

Session III

Testbed Dresden – Synchronized Mobility 2023

4th ASAM International Conference 2019

Autonomous Driving – Standardized Virtual Development as a Key to
Future Mobility

hosted in cooperation with the Saxon State Ministry for Economic Affairs, Labour and Transport

December 10th, 2019 in Dresden, Germany



Agenda

15:30 – 15:50

„Synchrone Mobilität 2023“ –
An Initiative of the Free State of Saxony

15:50 – 17:00

Automated Driving System for Cooperative, Automated Driving in Urban Areas

HMI in the Vehicle

ITS Testbed Backend for Automated Urban Traffic

Roadside Infrastructure for Connected Driving

Simulation based research of automated longitudinal control with GLOSA functionality

Traffic and Accident Scenarios Merged in the Harmonized PCM v5 Standard

Testbed Dresden – Synchronized Mobility 2023

Traffic and accident scenarios merged in the harmonized PCM v5 standard

Florian Spitzhüttl, VUFO GmbH

Martin Urban, Fraunhofer Institute for Transportation and Infrastructure Systems



Testbed Dresden – Synchronized Mobility 2023

Real scenario (accidents & critical events)



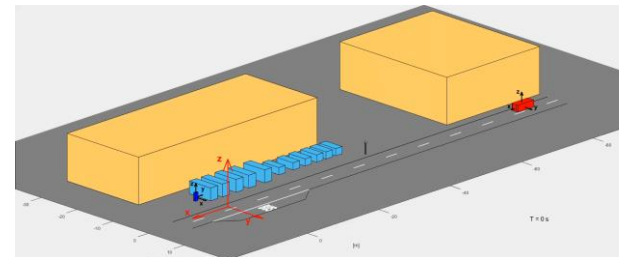
Different investigation methods and databases



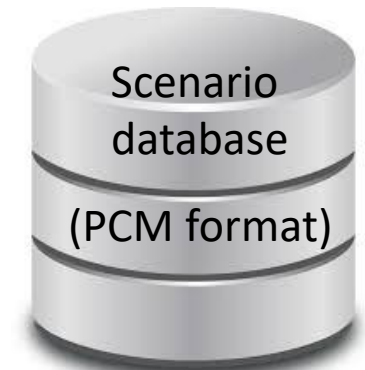
Digitalized scenario

PCM format specification

Open access
[@vufo.de](https://www.vufo.de)



Merged database for analyses and simulation



Pre-Crash-Matrix (PCM) format

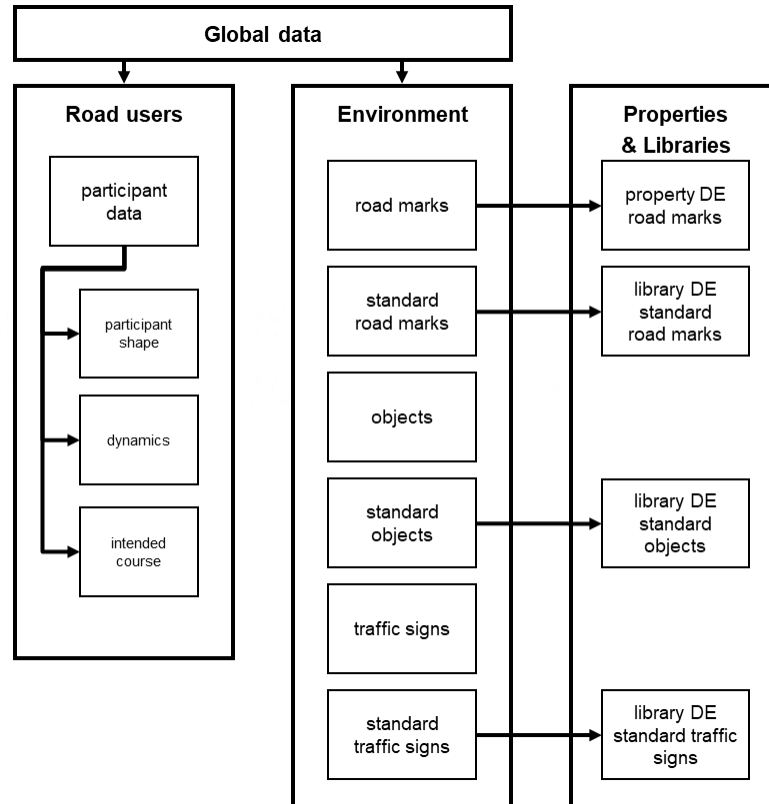


Table: global_data
Description: The table global_data provides general information about the accident / scenario.

Variable	Description	Unit	Type
CASEID	Unique case identifier		
DATETIME	Date and time expression. This represents the unknown digits may. Example: 2019-01-31		
PARTICIP	Number of involved participants		
SOLVER	Used solver for vehicle simulation: 1 – IPG CarMaker 2 – DSD PC-Crash 3 – AnalyzerPro 4 – Virtual Crash 5 – IPG TruckMaker 6 – IPG Motorcyclist 7 – Mechanical Simulation 8 – Mechanical Simulation 9 – Tass International 10 – dSPACE Auto 11 – TESIS DYNAMICS 12 – Pro Impact 13 – Pro Impact 88888 – other		
GPSLAT	GPS latitude of global coordinate system (decimal, e.g. 51.03)		
GPSLON	GPS longitude of global coordinate system (decimal, e.g. 13.74)		
GPSELE	Elevation of global coordinate system (ellipsoidal)		

Table: participant_data
Description: The table participant_data contains relevant variables to parameterize participants. This data can be used to model the geometry and further attributes. The variable PARTID is the participant identifier. Consider the table participant_shape to model the participant geometry in detail. The variable PARTTYPE describes the type of road user. It is recommended to use a local reference COS according to ISO 8855 with the COG as origin.

Variable	Description	Unit	Type
CASEID	Unique case identifier		
PARTID	Participant identifier per case		
PARTTYPE	Participant type: 0 – passenger car 1 – pedestrian 2 – motorbike 3 – bicycle 4 – truck 5 – bus 6 – train/train 7 – trailer 8 – camper 9 – agricultural vehicle 10 – construction vehicle		

Table: property_DE_road_marks
Description: The table property_DE_road_marks is referred to by table road_marks through OBJTYPE. It defines the width, length and gap of a line and can be used to visualize the various road boundaries and markings.

Comments: Countries-specific road boundaries and markings may be required. Additional properties can be added for this purpose. The format of the library must remain the same. The name of the library should be changed according to the ISO3166 Alpha-2 code.

Example:
Germany: "property_DE_road_marks"
China: "property_CN_road_marks"
....

In order to provide a uniform table for all users, it is recommended to forward extensions to pcm@vufo.de. The extensions can then be included in a new release.

Variable	Description	Unit	Type
OBJTYPE	Type of object		Long int
DESCRIPTION	Description object		Short text
WIDTH	Width of the line	[m]	Double
LENGTH	Length of line	[m]	Double
GAP	Length of gap	[m]	Double

Figure 2: Road marking dimensions and coordinate system.



Accident data in PCM

German In-Depth Accident Study¹

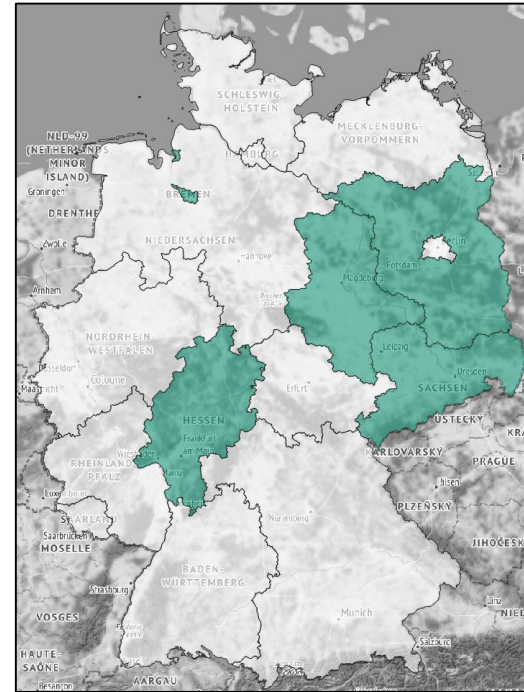
¹ provide by VUFO GmbH



- 36.000 accidents since 1999
- Ø 3.500 single information per accident
- ~ 2.000 accidents per year

