

# VERDAS

## VERification methods for Robust Driver Assist System performance Public report



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# 1. Table of Content

<b>1. Table of Content</b> .....	<b>2</b>
<b>2. Summary</b> .....	<b>3</b>
<b>3. Sammanfattning på svenska</b> .....	<b>5</b>
<b>4. Background</b> .....	<b>7</b>
<b>5. Purpose, research questions</b> .....	<b>8</b>
<b>6. Method</b> .....	<b>9</b>
6.1 Project methodology.....	9
6.2 WP 2 Field data analysis and definition of Robustness test scenarios .....	9
6.3 WP 3 Definition of Robustness test methods and Perception layers.....	12
6.4 WP 4 Development of virtual verification method chain and OpenSCENARIO and OpenDRIVE models .....	12
6.5 WP 5 Virtual test results and verification of results and validation of Virtual verification methods.....	12
6.6 WP 6 Verification tests at test track of robustness test methods with high and average performance ADAS and ADAS with new technology.....	13
6.7 WP 7 consist of Physical test protocol, Euro NCAP OpenSCENARIOS, repeatability and reproducibility of test results in dialog with other test labs .....	13
<b>7. Objective</b> .....	<b>14</b>
<b>8. State of the Art</b> .....	<b>14</b>
<b>9. Results and deliverables</b> .....	<b>15</b>
9.1 Field data analysis and definition of Robustness test scenarios .....	15
9.2 Definition of Robustness test methods and Perception layers.....	23
9.3 Development of virtual verification method chain and OpenSCENARIO and OpenDRIVE models.....	28
9.4 Virtual test results and verification of results and validation of Virtual verification methods .....	28
9.5 Verification tests at test track of robustness test methods with high and average performance ADAS and ADAS with new technology .....	29
9.6 Physical test protocol, Euro NCAP OpenSCENARIOS , repeatability and reproducibility of test results in dialog with other test labs .....	33
<b>10. Dissemination and publications</b> .....	<b>34</b>
10.1 Dissemination .....	34
10.2 Publication.....	34
<b>11. Conclusions and future research</b> .....	<b>35</b>
<b>12. Participating parties and contact persons</b> .....	<b>37</b>
<b>13. References</b> .....	<b>38</b>

## 2. Summary

The goal of the project was to support significantly improved road safety for automated vehicles by developing physical and virtual verification methods for the efficient development of Driver assistance systems to take care of a larger part of all accident scenarios and that the safety function performance should be robust in real-world accident scenarios.

The background to the project was that even if retrospective studies show reduction of seriously injured and killed it still shows limitations despite many years of development of Driver assistance systems and verification methods e.g. in Euro NCAP.

Euro NCAP has identified those limitations in Vision 2030 and the first introduction of verification methods for robust Driver assistance systems will be introduced in Euro NCAP rating 2026. To enable the verification of a larger number of all accident scenarios, virtual testing is required to complement physical testing. The rating will include a wider range of real-world accident test scenarios and robustness layers with e.g. traffic environments and other road users.

This project had a specific focus on accident scenarios with vulnerable road users. The project decided in the beginning of the project to narrow the focus to Pedestrian scenarios with Straight Crossing Path (SCP) accident scenarios.

The purpose of this research project was to support Euro NCAP with proposals of robustness physical and virtual test methods for Driver assistance systems for Euro NCAP 2026. The test methods are based on deep analysis of field data to take care of a larger part of all accident scenarios.

The main research questions were following:

- Which parameters are influencing reduced real life safety performance?
- Which real life scenarios are covered by Euro NCAP 2023 protocols for ADAS VRU systems?
- Which elements/parameters are most important to add or change to improve ADAS VRU performance with the Euro NCAP 2026 protocol for ADAS VRU systems?

The projects structured methodology:

1. Field data analysis and definition of Robustness test scenarios
2. Definition of Robustness test methods and Perception layers
3. Development of virtual verification method chain and OpenSCENARIO and OpenDRIVE models
4. Virtual test results and verification of results and validation of Virtual verification methods.
5. Verification tests at test track of robustness test methods with high and average performance ADAS and ADAS with new technology
6. Physical test protocol, Euro NCAP OpenSCENARIOs, repeatability and reproducibility of test results in dialog with other test labs

The focus in the VERDAS methodology was to capture the real-life parameters that need to be added or updated in the test methods in future Euro NCAP protocol.

Euro NCAP 2026 protocol will introduce only one parameter change in test scenarios based on Euro NCAP 2023 protocol. Euro NCAP 2029 protocol will include more than one parameter change, which will make it possible to capture the real-life scenarios more realistic. VERDAS was focusing on proposals towards Euro NCAP 2026.

VERDAS has used six different field data sets from Sweden and Germany.

The field data analyses in VERDAS have been made with descriptive statistics and case-by-case analysis data for the definition of Robustness test scenarios.

The VERDAS project has used a specific method to combine the descriptive statistics and the case-by case analysis to use representative cases in the analysis.

Statistics from car-pedestrian accidents show that SCPs are the most common accidents, accounting for 50–70% of all accidents.

SCP scenarios were analysed for different pre-crash factors that will influence the definition of Robustness test scenarios, e.g. posted speed limit, direction of the pedestrian, light conditions, obstructions.

The VERDAS project performed a large amount of case-by-case analyses with focus on infrastructure and clutter elements and/or obstructions for definition of Robustness layers. The analysis identified e.g. infrastructure and clutter as different types of posts, bollards, garbage bins and obstructions as parked/stopped vehicles and other pedestrians.

Based on the analyses of descriptive statistics and cases-by-case data was a list of tests scenario proposals defined for new Car-to-Pedestrian SCP test-scenarios for Euro NCAP 2026.

The definition of the test methods for the test scenarios included e.g. analysis of ADAS performance limitations and test equipment limitations.

Physical and virtual tests were performed in the test scenarios to verify ADAS performance and validate the proposed test scenarios and test methods.

VERDAS delivered test protocols with 26 proposed test scenarios for pedestrian SCP robustness layer scenarios towards Euro NCAP 2026. Euro NCAP has included the main part of them in Technical Bulletin CA 002 Verification conditions for robustness layers. and the rest in the standard protocol for Crash Avoidance Frontal Collisions.

AstaZero was leading the project, and the partners were Aptiv, Folksam, If, Terranet Tech AB, Toyota, Trafikverket, Viscando AB, VCC and Zenseact

### 3. Sammanfattning på svenska

Målet med projektet var att stödja en avsevärt förbättrad trafiksäkerhet för automatiserade fordon genom att utveckla fysiska och virtuella verifieringsmetoder för effektiv utveckling av förarstödssystem för att hantera en större del av alla olycksscenarioer och att säkerhetsfunktionens prestanda ska vara robust i verkliga olycksscenarioer.

Bakgrunden till projektet var att även om retrospektiva studier visar en minskning av allvarligt skadade och dödade, uppvisar det fortfarande begränsningar trots många års utveckling av förarstödssystem och verifieringsmetoder, t.ex. i Euro NCAP.

Euro NCAP har identifierat dessa begränsningar i Vision 2030 och den första introduktionen av verifieringsmetoder för robusta förarstödssystem kommer att introduceras i Euro NCAP rating 2026. För att möjliggöra verifiering av ett större antal av alla olycksscenarioer krävs virtuell testning för att komplettera fysisk testning. Klassificeringen kommer att omfatta ett bredare utbud av verkliga olyckstestscenarier och robusthetslager med t.ex. trafikmiljöer och andra trafikanter.

Detta projekt hade ett specifikt fokus på olycksscenarioer med utsatta trafikanter. Projektet beslutade i början av projektet att begränsa fokus till fotgängare i olycks-scenarier för Straight Crossing Path (SCP).

Syftet med detta forskningsprojekt var att stödja Euro NCAP med förslag på robusta fysiska och virtuella testmetoder för förarstödssystem inför Euro NCAP 2026. Testmetoderna baseras på djupgående analyser av fälldata för att hantera en större del av alla olycksscenarioer.

De huvudsakliga forskningsfrågorna var följande:

- Vilka parametrar påverkar minskad säkerhetsprestanda i verkligheten?
- Vilka verkliga olycksscenarioer täcks av Euro NCAP 2023-protokoll för ADAS VRU-system?
- Vilka element/parametrar är viktigast att lägga till eller ändra för att förbättra ADAS VRU-prestanda med Euro NCAP 2026-protokollet för ADAS VRU-system?

Projektets strukturerade metodologi:

1. Analys av fälldata och definition av scenarier för robusthetstest
2. Definition av metoder för robusthetstest och perceptionslager
3. Utveckling av virtuell verifieringsmetodkedja och OpenSCENARIO- och OpenDRIVE-modeller
4. Virtuella testresultat och verifiering av resultat samt validering av virtuella verifieringsmetoder.
5. Verifieringstester på testbana av metoder för robusthetstest med hög- och medelpresterande ADAS och ADAS med ny teknik
6. Fysiskt testprotokoll, Euro NCAP OpenSCENARIOs, repeterbarhet och reproducerbarhet av testresultat i dialog med andra testlaboratorier

Fokus i VERDAS-metodologin var att fånga de verkliga parametrarna som behöver läggas till eller uppdateras i testmetoderna i framtida Euro NCAP-protokoll.

Euro NCAP 2026-protokollet kommer att introducera endast en parameterändring i varje testscenario baserat på Euro NCAP 2023-protokollet. Euro NCAP 2029-protokollet kommer att inkludera mer än en parameterändring, vilket gör det möjligt att fånga verkliga scenarier mer realistiska. VERDAS fokuserade på förslag inför Euro NCAP 2026.

VERDAS har använt sex olika fältdataset från Sverige och Tyskland.

Fältdataanalyserna i VERDAS har gjorts med beskrivande statistik och djupstudiedata för definitionen av robusthetstestscenarier.

VERDAS-projektet har använt en specifik metod för att kombinera den beskrivande statistiken och djupstudieanalysen för att använda representativa fall i analysen.

Statistiken från bil-fotgängarolyckor visar att SCP är de vanligaste olyckorna, vilka utgör 50–70 % av alla olyckor.

SCP-scenarier analyserades för olika faktorer före olyckan som kommer att påverka definitionen av robusthetstestscenarier, t.ex. skyltad hastighetsgräns, fotgängarens riktning, ljusförhållanden, sikthinder.

VERDAS-projektet utförde en stor mängd djupstudieanalyser med fokus på infrastruktur och ”clutter” och/eller sikthinder för definitionen av robusthetslager. Analysen identifierade t.ex. infrastruktur och ”clutter” som olika typer av stolpar, pollare, soptunnor och hinder som parkerade/stannade fordon och andra fotgängare.

