Automotive LiDAR ecosystem and market

DVN LiDAR Conference
30 Nov. – 01 Dec. 2022

YOLE Intelligence

AGENDA

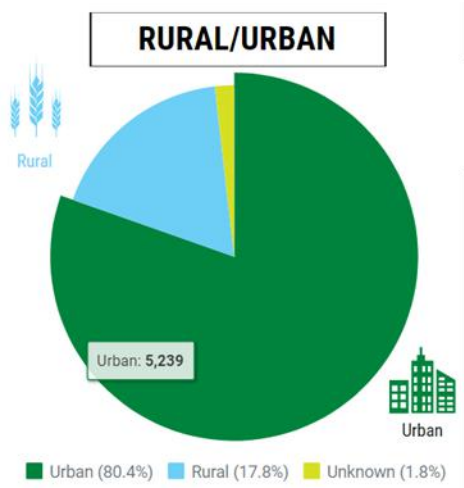
1. Context
2. Automotive LiDAR technology
3. Automotive LiDAR market
4. Key takeaways

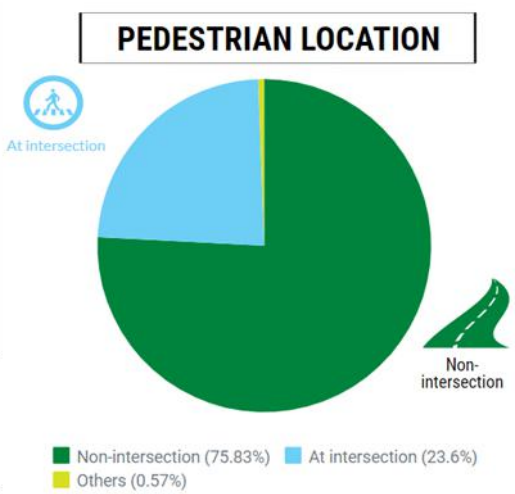
CONTEXT

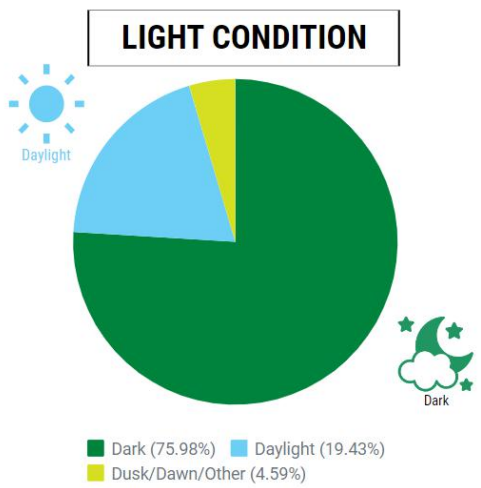
After the diesel gate, an ADAS gate ?

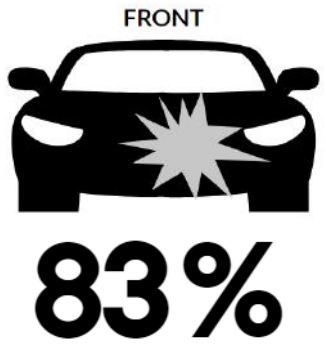
Active safety based on camera and radar is not enough. Another type of sensor is needed.

US Pedestrian fatalities overview, 2020









Source: NSC Injury facts - *Pedestrians and Car Crashes - Injury Facts (nsc.org)*

OEMs are developing safety features according to regulations and to get 5-star rating.

