

# WP3 + WP4: Laboratory and on-road RDE measurements of exhaust emissions

City and Stakeholder Group Event (May 15, 2024)



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# OBJECTIVES

## Laboratory measurements




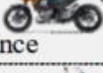











## On-road measurements



- Definition of procedure for laboratory testing including regulated and non-regulated pollutants
- Develop and validate of systems capable for on-road measurement of emissions for LVs (Standard PEMS, mini-PEMS and SEMS)
- Definition of an RDE test procedure for on-road LVs pollutant emissions measurement (vehicle set-up, instrumentation, measurement procedure and trip characteristics).
- Characterization of pollutant emissions of 150 L-category vehicles.
- Compare on-road and regulatory emission results, identify the gaps and provide input for final recommendations

# L-CATEGORY VEHICLES TESTING

Category	LV sub-category
L1e	L1eB - Two-wheel moped 
L2e	3-wheel moped 
L3e & L4e	L3e-A1 Low-performance 
	L3e-A2 Medium-performance 
	L3e-A3 High-performance 
	L3e-AxE Enduro 
L5e Tricycle	 
L6e	L6e-A Light on-road quad 
	L6e-B Light quadri-mobile  
L7e	L7e-B1 All terrain quad 
	L7e-B2 Side By Side Buggy 

- Number of vehicles for exhaust emissions measurements

# of vehicles to be tested (according Call)	150
# vehicles on-road (RDE) & Lab test	22
# vehicles on-road (RDE) only	90
# vehicles lab test only	38

- A total of 150 vehicles will be measured.
- 112 vehicles in real world
- 60 vehicles at laboratory