Baserat på analyser av deskriptiv statistik och djupstudiedata definierades en lista med förslag till testscenarier för nya SCP-testscenarier för bil-fotgängare för Euro NCAP 2026.

Definitionen av testmetoderna för testscenarierna inkluderade t.ex. analys av ADAS teoretiska prestandabegränsningar och testutrustningens tekniska begränsningar.

Fysiska och virtuella tester utfördes i testscenarierna för att verifiera ADAS prestanda och validera de föreslagna testscenarierna och testmetoderna.

VERDAS levererade testprotokoll med 26 förslag till testscenarier inför Euro NCAP 2026. Euro NCAP har inkluderat merparten av dessa i Technical Bulletin CA 002 Verification conditions for robustness layers och övriga i standardprotokollet för Crash Avoidance Frontal Collisions.

AstaZero ledde projektet och partnererna var Aptiv, Folksam, If, Terranet Tech AB, Toyota, Trafikverket, Viscando AB, VCC och Zenseact.

## 4. Background

Although retrospective studies show reduction of seriously injured and killed it still shows limitations despite many years of development of Driver assistance systems and verification methods e.g. in Euro NCAP, and the question is why the reduction is limited.

Today's physical verification methods of Driver assistance system only handle a subset of all accident scenarios even if the number of different accident scenarios has increased a lot since the first introduction of rating of Driver assistance systems 2014, see e.g. [1-4].

The rating scenarios are tested in very idealized conditions (see e.g. [5]) and with requirements which has been set based on previous State of the Art (SotA) technologies when the different rating scenarios were introduced.

Today's test scenarios are greatly simplified, which means that the detailed mechanisms are not captured.

Retrospective accident analyses of e.g. vulnerable road users show a limited safety effect of Driver assistant systems e.g. [6]. Other studies show that Driver assistance systems have reduced functionalities when the traffic environment is made more realistic with more road users and other objects in the test scenario and with variations in e.g. colours of clothes and vehicles respective light and weather conditions e.g. [7-9].

The conclusion of those limitations of tests methods and Driver assistance system performance is that the verification methods need to be further developed, to improve the overall robustness of Driver assistance system and that the test scenarios will reflect real accident situations more accurately to verify the performance in more real traffic environments.

Euro NCAP has identified those limitations in Vision 2030 [10] and the first introduction of verification methods for robust ADAS will be introduced in Euro NCAP rating 2026. In the Euro NCAP 2026 protocol, only one parameter will be added or changed in the test scenarios based on the test scenarios in the Euro NCAP 2023 protocol.

## 5. Purpose, research questions

The purpose of this research project was to support Euro NCAP with proposals of robustness physical and virtual test scenarios for Driver assistance systems for Euro NCAP 2026. The test scenarios are based on deep analysis of field data to take care of a larger part of all accident scenarios.

To enable the verification of a larger number of all accident scenarios, virtual testing is required to complement physical testing. A project goal for AstaZero, together with OEMs, Tier 1s and other partners, was to develop physical and virtual scenarios/methods and to verify that the virtual methods are valid in more realistic test environments.

The project focused on vulnerable road users (VRU) verification methods and specific on pedestrian scenarios. The level of innovation in the project consists, among other things, in evaluating SotA technical solutions of Driver assistance system, and algorithms based on new algorithm technology such as AI.

The project has included following steps: field data analyses, scenario definitions, development of physical test scenarios and virtual verification methods with test protocol and OpenSCENARIO files, verification of SotA Driver assistance system and moderate performance Driver assistance system, and proposal of robustness test methods to Euro NCAP.

The project has analysed what the current and upcoming SotA technology for Driver assistance system can fulfil in the extended accident scenarios representing more real traffic environment, to set requirement levels in future verification methods for robust Driver assist systems.

The project has used on-board data and on-site naturalistic data to combine with crash databases, enabling the development of more real accident scenarios for robust functionality of Driver assist system.

The project has included data about the driver acceleration, brake and steer reaction before and during the accident in the field data analysis.

The main research questions were following:

- Which parameters are influencing reduced real life safety performance?
- Which real life accident scenarios are covered by Euro NCAP 2023 protocols for ADAS VRU systems?
- Which parameters are most important to add or change to improve ADAS VRU performance with the Euro NCAP 2026 protocol for ADAS VRU systems?

## 6. Method

### 6.1 Project methodology

The project methodology has been to follow a stepwise approach, described below. The robustness verification development has been based on the flowchart in Figure 1. Today's use cases are greatly simplified, which means that the mechanisms are not captured. To tackle robustness therefore each accident scenario needs to be divided into a set of subgroups. This is important because many of the variables which the systems need to be robust against differ significantly between the subgroups. For each of the subgroups, the relevant parameters need to be found. The focus placed on capturing the relevant parameters is what distinguishes this project most from previous accidentology projects. The parameters which are captured include aspects such as e.g. road layout, other road users, infrastructure/clutter, adverse weather condition, glare, obstruction from moving or fixed elements, the driver behaviour as braking and steering in the pre-crash phases. The test scenarios which are created shall capture these parameters.

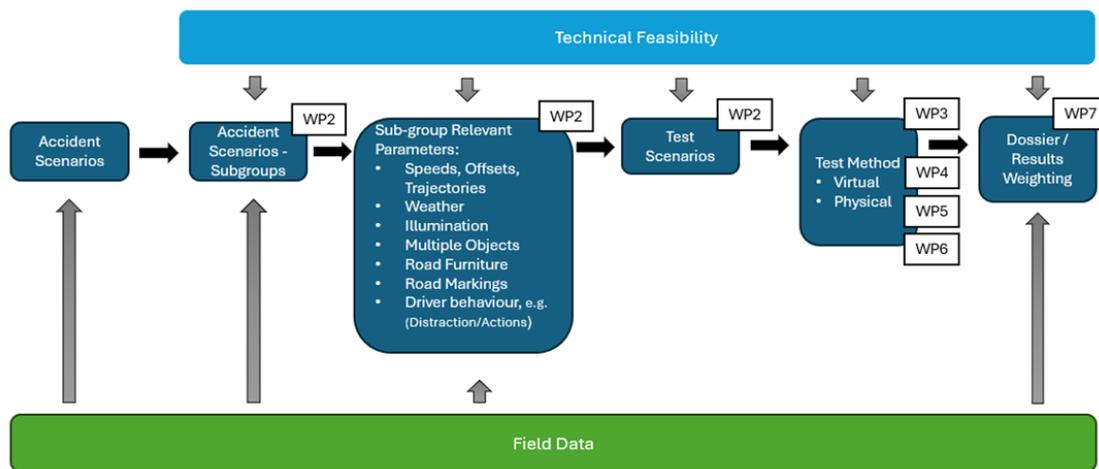


Figure 1: Flowchart of project's Working Package WP2 – WP7

### 6.2 WP 2 Field data analysis and definition of Robustness test scenarios

The field data analysis started with an overview of Euro NCAP's robustness matrix. The overview included to identify available field data analyses from previous projects [11-18], project partners and other literature [19-20]. The overview identified what can be updated in the accident scenarios in the matrix to increase the relevance for real life safety.

The field data analysis in WP2 focused on Straight Crossing Path accident scenarios for pedestrians. Identifying missing gaps in the crash data analyses and conducted an analysis of which parameters that was important towards Euro NCAP 2026 protocol update with regards to robustness and perception.

The following topics are important for a ADAS system to handle to increase its robustness and perception performance.

- Target type and classification
- Target appearance
- Degradation due to Adverse Weather Condition (AWC), illumination and contrast
- Target tracking, ability to follow an object in cluttered environment including obscuration
- ADAS intervention in real life safety conditions

The first main area of WP2 was to improve Crash Avoidance performance by a Robustness increased envelope, based on field data with analysis of which accident scenarios are covered with today's rating test scenarios from 2023, and which accident scenarios will be possible to handle with SotA systems in robustness tests 2026-2028.

The draft Euro NCAP robustness matrix is expanded by e.g. higher pedestrian velocities, smaller offsets and angles based on the current 2023 rating test scenarios. These are based on extracted field data and simplified average accident scenarios.

Each simplified accident scenario represents a cluster of sub-scenarios which will need different strategies for warnings and interventions. The field data analysis in this project needed to go deeper in the analysis of the sub-scenarios to identify what would be possible to include in robustness test scenarios towards 2026 and what will be needed to include in future ratings.

The second main area of WP 2 was Real life Perception layer variations of the test scenarios based on field data with analysis focused on target appearance, Traffic environment and other road user elements.

Analysis of various data sources (table 1) were performed. The project used both descriptive statistics and case-by-case analysis (figure 2).

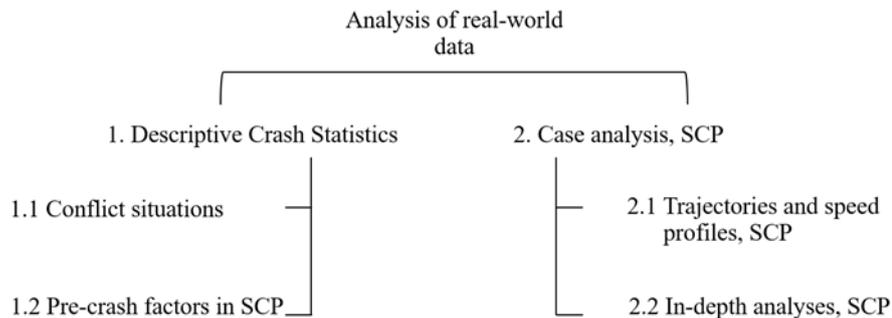


Figure 2: Overview of analysis. Numbers refer to sections in Results and to Table 1.

