



# PEMS-PM Pre-Pilot Program

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**EC JRC – PEMS Expert Group –3rd Meeting  
Brussels – 5th November, 2013**

# Content

- ***Introduction***
- ***Pre-Pilot Programme:***
  - **Results**
  - **Lesson learnt**
- ***Testing Centres (proposal)***

# Goals of the PEMS-PM Pilot Project

- Test if the available PEMS – PM equipment fulfill the requirements to be used as part of the ISC (EURO VI)
  - i. To measure the total Particulate Matter (PM) mass over a long sampling period
  - ii. To provide a second-by second (“real-time”) information on the emitted PM mass at any time during the test.
  - iii. To be ready for on-vehicle tests:
    - a. solution to transport the raw or the diluted exhaust,
    - b. to allow for an installation of the system within a few meters from the vehicle tailpipe.

# PEMS-PM Pre-Pilot Project

## *Objectives:*

- To look into all the logistic necessary to mount both the PEMS PM and PEMS gaseous equipment in a HDV.
- The JRC will perform some tests to check for the system good functioning.

# PEMS-PM Pre-Pilot Project

## *Results:*

### *1. Vehicle:*

*IVECO Eurocargo 5.9l,*

- 6 cylinder, 220kW,
- EU-IV with SCR



## 2. Equipment on board:

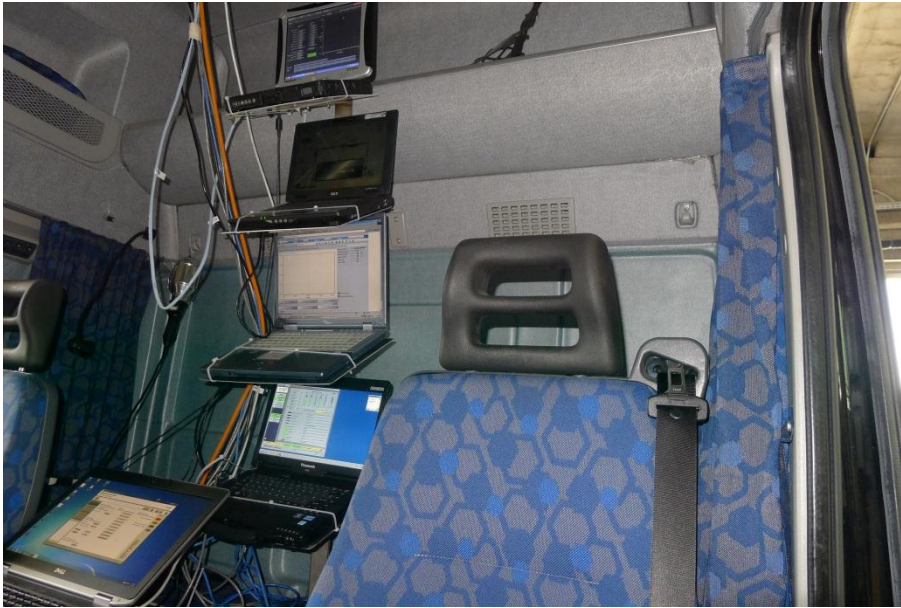


- 1 gaseous PEMS
- 4 PEMS PM

Instruments installed:

- AVL PM PEMS,
- Control Sistem/ Pegasor,
- Horiba TRPM,
- Semtech ecostar and PM,
- Semtech DS

### 3. Procedure



All the manufacturers has been at the JRC to supervise the setting up of their equipment

- Some problems in providing external power to all the equipment - Resolved
- The use of a UPS for power continuity and quality is being seek
- EFM signal were provided to CS and Horiba.

### **3. TESTS**

- Road tests of all PEMS PM Equipment using the IVECO Eurocargo were performed from 10/07/2013 to 12/07/2013.
- Chassis Dyno (VELA 7) test were carried out using the same vehicle from 22/07/2013 to 25/07/2013



## 4. Road Tests

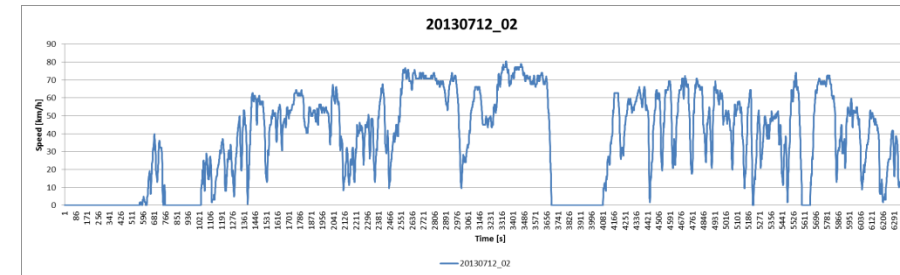
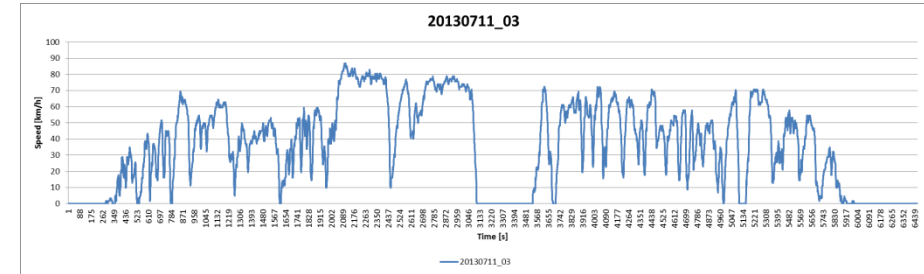
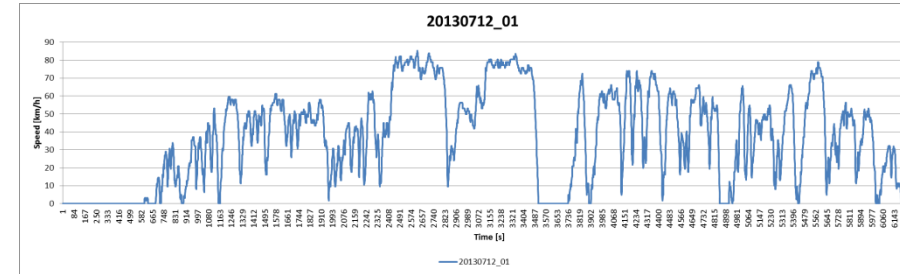
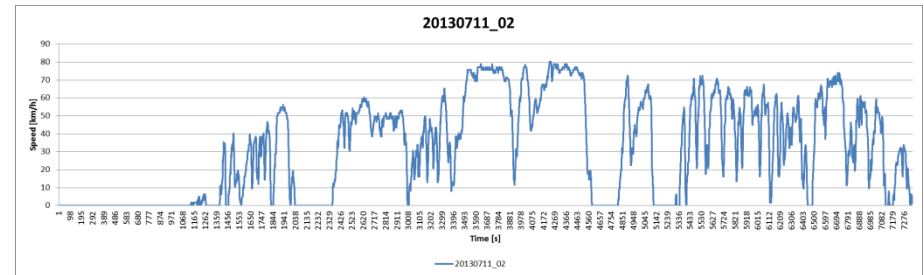
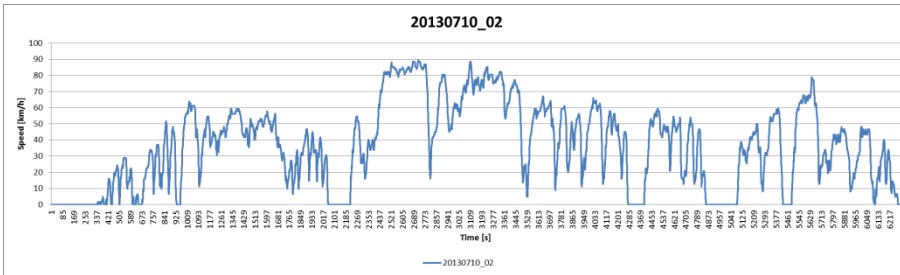
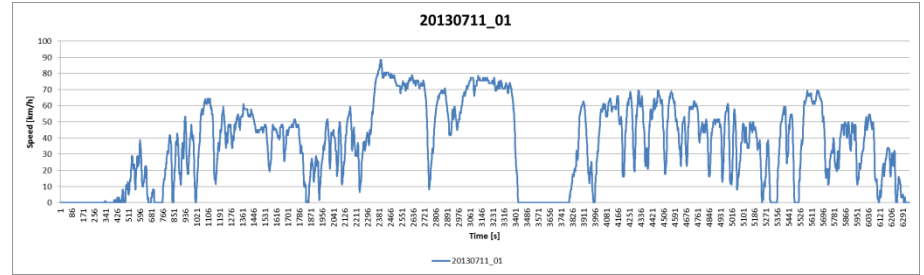
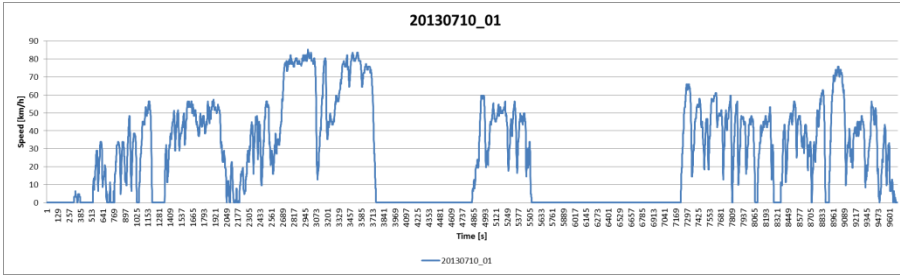
### 4.1 Trip Characteristics

