



Human driving behavior and ADF performance in urban traffic areas

L3Pilot Final Event

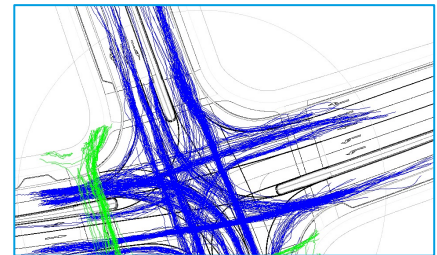
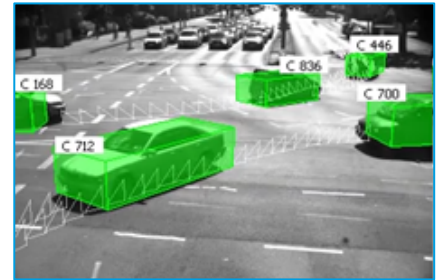
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AIM* Mobile Units

*Application Platform for Intelligent Mobility

- 24/7 instrument equipped with stereo-cameras for detecting and analysing road user behaviour
- trajectories / process chain: object data: camera → ... → UTM trajectories and low resolution videos with overlay boxes
- Data:
 - 25 Hz trajectories and videos
 - Data: time stamp, position, velocity, acceleration, type of road user (i.e. cars, trucks, vans, pedestrians and cyclists)
- GDPR compliance:
 - Very low resolution (less than 5% of the original)
 - Neither faces nor license plates can be detected and tracked

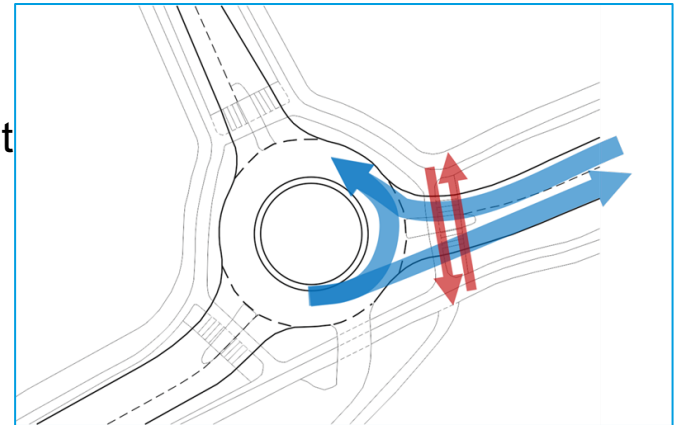
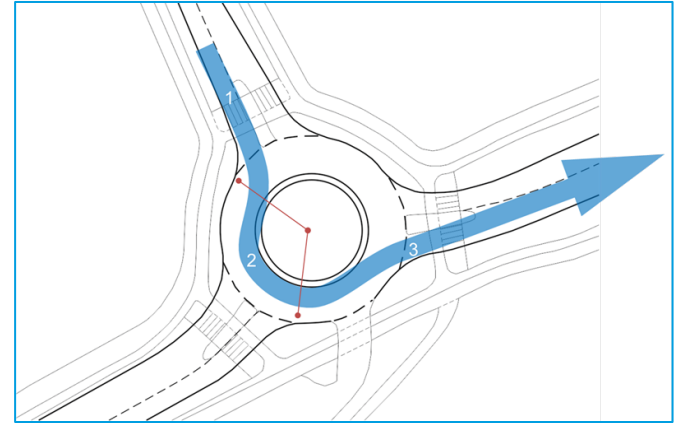