DATASET	DATA SELECTION	DATA FROM (YEAR)	SAMPLE SIZE	ANALYSIS
GIDAS	Car-to-Pedestrian crashes.	2003–2022	1976	1.1
Reconstructed two-participant crashes with known injury severity, December 2022 GIDAS release	Car-to-Pedestrian SCP crashes.	2003–2022	1017	1.2
	Car-to-Pedestrian SCP crashes.	2003-2018	35	2.2
GIDAS_ PCM	Car-to-Pedestrian SCP crashes.	2003-2018	471	2.1
	Car-to-Pedestrian SCP crashes.	2003-2018	35	2.2
PAV	Car-to-Pedestrian crashes.	2008-2024	1573	1.1
	Car-to-Pedestrian SCP crashes.	2019-2024	275	1.2
	Cars equipped with VRU-ADAS. Car-to-Pedestrian SCP crashes.	2020-2023	28	2.2
STA	Car-to-Pedestrian SCP crashes.	2009-2016	89	1.2
			24	2.2
STRADA	Car-to-Pedestrian SCP crashes.	2010-2020	8	2.2
V_PAD	Car-to-Pedestrian SCP crashes.	2000-2020	96	2.2
Viscando	Viken, Norway	2022-2024	Cars: 48856, Pedestrians: 2199	2.1
	Stockholm, Sweden Cars and pedestrians, SCP.		Cars: 38824, Pedestrians: 9089	
VCC-Fleet	Cars equipped with VRU-ADAS. Car-to-Pedestrian SCP crashes.	2022-2024	33	2.1 & 2.2

Table 1. Overview of used datasets with reference to Figure 1

The WP2 analysis has identified and delivered proposals of relevant robustness and perception layer elements and combination of elements in different accident sub-scenarios. Such as parameters for pedestrian appearance, other road users, infrastructure, and clutter specifications.

This input can be used both for the Euro NCAP 2026 as well as future test scenario updates.

### **6.3 WP 3 Definition of Robustness test methods and Perception layers**

In WP3, test scenarios have been developed based on the input from WP2, to reproduce the complexities of the accident scenarios on the test track. In the test scenario with added complexities, there are e.g. fixtures in and around the road which can cause challenges for the perception system. For example,

- row of bollards close to the pedestrian that could cause problems for radar.
- a stopped vehicle could be a temporary occlusion of a pedestrian.
- a second standing pedestrian close the road and pedestrian path.

In Euro NCAP 2026 rating protocol update, only one parameter will be changed or added based on Euro NCAP 2023 rating protocol.

Furthermore, based on the identified relevant factors during the field analysis in WP2, the work package has included development of additional reusable objects for perception layer scenarios.

### **6.4 WP 4 Development of virtual verification method chain and OpenSCENARIO and OpenDRIVE models**

The accidentology in WP2 created a list of prioritized scenarios which shall be tested. In this work package, OpenSCENARIO and OpenDRIVE models have been created for some of the prioritized scenarios. To capture the real-world complexities, a set of road fixtures has been created for OpenDRIVE which correspond to the road fixtures which were developed for the test track in WP3. Similarly, a set of roads and intersections with lane markings and zebra crossings which can be recreated on the test track has been created in OpenDRIVE.

### **6.5 WP 5 Virtual test results and verification of results and validation of Virtual verification methods.**

In work package 5 the virtual scenarios and a selection of corresponding physical test methods have been executed. Validation of the virtual scenarios shall primarily be achieved by comparing the performance of the system at the edges of the system's capabilities. The purpose has been to establish guidelines for spot testing to validate the virtual testing. It is not expected that the testing on test track will perfectly match the results from virtual testing and the results from this work package will help identify how much spot testing should be performed and how many re-runs should be tolerated when testing on test track does not match the predictions from virtual testing.

The consortium of OEMs and Tier 1's in the project runs the physical and simulated tests and analysis of the result and method from simulation and physical test. AstaZero has defined the credibility of method and argumentation, for the virtual verification from an independent approval organization.

## **6.6 WP 6 Verification tests at test track of robustness test methods with high and average performance ADAS and ADAS with new technology**

The verification tests were executed based on the test scenarios from WP3 and from some other Euro NCAP defined robustness test scenarios. The tests and considering the limitations of the test equipment (e.g. the pedestrian targets acceleration distance), the tests have given input to the potential improved Crash Avoidance robustness performance 2026-2028 and the relevance of the proposed Euro NCAP perception layers.

The robustness test scenarios matrix is large for both the increased Robustness envelope and the Robustness perception layer even for a limited scope of development of test scenarios in this project.

The tests needed to be done in iterations to build knowledge for the next step in the development.

It has been important for the project to continue deliver results to Euro NCAP and to follow the development from other partners in Euro NCAP.

## **6.7 WP 7 consist of Physical test protocol, Euro NCAP OpenSCENARIOS, repeatability and reproducibility of test results in dialog with other test labs**

In WP 7, AstaZero has supported Euro NCAP with development of some of the physical test protocols and some of the OpenSCENARIO and OpenDRIVE models for virtual testing. AstaZero have had dialog with other labs regarding the proposed test scenarios.

## 7. Objective

The goal of the project has been to support significantly improved road safety for automated vehicles by developing physical and virtual verification methods for the efficient development of Driver assistance systems to take care of a larger part of all accident scenarios and that the safety function performance should be robust in real-world accident scenarios.

The project has had a goal to support Euro NCAP with proposals of test scenarios & test methods based on field data towards Euro NCAP Crash Avoidance Robustness protocol 2026 and to deliver virtual & physical test results.

## 8. State of the Art

The Euro NCAP verification methods have been State of the Art and many other ratings (e.g. ANCAP, Latin NCAP, ASEAN NCAP, KNCAP, CNCAP) and legal requirements have been based on those verification methods.

Different Euro NCAP test labs and suppliers of test targets, target platforms and driving robots have continuously developed new test targets (e.g. [21-25]) and improved performance of the test methods e.g. [3].

There are still some limitations of the test targets related to acceleration and movement, e.g. when a pedestrian starts walking or running from standing still.

Virtual tests are done by OEM's and Tier 1's but have so far not been used in rating. Euro NCAP has a working group for Virtual Testing Active safety (VTA) and are planning to use VTA for verification of the expanded accident scenario envelope in robustness test methods 2026. It will be important that the verification methods are validated.

Today's rating test methods do not include driver input as braking and steering, which are very common driver reactions in real accident scenarios. The rating methods today have a steady-state of steering, acceleration and braking the seconds before collision which means they do not include driver input (see e.g. [5]).

Today's rating scenarios also do not include driver state input for autonomous interventions as AEB.

## 9. Results and deliverables

The result from the project is based on the work following the different steps in the project methodology described above.

### 9.1 Field data analysis and definition of Robustness test scenarios

The field data analysis in VERDAS was made with descriptive statistics and case-by-case analysis data for the definition of robustness layer test scenarios. See figure 2 and table 1 above. The analysis has included both pedestrian and cyclist data with focus on pedestrian data.

The VERDAS project has used following method in Figure 3 to combine the Descriptive statistics and the Case analysis to use representative cases in the analysis.

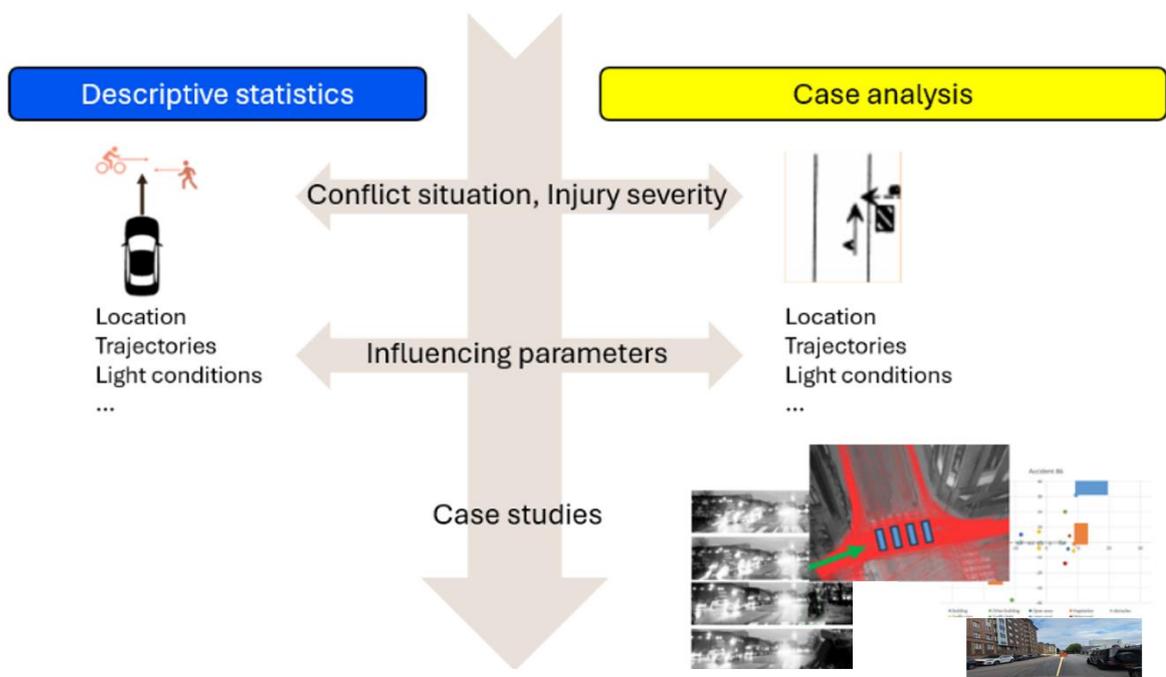


Figure 3: VERDAS method using multiple data sources

Results of detailed field data analyses for Descriptive statistics and Case analysis will be presented in an ESV paper 2026. Below follows summary of field data results.

**Results from Descriptive statistics**

The distribution of Car-to-Pedestrian/Cyclist crashes for all crashes shows a similar distribution between Swedish and German data in Figure 4.

**Statistics: Car-to-Pedestrian/Cyclist crashes**

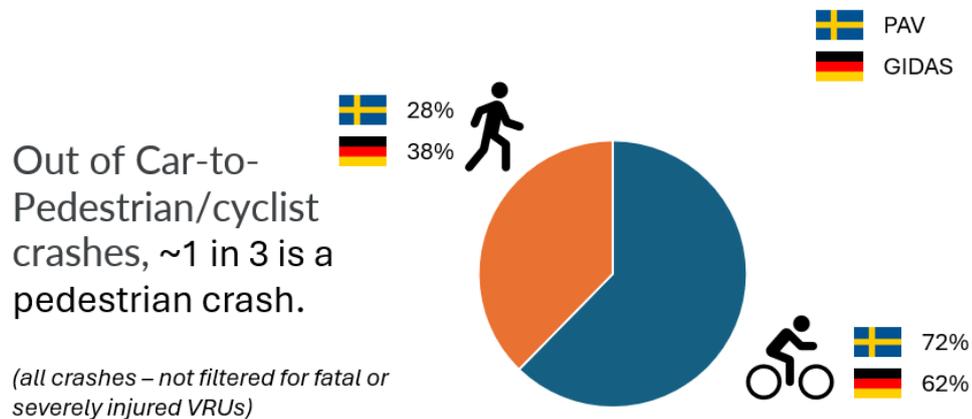


Figure 4: Car-to-Pedestrian/Cyclist crashes for all crashes in Sweden and Germany

The statistics from Car-to-Pedestrian crashes in Germany and Sweden shows in Figure 5 that Straight Crossing Path (SCP) are the most common crashes. In the VERDAS project application, the project had a plan to focus on Vulnerable Road Users (VRUs) verification methods, but the project decided to focus specific on Car-to-Pedestrian SCP scenarios based on the high frequency of SCP crashes and that environment parameters as infrastructure/clutter and obstructions has an important role in those crashes.

