



Federal Ministry
of Transport and
Digital Infrastructure

Informal document GRRF-82-34
82nd GRRF, 20-23 September 2016
Agenda item 9

Automatically Commanded Steering Function (ACSF)

Demonstration of Feasibility of Proposed Test Cases with a Production Vehicle



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Test Equipment and Facilities

Test Vehicle #1

- Mercedes E300 W213 with ADAS package („Fahrerassistenzpaket“)
- Vehicle
- Position Measurement: GeneSys ADMA v3 (combined DGPS + IMU)
- Relative Position Measurement: GeneSys ADMA v3 DELTA function (via WiFi communication)





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Test Vehicle #2

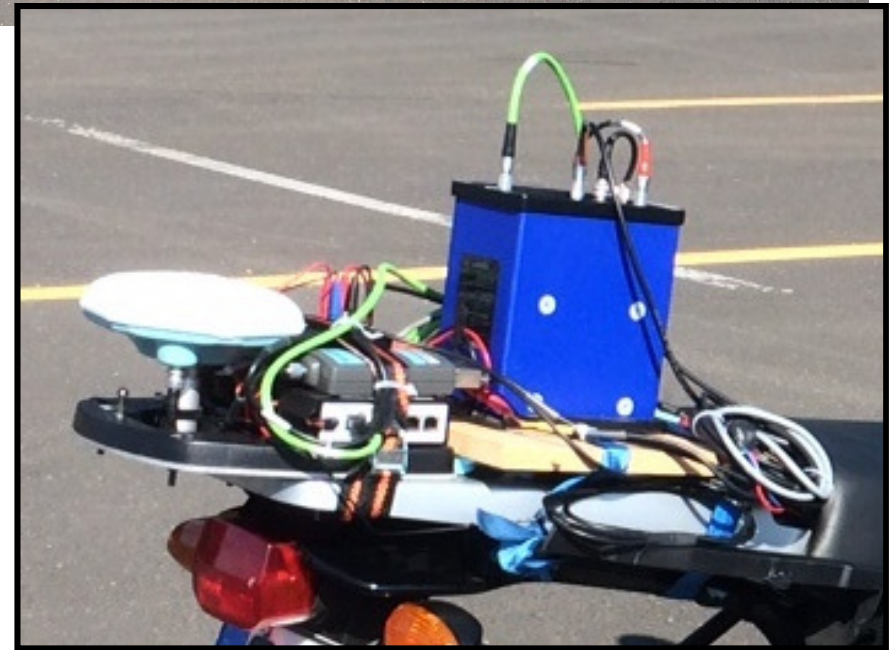
- Mercedes E240 W210 as Target / Towing Vehicle
- Position Measurement: GeneSys ADMA v3 (combined DGPS + IMU)
- Relative Position Measurement: GeneSys ADMA v3 DELTA function (via WiFi communication)
- Vehico Driving Robots for Speed and Deceleration (on test track only)





Test Vehicle #3

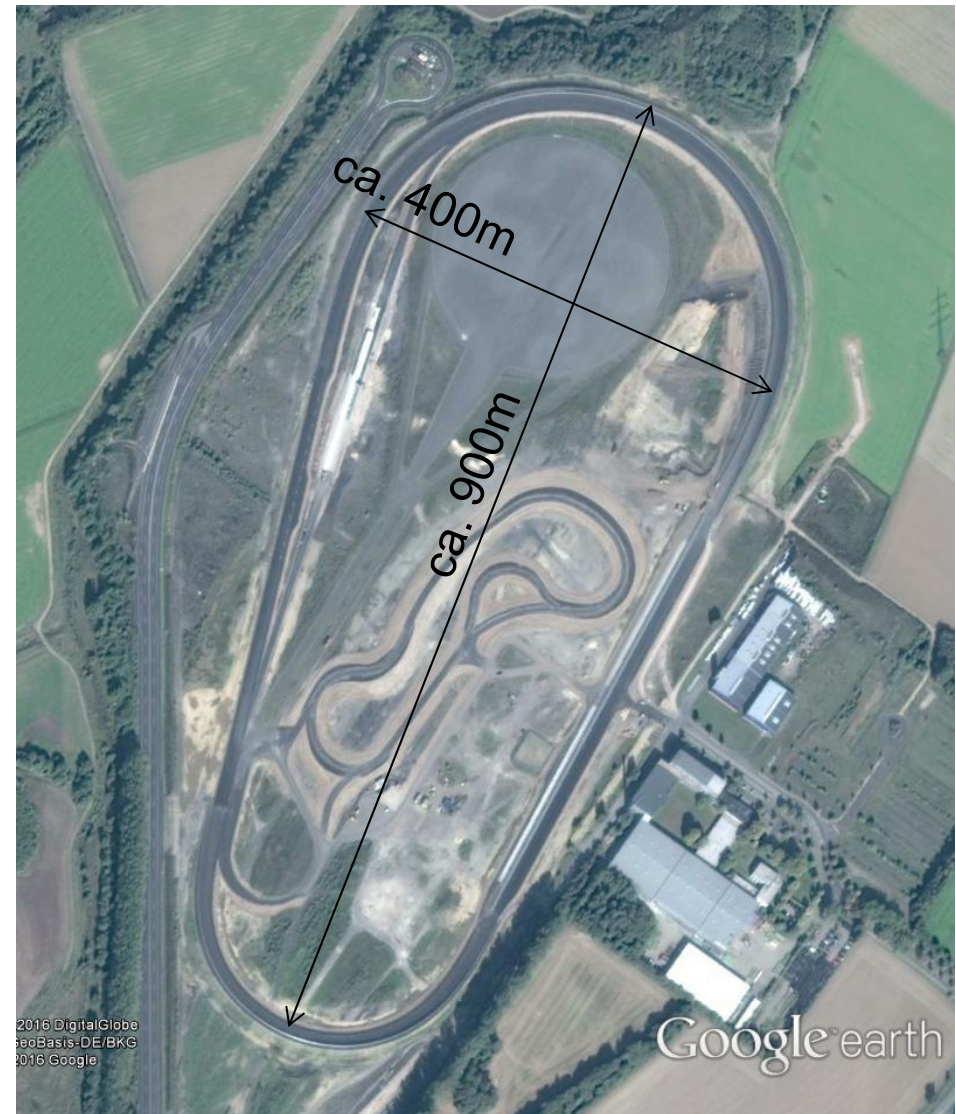
- BMW R1150GS R21
- Position Measurement:
GeneSys ADMA v3
(combined DGPS + IMU)
- Relative Position Measurement:
GeneSys ADMA v3 DELTA function
(via WiFi communication)





Test Track #1

- Aldenhoven Test Center
www.atc-aldenhoven.de
- In-between Aachen and Cologne
- Owned by Aachen University & the county of Düren
- One of the smaller commercial test tracks
- Certified EuroNCAP test track for BASt and TNO
- No Motorcycles on round course!
- All but FU2 tests performed here

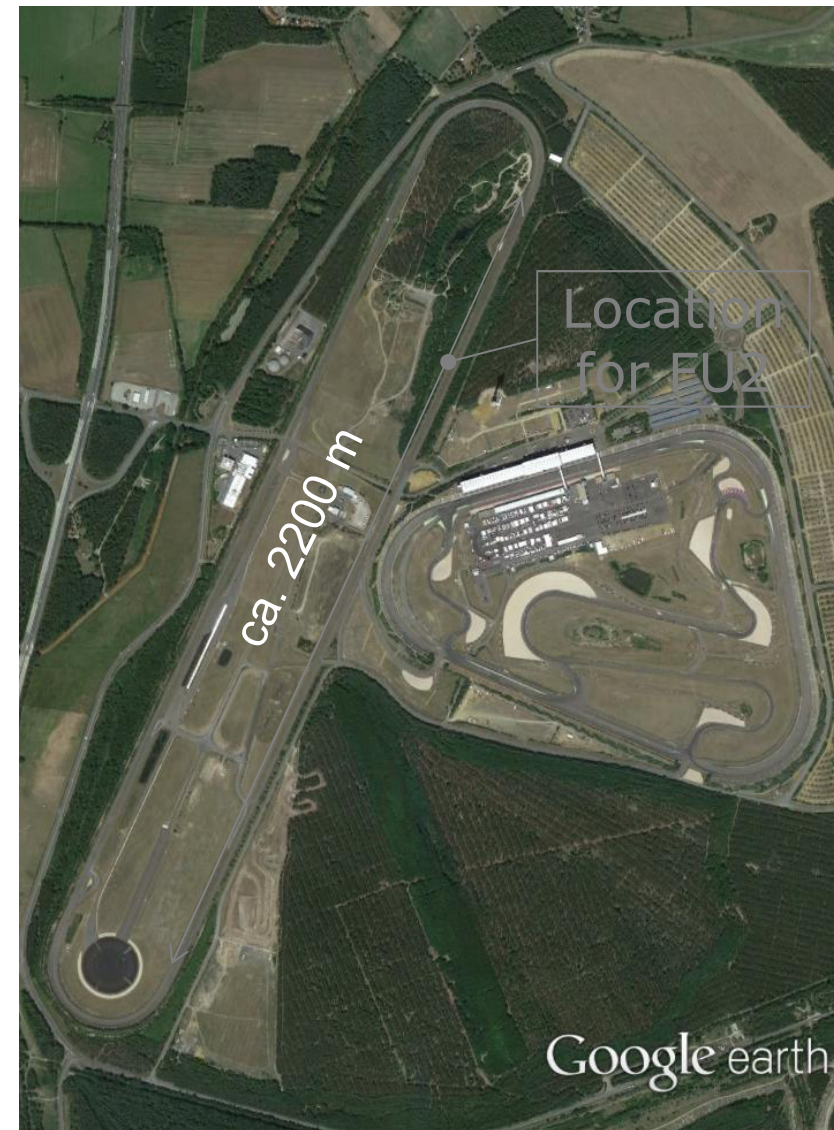




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Test Track #2

- DEKRA Automobil Testcenter
www.dekra.de
- In-between Dresden
and Cottbus
- Motorcycles allowed on Round
Course
- FU2 – Abort of lane change
performed on Oval Round Course