Measurement setup

Observed traffic areas

- **Location 1: urban roundabout**

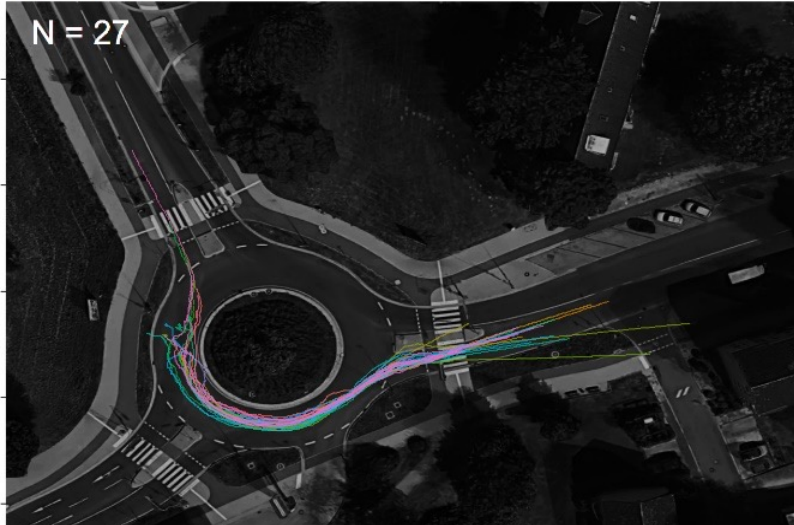
- 24/10 – 22/11/2019 (29 days of data)
- 49 ADF drives: 14/11 – 21/11/2019 (8 days)
 - 33 available, 16 lost (due to system error 21.11.2019)
 - 6 discarded due to North-North paths and trajectory losses
 - 27 usable for L3pilot analysis use case North-East
- 69 baseline situations of human driving
- Special focus on
 - relation N → E
 - VRU crossing in the East
 - Human driving behaviour



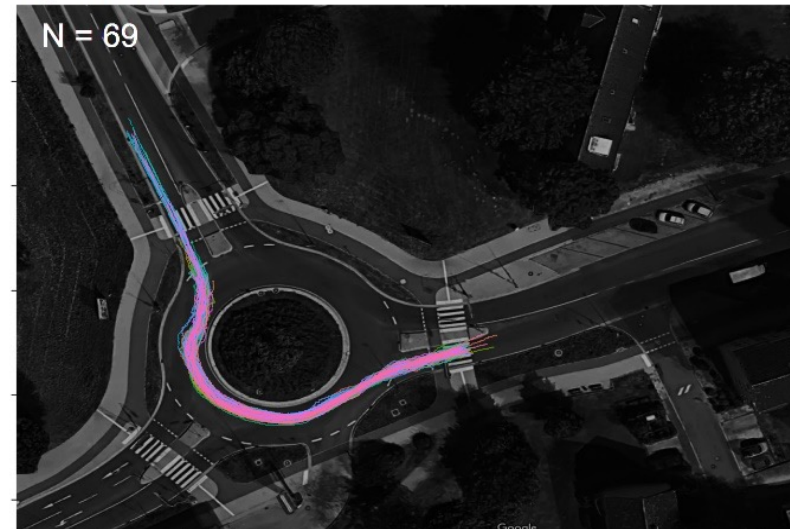
Results: ADF vs human driving

- AV drive from N → E
- Human drives (baseline selection): same paths (N → E), same day and time \pm 30min

