

# Assessment of RSD measurement performance against reference vehicles and PEMS emissions

Potential for Euro 6 in-service vehicle emissions screening

*Based on EC JRC 2017 Testing Program*

**Brussels, 28<sup>th</sup> of September 2017**

**P. Bonnel, M. Carriero, M. Clairotte, B. Giesaskiel  
European Commission - Joint Research Centre (JRC)**

## Disclaimer

- The information and views set out in this document are a property of the Joint Research Centre (JRC). They are of preliminary nature and were not fully screened and processed according to the JRC quality and publication rules. Neither the Commission nor any person acting on the Commission's behalf may be held responsible for the use which may be made of the information contained therein.
- The emissions results of the vehicles are relative to each other and do not represent a judgment on their compliance with the emissions standards.
- The tested vehicles are single and private vehicles. Their emissions behavior does not necessarily reflect the emissions behavior of the brand and model considered.

## Contents

- Background
- General Approach
- Overview of JRC RSD Test Campaign
- Results
- Preliminary Conclusions
- Next Steps

## Background

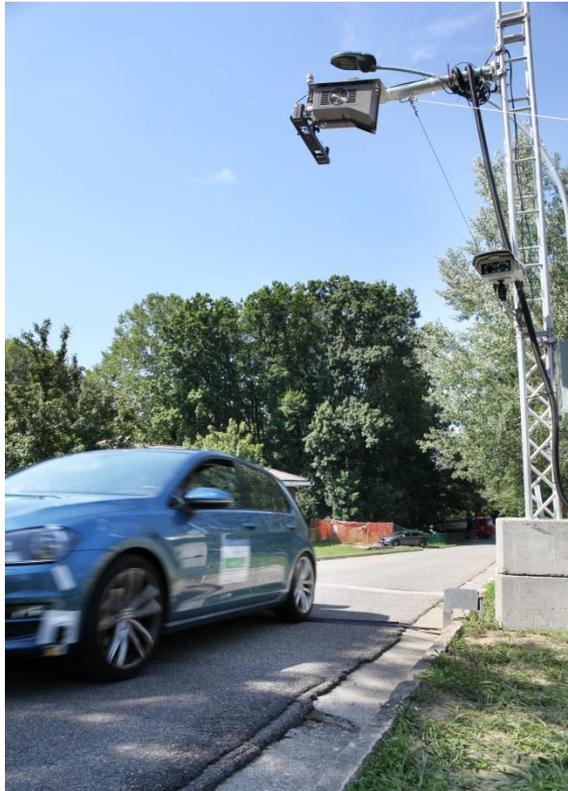
- In-Service Conformity (ISC) of road vehicles
- EU authorities responsibilities being defined in the 4th regulatory package on Real Driving Emissions (RDE)
- EC investigating the possibility to propose screening methods for vehicle/family selection (e.g. to find worst in class)
- Candidate screening methods: Remote Sensing Devices (RSD) / Simplified Emissions Measurement Systems (SEMS)

## General Approach

- Feasibility study of RSD for the European primary legislative purpose (Screening Euro 6 LDV emissions to identify worst cases or problematic vehicle families)
- Other possibilities: private vehicles issues such as tampering, evaluation of inspection and maintenance,...
- Roadmap
  - **Step1: Assessment of RSD instrumentation (JRC July 2017)**
  - Step2: Upon measurement performance assessment, proposal for minimum requirements and associated usage
  - Step3: Deployment campaigns, database and evaluation strategies

