Sensor Technologies for the Automotive Industry

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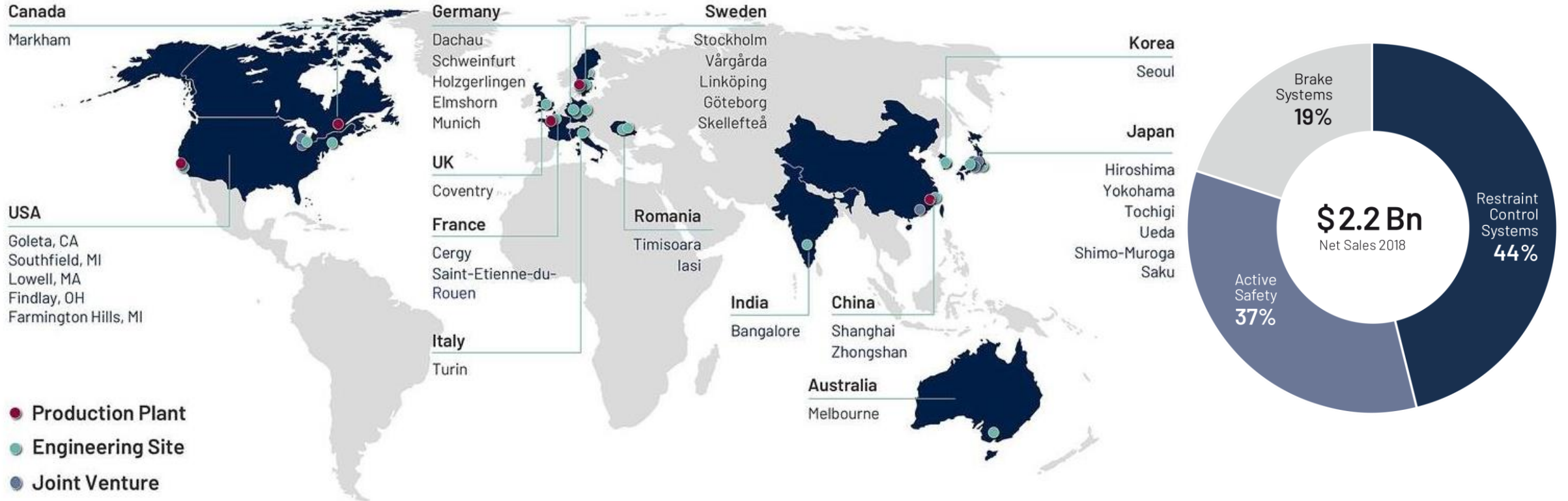
veoneer

Sensor Technologies for the Automotive Industry

Industry Pioneer with Strong Heritage

| MECHANICAL | PYROTECHNICAL | ELECTRONICS | DIGITAL |

1950s   1980s   1990s   2000s   2010s   2018

Sensor Technologies for the Automotive Industry

A Global Footprint

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Canada
Markham

USA
Goleta, CA
Southfield, MI
Lowell, MA
Findlay, OH
Farmington Hills, MI

Germany
Dachau
Schweinfurt
Holzgerlingen
Elmshorn
Munich

UK
Coventry

France
Cergy
Saint-Etienne-du-Rouen

Italy
Turin

Sweden
Stockholm
Vårgårda
Linköping
Göteborg
Skellefteå

Romania
Timisoara
Iasi

India
Bangalore

China
Shanghai
Zhongshan

Australia
Melbourne

Korea
Seoul

Japan
Hiroshima
Yokohama
Tochigi
Ueda
Shimo-Muroga
Saku

● Production Plant
● Engineering Site
● Joint Venture

Brake Systems 19%

Restraint Control Systems 44%
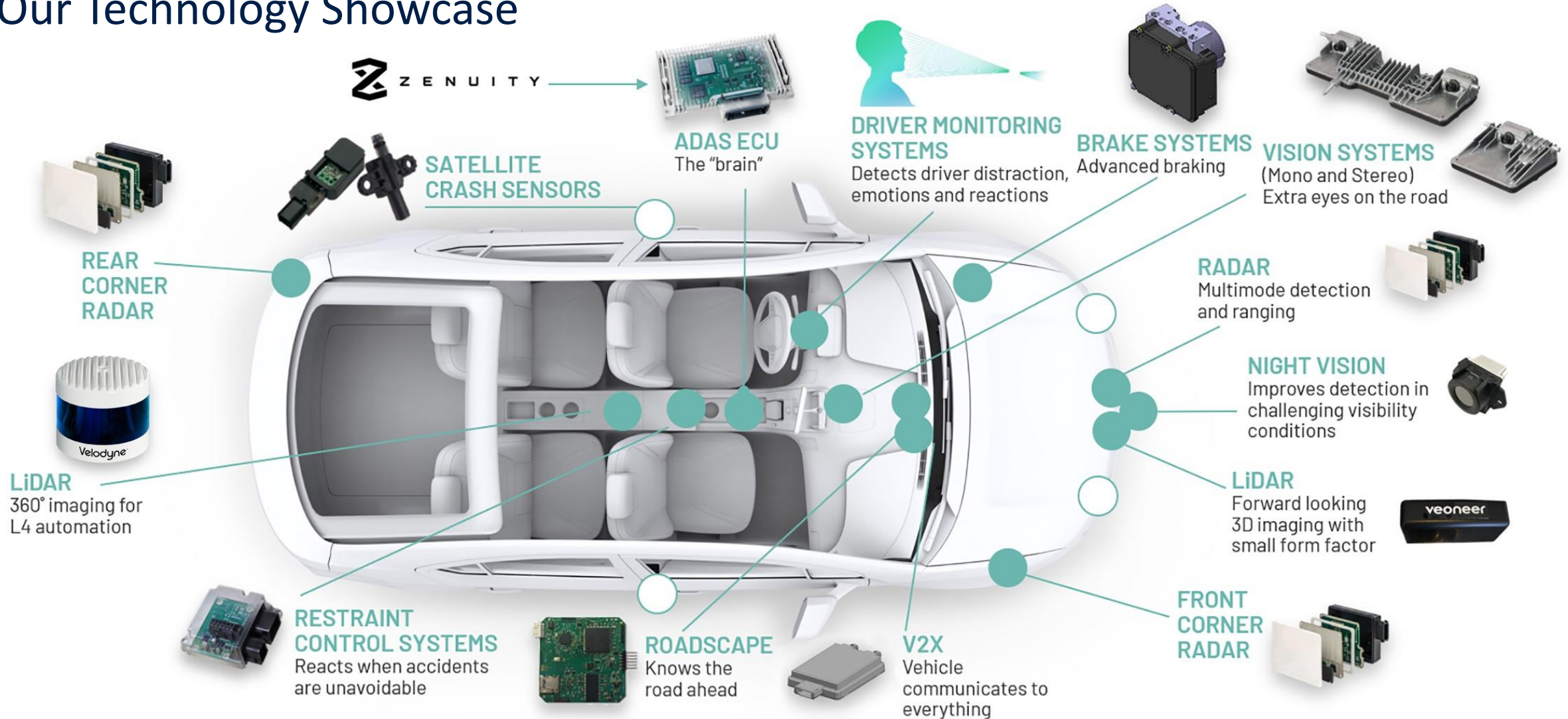
Active Safety 37%

