

CSTB
le futur en construction



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Kerosene space heaters: A major source of ultrafine particles indoors

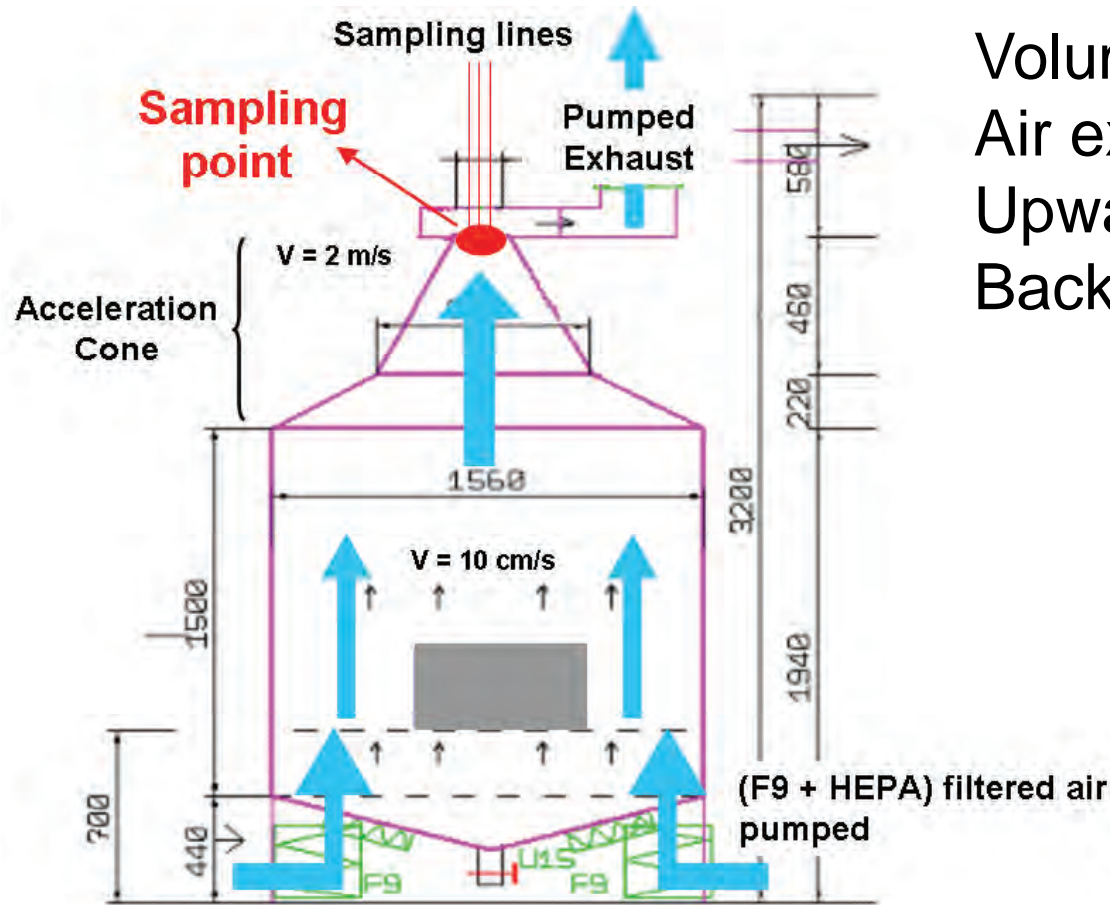
Kerosene portable heaters

- Used indoors as extra-heating
- Emission of combustion pollutants is known:
CO, NO₂, PM_{2.5}
- Progress in combustion efficiency:
PM_{2.5} negligible (in normal use)
- **Nothing is known about possible emission of ultrafine particles.**

Objective of the study

- **Chemical and physical characterization** of particle emissions from a modern kerosene space heater in an experimental chamber in the size range **5 nm to 20 μm** .
- Part of a larger study involving 20 domestic activities (cooking, printing, candles, incense sticks, vacuuming and aerosol sprays).