# Remote Sensing Devices (RSD) in the program

## HEAT



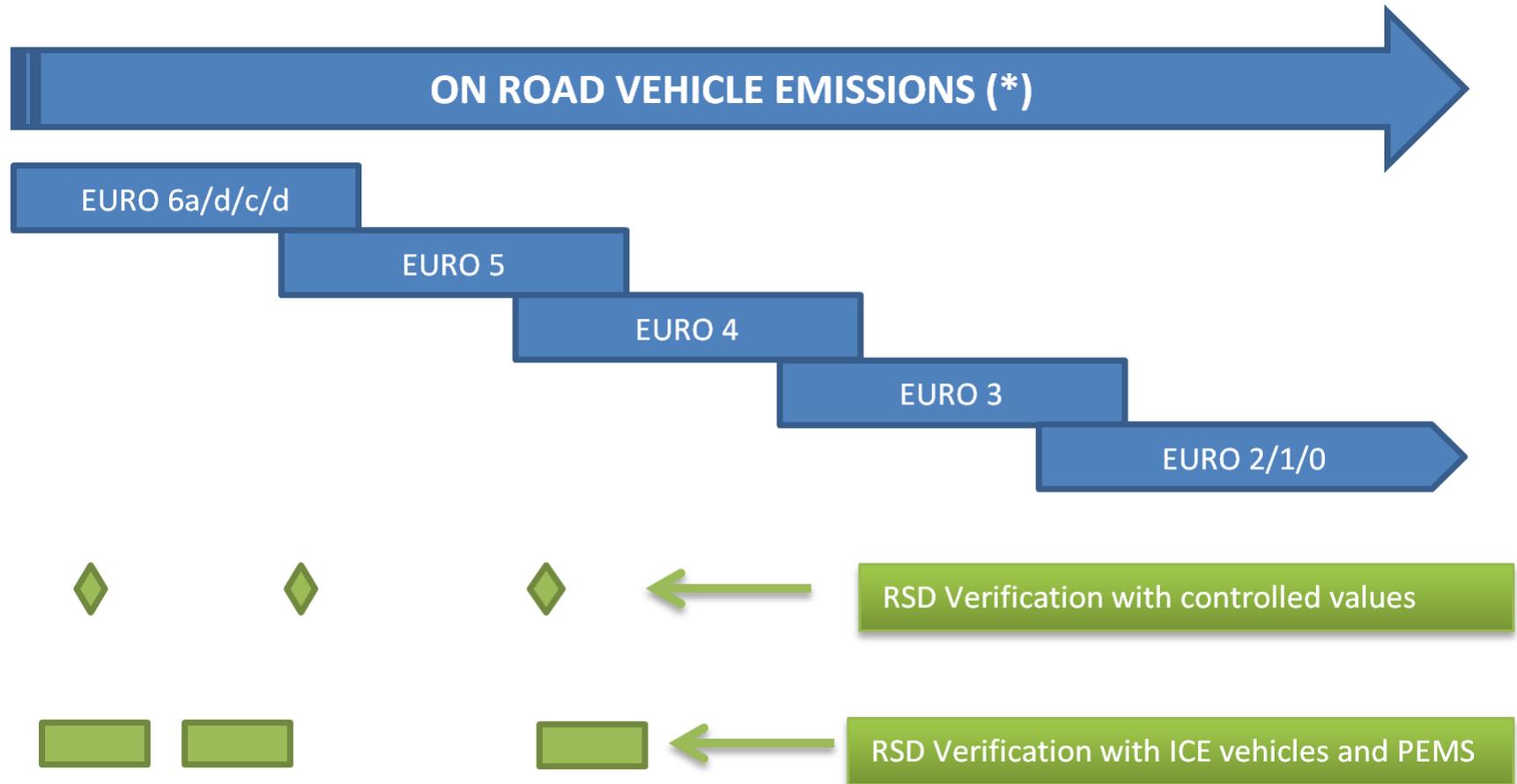
## OPUS



## Overview of JRC RSD Test Campaign

- One week in July 2017, 2 commercially available RSD systems (OPUS, HEAT) tested simultaneously
- Reference vehicles:
  - Electric vehicle with gas bottles (CO/NO/CO<sub>2</sub>) to simulate vehicle exhaust
  - Internal combustion engines vehicles equipped with PEMS
- Other vehicles covering various technologies and emissions standards passing several times through
- Total Number of vehicles: Reference (6) / Other (40)

