



ACEA

European  
Automobile  
Manufacturers  
Association



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Commission

# Particle Measurement Programme (PMP)

PN sampling from the tailpipe with fixed dilution for type-approval of heavy-duty engine

Summary and EU results

1 Dec, 2021

# Literature review 2017 (PMP 42)

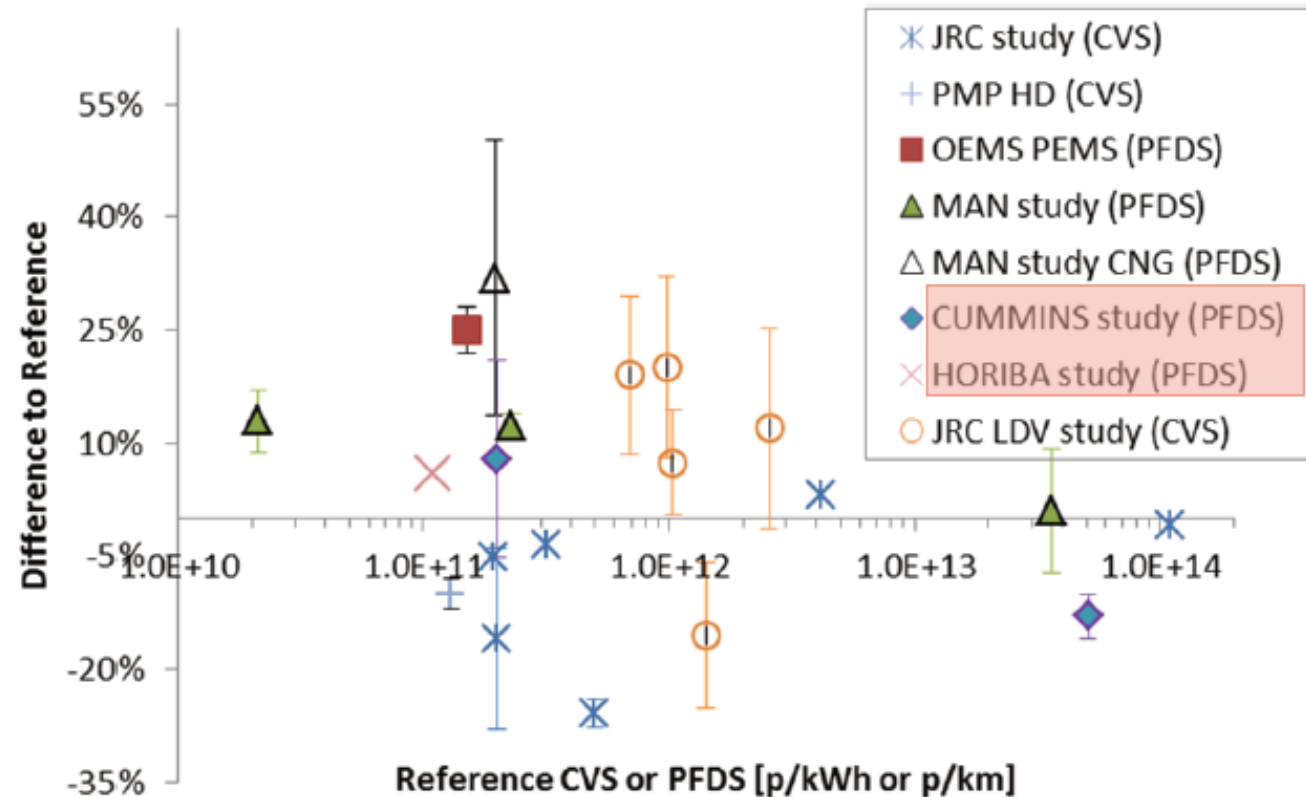
Tailpipe (TP) vs. **CVS** or **PFDS**

Only 23 nm PN systems

Two studies with pre-diluter  
(and good agreement)

