European Automobile Manufacturers Association

ACEA

iCSC 2012 international Cycling Safety Conference

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Cyclist Protection from the Perspective of the European Car Manufacturers

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ACEA Key Data

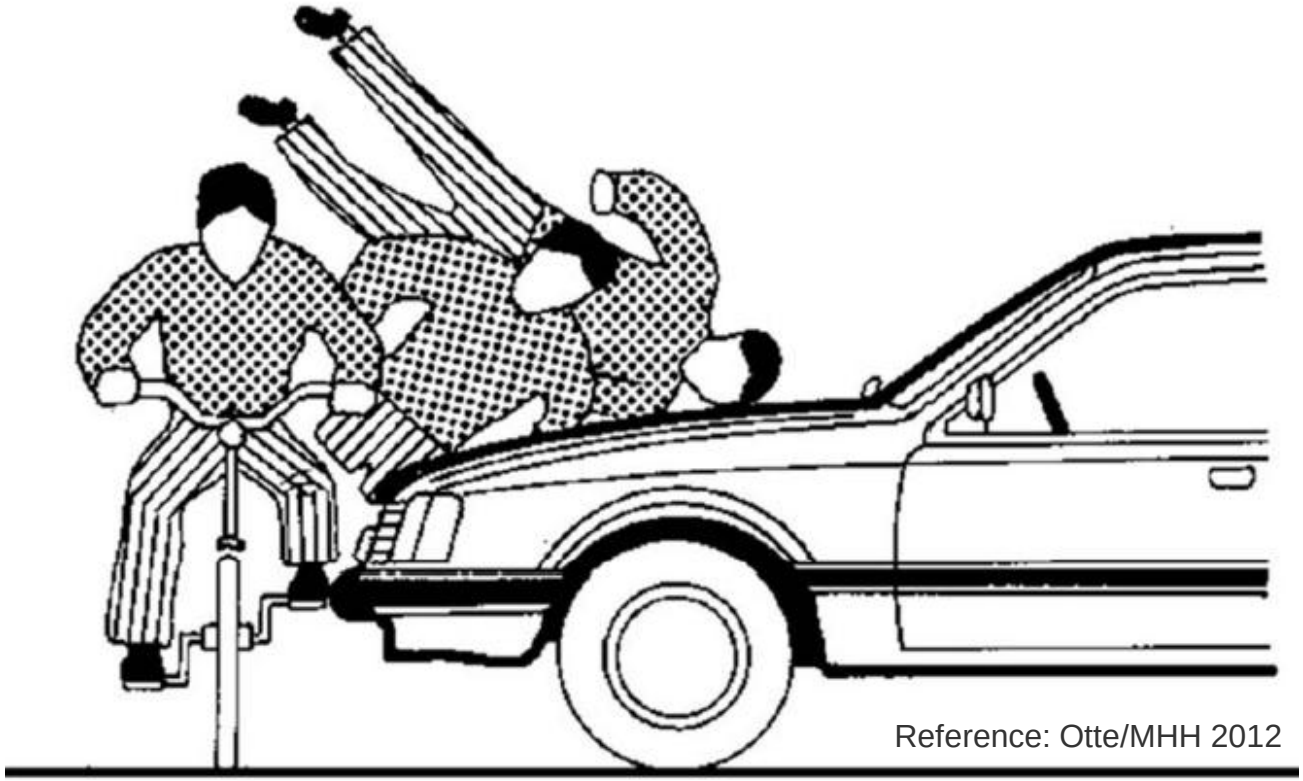
ACEA European Automobile Manufacturers Association

- 16 major international companies.
- 11.6 million direct and indirect jobs.
- € 26 billion in R&D spending, largest private investor.
- € 75 billion of net trade contribution.
- € 375.1 billion of tax revenues (EU15).

ACEA figures 2012

Accidents Involving Cyclists

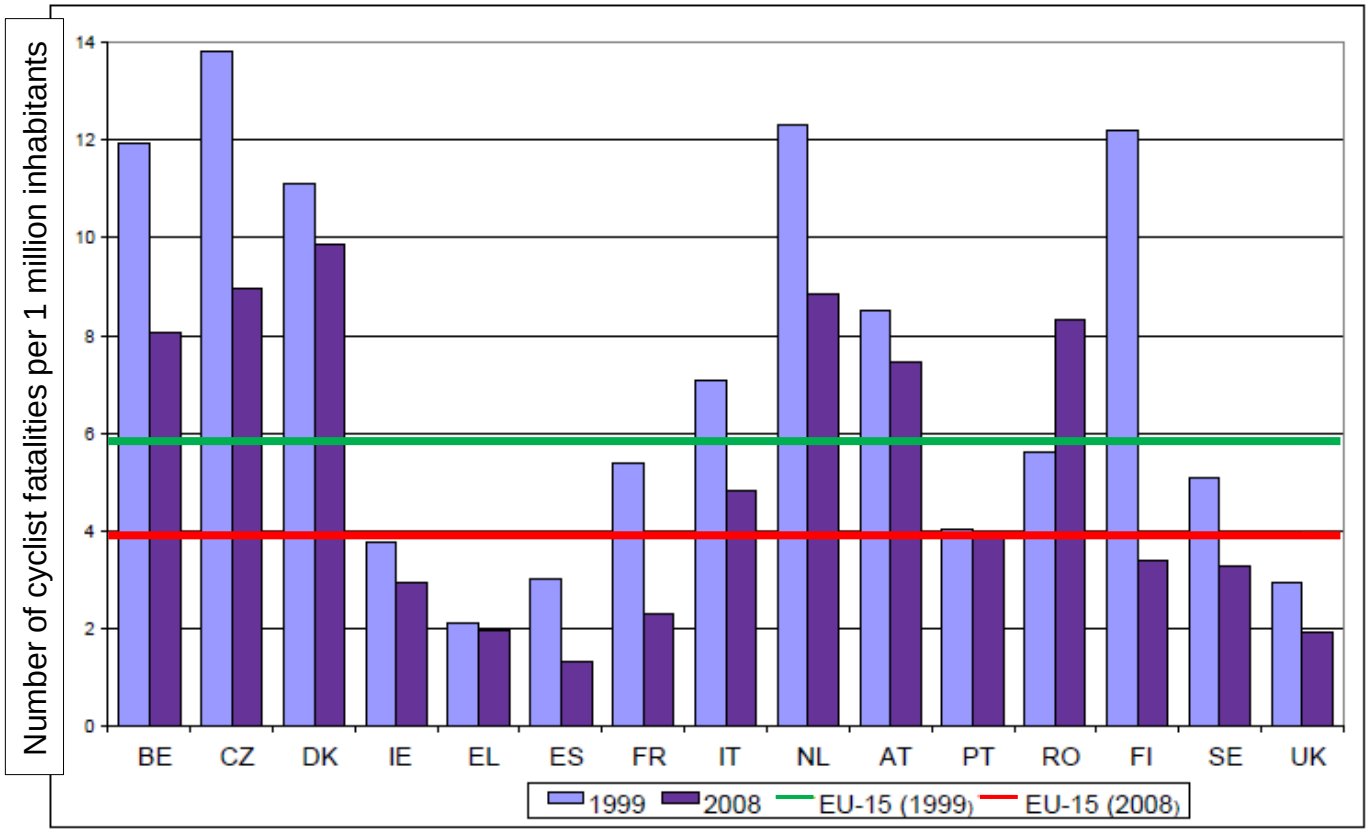
- Car-to-cyclist accident scenarios are comparable to those of car-to-pedestrian accidents: Cyclists who are struck by cars usually contact the same vehicle components and have similar injuries as pedestrians.
- However, kinematics also depend on the type of bicycle.



Reference: Otte/MHH 2012

Accident Statistics for Cyclists

Figure 1: Cyclist fatality rates, 2008 and 1999 compared



Reference: DaCoTA 2010

Source: CARE Database / EC
Date of query: February 2011

Good progress has already been achieved: According to EU 7th framework project DaCoTA (Road safety Data Collection, Transfer and Analysis), the number of fatalities decreased in the decade from 1999 to 2008 by 29 %.