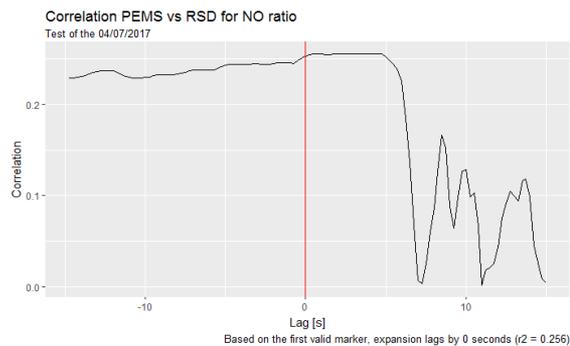
## Approach to assess the measurement performance



(\*) Ranges of emissions are pollutant and technology dependent

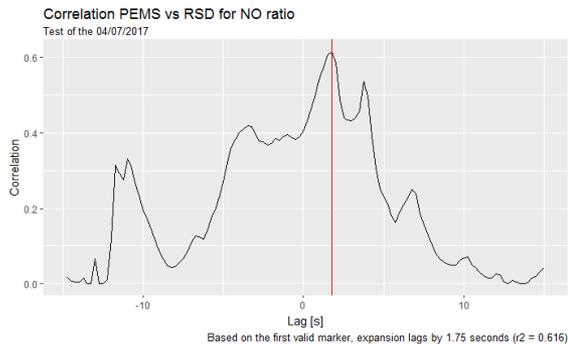
# Simulation of Emissions Values

- Electric vehicle equipped with Gas cylinders and small air compressor
- Different concentrations of NO and CO pollutants
- Gas flowing controlled by valves
- PEMS system to measure flows and concentrations
- Comparison with RSD



# Emissions from Internal Combustion Engines

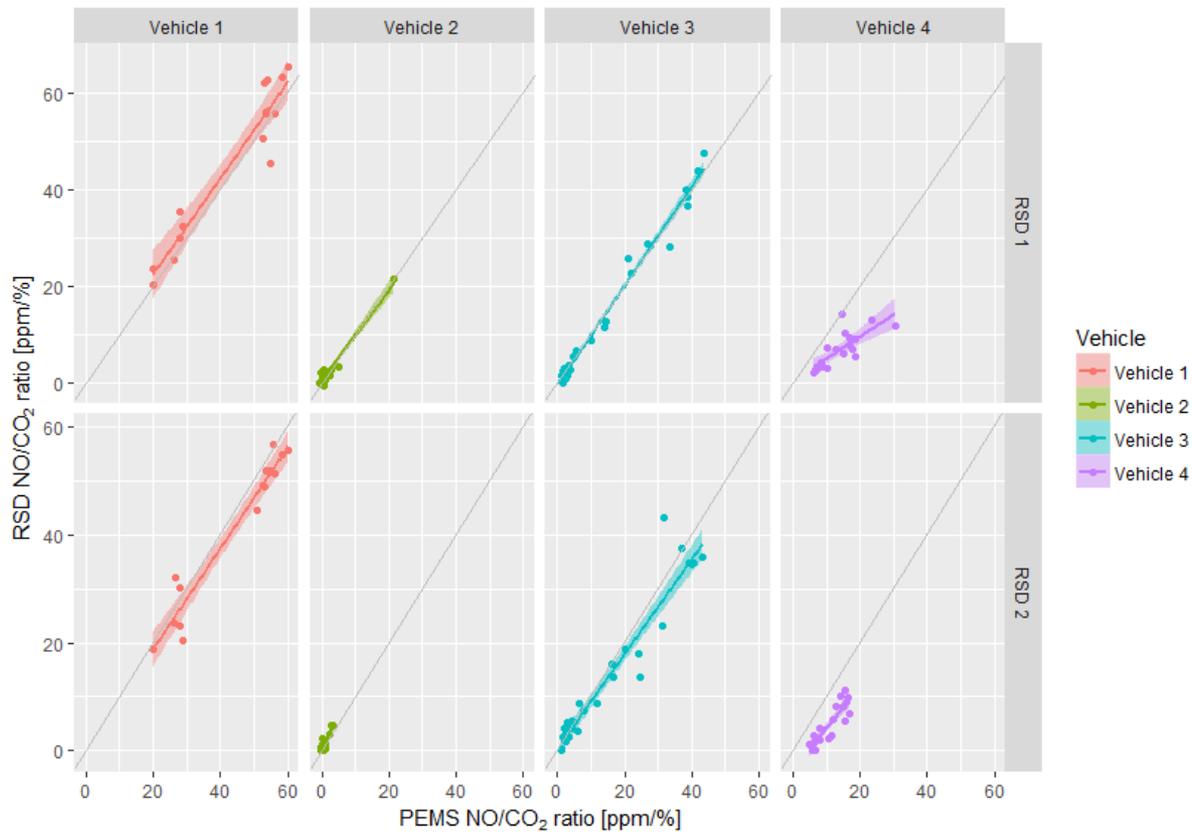
- Vehicles equipped with PEMS
- Vehicles without PEMS
- Various emissions standards (Euro 0 to Euro 6b)
- Measurement of tailpipe gaseous emissions (THC, NO+NO<sub>2</sub>=NO<sub>x</sub>, CO, CO<sub>2</sub>)
- Comparison with RSD



