UPC industrial event

Veoneer long-term collaboration with UPC



Dr. Jan-Erik Källhammer

Director Visual Enhancement & Cognitive Systems

veoneer

© 2023 Copyright Veoneer HoldCo, LLC. All Rights Reserved

What we do

© 2023 Copyright Veoneer HoldCo, LLC. All Rights Reserved



"This conference is an opportunity for the world to embrace a new agenda to radically reduce the number of lives lost on our roads and re-think how we can provide access to safe, affordable, accessible and sustainable transport systems for all."

Tedros Adhanom Ghebreyesus
WHO Director-General

© 2023 Copyright Veoneer HoldCo, LLC. All Rights Reserved

Adding Prevention to Protection

Our heritage: Impact protection



Active Safety: Accident prevention



© 2023 Copyright Veoneer HoldCo, LLC. All Rights Reserved

Global tier 1 delivering Automotive Safety

Delivered:

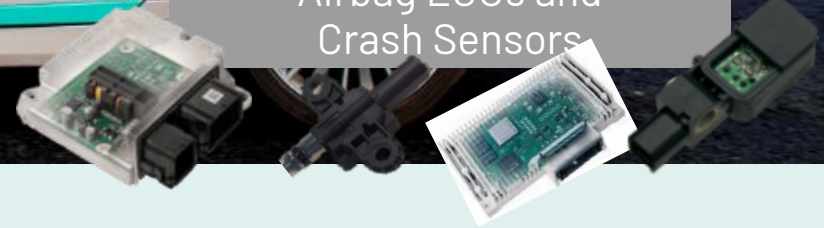
14 million
Camera Sensors

55 million
Radar Sensors

~ 1000 million
Airbag ECUs and Crash Sensors





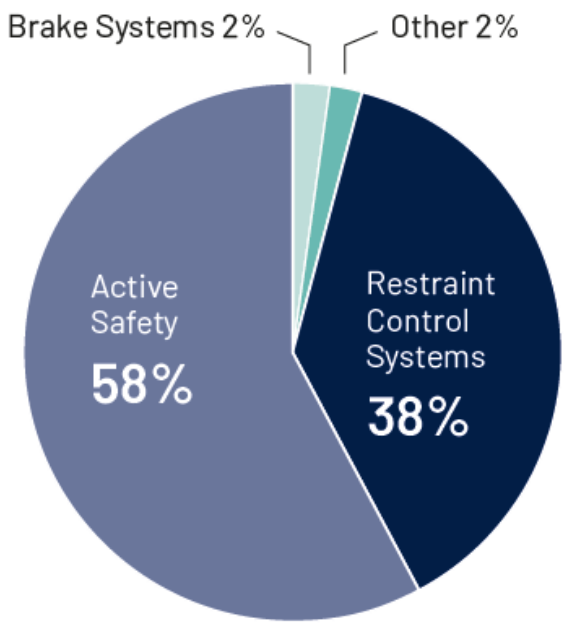


Delivered during the past decade, as Veoneer and as part of Autoliv, the number of airbag ECUs and crash sensors is for a longer period

