SIP-adus Workshop 2018

A Traffic-based Method for Safety Impact Assessment of Road Vehicle Automation

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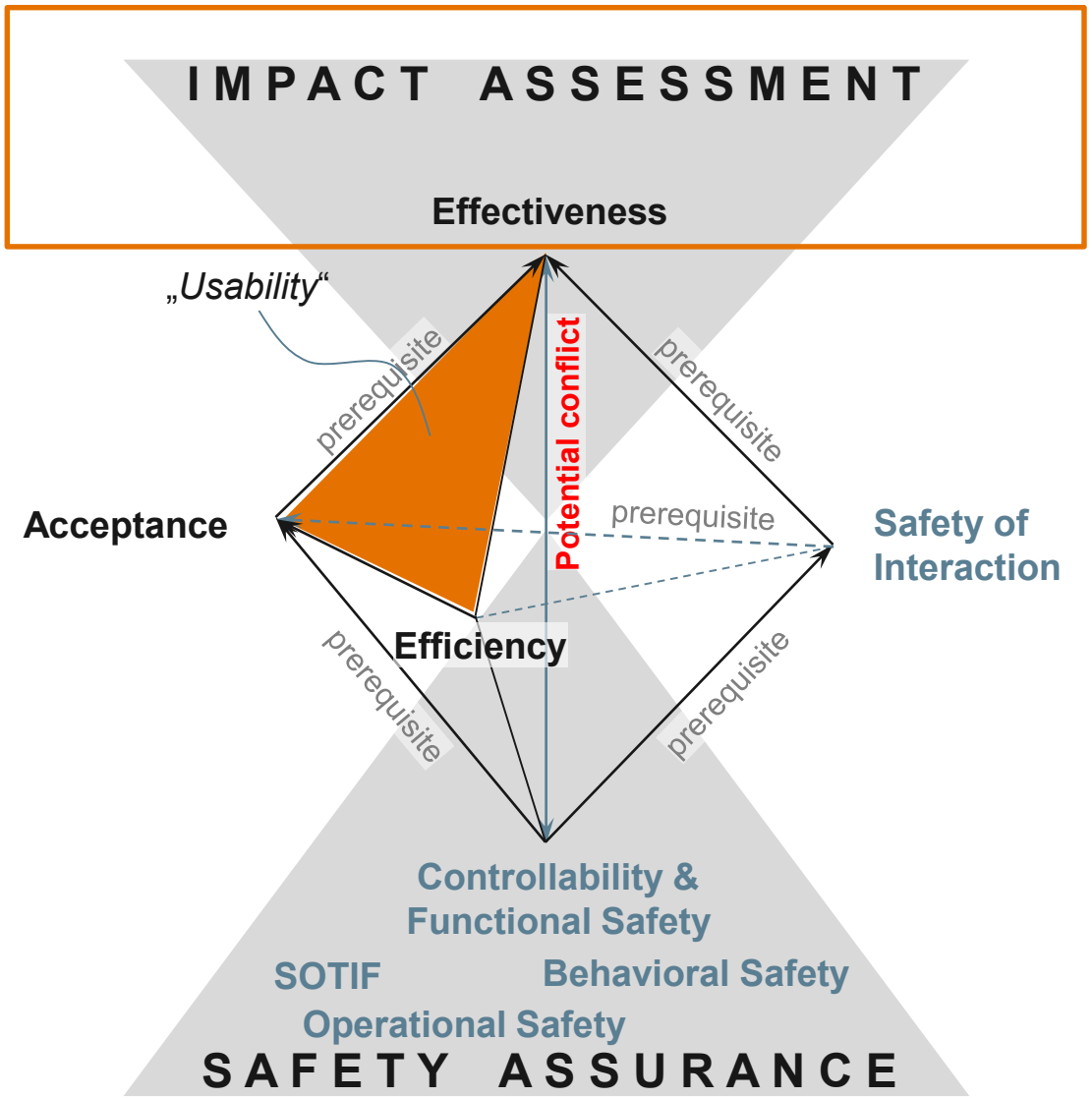
Motivation
Public View on Automated Driving

How SAFE is Automated Driving?

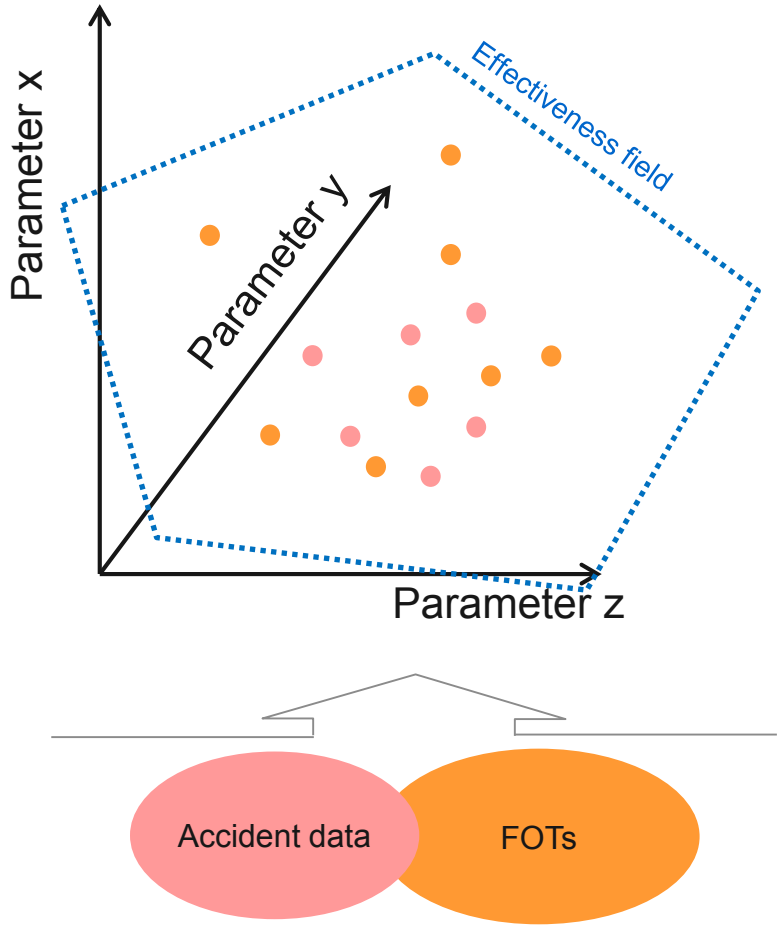
- ***Research Question***
  What is the safety level of automated driving?

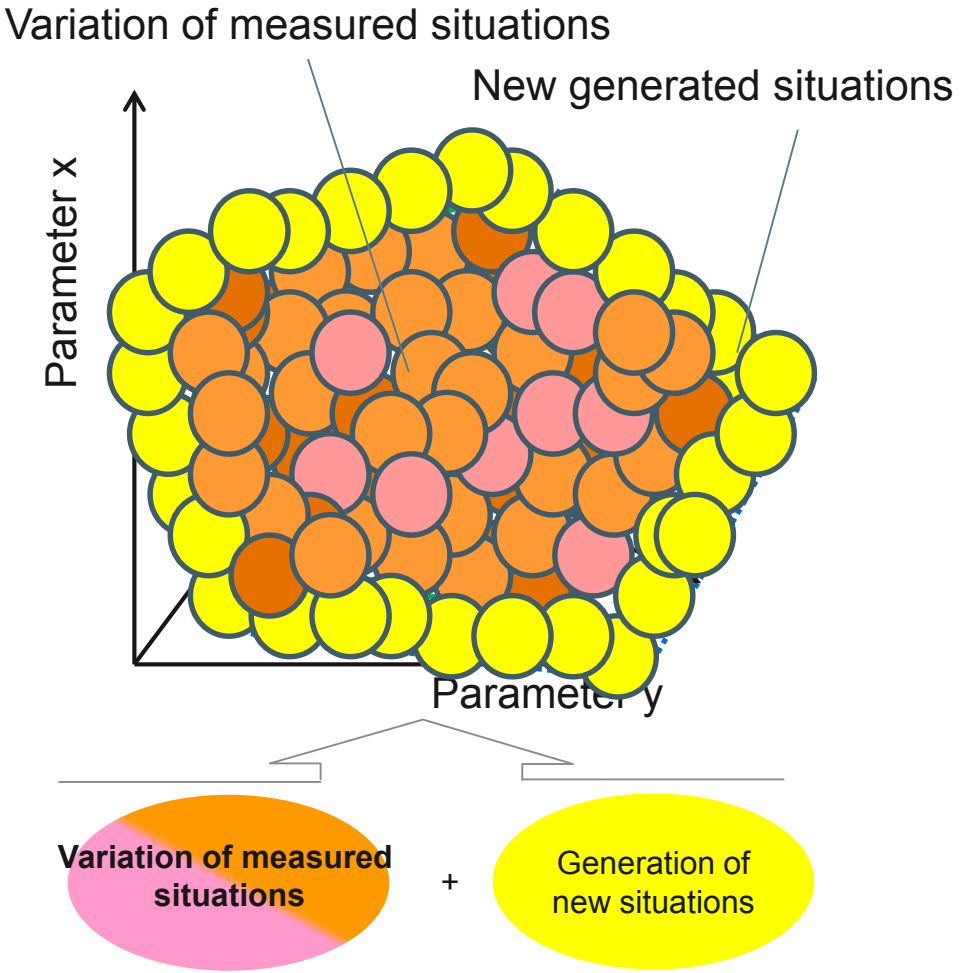
- ***Methodology***
  A Traffic-based Method for Safety Impact Assessment of Road Vehicle Automation