## Reference Vehicles Characteristics

	Engine	Euro standard	Engine capacity [cm <sup>3</sup> ]	Power [kW]
<b>Vehicle 1</b>	Electric	-	-	-
<b>Vehicle 2</b>	Gasoline	Euro4	1368	57
<b>Vehicle 3</b>	Diesel	Euro6b	1968	110
<b>Vehicle 4</b>	Diesel	Euro6b	2967	184

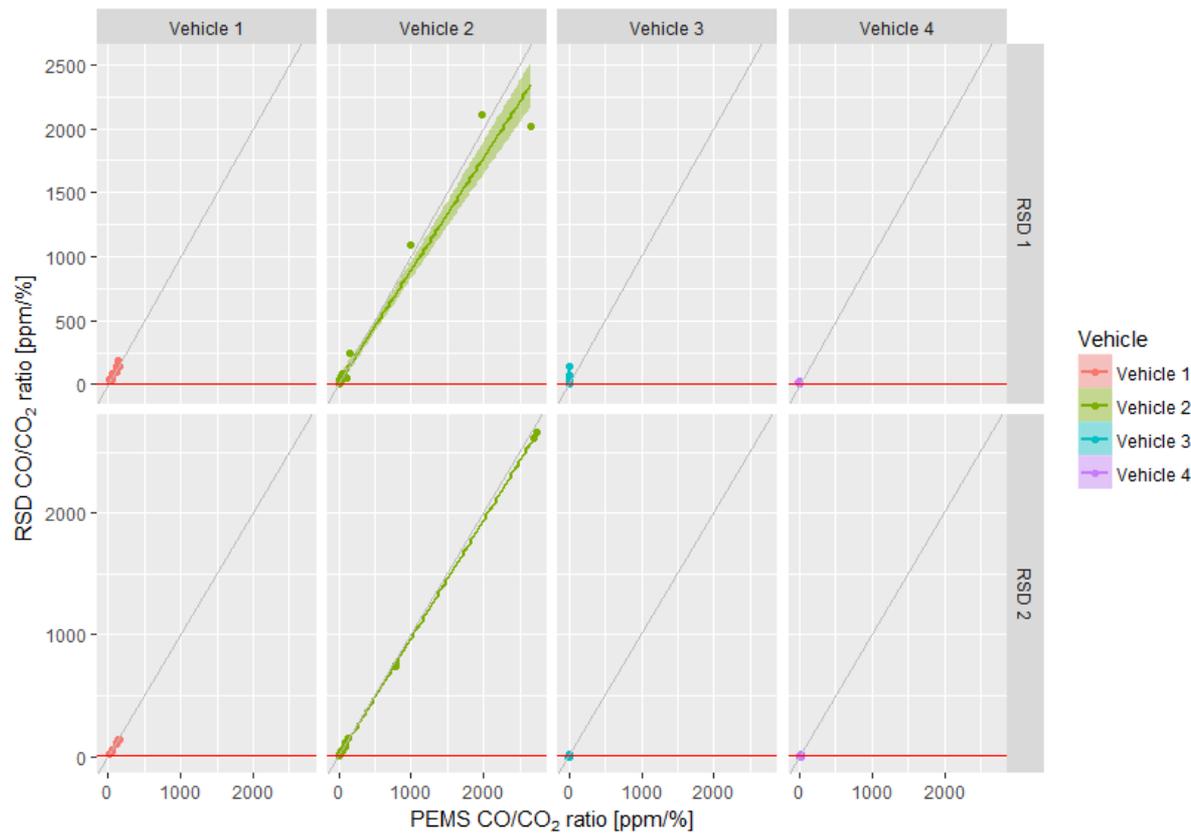
## Results - NO/CO<sub>2</sub> ratio



PRELIMINARY ANALYSIS  
TO BE CONFIRMED  
IN FINAL REPORT

