Berner Fachhochschule
Haute école spécialisée bernoise
Bern University of Applied Sciences

Dynamic Test Center

Bicycle accidents, risks and potential for drive assistance systems

DTC Dynamic Test Center AG

CH-2537 Vauffelin

Bernhard Gerster, CEO

Raphael Murri, head of passive safety

Sandro Caviezel, engineer of passive safety

Bike crash test with car

Bicycle accidents, risks and potential for drive assistance systems:

FAMES, Biel School of Engineering and Informatics (CH), Automotive Technology Department

Source: youtube

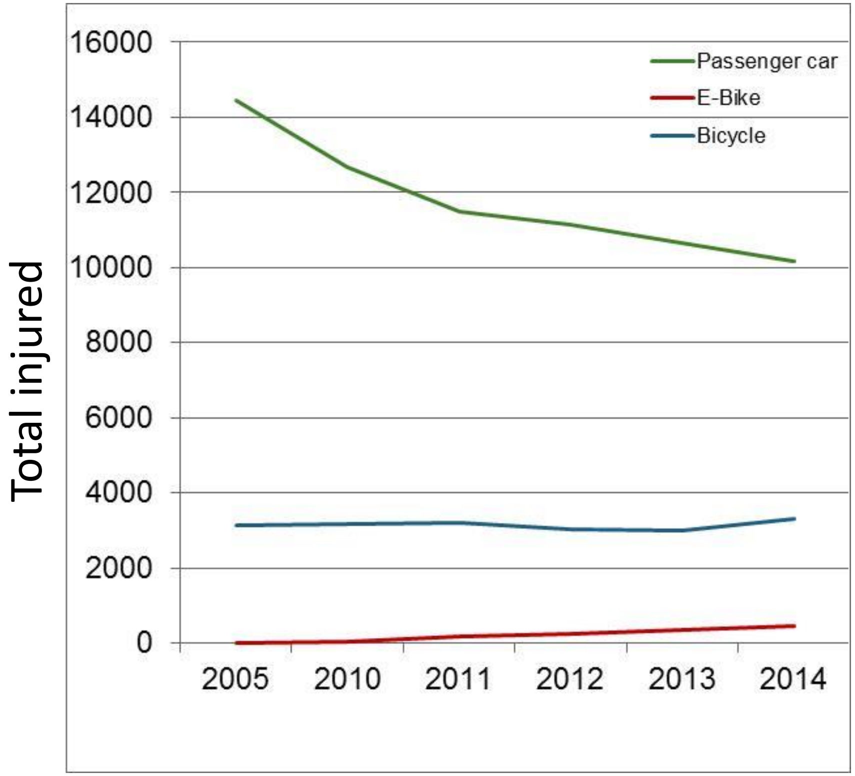
Content

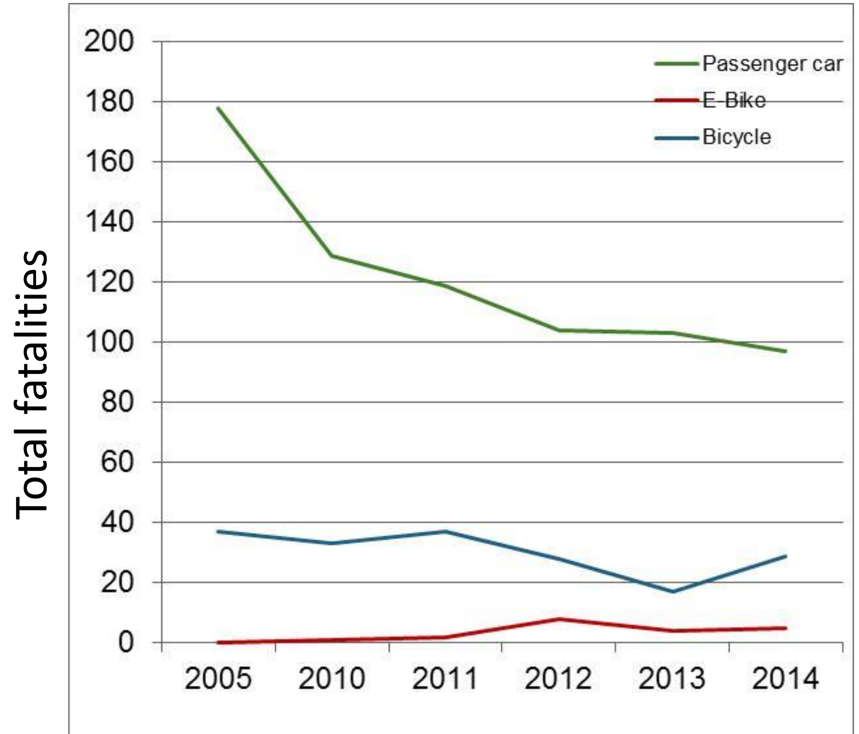
1. Safety for cyclists
2. Typical accident scenarios with bicycles
3. Risks and potential for drive assistant systems
4. Summary