Evaluation Methodology
Impact Assessment vs. Safety Assurance



Analysis of Automated Driving Field Test Data
Scenario Classification of Real-World Data

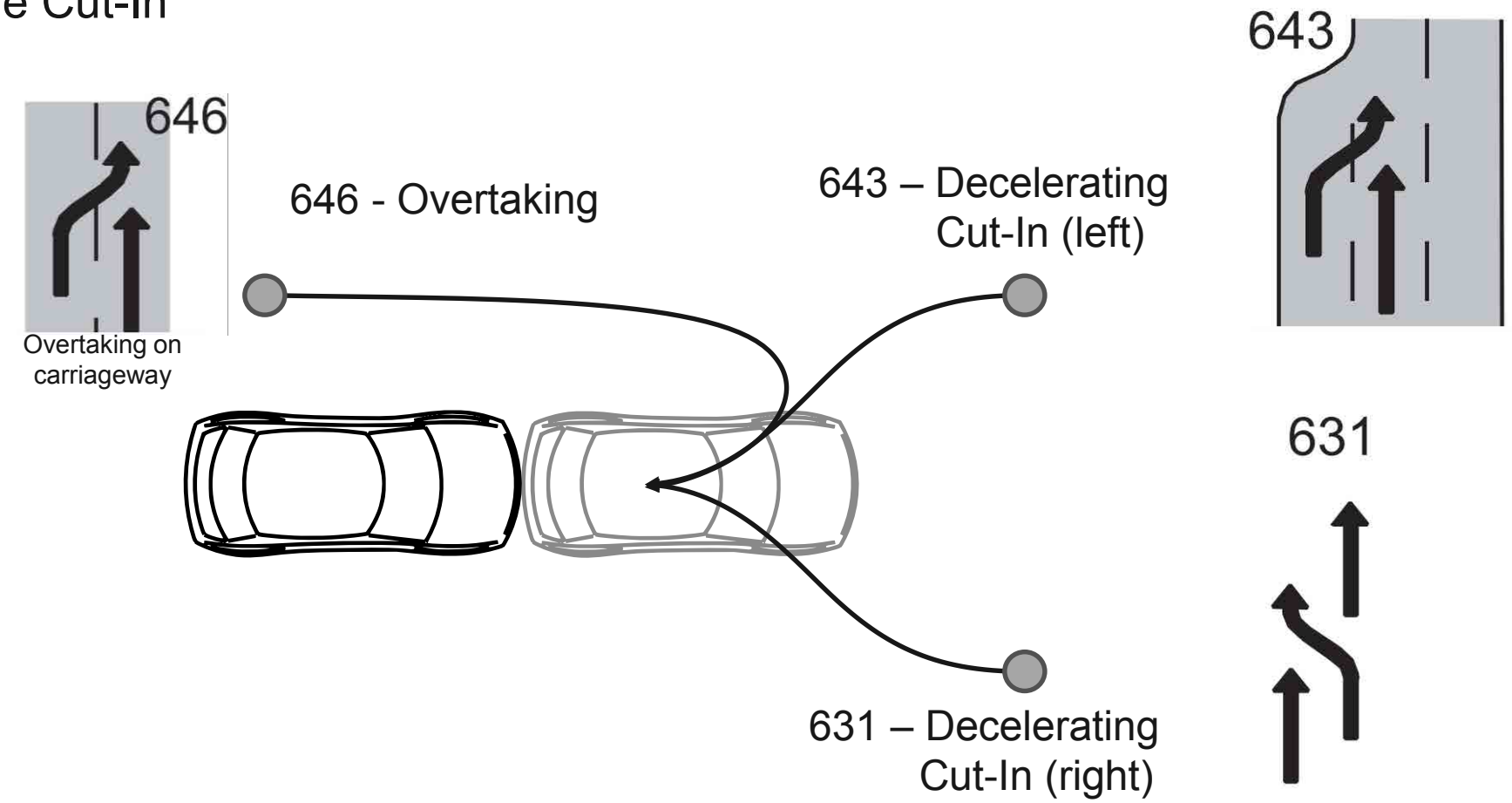




Source: Eckstein, L., Zlocki, A.: Safety Potential of ADAS - Combined Methods for an Effective Evaluation, 23rd ESV 2013, Seoul, 2013

Impact Assessment of Automated Driving
Driving Scenarios from Accident Type

Example: Passive Cut-In



Approach: The **types of driving scenarios**, respectively physical accident constellations, do not change with automated driving.

The **frequency of occurrence** and the **severity** of these driving scenarios may change with automated driving.

Impact Assessment of Automated Driving
Definition of Methodology for Impact Assessment

