

European Aerosol Conference, Milano, September 6-11, 2015

1COA_PO16

Internal combustion engines are still the dominant source of nanoparticles in residential neighborhoods

Michal Vojtisek-Lom

*Institute for Automobile, Combustion Engine and Railway Engineering,
Czech Technical University in Prague*

Martin Pechout, Luboš Dittrich

*Department of Vehicles and Engines, Faculty of Mechanical Engineering,
Technical University of Liberec*

Jitka Štolcpartová

*Department of Genetic Ecotoxicology, Institute of Experimental Medicine,
Czech Academy of Sciences*

Contact: michal.vojtisek@fs.cvut.cz, tel. (+420) 774 262 854

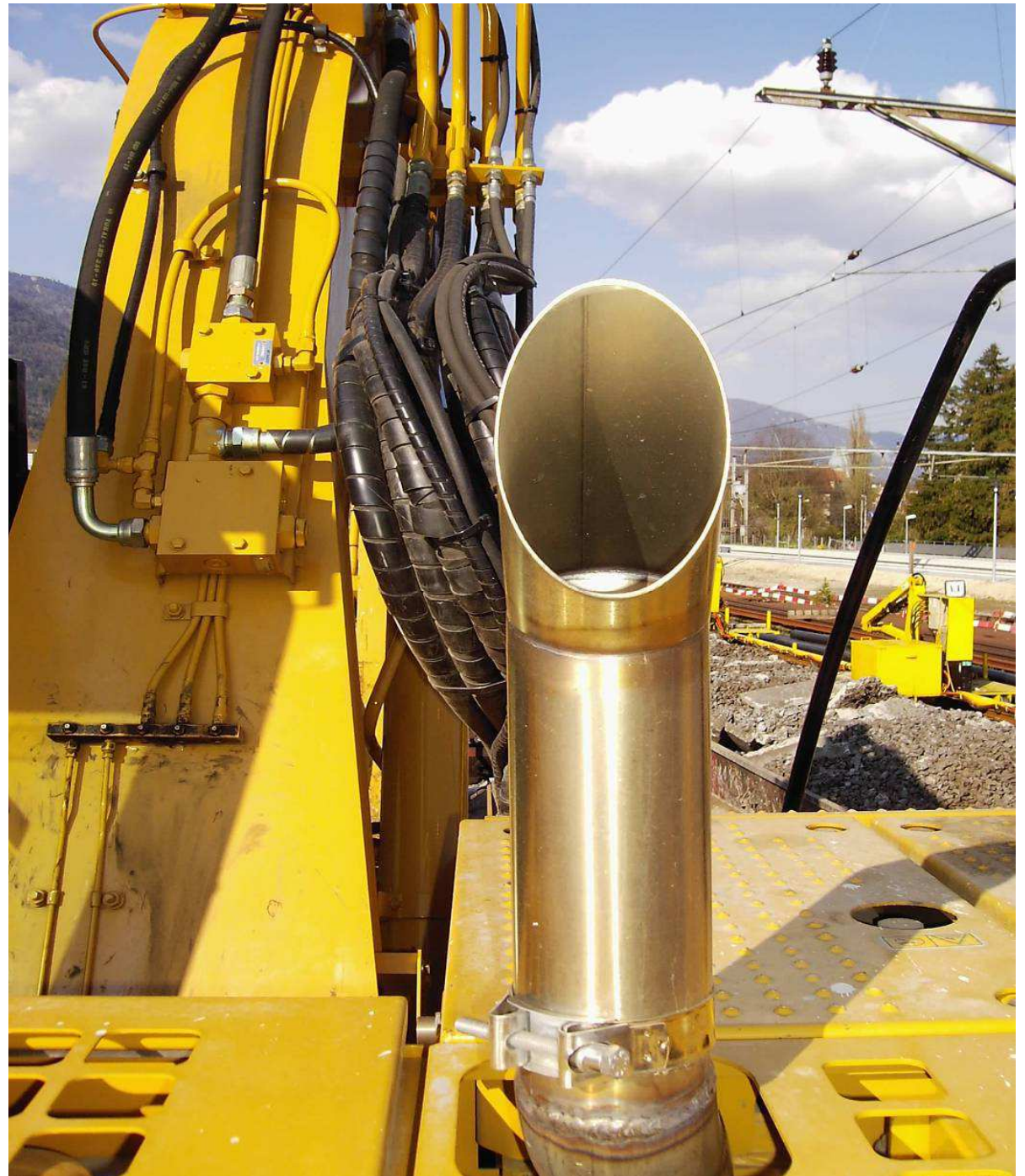
**Particulate matter and ground-level ozone are responsible for over 400 thousands premature deaths in the EU
(traffic accidents for „only“ 39 thousands)**



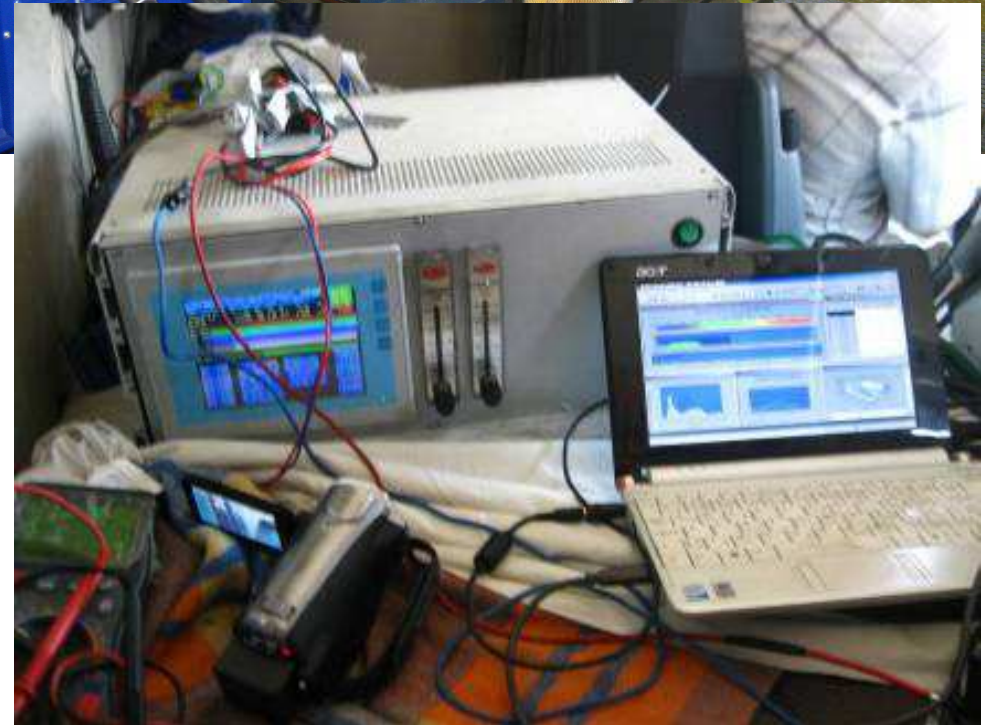
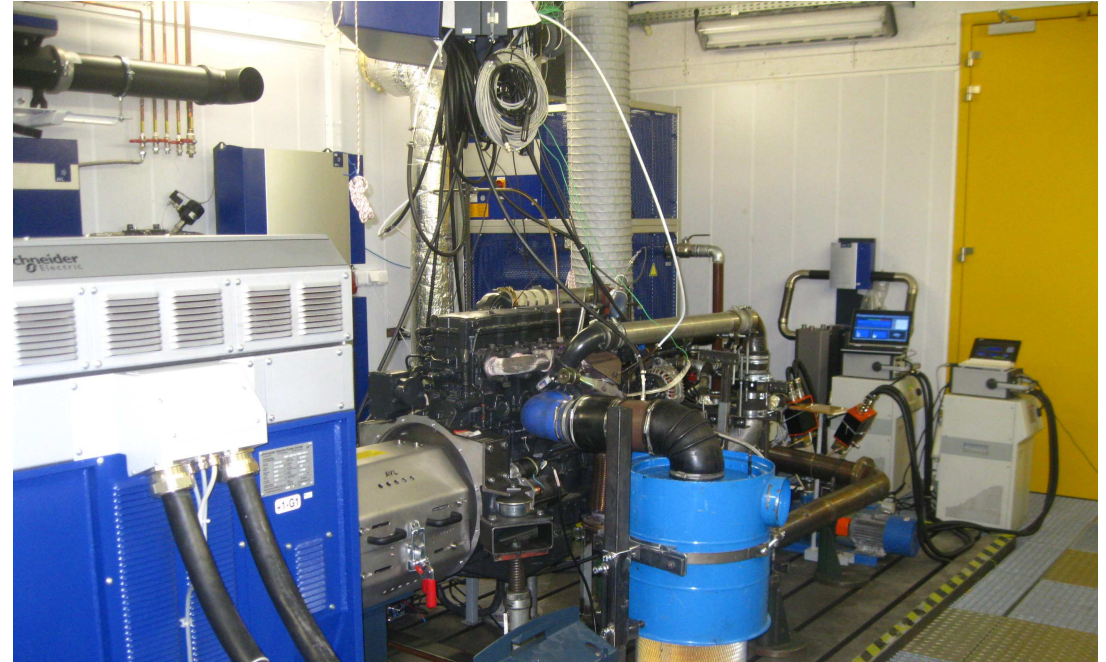
Internal combustion engines produce very small particles which are harmful to human health and released in the immediate vicinity of people.

We have diesel particle filters (DPF) and other technology to take care of this. But does it help? Is the situation improving sufficiently?

Air quality improvement actions need to be based on educated decisions supported by facts.



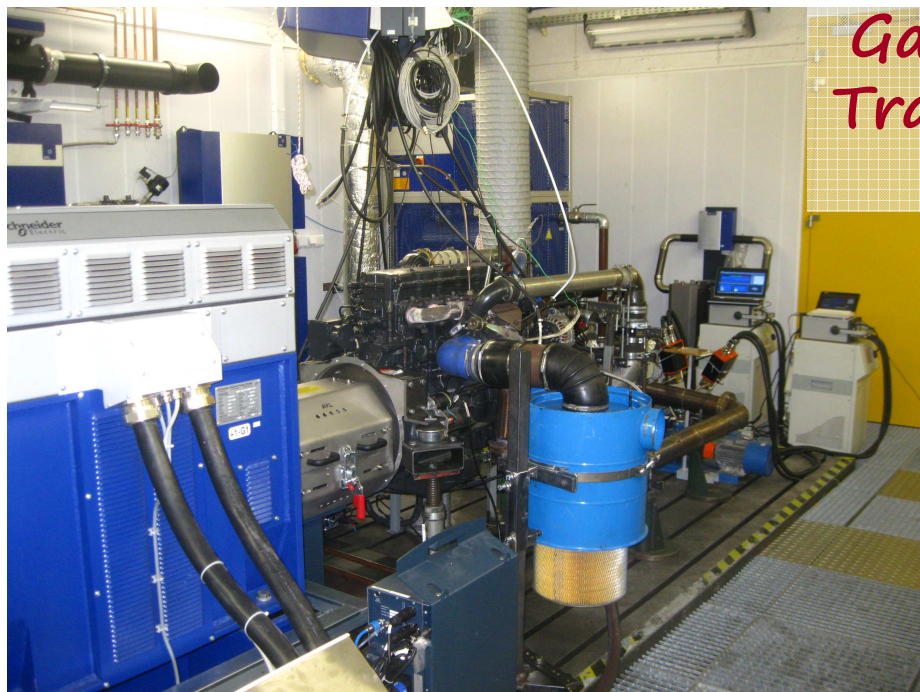
Online PM measurement at Czech Technical Univ. in Prague



Project BIOTOX – Mechanisms of Toxicity of Particles from Biofuels

PM measurement and sampling using high-volume samplers

Gasoline MPI and direct injection, diesel, Traditional and alternative fuels (ethanol, butanol, biodiesel, NExBTL, blends)

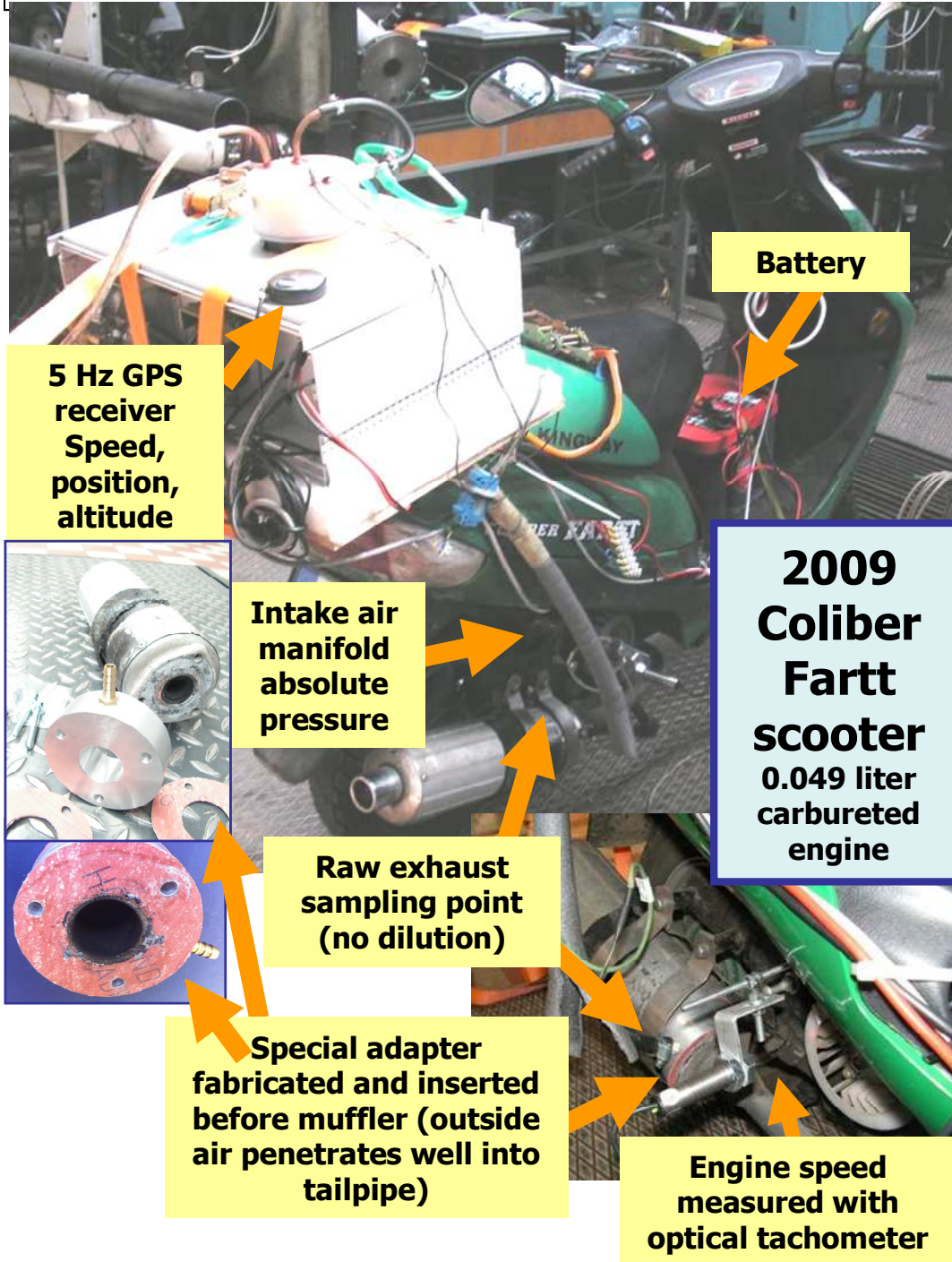


Real driving emissions measurement Portable on-board monitoring systems (PEMS)



Cars, buses, trucks, tractors, loaders, mowers, small airplanes, mopeds, ferries, locomotives, construction machinery

On-board system versatility: Motorcycle to locomotive



Portable on-board emissions monitoring systems (PEMS)

“Research PEMS”: On-board FTIR (gaseous compounds),
EEPS (size distributions), CPC (particle count)



