



European Commission

# Results of the PEMS PM Pre-Pilot program

To support the PEMS PM Pilot Program, DG JRC conducted a Pre-Pilot Program with the collaboration of one of the ACEA's member, IVECO, and PM instrument manufacturers. The aim of this activity was to look into all the logistic necessary to mount both the PEMS PM and PEMS gaseous equipment in a HDV, and to verify the good functioning of the system. One gaseous PEMS and four candidates PEMS PM instruments were operated together on the same vehicle and the experience was shared with all the participants on the PEMS PM Pilot program. The Pre-Pilot program was run at the JRC Vela 7 and on the roads around the JRC-Ispra site; it also constitutes part of the work performed to complete the research on the introduction of PEMS PM measurement in the PEMS Procedure for Euro VI. This program was run after the successful completion of the laboratory evaluation program with the identification and recommendation of the candidate principles [1-3], and within the validation program (PEMS PM Pilot Program[4]).

## VELA 7 testing:

IVECO Eurocargo	
Emissions category:	Euro IV
Engine type:	F4AE3682A*P
Max power:	220 kW @ 2500rpm
Fuel:	Diesel
ETC ref work:	32.75 kWh
Cylinders:	6
Aftertreatment:	SCR

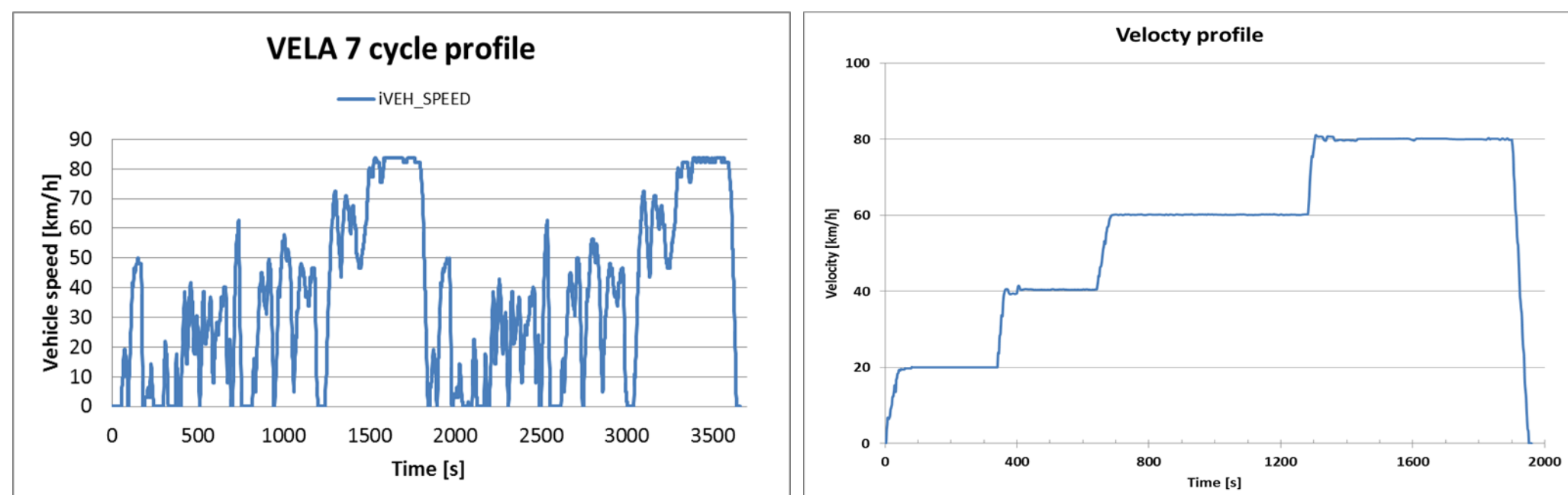


Figure 1. WHVC test schedule (cold/hot) & constant speed profile for VELA 7 testing

The vehicle was equipped with 4 different PEMS PM instruments available:

- AVL MOVE PEMS PM (AVL-MOVE/MSS)
  - Control System PEMS PM (CS-PSS)
  - Horiba TPRM (HOR/OBS) – Not available for VELA 7 testing
  - Semtech Ecostar (ECO) – Not available for VELA 7 testing
- And 1 gaseous PEMS:
- Semtech DS

Total # of hot WHVC tests: 4

Total # of constant speed tests: 2

A detailed description of the PEMS PM instruments can be found in previous JRC reports[1-3].