**Statistics: Car-to-Pedestrian conflict situation**

Among Car-to-Pedestrian crashes, Straight Crossing Path (SCP) crashes are the most common situations with:

- 49-67% of all crashes
- 50-72% of MAIS2+ crashes
- ~70% of fatal crashes

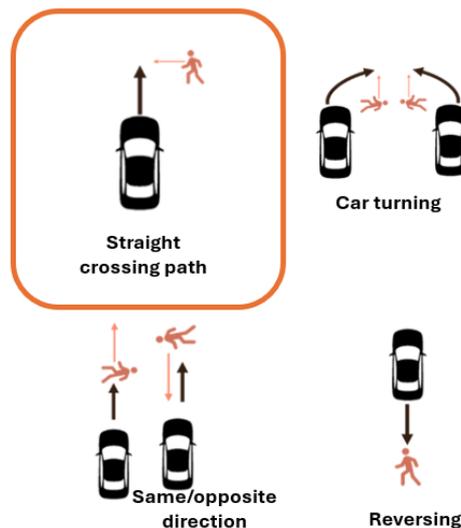


Figure 5: Car-to-Pedestrian conflict situations in Germany and Sweden

The SCP scenarios were analysed for different pre-crash factors that influenced the definition of Robustness test scenarios. Statistics for some of the most important precrash factors are shown in figure 6.

The proportion of the accidents with sight obstruction is proportional distributed between pedestrians crossing from left and right.

### Statistics: Pre-crash factors for Car-to-Pedestrian SCP

	 GIDAS	 PAV	 fatal
<u>Posted speed limit = 40-50 kph</u>	76%	59%	90%
<u>Pedestrian from right</u>	59%	61%	65%
<u>Darkness/Dusk/Dawn</u>	29%	38%	57%
<u>Sight obstruction</u>	42%	37%	.

Figure 6: Pre-crash factors for Car-to-Pedestrian SCP

### **Results from qualitative data: Case-by-case analysis**

In previous projects, the analyses relied on techniques for aggregating data to a higher level of abstraction. There are in general limited analysis of case-by-case analyses as e.g. Pedestrian PCM data in previous projects. The VERDAS project has performed a large amount of case-by-case analyses for Car-to-Pedestrian SCP scenarios in the different data sets for the definition of in robustness layer test scenarios with focus on infrastructure and clutter elements or/and obstructions.

Six different data sets were used for case-by-case analysis. The cases from the different data sets had a similar distribution as the descriptive statistics with regards to pedestrians crossing from right with/without obstructions and pedestrians crossing from left with/without obstructions.

In only a few cases where there are no infrastructure or clutter elements present, where the accident environment could be described as similar to the current clean idealized physical verification methods of Driver assistance system. Most cases include not only one but a combination of infrastructure and clutter elements or/and obstruction that could have had influence on the ADAS performance of object detection and tracking.

The most common infrastructure and clutter elements were different types of posts, which could be seen in the main part of cases with infrastructure/clutter. These could be grouped into three main categories based on the post thickness: streetlight post, traffic light post and traffic signpost. In almost all cases with posts there were multiple posts in the field of view for the sensor system. Other elements but less frequent than posts were rows of bollards, fences, guard rails, electrical cabinets, garbage bins.

In over half of the cases, visibility was obstructed. The most common cases were pedestrians walking out behind or between parked vehicles or behind temporarily stopped vehicles in adjacent lanes. Buildings and hedges close to the road were also found obstructing the view, although less frequently.

The presence of other VRUs at the time of the accident is based on image recorded on camera for the Volvo-Fleet dataset for the other datasets it is bases on witness statement. It can though be seen in the VCC Fleet data, that in around one fifth of the accidents there are other VRUs in the vicinity (0-7m) of the pedestrian.

### **Example of case analyses in VERDAS**

Examples of case-by-case analysis from the different data sources are shown in figure 7-12 below.

- **Case-by-case analysis / GIDAS PCM**

case-by-case analysis / GIDAS PCM

pre-crash reconstructions with information on speeds and trajectories

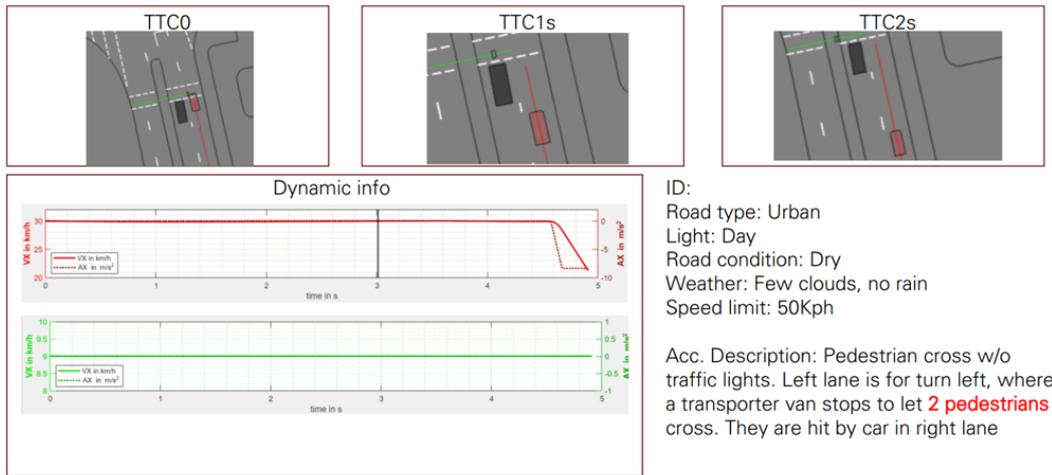
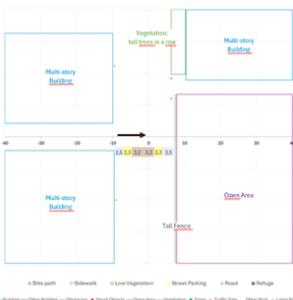
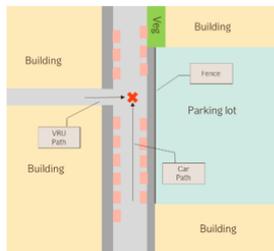


Figure 7: Example of case-by case analysis of GIDAS PCM data by Toyota

- **Case-by-case analysis / PAV (If)**

Illustration of in-depth information collection for crashes in PAV for 2.2, using a fictive case.



For each crash, the aim was to express details of the infrastructure and surrounding environment as datapoints, in relation to the paths of both vehicles and pedestrians.

1. Photographs of the accident site and information in insurance files were revisited.

2. Measurements were taken of a) the road layout, and b) distances from the collision point to nearby objects such as obstacles, buildings, parking areas, and vegetation. This approach provides a clear overview of traffic elements and potential view obstructions.

Figure 8: Example of case-by case analysis of PAV data by If

- **Case-by-case analysis / V\_PAD (Volvo Cars)**  
 case-by-case analysis / V\_PAD  
 Volvo vehicles, pre-crash reconstructions

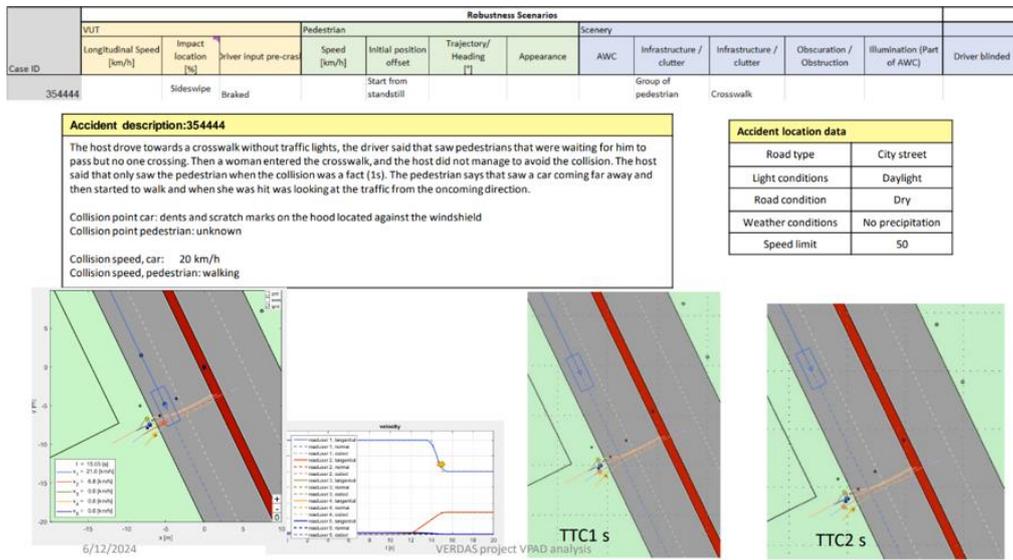


Figure 9: Example of case-by case analysis of V-PAD data by VCC

- **On-site traffic data analysis / Viscando**  
 Illustration of on-site traffic data measurement example with pedestrian starting position when crossing from either side of the road.

on-site traffic data / Viscando

objective data,  
 many pedestrians & vehicles,  
 many datapoints per pedestrian



Pedestrian starting location when stepping out on the road



42%-53% of pedestrian steps out within the width of painted zebra-markings.

Figure 10: Example of on-site traffic data analysis by Viscando.

- **On-board data analysis / Volvo-Fleet (Volvo Cars)**

Two cases (day and night) of on-board data from Volvo-Fleet.

on-board data  
/Volvo Cars  
ADAS interventions,  
objective data,  
many datapoints per  
pedestrian



View obstructions vs  
host vehicle  
speed/position:



Figure 11: Example of on-board data case (day) Volvo-Fleet.

on-board data/  
Volvo Cars  
ADAS interventions,  
objective data,  
many datapoints per  
pedestrian



Darkness, rain,  
oncoming vehicles  
with headlights.



Figure 12: Example of on-board data case (night) Volvo-Fleet.

