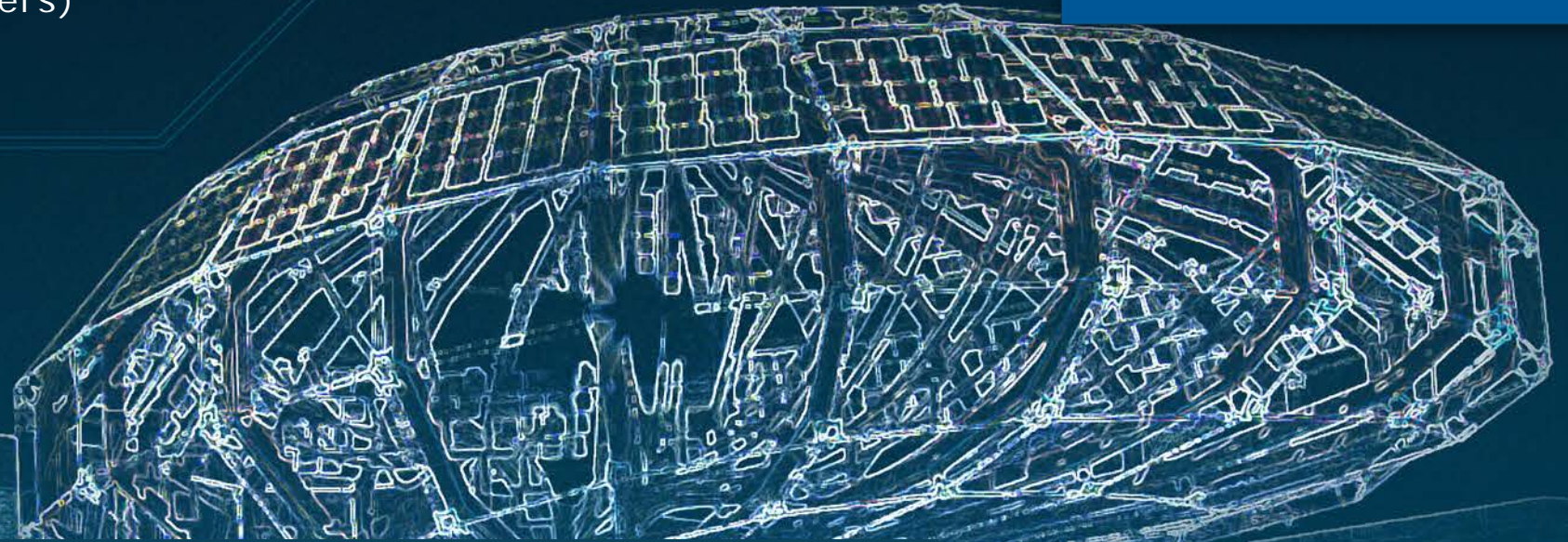


AVL List GmbH (Headquarters)



First insights on brakewear PN over the novel cycle

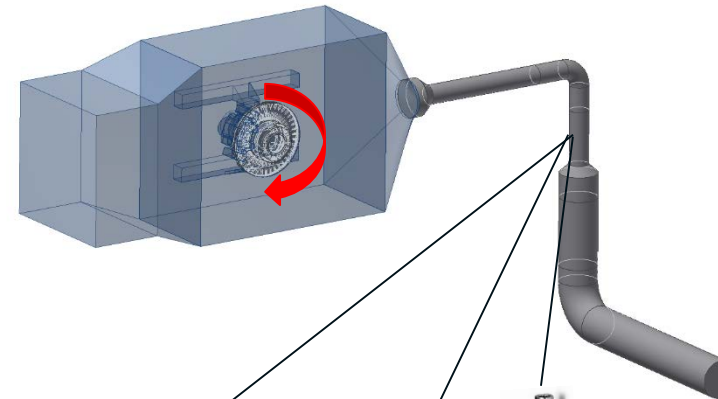
Mamakos A., Arndt M. (AVL)

Augsburg K., Hesse D. (TUI)

Experimental setup

First phase of the campaign focuses on PN and particularly on the size range and the volatility of the emitted particles under different operating conditions.

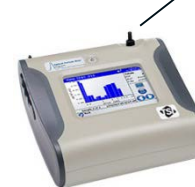
Tests were performed on a new tunnel design, optimized for PM10.



