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BRAKE PARTICLE EMISSIONS

TASK FORCE 1

DEVELOPMENT OF A NEW REAL-WORLD BRAKING CYCLE FOR STUDYING BRAKE PARTICLE EMISSIONS

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48th PMP IWG Meeting – Ispra (IT) – 08.11.2018

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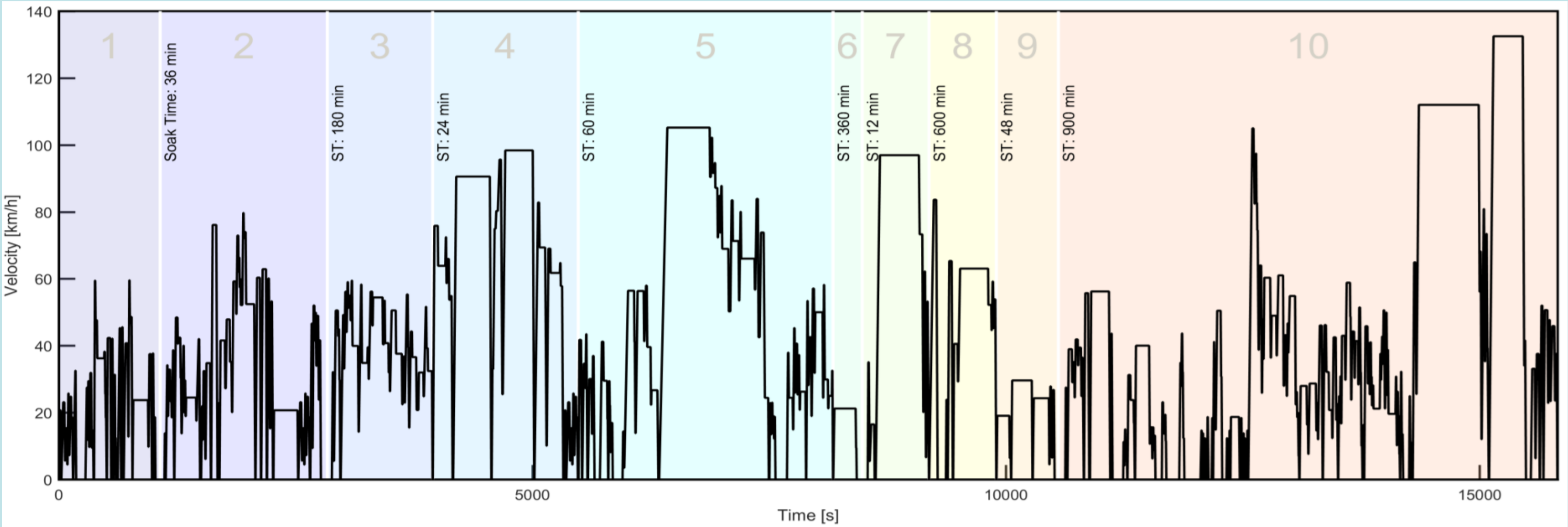
DEVELOPMENT OF A NEW REAL-WORLD BRAKING CYCLE FOR STUDYING BRAKE PARTICLE EMISSIONS

June 2016: The PMP identified the need for the development of a novel cycle (representative of real-world conditions) as an important step for the development of the commonly accepted methodology - A four steps approach was followed

- WLTP Database Analysis - Definition of "typical" and "extreme" driving/braking conditions (Concluded)
- Comparison of WLTP statistics extracted from Step 1 with those of existing braking cycles (i.e. LACT, Mojacar, AK Master) (Concluded)
- Development of a first version of the novel braking schedule (Concluded)
- Validation of the cycle in terms of its repeatability and reproducibility - Round robin (On-going Deadline: December 2018)

DEVELOPMENT OF A NEW REAL-WORLD BRAKING CYCLE FOR STUDYING BRAKE PARTICLE EMISSIONS

- FORD took over the development of the novel cycle in collaboration with Heinz Steven (WLTP database expert) and with the support of the TF1
- The cycle became available to the public in July 2018 through Mendeley and can be downloaded at https://data.mendeley.com/datasets/dkp376g3m8/1



- 10 trips with 303 stops in 4½ h and 192 km cycle
- Average vehicle speed of 44 km/h with maximum speed of 133 km/h
- Deceleration rates of 0.5–2.2 m/s² are applied (mean value of 1.0 m/s²)