Traffic Accident Scenario Community²

² provide by Fraunhofer IVI

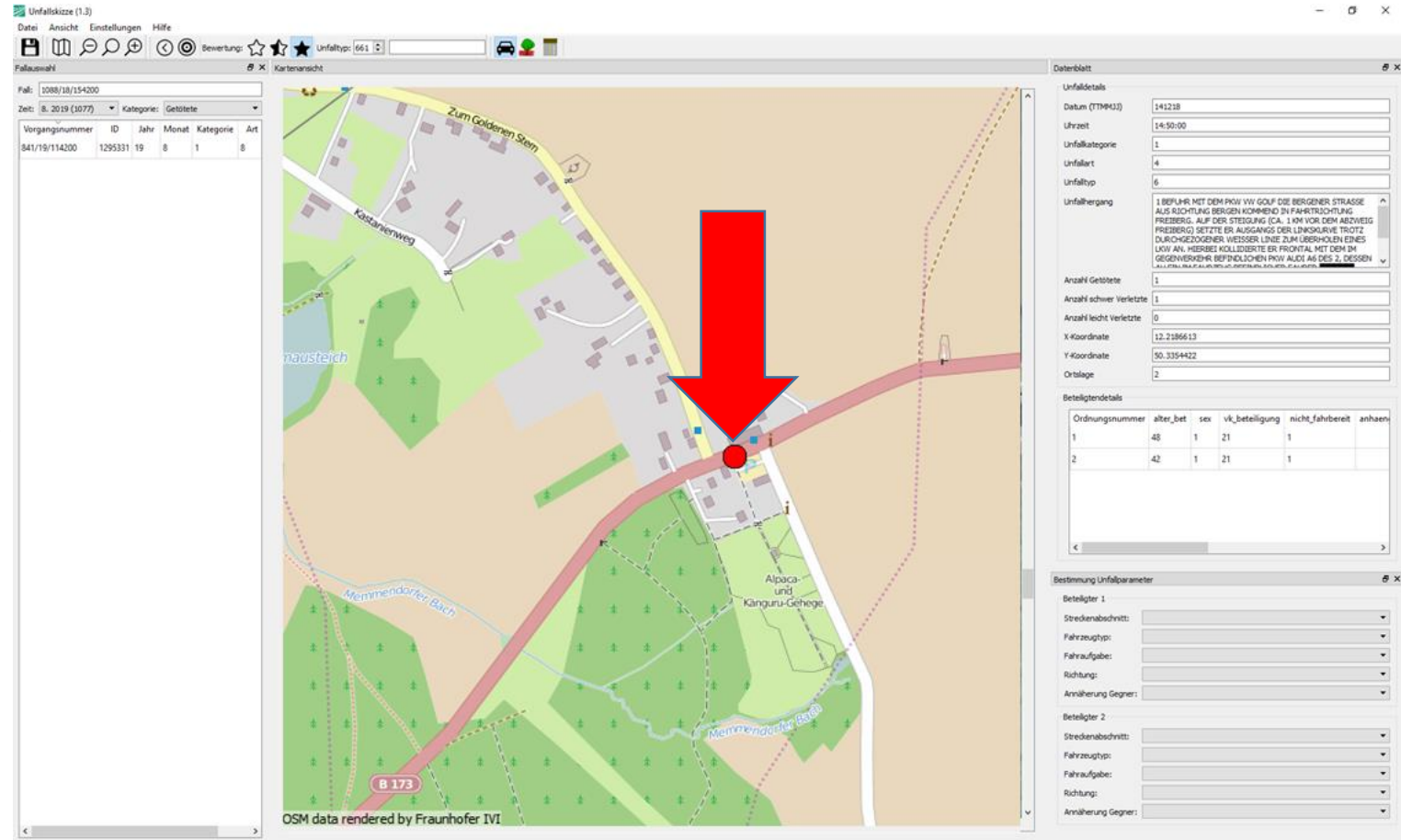


- ~ 4,1 Mio. accidents since 2010
- Ø 110 single information per accident
- ~ 500.000 accidents per year

from police recorded accidents to simulation

content EUSka database

- Location



from police recorded accidents to simulation

content EUSka database

- Location
- Date and time

The screenshot displays the 'Unfallskizze (1.3)' software interface. The central map shows a road network with a red dot indicating the accident location. The interface includes several panels:

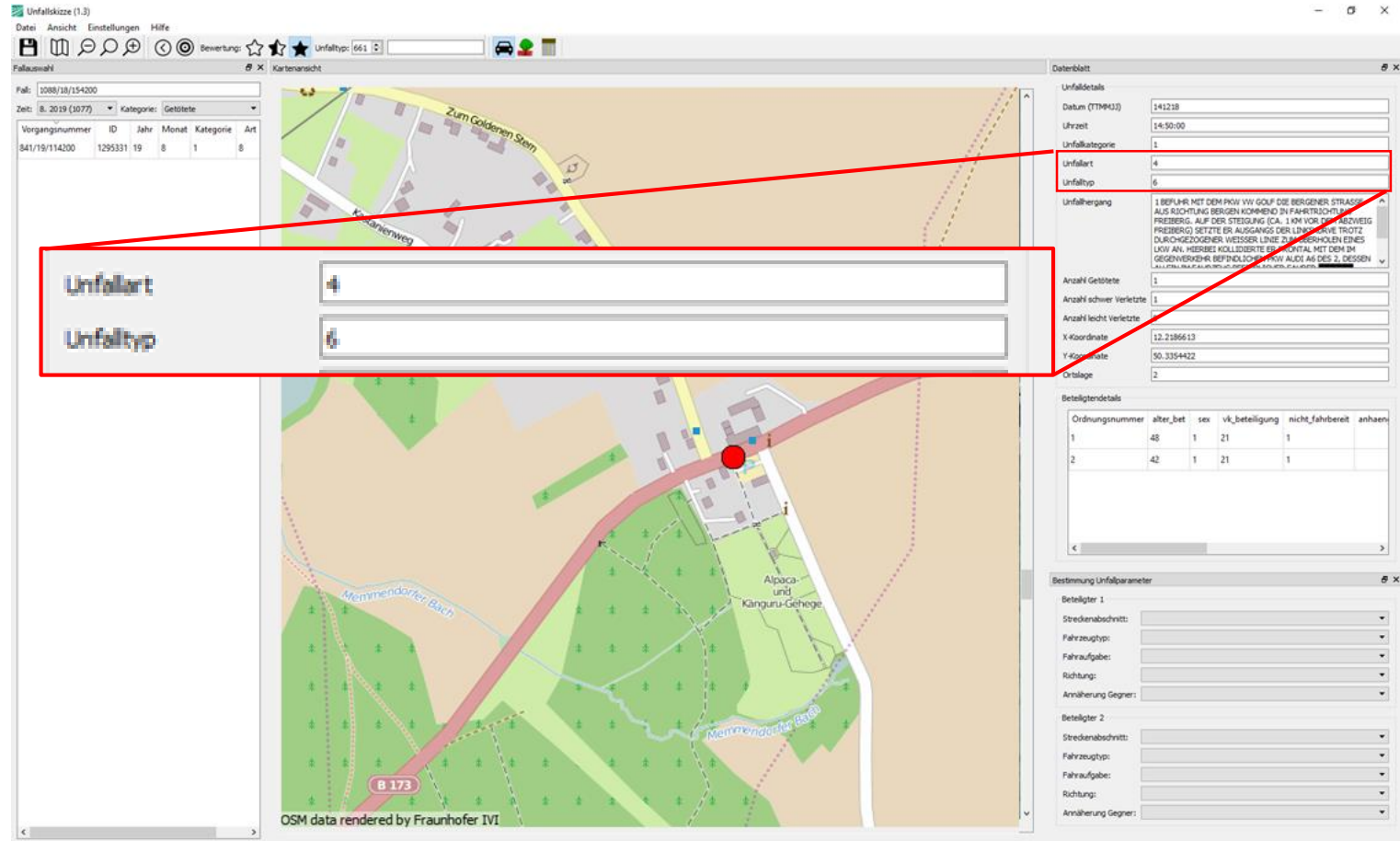
- Top Left:** Case information including 'Fall: 1088/18/154200', 'Zeit: 8. 2019 (1077)', and a table of 'Vorgangnummer'.
- Top Right:** 'Unfalldetails' panel with fields for 'Datum (TTMMJJJ)' (141218) and 'Uhrzeit' (14:50:00), both highlighted with red boxes. Other fields include 'Unfallkategorie', 'Unfallart', 'Unfalltyp', and 'Unfallhergang'.
- Bottom Right:** 'Bestimmung Unfallparameter' panel with dropdown menus for 'Beteiligter 1' and 'Beteiligter 2', including options for 'Streckenabschnitt', 'Fahrzeugtyp', 'Fahrtaufgabe', 'Richtung', and 'Annäherung Gegner'.

The map shows roads like 'Zum Goldenen Stern', 'Kastanienweg', and 'Memmendorfer Bach'. The text 'OSM data rendered by Fraunhofer IVI' is visible at the bottom of the map area.

from police recorded accidents to simulation

content EUSka database

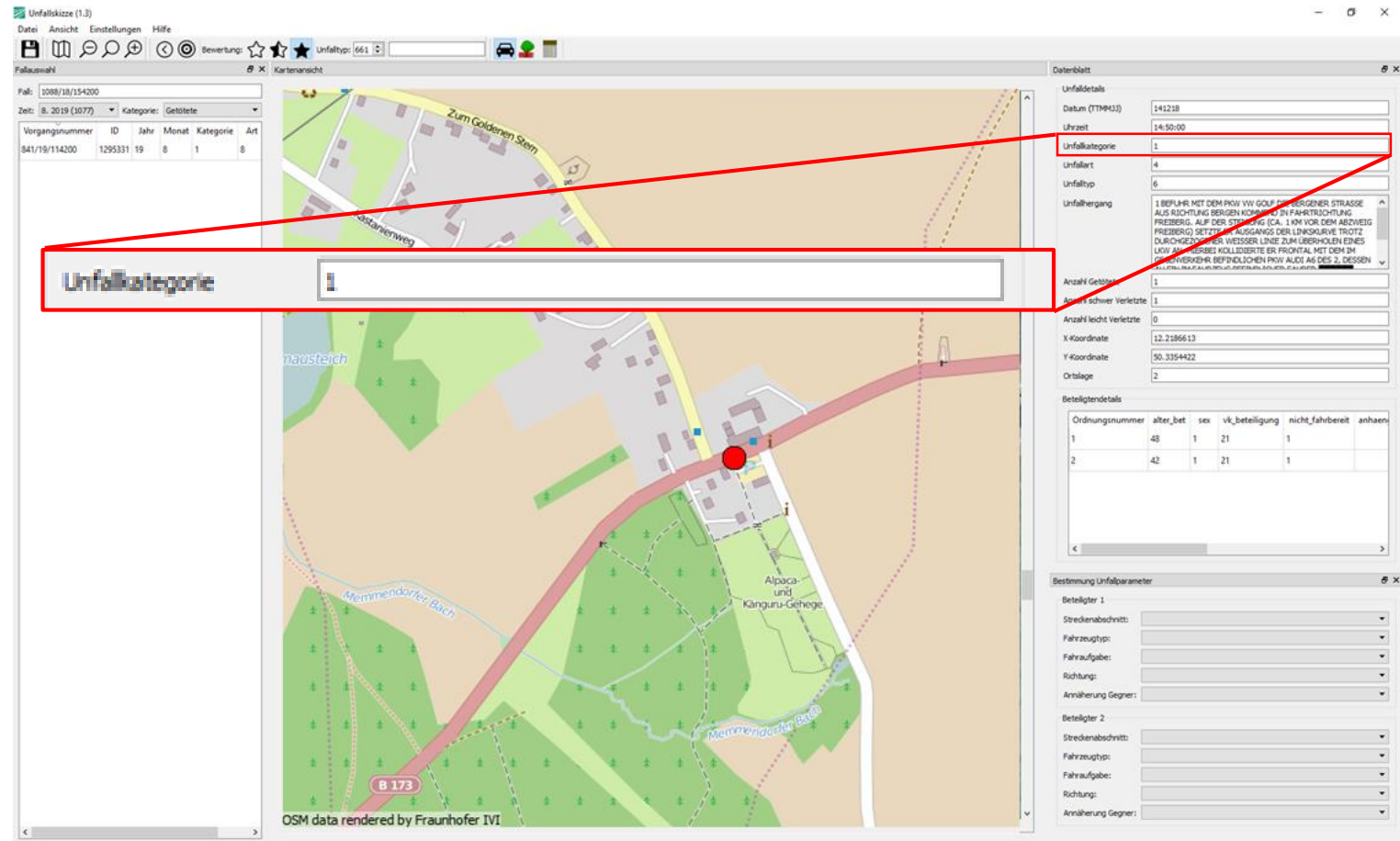
- Location
- Date and time
- Kind and type of accident



from police recorded accidents to simulation

content EUSka database

- Location
- Date and time
- Kind and type of accident
- Accident category (severity)



from police recorded accidents to simulation

content EUSka database

- Location
- Date and time
- Kind and type of accident
- Accident category (severity)
- Description