Safety for cyclists

Accident statistics CH:

- Positive development of traffic safety by reduction of injured and fatalities in passenger cars
- The number of injured and fatalities on cyclist accidents stays constant, number of injured E-bikers increases





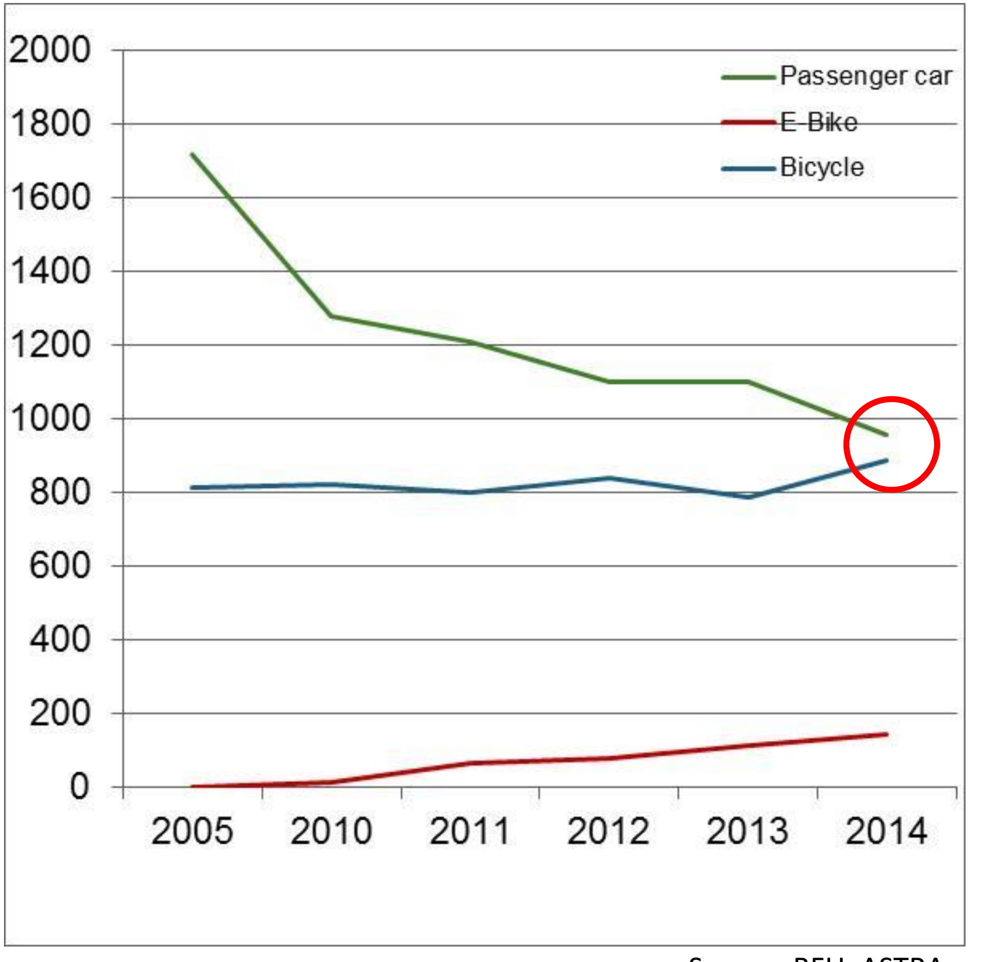
Source: BFU, ASTRA

Safety for cyclists

Accident statistics CH:

- Number of seriously injured cyclists stayed constant
- 2014 on same level as on passenger cars
- With E-bike in total more seriously injured than on passenger car

Seriously injured



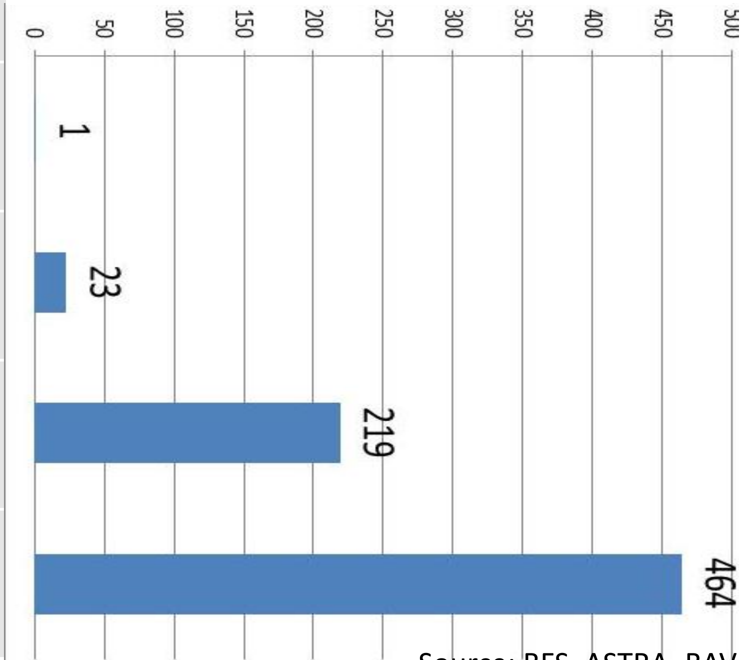
Source: BFU, ASTRA

Safety for cyclists

- Compared to passenger cars, the fatality risk on bicycles is 10 x higher, from the age of 70 years, the accident risk rises significantly
- Of 48% accident caused by passenger car / 42% by cyclists
- High potential on safety measurements for two wheel vehicles
- 2015 were 2/3 of fatalities on E-Bike older than 65

2004 - 2013	one fatality at
Railway	12770 Mio. person km
Passenger car	556 Mio. person km
Bicycle	58 Mio. person km
Motor bike	28 Mio. person km

