

Experience using a diffusion charging particle counter in a Euro V diesel city bus in Madrid. Influence of the transient conditions on PN emission factors

Casanova, J.* , Rosero, F. A.*,** . Fonseca, N.* and Flores, N.*

* Institute for Automobile Research (INSIA) of the UPM (Spain). Contact: jesus.casanova@upm.es

** Faculty of Applied Sciences, Universidad Técnica del Norte (Ecuador)



POLITÉCNICA



INSIA

Introduction & Background

- City buses fleet in Madrid still has Euro V diesels
- Contribute in an unknown % to small particles in the urban environment
- Driving patterns and driver behavior influence PN emissions
- Real driving tests carried out with a PN analyser and PEMS
- Objectives:
 - (1) to understand the driving pattern of city buses in Madrid (slopes and positive acceleration $\Rightarrow$ transient and averaged emissions)
 - (2) to validate the PEGASOR low cost DC particle counter in real driving emissions measurements.

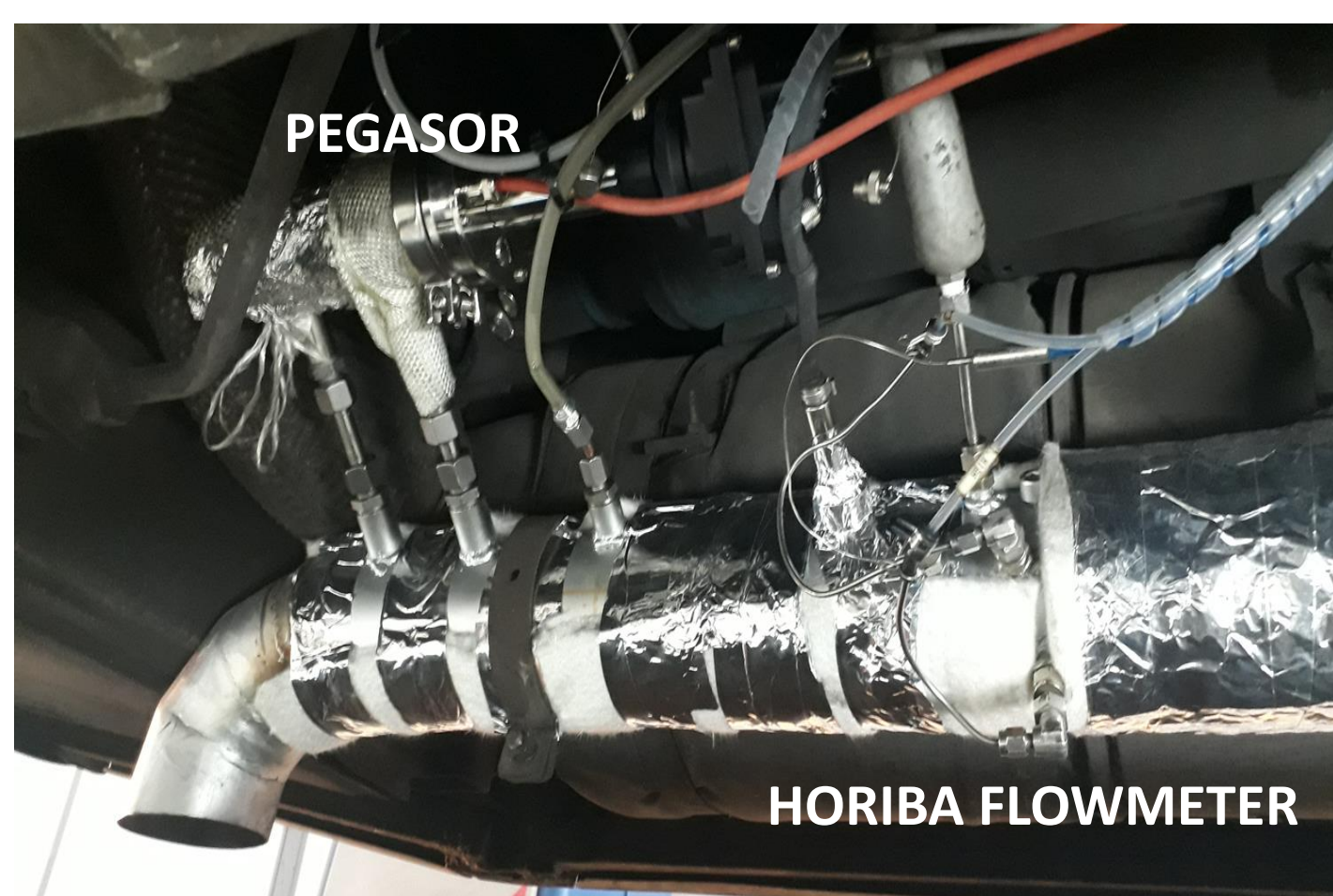
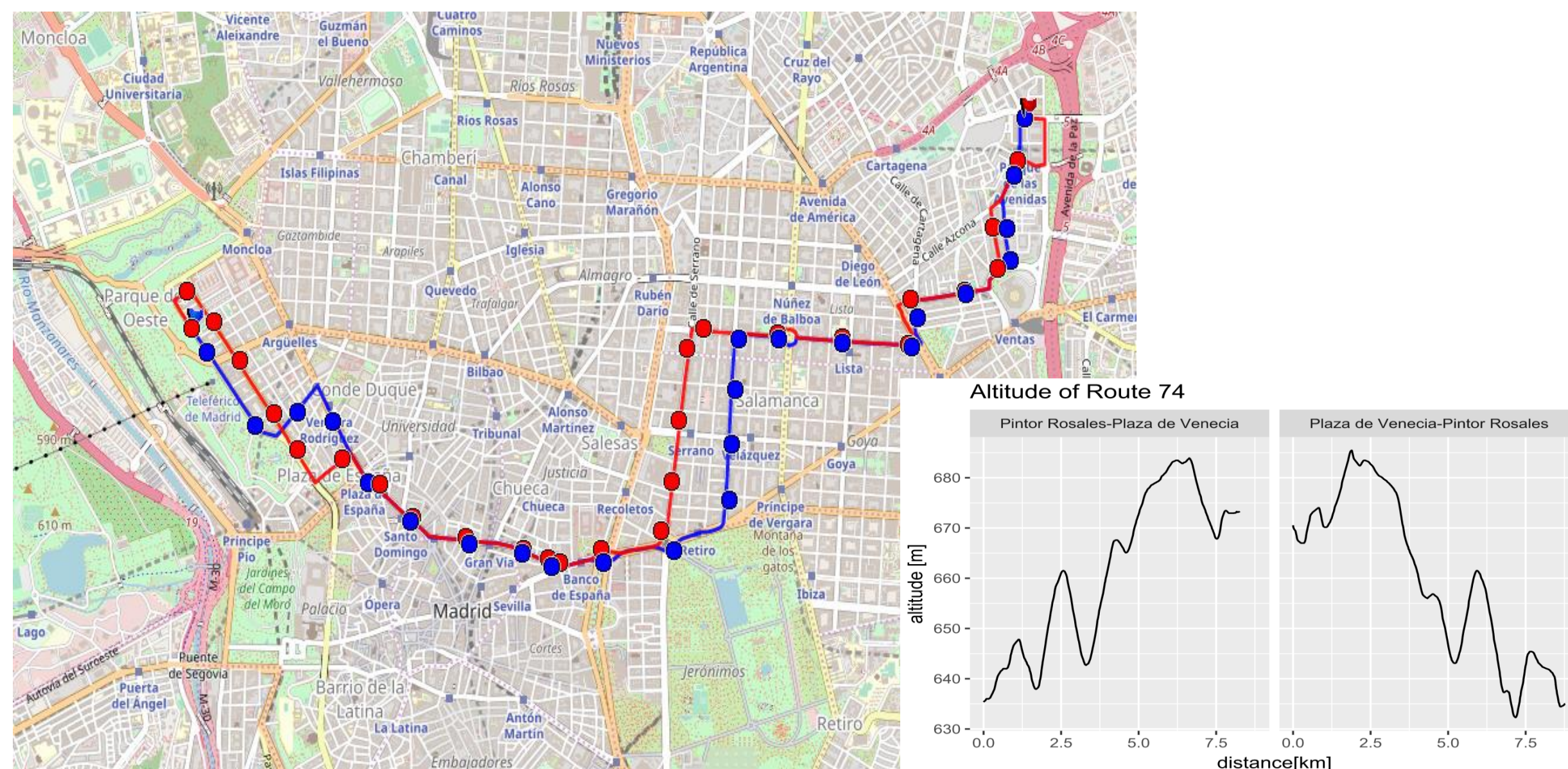
Methodology