The screenshot displays the EUSka database interface for an accident record. The main window shows a map with a red line indicating the accident location on Bergener Strasse. A red box highlights the 'Unfallhergang' (Accident Description) field, which contains the following text: "1 BEFUHR MIT DEM PKW VW GOLF DIE BERGENER STRASSE AUS RICHTUNG BERGEN KOMMEND IN FAHRRICHTUNG FREIBERG. AUF DER STEIGUNG (CA. 1 KM VOR DEM ABZWEIG FREIBERG) SETZTE ER AUSGANGS DER LINKSKURVE TROTZ DURCHGEZOGENER WEISSER LINIE ZUM ÜBERHOLEN EINES LKW AN. HIERBEI KOLLIDIERT ER FRONTAL MIT DEM IM GEGENVERKEHR BEFINDLICHEN PKW AUDI A6 DES 2, DESSEN...". The right sidebar shows 'Unfalldetails' with fields for Datum (14.12.18), Uhrzeit (14:50:00), Unfallkategorie (1), Unfallart (4), and Unfalltyp (6). Below this, 'Anzahl Getötete' (1), 'Anzahl schwer Verletzte' (1), and 'Anzahl leicht Verletzte' (0) are listed. The 'Beteiligte' table shows two participants: a driver of a VW Golf (age 48, sex 1, 21 years of driving experience) and a driver of an Audi A6 (age 42, sex 1, 21 years of driving experience). The bottom right shows 'Bestimmung Unfallparameter' for two participants, including fields for Streckenabschnitt, Fahrzeugtyp, Fahraufgabe, Richtung, and Annäherung Gegner.

from police recorded accidents to simulation

content EUSka database

- Location
- Date and time
- Kind and type of accident
- Accident category (severity)
- Description
- Kind and type of participants

The screenshot displays the EUSka database interface. At the top, there are menu options like 'Datei', 'Ansicht', 'Einstellungen', and 'Hilfe'. Below that, there's a search bar and a 'Fallauswahl' section with filters for 'Fall:' (1088/18/154200), 'Zeit:' (8. 2019 (1077)), and 'Kategorie:' (Getötete). A table lists accident records with columns for 'Vorgangsnummer', 'ID', 'Jahr', 'Monat', 'Kategorie', and 'Art'. The main area shows a map with a red line indicating the accident location near 'Zum Goldenen Stern' and 'Kastanien'. A table in the center, highlighted with a red border, lists participants:

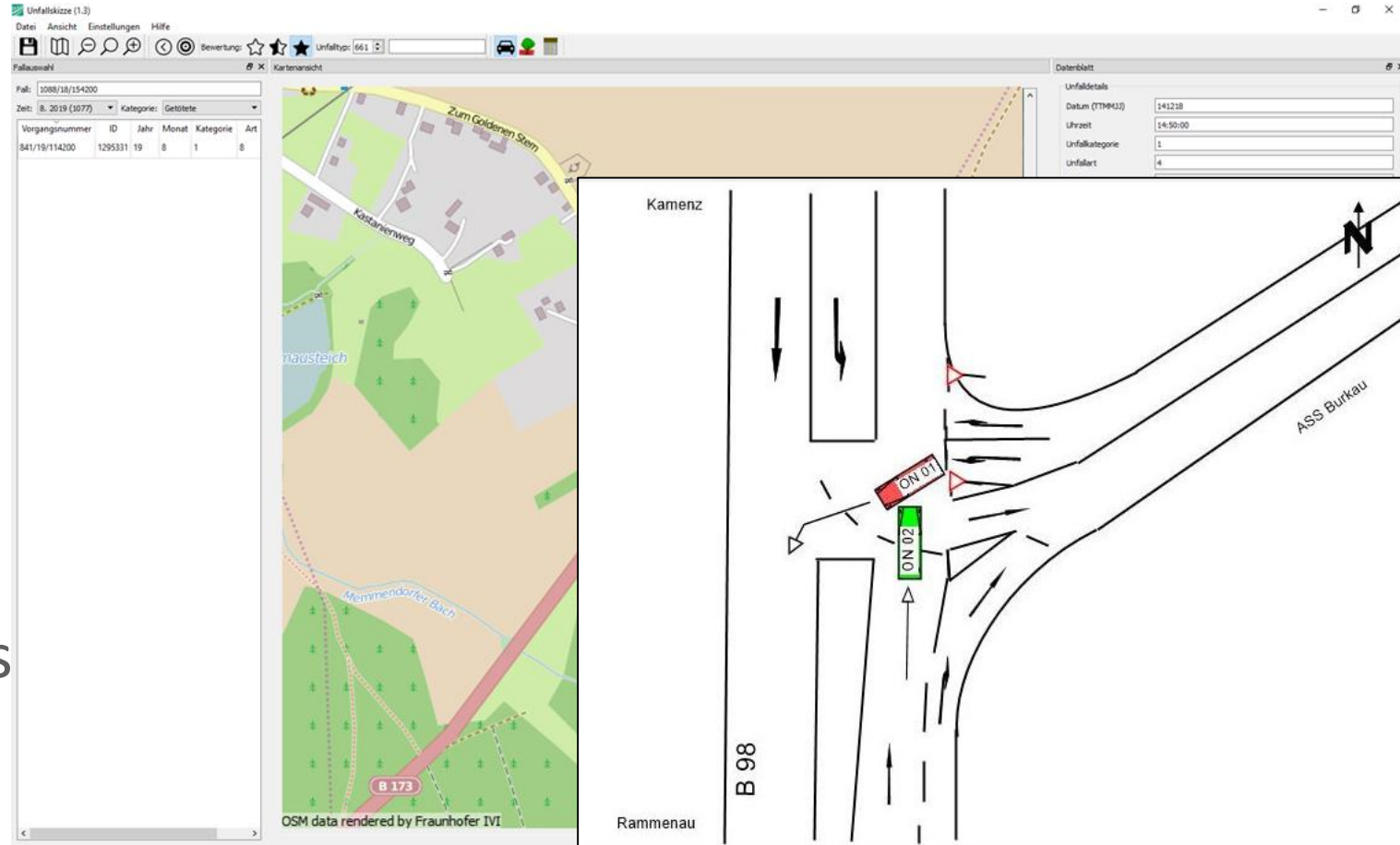
Ordnungsnummer	alter_bet	sex	vik_beteiligung	nicht_fahrbereit	anhaere
1	48	1	21	1	
2	42	1	21	1	

On the right, there's a 'Datenblatt' section with fields for 'Unfalldetails' (Datum, Uhrzeit, Unfalldetails, Unfallart, Unfalltyp, Unfallhergang) and 'Anzahl Getötete', 'Anzahl schwer Verletzte', 'Anzahl leicht Verletzte'. Below that, there's a 'Bestimmung Unfallparameter' section with dropdown menus for 'Beteiligter 1' and 'Beteiligter 2' (Streifenabschnitt, Fahrzeugtyp, Fahraufgabe, Richtung, Annäherung Gegner).

from police recorded accidents to simulation

content EUSka database

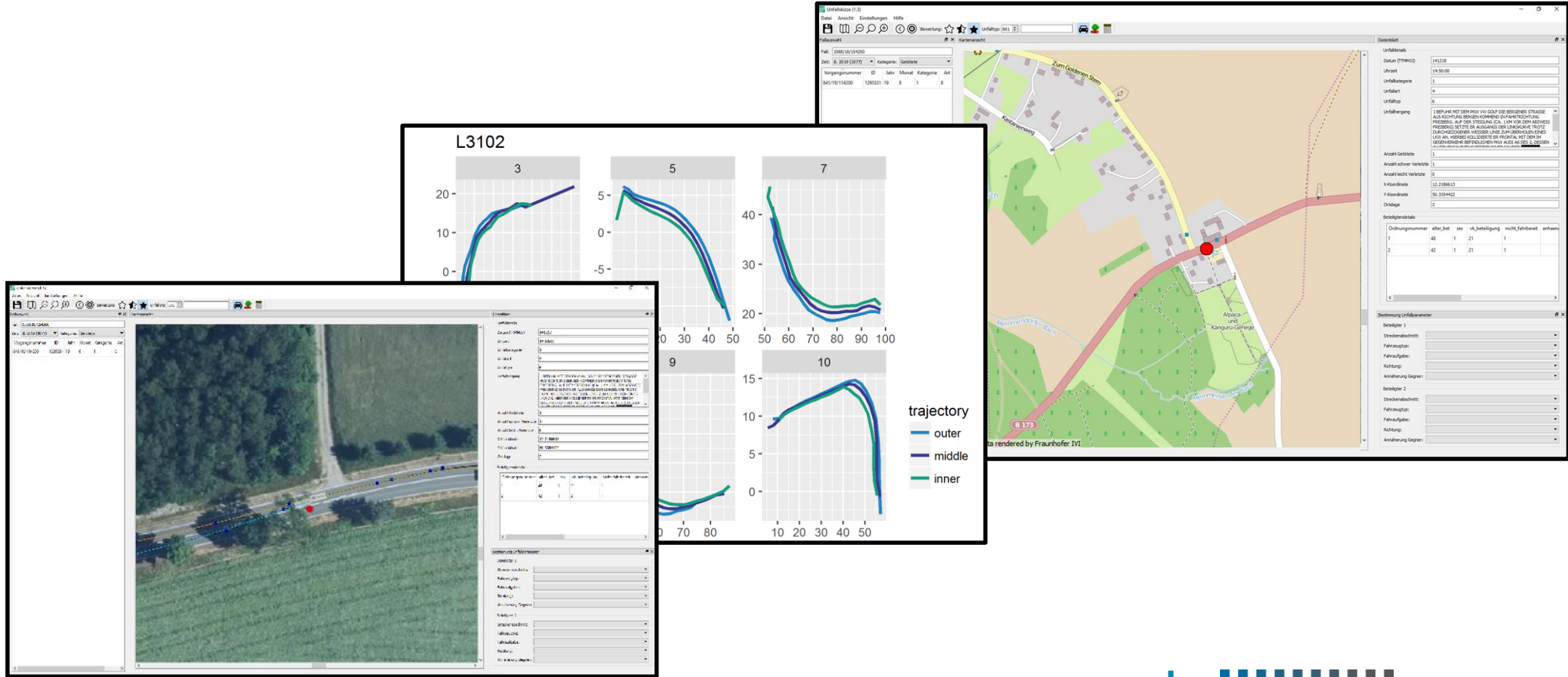
- Location
- Date and time
- Kind and type of accident
- Accident category (severity)
- Description
- Kind and type of participants
- Accident sketch