Tunnel flows 170
& 270 Nm³/h

TSI 3330

ELPI +



TSI 3790
23 nm

APC^{plus} advanced
for sub 23 nm



TSI 3772
10 nm



TSI 3776
2.5 nm



TSI 3790
23 nm



Ejector

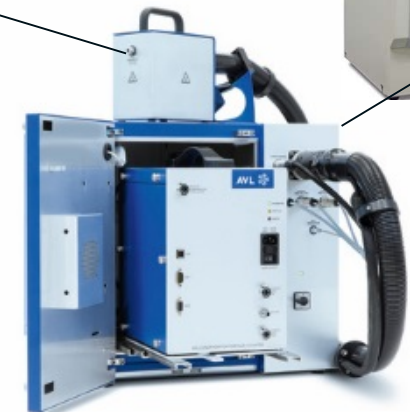


23 C,
200 C
or 300 C

Ejector



EEPS



Experimental – Brake pads

Three different types of commercial brake pads were tested. Two of them were series-production pads from European market (ECE) and one was of non-asbestos organic (NAO) type (US market). One of the ECE pads had no copper in its formulation. Here we will present only results from ECE.

Dyno setting (same as previous campaign for reference): Left front wheel of an entry-level luxury car

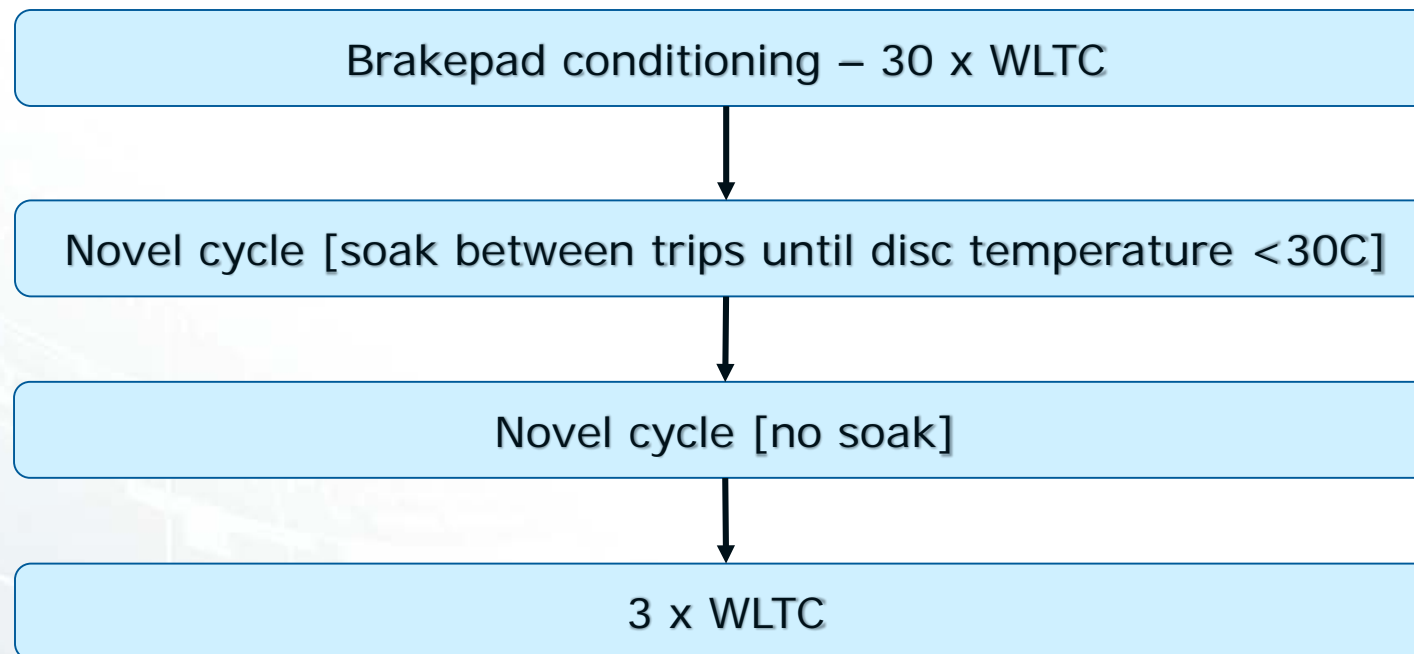
- Inertia: 60.4 kgm²

Experimental – Test procedure

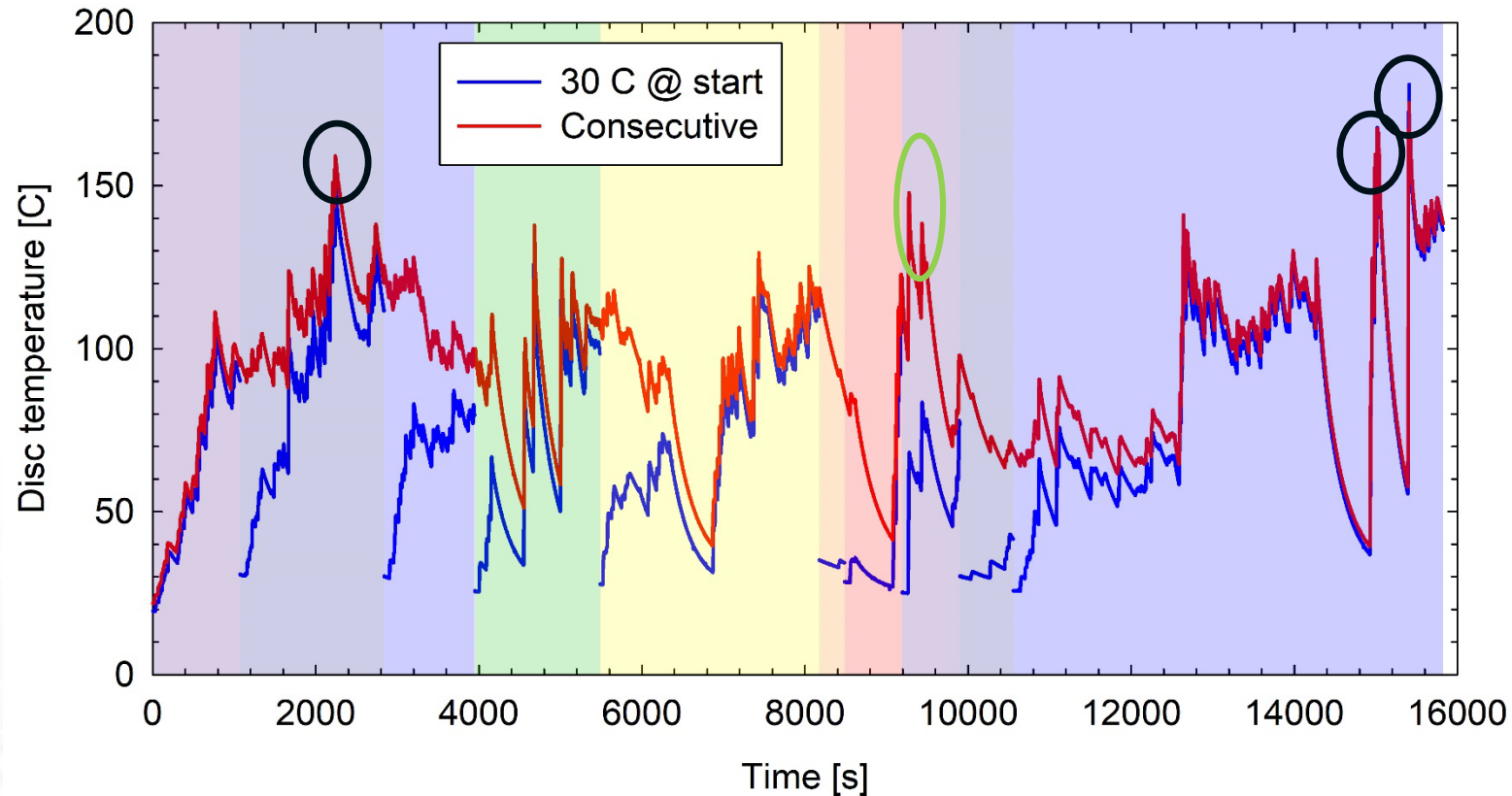
Investigations with the novel cycle aimed at gaining some first insights on the anticipated properties of the produced particles.

All tests at CVS flow of 270 Nm³/min.

Test sequence as follows:



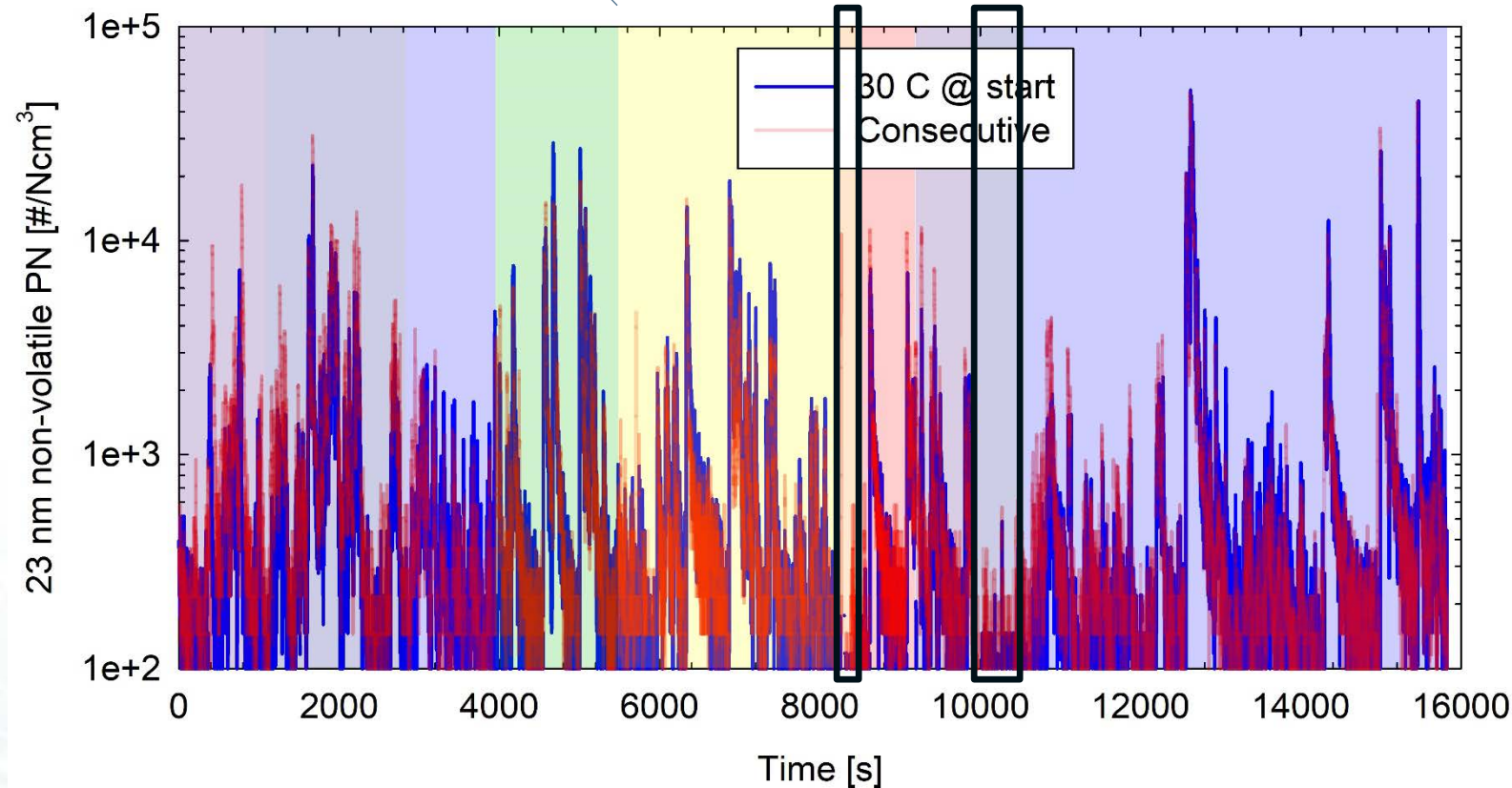
Disc temperature profiles



Start temperature did not affect the peak temperature in the different segments.

One notable exception being trip 8.

