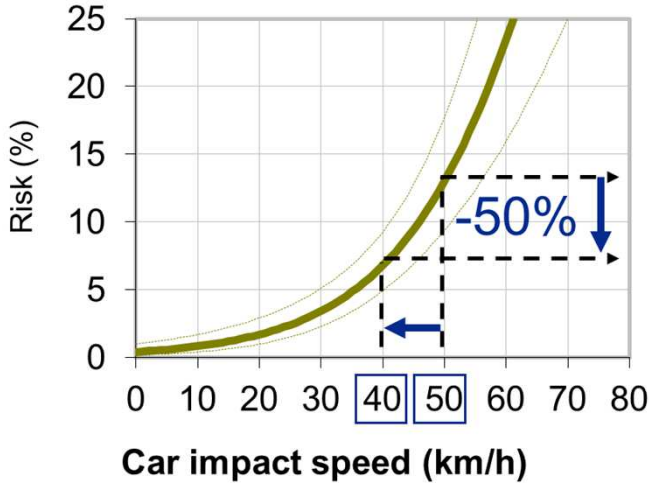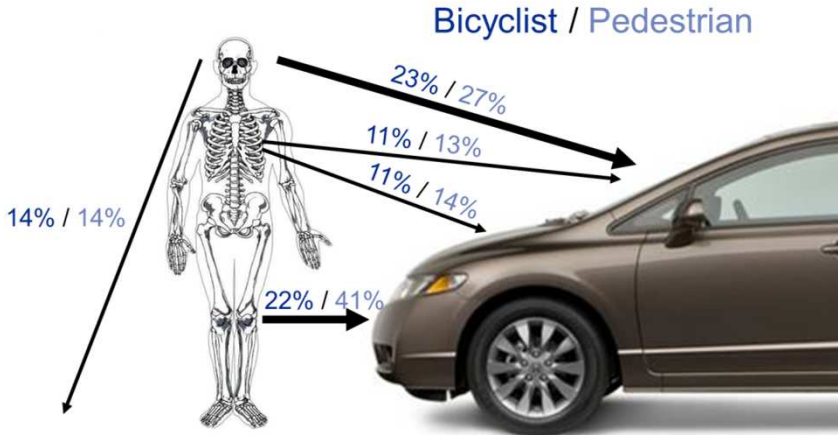# Potential of protection systems for vulnerable road users

Rikard Fredriksson & Erik Rosén
International Cyclist Safety Conference
Helmond, November 8 2012

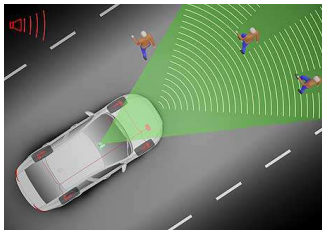**Autoliv**

Introduction

Bicyclist / Pedestrian

23% / 27%
11% / 13%
11% / 14%
14% / 14%
22% / 41%

Risk (%)

-50%

Car impact speed (km/h)

Aim

Estimate potential to save cyclists and pedestrians from severe (AIS3+) head injury for:
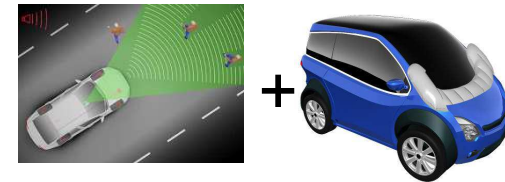
1. Auto-brake

2. Passive deployable

3. Integrated

Method

- <u>Passive</u> safety
  - GIDAS sample with AIS3+ head/face injuries
  - N=54/52 pedestrians/cyclists

- <u>Active</u> safety
  - GIDAS PCM, all injury levels
  - N=431/391 pedestrians/cyclists

- <u>Integrated</u> safety
  - Cases with data available from both sources
  - N=11/35 cyclists/pedestrians

Passive systems

- Case-by-case conclude if the head impact is within the protected area of the safety measure
- *Note: Any VRU with AIS3+ head/face injuries from ground or other source was considered NOT saved by the safety measure)*
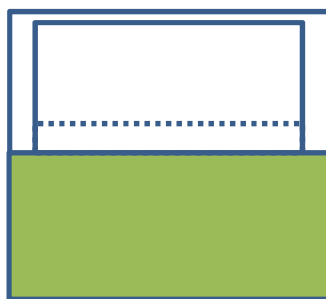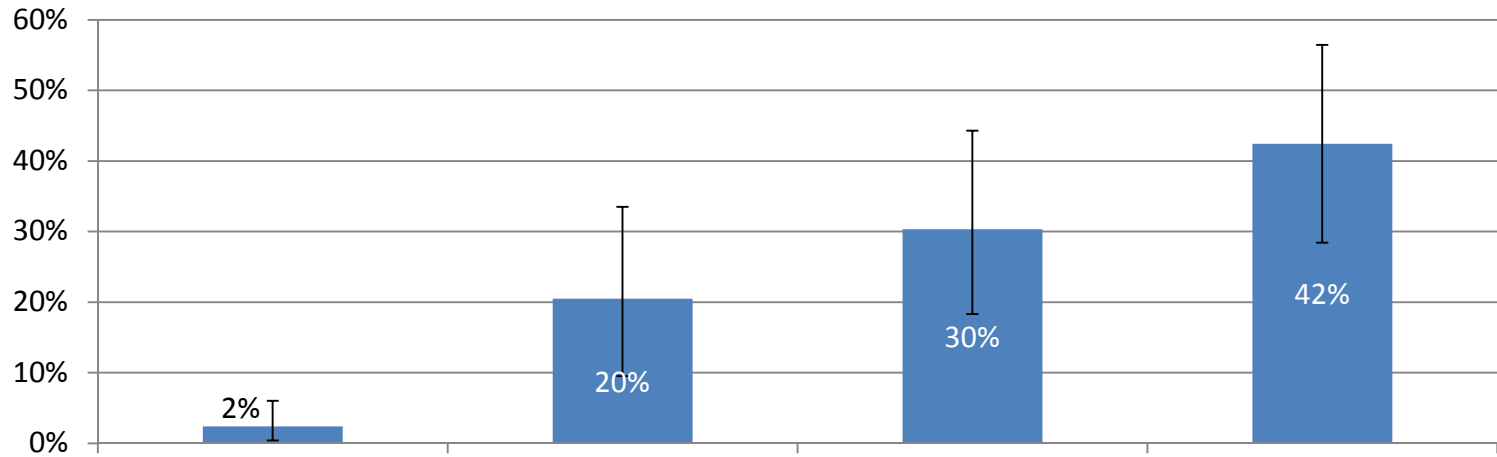