Target

EuroNCAP Vehicle Target (EVT)





Target Trailer for Moving Tests



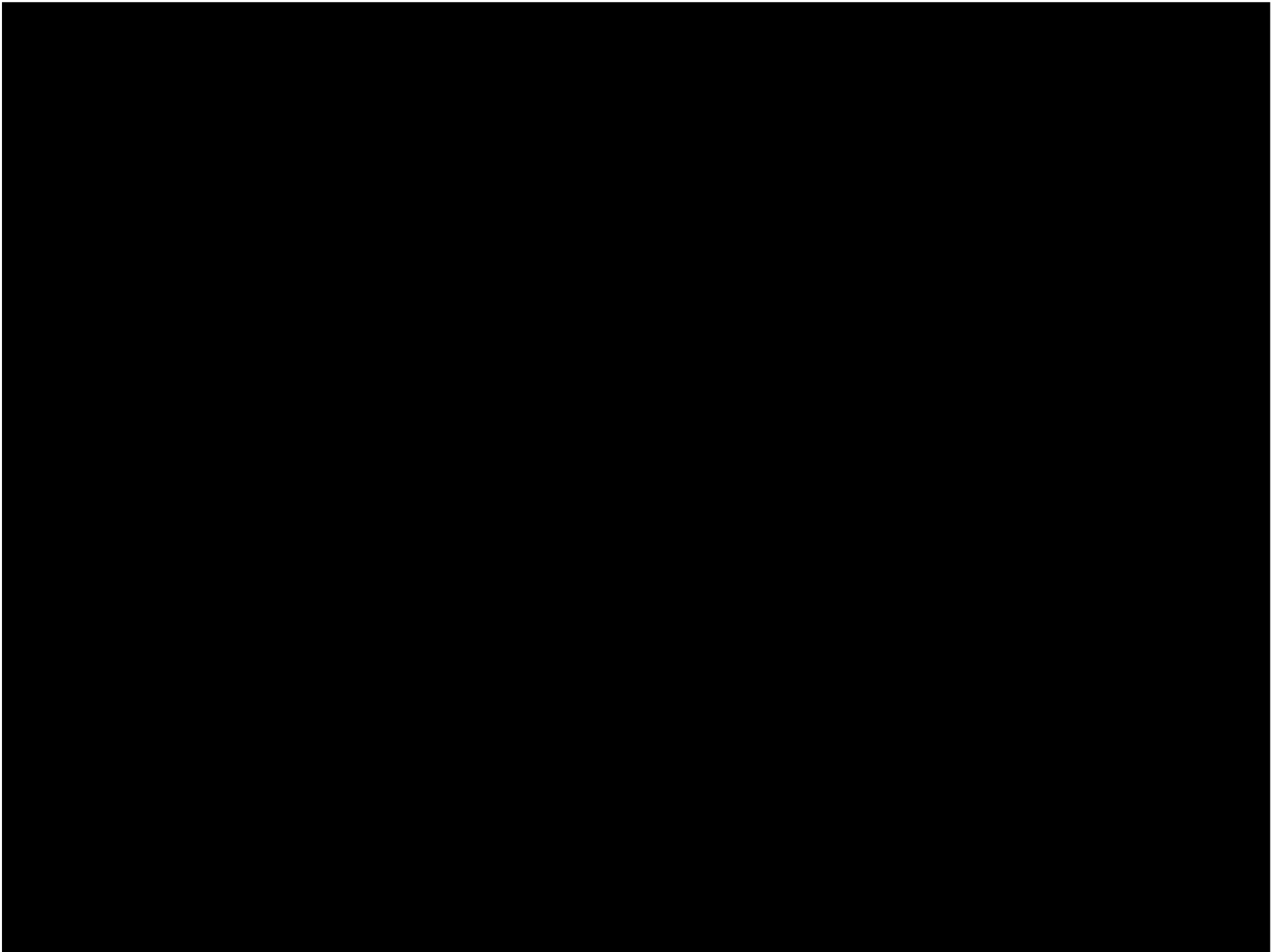


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Functional Tests

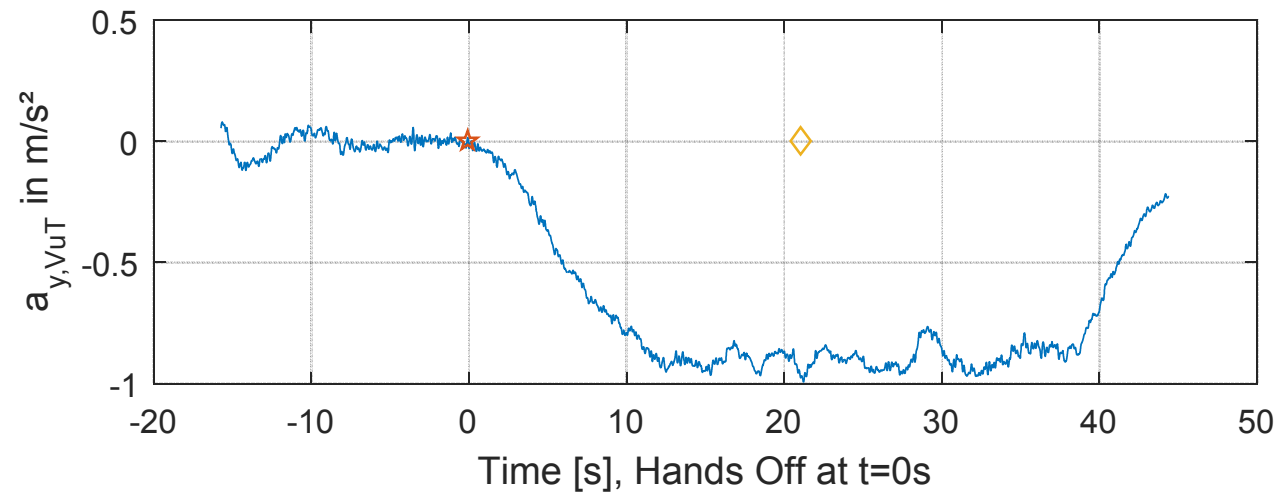
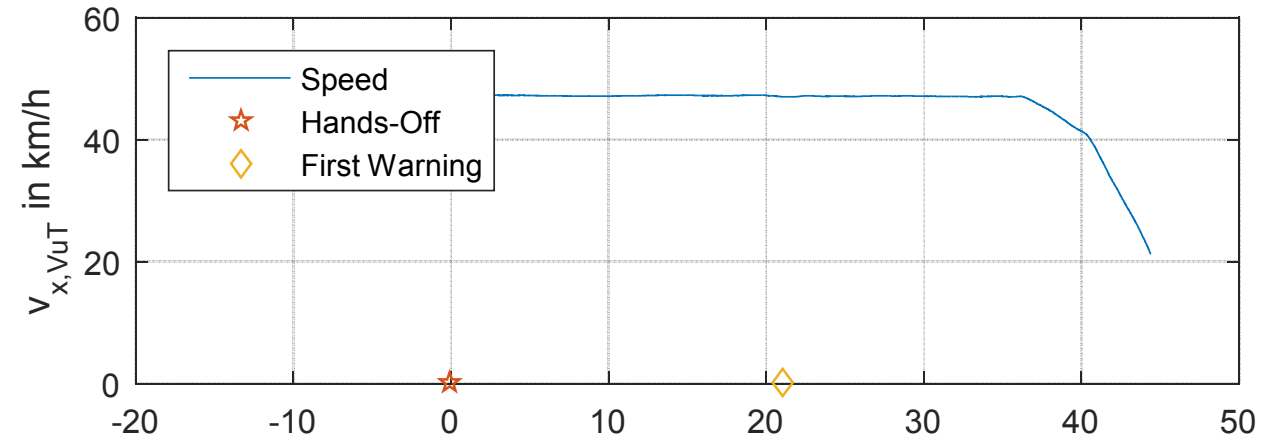
FU0 – Hands-Off test (1)