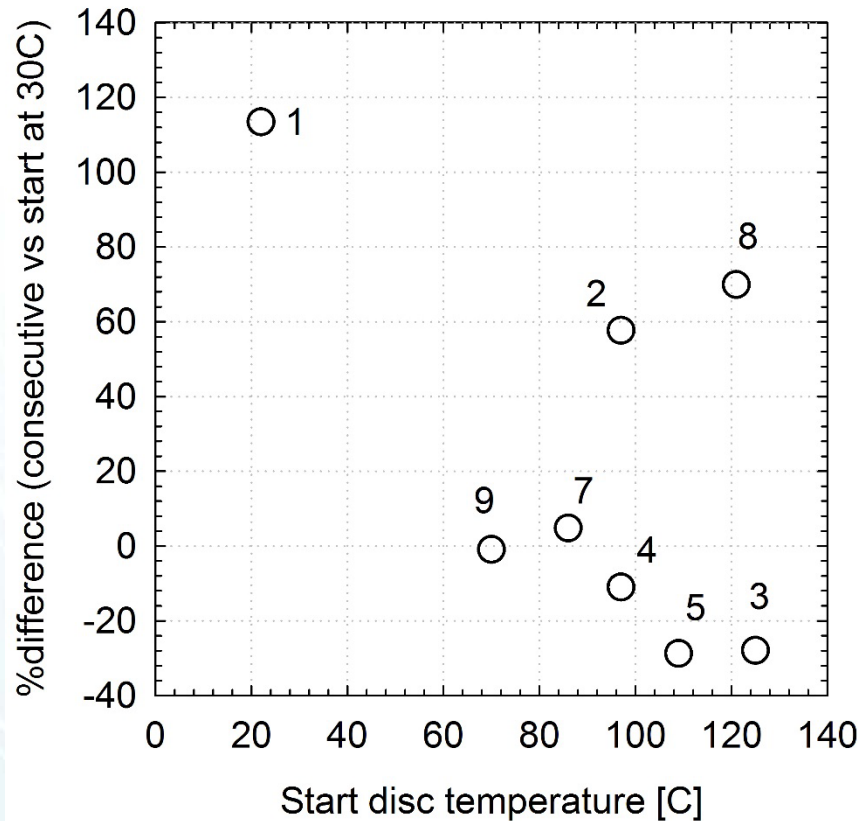
PN concentration levels



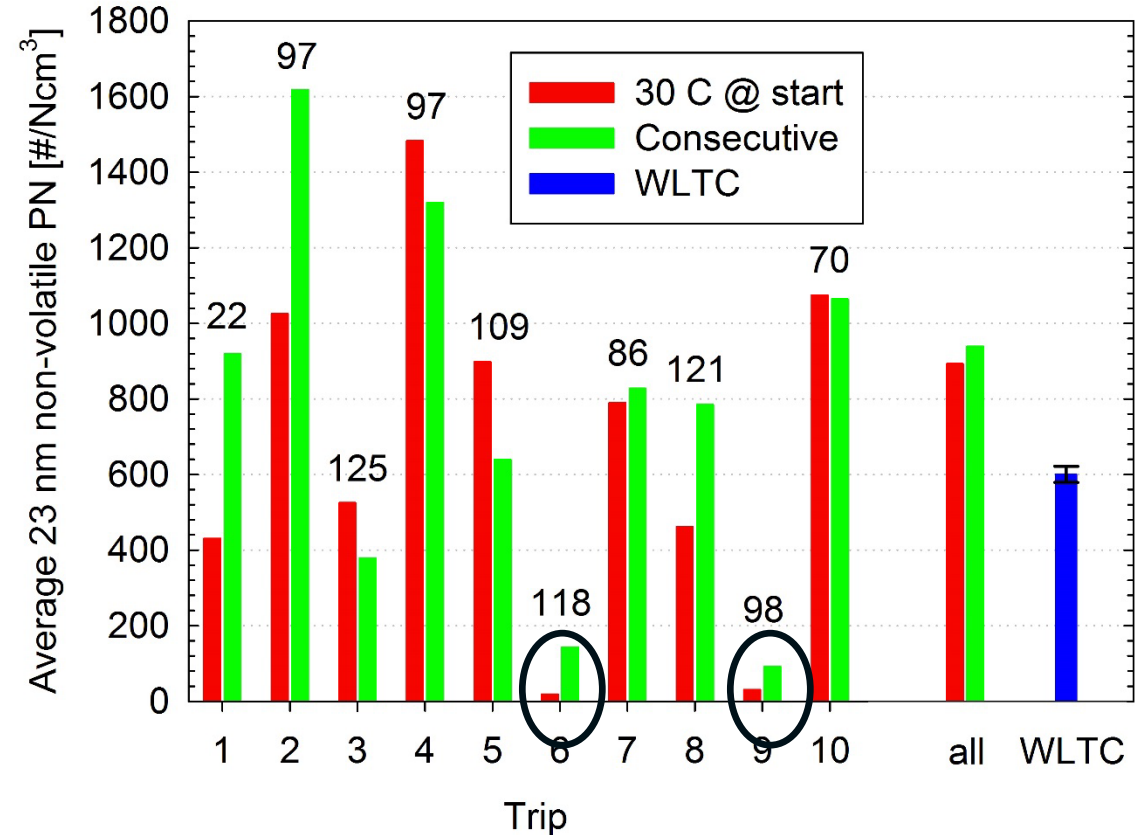
Peak concentrations exceed the single count mode ($1\text{--}3 \times 10^4 \text{ \#}/\text{Ncm}^3$) of full flow CPCs → dilution is required.