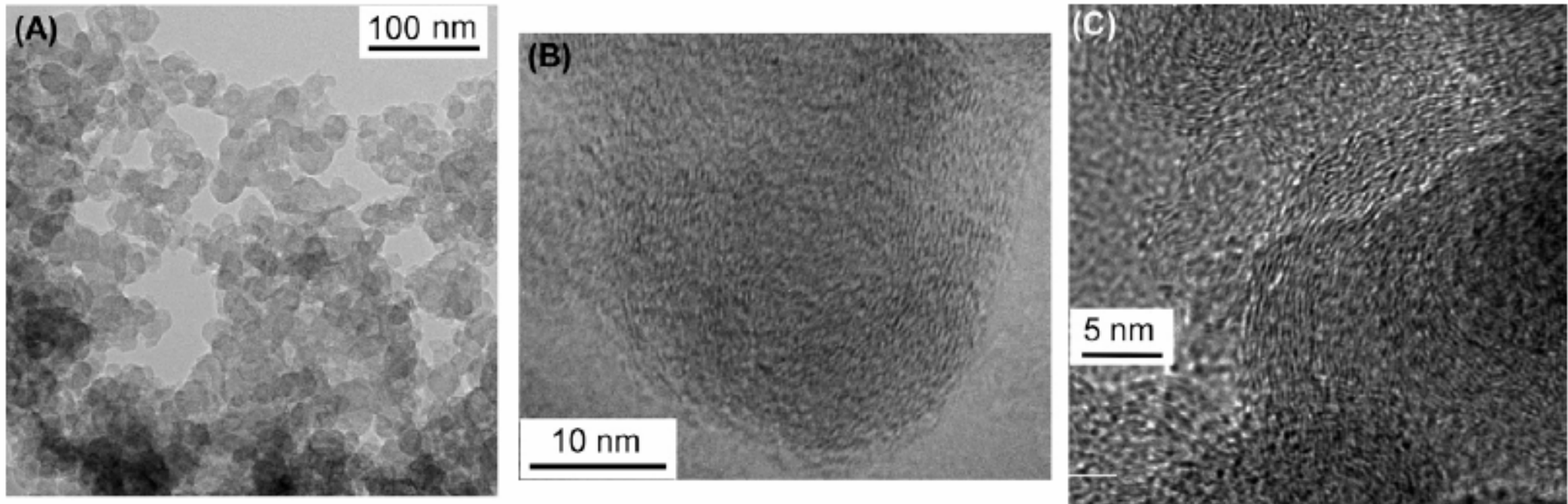
Student projects: E85, n-butanol, isobutanol in unmodified gasoline engines in Škoda cars



On-board FTIR
~ 30 kg
~ 300-400 W
3 hours on
26 kg of batteries

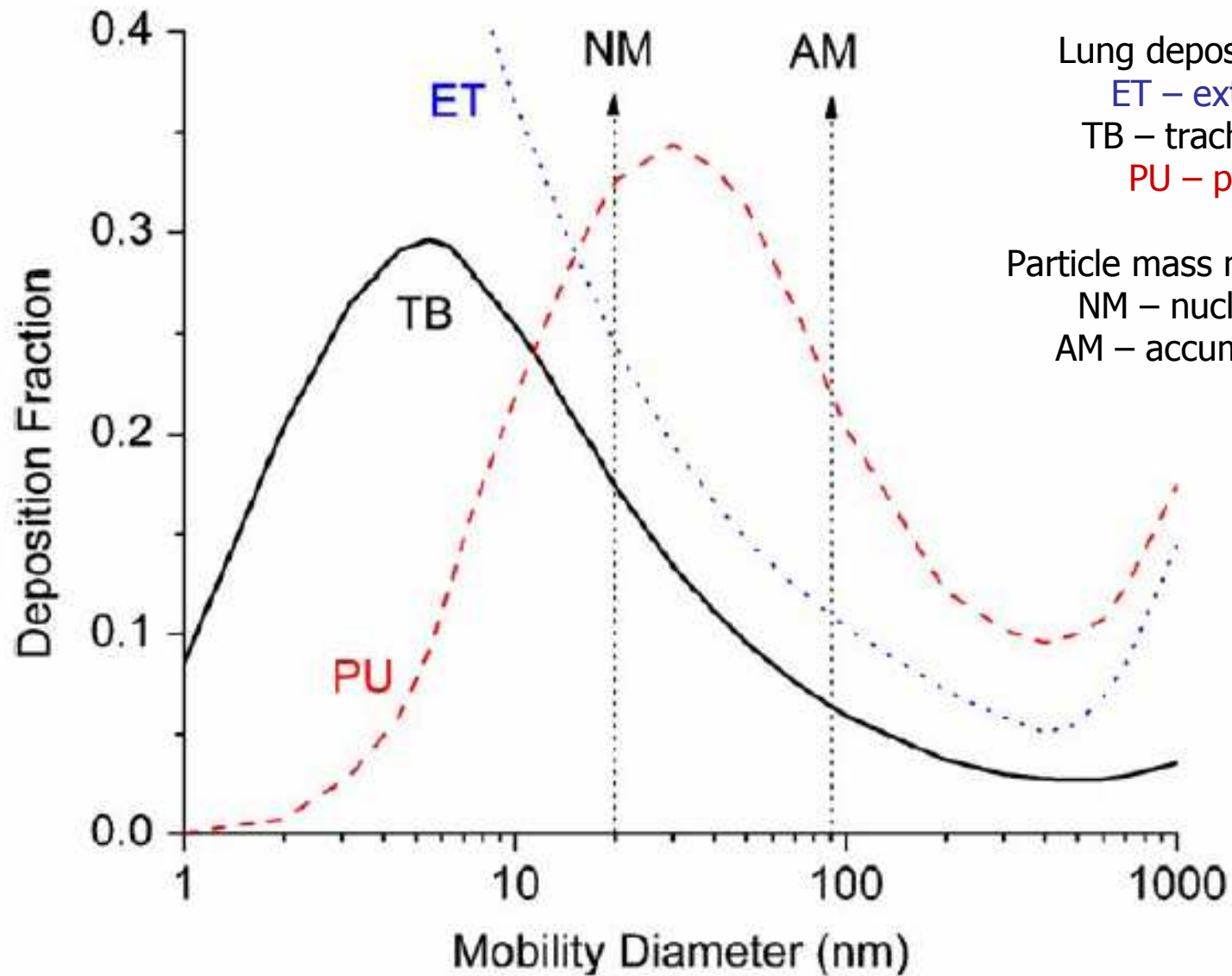
(Diesel) ICE exhaust particulate matter

- Small particles (units to hundreds of nm) formed by incomplete combustion of fuel and engine lubricating oil and wear metals
- Complex mixture of compounds, many known to be carcinogenic
- More premature deaths (> 400 K per year in EU) than traffic accidents (< 40 K per year)
- One of the most pressing urban environmental problems



Liati A., Dimopoulos P.E., Combustion and Flame 157 (2010) 1658–1670.

Lung particle capture efficiency



B. Alföldy et al., Aerosol Science 40 (2009) 652–663.

Lung particle capture efficiency

Fractional Deposition of Inhaled Particles (Oberdörster)

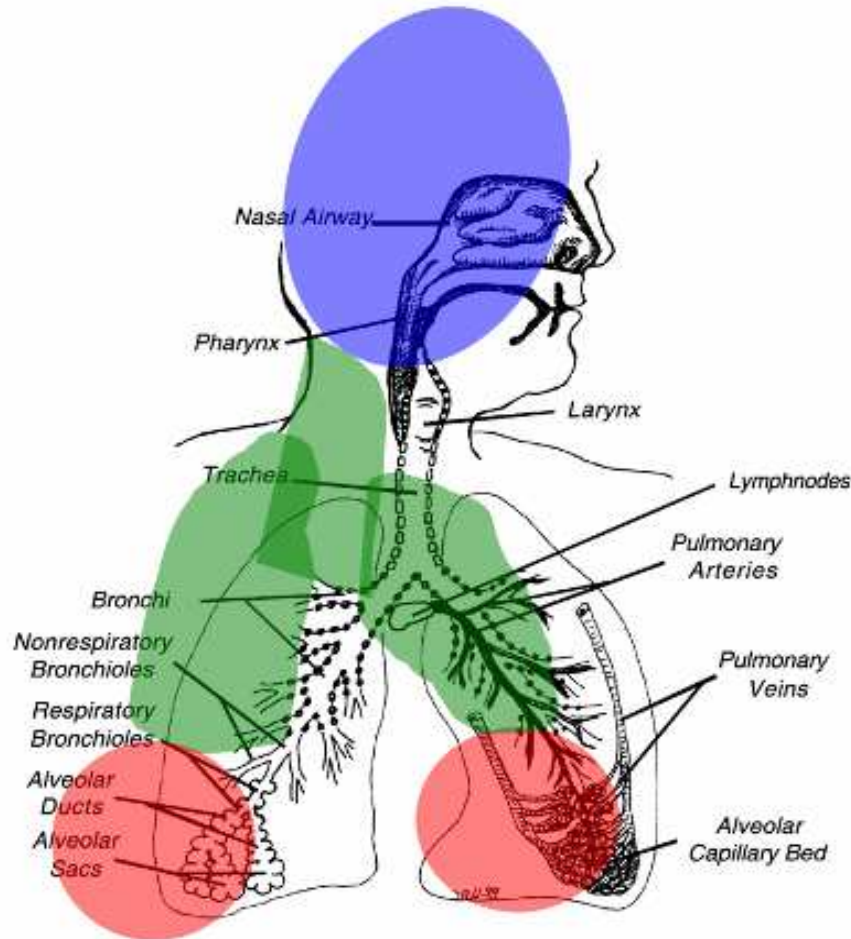
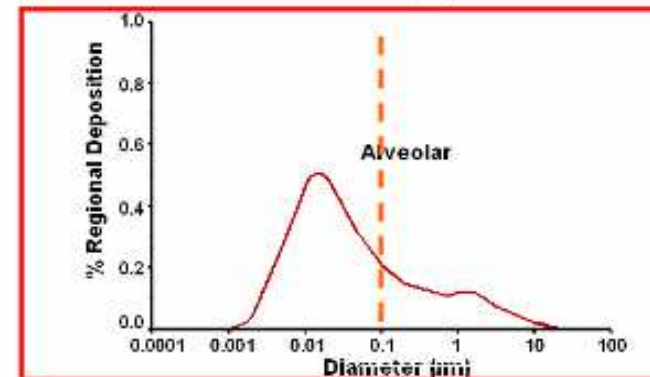
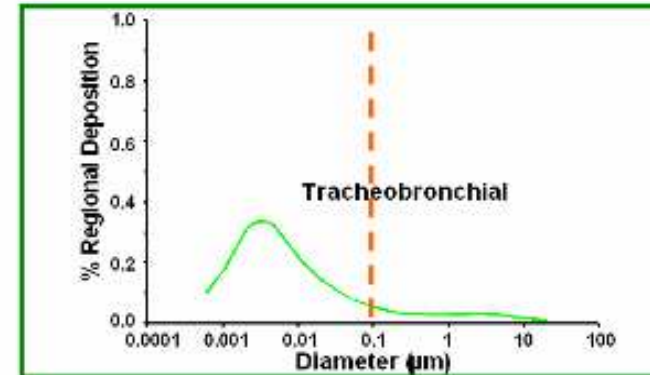
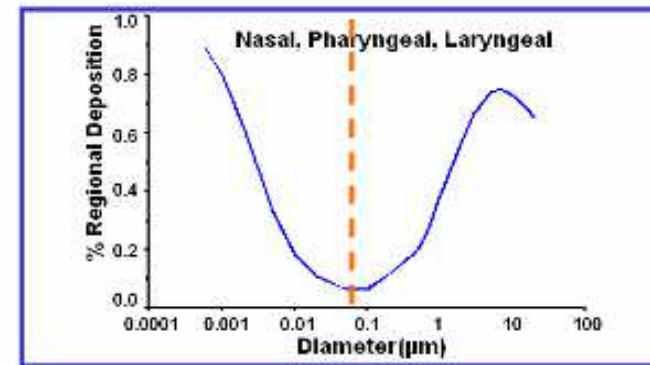


Figure courtesy of J.Harkema



A. Mayer, 12th ETH Conference on Combustion Generated Nanoparticles, Zurich, 2008

Is diesel PM becoming more of a question of public policy rather than technology?



With DPF



Euro 5 with no DPF (Prague, CZ)

Warning: This engine emits carcinogenic nanoparticles that are harmful when inhaled.

DPF work, but ... are they the EU norm, or the privilege of wealthy and progressive countries and regions?

Polish advertisement for emulation of (removed) DPF to the ECU

Emulatory FAP-DPF :: O firmie - Mozilla Firefox

File Edit View History Bookmarks Tools Help

dpf removal s... Improve MPG... Emulatory ... x DPF / FAP re... DPF Removal... FAQ's | DPF R... Filtr pevných ... Odstranění fit... Filtry pevných... F

fap-dpf.pl/en/?gclid=CLGgs8W74rACFUJL3wodpG_u1A

ADS
ADVANCED DIGITAL SYSTEMS

get rid of the problem of diesel particulate filter... forever!

EMULATORS FAP-DPF

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o firmie

Advanced Digital Systems is dynamically burgeoning company, which operates in the automotive industry, electronics and lighting. Our team is based on highly experienced, ambitious people, graduated of the Silesian Technical University, the Silesian higher education and the Technical University of Cracow, which are caring for the best cooperation with many European and Asian business partners. Main priority of company is satisfaction of our customers. Continuously we improve the quality of our services and products.

emulatory fap-dpf

ADS
EMULATORY DPF PL
-18 TDS 130 132
Diesel particulate filter emulator
INPUT: 12V DC 25 mA
R0030
CE
MADE IN EU

Do we mandate the installation of DPF through emissions limits, but then tolerate DPF removal?

DPF / FAP removal - Mozilla Firefox

www.ecusafe.com/html/dpf_fap_removal.html

DPF / FAP removal

Removing of FAP / DPF is easy ! All you need is to read original file from car and process it with proper ECUsafe module, designed to find and remove all important DPF structures automatically, without your attendance.

File can be then directly written in ECU, or it can be tuned by you and then - written into car. DPF can be removed from car, sensors left unplugged (no sensors at all) or left in the exhaust. It does not matter.

No more regeneration, no more black smoke behind. No more DPF check light or lamps on the dashboard. Add DPF removal offer to your workshop capabilities !

You can buy selected modules from list above or bundle set of all for discount price.



Software includes FAP/DPF level EEPROM editor. You can open EEPROM file. This is useful in case, when too high level of fill of FAP is stored in EEPROM of ECU. In that case even removing FAP from main memory of ECU may omit dashboard blinking error. You can edit EEPROM memory and set level of FAP.

UK advertisement for removal of DPF and corresponding adjustments of ECU

ate and Diesel Tuning - Mozilla Firefox

www.viezu.com

VIEZU TECHNOLOGIES

DPF Delete And DPF Removal With Viezu

FIND OUT BY HOW MUCH PERFORMANCE WILL INCREASE ON YOUR VEHICLE

CLICK BELOW TO FIND OUT

PERFORMANCE

HOME ABOUT US FAQ CONTACT ENQUIRY BLOG

DEALER MAP

BECOME A DEALER


SAVINGS CALCULATOR

Watch Tuning Process

Join us on Facebook

DPF Delete software and tuning is becoming ever more popular and needed. Viezu technologies, the world leading provider of vehicle tuning services offer a full range of DPF removal, DPF delete, and DPF problem solving services

A DPF (Diesel particulate filter) or FAP (Filtre A Particules) is a device designed to remove diesel particles or soot from the exhaust gas of a diesel engine. It basically traps the diesel particles in the filter and at a given condition the vehicles ECU will carry out a "regeneration" cycle when these particles are burnt and blown out of the exhaust.

