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KO-FAS

Cooperative Pedestrian Protection

Kooperativer Fußgängerschutz

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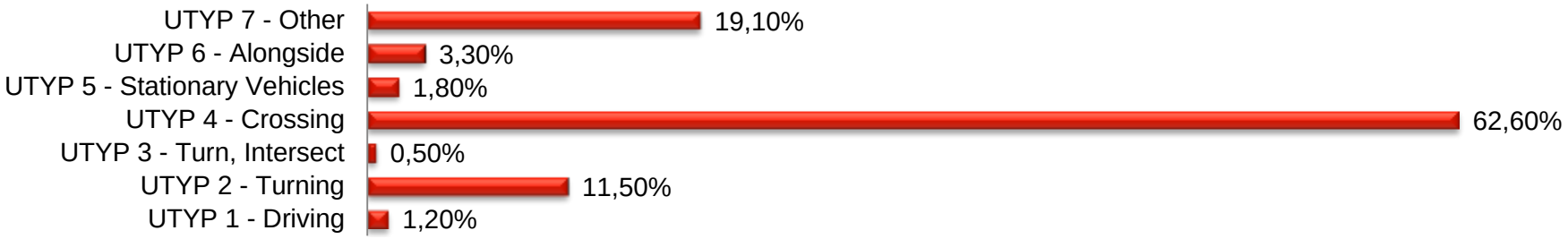
on the basis of a decision by the German Bundestag

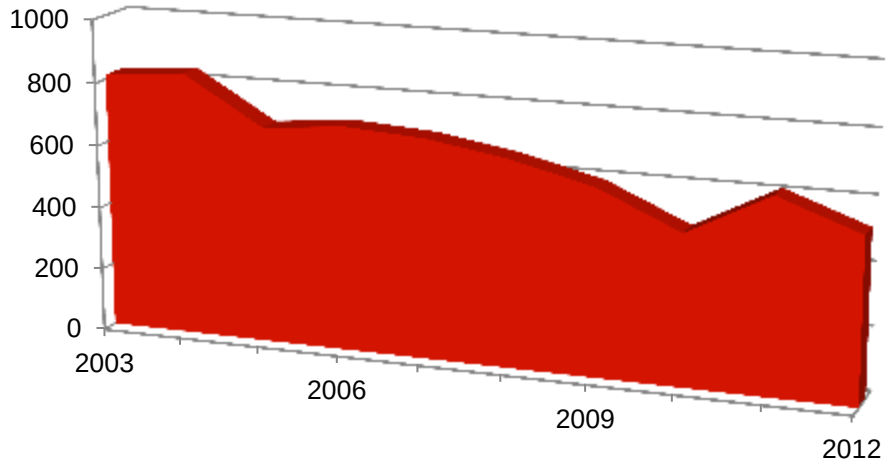
Motivation

Accident statistics by types of accidents 2009:



Causes of accidents: Inattention, misjudgment, visual obstruction

Killed VRUs:



Caused by: Unbraked collisions (33%), No evasion (80%)

Very high potential to avoid most of the collisions by means of Active Safety Systems

Potential of Cooperative Systems

State of the art pedestrian detection:

- Warn or brake decision based on sensor fusion
- E.g. combination of (mono) camera and radar
- Recall and precision limited by hardware
- Depending on line of sight

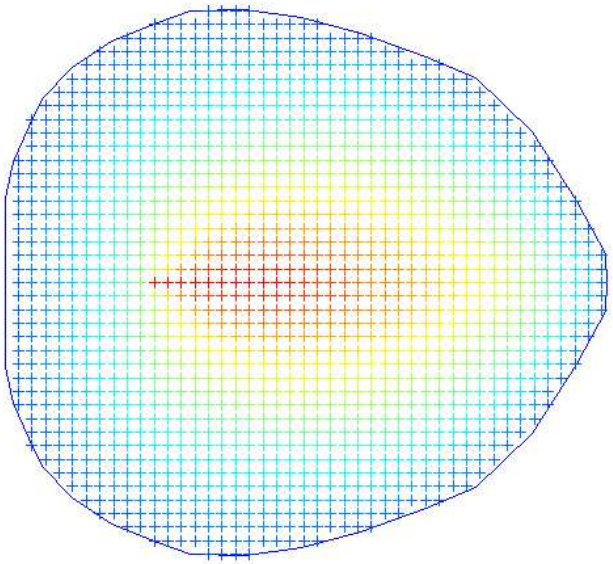
Potential of cooperative systems:

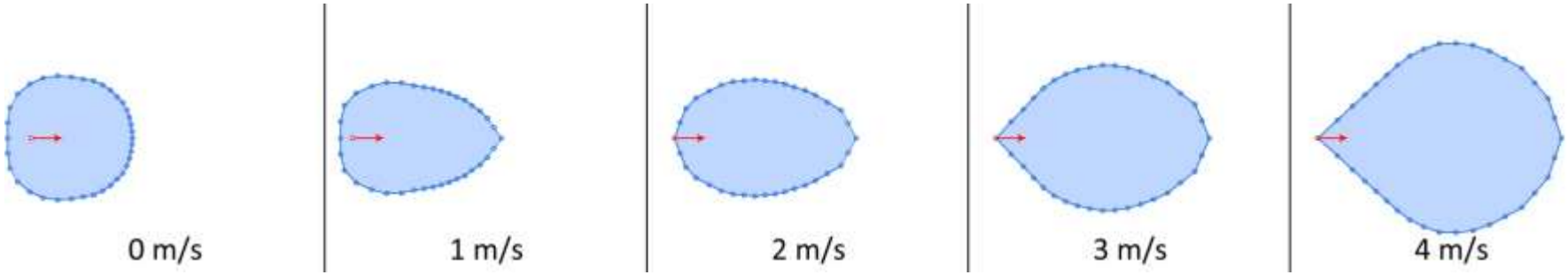
- Possible candidate for sensor fusion
- Mono / Stereo Camera + Ko-TAG:
  - Systematic hypothesis generation
  - Scene-optimized use of the processing capabilities
  - Improved detection delay in obscured scenarios
- Stereo Camera + Ko-TAG:
  - Complementary position measurement
  - Improved precision and higher reliability

Pedestrian Model

Physiological pedestrian movement model

- Based on empirical assessment of motion capabilities
- First stage:
  - Simple model of the maximum physiological potential
  - Typical pedestrian movement velocities
  - Physiological potential of acceleration and rotation
- Second stage:
  - Model of the physiological motion range
  - Weighted movement area





Pedestrian Model

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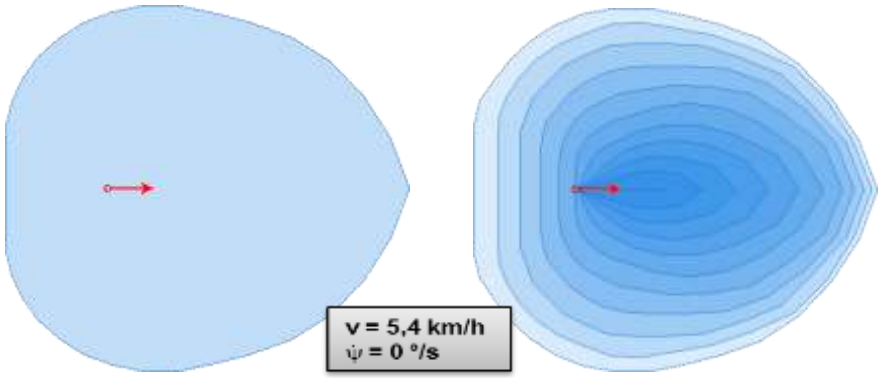
Potential of the physiological pedestrian movement model