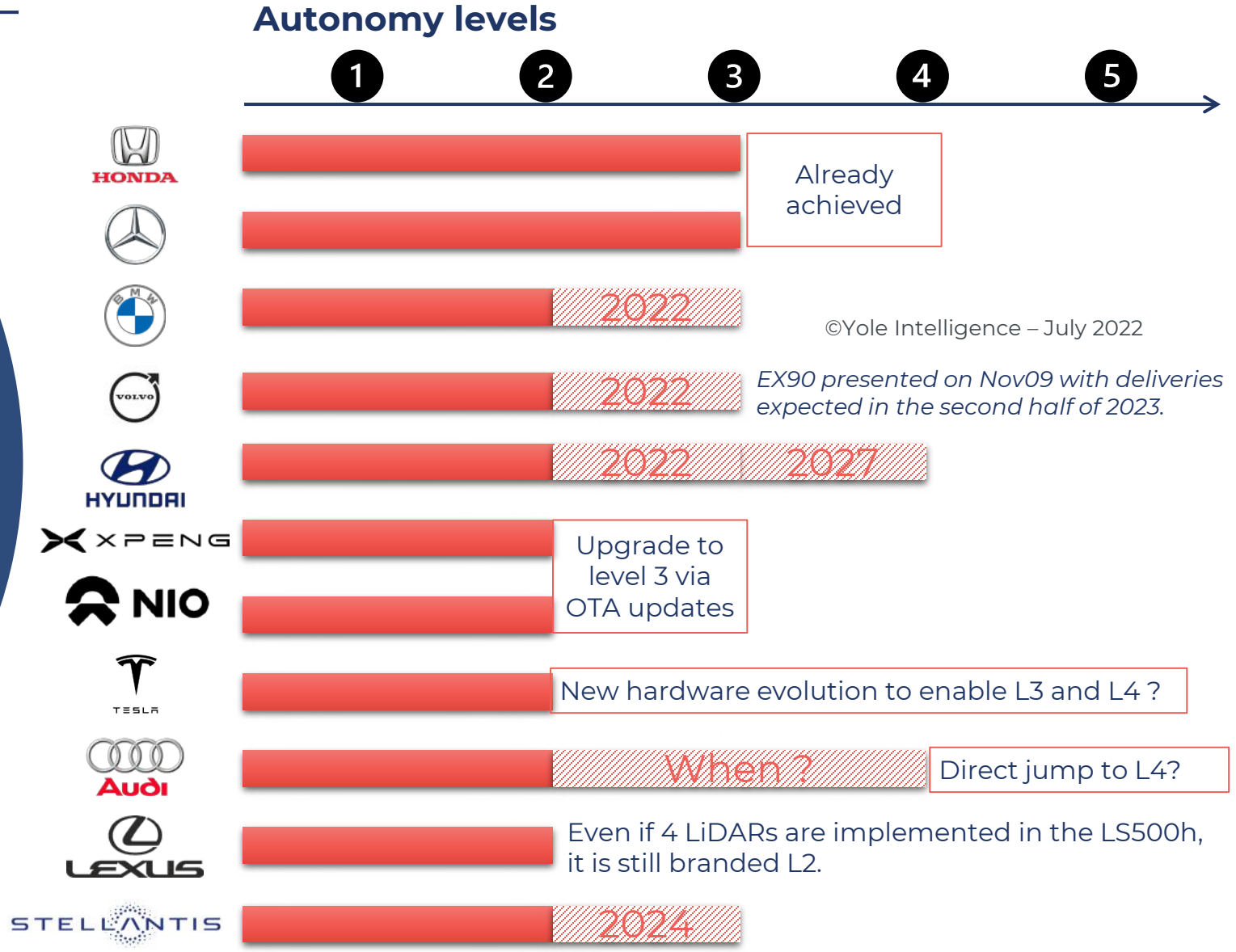
Since 2019, agencies are showing that AEB performances (based on camera and radar) are not good enough.

Better performances can be obtained with more severe tests from rating agencies and with the use of more sensors and/or more performant data processing.

CONTEXT

OEM achievements on automated driving (non-exhaustive list)

As of Q2-2022, only two OEMs have officially released cars with L3 capability.



On the road to autonomy levels, Audi was the first one to implement a LiDAR to target level 3 applications in 2018 but stepped back a few time after due to a lack of regulation and the fear of liabilities in case of accident.

New EV OEMs like Xpeng or Nio are embedding the necessary hardware to enable level 3 applications, but it is not yet activated. This will be the case using OTA updates.

Big players like VW or Toyota are still not delivering cars with L3 features.

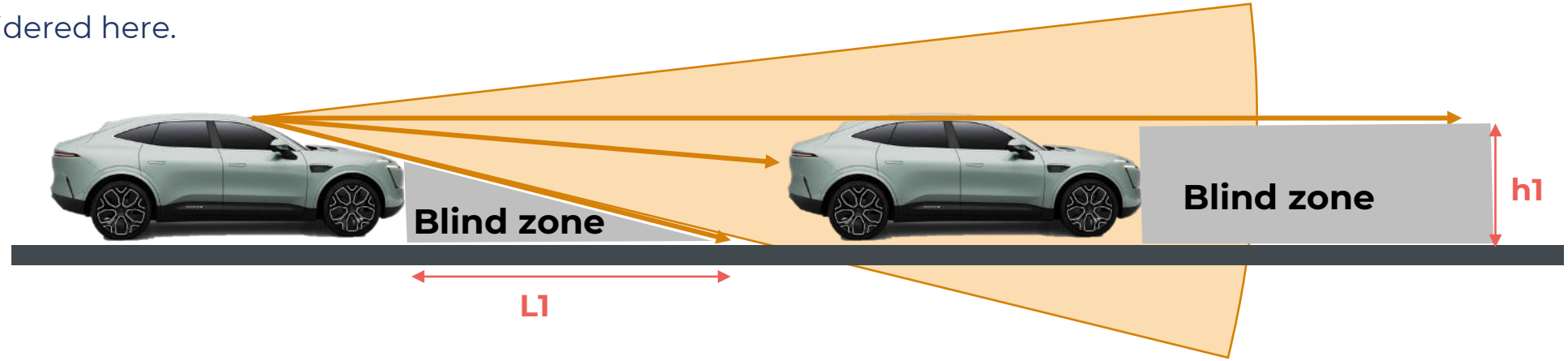
Stellantis has recently partnered with Valeo to develop L3 functionalities.

