String-stability requirements for DCAS vehicles.

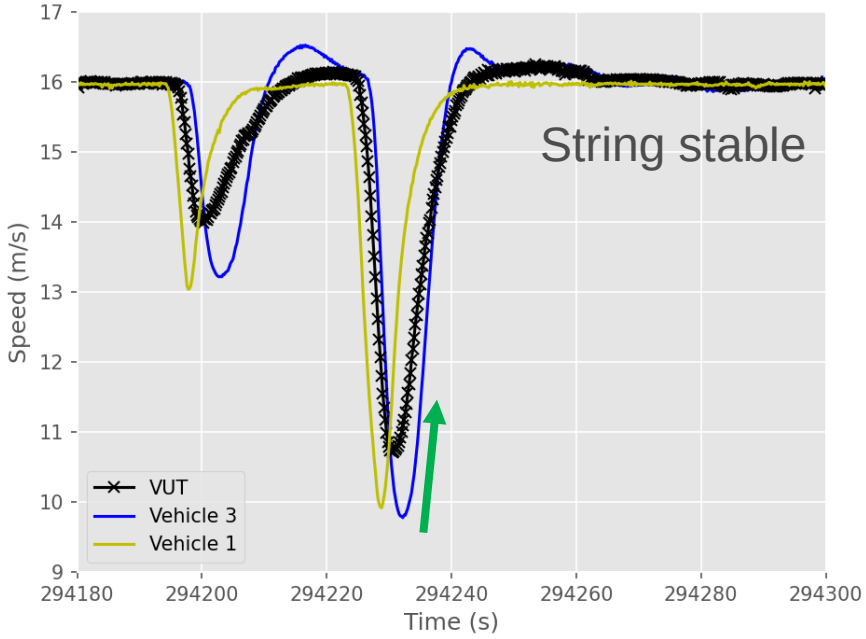
A. Kriston, K. Mattas, D. Maggi, B. Ciuffo
European Commission Joint Research Centre

