DEVELOPMENT OF A CYCLIST-AEB TESTING SYSTEM

CATS - Sjef van Montfort, TNO

TNO innovation for life

OUTLINE

- Introduction
- CATS project:
  - Objectives & timing
  - Process
  - Accident analysis
  - Test scenario definition
  - Dummy & Propulsion system development
  - Verification & testing
  - CATS test matrix
- Euro NCAP: AEB-Cyclist 2018 proposal
- Conclusion & Outlook
- Acknowledgment

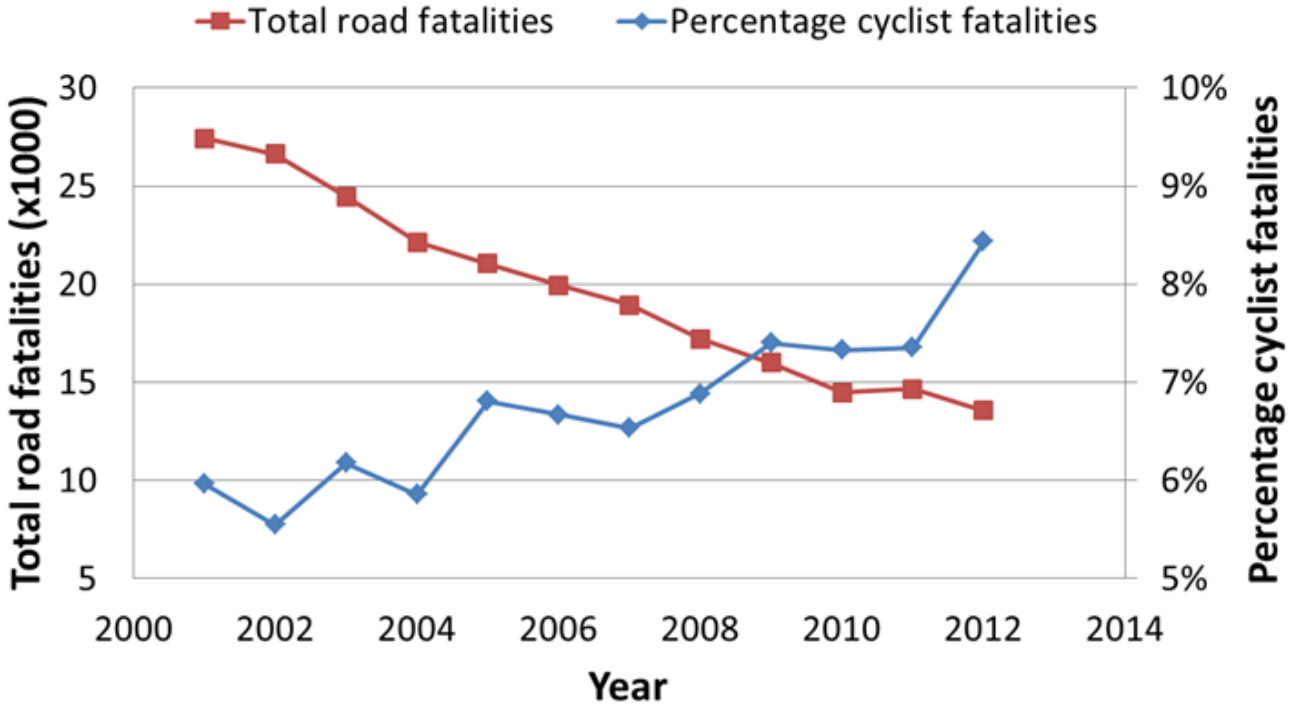
INTRODUCTION

- Cycling is increasingly popular
  - In the Netherlands, 26% of all journeys occur by bicycle (CROW, ECF)

- Electric power-assisted bicycle:
  - annual sales (in units) increased with factor of 10 in last 8 years in EU

