MATLAB EXPO

November 13–14, 2024 | Online

From Simulation to Vehicle: End-to-End Lidar-AEB Development for a Level 5 Car

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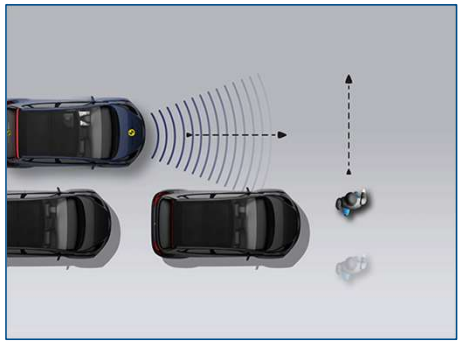
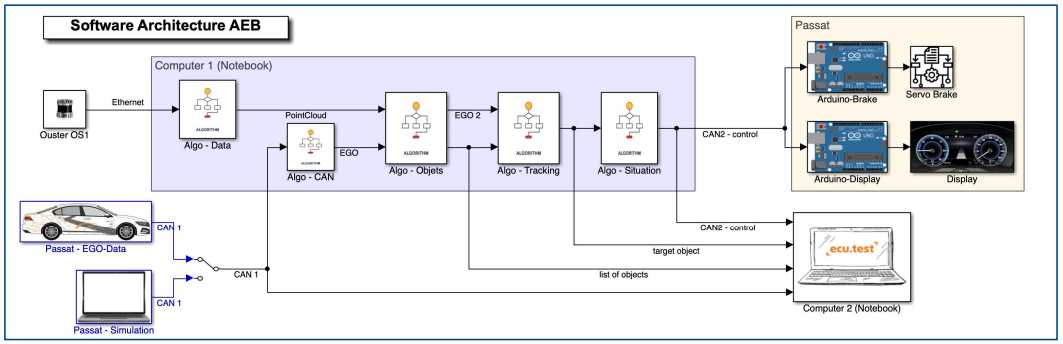
This presentation focuses on the overall process of algorithm development in an automotive use-case



Introduction



Implementation in Simulink

Test and results

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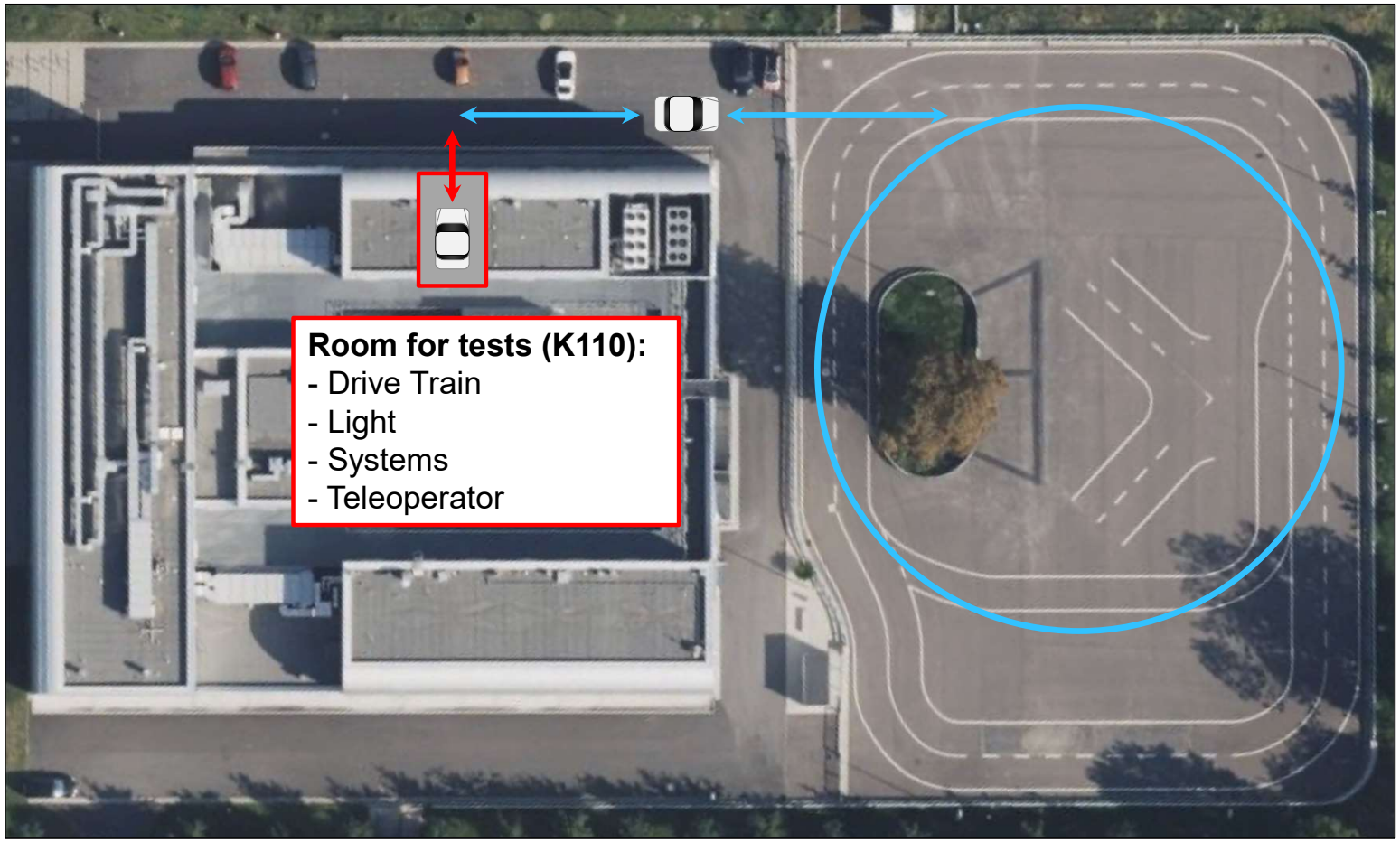
Need for development

- In Germany, the type approval of autonomous vehicles (level 5) is possible.
- The corresponding regulation (AFGBV) regulates both the approval and the daily operating release.
- As part of a research project, the effort and informative value of the daily release will be investigated using the example of the automatic emergency brake (AEB).
- The function is used at the same time to show students the function development with MATLAB/Simulink.

