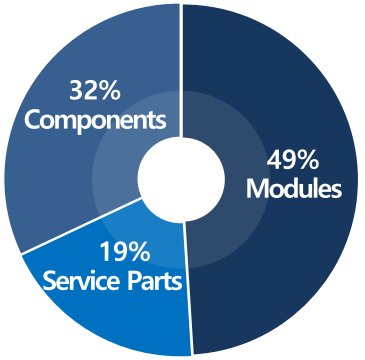
※ ADAS: Advanced Driver Assistance System, ADB: Adaptive Driving Beam

Future-oriented MOBIS with 45-year experience

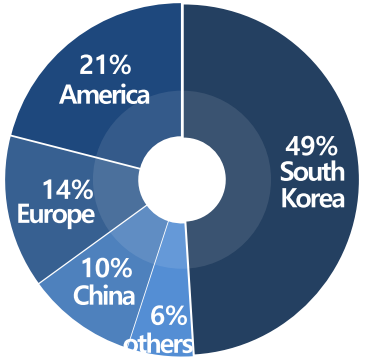
Overview

- Since **1977** with headquarters in Seoul, Korea
- Sales of **$ 32.8** billion, **7th** Global standings
  [Sales in 2020, Standing in 2019 Automotive News]
- **32,065** employees worldwide
  [Korea : 10,172 / Overseas : 21,893]]
- **S&P BBB+ / Moody's Baa1** Credit Rating
  [Dated : Sep. 30th, 2019]

Revenue Breakdown(2020)



by Business



by Region

Business Units [BU]

IVI	AV	Lighting	E-Powertrain	Chassis	Safety	Module
• Head Unit • Head-Up Display • Sound System • Digital Cluster • Integrated Center Stack	• Auto Parking System • Surround View Monitoring System • Driving/Parking Sensor • In-Cabin System	• LED Head Lamp • ADB/HD Head Lamp • Rear Lamp • Grill Lamp	• Traction Motor • Inverter • DC-DC Converter • On-Board Charger • BMS & Battery System	• Caliper, DIH, Drum Brake • EPB • Electronic Brake System • Steering System • Air Suspension	• Airbag Module • Safety Control Module • Safety Sensor • Active Safety System for Pre-Safety	• Chassis Module (Axle Assembly) • Cockpit Module • FEM

◆ MOBIS Global Footprint

Located strategically worldwide to support OE

5
Sales Offices
(Korea/US/Germany/China/Japan)

44
Plants
(27 Modules / 17 Components)

5
R&D Centers
(Korea/US/Germany/China/India)

Europe
- Module
- Lighting, Airbag
- Brake System, Electric Power Steering
- Electrification

America
- Module
- Lighting, Airbag
- Conventional Brake System, EPB, ESC
  Electric Power Steering,
- Electronics

China
- Module
- Lighting, Airbag, Bumper, IP , Carrier
- Electronic & Conventional Brake System, Electric Power Steering, Steering Gear
- E-Mobility Parts, Electronics, Audio, Video, Navigation