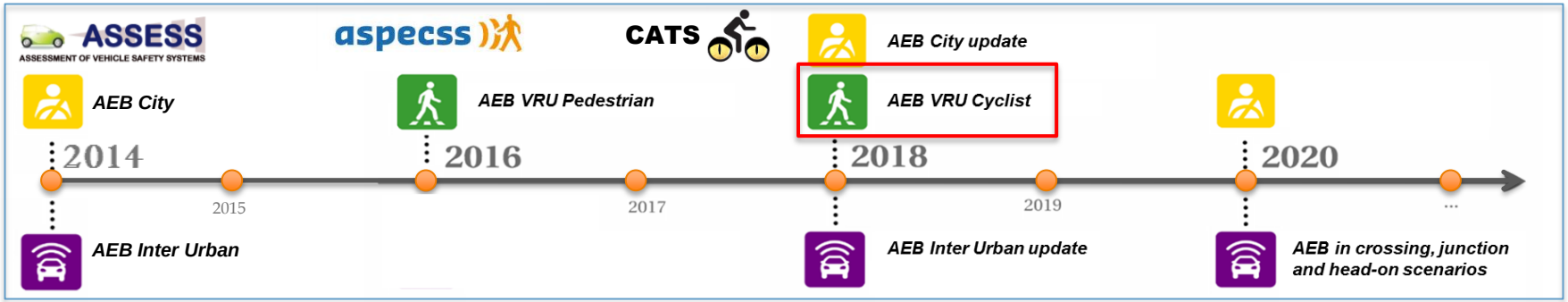
- Social benefits of cycling
  - Scope for development (working, learning, recreating) in case no car / driving license
  - Elderly keep mobile avoiding social isolation
  - Environmental benefit (true zero emission)
  - Flow problem for car traffic
  - Parking problem in town centres and at workplace
  - Health of cycling
  - Traffic safety: more cyclists, less risks

INTRODUCTION



Total number of road fatalities and cyclist fatalities over the period of 2001 to 2012 for: France, Germany, Italy, the Netherlands, Sweden and the UK

INTRODUCTION
EURO NCAP ROADMAP FOR AEB – FCW



CATS: OBJECTIVES & TIMING

CATS (Cyclist-AEB Testing System) project:

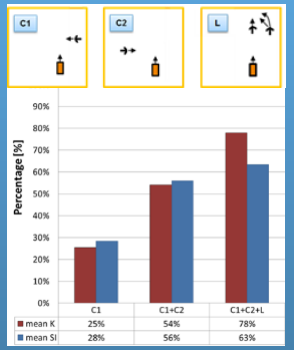
- Prepare the introduction of a protocol for consumer tests of Cyclist-AEB systems on board passenger cars
- Propose a test setup (incl. hardware) and test protocol for Cyclist-AEB systems based on technical/scientific considerations
- Base the tests on analysis of most relevant cyclist accident scenarios in EU countries

Timing: 2014 Q1 – 2016 Q2

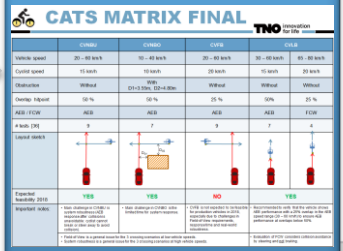
Public information and reports to be found on: ***TNO.NL/CATS***