$2.2 Bn
Net Sales 2018

9,200 ASSOCIATES
~5,200 in R,D&E

13 COUNTRIES
10 MANUFACTURING SITES
26 TECHNICAL CENTERS

1,100 ENGINEERS
HIRED DURING 2018

Sensor Technologies for the Automotive Industry

Our Technology Showcase

ZENUITY

ADAS ECU
The "brain"

DRIVER MONITORING SYSTEMS
Detects driver distraction, emotions and reactions

BRAKE SYSTEMS
Advanced braking

VISION SYSTEMS
(Mono and Stereo)
Extra eyes on the road

SATELLITE CRASH SENSORS

REAR CORNER RADAR

RADAR
Multimode detection and ranging

NIGHT VISION
Improves detection in challenging visibility conditions

LiDAR
360° imaging for L4 automation

LiDAR
Forward looking 3D imaging with small form factor

RESTRAINT CONTROL SYSTEMS
Reacts when accidents are unavoidable

ROADSCAPE
Knows the road ahead

V2X
Vehicle communicates to everything

FRONT CORNER RADAR

The Road Towards Saving More Lives

Global Traffic Fatalities (millions)
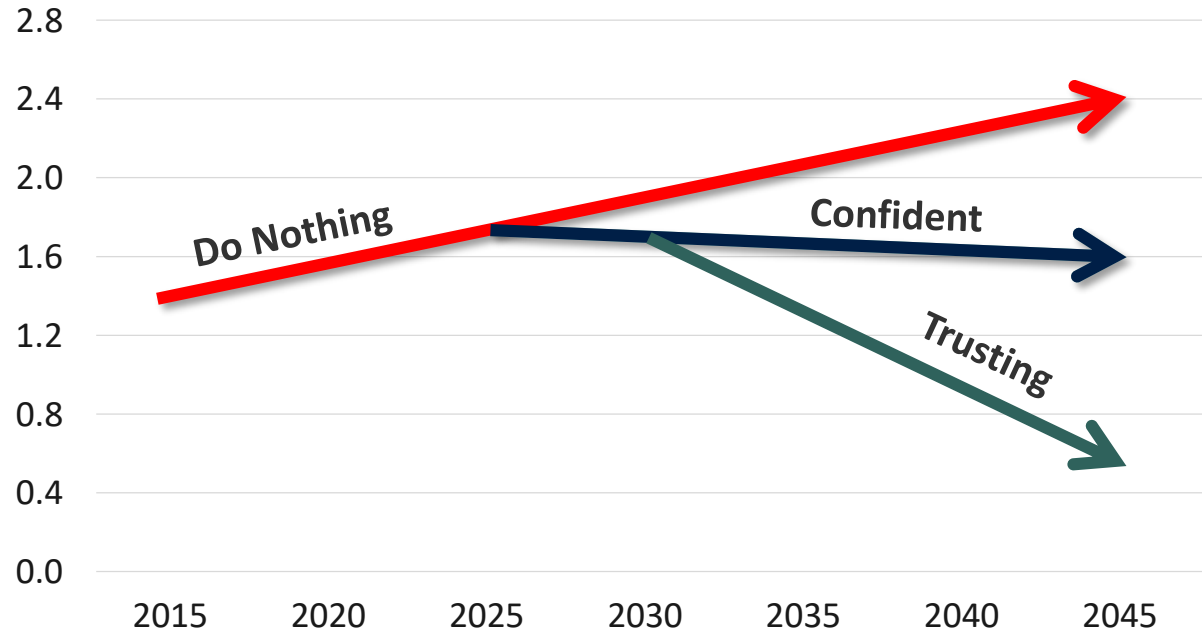
Source: Veoneer Research

Driver Confidence

- Today's safety technology in all new vehicles
- Consumers willingness to buy and use
- Confidence in the vehicles' perception

Occupant Trust

- Driver co-pilot and shared control
- The driver considers the vehicle intelligent
- Eventually full trust in the vehicle to drive

Sensing
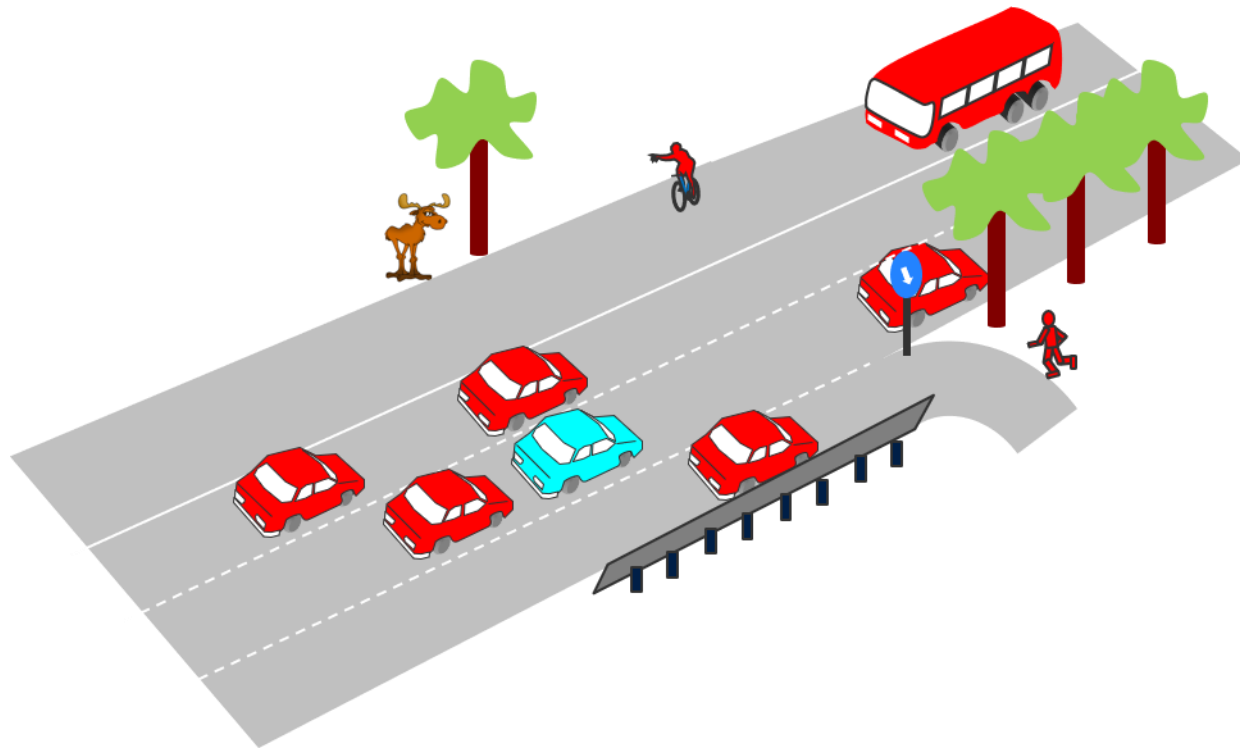
- Object sensing
  - Object in travel path & free space
- Ego localization
  - Drivable area/surface
  - Travel path
- Surround perception
  - Objects that may interfere
- In-cabin monitoring
  - Driver/passenger status
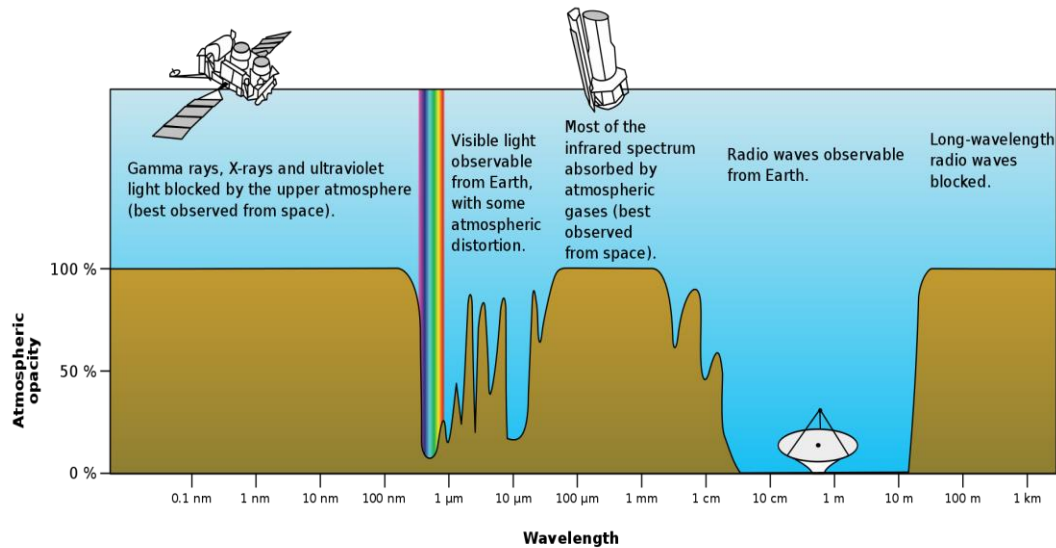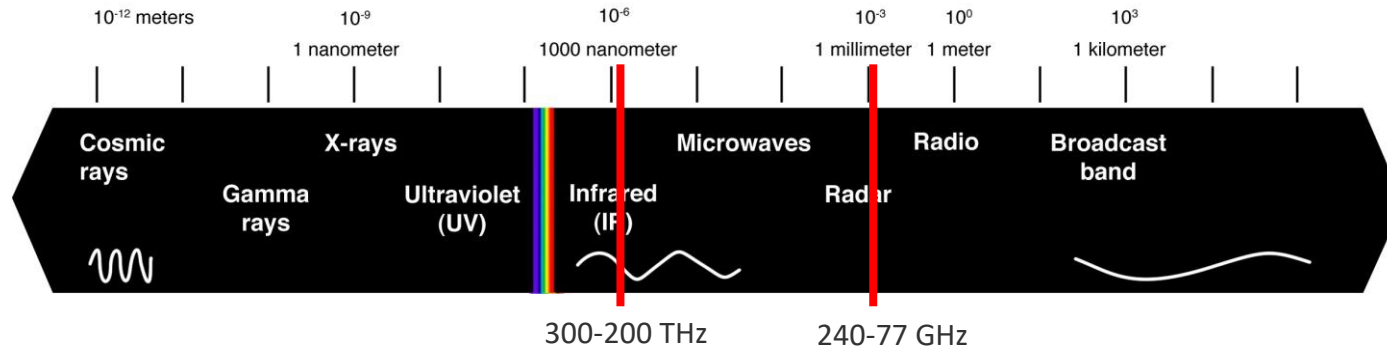- Data management
  - Communication
  - Security, Integrity

