UPC industrial event

Veoneer long-term collaboration with UPC

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Director Visual Enhancement & Cognitive Systems

veoneer

What we do

"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

Adding Prevention to Protection

Our heritage: Impact protection

Active Safety: Accident prevention

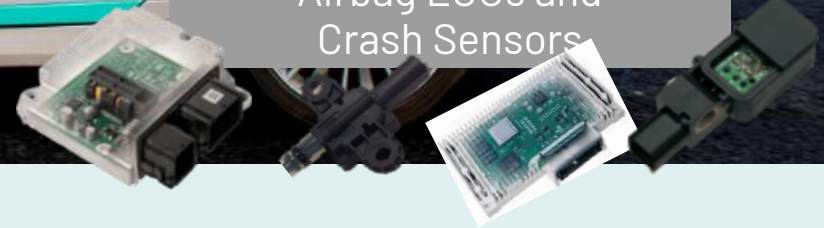
Global tier 1 delivering Automotive Safety

Delivered:

14 million
Camera Sensors

55 million
Radar Sensors

~ 1000 million
Airbag ECUs and Crash Sensors

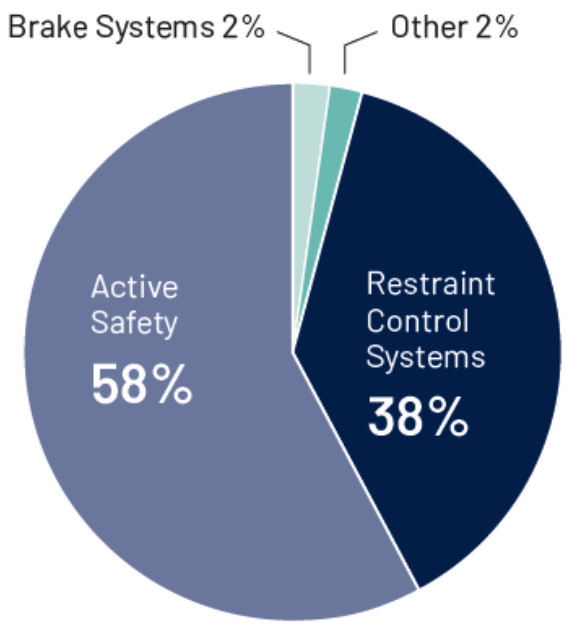


Delivered during the past decade, as Veoneer and as part of Autoliv, the number of airbag ECUs and crash sensors is for a longer period