CATS: PROCESS

1 Accident Analysis



2 Test scenario definition

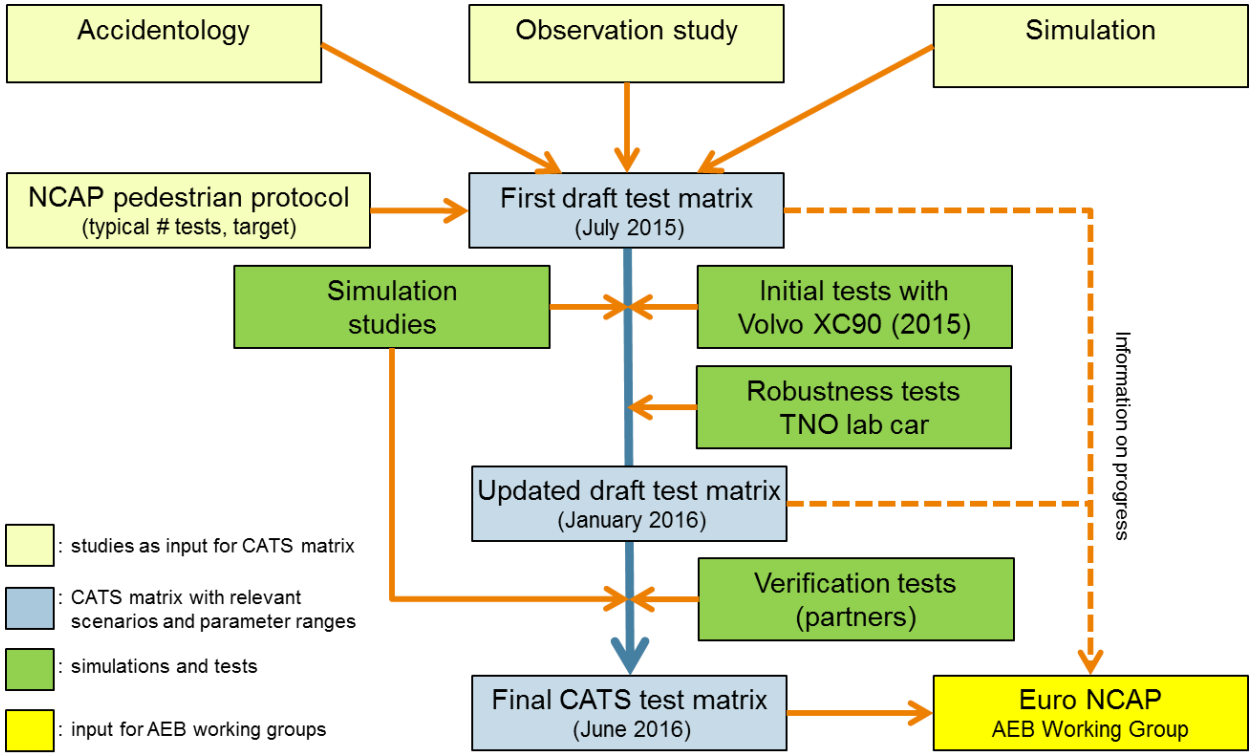


3 Dummy development

4 Propulsion system development

5 Verification & Testing

CATS: PROCESS

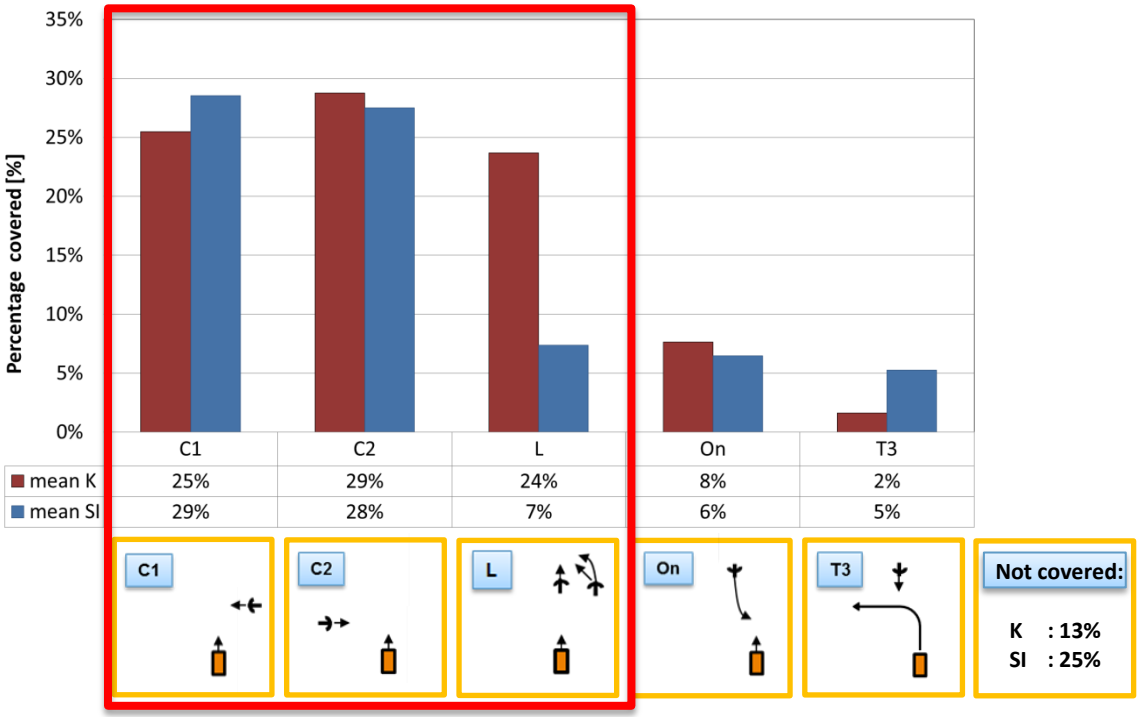


European Automobile Manufacturers Association
ACEA

CLEPA
European Association of Automotive Suppliers

FOR SAFER CARS
EURO NCAP

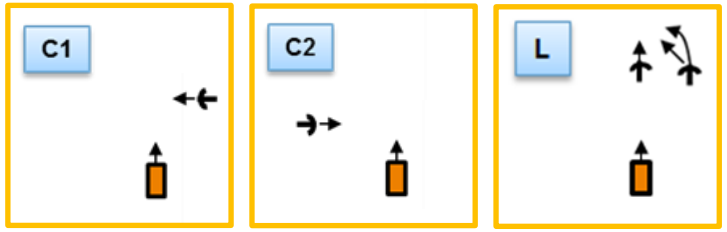
CATS: ACCIDENT ANALYSIS



- Study databases for 6 European countries;
- Select severe car-to-cyclists accidents → fatalities and seriously injured;