Trip Number	Composition			Work vs ETC
	Urban	Rural	Motorway	
20130710_01	68.89	20.90	10.21	3.31
20130710_02	62.47	25.82	11.70	2.96
20130711_01	60.27	33.18	6.56	3.04
20130711_02	54.67	36.38	8.95	3.13
20130711_03	56.17	34.13	9.69	3.09
20130712_01	57.83	30.81	11.35	3.07
20130712_02	52.47	45.12	2.41	3.04

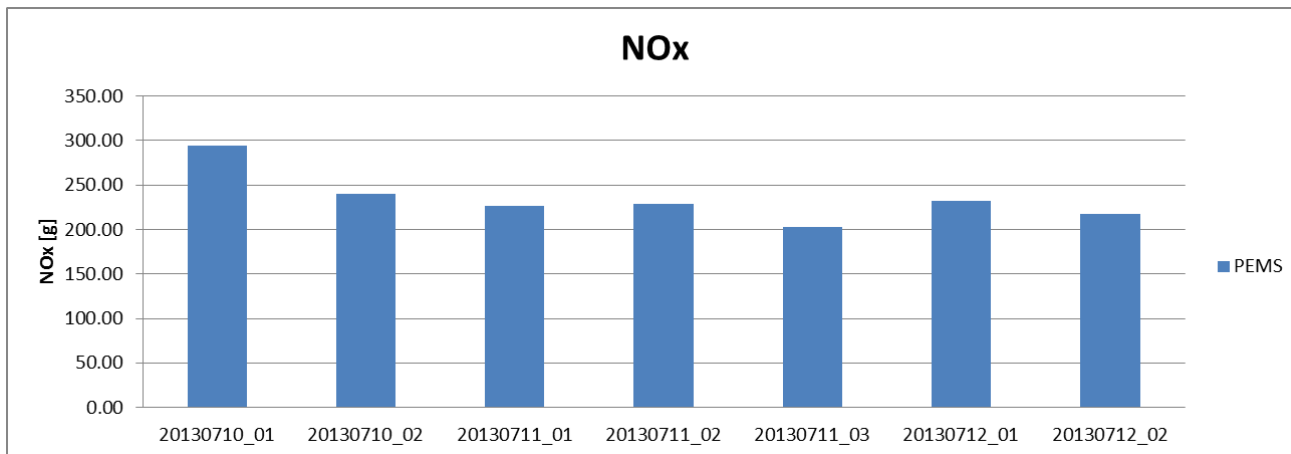
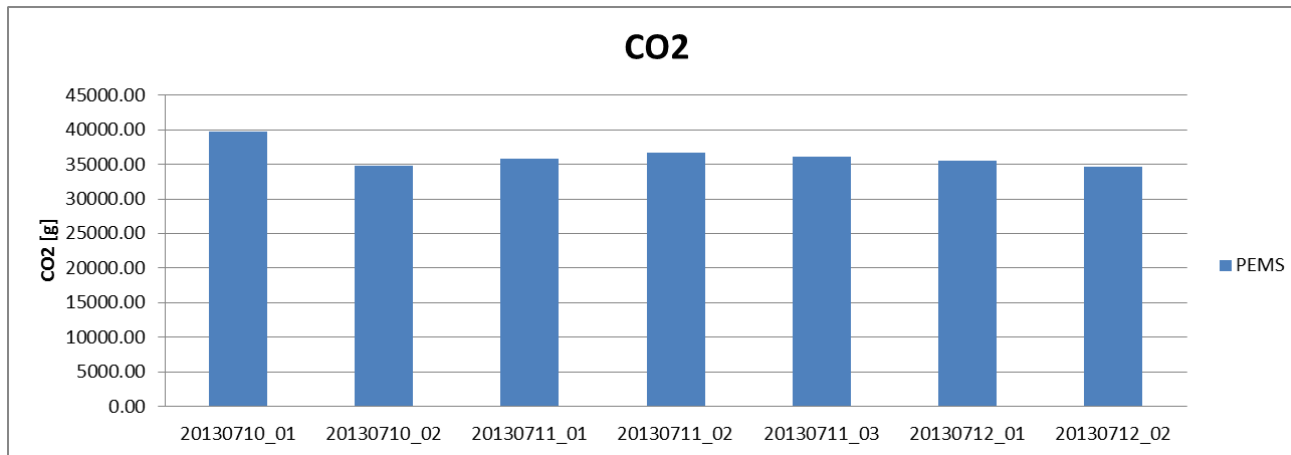


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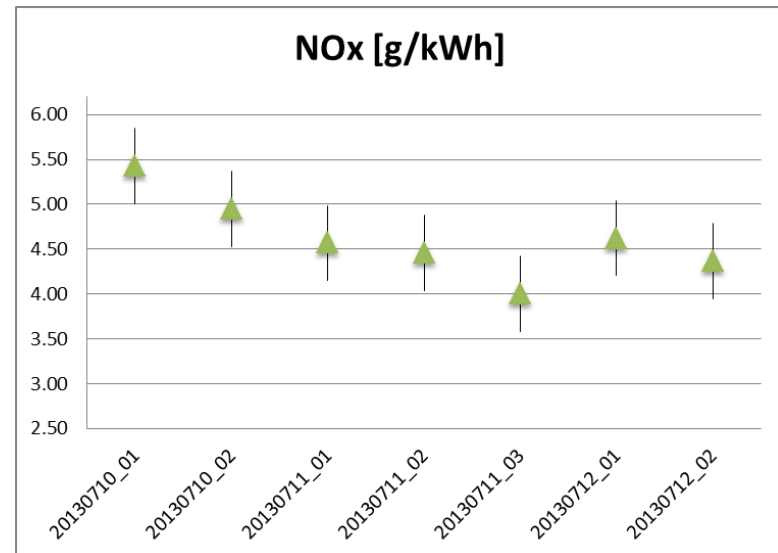
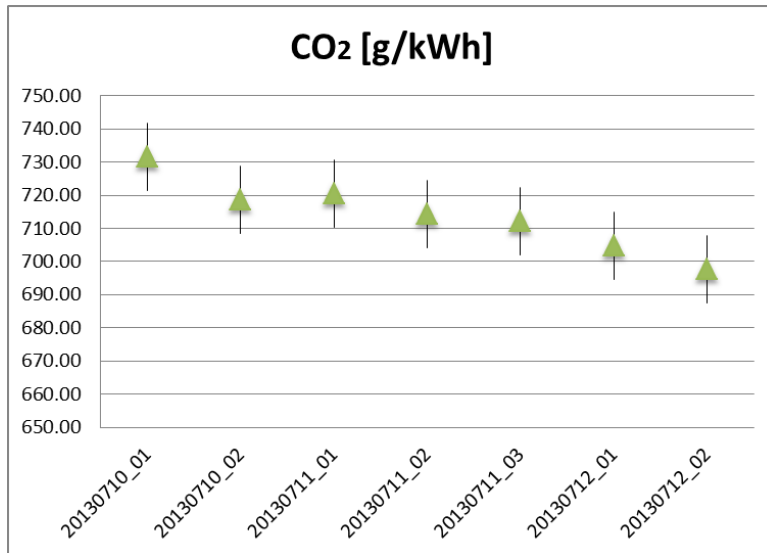
# 4.2 Trip velocity profiles



