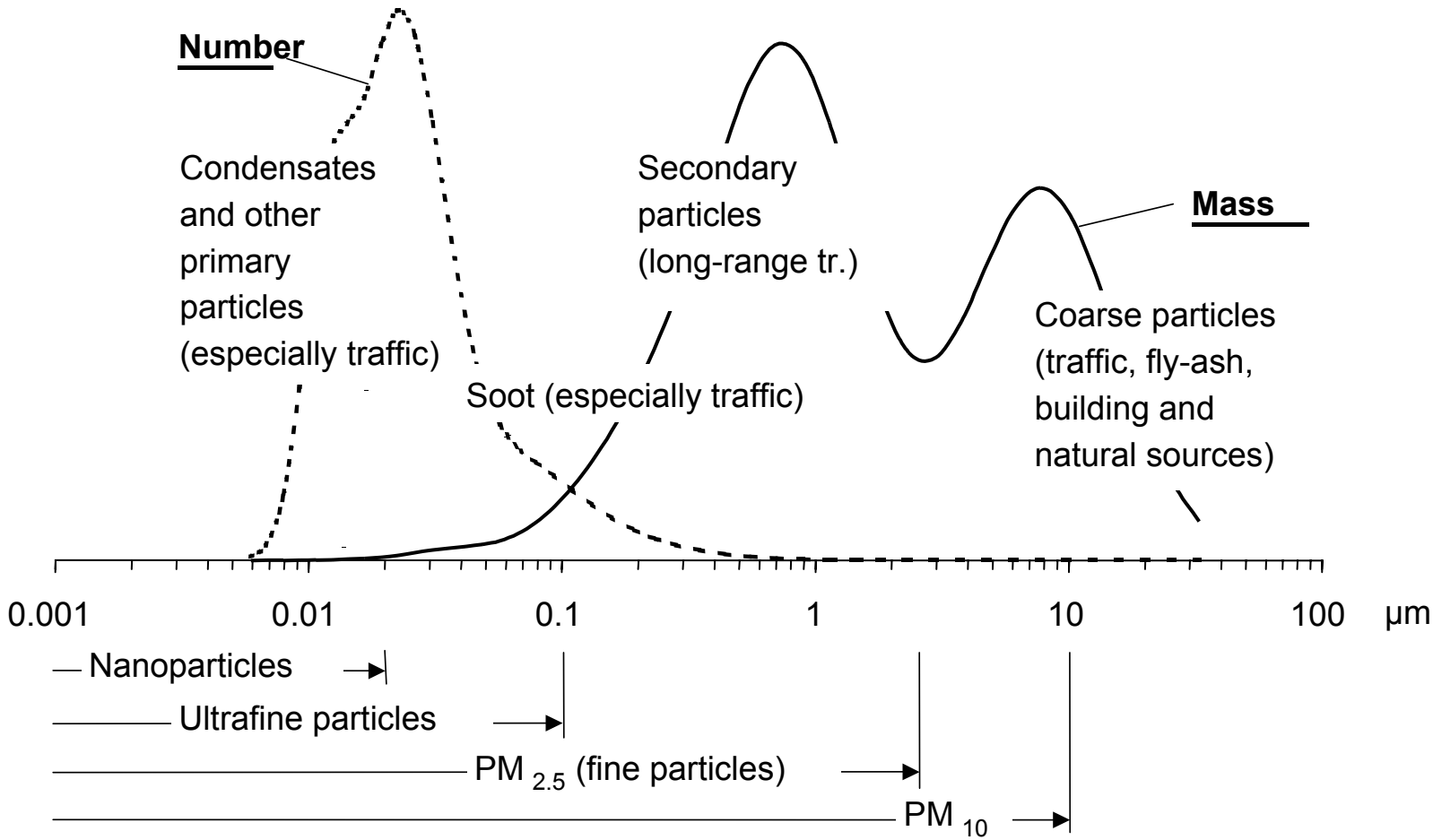
Chemical characterization of particles

Marianne Glasius,
Peter Wåhlin, Jacob G. Mønster, Rossana Bossi,
Bjarne Jensen, and Finn Palmgren

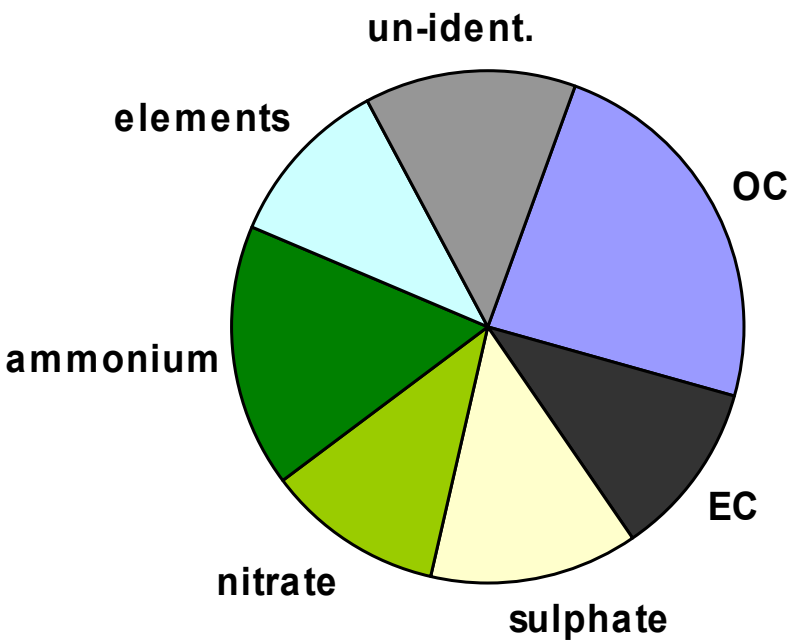
Contents

- Basic physics and chemistry
- Ambient measurements - monitoring of air pollution
- Ambient measurements - wood stoves
- Indoor air quality in relation to outdoor pollution