Experimental chamber



Volume: 2.4 m^3

Air exchange rate: 46 ach

Upward air velocity: $0.1 \text{ m}\cdot\text{s}^{-1}$

Background particle negligible

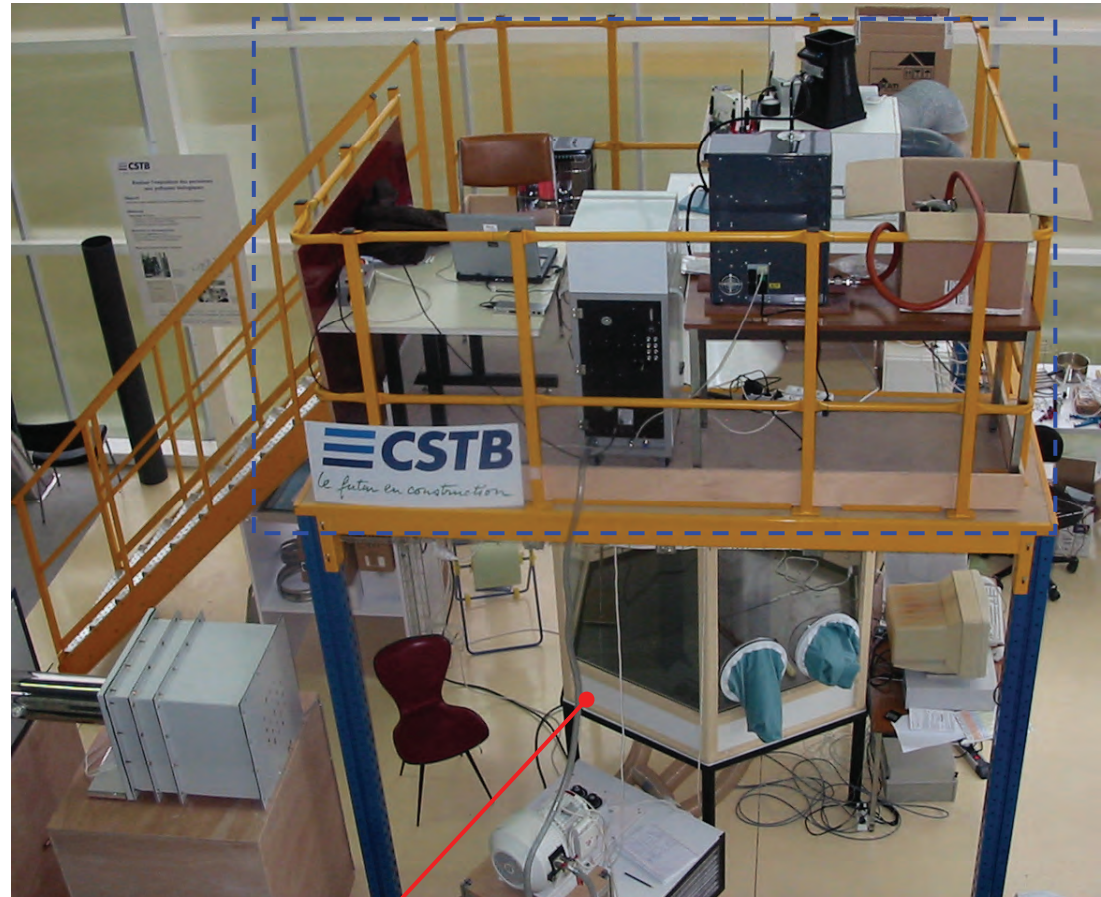


Particle interaction with chamber walls and other particles reduced

Efficient transport of particles to sample points

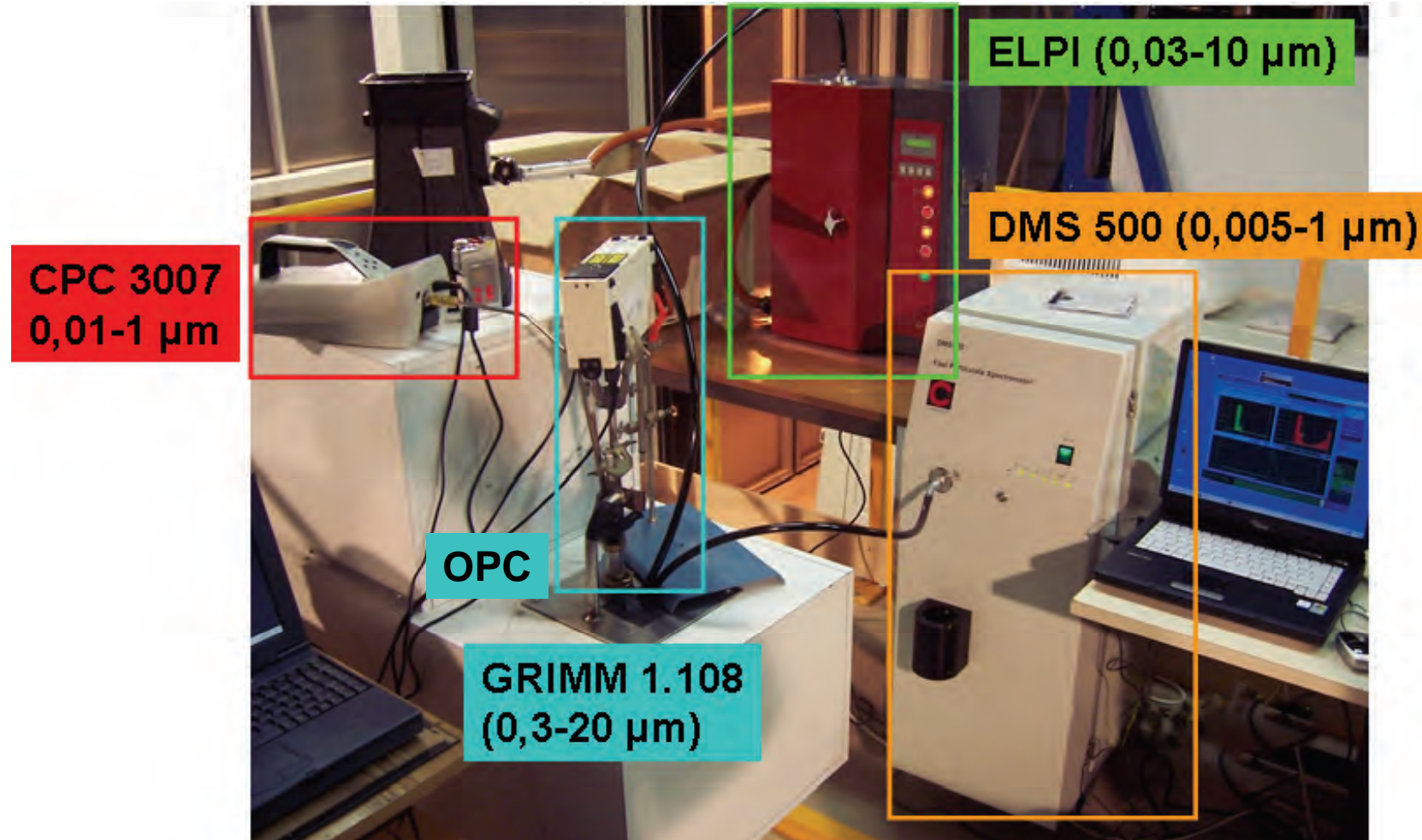
Experimental chamber

Measuring instruments – monitoring zone

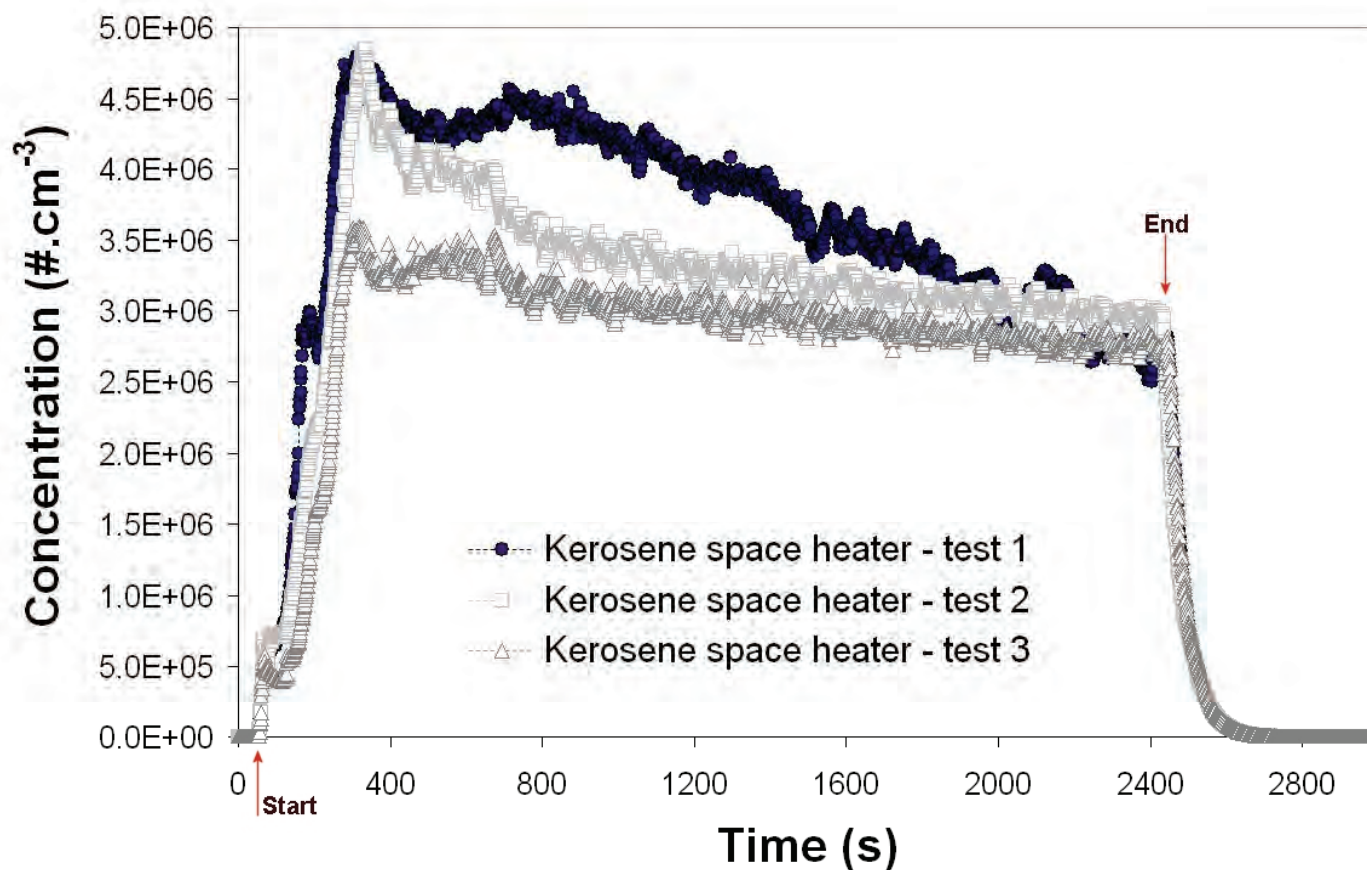


