



## Emissions and noise monitoring: a focus on pilot projects

RP1 consortium meeting

M1-M18



This project has received funding from the European Union's Horizon 2020 research and innovation programme under the Grant Agreement n° 860441.

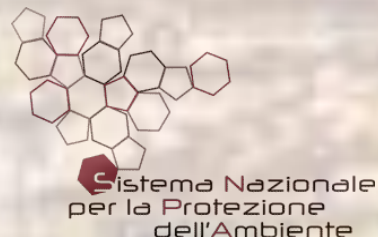
Firenze 7 ottobre 2022

## PROJECT LIFE E-VIA

**Electric mobility and low-noise asphalts:  
the results of the LIFE E-VIA project and contributions  
from other projects**

**Networking per la riduzione del rumore e delle emissioni:  
i progetti pilota**

***Gaetano Licitra - ARPAT***



# NEMO:

## Noise and Emissions Monitoring and Radical Mitigation

NEMO will create and test a **completely new remote sensing technology** that can measure **noise and emissions** from individual road vehicles and trains in real time, along with the multispectral camera technology to measure emissions from cruise ships. The system will make possible a limited access or charging system based on actual environmental impacts.

The new technologies will be tested and validated in several European cities, as a tool to control noise and air quality and reduce damage to people and the environment.

# NEMO: Noise and Emissions Monitoring and Radical Mitigation

[www.nemo-cities.eu](http://www.nemo-cities.eu)

May 2020 – April 2023

Project funding:  
€ 6 564 892,50

18 partners  
11 countries

7 demo sites

## Vehicle Sensing

- Exhaust emissions
- Noise



## Integration

- Physical: road infrastructure
- Virtual: IT platform, V2I-I2V, sensors synchronization

## Mitigation

- New **asphalts** & multifunctional **barrier** to reduce/absorb noise & emissions

# NEMO's main objectives

- To develop a new, ready-to-use technology to measure environmental impacts, such as air and noise pollution of road and rail traffic
- To integrate the new technologies into existing infrastructures to offer a complete turn-key monitoring solution
- To create an *IT service* where collected data from the system is connected and analyzed to inform vehicle operators and road or rail authorities about pollution levels and potential restrictions or charges.

# NEMO's main objectives

- To develop mitigation solutions such as **green noise barriers** and road surface designs to reduce vehicle noise emission and prevent most **microplastics** from tires' wear and tear to reach the marine environment
- To validate the new noise and emission remote sensing technology and the mitigation solutions in several European locations, as a tool to control the acoustic and air quality and reduce the damage on people and environment.
- To develop standardized measurement methodologies to ensure reliability of collected data and harmony with existing methods for vehicle inspections

# Partners

#	Organisation name	Country
1	Fundación CARTIF ( <b>coordinator</b> )	ES
2	M+P Raadgevende Ingenieurs Bv	NL
3	Muller-BBM GmbH	DE
4	Muller-BBM Rail Technologies GmbH	DE
5	Agenzia Regionale per la Protezione Ambientale Della Toscana	IT
6	Sintef AS	NO
7	Gate 21	DK
8	Université Gustave Eiffel	FR
9	Universidad de Cantabria	ES
10	Opus RS Europe S.L.	ES
11	Comune di Firenze	IT
12	European Federation for Transport and Environment	BE
13	Ricardo AEA Ltd.	UK
14	Opus Technology Solutions AB	SE
15	Kapsch TrafficCom AG	AT
16	Fundación Valenciaport	ES
17	Joint Research Centre (European Commission)	BE
18	Audiotec Ingeniería Acústica S.A.	ES





# Partners

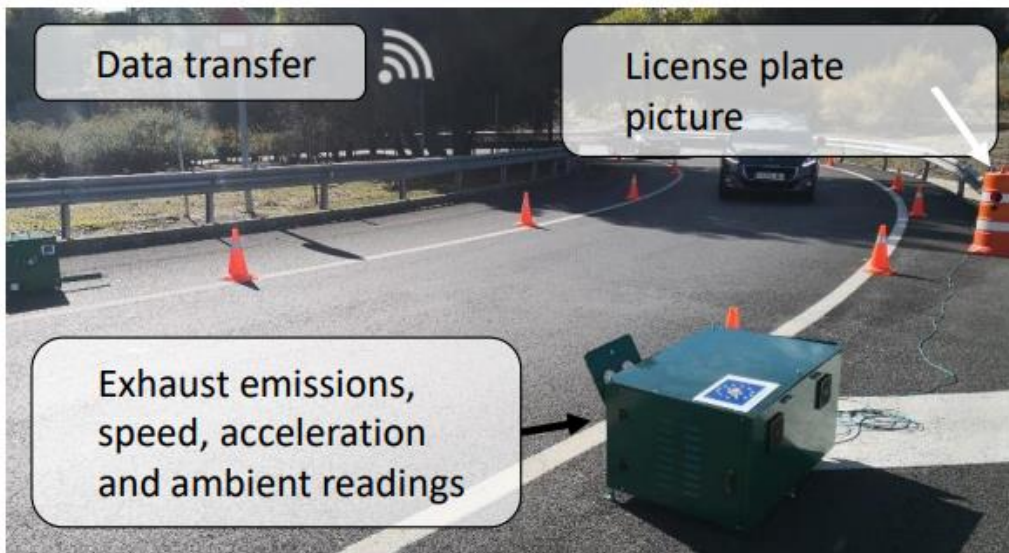
Project coordinator: **CARTIF**



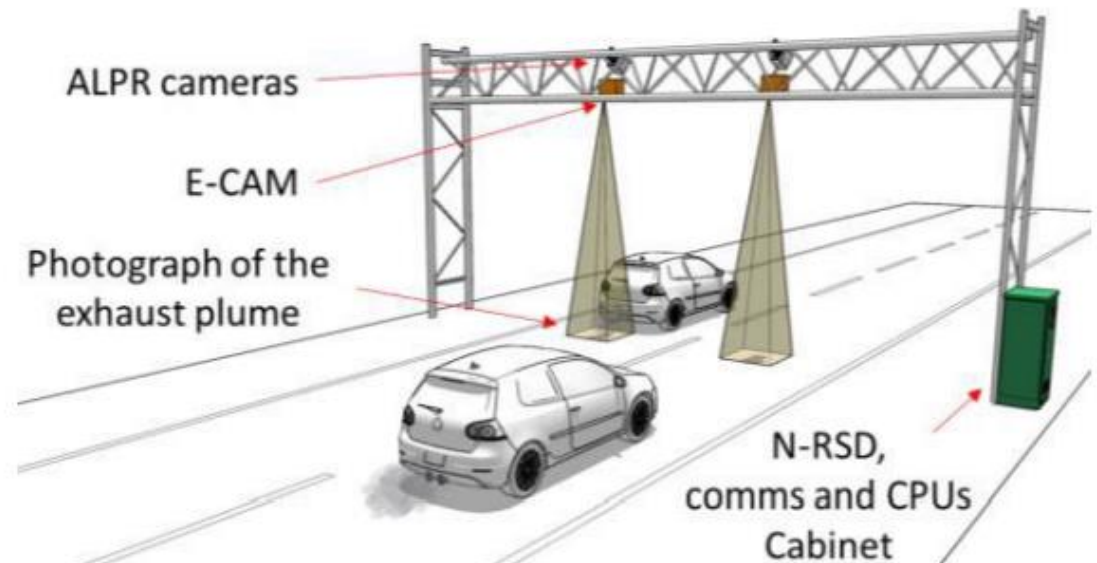
# Aims:

- Integrating measurements systems (air and noise) in the transportation infrastructures
- Implementation of scalable mitigation solutions reducing noise impact and improving air quality in cities
- Development of systems for the enforcement against high-emitters in LEZ or other sensitive areas

## E-RSD

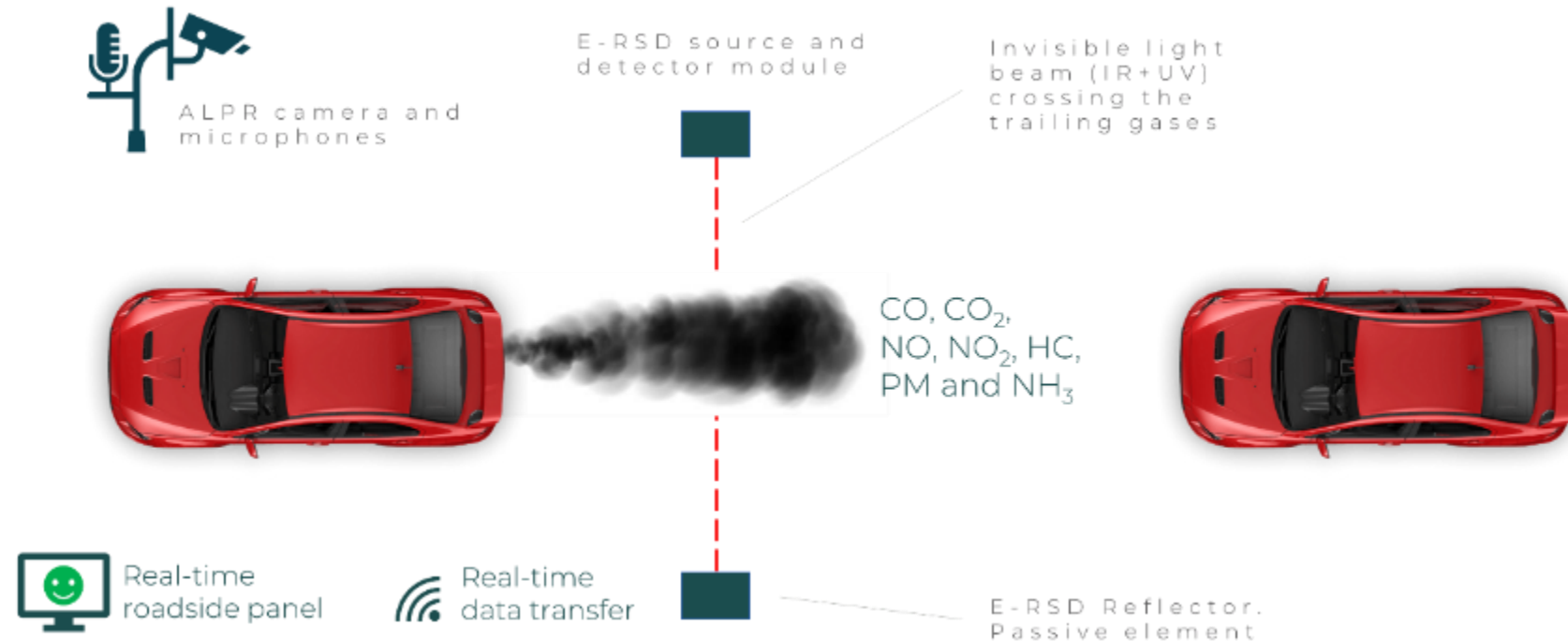


## N-RSD





# Remote sensing technology



From OPUS RSE presentation at ACUSTICAT 2022 (<https://www.opusrse.com/>)

**Pilot projects (ARPAT WP leader)**

**Work Done**

# Pilot projects:



# Pilot projects

## General information:

### General objective:

Validate the new Noise and Emission RS technology and the mitigation solutions in several European locations, as a tool to control the acoustic and air quality and reduce their damage on people and environment. Test feasibility for rail vehicles and for shipping.

### Specific objectives:

- Reallife pilots in 3 cities (Florence, Madrid and Valencia) and in 1 railway line (Susteren) to demonstrate NEMO solutions and the implementation of a standardized methodology. The pilots will be carried out together with local administrations and related stakeholders, to guarantee the smooth execution of each activity, to put in motion the required mobility policies and to monitor the impact and results of the pilots.

**Partners involved:** CART, M+P, MLL, MRAIL, TOSC, SINT, G21, IFT, UC, ORSE, IND, FIRE, T&E, RIC, OTS, KTC, VPF, JRC, AUD

[illegible]



# Real-life environments

## Florence

- The demo in **Florence** will be focused on urban road traffic.
- ARPAT and the municipality of Florence (FIRE) will lead this demo.
- Their direct involvement will facilitate the entire execution of the demo, granting permits, providing technical data of the identified vehicles and sending notifications to the drivers.
- This demo is focused on the implementation of HE identification programs in combination with existing LEZs in Europe.
- One mixture of NEMO's urban porous asphalt will be tested in a road city as well.

# Real-life environments

## Madrid

The demo in **Madrid** will be focused on urban and peri-urban road traffic. An integration of the  $\beta$  Prototype in a gantry of the major motorway that surrounds the city (M-30) will test a fixed monitoring scenario.

This demo will be complemented with the LEZ “Madrid Central”, which will be improved with Remote Sensing.

In addition to the above, the mitigation potential of the multifunctional barrier in real conditions will also be assessed in a real road

# Real-life environments

## Valencia, Spain

The demo in **Valencia** will be focused on railway traffic emissions and sea traffic noise and emissions.

The port of Valencia is the main port in the Mediterranean in container traffic and the fifth in Europe<sup>26</sup>. In 2018, 6,048 ships arrived at the Port. All the trains that arrive at the port (+3,600 per year) are diesel and will remain diesel for at least the next decades.

The E-RSD will be a system that can be integrated into the railway environment. The E-RSD cross-rail configuration will be mounted with the laser crossing the track at a height of approximately 5 meters to measure gaseous emission by diesel traction.