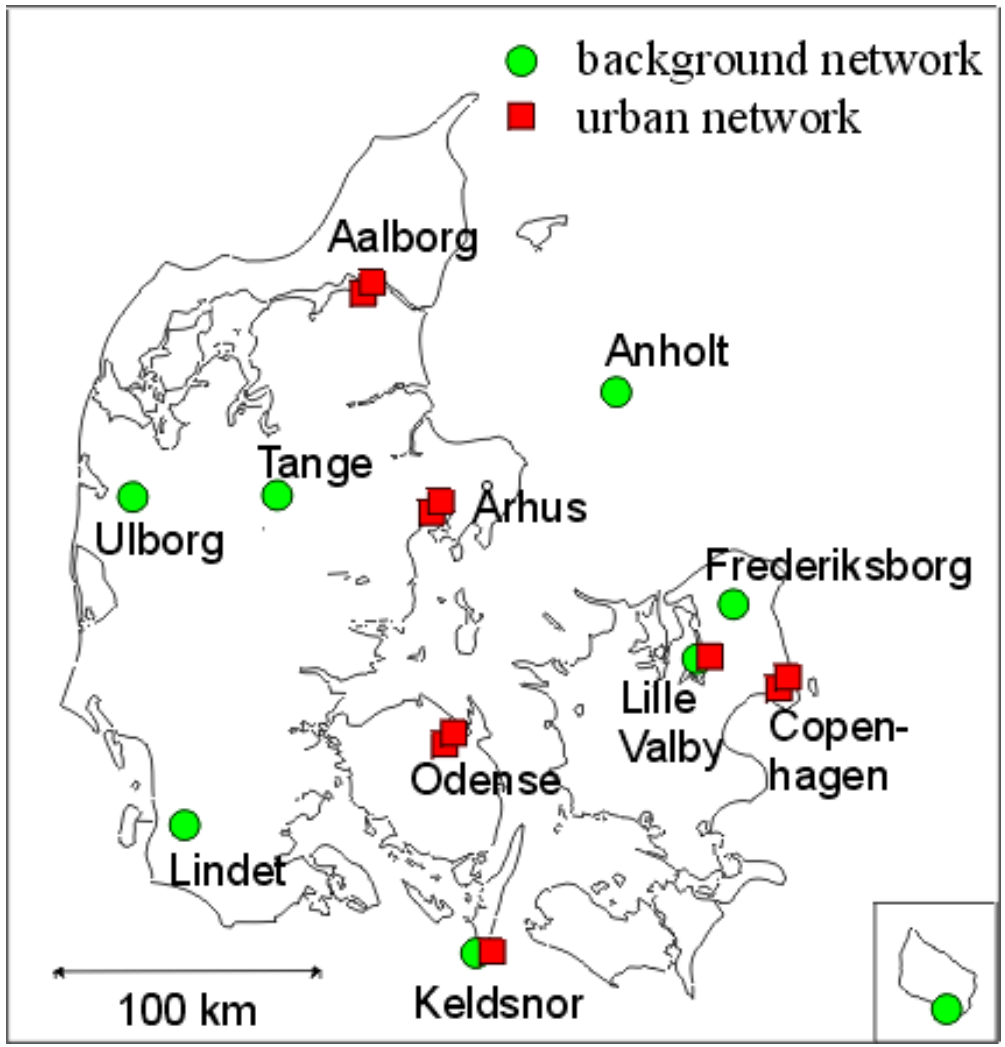
Typical particle size and mass distribution in street air