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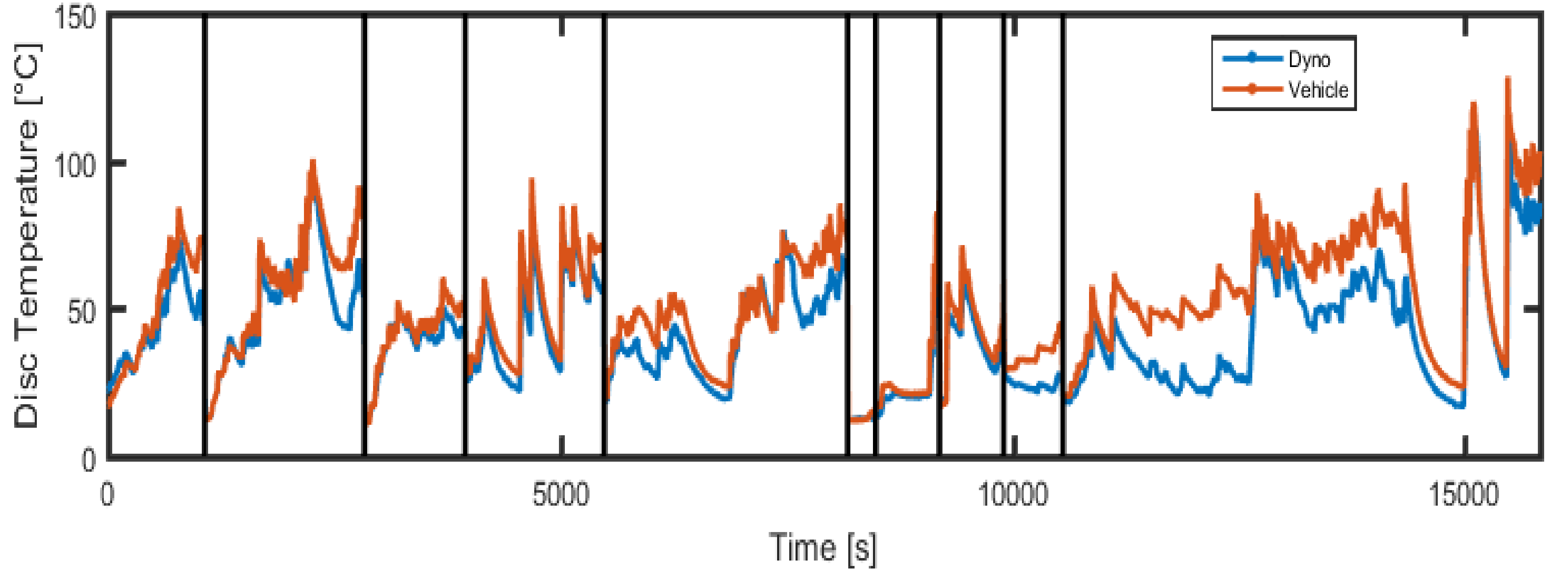
VALIDATION OF THE NOVEL REAL-WORLD BRAKING CYCLE ROUND-ROBIN EXERCISE

Round Robin: The objective is to reproduce at brake dyno level the brake temperature recorded at the vehicle - it should be reproduced at different dynos



- Mid-size vehicle brake (15″ brakes: Sliding callipers, Grey Iron Discs and LowMet Pads)
- Standard brake dyno test setup with a horizontal cooling of 2200 m³/h

Mathissen et al. 2018

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VALIDATION OF THE NOVEL REAL-WORLD BRAKING CYCLE ROUND-ROBIN EXERCISE

	Laboratory - Representative in TF1
1	AUDI - Sebastian Gramstat
2	BREMBO - Francesco Riccobono
3	FORD (Reference Lab) - Jarek Grochowicz
4	GENERAL MOTORS - Matt Robere
5	ITT - Agusti Sin
6	LINK/Europe - Marco Zessinger
7	LINK/US - Carlos Agudelo
8	TMD FRICTION - Ilja Plenne
9	TU Ilmenau/BMW (Validation Lab) - David Hesse/Rasmus Leicht

- Identical brake parts as during vehicle testing have been distributed to all labs. This includes "dummy" parts that will be used for the adjustment of the cooling rate
- Full climate control dyno setups will be used where applicable. Tests will be performed with the adjusted cooling rate over 50% humidity and 20°C temperature
- Inertia of 56.7 kg/m^2 has been selected for the testing as representative to real-world applications
- Two rounds of six repetitions of the deceleration and time controlled version of the novel cycle will be performed

VALIDATION OF THE NOVEL REAL-WORLD BRAKING CYCLE ROUND-ROBIN EXERCISE

- Data recording of 250 Hz during braking and 2 Hz during off-brake and soaks
- Disc temperature measurement with reference method using Sliding Thermocouples 0.5 mm below the disc surface, 10 mm outwards from centre of braking surface based on specification distributed by Ford. Other methods will also be evaluated
- Pad temperature measurement 2 mm below surface based on specification distributed by Ford
- Apart from temperature measurements channels to be recorded include

	Parameter	Unit
1	Speed	Km/h
2	Brake Pressure	Bar
3	Brake Torque	Nm
4	Rotor temperature	°C
5	Pad temperature	°C
6	Deceleration Rate	m/s^2
7	Cooling air temperature	°C
8	Cooling air humidity	%RH
9	Cooling air speed	m/s
10	Friction coefficient	-

BRAKING TEST CYCLE
OPEN ISSUES FOR TF1 CONSIDERATION

- ✓ Low flow dynamometer testing will lead to higher maximum temperatures than observed in the field. How can we reproduce correct temperature levels?
- ✓ Which temperature will be achieved for other vehicles/vehicle classes and how to adapt cycle to other vehicle classes?
- ✓ What is the influence of breaks between the trips (soaking time)?

Any questions?

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