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Use of sensor data

Safety and Comfort

- Perception
  - Private
  - Collective

- HMI

- Regulation & standards
  - e.g. EuroNCAP

EM sensing

300-200 THz   240-77 GHz
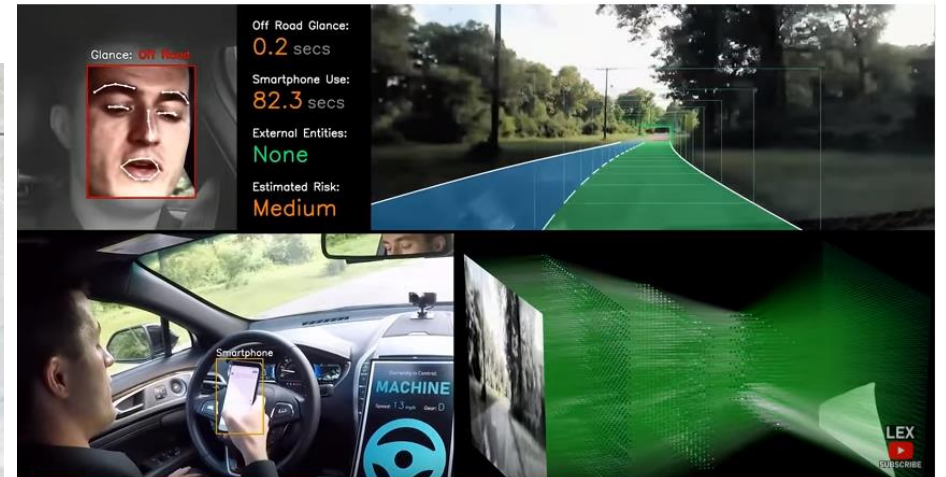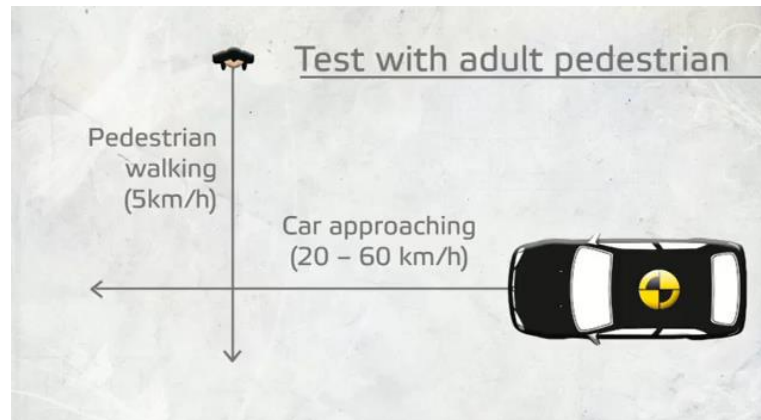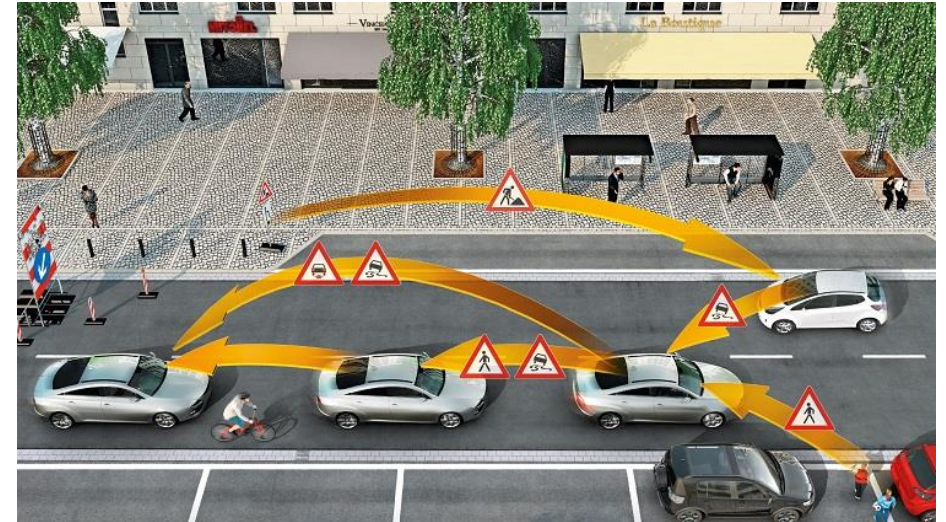
- Sensing technology
  - Visible light camera
  - TOF camera
  - Lidar
  - Thermal camera
  - Radar
  - Radio (DSRC, cellular)
  - GNSS
- Active and passive
- Parameter extraction
- Components
- Signal processing
- Modelling
- Functional Safety