Chemical composition of particles



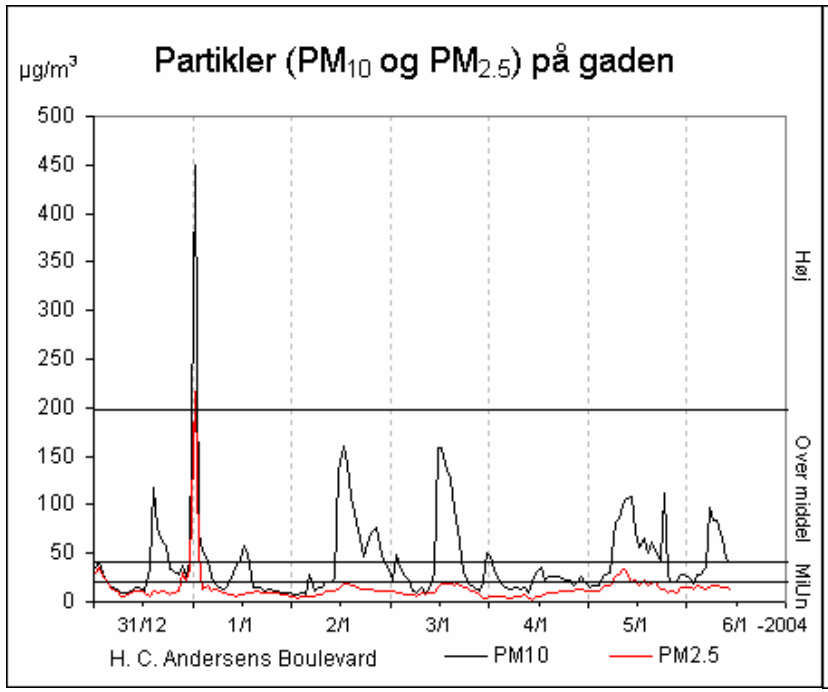
Ambient measurements - overview

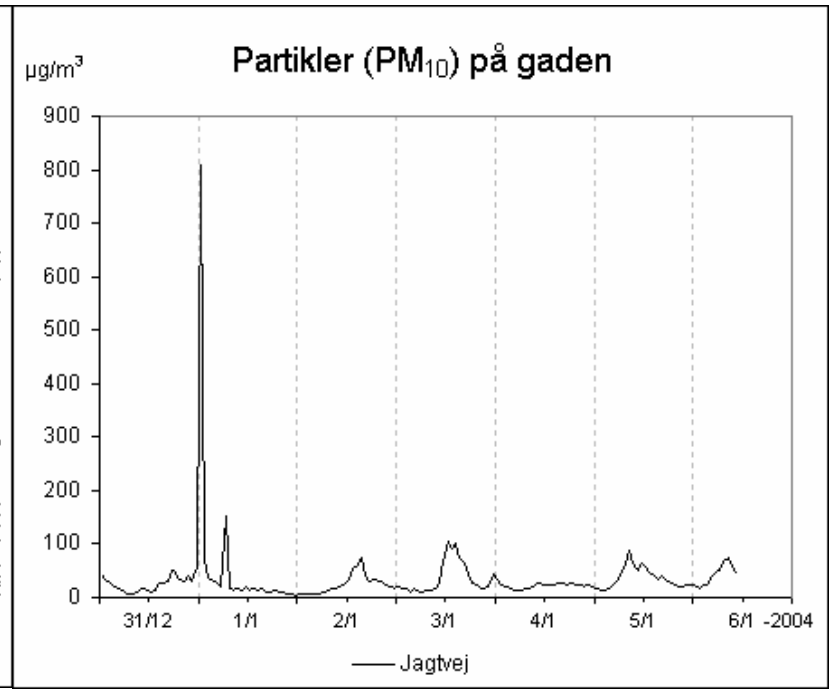


Monitoring station at Jagtvej, Copenhagen

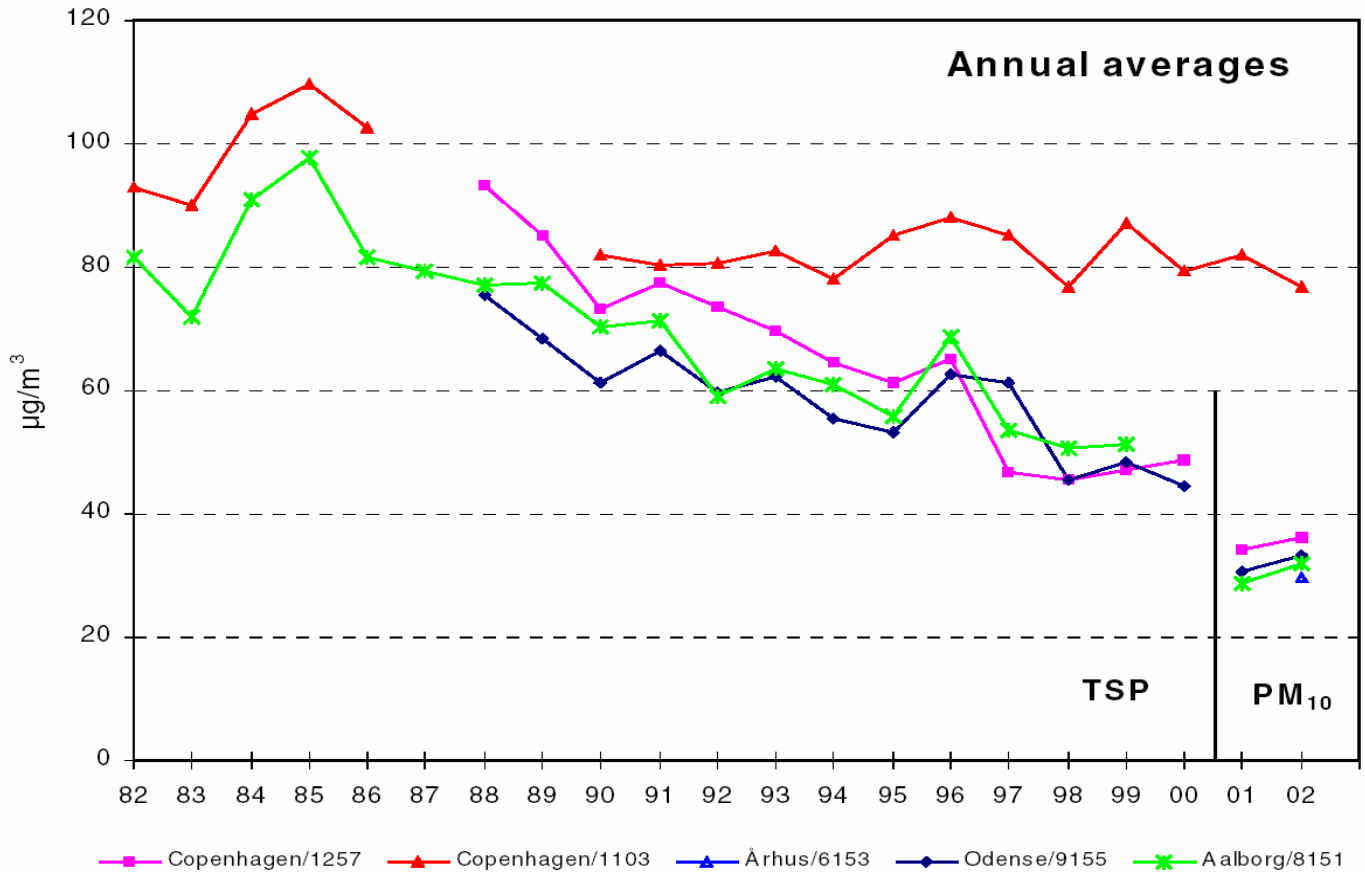
View from monitoring station at University of Copenhagen

luft.dmu.dk


µg/m³
Partikler (PM10 og PM2.5) på gaden
500
450
400
350
300
250
200
150
100
50
0
Høj
Over middel
Middel
31/12
1/1
2/1
3/1
4/1
5/1
6/1
-2004
H. C. Andersens Boulevard
PM10
PM2.5