Concentrations over trips 6 and 9 are at challengingly low levels.

Mean concentration levels



Numbers correspond to disc temperatures at the start of each trip

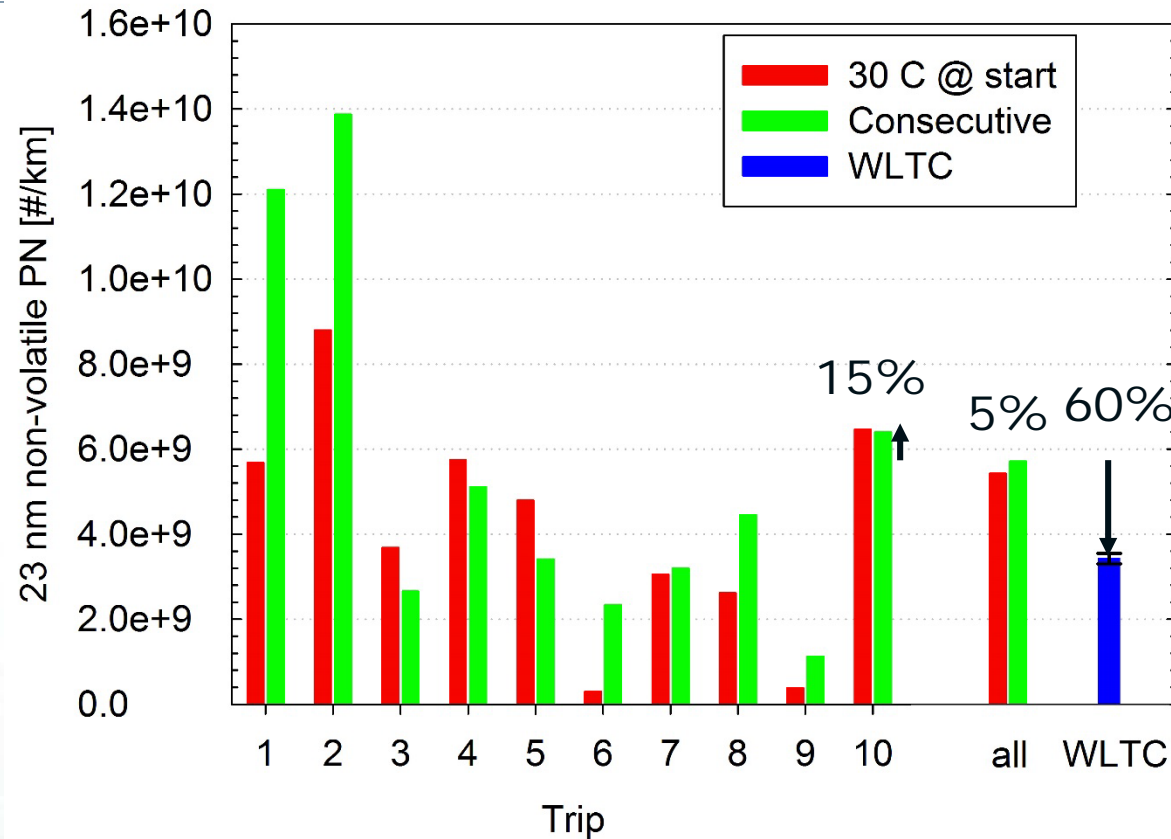


Mean concentrations in the range of 400 to 1400 $\#/\text{Ncm}^3$ (270 m^3/h) similar to WLTC.

Disc temperature at the start of the trip had no clear effect on PN emissions.

Trips 6 and 9 at challengingly low levels.

Emission rates



Cycle average emissions agreed within 5% as did emissions over trip 10.

Cycle-average emission rates ($\sim 6 \times 10^9$ #/km/pad) $\sim 60\%$ higher than those over WLTC.

Last segment (40% of the total emitted particles) within 15% of the cycle average emission rate.

Conclusions

- The novel cycle includes very long soaking times (37 h compared to 4 ½ h of actual measurement).
- We did not observe a strong effect of soaking between trips on the cycle-average PN emissions.
- Emission levels over trips 6 and 9 are challengingly low, containing 1 and 5 brake events, respectively with a mean speed of 16 and 22 km/h, respectively.
- Trip 10 was found to capture within ~15% the PN emissions over the entire cycle.
- PN emissions ~60% higher from those over WLTC.
- Precise measurements at the observed emission levels require extremely low background and very sensitive detectors practically dictating CPCs.

Thank You



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