Euro V diesel city bus was selected for these tests:

- Manufacturer: Irisbus
- Model: Citelis12
- Kerv Weight: 12575 kg
- Year: 2010 (Euro V)
- Mileage: 378000 km
- SCR + Particle filter
- Engine: IVECO
- Displacement: 7796 cm³
- Rated Power: 157 kW
- Torque: 1100 Nm



The real Municipal Transport Company (EMT) bus line N° 74 was selected and driven in three conditions: empty bus, 1500 kg and 4000 kg of payload, following the actual bus stops



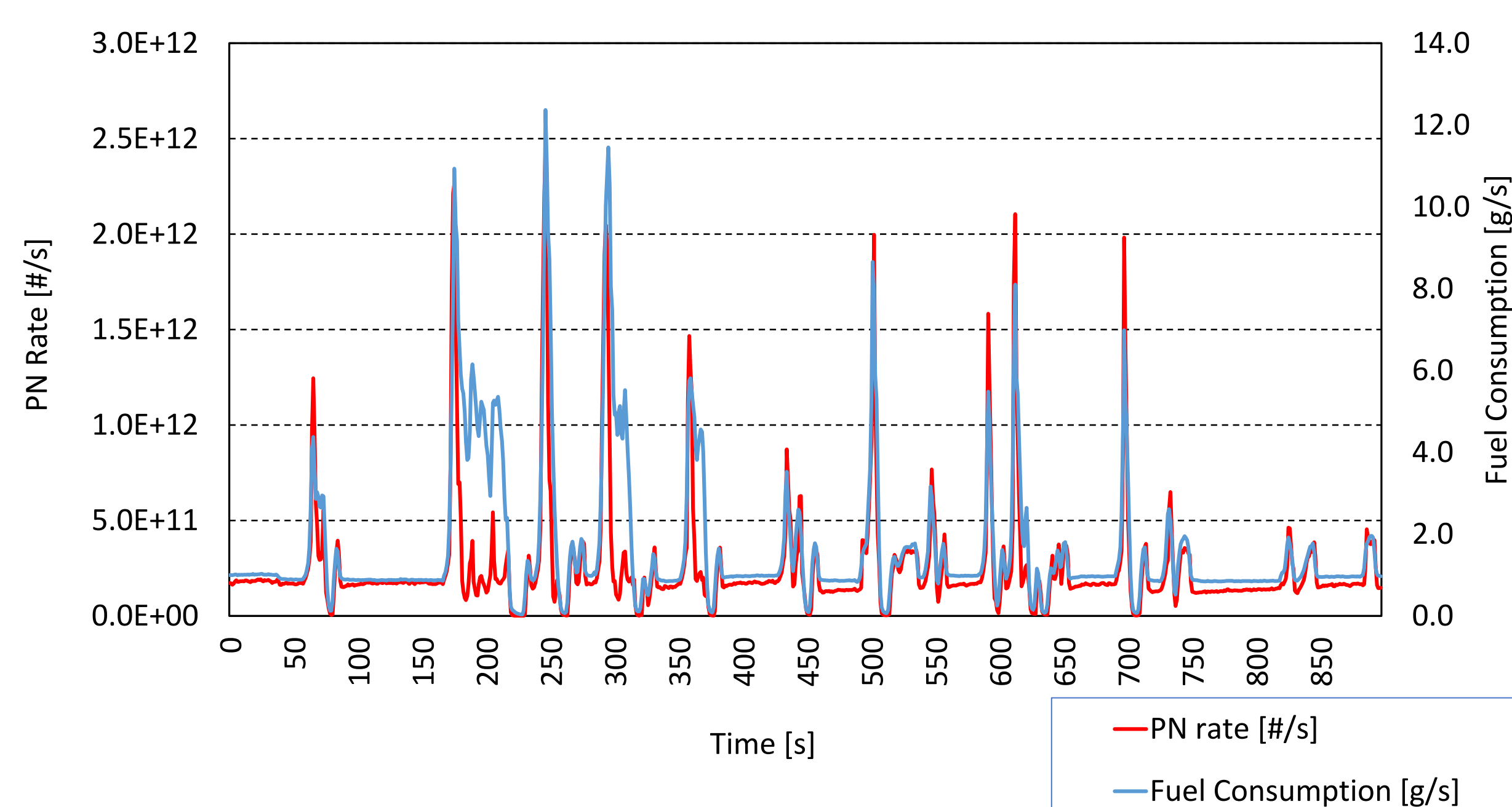
The PN are measured in #/cm³ and passed to #/s by the instantaneous exhaust flow (Horiba OBS2200 PEMS)