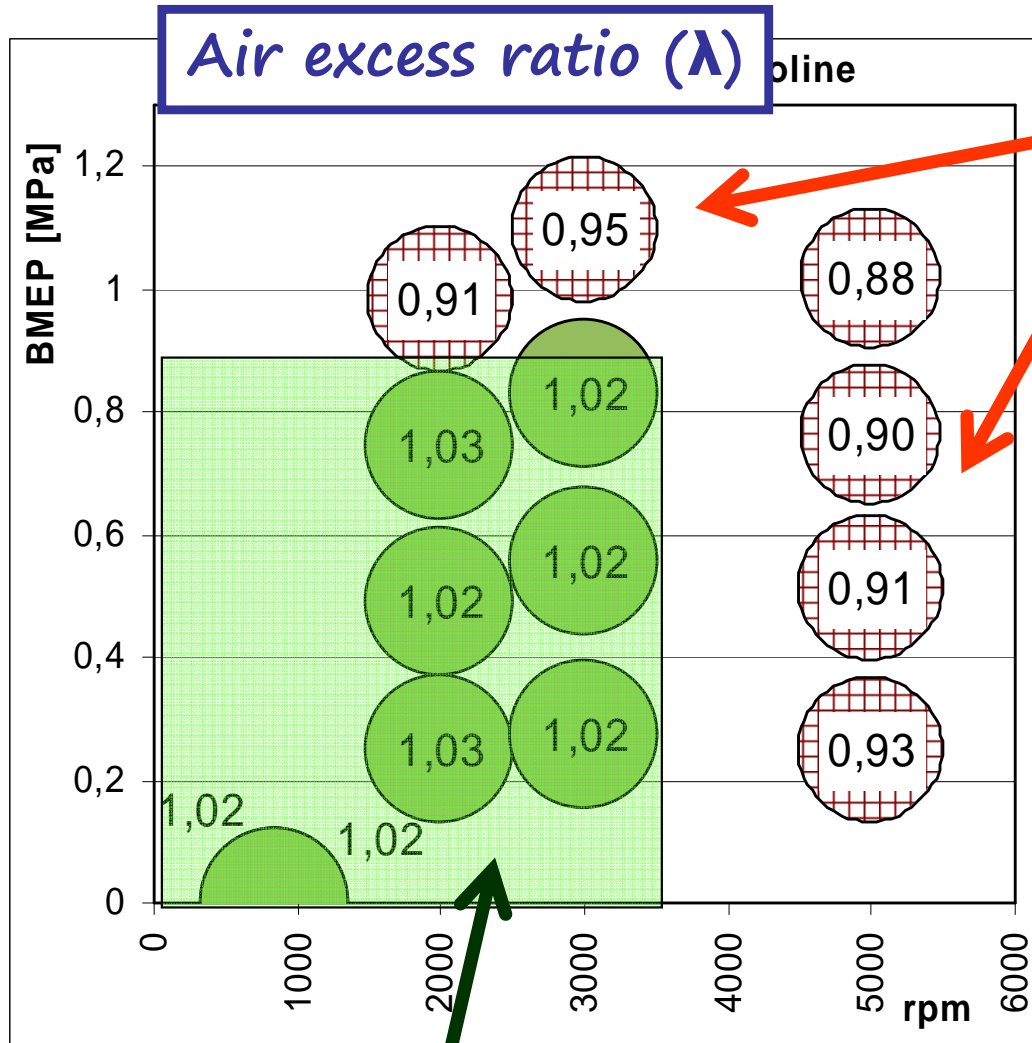


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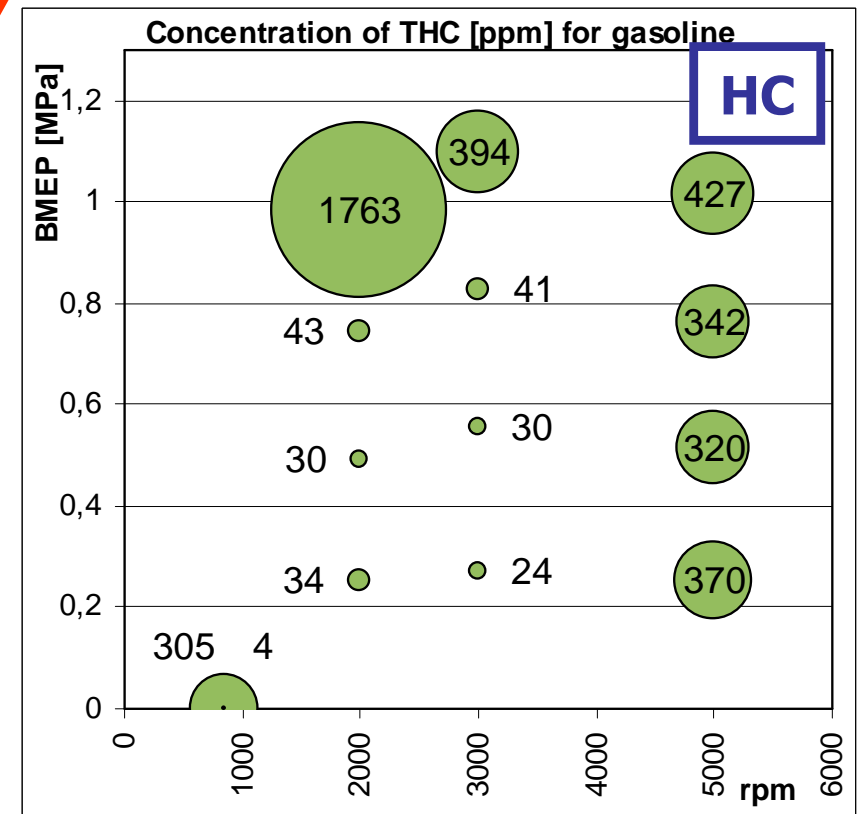
Do we mandate the installation of DPF through emissions limits, but then tolerate DPF removal?

Challenges of EU automobile gasoline engines

Euro 4 Skoda Fabia – engine dynamometer runs



Reducing exhaust gas temperatures (catalyst protection) by fuel-rich operation at high rpm and at high loads

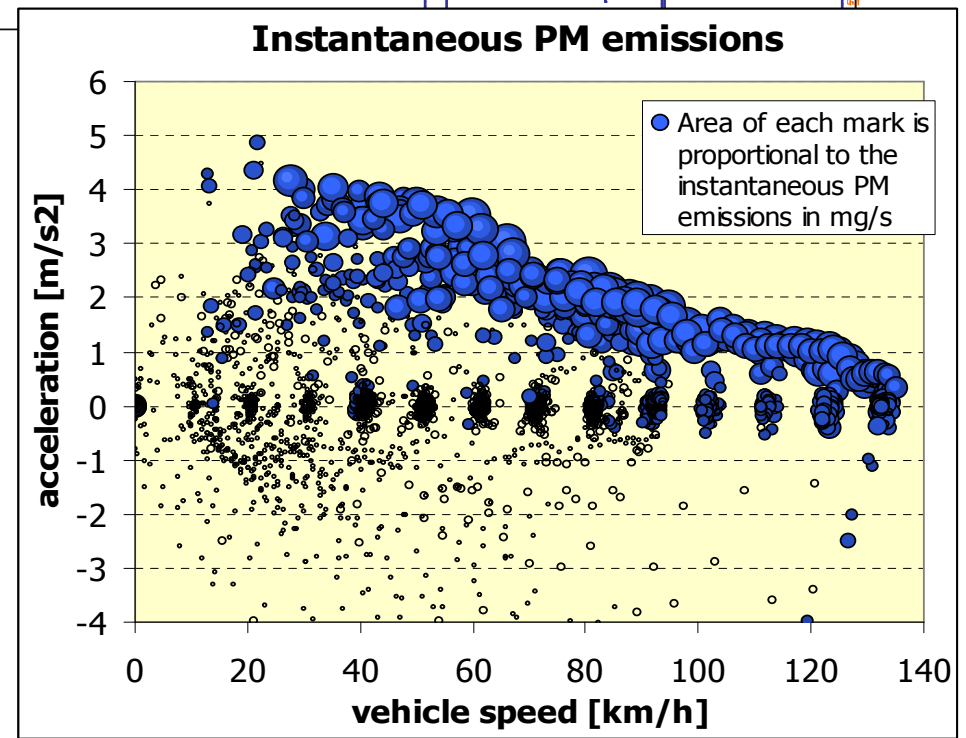
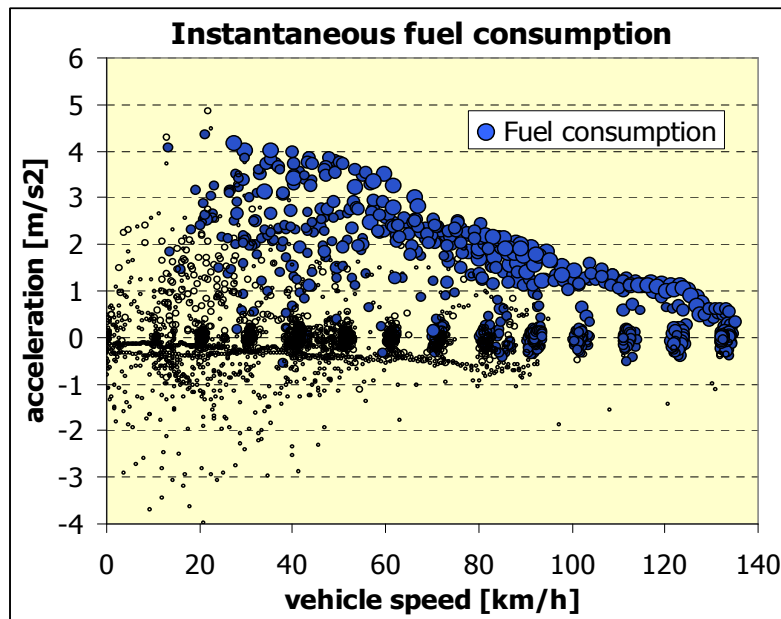
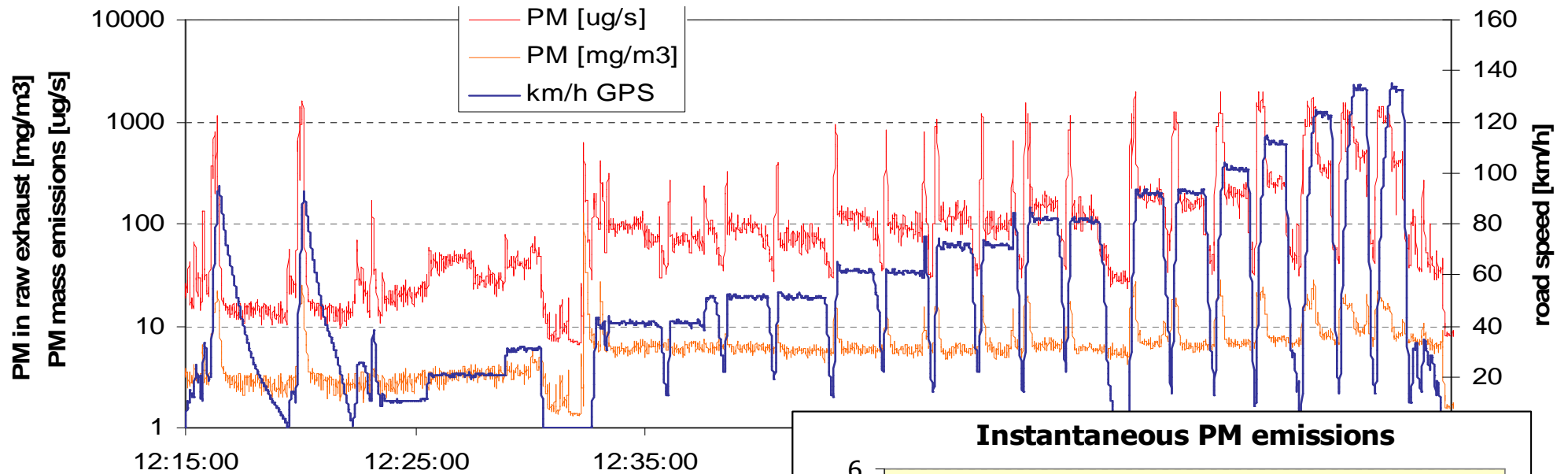


Stoichiometric operation

Gasoline engine real-driving PM emissions



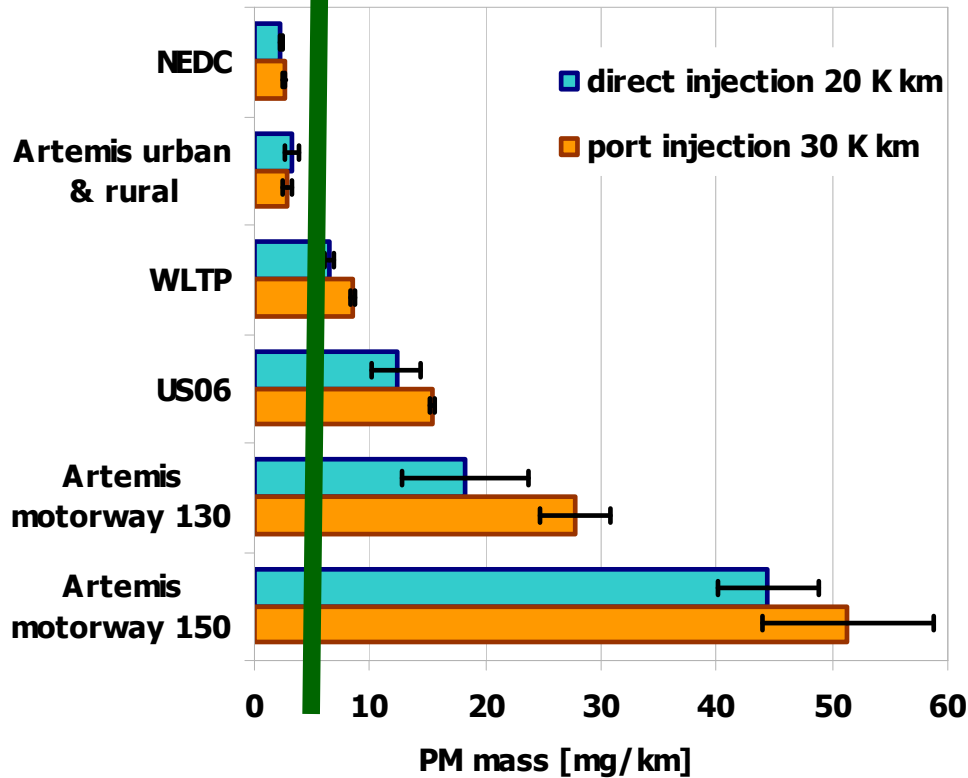
Gasoline engine on-road PM emissions: steady speed vs. full-power acceleration



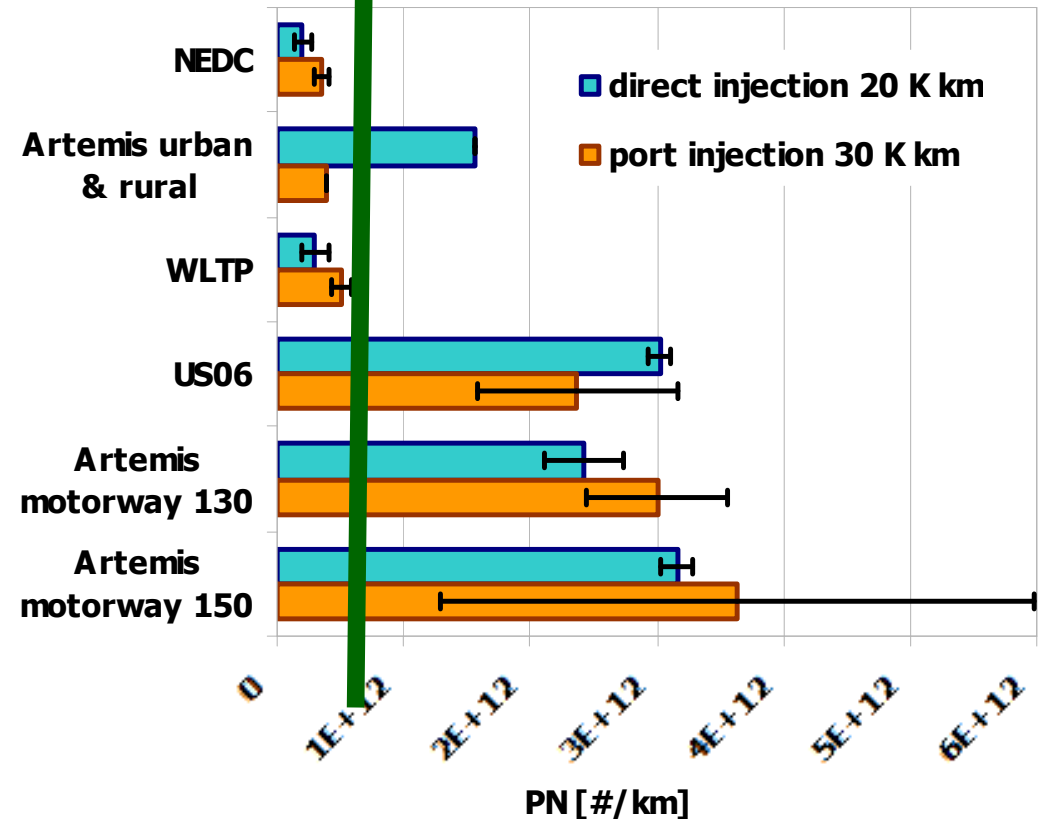
Gasoline engine PM: Choice of cycles

WLTP is “not as lame as NEDC”, but does it cover the problematic enrichment at high load (prohibited by EPA)?
 US06 and Artemis motorway cycles as a supplement?

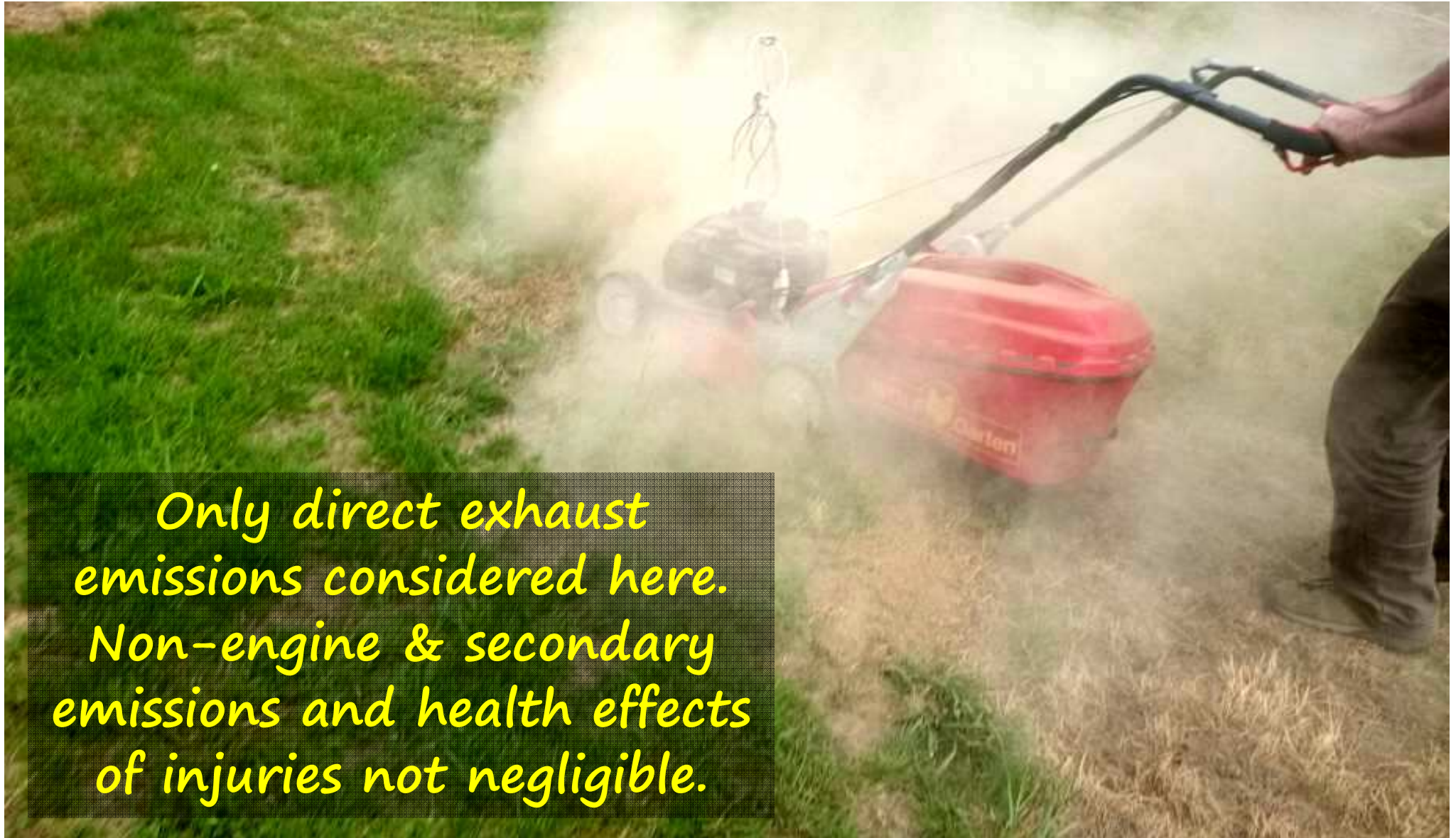
EURO 5 PM mass limit



EURO 5 PN limit



Particle emissions from small engines under real “driving” conditions



Only direct exhaust emissions considered here. Non-engine & secondary emissions and health effects of injuries not negligible.

