

Vehicle-in-the-Loop

Operating a real vehicle in a virtual environment



ARE YOU SAFE?



SURE?

**TEST CRITICAL SCENARIOS
WITH A REAL VEHICLE
IN THE VIRTUAL WORLD**

Vehicle-in-the-Loop (VIL) Technology

How it works



USE CASES

Park Assist

Emergency Braking

Lane Departure Warning

Lane Keeping Assist

Rear Collision Warning

Lane Change Assist

Adaptive Cruise Control

Automated Driving Functions



Vehicle-in-the-Loop Combines Both Worlds

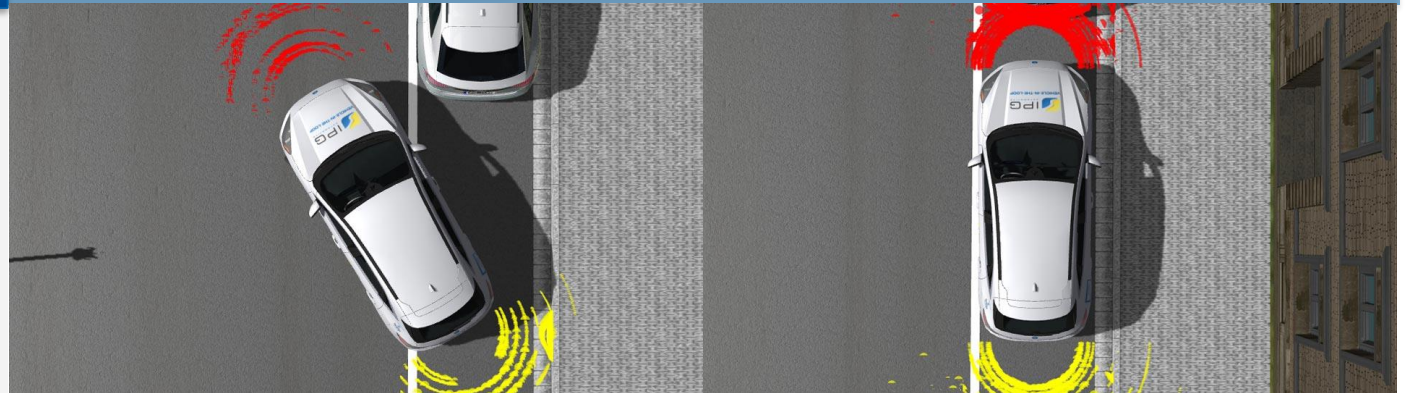
Real world strengths

- Testing on high integration level
- Integration HIL system on wheels
- High reliability
- Experience of system behavior



Virtual world strengths

- Perfect repeatability and reproducibility in dynamic scenarios
- Effort reduction
- Re-use of test cases from earlier development stages
- Flexibility in test case variation