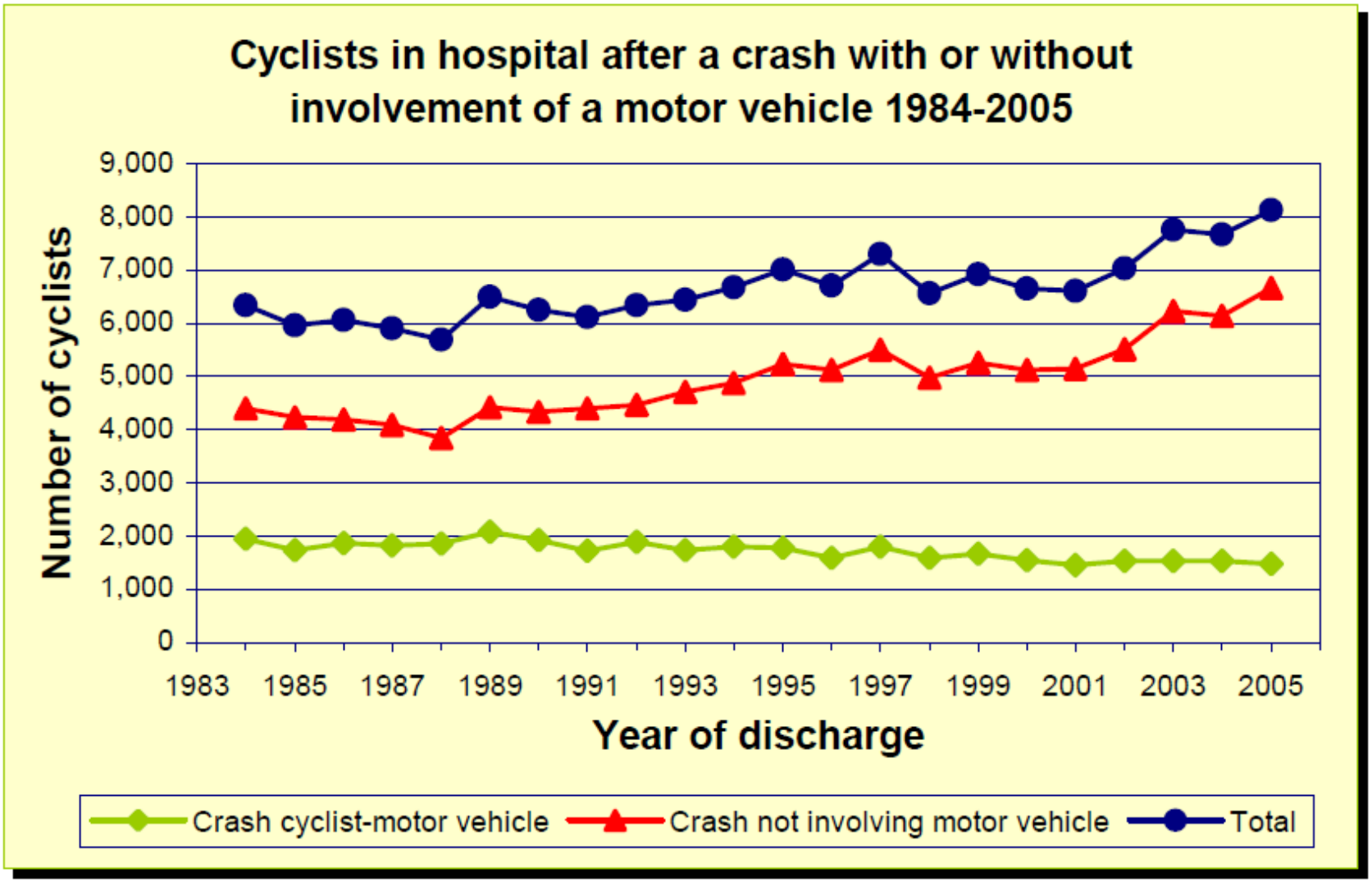
Comparison of Cyclist Fatalities

COUNTRY	Cyclists	Pedestrians
Australia	31	195
Austria	39	101
Czech Republic	84	176
Denmark	25	52
Finland	20	30
France	162	496
Germany	462	591
Great Britain	104	500
Greece	15	202
Hungary	103	186
Ireland	7	40
Israel	15	105
Italy	295	667
Japan	933	2012
Luxemburg	2	12
Netherlands	**138**	**63**
New Zealand	8	31
Northern Ireland	0	24
Norway	9	25
Poland	371	1467
Portugal	29	148
Slovenia	18	24
South Korea	333	2137
Spain	56	470
Sweden	20	44
Switzerland	54	60
United Kingdom	104	524
United States of America	630	4092

Reference: 2009 figures according to IRTAD Report 2010

- The Netherlands is the only country with a higher number of cyclists fatalities (138) than pedestrians (63).
- A deeper analysis of the accident situation seems necessary for the understanding of the NL figures compared with data from other countries, e.g. trend just for accidents with passenger vehicles, comparison with usage of bicycles (km/year), infrastructure, drivers' behaviour, accident types…

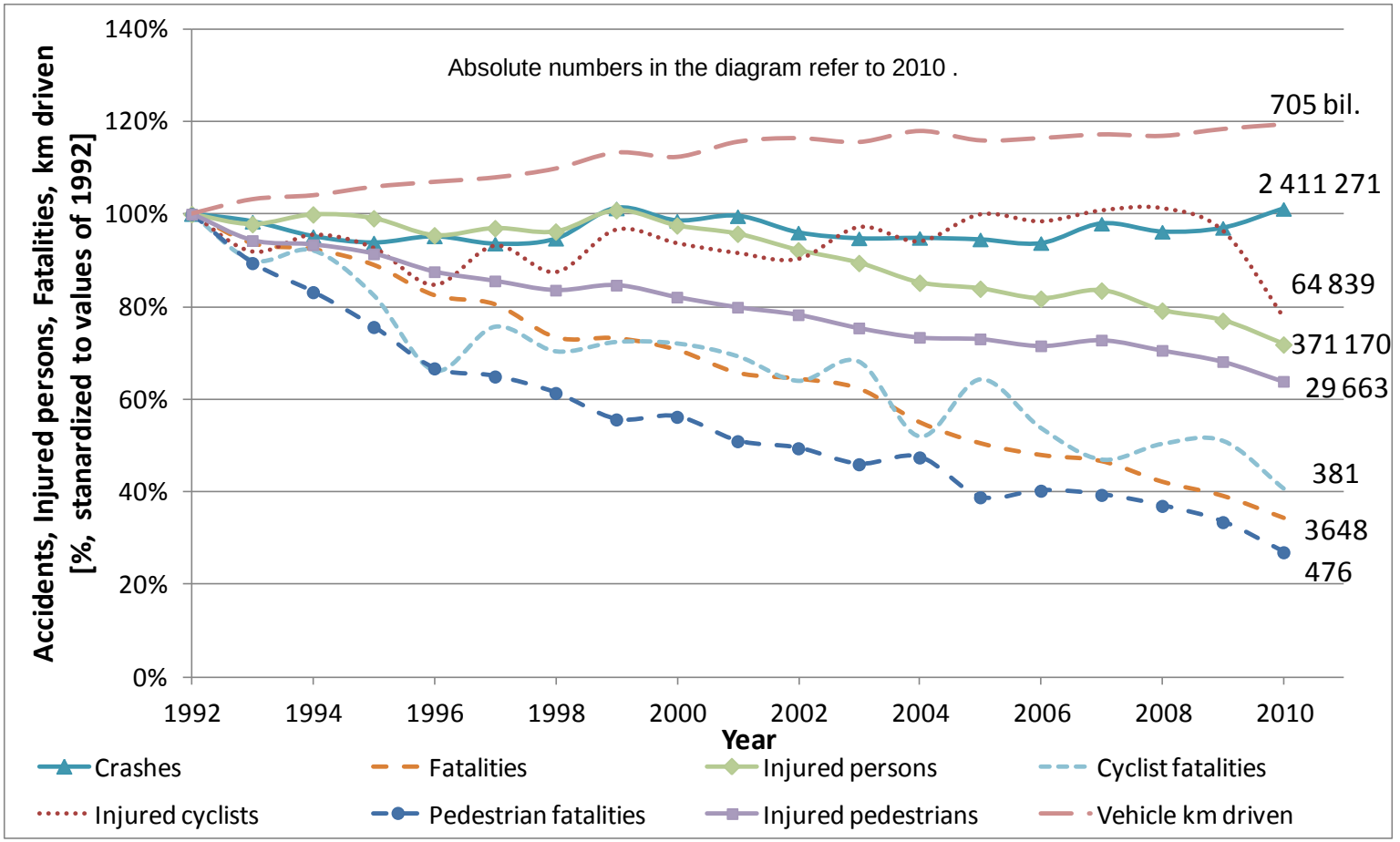
Long Term Accident Trends in the Netherlands