VELA 7 reference instrument - A PMP compliance instrument is used to measure particle number (AVL APC-489) + CVS



Figure 2. On-board PEMS instrumentation for VELA 7 testing

## PEMS PM instrumentation correlation with VELA 7

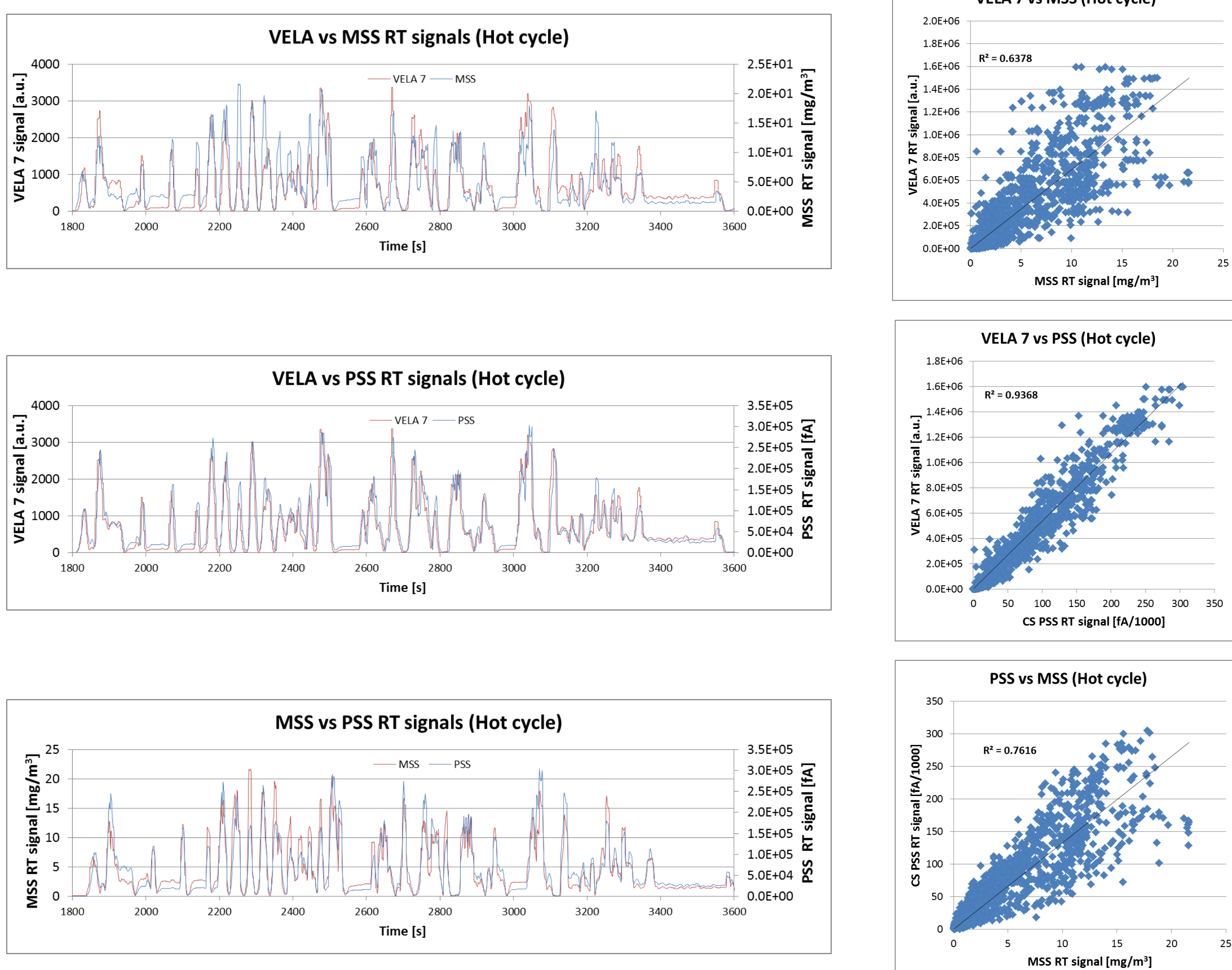


Figure 3. PEMS PM instrumentation signal correlation with VELA 7 & between each other

## References:

1. P Bonnel, M.C., F Forni, S Alessandrini, F Montigny, H Demircioglu, B Giechaskiel EU-PEMS PM evaluation program - First report. 2010, Joint Research Centre. EUR 24543EN
2. A Mamakos, M.C., P Bonnel, H Demircioglu, K Douglas, S Alessandrini, F Forni, F Montigny, D Lesueur EU-PEMS PM evaluation program - Second report : study on post DPF/PM/PN emissions 2011, Joint Research Centre. EUR 24793EN
3. A Mamakos, M.C., P Bonnel, H Demircioglu, K Douglas, S Alessandrini, F Forni, F Montigny, D Lesueur EU-PEMS PM evaluation program - Third report, further study on post DPF PM/PN Emissions 2011, Joint Research Centre. EUR 24883EN
4. P Mendoza Villafuerte, A.Perujo Mateos del Parque., P Bonnel, M Carriero, F Forni, F Riccobono, EU-PEMS PM Pilot Program: Testing, data analysis and results. 2015. EUR TBD