- Provide overview of distinguished accident scenarios;
- Determine the distribution of scenarios in the different countries;
- Prioritize scenarios & indicate how many fatalities and seriously injured are covered.

CATS: TEST SCENARIO DEFINITION

- Most relevant accident scenarios



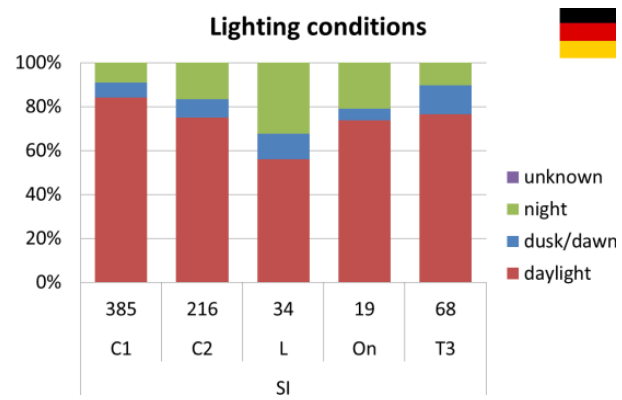
- Relevant accident parameters for those scenarios

Accident conditions	Accident partners
Precipitation	Cyclist speed
Lighting conditions	Vehicle Speed
Location	Impact point
Road layout, obstruction	Cyclist gender
Speed limit	Cyclist age
Season	Helmet use