- Vehicles to reflect national fleet mix to the degree possible

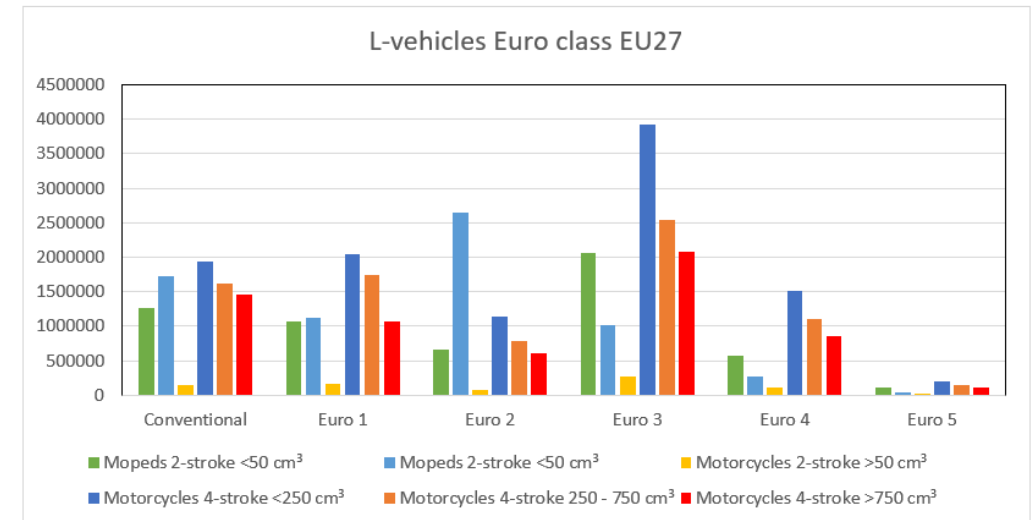


Figure 2.4: Figure 4: Euro class of L-vehicles in the EU27 fleet

# LABORATORY TESTING

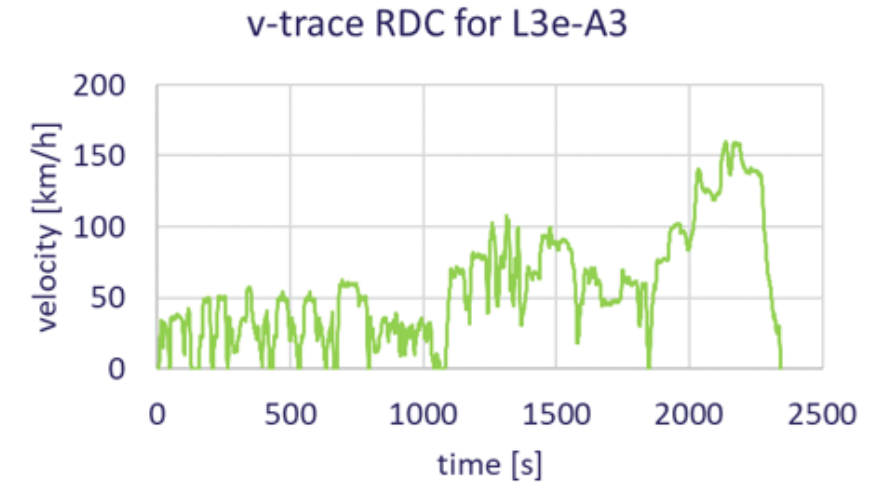
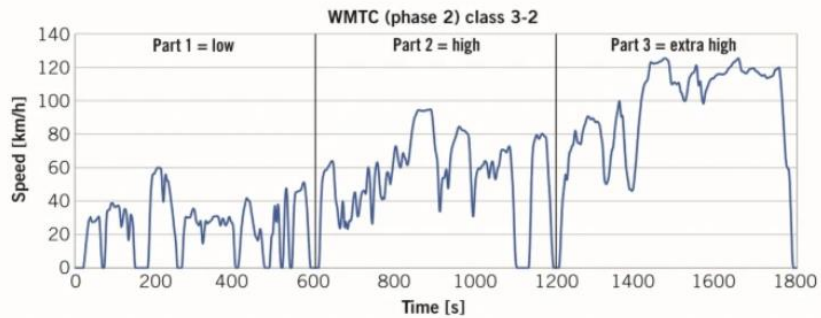


Figure 1-3: Example for a RDC for L3e-A3 vehicles developed by [TUG](#)

## Exhaust gas emission components:

Type Approval emissions with standard laboratory CVS system:

FID (Flame Ionization Detector): HC

CLD (Chemiluminescence Detector): NO<sub>x</sub>

NDIR (Non-Dispersive Infrared): CO and CO<sub>2</sub>

Additionally, Particle number (PN<sub>23</sub>, PN<sub>10</sub>), Particle mass, and other regulated pollutants with FTIR (Fourier Transform Infrared Spectroscopy) including NH<sub>3</sub>, N<sub>2</sub>O and CH<sub>4</sub>.

# ON-ROAD MEASUREMENT EQUIPMENT

- Special measurement devices for on-road measurement = PEMS, developed for passenger cars
- Difficulty: standard instruments built for passenger car application → big and heavy
- LENS: → adapt, modify and build dedicated instruments suitable for L-Cat vehicles

