



# AirMonTech



More flexibility, more information, less effort:  
Science or fiction?

U. Quass, A. John, U. Sager, T.A.J. Kuhlbusch  
and AirMonTech Consortium

Current and future air quality monitoring  
Duisburg, 04.-06.03.2013

[www.airmontech.eu](http://www.airmontech.eu)

## Primary:

- Compliance to limit values

**permanent,  
everywhere**

## Secondary:

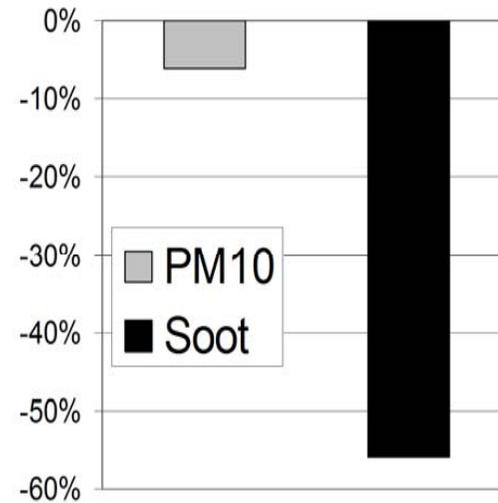
- Evaluation of mitigation measures
- Identification and quantification of source contributions
- Exposure assessment and modelling
- Test of new health-relevant metrics

**So far:  
temporary,  
localised**





G. Ludes et al. UBA-Texte 25/2010



reduction in Berlin  
2011 compared  
to 2007

A. Rauterberg-Wulff, M. Lut (2011)  
Ein Jahr Umweltzone Stufe 2 in Berlin  
[http://www.stadtentwicklung.berlin.de/umwelt/luftqualitaet/de/luftreinhalteplan/download/umweltzone\\_1jahr\\_stufe2\\_bericht.pdf](http://www.stadtentwicklung.berlin.de/umwelt/luftqualitaet/de/luftreinhalteplan/download/umweltzone_1jahr_stufe2_bericht.pdf)