- Effectiveness of safety measure assumed to be 100% for impacts below 40 km/h and decrease to 0% at 70 km/h
- Impact speed was the
    - impact speed of the car for pedestrian
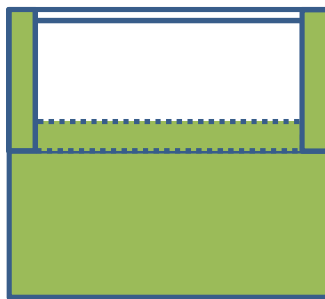   - relative speed for cyclist
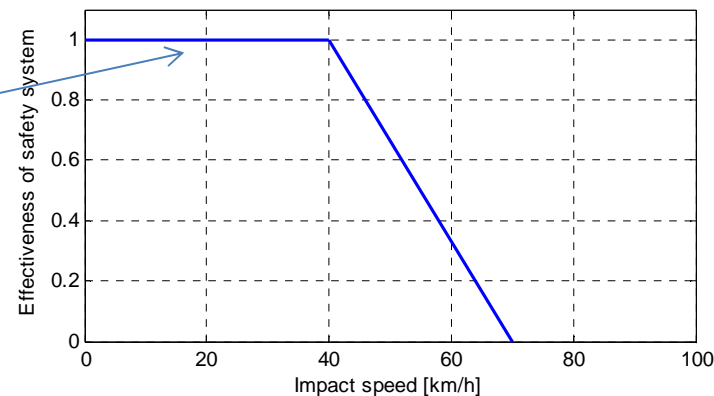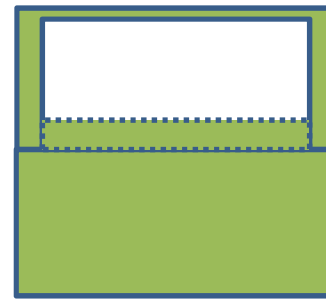
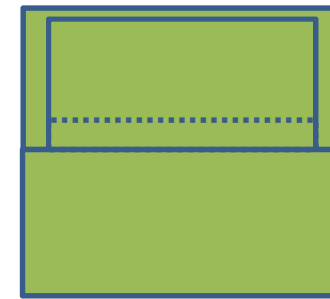# Potential for AIS3+ head/face injury reduction
Cyclists

Potential for AIS3+ head/face injury reduction
Pedestrians

System 1: E=5%
(95% CI*: 0-10%)

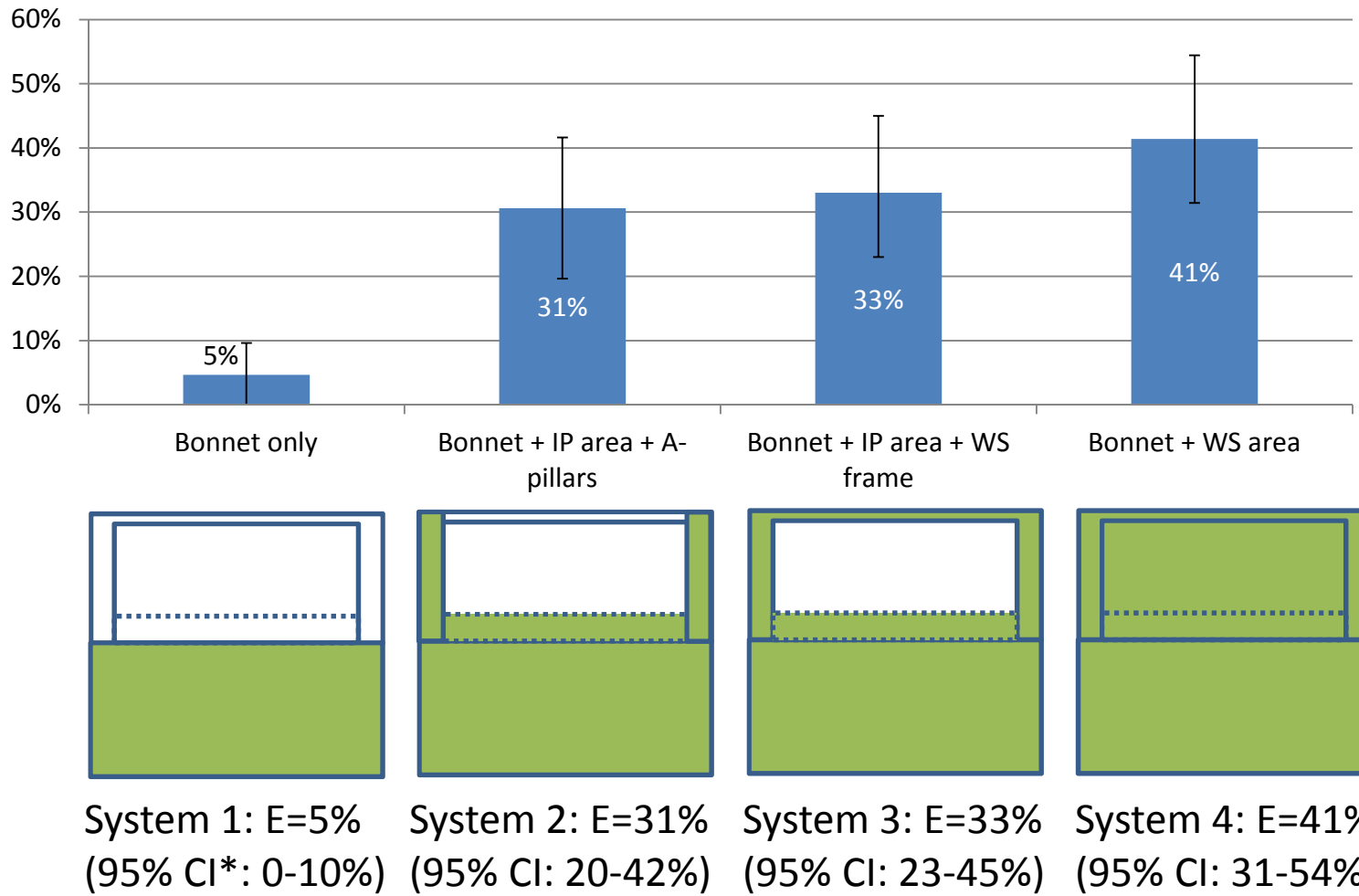System 2: E=31%
(95% CI: 20-42%)