Reference: SWOV Cyclists 2009

The trend for moderately to fatally injured cyclists in accidents without a motor vehicle involved should be a cause for alarm.

Current Trends in Germany



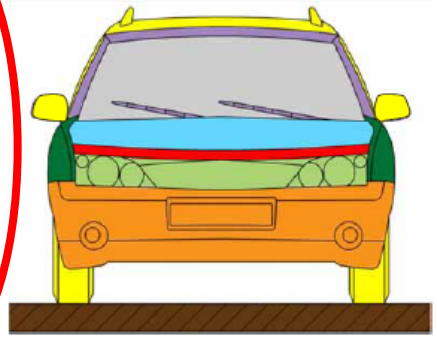
- Absolute numbers as well as ratios to exposure (km driven) decline strongly.
- VRU fatalities follow the general declining trend
  (all fatalities: -66%; cyclists: -60%; pedestrians: -73% compared to 1992).

Cyclist Accidents: How to Further Decrease Injury Risks?

head/face injuries	*AIS1+*	*AIS2+*	*AIS3+*
window frame / A-pillar	43,3	28,9	15,8
windscreen	131,5	74,4	21,9
bonnet	12,2	6,6	--
bonnet leading edge	0,5	0,5	--
fender	3,9	1,6	--
grill and headlamps	--	--	--
bumper	--	--	--
other veh. parts / front nfs. *	23,4	9,5	2,9
own bicycle / other / unknown **	10,4	0,5	--
ground impact	378,9	159,9	25,0
total	**604,1**	**281,9**	**65,6**

injuries on lower extremities	*AIS1+*	*AIS2+*	*AIS3+*
window frame / A-pillar	1,4	0,5	--
windscreen	6,5	1,7	--
bonnet	22,7	5,9	1,1
bonnet leading edge	25,8	9,8	3,7
fender	27,0	8,6	0,9
grill and headlamps	8,1	3,9	0,5
bumper	118,3	70,7	14,1
other veh. parts / front nfs. *	34,8	12,1	3,1
own bicycle / other / unknown **	38,5	10,7	--
ground impact	210,1	49,8	7,9
total	**493,1**	**173,8**	31,3

thorax injuries	*AIS1+*	*AIS2+*	*AIS3+*
window frame / A-pillar	8,8	6,4	3,3
windscreen	20,1	10,3	7,4
bonnet	24,2	8,6	5,4
bonnet leading edge	4,1	4,1	0,6
fender	2,9	1,5	1,5
grill and headlamps	--	--	--
bumper	--	--	--
other veh. parts / front nfs. *	5,7	2,1	1,6
own bicycle / other / unknown **	6,5	--	--
ground impact	40,6	12,1	9,0
total	**112,9**	**45,1**	**28,8**



Reference: Liers/VUFO 2011

- Head injuries represent the majority of severe injuries for cyclists in accidents with cars, the most dangerous contact surface for the head is the ground.
- Wearing helmets can help to further decrease the injury risks.

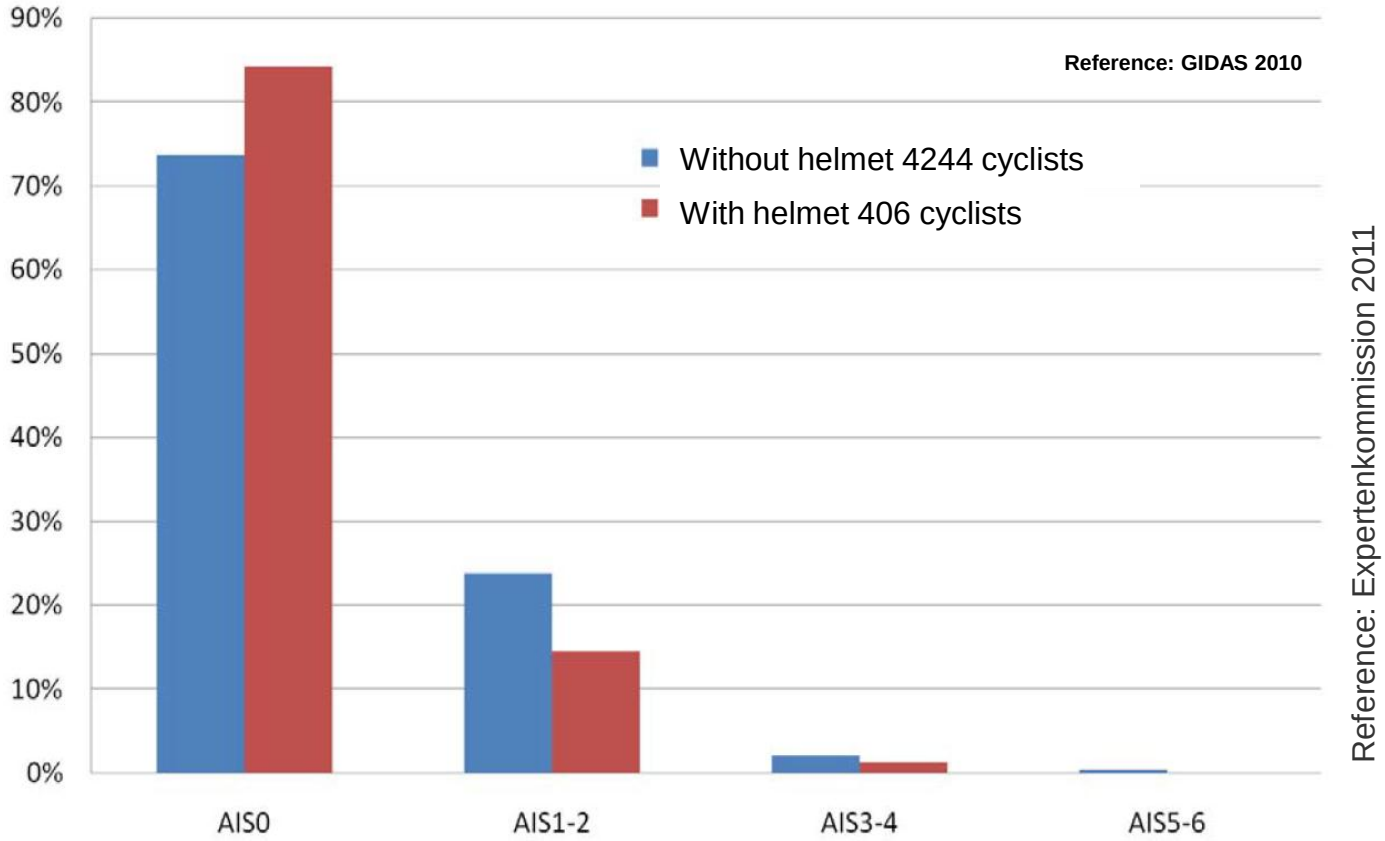
A First Step

- Vehicles designed to meet pedestrian safety requirements also contribute to cyclists' safety.
- However, not all injuries can be effectively addressed by vehicle design.
- Cyclists are also required to share the responsibility:

Photograph: Kinsky/Opel

Effectiveness of Helmet Use

Distribution of Maximum AIS (AIS 2005) for head injuries



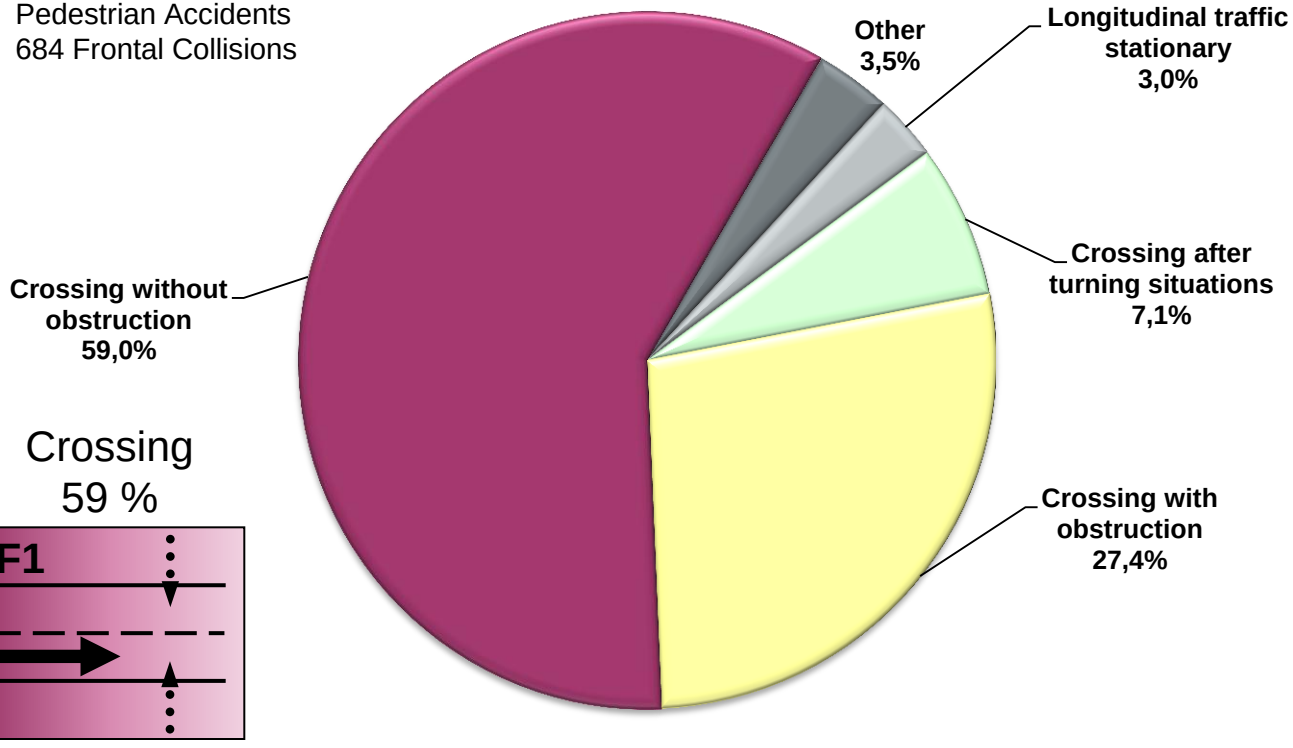
- According to GIDAS data, the helmet wearing rate is < 10 % in Germany.
- However, cyclists wearing helmets did not suffer any AIS4+ head injuries during accidents (in contradiction to those not wearing helmets) and wearing a helmet significantly reduces the risk of AIS 2 - 6 injuries.

Predicting the Potential Benefits of AEB Systems for VRU's

GIDAS Analysis Pedestrians

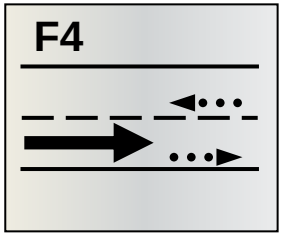
Frontal pedestrian accidents MAIS 2+: Summary of initial conflicts

GIDAS Database 1990 – 02/2006:
Pedestrian Accidents
684 Frontal Collisions

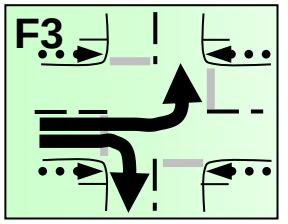


Crossing
59 %

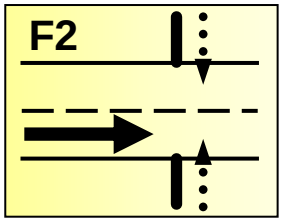
Longitudinal
3 %



Turning/crossing
7 %



Obstruction/crossing
27 %



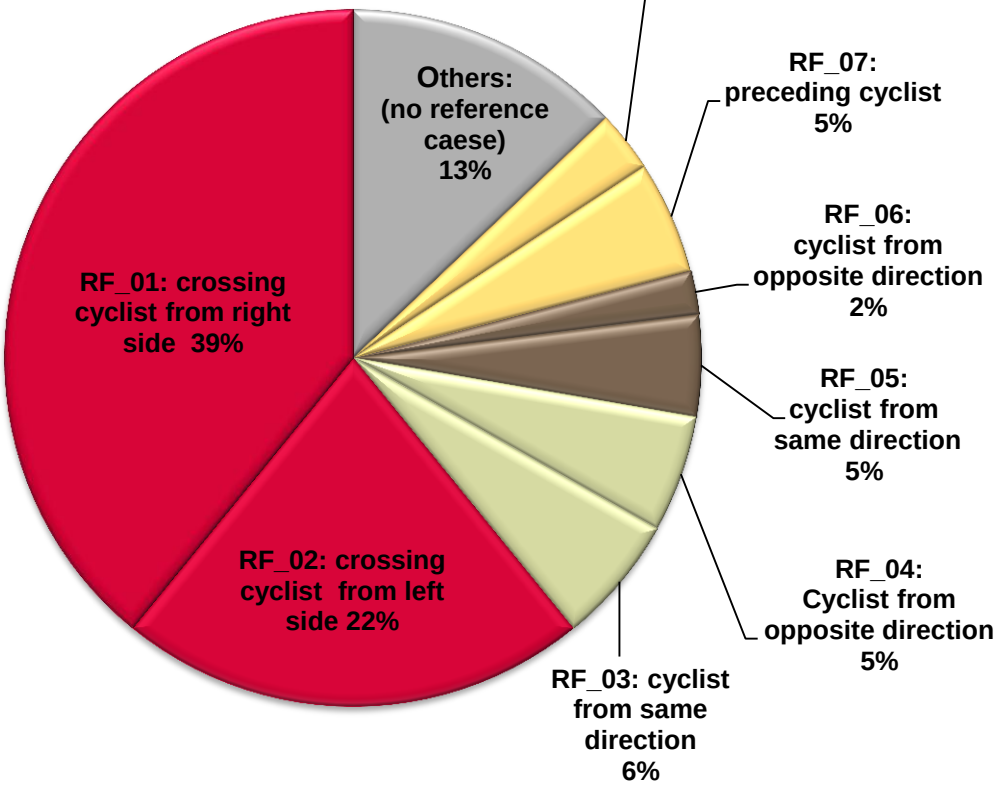
- Main scenario for pedestrian accidents are crossing accidents.