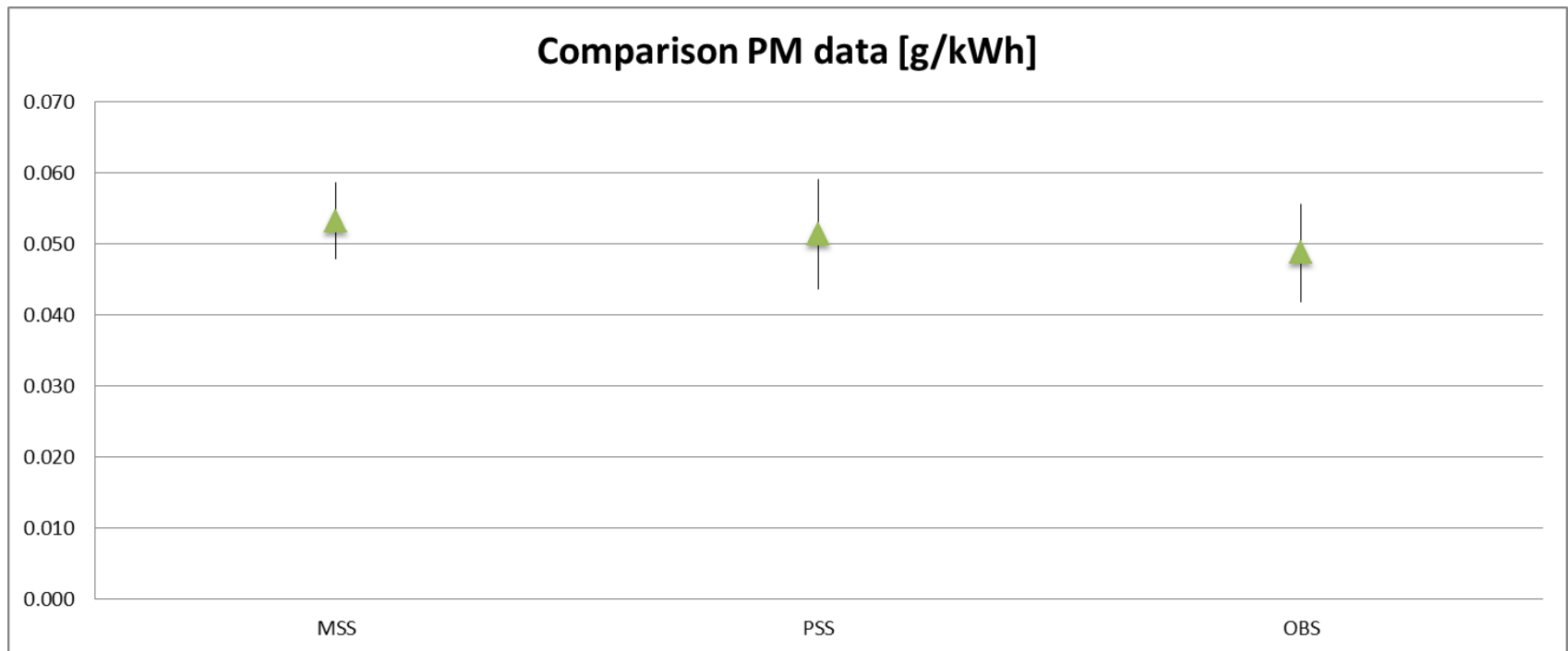
## 4.3a Results CO<sub>2</sub>, NO<sub>x</sub>



## 4.3b Results CO<sub>2</sub>, NO<sub>x</sub>



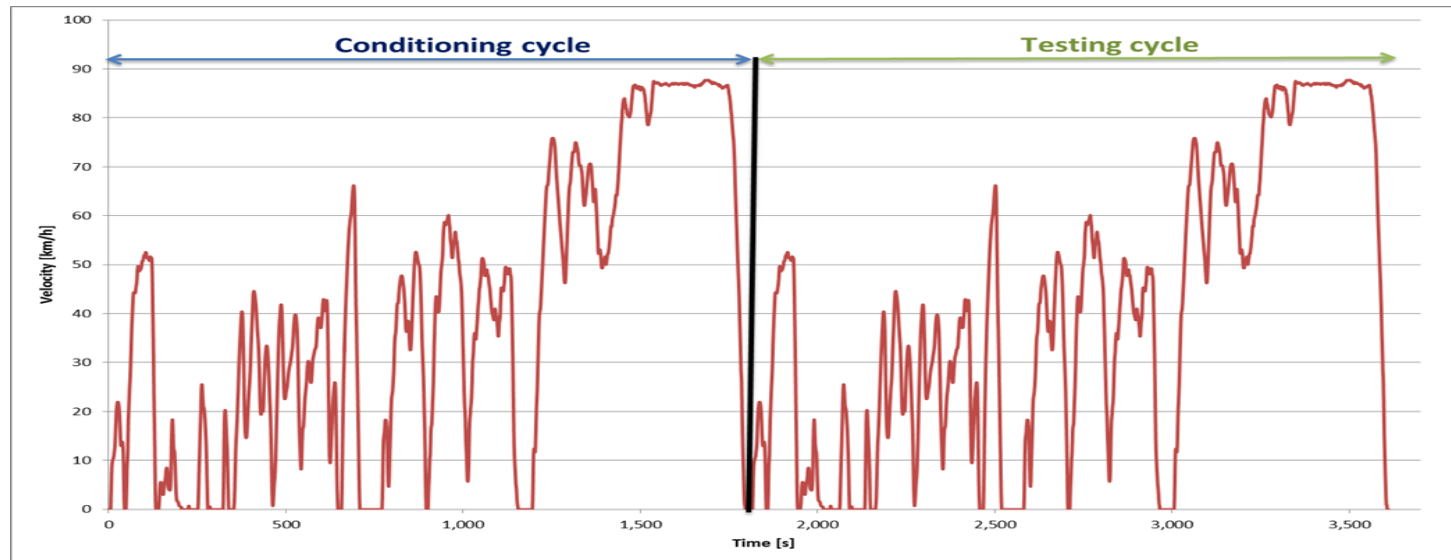
## 4.4 Results PM



## 5. Chassis Dyno (VELA 7) Tests

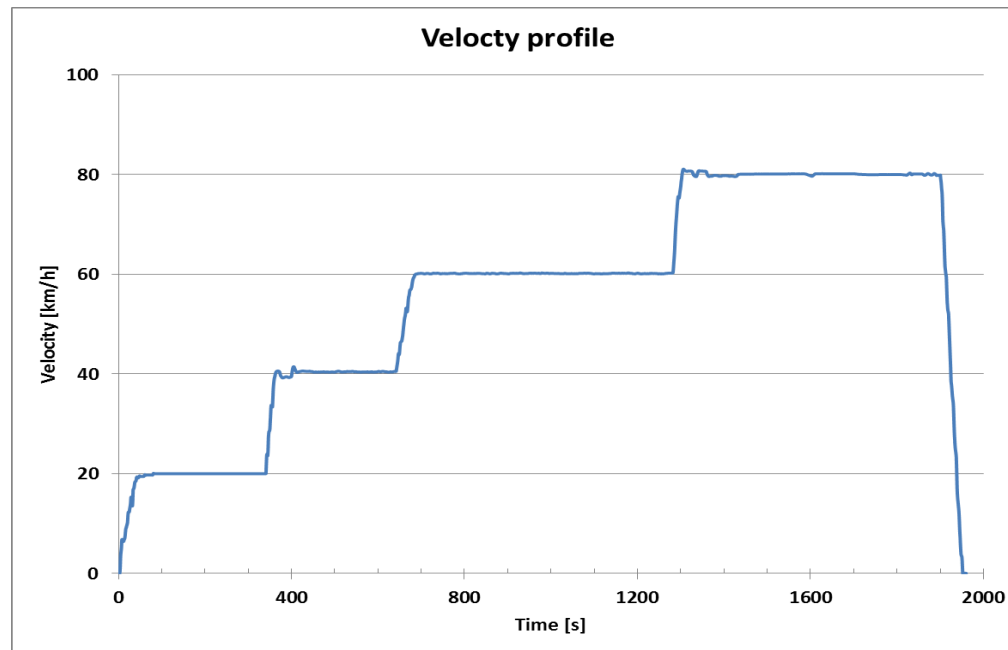
### 5.1 Procedure

- 3 WHVC runs were carried out
- Each run was made of a conditioning WHVC cycle followed by the test WHVC cycle (total 3600 s)
- Values from the laboratory equipment and PEMS equipment were collected for comparison.