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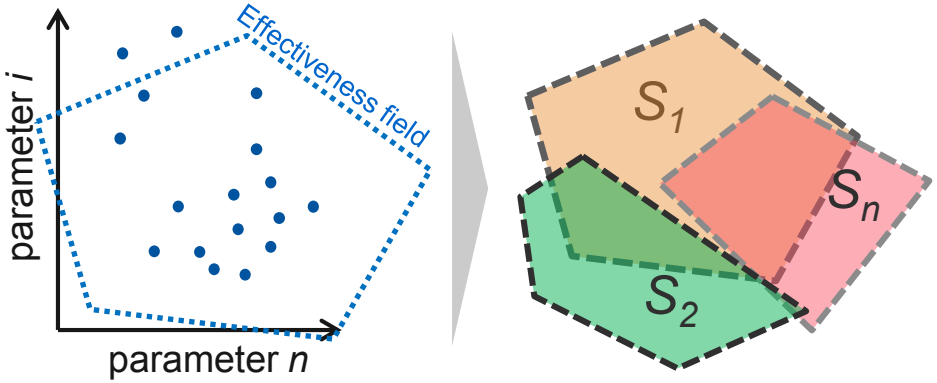
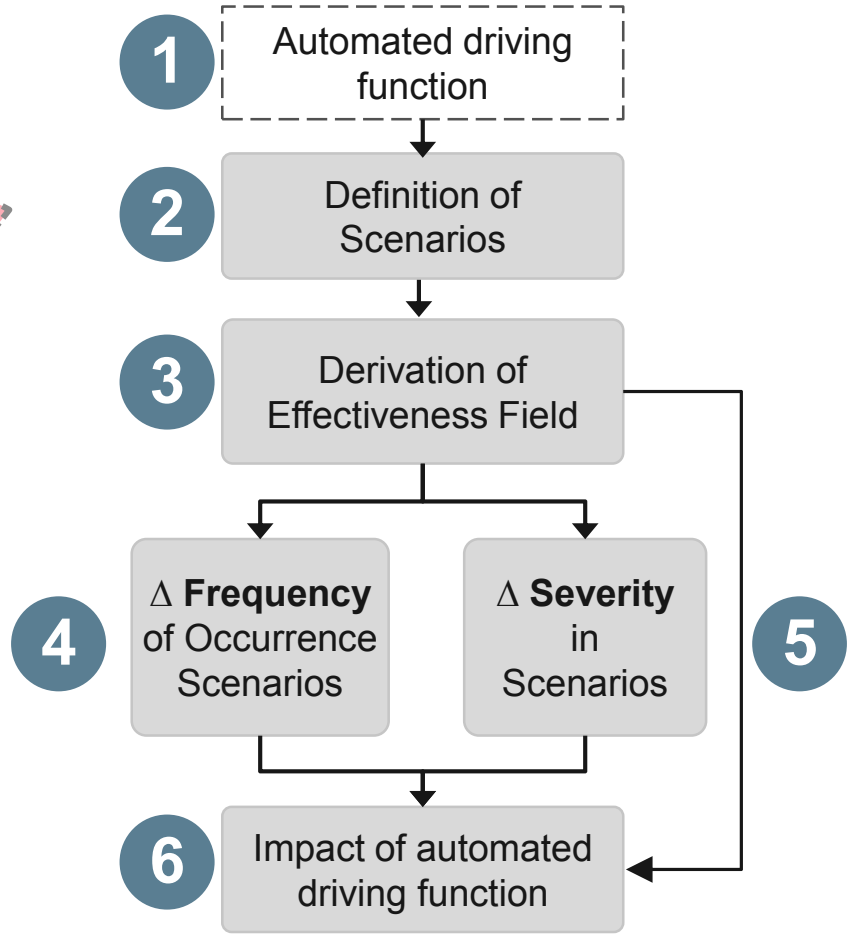
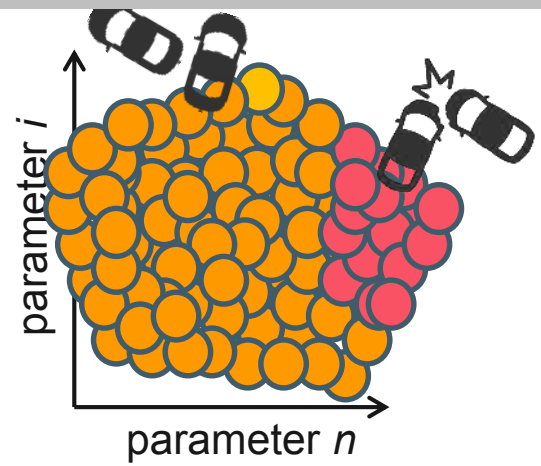
3 Driving scenario-based estimation of effectiveness field



4 Δ Frequency of occurence of driving scenarios



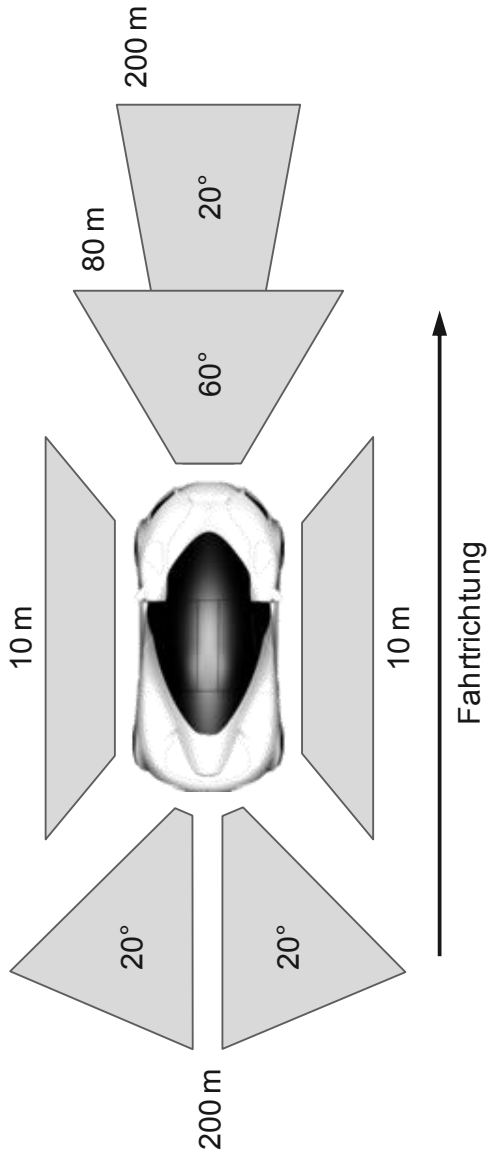
5 Δ Severity in driving scenario



Impact Assessment of Automated Driving

1 Definition of automated driving function and 2 scenarios

1



2

Motorway-Chauffeur

Automation level (SAE): 3

Operational design domain (ODD):

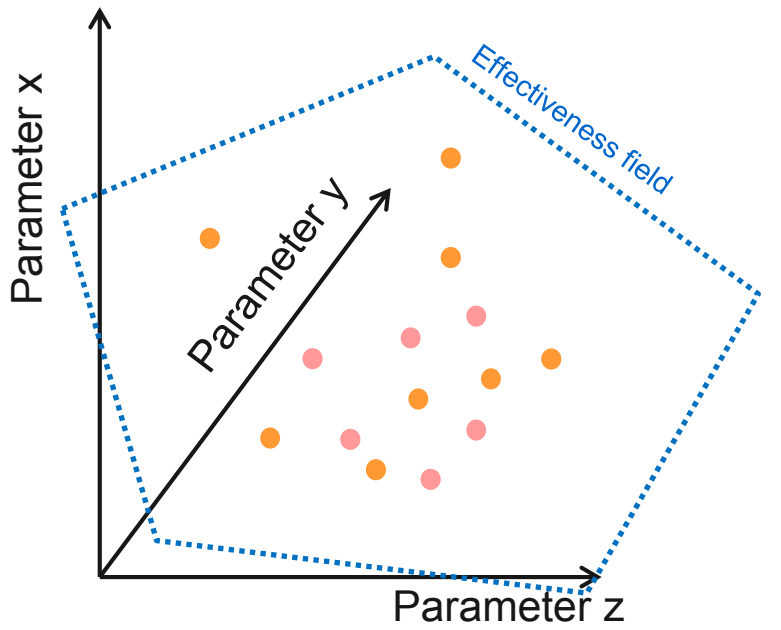
Operation domain:

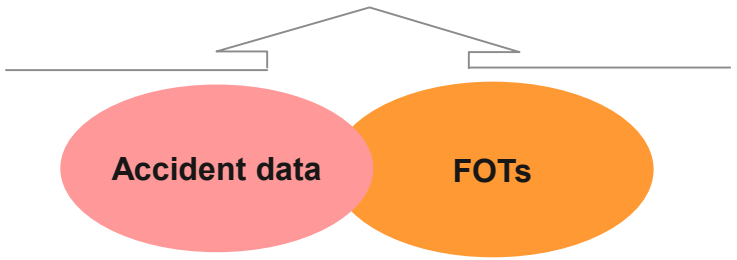
Relevant driving scenarios:

Driving accident	Approaching static Object	Approaching vehicle	Traffic Jam
Lane change	Cut-in	Take over	Approaching lateral Object
Crossing intersection	Turn around	Turn at intersection	