MAAP

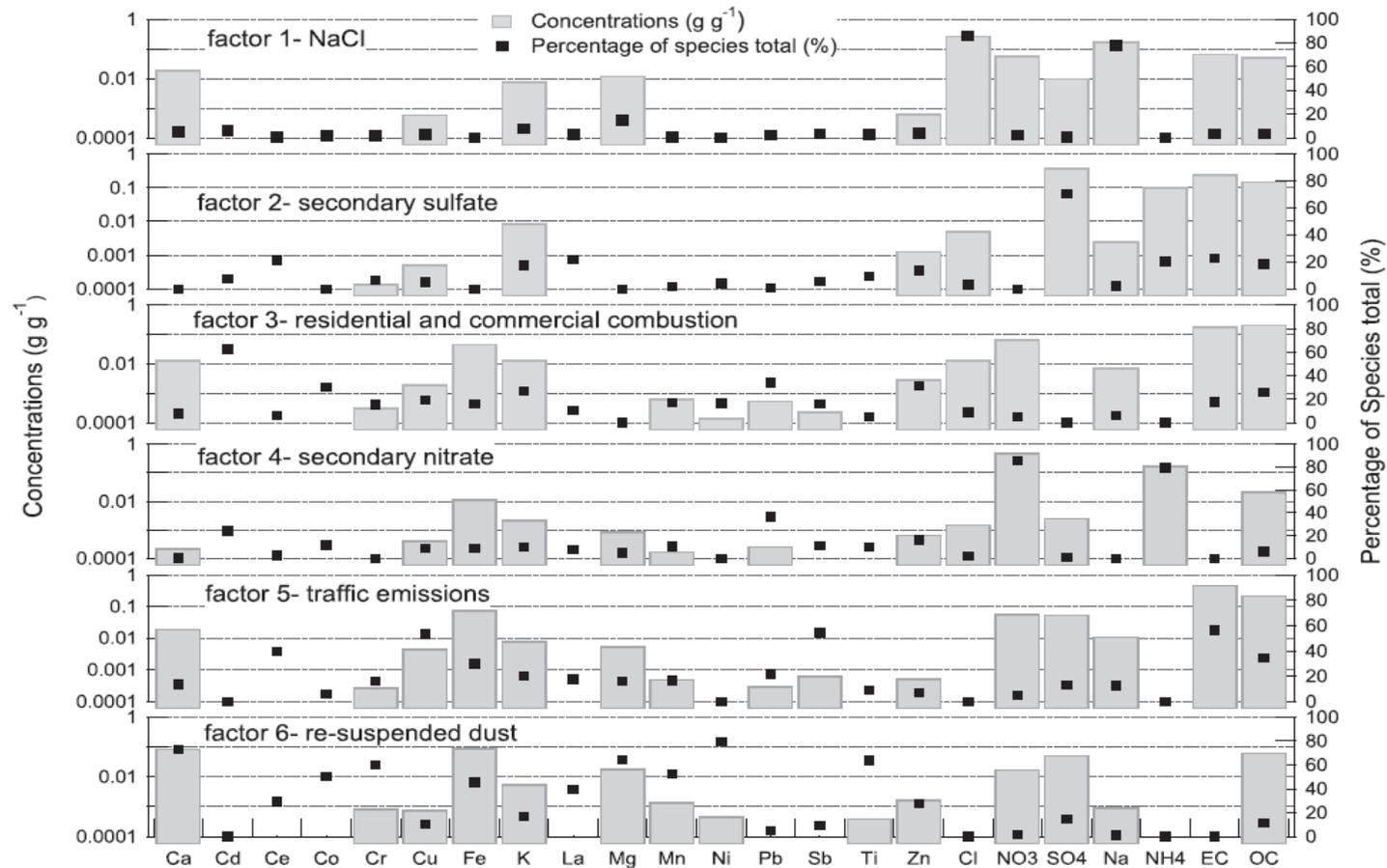


Aethalometer

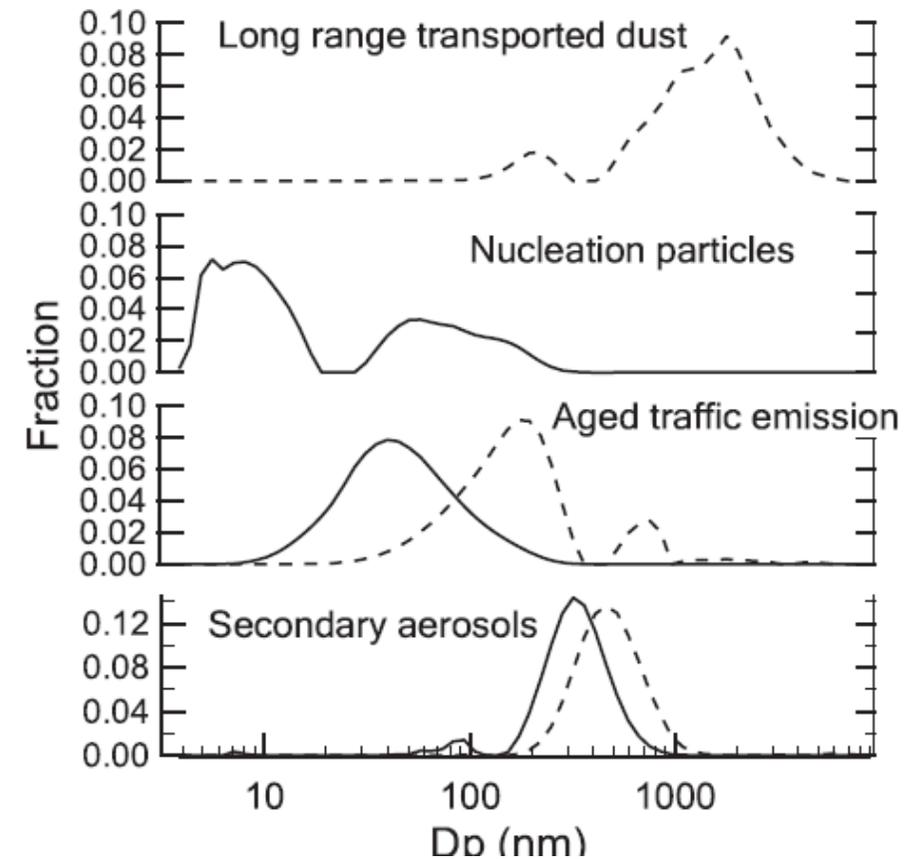
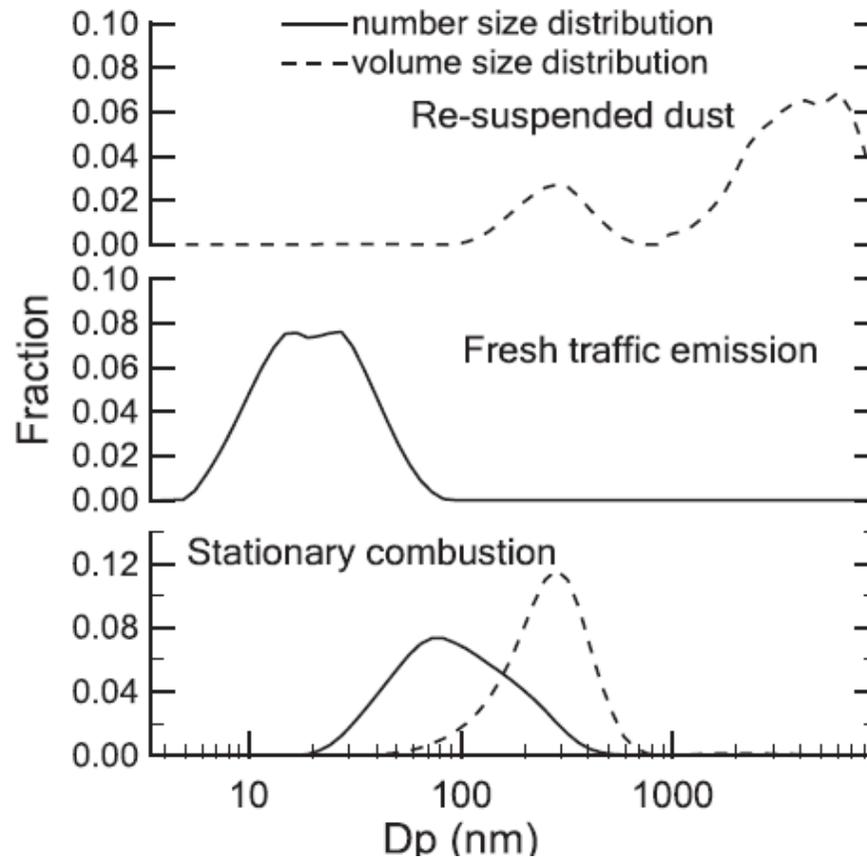


Photoacoustic Extinctionmeter

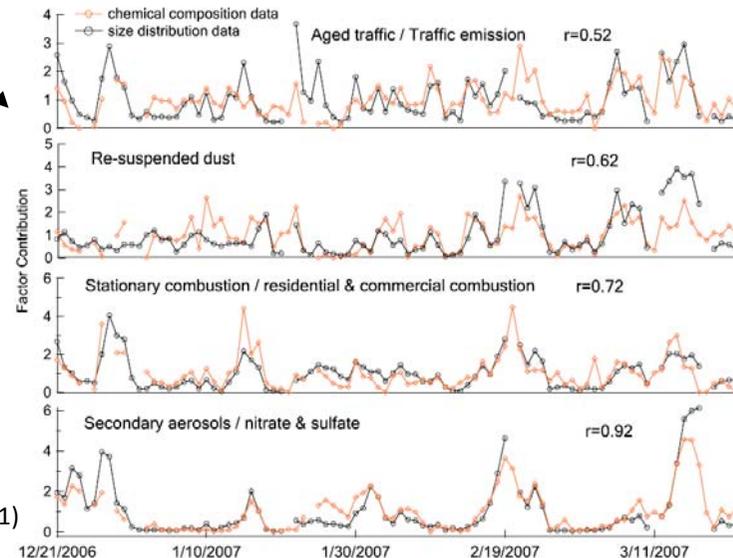
## Off-line chemical composition min 100 daily samples



## On-line number/volume size distribution (SMPS and APS)



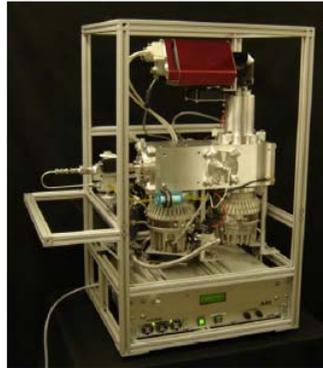
Acceptable/good correlations for combined factors



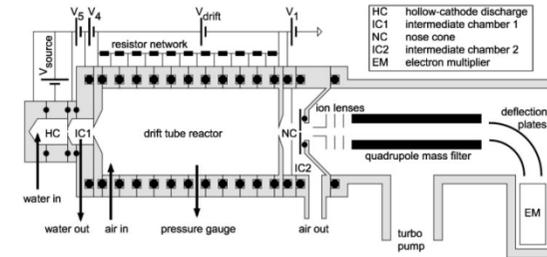
➔ Continuous source apportionment possible from size distribution measurements

Aerosol Chemical  
Speciation Monitor  
(ACSM, Aerodyne)

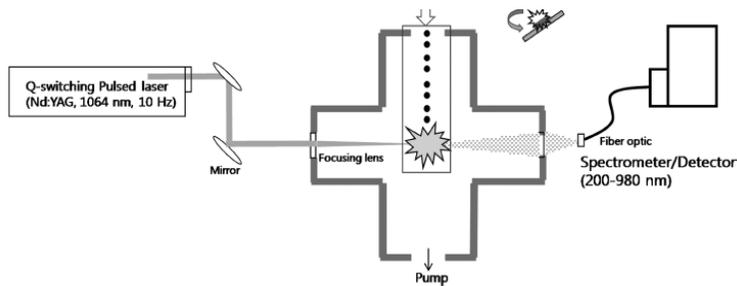
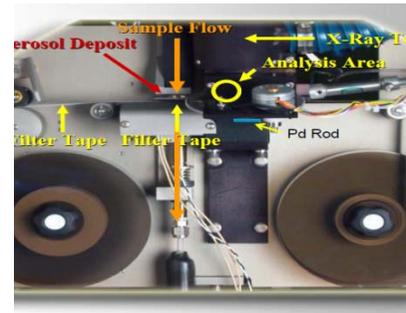
$\text{NO}_3^-$ ,  $\text{SO}_4^{2-}$ ,  $\text{NH}_4^+$ ,  $\text{Cl}^-$ ,  
HOA, OOA