Predicting the Potential Benefits of AEB Systems for VRU's

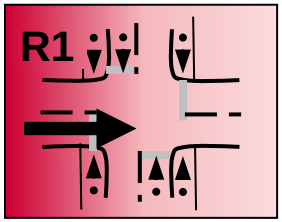
GIDAS Analysis Cyclists

Cyclist accidents MAIS 2+:
Summary of initial conflicts

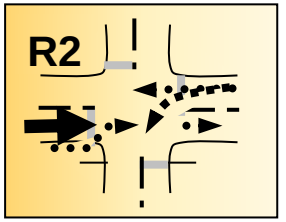
GIDAS Database 1999 – 2010:
Cyclist Accidents
3412 Collisions



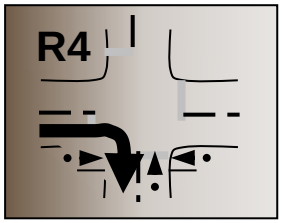
Crossing
61 %



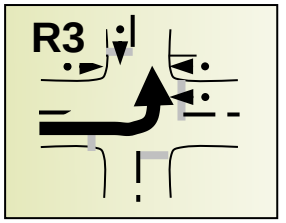
Longitudinal
8 %



Turning right
7 %

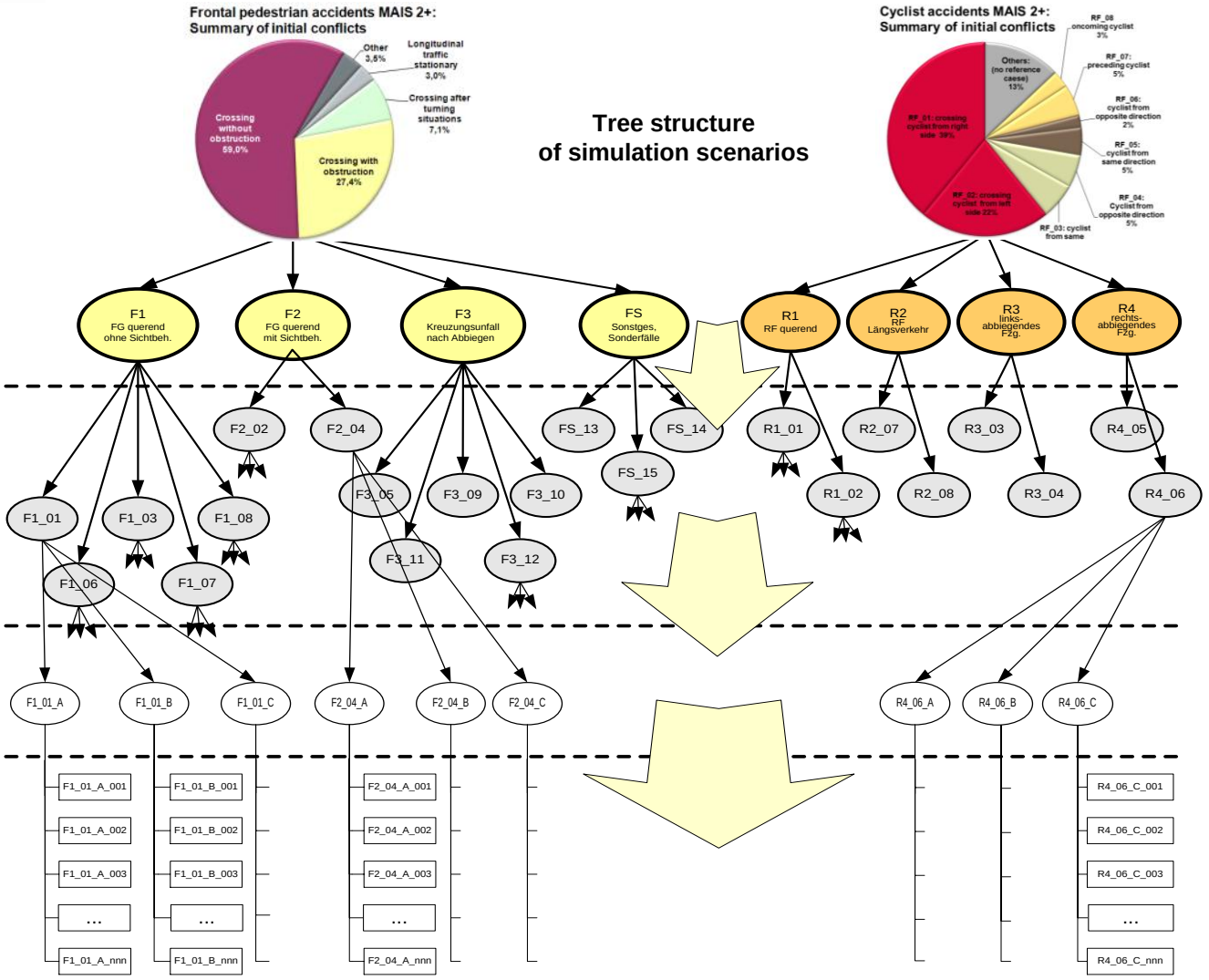


Turning left
11 %



- Main scenario for cyclist accidents are also crossing accidents.

Analyses of Pedestrians and Cyclists: Reference Scenarios



GIDAS Analysis

Reference scenario

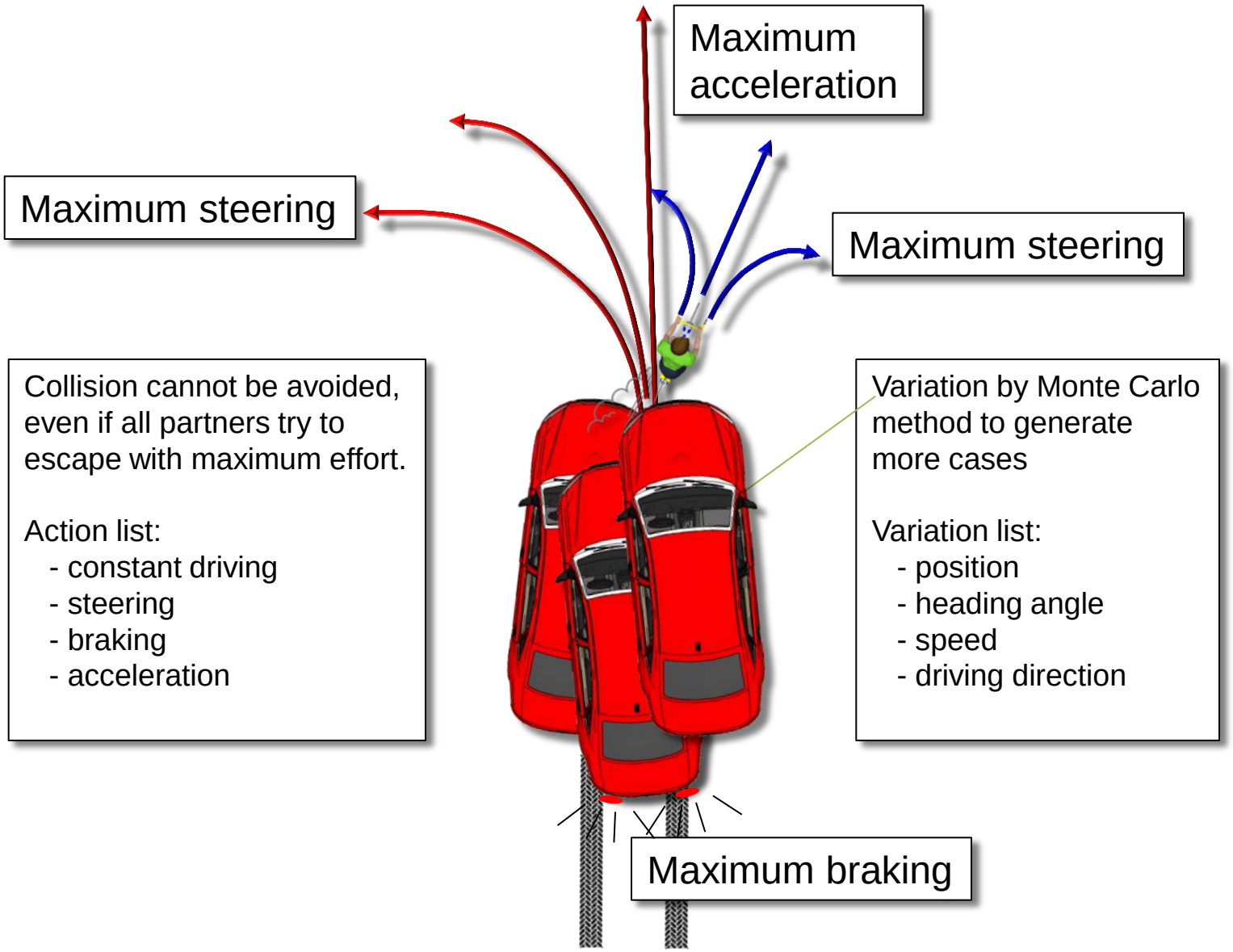
Typical scenarios

Simulation action:
- acceleration
- braking
- constant

Variation:
- speed
- acceleration
- position
- direction

- Stochastic simulation of initial conditions to generate millions of accidents.