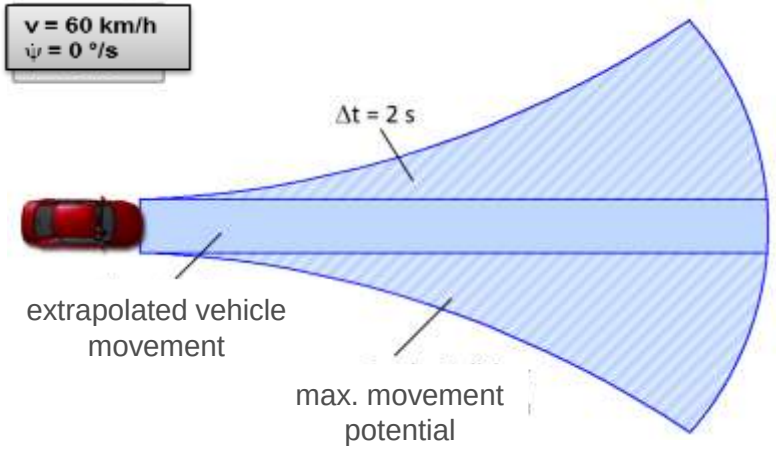
- Improved tracking algorithms:
  - Traditional object tracking in Cartesian coordinates
  - Filter prediction based on generic movement models
  - Noise / Prediction enhancement with the physiological model
  - e.g.: Kalman Filter with constant velocity movement model
- Refined ADAS functions:
  - More precise movement information for pedestrians
  - Improved scene understanding and collision risk estimation
  - Reliable warn and brake functionality of the system

Collision Risk Prediction

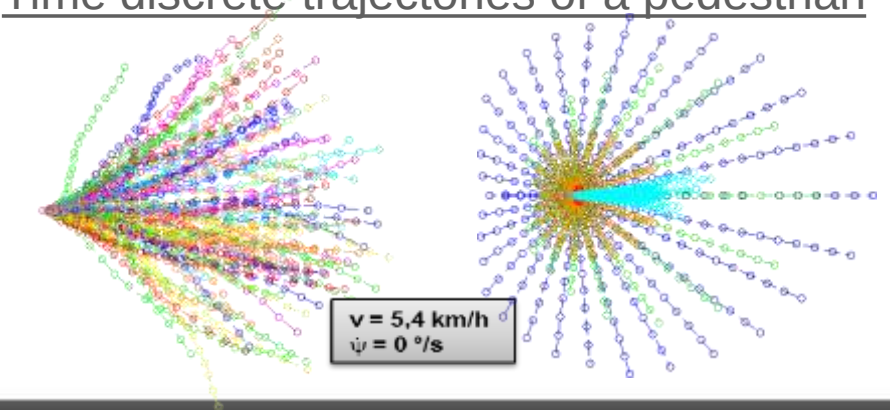
Movement area of a pedestrian (2s)



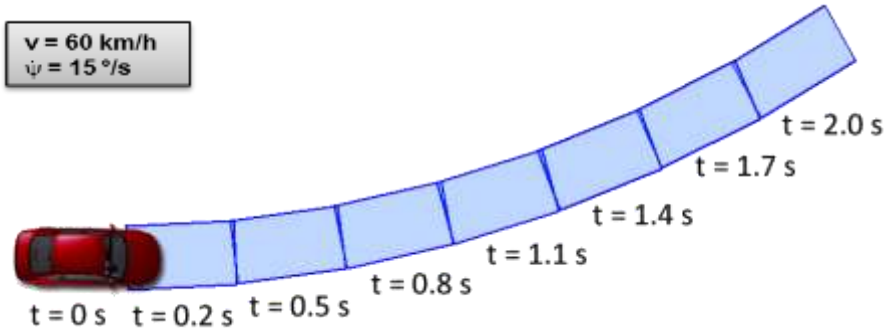
Vehicle possible driving path (2s)