AUTOMOTIVE LIDAR TECHNOLOGY

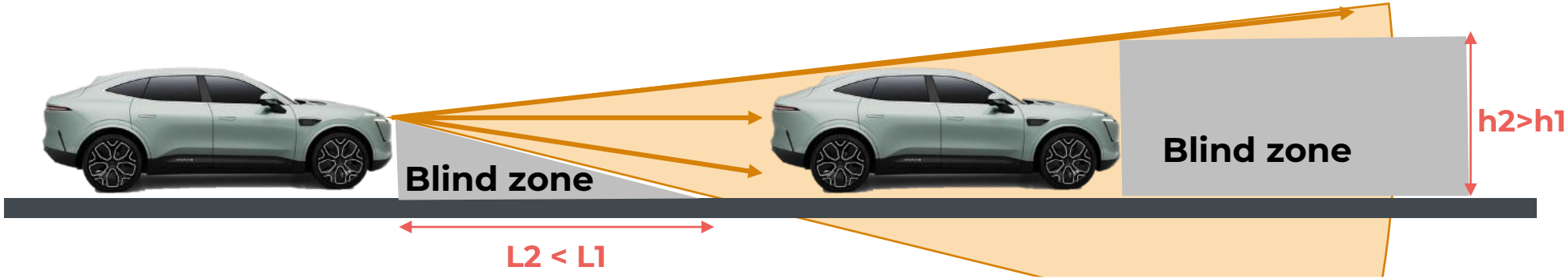
Lidar position comparison – vertical field of view

A vFoV of 20° has been considered here.