Test site of the HTW Dresden



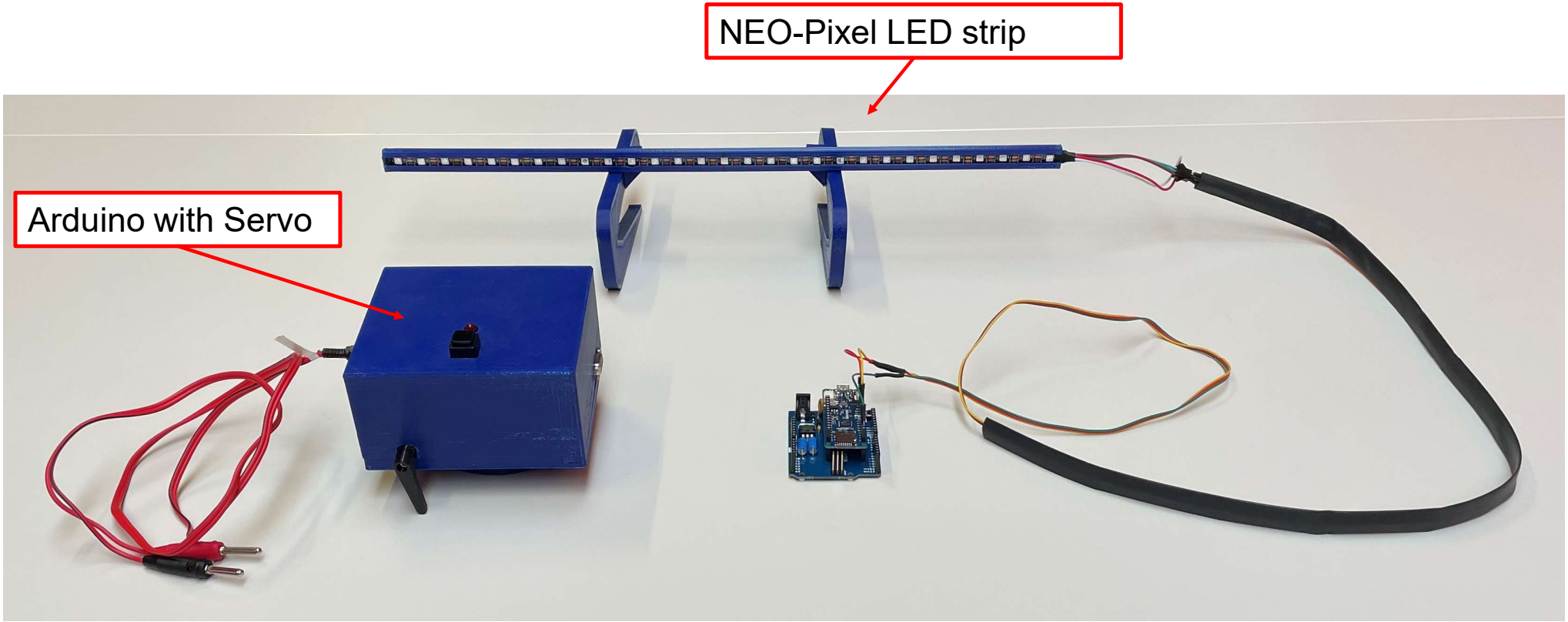
Test drive for activation :
- Sensors
- Brake
- Damper
- AEB

Test Cars

- Converted BMW i3:
  - Lateral control: Simulink Pure Pursuit controller
  - Longitudinal control: Simulink PID controller
  - Good functionality up to 15 km/h
- Series Car VW Passat GTE:
  - additional brake actuator for braking intervention
  - additional visualization through LED strip
- Series Car Renault Twizy:
  - Longitudinal control: Simulink PID controller

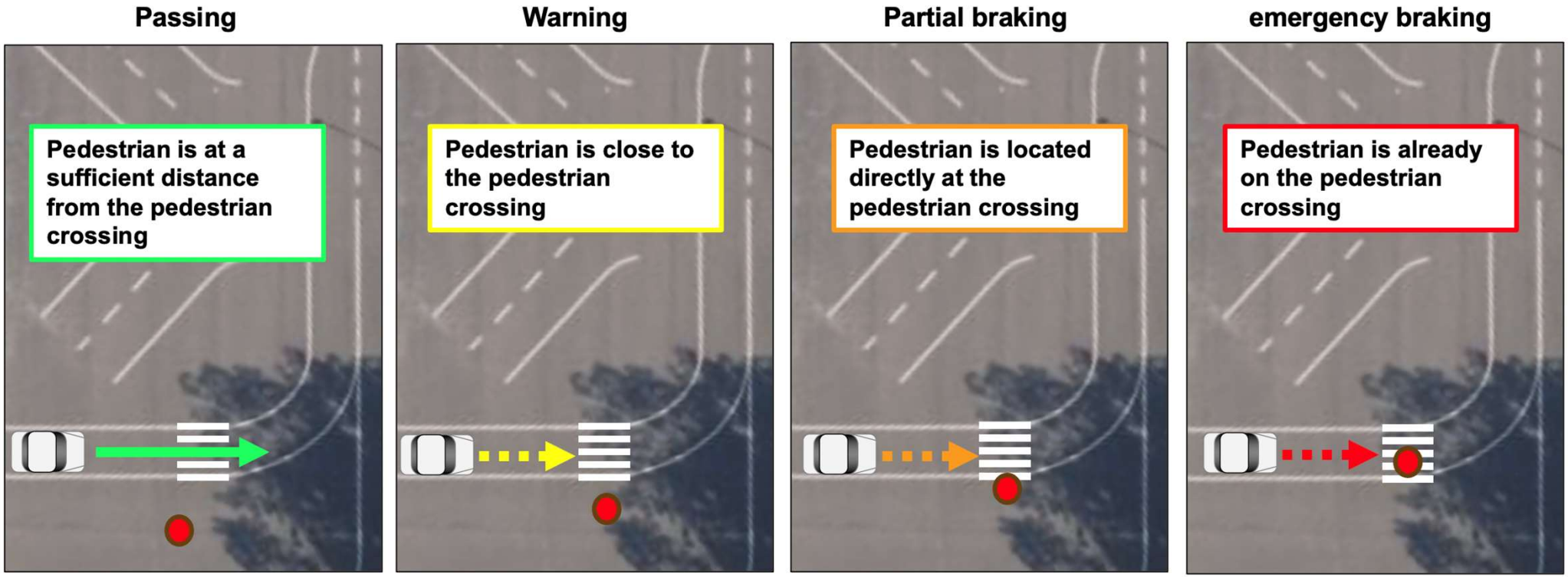
Multiple use of AEB to develop new test procedures for the ***ecu.test*** software from tracetronic company (cooperation partner) and for education.

Additional components (programmed with Simulink)



Use cases for an automatic emergency brake (AEB) for an autonomous vehicle

There are four basic situations with different interventions.