The E-CAM will be deployed on the port ground to measure the emissions from large ship cruises. The lessons learned in this experiment will be transferred to other transport modes.

# Real-life environments

## The Netherlands

The demo in the **Netherlands** will be focused on railway traffic noise.

The N-RSD will focus on detecting noisy wagons in a train. Freight trains are composed of a series of wagons and some of these may be significantly noisier than average.

NEMO's solution will establish noise emissions from individual wagons in a train and thereby be able to identify the high emitters. **Photocells and force sensors** in the rail will determine the speed of the passing train and the position of each wagon.

The identification of the vehicle in terms of UIC registration shall be done either by the code readable through RFID or by optical reading of the displayed code at the side of the passing wagon. The system will operate on both tracks with opposing directions

# Noise monitoring



## Classification of noisy vehicles from unsupervised measurements

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The Netherlands

Rotterdam

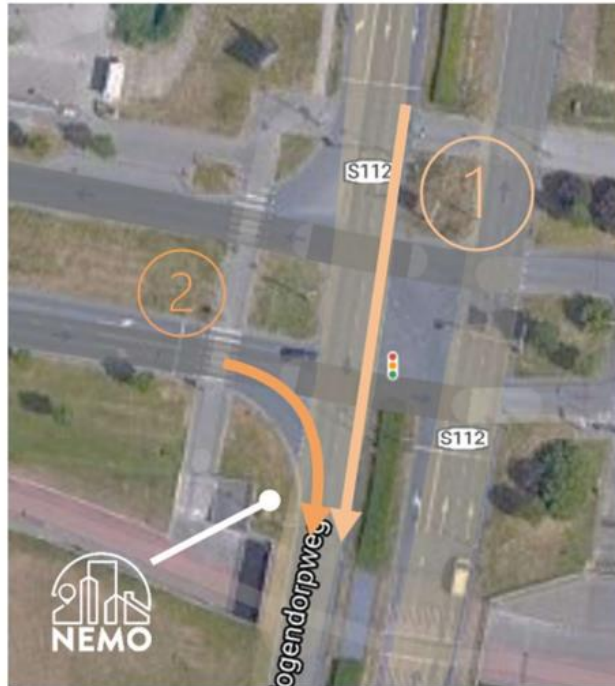
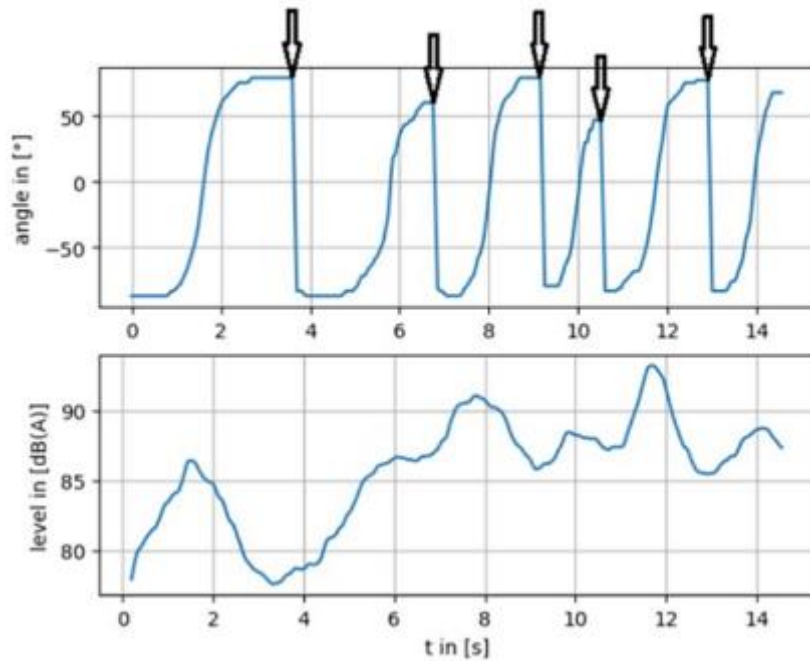


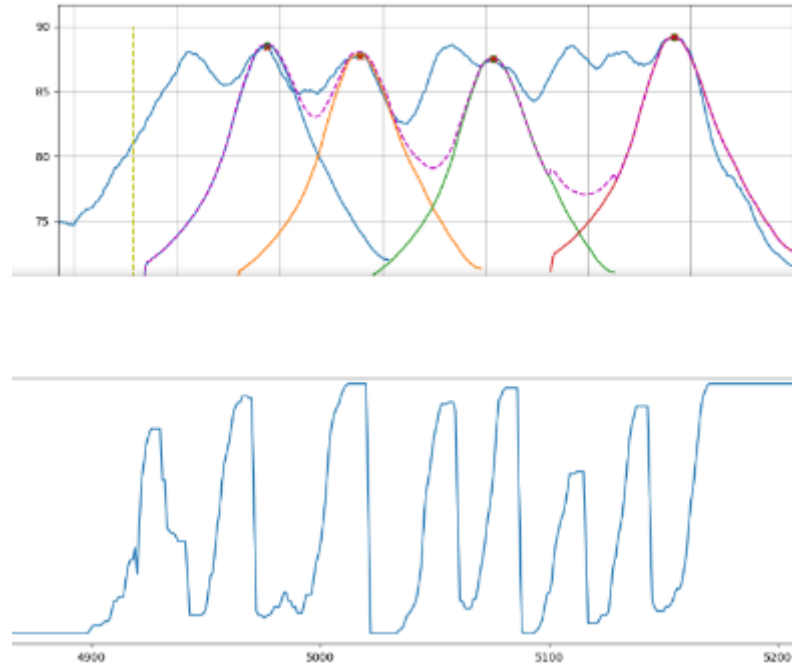
Figure 1: The NEMO noise-RSD measurement setup in Rotterdam, October 2021