from police recorded accidents to simulation

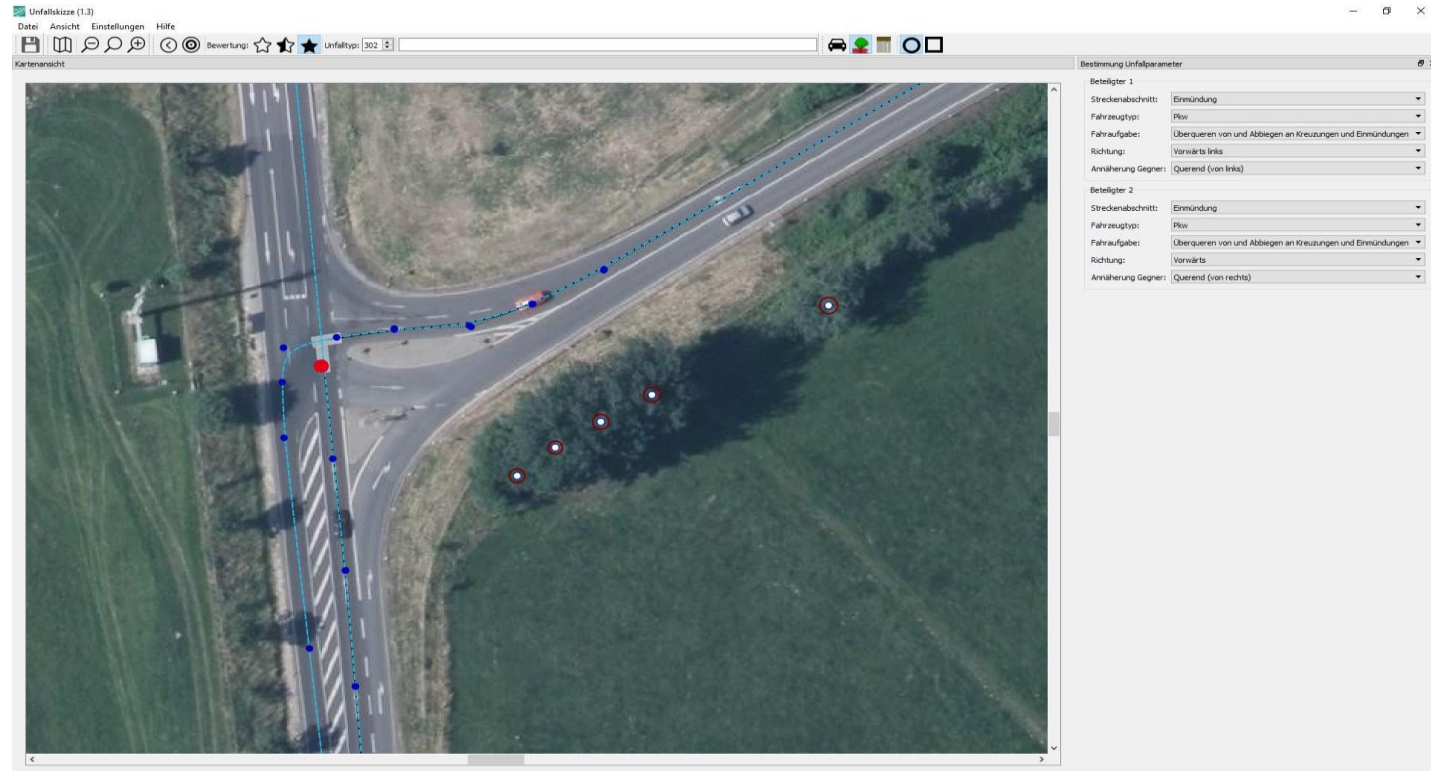
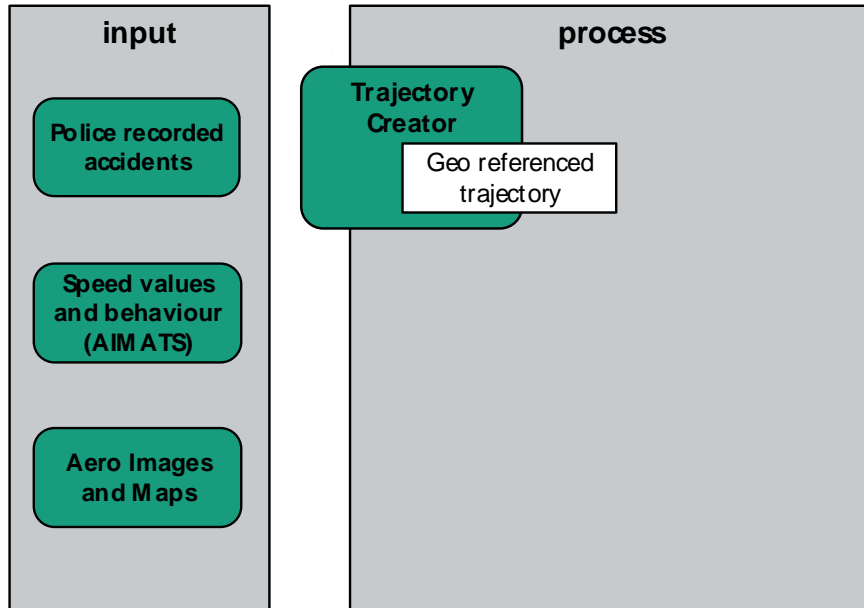
input

- Police recorded accidents
- Speed values and behaviour (AIMATS)
- Aero Images and Maps



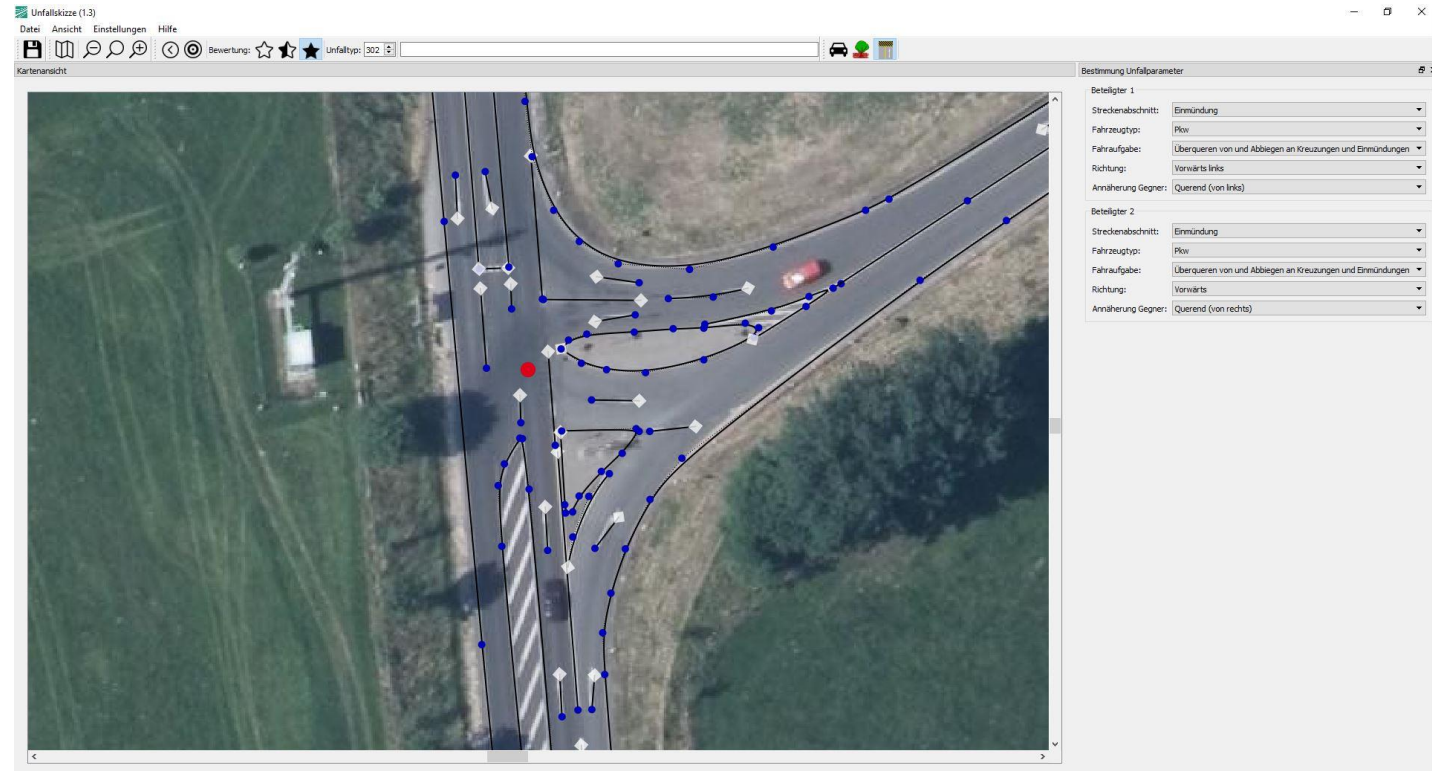
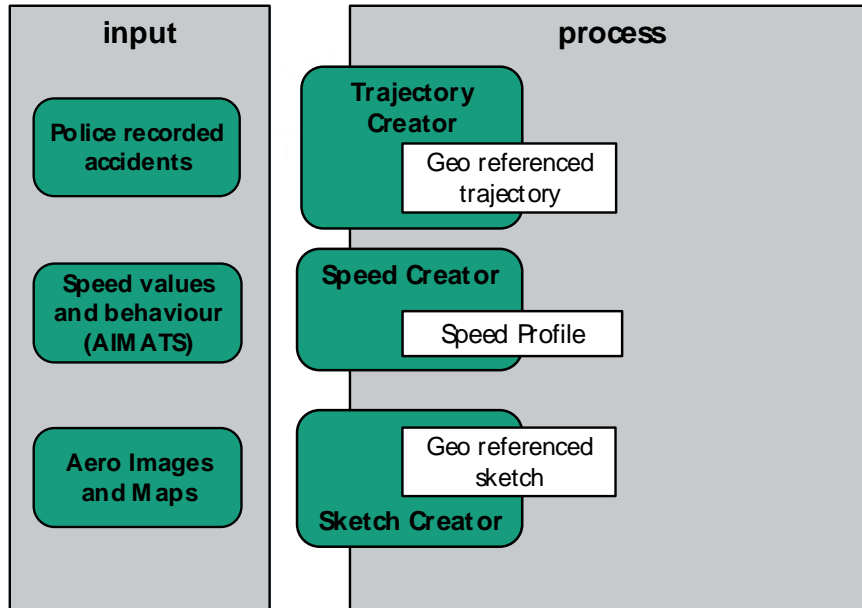
from police recorded accidents to simulation
Information added by Fraunhofer