## 5.1 Procedure

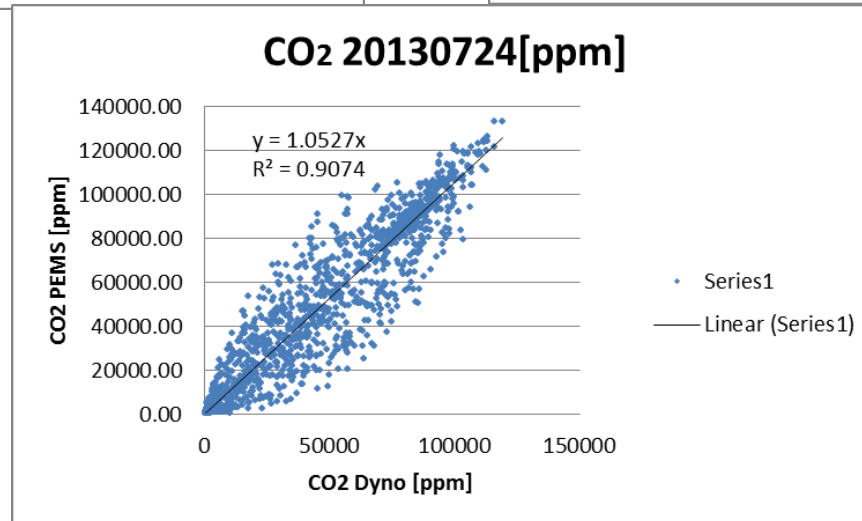
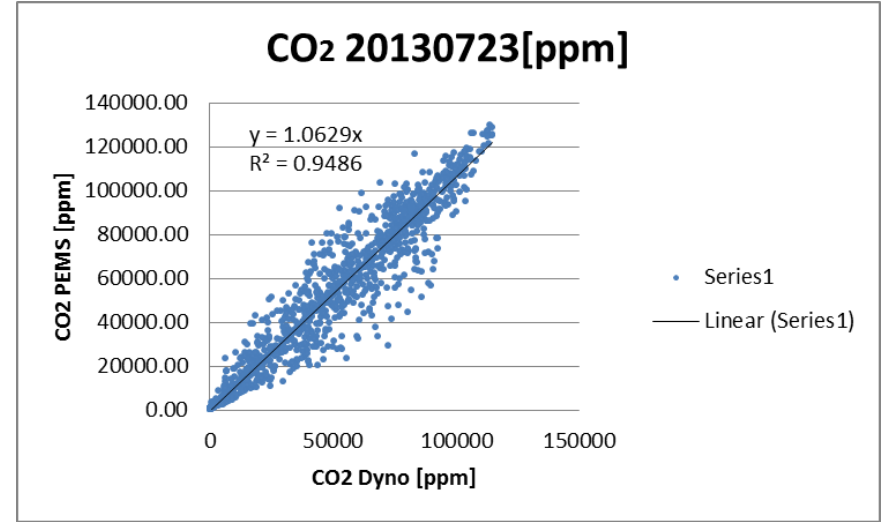
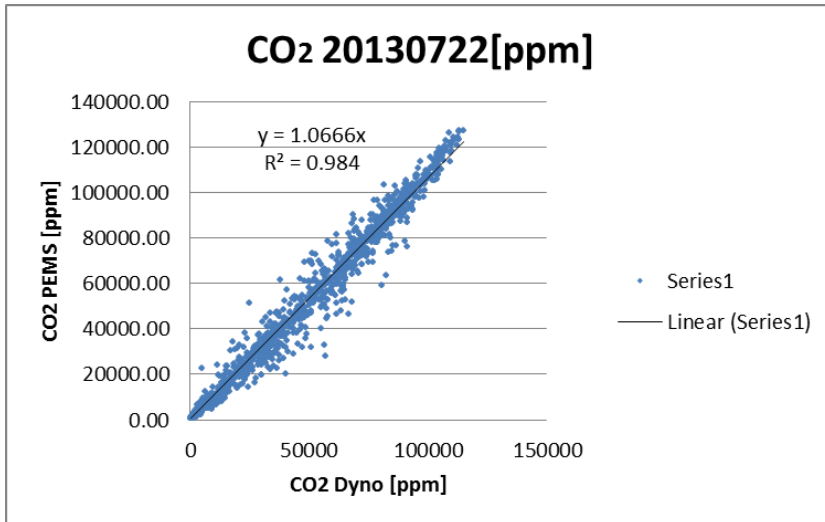
- 2 steady state velocity runs were carried out
- Each run was made of steady velocity portions for a total time equivalent to a WHVC cycle (total 1800 s)
- Values from the laboratory equipment and PEMS equipment were collected for comparison.





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## 5.2 Results CO2



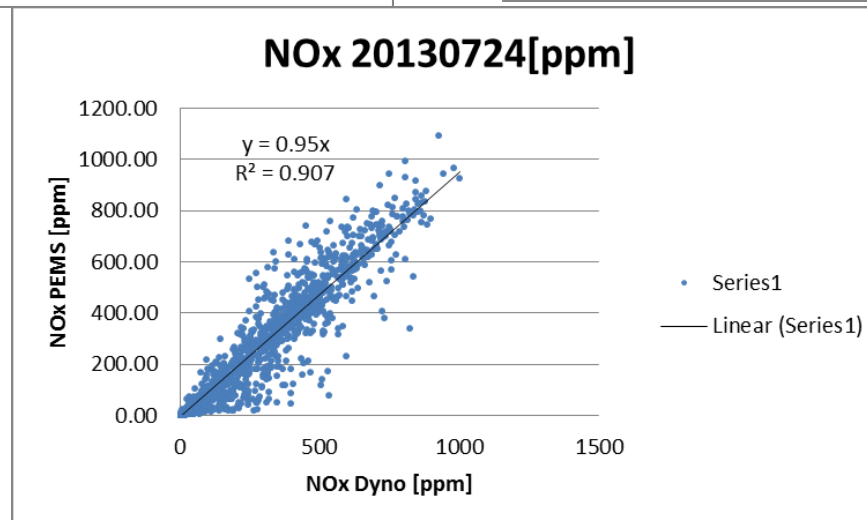
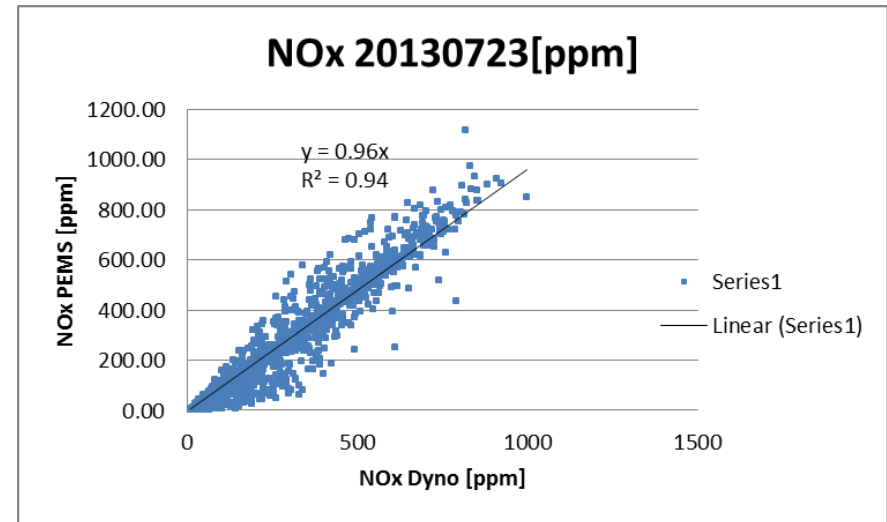
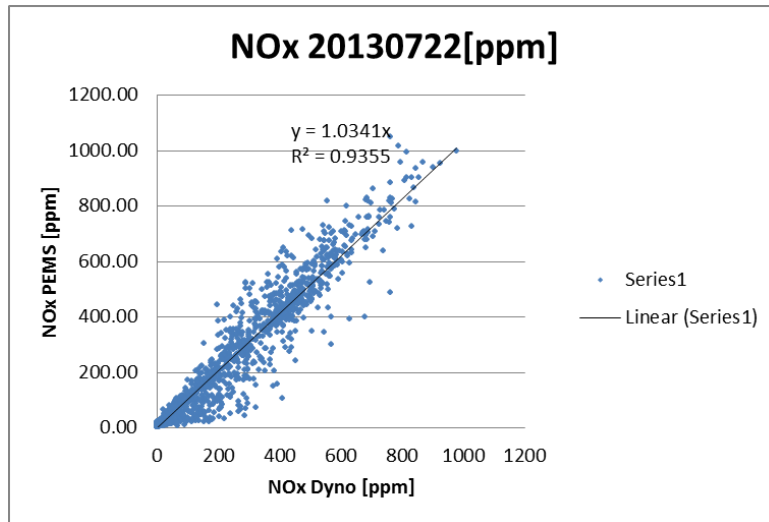
PEMS Expert Group – 3<sup>rd</sup> Meeting - Brussels – 5<sup>th</sup> November, 2013





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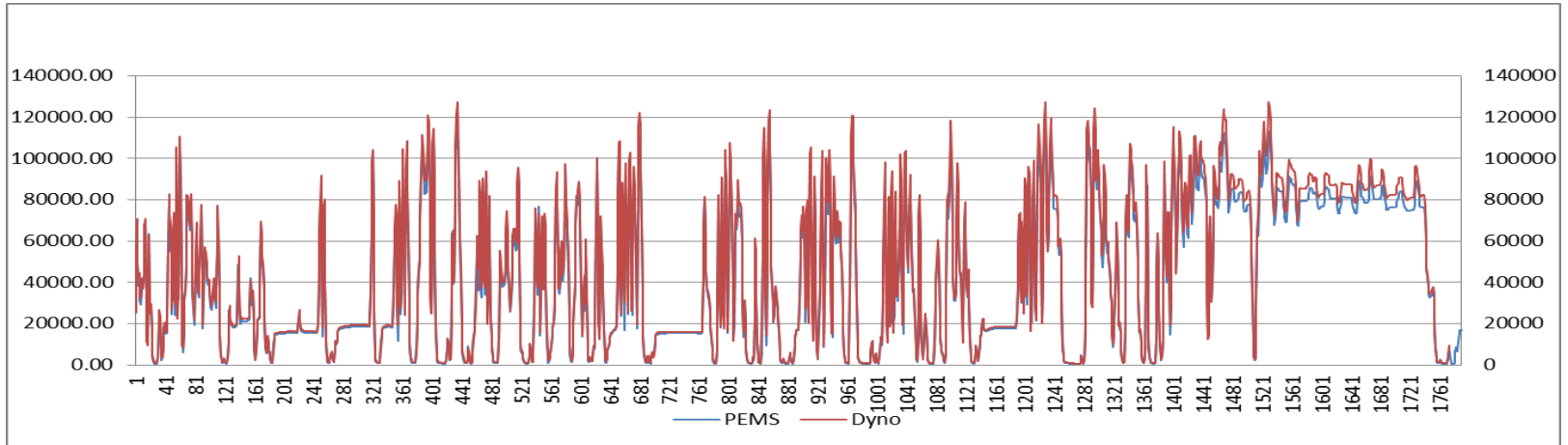
## 5.3 Results NOx



