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Method to Evaluate the Effectiveness of an Active Safety System for Cyclist Protection

Alexandra Fries

ICSC, 18th November 2014

Agenda

- Method for Effectiveness Evaluation
- Accident Analysis
- Reference Scenarios
- Detailed Analysis of Scenarios
- Results and Outlook
- Questions and Discussion

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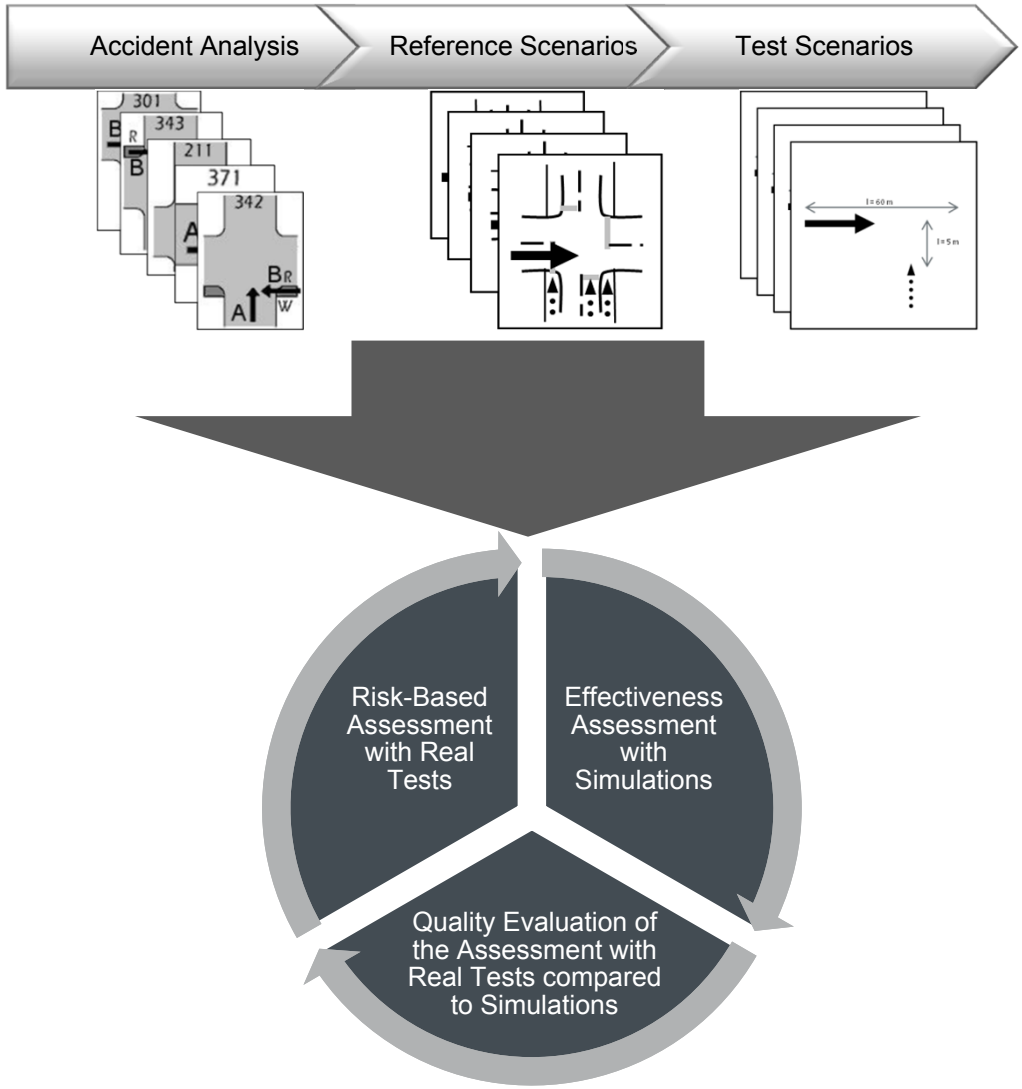
Method for Effectiveness Evaluation



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Accident Analysis

- Analyzed car-to-bicycle accidents
  - German In-Depth Accident Study (GIDAS)
  - Accidents from 2000 to 2013

- First collision for both passenger car and cyclist → no consecutive collisions
- Only bicycle riders themselves