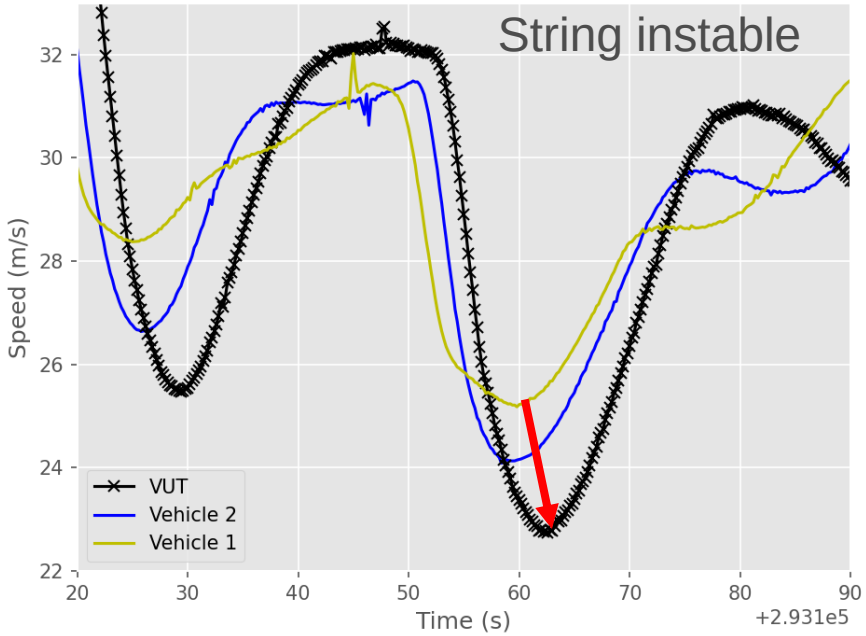
DCAS Meeting
15 May 2024

European Commission

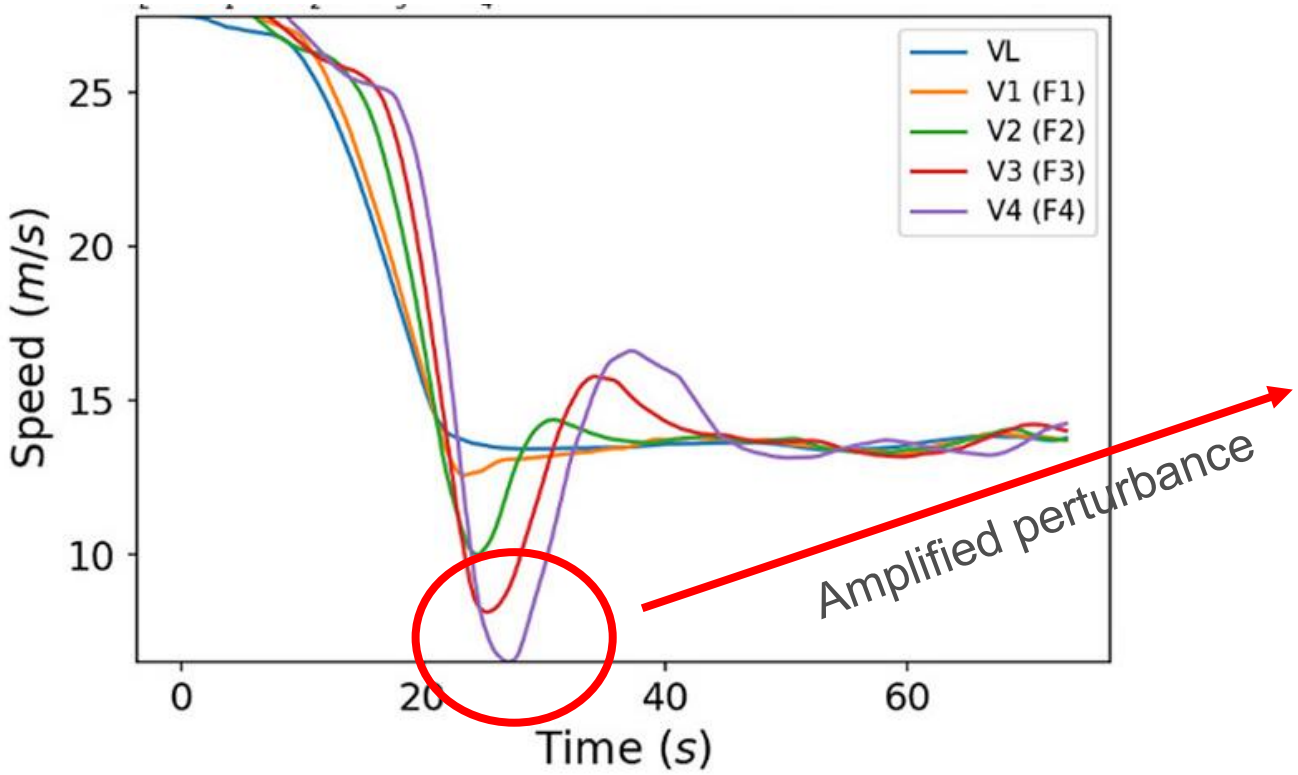
What is string stability?

Definition: "String instability" is when a disturbance in the speed profile of the vehicle in front is amplified by the following vehicle(s).





Why string stability is relevant?



- Could be a comfort function for driver – Not relevant to DCAS
- Safety case: Instable strings may induce harsh barking or even full stop -> Relevant for DCAS

Transportation Research Record, *2674*(4), 471-484.
Transportation Research Part C 130 (2021) 103305

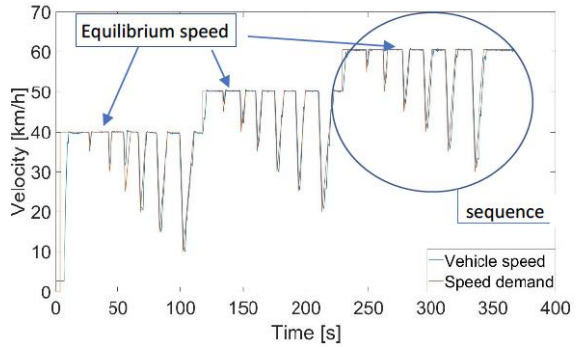
ZalaZone test campaign

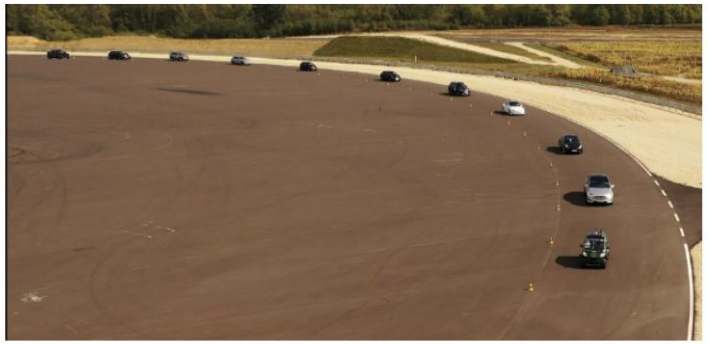
10 ACC equipped vehicles following a robotized leader

Dynamic platform

d = -3m/s^2

a = 1 m/s^2





Full factorial design on 4 different factors

Equilibrium Speed (km/h)	Perturbation- final speed (km/h)	Time gap settings	Number of vehicle orders
30	25, 20, 15	Long, short, medium	4
40	35, 30, 25, 20, 15, 10	Long, short, medium	4

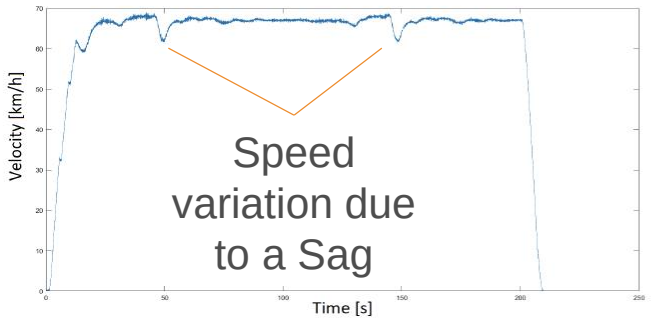
Transportation Research Part C 130 (2021) 103305