Goal of sensing projects

What I want to know

- **Environmental perception**
  - Object
    - position
    - behavior
    - classification
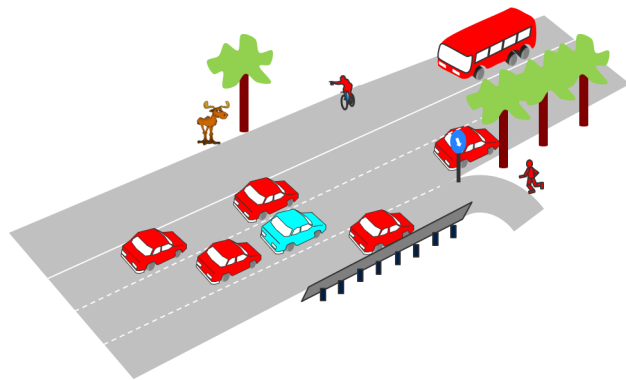 - Ego
    - Position

    …

Variables to play with

- **Time of flight**
- **Time of arrival**
- **Direction of Arrival**
- **EM parameters**
- **Signal processing**
- **Fusion**
- **Communication**

Try find solutions for

- **High resolution**
- **Wide coverage**
- **High update rate**
- **Small sensor physical size**
- **Low cost**
- **Low power consumption**
- **Low interference risk**
- **Classification**
- **User integrity**
- **Health**

Automotive applications

- Collision detection, warning and mitigation
- Collision avoidance
- Blind spot monitoring / blind spot detection
- Lane change assistance
- Lane departure warning system
- Lane keeping assistance
- Lane centering
- Rear cross-traffic alerts
- Intersection collision alert
- Vulnerable road user detection
- Adaptive Cruise Control with Stop & Go
- High speed ACC
- Forward Collision Warning
- Automatic Emergency Braking (AEB)
- Brake Support
- Headway Alert
- Backup aid
- Parking aid
- Safe Door Opening
- Passive safety pre-activation
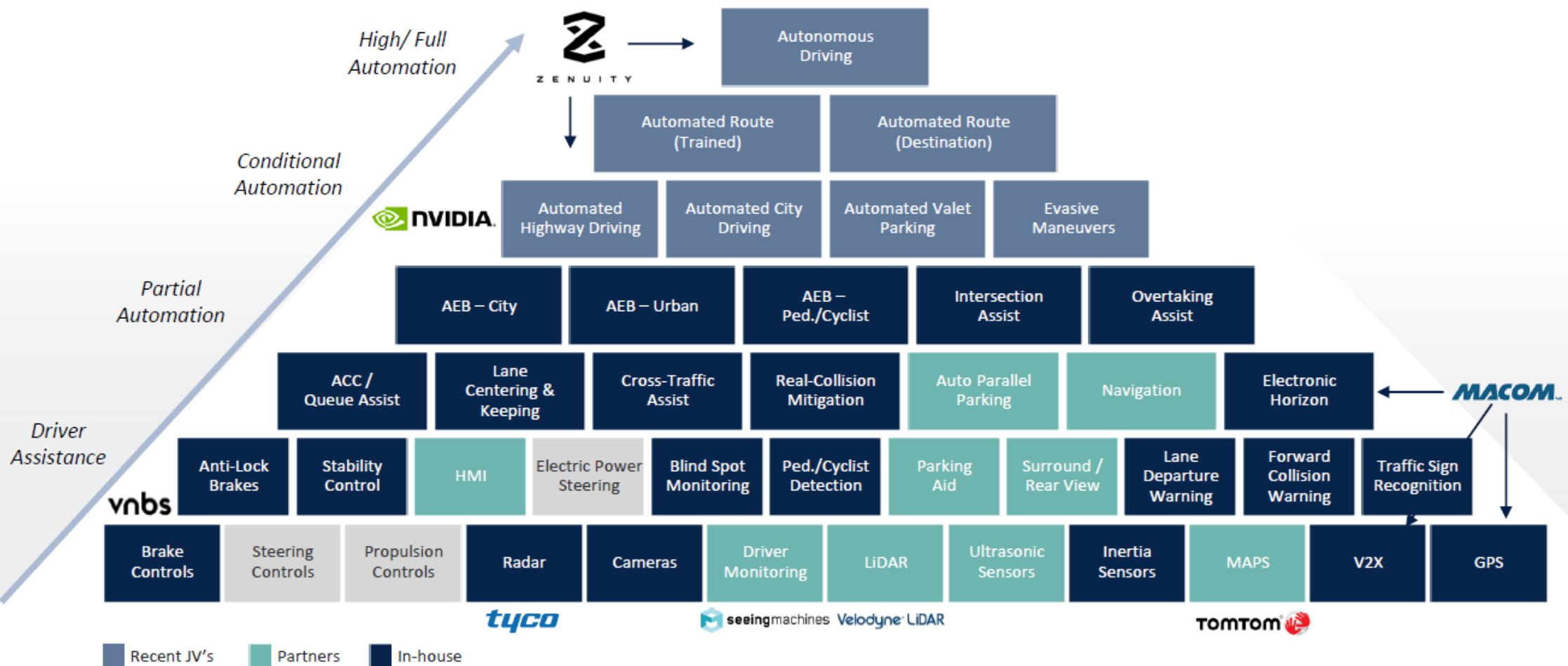- Traffic sign recognition
- Driver monitoring
- …….

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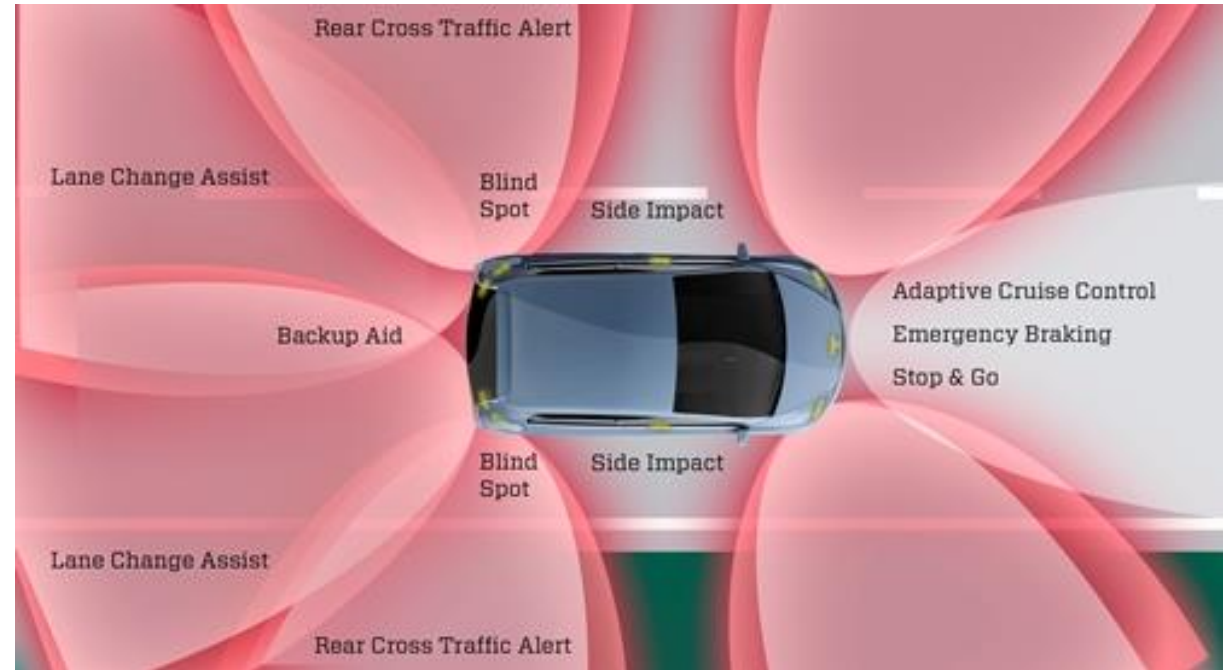
AD levels