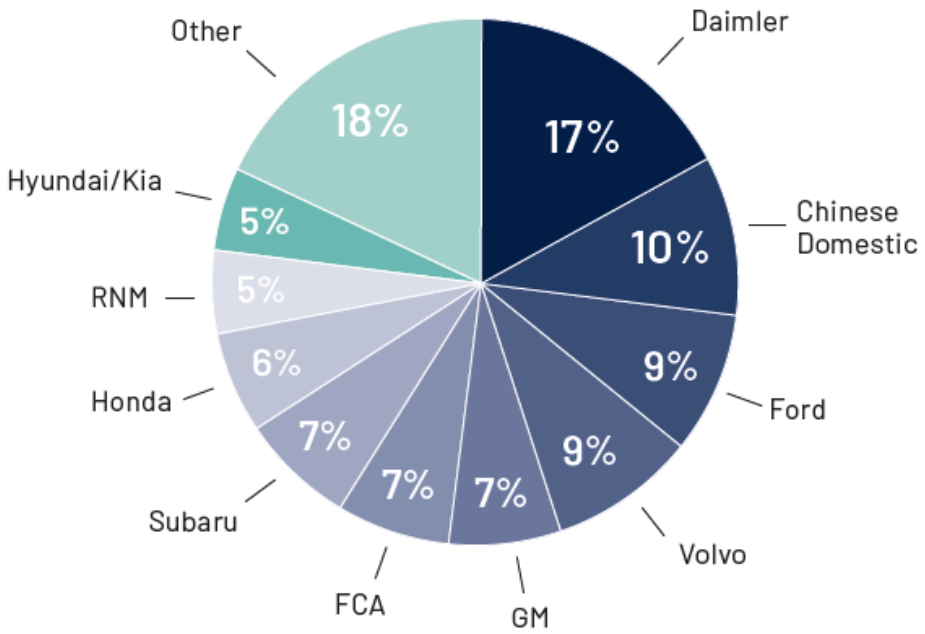
Net Sales

2022: ~2 BUSD

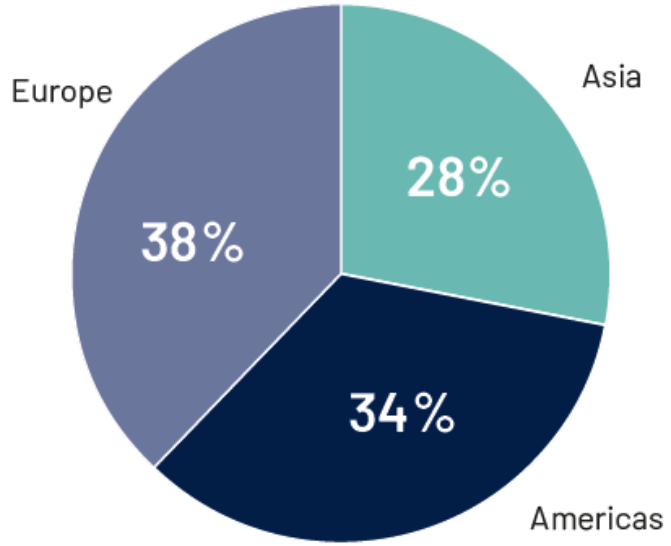
Sales by Product



Sales by Customer

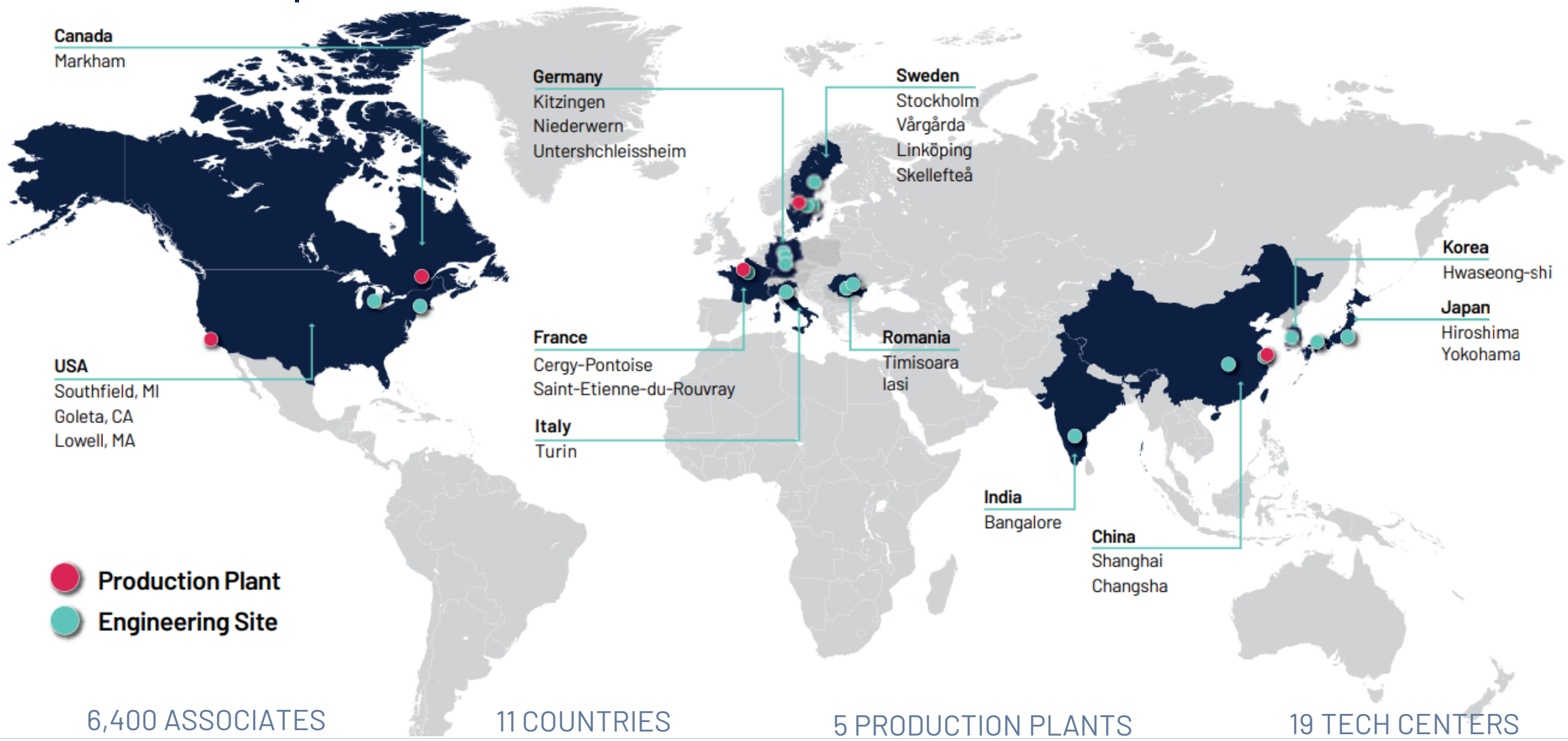


Sales by Region



© 2023 Copyright Veoneer HoldCo, LLC. All Rights Reserved

Global Footprint



6,400 ASSOCIATES

11 COUNTRIES

5 PRODUCTION PLANTS

19 TECH CENTERS

© 2023 Copyright Veoneer HoldCo, LLC. All Rights Reserved

Consolidation and restructuring of automotive suppliers

- Spin-off from Autoliv 2018
- SW arm purchased by Qualcomm 2022
- Active Safety purchased by Magna 2023