# Noise monitoring

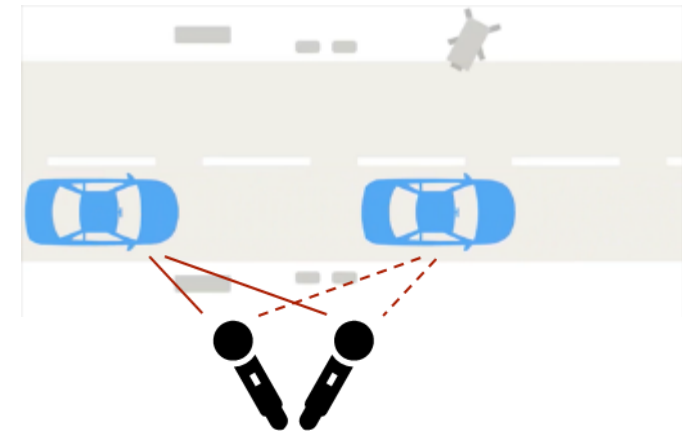


Vehicle separation



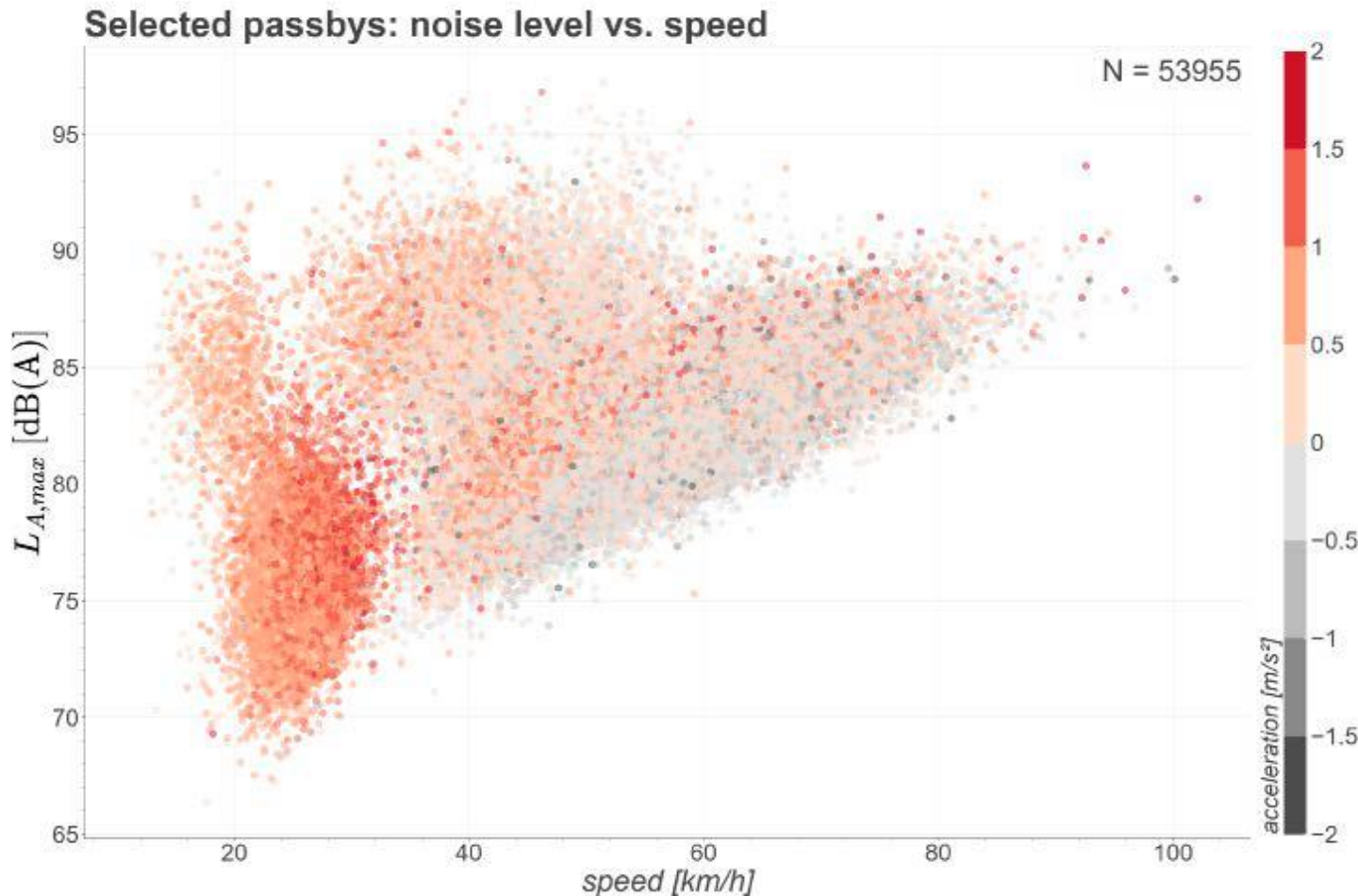
Peak level correction

- ✓ Source localization
- ✓ Distance measurement



# Noise monitoring

## Rotterdam



Noisy vehicle  $\neq$  Noise driving

High emitter = vehicle making (much) more noise than “expected”?

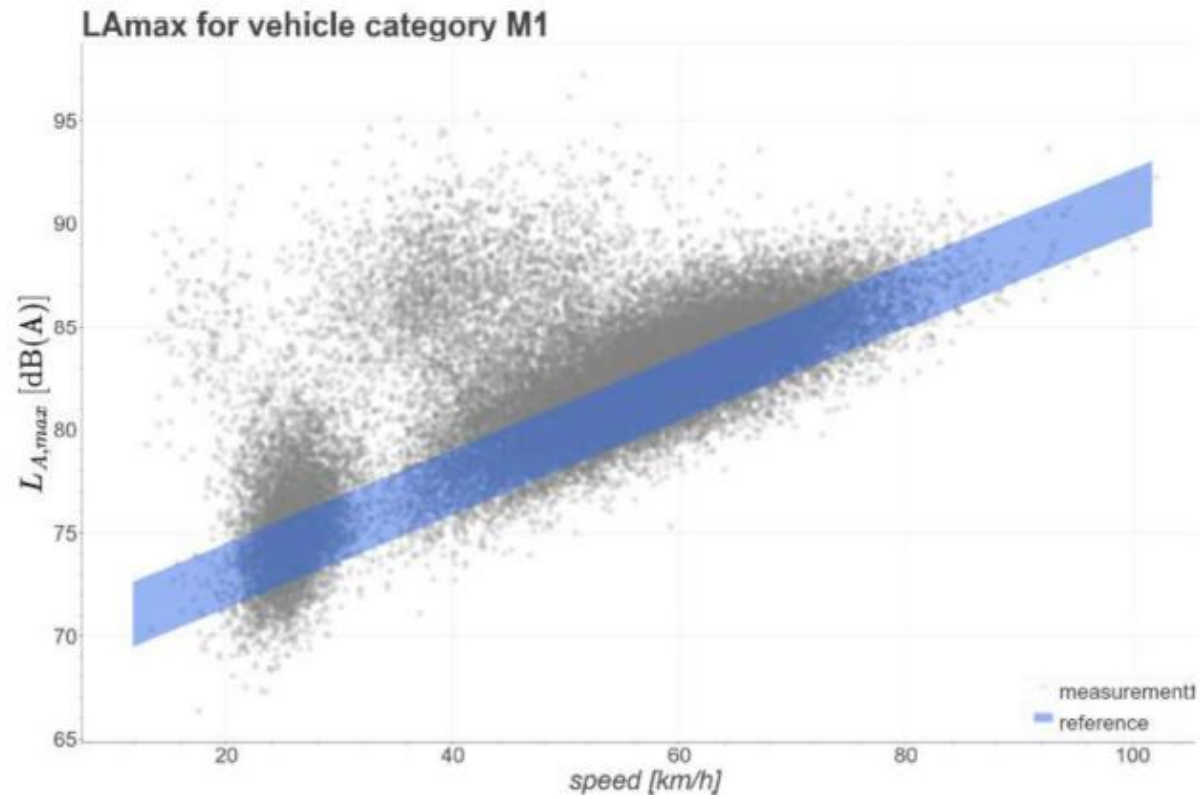
- To determine a ‘normal’ level  $L_{Amax,ref}$  per vehicle category
- High emitter if  $L_{Amax,ref} \ll L_{Amax,meas}$