In general differences within  
30%

More studies with CNG engines  
needed

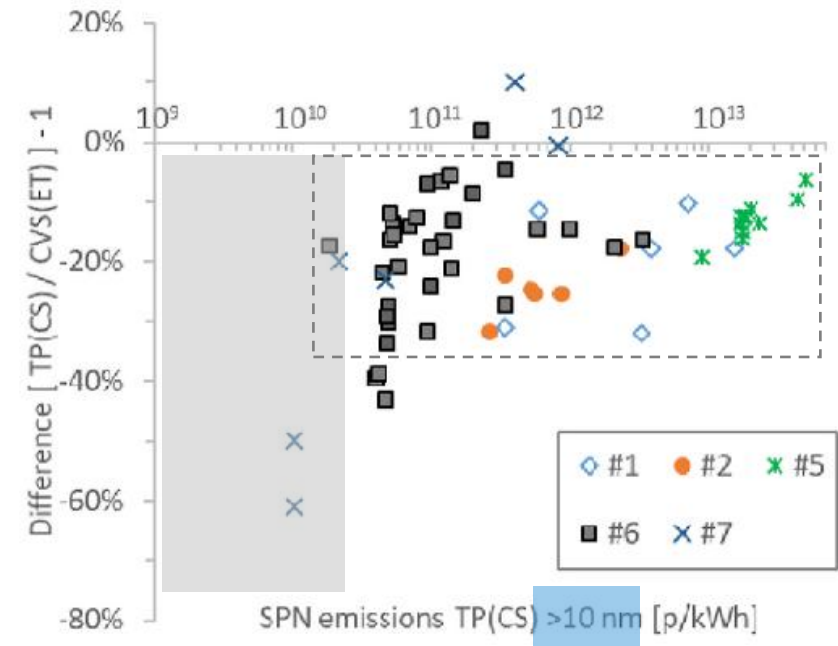
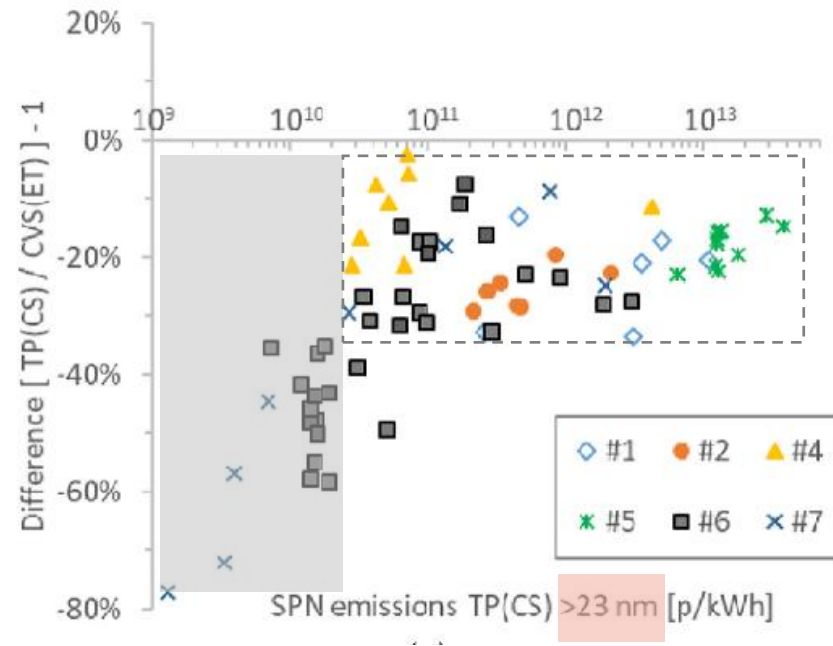