© 2023 Copyright Veoneer HoldCo, LLC. All Rights Reserved

UPC cooperation 1
Development of a solid-state Lidar

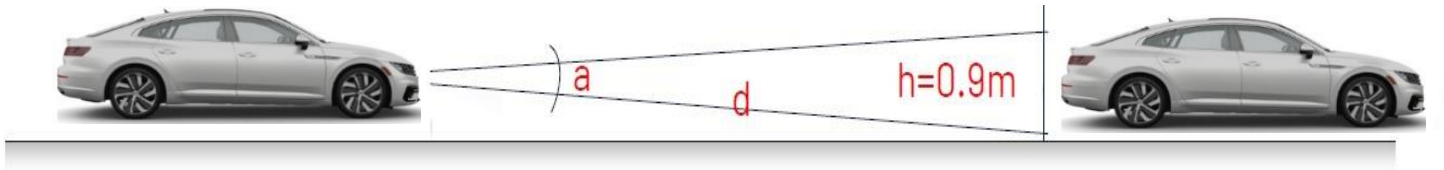
© 2023 Copyright Veoneer HoldCo, LLC. All Rights Reserved

Limitations of early Lidar

Moving parts and precision optics do not match well

- 2015 Lidar were sensitive to vibration, shock and thermal variations
- Vertical resolution insufficient
  - Example: Velodyne HDL-64E S3 (64 channels)
    - Measurement Range: Up to 120 m
    - Vertical Field of View: 26.9° ->
      Vertical angular resolution: 0.42°