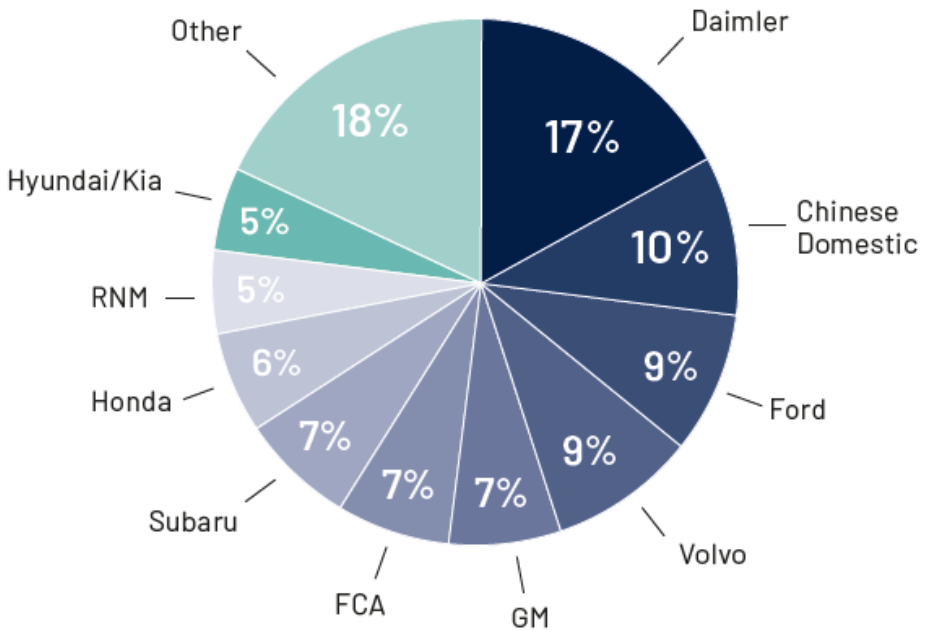
Net Sales

2022: ~2 BUSD

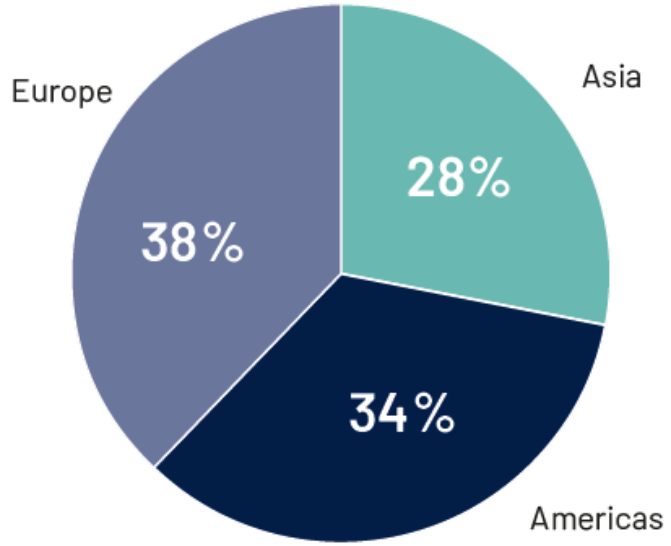
Sales by Product



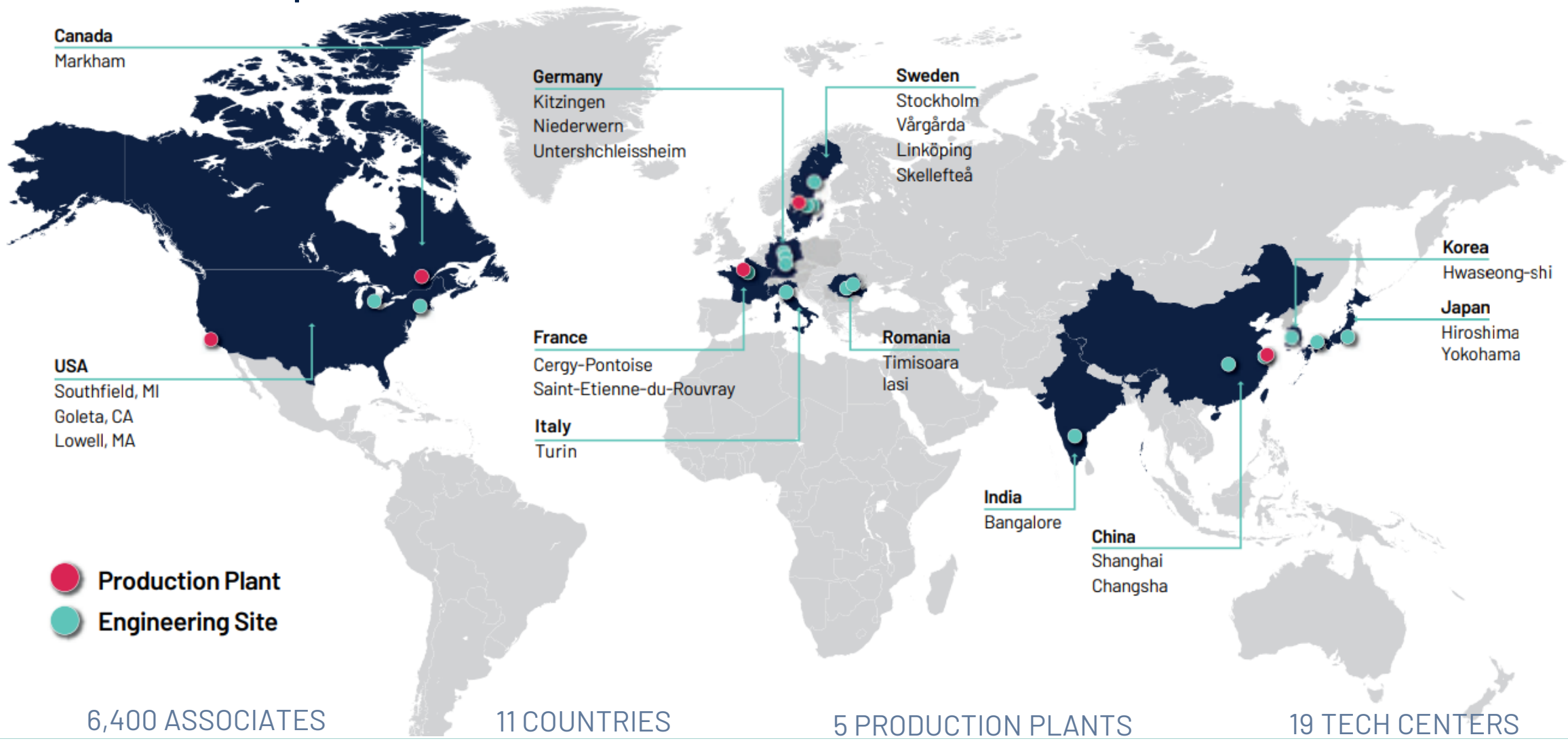
Sales by Customer



Sales by Region



Global Footprint



6,400 ASSOCIATES

11 COUNTRIES

5 PRODUCTION PLANTS

19 TECH CENTERS

Consolidation and restructuring of automotive suppliers

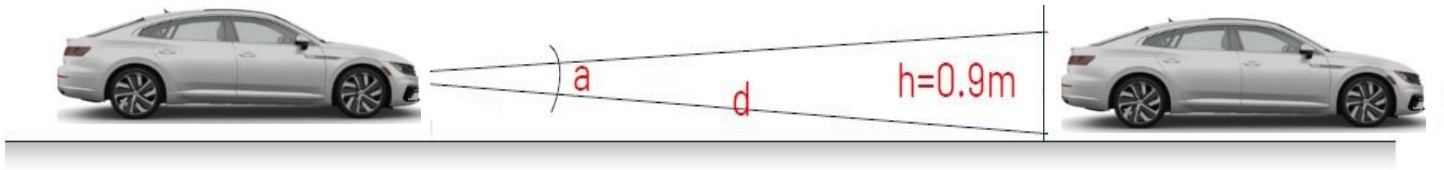
- Spin-off from Autoliv 2018
- SW arm purchased by Qualcomm 2022