Consider **driving style**:

- fast acceleration is not forbidden
- noisy drivers or noisy vehicles require different measures
- to enable relation with type approval

# Noise monitoring

## Rotterdam

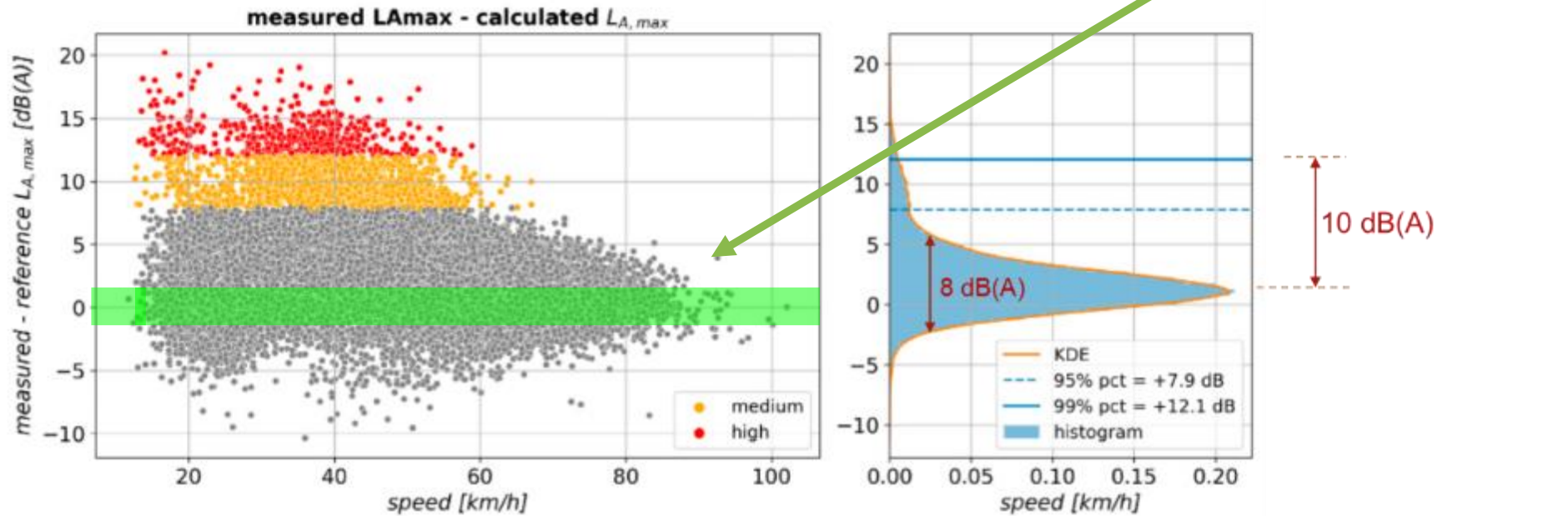


$$L_{Amax,ref}(v, a) = c_0 + c_v \cdot v + c_a \cdot a$$

The coefficients  $c_0$ ,  $c_v$  and  $c_a$  are different for each vehicle category (M1, N1...)