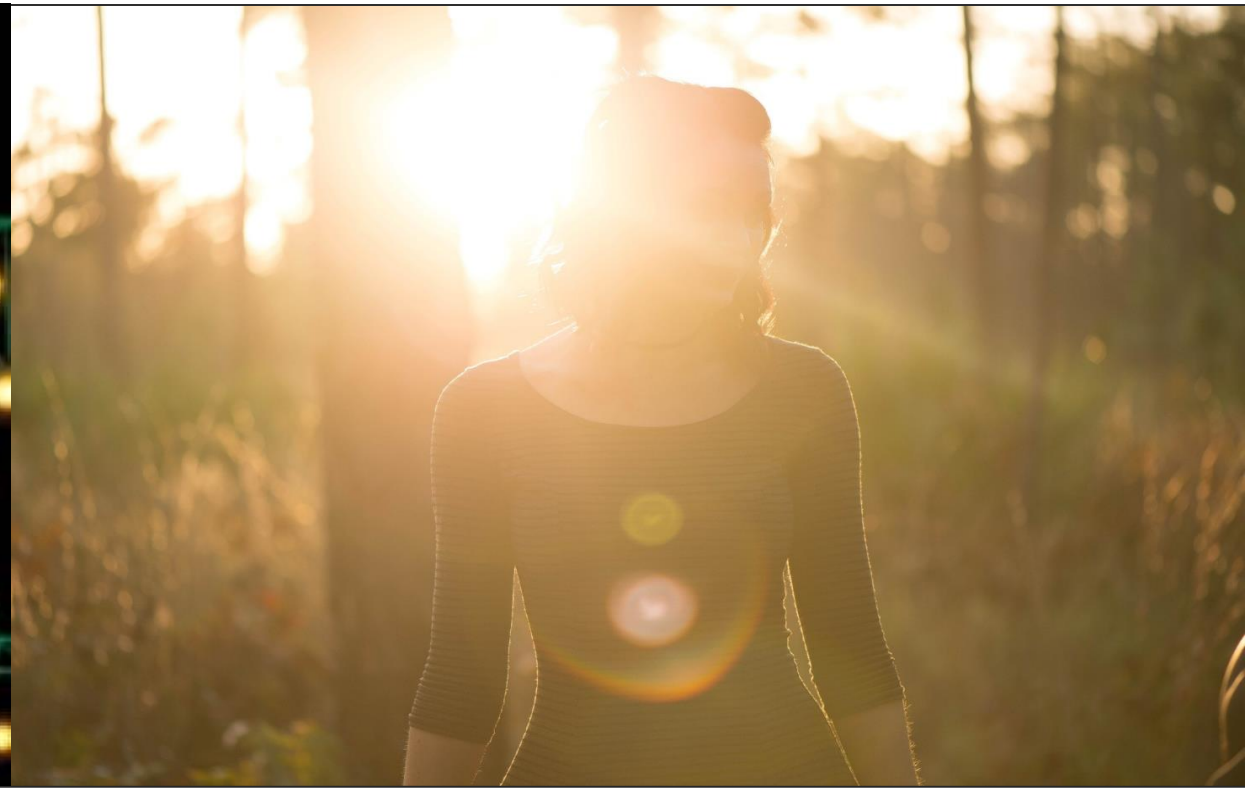


*Velodyne spec

Lidar must handle all kinds of disturbances

Both night & day, background light limits performance





Source: 3M

© 2023 Copyright Veoneer HoldCo, LLC. All Rights Reserved

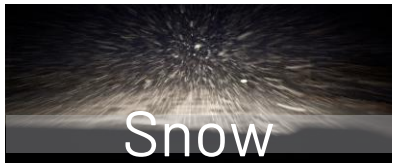
Signal levels depend on obscurants in the atmosphere











How much degradation can we allow?
How severe conditions?
Will determine system specifications (how much laser power we need to emit).

© 2023 Copyright Veoneer HoldCo, LLC. All Rights Reserved

UPC-CD6 has helped us with assessing different options

Example optical link budget trade off:

$$N_{phot} = \frac{1}{4} \cdot \frac{\lambda}{hc} \cdot \frac{A_{pix} FF}{A_{array}} \cdot \left(\frac{f}{z \cdot F\#} \right)^2 \cdot P_E \, T_{pulse} \cdot \rho \cos\Theta \cdot k$$

Adverse weather effect

N_{phot} the number of photons per frame that inpinges on a detector pixel

λ	Wavelength
h	Planck's constant
c	Speed of light
A_{pix}	Pixel area
A_{array}	Array area
FF	Fill factor of pixel
f	Focal length of detector optics
z	Object distance
$F\#$	F-number of optics
P_E	Emitted laser power
ρ	Reflectance of object

Assumptions:

- object modelled as a Lambertian diffusor
- the illuminated area is exactly covering the imaging detector