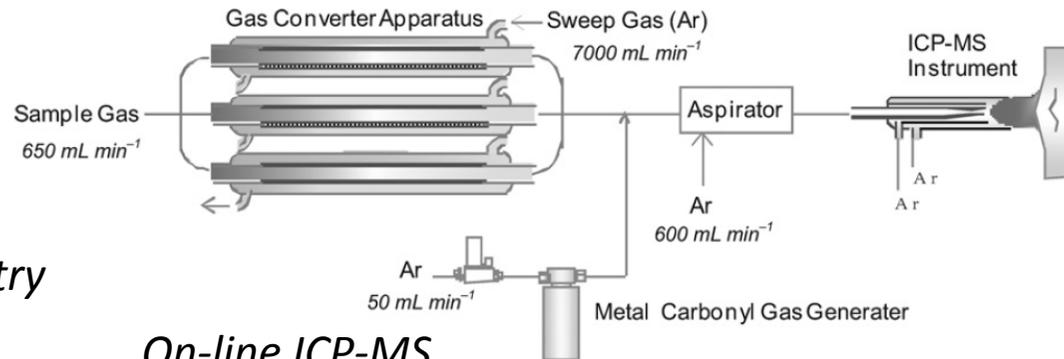
VOCs:  
e.g. PTR-MS  
(IONICON)



Metals and other elements:  
• XRF on Filter-tape (Pall)