## Prototype of very small PEMS (Mini-PEMS)



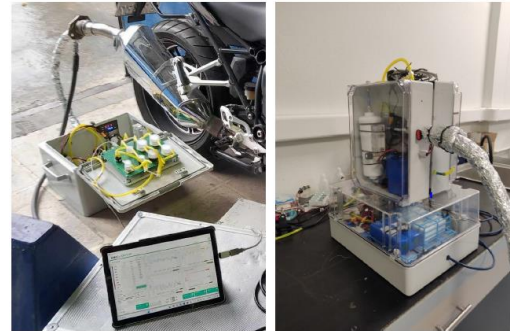
# ON-ROAD MEASUREMENT EQUIPMENT

- On-road emissions equipment developed

HORIBA SEMS



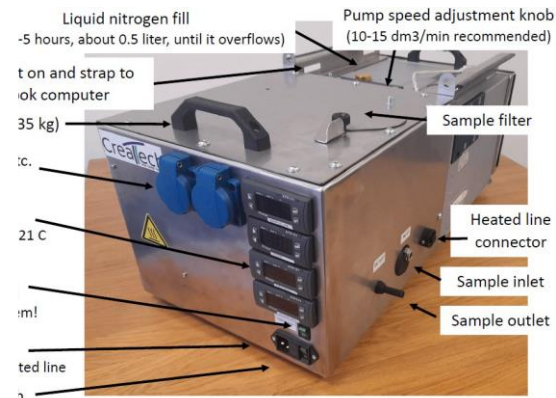
EMISIA ReTEMS