High-mounting position



Low-mounting position

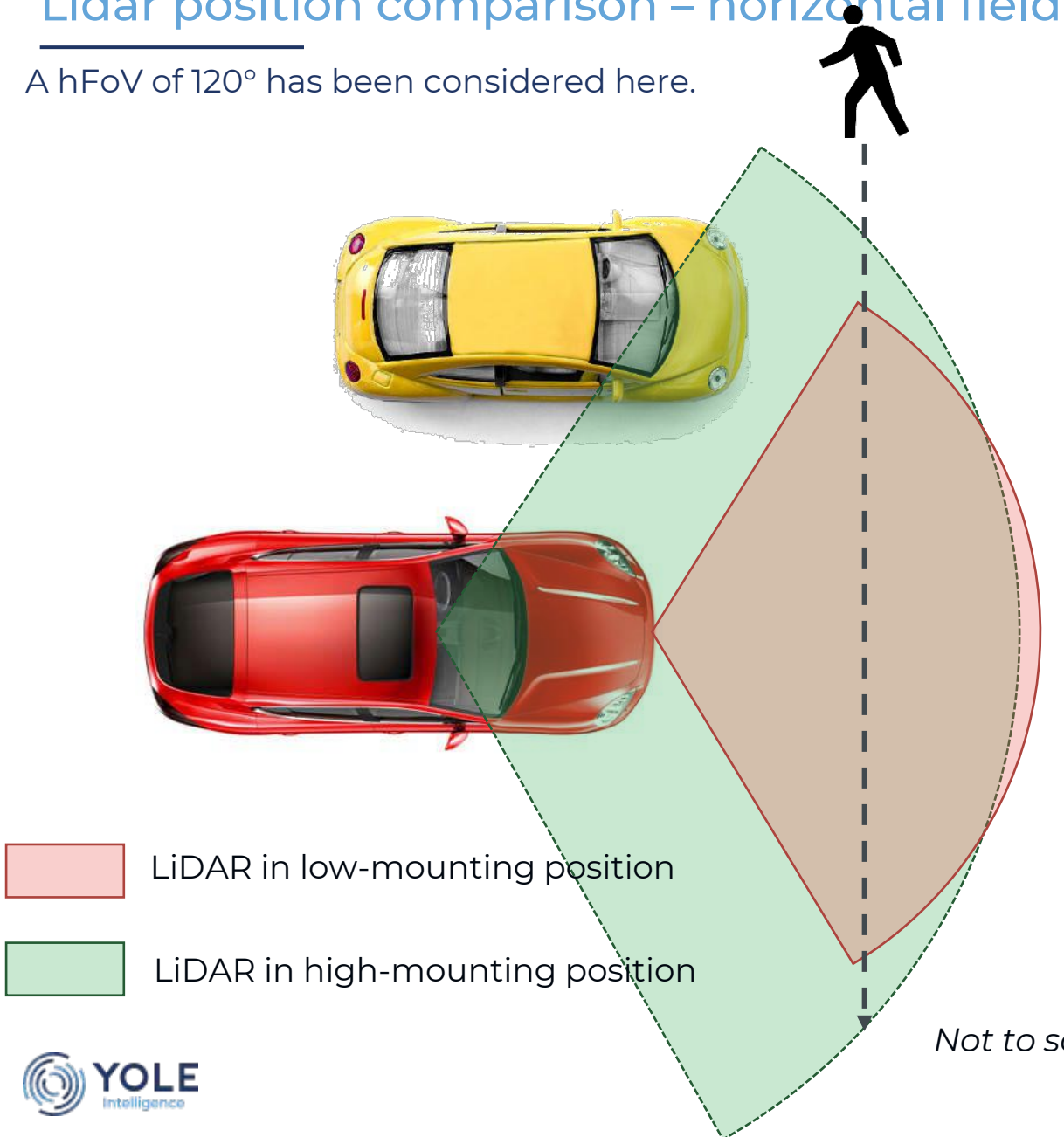


	High-mounting position	Low-mounting position
Pros	Possibility to see beyond the preceding car Possible advantage for high-speed use case	Shorter blind zone in front of the car Good enough for ALKS (<130kph)
Cons	Longer blind zone in front of the car	Totally blinded by the preceding car

AUTOMOTIVE LIDAR TECHNOLOGY

Lidar position comparison – horizontal field of view

A hFoV of 120° has been considered here.



	High-mounting position	Low-mounting position
Pros	Better performance to detect an object or a pedestrian on the sides. Good for active safety.	Similar performance can be achieved using two LiDARs (cost → x2)
Cons	Integration of the LiDAR → Aesthetic of the car if the LiDAR is on the roof	Low performance for side detection
	Good position of LiDAR if used to improve performance of active safety or for city driving	Good enough for actual automated driving use case (highway → no pedestrians)
	Good for L3, L4	Good enough for L3

AUTOMOTIVE LIDAR TECHNOLOGY

Imaging technology (non-exhaustive list)

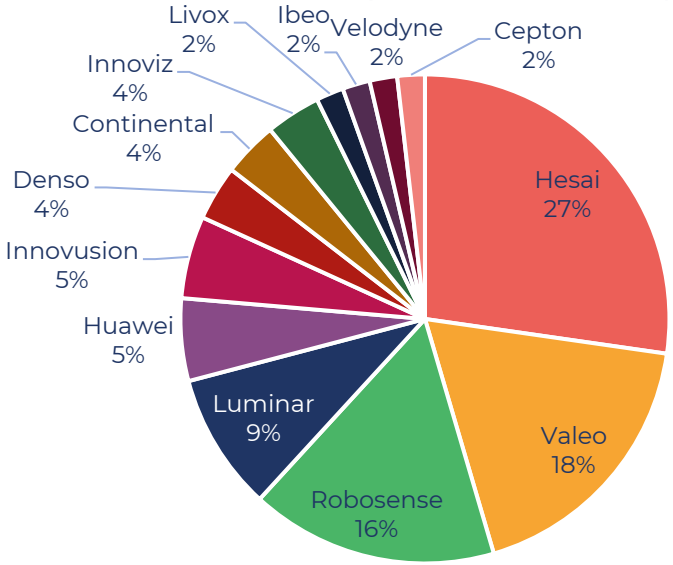
	Mechanical	Hybrid Solid-State					Fully Solid-State		
	360° rotating mirror	1D Scan		2D Scan			Optical	Flash	Individually addressable
		Polygon mirror	Other	MEMS	Polygon + Galvo	Prisms			
LiDAR Manufacturers	Velodyne, Waymo, Ouster, Hesai, Robosense, SureStar, LSLiDAR	Valeo, Hesai, Huawei, Denso	Cepton, Velodyne	Innoviz, Robosense, LSLiDAR, AEye, Neuvition, Beamagine, MicroVision, Blickfeld, Pioneer	Luminar, InnoVusion	Livox	Baraja, Benewake, Lumotive, Aeva, Lidwave, Scantinel Photonics, Analog Photonics, SiLC, Insight LiDAR, Voyant Photonics, SteerLight, mobileye	Continental, fastree 3D, LiangDao, SureStar	ibeo, Xenomatix, Opsys Technologies, SOS LiDAR, Marelli
OEMs	Waymo, Aurora, Cruise, DiDi, Motional, autox	Audi, Honda, Mercedes-Benz, Lexus, Xpeng, Toyota, Human Horizons, Lotus, WEY, Changan, Aiways, JiDU, Leapmotor, Stellantis, Xiaomi, Genesis	Faraday Future, GM	Lucid, Weltmeister, BMW, Lotus, FAW, Zeekr, GAC Motor, Arcfox, Volkswagen	Volvo, Polestar, Mercedes-Benz, Nio	Xpeng	*Baraja has an advanced development agreement with an OEM*	Toyota, Lexus	WEY, Genesis