India
- Module
- Airbag, Audio, ABS, ESC, Electric Power Steering

South Korea
- All product

Worldwide customers and its number growing steadily

HYUNDAI
All module, parts

KIA
All module, parts

Stellantis(NA)
Complete Chassis Module, **Lighting**, Center Display

Stellantis(EU)
Center Switch, Center Display, **Lighting**

GEELY
Sound System

GMMC
Lighting, Caliper

BYD
C-EPS

MMC
Caliper, PAS, D-Audio, **Lighting**

GM
EPB(e-DIH), DIH, Center Display

VW
Lighting

FAW
EPB, Air suspension

GAC-FCA
Lighting

BAIC
C-EPS

SUBARU
Lighting

KARMA
EPS

Rivian
Lighting, Sound, Radar

Canoo
Caliper, EPB

Arrival
Lighting, SCM

TOGG
R-EPS
iMEB, Caliper

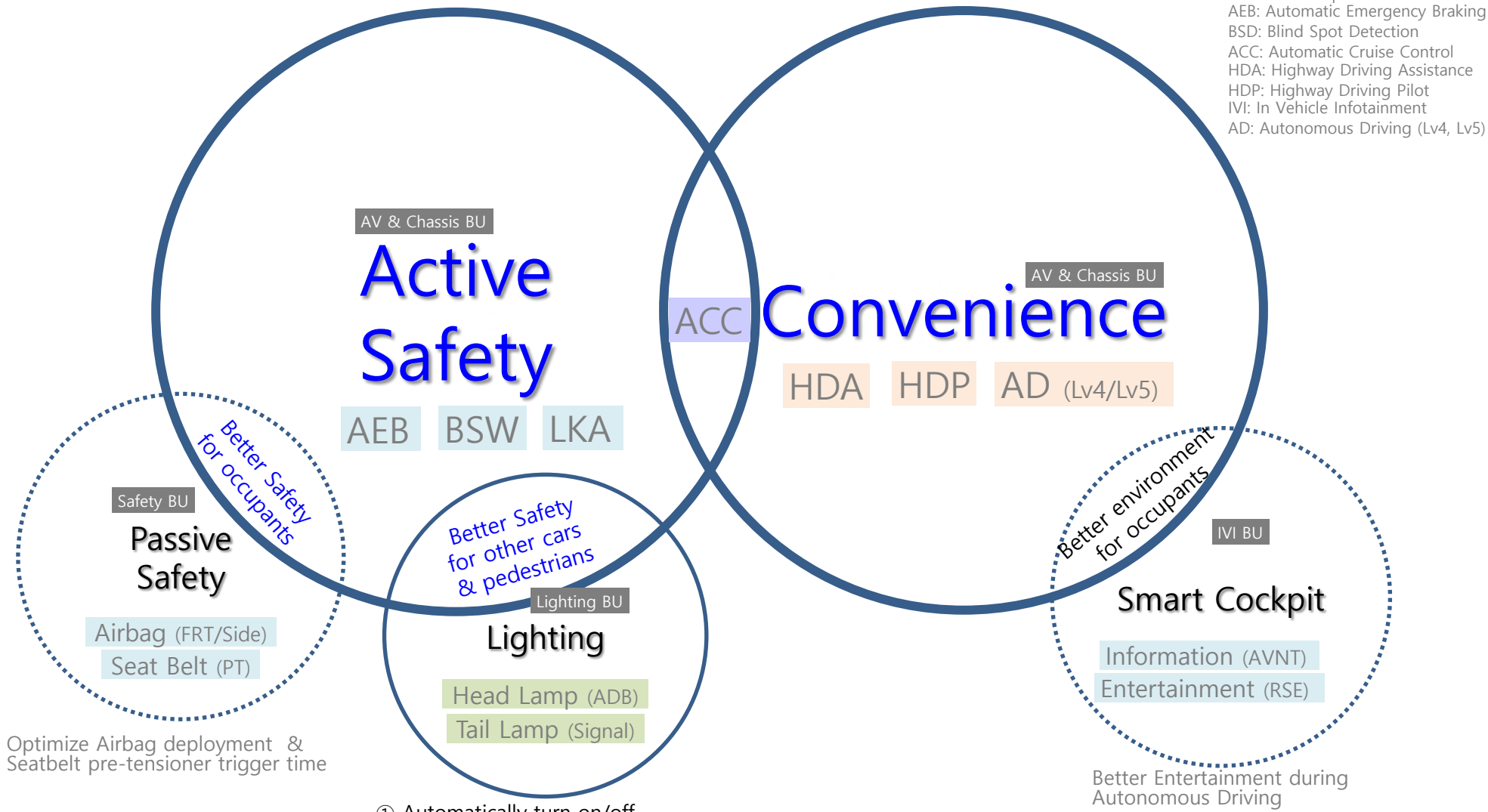
MAZDA
Lighting

※ DCSD (Dissociated Center Stack Display) / IBS (Intelligent Battery Sensor) / ICS (Integrated Center Stack)