Time discrete trajectories of a pedestrian



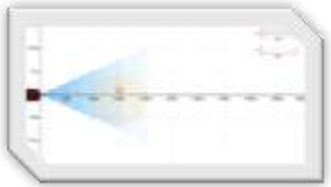
Time discrete position of a vehicle

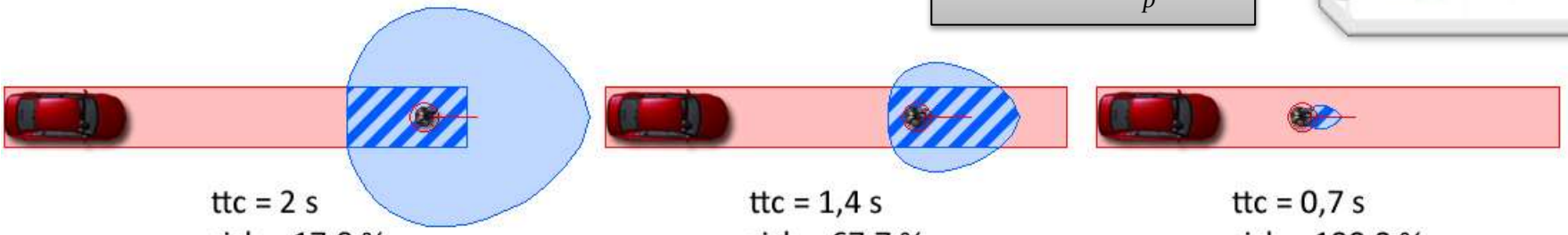


Collision Risk Prediction

Collision risk model: Area-Pedestrian-Car (APC)

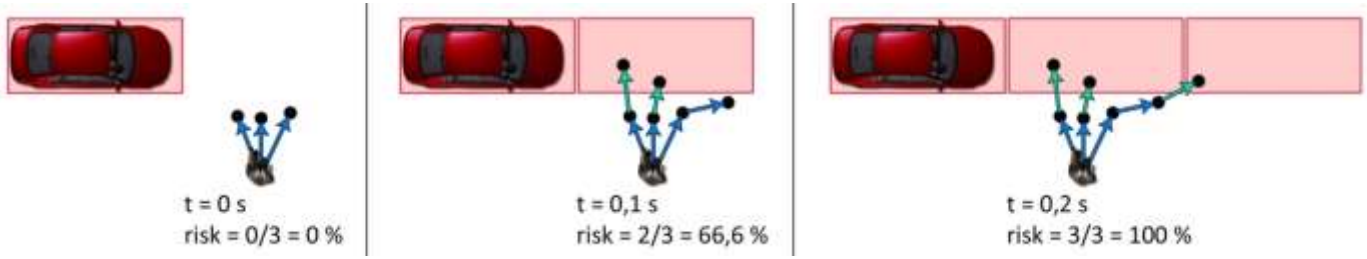
$$A_{pc} = \frac{A_p \cap A_c}{A_p}$$

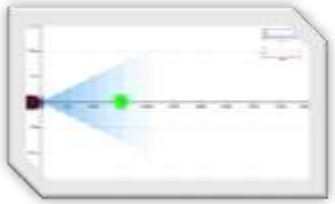




Collision risk model: Probabilistic Monte Carlo (PMC)