Example drive (BMW i3)

Systematic functional development according to the V-Model

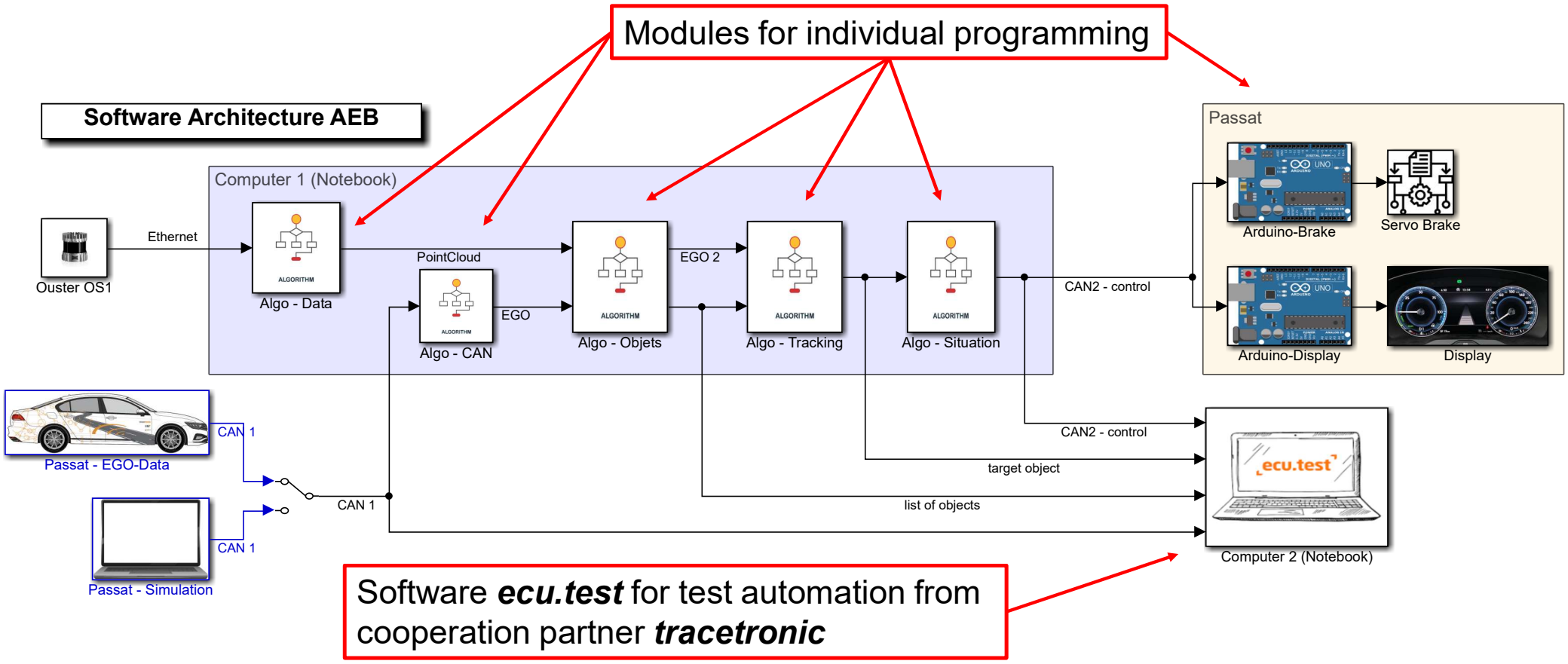
1
- Full simulation
  - Simulink model (PC) without external modules
  - no real-time processing necessary

2
- Hardware-in-the-Loop (HiL)
  - Simulink model (PC) with external sensors and actuators
  - **real-time** processing necessary !

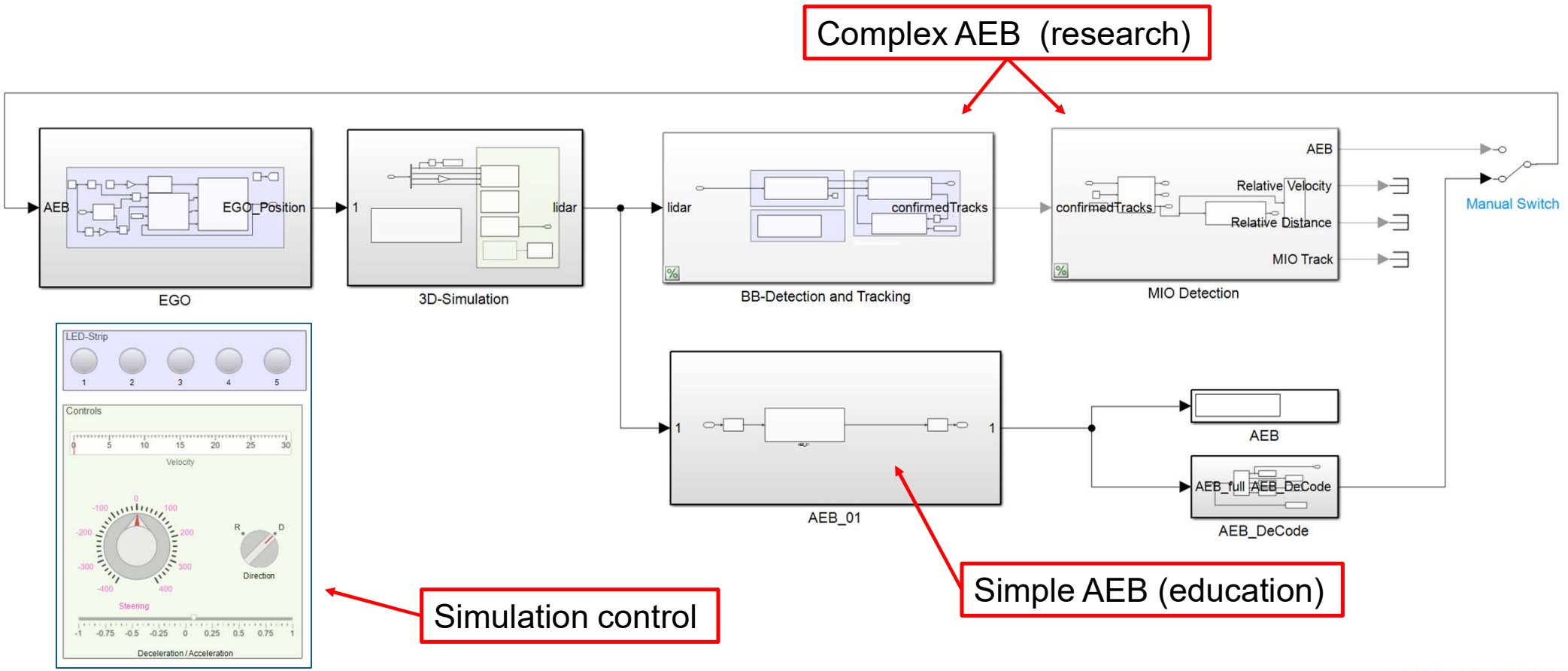
3
- Vehicle test (1)
  - Simulink model (PC) inside test vehicle

