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Measurement of particle concentrations in Piacenza urban area: Ambient air levels and personal exposure concentrations

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Research background

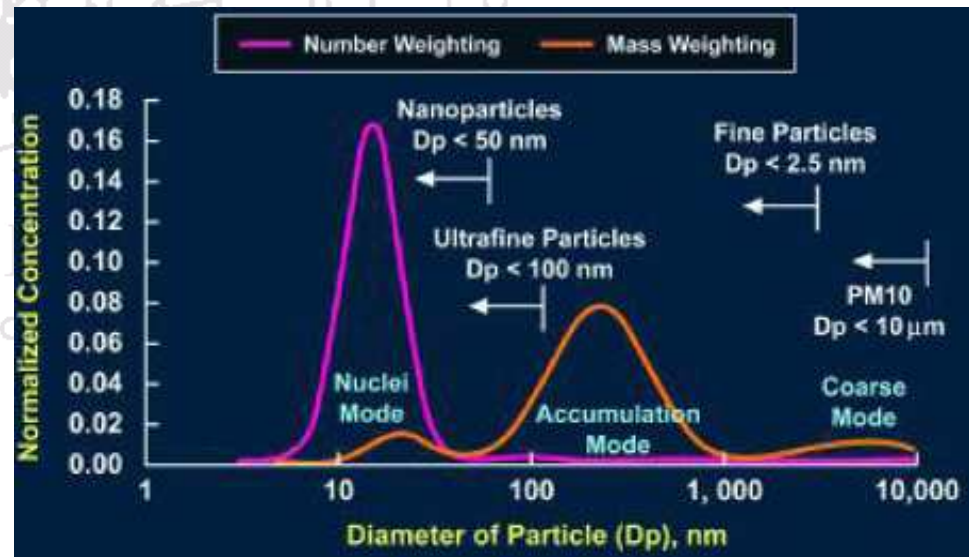
- Adverse health effects associated with particulate air pollution
- Ultrafine particles have gained attention with recent evidence showing them to be more toxic than larger particles
- Air quality standards are still focused on particle mass concentrations (TPS, PM10, PM2.5)
- Limited knowledge on UFP, the measurement of UFP is an open field of research.

Coarse and Fine particle (PM10, PM2.5)

↓
Mass concentration

↓
Ultrafine and Nanoparticles

↓
Particle number concentration





- River Po valley: area affected by sever air pollution episodes (PM air quality standard are often not attained)
- PM levels are continuously monitored (air quality monitoring network)
- Scares information on UFP levels, only few studies exist.



UPUPA Project: Ultrafine particle in urban Piacenza area

- Investigation on ambient air UFP levels : continuos measurment at fixed station positioned at traffic exposed site and urban background site
- Investigation on personal exposure to UFP: measurement campaigns using portable instruments



Outdoor concentrations
measured at fixed
monitoring stations



Personal Daily
Exposure

Transport micro-environments appear to be of particular relevance in the determination of the total daily exposure :

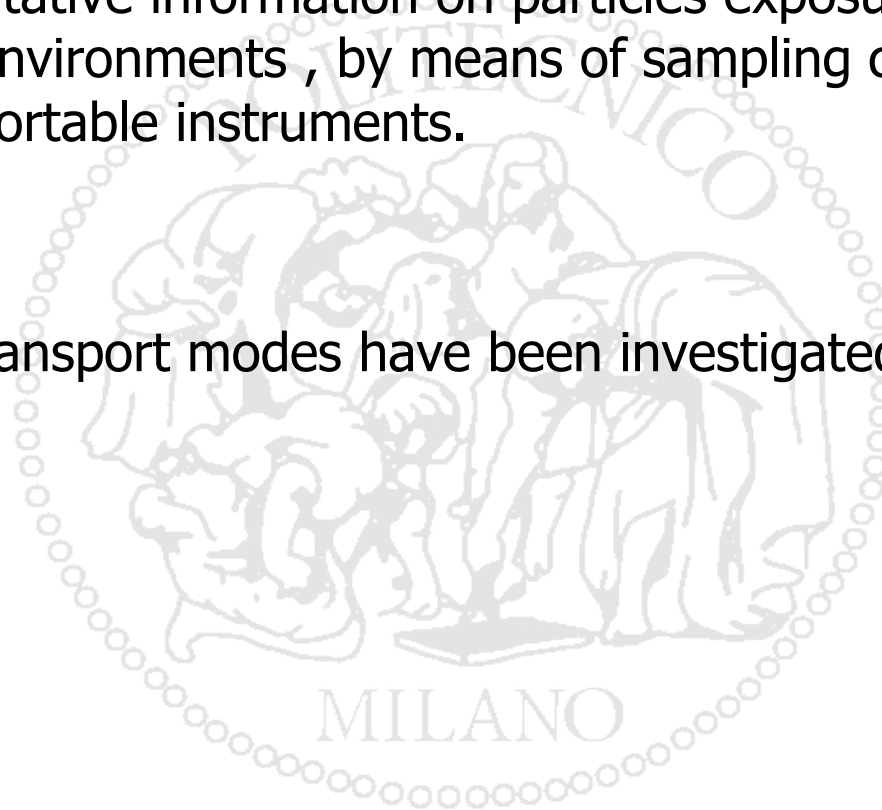
- People spend a non- negligible part of the day commuting
- Proximity of important sources of PM and UFP (vehicle exhaust emissions, wear of brake etc.)