# Noise monitoring

## Rotterdam

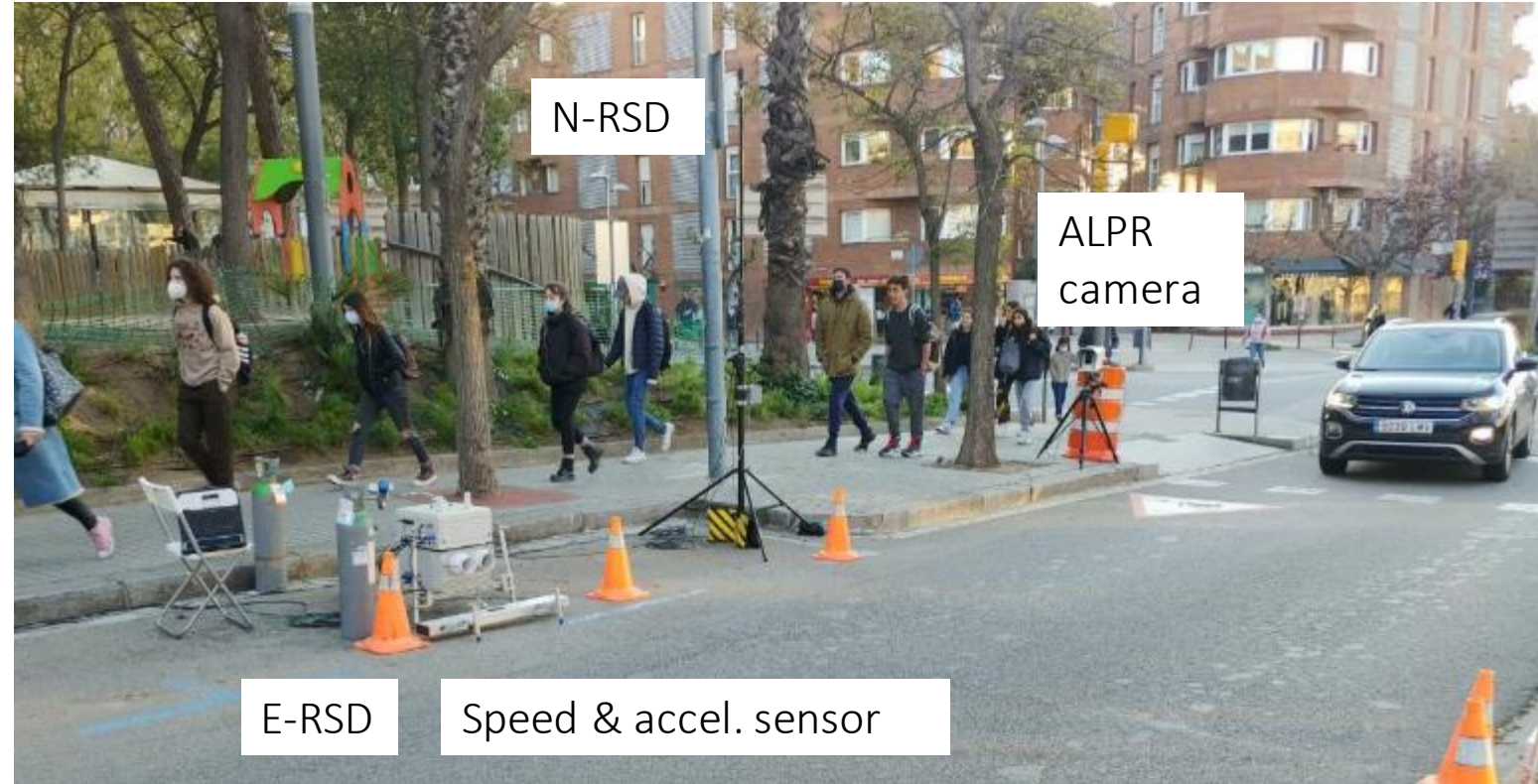


- Some vehicles are **15 to 20 dB(A)** louder than similar vehicles under similar conditions (speed, acceleration)
- Highest 1% is **10 dB** louder than the majority → these are all passenger cars!



# Noise monitoring

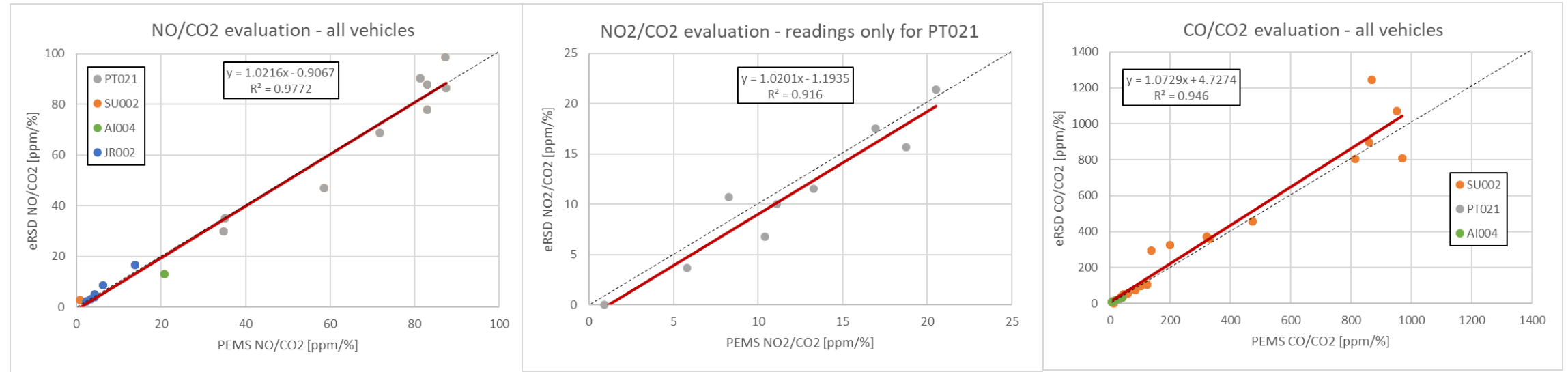
## Barcelona





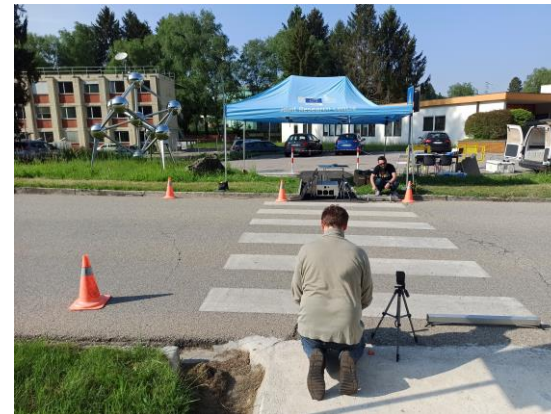
# Emissions measurements: main achievements so far

## Emissions remote sensing



- Evaluated by JRC vehicle emissions laboratory at Ispra.
- Excellent correlation between PEMS-equipped vehicles and the sensor.

From OPUS RSE (<https://www.opusrse.com/>)



# Florence

Urban road traffic: The demo project will test a dynamic **remote sensing system** in an urban environment. It will deploy a crossroad configuration of the remote sensing devices.

**Initial characterization:** The dynamic, portable system has been deployed in different locations of the city in order to demonstrate the flexibility and ease of use of the system and to initially characterize the emissions and noise of the fleet of vehicles circulating in Florence. Meanwhile, ambient air quality has been monitored with general air quality sensors.

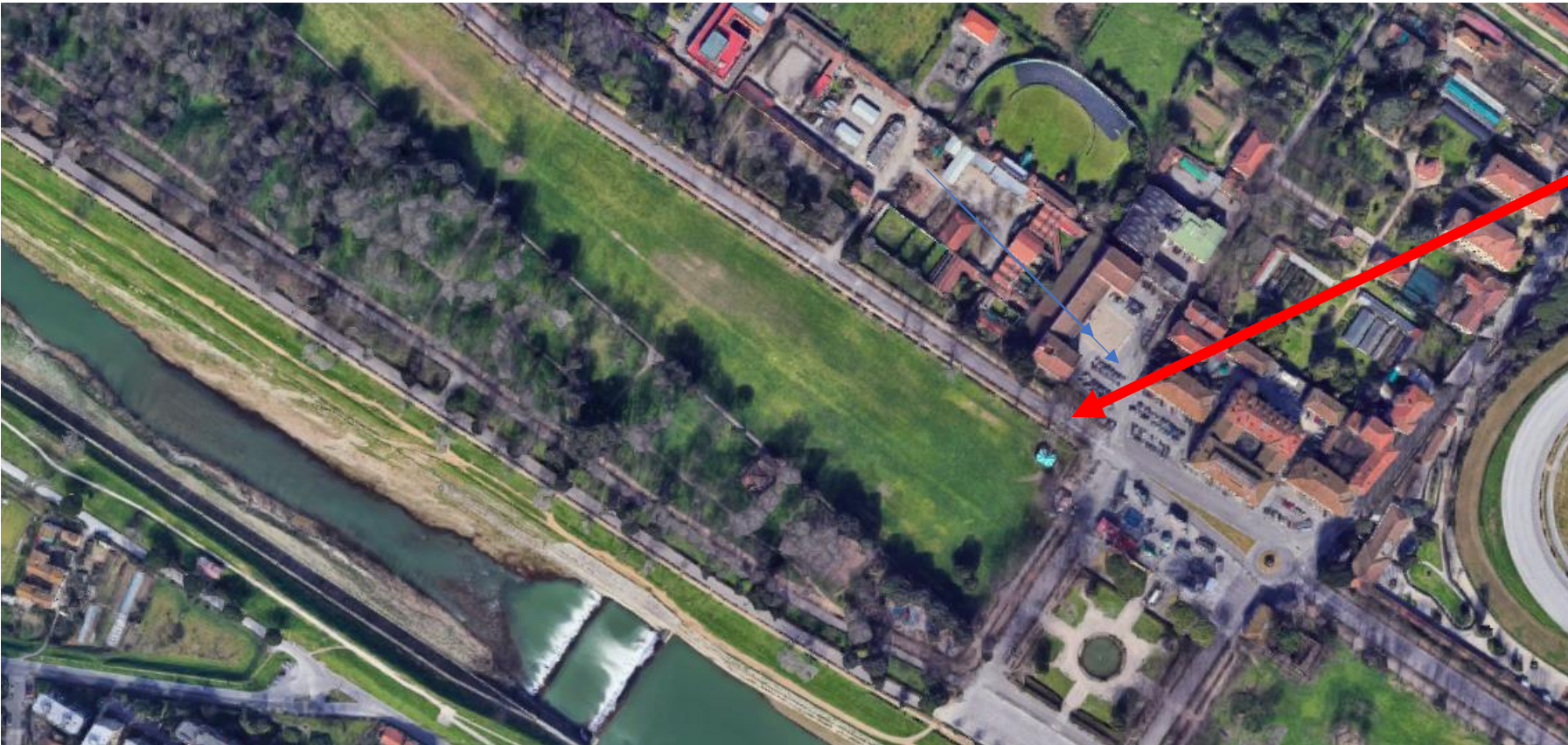
**Pavement validation:** A pavement test section will be implemented by the municipality of Florence in a city street. The porous asphalt mix will be tested, and real-life performance will be evaluated.