- Active Safety purchased by Magna 2023

UPC cooperation 1
Development of a solid-state Lidar

Limitations of early Lidar

Moving parts and precision optics do not match well

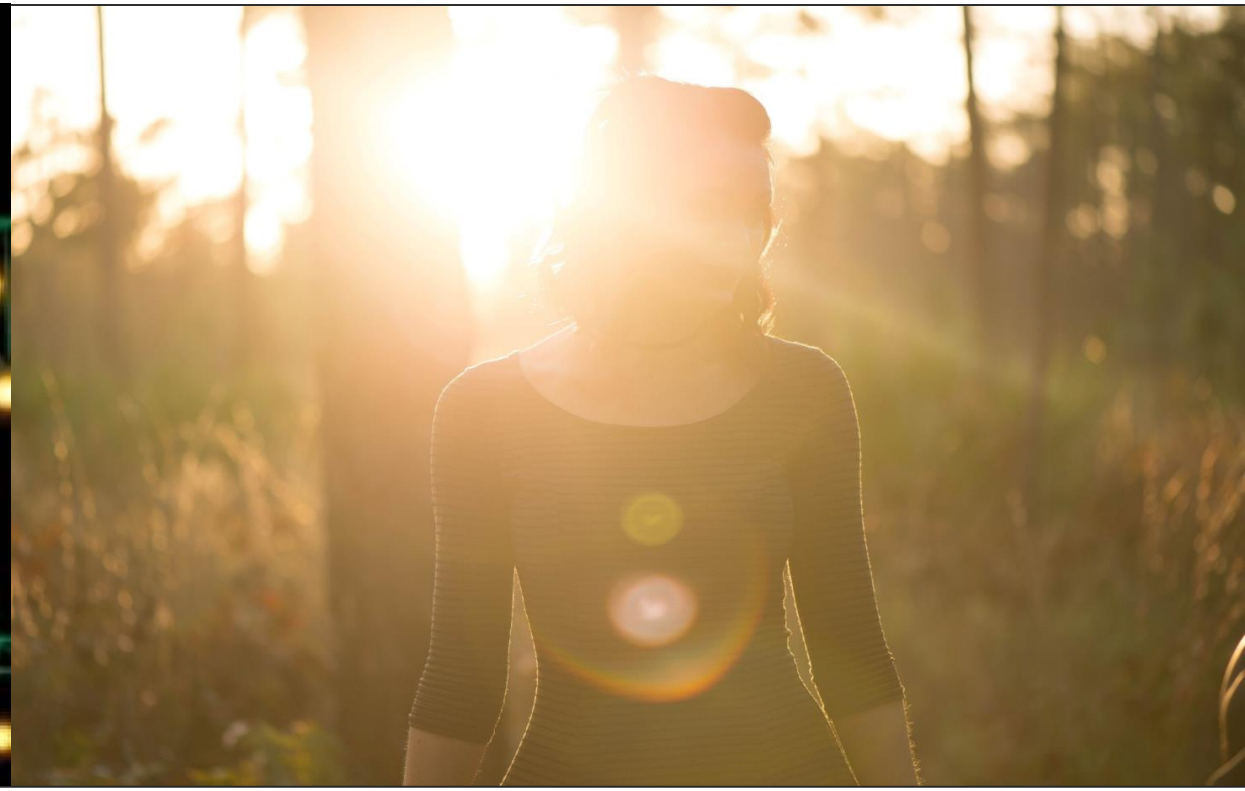
- 2015 Lidar were sensitive to vibration, shock and thermal variations
- Vertical resolution insufficient
  - Example: Velodyne HDL-64E S3 (64 channels)
    - Measurement Range: Up to 120 m
    - Vertical Field of View: 26.9° ->
      Vertical angular resolution: 0.42°