ZalaZone test campaign

Handling course

2 laps

CC to keep
constant speed



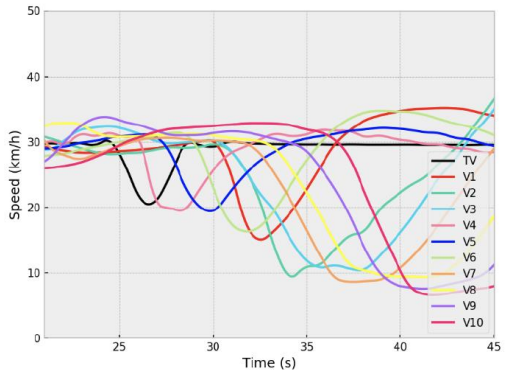
Full factorial design on 3 different factors

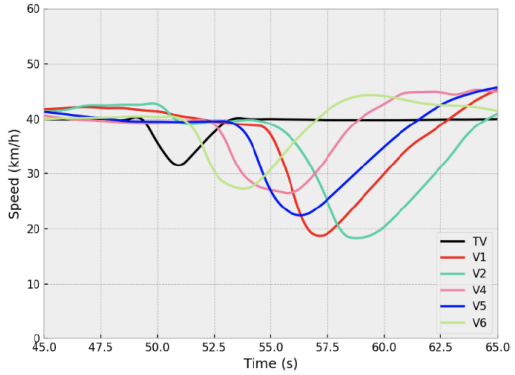
Constant Speed (km/h)	Settings	Number of laps	Number of vehicle orders
30	Long, short, mixed time gap, manual driving	2	3
50	Long, short, mixed time gap, manual driving	2	3
60	Long, short, mixed time gap, manual driving	2	3