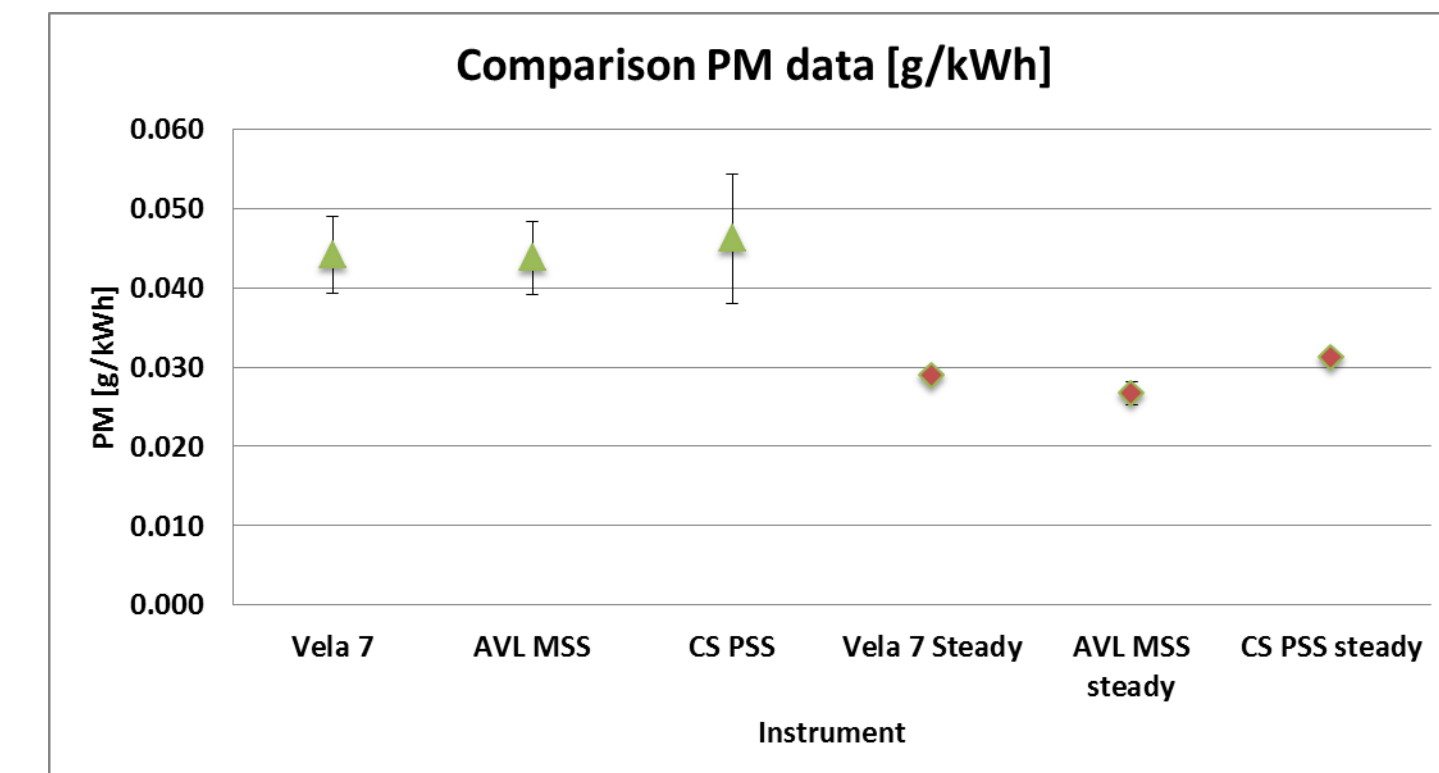


Figure 4. PM (g/kWh) comparison of laboratory based tests (WHVC) & constant speed (steady). Based