Bus speed recorded from the OBD.

The PEGASOR coupled to the exhaust duct just before the flowmeter.

Measured data

Example of measured instantaneous PN rate (#/s) and fuel consumption (g/s) calculated from carbon balance

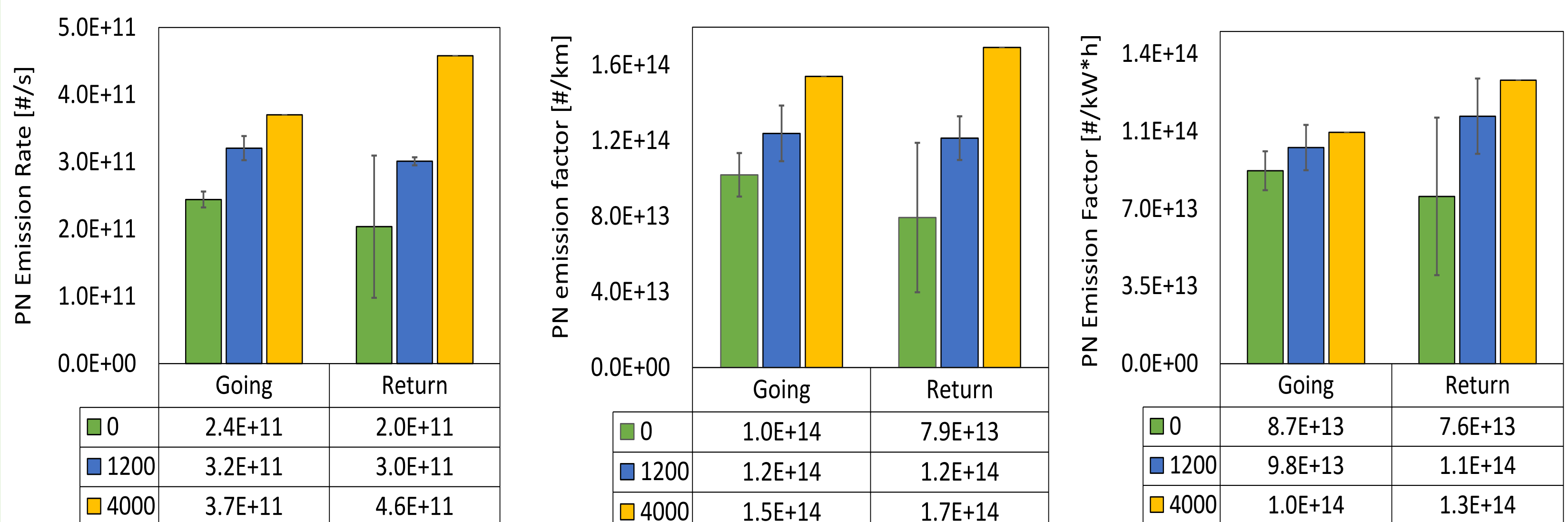


Data processing

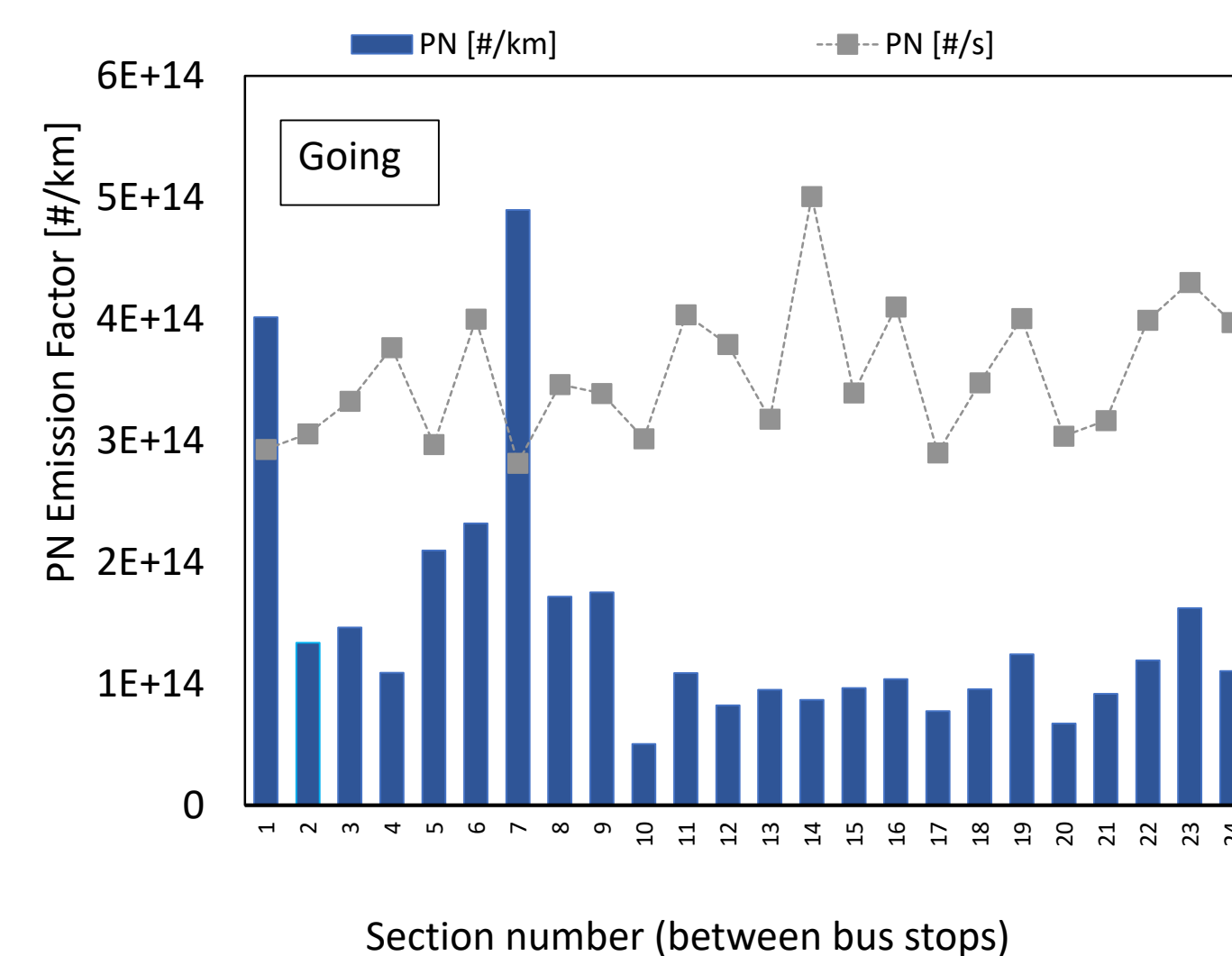
- PEMS, PEGASOR and OBD signals synchronization
- PN instantaneous emissions measured in #/cm³ and calculated to #/s, #/km and #/kWh by exhaust mass flow instantaneous measurement
- kWh calculated from bus speed, street slope and assuming C_x , A_f and f_R
- Emissions and flow signals different delay is the cause of some unexpected results in transient conditions