System 3: E=33%
(95% CI: 23-45%)

System 4: E=41%
(95% CI: 31-54%)
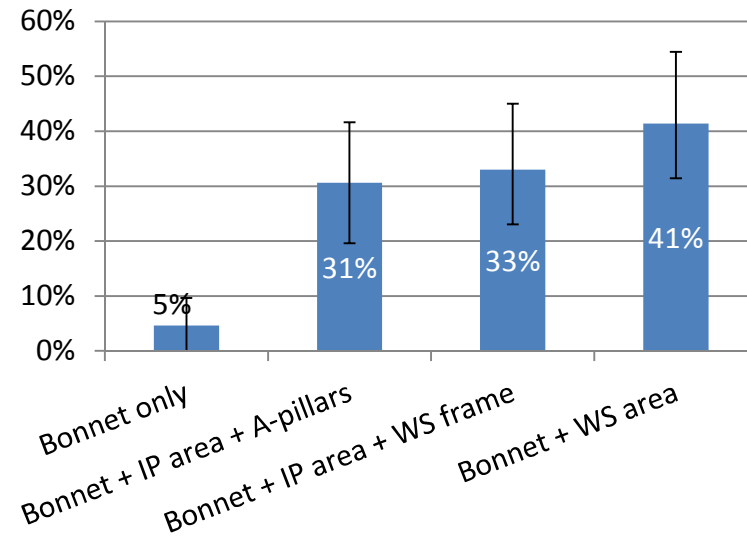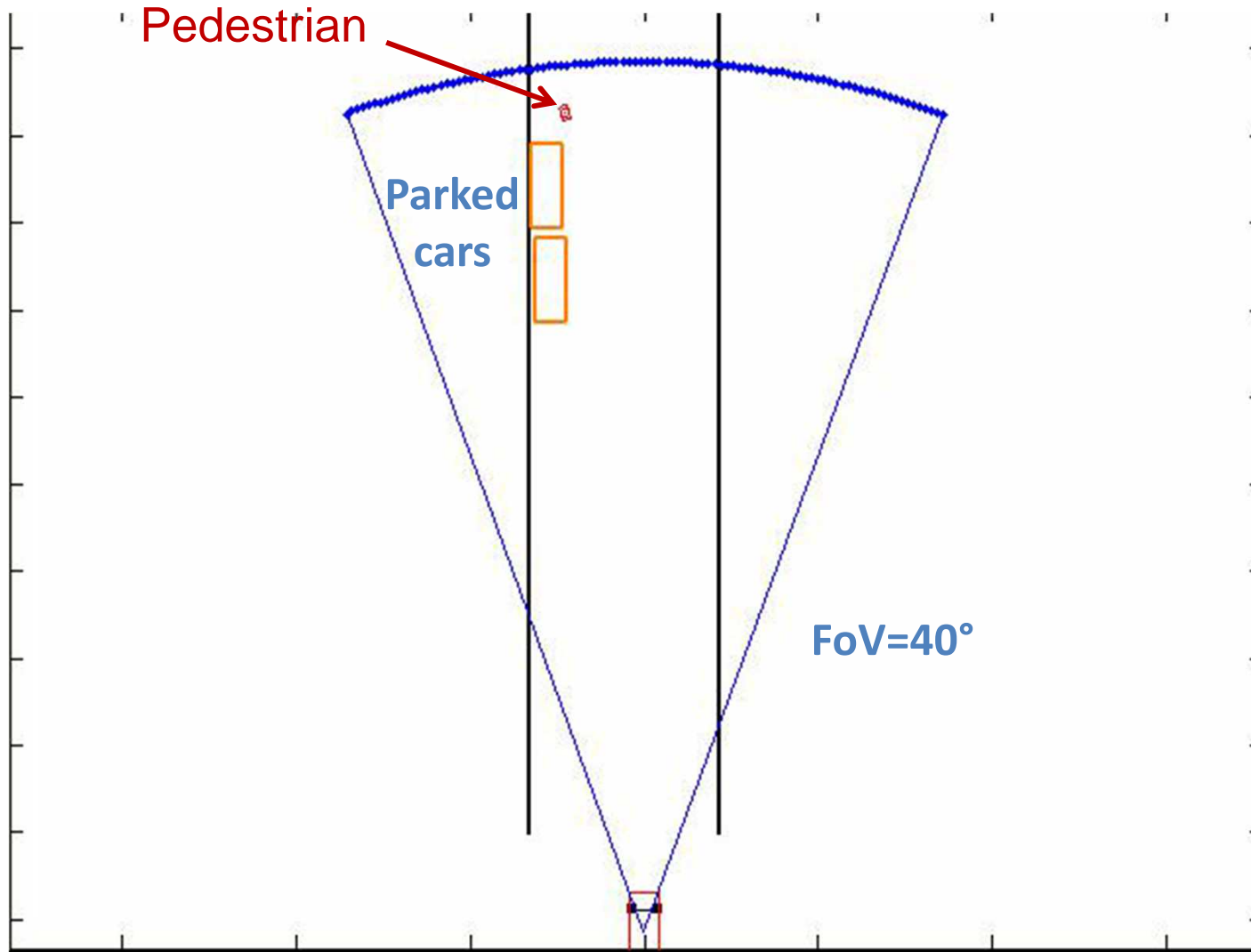
Potential for AIS3+ head/face injury reduction
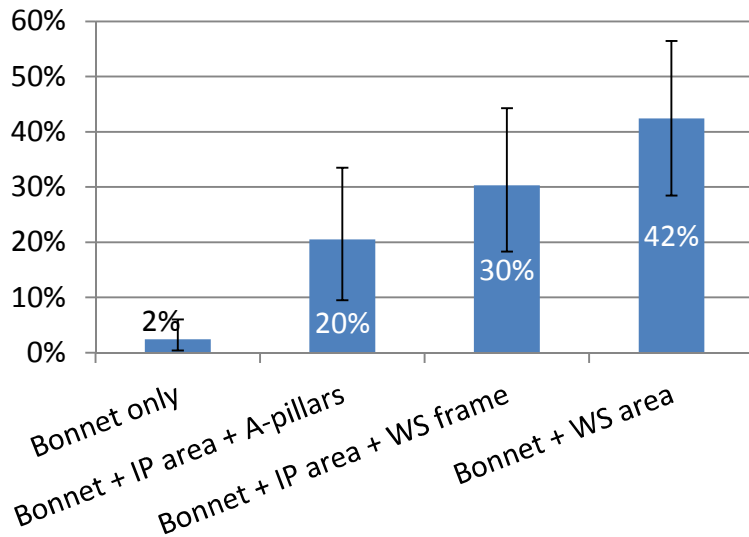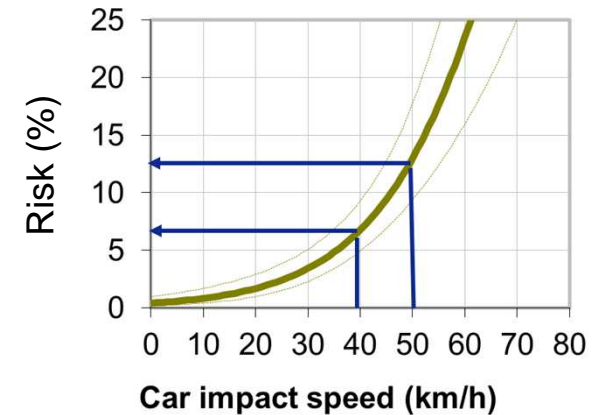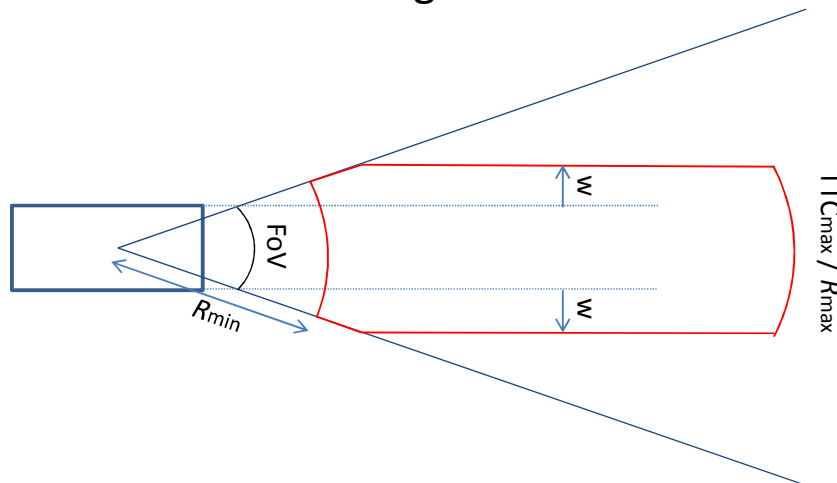
GIDAS Pre-Crash Matrix