Total of 4286 examined accidents

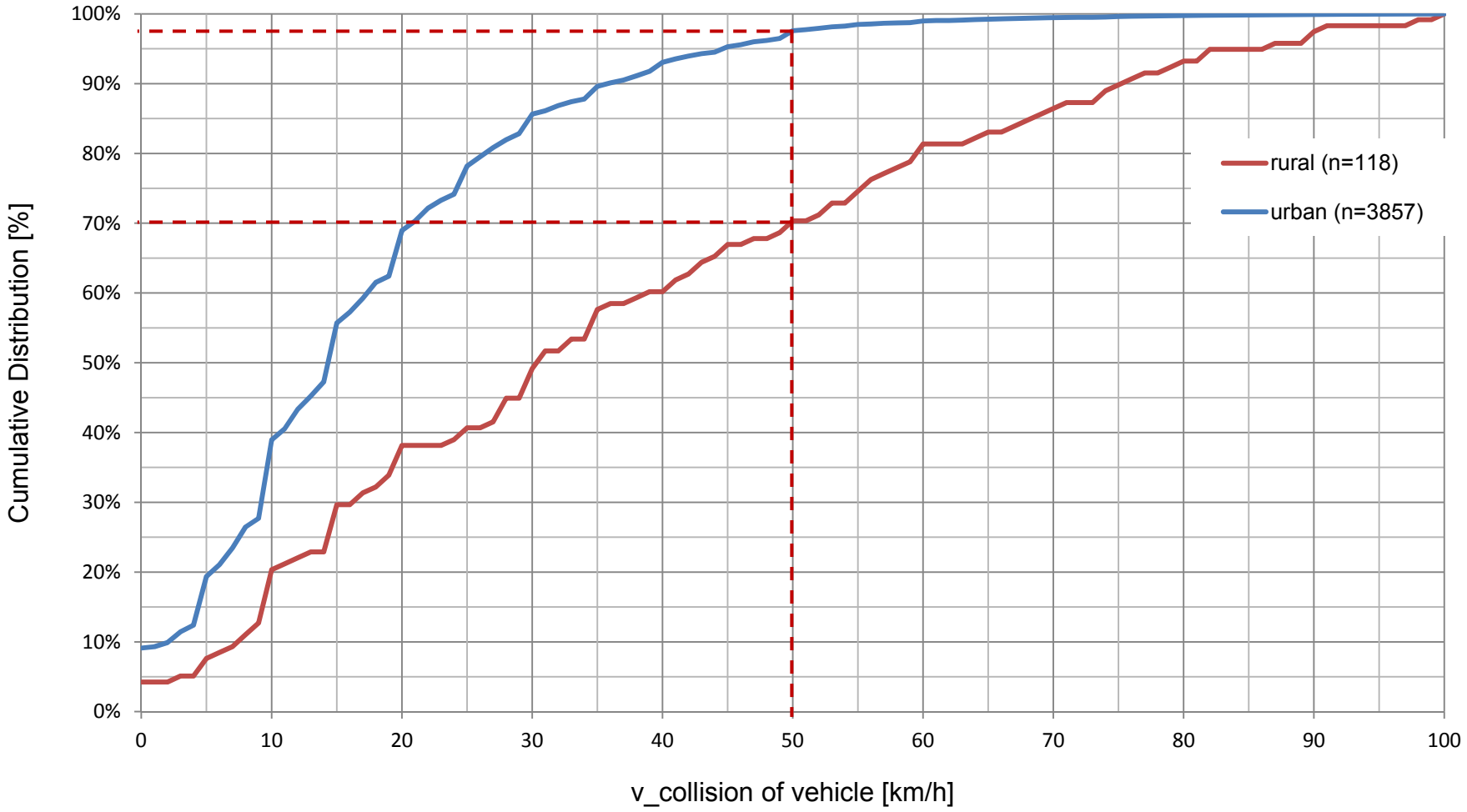
Accident Analysis – Parameters

- Effect of different accident parameters on cyclist's injury severity
  - Logistic Regression → injury risk function for the cyclist

Parameter	Share	Effect on Injury Severity	Remarks
Vehicle Speed	---	**+**	
Rural	3 %	**+**	Influenced by vehicle speed
Nighttime	9 %	**+**	Influenced by vehicle speed
Longitudinal	5 %	**+**	Influenced by vehicle speed
Obstructions	23 %	**o**	
Cyclist Speed	---	**o/+**	Depending on the location of impact at the vehicle
Helmet Usage	10 %	**–**	
Age (Cyclist)	---	**+**	