Lawnmower and weed-eater – test summary (PAH analysis and toxicology assays to follow)

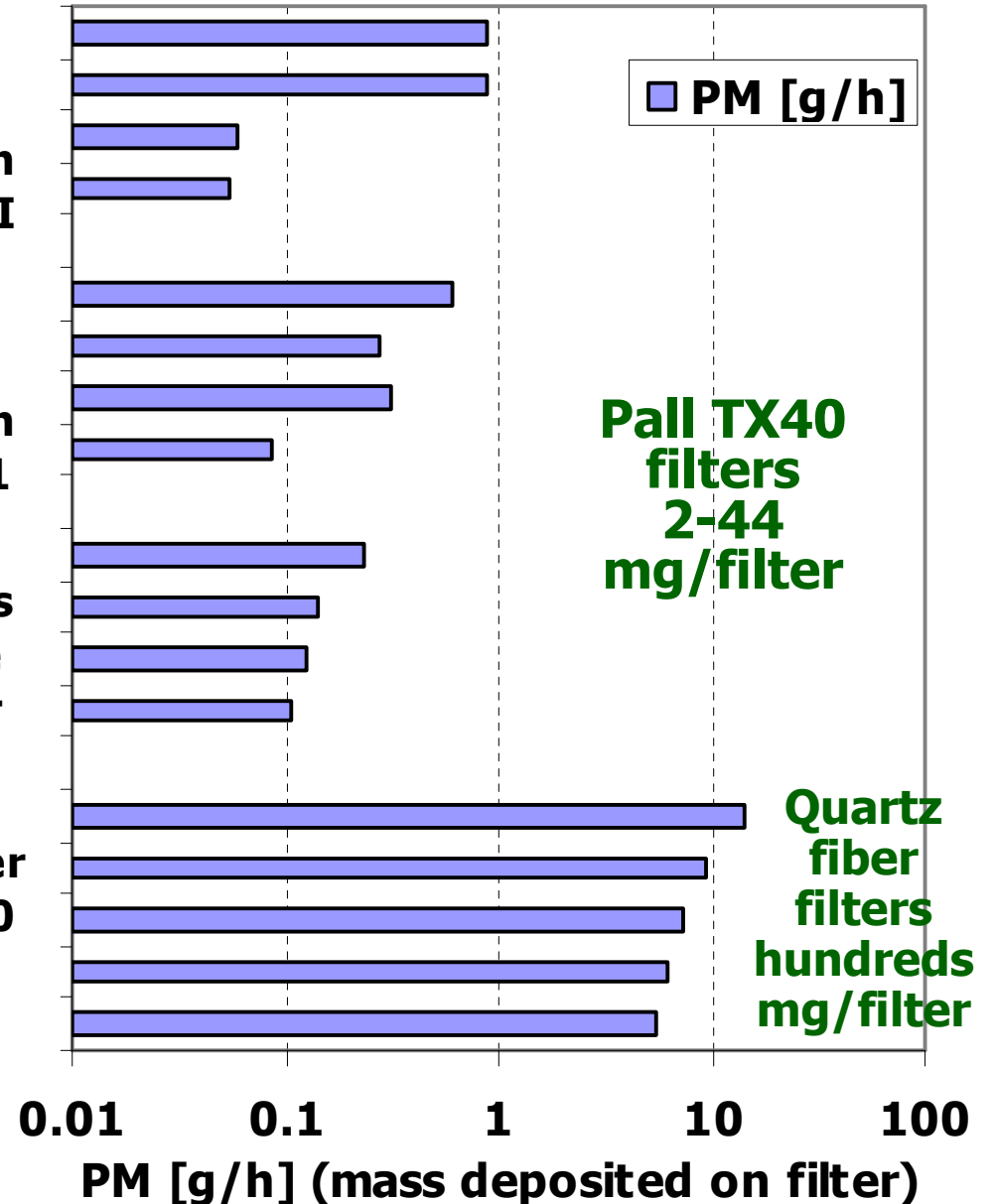


**Wolfgarden
4-cycle
Briggs&Stratton
US EPA Stage II**

**Stiga
4-cycle
Briggs&Stratton
US EPA Phase 1**

**Mid-90's
4-cycle
mower**

**Weed-eater
Stihl FS350
2-cycle**



Challenges of EU automobile diesel engines

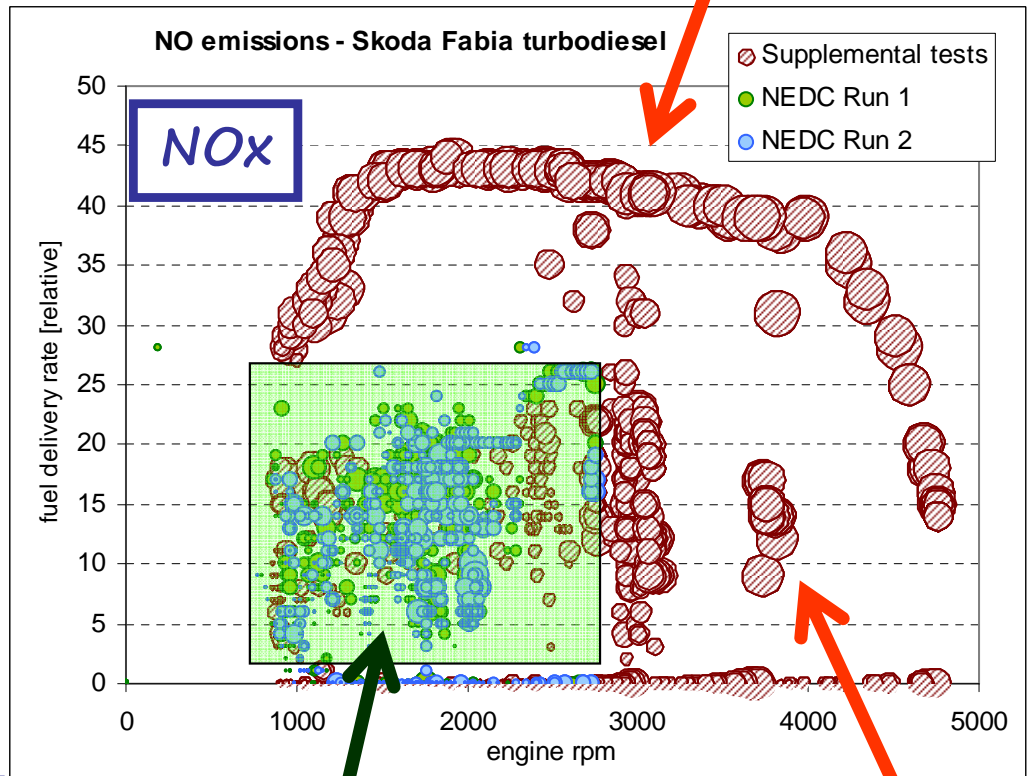
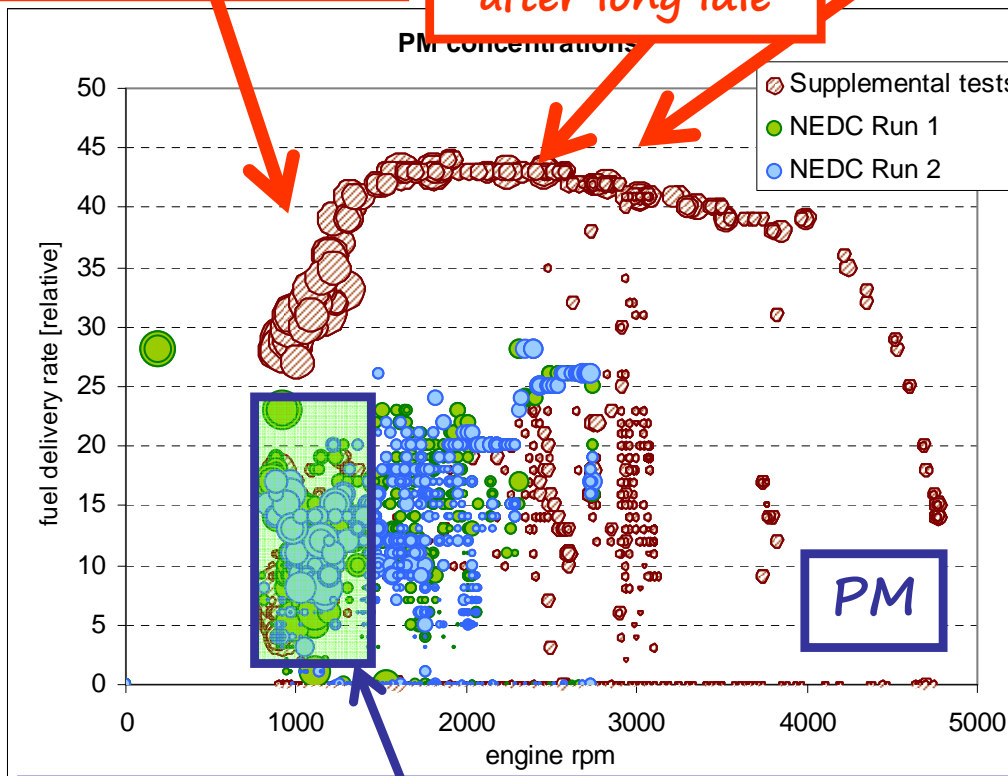
Euro 4 Skoda Fabia – chassis dynamometer runs NEDC vs. full-power loaded accelerations

Problem compounded by downsizing & turbocharging: Relatively low torque at idle.

Problem compounded by cold DOC during accelerations after long idle

Maintaining adequate excess air competes with desire for additional torque

NOx: Use of EGR competes with the desire for additional torque

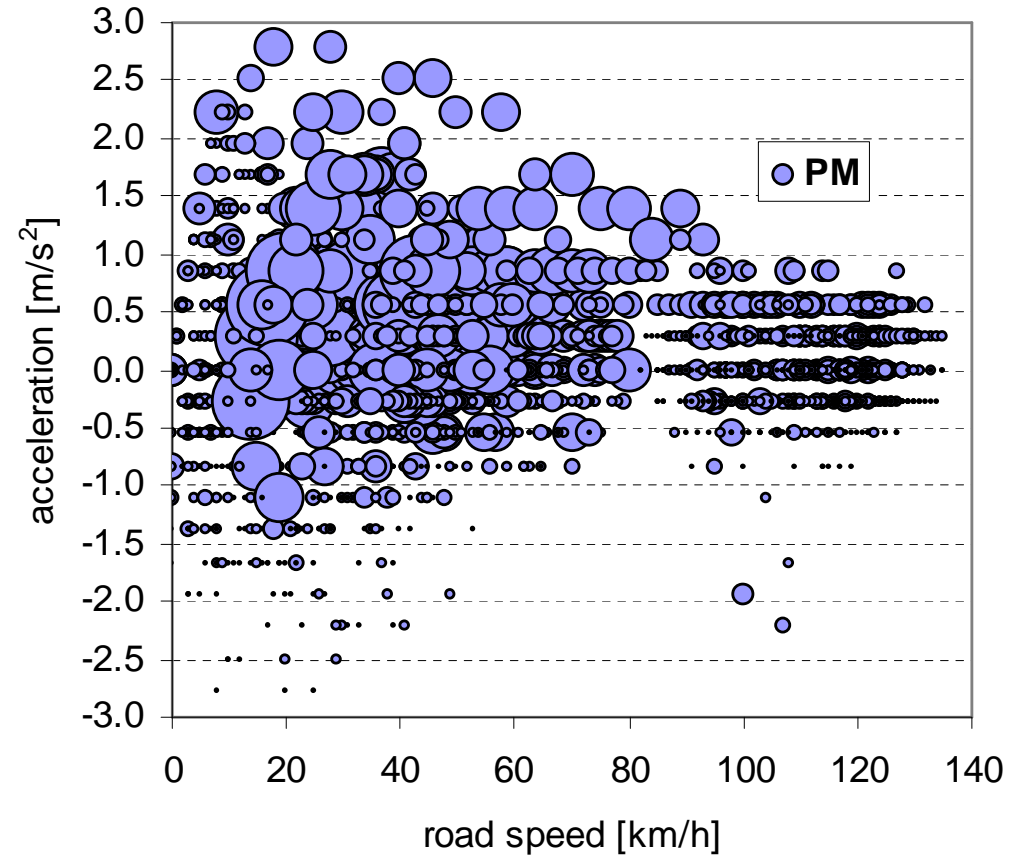
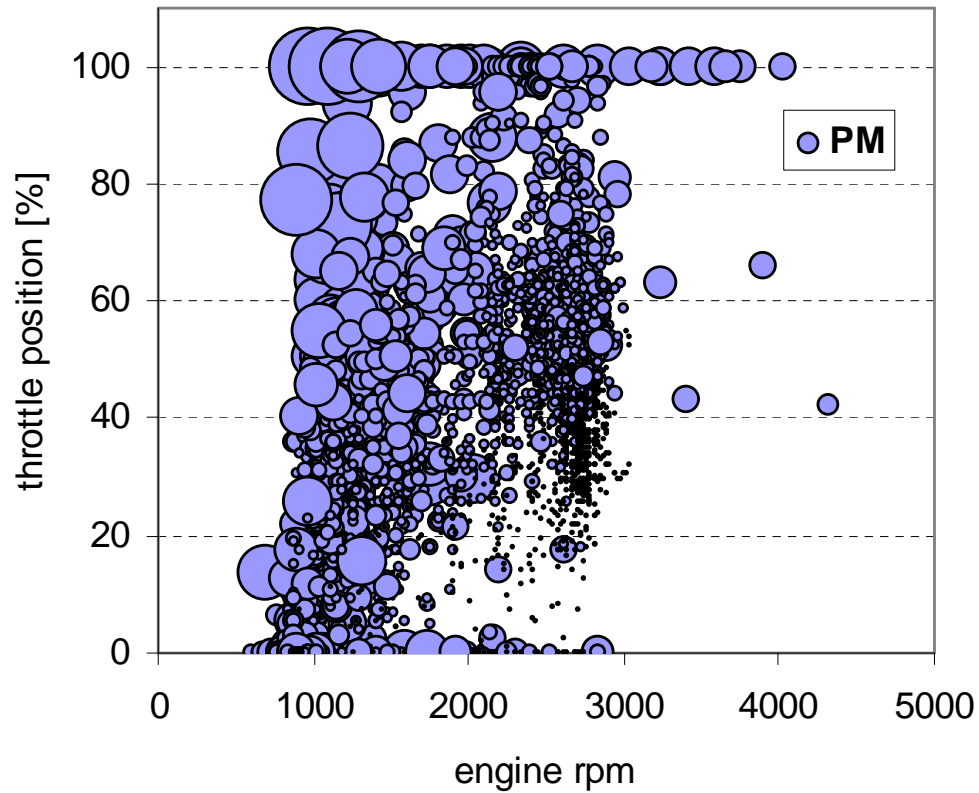


Long idle / low load: DOC cooldown, combustion deterioration, high fraction of OC in PM