Direct measurement of exposure concentrations using portable instruments able to measure at high time resolution.



- To Provide quantitative information on particles exposure concentrations in transport micro-environments , by means of sampling campaigns performed with portable instruments.
- Three different transport modes have been investigated:
 - BUS
 - CAR
 - BIKE





Methods: Instruments

Particle number concentrations (PNC) were measured at 1-min time resolution by means of two different portable instruments:

➤ **Optical Particle Counter OPC:**

PNC → Size range: 0,300-10,0 μm — size
resolved data 8 intervals

Fine & coarse particles



➤ **P-Trak UFP particle counter:**

PNC → Size range 0,020-1,0 μm - Total PNC

Ultrafine particles





- Period: Two weeks in July and September 2011
- Time: Two daily session during traffic rush hour:
 - Morning: 8:00 -9:30
 - Evening: 17:00 -18:30.
- Method: A route covering different city-centre trafficked roads was performed consecutively with the three transport modes.
- Method: The instruments were held in a backpack carried by an operator maintaining the instruments inlets near the breathing zone. During the car and bus trips the backpack was positioned on a passenger seat



Methods: Car and bike route



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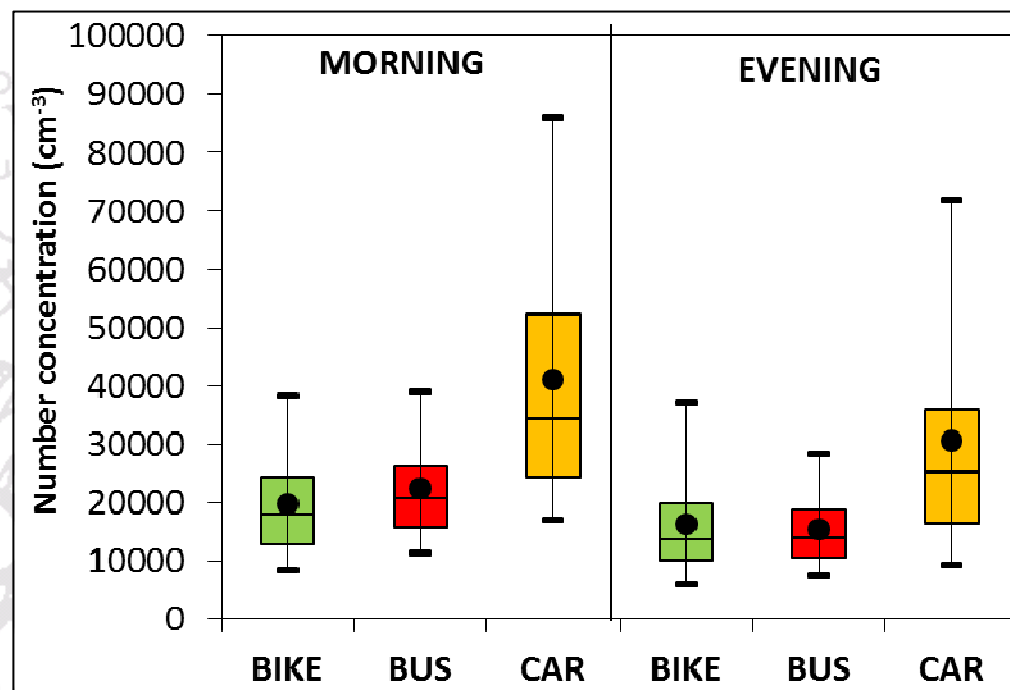
Results: Comparison between transport modes