SAE level	Name	Narrative Definition	Execution of Steering and Acceleration/ Deceleration	Monitoring of Driving Environment	Fallback Performance of Dynamic Driving Task	System Capability (Driving Modes)
Human driver monitors the driving environment						
0	No Automation	the full-time performance by the *human driver* of all aspects of the *dynamic driving task*, even when enhanced by warning or intervention systems	Human driver	Human driver	Human driver	n/a
1	Driver Assistance	the *driving mode*-specific execution by a driver assistance system of either steering or acceleration/deceleration using information about the driving environment and with the expectation that the *human driver* perform all remaining aspects of the *dynamic driving task*	Human driver and system	Human driver	Human driver	Some driving modes
2	Partial Automation	the *driving mode*-specific execution by one or more driver assistance systems of both steering and acceleration/ deceleration using information about the driving environment and with the expectation that the *human driver* perform all remaining aspects of the *dynamic driving task*	System	Human driver	Human driver	Some driving modes
Automated driving system ("system") monitors the driving environment						
3	Conditional Automation	the *driving mode*-specific performance by an *automated driving system* of all aspects of the dynamic driving task with the expectation that the *human driver* will respond appropriately to a *request to intervene*	System	System	Human driver	Some driving modes
4	High Automation	the *driving mode*-specific performance by an automated driving system of all aspects of the *dynamic driving task*, even if a *human driver* does not respond appropriately to a *request to intervene*	System	System	System	Some driving modes
5	Full Automation	the full-time performance by an *automated driving system* of all aspects of the *dynamic driving task* under all roadway and environmental conditions that can be managed by a *human driver*	System	System	System	All driving modes

Our Vision Becomes Reality

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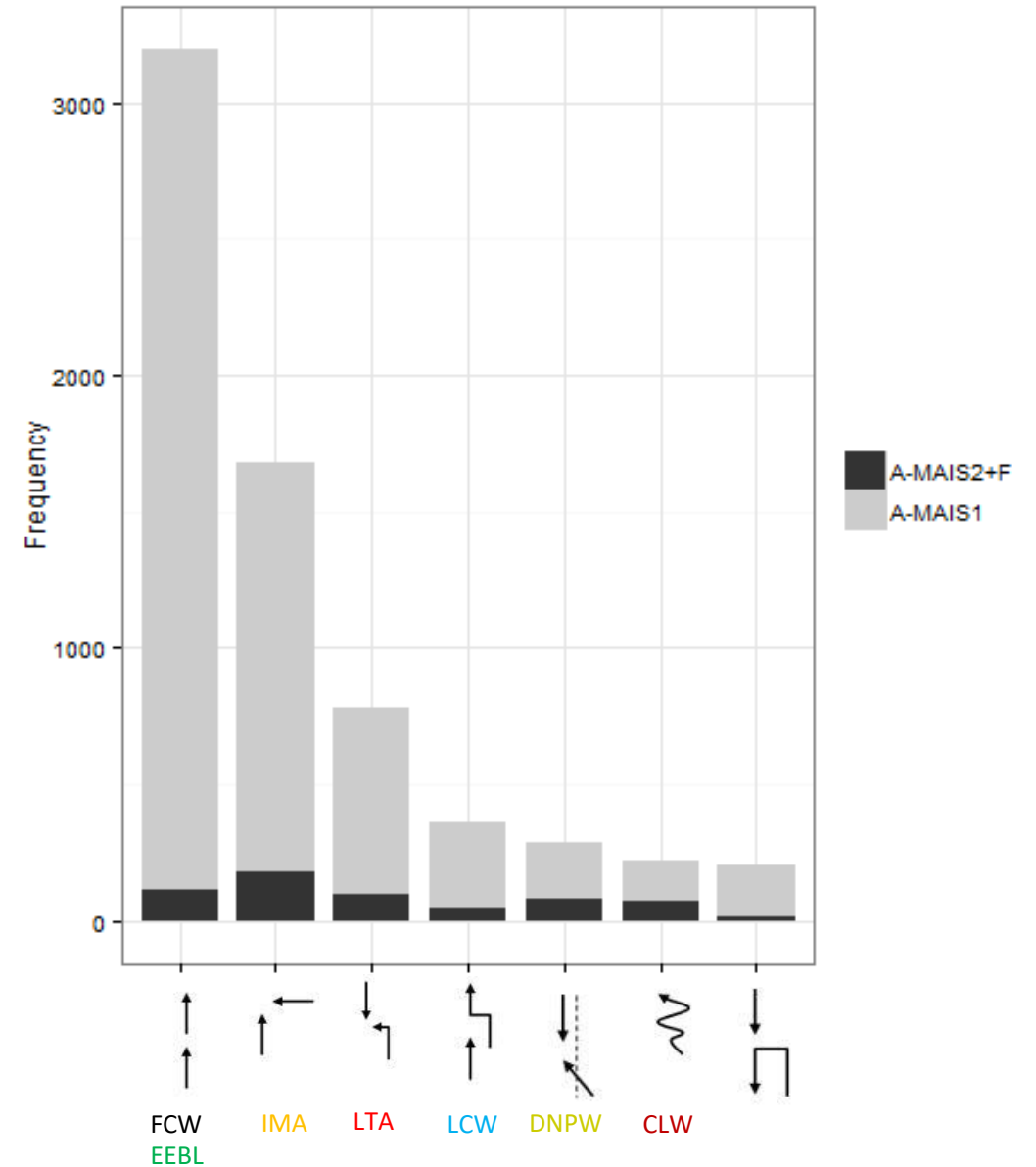
Real life safety