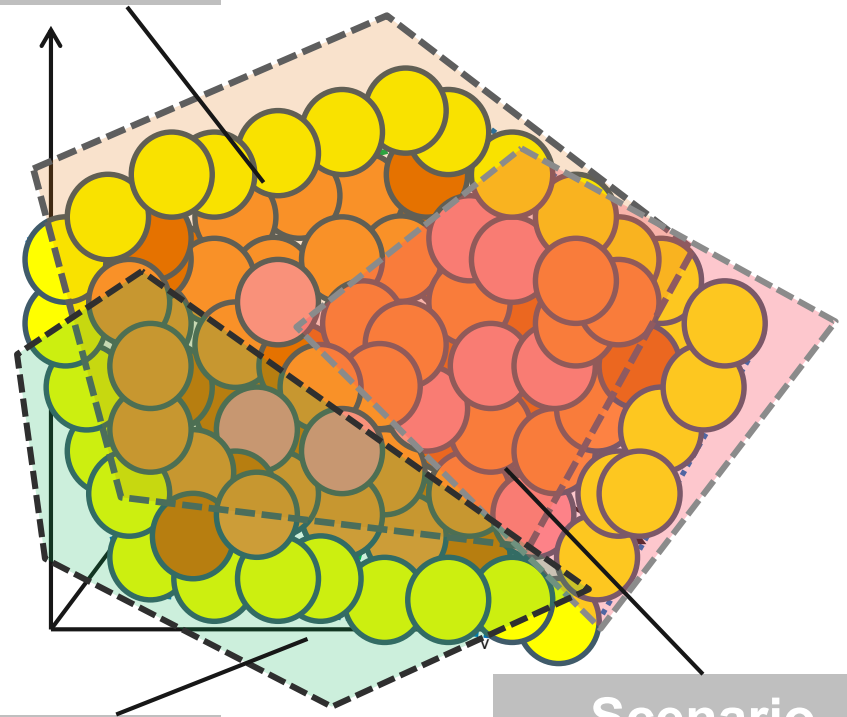
Impact Assessment of Automated Driving

3 Effectiveness Field and Scenario Classification





Scenario „Approaching vehicle“



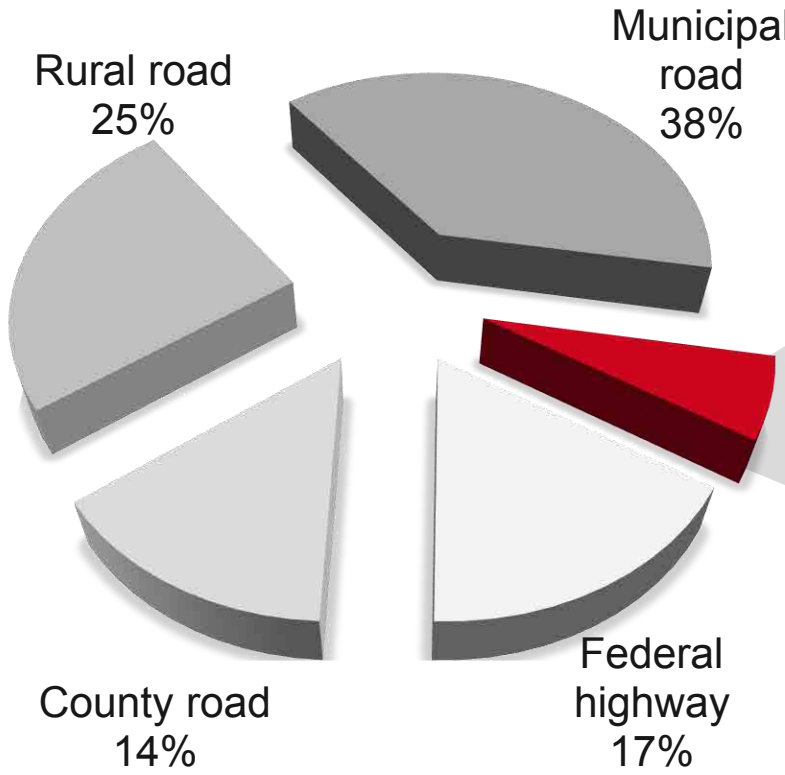
Scenario „*Cut-in of other vehicle*“

Scenario „*Lane change*“

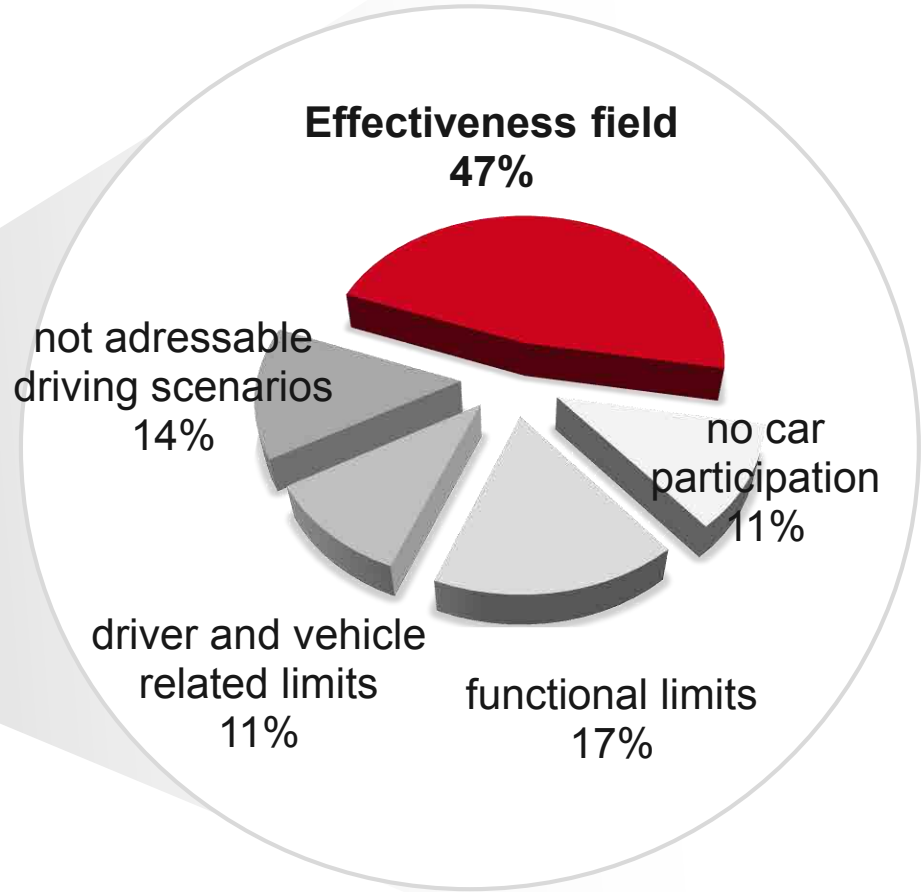
Driving scenario-based estimation of effective. field

3 Accidents in Germany according to ODD

Accidents in Germany in 2016
308.145 A(P)



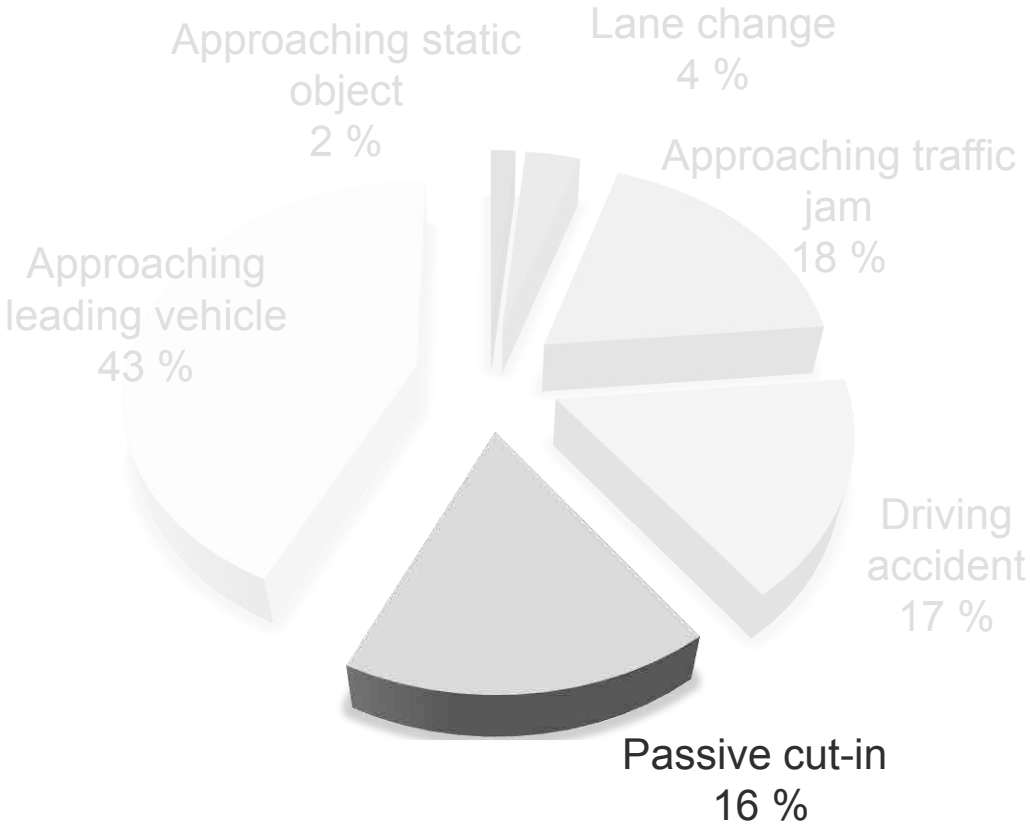
Accidents in domain „Motorway“
19.010 A(P)