Trajectories of ADF



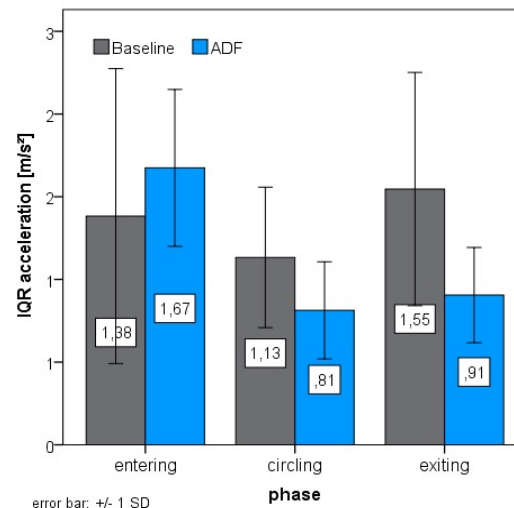
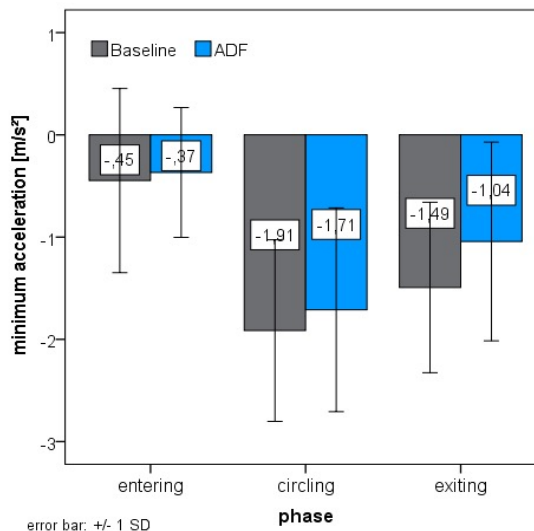
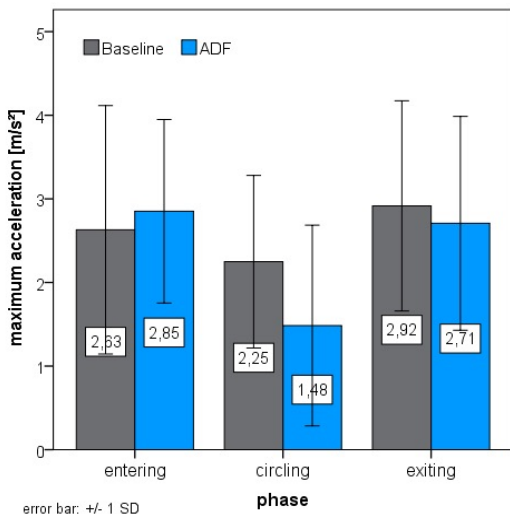
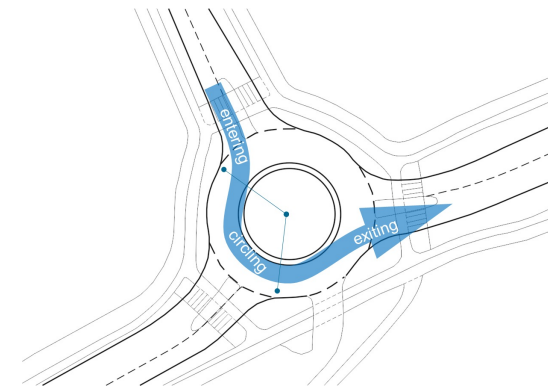
Trajectories of Baseline