Animation of accident in GIDAS PCM + AEB sensor

Autonomous emergency braking (AEB)
based on forward-looking sensor

AEB system parameters

- FoV = 40 deg
- R_{min} = 7 m
- R_{max} = 60 m
- System latency due to data processing = 300 ms
- Brake deceleration = 0.6g
- Trig width, w = 1 m
- Max TTC at trig = 0.75 s

Potential for injury reduction
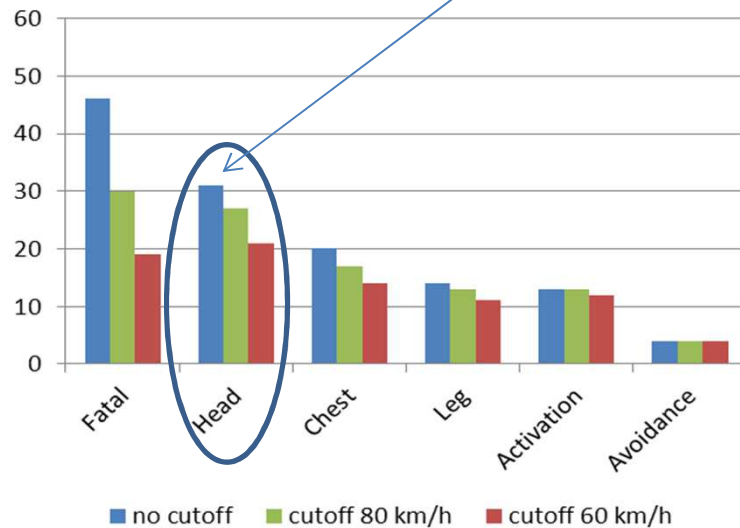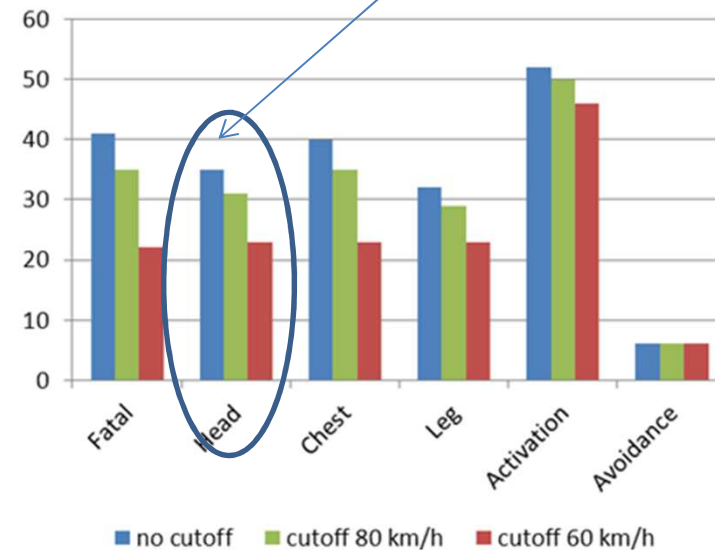## Autonomous emergency braking (AEB)