FU0 - Data



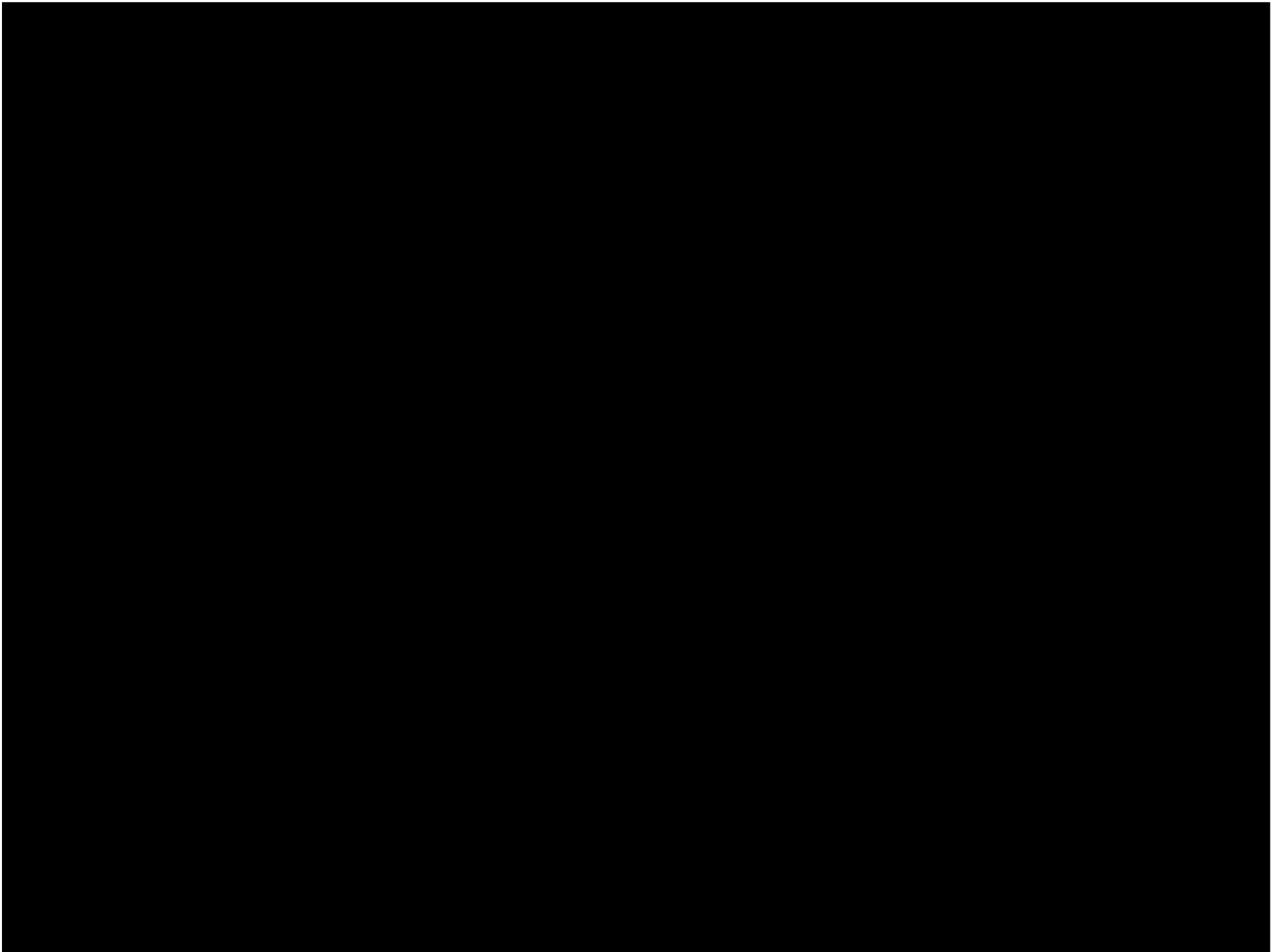


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FU1 – Lane Keeping test

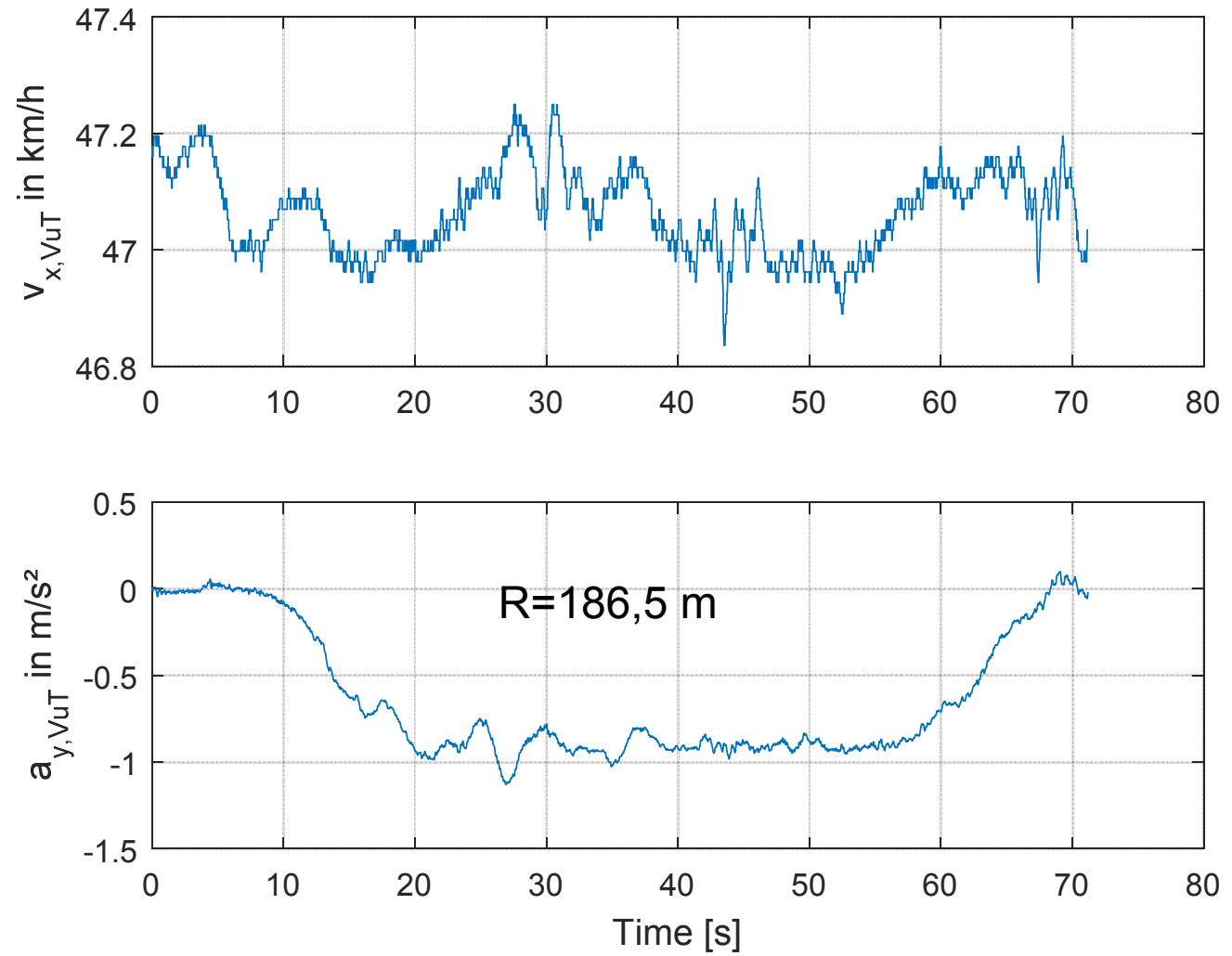


Attention: both cameras are **NOT** accurately synchronized
(no common audio signal available in these tests)