STRAIGHT GREY LINE: 1:1

## Results - CO/CO<sub>2</sub> ratio



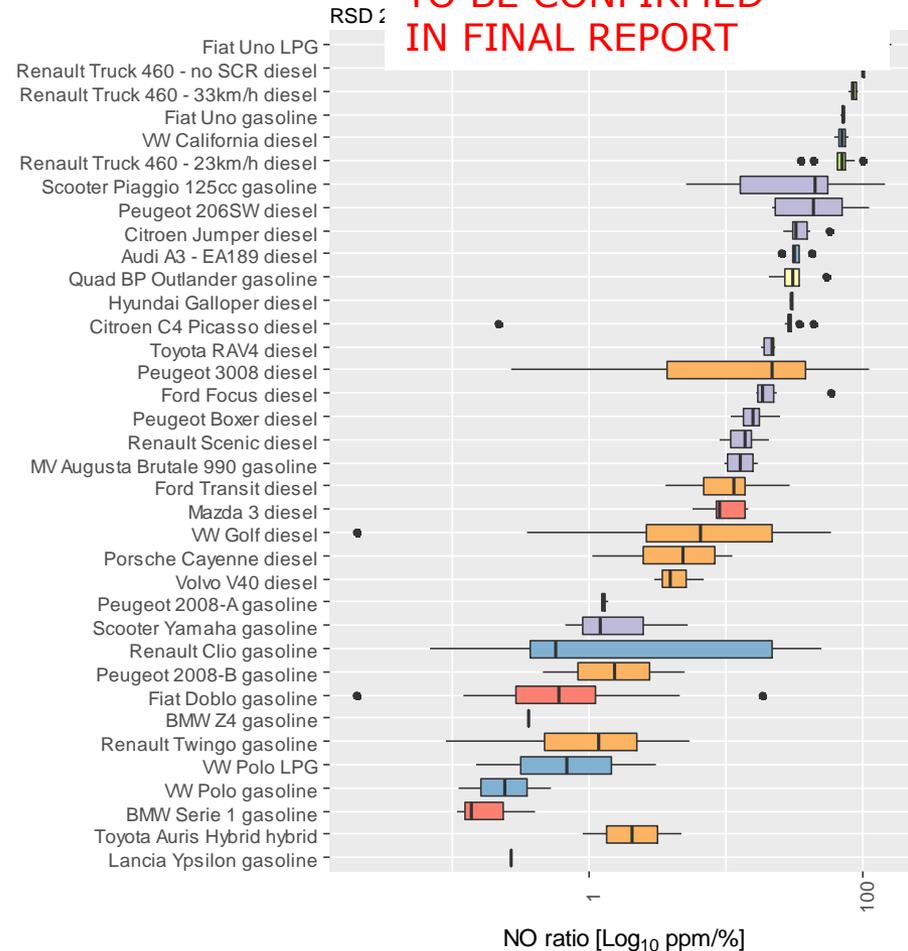
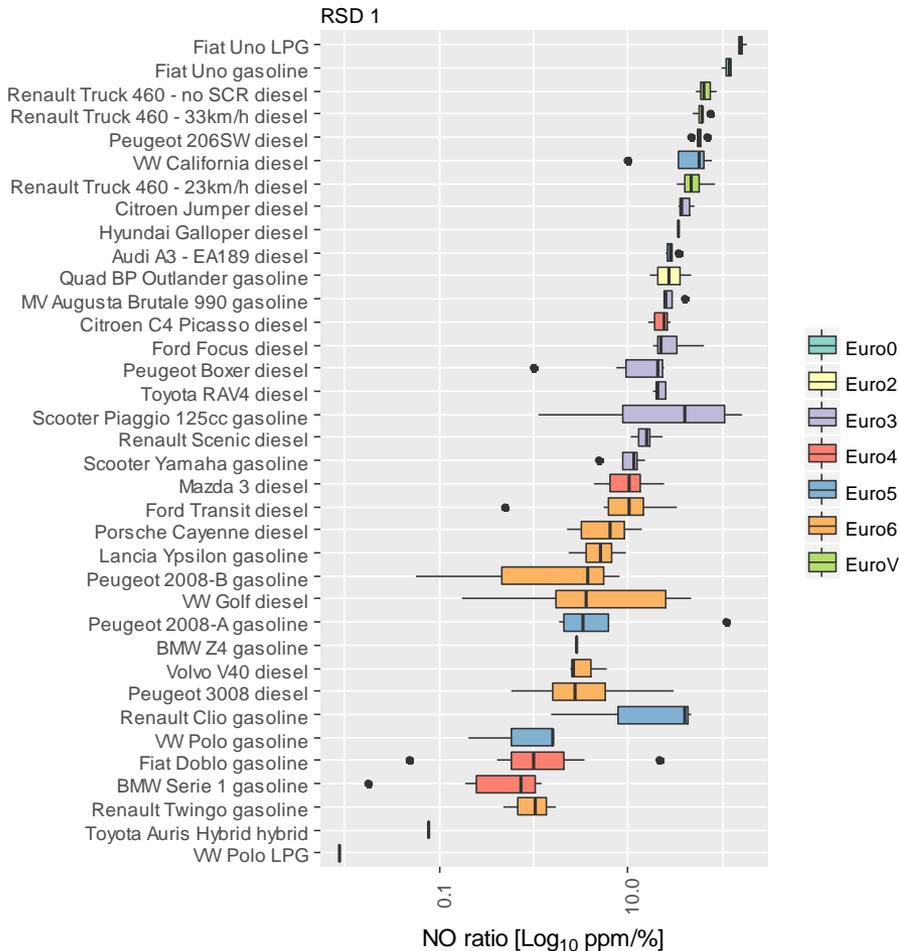
**PRELIMINARY ANALYSIS  
TO BE CONFIRMED  
IN FINAL REPORT**