Mortal risk, compared with railway

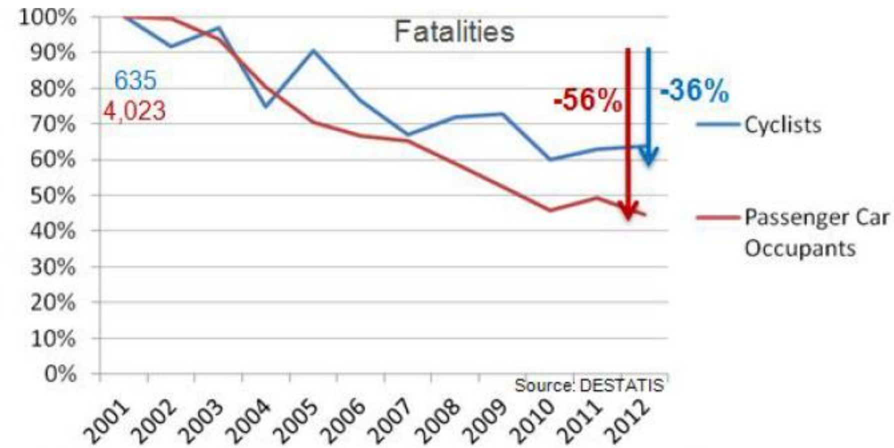


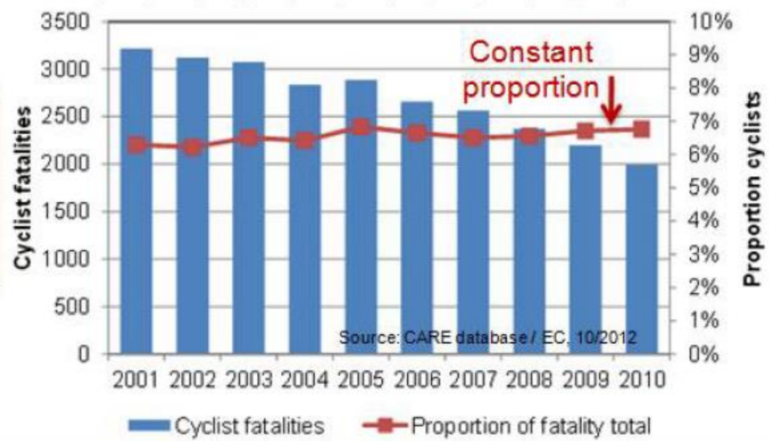
Source: BFS, ASTRA, BAV

Safety for cyclists

Accident statistics EU:

- Same trend of fatally injured cyclists in Germany and Europe





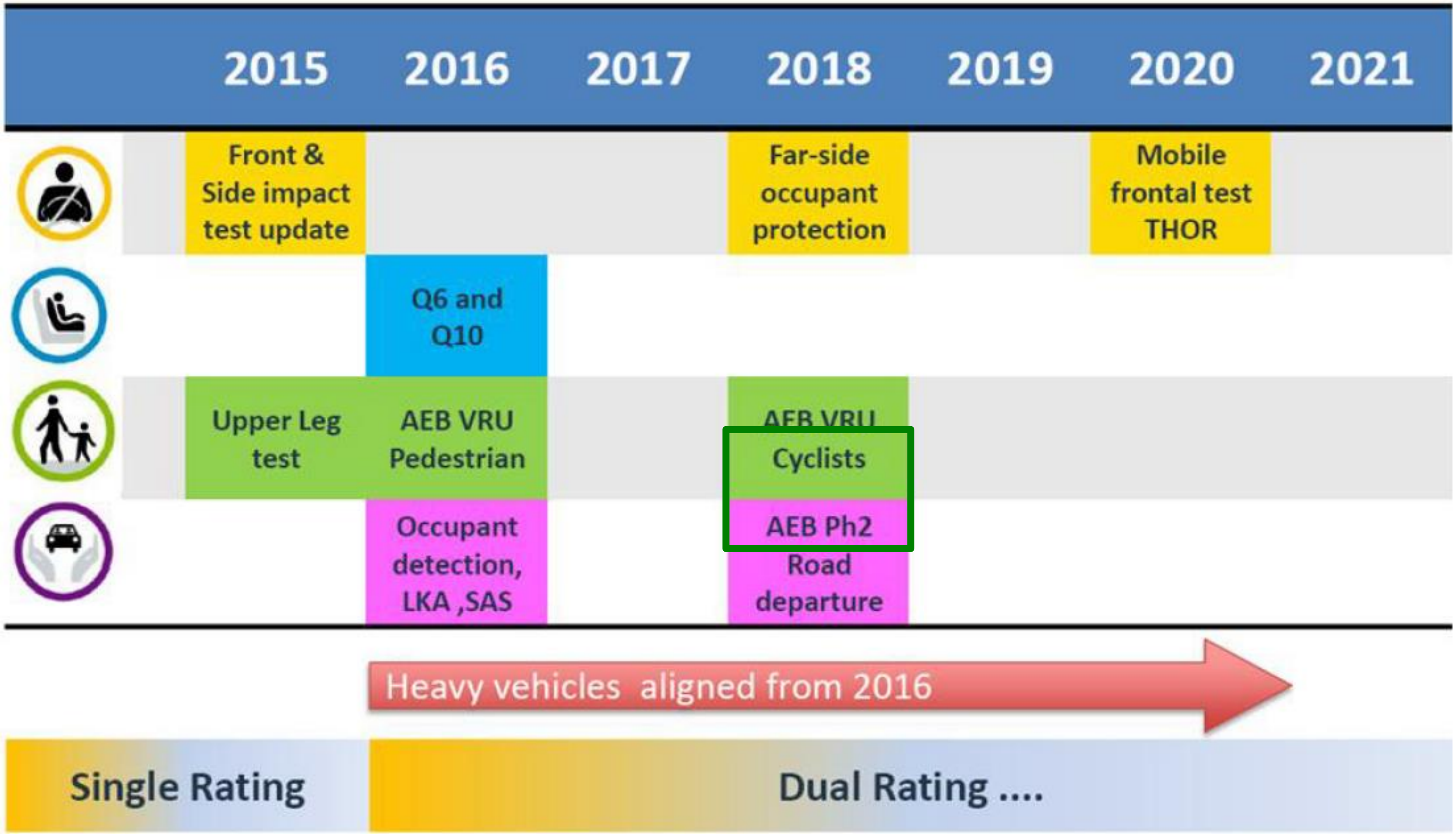
Source: PGV

Source: PGV

- In CH on E-Bikes > 25 km/h a bike helmet must be used

Safety for cyclists

EuroNcap Road Map 2020: Rating for AEB VRU Cyclists from 2018

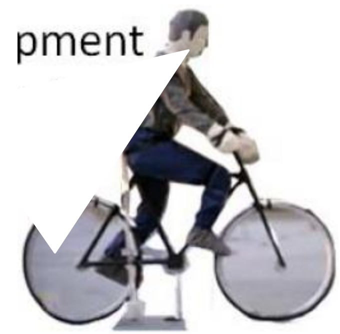


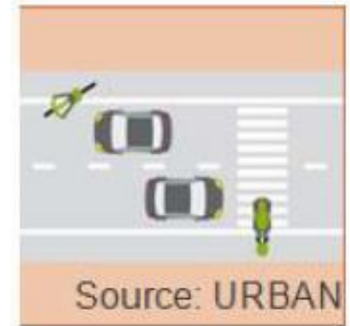
Source: EuroNcap, Director & Professor Andre Seeck

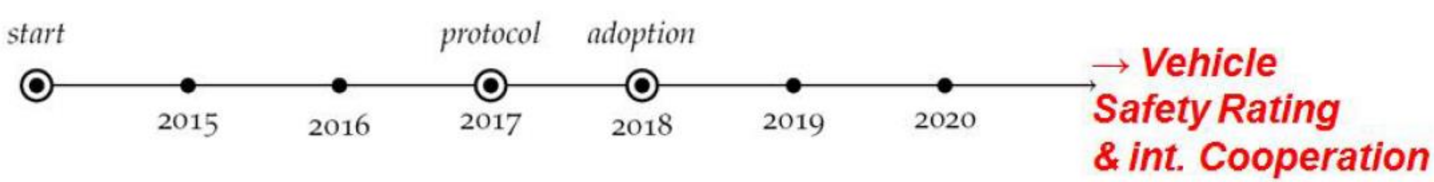
Safety for cyclists

Update AEB VRU for pedal cyclist:

- In daylight, darkness and obscure lighting conditions
- Representative for EU28
- Different sources needed
- Bicycle dummy and propulsion system under development
- Harmonization





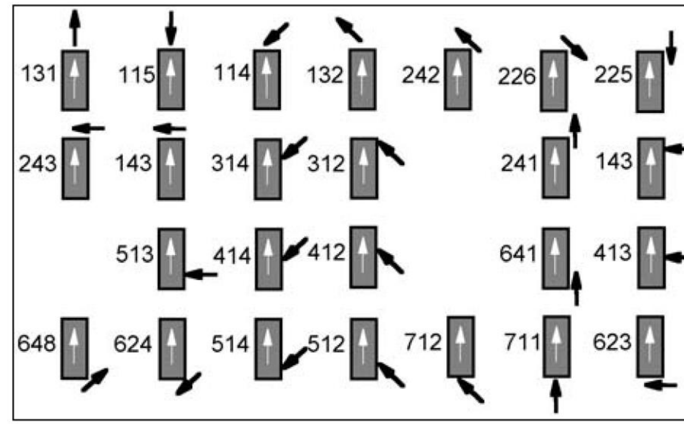


Source: EuroNcap, Director & Professor Andre Seeck

Typical accident scenarious with bicycles

Car – PTW collision configurations according to ISO 13232:

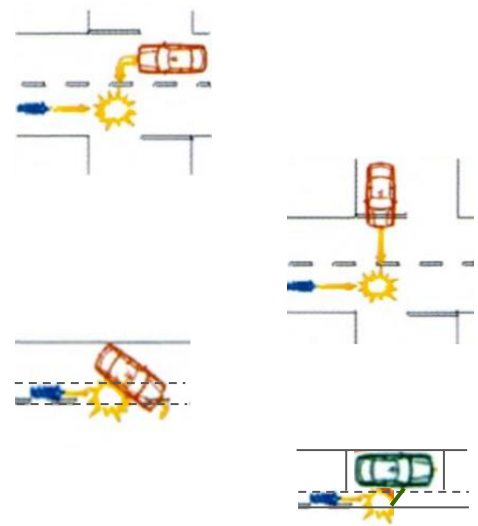
- 25 collision configurations
- Most of them are also relevant for cyclists



Source: ISO 13232

Typical cyclist accidents:

- Turn collision: miscalculation of distance and velocity (E-bike)
- Crossing collision: miscalculation and obstructed view (A-pillar)
- Push collision: blind spot
- Open door on parked car: missing mirror

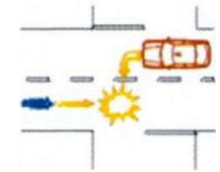


Risks and potential for drive assistant systems

Facility for the acceleration of cyclists:

- Sled with guidance rail for wheels, like a catapult
- Holding device for bike, saddle bar
- Holding device for ATD, armpits
- Pedestrian HIII 50% ATD, **with bike helmet (CH)**
- In-dummy DAS

Risks and potential for drive assistant systems



Turn collision:

- Miscalculation of distance and velocity
- High risks for E-bike

Side collision E-bike 45 km/h

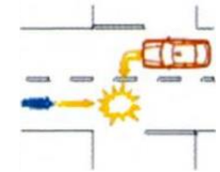
- Impact to cant rail & roof
- Forehead not protected by the helmet
- Loads on thorax to high

Side collision bike 25 km/h

- Impact to cant rail
- Forehead protected by the helmet
- No biomechanical limits exceeded

Risks and potential for drive assistant systems

Turn collision – findings:

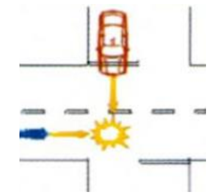


- Injury risk essentially influenced by
  - ☞ impact velocity of bike
  - ☞ helm protection of forehead not ideal
  - ☞ impact location on car structure; cyclist-safety for cant rail & roof ?
- With EBS main influence on impact location

	w/o EBS	with EBS
Scenario 1	413	143 243
Scenario 2	623	413

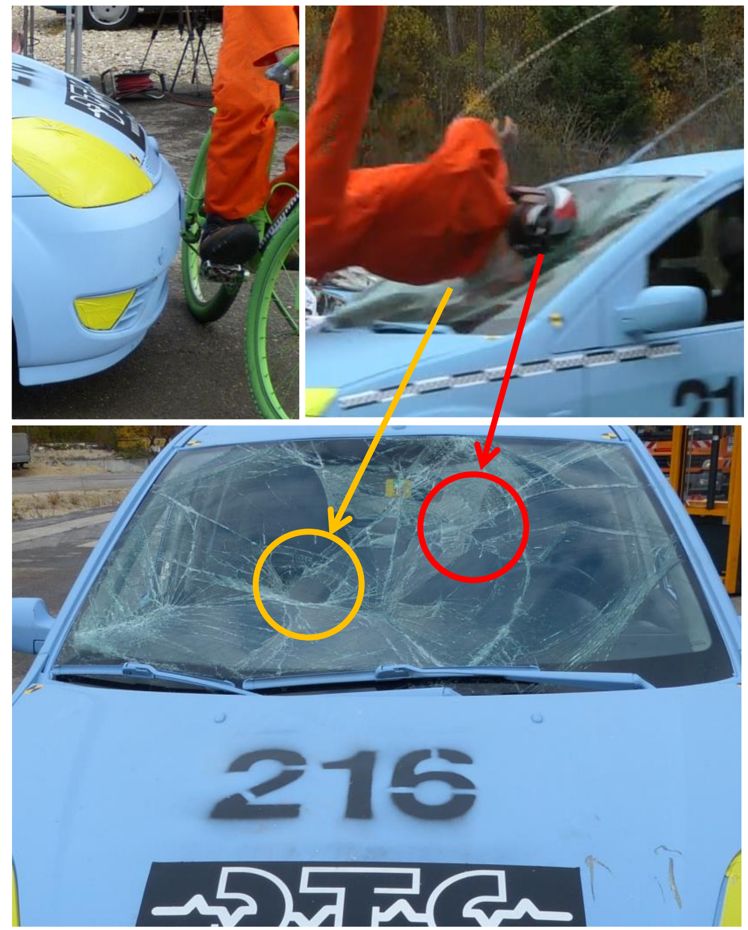
- Scenario 1
  - ☞ probability for "free flight"
  - ☞ risk of changed impact scenario (243)
  - ☞ high injury risk by secondary impact on road surface
- Scenario 2
  - ☞ in worst case the accident occurs because of EBS action