AUTOMOTIVE LIDAR TECHNOLOGY

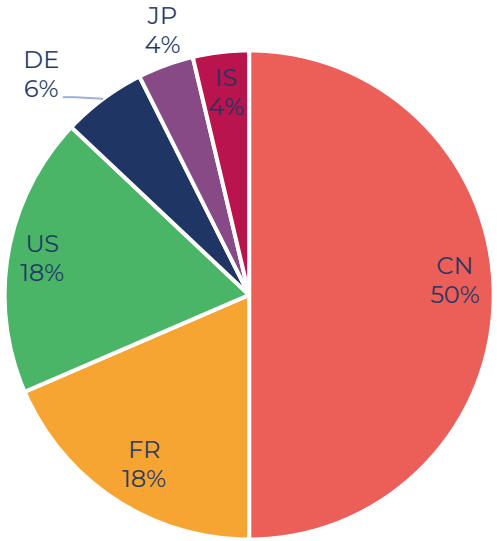
Known design wins since 2018 (total of 55) 1/2

There is a strong Chinese activity in LiDAR with a local supply chain being established between OEMs and LiDAR suppliers.

Design wins - Split by LiDAR supplier



Design wins - Split by country of origin



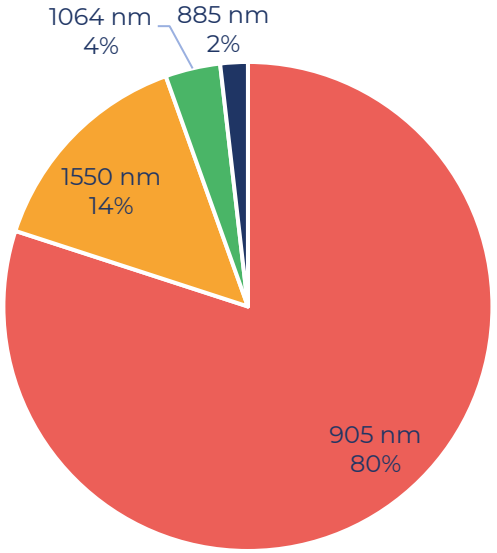
- Thanks to 27 designs-wins, the Chinese LiDAR manufacturers, Hesai and Robosense have completely changed the landscape, being ranked in 1st and 3rd position, respectively.
- More globally, Chinese LiDAR suppliers are representing 50% of the design wins. This representation of Chinese players is closely linked to the release of electric vehicles from new Chinese OEMs.
- The US activity is led by Luminar with partnerships with Volvo, Polestar or SAIC. Innovusion is also a US player but has close links with China.
- Europe is represented by Valeo, Continental, and Ibeo representing 24% of design wins, and Middle-east is represented by Innoviz.

AUTOMOTIVE LIDAR TECHNOLOGY

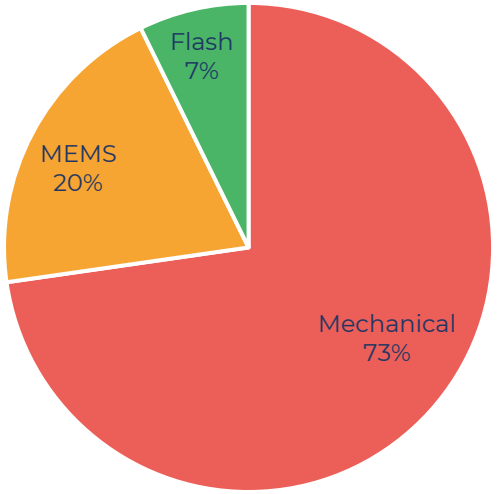
Supply chain for ADAS vehicles analysis - Known design wins since 2018 (total of 55) 2/2

While 905nm domination is still here, there is a clear push of LiDAR using MEMS technology for imaging.

Design wins - Split by wavelength



Design wins - Split by technology



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- In terms of wavelength, only two LiDAR suppliers are using a 1,550nm-based architecture, Luminar and Innovusion. Both are based on fiber laser light sources.
- 905nm-based LiDAR are still far ahead due to the limited cost of their components. Also, we have seen some performance improvements for long-range LiDAR, especially with photodetectors like SiPM that are much more sensitive than APDs and are necessary to reach the 200m range target.
- Mechanical LiDARs are still dominating but MEMS-based LiDAR market share is increasing rapidly as this technology is used by Chinese LiDAR supplier Robosense.