GIDAS database - All car-2-car accidents

Real life safety

Sensors
Intersection movement assist

Radar
18^0 / 300m

Information
Warning
Intervention

IMA

Camera
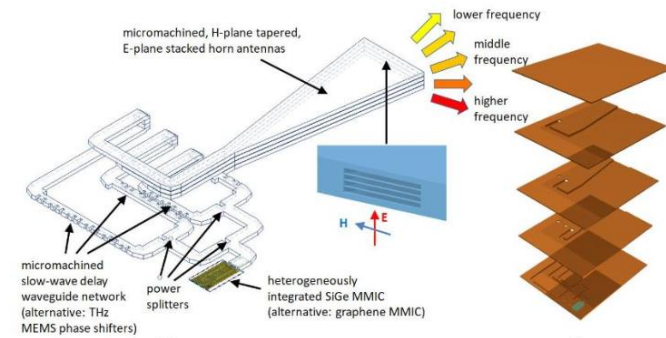100^0 / 200m

Radar
90^0 / 60m
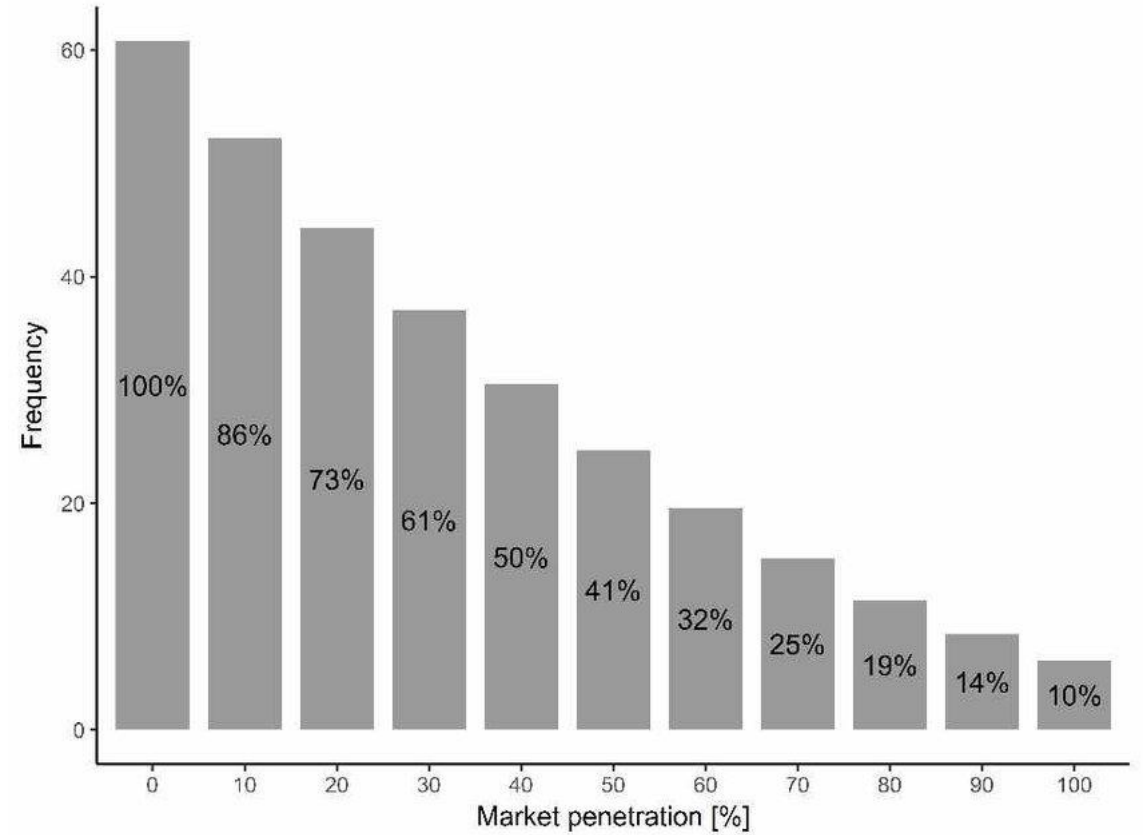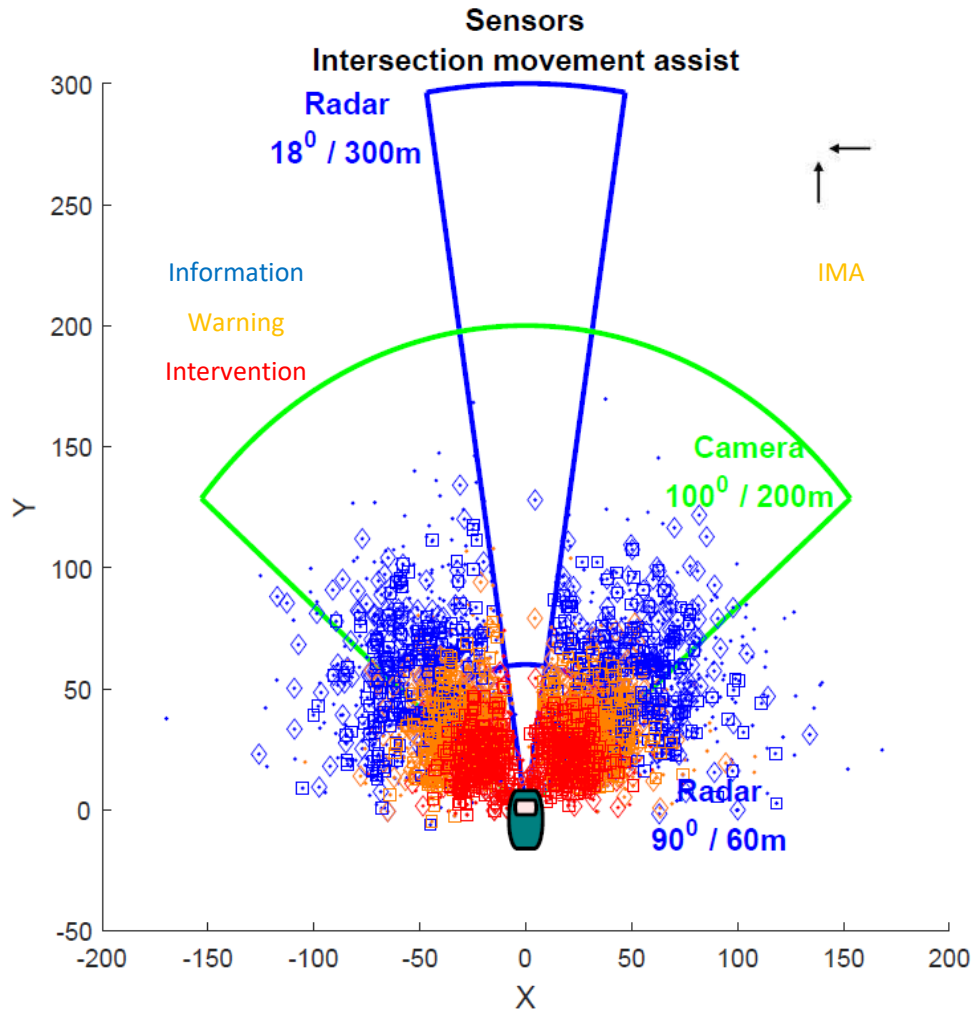