Risks and potential for drive assistant systems

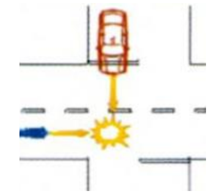


Crossing collision:

- Miscalculation of distance and velocity
- Obstructed view by A-pillar
- High risk for E-bike
- Knee-impact location to bumper higher (lower injury risk)
- Head-impact location to wind screen
  ☞ in tendency higher than
  on pedestrians
  ☞ similar impact velocity
- Temple protected by the helmet
- High loads on head, below biomechanical limits (primary & secondary impact)



Risks and potential for drive assistant systems



Front-Side collision with reduced impact velocity (EBS)

- Lower impact energy

Test prim. Imp.	HIC
40 km/h (50 % ATD)	408
20 km/h (50 % ATD)	74
25 km/h (P3 ATD)	725

- Depending on kinematic critical loads on head by secondary impact on road surface

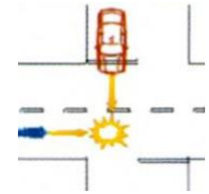
Test sec. Imp.	HIC
40 km/h (50 % ATD)	30
20 km/h (50 % ATD)	707
25 km/h (P3 ATD)	**1403**

v_0 = 20 km/h

v_0 = 25 km/h

Risks and potential for drive assistant systems

Crossing accident – findings:



- Injury risk essentially influenced by
  - ☞ impact velocity of car
  - ☞ good helm protection for temple
  - ☞ impact location on car structure; extended cyclist-safety area
- With EBS main influence on impact velocity and location

	w/o EBS	with EBS
Scenario 1	243	prim. 143 sek.
Scenario 2	143	no impact

- Scenario 1
  - ☞ reduced impact velocity → lower injury risk
  - ☞ risk of changed impact scenario → example A-pillar
  - ☞ high injury risk by secondary impact on road surface
- Scenario 2
  - ☞ in best case the accident can be avoided because of EBS action

Risks and potential for drive assistant systems

Push away collision:

- Blind spot
- Obstructed view
- Car and bike with just same velocity (low impact velocity)
- Possible head impact to wind screen, A-pillar or cant rail
- Temples and back of head protected by the helmet
- Low injury risk by primary impact

$v_0 = 10$ km/h

- High injury risk (HIC P3 777) by secondary impact or run over

Risks and potential for drive assistant systems

Push away collision – findings:

- Injury risk essentially influenced by
  - ☞ impact velocity of car
  - ☞ good helmet protection
  - ☞ secondary impact or run over

Source: Mercedes-Benz

Possible assistant systems

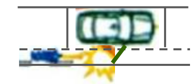
- Blind spot assist
- Blind spot monitoring
- Lane Change Assistant
- Multi collision brake → autonomous brake after collision with a bike
- …

With this for bike detection expanded systems, most accidents could be avoided

Risks: - information overload for driver
- question of guilt, if accident occurs

Risks and potential for drive assistant systems

Collision with open door on parked car:



- Blind spot
- Missing mirror during door opening
- Injury risk depending on impact velocity, impact location to door and stiffness
- Thorax impact to door frame
- Low risk for head impact
- High injury risk by secondary impact

Source: AXA Winterthur/DEKRA

$v_0 = 40$ km/h

Risks and potential for drive assistant systems

Push away collision – findings:

- Injury risk essentially influenced by
  - ☞ impact velocity of bike, high risk for E-bike
  - ☞ door stiffness
  - ☞ secondary impact - helmet

Example of assistant system

- Audi exit warning
  - optical and acoustic warning
  - resistance for door opening in discussion

With this system most accidents could be avoided

Risks: system failure

Source: Audi

Summary

Pedestrian safety on cars for cyclists?