- Trajectory of each participant



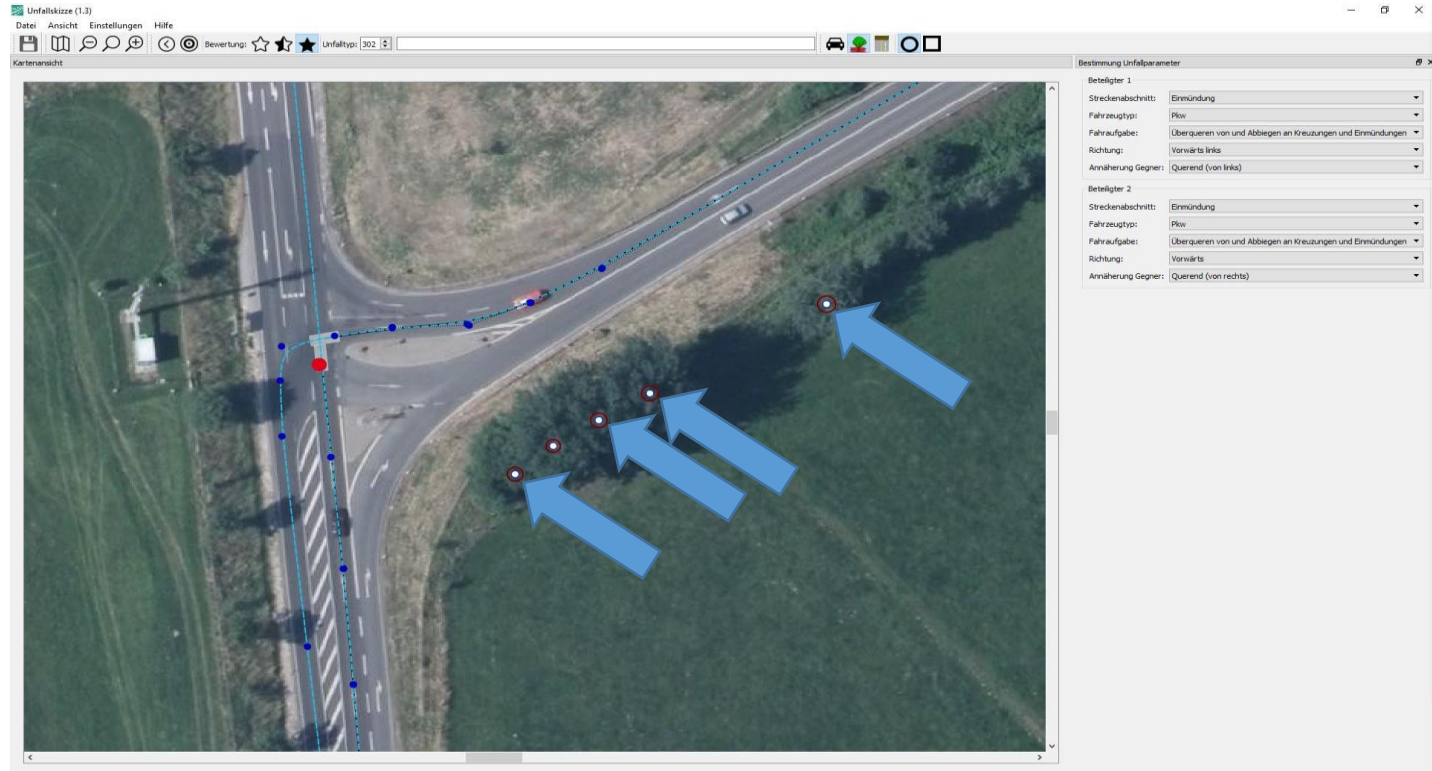
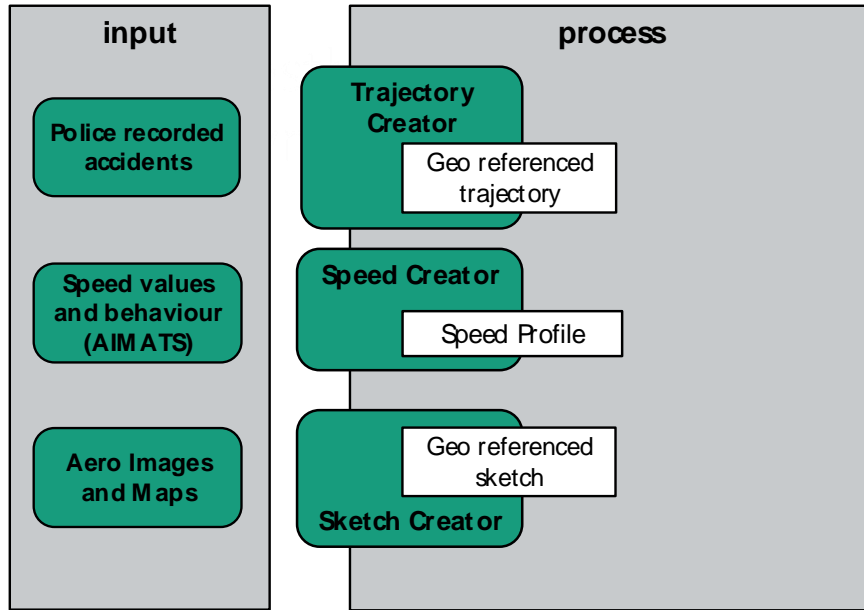
from police recorded accidents to simulation
Information added by Fraunhofer

- Roadside, lanes and marks



from police recorded accidents to simulation
Information added by Fraunhofer

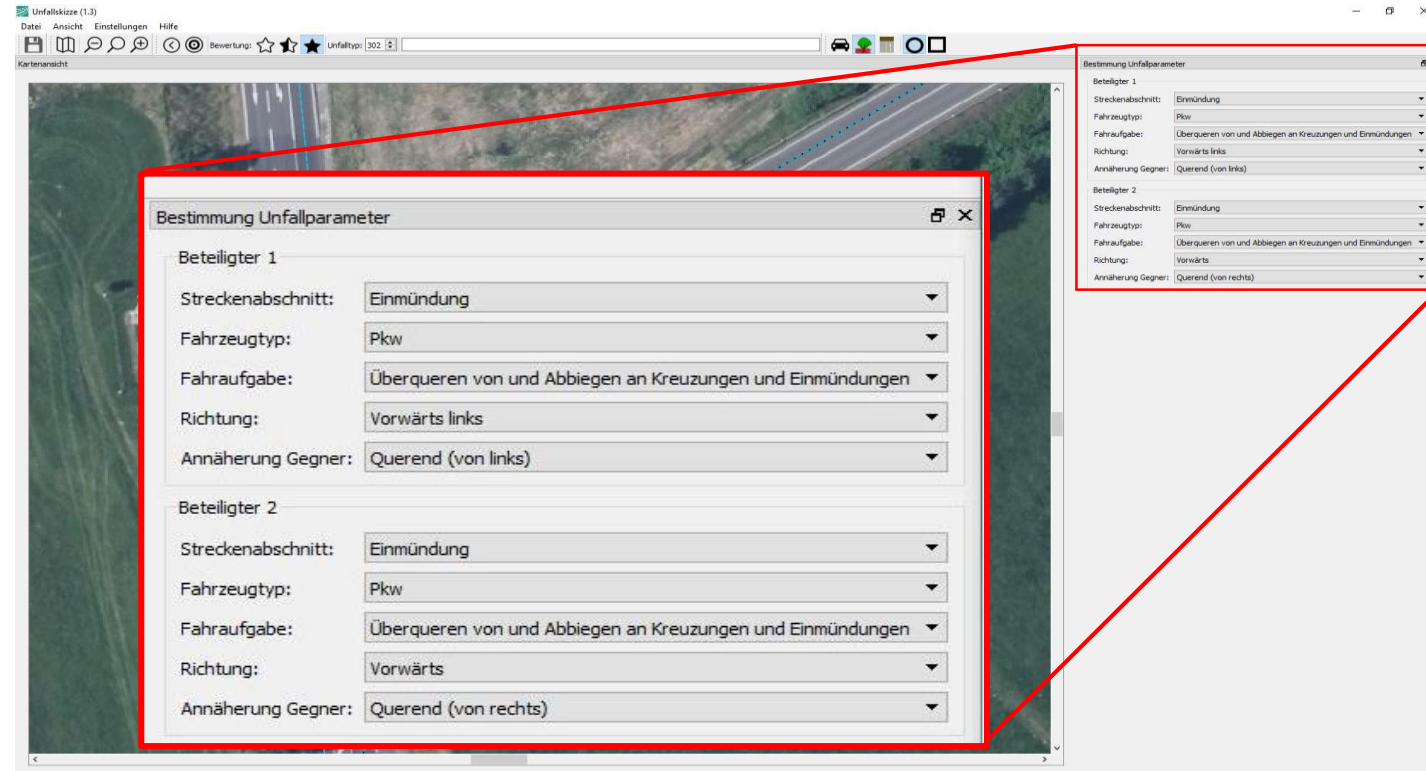
- View obstacle (trees)



from police recorded accidents to simulation

Information added by Fraunhofer

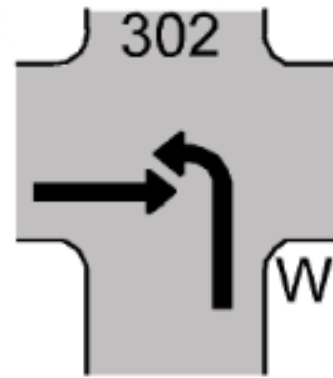
- Logic description of participant behaviour