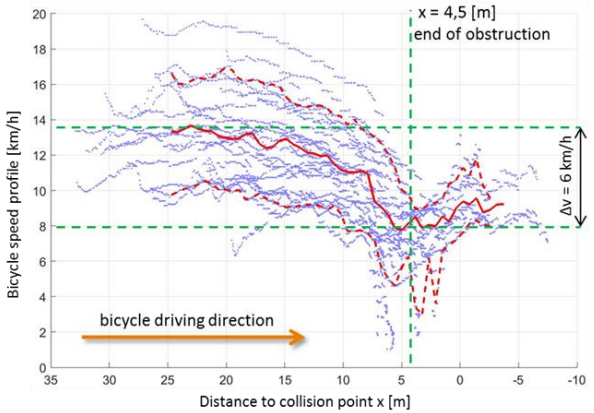
CATS: TEST SCENARIO DEFINITION

- Examples of parameter evaluation

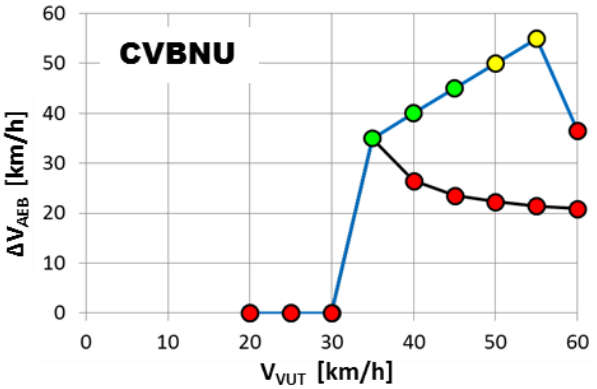
Accidentology



Observation study



Simulation



CATS: DUMMY & PROPULSION DEVELOPMENT

- Various development workshops where together with partners different stages of dummy and propulsion system have been evaluated.

Dummy:
- Dimensions
- Features
- Camera
- LIDAR
- Radar
- Impactability/ Durability

Test set-up:
- Accuracy
- Repeatability
- Reproducibility





Target Bike and Bycyclist target vs. Real Bike and Bicyclist

	Static RCS						Dynamic RCS		Dynamic Micro-Doppler		Optical Representation		
	270.0	90.0	112.5	135.0	157.5	180.0	0.0	90.0	0.0	90.0	0.0	0.0	90.0	180.0
CATS partner 1	⇘	✓	⇘	⇘	✓	✓	✓	⇘	⇘	✓	⇘	✓	✓	✓
CATS partner 2	✓	✓	⇘			✓	✓	✓	⇘	✓	✓			
CATS partner 3												✓	✓	✓
CATS partner 4	⇘	✓	⇘	✓	⇘	✓	✓	⇗	✓			✓	✓	✓
CATS partner 5	✓	✓	⇘	⇘	✓	⇘	✓	✓	⇘	⇘	⇘	✓	✓	✓
….														

⇧	much to high
⇩	much to low
⇗	bit to high
⇘	bit to low
✓	OK
✖	nOK

Definition: Real bike is the reference e.g. in this case the dummy RCS is bit to low compared to the Holland bike

CATS: DUMMY & PROPULSION DEVELOPMENT

4activeBS v5

- Changeable handle bar for Dutch and European bike
- White reflector in the front mounted on the frame
- Polymer frame with metal layer for radar properties
- Plastic mud guard
- Real rubber tire with reflecting ring
- Rim with reflecting material

- Materials and properties of bicyclist same as Euro NCAP Pedestrian Target
- Adjustable torso-angle
- Rotational joint of hip connected to bike frame
- Rear red reflector mounted on the luggage rack
- Rotational joint at the knee point
- Rotating wheels due to contact to the ground