4
- Vehicle test (2)
  - Simulink model (target control unit) inside test vehicle

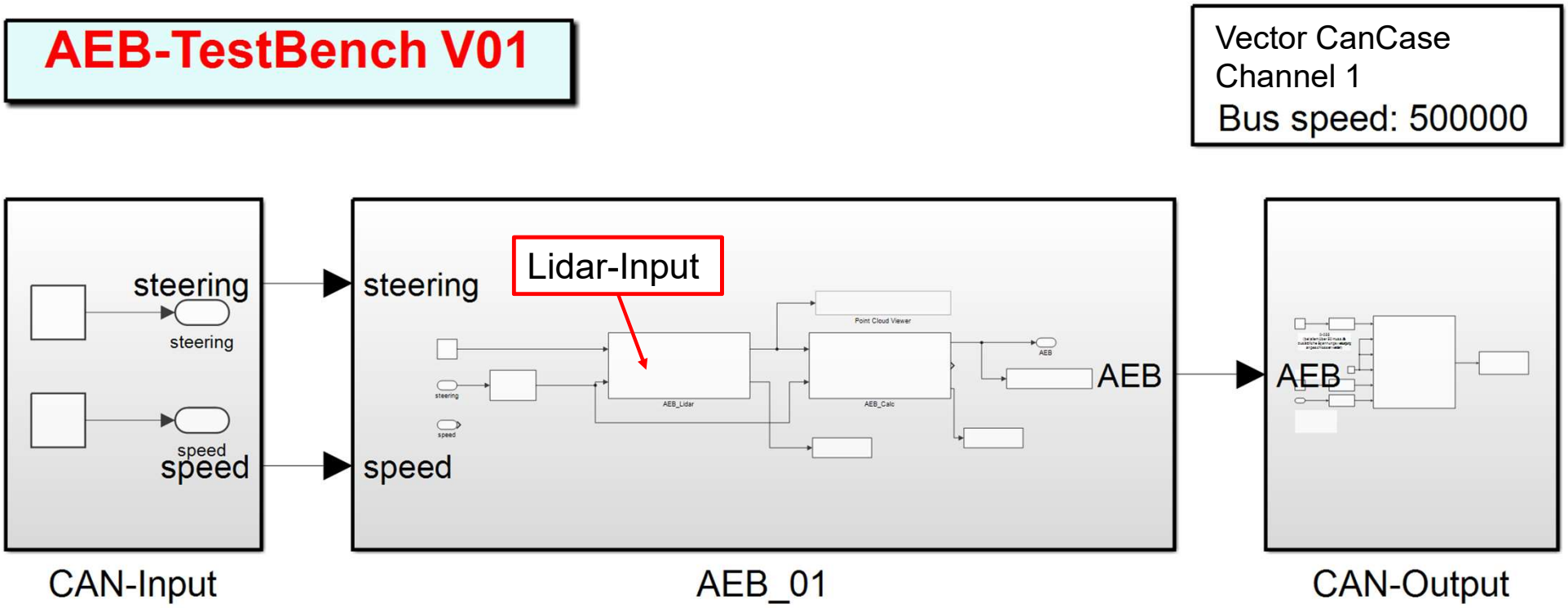
Overview of the entire system



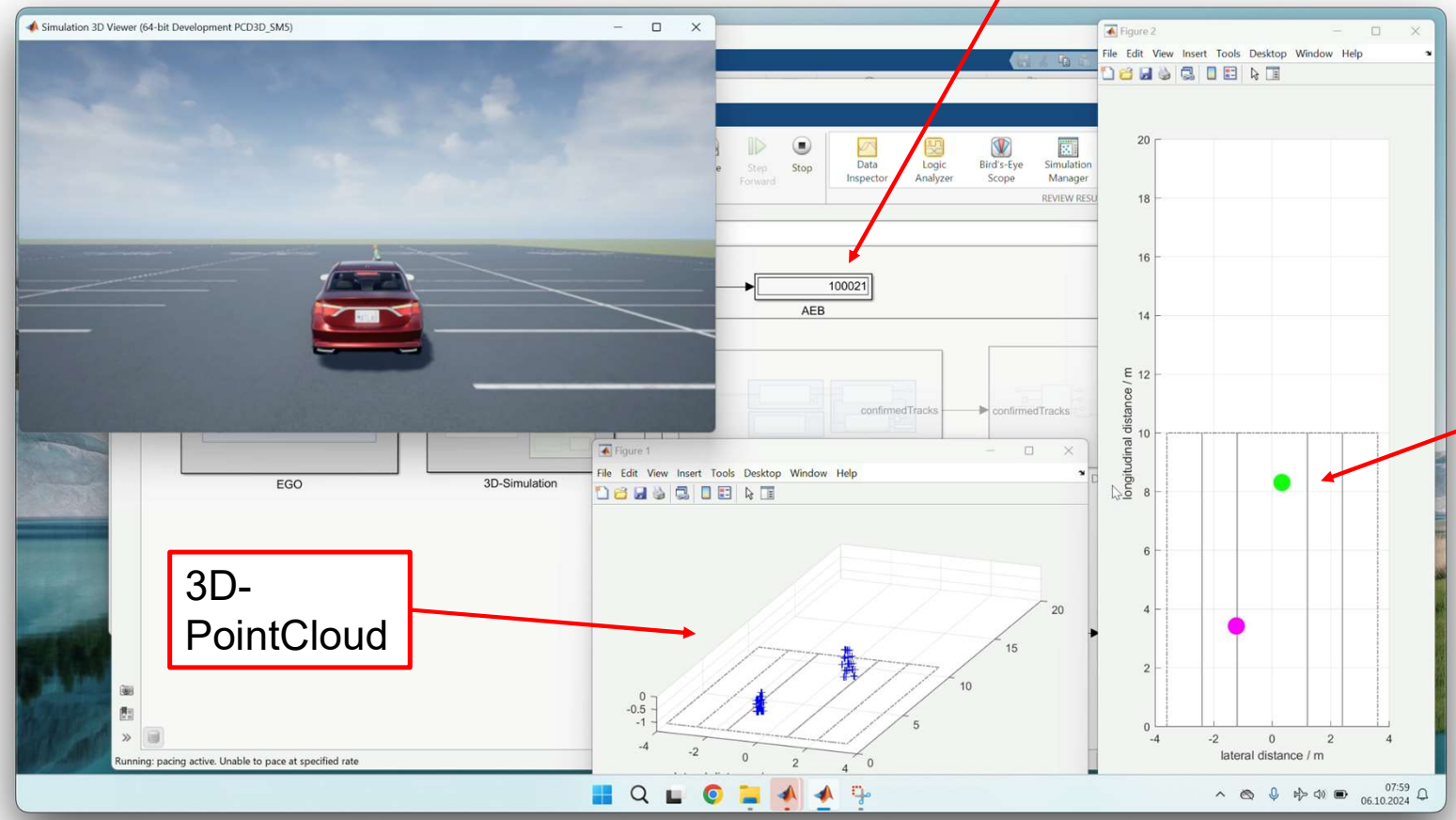
Simulation model



Hardware implementation model (HiL & Car)