µg/m³
Partikler (PM10) på gaden
900
800
700
600
500
400
300
200
100
0
31/12
1/1
2/1
3/1
4/1
5/1
6/1
-2004
Jagtvej

Trends in particle mass concentrations



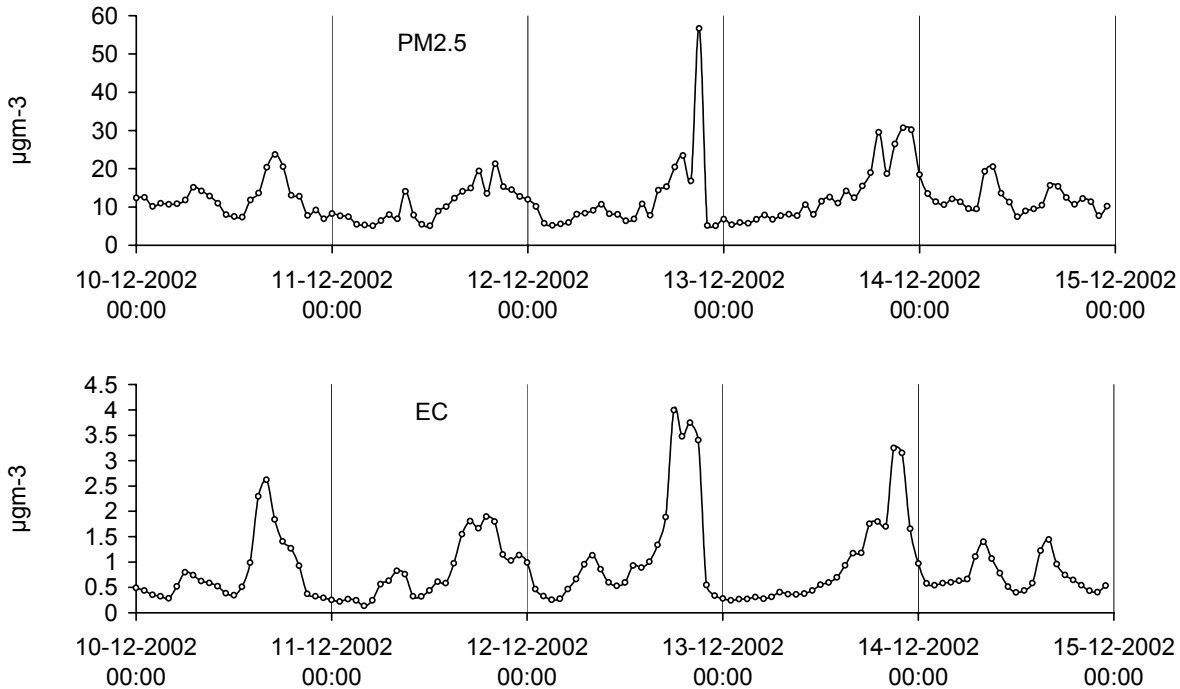
Total suspended particulate matter shows a decreasing trend, except at H.C. Andersens Boulevard. (Kemp and Palmgren, 2003)


Danmarks Miljøundersøgelser

Measurements of

- Gases: NO_x and CO
- Particles:
  - PM_{10} and $PM_{2.5}$
  - particle size distributions (6-700 nm)
- Particle characterisation:
  - Elemental carbon/organic carbon, hourly values
  - inorganic composition of PM_{10} or $PM_{2.5}$, and size-fractionated particle samples (MOUDI)
  - PAH in size-fractionated particle samples (ChemVol)

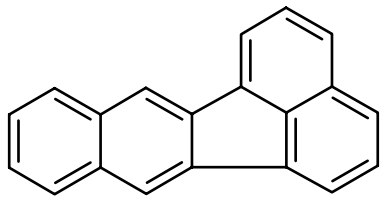
Wood stove episodes - Gundsømagle



- **Increase in particle concentrations (particle volume, PM_{10} and $PM_{2.5}$) and combustion related compounds (CO, OC and EC) especially on days with cold weather and calm wind conditions**
- **Cause: less dilution of local emissions from residential wood combustion.**

Polycyclic aromatic hydrocarbons (PAH)