IFPEN REAL-e SEMS

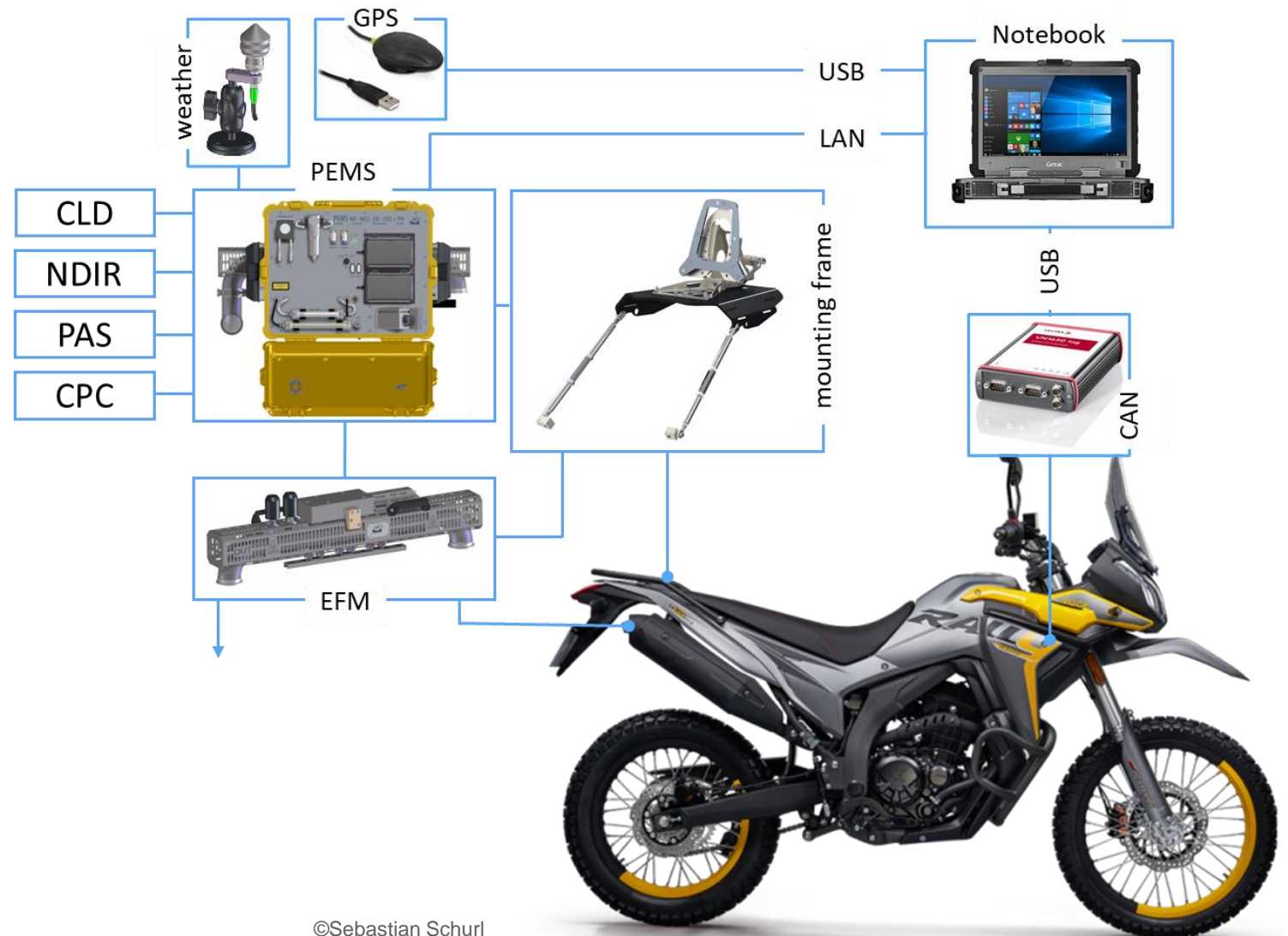


CZU FTIR



# ON-ROAD MEASUREMENT EQUIPMENT

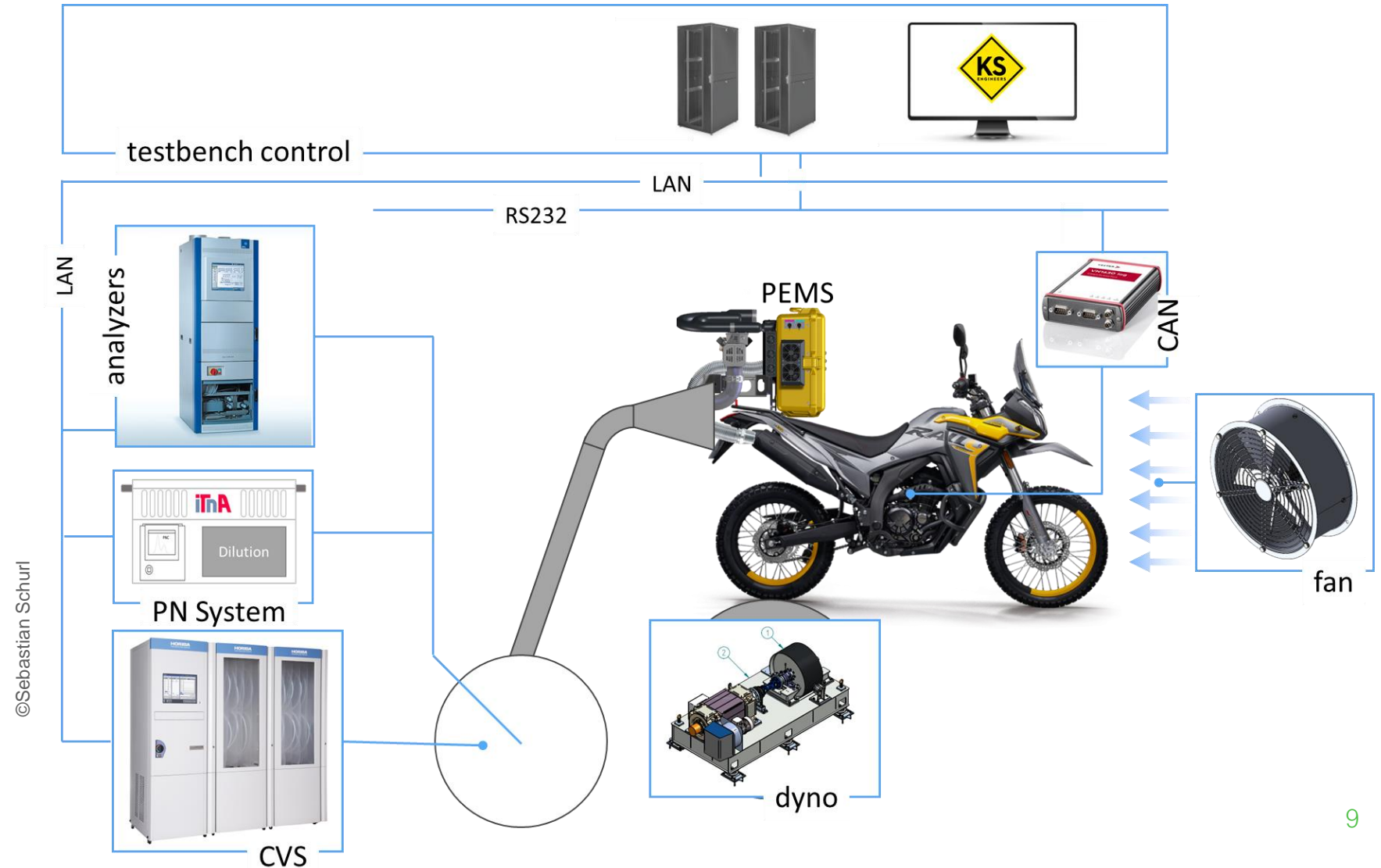
- Setup of instruments for RDE measurement and adaptation for L-category Vehicles