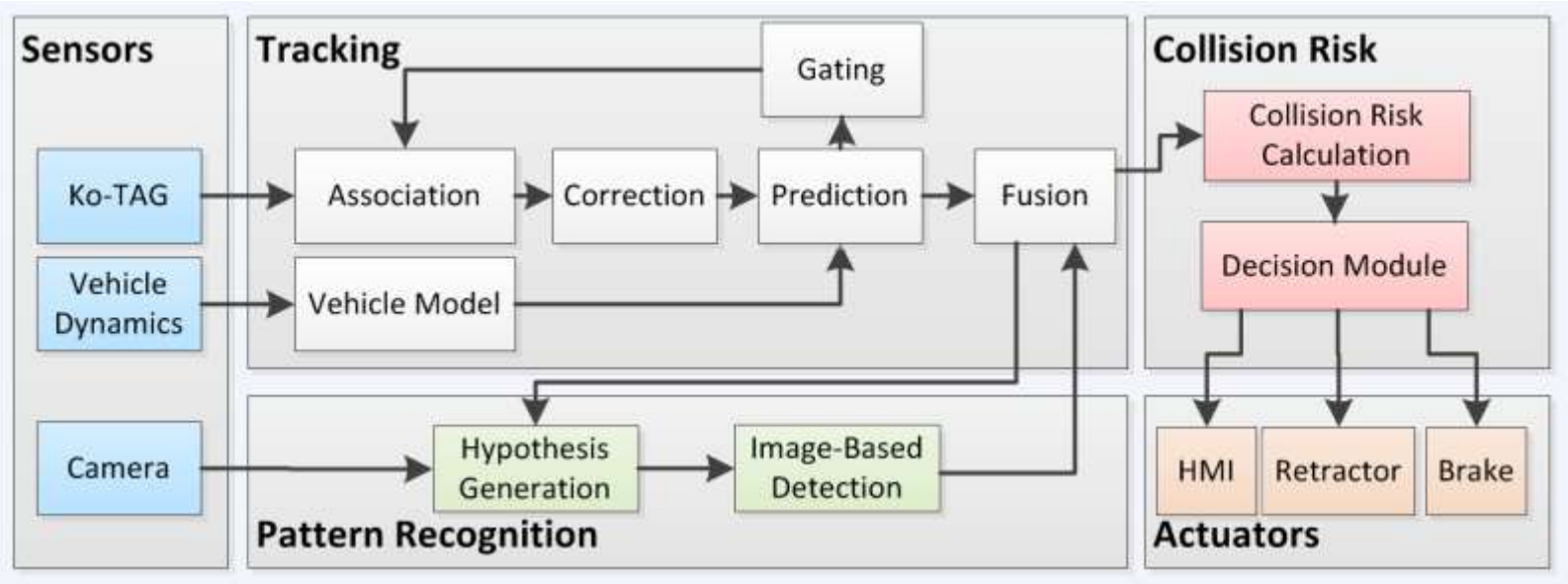
$$P_{mc} = \frac{Collision\ Count}{Trajectory\ Count}$$





System Architecture

System architecture of a Pedestrian Safety System



Verdeckung:

Unverdeckt:

Testing Possibilities

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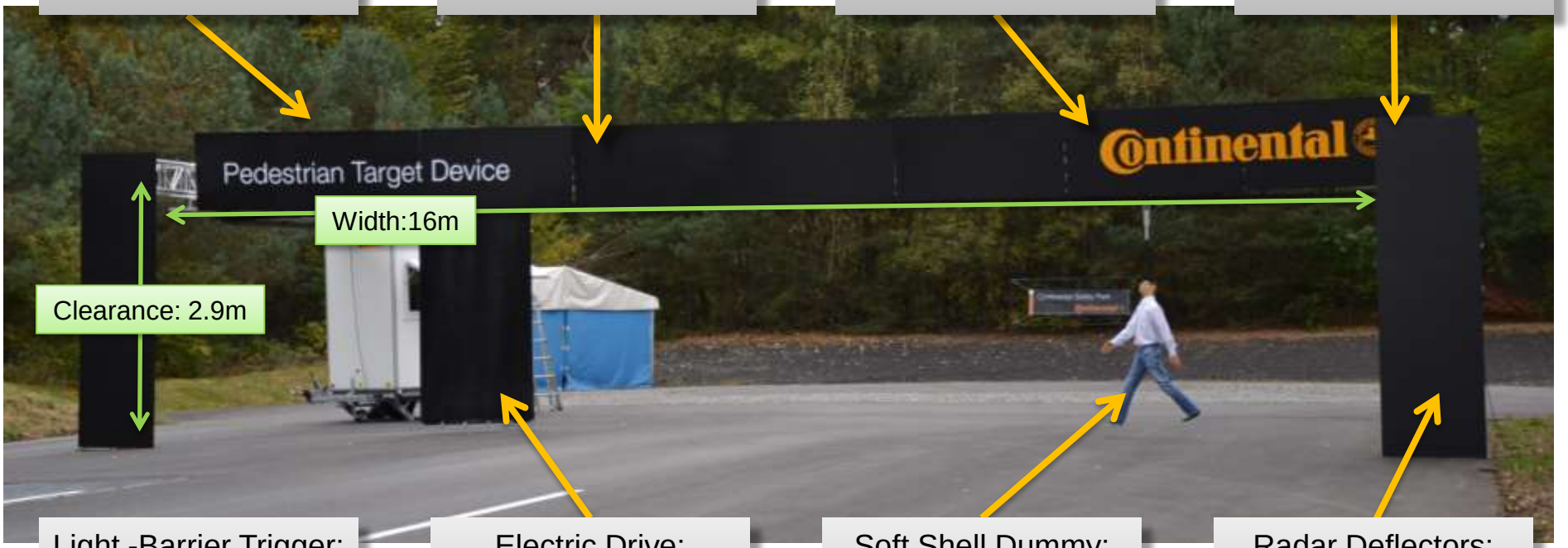
Control Room:
For control,
data acquisition
and power source, heated