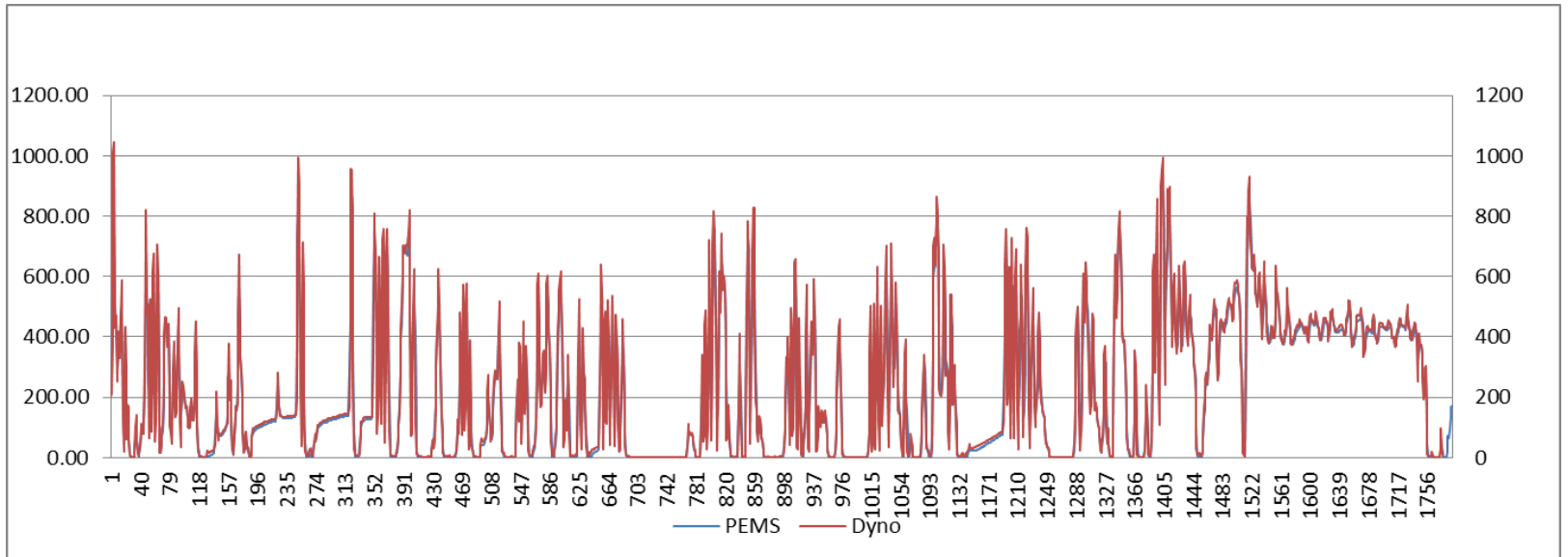
PEMS Expert Group –3<sup>rd</sup> Meeting - Brussels – 5<sup>th</sup> November, 2013

## 5.4 Results CO<sub>2</sub>, NO<sub>x</sub>

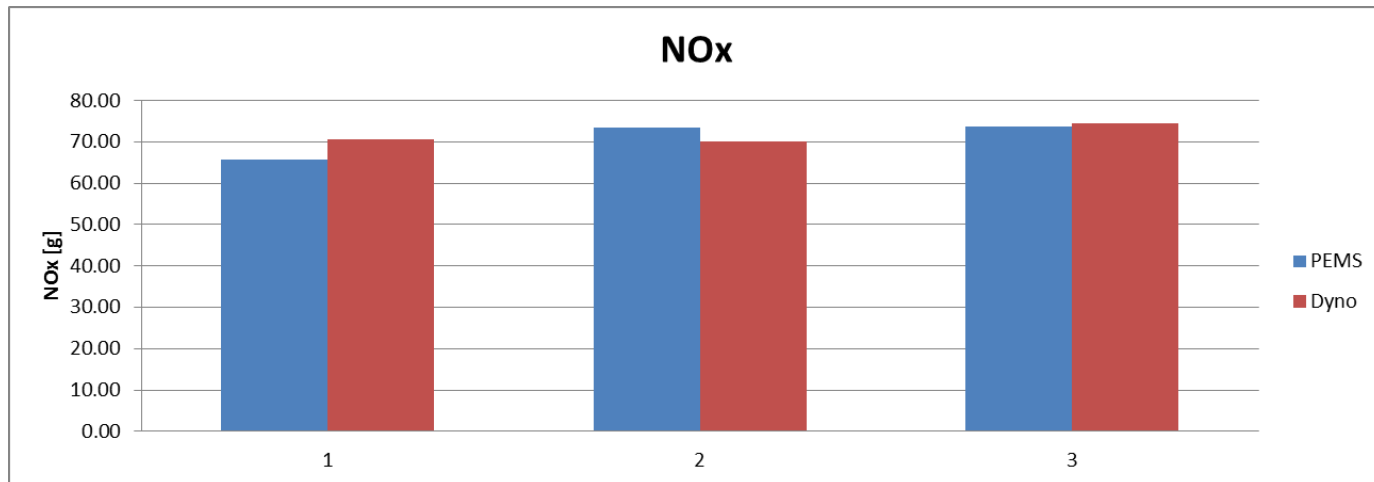
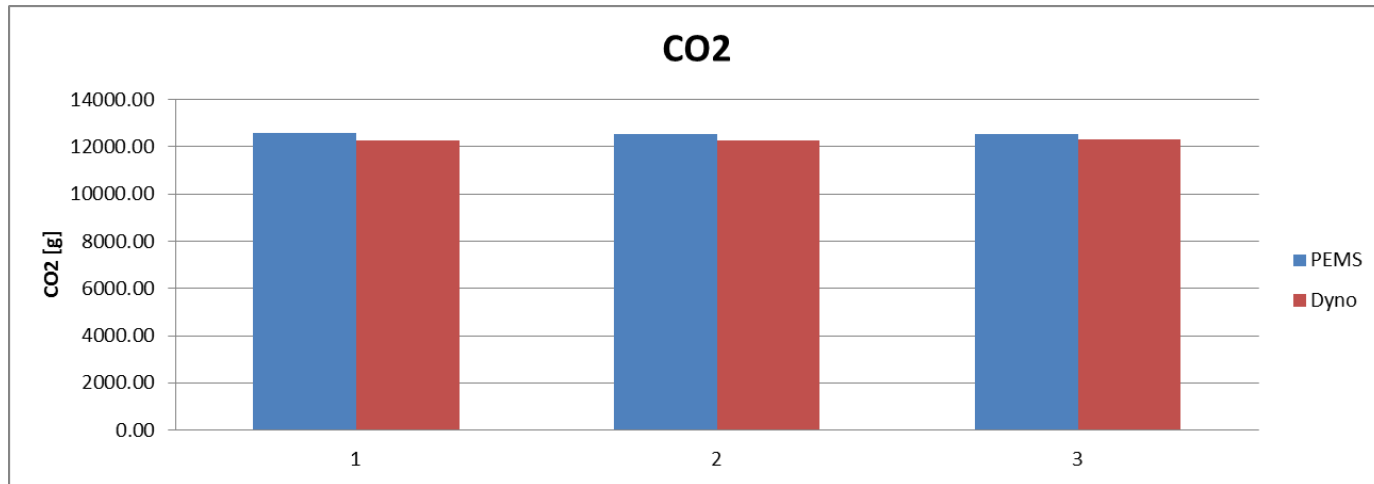
CO<sub>2</sub>