Frequency of remaining MAIS2+F injured occupants as a function of market penetration of Intersection AEB for a 180° field-of-view sensor. [Ulrich Sander, Nils Lubbe]
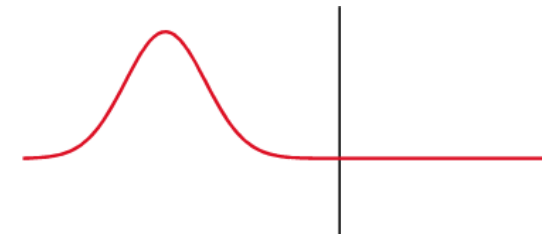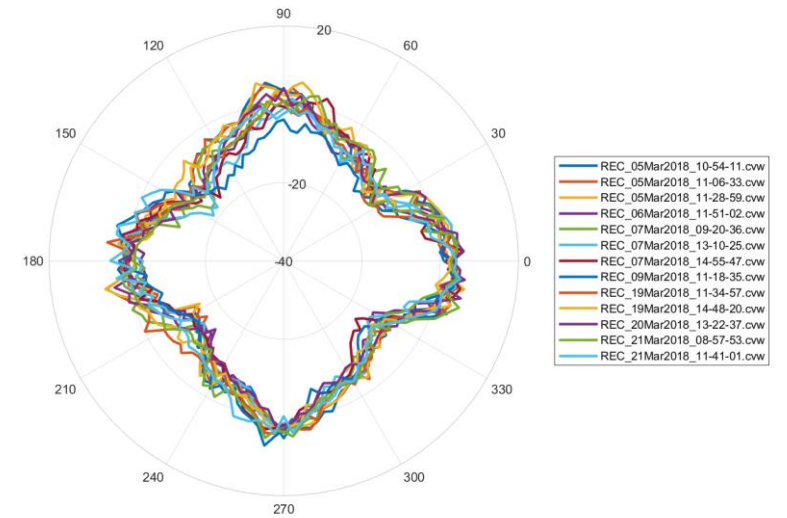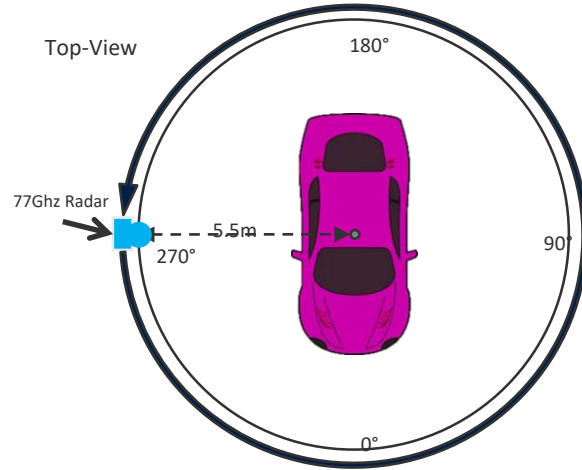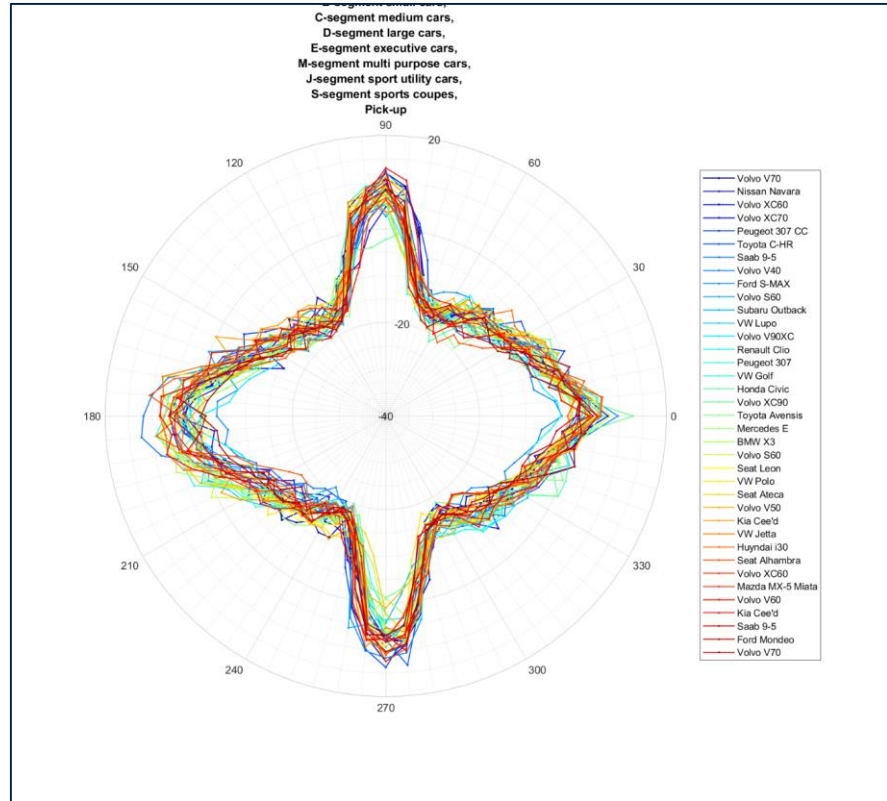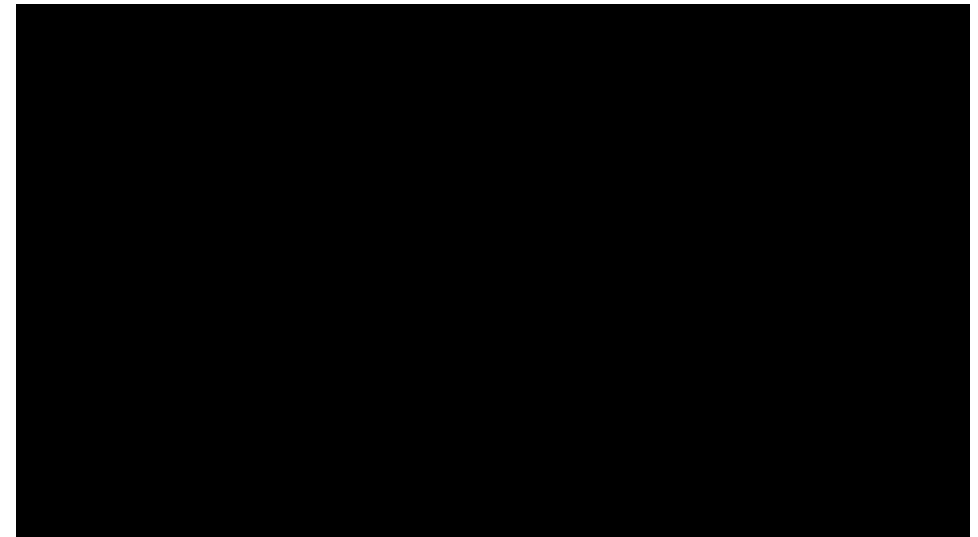
Testing; Asta Zero