Accident Analysis – Correlation between Parameters

- Example: Accident Site and Vehicle Speed



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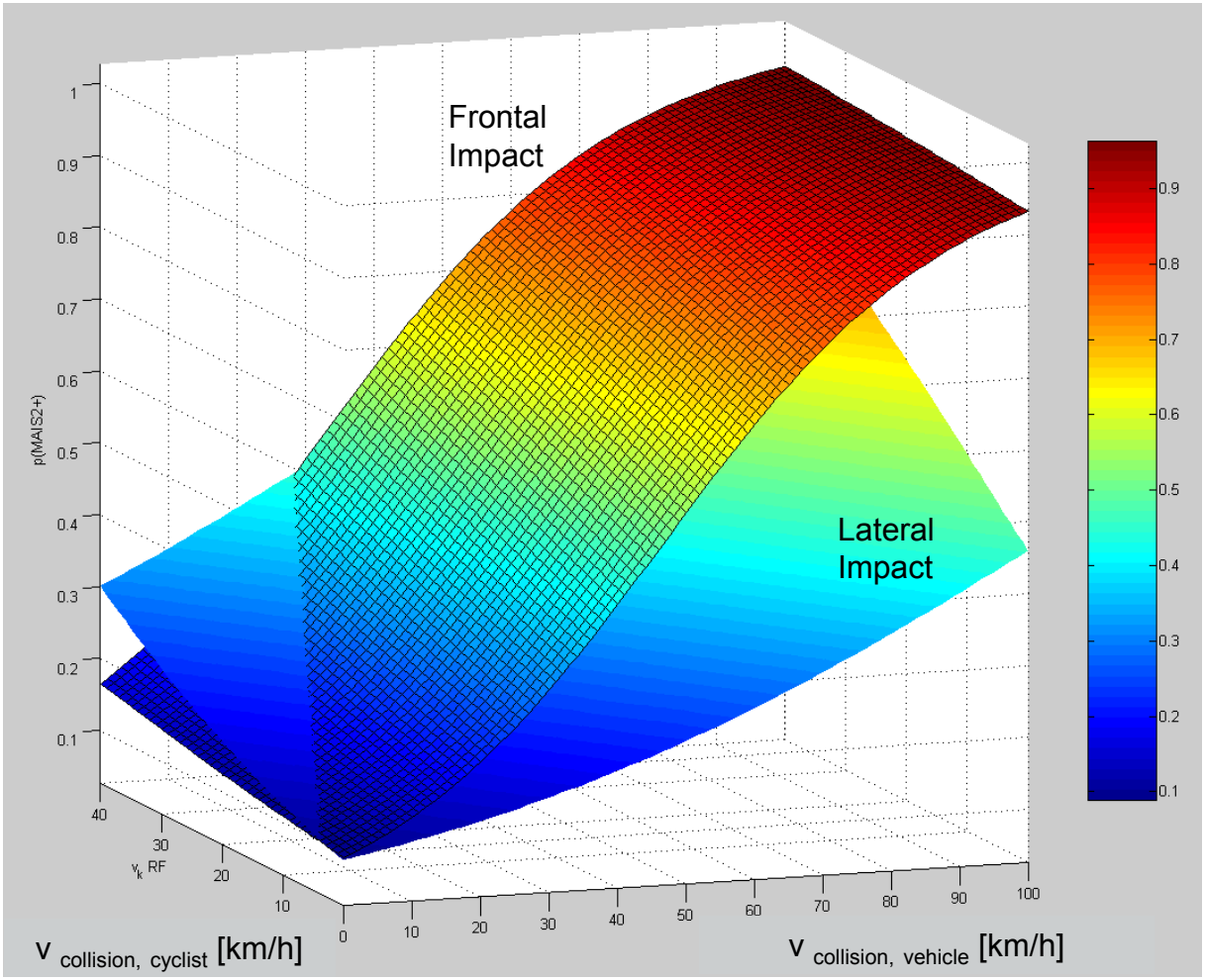
Age (Cyclist)	---	**+**	

Accident Analysis – Injury Risk Function

- **All accidents** (n=4286)
- Splitting the data:
  - Frontal Impact
  - Lateral Impact
- Logistic Regression for each data set