# VETC/JRC (China) study 2020

Many engines, both 23 and 10 nm systems

TP system with heated line (on average 20% lower) vs CVS

Background level CVS



# ACEA/JRC study 2019

Many OEMs and engines

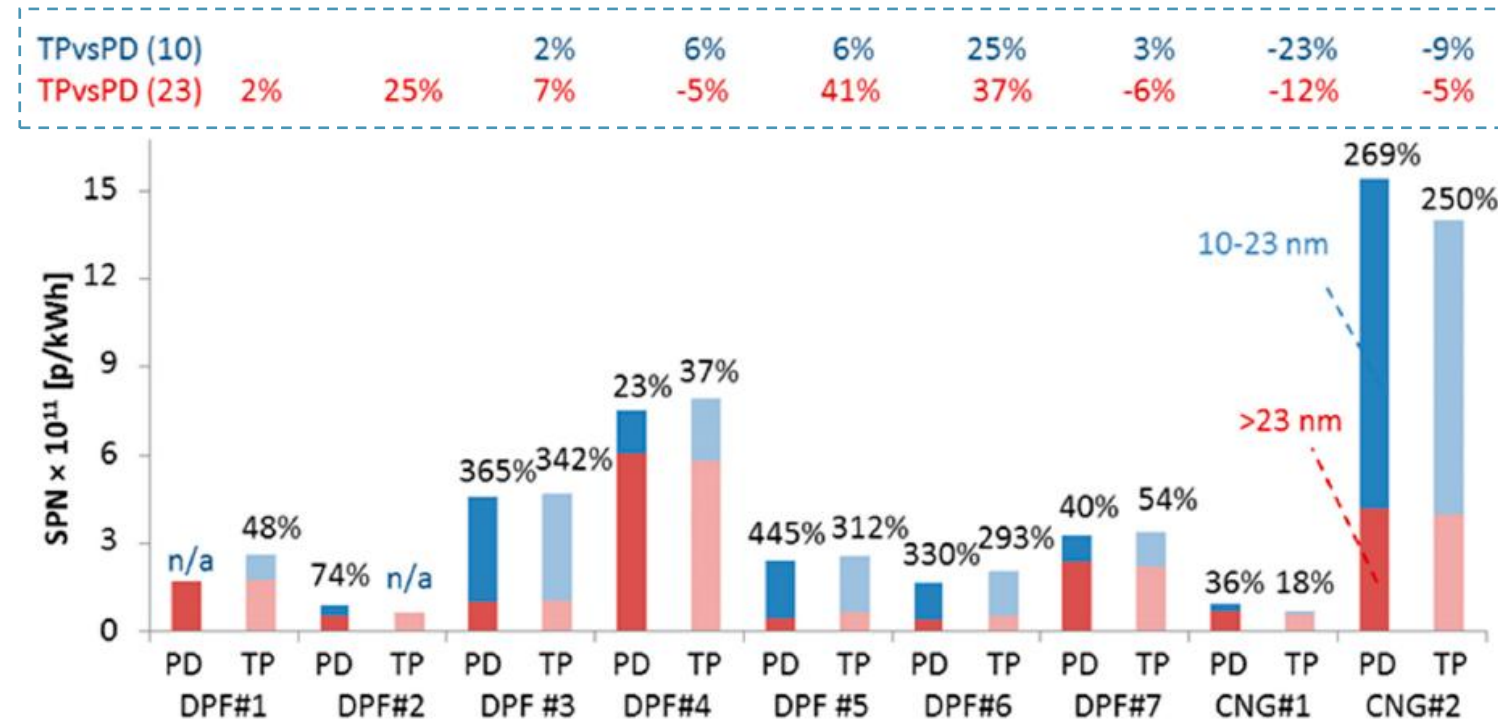
Both 23 and 10 nm systems

TP system with heated line

Differences to PFDS:

±25% (10 nm) or

-6 to 40% (23 nm)