FU1 - Data

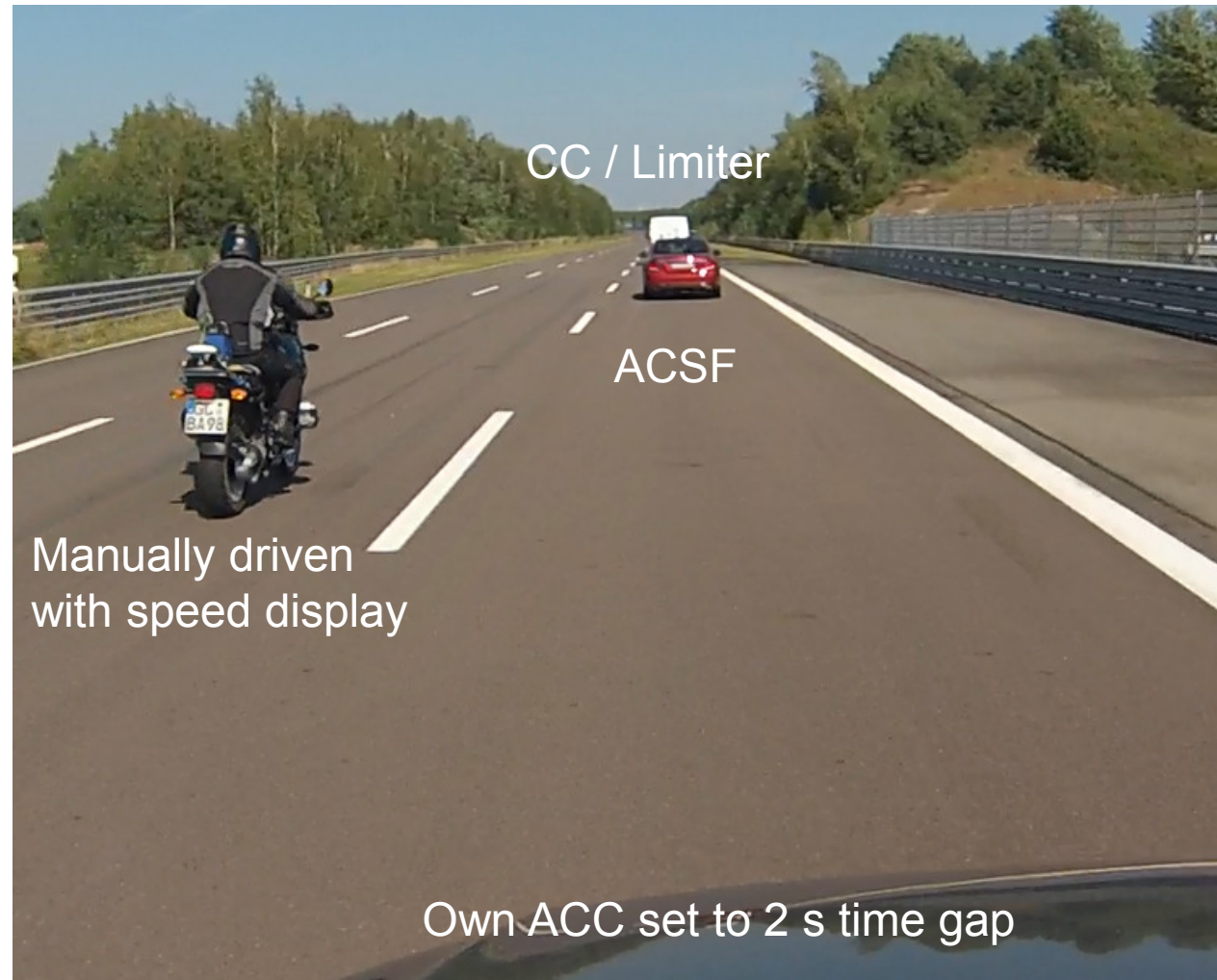




FU2 – Aborted Lane Change

- Motorcycle overtakes a convoy (120 to 70 km/h)
- Convoy
 - Lead vehicle (Cruise control to 70 km/h)
 - ACSF vehicle (time gap selected by vehicle)
 - Closing vehicle (ACC, time gap 2 s)
- Lane change commanded in ACSF vehicle when motorcycle becomes critical
- ACSF vehicle must not overtake
- Test vehicle changes lanes only on real roads → cannot be tested with this method