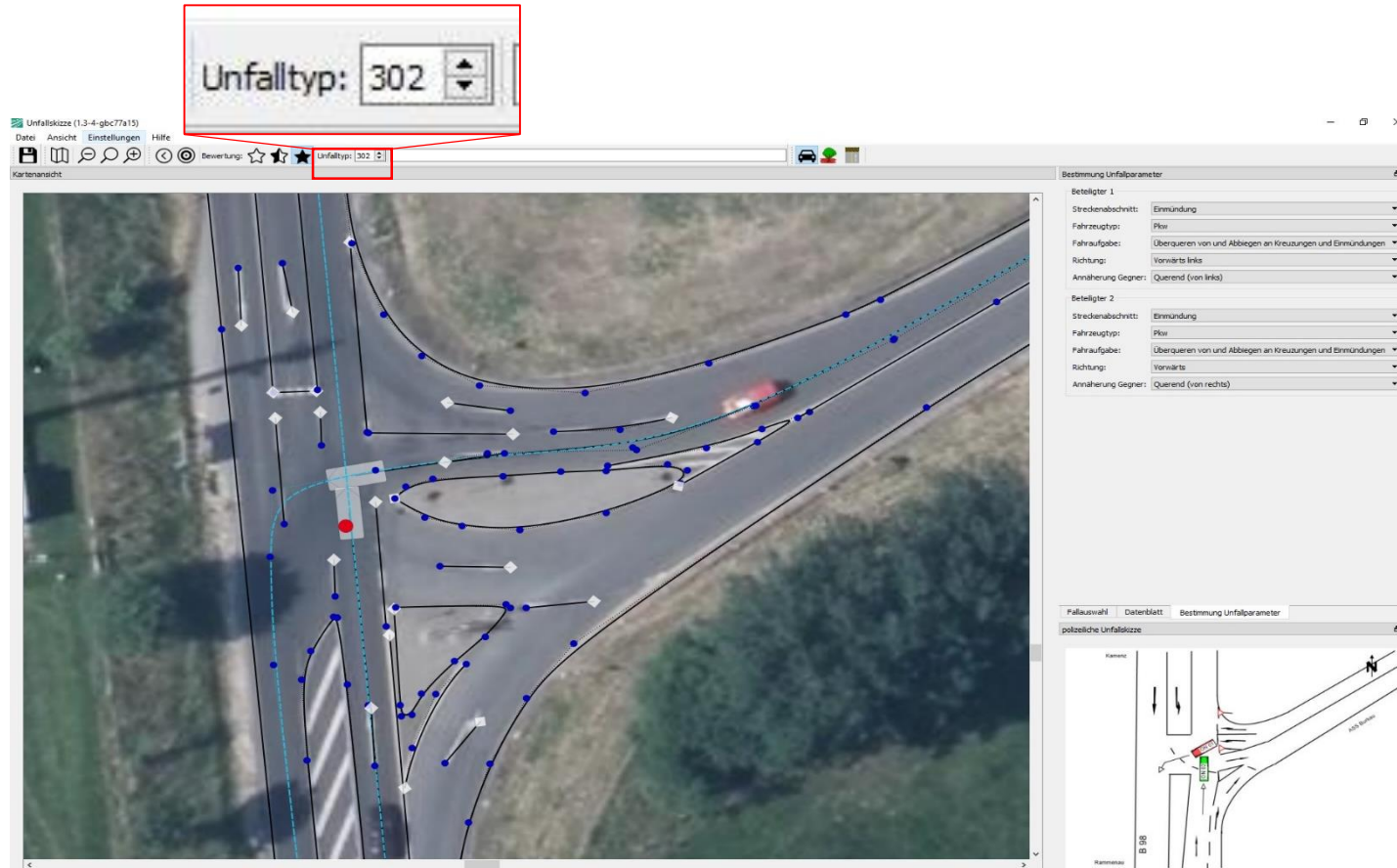
from police recorded accidents to simulation

Information added by Fraunhofer

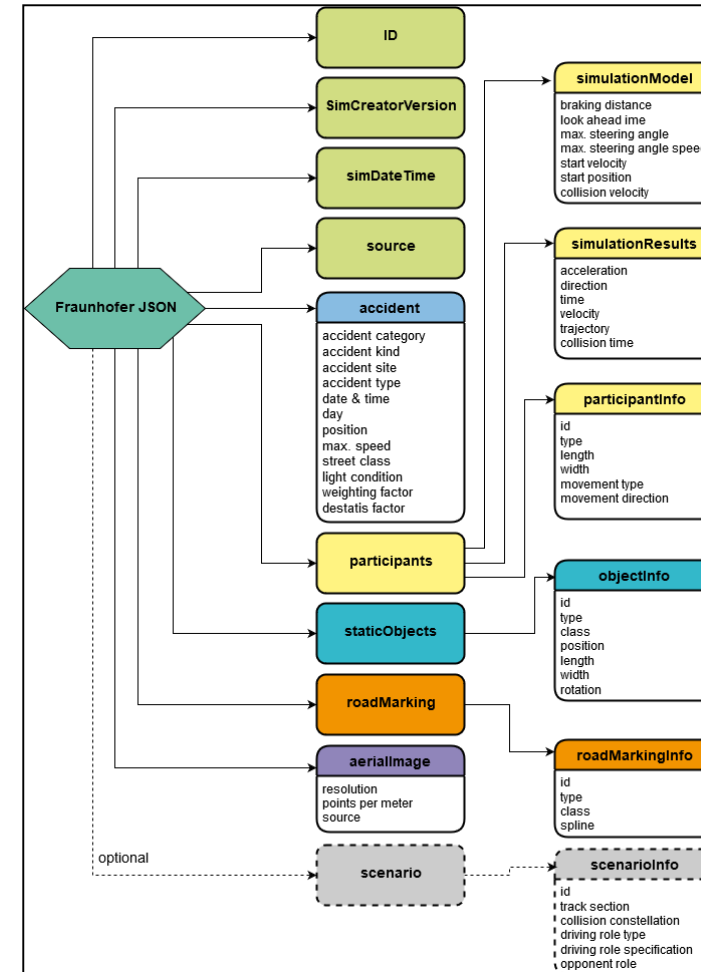
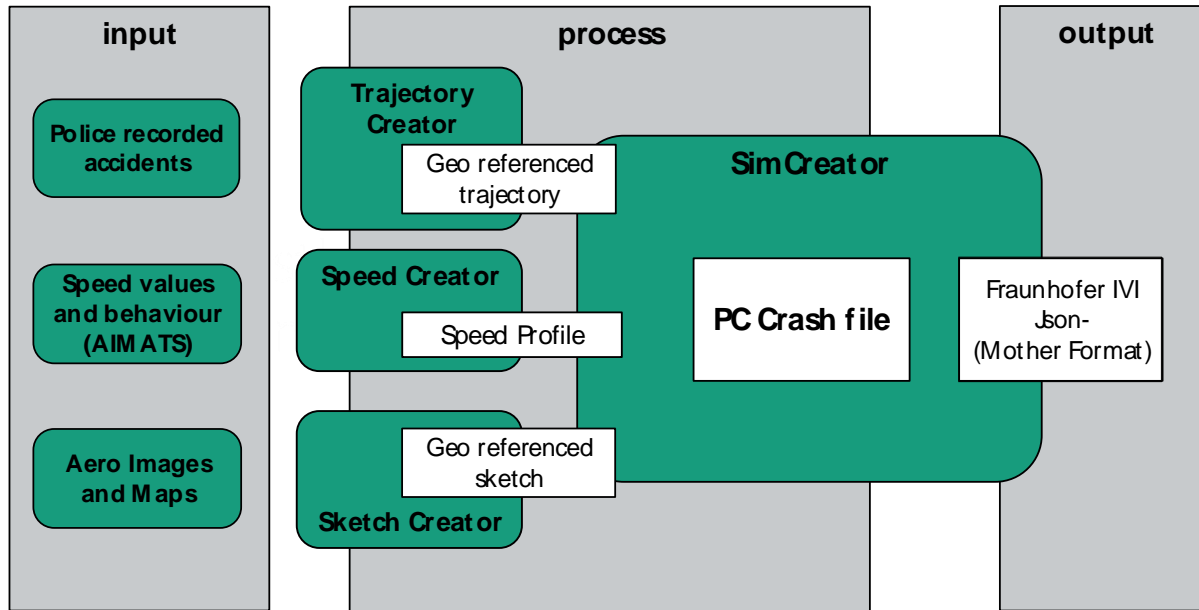
- Logic description of participant behaviour
- 3-digit type of accident



(s.306)