ULTRAFINE PARTICLES

- High 1 min peaks ($6-9 \cdot 10^4 \text{ cm}^{-3}$) were measured in all the transport mode.
- Similar PNC average levels characterize bike and bus mode ($\sim 2 \cdot 10^4 \text{ cm}^{-3}$).
- Car mode presents the highest average levels ($\sim 3 \cdot 10^4 \text{ cm}^{-3}$) and the most disperse 1-min values.



Infiltration and accumulation in
car-cabin of direct vehicle
emissions



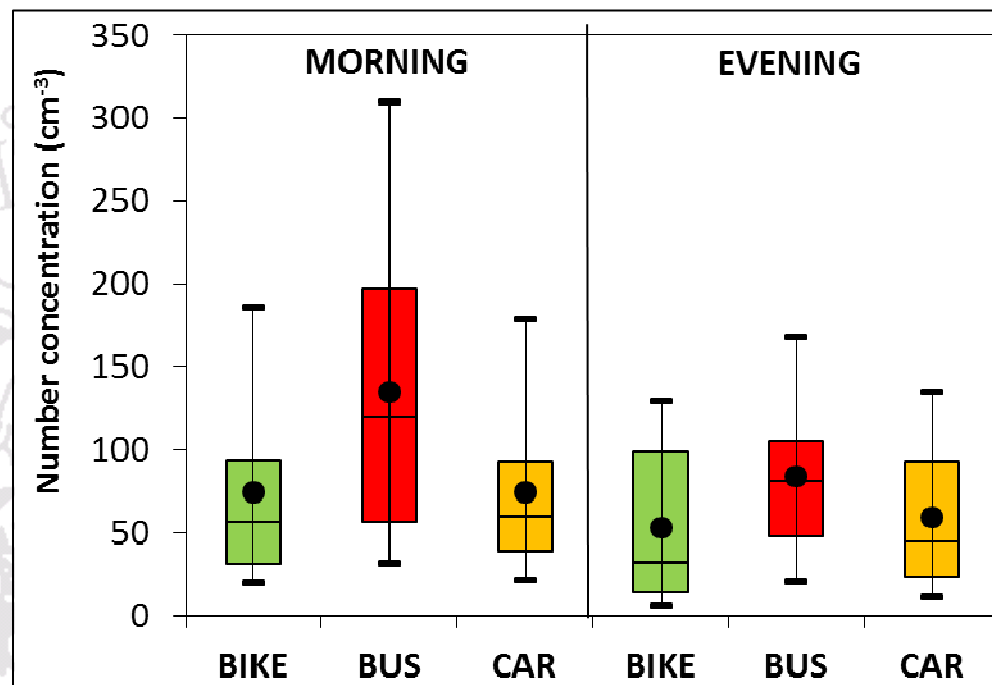
	Number concentration (cm ⁻³)		
	BIKE	BUS	CAR
MORNING	19700	22500	41000
EVENING	16400	15300	30500



Results: Comparison between transport modes

FINE PARTICLES ($0,3 \div 10,0 \mu\text{m}$)

- High 1 min peaks (**$150\text{-}300 \text{ cm}^{-3}$**) were measured in all the transport modes.
- Similar PNC average levels characterize bike and car mode (**$\sim 60\text{-}70 \text{ cm}^{-3}$**).
- Bus mode presents the highest average levels (**$\sim 80\text{-}140 \text{ cm}^{-3}$**) and the most disperse 1-min values (**$\text{IQR} \sim 150 \text{ cm}^{-3}$**).