- **Compounds with two or more aromatic rings**

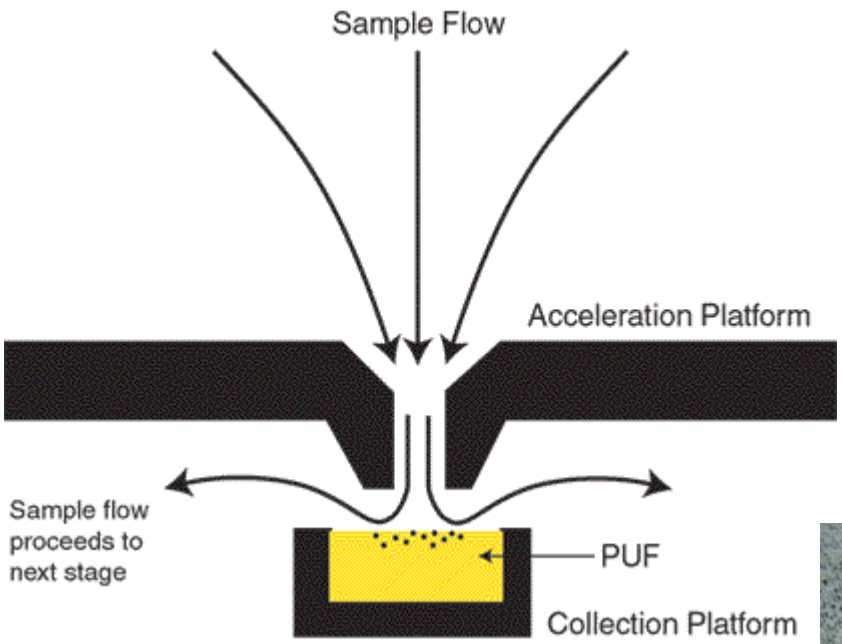


Benzo(k)fluoranthen

- **Many related compounds e.g. methyl-, oxy- and nitro compounds**
- **Many carcinogenic PAH - some known since 1930'ties**
- **Sources are incomplete combustion of organic matter such as diesel, gasoline, and wood.**

Measurements of PAH. Sampling

- Sampling using ChemVol
  - High volume impactor samples about 750 l/min
  - Collection on polyurethane foam (PUF) and a polypropylene filter
  - Stages: >10, 10-2.5, 2.5-1, 1-0.1, and <0.1 μm.

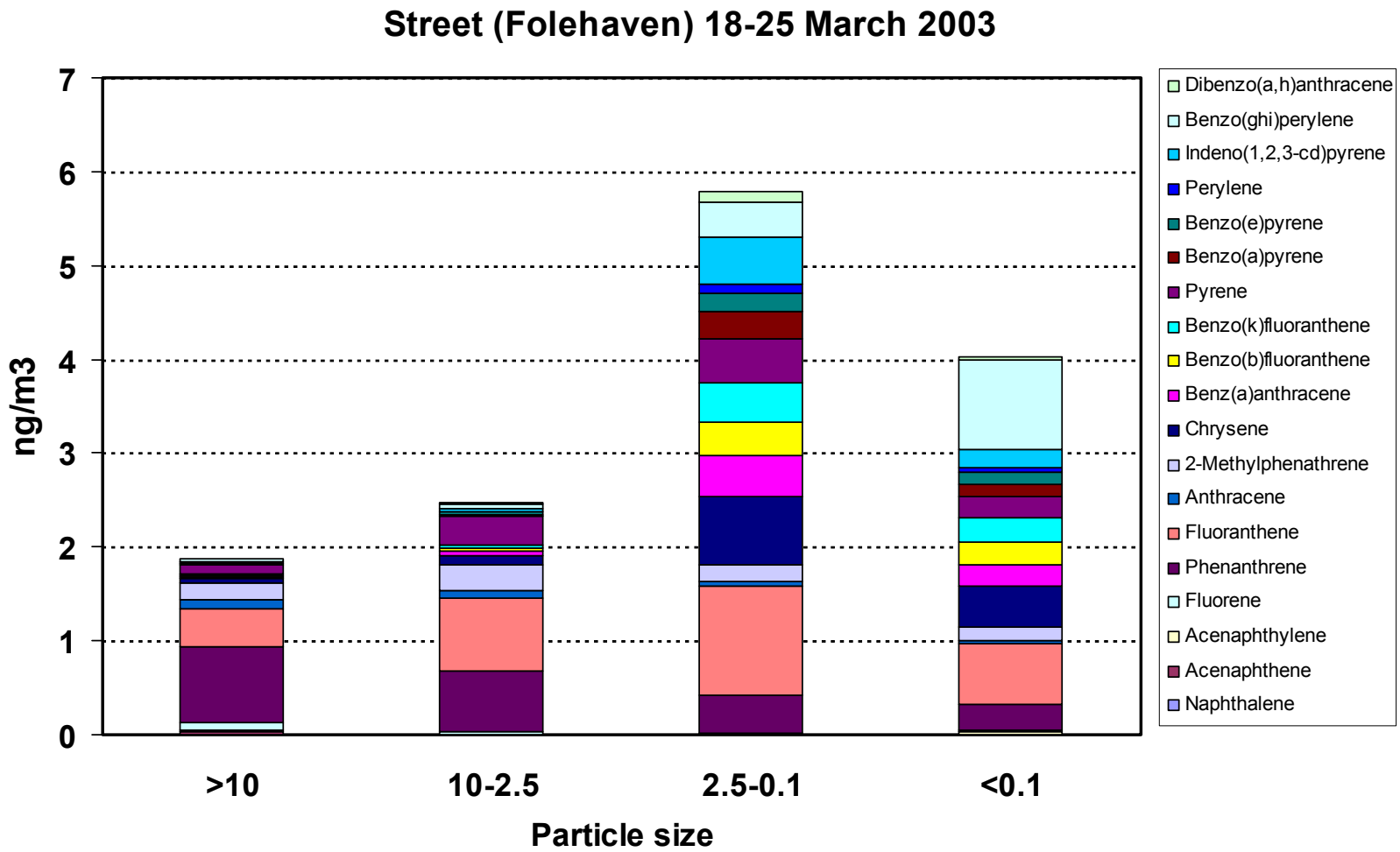

Sample Flow
Acceleration Platform
Sample flow
proceeds to
next stage
PUF
Collection Platform