# ON-ROAD MEASUREMENT EQUIPMENT

- In-Lab Verification of PEMS/SEMS



# TRIP CHARACTERISTICS



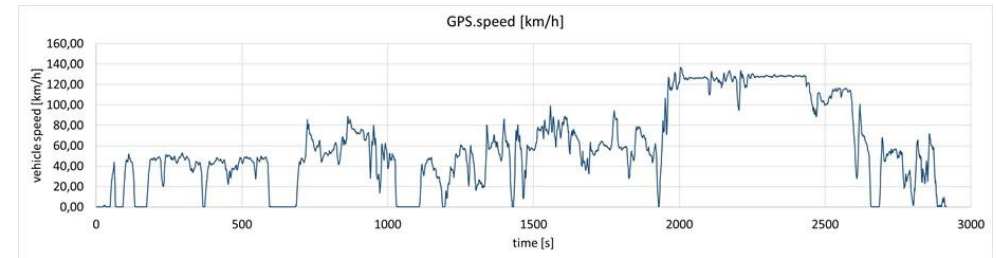
- Trip characteristics are developed according to its engine size, power and maximum speed, and the intended use of the L subcategory vehicle.
- Proposal of trip dynamics and urban/rural/motorway shares for future regulations and policy recommendations.

# TRIP CHARACTERISTICS

- Example of some routes performed

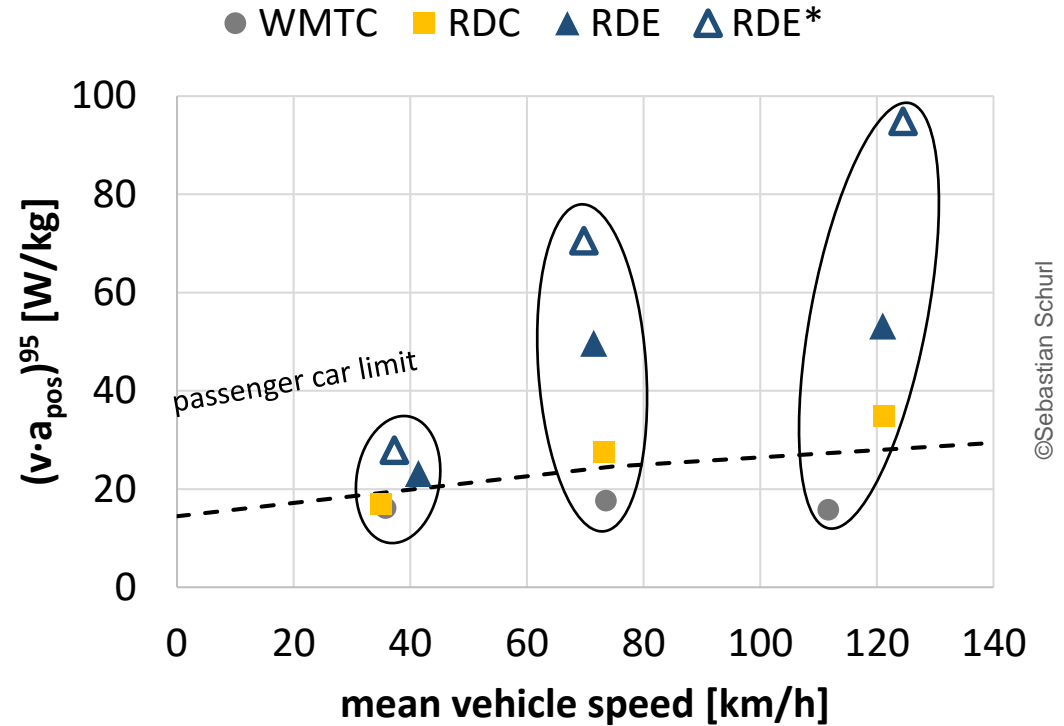
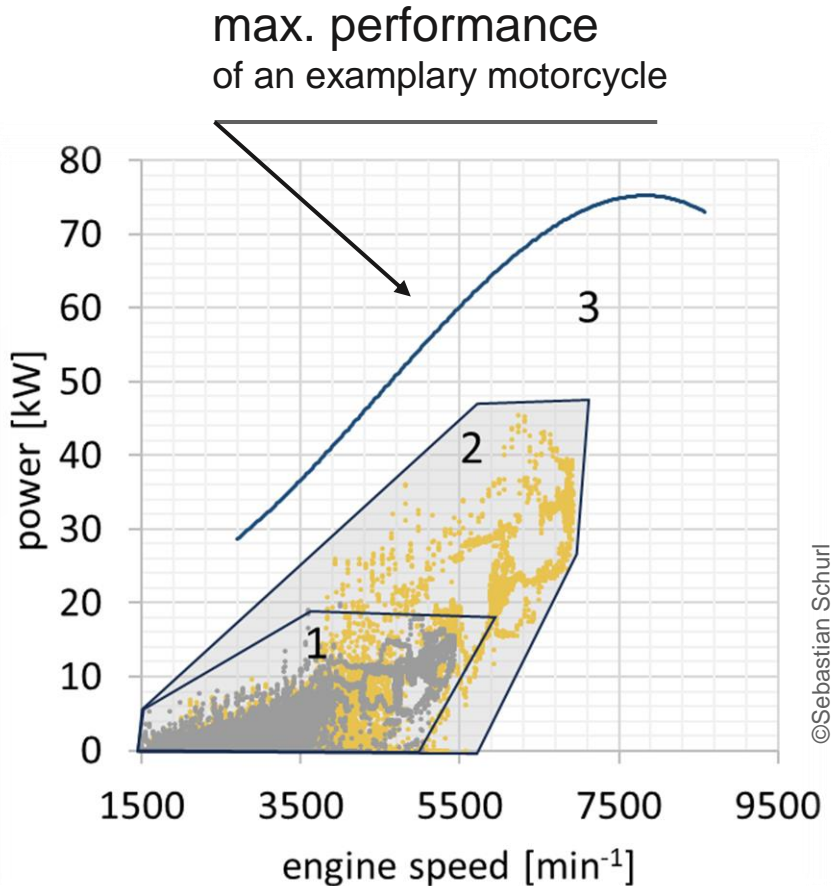