Effectiveness for AEB <u style="color:red">cyclists</u>
Main estimate = 31%
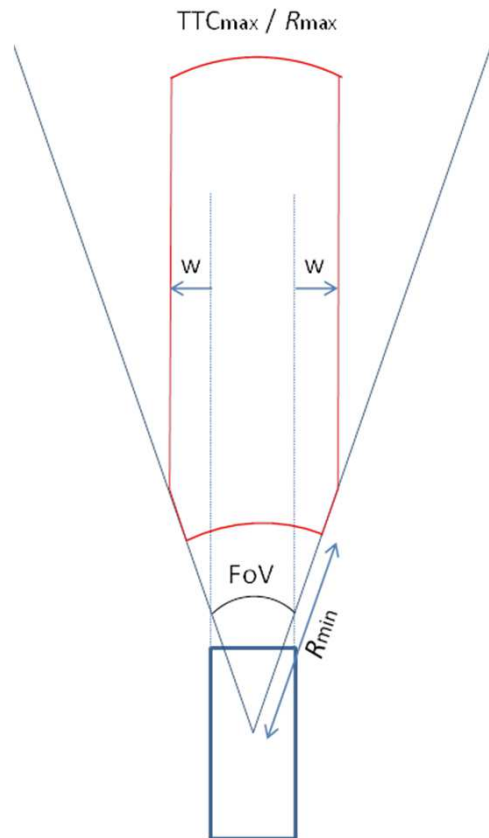
Effectiveness for AEB <u style="color:red">pedestrians</u>
Main estimate = 35%

Note that effectiveness varied considerably when altering system parameters. E.g., effectiveness for severe head injury varied between 5 and 85% (3 and 80%) for cyclists (pedestrians).

Varying sensor parameters

- Field of View = 40°
- Earliest activation time = 0.75 s
- Max braking = 0.6 g
- Trig width = 1 m
- Max front wheel angle=5°
- Cut-off speed= unlimited

Variation:

90°

0.5 s, 1.0 s

0.3 g, 0.9 g

0 m, 5 m

1°, unlimited

60, 80 km/h

Potential for injury reduction
Auto-brake - <u>Cyclists</u>
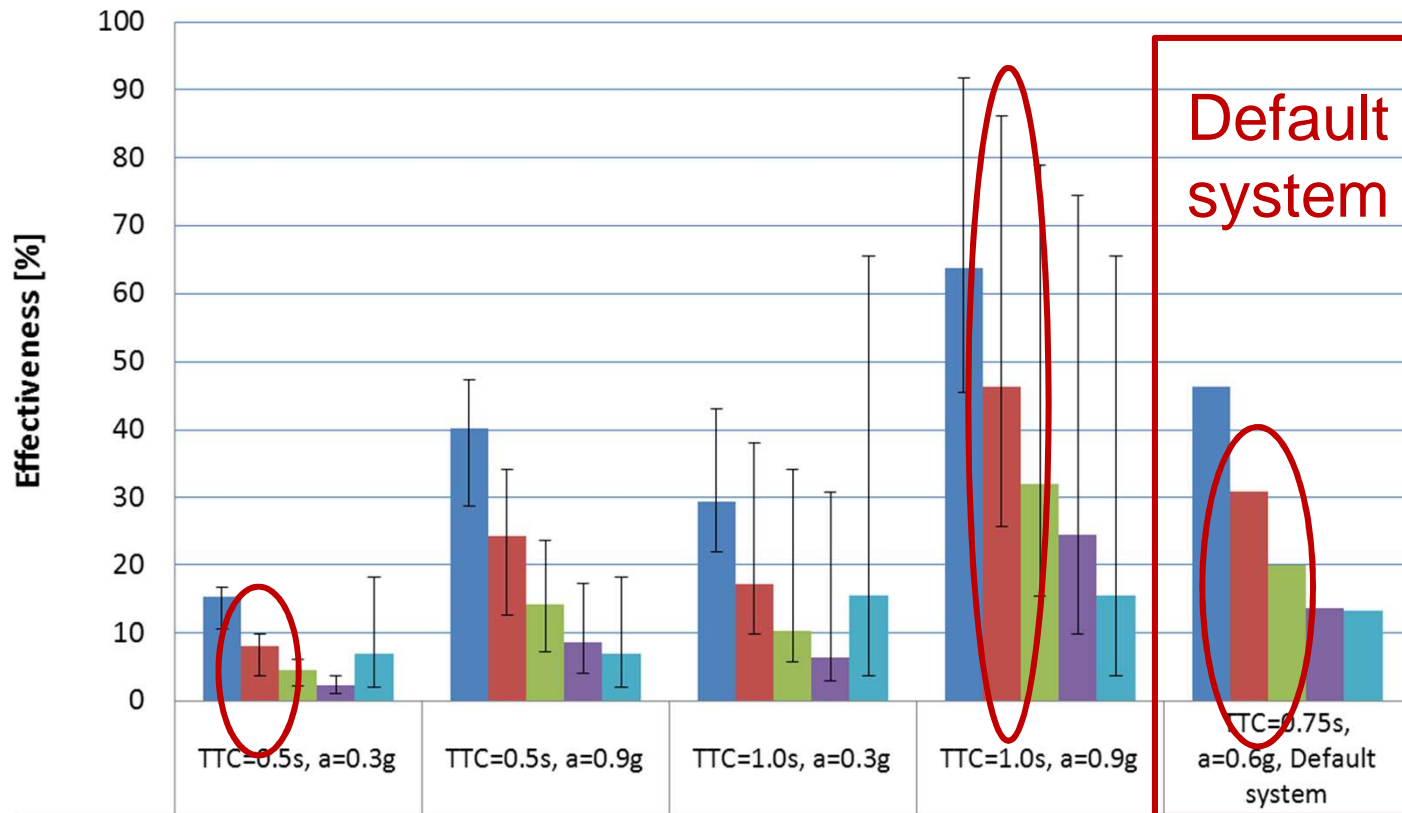
	TTC=0.5s, a=0.3g	TTC=0.5s, a=0.9g	TTC=1.0s, a=0.3g	TTC=1.0s, a=0.9g	TTC=0.75s, a=0.6g, Default system
E_fatal	15	40	30	64	46
E_head	8	24	17	46	31
E_chest	5	14	10	32	20
E_leg	2	9	6	24	14
Activation	7	7	16	16	13