Source: R&P

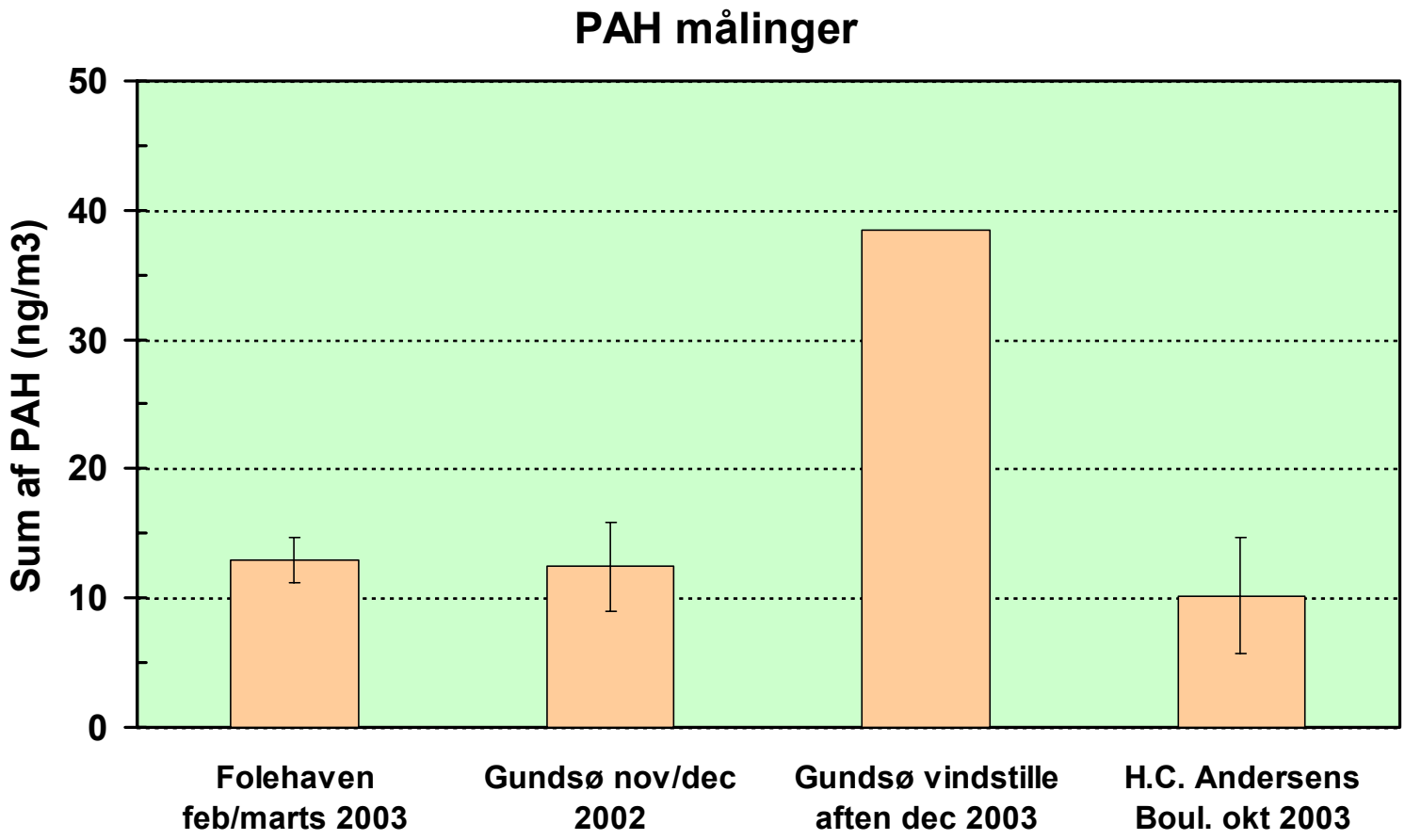
Measurements of PAH. Analysis

- Deuterated internal standards for most analysed PAH added before extraction in toluene
- clean-up on silica columns, extract with hexane
- reduction of solvent volume and re-dissolve in toluene
- Analysis by gas chromatography - mass spectrometry

PAH composition



PAH in particles



Indoor air pollution in an apartment

- Part of a large study on traffic and traffic-related air pollution in Denmark (the TRIP project)
- Our part is in collaboration with National Institute of Occupational Health, Danish Building Research Institute, University of Copenhagen, Danish EPA, Risø National Laboratory
- Detailed characterisation of gas-phase and particle-phase pollutants inside and outside apartment

Apartment kitchen!