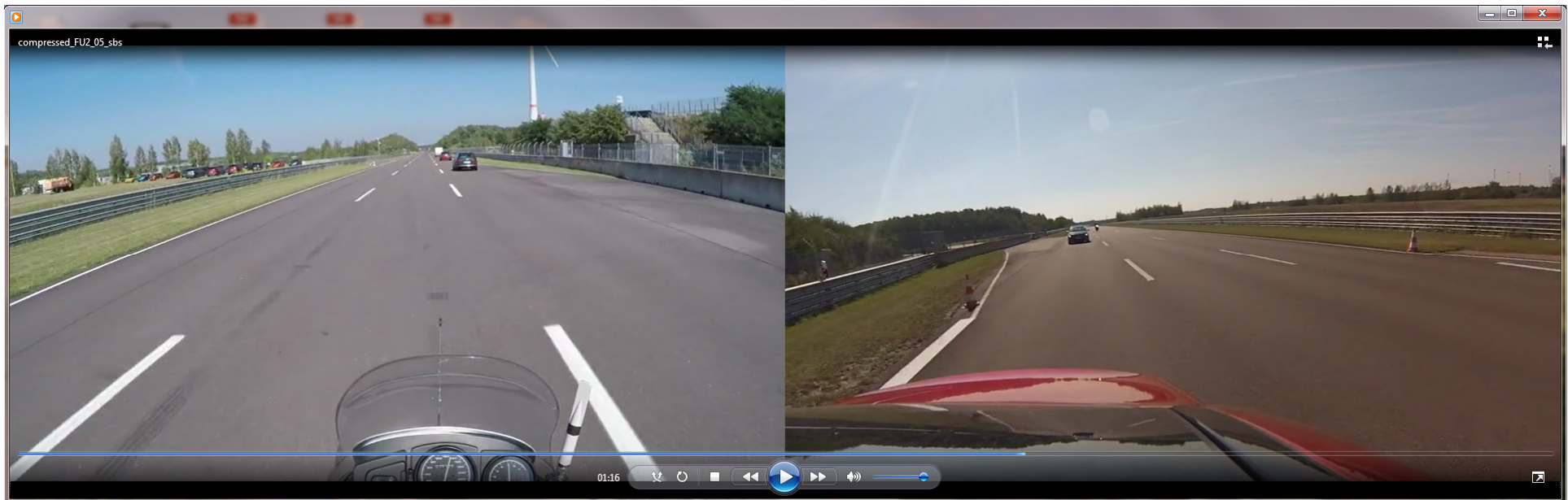
Test Setup



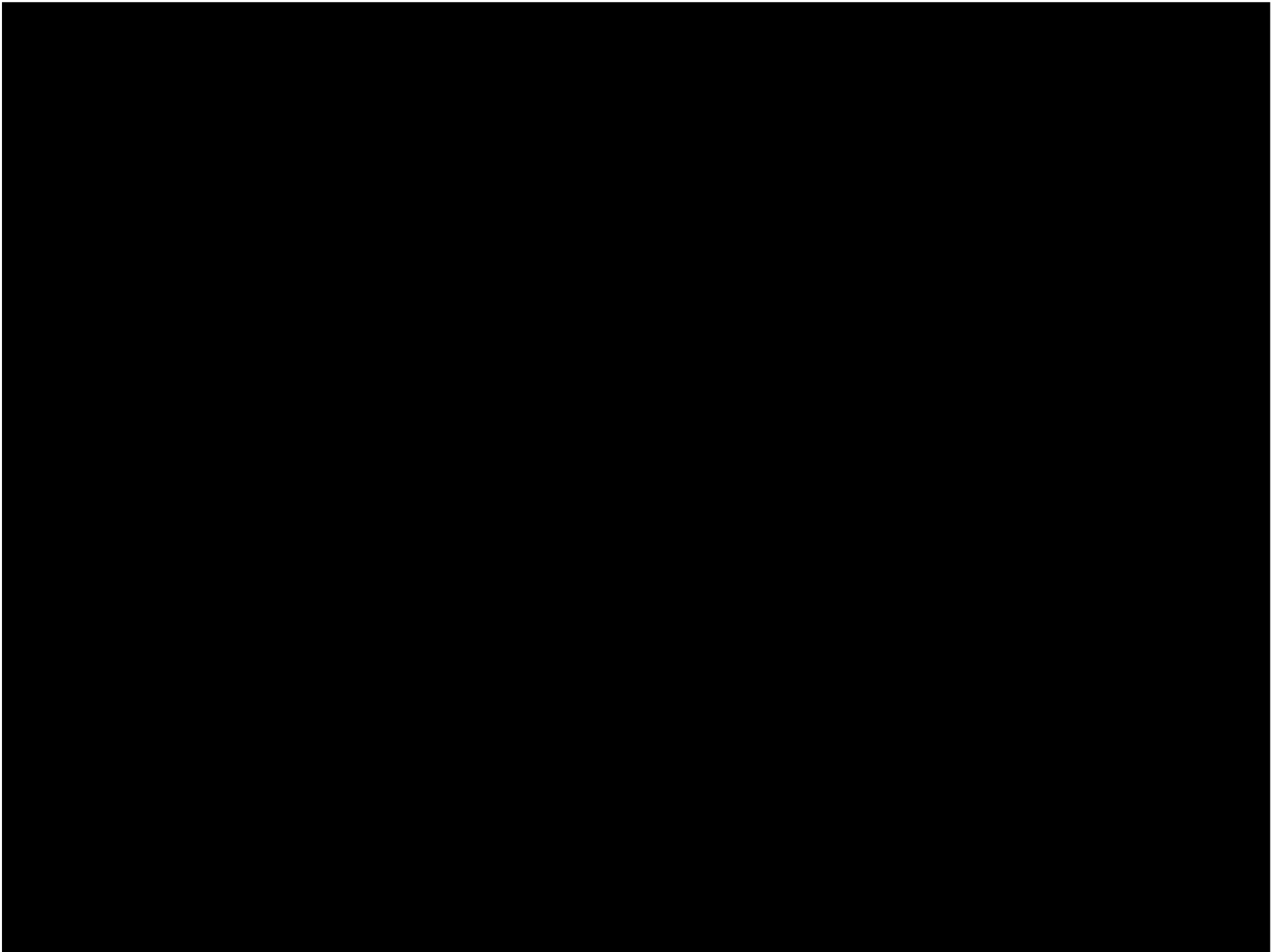


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FU2 Tests - Video

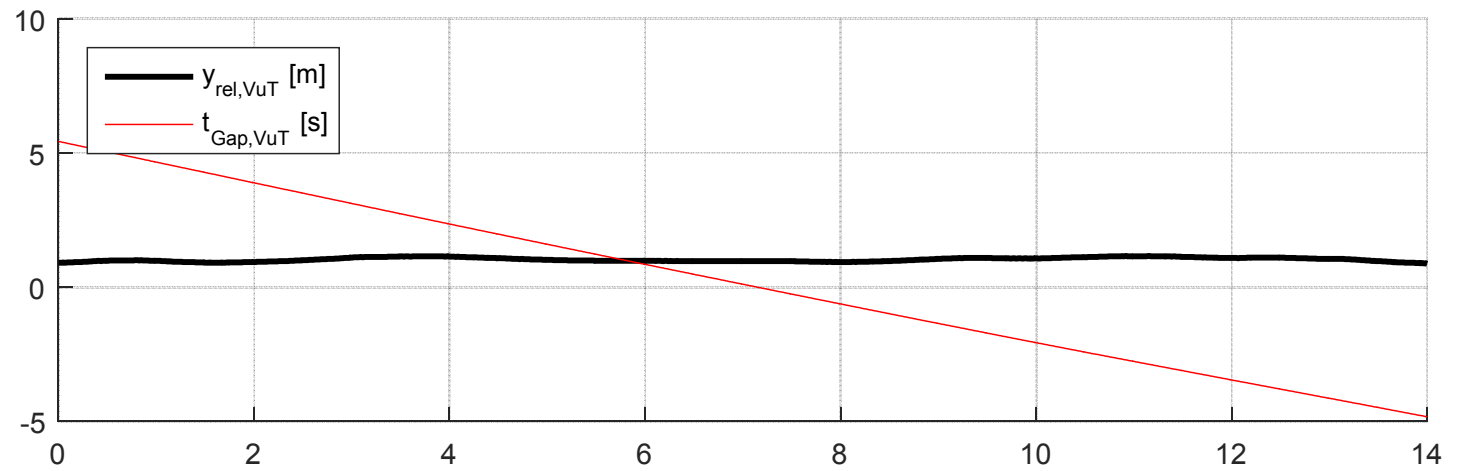
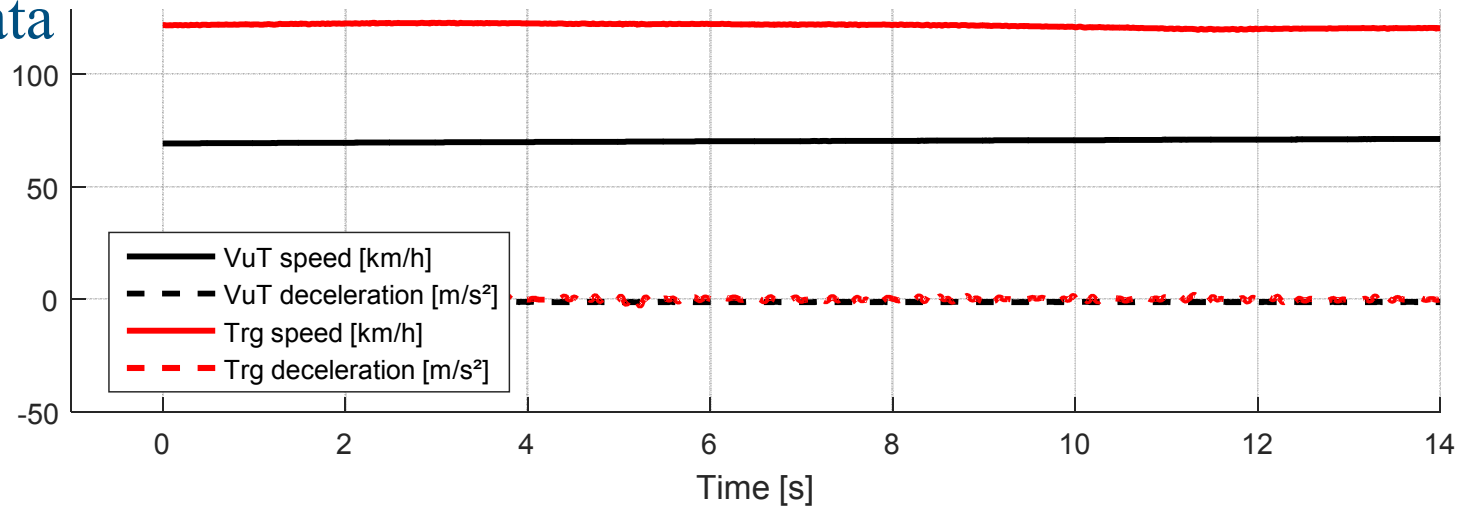


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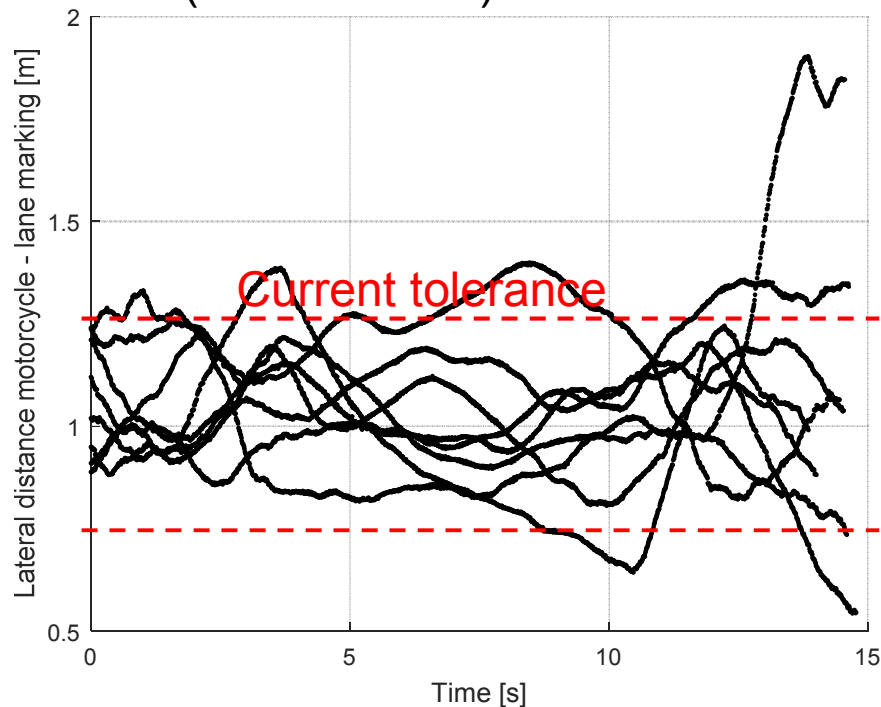
FU2 - Data





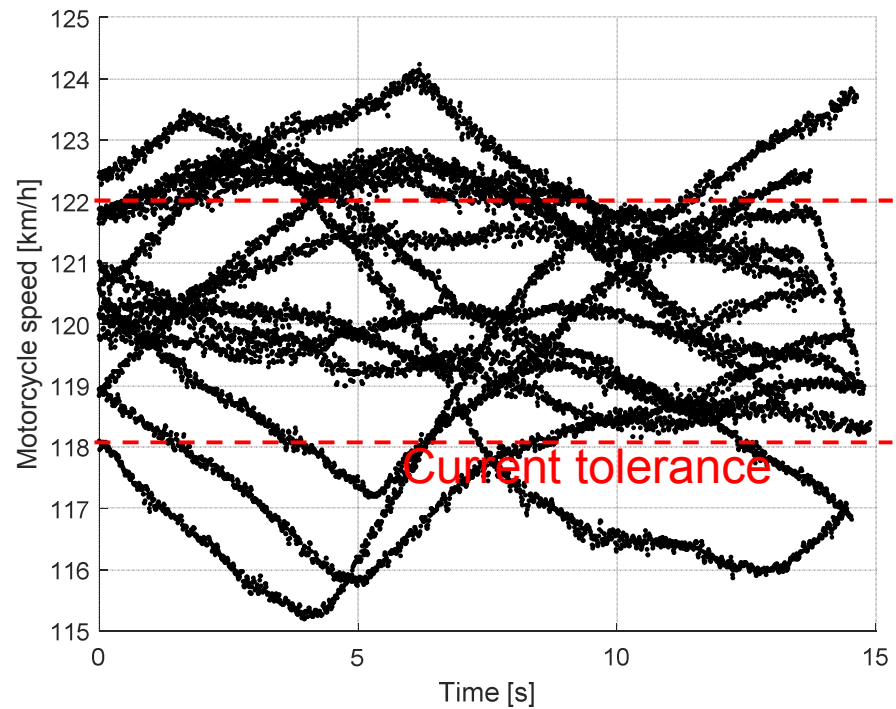
FU2 – Repeatability

Motorcycle Distance to Lane
(TTC 5 to -5 s)



Suggested lateral distance
 1 ± 0.5 m

Motorcycle Speed
(TTC 5 to -5 s)



Suggested speed tolerance
 120 ± 5 km/h

FU3 – Successful Lane Change

- Vehicle Mercedes E300 CAN perform automated lane changes (driver-initiated)
- ONLY on real roads (not possible on any test track)
- Time gap selected to approx. 1 s (to not annoy other traffic)