AUTOMOTIVE LIDAR TECHNOLOGY

Technology roadmap

APD (Discrete)

EEL (Discrete)

FPGA (250 MHz)

Manual

High

Photodetector (1D in 2022)

Laser (1D in 2022)

Processing (FPGA at 1.2GHz in 2022)

Assembly

Cost of production

SPAD / SiPM (array)

VCSEL (array)

Custom ASIC

Highly automated

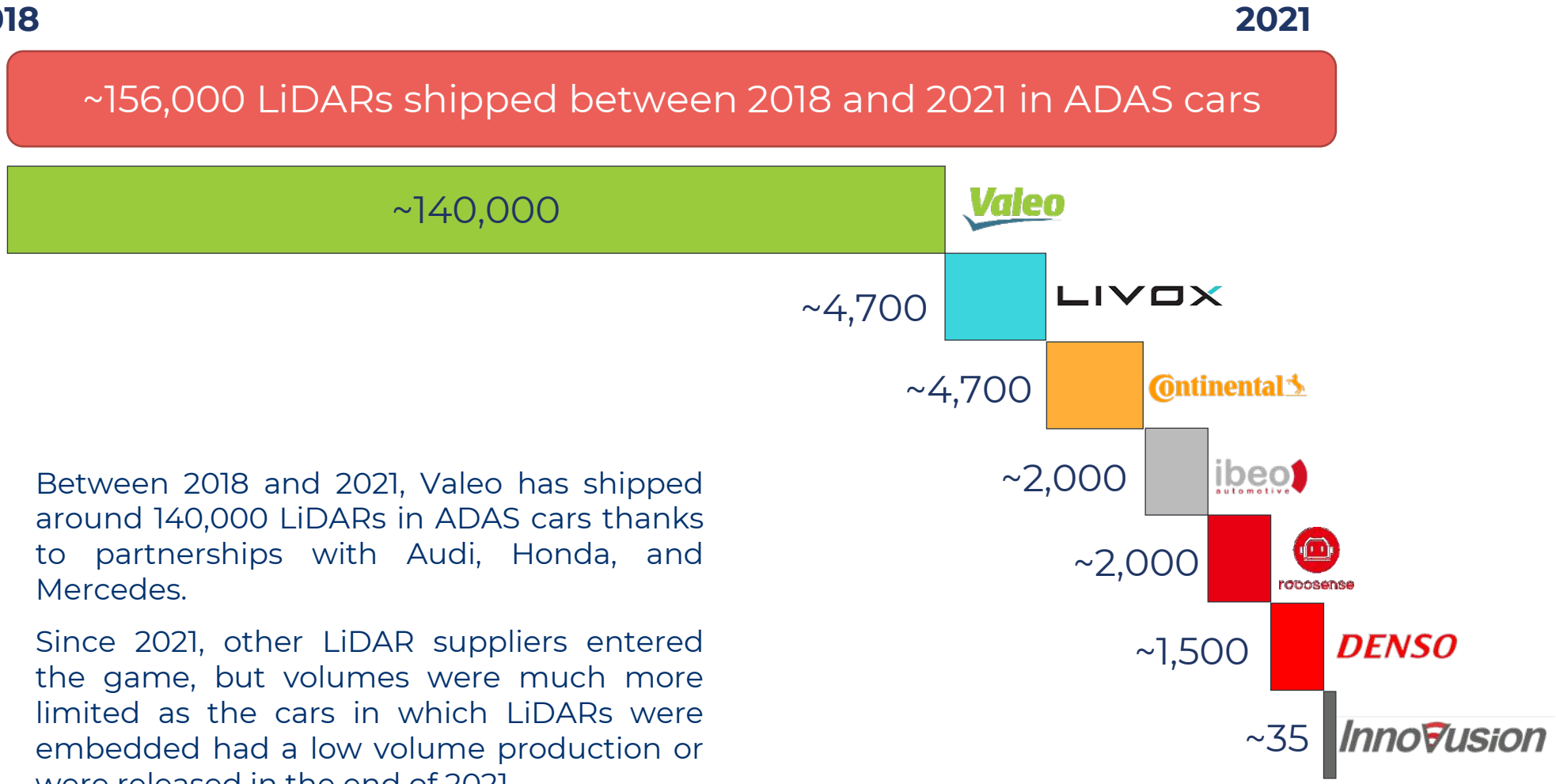
Low

Better semiconductor integration

AUTOMOTIVE LIDAR MARKET

LiDAR shipments between 2018 and 2021

Between 2018 and 2021, Valeo has shipped almost 90% of the LiDAR in ADAS vehicles.



Between 2018 and 2021, Valeo has shipped around 140,000 LiDARs in ADAS cars thanks to partnerships with Audi, Honda, and Mercedes.