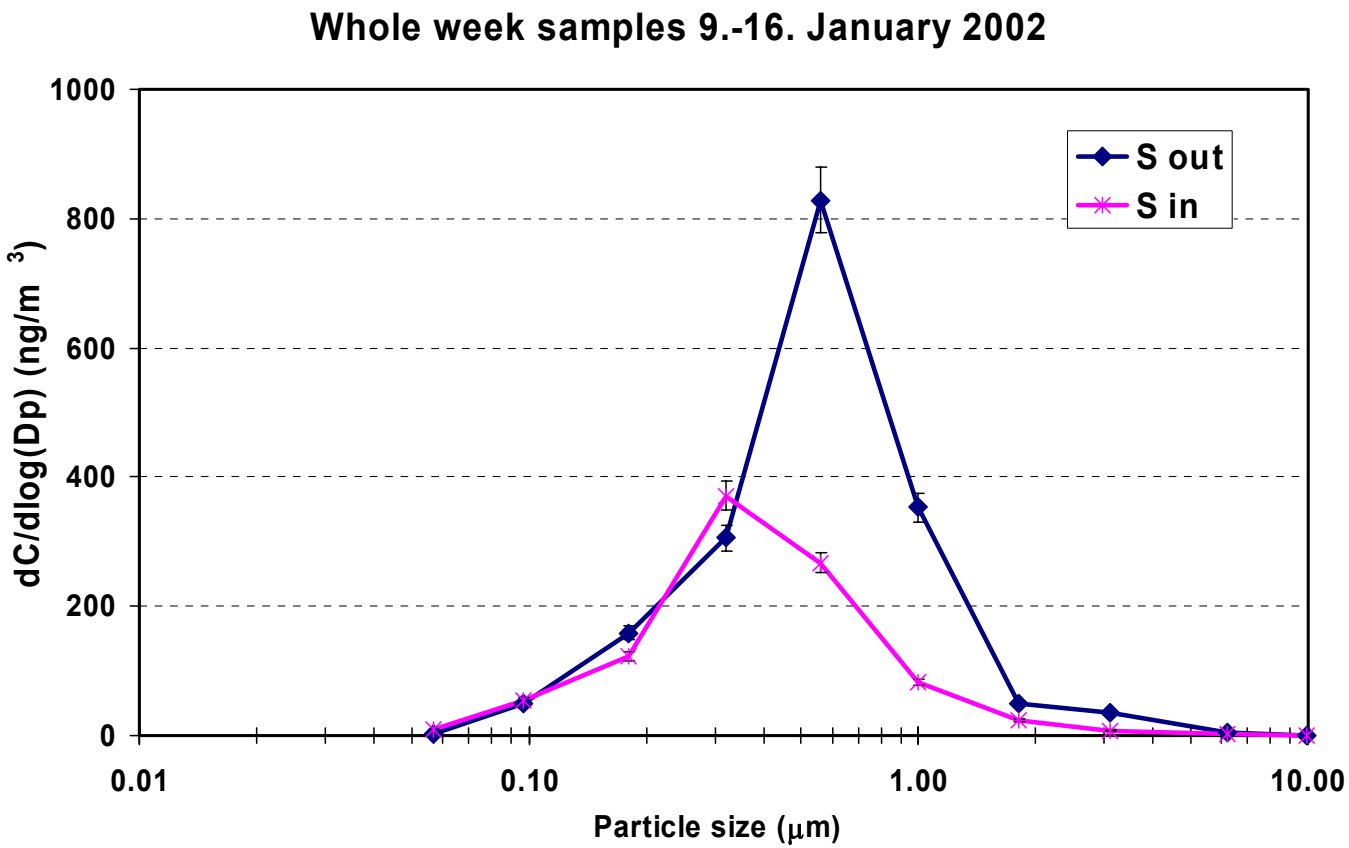
Micro-Orifice Uniform Deposit Impactor (MOUDI)

- 10-stage impactor with rotating impactor plates
- Sampling on polycarbonate filters coated with grease
- Flow 30 L/min