	Number concentration (cm ⁻³)		
	BIKE	BUS	CAR
MORNING	74	135	74
EVENING	54	84	60



Results: Comparison between transport modes

FINE PARTICLES ($0,3 \div 10,0 \mu\text{m}$)

• BUS:

- Higher presence of particles in the size range $0,5 < dp < 1,5 \mu\text{m}$



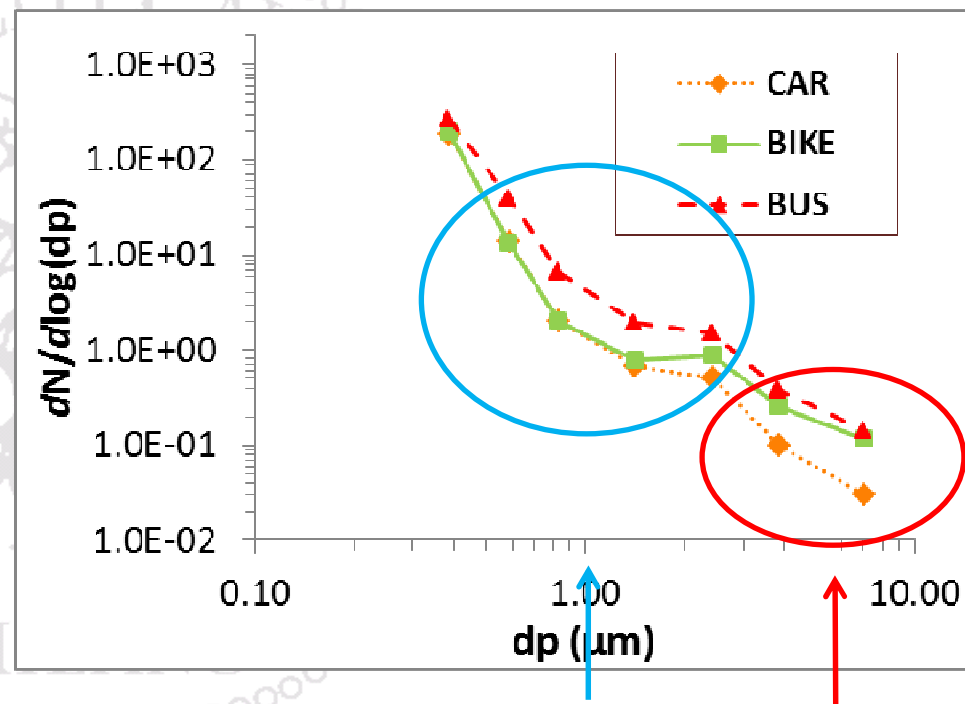
Infiltration in the bus cabin of diesel engine exhaust from the bus itself

• CAR:

- Lower presence of coarse particles ($dp > 2,5 \mu\text{m}$)