1. Benefits of ADAS Convergence

Active Safety and Convenience are Key Benefits of ADAS

LKA: Lane Keep Assistance
AEB: Automatic Emergency Braking
BSD: Blind Spot Detection
ACC: Automatic Cruise Control
HDA: Highway Driving Assistance
HDP: Highway Driving Pilot
IVI: In Vehicle Infotainment
AD: Autonomous Driving (Lv4, Lv5)



Converging Steering & Braking Information → Better Passive Safety & Lightting System

AV & Chassis BU

ADAS (Steering & Braking system)

- Steering- MDPS full redundancy line-up


C-MDPS


P-MDPS


R-MDPS

- Full Redundancy line-up

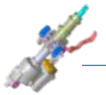

iMEB

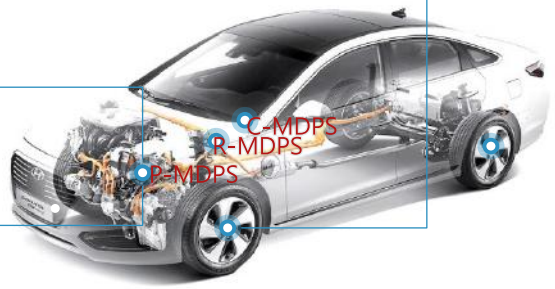

ESC


MOC

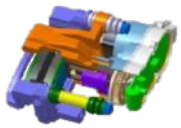
- Steer by Wire


Actuator


Reaction force control device



- Brake by Wire

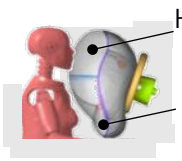

Combination EMB

※ EMB : Electro-mechanical Brake

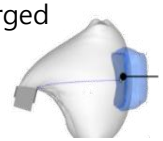
Safety BU

Passive Safety - New safety concept with ADAS


Surround airbag
Seat variation
(RR/Side face etc)



Euro NCAP
Reduce head
& neck injury

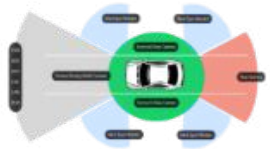


US NCAP
High speed oblique

Lighting BU

Lighting System - ADB & ADB with ADAS


ⓐ Conventional ADB


ⓑ ADB with ADAS

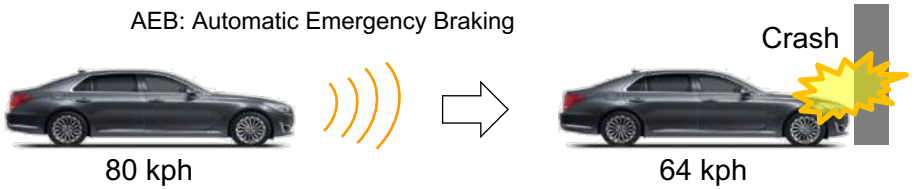
※ ADB : Adaptive driving beam

AEB converged Airbag system

AEB activation [Crash Energy ↓] → Occupant forward movement [Injury ↑] → Activate AEB Airbags [Injury↓]

AV & Chassis BU

[Step1] AEB Activation (Crash Energy Down)