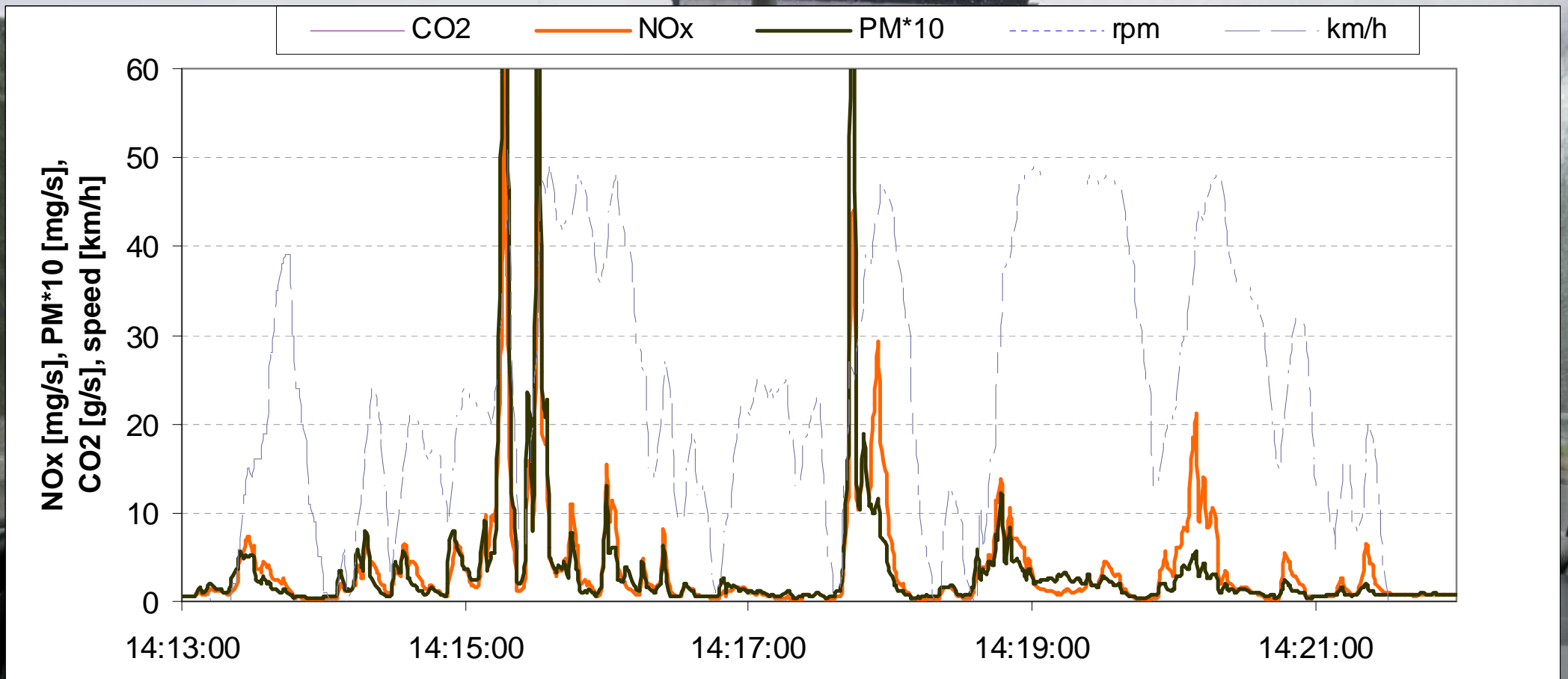
NOx reduced by EGR

?

Euro 4 Skoda Octavia – real-world city driving tests

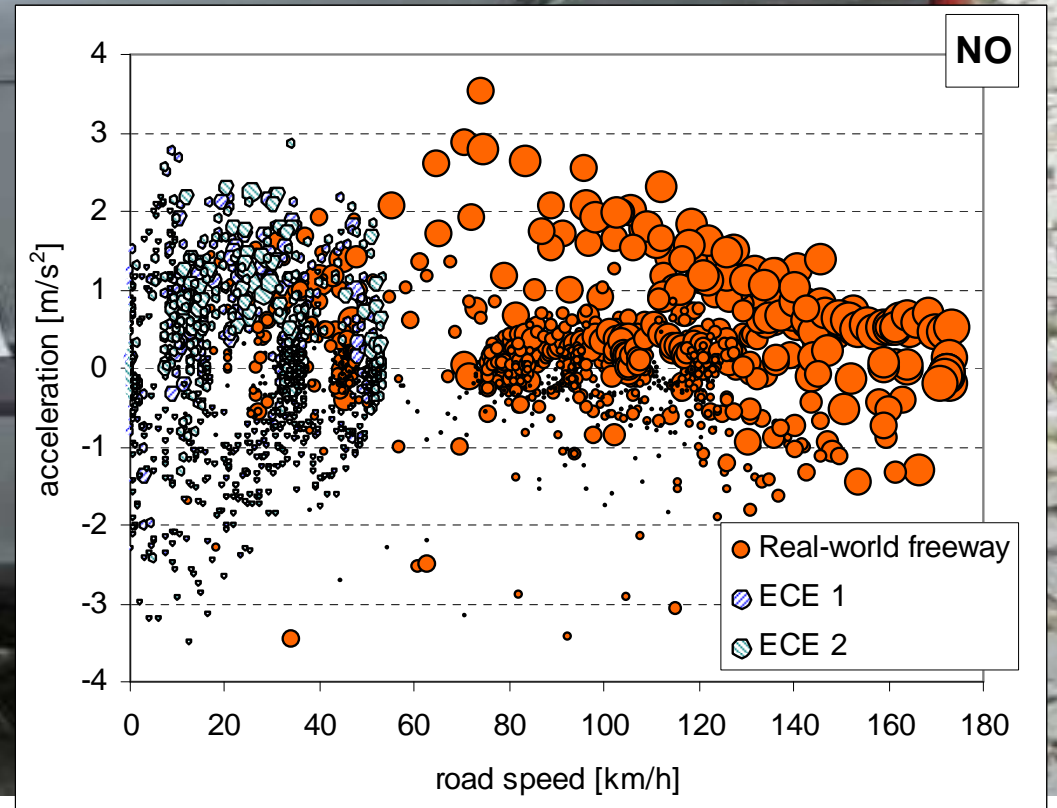
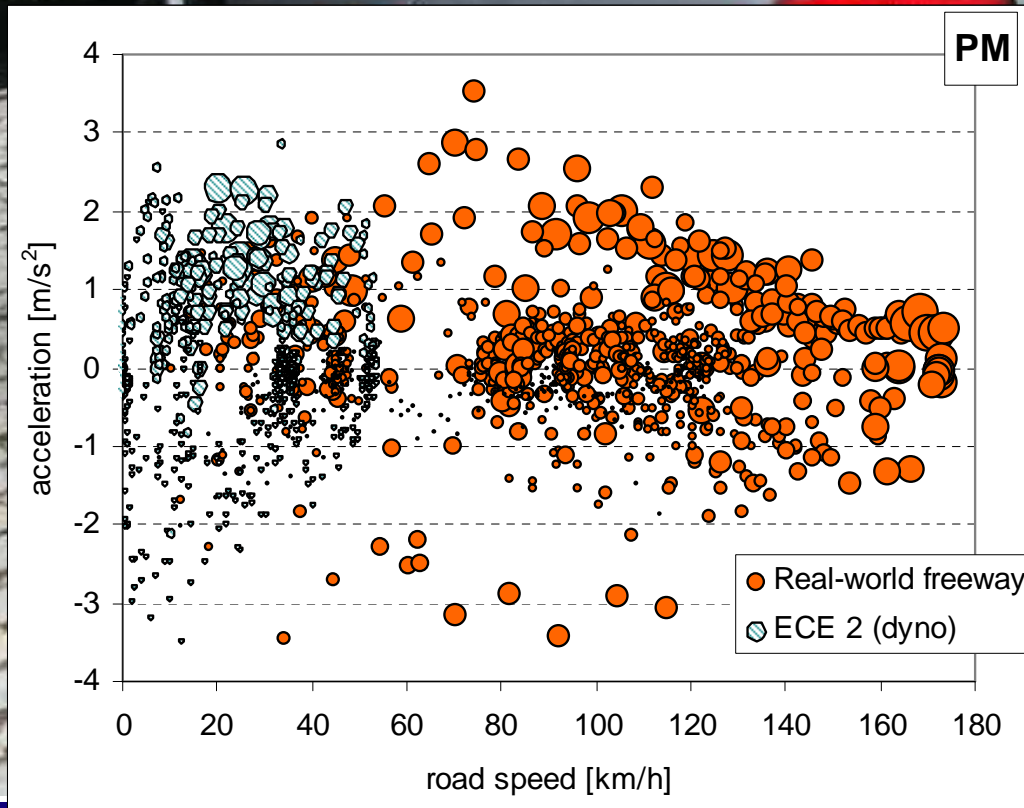


Euro 4 Skoda Octavia – real-world city driving tests



Euro 4 Škoda Octavia – high-speed freeway tests

Aggressive, high-speed driving on a freeway, not atypical for Czech roads
Results contrasted with ECE cycle test on a chassis dynamometer



Congestion effects: DAF 1505 truck, 2006, Euro 5 Paccar engine, 540 thousands km, with loaded trailer (39 tons total weight)



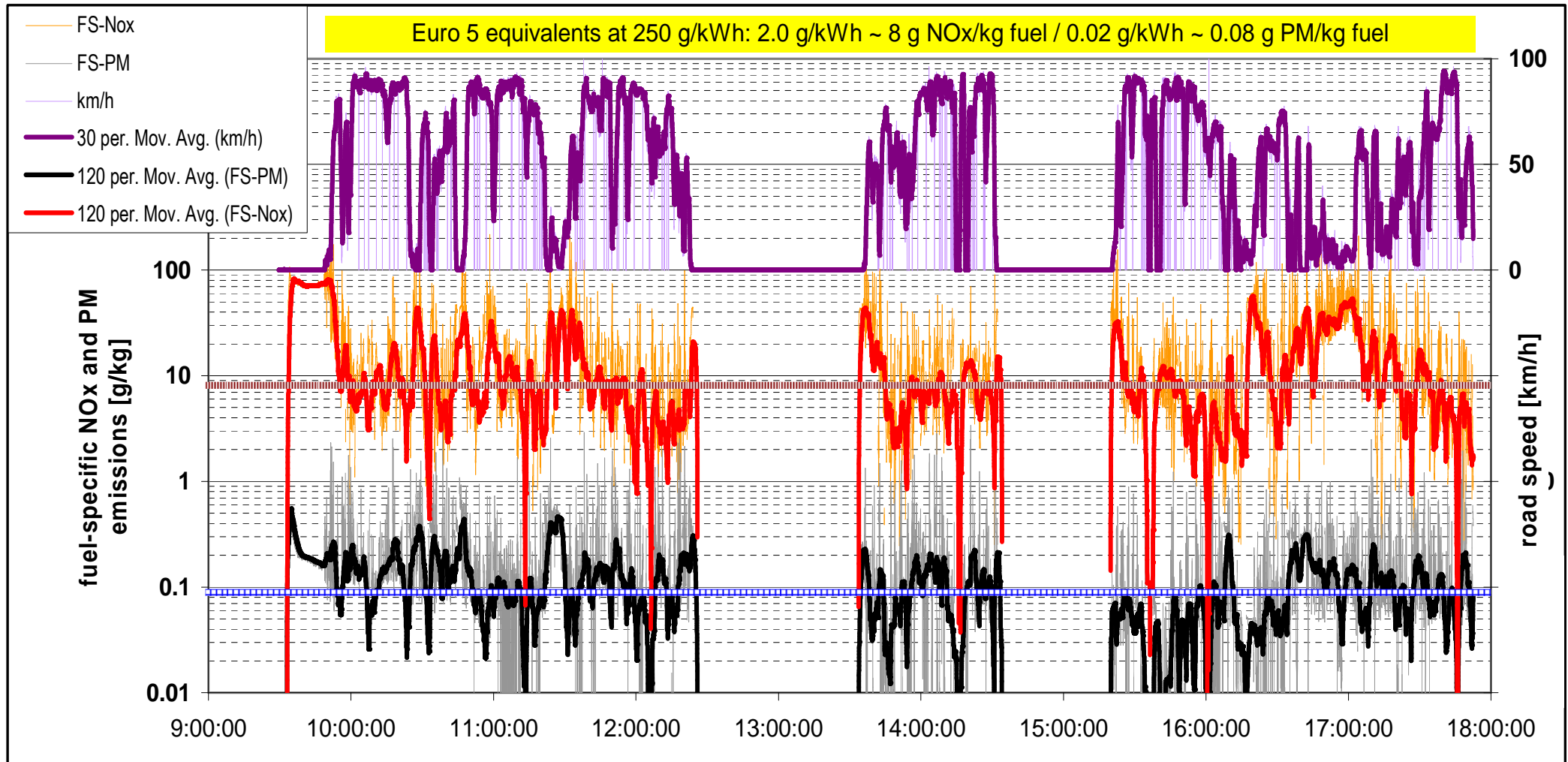
The horror of transit truck traffic

We took a DAF truck with semi-trailer, 39 tons, EURO 5 but no DPF, and circulated the Prague perimeter road waiting for congestion to happen

“Urban creep”:

combustion worsens, DOC cools down, SCR cools down, EGR not feasible

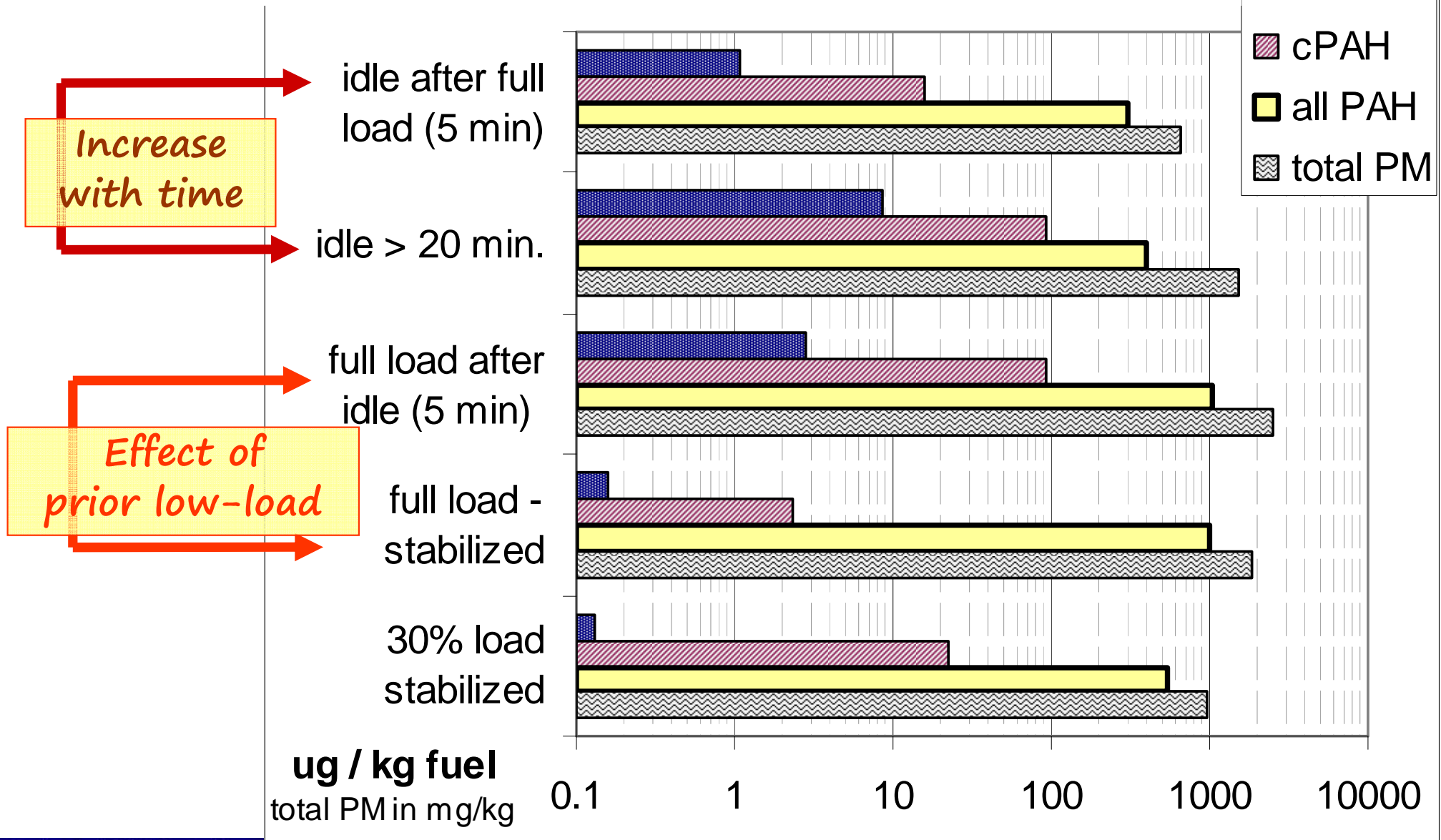
Result: NOx and PM up to one order of magnitude higher



Extended idling effects – diesel fuel – logarithmic scale

An order of magnitude increase during + after extended low-load of emissions of BaP, carcinogenic PAH, all PAH, PM mass

EU Stage III A non-road diesel engine, no aftertreatment



Experimental setup:

Ambient size and time resolved nanoparticle measurement in inhabited areas
Portable vehicle emissions monitoring instrumentation used for ambient measurement

Fast mobility spectrometer (Engine Exhaust Particle Sizer, Model 3090, TSI Inc.)
Condensation counter (UF-CPC 200, Palas)
notebook, GPS, batteries mounted on hand carts (or a baby carriage).