on total number of tests.

## On-road testing:

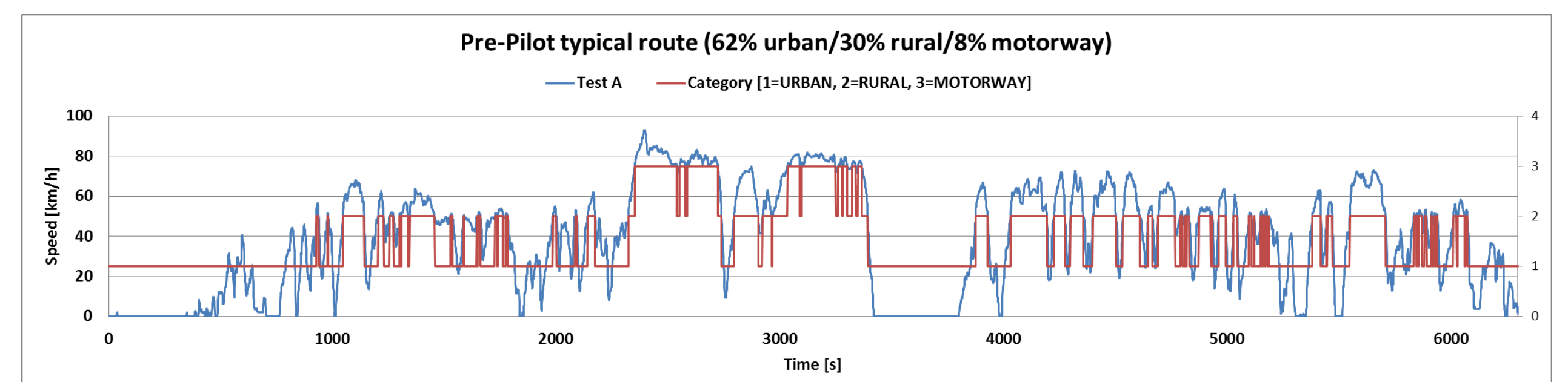


Figure 5. Typical route for on-road tests.