*Velodyne spec

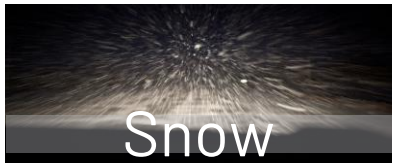
Lidar must handle all kinds of disturbances

Both night & day, background light limits performance



Source: 3M

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).

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

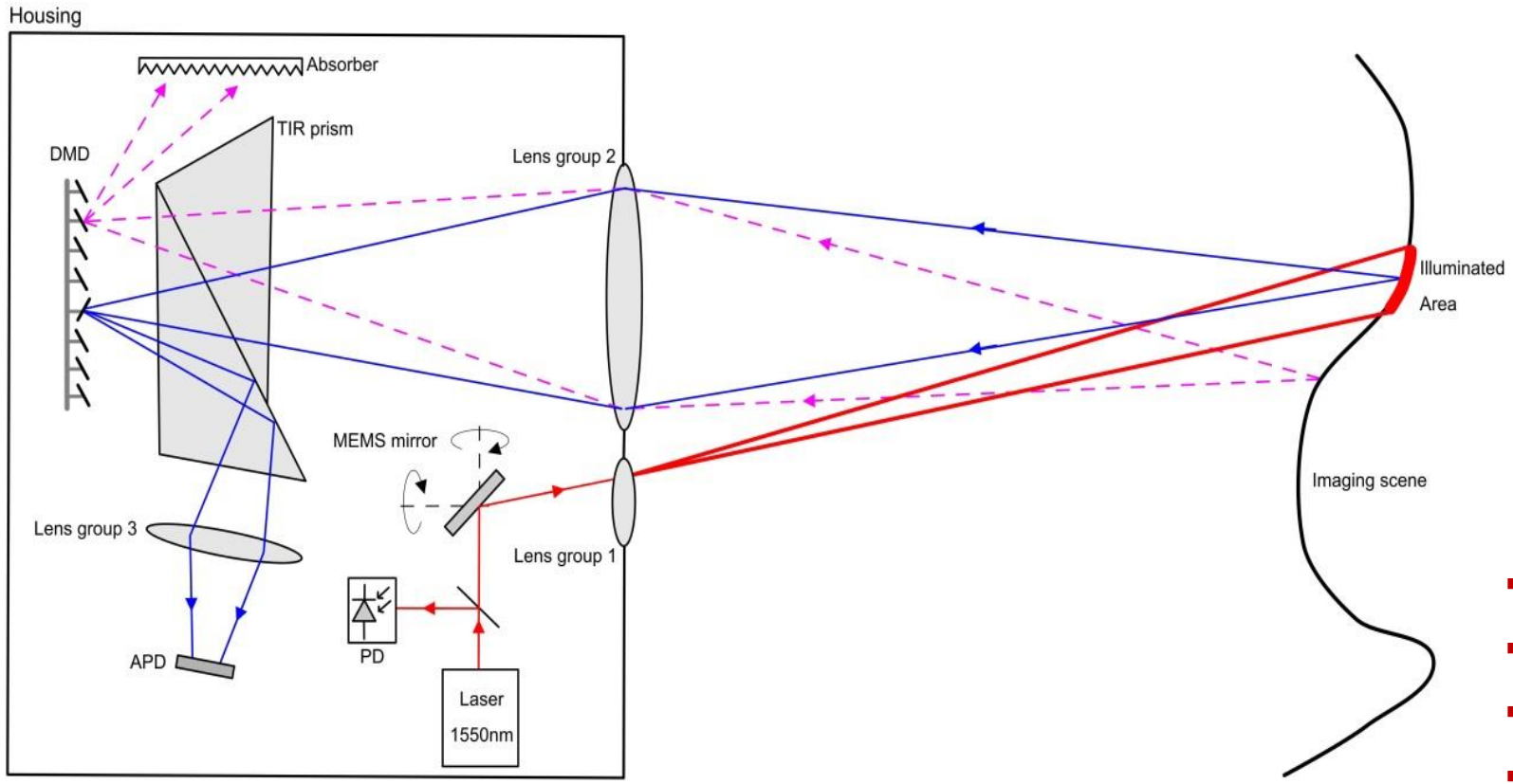