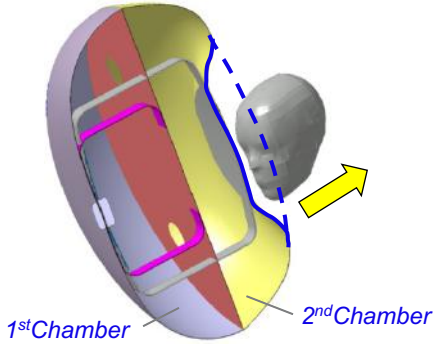


Safety BU

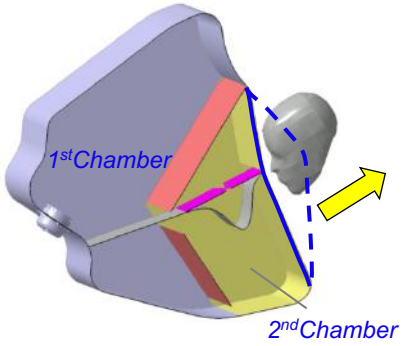
[Step2] Forward Movement of Occupant

Safety BU

[Step3] Dual Chamber AEB Airbag Activation



<Driver side Airbag>



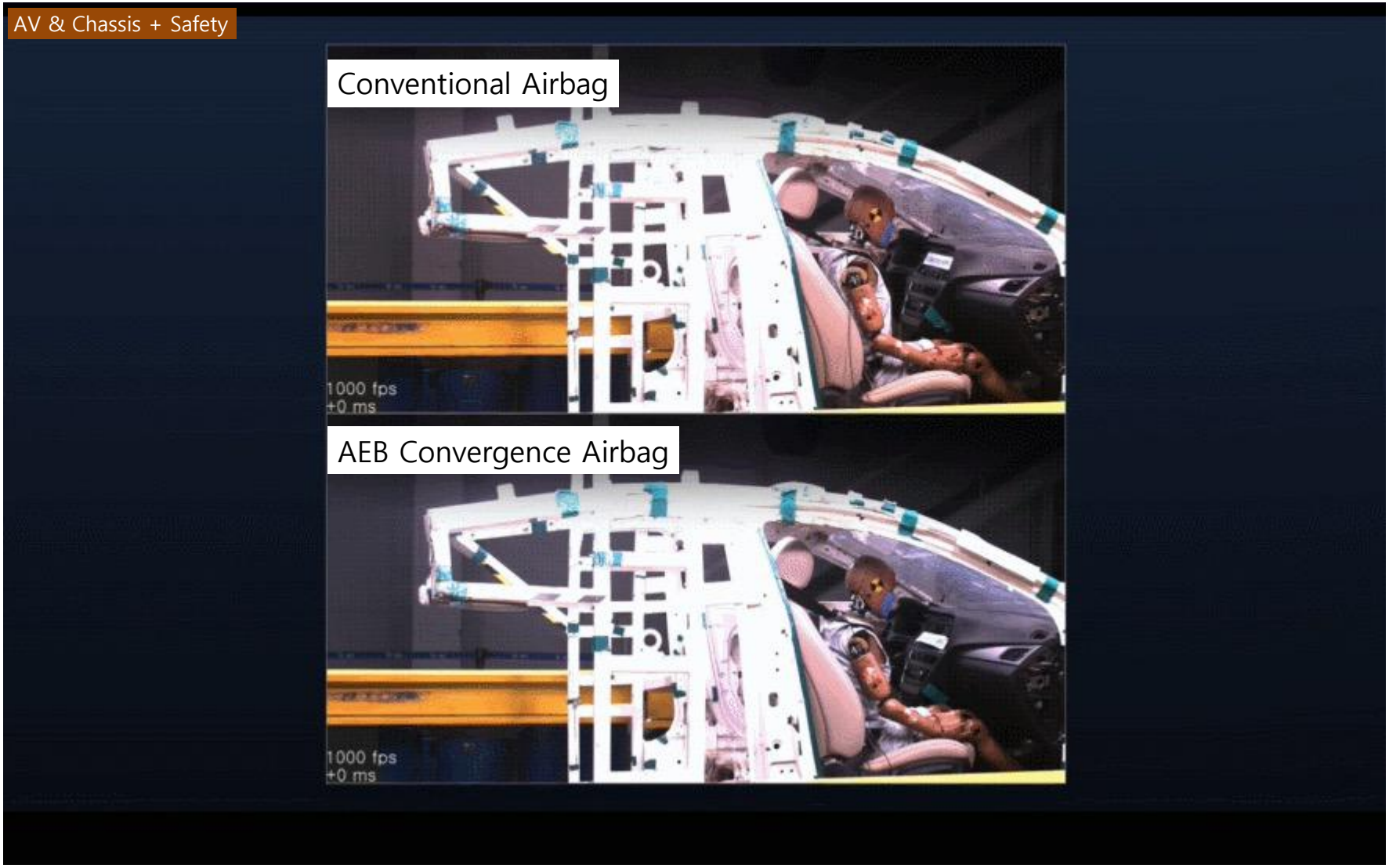
<Passenger side Airbag>

AV & Chassis + Safety

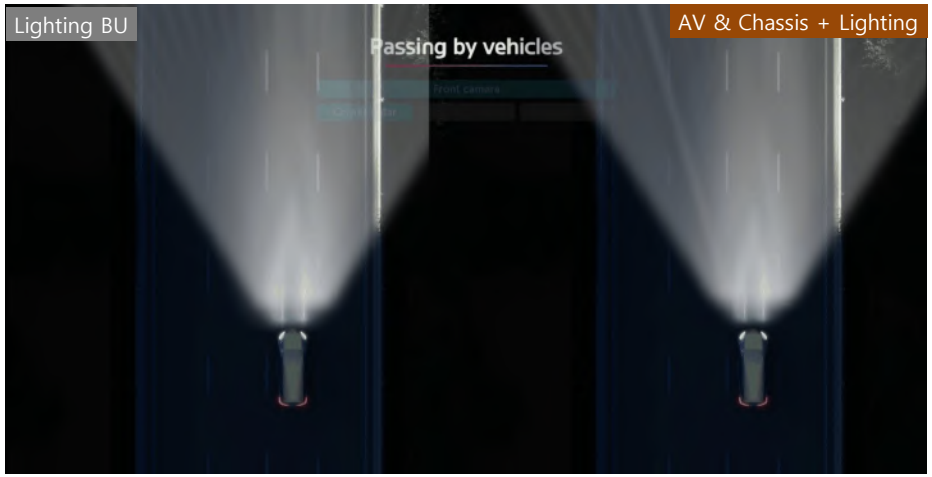
[Step4] Occupant Injury Evaluation Results

Conditions	Occupant Neck Injury	