Driving scenario-based estimation of effective. field

3 Input data for scaling-up and simulation

Driving scenarios in effectiveness field
9.395 A(P)



Accident statistics

Number of accidents for scaling-up of effectiveness

Driving scenario	Accidents
Passive cut-in	*1.219*

GIDAS

FOT

Situational variables for effect of function by simulation

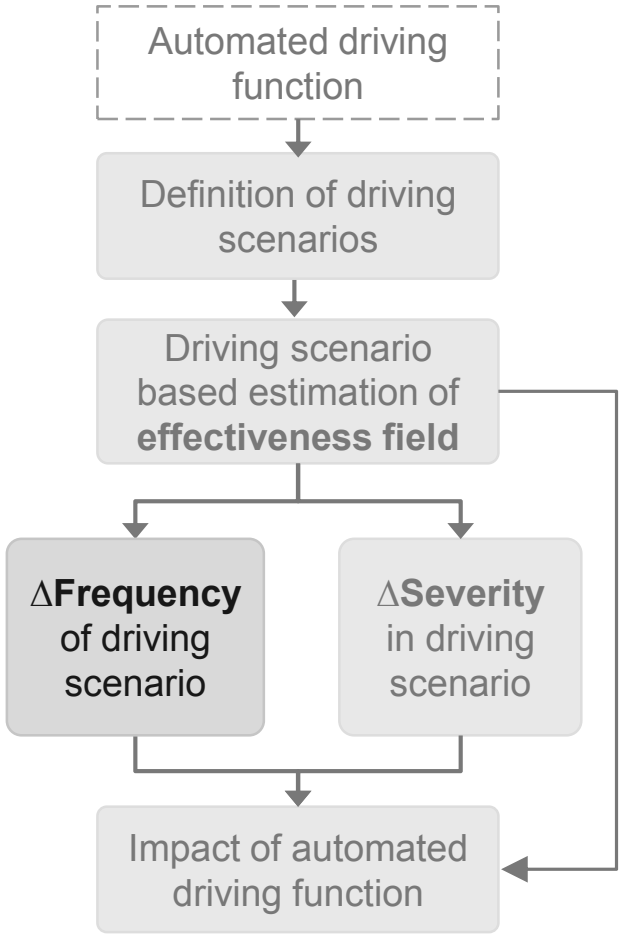
v_1=67 km/h

v_2= 93 km/h

Safety Impact Assessment of Automated Driving

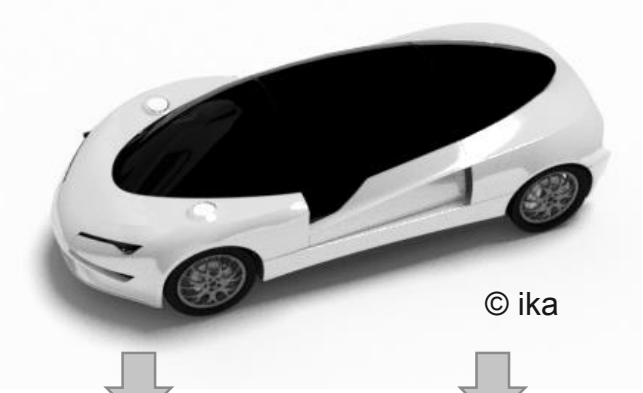
4 Identification of Δ frequencies of driving scenarios