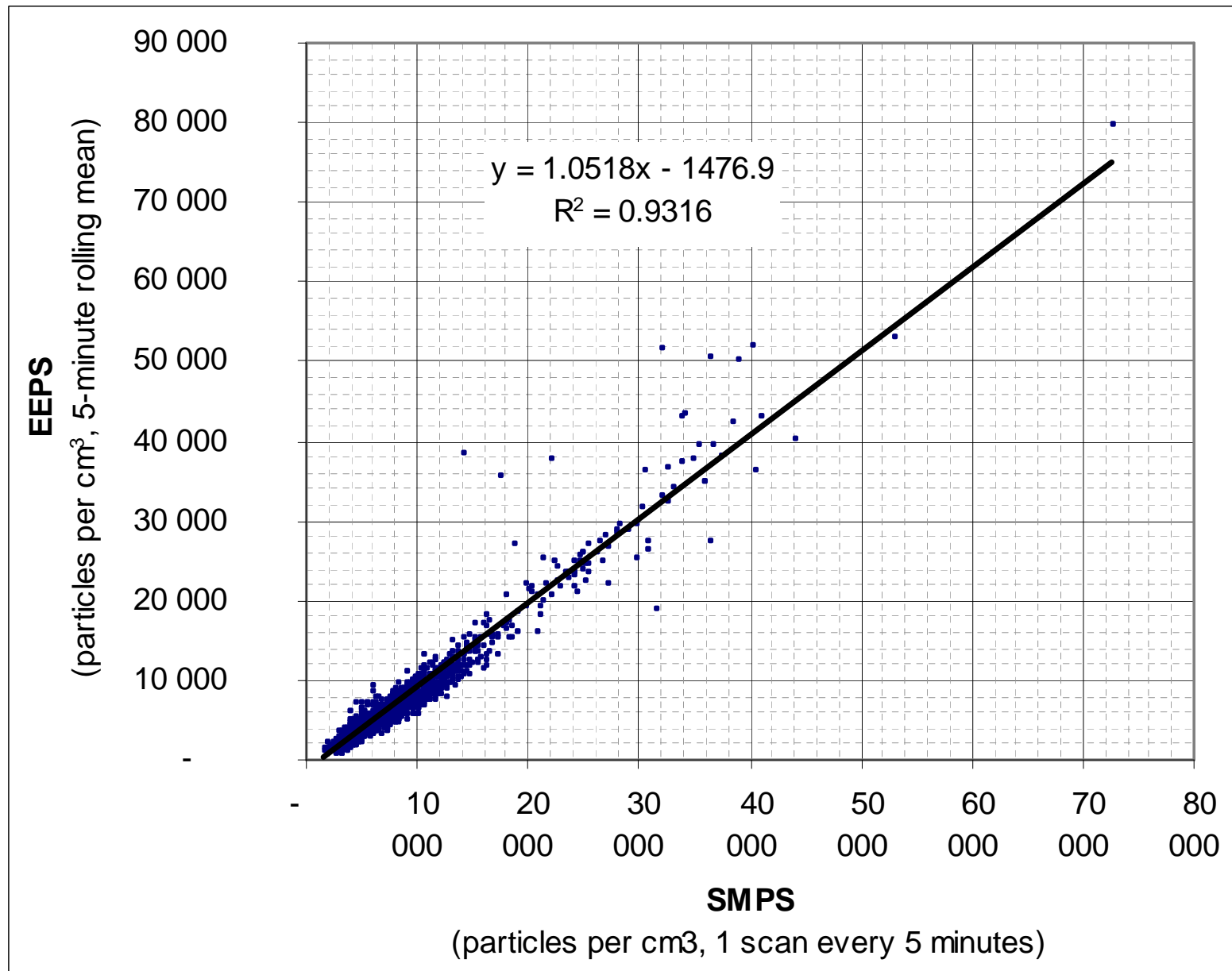
Study designed, measurements done, and data interpreted by an interdisciplinary team of engine – combustion – aerosols – toxicology specialists.



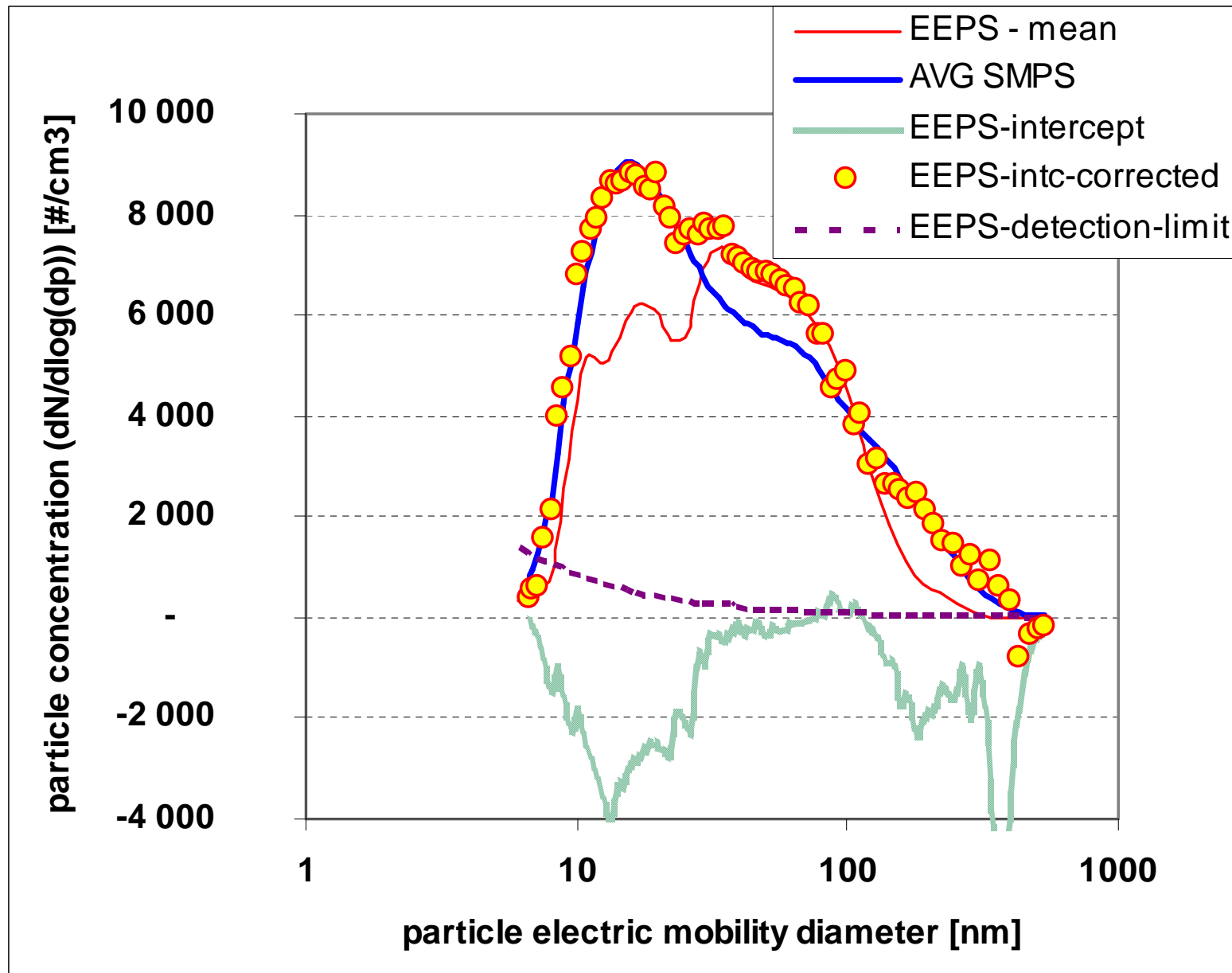
EEPS
5-560 nm

CPC
> 4 nm

Validation of EEPS for ambient measurements: co-location with SMPS+CPC (UFIREG project, 28.6.-3.7.2014) total particle count



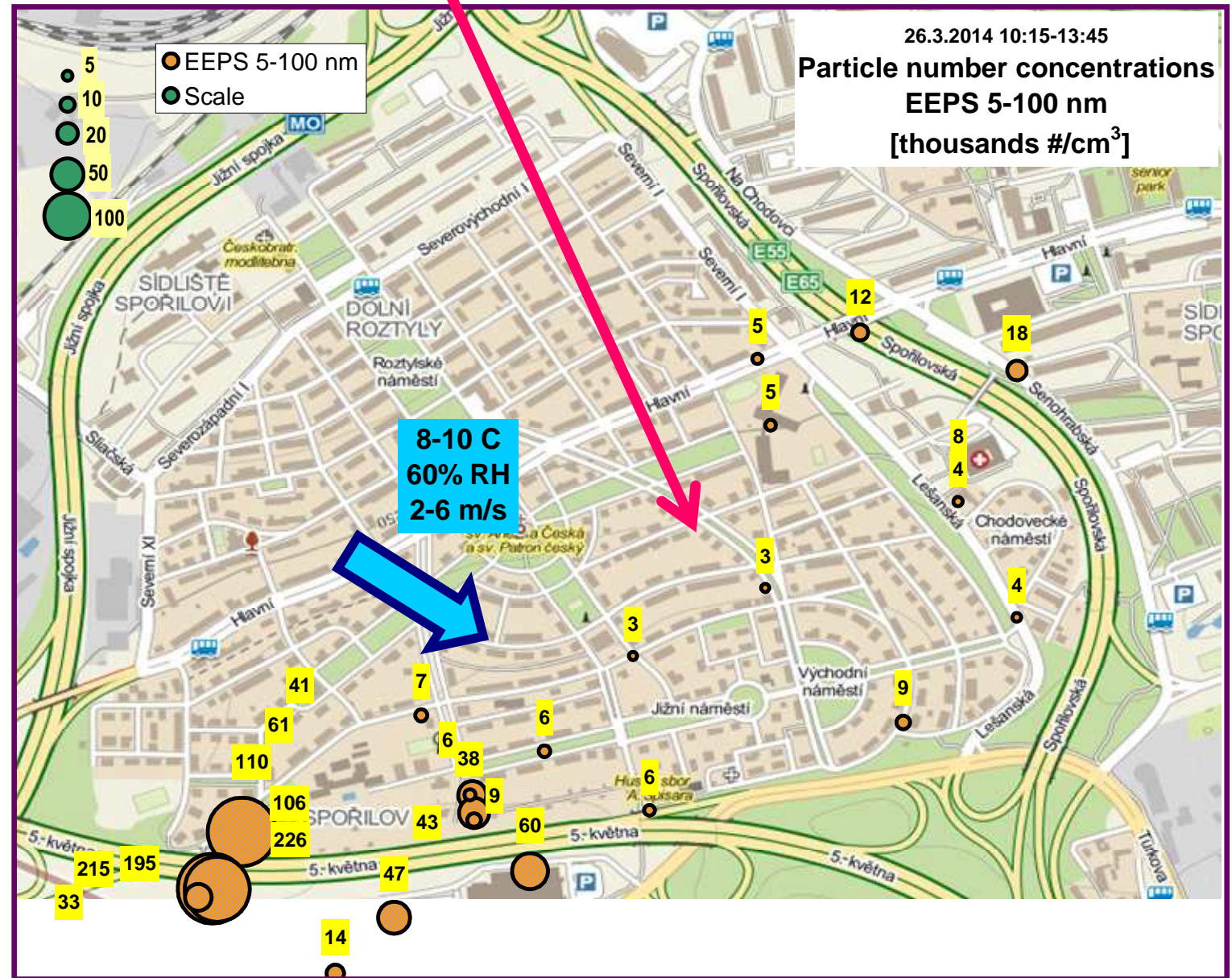
Validation of EEPS for ambient measurements: co-location with SMPS+CPC (UFIREG project, 28.6.-3.7.2014) average particle size distribution



Results: Neighborhood of Spořilov instrumented walking tour

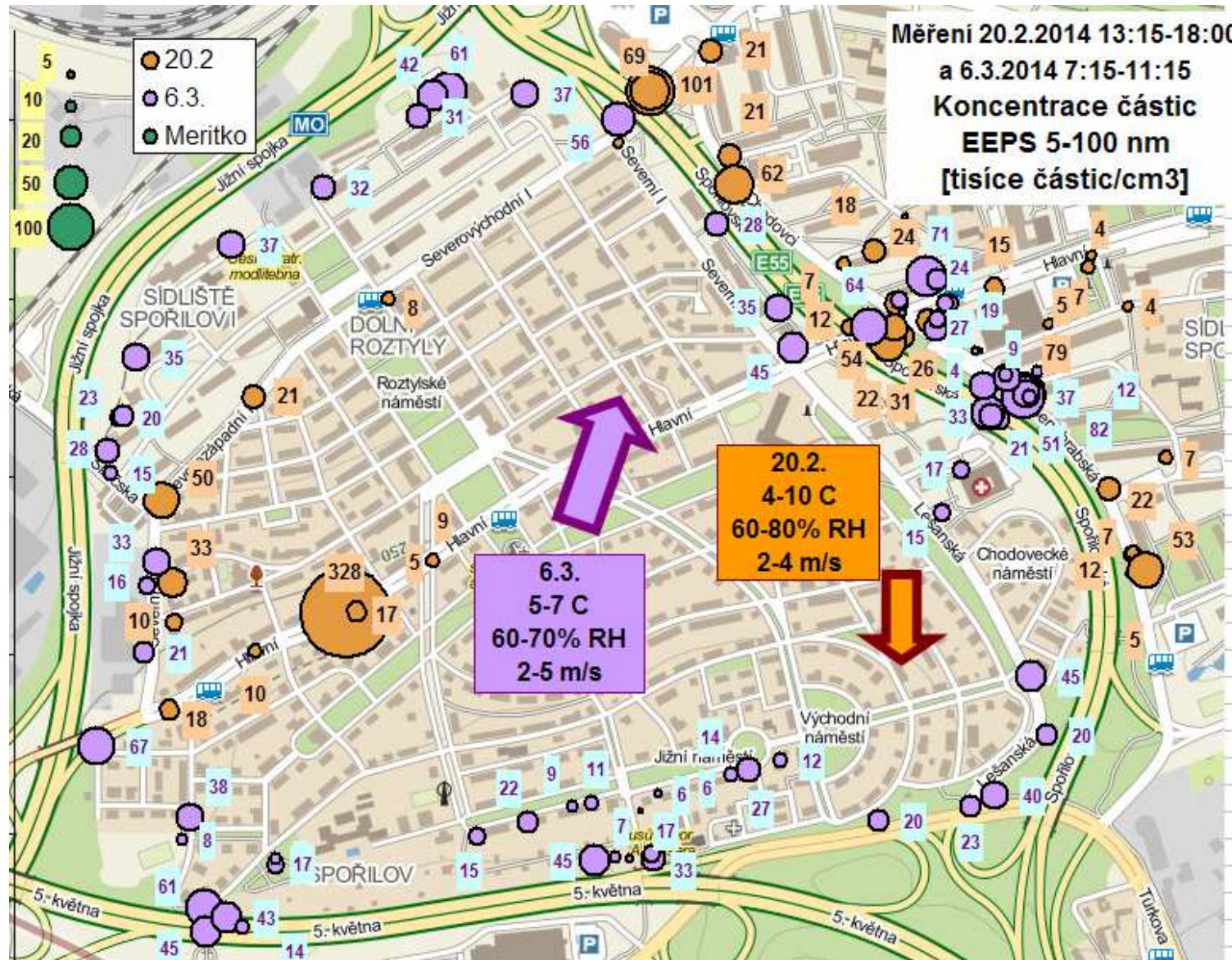
Absence of larger particles & absence of higher concentrations in the inner neighborhood away / upwind from traffic

Assuming that home heating appliances are evenly distributed throughout the neighborhood, why don't we see anything upwind of the road?