Dummy specification document available on ***TNO.NL/CATS***

4activeSB Platform II

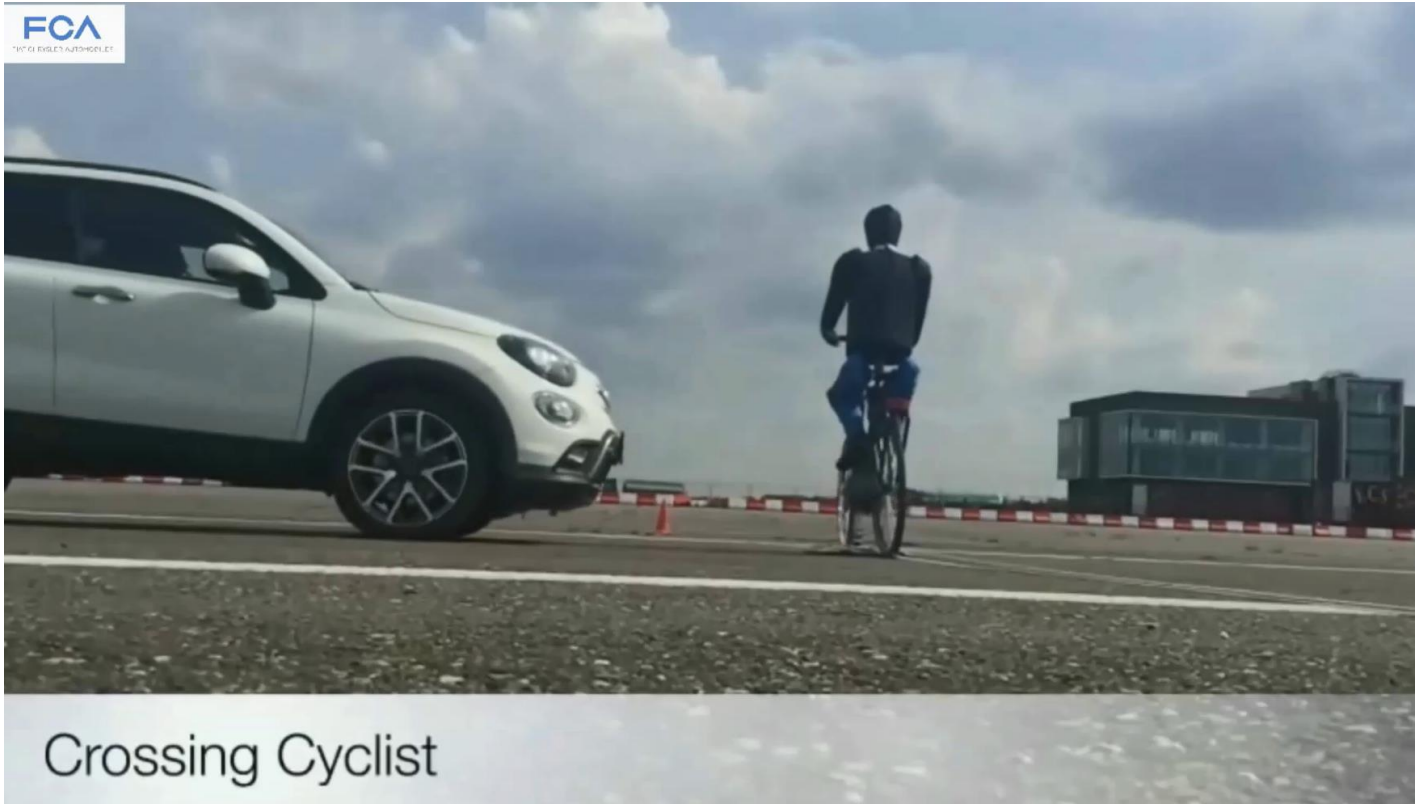
Longitudinal set-up

CATS: VERIFICATION & TESTING

Scenario:
- Realism
- Feasibility

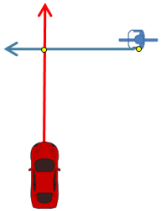
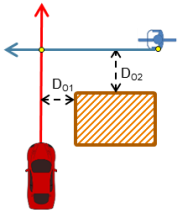
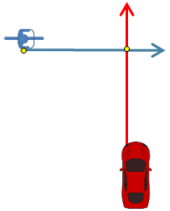
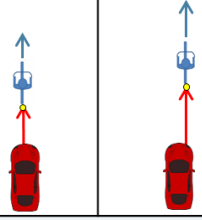
Test set-up:
- Accuracy
- Repeatability
- Reproducibility