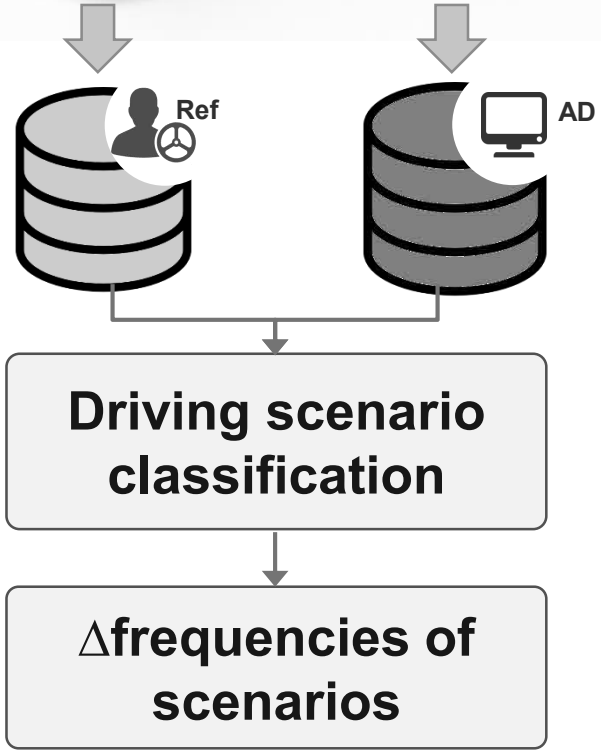
Δ Frequencies of driving scenarios



Identification of Δ frequencies of driving scenarios

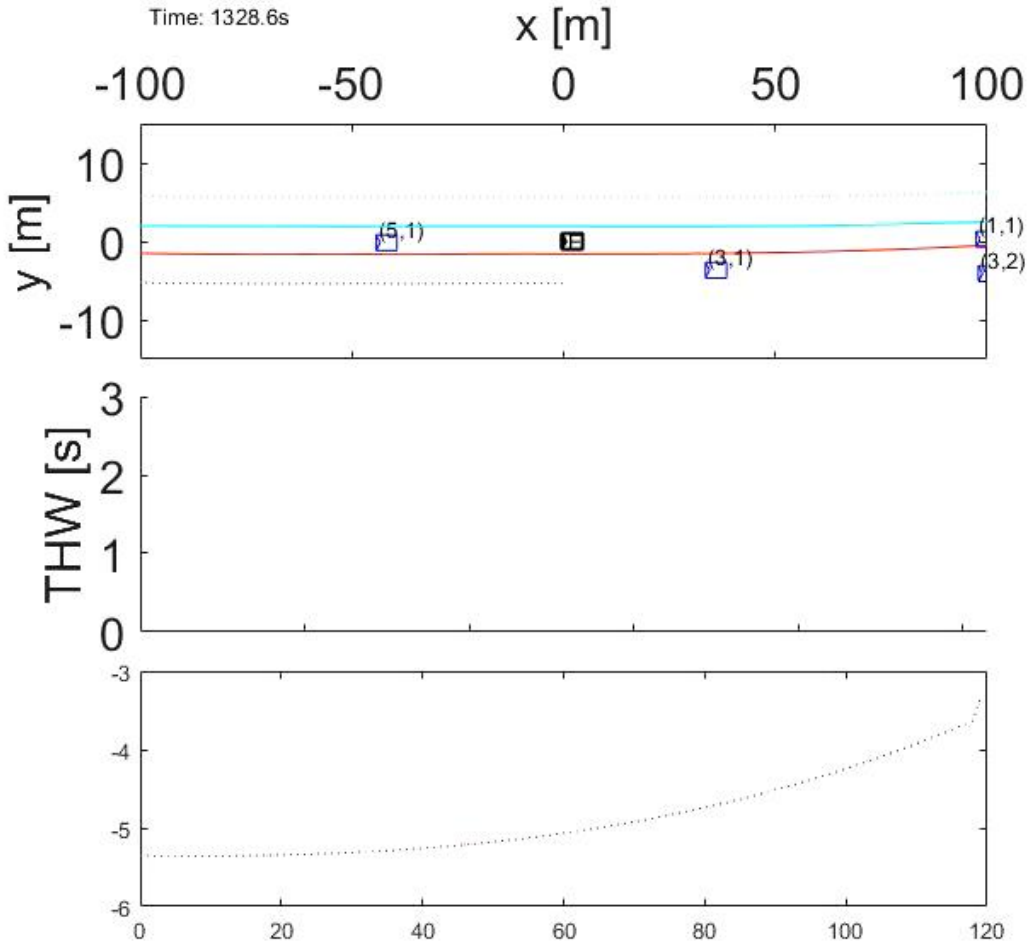
4 FOT-data





Impact Assessment of Automated Driving

4 Identification of Δ Frequency from FOT Data



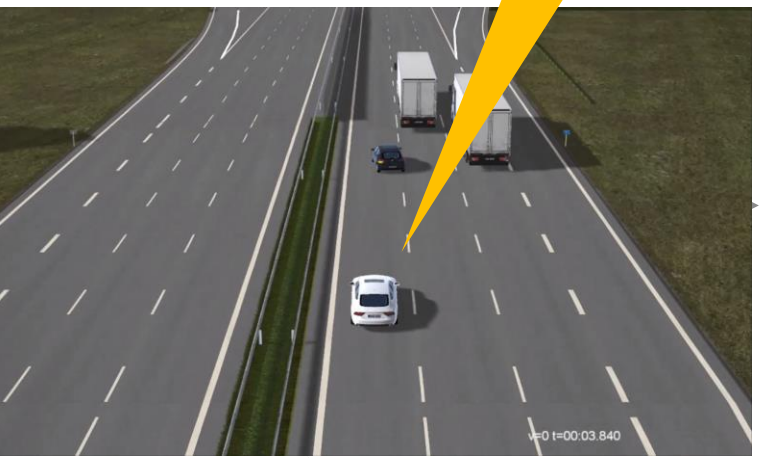
Identification of Δ frequencies of driving scenarios

4 Traffic simulation

Δ Severity in driving scenarios by re-simulation

5 Simulation framework

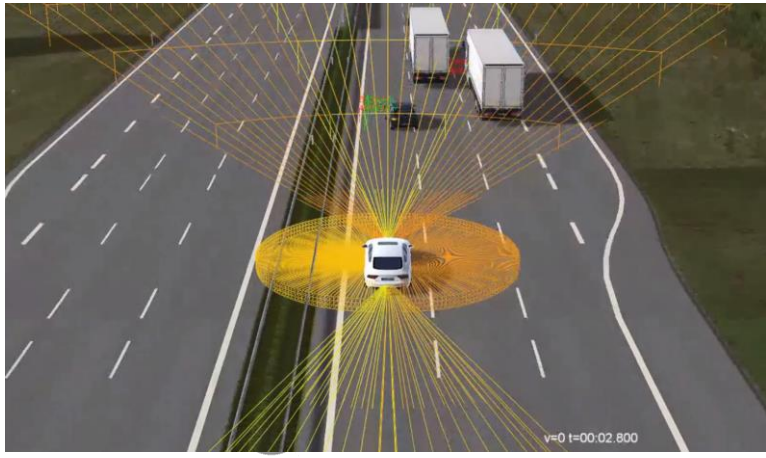
► **Human driver performance models** from driving simulator study/FOT for reference



Driving scenario
„passive cut-in“

Simulation of **reference**

Simulation **with ADF**



Δ Severity

Safety Impact Assessment of Automated Driving

6 Impact Assessment Results

Safety Impact Assessment of Automated Driving

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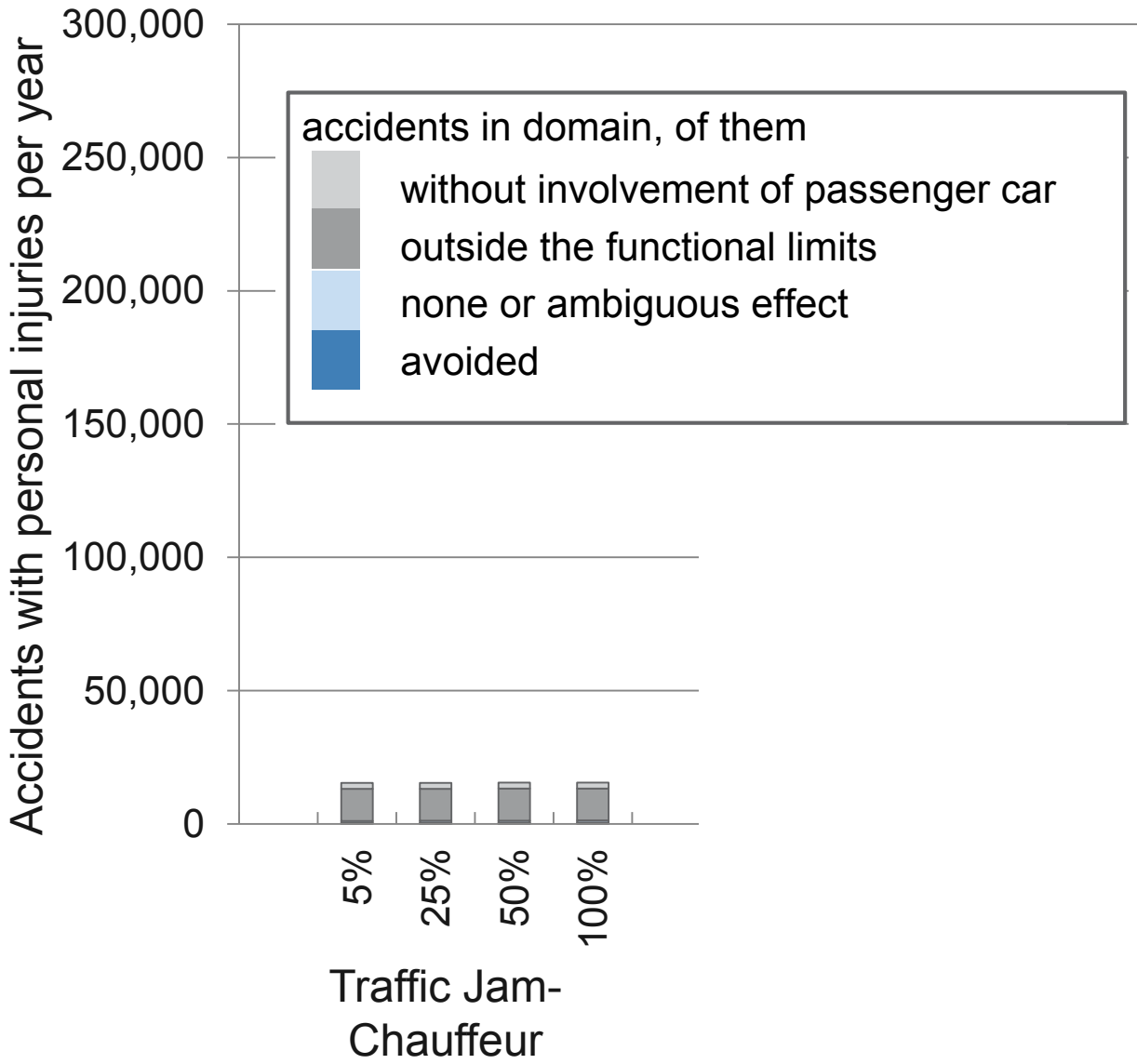
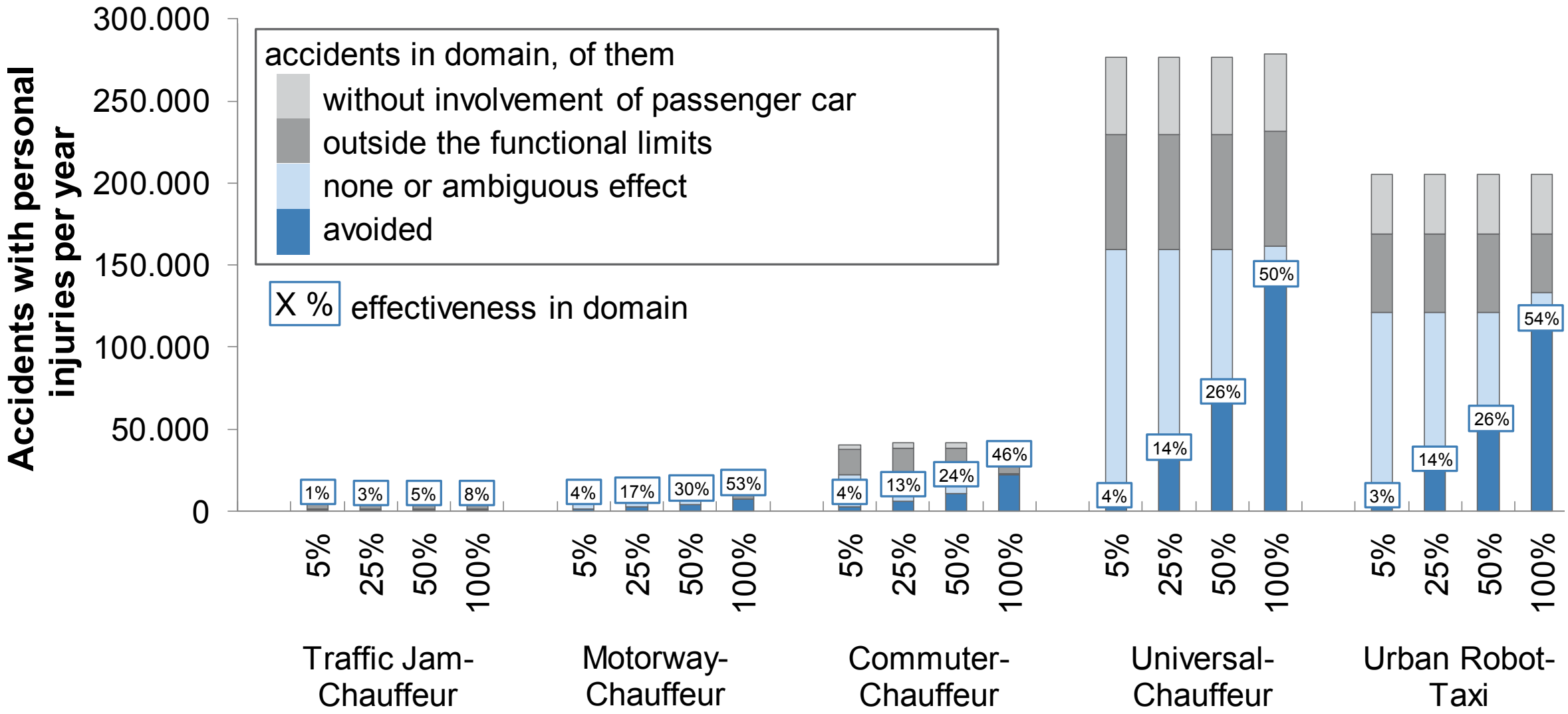