String stability

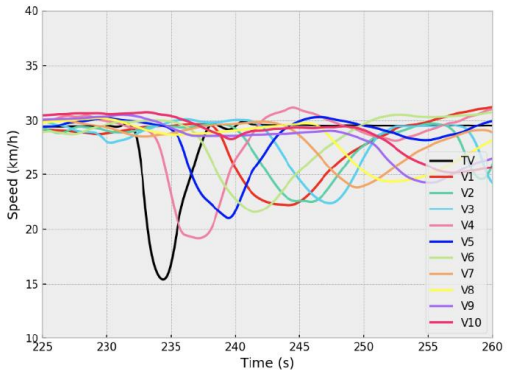
Dynamic platform

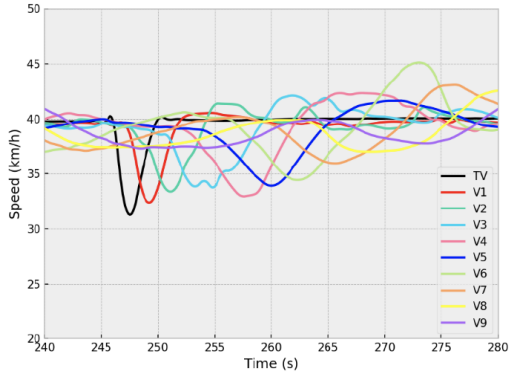
Minimum time-gap setting

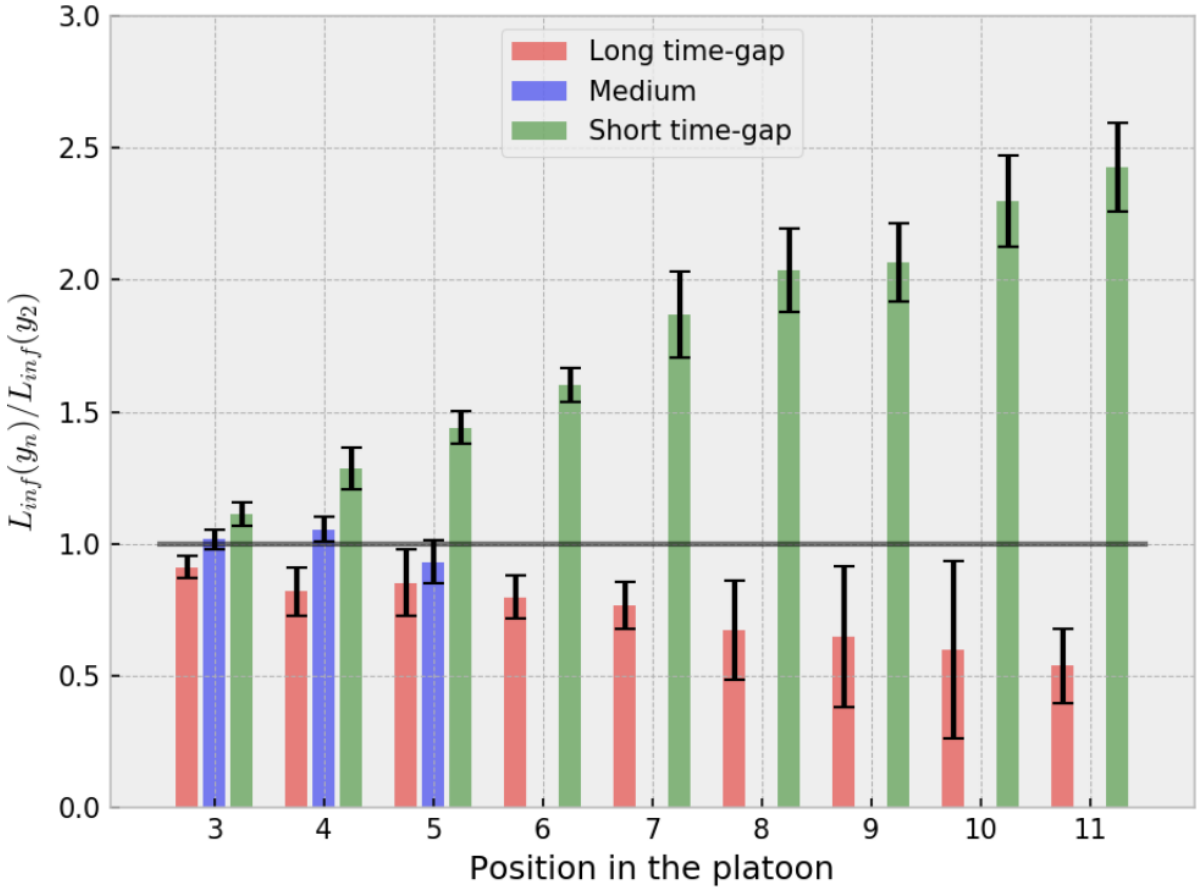




Maximum time-gap setting



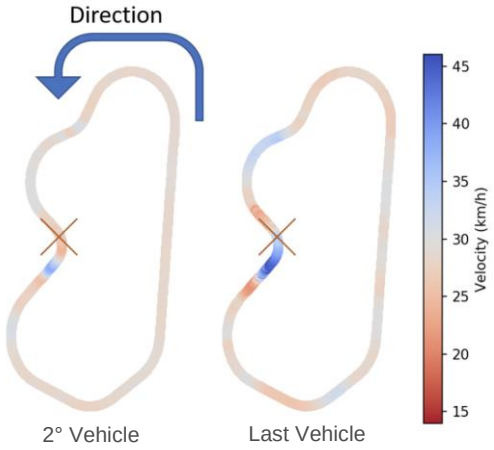