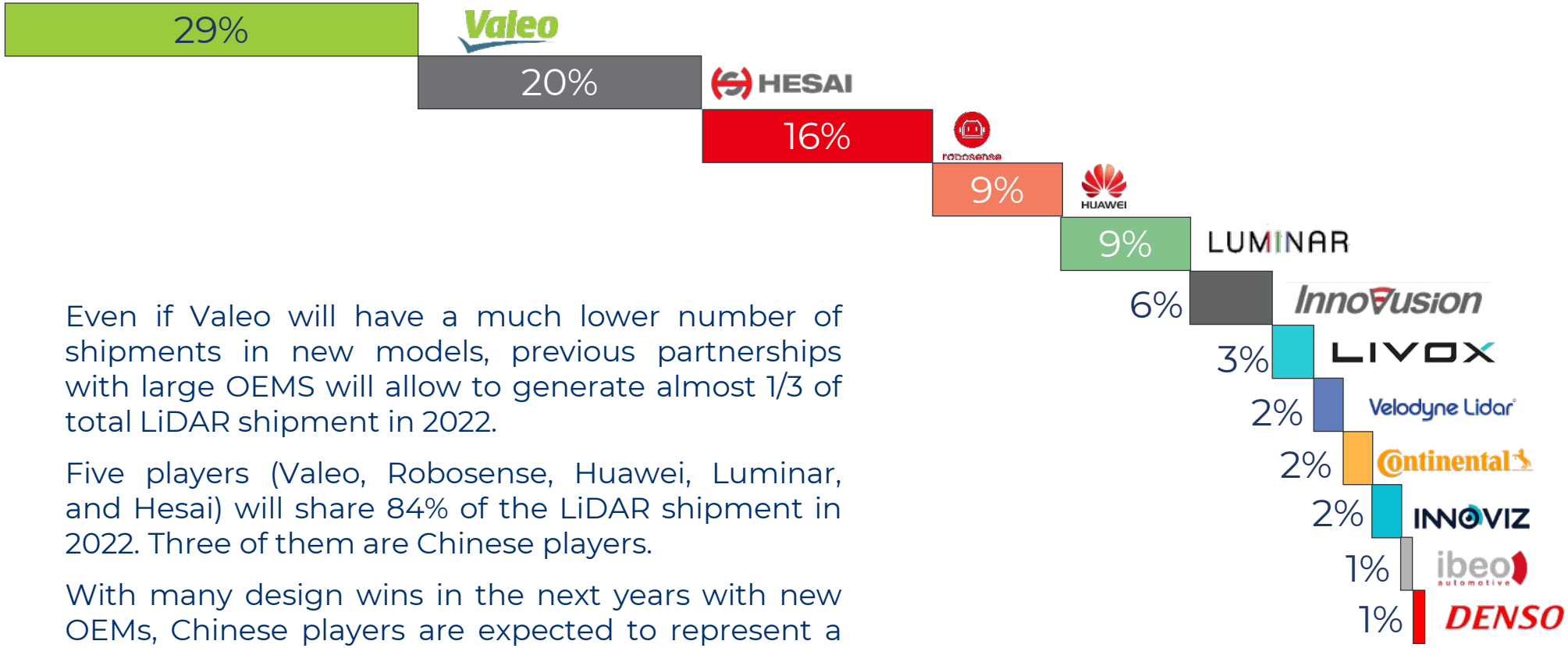
Since 2021, other LiDAR suppliers entered the game, but volumes were much more limited as the cars in which LiDARs were embedded had a low volume production or were released in the end of 2021.

AUTOMOTIVE LIDAR MARKET

LiDAR shipments expected for 2022

Valeo is expected to remain leader, but competition is increasing, especially from Chinese players.

~221,000 LiDARs are expected to be shipped in ADAS cars in 2022



Even if Valeo will have a much lower number of shipments in new models, previous partnerships with large OEMS will allow to generate almost 1/3 of total LiDAR shipment in 2022.

Five players (Valeo, Robosense, Huawei, Luminar, and Hesai) will share 84% of the LiDAR shipment in 2022. Three of them are Chinese players.

With many design wins in the next years with new OEMs, Chinese players are expected to represent a significant part of the LiDAR market.

AUTOMOTIVE LIDAR MARKET

Partnerships of TOP-15 OEMs

Few opportunities left for LiDAR suppliers to enter the automotive market.

OEM groups	LiDAR partner
Toyota Group	DENSO, Continental
VW Group	Valeo, INNOVIZ
Renault-Nissan-Mitsubishi	No partner identified
Hyundai – Kia	SOS LAB ?, Valeo ?
Stellantis Group	Valeo
GM Group	CEPTON
Honda	Valeo
Ford	~~ARGO~~ ?
Suzuki	No partner identified
BMW	INNOVIZ
Geely	LUMINAR, HESAI, robosense
Daimler	Valeo, LUMINAR
Changan Automobile	HESAI
Great Wall Motor	~~ibeo~~ ?, robosense, HUAWEI
Mazda	No partner identified