Results: ADF vs human driving

Own driving behaviour / examples

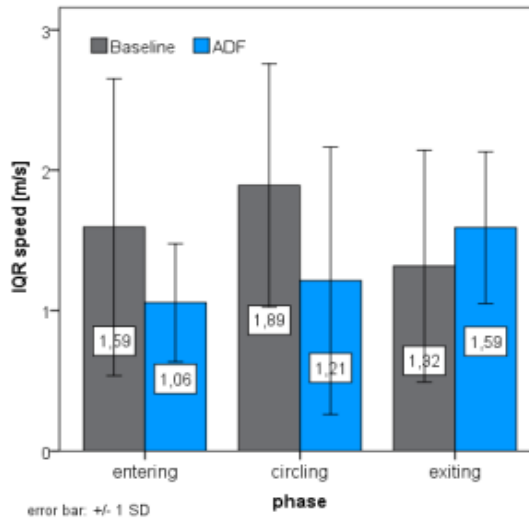
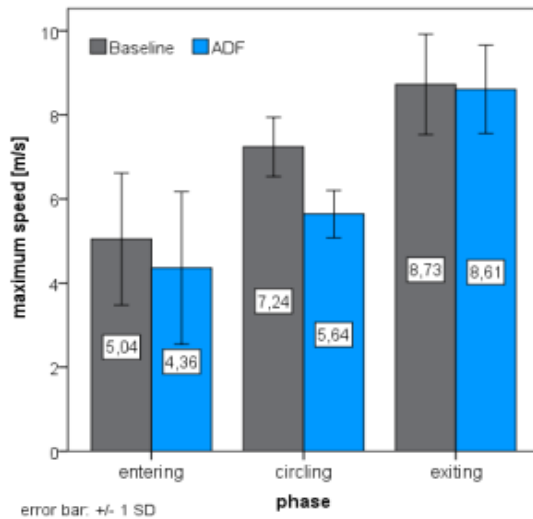
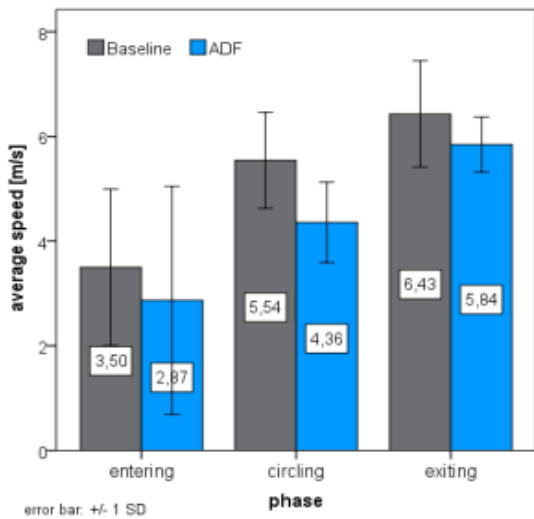
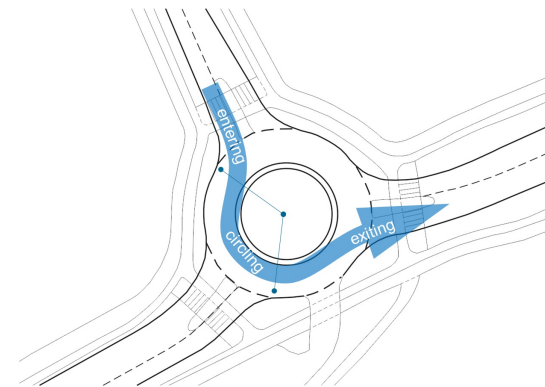
- Impact of ADF on driving dynamics - longitudinal acceleration: max and iqr of ADF significantly lower; no significant difference in deceleration between ADF and baseline.



Results: ADF vs human driving

Own driving behaviour / examples

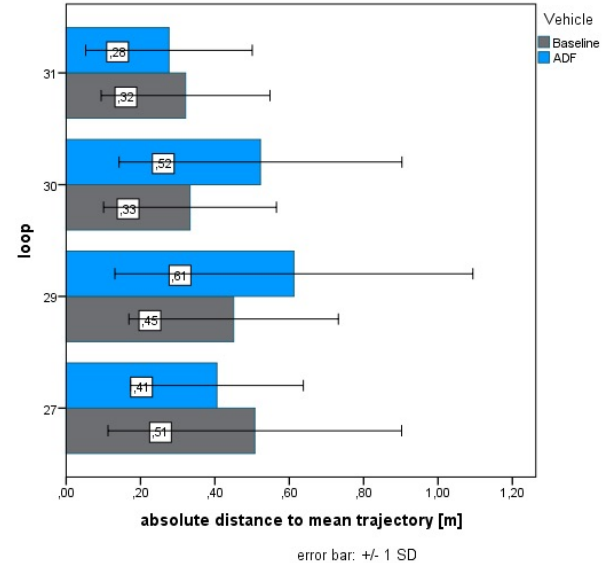
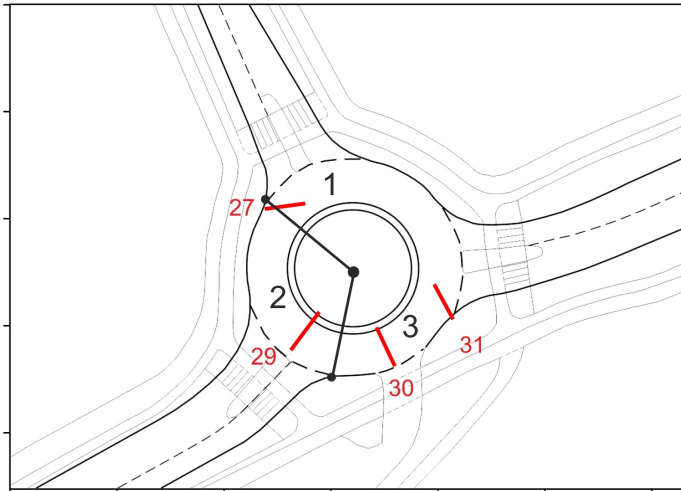
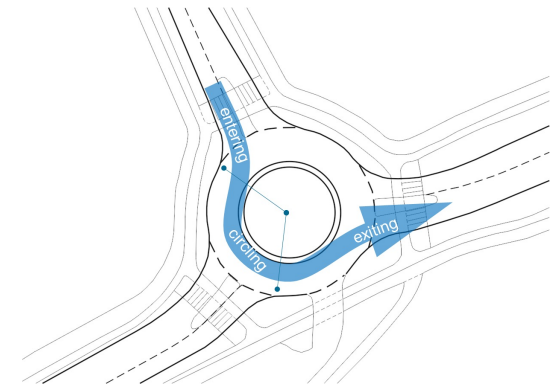
- Impact of ADF on driven speed: mean and max of ADF speed significantly lower than baseline; roundabout phase has a larger effect on speed than automation