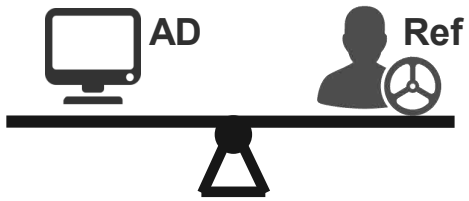
Safety Impact Assessment of Automated Driving

6 Impact Assessment Results



- Motorway-Chauffeur can **reduce 30 % of all accidents** on **German motorways** at a market **penetration of 50 %**. This equals **2 % of all accidents on German roads**.

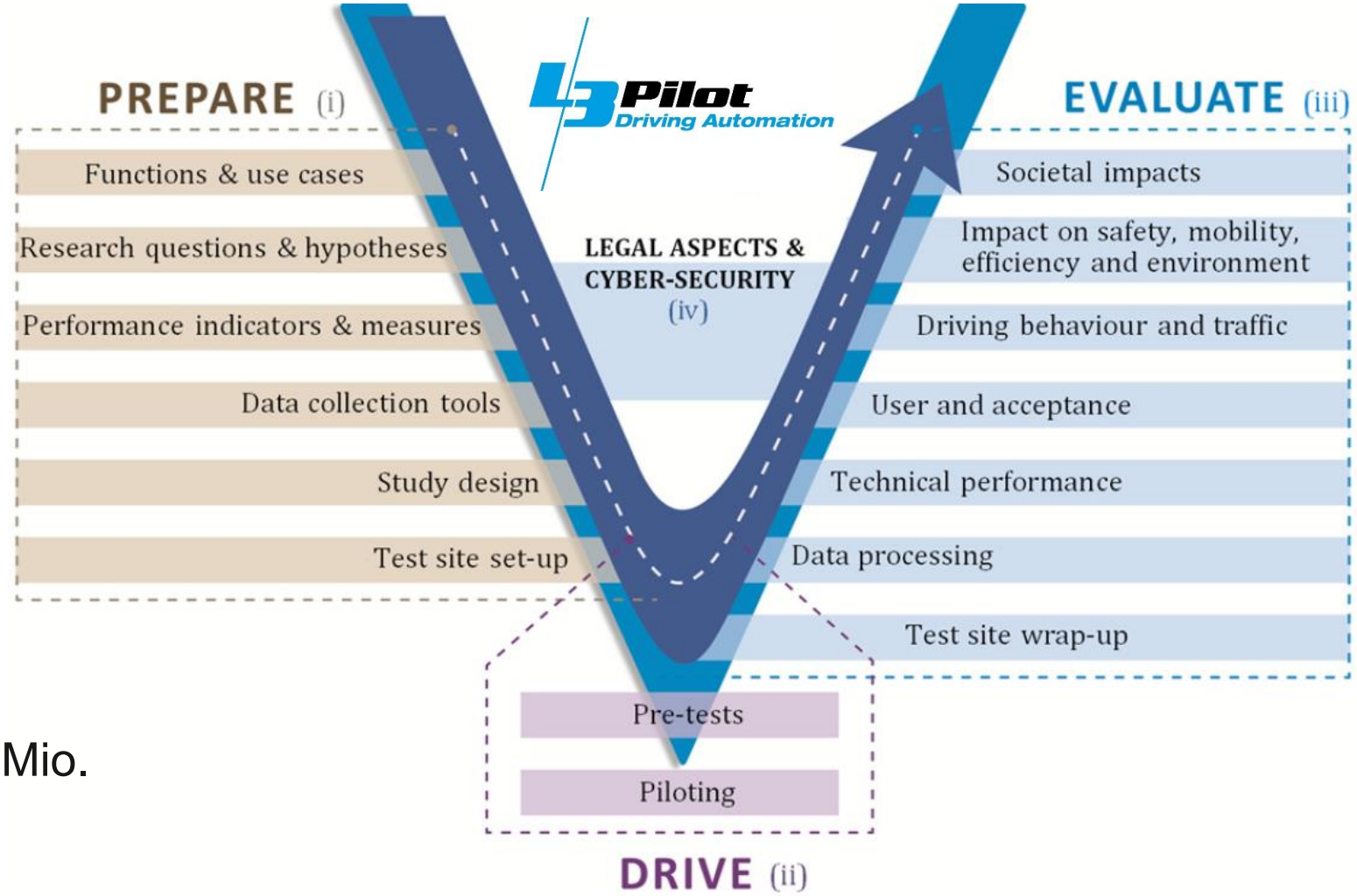
- The Urban Robot-Taxi **can avoid 26 % of all accidents** with personal injury within city-limits at a market **penetration of 50 %**. This equals **17 % of all accidents on German roads**.