Results – Simulation (simple model)



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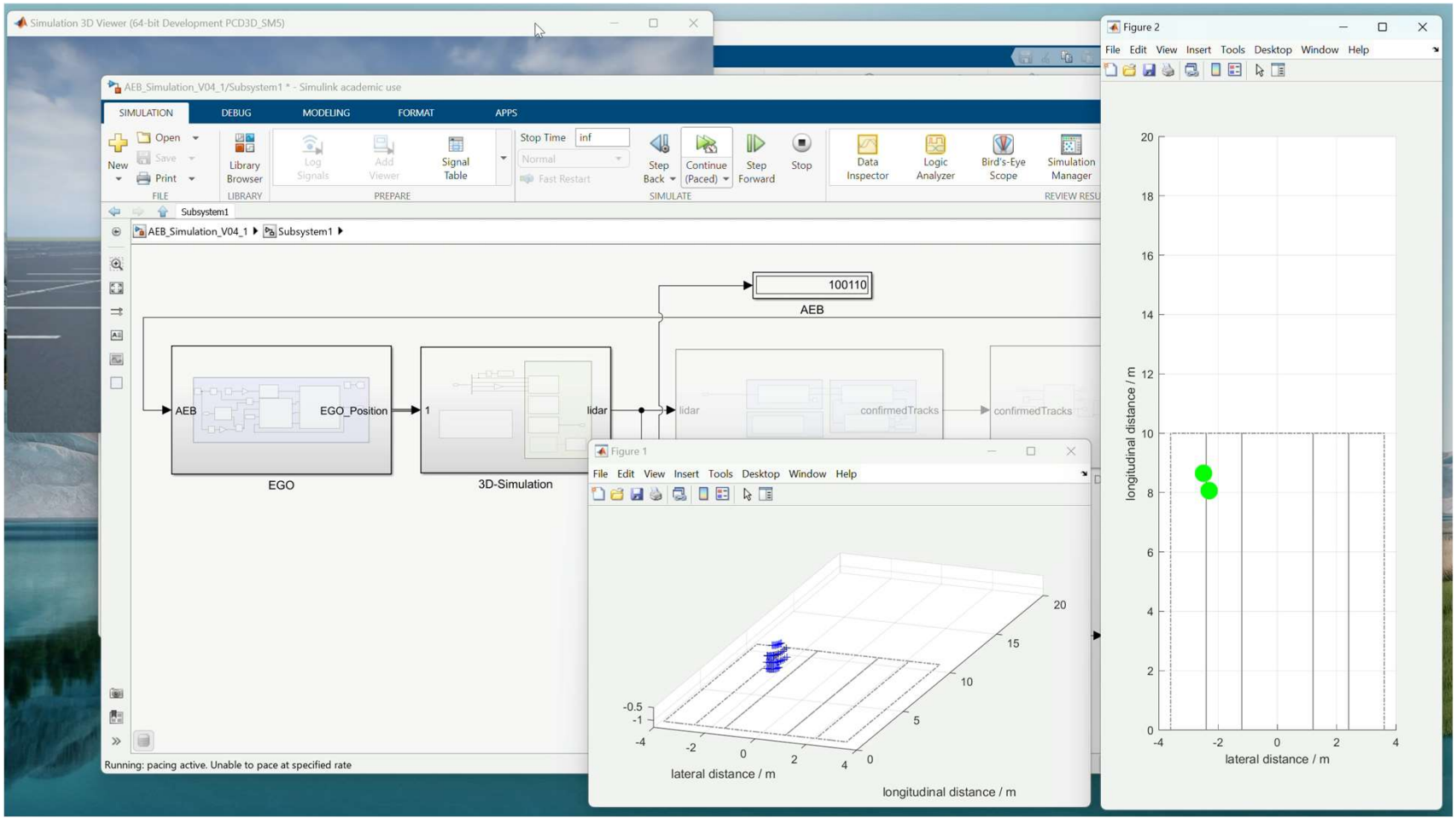
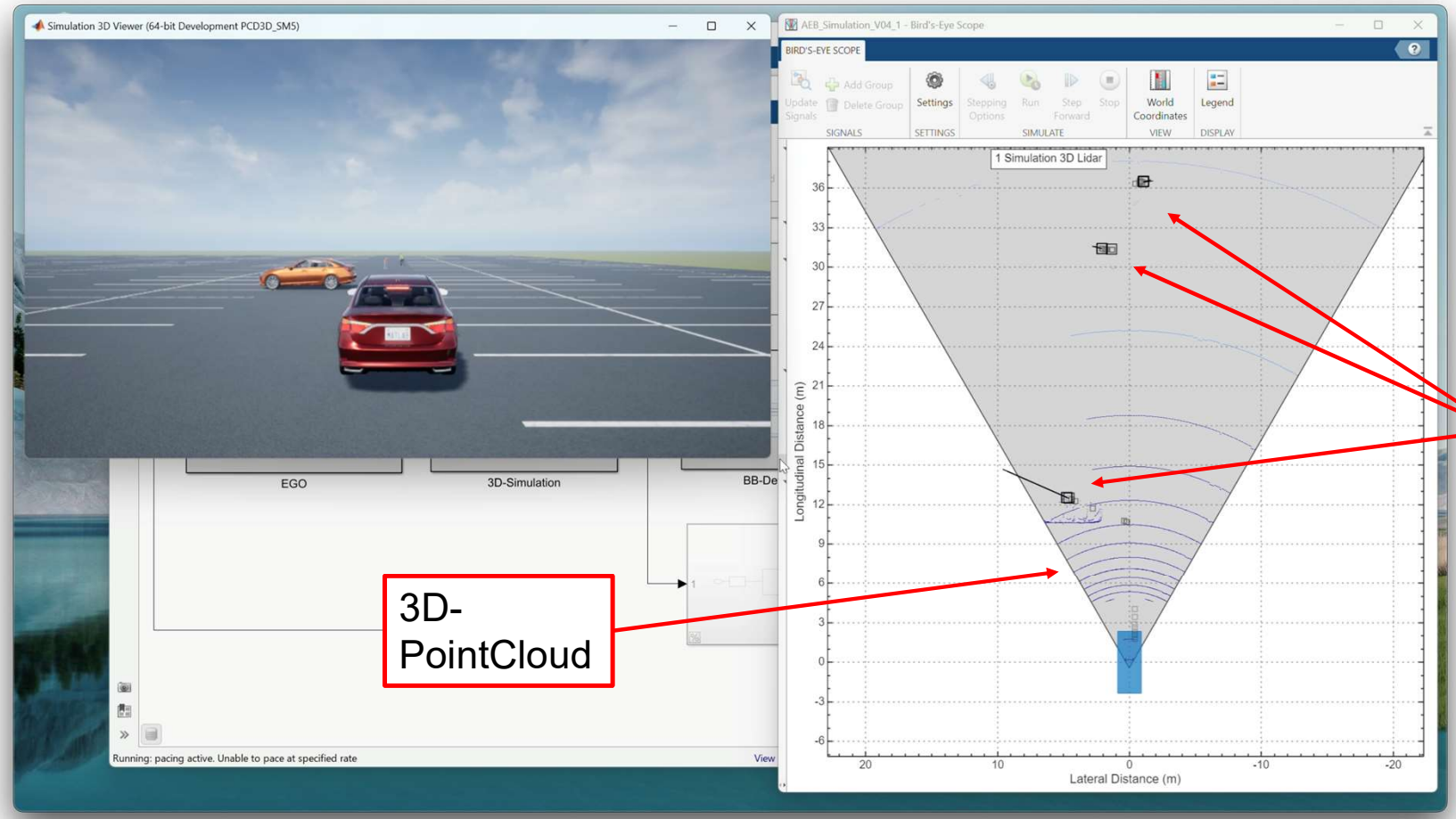