Dedicated urban route for Mopeds (L1e, L2e), light quads (L6e)



# TRIP CHARACTERISTICS

Dynamic parameter shows clear extreme dynamics of motorcycle → much more than passenger car



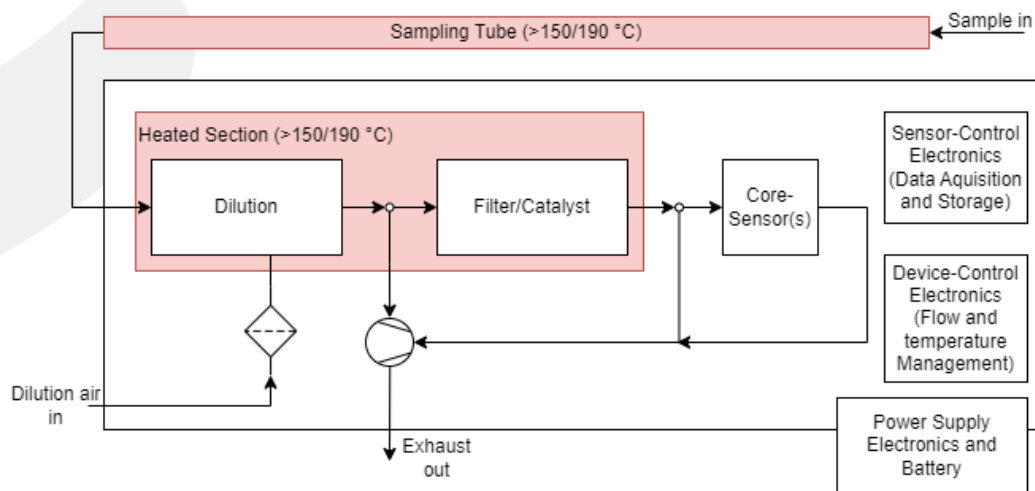
## Operational Points

1. regulatory cycle (WMTC)
  2. high dynamic cycle (RDC)
  3. potential on- road testing RDE
- } lab testing