### Definition of Robustness test scenarios

These findings in descriptive statistics and case-by-case analysis give input to changes within existing Euro NCAP test-scenarios, and for the proposal of new Car-to-Pedestrian SCP test-scenarios with robustness layers. As a first step towards the Euro NCAP 2026 protocol update, only one parameter will be added to the current rating test scenarios.

Based on the results above and deeper analysis of the case data with regards to, for example, the appearance and position of the most relevant infrastructure/clutter elements. A list towards the Euro NCAP 2026 update was created with 26 proposals with one parameter change for new Car-to-Pedestrian SCP test-scenarios with robustness layers, to better mirror real-world conditions. For future updates with possible change of multiple parameters new list could be created based on the analysis.

### Coverage of Car-to-Pedestrian real-life crashes vs Euro NCAP tests 2023

To estimate the coverage of the real-world car-to-pedestrian crashes by Euro NCAP 2023 Car-to-Pedestrian tests. GIDAS Car-to-Pedestrian data was filtered with the Euro NCAP 2023 Car-to-Pedestrian tests and its defined parameters. This showed that the Euro NCAP 2023 tests approximately covered 10% of Car-to-Pedestrian crashes. The figure 13 shows the potential of different robustness elements in increasing the coverage of crash data. Some of these results were published at the Euro NCAP Update event in December 2024.

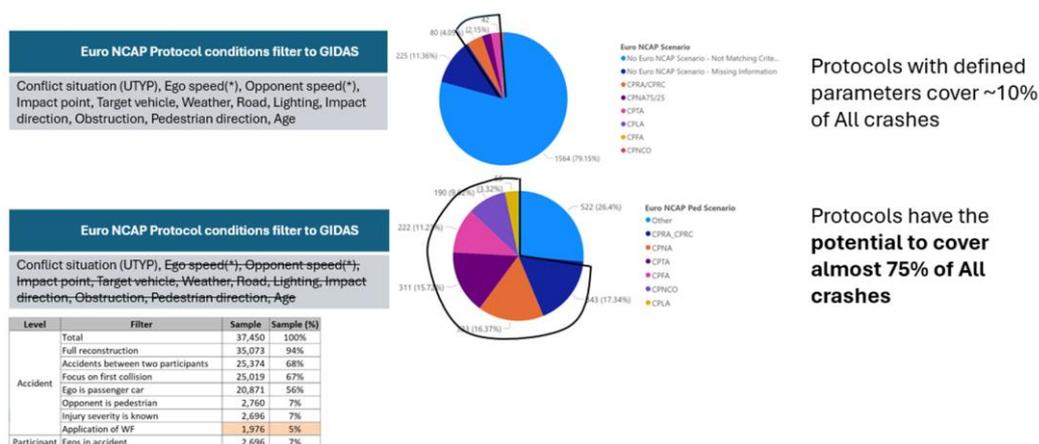


Figure 13: Coverage of Car-to-Pedestrian real-life crashes vs Euro NCAP test 2023

## 9.2 Definition of Robustness test methods and Perception layers

In the in-depth analyses of the case data, a description of each of the case was done with a scenario sketch (see figure 14.). Compiling situation elements in the accident scenario that might influence the detection and tracking of the pedestrian and hence the ADAS performance. Like the road layout, illumination, weather condition, fixed elements (e.g. posts, tree/hedges, fences etc) and other road users (e.g. vehicles, bicyclists, pedestrians). Google map street view was also used as a complement to determine the type of fixed elements and their positions.

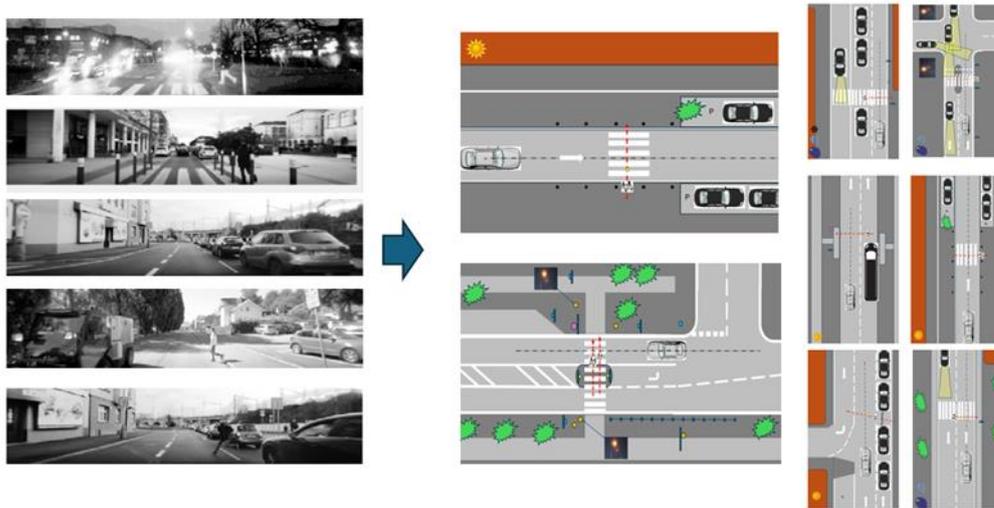


Figure 14: Compiling situation elements from case-by-case crashes

The most common and important elements and parameters that might influence the ADAS performance were compiled from all cases.

To support Euro NCAPs robustness update of the 2026 protocols with test scenario proposals. A comparison was made between the accident scenarios and the test scenarios in the 2023 protocol (Figure 15), to select the elements/parameters derived from the case-by-case analyses. Euro NCAPs limitation for the 2026 protocol update was though only one element/parameter change compared to the 2023 protocol for each test case.

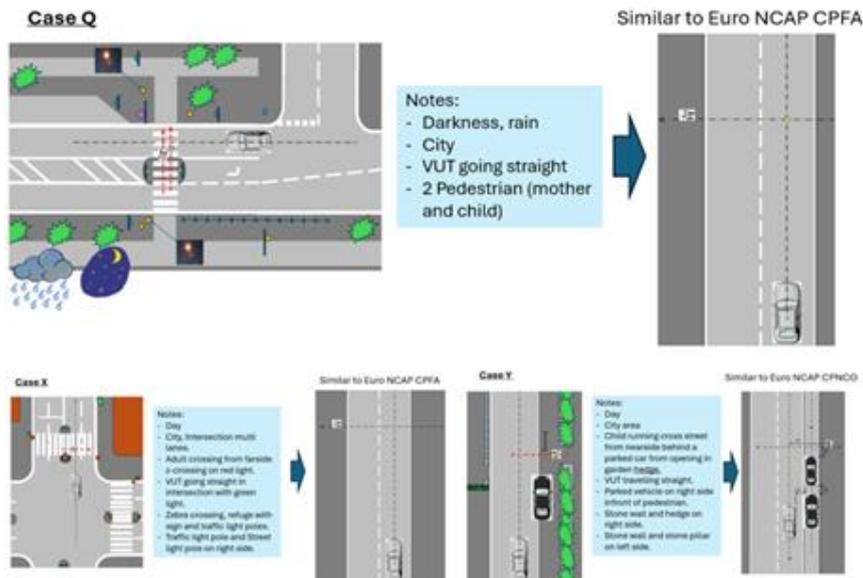


Figure 15: Comparison with Euro NCAP 2023 test scenarios.

A list of 26 test case proposals was created from the selected parameters and elements. To finalize the layout for the test case proposals a comparison was made with layouts in traffic environment in different EU countries. Among other things standards for road layouts and Google Map street view were used. This provided input data on, for example, dimensions, appearance, position relative to vehicle path, pedestrian crossing.

In figure 16 to the

left Euro NCAP test layout for Car-to-Pedestrian Nearside Adult,

centre examples of pedestrian crossings layout in Sweden, also compared with European examples from Google Maps Street view e.g. 43 Bondgenotenlaan, Leuven Belgium (50.879983515592954, 4.707532776998711), R. do Comércio 178 Lisabon (38.70843917254758, -9.13865483089815) and 50 Lugengasse, Cologne (50.935069886104806, 6.946216429231167).

right some examples of proposed added infrastructure element.



Figure 16: Traffic environment comparison

With this information, the layout for the 26 different test case proposals with added robustness layer was specified. Based on the Euro NCAP 2023 test scenarios with one parameter/element change. Figure 17 show some examples.

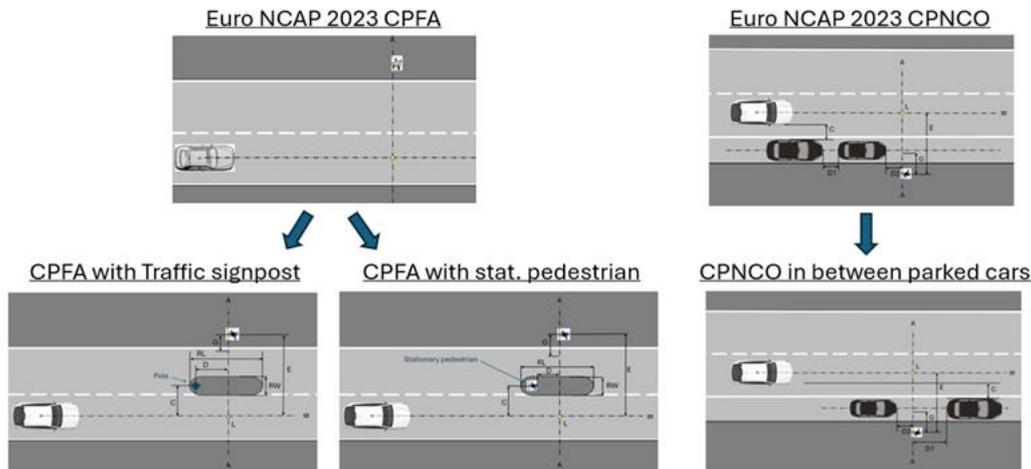


Figure 17: Proposal of Test cases with added robustness layer

Both a theoretical technical feasibility check and an iterative process of verification tests in WP6, was performed for each of the test case proposals, regarding test equipment and ADAS limitations (figure 18). To determine that the tests could i) be performed within Euro NCAPs applicable specification and test conditions and ii) be reasonable based on theoretical detection-classification-activation limits and false/positive balance.

The test methods also need to take the technical feasibility in consideration. Both regarding the test equipment as well as the ADAS.

- Test equipment limitations.
- Theoretical limits for ADAS.

Detection-Classification-Activation  
Balancing False/Positive.