Simulation 3D Viewer (64-bit Development PCD3D_SM5)
AEB_Simulation_V04_1/Subsystem1 * - Simulink academic use
SIMULATION
DEBUG
MODELING
FORMAT
APPS
Stop Time
inf
Normal
Fast Restart
Step Back
Continue (Paced)
Step Forward
Stop
Data Inspector
Logic Analyzer
Bird's-Eye Scope
Simulation Manager
Subsystem1
AEB_Simulation_V04_1
Subsystem1
100110
AEB
AEB
EGO_Position
EGO
1
lidar
3D-Simulation
lidar
confirmedTracks
confirmedTracks
Running: pacing active. Unable to pace at specified rate
Figure 1
File Edit View Insert Tools Desktop Window Help
lateral distance / m
longitudinal distance / m
Figure 2
File Edit View Insert Tools Desktop Window Help
longitudinal distance / m
lateral distance / m

Results – Simulation (complex model)



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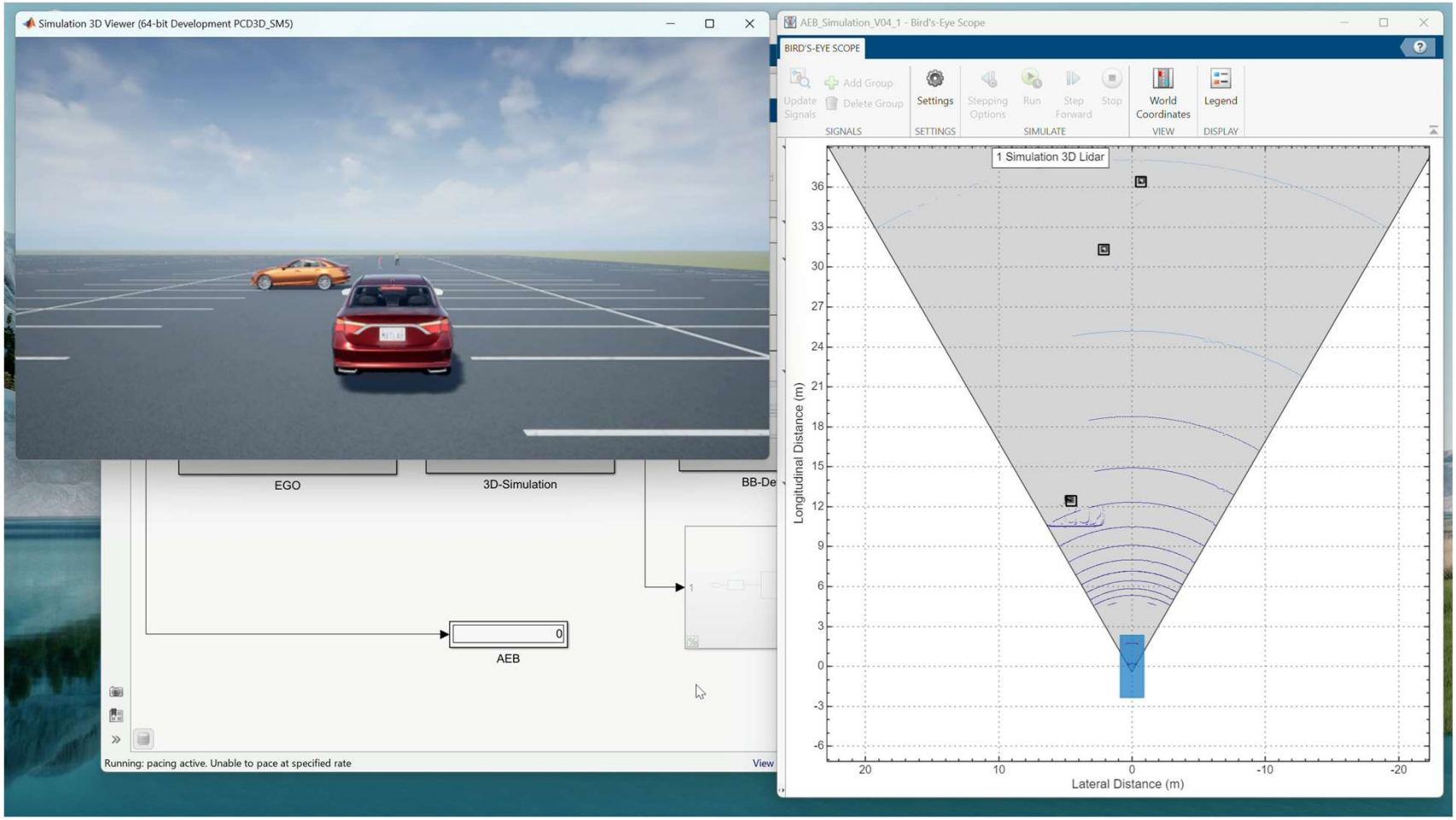
Simulation 3D Viewer (64-bit Development PCD3D_SM5)
AEB_Simulation_V04_1 - Bird's-Eye Scope
BIRD'S-EYE SCOPE
Add Group
Update Signals
Delete Group
Settings
Stepping Options
Run
Step Forward
Stop
World Coordinates
Legend
SIGNALS
SETTINGS
SIMULATE
VIEW
DISPLAY
1 Simulation 3D Lidar
Longitudinal Distance (m)
Lateral Distance (m)
EGO
3D-Simulation
BB-De
0
AEB
Running: pacing active. Unable to pace at specified rate
View