Results

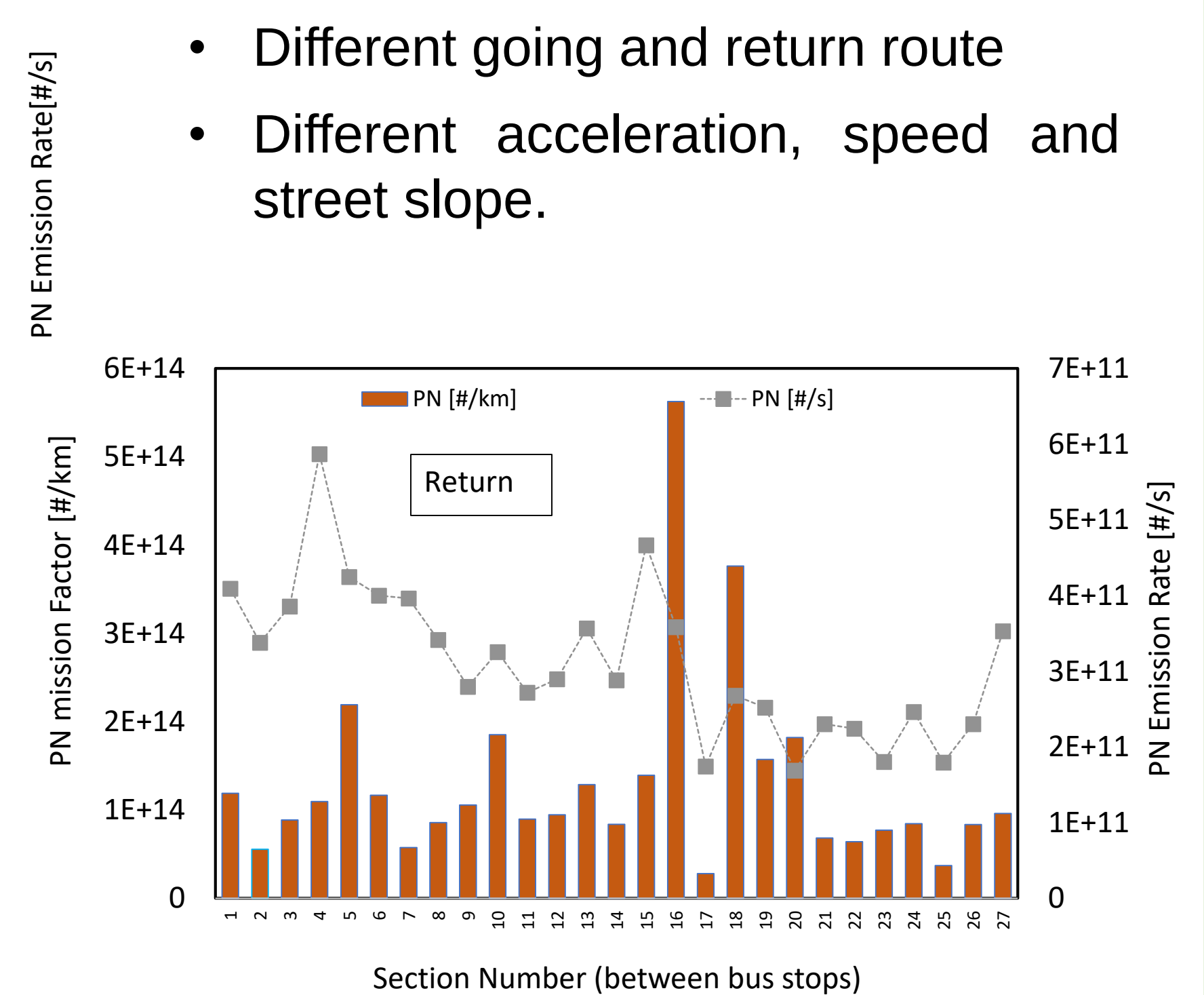
PN averaged emission factors increase with the payload of the bus (0, 1200 and 4000 kg), well above Euro VI standards and strong effect of slope