k Optical attenuation in the light path

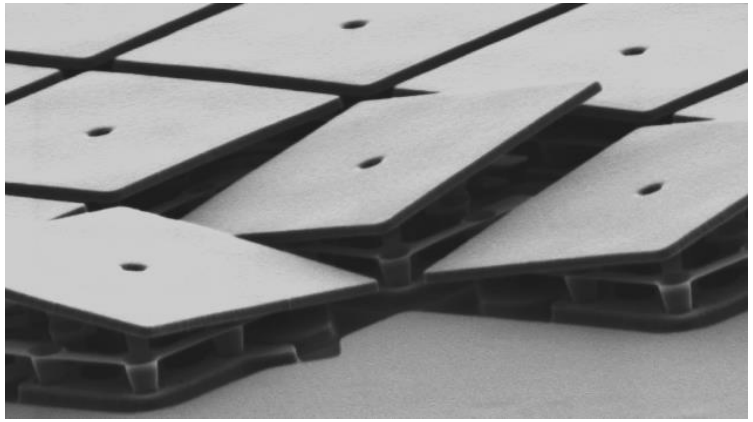
Sensor fusion

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

UPC patents (licensed)





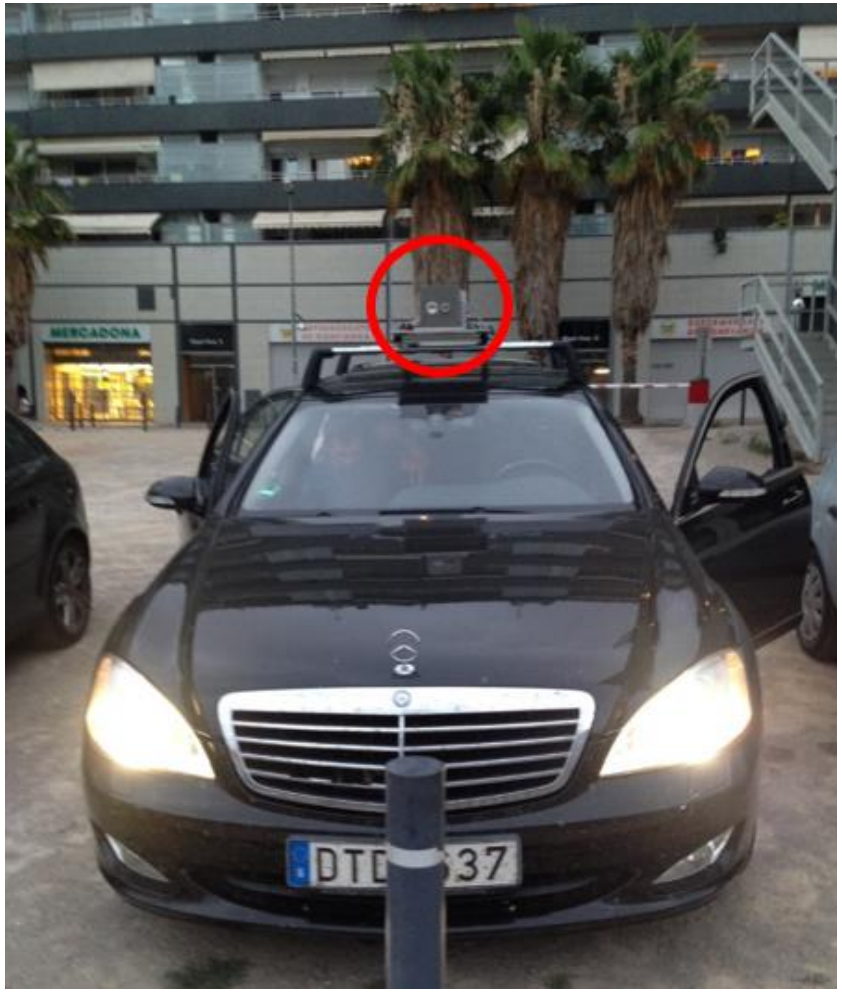
- Solid State (double MEMS approach)
- Filtered background light
- High vertical resolution (0,05deg)
- Suitable for data fusion (squared FOV)