# Demo in Florence

Work Done:

"Parco delle Cascine"

Florence





# Demo in Florence

Work Done:

"Parco delle Cascine"

Florence





# Demo in Florence

**Work Done:** E-RDS: more than 2 weeks  
N-RSD: from 14/06 to 21/06

Laying of new pavement in September  
Air quality measurements in August

**Added value:** experience exchange between ARPAT and Polish Ministry of the Environment in a TAIEX event in Florence





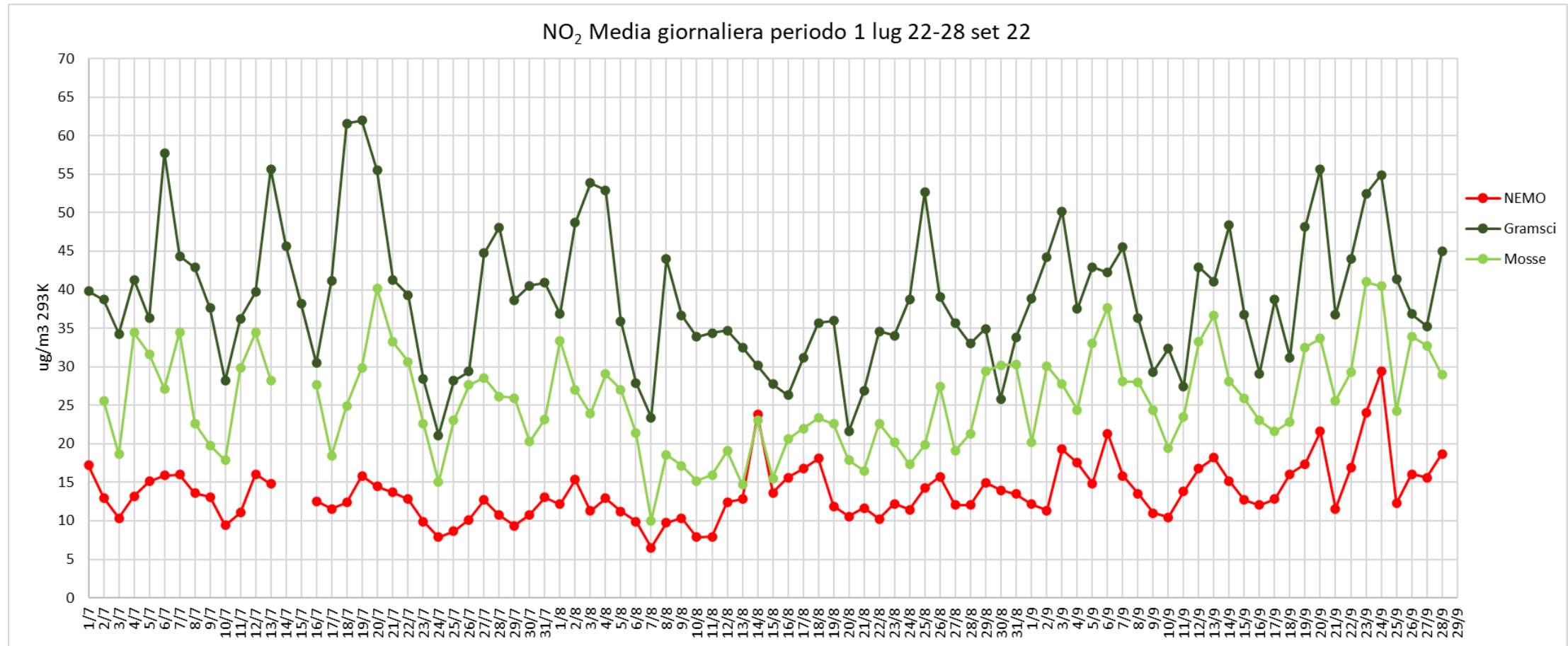
# Demo in Florence

**Work Done:** E-RSD and air quality measurements with ARPAT mobile laboratory according to the Italian legislation

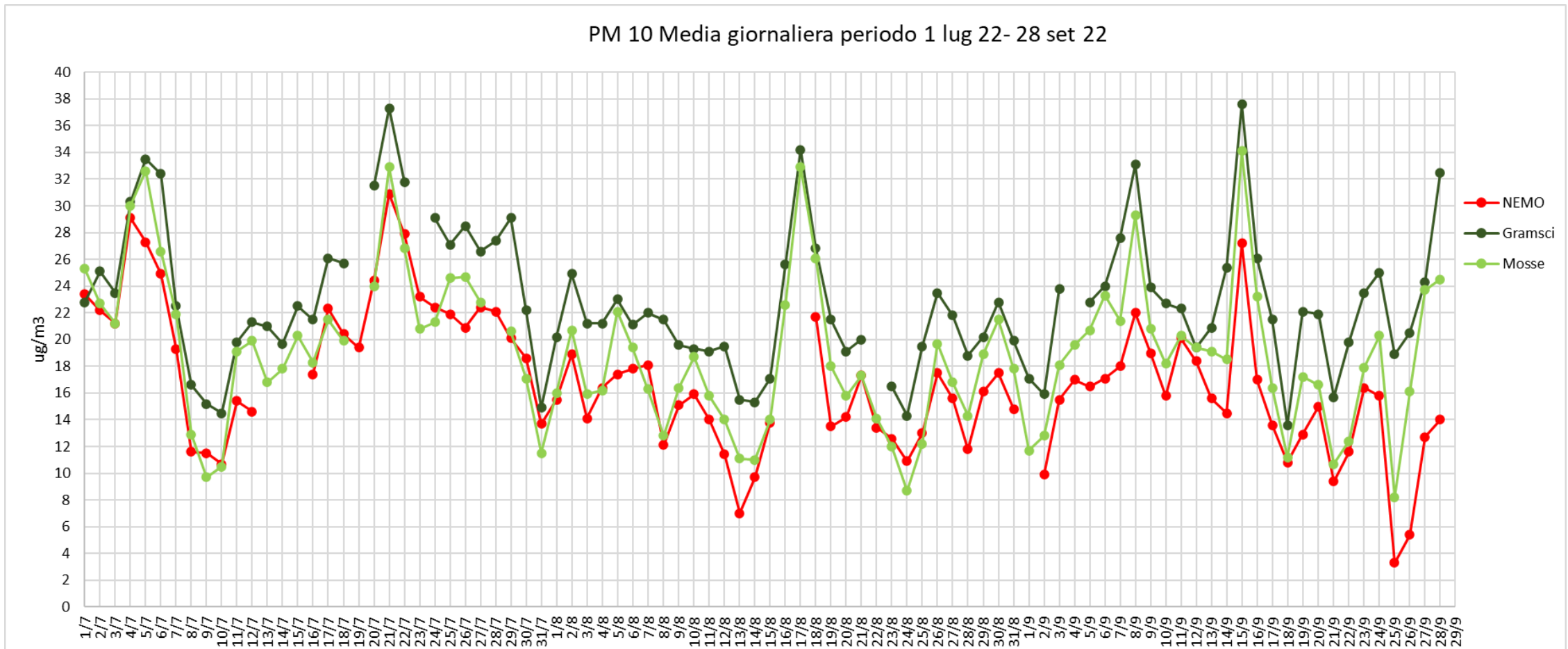
**Added value:** NO-NO<sub>x</sub>-NO<sub>2</sub> (UNI EN 14211:2012), PM<sub>10</sub> (UNI EN 12341:2014), SO<sub>2</sub> (UNI EN 14212:2012), CO (UNI EN 14626:2012), O<sub>3</sub> (UNI EN 14625:2012)



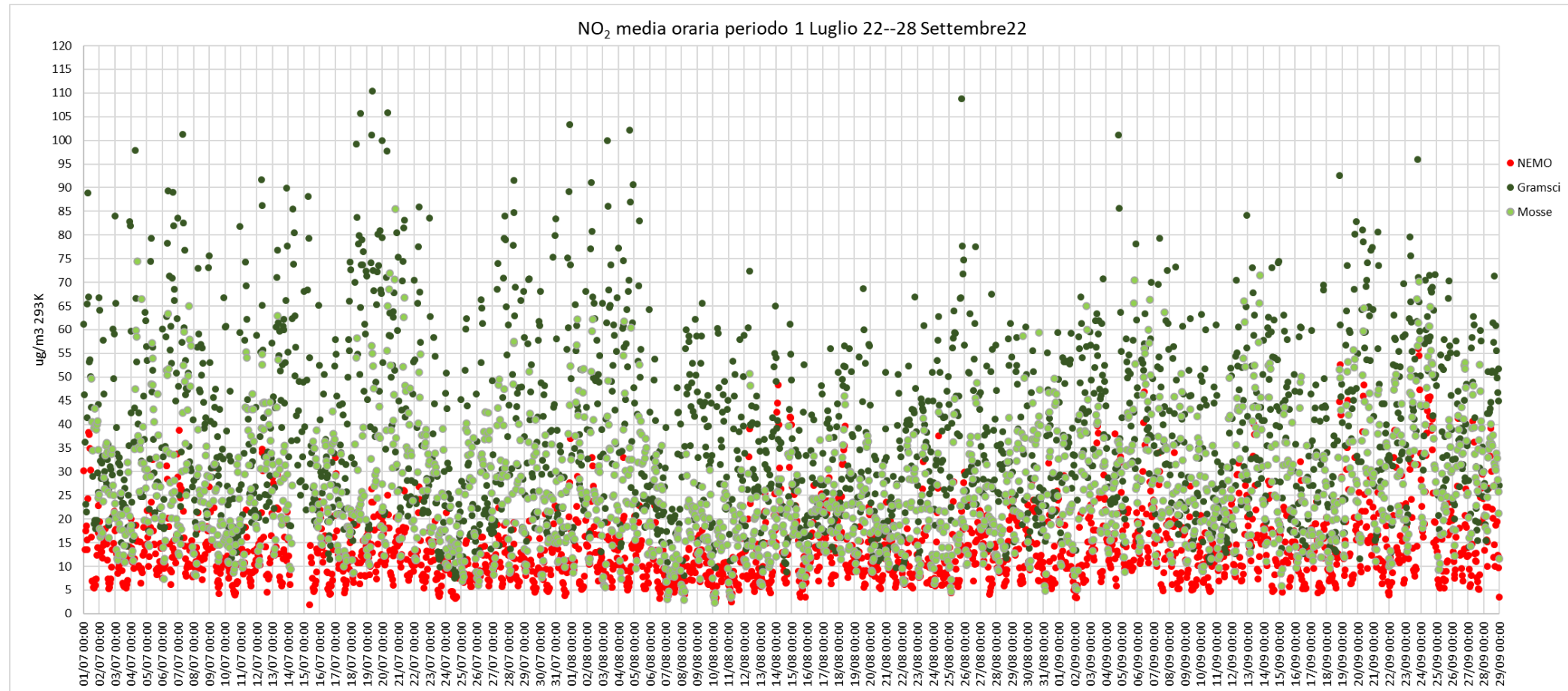
# Demo in Florence: *mean values $NO_2$*



# Demo in Florence: *mean values $PM_{10}$*



# Demo in Florence: *data variability*



# Demo in Florence:

## *mean values in different areas*

### Sampling period

- from: 1 luglio 2022
- to: 28 settembre 2022

Parameter	Mean			Max		
	NEMO	Gramsci	Mosse	NEMO	Gramsci	Mosse
NO <sub>2</sub> (µg/m <sup>3</sup> 293K)	14	39	26	29	62	41
PM 10 (µg/m <sup>3</sup> )	17	23	19	31	38	34



# **Grazie**

***<https://nemo-cities.eu/>***

# Social media

**You can also follow us and connect on social media.**

LinkedIn: <https://www.linkedin.com/showcase/nemo-cities>

Twitter: <https://twitter.com/NemoCities>





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