T_{pulse} (Integrated) active pulse time during frame

Θ Angle of incidence for object

k Optical attenuation in the light path

© 2023 Copyright Veoneer HoldCo, LLC. All Rights Reserved

Sensor fusion

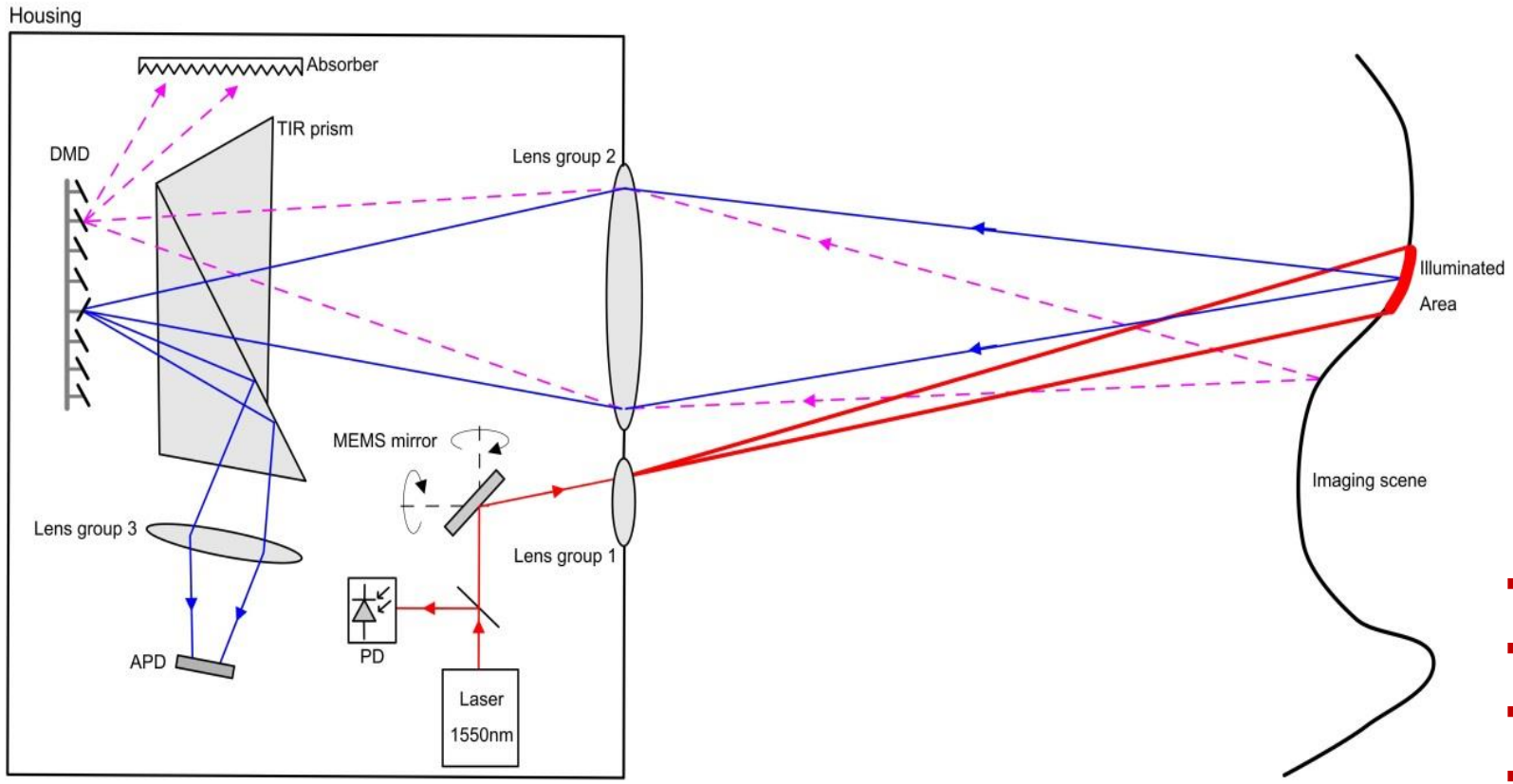
Using several sensors is complex to match

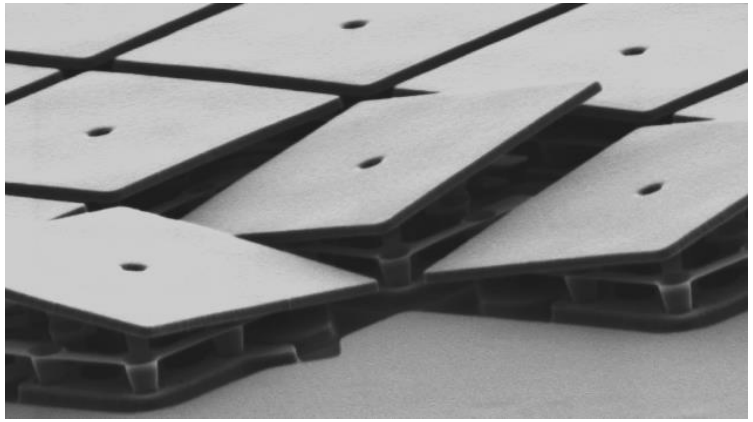
- Several sensors required for redundancy and to cover the different failure modes
- Parallax error when fusing sensors at different positions
- Different sensor geometries and update frequencies
- Transform Lidar points into camera image
  - Alignment transformation distance dependent
  - Motion of objects between different sensors



© 2023 Copyright Veoneer HoldCo, LLC. All Rights Reserved

UPC patents (licensed)





- Solid State (double MEMS approach)
- Filtered background light
- High vertical resolution (0,05deg)
- Suitable for data fusion (squared FOV)