Potential for injury reduction

Auto-brake - <u>Pedestrians</u>

|	TTC=0.5s, a=0.3g	TTC=0.5s, a=0.9g	TTC=1.0s, a=0.3g	TTC=1.0s, a=0.9g	TTC=0.75s, a=0.6g, Default system
E_fatal	8	41	19	66	41
E_head	5	33	14	62	35
E_chest	7	40	18	65	40
E_leg	4	29	12	60	32
Activation	30	30	55	55	52
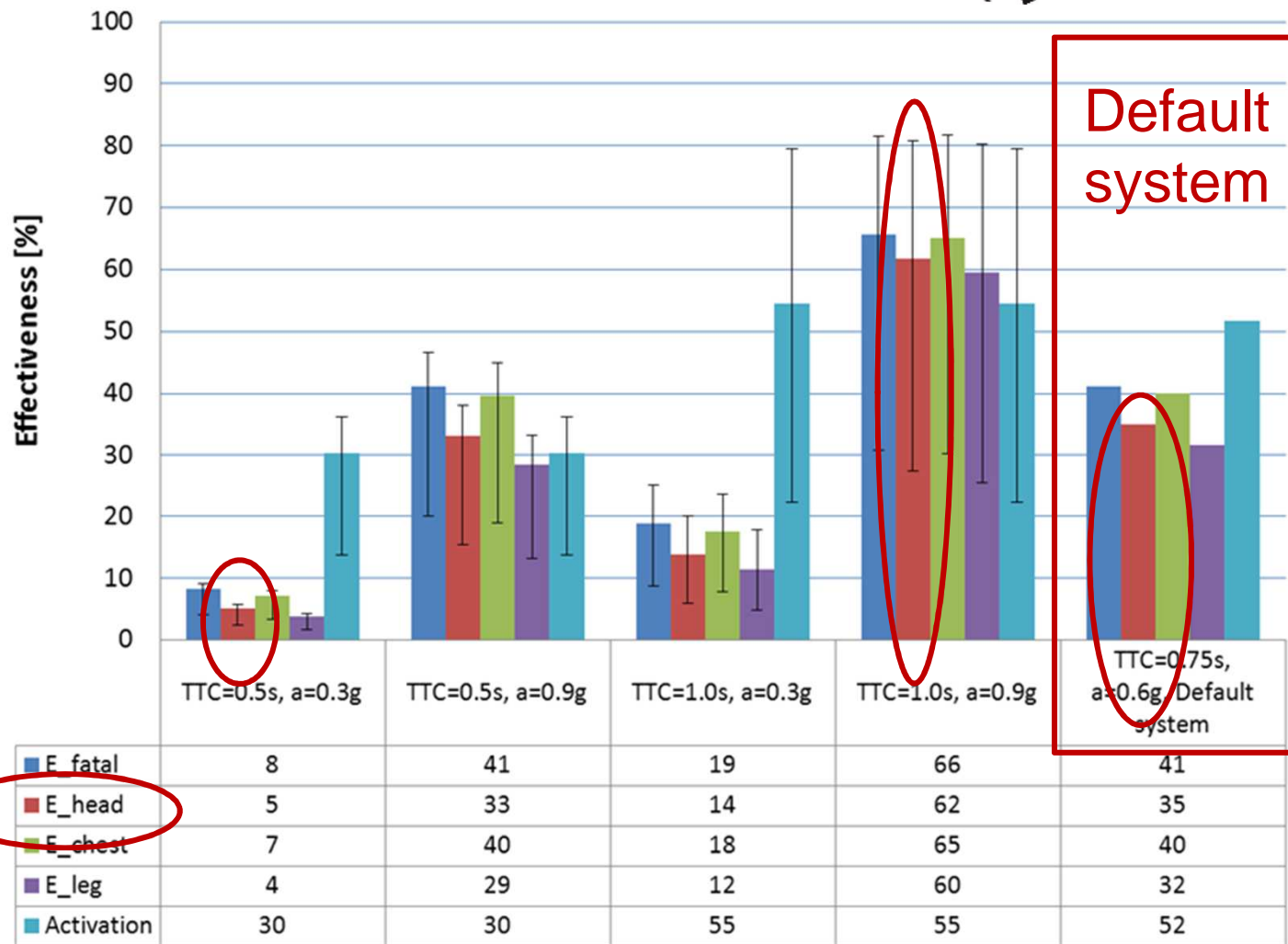
Integrated safety - cyclists

Based on 11 cases only → Great uncertainty

Based on 11 cases (with sufficient information available), the passive and active effectiveness were re-analysed. The passive countermeasure was system 2 above, consisting of a deployable bonnet and a VRU airbag protecting the A-pillars and IP area. The active countermeasure was the default system described above. The integrated system was a combination of the passive and active systems.
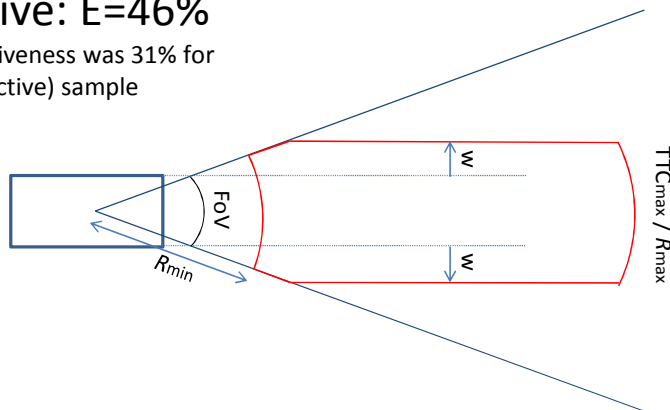
Passive: E=36%
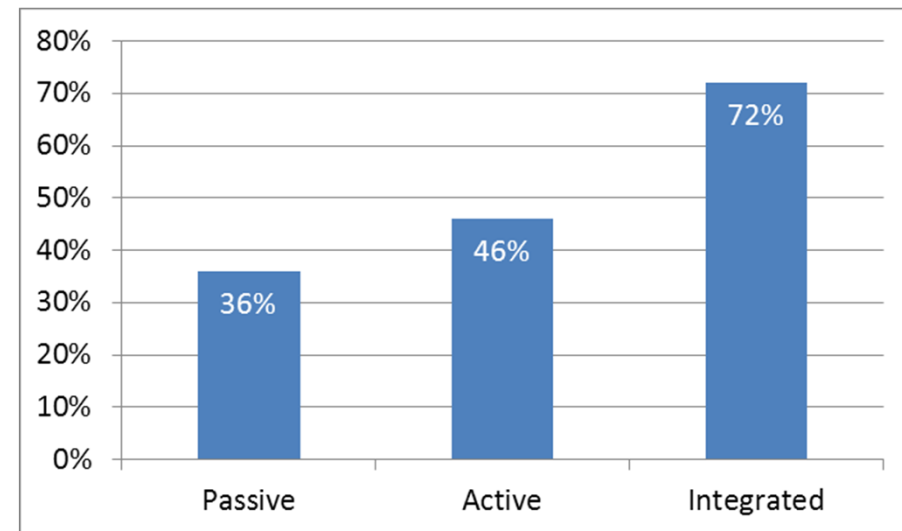Effectiveness was 20% for full (passive) sample
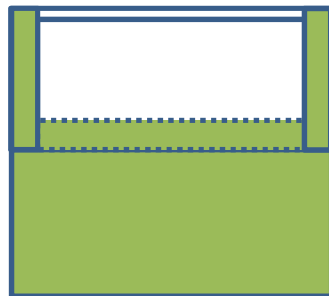
Active: E=46%
Effectiveness was 31% for full (active) sample