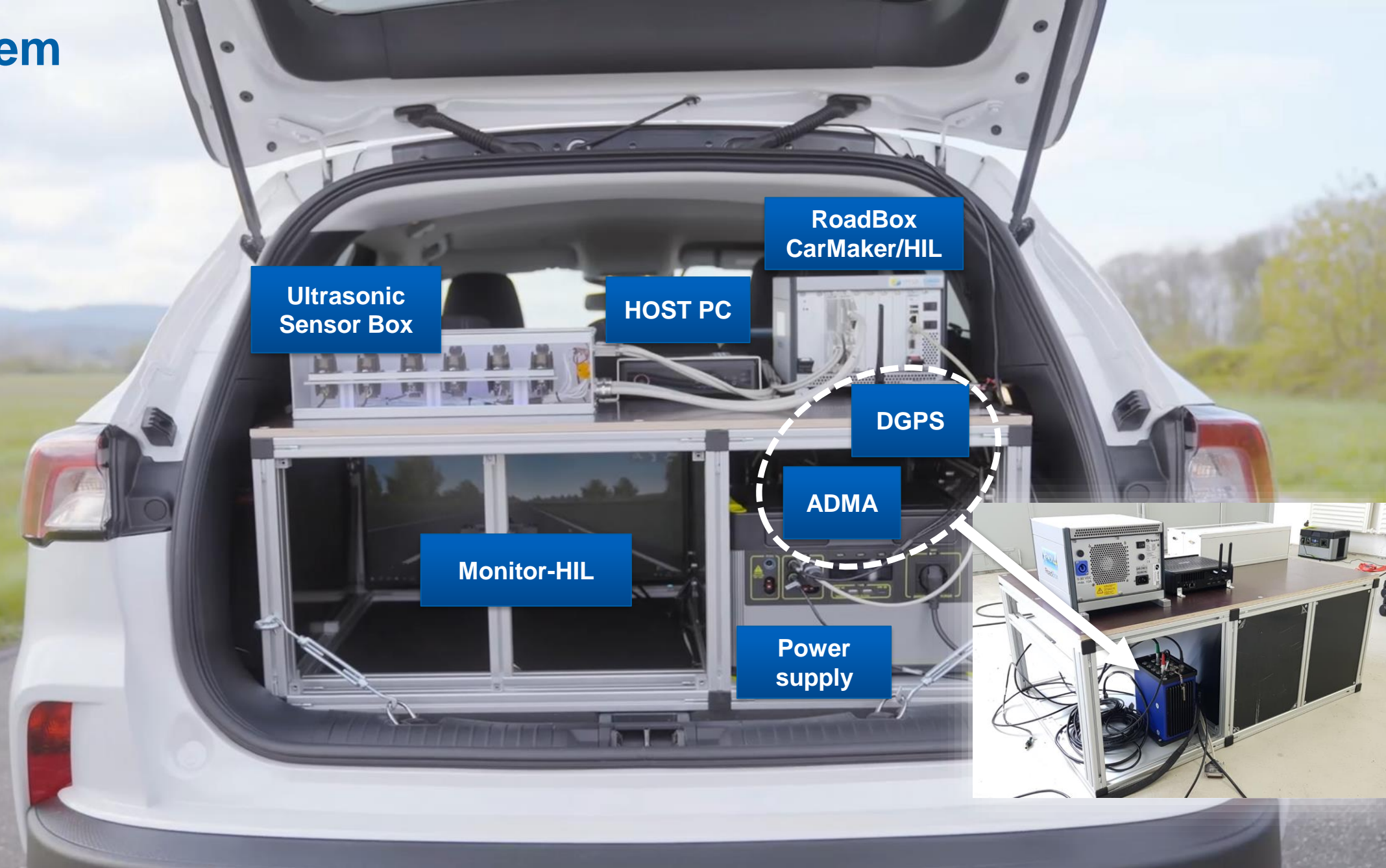


Closing the Integration Gap between HIL and Real World Tests

<div> <div>V</div> Virtual world <div>R</div> Real world </div>	MIL	SIL	ECU HIL	System HIL	PT HIL/ Stat. VIL	Dynamic VIL	Real World
ECU-Code / Function	V	R	R	R	R	R	R
ECU	V	V	R	R	R	R	R
System (e.g. Steering gear)	V	V	V	R	R	R	R
Vehicle	V	V	V	V	R	R	R
Road and static environment	V	V	V	V	V R	R	R
Vehicle dynamics	V	V	V	V	V	R	R
System experience	V	V	V	V	V	R	R
Driver	V	V	V	V	V	V R	R
Surrounding traffic	V	V	V	V	V	V	R

VIL System

Setup



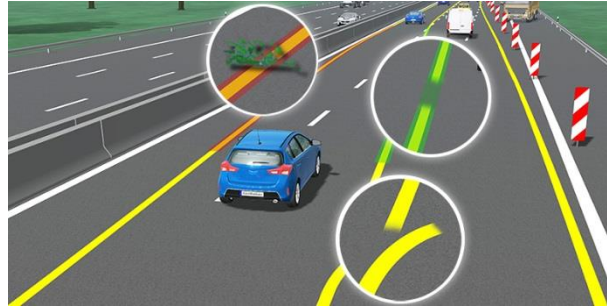
Rear view

Testing capabilities of CarMaker

Development and testing of present and future safety assistance systems



**Autonomous emergency
braking systems**



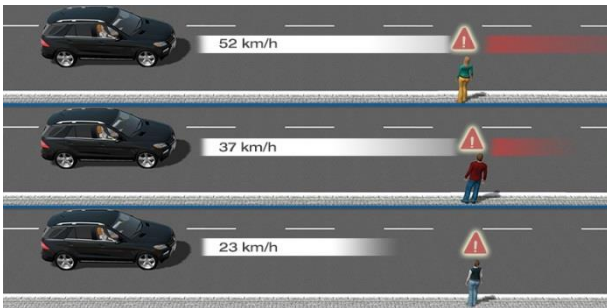
Lane support systems



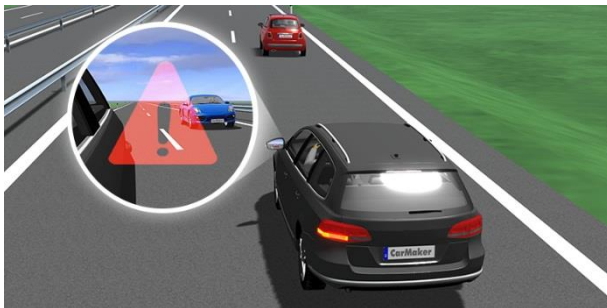
**Electronic stability
control systems**



**Speed assist
systems**



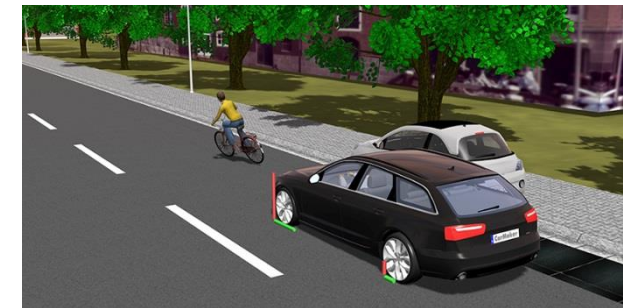
Pedestrian detection



**Lateral collision
avoidance systems**



Adaptive headlights



Cyclist detection

Many different ADAS functions can be tested within CarMaker

Reusable throughout the entire development process



Vehicle-in-the-Loop

Conclusion

Highlights and benefits

The Vehicle-in-the-loop method...

- combines **real** and **virtual test driving**.
- can be applied for testing **ADAS & AV**.
- enables real test driving in **reproducible** and **deterministic conditions**.
- is **time** and **cost saving** (material + human).
- makes **front-loading** tests of ADAS in a real vehicle possible.
- can be used for testing **NCAP scenarios**.



Vehicle-in-the-loop is an efficient method for ADAS/AV development and NCAP testing

SOLUTIONS FOR VIRTUAL TEST DRIVING

Locations: Germany | China | France | Japan | Korea | Sweden | UK | USA

Sales partners: India | Italy | Taiwan | Turkey



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