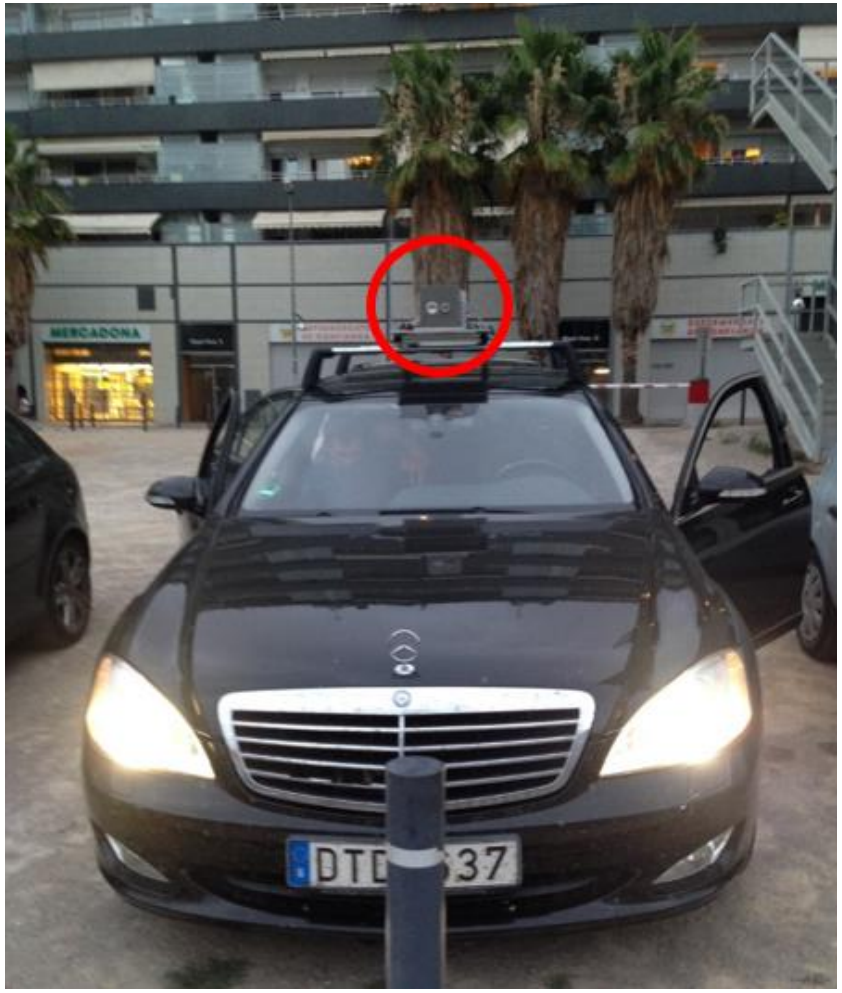
S.Royo, J.Riu PCT/IB2012/000501
S.Royo, J.Riu PCT/IB2014/070108

Lessons learnt:

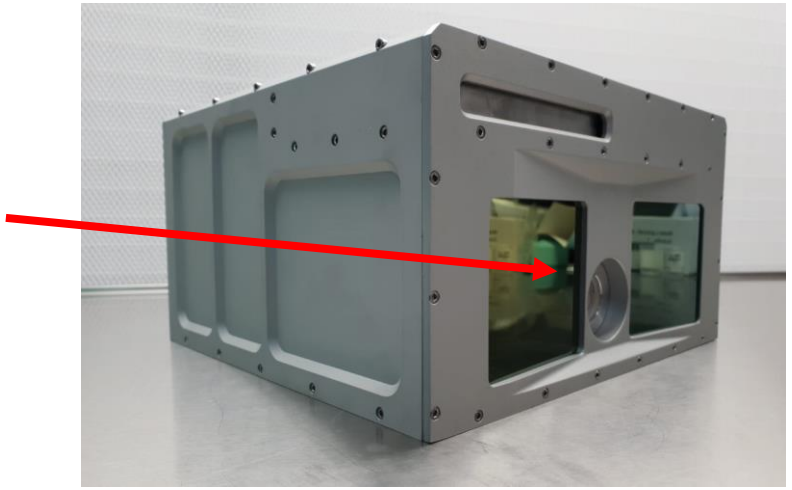
Poor patent attorney: Almost lost US patent