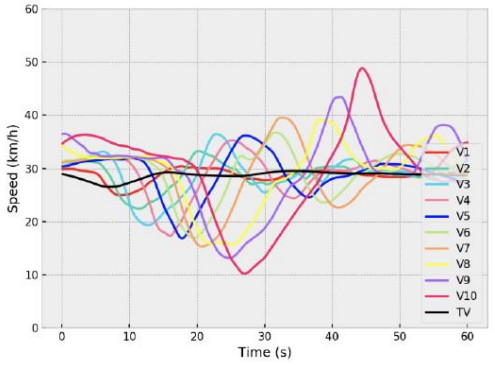
European Commission

String stability

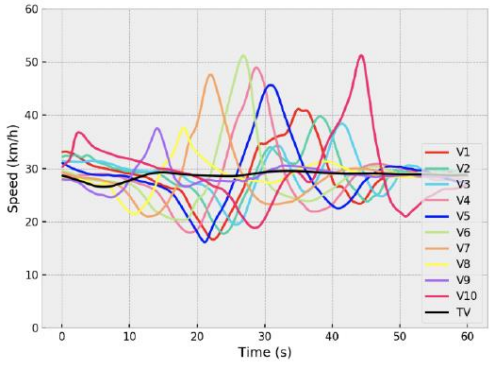
Handling Course

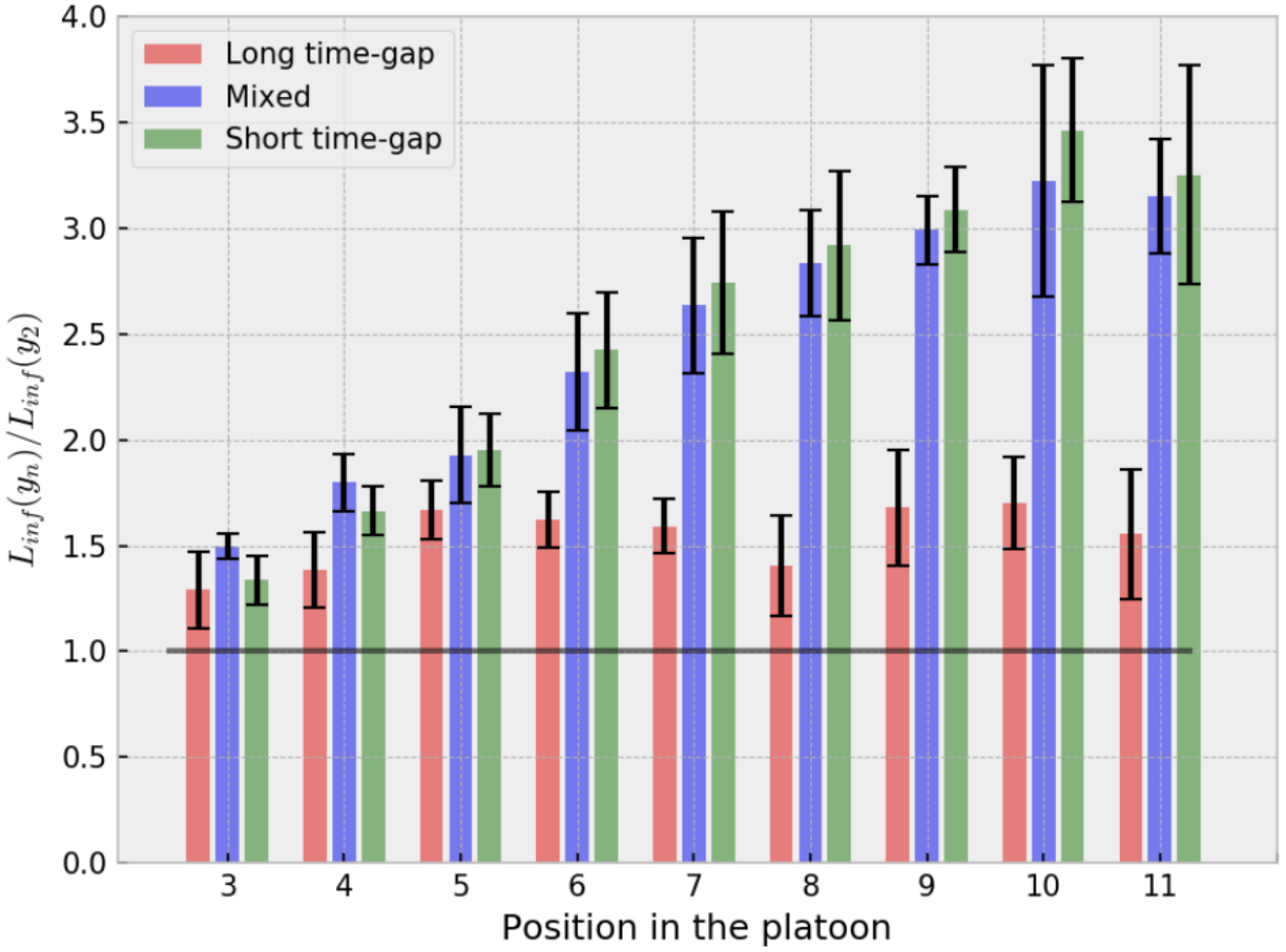


Minimum time-gap setting



Maximum time-gap setting