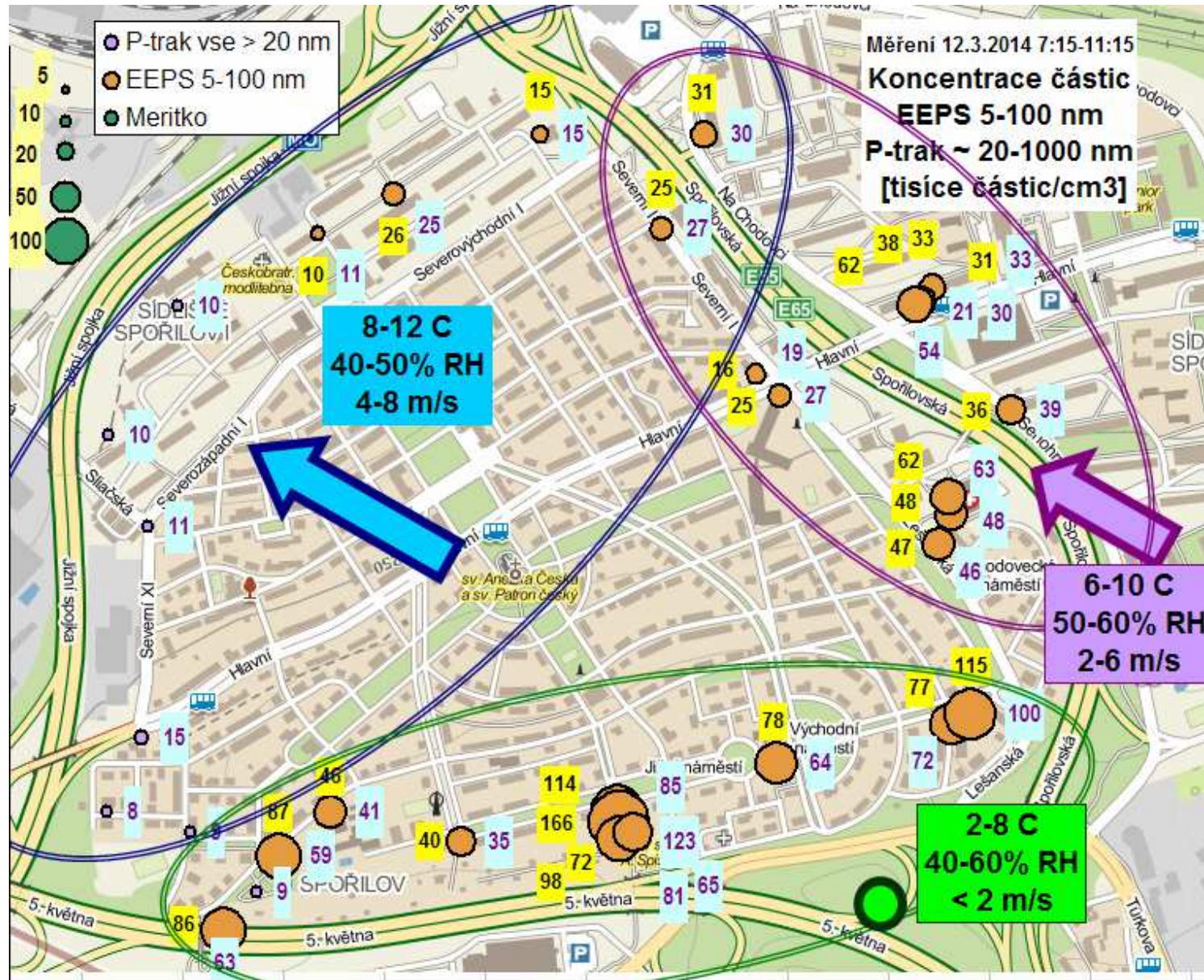
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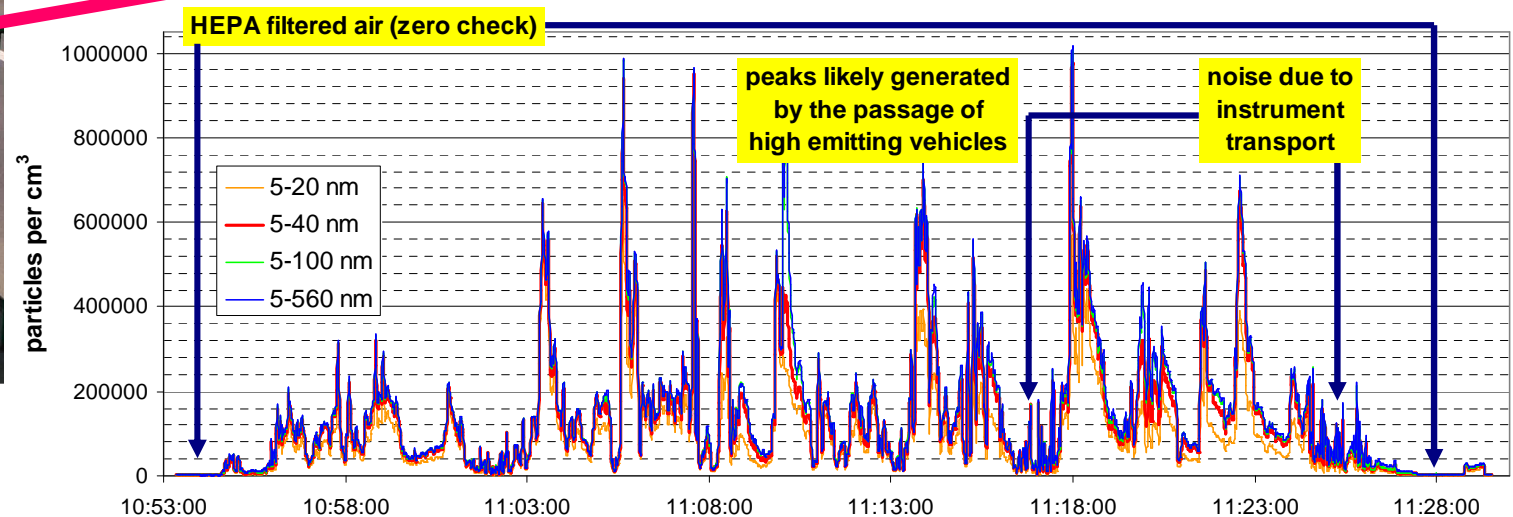
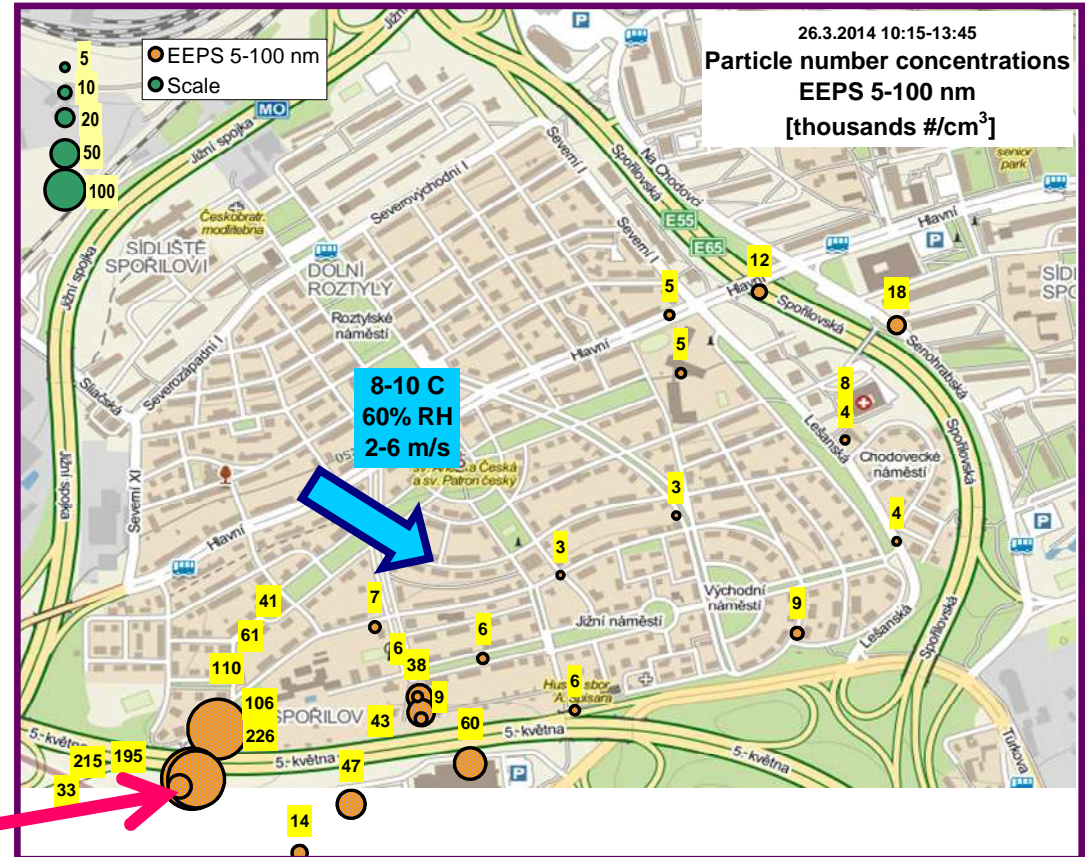
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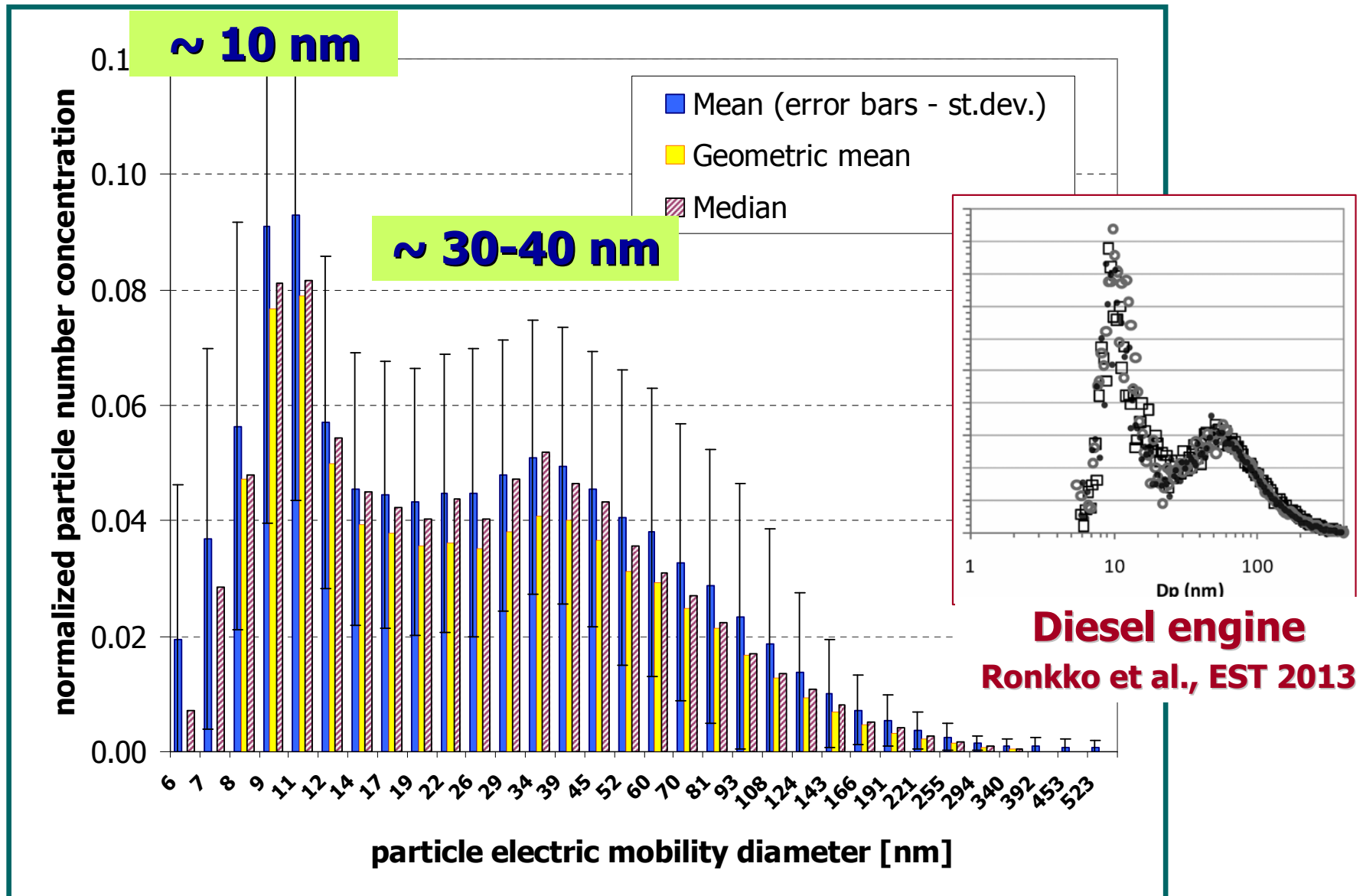
Results: Neighborhood of Spořilov instrumented walking tour

“Spořilov hotspot”:
 After low-speed travel through congested area of Prague, heavy trucks accelerate onto a freeway and climb a hill – “reentrainment” of material deposited in the exhaust system.



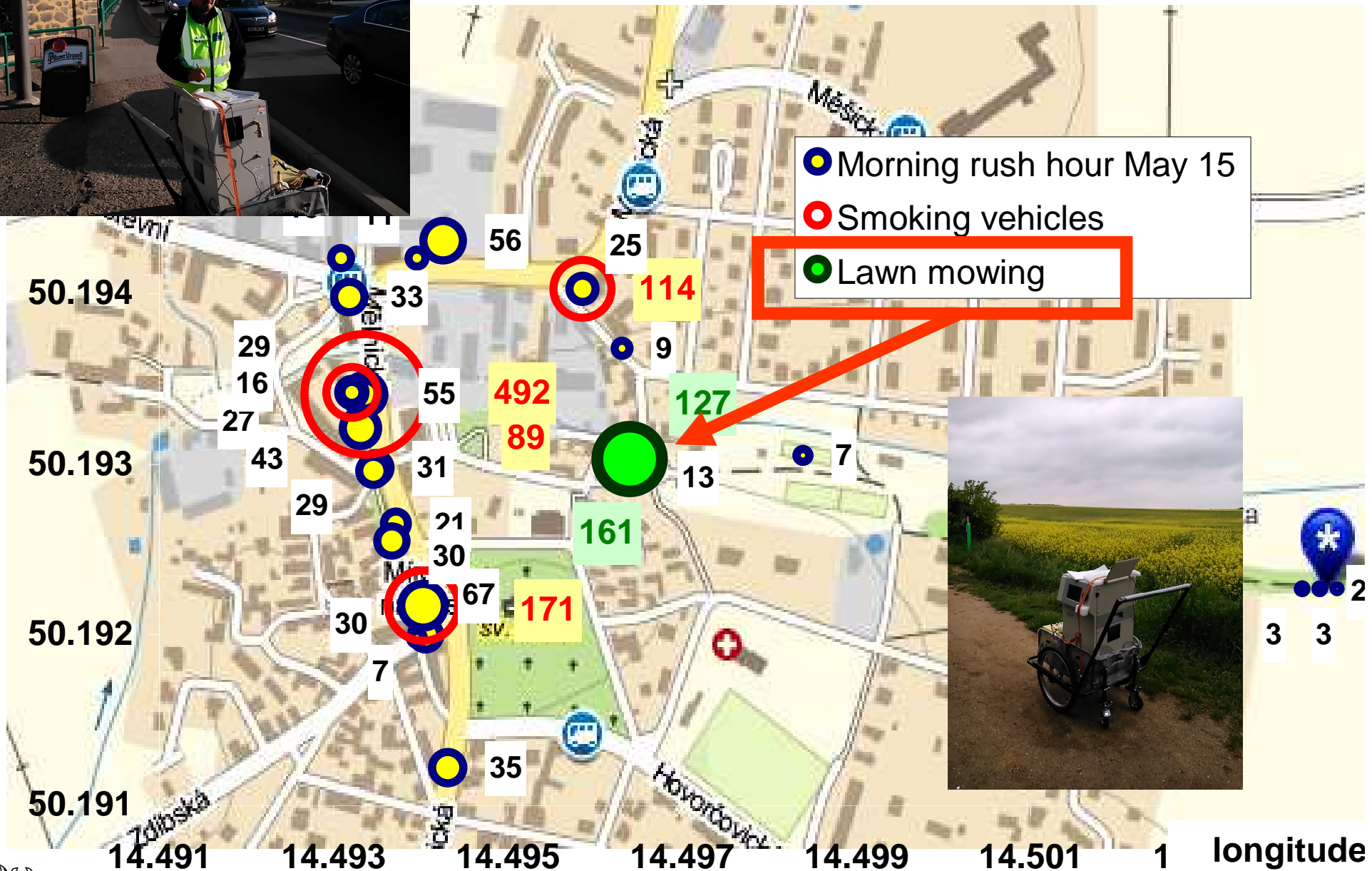
Particle concentrations vary, size distributions remain similar near roadways, and match engine exhaust size distributions

