

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

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Nanoparticles ( $d_p < 100$  nm) are more detrimental to human health than equivalent mass of larger particles. In order to reduce their concentrations in air, we should know their sources, just like we did with PM mass. Emissions of nanoparticles from internal combustion engines are strongly dependent on current and prior engine operating conditions and their distribution is therefore highly non-uniform (in time, in space, in different vehicles, etc.).

**Goal:** Compact, mobile, size-resolved measurement of nanoparticles in ambient air in residential neighborhoods.

## Experimental setup:

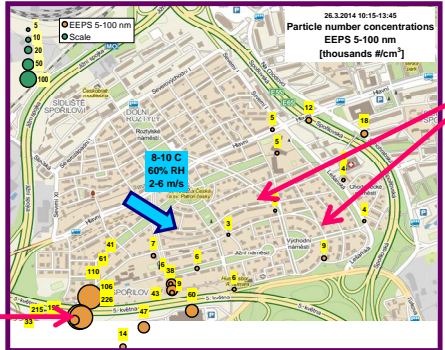
Portable vehicle emissions monitoring instrumentation used for ambient measurement:  
Fast mobility spectrometer (Engine Exhaust Particle Sizer, TSI Inc.), condensation counter (UF-CPC, Palas), notebook, GPS, batteries mounted on hand carts (or a baby carriage).  
Study designed, measurements done, and data interpreted by an interdisciplinary team of engine – combustion – aerosols – toxicology specialists.



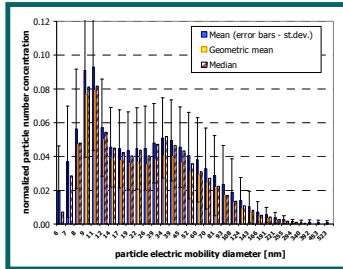
## Spořilov neighborhood "instrumented walking tour"

Quantitative measurements taken during 1-5 minute stops, qualitative assessment during walking.

**"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.



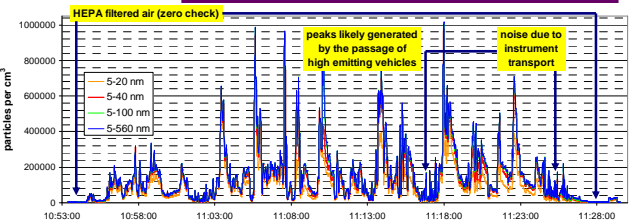
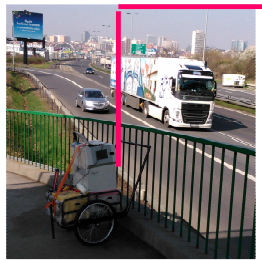
Absence of larger particles & absence of higher concentrations in the inner neighborhood: Assuming that home heating appliances are evenly distributed throughout the neighborhood, why don't we see anything upwind of the road?



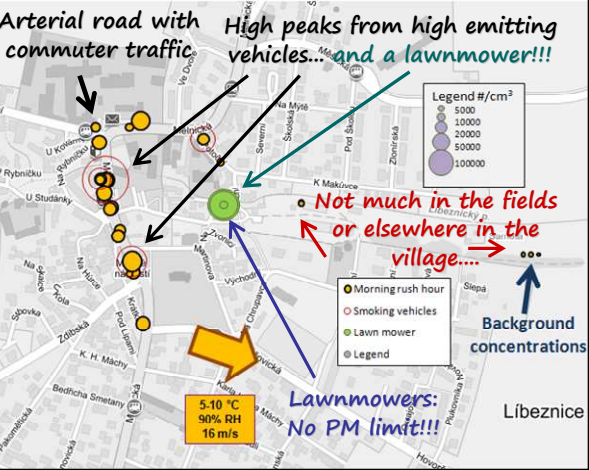
Average of 40 normalized size distributions at various locations

Size matters:

Large peaks around 10 nm, with a second peak in tens of nm, correspond to engine exhaust particle size distribution. Particles around 10 nm can be missed if measurements start around 15-20 nm (ambient studies) or 23 nm (vehicle emissions type approval - PMP).



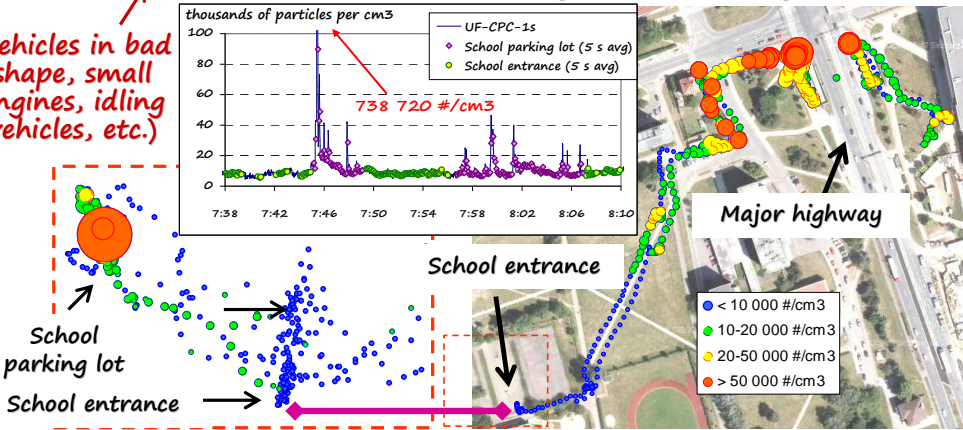
## Village of Libeznice "instrumented walking tour"



Highest concentrations: High emitting engines

(vehicles in bad shape, small engines, idling vehicles, etc.)

Sion High School "instrumented walking tour" Highest concentrations at parking lot. High contribution of high emitters.



**Concluding remarks:** 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).

## Acknowledgments:

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