Results: ADF vs human driving

Own driving behaviour / examples

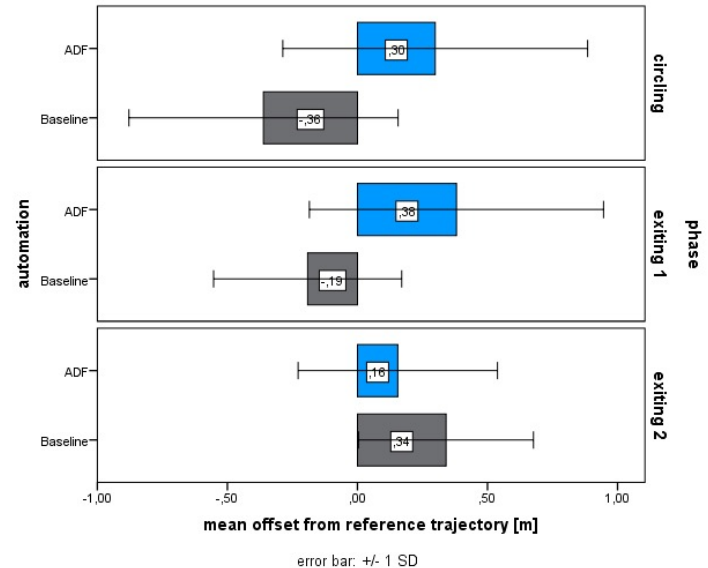
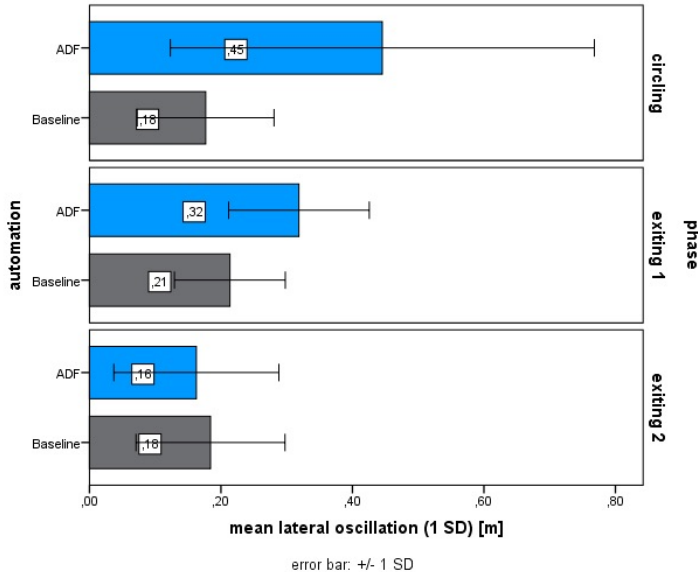
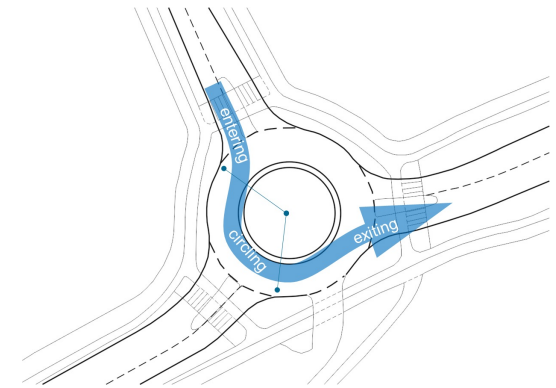
- Impact of ADF on accuracy of driving - manoeuvre precision: no significant differences between ADF and baseline