Cyclists, head effectiveness
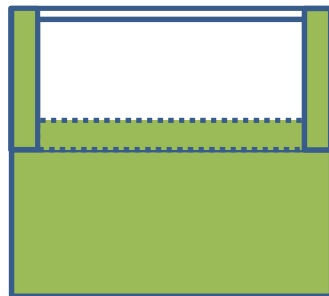
Integrated safety - pedestrian

Based on subset of 35 cases

Based on 35 cases (with sufficient information available), the passive and active effectiveness were re-analysed. The passive countermeasure was system 2 above, consisting of a deployable bonnet and a VRU airbag protecting the A-pillars and IP area. The active countermeasure was the default system described above. The integrated system was a combination of the passive and active systems.
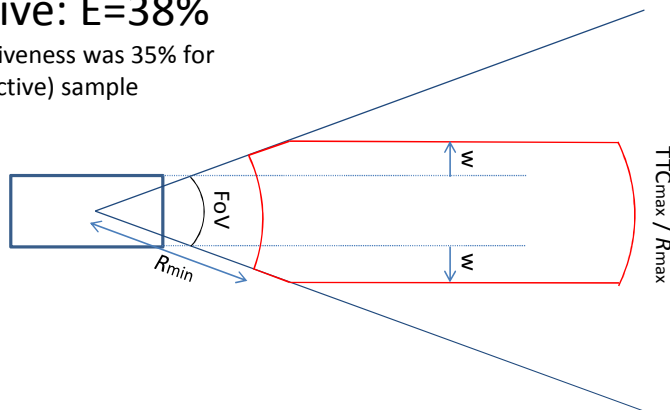
Passive: E=36%
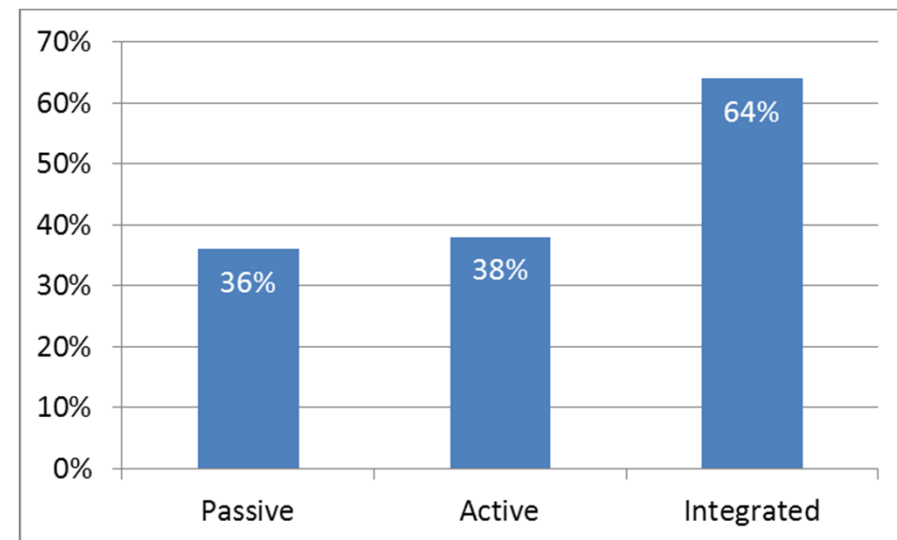
Effectiveness was 31% for full (passive) sample

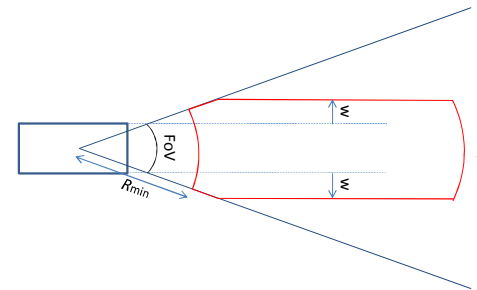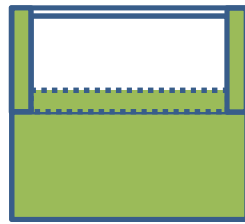### Active: E=38%