	Conventional Airbag	AEB Convergence Airbag
AEB Non-Activated	0.36 (+0.26)	0.43 (+0.01)
AEB Activate	0.62	0.44

AEB converged Airbag system



ADAS[Corner Radar & Steering] converged ADB system



Camera + Corner radar FUSION

Camera + Steering FUSION

Camera + Navigation FUSION

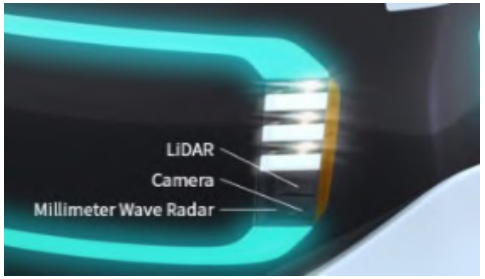
2. MOBIS ADB System

Genesis G80 [ADAS + ADB]

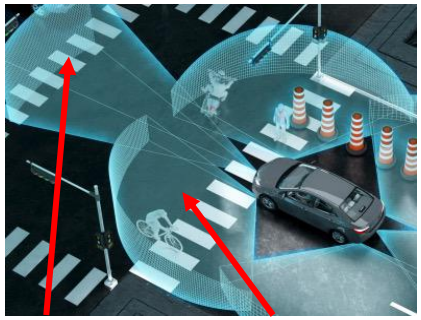
Genesis G80 [ADAS + ADB]