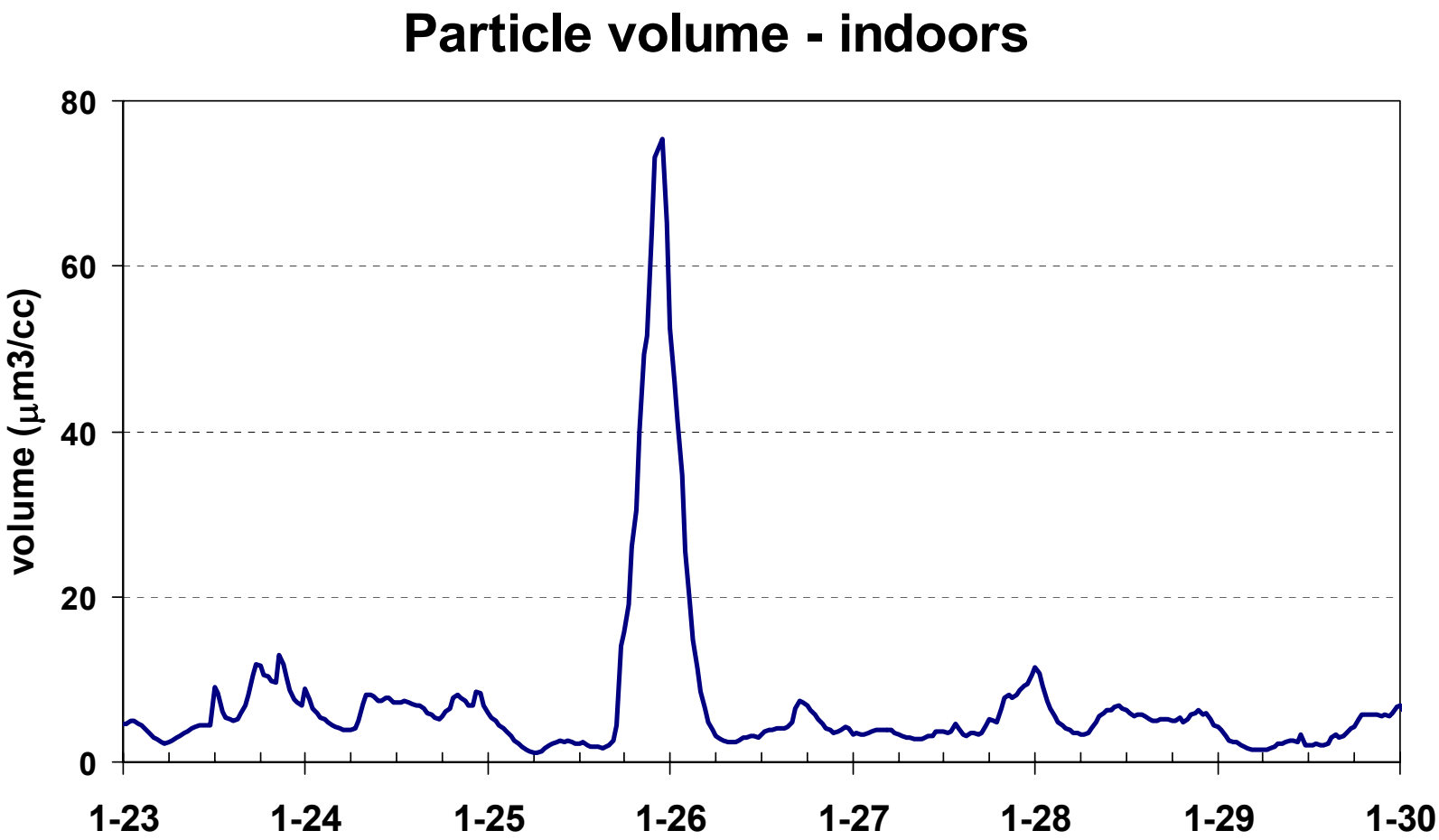
PIXE-analysis

- Proton-Induced X-Ray analysis
- Elemental analysis of particles can distinguish between origin from
  - geological materials (e.g. aluminium, calcium, and silicon)
  - fossil fuels (e.g. sulphur, vanadium, nickel, and lead)
  - sea spray (chloride and bromide)

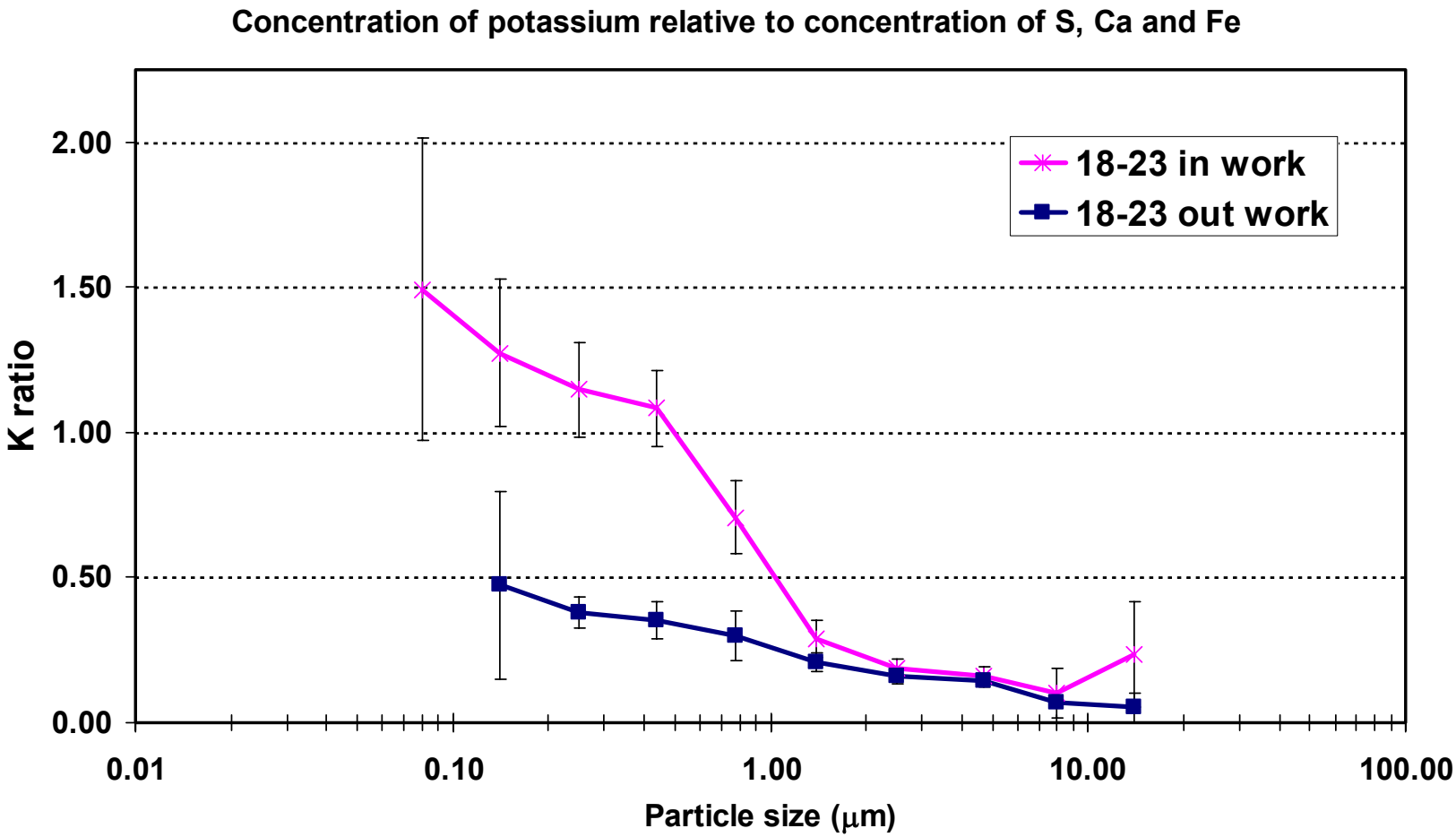
Sulphur indoors and outdoors



Particle episode



Potassium - indicator of cigarettes or cooking?



First answers

- Q: How do outdoor traffic emissions of particles affect the indoor environment in urban areas?
- Particles, especially smaller ones, are indeed transported to the indoor environment.
- Indoor particle numbers (size > 100 nm) mainly related to urban background (Wåhlin et al., 2003)

Thank you

- For funding
  - Municipality of Copenhagen, Danish EPA, Strategic Environmental Research Programme, EU
- For collaboration
  - Municipality of Copenhagen, National Institute of Occupational Health, Danish Building Research Institute, University of Copenhagen, Danish EPA, Risø National Laboratory, and co-workers at NERI.

Thank you for your attention!