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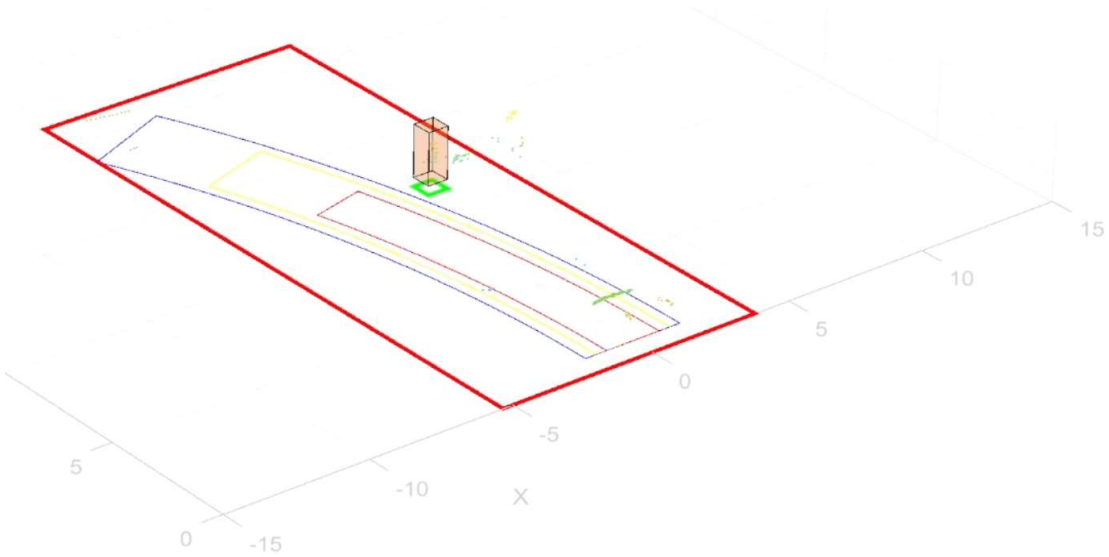
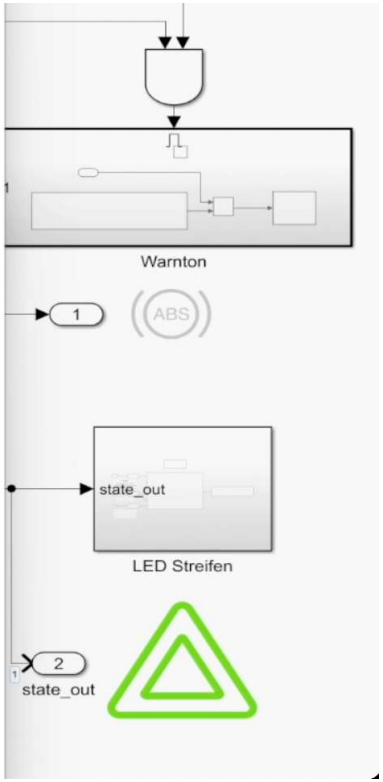
Real Drive - Drive





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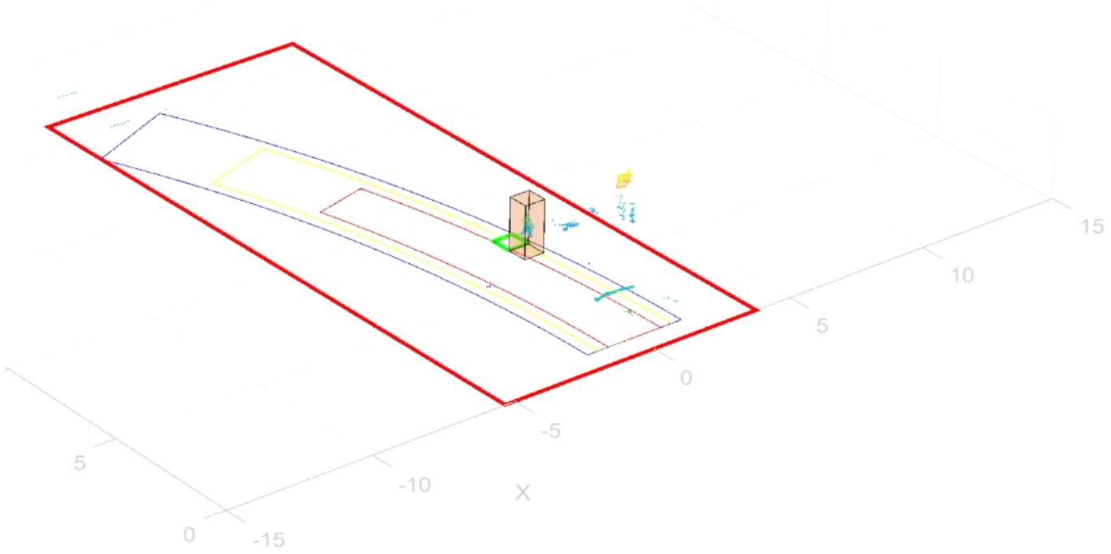
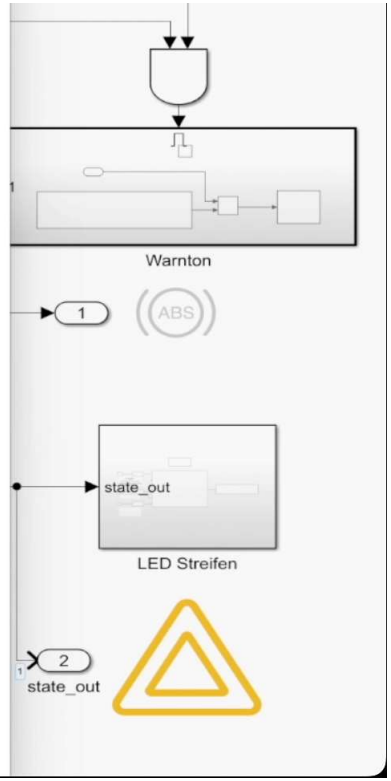
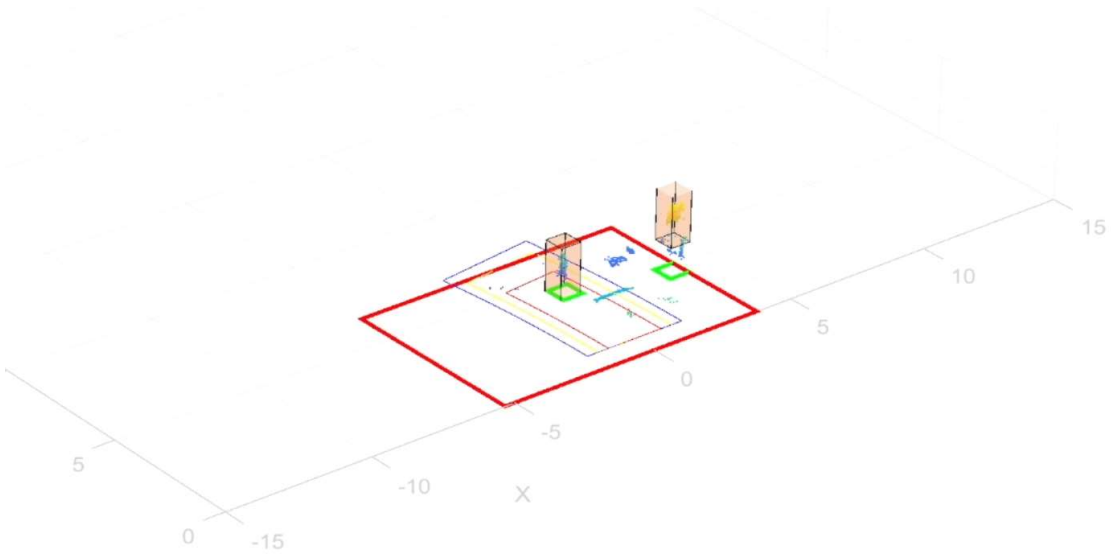
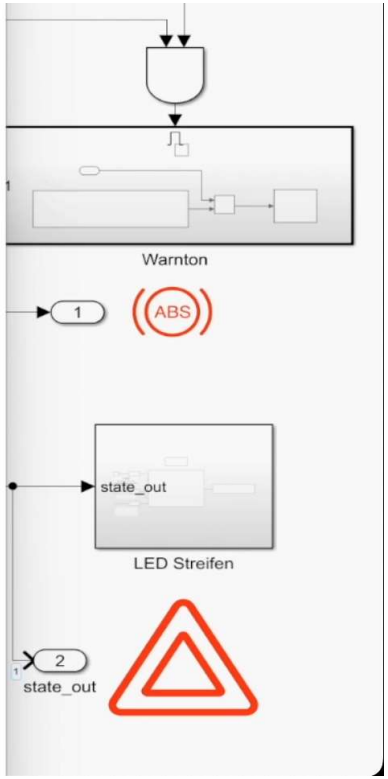
Real Drive – Warning