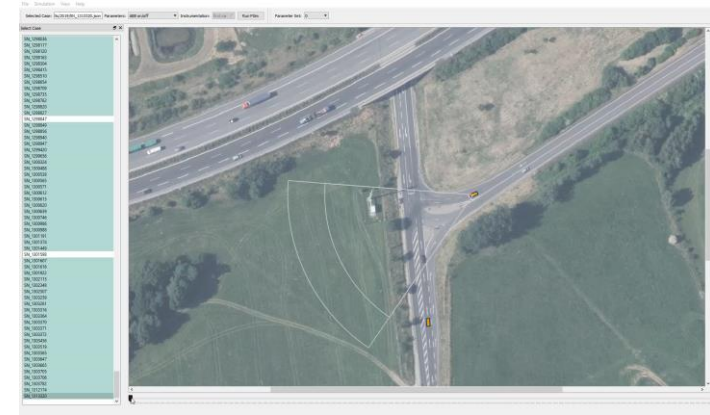
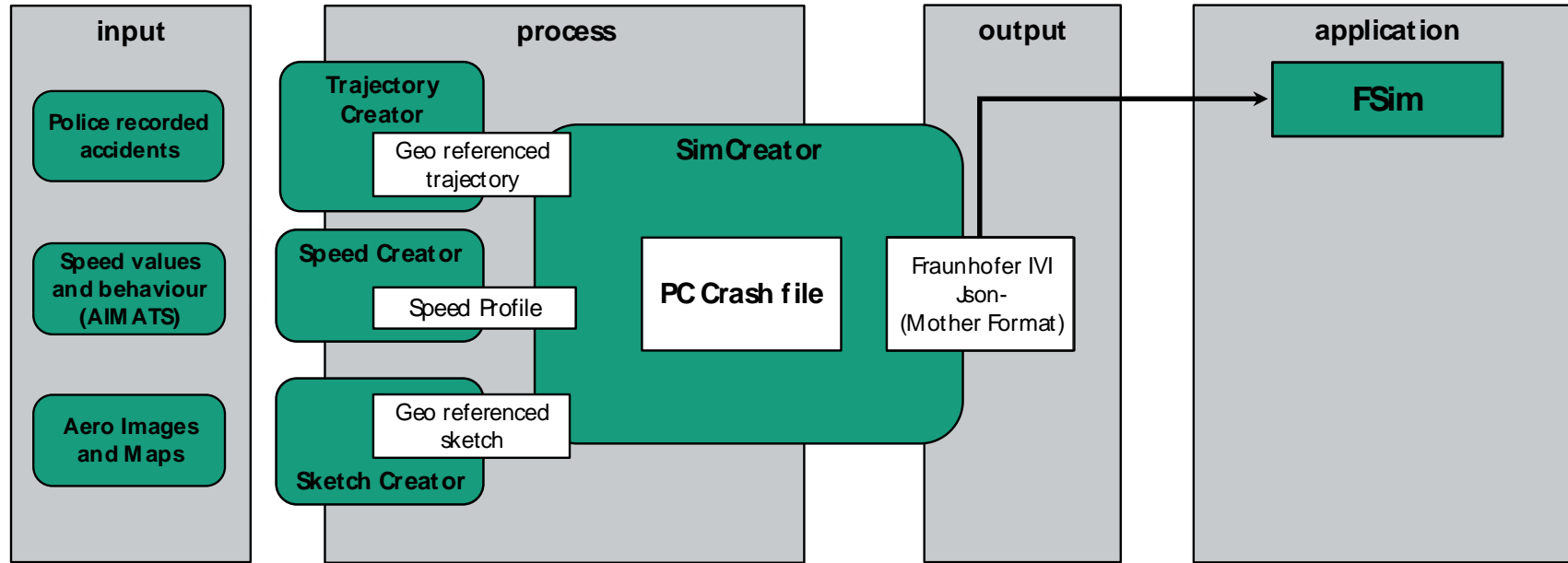


from police recorded accidents to simulation
store simulation results



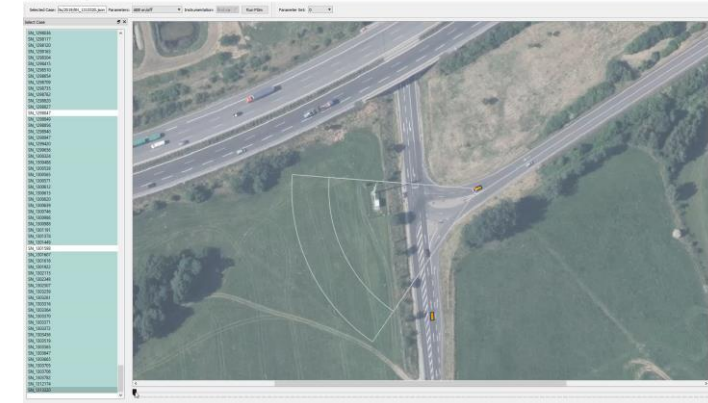
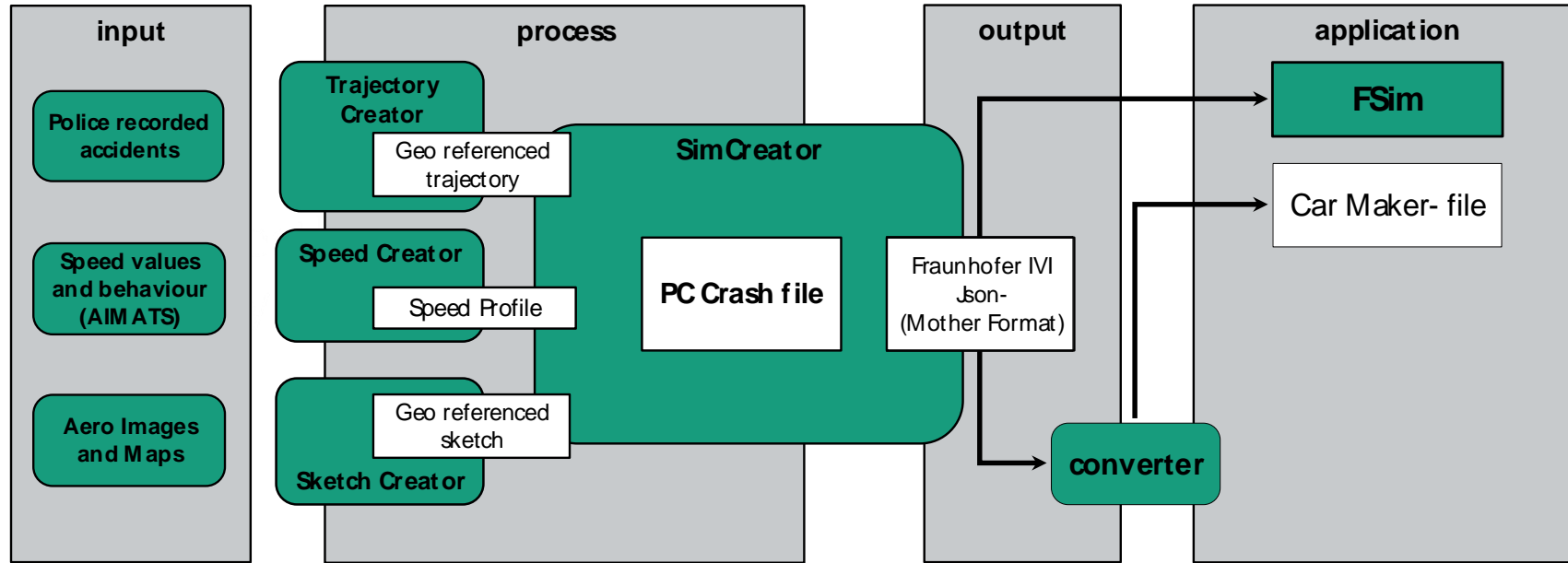
from police recorded accidents to simulation

- use in simulation Fraunhofer Simulation (Fsim)



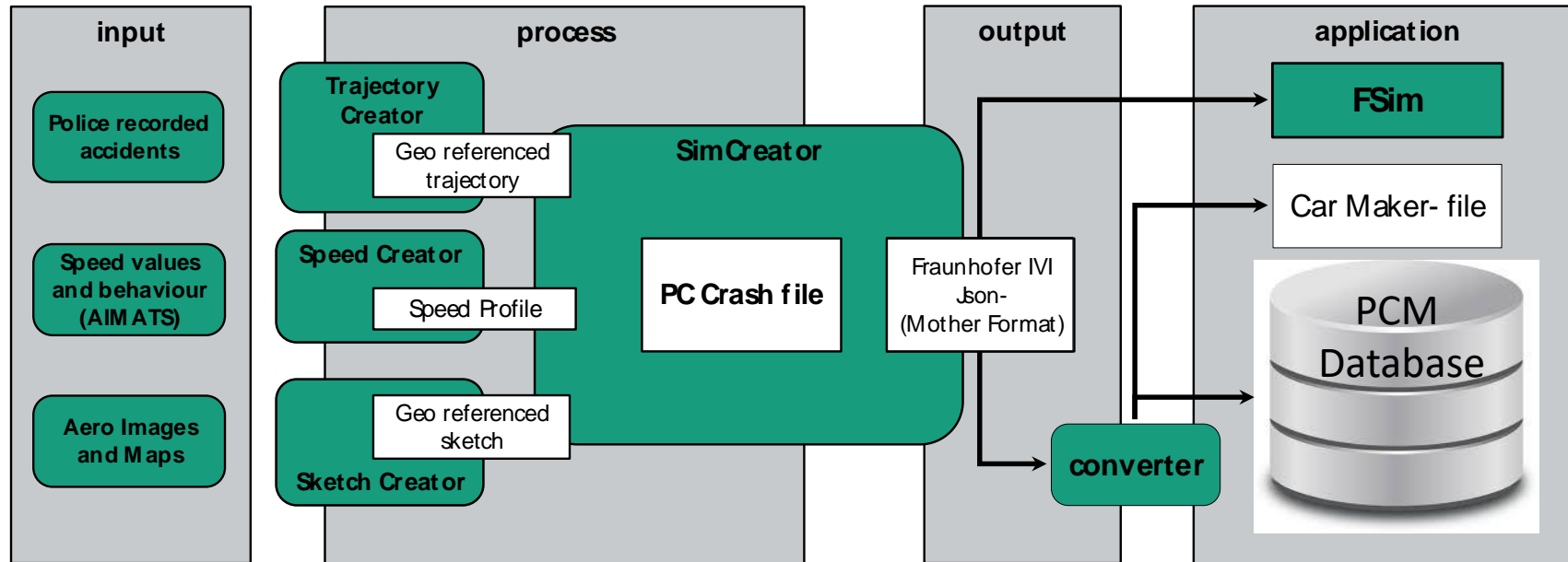
from police recorded accidents to simulation