Results: ADF vs human driving

Own driving behaviour / examples

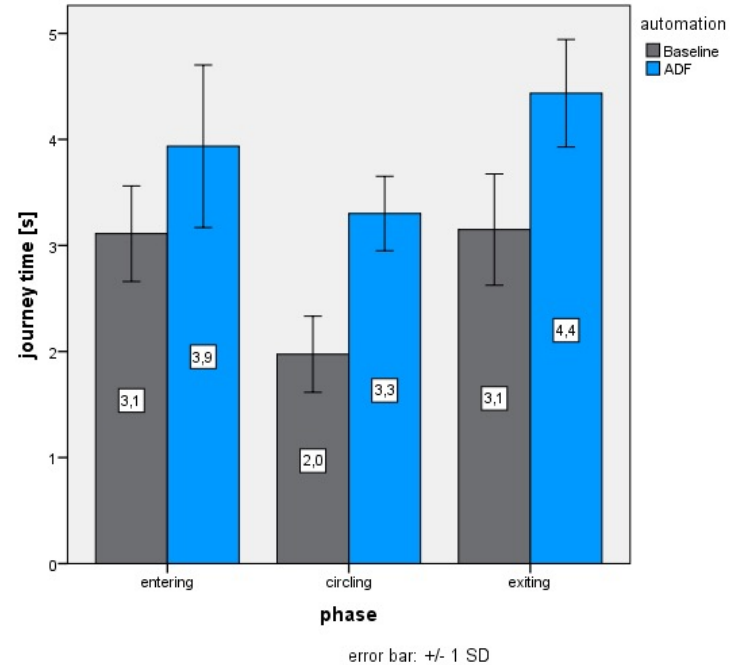
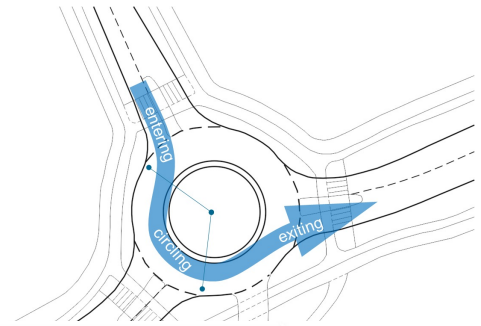
- Impact of ADF on accuracy of driving - lane keeping performance: no significant difference in the exiting phase, and baseline slightly better in the first phases