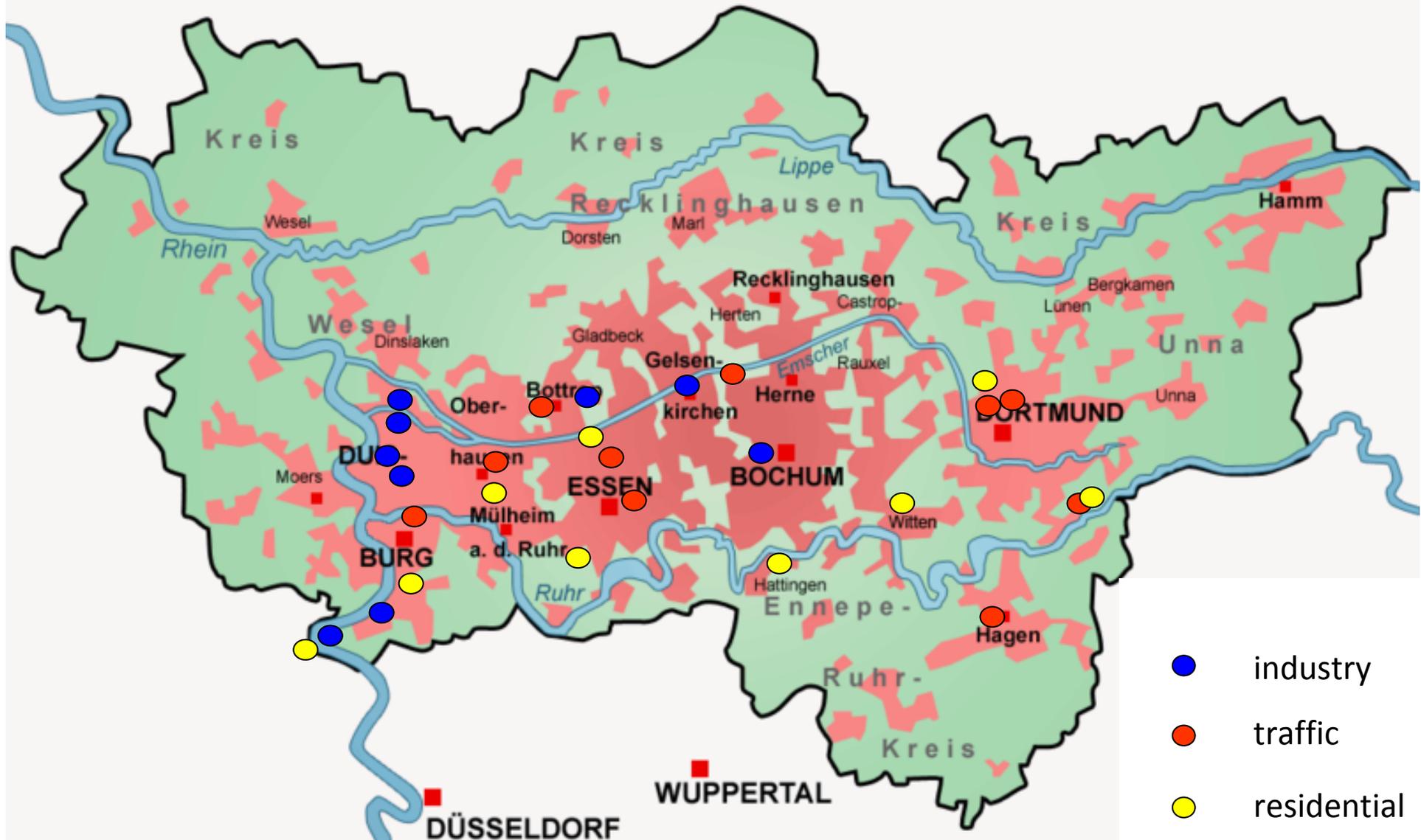


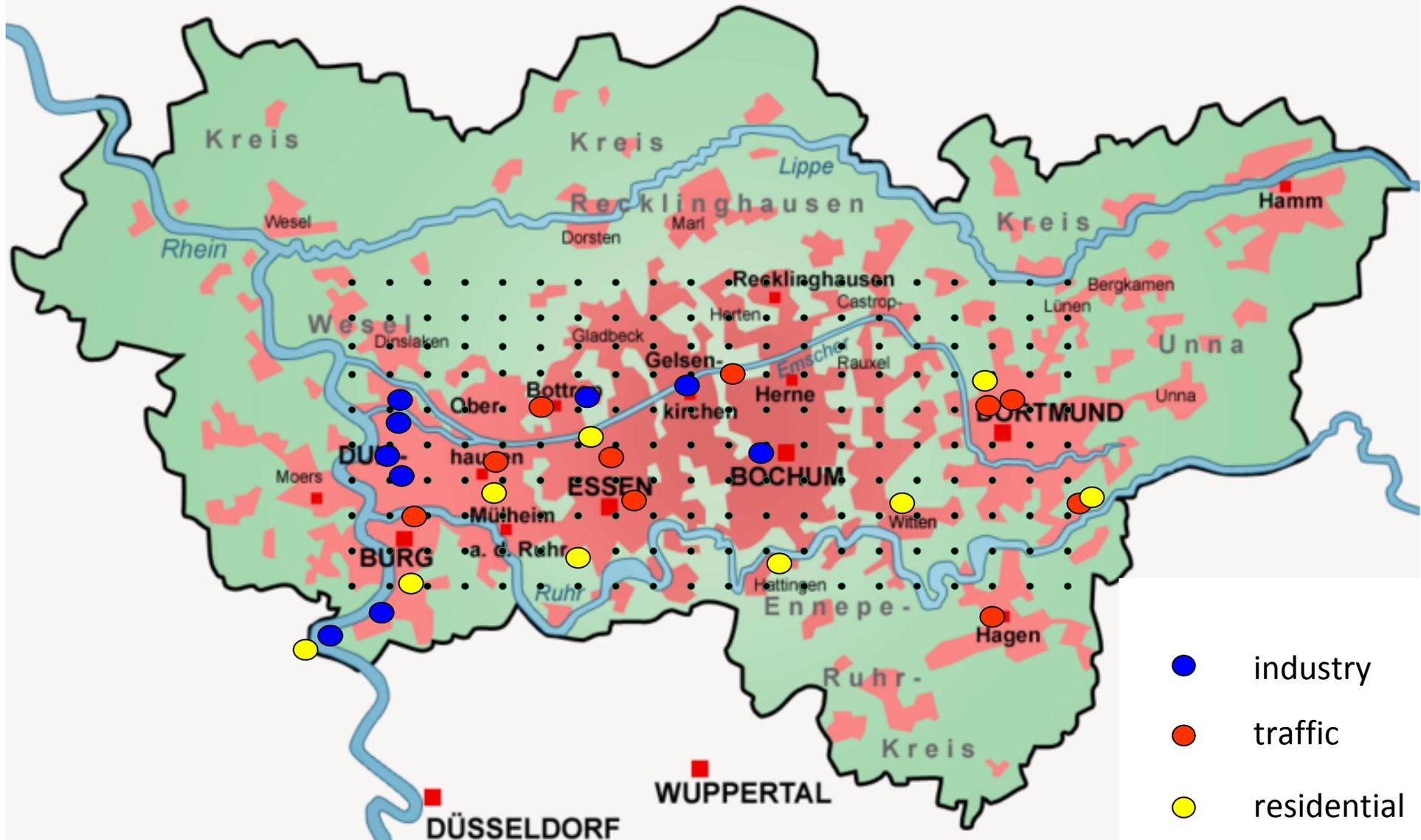
• *Laser-induced breakdown spectrometry*  
(Park et al. *Aerosol Science and Technology*, 43, 375–386)



*On-line ICP-MS*

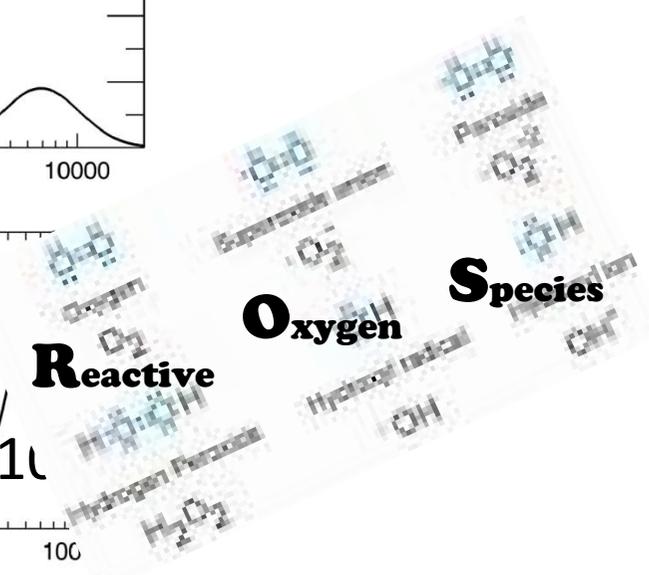
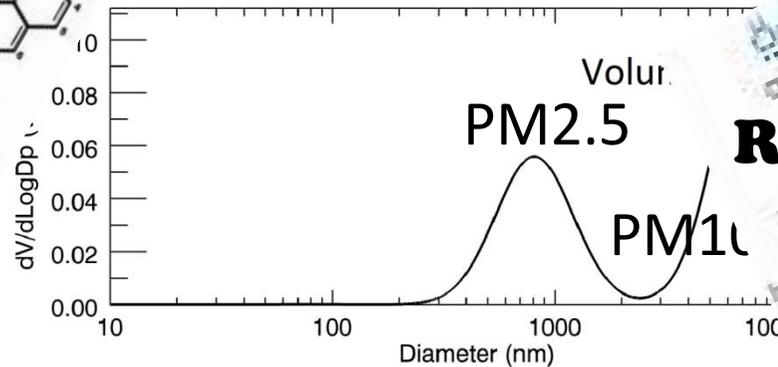
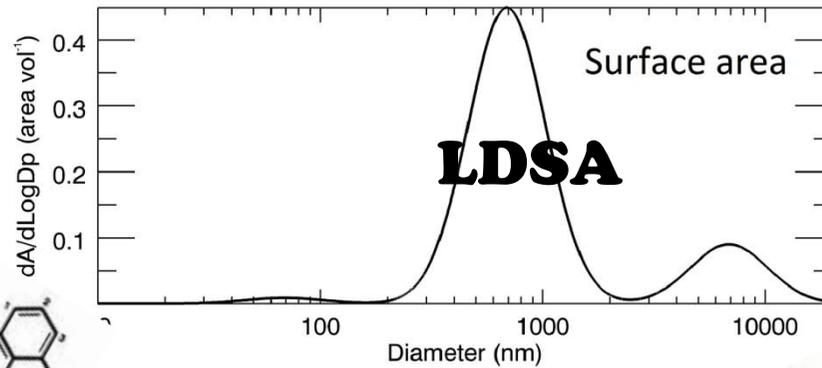
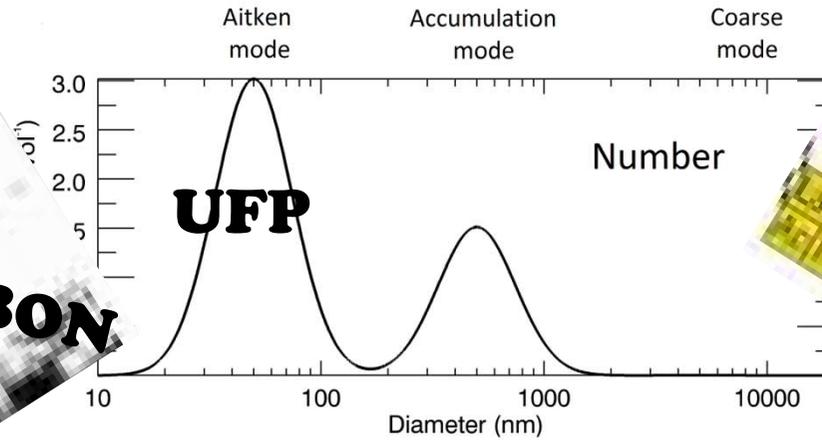
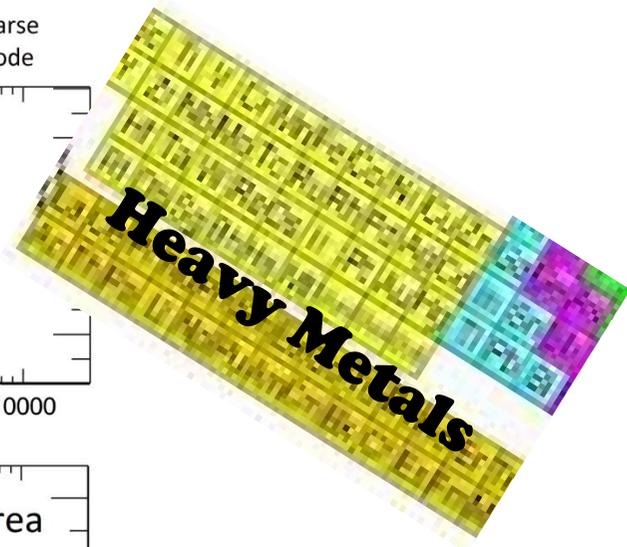
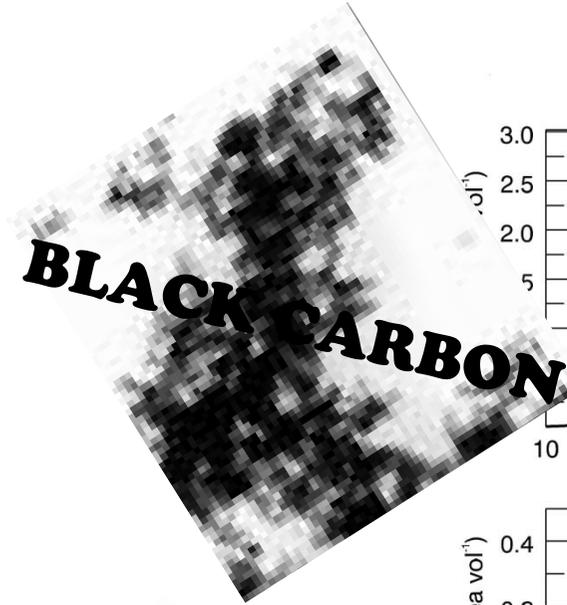
K. Nishiguchi *J. Anal. At. Spectrom.*, 2008, 23, 1125–1129