- Front: IRF independent of $v_{collision}$-cyclist

- Side: IRF highly dependent of $v_{collision}$-cyclist



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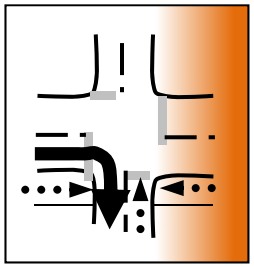
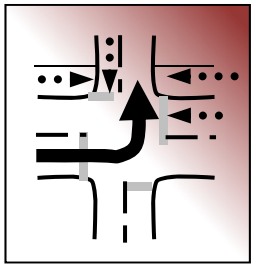
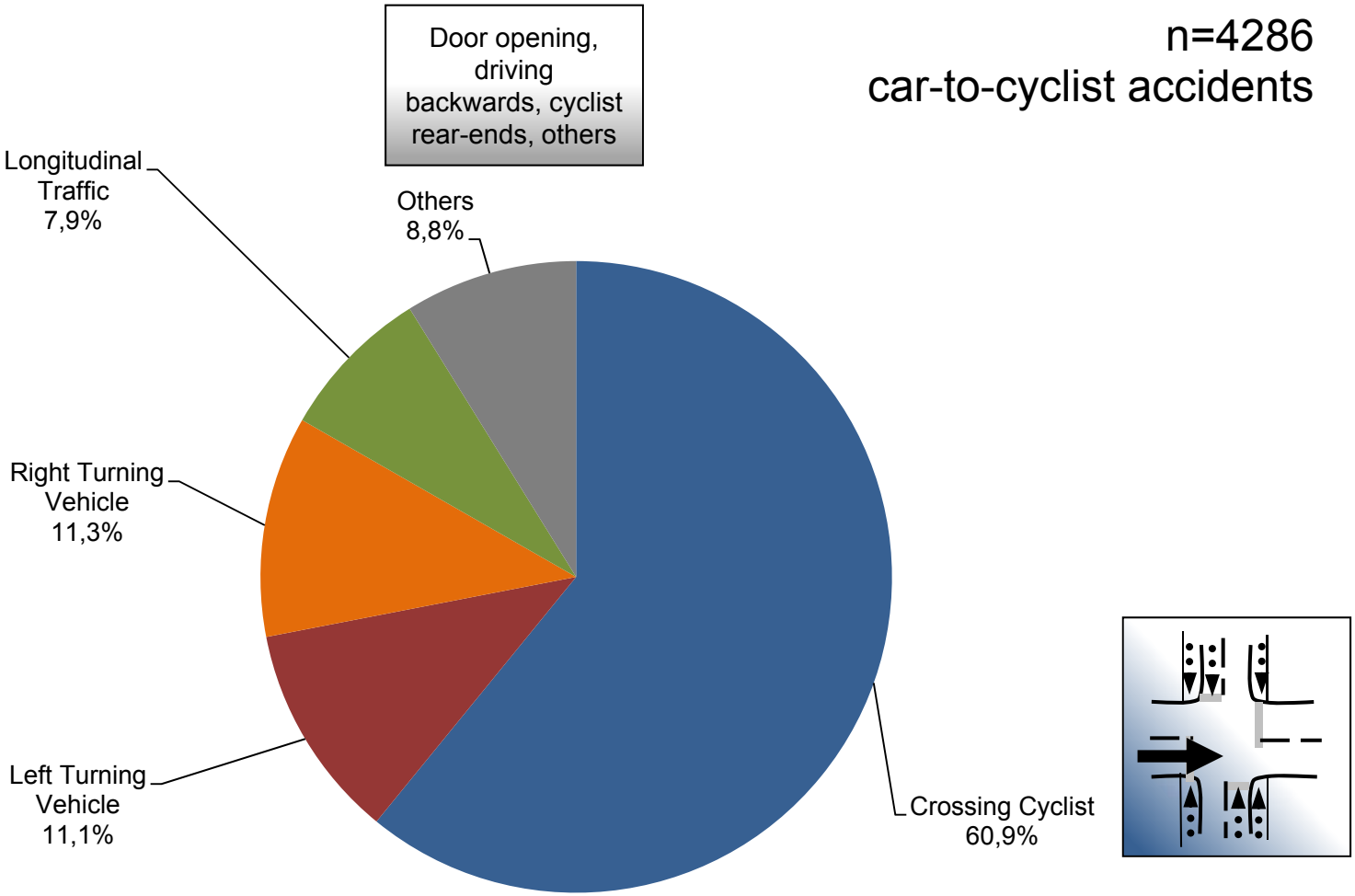
Reference Scenarios