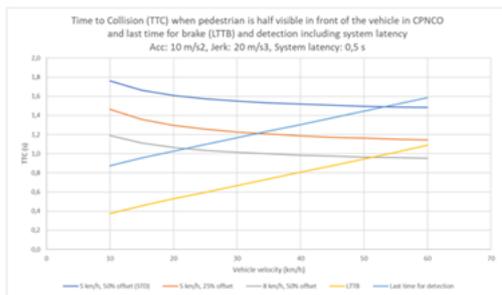
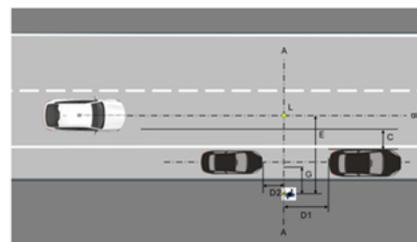


Figure 18: Feasibility check

CPNCO – 50% with pedestrian walking in between parked vehicles

Standard CPNCO-50% with 1<sup>st</sup> parked vehicle moved to behind the pedestrian path. Allowing the pedestrian to walk in between the two vehicles.



Axis	Values
AA	Trajectory of pedestrian dummy H-point in std CPNA
BB	Axis of centreline of Vehicle under test
Distances	
E	Dummy H-point start to 50%-impact 4.0m
G	Dummy acceleration distance (walking) 1.0m
C	Distance between Vehicle under test and larger obstruction vehicle 1.0m
D2	Distance dummy H-point to front of obstruction vehicle 1.0m
D1	Distance dummy H-point to rear of the parked vehicle behind the pedestrian path. 1.3m
Points	
L	Impact position for 50% scenarios

The final proposal of 26 Car-to-Pedestrian Straight-Crossing-Path test cases for Euro NCAP 2026 protocols update with regard to robustness was as follows (Table 2).

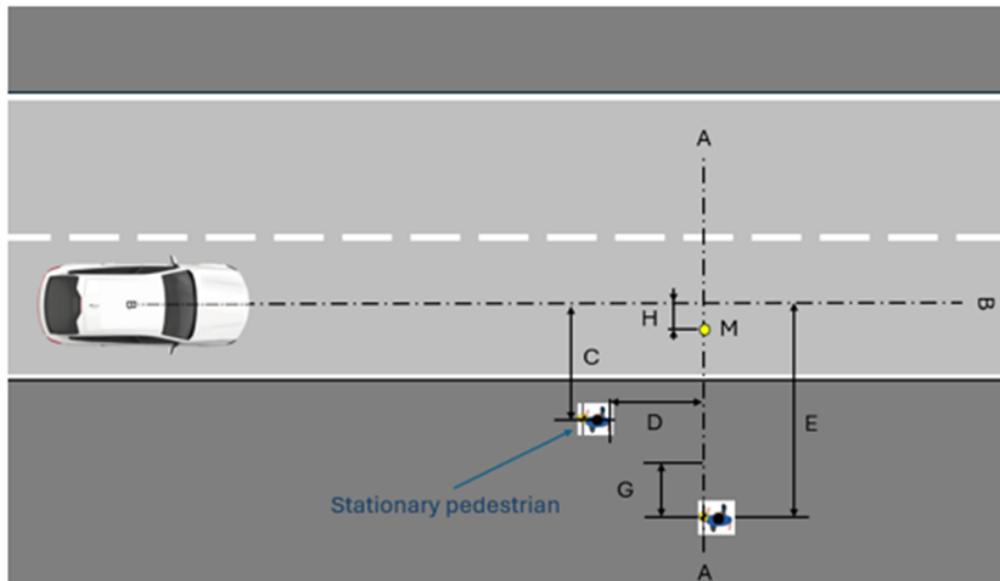
VERDAS test case proposal	Euro NCAP 2023 scenario (baseline)	VERDAS test case proposal description for 2026 update (Euro NCAP 2023 with one change of parameter, element regarding perception and obstruction)	
		Purpose	Description of the change proposal
A.1	CPNA 25% & 75%	Target	Use of child pedestrian instead of adult pedestrian.
A.2	CPNA 25%	Parameter	Pedestrian starting position closer to the road at 3.0m (4.0m-25%).
A.3	CPNA 25%	Parameter	Decreased impact point 10% instead of 25%.
A.4	CPNA 25%	Parameter	Increased pedestrian speed, running 8km/h instead of walking 5 km/h.
A.5	CPNA 25%	Parameter	Pedestrian trajectory variation +/- 20deg from 270deg.
A.6	CPNA 25%	Perception	Car (dark colored) parked to right side behind the pedestrian path.
A.7	CPNA 25%	Obstruction	Adult pedestrian dummy standing nearside in front of pedestrian path.
A.8	CPNA 25%	Obstruction	Electrical cabinet/trash bin positioned nearside in front of pedestrian path.
A.9	CPNA 25%	Obstruction	Streetlight post positioned nearside in front of pedestrian path.
A.10	CPNA 25%	Obstruction	Traffic light post positioned nearside in front of pedestrian path.
A.11	CPNA 25%	Obstruction	Traffic signpost positioned nearside in front of pedestrian path.
A.12	CPNA 25%	Obstruction	Parked bicycles positioned nearside in front of pedestrian path.
A.13	CPNA 25%	Obstruction	Row with multiple bollards positioned nearside in front of pedestrian path.
A.14	CPNA 25%	Obstruction	Low traffic signpost positioned nearside in front of pedestrian path
A.15	CPFA 50%	Target	Use of child pedestrian instead of adult pedestrian.
A.16	CPFA 50%	Obstruction	Traffic light post positioned far side in front of pedestrian path.
A.17	CPFA 50%	Obstruction	Traffic signpost positioned far side in front of pedestrian path.
A.18	CPFA 50%	Obstruction	Adult pedestrian dummy standing on far side in front of pedestrian path.
A.19	CPFA 50% (day)	Perception	Stopped oncoming car in adjacent lane behind pedestrian path. (Day time)
A.20	CPFA 50% (night)	Illumination (Glare)	Stopped oncoming car in adjacent lane behind pedestrian path. With low beam and streetlights (Nighttime),
A.21	CPNCO 50%	Parameter	Decreased impact point 25% instead of 50%.
A.22	CPNCO 50%	Parameter	Pedestrian starting position closer to the road at 3.0m (4.0m-25%).
A.23	CPNCO 50%	Parameter	Increased pedestrian speed, 8 km/h instead of 5 km/h.
A.24	CPNCO 50%	Perception	Child pedestrian walking in between parked cars.
A.25	CPNCO 50%	Obstruction	Cars parked in reverse order compared to 2023, with larger car as 2 <sup>nd</sup> car.
A.26	CPNA 25% (night)	Illumination (Glare)	Stopped oncoming car in adjacent lane behind pedestrian path. With low beam and streetlights (Nighttime),

Table 2: VERDAS – the 26 proposed test scenarios for Euro NCAP 2026

Each of the proposed 26 Car-to-Pedestrian SCP robustness test cases above, was described in more detail based on the Euro NCAP 2023 test scenario description. As an example, test details for the proposed test scenario A.7 are shown in figure 19 below.

**A.7 CPNA – 25% with stationary pedestrian in front of pedestrian path**

Standard CPNA-25% with stationary pedestrian standing before walking pedestrian path AA.



Axes		Values
AA	Trajectory of pedestrian dummy H-point in std CPNA	
BB	Axis of centreline of Vehicle under test	
Distances		
E	Dummy H-point, start to 50%-impact	4.0m
G	Dummy acceleration distance (walking)	1.0m
C	Stationary dummy H-point to VUT centreline BB	2.5m
D	Stationary dummy right shoulder to pedestrian path AA	1.0-1.5m
H	Impact point offset for 25%	
Points		
M	Impact position for 25% nearside scenario	

Figure 19: Test scenario description for VERDAS proposal A.7

### 9.3 Development of virtual verification method chain and OpenSCENARIO and OpenDRIVE models

AstaZero created OpenScenario and OpenDrive files of the tests requested from the project, that could be used to compare virtual and physical tests.

These Scenarios include

- CPNA-25: Pedestrian adult, with start position of target 2.5m, (A.2 variant)
- CPNA-25: Pedestrian adult & angled trajectory 250 and 290 degrees, (A.5)
- CPNA-25: Pedestrian adult & stationary pedestrian in front of path. (A.7)
- CPNCO-50: Pedestrian child obscured std,
- CPNCO-25: Pedestrian child obscured std with 25% offset
- CPNCO-50: Pedestrian child obscured std with target 8km/h instead of 5km/h. (A.23)

The created OpenScenario files from AstaZero were distributed together with OpenDrive files of the proving ground where partners could run the physical or virtual test.

After the creation of these files' methods and software were developed to create driving files for robots that correspond to the OpenScenario files to make it easier and faster to run the same test in the physical world as the Scenarios that is executed in the simulated world. To facilitate a simpler and faster way to analyse and compare a physical and virtual test, for validation and verification of simulation models.

Methodology and code were also developed to analyse physical and virtual tests given they are given in ISO-MME files, AstaZero started by following the scoring and analysis given by Euro NCAP VTA group.

### 9.4 Virtual test results and verification of results and validation of Virtual verification methods

OEM and Tier 1 suppliers gave data from their virtual tests, this together with physical test data from robots were then used to compare physical and virtual tests as described in Euro NCAP supporting protocol for virtual testing active safety [26] AstaZero used the same methods as Euro NCAP work method, took the input data converted it to ISO-MME then did the comparison and analytics. The virtual testing assumes ideal sensors. In the future the perception stack might be included into the virtual tests but that is something for future projects to look in to and have the potential to increase the robustness of ADAS systems in the future. But for Vehicle dynamics testing this method can help validate the simulated dynamics model for a vehicle. As seen in figure 20 below the Vehicle model performs similar in physical and virtual tests but there are some differences.