# Test of new particle metrics



## Trends in instrumentation

- Improved performance by
  - new techniques
  - higher time-resolution
- Miniaturisation
  - Compact monitoring „stations“
  - Handheld detectors and microchip sensors
- Multi-component detection
  - for gases and particles (elements, solubles, organic matter)
- Open-path monitoring
  - mapping the air quality of a city
- New chemical-physical metrics
- Health effect related proxies
- On-line in-vitro assays

**In addition to compliance assessment,  
recent and evolving air quality monitoring technologies  
may help to**

- better evaluate mitigation efficiency
- make source apportionment a continuous process
- improve exposure assessment and modelling accuracy
- check the health relevance of potential alternative metrics

**and ...**

## AIR QUALITY EGG



<http://airqualityegg.com/>

... might even become part of  
everybody's everyday life

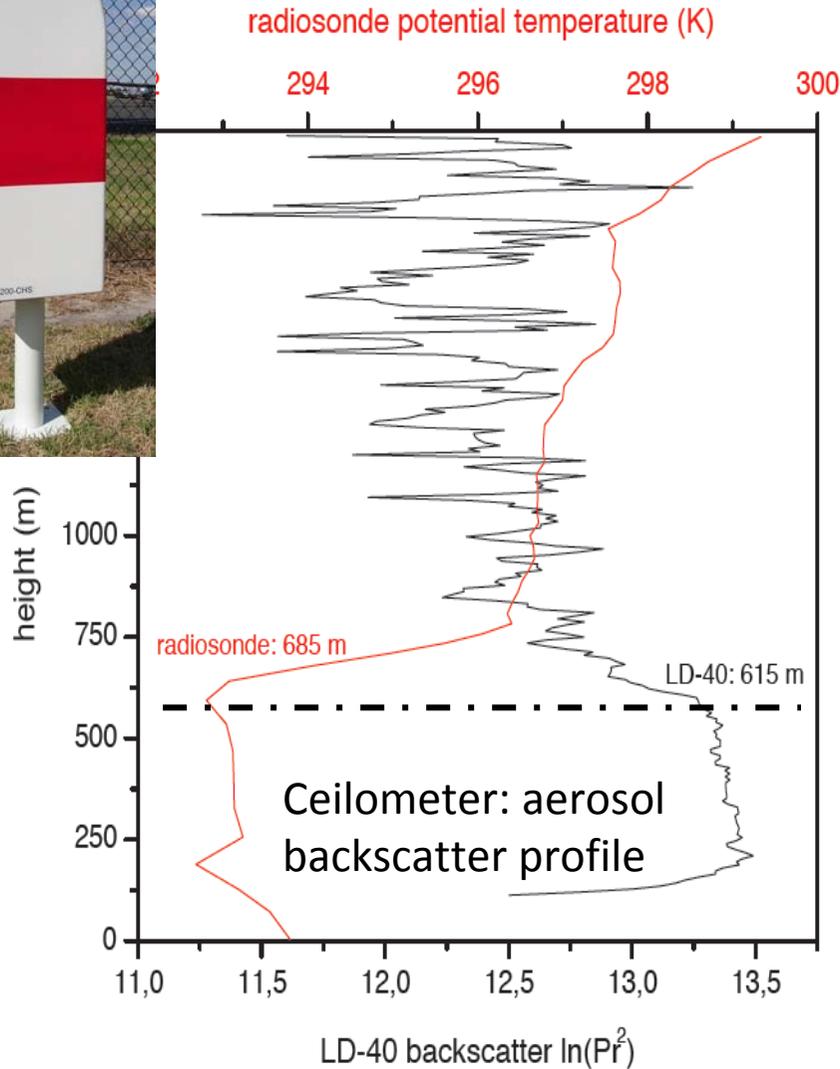


**Thanks for your attention!**

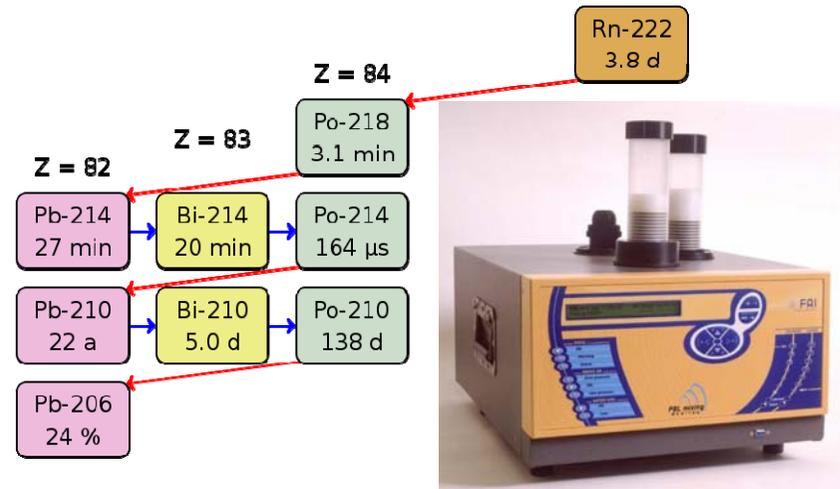
<https://sosa.ucsd.edu/confluence/display/CitiSensePublic/CitiSense>