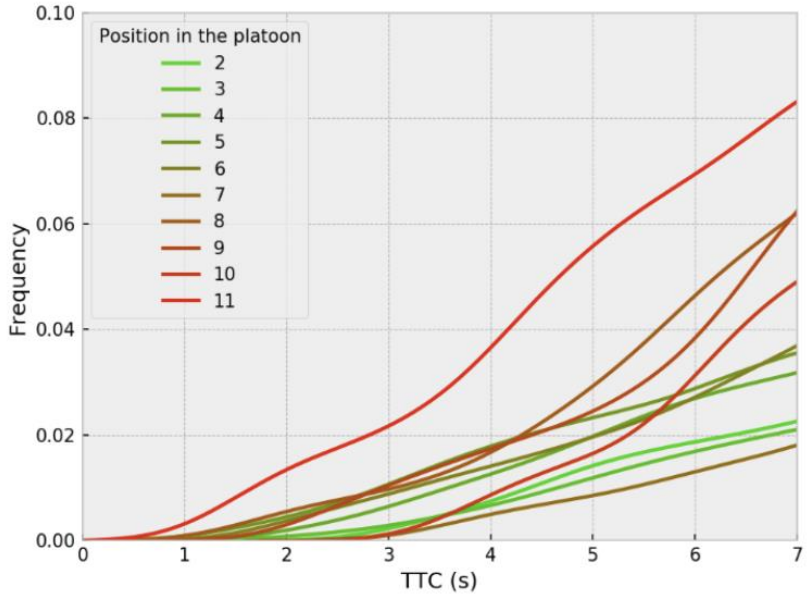
European Commission

Safety

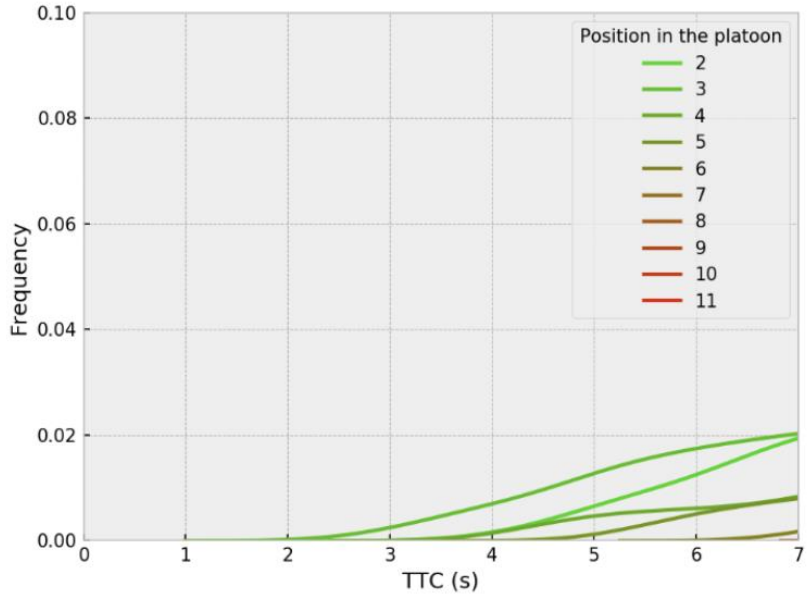
Dynamic Platform

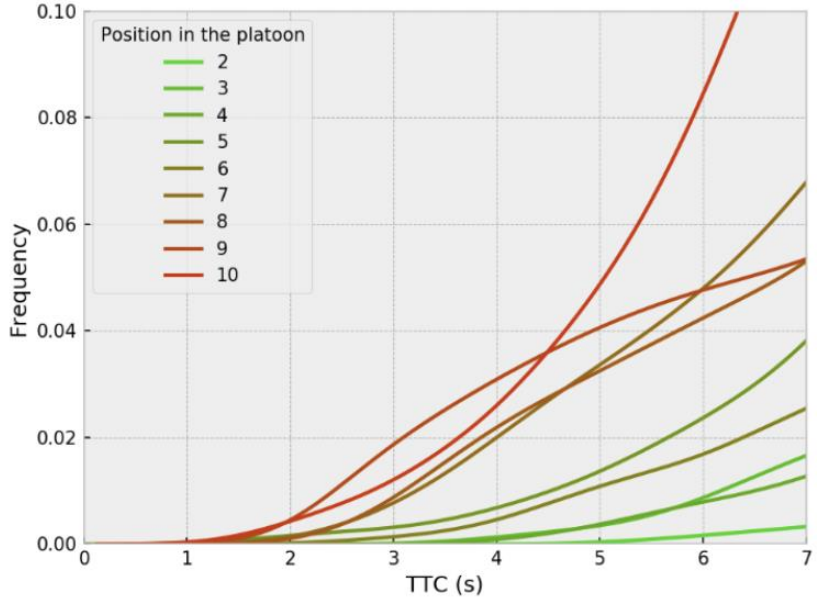
Handling Course

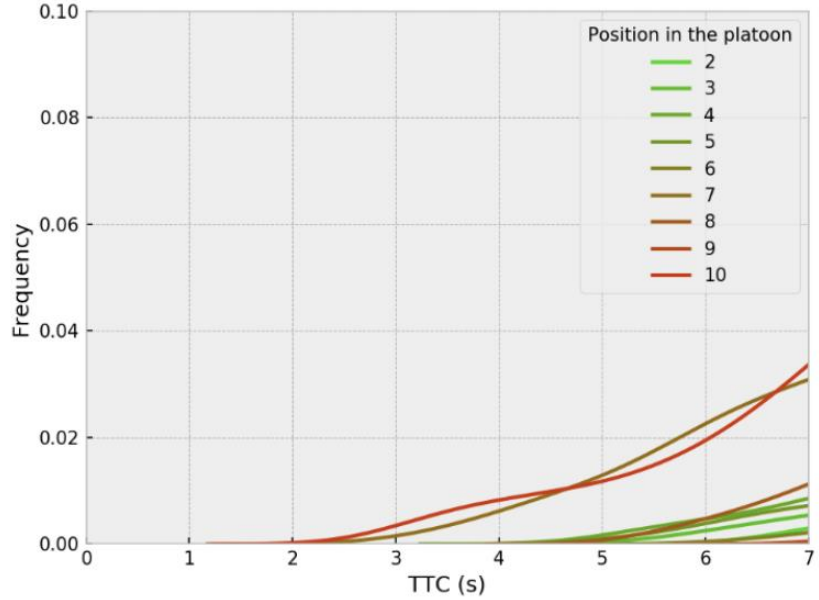
Minimum time-gap setting
String-unstable platoon