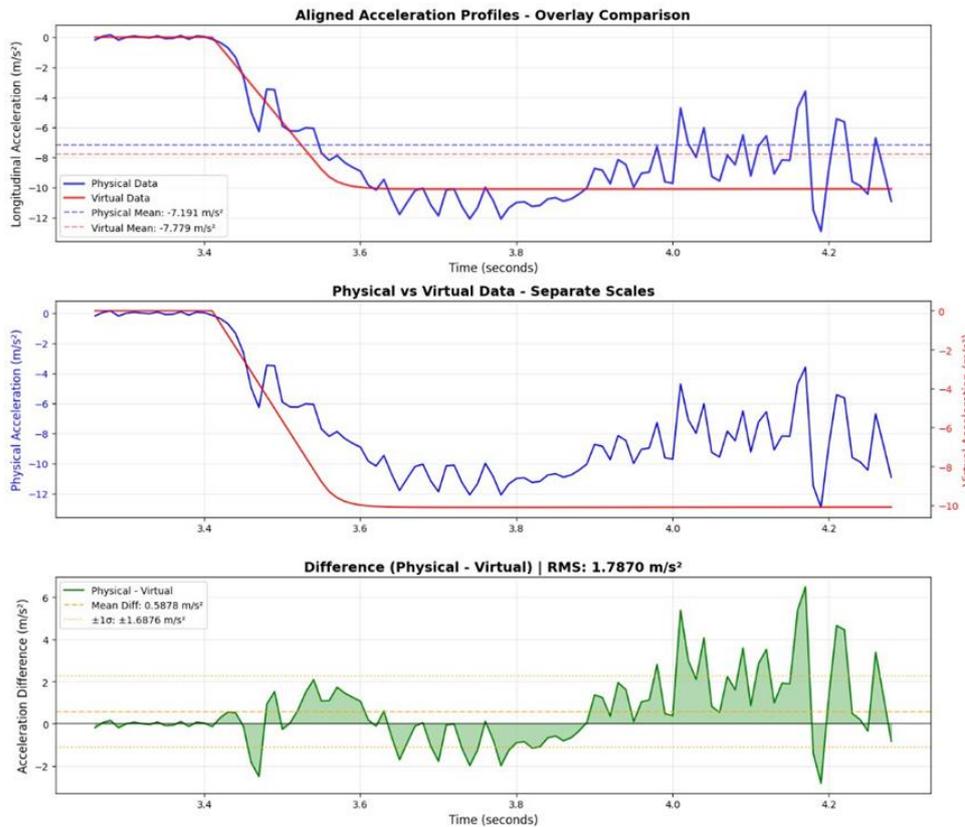


Figure 20. Show the behaviour of the vehicle model compared with the physical tests.

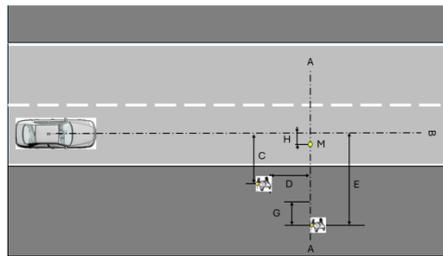
### 9.5 Verification tests at test track of robustness test methods with high and average performance ADAS and ADAS with new technology

Verification tests were performed of the proposed Car-to-Pedestrian SCP test scenarios in multiple loops on test track. Three different ADASs were tested (two classified as high-end and one average system).

Test results from some of the performed tests can be seen in figure 23-28 below and in figure 21-22 are information how to read the result tables.

The test scenario is marked in the headline, on the left side is description of the layout and test parameters. The altered parameter compared to Euro NCAP 2023 test scenario is marked with red text. On the right side is a result table, the first column states the parameter change and the test speeds, the second column marked “Best in Group” are the results from the best of the three systems in that test scenario (see figure 22). The next three columns marked “Vehicle” are the results from the tests of the three different systems. The figures in the cells are the impact speed in km/h and normally multiple tests are run per test speed. The order of the systems is changed between the tests.

CPNA – 25% Adult / Stationary pedestrian in front of pedestrian path



Stationary pedestrian Infront of ped.path	Best in Group	Vehicle.	Vehicle.	Vehicle.
10 km/h				
20 km/h	0		13,18	0,0,0
30 km/h				
40 km/h	0	40	0,31	0,0,0,0
50 km/h				
60 km/h	0		0,8,32	0,0,0,0

**Test setup**  
 VUT: speed 10, 20, 30, 40, 50 & 60 km/h  
 Impact loc 25%  
 Target: type Ped adult, normal clothing  
 speed 5km/h  
 start pos E 4 m  
 Environment: Stationary adult pedestrian  
 C= 2.5m  
 D= 1m

Road lane marking:

Figure 21. Example of test results and how to read it.

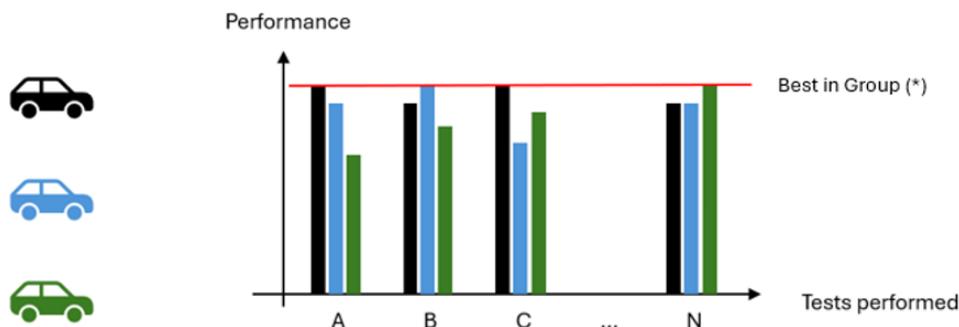
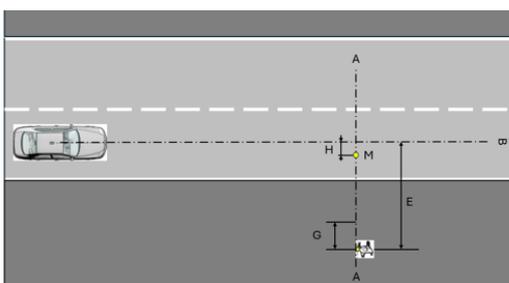


Figure 22. Explanation “Best in Group”.

CPNA – 25% Adult , Standard Euro NCAP test scenario 2023.

CPNA = Car – Pedestrian – Nearside – Adult

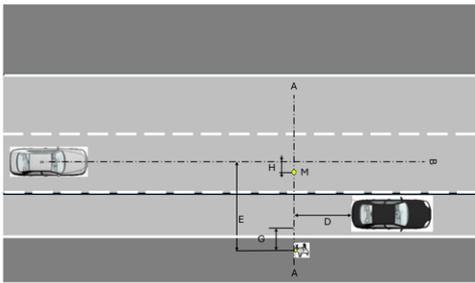


E=4.0m	Best in Group	Vehicle.	Vehicle.	Vehicle.
10 km/h				
20 km/h	0	0, 0, 0	0	0
30 km/h				
40 km/h	0	0, 0, 0	0	0
50 km/h				
60 km/h	0	0, 0, 0	0	0

**Test setup**  
 VUT: speed 10, 20, 30, 40, 50 & 60 km/h  
 Impact loc 25%  
 Target: type Ped adult, normal clothing  
 speed 5km/h  
 start pos E 4m  
 Road lane marking:

Figure 23. Test results for the standard Euro NCAP test CPNA 25%. To be compared with the results in figure 24-26.

CPNA – 25% Adult / Parked vehicle behind pedestrian path



**Test setup**

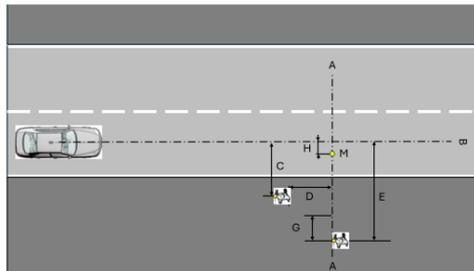
VUT: speed 10, 20, 30, 40, 50 & 60 km/h  
 Impact loc 25%  
 Target: type Ped adult, normal clothing  
 speed 5km/h  
 start pos E 4 m  
 Environment: **Parked dark SUV behind ped path**  
**D= 1.5m & 2.5m**  
 Road lane marking:

D = 1.5m	Best in Group	Vehicle	Vehicle	Vehicle
10 km/h				
20 km/h	0	0,0,0	0,0,0	20,0,0
30 km/h				
40 km/h	0	0,0,40	0,0,0	0,0,0
50 km/h				
60 km/h	0-21	0,0,41	0,0,21	M,M

D = 2.5m	Best in Group	Vehicle	Vehicle	Vehicle
10 km/h				
20 km/h			0,0,0	
30 km/h				
40 km/h			0,0,0	
50 km/h				
60 km/h			0,18,21,23	

Figure 24. Test results for A.6 CPNA 25% with parked car (dark) behind the pedestrian path at two distances to the pedestrian path.

CPNA – 25% Adult / Stationary pedestrian in front of pedestrian path



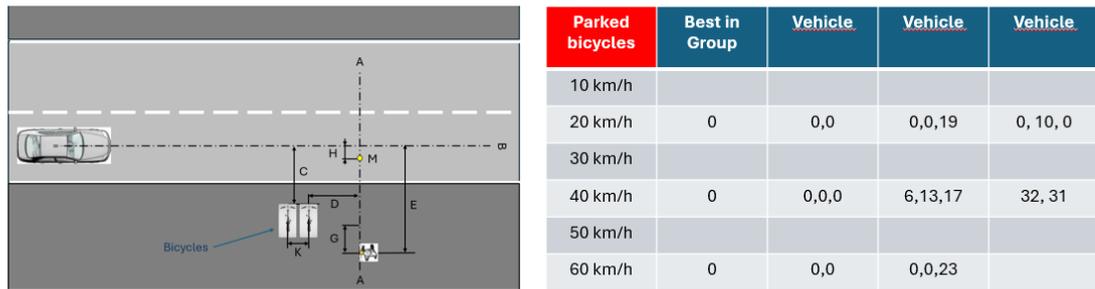
**Test setup**

VUT: speed 10, 20, 30, 40, 50 & 60 km/h  
 Impact loc 25%  
 Target: type Ped adult, normal clothing  
 speed 5km/h  
 start pos E 4 m  
 Environment: **Stationary adult pedestrian**  
**C= 2.5m**  
**D= 1m**  
 Road lane marking:

Stationary pedestrian in front of ped.path	Best in Group	Vehicle	Vehicle	Vehicle
10 km/h				
20 km/h	0		13, 18	0,0,0
30 km/h				
40 km/h	0	40	0,31	0,0,0,0
50 km/h				
60 km/h	0		0,8,32	0,0,0,0

Figure 25. Test results for A.7 CPNA 25% with stationary pedestrian in front of pedestrian path.

CPNA – 25% Adult / Parked bicycles in front of pedestrian path



**Test setup**  
 VUT: speed 10, 20, 30, 40, 50 & 60 km/h  
 Impact loc 25%  
 Target: type Ped adult, normal clothing  
 speed 5km/h  
 start pos E 4 m  
 Environment: **Parked bicycles (real bicycles)**  
 C= 2.5m  
 D= 2m  
 K= 1m

Figure 26. Test results for A.12 CPNA 25% with parked bicycles in front of pedestrian path.