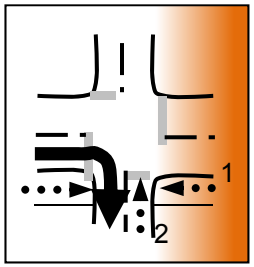


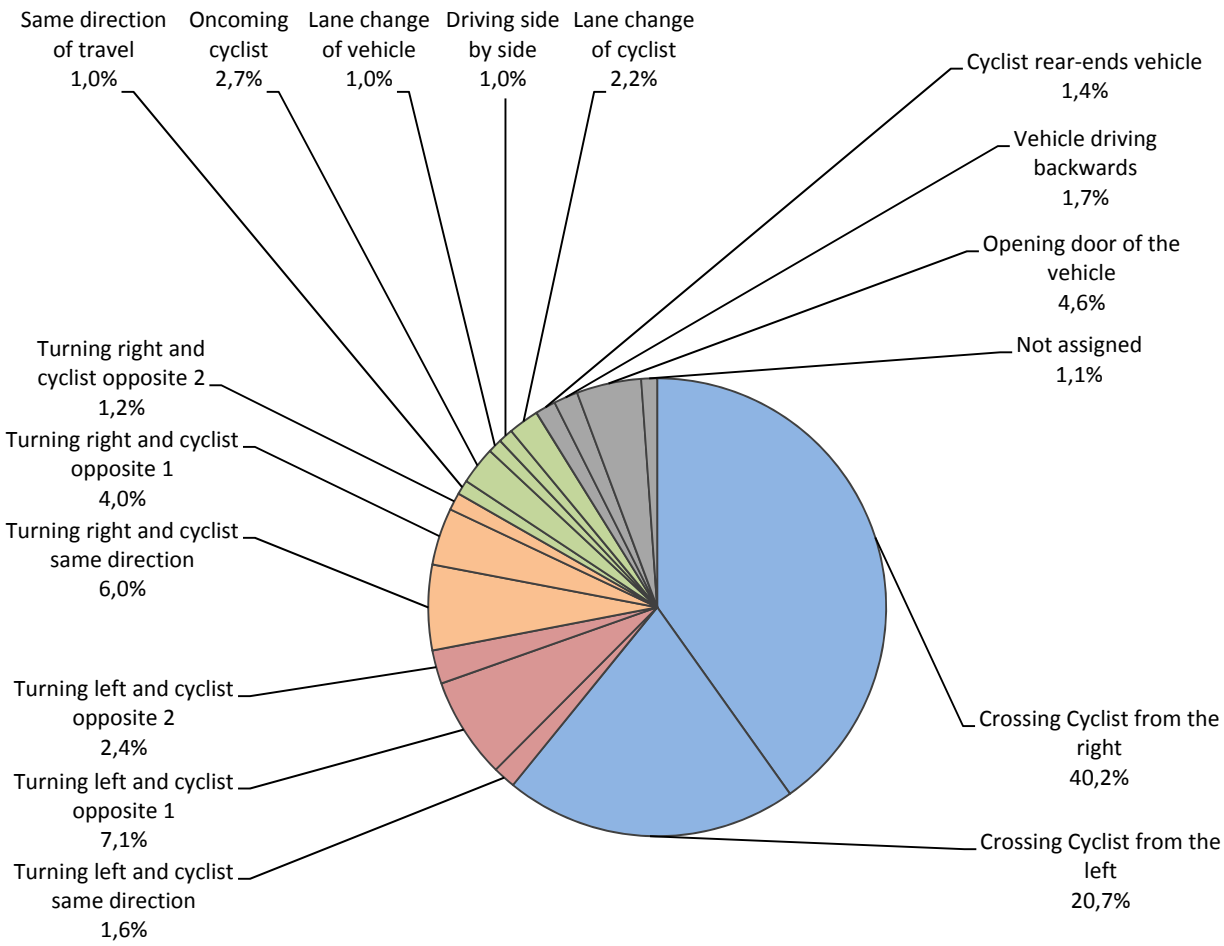


n=4286
car-to-cyclist accidents

- Scenario of Crossing Cyclist highly relevant with 61% of all car-to-cyclist accidents.