Human interaction

Testing; Veoneer & real life

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NCAP, standardization

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Sensor requirements

- FOV

- Resolution (multi-dimension)

- Detection quality (target object characteristics)

- Environment (sun, rain, fog, snow, tunnels, interference and more)

- Robustness, (ISO26262, SOTIF, redundancy, verification)

- Application, sensor system output

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Signal processing

00:52. På en av Sveriges mest trafikerade motorleder automatbromsar vissa Volvobilar – helt utan anledning.

Mitt på en av Sveriges mest trafikerade motorleder, Essingeleden, autobromsar vissa Volvobilar helt

https://www.dn.se/sthlm/volvobil-autobromsar-utan-anledning-pa-essingeleden/

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Data cube, radar example

The raw data cube size is directly set by the required max and resolution values of range and speed and the number of antennas.

max range	250 m
range resolution	0.5 m
speed range	± 60 m/s
speed resolution	0.25 m/s
number of antennas	64

500 x 480 x 64 = 15.36 M data

With an update rate of 20 ms data flow is
768 Mdata / s   (~12 Gbit/s)

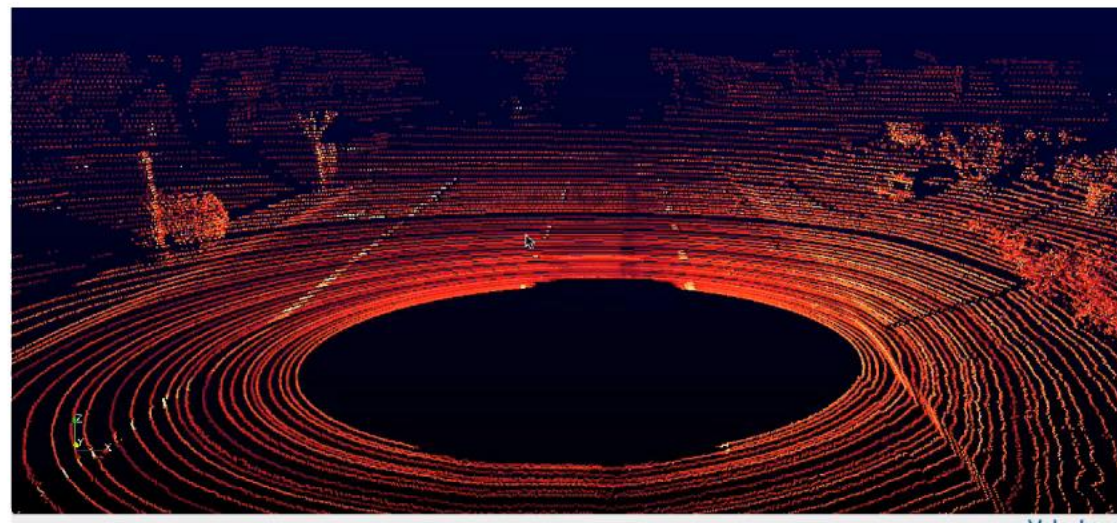Sensor Technologies for the Automotive Industry
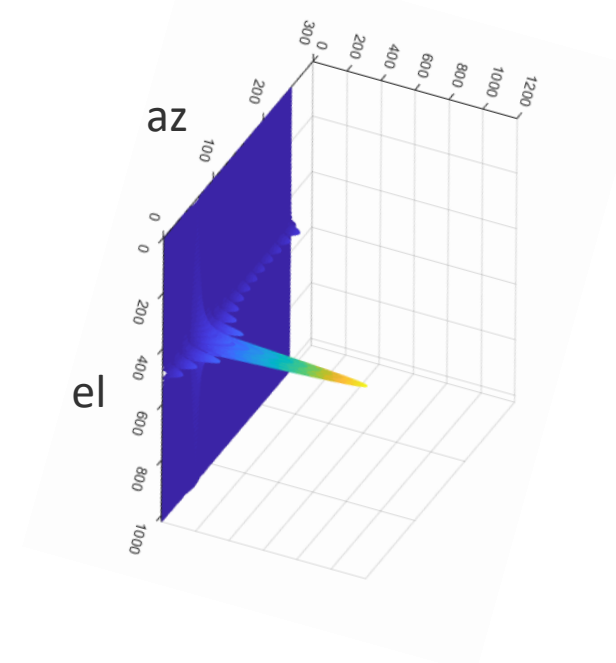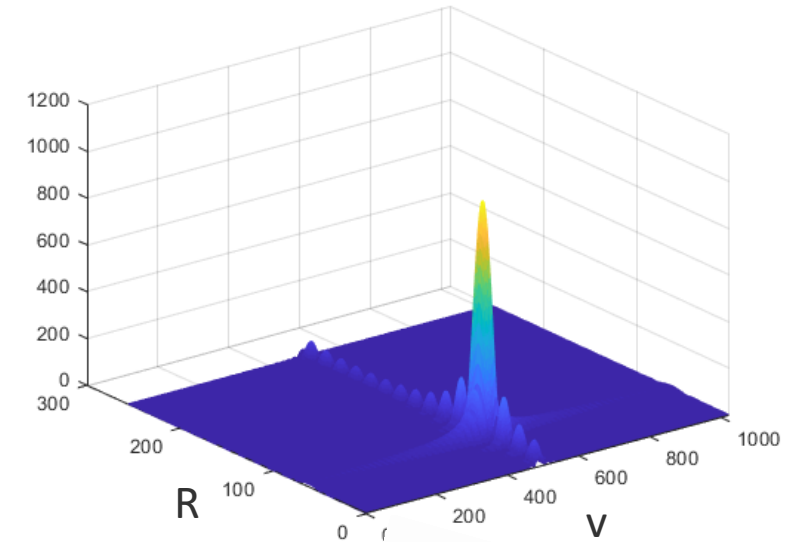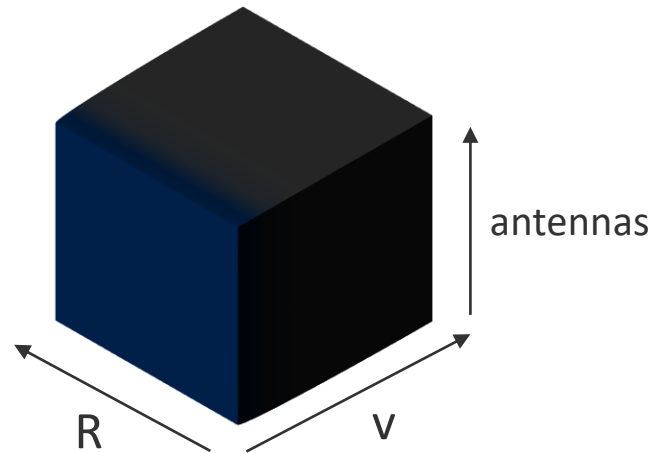
Design criteria's for safety applications

- Robustness
  - System latency
  - Functional safety

- Regulation

- Environmental

- Power consumption

- Cost

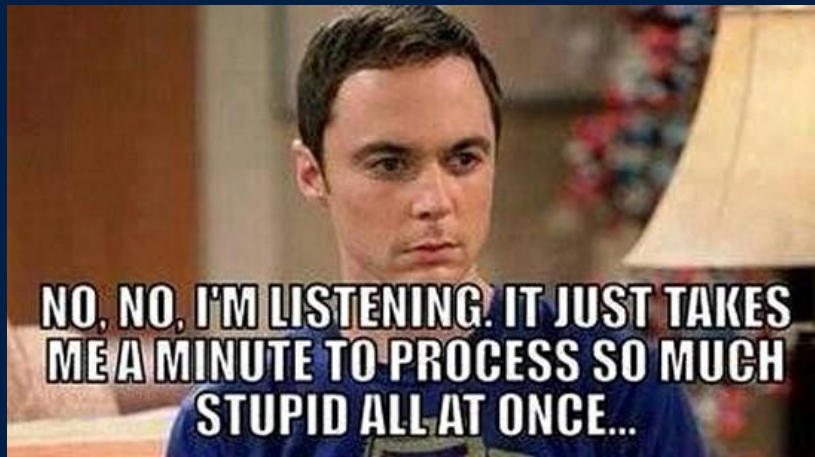Sensor Technologies for the Automotive Industry

LiDAR

- Veoneer has partnered with Velodyne to offer superior LiDAR performance at a competitive price

- Veoneer will be one of the earlier LiDARs on the marketplace in Wave 2

2018	2021	2024	2027
WAVE 1	**WAVE 2**	**WAVE 3**	

AUTONOMOUS (L4/5)
- 360° coverage
- High performance
- Short time to market

PREMIUM OEMs (L3/4)
- Forward looking
- Highly reliable
- Small form factor

MASS MARKET (L3/4)
- Cost and size reduction
- One design for L3+

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Thank You!

(and I hope this is not your response)

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