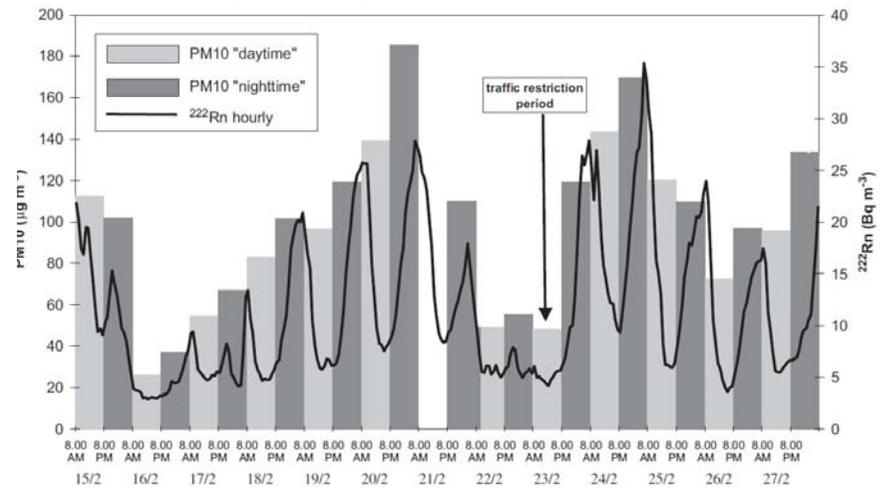
Intentionally BLANK



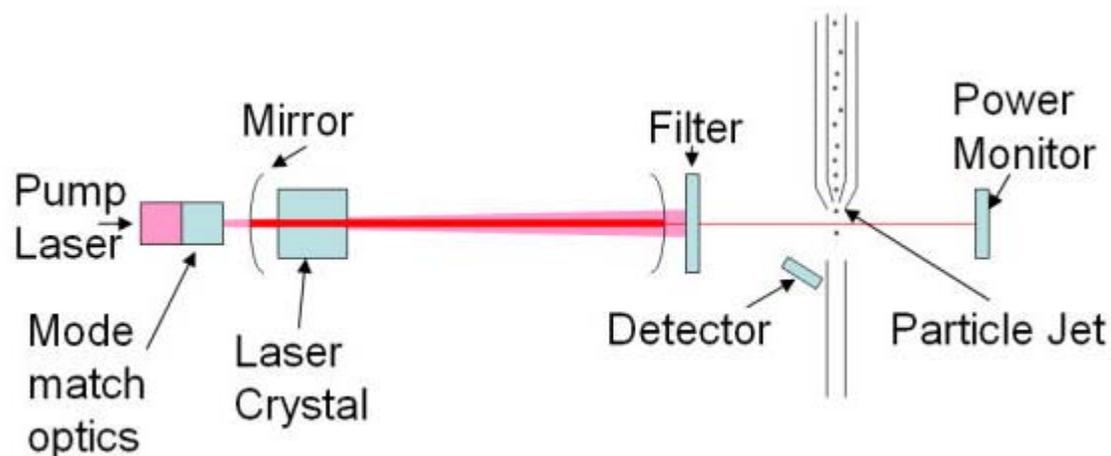
M. De Haij et al, KNMI biennial reports 2005-2006



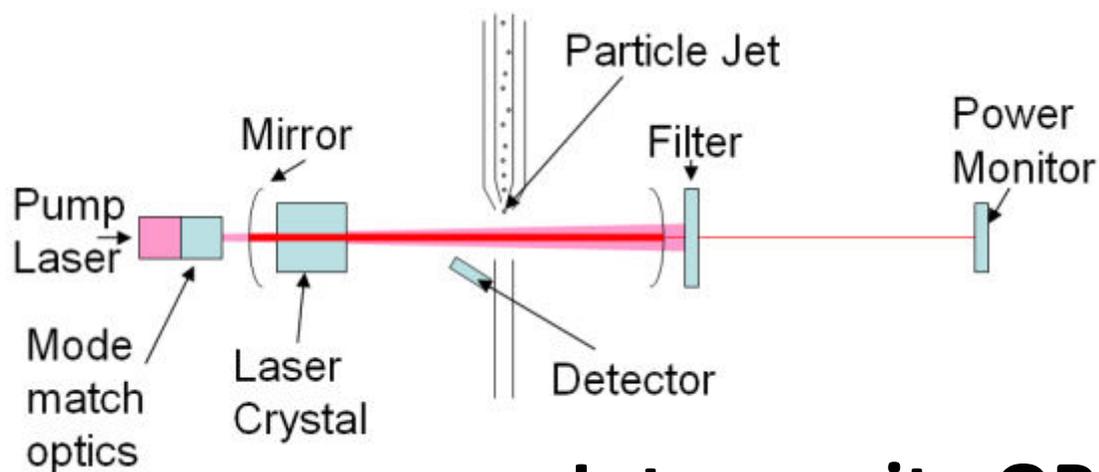
## Radon progeny: fluctuation follows atmosph. dispersion conditions



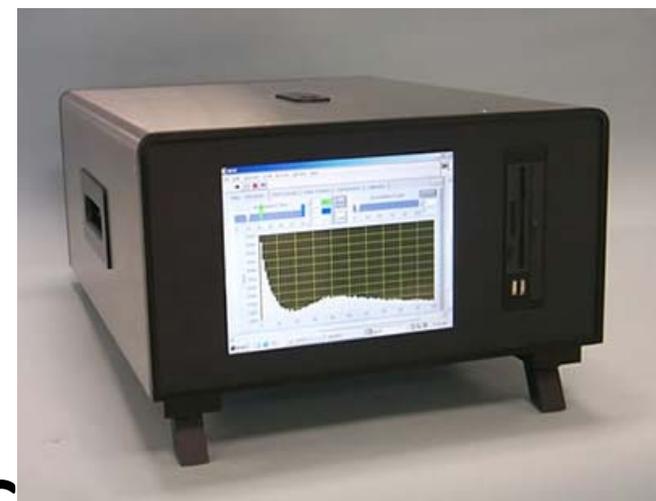
R. Vecchi et al. Atmospheric Environment 41 (2007) 2136-2144



## Standard OPC



## Intra-cavity OPC



<http://www.dropletmeasurement.com/>



FIDAS (Palas)  
PNC, Mass  
(PM<sub>1</sub>, 2.5, 4, 10, TSP)  
LED light scattering

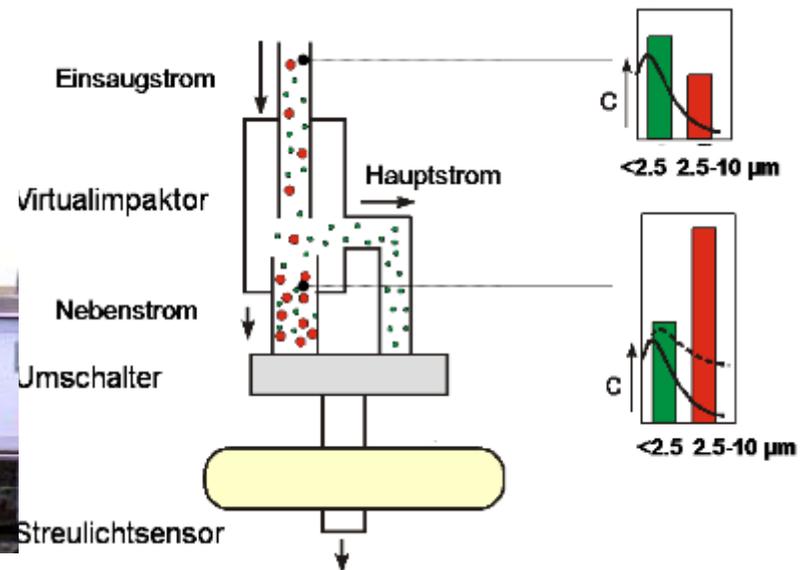
SHARP (Thermo)  
Mass  
Nephelometry +  $\beta$ -Absorption