Reference Scenarios





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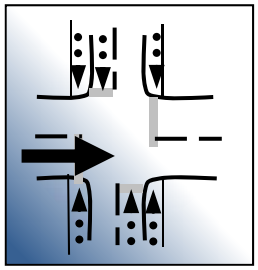

- Especially Crossing Cyclist from the right highly relevant with 40 % of all accidents.

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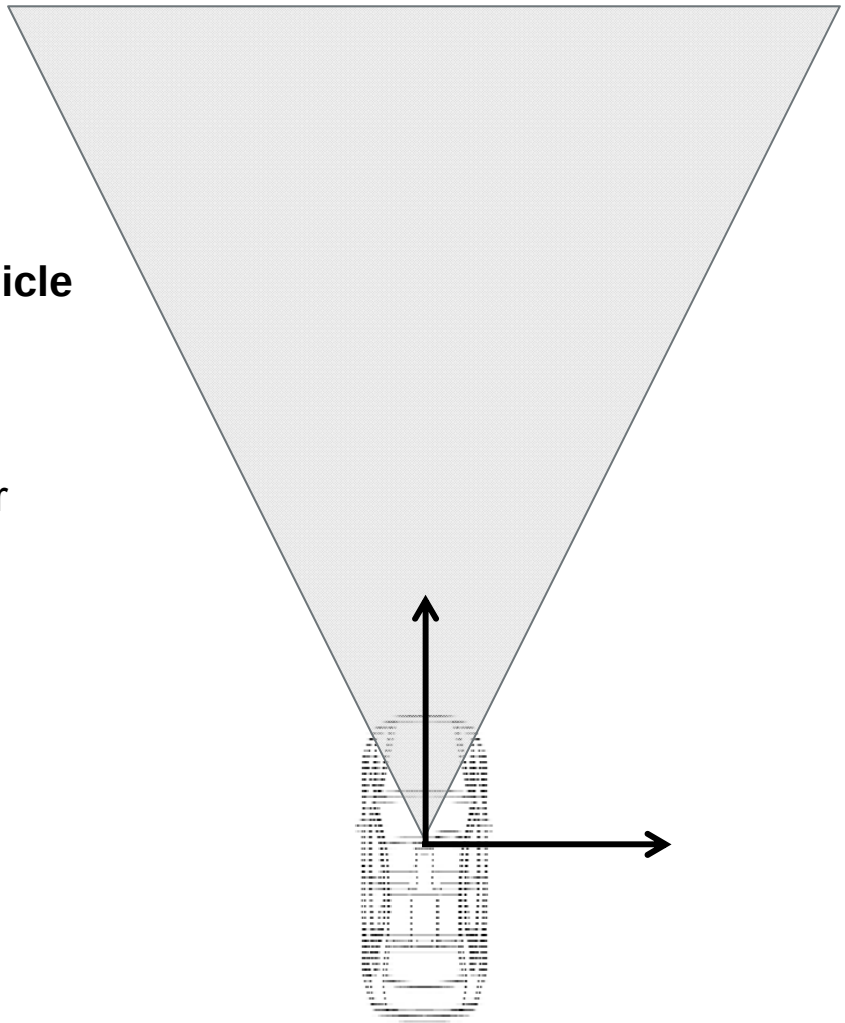
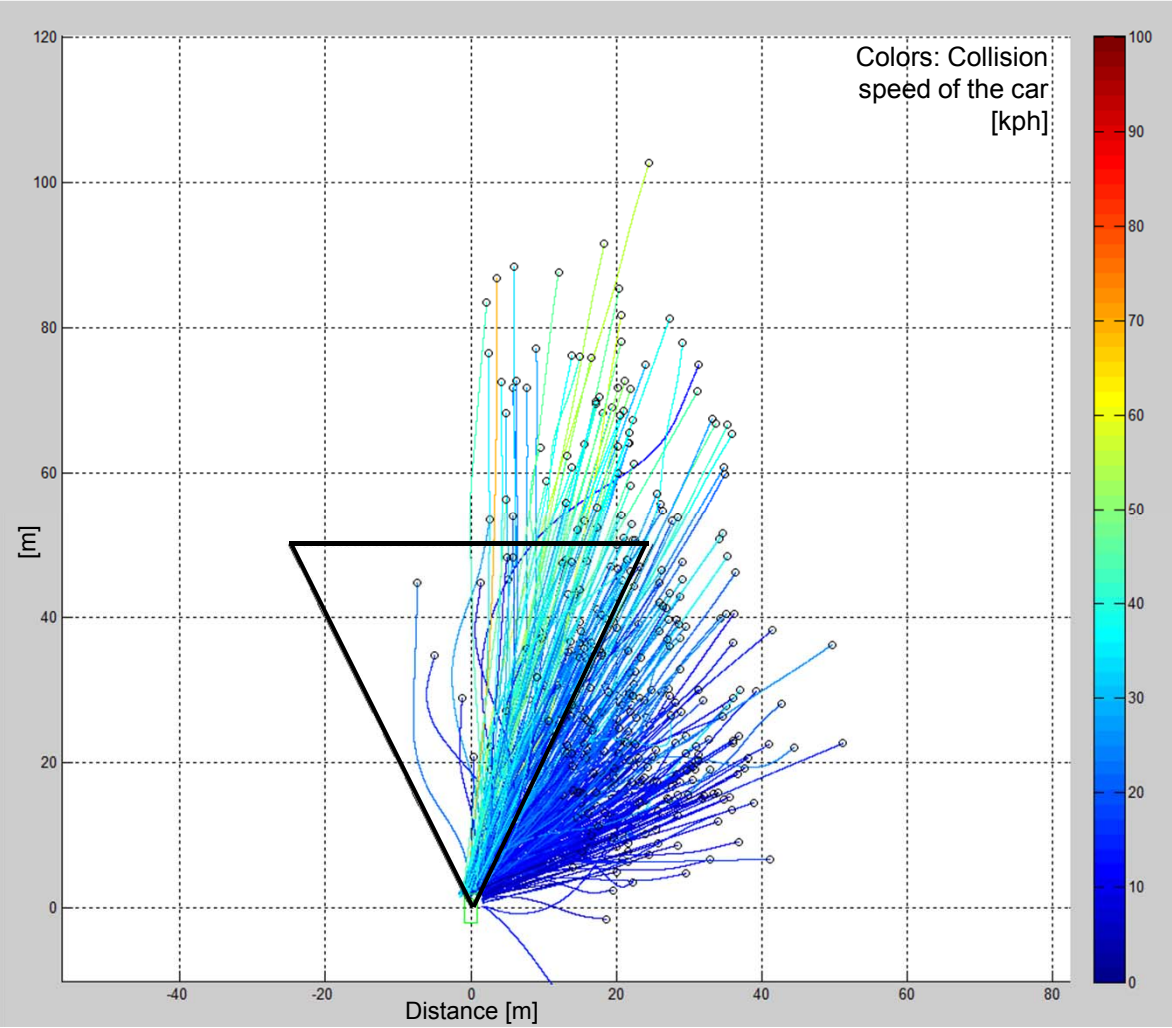
Detailed Analysis of Scenarios