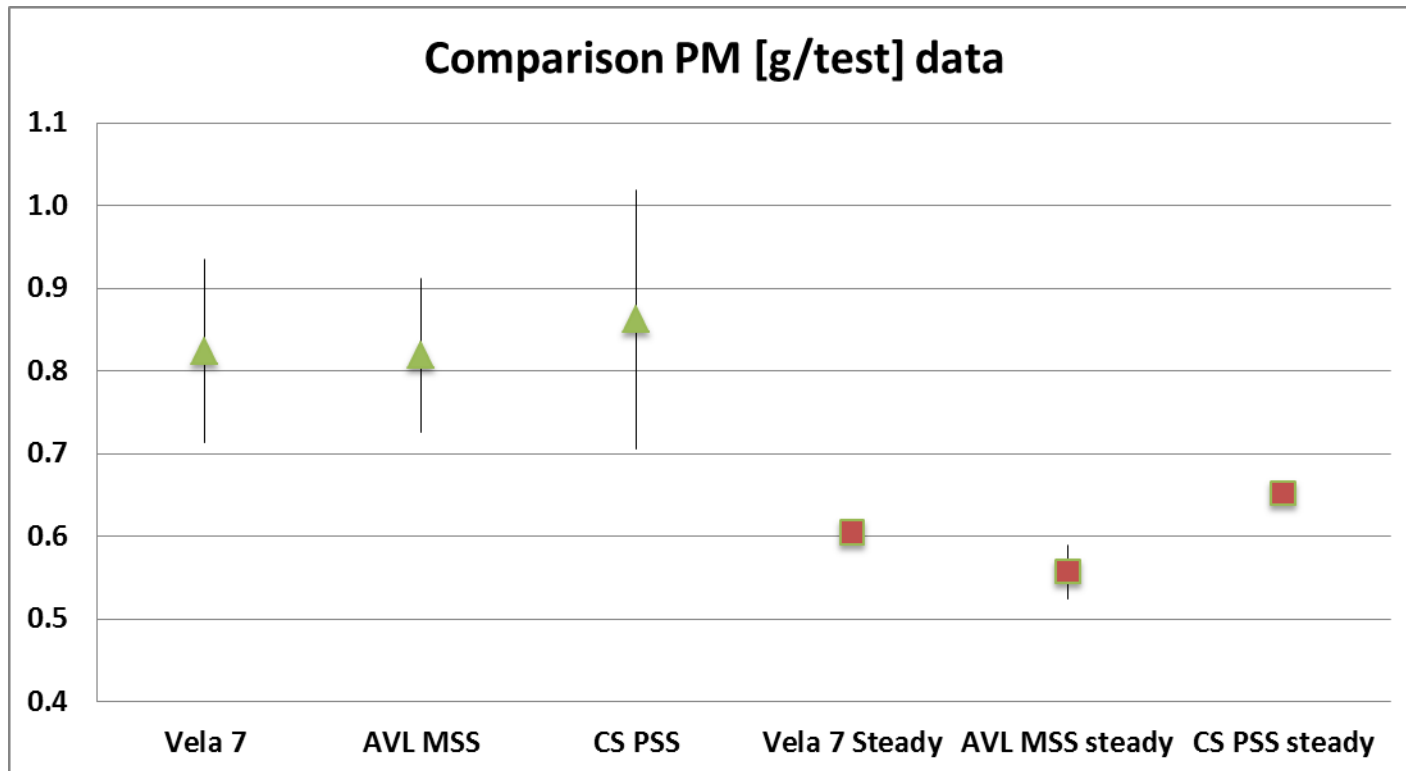
NO<sub>x</sub>



## 5.5 Results CO<sub>2</sub>, NO<sub>x</sub>



## 5.6 Results PM



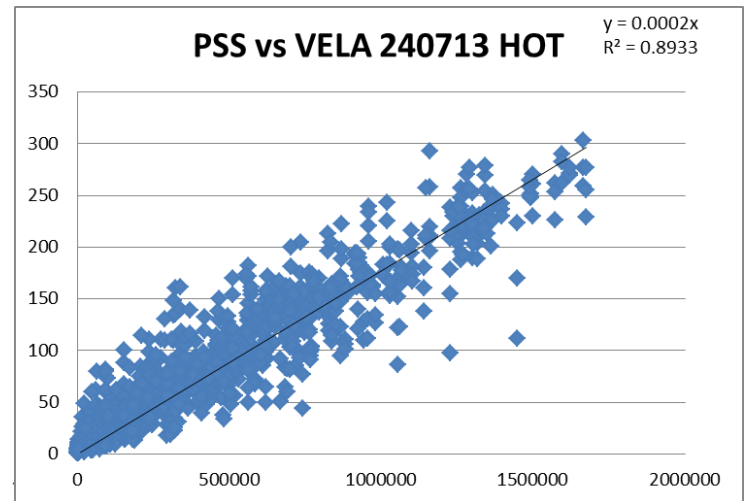
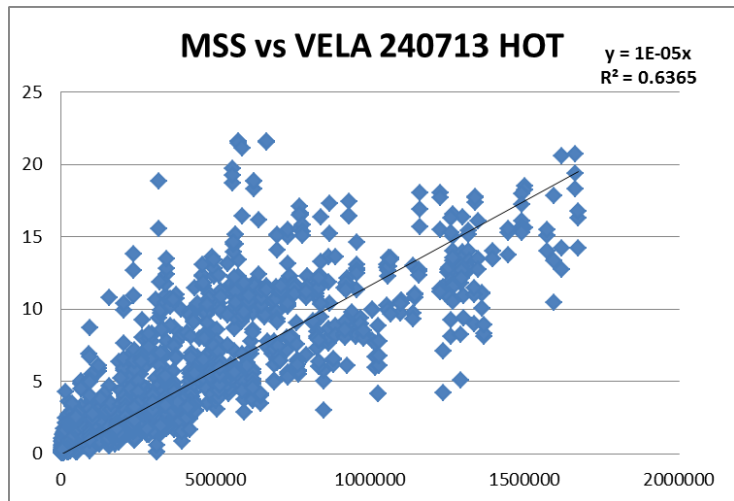
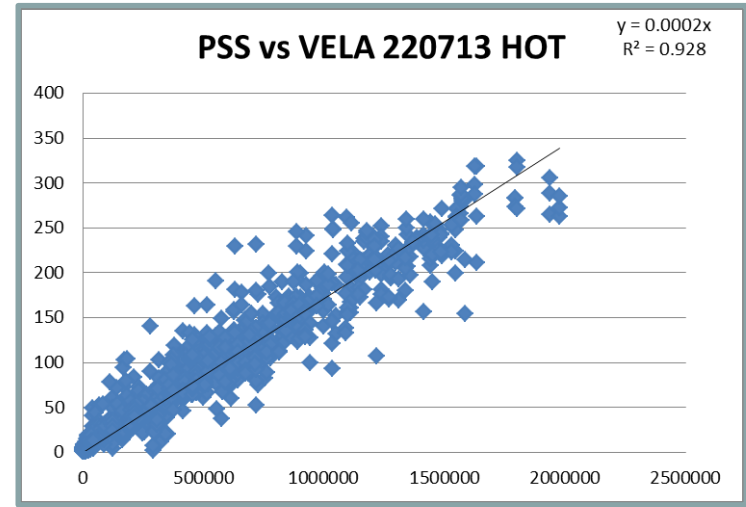
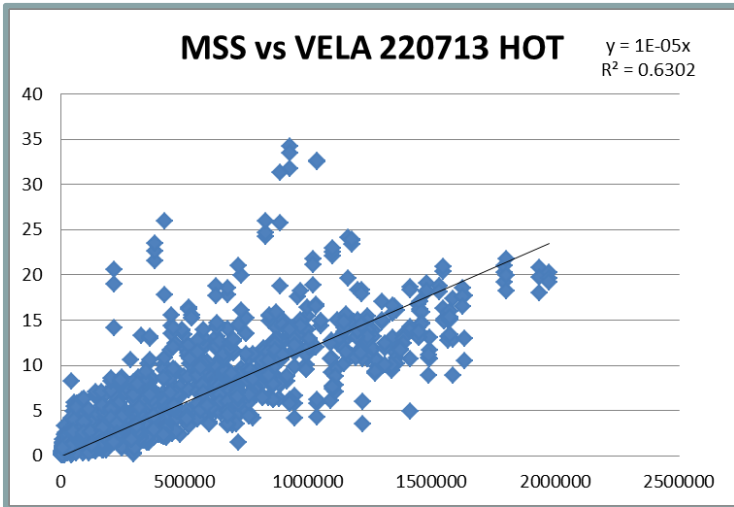
**Comparison of PM data between Dyno results and PEMS PM instruments**



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## 5.6 Results PM

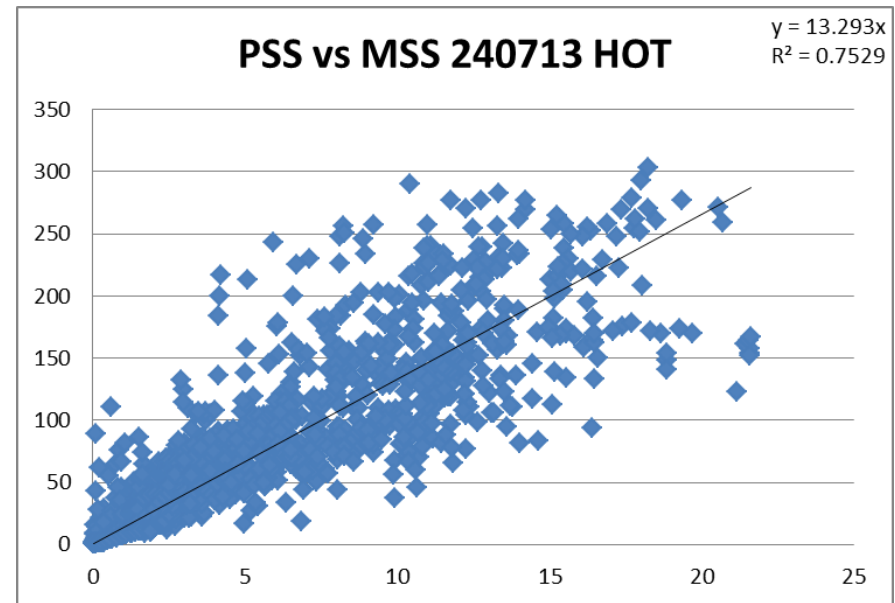
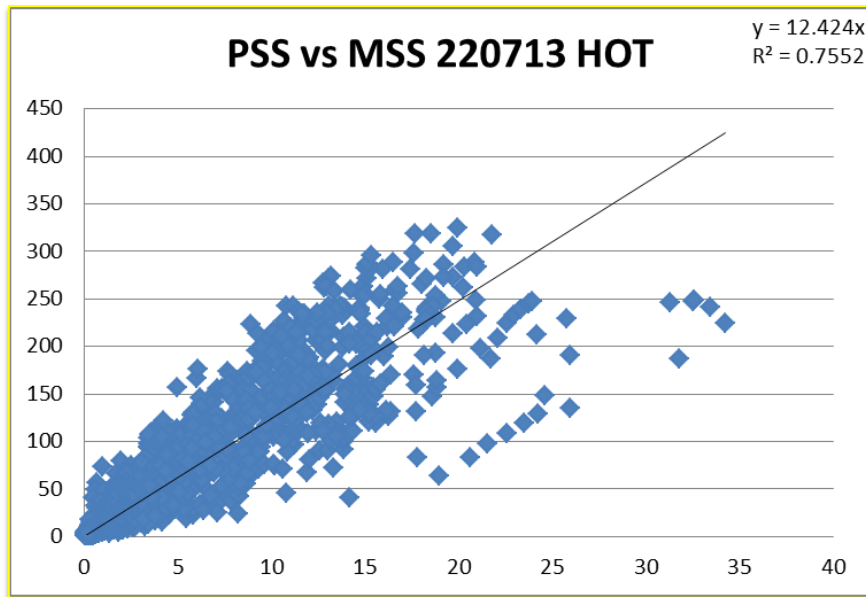
Second to second comparison between VELA measurements and PEMS PM apparatus.