- use in simulation IPG CarMaker



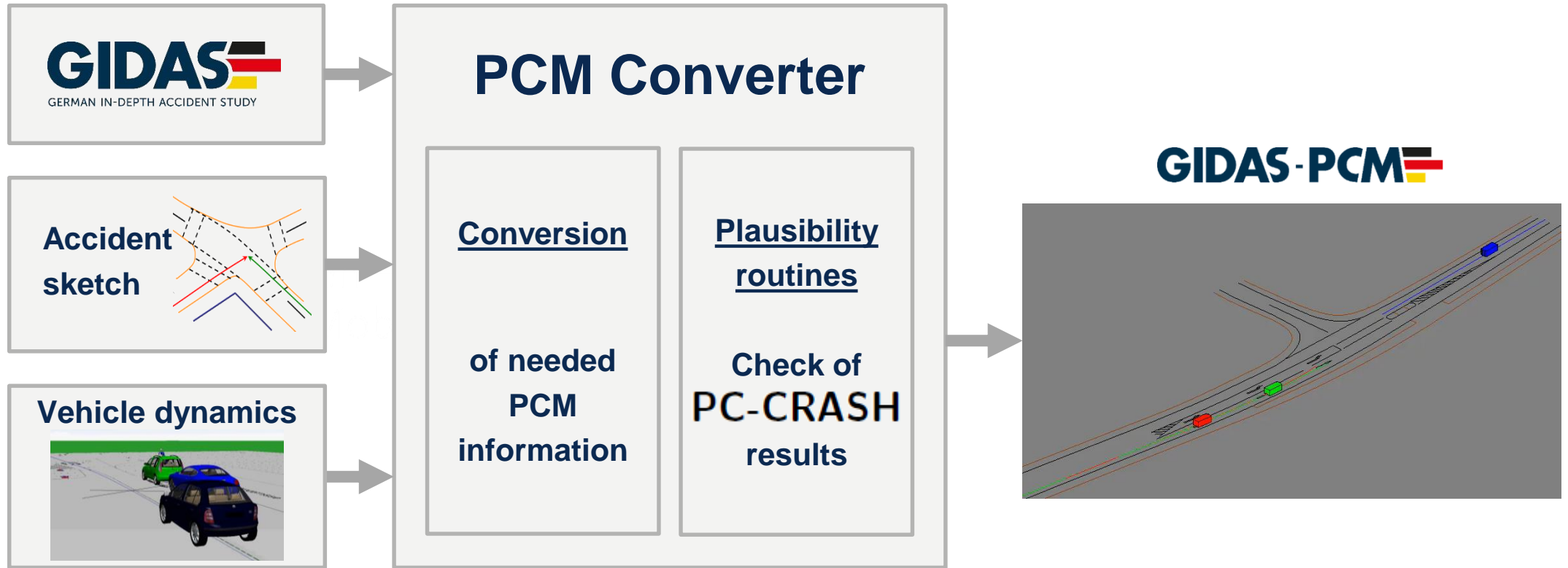
from police recorded accidents to simulation

- Store in PCM database



- 5.000 accidents per year
- 900 variations per accident







Naturalistic Driving Study (NDS)



Recording



Processing



Digitalized
Scenario



Florian Spitzhüttl – VUFO GmbH
Martin Urban – Fraunhofer IVI



Testbed Dresden – Synchronized Mobility 2023



Recording



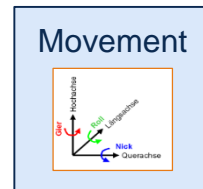
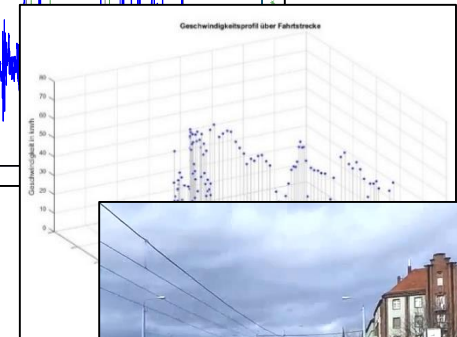
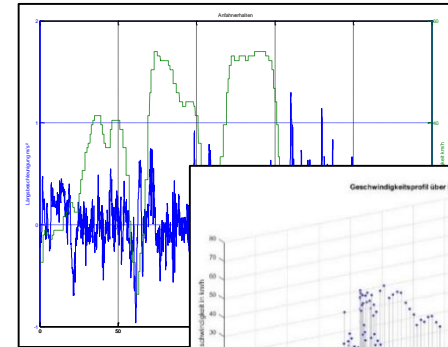
Processing



Digitalized Scenario



- Sensor data
 - Accelerometer
 - Rotation rate sensor
- GPS
- Camera
- Processor and ring memory



Florian Spitzhüttl – VUFO GmbH
Martin Urban – Fraunhofer IVI



Testbed Dresden – Synchronized Mobility 2023



Recording



Processing

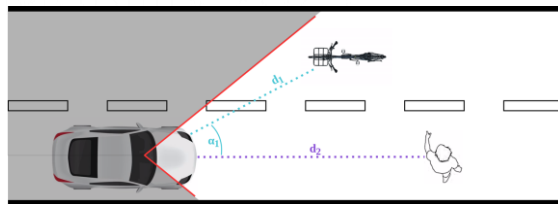


Digitalized Scenario

Object recognition and Object tracking



Distance estimation



GPS and map data



Methods and framework developed within the consortium of SePIA



PROFESSUR FÜR COMPUTERGRAPHIK UND VISUALISIERUNG

Prof. Dr. rer. nat. Gumhold



Florian Spitzhüttl – VUFO GmbH
Martin Urban – Fraunhofer IVI



Testbed Dresden – Synchronized Mobility 2023



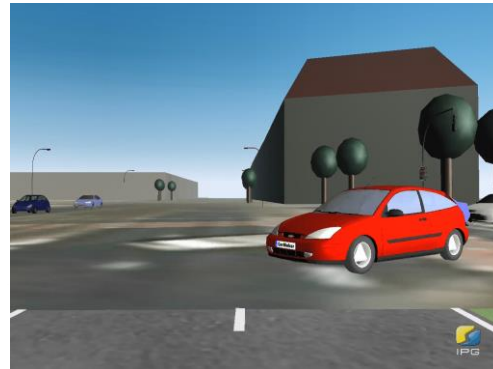
Recording



Processing

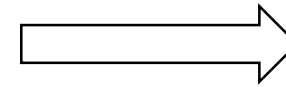


Digitalized Scenario

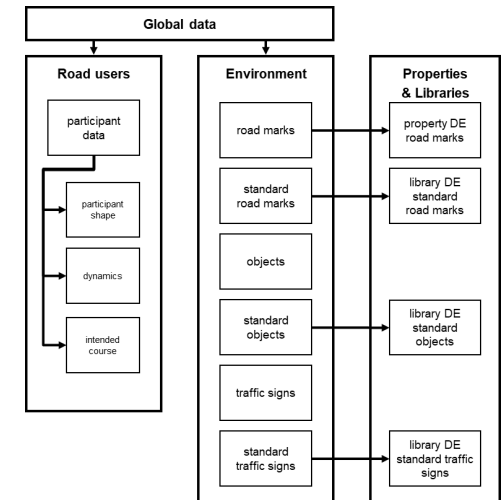


Parametrization / Detection of

- Ego vehicle
- Other participants
- Objects / buildings
- Road markings
- Traffic signs



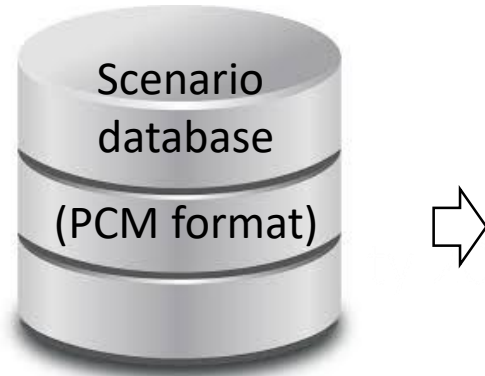
PCM format



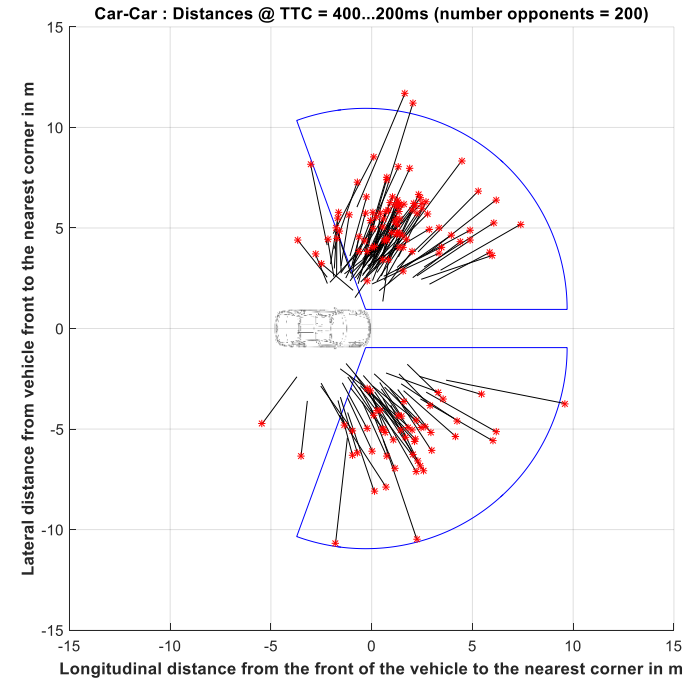
Florian Spitzhüttl – VUFO GmbH
Martin Urban – Fraunhofer IVI



Application: evaluation of opponent's position at specific times

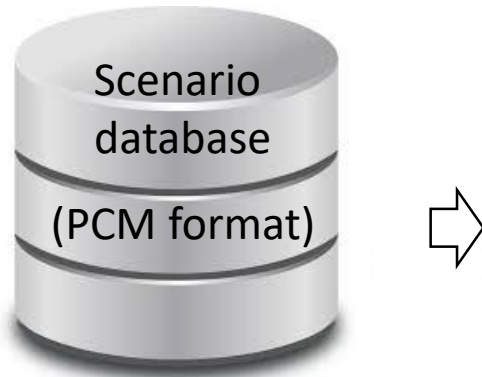


Florian Spitzhüttl – VUFO GmbH
Martin Urban – Fraunhofer IVI



- * 400 ms before crash
- 200 ms before crash

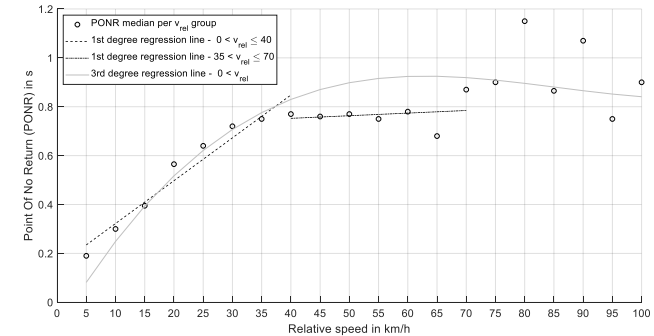
Application: assessment of scenario's criticality (e.g. Point Of No Return)



avoidance maneuvers



PONR^[1]
as function of v_{rel}



Application: assessment of scenario's criticality (e.g. Time To Collision)