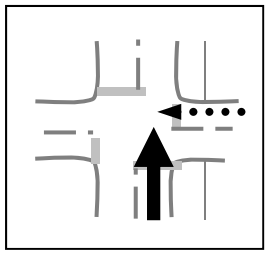
- Simulation of 697 accidents with PC-Crash
- Plots of the **cyclists‘ trajectories relative to vehicle**
  - Vehicle-fixed coordinate system
- Analysis of the detection of the cyclist by a sensor
- Typical sensor system:
  - Forward looking (e.g. camera or radar)
  - Range: 50 m
  - Opening angle: 45°



Detailed Analysis of Scenarios

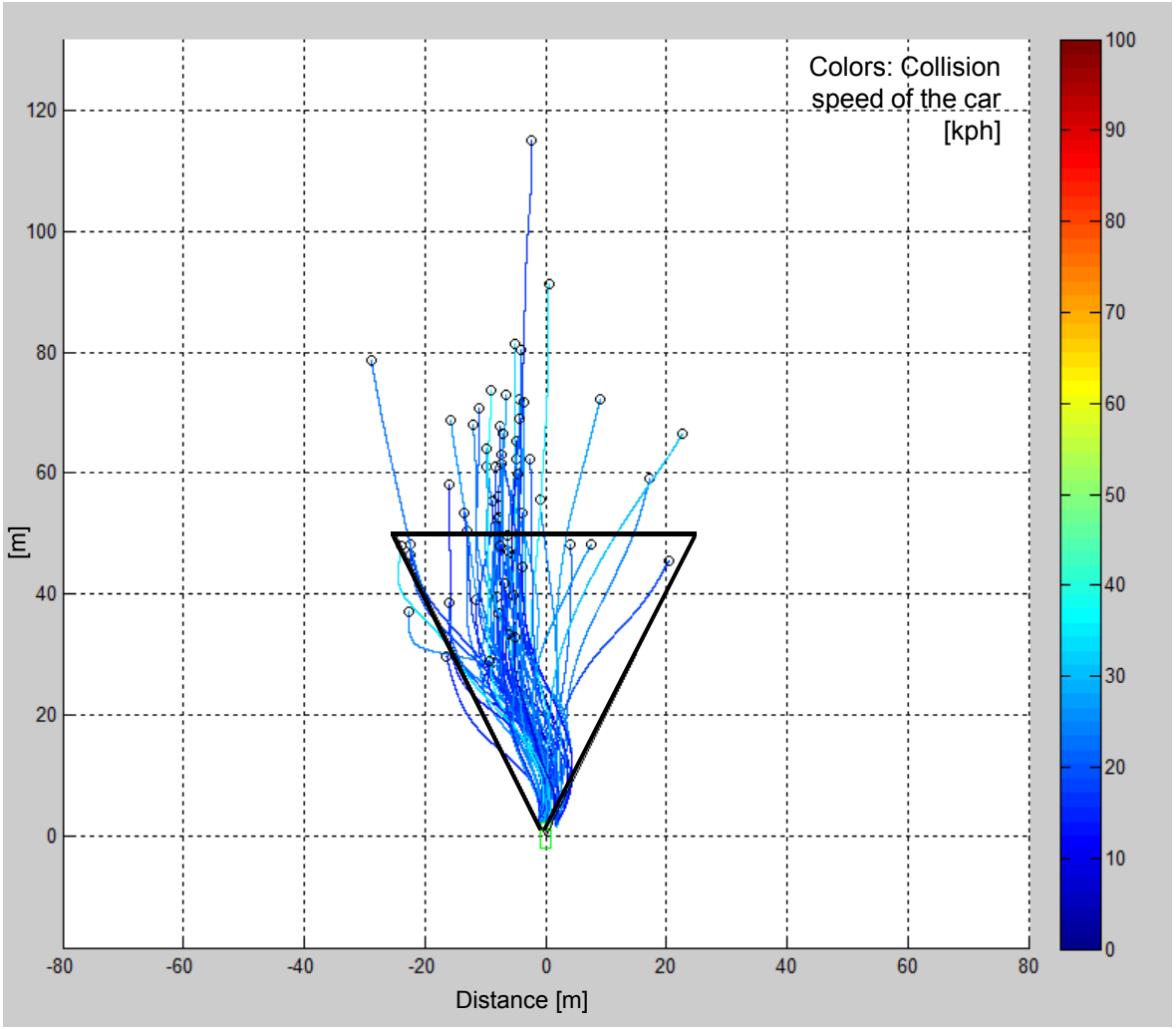


- Crossing cyclist from the right side
- n = 329

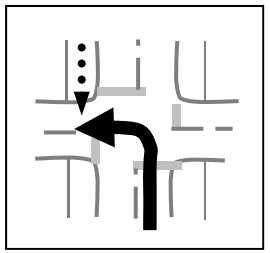


- Nearly all critical crossing cyclists with high collision speeds within field of view of state of the art forward looking sensor set

Detailed Analysis of Scenarios



- Left turning vehicle and cyclist from the opposite direction
- n = 61



- Oncoming cyclists are detectable with a forward looking sensor system

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Results and Outlook

- Results
  - Identification of parameters influencing car-to-bicycle accidents
  - Injury risk function with logistic regression
  - Aggregation to reference scenarios
  - Detailed analysis of scenarios (trajectories, obstruction, etc.)

- Outlook
  - Simulation of accidents with and without AEB system
  - Simulative effectiveness evaluation
  - Set up of test scenarios
  - Risk-based assessment with real tests
  - Quality evaluation of the assessment with real tests compared to simulations

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Thank you.