STRAIGHT GREY LINE: 1:1

RED HORIZONTAL LINE = BACKGROUND

# Results – All vehicles - NO/CO<sub>2</sub> ratio

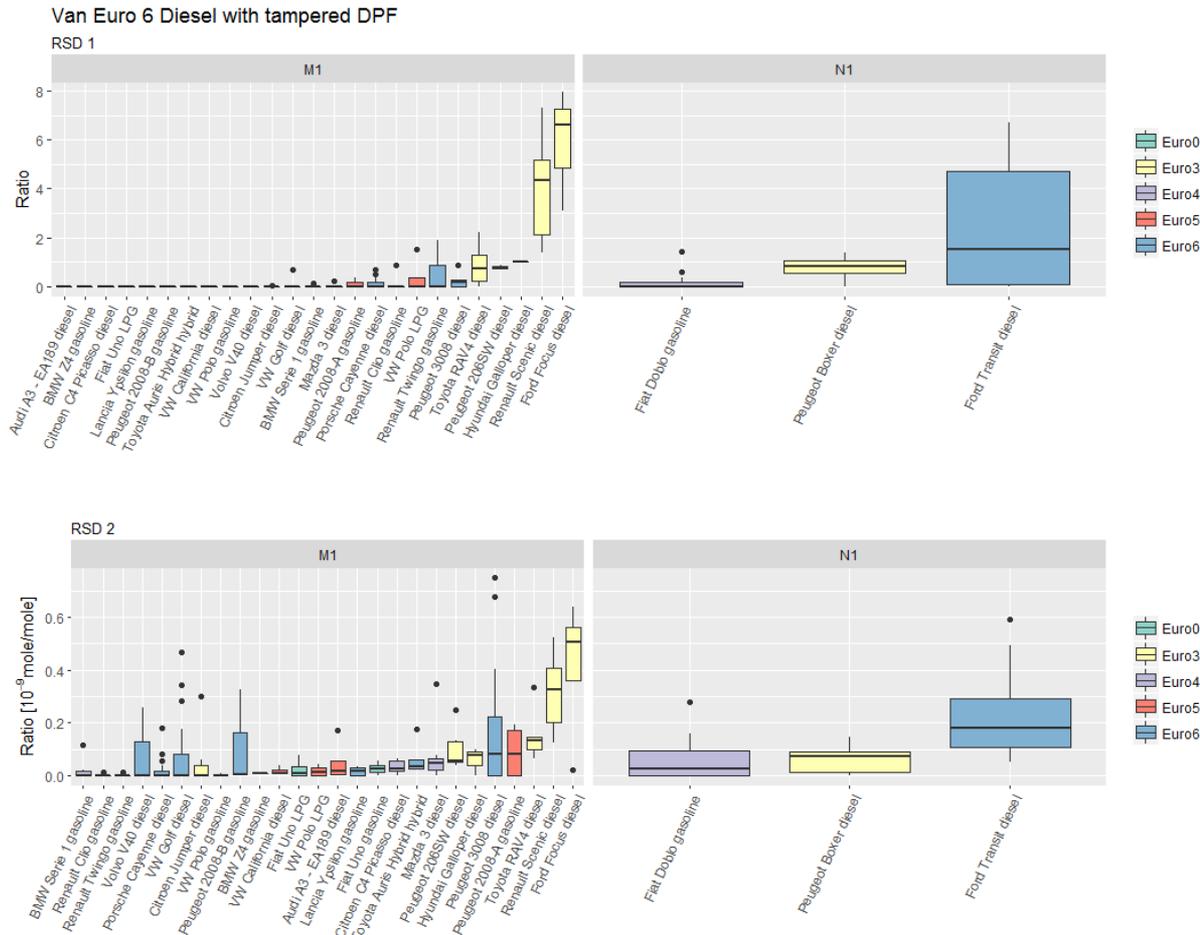
PRELIMINARY ANALYSIS  
TO BE CONFIRMED  
IN FINAL REPORT



The emissions results of the vehicles are relative to each other and do not represent a judgment on their compliance with the emissions standards.

The tested vehicles are single and private vehicles. Their emissions behavior does not necessarily reflect the emissions behavior of the brand and model considered.