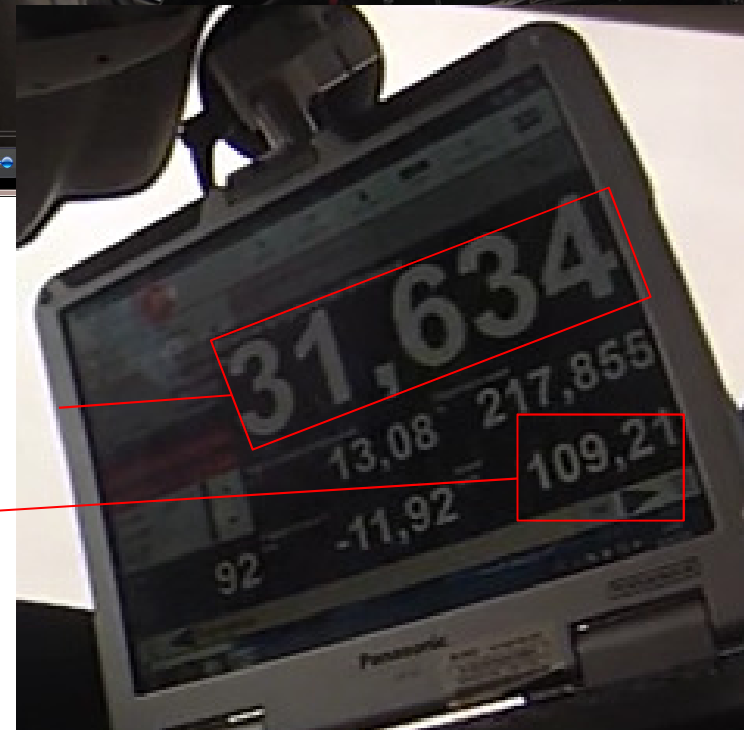


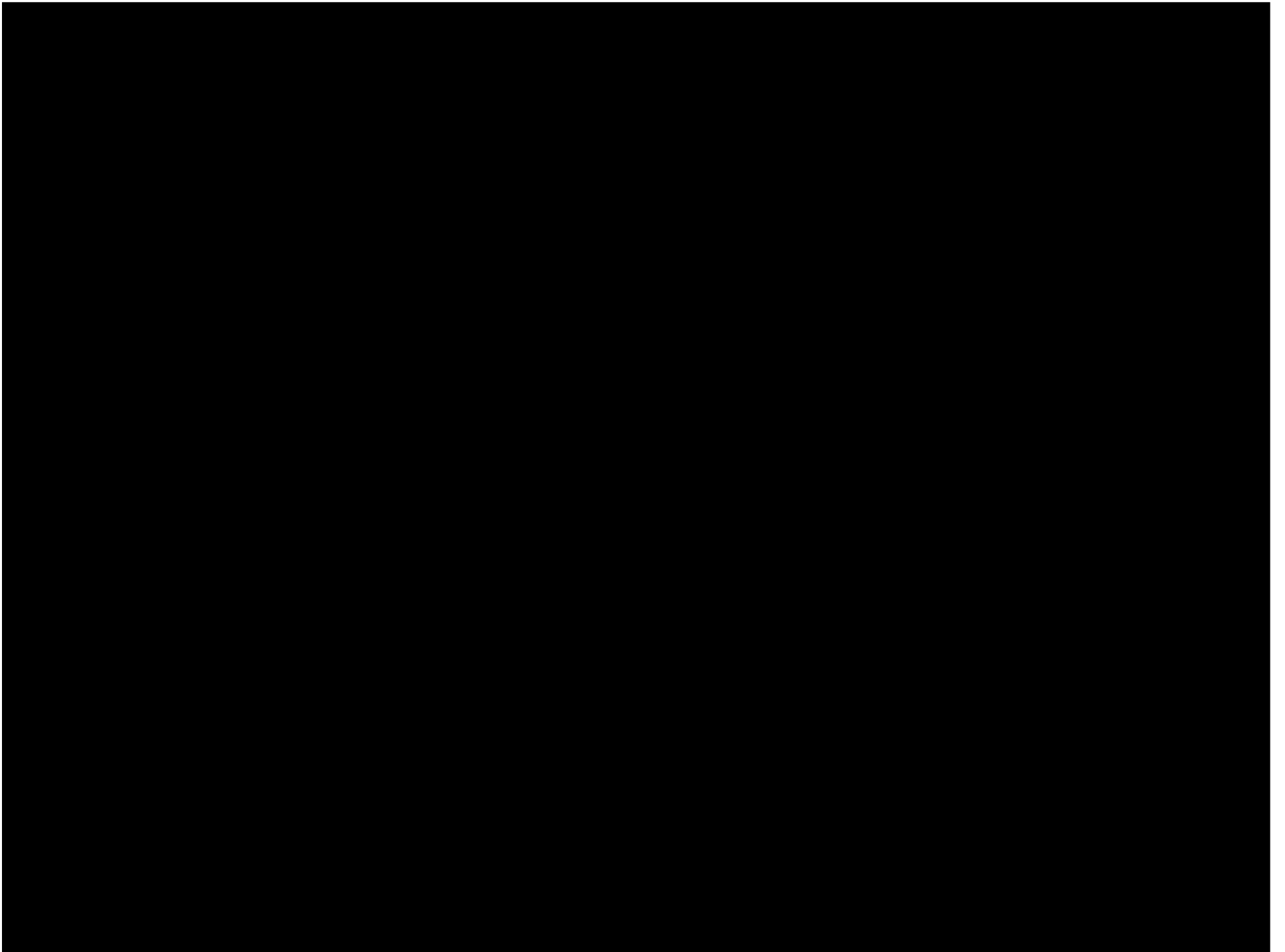
FU3



Distance Vehicle Front – Vehicle Front [m]

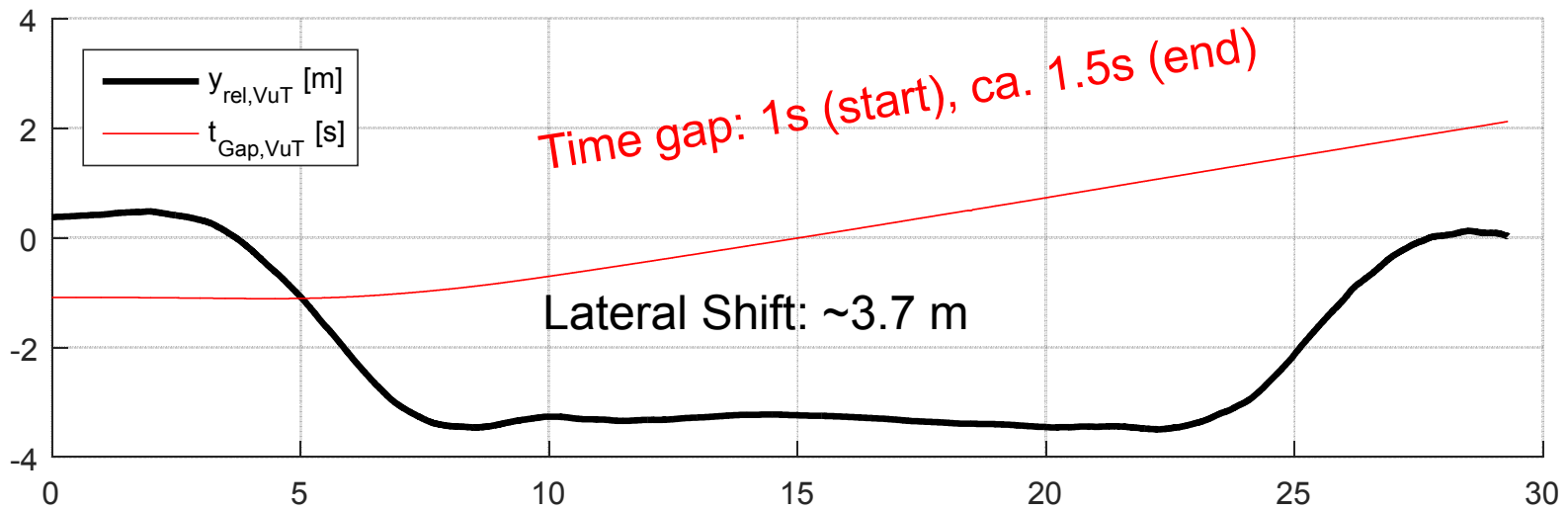
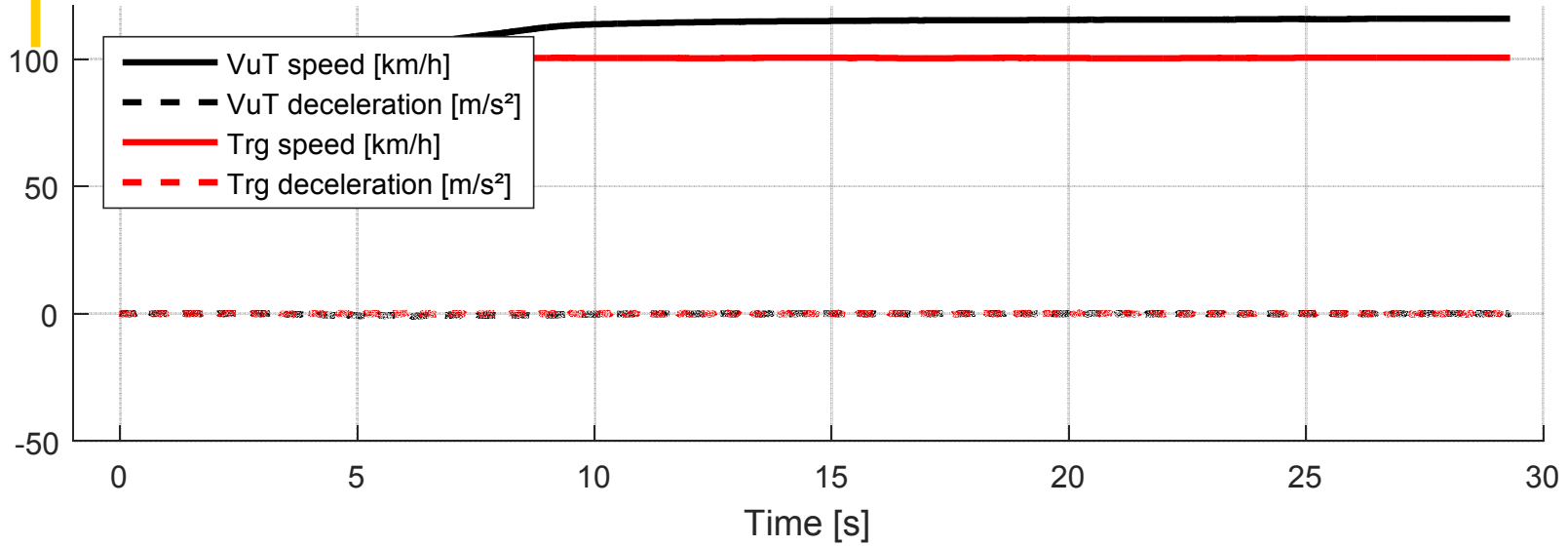
Actual Speed [km/h]







FU3 - Data





Conclusions – Functionality Tests

- FU0: yes/no assessment is possible with camera and UTC time reference.
- FU1: yes/no assessment for crossing lane markings is possible with simple wheel camera.
- FU2: is possible with a motorcycle, tolerances might have to be extended.
- FU3: currently only on highway. Suggested time gaps (based on overtaken vehicle's speed) seems to be too restrictive (1 s time gap not acceptable by other traffic).