# PARTICLE MEASUREMENT

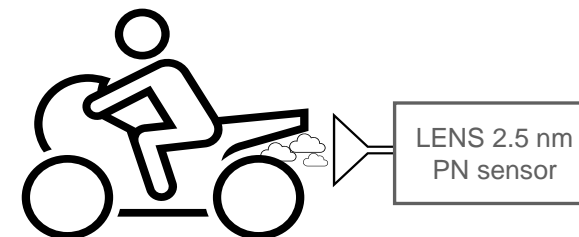
## Portable Emission Measurement System (PEMS)

- Miniaturised lab/test-bench sample preparation and sensor system
- To large and heavy for most L-vehs



## LENS 2.5 nm PN Sensor

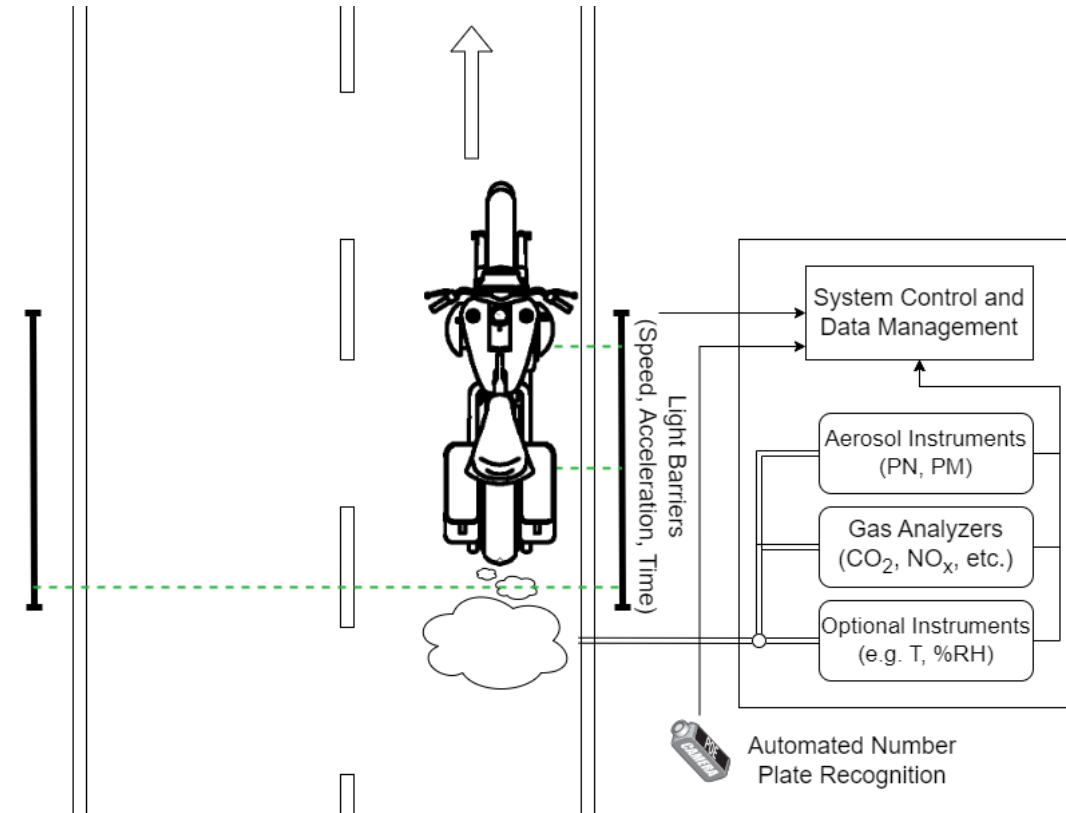
- Exhaust Particle Number Measurement On Board
- Directly applicable to unconditioned exhaust, small and portable for L-vehicles
- Currently lab-validation of 1st prototype at TU Graz, ready for exhaust by August 2024



# PARTICLE MEASUREMENT

## Exhaust Particle Number Measurement Roadside

- Roadside inspections of LVs with on-road equipment will be done to validate the measurement values obtained with roadside PN measurement
- Comparison of PN emissions data of roadside equipment, on-board equipment, and emissions laboratory reference measurements.
- Uncontrolled sample conditions, referenced absolute measurement difficult → CO<sub>2</sub>-based emission factors.



*Thank you!*