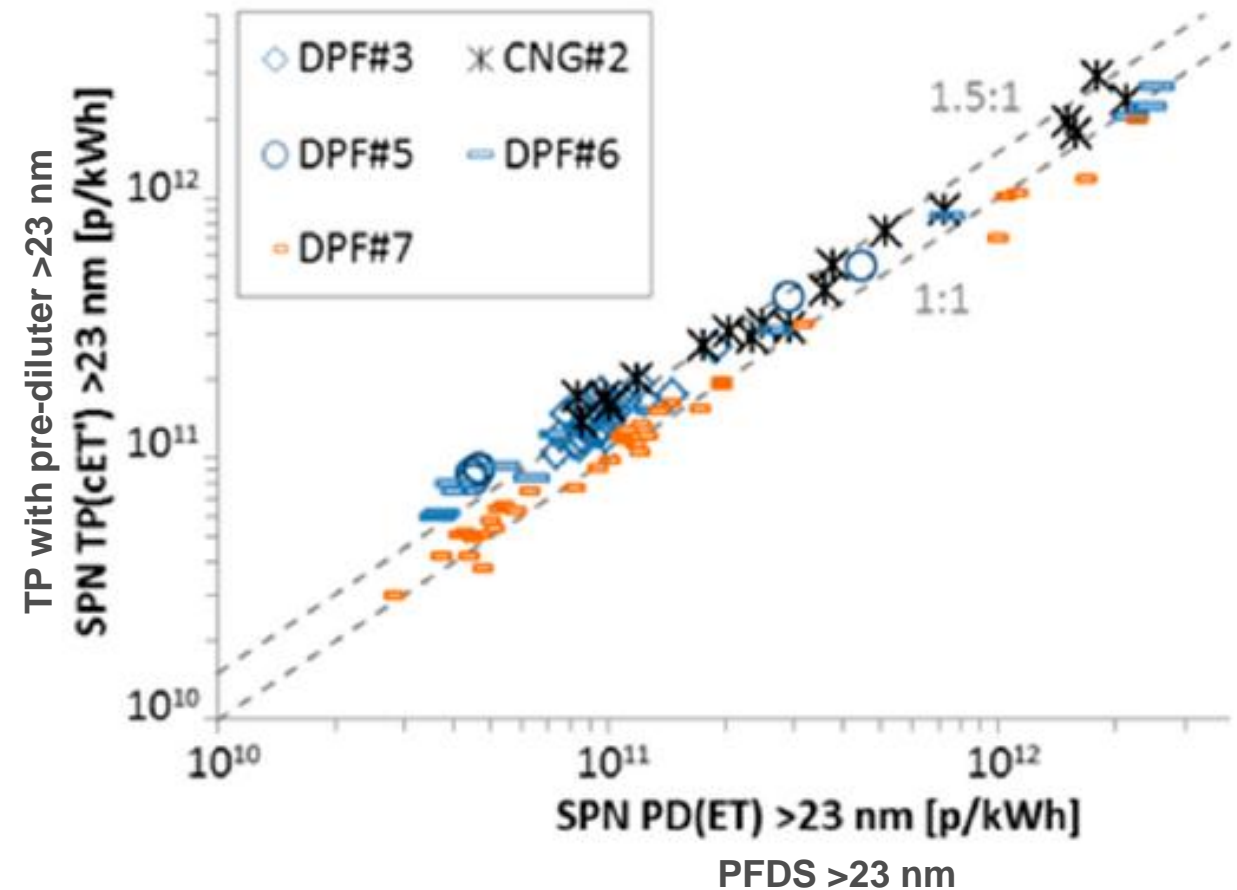
# ACEA/JRC study 2019

TP system with pre-diluter

Only 23 nm data

Average difference of +26%  
(0-50%)

Most likely due to calibration uncertainty based on dedicated comparisons of the system connected at different sampling systems



# ACEA/JRC study 2021

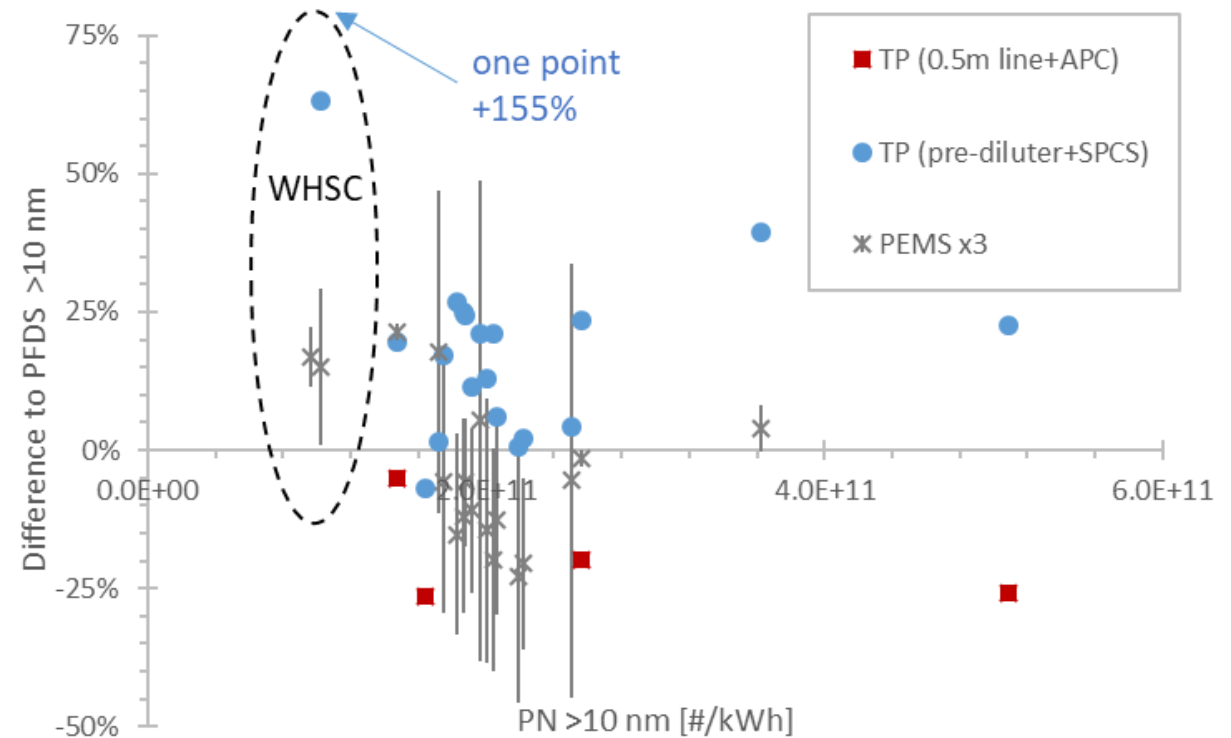
Part of measurement uncertainty program

One CNG engine

Most differences  $\pm 25\%$  (with some exceptions under investigation)

Pre-diluter with higher values

System with heated line lower values



# Conclusions

PN sampling directly from the tailpipe with fixed dilution for heavy-duty engines type approval is an acceptable alternative.

The results (compared to PFDS or CVS) show a variability of  $\pm 40\%$  (typically  $\pm 25\%$ ). In most cases positive values with the pre-diluter and negative values with the heated line concept.

Most cases were with diesel engines (lower exhaust temperatures). Few CNG engines with temperatures around 400-600°C were included. However better understanding is needed for temperatures at the  $>500^\circ\text{C}$  range

It is suggested to postpone the inclusion of tailpipe sampling for Euro 7 until more data are collected