Results: ADF vs human driving

Own driving behaviour / examples

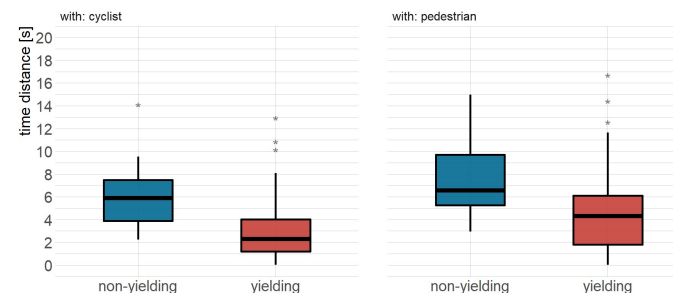
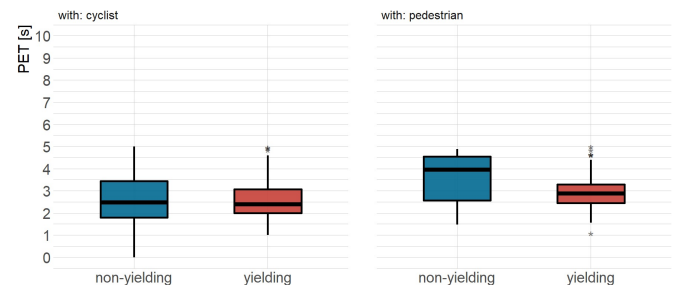
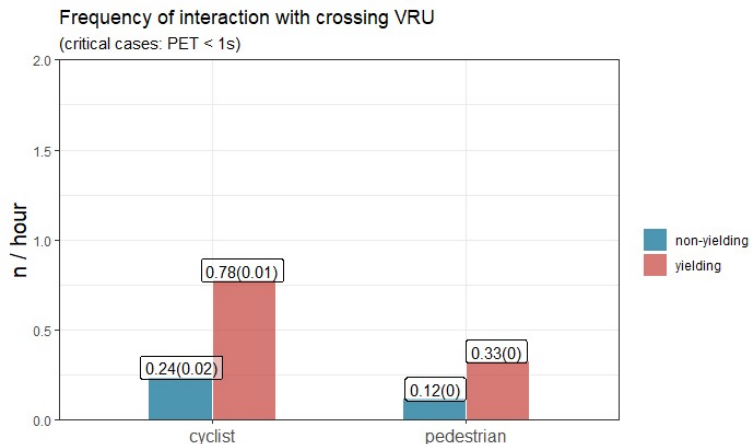
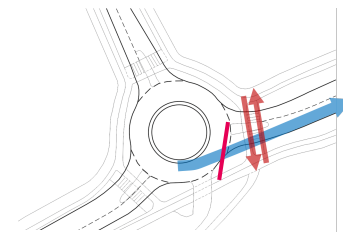
- Impacts of ADF on traffic efficiency – time loss: Journey time of ADF significantly larger than for human drivers:
- Journey time about 1.2 seconds larger per phase leading to an overall increase of 3.5s (40%) for ADF



Results: Human driving

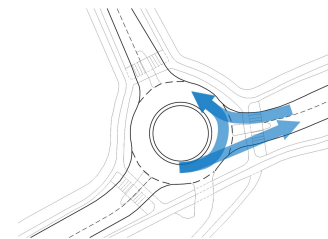
Interaction with other road users

- Interaction with crossing VRU
 - PET < 6s
 - Sub-scenario: (vehicle) yielding, non-yielding

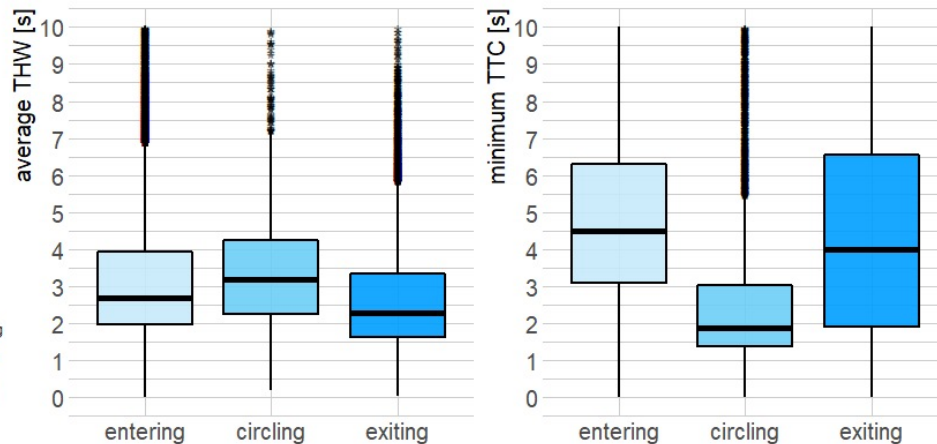
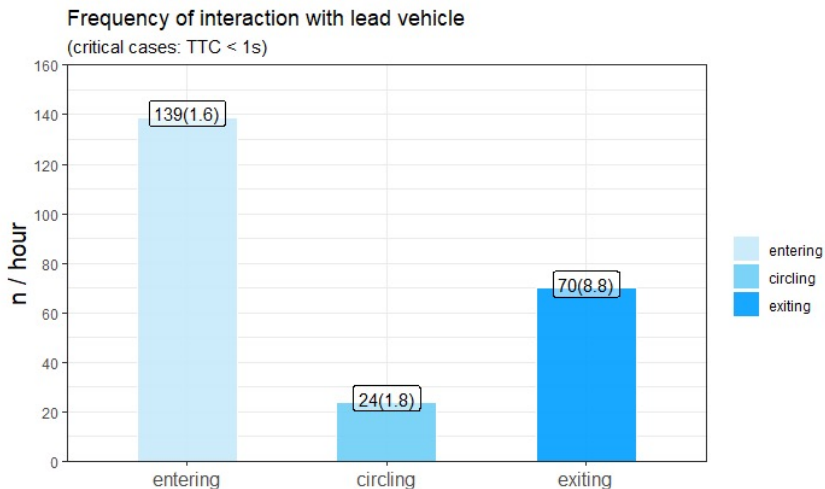