- Similar head contact area on vehicles as pedestrians
  → pedestrian safety also for cyclists helpful
  → in tendency higher positioned, extension to cant rail and door frame?

- Injury risk for cyclists compared to pedestrians
  → Better protection with helmet
    - ☞ helmet obligatory, for all bikers?
    - ☞ bad protection for forehead - high quality differences
    - ☞ good bike helmet is better than a bad motorcycle helmet, and a good bike helmet as a comparable protection

  → Often higher impact velocity
    - ☞ extended energy absorption needed
    - ☞ high risk with E-bikes

E-bike with motorcycle helmet

Summary

Assistant systems:

- Complexes impact scenarios
  → different bicycles, different front geometry
  → different drive assistant systems are needed
- AEB best effect on frontal collision situations
  → A reduction of the impact velocity by min. 20 km/h reduces serious head injuries
  → Depending on kinematics higher loads on head can result by secondary impact (road surface) with reduced impact velocity
- Other systems can be extended for cyclists

Summary

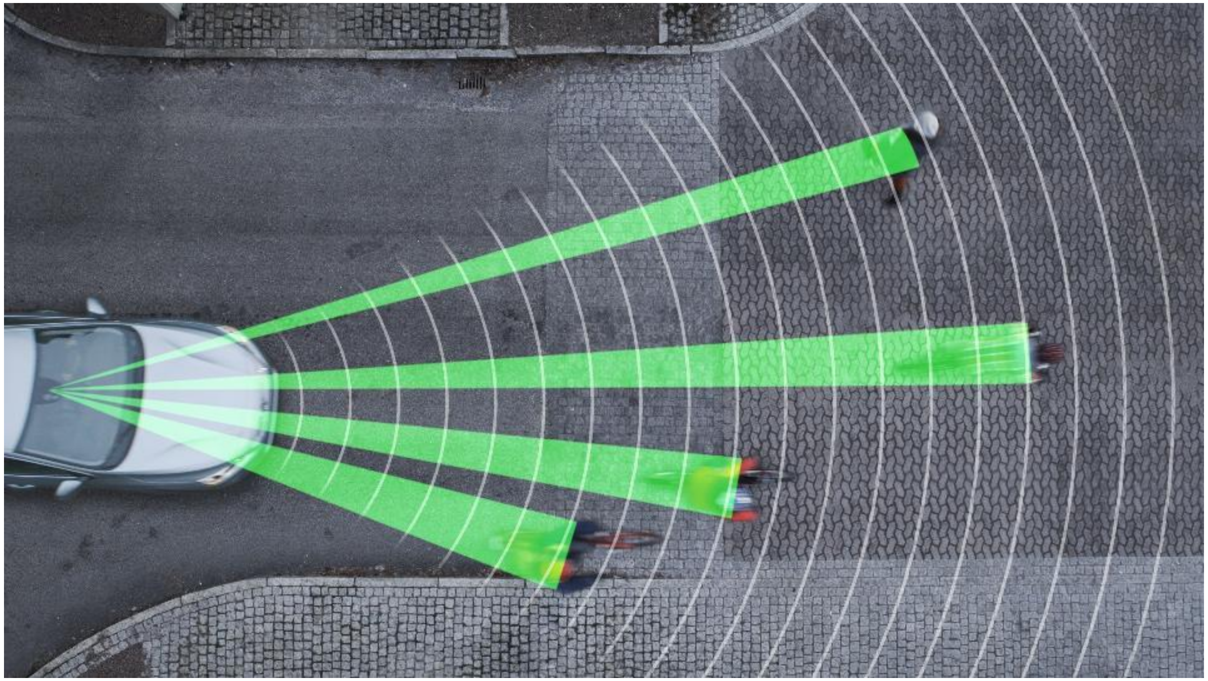
Questions for accident analytics:

- Would the accident occur without assistant intervention?
- Should the assistant system had work in the specific accident?
- …

Thank you for your attention!

It is the time to start with cyclist safety

→ by hold automotive industry
AND cyclists accountable



Volvo EBS with cyclist detection assistant

Concept study with a belted cyclist