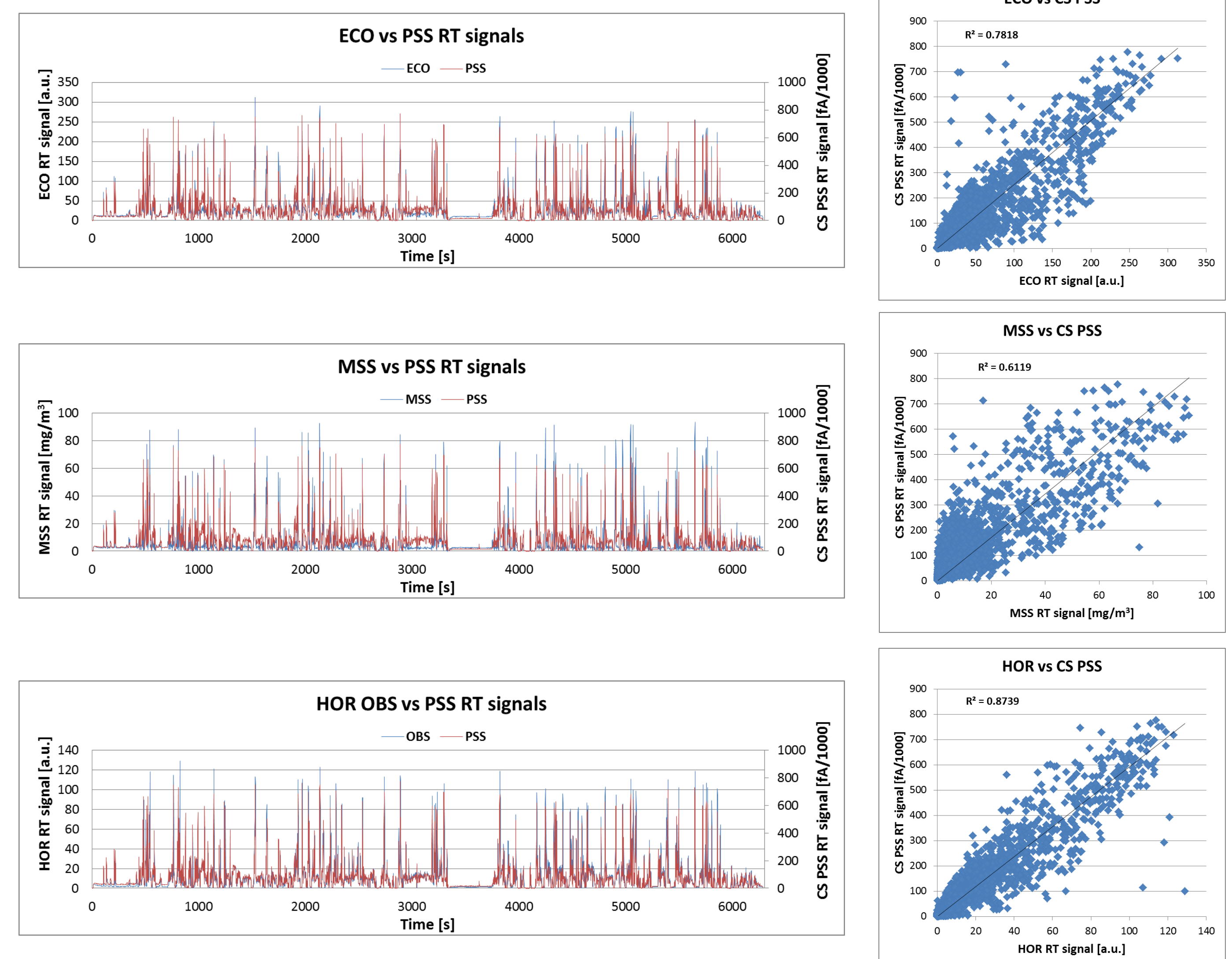


Figure 6. PEMS PM instrumentation signal correlation between each other for on-road test.

Total # of on-road tests: 7

## Conclusions:

1. In general terms, correlation between PEMS PM instruments with VELA 7 reference system was acceptable. All tests showed good correlation between the two PEMS-PM instruments ( $r^2 \geq 0.8$ ). A good correlation between the VELA 7 and the CS PSS was also found ( $r^2 > 0.9$ ), while for the cases of the correlation between VELA 7 and the MSS is not as satisfactory ( $r^2 > 0.6$ ). It must be noted that the correlation factor ( $r^2$ ) between the real time signal from CS PSS and the AVL MOVE (MSS) for all the hot WHVC tests is larger than 0.78; while in the case of the correlation ( $r^2$ ) between the real time signal from VELA 7 and the CS PSS is larger than 0.87.
2. The relationship between the conformity factors for on-road test show a bigger spread in relation to results shown in Figure 7, but still in good agreement with each other. This is probably caused by the fact that the instantaneous PM real time signal introduces some additional variance which is reflected in the calculation of the CF (work-based window with a length equal to the ETC reference work). The CFs' standard deviation on averaged values along the on-road tests is 16%.