APM2 (COMDE)  
Mass PM<sub>2.5/10</sub>  
Light Scattering  
(Nephelometer)



EDM 180 (Grimm)  
Mass, size distr. 31 ch.  
Light Scattering  
(Nephelometer)



# Compact Monitoring Stations



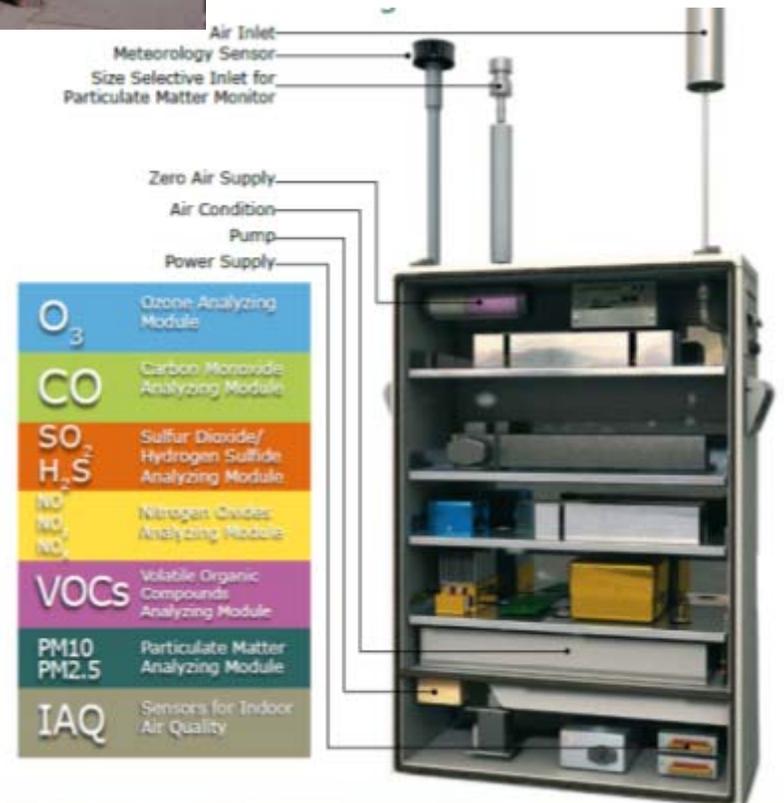
Aeroqual  
AQM 60

<http://www.aeroqual.com/>



AirPointer

<http://www.recordum.com>

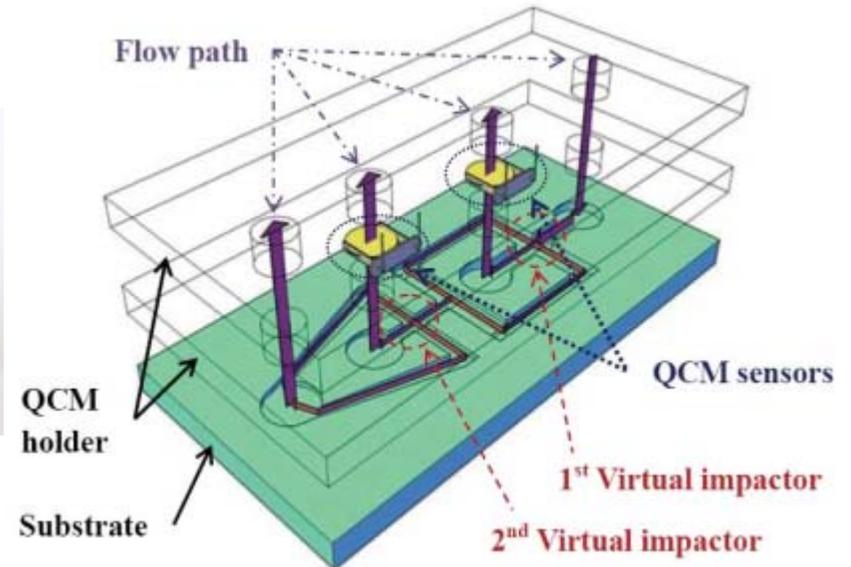




NanoTracer (Philips)  
PNC, av. dp



MicroAeth (Magee)  
BC in TSP, PM2.5



FIDAS mobile (Palas)  
PNC, size-distr. (32ch/decade)  
0.2-18  $\mu\text{m}$   
PM10/4/2.5/1

Quartz Crystal  
Microbalance  
Sensor  
PM mass  
Liang et al.  
*Sensors* 2010:3641-3654