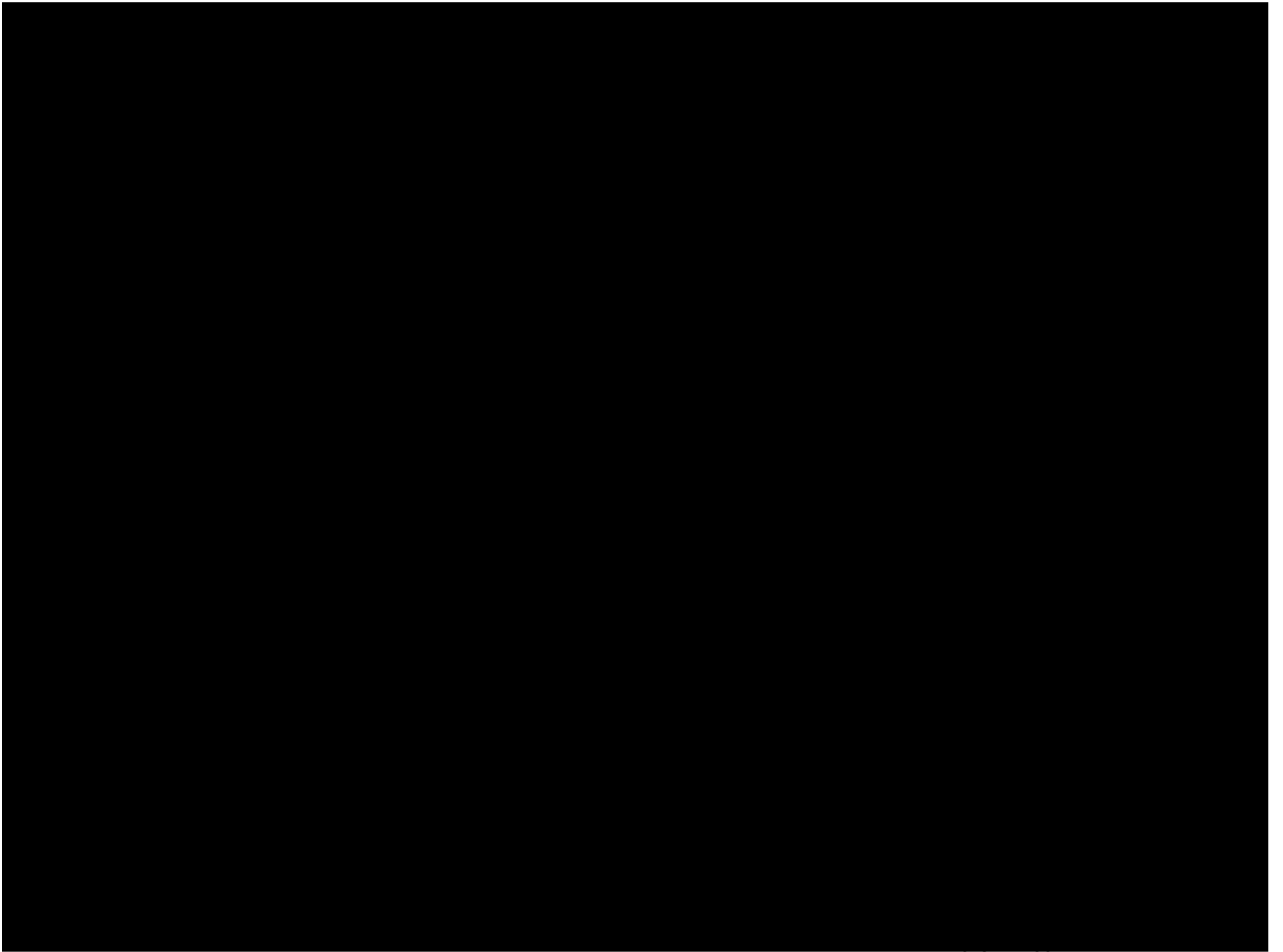




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EM1 – Setup





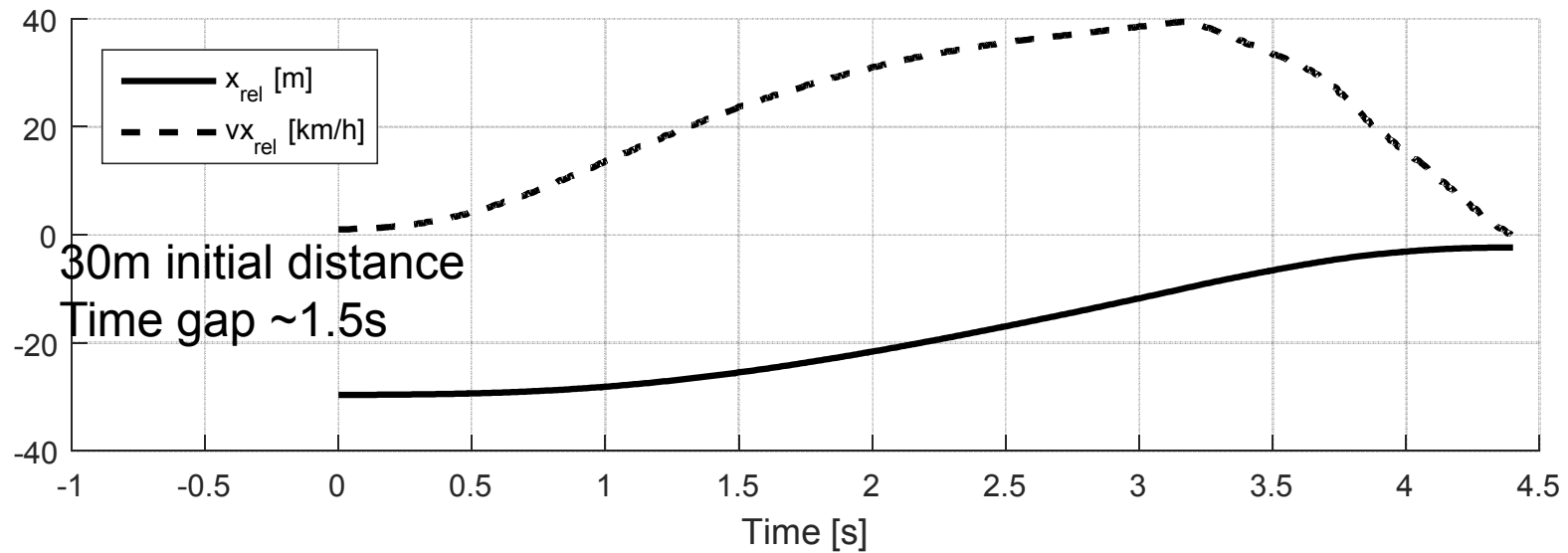
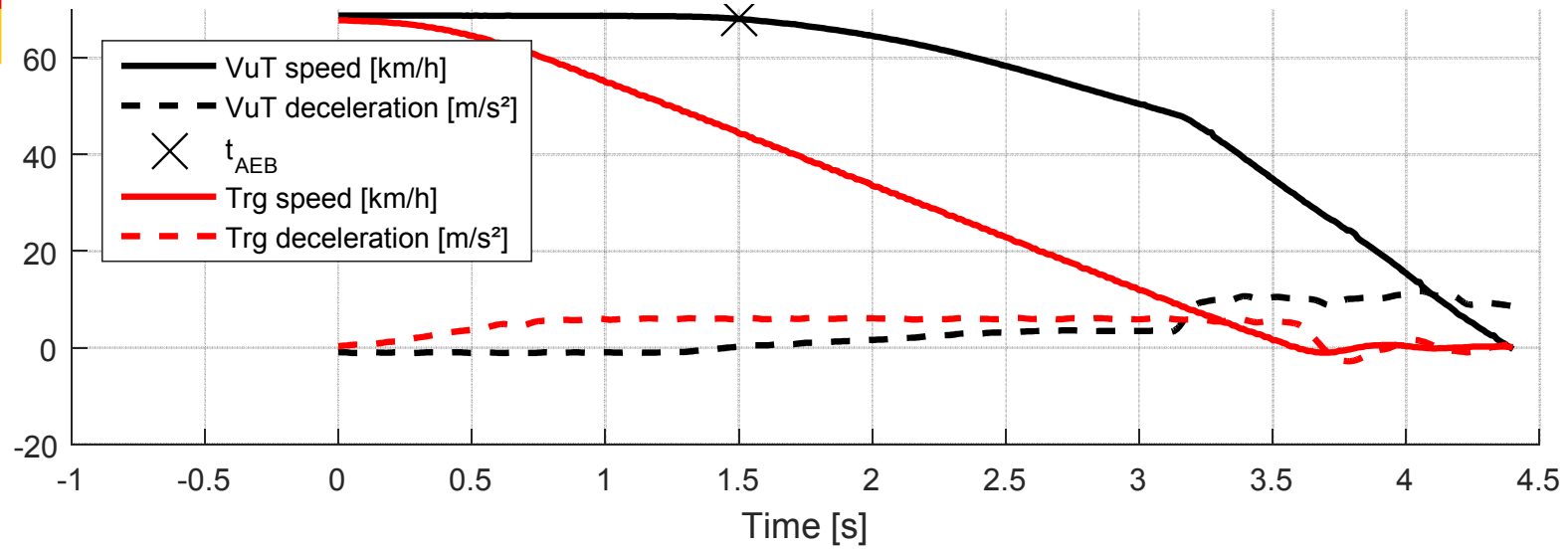