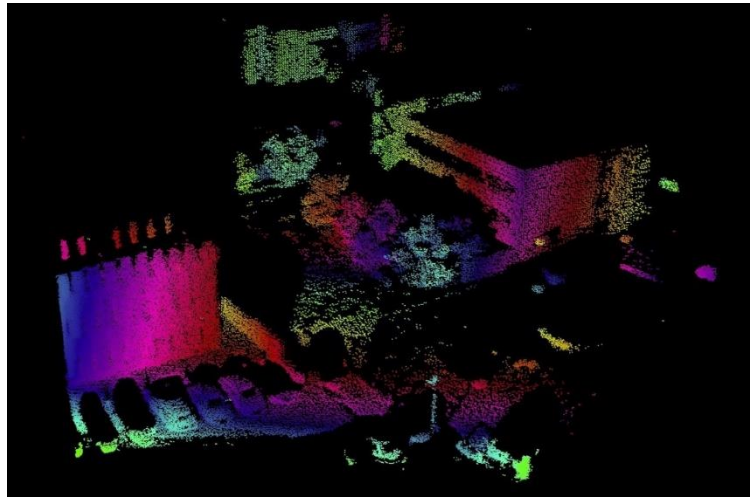
© 2023 Copyright Veoneer HoldCo, LLC. All Rights Reserved

Development and integration of customized lidar prototypes



Co-located Lidar & cameras for improved sensor fusion





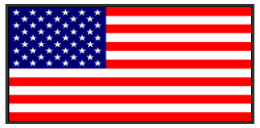
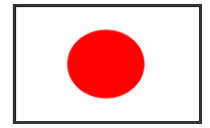
© 2023 Copyright Veoneer HoldCo, LLC. All Rights Reserved

UPC cooperation 2: EU project for AEBS based on Night Vision (EU proposal)

© 2023 Copyright Veoneer HoldCo, LLC. All Rights Reserved

Main driving force for Night Vision 1(2)

Many pedestrian fatalities in darkness

				
Pedestrian fatalities	**4,884***	**7,000**	**24,500**	**1,884**
% of total traffic fatalities	**12%**	**14%**	**25%**	**32%**
% at night time	**71%**	**47%**	**-**	**68%**

* http://www.iihs.org/iihs/topics/t/pedestrians-and-bicyclists/fatalityfacts/pedestrians

© 2023 Copyright Veoneer HoldCo, LLC. All Rights Reserved

Pedestrians



Cadillac Night Vision



Night Vision camera



© 2023 Copyright Veoneer HoldCo, LLC. All Rights Reserved

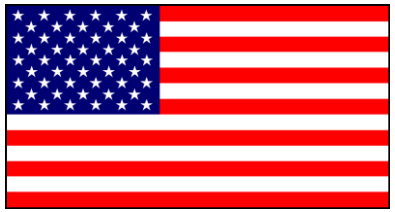
Animal Accidents Can Be Deadly



© 2023 Copyright Veoneer HoldCo, LLC. All Rights Reserved

Main driving force for Night Vision 2(2)

Many animal accidents in darkness & twilight

		
Deer/Vehicle Accidents [1]	**1,090,000**	**500,000**
Human Fatalities [2]	**200**	**300**
Human Injuries [2,3]	**26,647**	**30,000**
Property Loss [1]	**3.5 B$**	**1.0 B€**

Sources: (1) State Farm, (2) Langley, et al 1995-2004, (3) Center for Disease Control and Prevention 2001-2002

© 2023 Copyright Veoneer HoldCo, LLC. All Rights Reserved

Night Vision with Marking Light



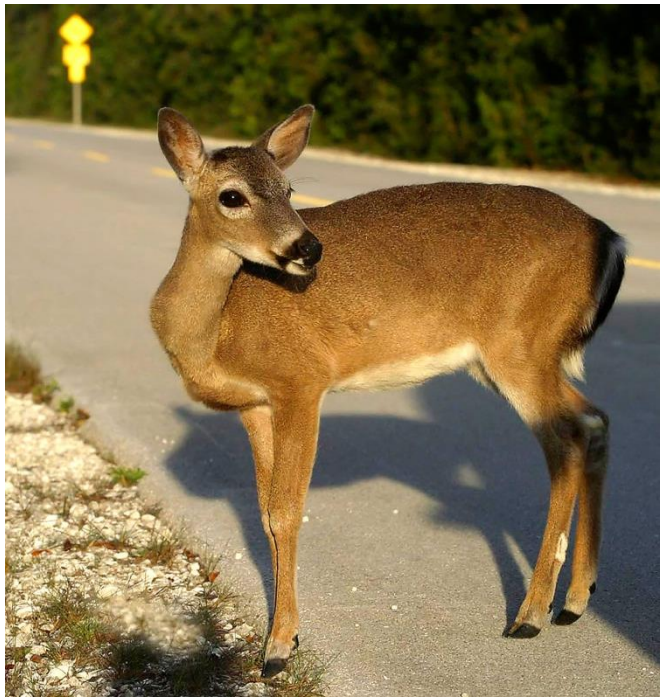
© 2023 Copyright Veoneer HoldCo, LLC. All Rights Reserved