up -3rd Meeting

## 5.6 Results PM

Comparison among PEM PM systems



## 6. Comments

- **From the functionality and ease-of-use only two instruments are in our opinion were ready to use in the PEMS PM pilot programme; namely Control System and AVL (it was constant dilution).**
- **Horiba OBS TRPM is not in our opinion a portable instrument although in the verification campaign did show the best correlation with laboratory equipment (VELA 5). Further, it blocked immediately after the first on-road test. It has been already repaired!**
- **Sensors instrument has showed problems with filter loading and therefore we have few valid tests that can be used. Further, although if the test data have been generated it lacks the final step where the different files (FEM, MPS, PFS, PM) are combined in a single file (this extent needs to be address by the company). We know they are doing so!**

## 7. Calculation principle

1. Calculation of total PM emissions from the gravimetric (filter) method:  $mass_{PM}$

$$[\text{mass}]_{PM} = (\text{Filter Mass}) \times (\text{Total Exhaust Mass}) / (\text{Sampled Exhaust Mass})$$

2. Calculation of the "equivalent mass" estimated by the Real Time sensor:  $[\text{mass}]_{RT}$

$$mass_{RT} = K \int_0^t RT(t) \cdot DR(t) \cdot EF(t) \cdot dt$$

where:

RT(t) is the Real Time sensor measurement

DR(t) is the Dilution Ratio.

EF(t) is the exhaust flow

K is the mass conversion factor

3. Calculation of the mass conversion factor

$$K = [\text{mass}]_{PM} / [\text{mass}]_{RT}$$

4. Calculation of real-time PM mass emissions (e.g. with EMROAD)

$$PM(t) = K \cdot RT(t) \cdot DR(t) \cdot EF(t)$$

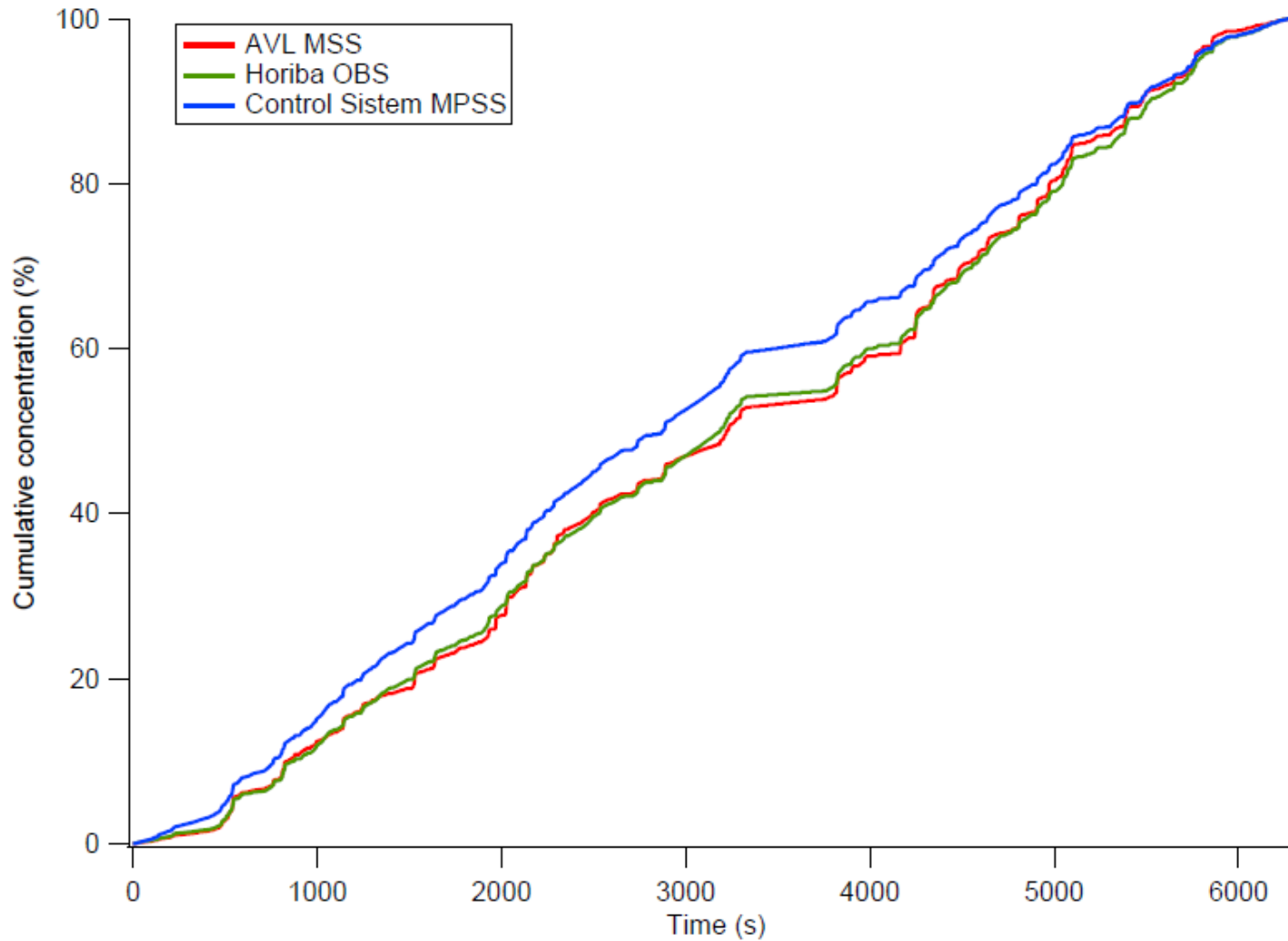
where:

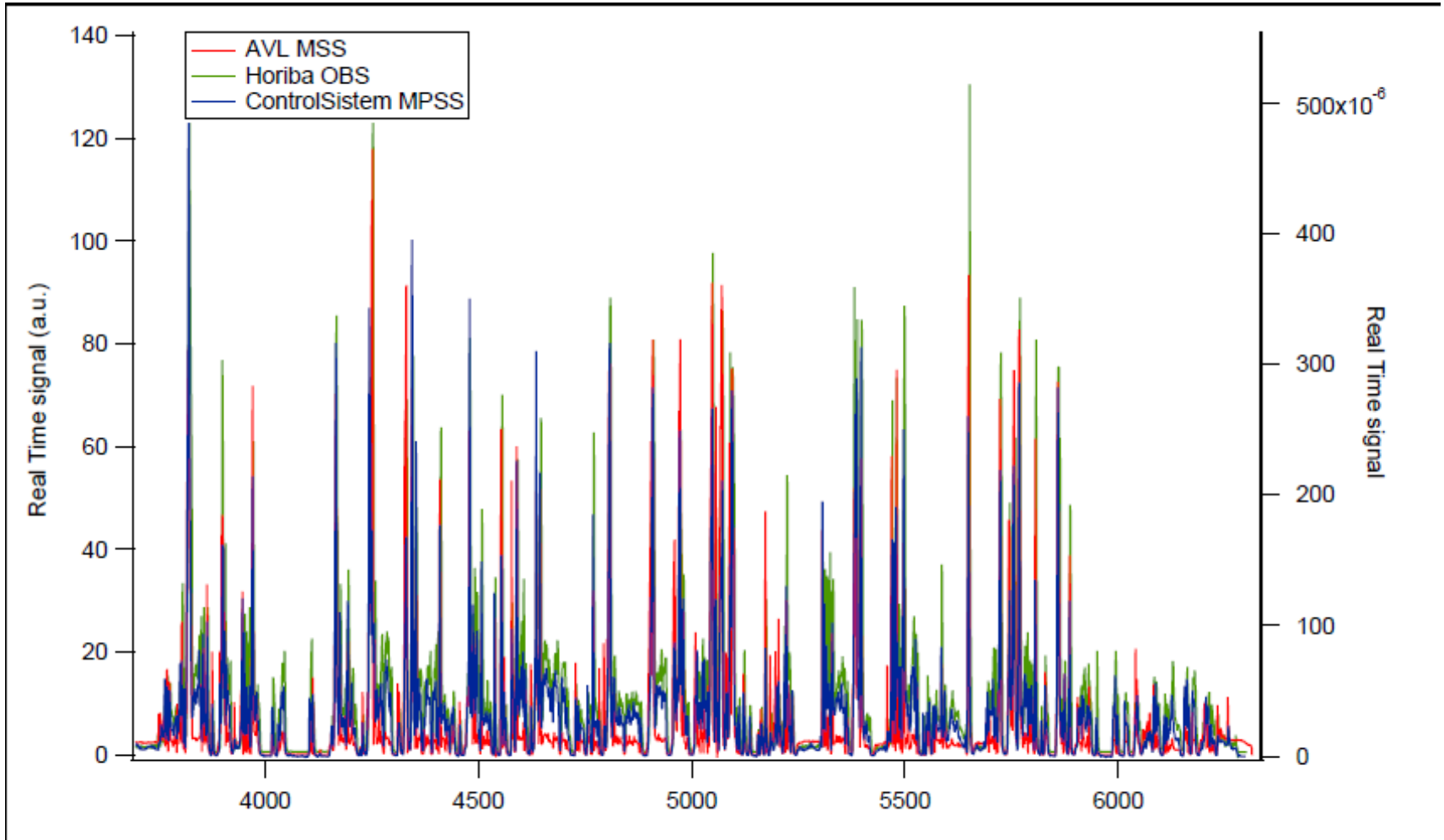
PM(t) is the Real Time PM mass

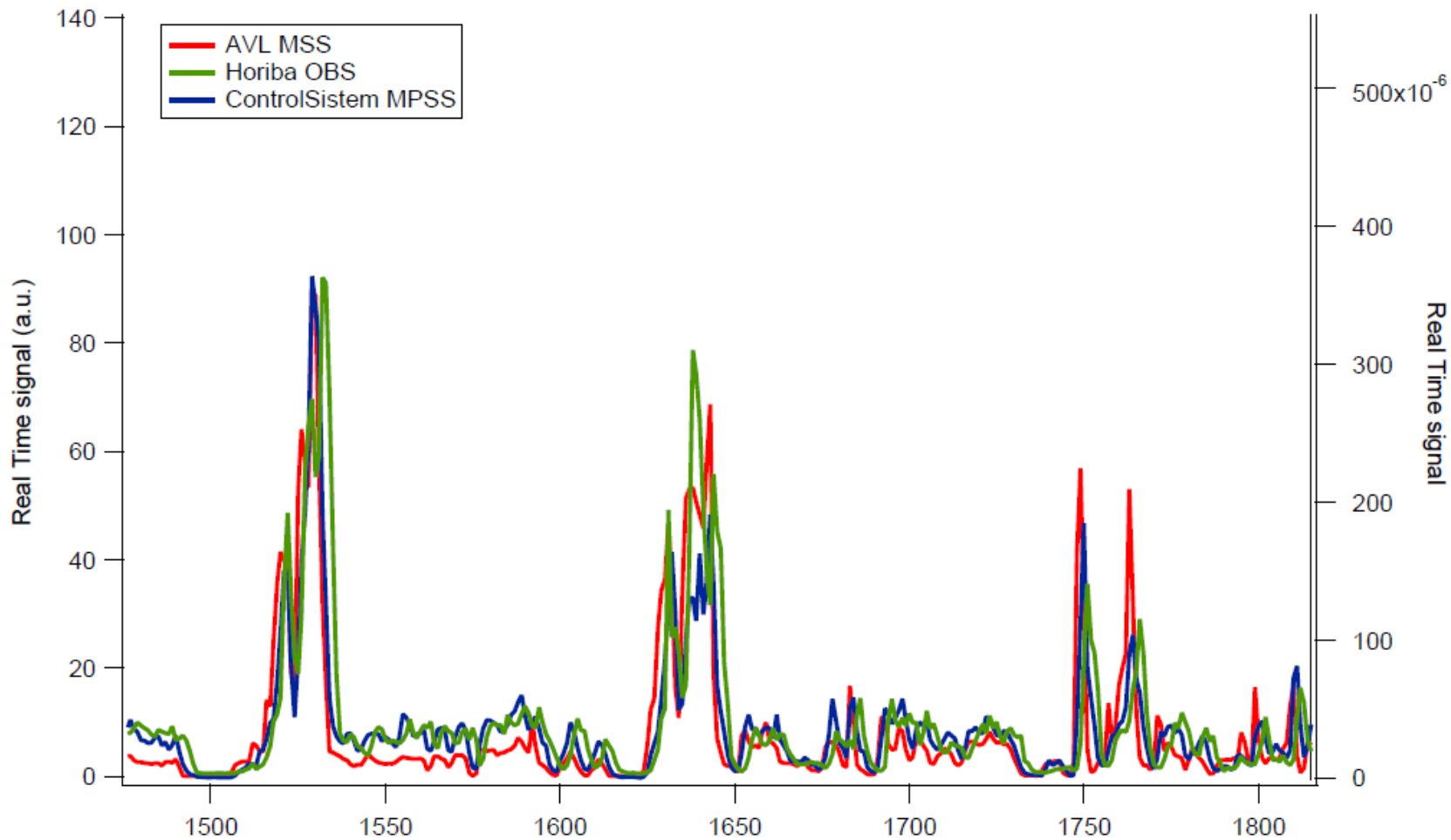
EMROAD requires as input (to be uploaded to TEST DATA):  $\cdot$  RT(t), DR(t) and  $[\text{mass}]_{PM}$

EMROAD calculates:  $\cdot$  K,  $[\text{mass}]_{RT}$  and PM(t)











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# TEST CENTERS



**For an easier logistic**

# Testing required for PEMS PM Pilot Program

Category	Sub-category	Condition	3 Payloads	Test routes proposed (U=Urban, R=Rural, MW=Motorway)
<b>M</b>	M1	5 x Work/CO2 from WHTC	50-60% / Low payload / high payload	U 45% / R 25% / MW 30%
				R 25% / MW 30% / U 45%
				U/R/MW - U/R/MW - U/R/MW...
				Random
	M2	5 x Work/CO2 from WHTC	50-60% / Low payload / high payload	U 45% / R 25% / MW 30%
				U 70% / R 30%
				R 30% / U 70%
				R 25% / MW 30% / U 45%
				U/R/MW - U/R/MW - U/R/MW...
				Random
	M3	5 x Work/CO2 from WHTC	50-60% / Low payload / high payload	U 45% / R 25% / MW 30%
				U 70% / R 30%
				R 30% / U 70%
				R 25% / MW 30% / U 45%
				U/R/MW - U/R/MW - U/R/MW...
				Random

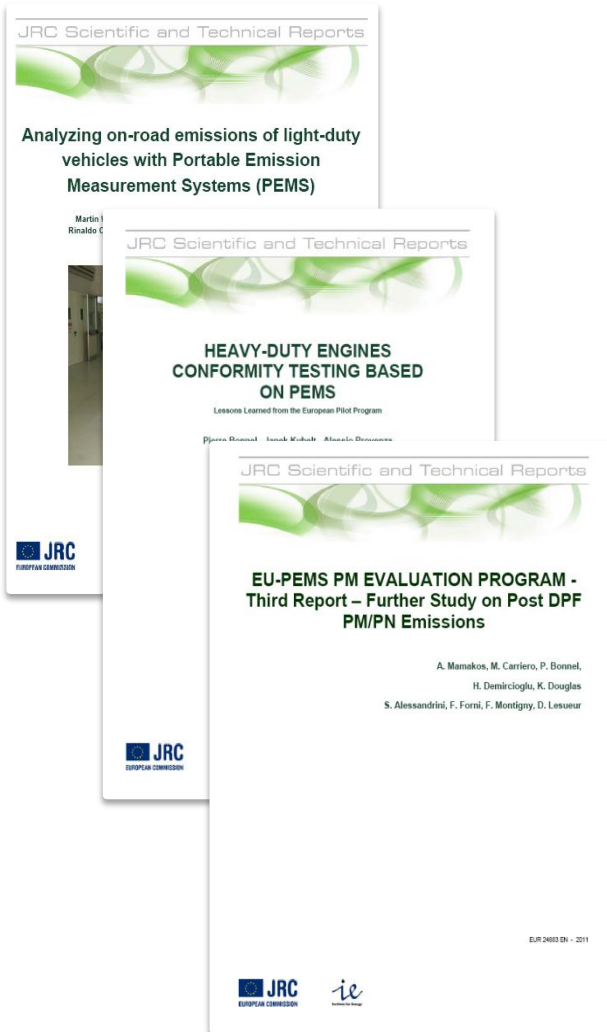
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N	N1	5 x Work/CO2 from WHTC	50-60% / Low payload / high payload	U 45% / R 25% / MW 30%
				R 25% / MW 30% / U 45%
				U/R/MW - U/R/MW - U/R/MW...
				Random
	N2	5 x Work/CO2 from WHTC	50-60% / Low payload / high payload	U 45% / R 25% / MW 30%
				R 25% / MW 30% / U 45%
				U/R/MW - U/R/MW - U/R/MW...
				Random
	N3	5 x Work/CO2 from WHTC	50-60% / Low payload / high payload	U 20% / R 25% / MW 55%
				R 25% / MW 55% / U 20%
				U/R/MW - U/R/MW - U/R/MW...
				Random



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*Thank you for your attention*



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