Real Drive – Full Brake






01.10.2024

Outlook

- Connection of various Lidar sensors via a ROS interface.
  - A total of 6 different additional Lidar-Sensors are available for use.
  - ROS interface is always present.
- Investigations in bad weather conditions.
  - Research area of the laboratory, particularly important for system safety of autonomous vehicles.
- Inclusion of camera and radar sensors.
- Use of Lidar-SLAM to improve lateral control at higher speeds.

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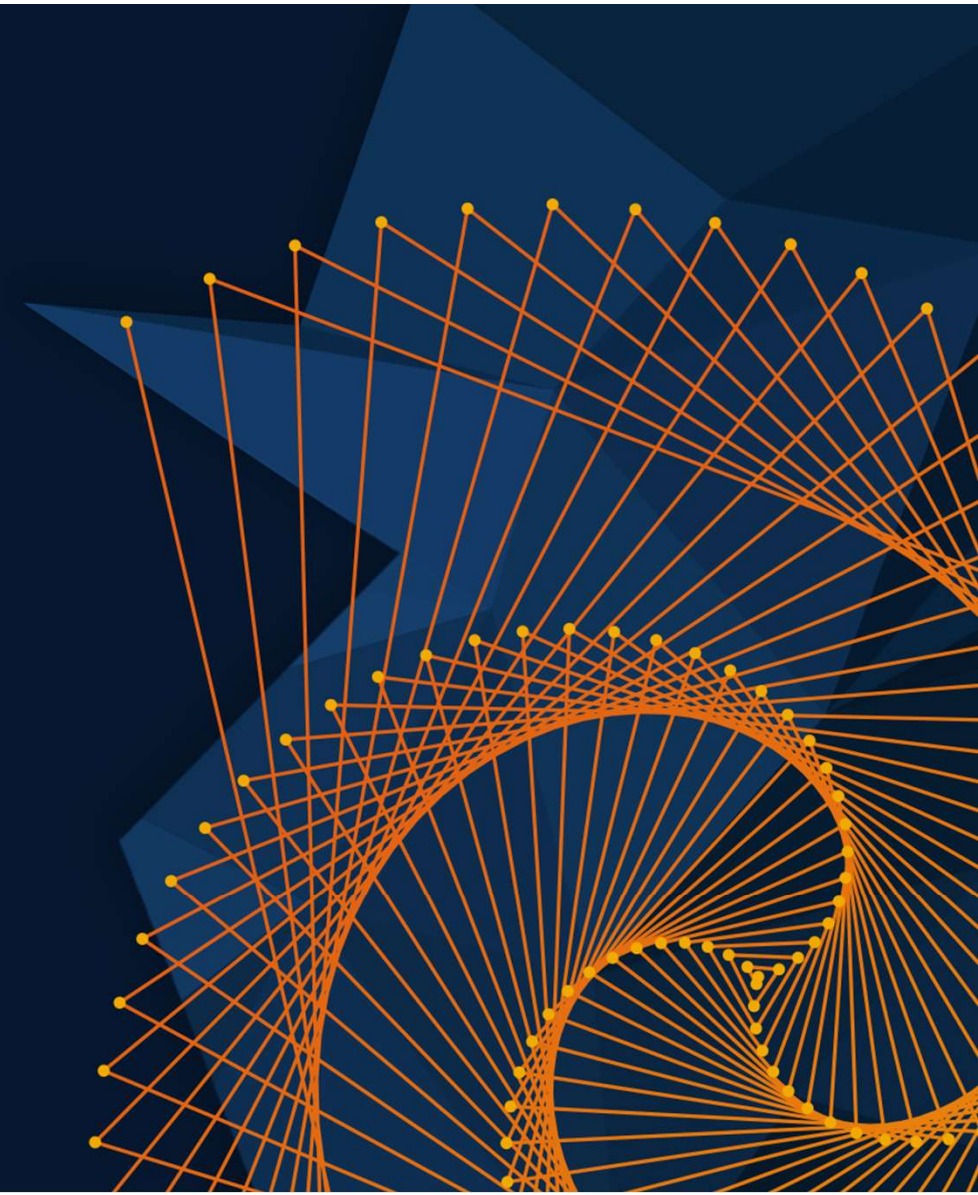
Thank you

Software/Documents at:

www.mechlab.de



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