Analyses of Pedestrians and Cyclists: Simulation Models



Collision cannot be avoided, even if all partners try to escape with maximum effort.

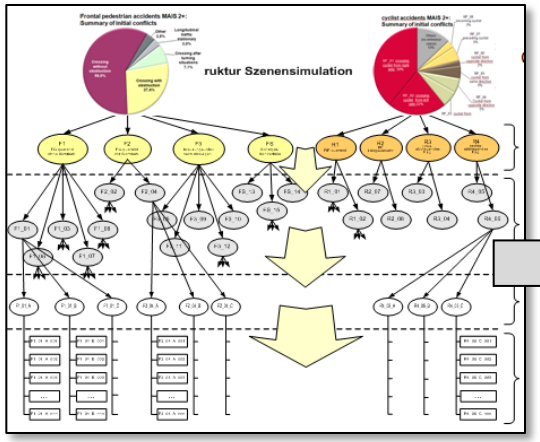
Action list:
- constant driving
- steering
- braking
- acceleration

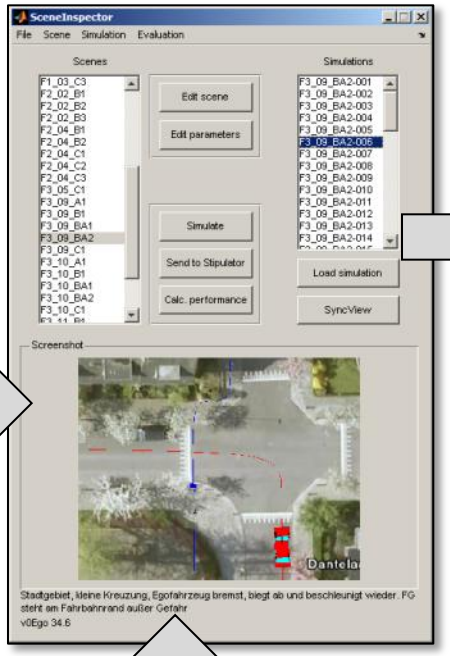
Variation by Monte Carlo method to generate more cases

Variation list:
- position
- heading angle
- speed
- driving direction

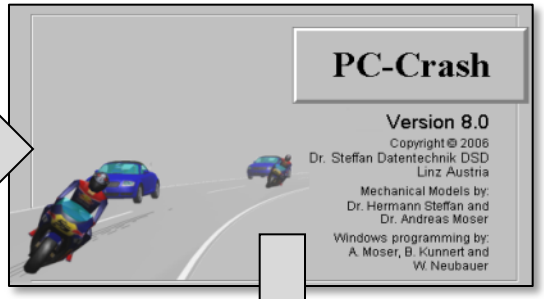
Simulation Process

1. Step
Analysis of databases

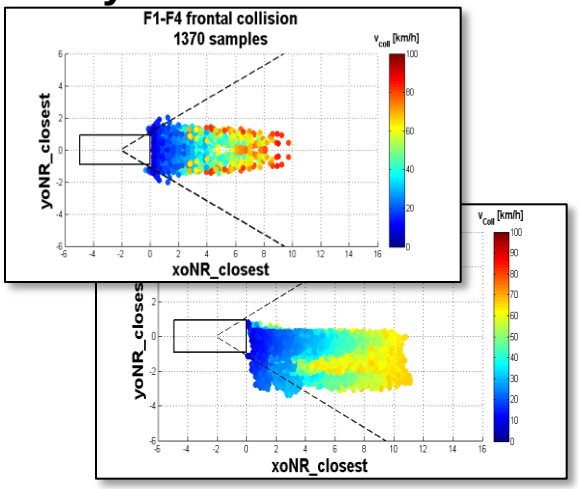




3. Step
Simulation by PC-crash



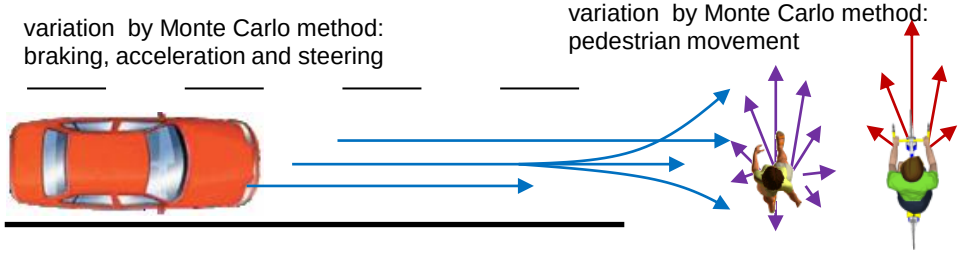
4. Step
Analysis of scenarios



2. Step
Variation of scenarios by Monte Carlo

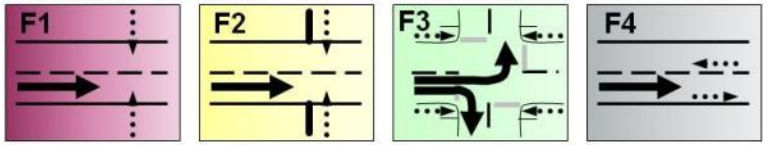
variation by Monte Carlo method:
braking, acceleration and steering

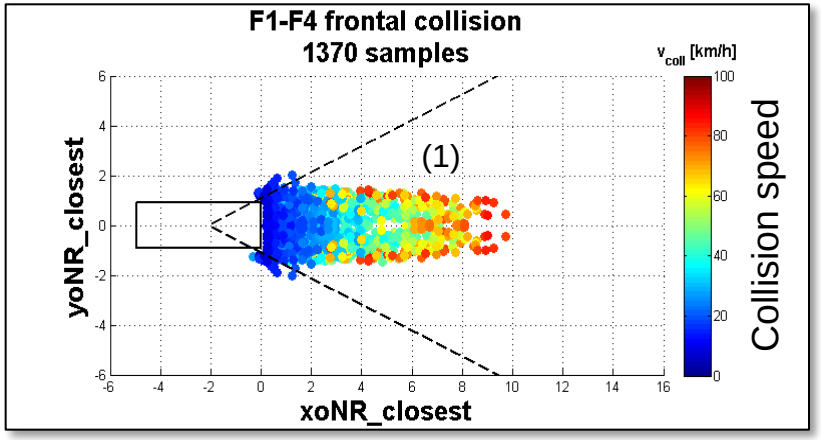
variation by Monte Carlo method:
pedestrian movement



Comparison of Results for Pedestrians and Cyclists

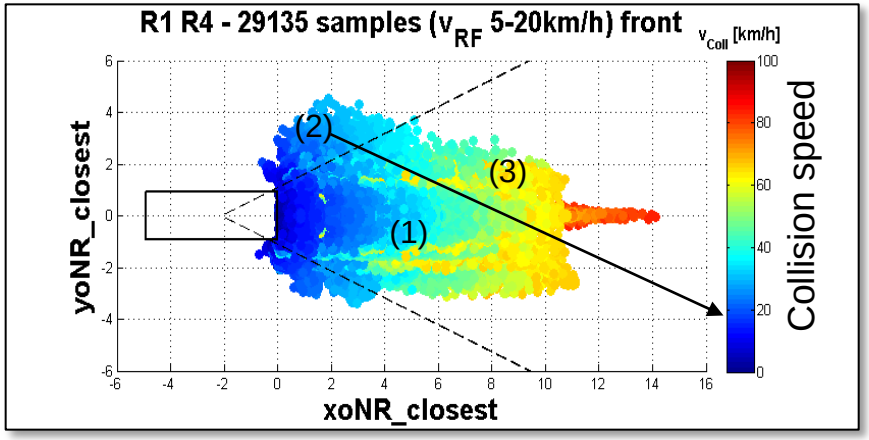
Analysis pedestrians





(1) Nearly all pedestrian cases in sensor field of view.