Maximum time-gap setting
Quasi-String-stable platoon





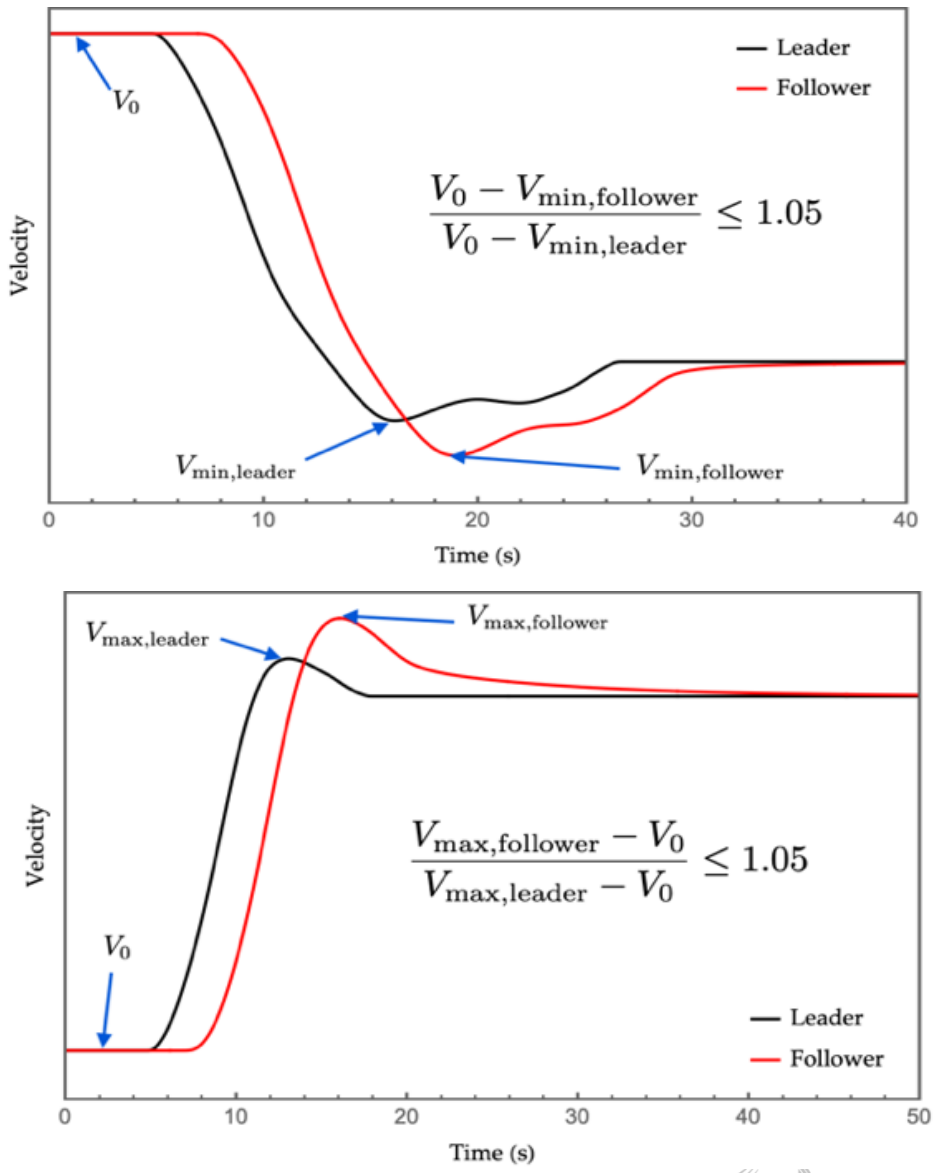


String stability requirements

Adding to 5.3.6.3.2.

Version 1 (UNR157): While following another vehicle the activated DCAS system shall aim to be string stable and shall aim to avoid further amplifying the perturbation caused by the lead vehicle from one vehicle to the next.

Version 2: A DCAS vehicle following another vehicle at constant speed and at a distance such that the speed profile of the DCAS system is influenced by the speed profile of the vehicle in front, the activated DCAS system shall aim to respond to a perturbation in the speed of the vehicle in front with a perturbation in its speed profile by at most a [5%] increase in the maximum difference in speed compared to the vehicle in front before reaching a new equilibrium velocity.



European Commission

Base test:

- Each test shall comprise the deceleration of the car target from steady state platoon formation to achieve a speed reduction of at least [3] m/s. The speed of the car target at the end of the deceleration shall not be lower than [5] m/s.

Extended test: The test shall be executed with

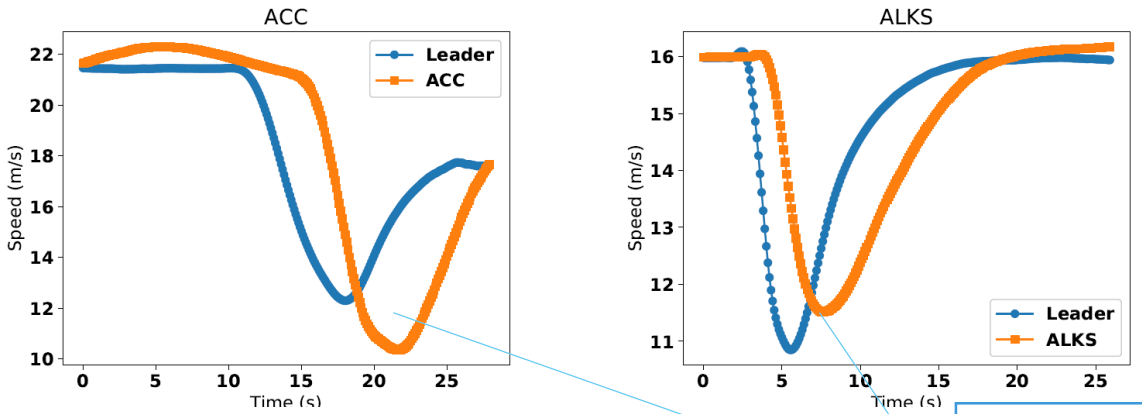
- different combinations of initial speed,
- final speed and deceleration adopted by the car target,
- on different roads (e.g. curvatures)
- different targets (i.e. motorcycle)