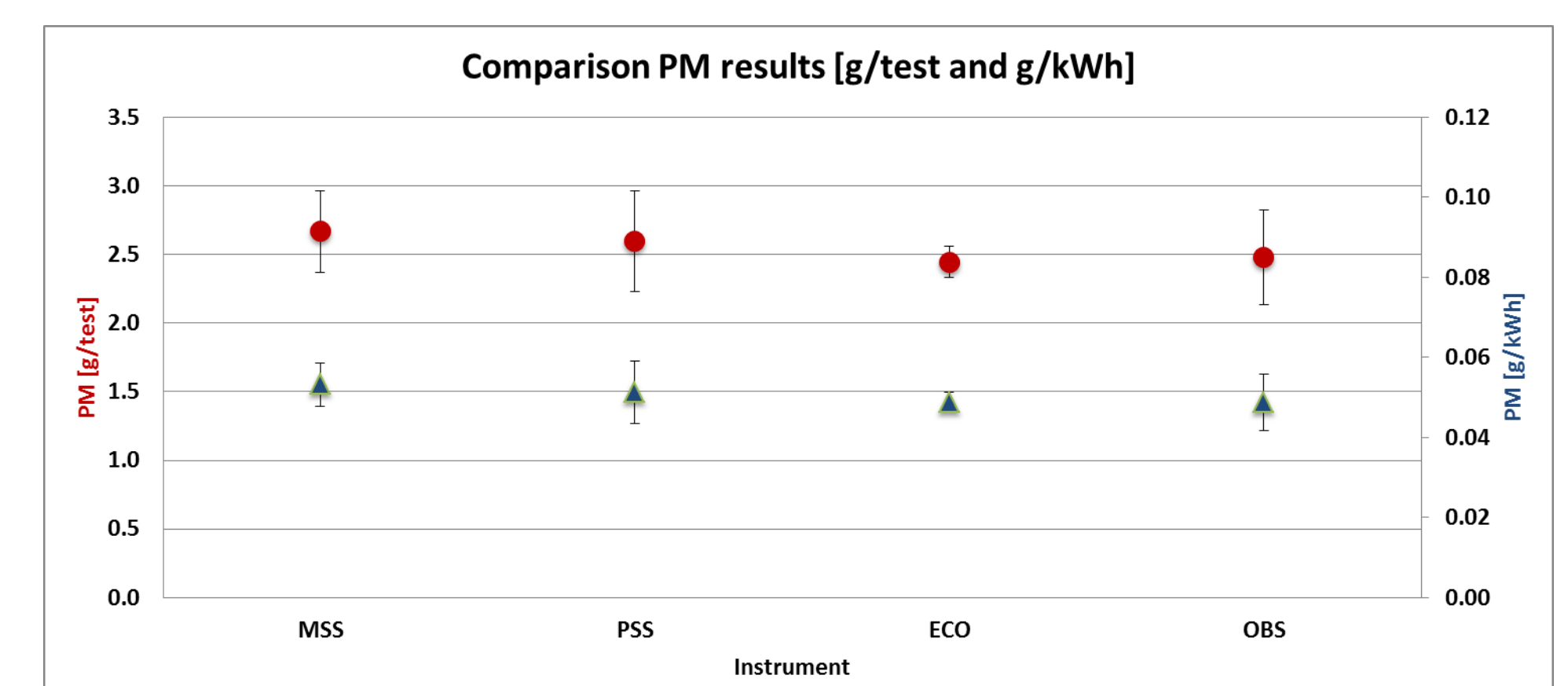


Figure 7. PM (g/kWh & g/test) comparison of on-road tests. Based on total number of tests.