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EM1 - Data

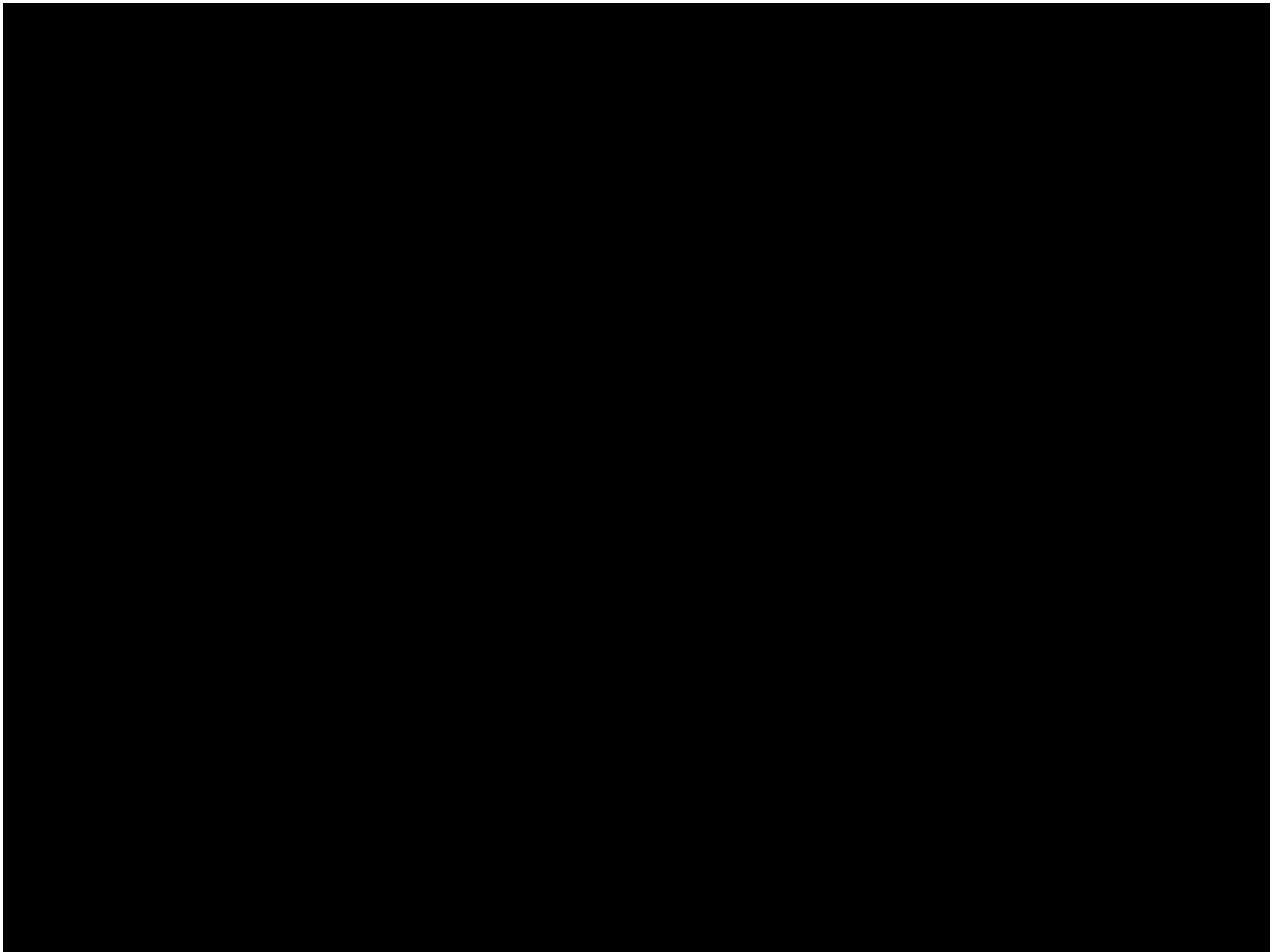




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EM2 – Setup

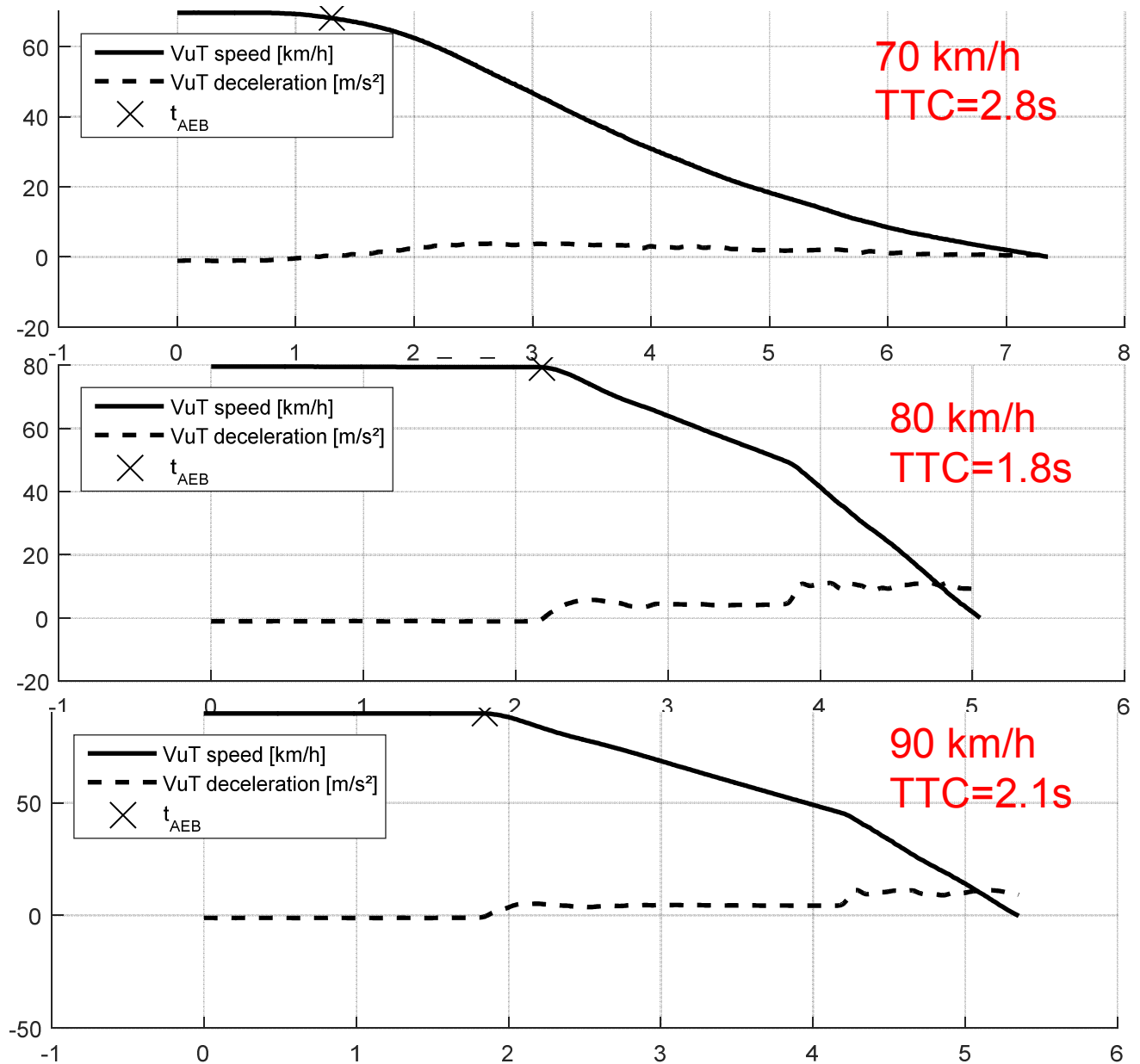








EM2 – Data





Conclusions – EM tests (1)

EM1 tests are a modification of current Euro NCAP braking tests

- Speed is higher (70 to 50 km/h).
- Tests can be performed with current target and propulsion system
- Equipment of Vehicle under Test (VuT) with robots is NOT necessary
- Target vehicle needs to be equipped with brake robot for exact brake profile

=> EM1 tests possible.



Conclusions – EM tests (2)

EM2 tests are a modification of current Euro NCAP stationary tests

- Tests have been conducted up to 90 km/h approach speed
- Current Euro NCAP vehicle target can be used for the tests
- Test vehicle has passed

If not passed, impact with > 50 km/h needs to be avoided

- Abort the test by automatically applying full brake force at a limit TTC
- Proposal: $TTC = v / (2\mu g) + 0.3$ [s] (close to physical limit!)
- Determine μ before test run, ensure full brake force 0.3 s after activation



Summary

- BAST has carried out demonstration tests for ACSF functionality and emergency scenarios
- All scenarios can be tested using state-of-the-art target systems

Thank you for your attention!

Federal Ministry of Transport
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www.bmvi.de