3. Sensor Integrated Lamp (Background)

Market Trend in CES 2019 → Sensor Integrated Lamp

Type - A	Type - B	Type - C
		
2019 CES	2019 CES	2019 DVN
Camera, LiDAR	Camera, LiDAR, Radar	LiDAR, Radar

AD L3~ needs Corner Coverage → Challenge for Sensor Integration



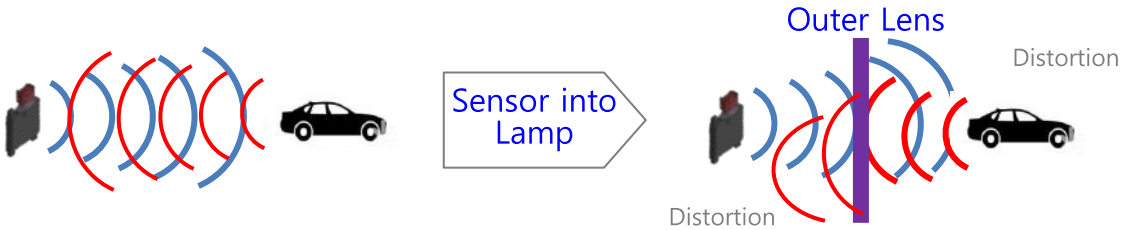
Coverage for AD L1~ Coverage for AD L3~

Level	1	2	3	4	5
Definition	Driver Assistance	Partial Automation	Conditional Automation	High Automation	Full Automotation
Sensors	Camera Radar	Camera Radar	Camera Radar LiDAR	Camera Radar LiDAR V2X	Camera Radar LiDAR V2X
Coverage	Front	←	Front + Corner	←	←

Challenges : ① Signal Distortion, ② Reliability Test, ③ Styling Trends

1) Signal distortion and subtraction by the Lamp Outer Lens

- Material, Thickness, Curvature, Coating of outer lens



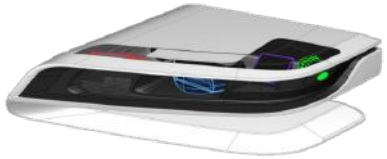
2) Reliability test

- High temperature due to engine and light source

	Sensor	Operating Temp.
Inside Bumper	Lidar, Radar,	-40~85°C
Inside Cabin	Camera	-40~85°C
Inside Lamp	-	-40~105°C

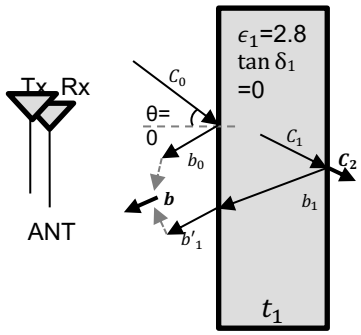
3) Lamp Styling (slim lamp)

	Lidar	Radar	Camera
Height	70~80 mm	80~90 mm	~ 30 mm



RADAR : Transmittance and Reflection analysis → Multilayer to minimize Reflection

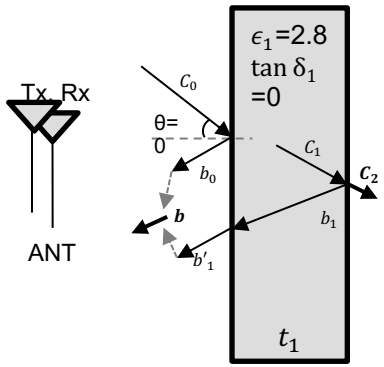
- Transmittance analysis
  - ➔ incidence, permittivity (use “Parametric study of flat sandwich multilayer radome”)



Permittivity(F/m)	2.4	2.8	3.2	5.4
Frequence(Ghz)	76.5	76.5	76.5	76.5
Incidence(°)	0	0	0	0
1-way(C2) Transmittance(%),	90.9%	87.7%	84.6%	70.8%
2-way Transmittance(%),	82.7%	76.9%	71.6%	50.1% (-3dB)
Detection Range Reduction	4.6%	6.3%	8.0%	15.9%

- Reflection analysis
  - ➔ Destructive interference can minimized unnecessary reflected waves