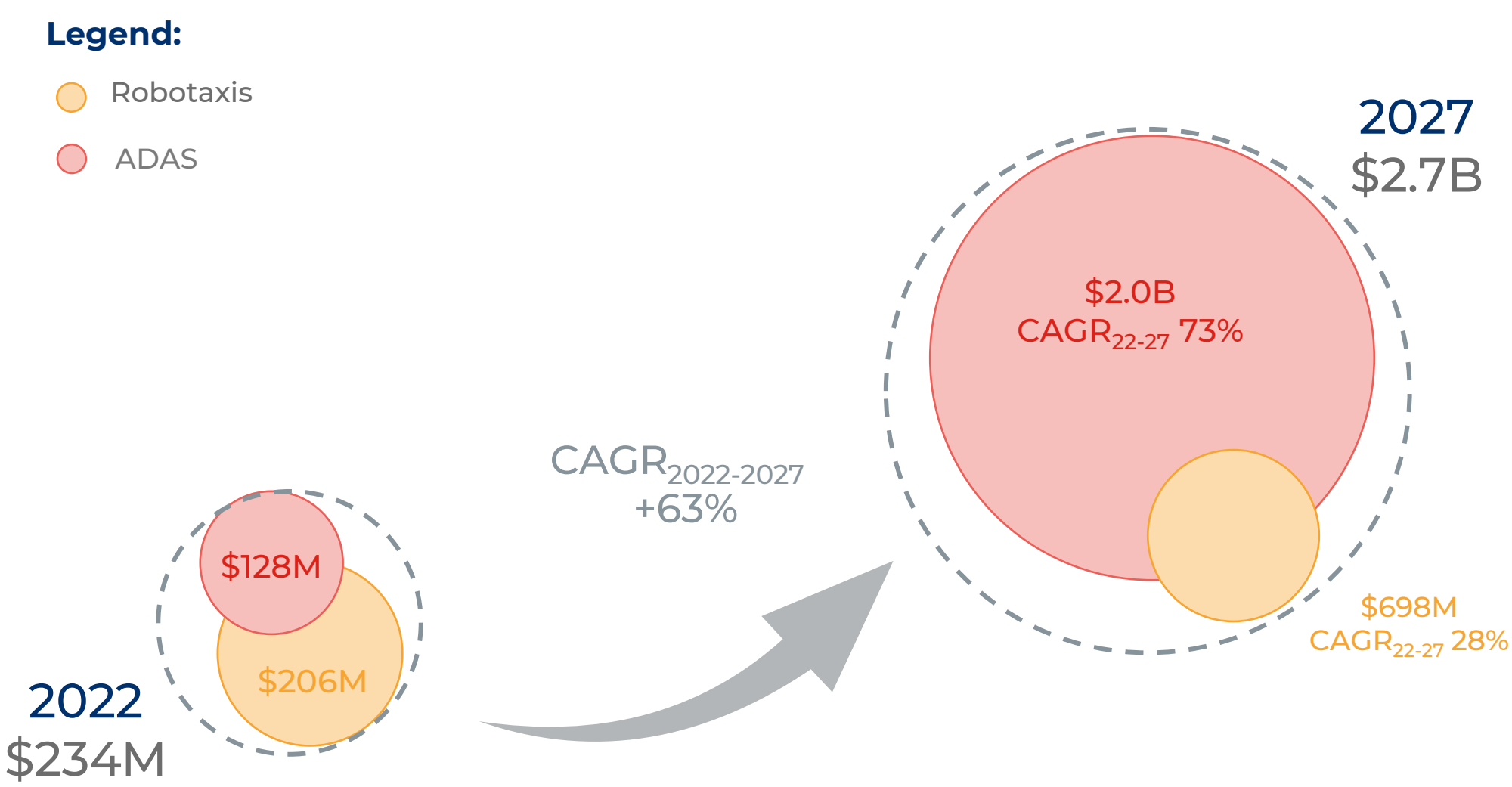
Outputs

- Among TOP-15 OEM groups, 3-4 OEMs do not have a publicly known partnership with a LiDAR manufacturer.
- Among one OEM group, multiple LiDAR suppliers can be selected.
- Consolidation among LiDAR manufacturers has already started with recent news about Ibeo, Argo AI or the Ouster-Velodyne Merger.

- 15 OEM groups represented ~80% of PC + LCV sales in 2021.

AUTOMOTIVE LIDAR MARKET

ADAS market is expected to have a major impact on the LiDAR market.



KEY TAKEAWAYS

- Regulations on L3 automated driving are emerging. Japan and Germany were the first countries to approve such regulation.
    - EU has also recently approved L3 driving.
    - There are discussions in China and in the US.
- Only two OEMs have developed cars for L3 driving: Honda and Mercedes
    - Others are expected shortly with the use of a LiDAR.
    - Some will have to update their software via OTA update as necessary sensors are already implemented.
- Valeo is still the leader in this market, but others are coming fast, especially Chinese players.
    - Strong Chinese ecosystem is being built from OEMs to their suppliers.
- Consolidation among players is starting (Argo AI, Ibeo, Ouster-Velodyne).
- The LiDAR market for ADAS is expected to reach $2.0B in 2027 at a 73% CAGR between 2022 and 2027.

THANK YOU

Thank you for your attention!

If any questions, you can contact me by email:
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