- However, there will be accidents remaining that automated vehicles cannot avoid (due to weather conditions or physics). **But we can show that a human cannot avoid these accidents either.**

Piloting Automated Driving on European Roads

L3Pilot – Real World Data for Impact Assessment

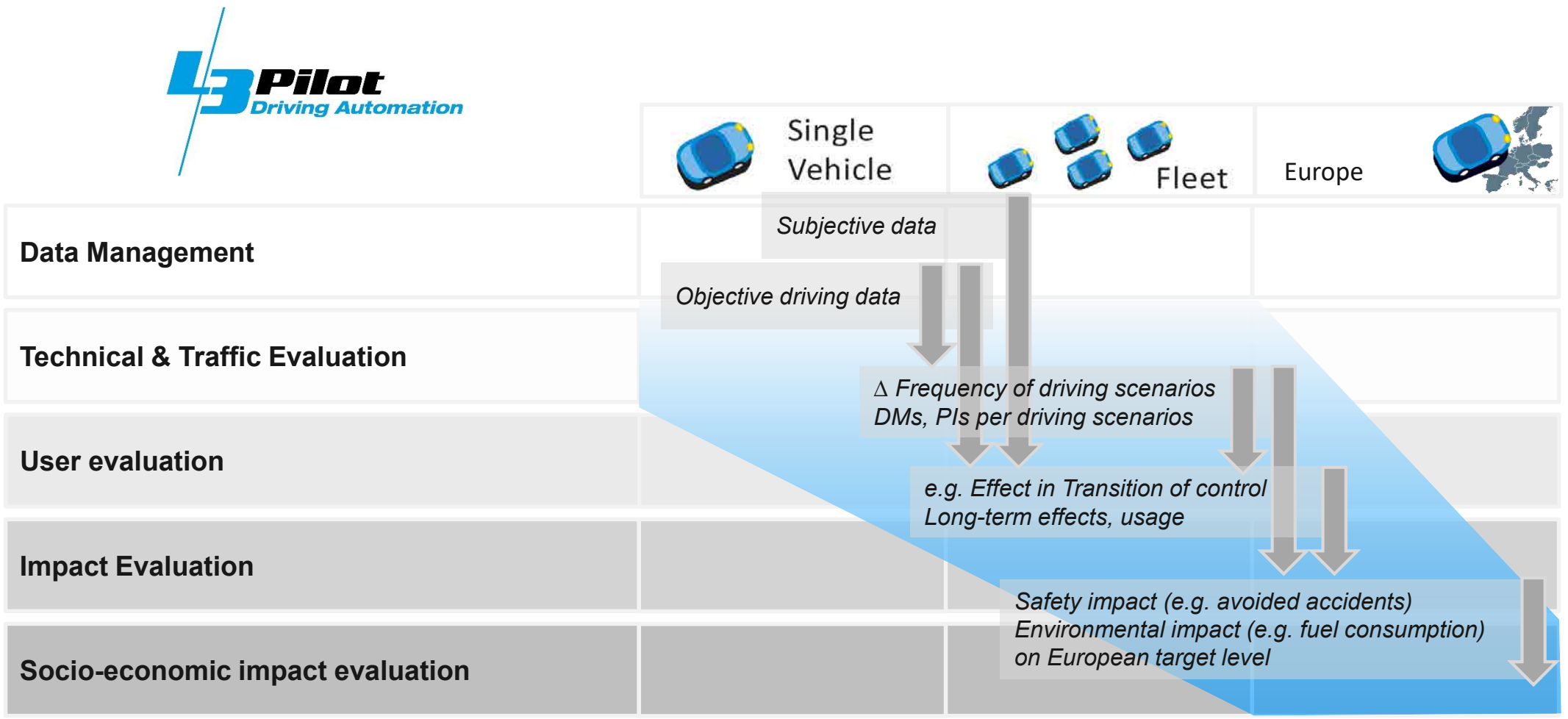


- Large-scale Level 3 piloting
- 1,000 test drivers,100 vehicles in 11 European countries
- EC funded in Horizon 2020
- 34 partner
- Budget: 68 € Mio., Funding: 36 € Mio.

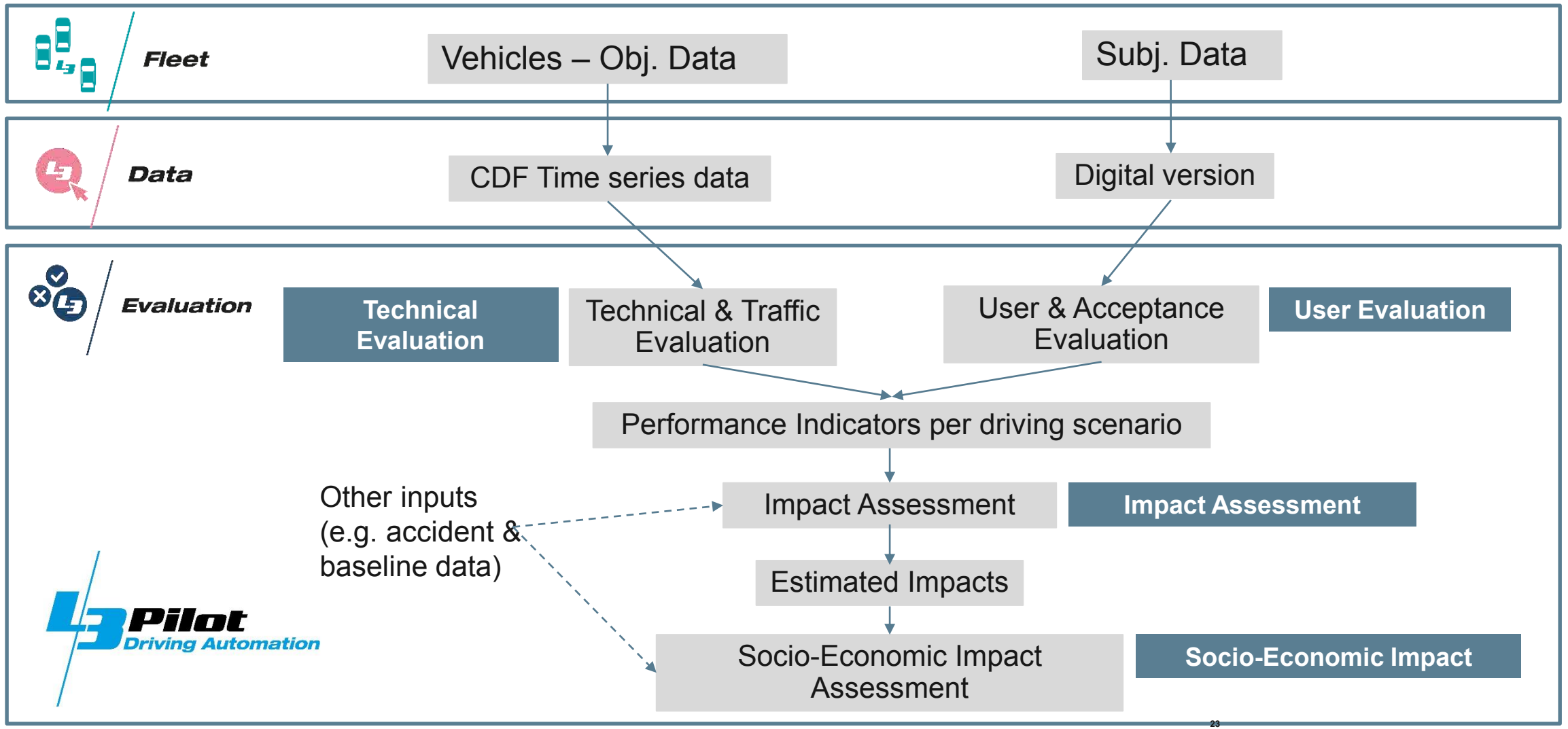
- Website: **http://www.l3pilot.eu**

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 723051.

L3Pilot
Evaluation Levels



L3Pilot
Evaluation Workflow



Summary

- Prospective safety **impact assessment** for automated driving requires new methodologies
- Automated driving provides many challenges with regards to impact assessment since **limited real world data is available yet** and many new aspects (e.g. user-interaction) needs to be taken into account
- Safety impact assessment shows **positive results** with different automation function
- Current research in L3Pilot start **data collection for safety impact assessment**
- Safety Impact Assessment in L3Pilot will provide results based on **data from vehicles combined with simulation** for the first time

Contact

THANK YOU FOR YOUR ATTENTION!

QUESTIONS?

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