Guide Rail:
Easy assembly
in various setups
including curves

Carriage:
Cable driven, with robust
dummy suspension

Aluminum Frame:
Easy assembly
in various setups



Light -Barrier Trigger:
(not pictured), light-barrier
for triggering a movement
with adjustable delay

Electric Drive:
Precise positioning with
external absolute encoder

Soft Shell Dummy:
Impact resistant,
interchangeable,
Adult / Child dummy

Radar Deflectors:
Preventing the frame
from
disturbing radar signals

Testing Possibilities

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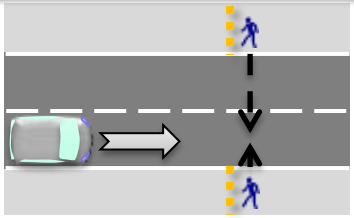
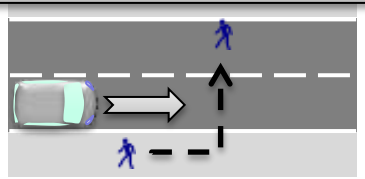
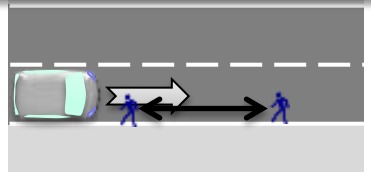
Crossing (un)obstructed



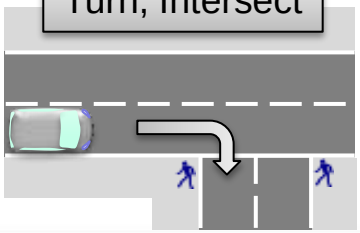
Alongside then crossing



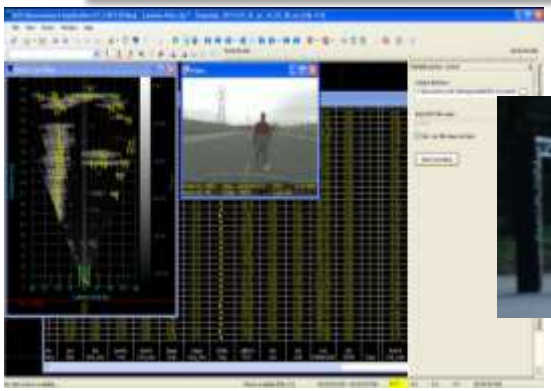
Alongside in Vehicle Lane



Turn, Intersect



Also suitable for Radar due to Radar deflectors



Dummy strikeable without damage

System Demonstration

Thank you for your attention!

BMW Group
Forschung und Technik

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Continental

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Steinbeis-Innovationszentrum Embedded Design und Networking

Technische Universität München