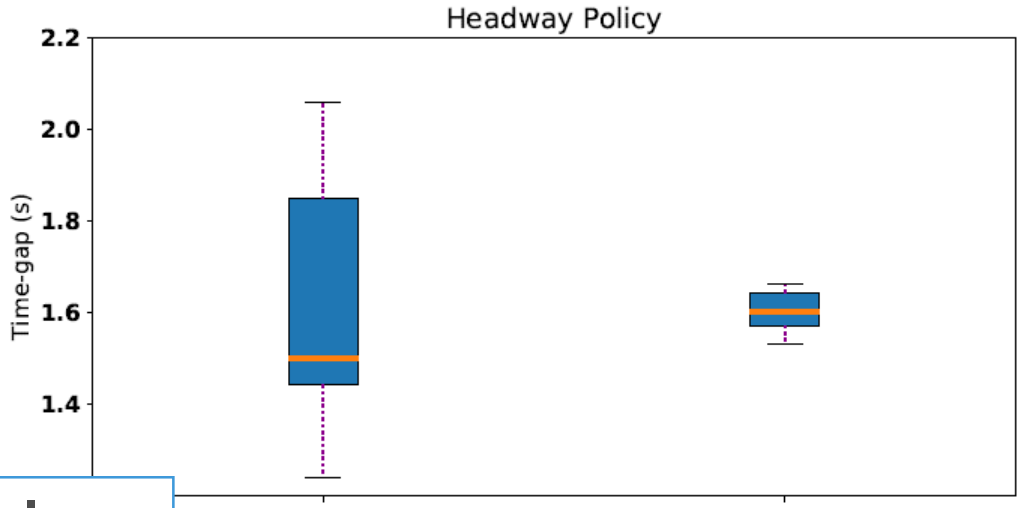
Latest evidence - ALKS test-campaign

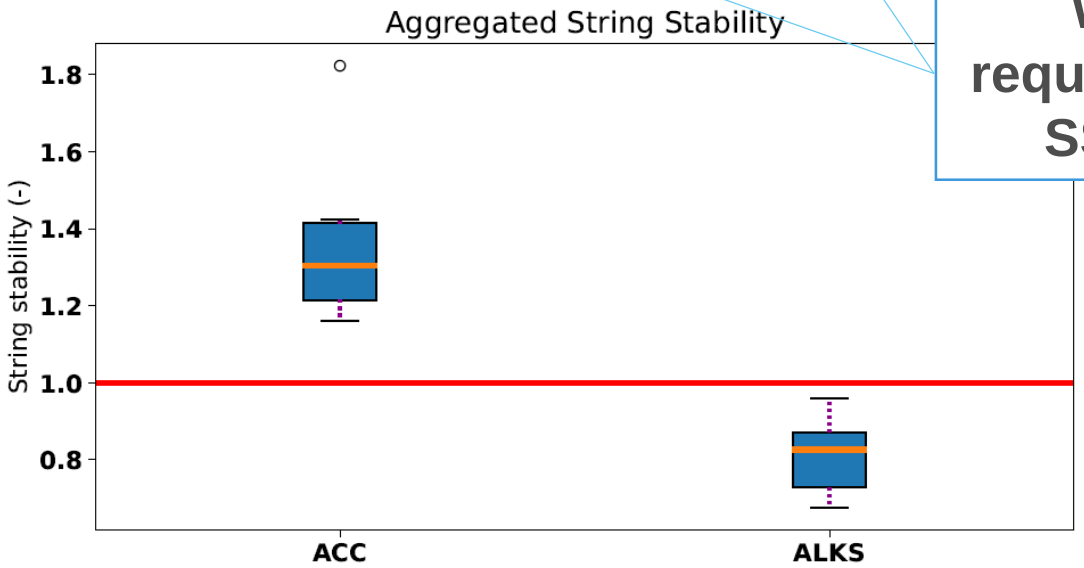
- Test-campaign carried out in October 2023
- The Mercedes was driven with other 2 vehicles in platoon formation between Stuttgart and Dusseldorf several times (~3000km).
- Position of all vehicles measured with GNSS at 10Hz frequency
- When ALKS not available, tests focused on ACC
- All tests concerned normal conditions of use

European Commission

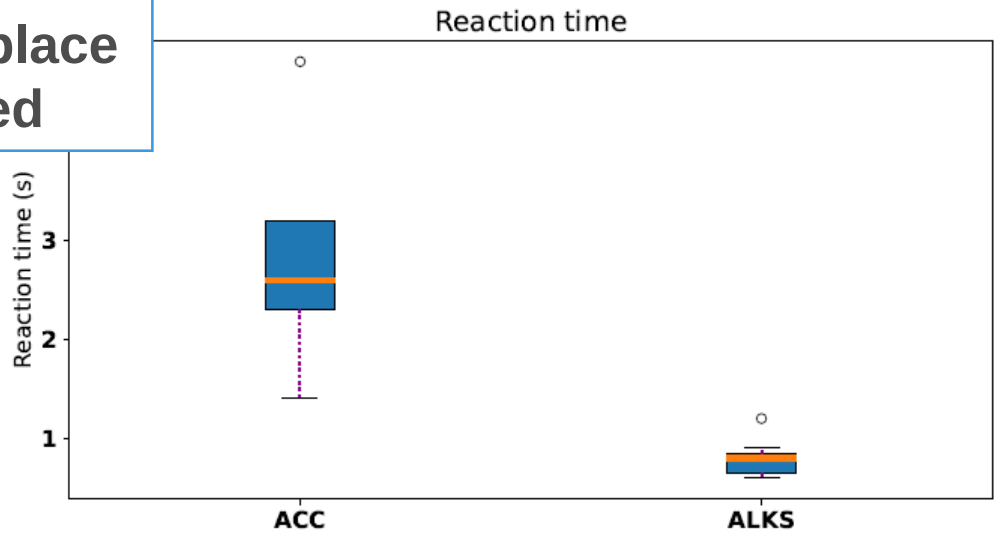
String stability in Mercedes ACC vs. ALKS







With general requirement in place SS is achieved



Keep in touch

EU Science Hub
joint-research-centre.ec.europa.eu

 @EU_ScienceHub

 EU Science Hub – Joint Research Centre

 EU Science, Research and Innovation

 EU Science Hub

 @eu_science

Biagio.CIUFFO@ec.europa.eu

European Commission

Thank you

European Commission