CPNCO – 50% & 25% Child / Impact location

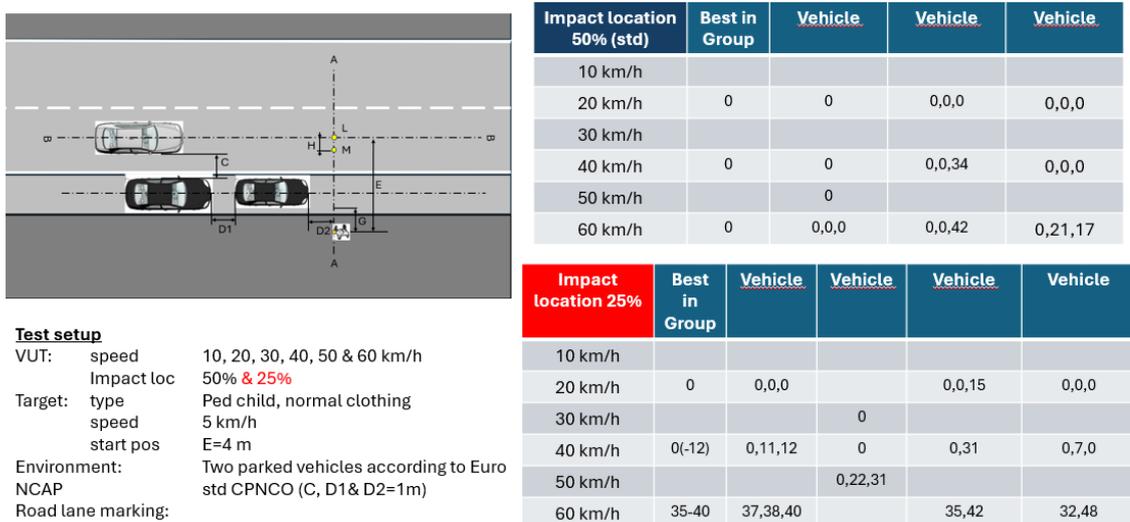
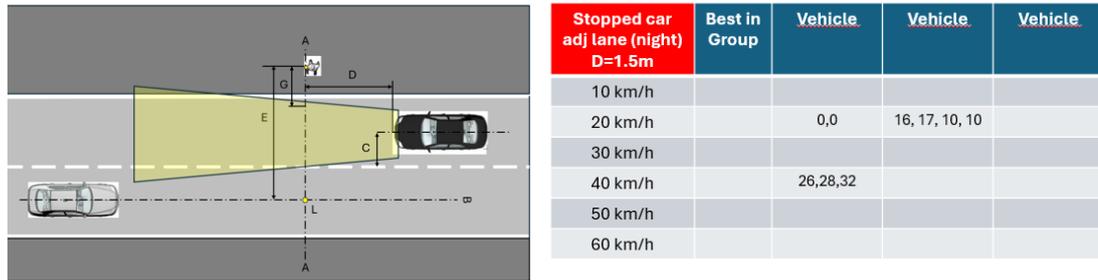


Figure 27. Test results for standard CPNCO 50% and A.21 CPNCO 25% (impact location change).

CPFA – 50% Adult / Stopped oncoming vehicle adj lane (night, street lights & low beam)



**Test setup**  
 VUT: speed 10, 20, 30, 40, 50 & 60 km/h  
 Impact loc 50%  
 Target: type Ped adult, normal clothing  
 speed 8 km/h  
 start pos E=6 m  
 Environment: **Stopped SUV in adjacent lane w low beam.**  
**D= 1.5m**  
 Euro NCAP street lights for CPFA (Test protocol Annex B5.7)

Figure 28. Test results for A.26 CPFA 50% with stopped vehicle in adjacent lane behind pedestrian path at night with streetlight and vehicle low beam.

**9.6 Physical test protocol, Euro NCAP OpenSCENARIOS , repeatability and reproducibility of test results in dialog with other test labs**

The VERDAS project proposed a list of 26 Car-to-Pedestrian SCP test scenarios (see table 2) for the Euro NCAPs 2026 rating update. Euro NCAP adopted all of the proposals. A few into variation of the standard test scenario in the Test protocol [27] and main part formed the basis for the Technical Bulletin CA 002 – Verification conditions for robustness layers v1.1 [28].



Figure 29. Euro NCAP TB CA 002

## 10. Dissemination and publications

### 10.1 Dissemination

How are the project results planned to be used and disseminated?	Mark with X	Comment
Increase knowledge in the field	X	The results and knowledge from the project are already spread to all OEM's, Tier's and public by the project delivery to the Euro NCAP 2026 protocol Technical Bulletin CA 002 - Verification Conditions for Robustness Layers. The knowledge about the methodology and the results will also be spread by a paper and presentations at conferences.
Be passed on to other advanced technological development projects	X	The knowledge and results will be used in the ongoing VERDAS 2 and coming VERDAS 3 project and other projects that will support future Euro NCAP rating development. The results and knowledge will also be used in dialog with new potential project partners in future projects. The method is also applicable to use for SAE level 2 - 5 for the Safety back-up.
Be passed on to product development projects	X	The results from the project in Technical Bulletin CA 002 will be used of OEM's and Tier 1's for improvement of ADAS performance to fulfil the Euro NCAP 2026 rating protocol.
Introduced on the market	X	The results will be introduced on the market by the OEM's improved system performance to reduce accidents, injuries and fatalities.
Used in investigations / regulatory / licensing / political decisions	X	The results are included in Euro NCAP rating 2026. It could be used in other ratings and legal requirements in the future.

Table 3: VERDAS Dissemination

### 10.2 Publication

VERDAS project results will be presented in a paper and the conference in the table below.

Publication name	Author	Conference Date	Status at report release
From Data to Road Safety: Advancing Car-to-Pedestrian AEB Test Scenarios	<ul style="list-style-type: none"> <li>• Mats Petersson</li> <li>• Stephan Ryrberg</li> <li>RISE AstaZero</li> <li>• Jorge Lorente</li> <li>Mallada</li> <li>Toyota</li> <li>• Paloma Díaz</li> <li>Fernández</li> </ul>	ESV May 12-15, 2026	Submission deadline for final paper of 19 December 2025

	VCC <ul style="list-style-type: none"> <li>• Yury Tarakanov</li> </ul> Viscando AB <ul style="list-style-type: none"> <li>• Magdalena Lindman</li> </ul> If Insurance <ul style="list-style-type: none"> <li>• Anders Ydenius</li> </ul> Folksam		
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Table 4: VERDAS Publications

## 11. Conclusions and future research

The VERDAS project methodology has successfully developed proposals of Pedestrian robustness layer test scenarios based on the combination of descriptive statistics and in-depth analyses of case-by-case data to capture relevant parameters for perception layers.

The field data analysis in VERDAS gave a unique compilation of data with statistics and complementary information from:

- case-analysis of crashes
- on-site traffic data
- on-board accident data

New details for test scenarios were identified, such as:

- objects in the road environment
- other road users
- variations in visibility conditions and speeds.

The gained experiences and insights will also support analysis in future projects.

VERDAS has developed an effective virtual verification method chain to facilitate a simpler and faster way to analyse and compare physical and virtual tests, for validation and verification of simulation models.

VERDAS had a continuous dialog with Euro NCAP during the project to deliver and get feed-back on test scenario proposals and test results to support the development of Pedestrian robustness layers in Euro NCAP 2026 protocol.

Euro NCAP has included VERDAS proposals of Robustness layer test scenarios in Euro NCAP 2026 Technical Bulletin CA 002 - Verification Conditions for Robustness Layers.

The field data analysis in VERDAS has also verified the need of the other updates of Extended range and Robustness Layer e.g. impact locations, velocities, adverse weather conditions, glare updates in Euro NCAP Crash Avoidance protocol 2026.

VERDAS has also identified test scenarios with Pedestrian Robustness layers towards Euro NCAP 2029 with more than 1 parameter changes or new test scenarios.

Those Robustness layer scenarios need to be further developed during 2026-2027 for test methods towards Euro NCAP 2029.

Example of draft VERDAS Pedestrian Robustness layer test scenarios towards 2029:

- CPNA – Adult pedestrian walks slowly and starts close to the road
- CPNA – Adult pedestrian starts walking behind Stationary adult
- CPNA – Car starts from standstill or slowly rolling forward
- CPFA – Adult pedestrian starts walking slowly at refuge behind traffic light posts & traffic signposts.

Needs for future research towards Euro NCAP 2029:

- Analyse of Car2Bicycle, Car2Car and Car2PTW with the same methodology as in the VERDAS project used for Car2Pedestrian.
- Review the need of updated or new Robustness layers for relevant accident scenarios towards 2029 based on descriptive statistics and in-depth analyses of case-by-case data.
- Review of existing 2026 test scenarios and new scenarios to identify scenarios for improvement by address mechanism behind them to make the scenarios more relevant to reduce number of False Positives by adding relevant context.
- Reuse/analysis of VERDAS field data to propose new 2029 scenarios.
- Further development of test methods based on accident scenarios from VERDAS for implementation 2029.
- Investigate the use of V2X both in Crash Avoidance and Safe Driving for test scenarios with target that is not in line of sight for the VUT.
- Investigate the inclusion of Driver monitoring to AEB scenarios.
- Investigate the inclusion of Illumination and Adverse weather conditions to AEB test scenarios.

## 12. Participating parties and contact persons

Partner	Partner Contribution	Contact person	Role	Logo
<b>AstaZero AB</b>	Coordinator, Field data analysis, Physical test facility, Simulations Test protocol	Mats Petersson	Project manager	
<b>Aptiv</b>	Test vehicle provider Simulations ADAS feasibility	Martin Larsson	Steering group	
<b>Folksam</b>	Field data analysis	Anders Kullgren	Steering group	
<b>If Insurance</b>	Field data analysis	Magdalena Lindman	Steering group	
<b>Terranet Tech AB</b>	Test vehicle provider ADAS feasibility	Pierre Ekwall	Steering group	
<b>TOYOTA</b>	Field data analysis Test vehicle provider ADAS feasibility	Jorge Lorente Mallada	Steering group	
<b>Trafikverket</b>	Field data analysis	Rikard Fredriksson	Steering group	
<b>Viscando</b>	Field data analysis	Amritpal Singh	Steering group	
<b>VCC</b>	Field data analysis Test vehicle provider ADAS feasibility	Lena Westervall	Steering group	
<b>Zenseact</b>	Test vehicle provider Simulations ADAS feasibility	Jonas Ekmark	Steering group	

Table 5: Partner contacts

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