A comparative analysis of ultrafine particles air pollution inside diesel-propelled passenger trains and intercity buses

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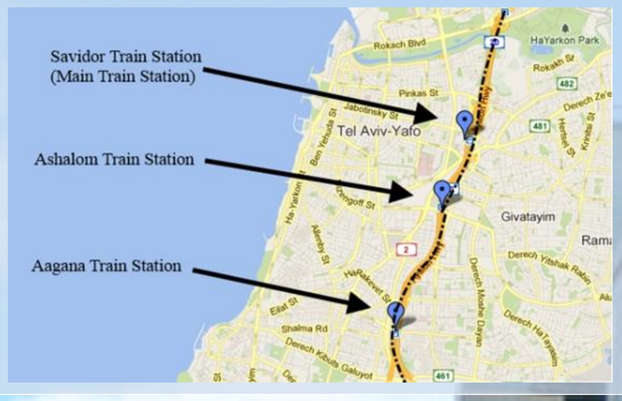
Introduction

- The worldwide railway passenger transport activity is constantly growing
- Railway passengers spend much more time in trains than in buses
- 2/3 of total railway line length worldwide is non-electrified
- Diesel-powered trains are an important source of air pollution
- Pollutant emissions by locomotive engines affect air quality inside passenger trains
- Exposure to dangerous particulate matter is associated with adverse health effects

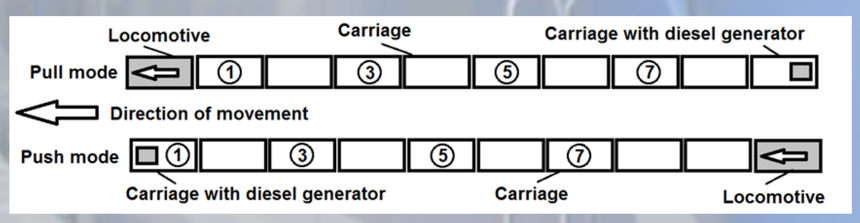


Research Goals

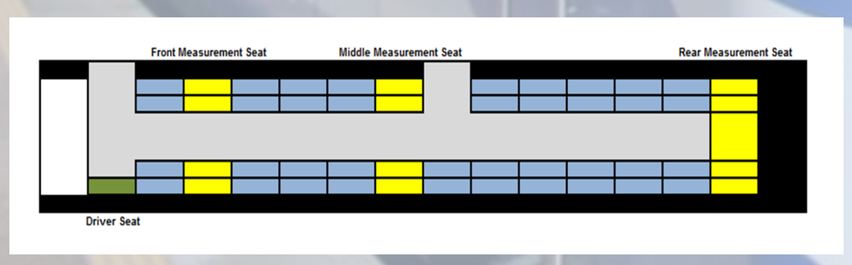
- An assessment of UFP concentrations inside passenger trains and intercity buses
- Identifying main factors affecting UFP concentrations in the train carriages, like train operation mode (push or pull), age, carriage location in the train and more
- A comparison of UFP air pollution in train carriages and intercity buses

Methodology

- Carriage types tested: new and old single-deck, double-deck, multiple unit trains
- Railway route length – 95 km, one-way trip – 66-70 min
- Bus route length – 150 km, one-way trip – 120 min
- PN measurement duration – 15 min

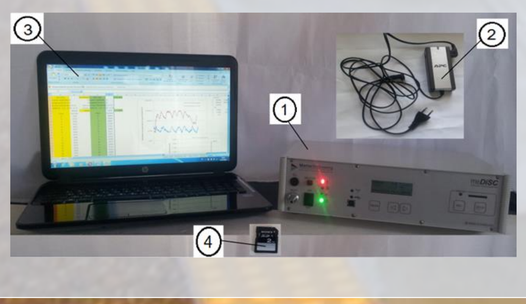


Scheme of measurements in a train carriage



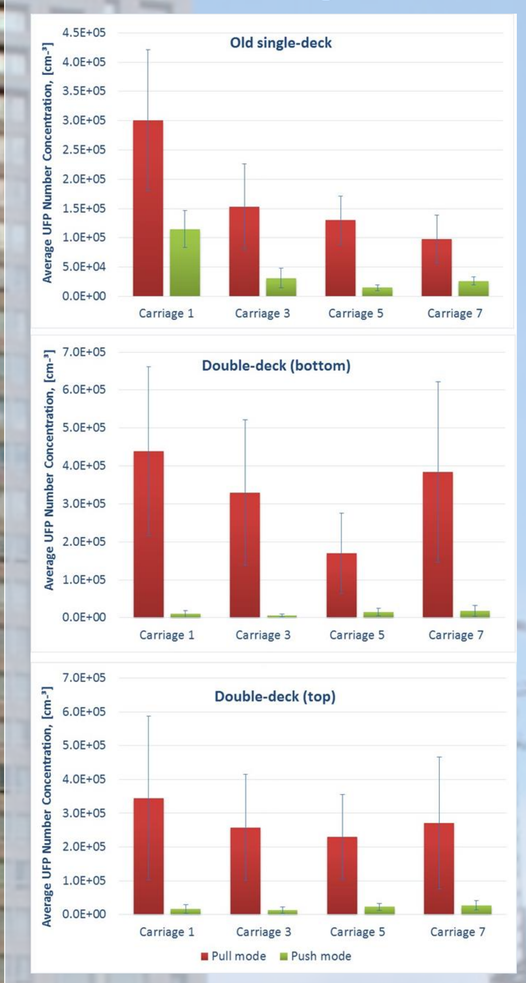
Scheme of measurements in an intercity bus