# Results – Euro 6 Diesel with tampered DPF



## PRELIMINARY ANALYSIS TO BE CONFIRMED IN FINAL REPORT

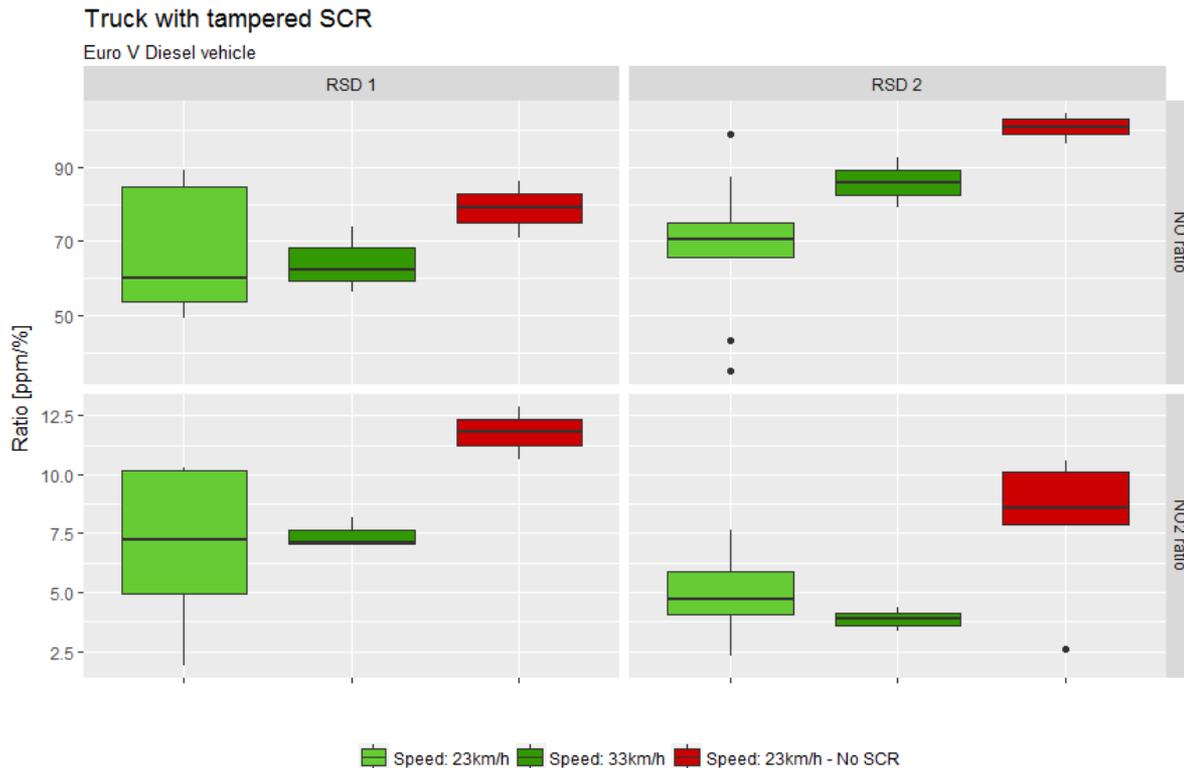
The emissions results of the vehicles are relative to each other and do not represent a judgment on their compliance with the emissions standards.

The tested vehicles are single and private vehicles. Their emissions behavior does not necessarily reflect the emissions behavior of the brand and model considered.

Some vehicles were tampered for the need of the project only.



# Results – Euro VI Diesel Truck with tampered SCR



## PRELIMINARY ANALYSIS TO BE CONFIRMED IN FINAL REPORT

The emissions results of the vehicles are relative to each other and do not represent a judgment on their compliance with the emissions standards.

The tested vehicles are single and private vehicles. Their emissions behavior does not necessarily reflect the emissions behavior of the brand and model considered.

Some vehicles were tampered for the need of the project only.



## Preliminary Conclusions (1)

- RSD Instrumentation measurement performance verified under real-world conditions: both OPUS/HEAT systems exhibited excellent correlation with the references for CO and NO, within wide ranges
- Ability of the RSD to discriminate Euro 0 to Euro 6 emissions standards within a given vehicle technology (diesel, gasoline, LPG, with and without DPF)
- Ability of the RSD instrumentation to check the tailpipe emissions of tampered or poorly performing vehicles (e.g. due to ageing effects), relative to the functioning ones

## Preliminary Conclusions (2)

- RSD does not provide absolute values and is only **complementary** to detailed RDE/PEMS testing
- RSD appropriate to assess emissions performance of vehicles/vehicle families **relative** to other vehicles/families or functioning vehicles

## Next Steps

- Final review of the collected data with Opus and Heat
- Potential for other pollutants: THC, PM will be further assessed from the data
- Publication of JRC report including complete results and preliminary recommendations
- Open question regarding RSD instrumentation sensitivity:
  - Within the vehicles compliant with the RDE regulation, will RSD be able to discriminate good and bad Euro 6 c/d vehicles?



JRC TECHNICAL REPORTS

Assessment of RSD measurement performance against reference vehicles and PEMS emissions -

*Potential for Euro 6 in-service vehicle emissions screening*

Authors