Analysis cyclists



(1) Nearly all critical cyclist cases in sensor field of view.

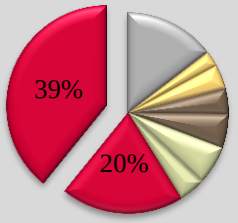
(2) Compared to pedestrians, more cyclists out of sensor field of view, but lower collision speed in these cases.

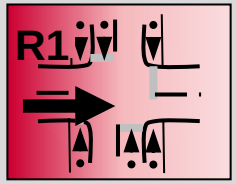
(3) Accidents with higher collision speeds can be predicted for cyclists due to their lower agility caused by their own dynamic behaviour.

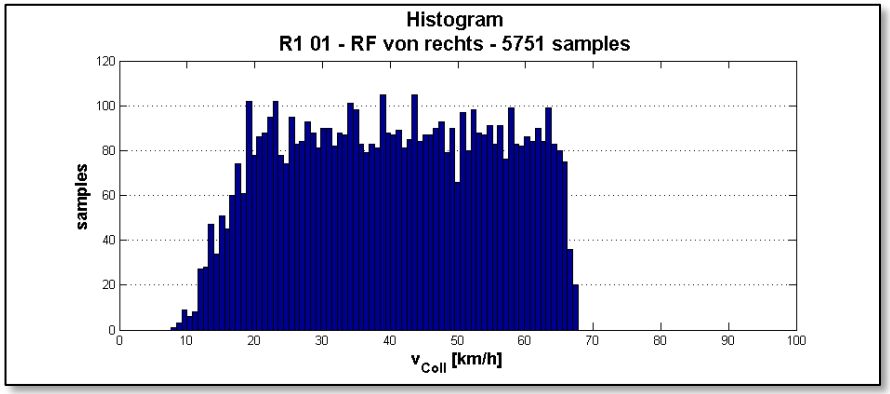
Detailed Analysis: Crossing Cyclists from Right

R1_01 RF from right

- v_{car}: 5 – 65 km/h, $v_{cyclist}$: 5 – 20 km/h, frontal collision.
- Highest proportion of GIDAS cases.

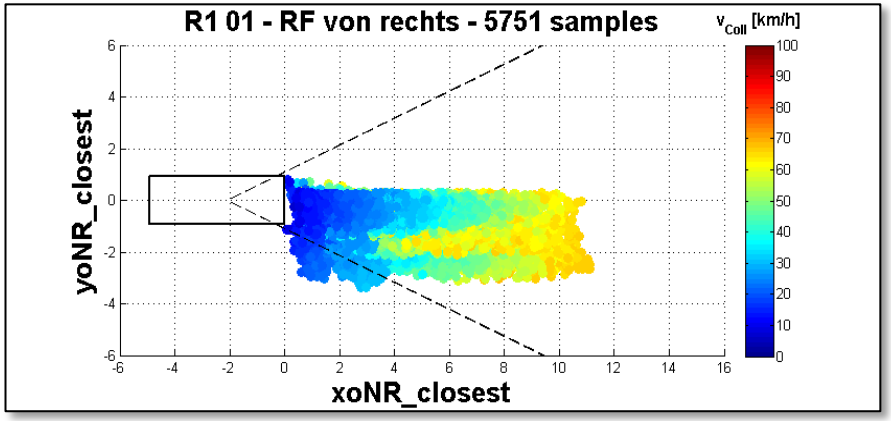


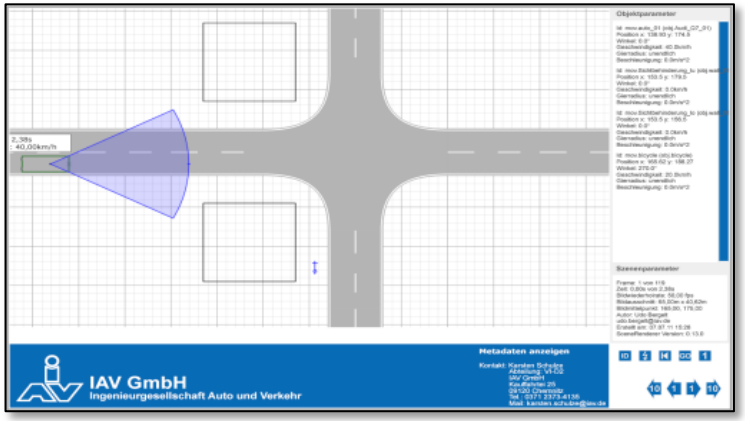




Results:

- Relevance is high: 39 %.
- Nearly all cases in sensor field of view.
- Median of collision speeds for all samples is 40 km/h.