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

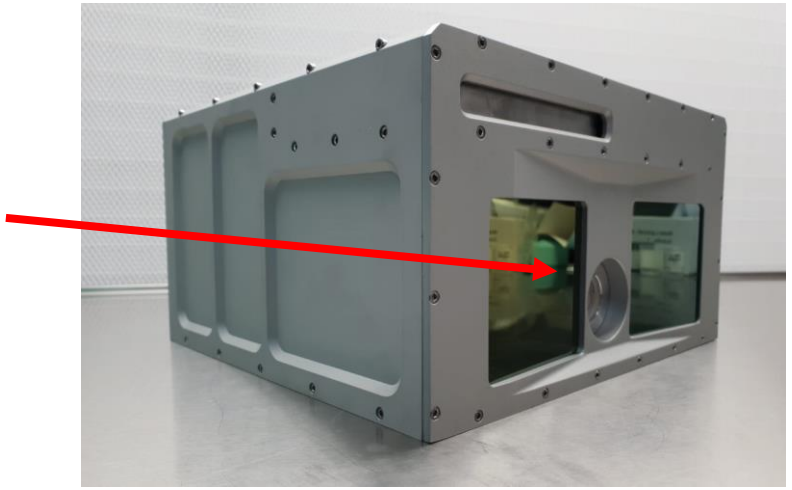
Lessons learnt:

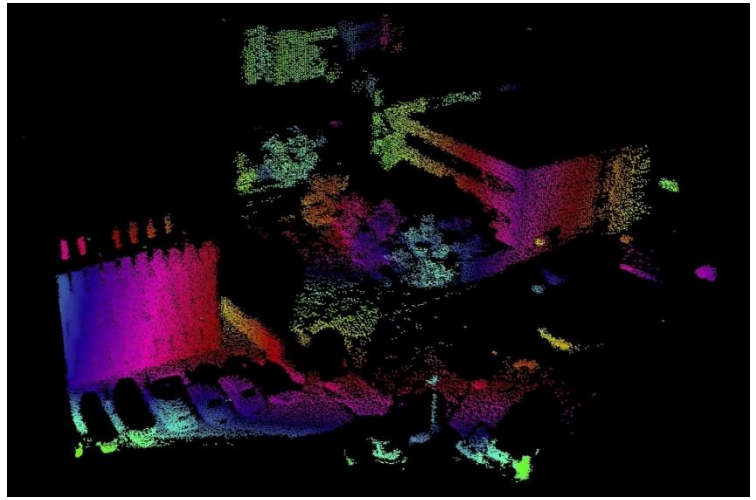
Poor patent attorney: Almost lost US patent

Development and integration of customized lidar prototypes



Co-located Lidar & cameras for improved sensor fusion

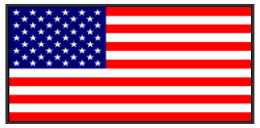
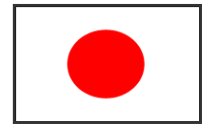




UPC cooperation 2: EU project for AEBS based on Night Vision (EU proposal)