Removal of large particles in the air ventilation system





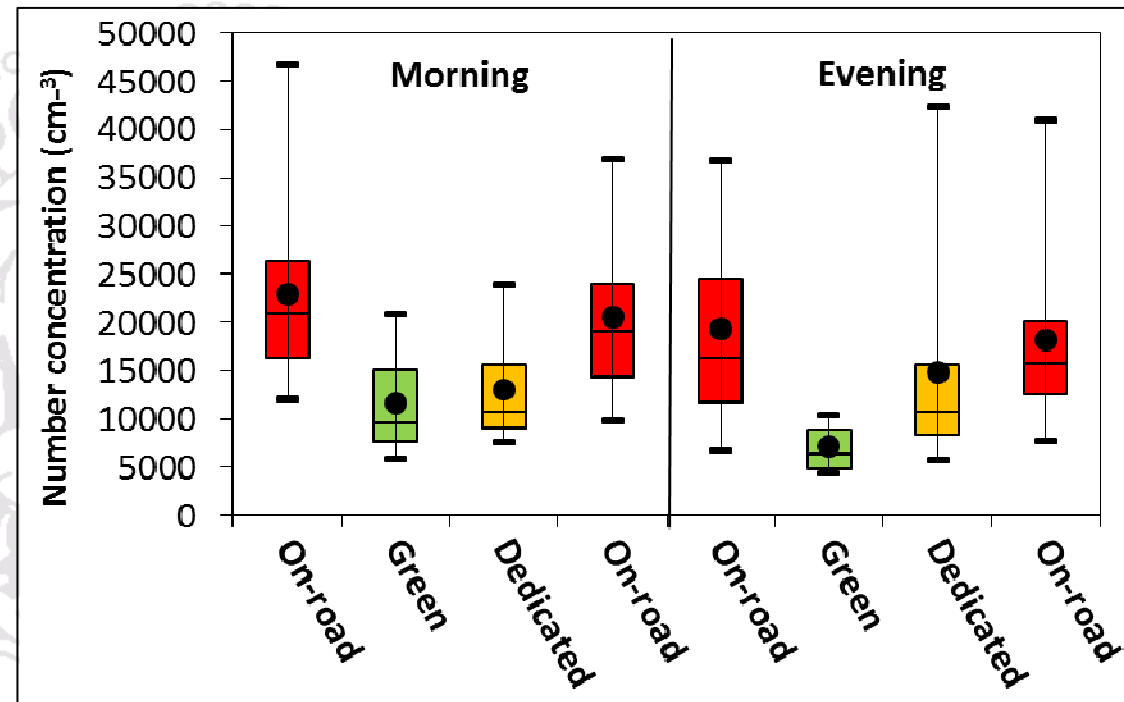


Comparison between cycle lanes

PARTICOLATO ULTRAFINE

○ Average levels **2-3 times lower** for green and dedicated lanes that on-road lane.

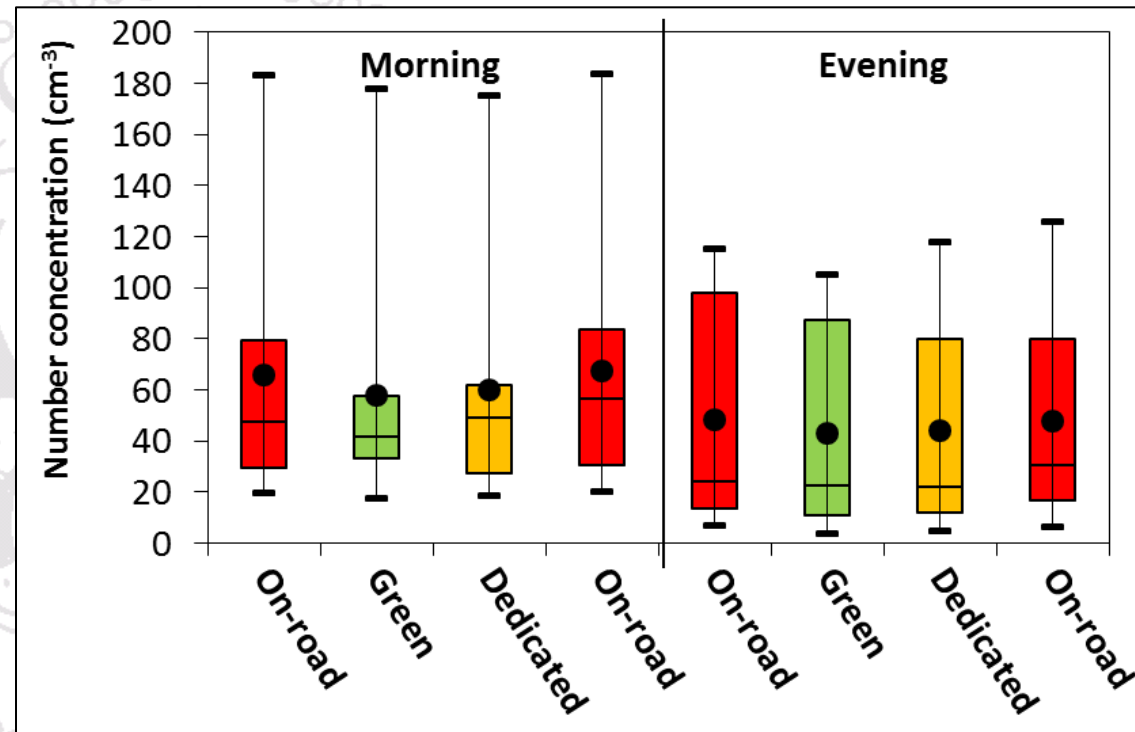
○ Low variability of 1-minute PNC for the green lane, with peak values 2-3 times lower than the other lanes.





PARTICOLATO FINE ($0,3 \div 10,0 \mu\text{m}$)

- Similar levels for all type of bike lanes;
- Low spatial variability of fine particle concentrations





Thanks for the attention!