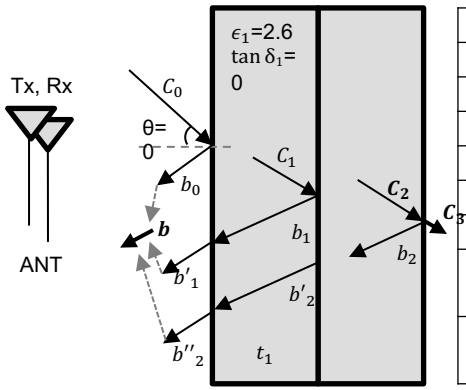
$b = b_0 + \alpha b'_1,\ -1 < \alpha < 1,\ b_{min} = b_0 - b'_1,\ b_{max} = b_0 + b'_1$



Permittivity(F/m)	2.4	2.8
Frequence(Ghz)	76.5	76.5
Wavelength(mm)	2.34	2.34
Incidence(°)	0	0
Reflectivity	4.6%	87.7%
Max Reflectivity	8.9%	11.9%
Min Reflectivity	0.4%	0.8%

- Minimize reflection
  - ➔ Multilayer structure can minimize reflection

$b_r = b_0 + \alpha b'_1 + \beta b''_2 \quad -1 < \alpha, \beta < 1$

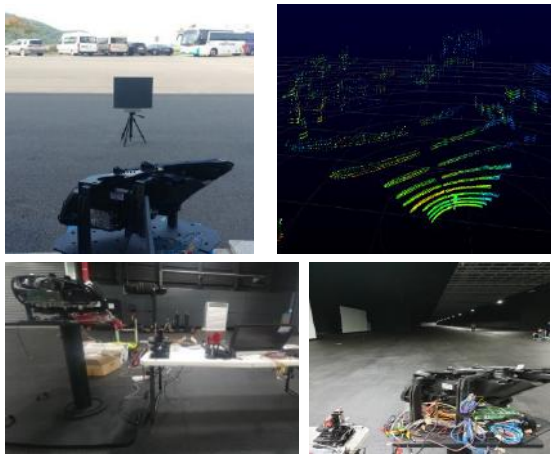


ε_1	2.4	2.6
ε_2	2.8	2.8
b_0	2.9%	5.5%
b'_1	0.7%	0.0%
b''_2	5.9%	5.7%
b_{max}	10.5%	11.2%
b_{min}	1.0%	0.1%
2-way Transmittance(%)	79.5%	78.3%
Detection Range Reduction	5.6%	5.9%

LiDAR : Maximum detection range, Cleaning system, Durability

General
1) Laser-based distance scanning
   → ToF, High precision, 905nm, 1550nm
2) Mid environmental robustness
   → Performance is affected by snow and rain
3) Low environmental reliability
   → Heat, Vibration

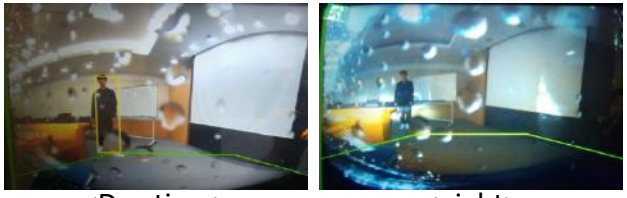
Experiment & Conclusion
1) Reduced maximum detection range
   → Outer lens attenuation
2) Cleaning system required
   → Greatly affected by pollution
3) Need to strengthen durability
   → Heat, Vibration



Camera : Low light condition, Snow & Rain, Interference with light source, etc

General
1) Object Detection & Classification
   → Pedestrian, Lane, Traffic Sign…
2) Low environment robustness
   → Snow, Rain, Night, Fog…
3) Synergy or interference by Lamp
   → visible light, IR

- Lamp Integration Test
  → Severely adversely affected by the lamp in low light conditions.

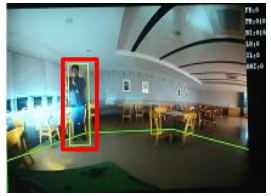


<Day time> <night>

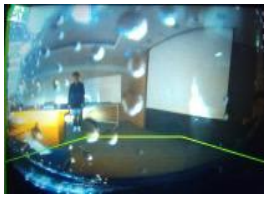
<Without outer lens> <With outer lens>

Radar and LiDAR seems to be feasible but Camera seems difficult to mount inside the Lamp.