Experimental chamber

Measuring instruments



Results - DMPS

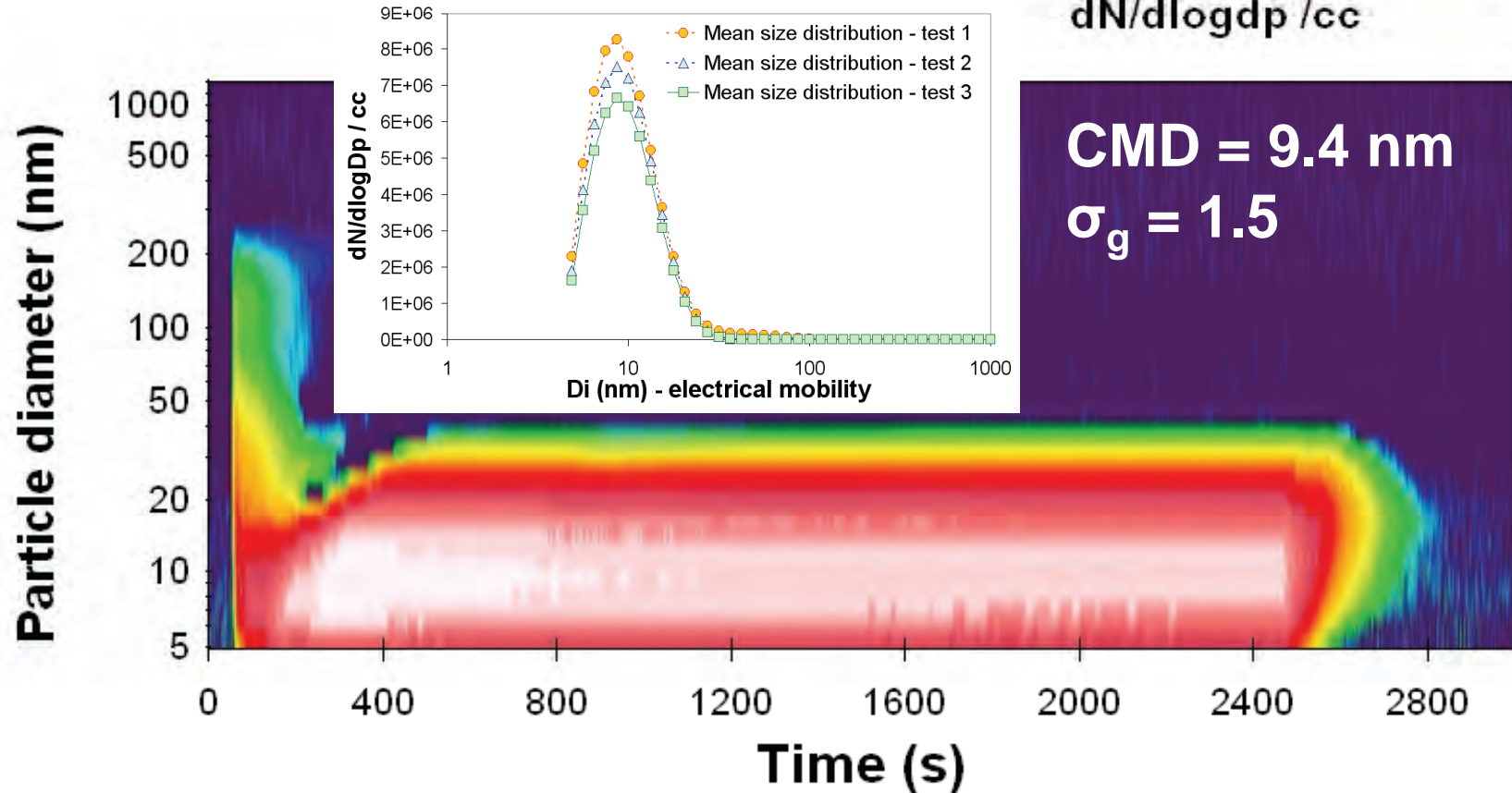
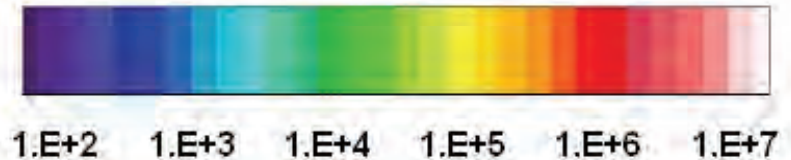


**EMISSION
RATE**

**1.8×10^{11}
particles.s⁻¹
(rsd = 16%)**

***Deposition
velocity
0.23 cm.s⁻¹***

Particle size distribution (DMPS)



Chemical analysis



Particles collected on 4-stages impactors
11 heating cycles

Elemental analysis (PIXE):

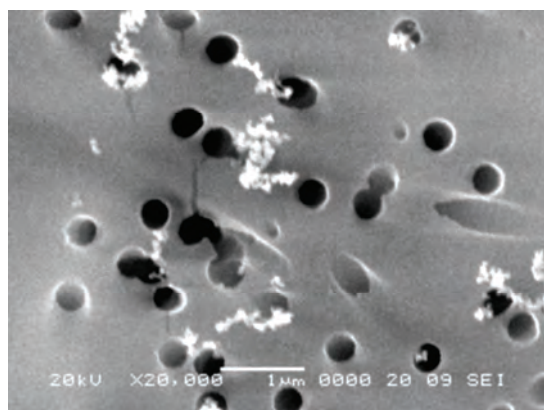
Cr 4 ng.g⁻¹ and Mn 0.05 ng.g⁻¹ burned fuel

Organic and elemental carbon
< LD (28 ng.g⁻¹)

Anions/Cations: **SO₄²⁻ and NO₃⁻ = 6 ng.g⁻¹**
Other ions < LD

PAHs: **Phenanthrene 0.09 ng.g⁻¹,**
Fluoranthene 0.015 ng.g⁻¹.

SEM/X-ray: **Carbon, Si (traces)**



Conclusion

- Kerosene space heaters are among the strongest sources of particles indoors (high emission rate and long duration of use).
- Real room experiments are needed to account for surface-particle and particle-particle interactions (work in progress).
- The influence of different burning technologies, age of devices and nature of fuel must also be checked.
- Improving combustion efficiency decreases soot and pollutant formation but small ultrafine particles are still emitted.
- The risk associated with exposure to UFP from kerosene heaters remains unknown. The risk may become high as frequency of use increases, specially in the lower social classes.