Results: Human driving

Interaction with other road users

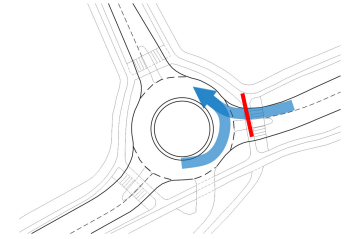


- Interaction with lead vehicle
 - THW < 6s



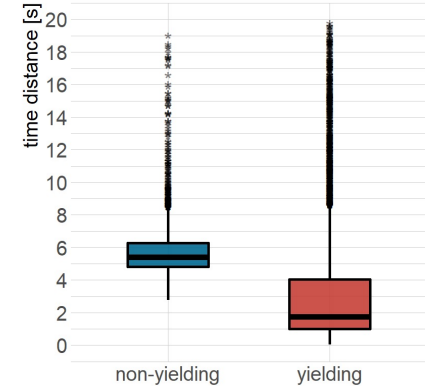
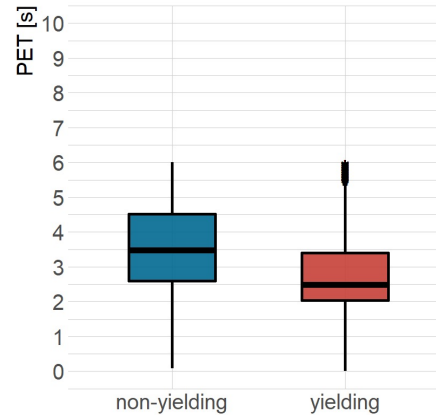
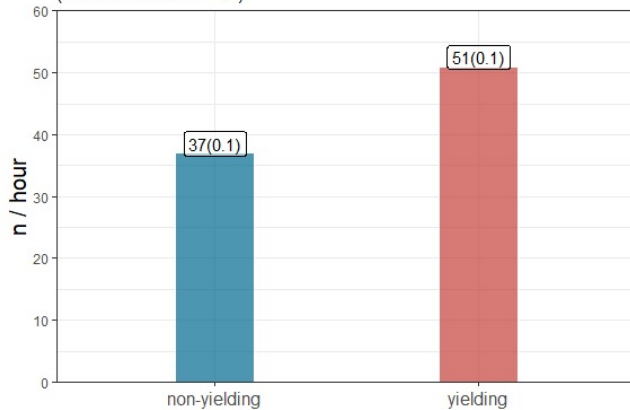
Results: Human driving

Interaction with other road users



- Interaction with circling vehicle (merging)
 - PET < 6s
 - Sub-scenario: (vehicle) yielding, non-yielding

Frequency of interaction with circling vehicle
(critical cases: PET < 1s)



Discussion

Conclusion & future prospects

- Statistically significant differences between ADF and human drivers found in the roundabout but very low effect sizes
 - ADF show lower speeds and accelerations than human drivers
 - ADF being slower might be safer (?) but this causes higher journey/ loss time
 - Neither critical incidents nor near crashes found between ADF and human drivers or VRU
- Consequences
 - Results of normal human driving and interaction behaviour can be used to mature ADF for SAE L3 and L4 vehicles

Trajectory data will be available from the L3Pilot data framework.



Thank you for your attention!

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FINAL EVENT

Hamburg 2021

ITS World Congress