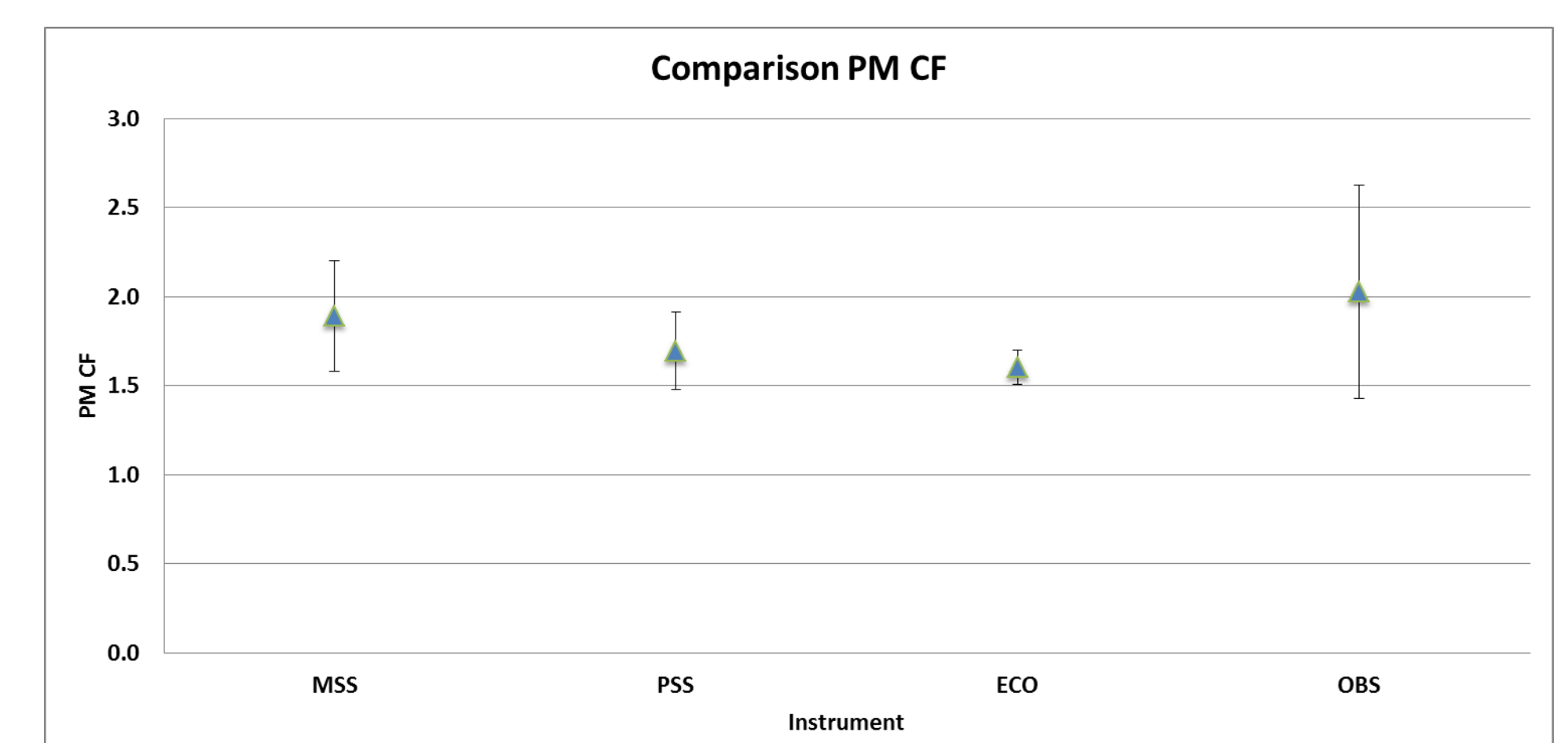


Figure 8. PM (CF) comparison of on-road tests. Based on total number of tests.

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