- Instrumentation – diffusion size classifier DiSC
  - PN concentrations range (100 nm): 10^3 – $5 \cdot 10^5$ cm^{-3}
  - Particle size range: 20-200 nm
  - Time resolution:1 sec
  - Accuracy: ±30%
  - Weight: 5.5 kg



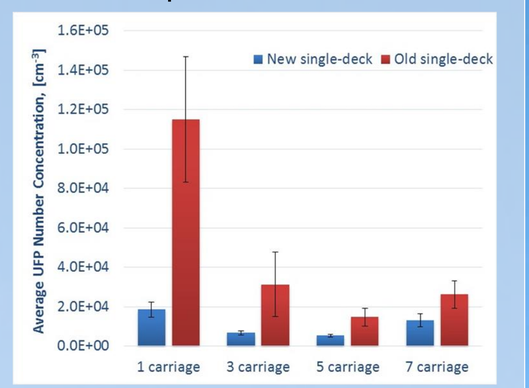
Results and Discussion

- Effect of train operating mode and carriage location

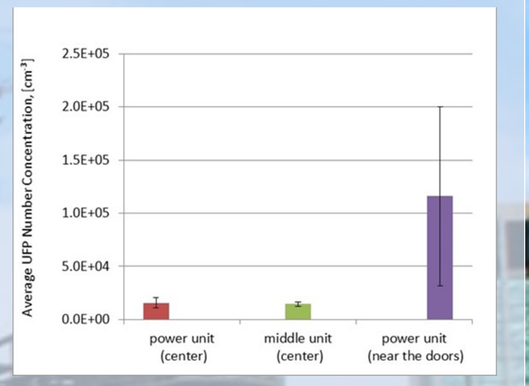


- Effect of carriage age

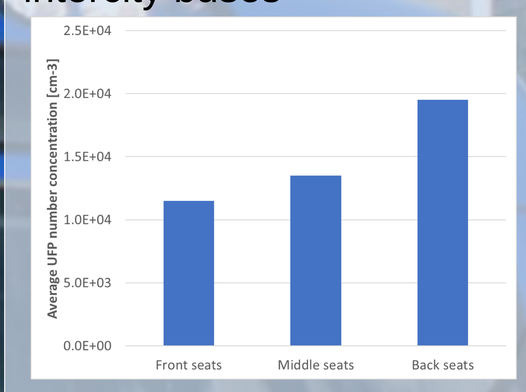
push mode



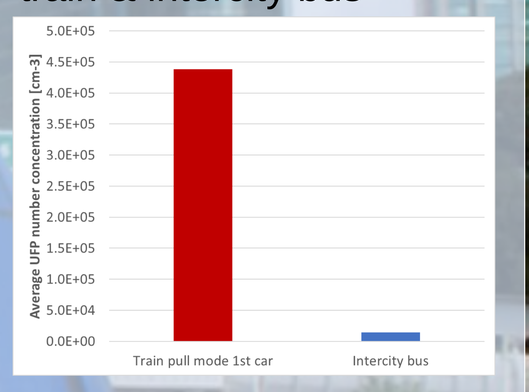
- UFP concentrations in multiple-unit trains



- UFP concentrations in intercity buses



- UFP concentrations in train & intercity bus



UFP concentrations in the 1st car of a train running in pull mode are higher than in an intercity bus by a factor of 30

Conclusions

- Locomotive engine emissions are a dominant factor in train passengers' exposure to UFP
- UFP concentrations inside the carriages are dramatically higher when the train operates in pull mode
- Highest levels of UFP air pollution are observed inside the carriages of pull trains adjacent to the locomotive
- In push mode, the UFP number concentrations were lower by factors of 2.6 to 43 compared to pull mode
- Average UFP concentration in intercity buses is approximately 1.5E+04
- UFP concentrations in the 1st car of a train running in pull mode are higher than in an intercity bus by a factor of 30
- Retrofitting locomotive engines with DPF is an effective measure of reducing passengers' exposure to air pollution inside trains

Acknowledgments

- Financial support of the Israeli Ministry of Environmental Protection (grant No. 145-5-4) is highly appreciated. The authors wish to thank the Israel Railways for their technical support and cooperation