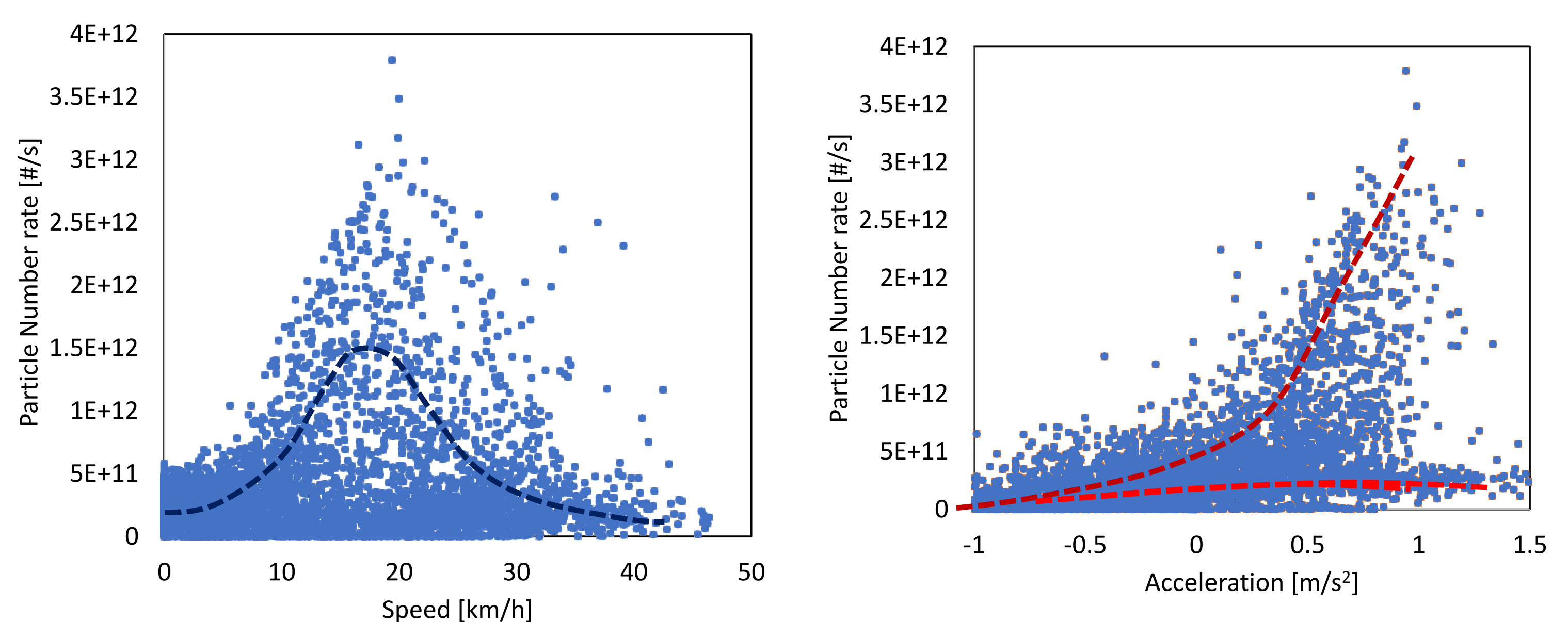
PN emission (#/km) are quite different between sectors: slope, dynamicity, ...



PN emissions factors and PN emission rates do not follow the same trend



PN emission rate (#/s) is a function of bus speed and acceleration



Two trend lines can be observed. Probably due to the smoothing of the signals in transient periods

Conclusions

- Small particles are emitted in higher quantity in acceleration periods and positive slopes
- Pegasor DC Particle Counter is able to detect high PN periods in real driving
- PN in #/s, #/km and #/kWh can be calculated from bus activity and exhaust flow
- It is simple and light in weight, but the need of compressed air is a problem (noise and energy consumption)

Acknowledgment

Supported by the Spanish Ministry of Economy and Competitiveness - State Program of R&D&I Oriented to the Challenges of Society. National Plan 2016-2018. Research project: *Optimization system for urban driving cycles, application to the generation of patterns adapted to environmental requirements and vehicle fleet exploitation situations*. TRA2015-68803-R.



23rd ETH-Conference on Combustion Generated Nanoparticles

June 17th – 20th, 2019 ETH Zurich, Switzerland