Spořilov, February 2014, mean of 40 normalized distributions

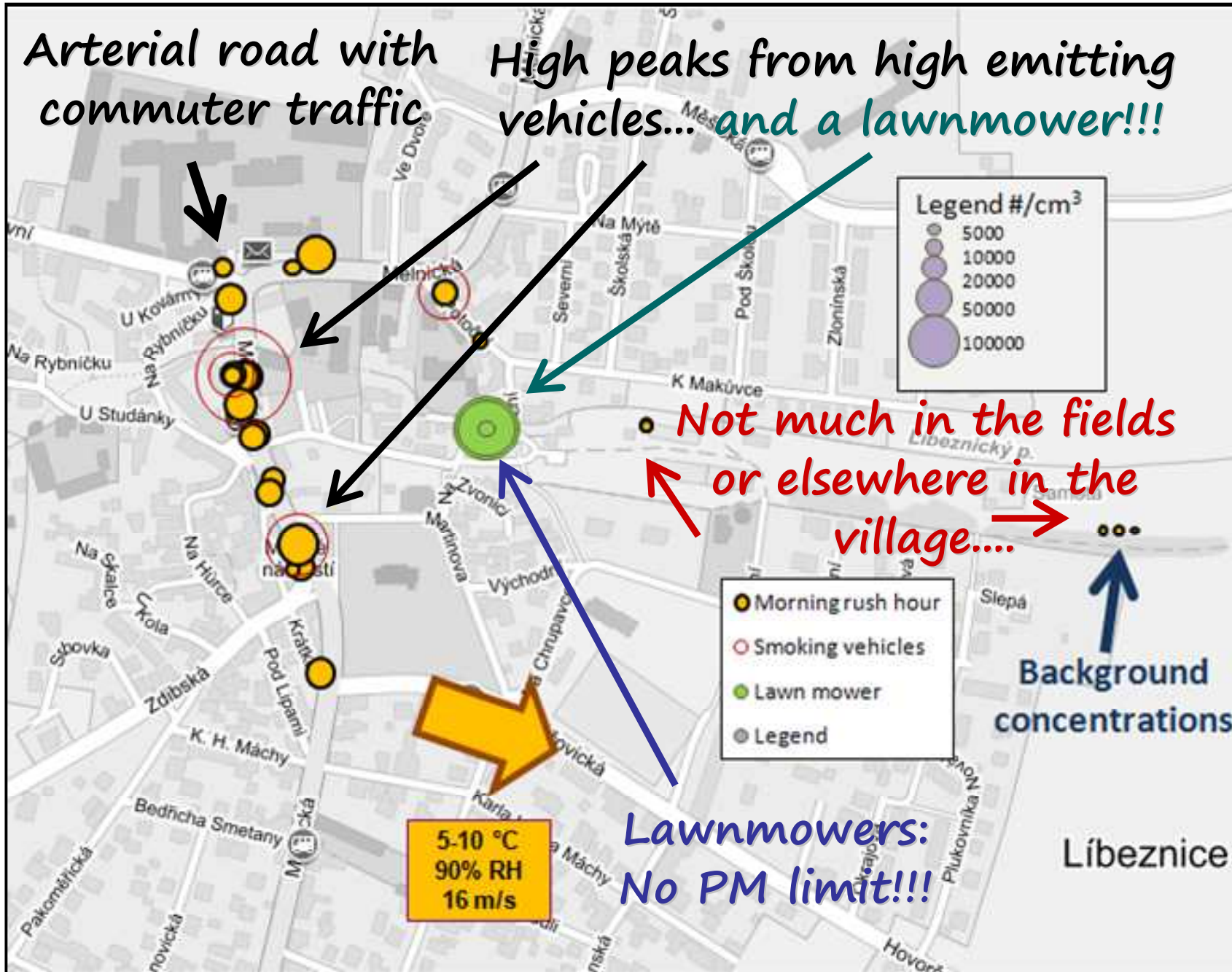


Vojtišek et al., NanoCon 2014

Total particle counts, 10-500 nm
thousands of particles per cm³
Libeznice, 15. 5. 2014, morning rush hour



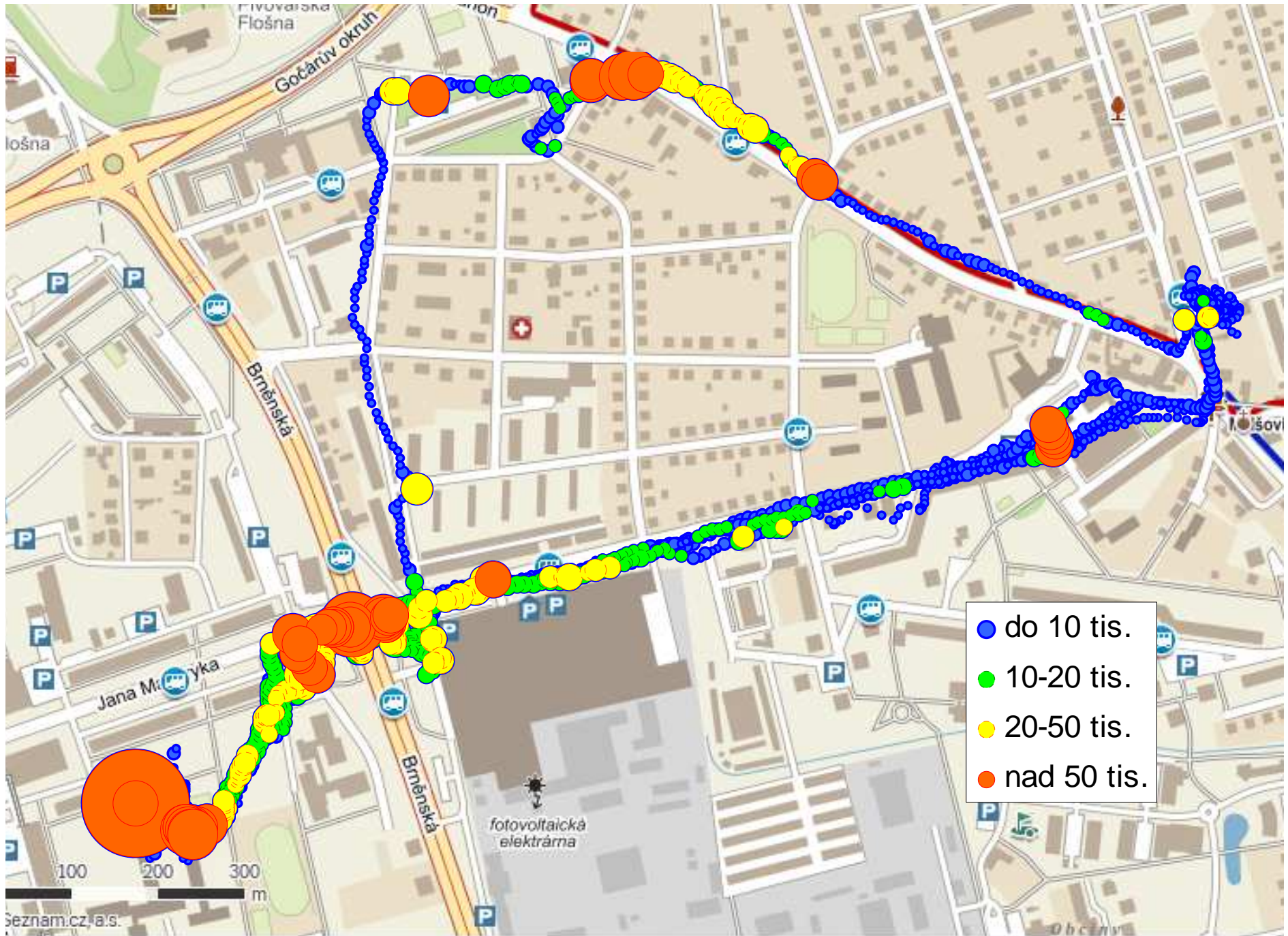
Results: Village of Libeznice instrumented walking tour



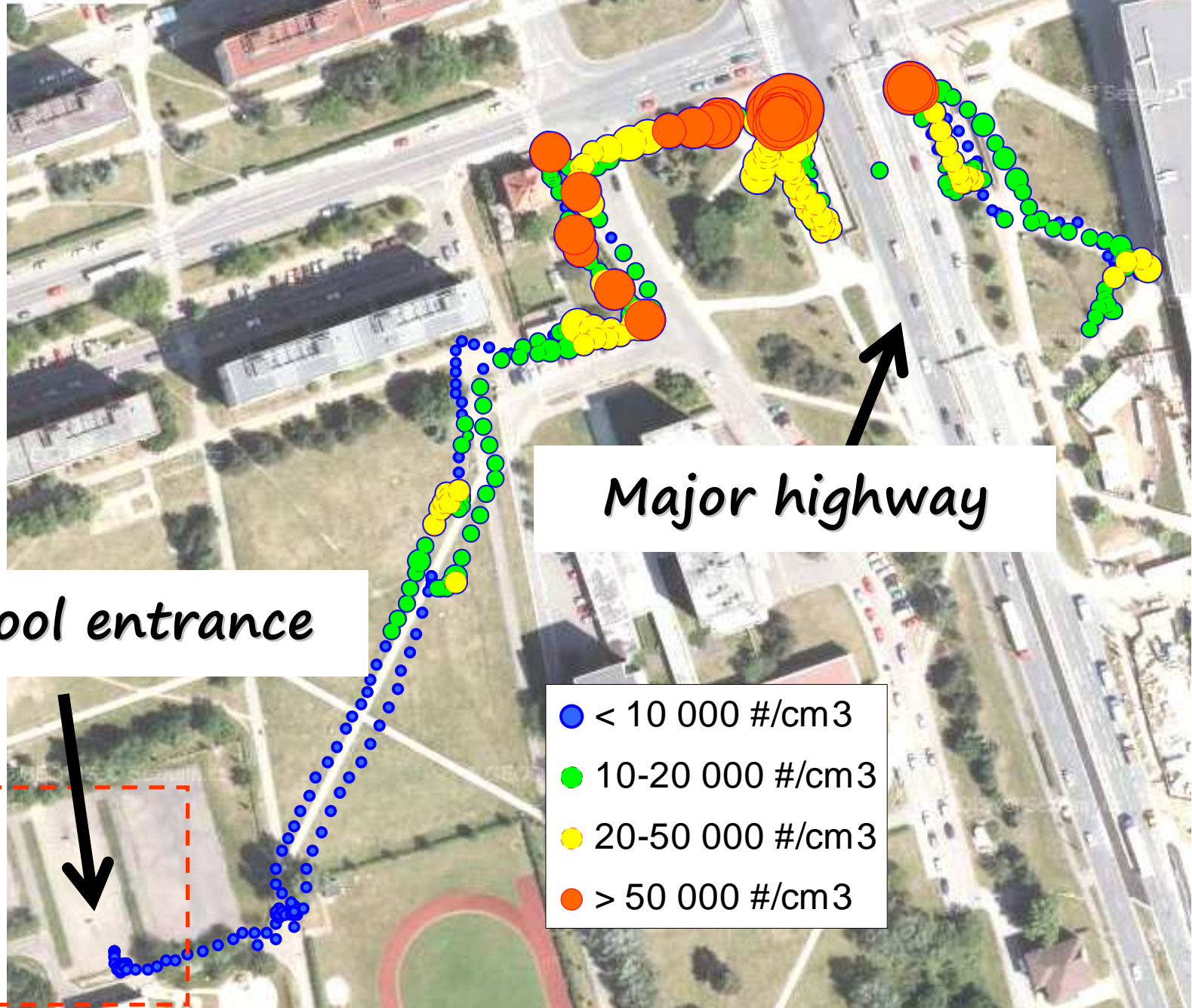
Results: Sion Elementary School instrumented walking tour



Results: Sion Elementary School instrumented walking tour

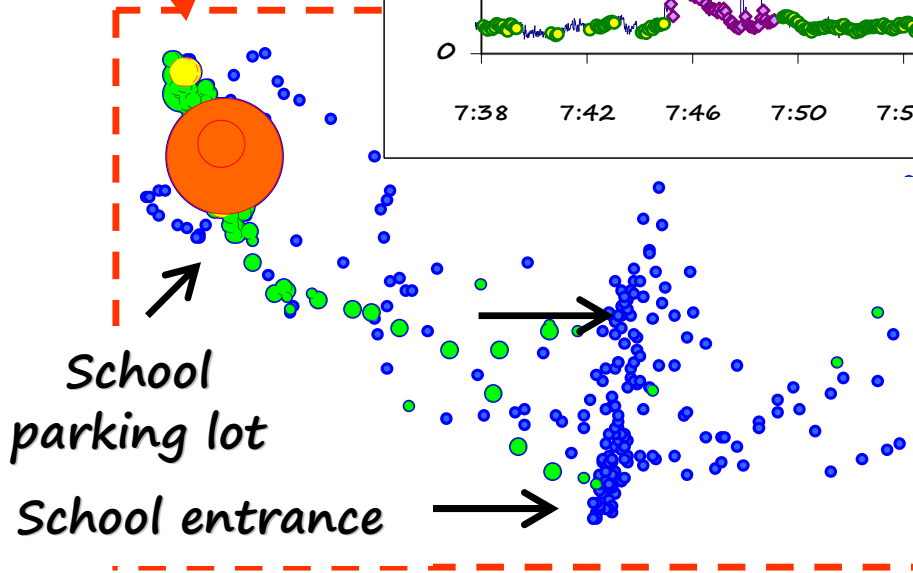
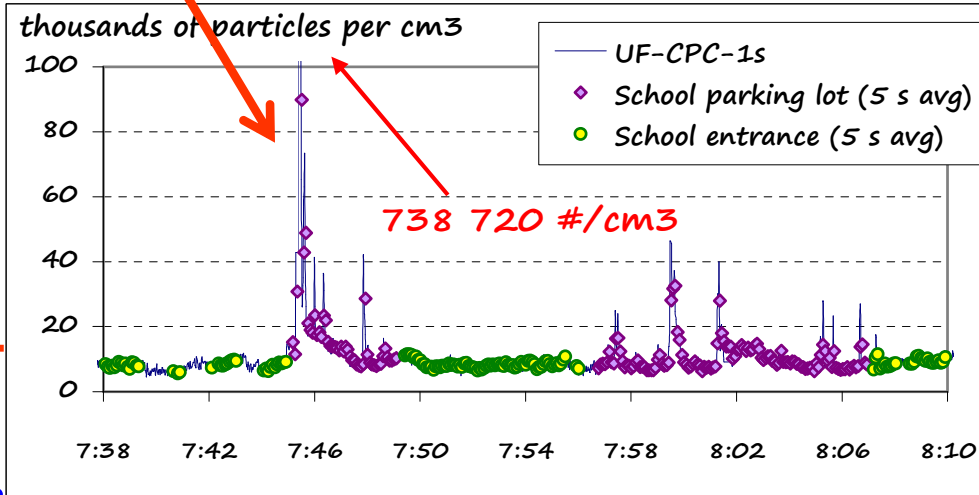


Results: Sion Elementary School instrumented walking tour

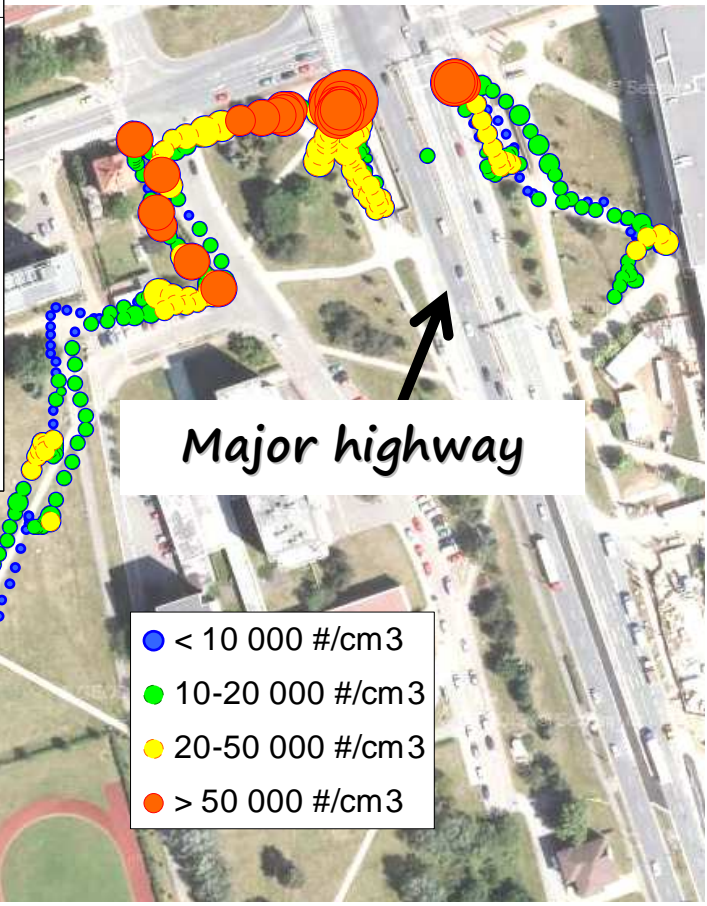


Results: Sion Elementary School instrumented walking tour

Highest concentrations:
High emitting engines
 (vehicles in bad shape, small engines, idling vehicles, etc.)



School entrance



What we have learned summarized

Large temporal and spatial variance of nanoparticle concentrations.

Higher number concentrations of nanoparticles always correlated to the presence of internal combustion engines upwind and/or in the vicinity. Away / upwind from roads, concentrations were low.

Normalized size distributions generally agreed with engine exhaust size distributions.

Despite measuring during heating season, no other major sources of nanoparticles (home heating) identified.

High emitting engines – vehicles in bad shape, small engines (lawnmower, scooter) with no PM limit – responsible for peaks.

Highest concentrations found where expected based on knowledge of engine emissions: traffic were entering a freeway after extended idling, at intersections, etc.

Working knowledge of engines and their emissions helpful in data interpretation, engines are complex non-linear dynamic systems.

Findings useful for transportation & land-use planning.

Conclusions

Examples of data from several instrumented neighborhoods walking tours suggest that internal combustion engines remain the dominant source of nanoparticles in the Czech Republic.

Nanoparticles are concentrated where they are expected based on knowledge of internal combustion engine emissions: in the vicinity of high emitting vehicles, idling vehicles, congested areas, intersections.

Large peaks around 10 nm, with a second peak in tens of nm, correspond to engine exhaust patterns.

Large concentrations are generally absent away from engines, but where one would expect operational home heating appliances (all measurements done in winter).



Thank you !

European Social Fund, CZ.1.07/2.3.00/30.0034
Support of Research Teams at Czech Technical University in Prague.



Warning: This engine may produce nanoparticles that are harmful when inhaled.



EU LIFE+ program, project MEDETOX - Innovative Methods of Monitoring of Diesel Engine Exhaust Toxicity in Real Urban Traffic (LIFE10 ENV/CZ/651)

Czech Science Foundation project BIOTOX (13-0148S): Mechanisms of toxicity of particles from biofuels