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

Pedestrians

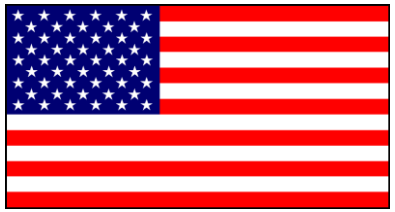
Cadillac Night Vision

Night Vision camera

Animal Accidents Can Be Deadly

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€**

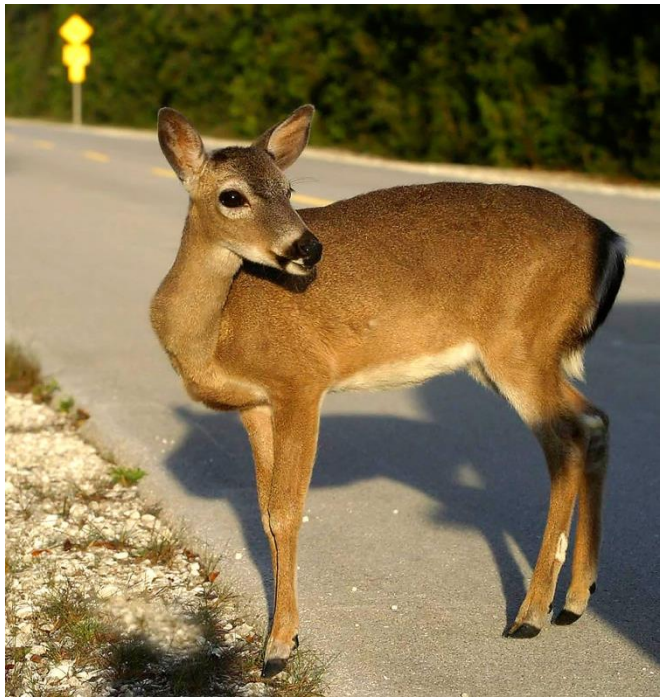
Sources: (1) State Farm, (2) Langley, et al 1995-2004, (3) Center for Disease Control and Prevention 2001-2002

Night Vision with Marking Light

Animal Detection with Marking Light System: BMW interface

Animal Detection

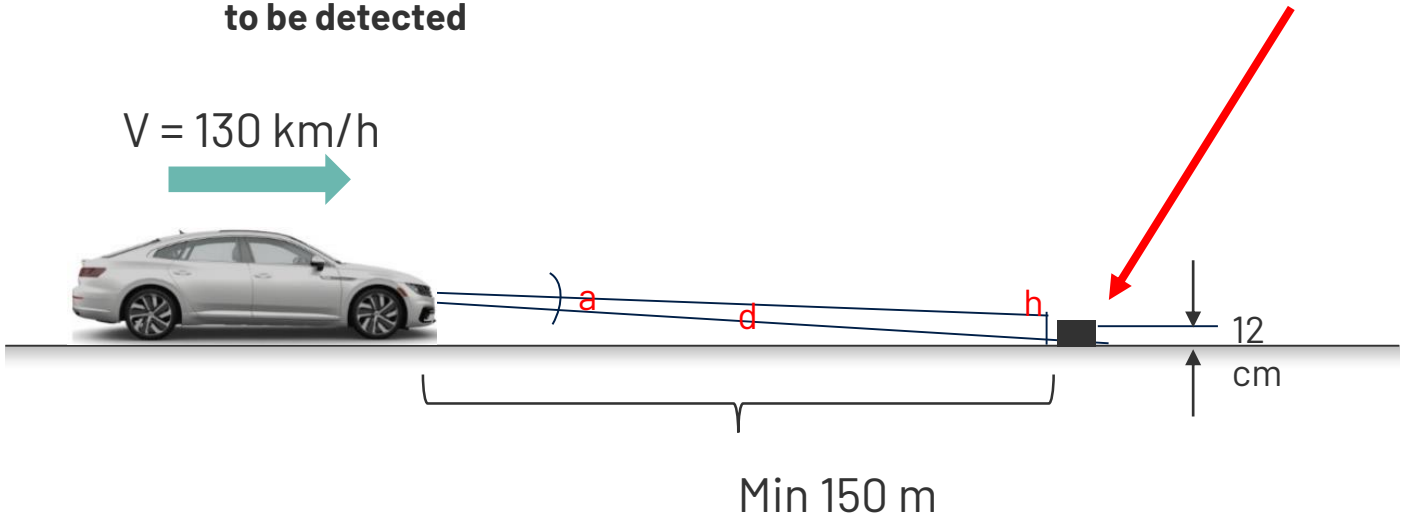





UPC cooperation 3
Sensing for automated driving

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

Summary: Benefits of UPC cooperation

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