Effectiveness was 35% for full (active) sample

Pedestrians, head effectiveness
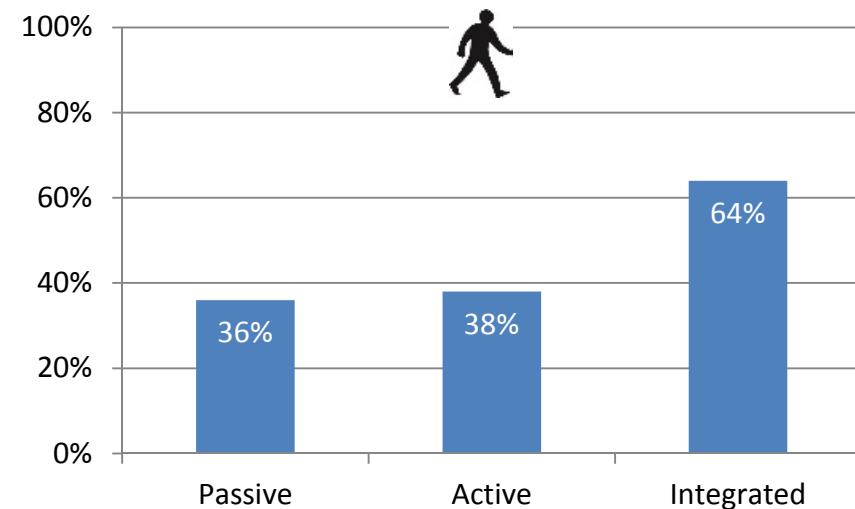
Integrated safety
Default systems
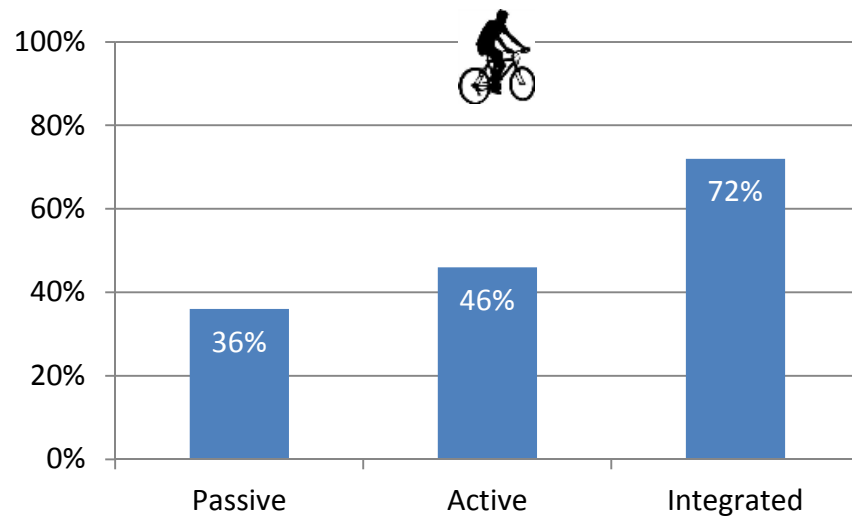
Cyclists, head effectiveness

Based on 11 cases only → Great uncertainty

Pedestrians, head effectiveness

Based on subset of 35 cases

Active and passive protection systems
Auto-brake and airbag

Stereo camera

Airbag

Active bonnet

Electronic
Control Unit
(ECU)

Accelerometers
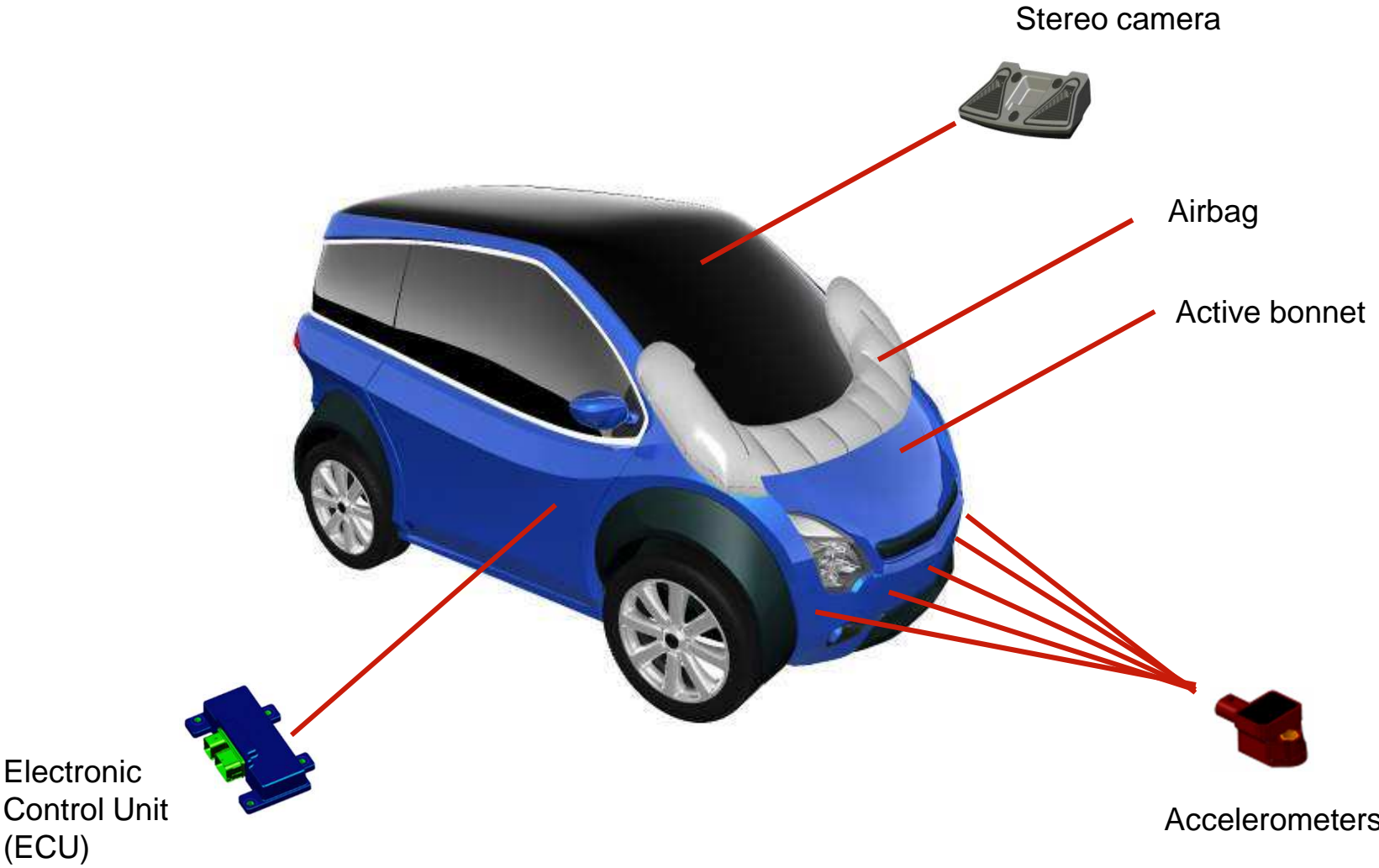
Acknowledgements

- Vinnova FFI
- Swedish Transport Administration – "Skyltfonden"

Autolív

Thank you!

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