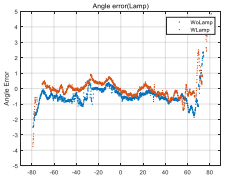
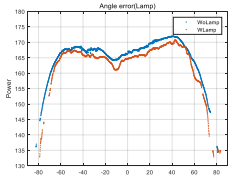
		Camera		RADAR		LiDAR	
		Attenuation of signal	Image distortion	Attenuation of signal	Signal distortion	Attenuation of signal	Signal distortion
Outer Lens	Material	COK	OK	OK	OK	COK	OK
	Thickenss	COK	OK	OK	OK	COK	OK
	Curvature	COK	NG	OK	OK	COK	COK
	Coating	OK	OK	OK	OK	COK	OK
Water /Mud	Water	COK	NG	OK	OK	OK	OK
	Mud	NG	NG	OK	OK	NG	NG
Light Source		OK	NG	OK	OK	OK	OK
Photo							

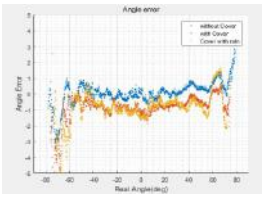

[Recognition]

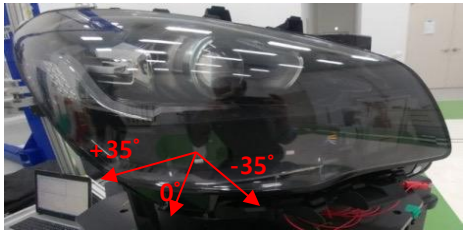

[Curvature]


[Water droplet]


[Light source]



[Effects of Outer Lens]



[Effects of Water, Dust]



angle	Attenuation of signal [M]	
	No Outer Lens	Outer Lens
-35	**100%**	**86%**
0	**100%**	**96%**
35	**100%**	**96%**

* COK: Conditional OK

Lighting Trend [EV Front Digital Lighting] : Slim & Wide, Unexpected Lighting Design

<Mass Production Trend>

Benz EQA — Slim Light Guide

Hummer EV — Inner Lens Type

BMW X6 — Radiator Grille Ambient light

Hyundai IONIC 5 — Laser Etching Pattern light

<Concept Trend>

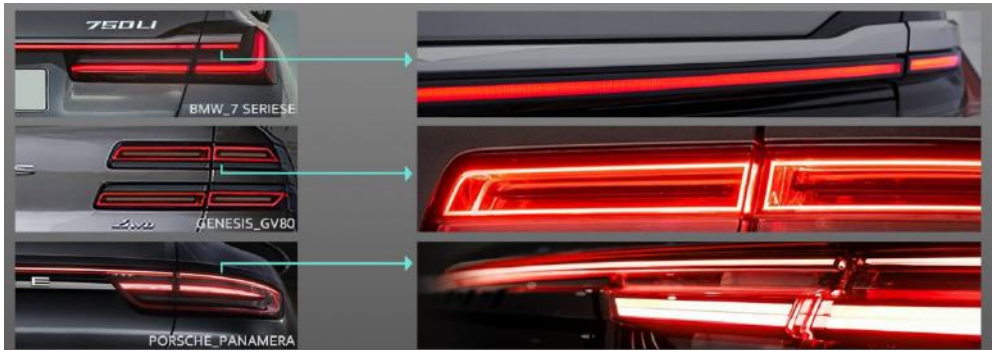
Cadillac Lyriq concept — Black Masking Type

Bentley EXP 100 GT concept — Parametric Type

BMW 100 year concept — Pattern Lens Type

Benz AVATAR concept — Inner Bezel Masking Type

Lighting Trend [Wide slim lighting] : Simple & Wide, Ultra Slim, Same FRT & RR, Detail Patterns



Thank you

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