CATS: VERIFICATION & TESTING



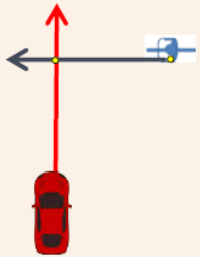
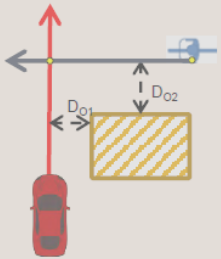
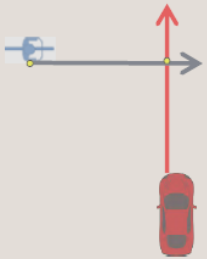
source FCA

CATS: TEST MATRIX

	CVNBU	CVNBO	CVFB	CVLB	
Vehicle speed	20 – 60 km/h	10 – 40 km/h	20 – 60 km/h	30 – 60 km/h	65 - 80 km/h
Cyclist speed	15 km/h	10 km/h	20 km/h	15 km/h	20 km/h
Obstruction	Without	With D1=3.55m, D2=4.80m	Without	Without	Without
Collision point	50 %	50 %	25 %	50%	25 %
AEB / FCW	AEB	AEB	AEB	AEB	FCW
# tests [36]	9	7	9	7	4
Layout sketch					
Expected feasibility 2018	YES	YES	NO	YES	
Important notes:	• Main challenge in CVNBU is system robustness (AEB response after collision is unavoidable: cyclist cannot break or steer away to avoid collision).	• Main challenge in CVNBO is the limited time for system response.	• CVFB is not expected to be feasible for production vehicles in 2018, especially due to challenges in Field-of-View requirements, response time and real-world robustness.	• Recommended to verify that the vehicle shows AEB performance with a 25% collision point with one VUT speed in the 30-60 km/h speed range to ensure AEB performance at a collision point below 50%.	
	• Field-of-View is a general issue for the 3 crossing scenarios at low vehicle speeds. • System robustness is a general issue for the 3 crossing scenarios at high vehicle speeds.			• Evaluation of FCW considers collision avoidance by steering and not braking.	

EURO NCAP: AEB-CYCLIST 2018 PROPOSAL

EURO NCAP FOR SAFER CARS

	CBAN	CBANO	CBAF	CBAL	
VUT speed	20-60 km/h	20-60 km/h	20-60 km/h	25-60 km/h	50- 80 km/h
Cyclist speed	15 km/h	10 km/h	20 km/h	15 km/h	20 km/h
Obstruction	No	Yes	No	No	No
Impact point	50%	50%	25%	50%	25%
AEB/FCW	AEB	AEB	AEB	AEB	FCW
					
Year of test	2018	2020	2020	2018	2018

CONCLUSION & OUTLOOK

Conclusion

- Successful process to develop the Cyclist-AEB Testing System
- CATS protocol including test matrix proposed to Euro NCAP AEB VRU working group
- Euro NCAP proposal for 2018 and 2020 in line with CATS findings, both test matrix and test target

Outlook

- Active global communication and dissemination of CATS results
- Support further development & evaluation of Cyclist-AEB for Euro NCAP and others
- Considerations towards 2020:
  - Specification of view-blocking barrier
  - Dealing with parameter ranges in protocol
- Development of cyclist intent prediction models to support Cyclist-AEB control law
- Market introduction of Cyclist-AEB systems on more production vehicles

ACKNOWLEDGEMENT

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Ministry of Infrastructure and the Environment
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BMW
BOSCH
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THANK YOU FOR YOUR ATTENTION

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