Preventive Cyclist Protection

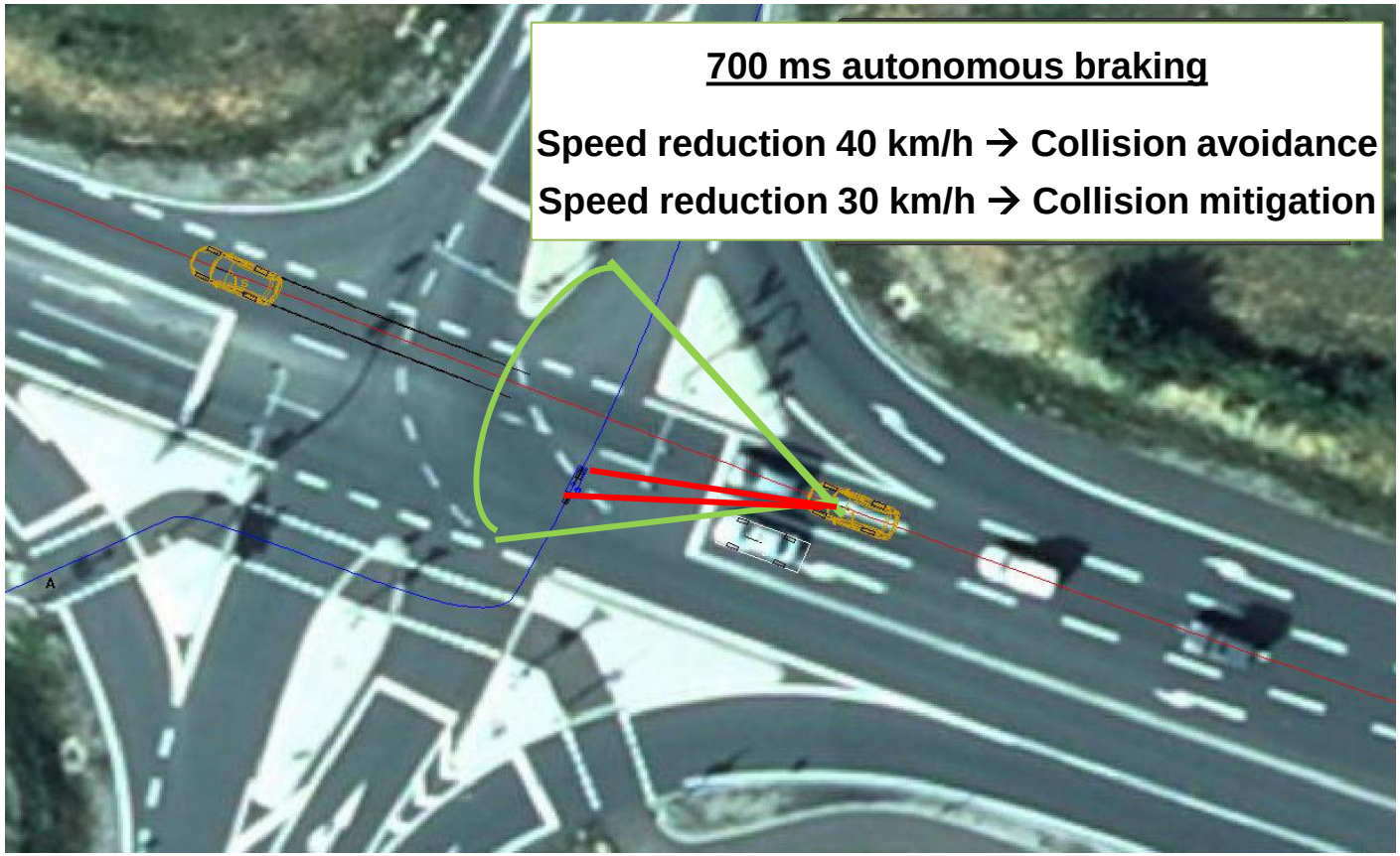
Example Accident

Simulations of a real-world reconstructed accident: crossing cyclist collision with a vehicle without and with forward-looking AEB system.

Preventive Cyclist Protection

Benefit for cyclists: case study

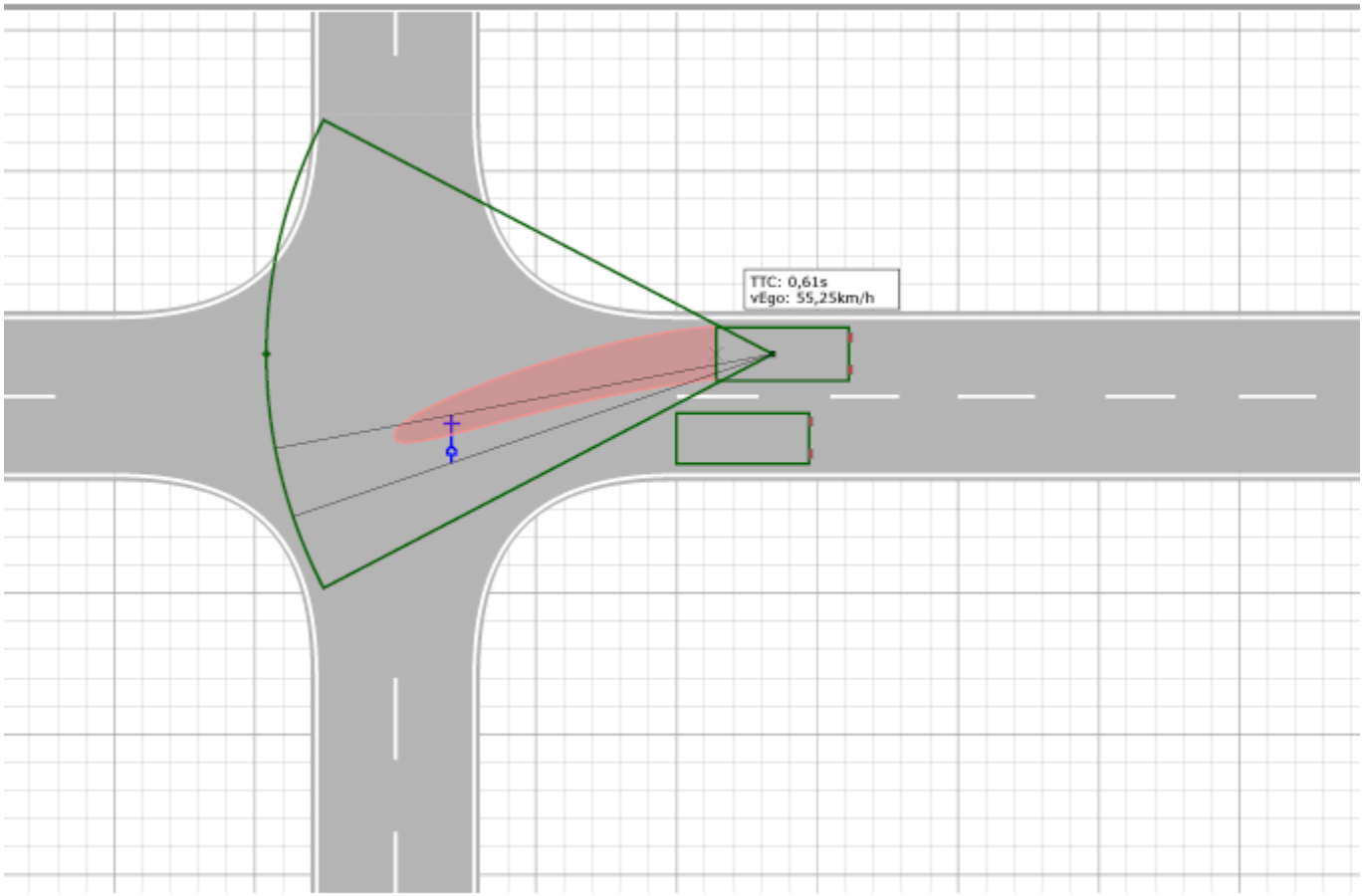
- Example accident: car vs. cyclist;
- Reconstruction by AARU (AUDI Accident Research Unit).



Preventive Cyclist Protection

Example Accident

- Virtual reconstruction with preventive AEB system.

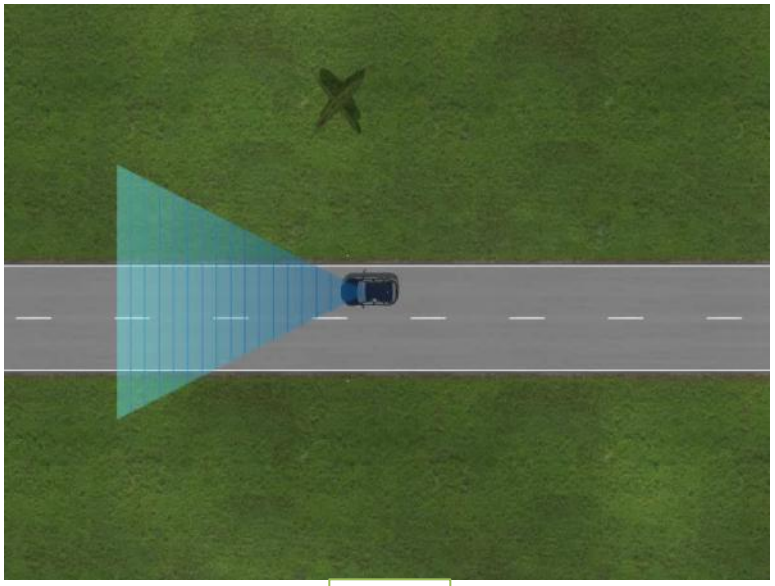


Preventive Cyclist Protection

Example Accident

- Original accident.

- Accident with preventive system.



Conclusions

- A deeper understanding of cyclist behaviour is required if the trend of single cyclist collisions is to be reversed.
- Vehicles designed to meet the pedestrian safety requirements also contribute to cyclist safety.
- However, not all injuries can be effectively addressed by the vehicle design. Cyclists are also required to share the responsibility by wearing helmets.
- Future AEB systems designed for pedestrians potentially offer additional benefits for cyclists as well.

Thank you for your attention!

Literature

- **DaCoTA** (Road Safety Data Collection, Transfer and Analysis) **2010**: Traffic Safety Basic Facts 2010, Cyclists; available at the website dacotapilot.swov.nl/Statistics/Basic%20fact%20sheets/BFS2010_DaCoTA-SWOV-1-3-Cyclists_SWOV20110223.pdf [26.10.2012]
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