Animal Detection with Marking Light System: BMW interface



Animal Detection







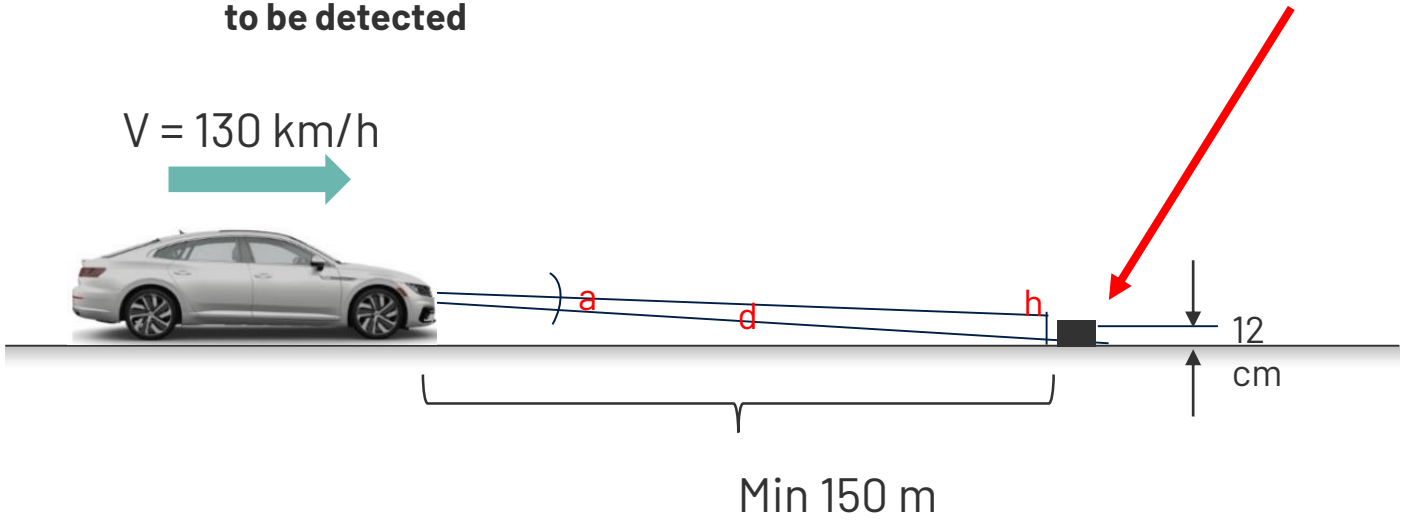

© 2023 Copyright Veoneer HoldCo, LLC. All Rights Reserved

UPC cooperation 3
Sensing for automated driving

© 2023 Copyright Veoneer HoldCo, LLC. All Rights Reserved

UN Regulation extends automated driving up to 130 km/h in certain conditions

- Revised UNECE regulation R157 for Automated Lane Keeping Systems (ALKS) entered into force on 1 Jan 2023 for all contracting countries (42).
  - Allows OEMs to legally provide customers with ALKS (SAE Level 3 up to 130 km/h for "Minimum forward detection range")
  - "A passable object is such an object, **that may be driven over without causing an unreasonable risk** to the vehicle occupants or other road users regardless of whether the tyre of the ALKS vehicle comes in contact with the object or not."
  - **ALKS can only operate in conditions that allow bigger than "passable object" to be detected**



Specified maximum speed / km/h	*Minimum forward detection range / m*
0…60	46
70	50
80	60
90	75
100	90
110	110
120	130
130	150

© 2023 Copyright Veoneer HoldCo, LLC. All Rights Reserved

Summary: Benefits of UPC cooperation

© 2023 Copyright Veoneer HoldCo, LLC. All Rights Reserved

Summary

Cooperation with UPC

- Benefit
  - Access to technology (IP)
  - Evaluate technological options
  - Search for solutions (e.g., sensing, compute) for emerging challenges
- Conduct
  - Skilled
  - Professional
  - Flexible
  - Uncomplicated/unbureaucratic
  - Fast prototyping

© 2023 Copyright Veoneer HoldCo, LLC. All Rights Reserved



© 2023 Copyright Veoneer HoldCo, LLC. All Rights Reserved