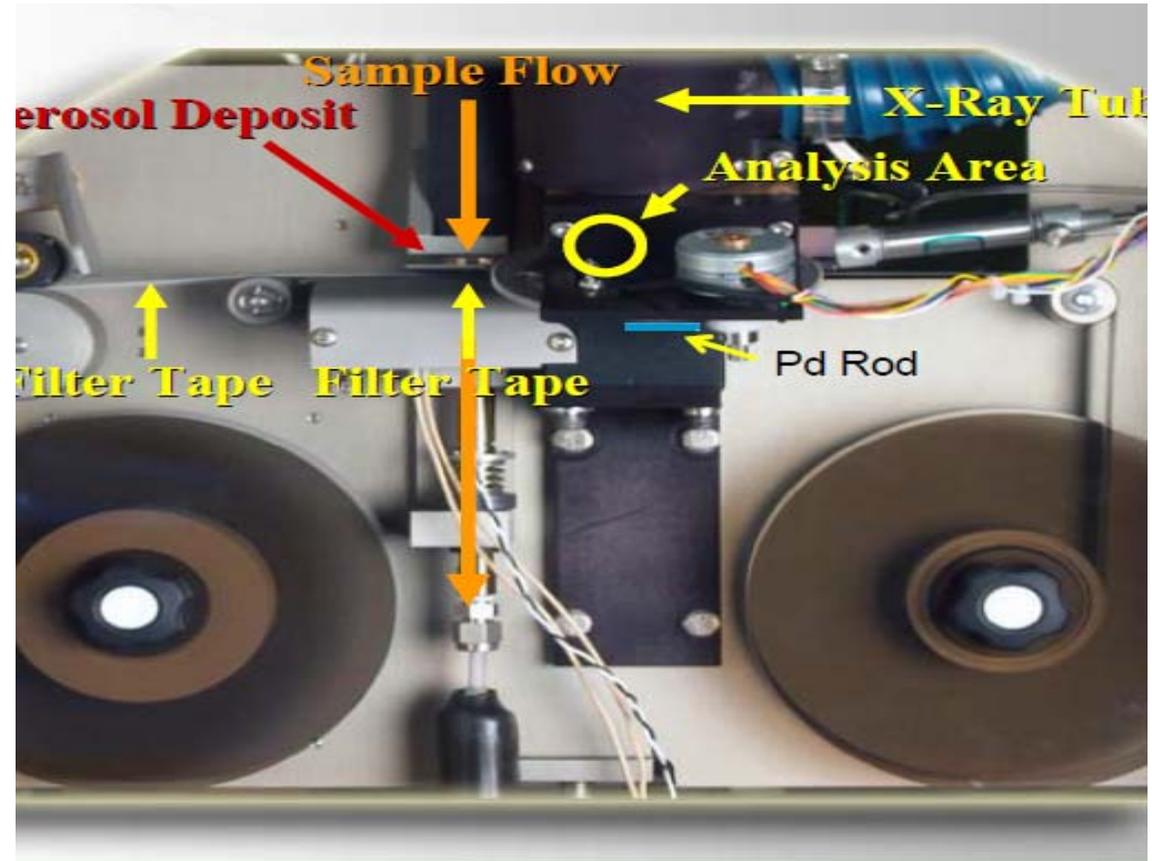


Handheld CPC (TSI)  
PNC 10->1000 nm



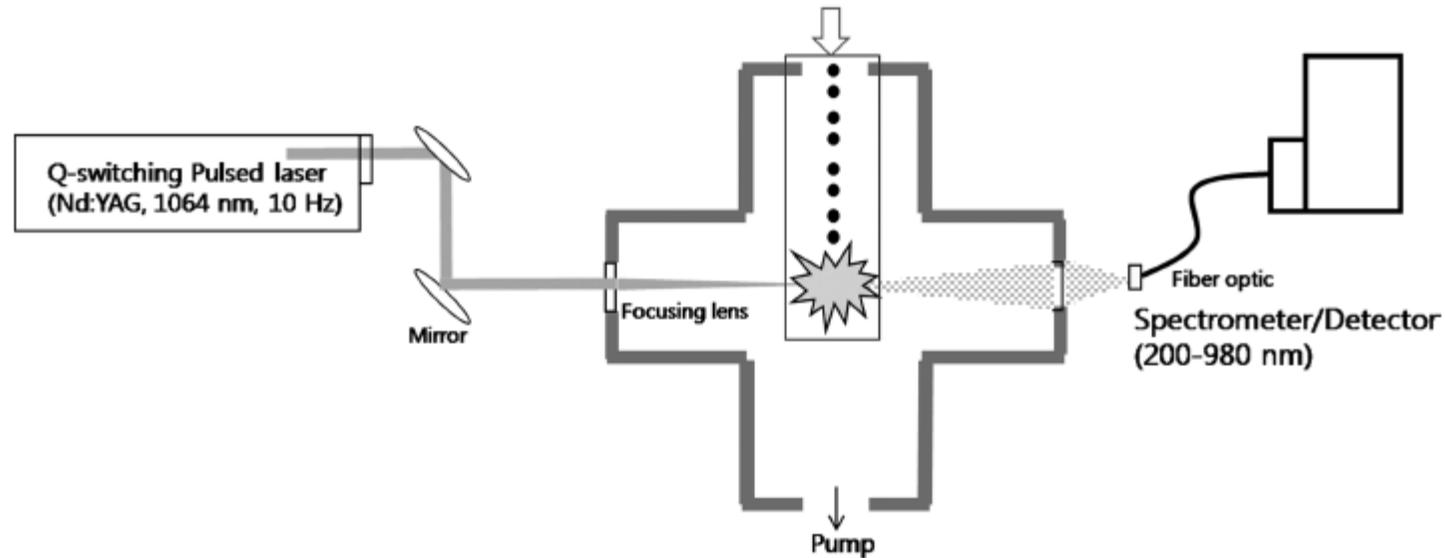
DiSCmini (Matter Engineering)  
PNC/LDSA(alveo.)  
10-300 nm modal

1 m<sup>3</sup>/h,  
PM10, 2.5, TSP

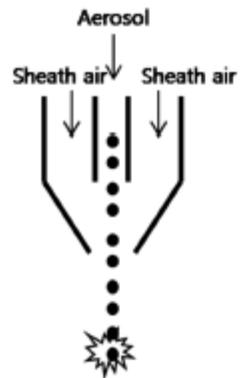


XAct 620 Ambient Metal Monitor (**Pall Corp.**)

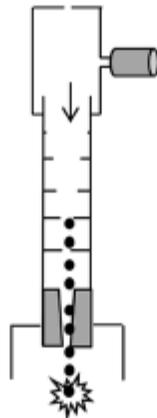
Up to 36 elements, 15-240 min., DLs down to  $\ll 1$  ng/m<sup>3</sup>



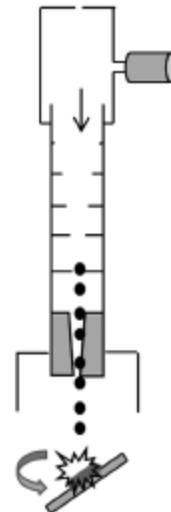
(a) Sheath air focusing



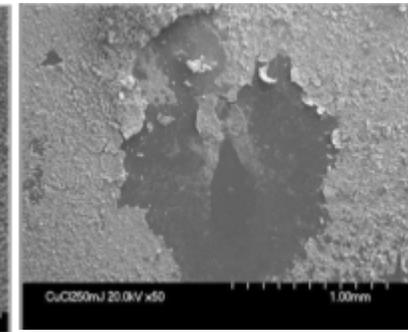
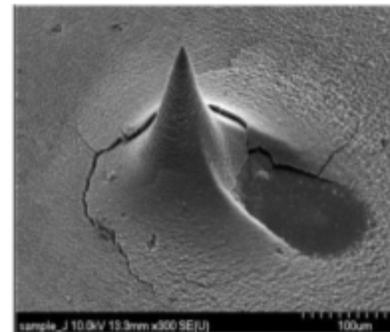
(b) Aerodynamic focusing



(c) Aerodynamic focusing with a rotatable substrate

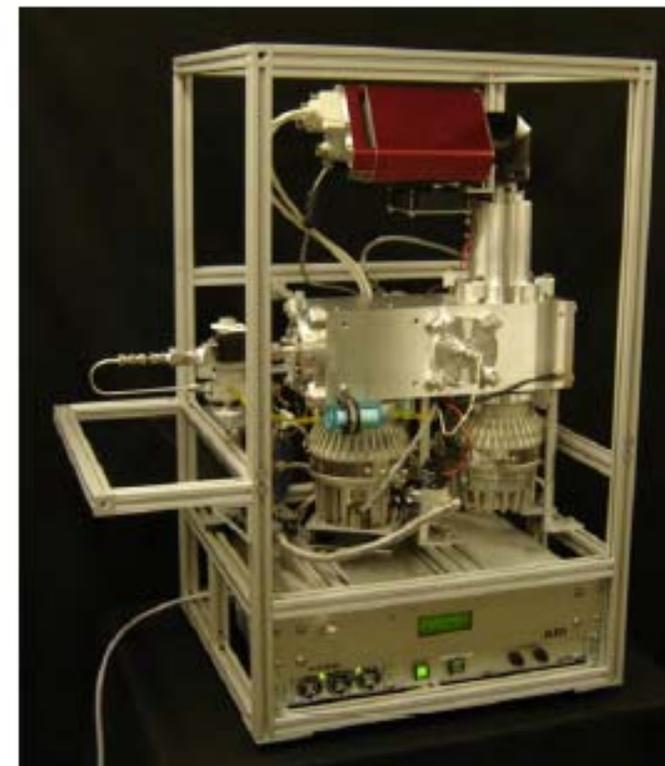
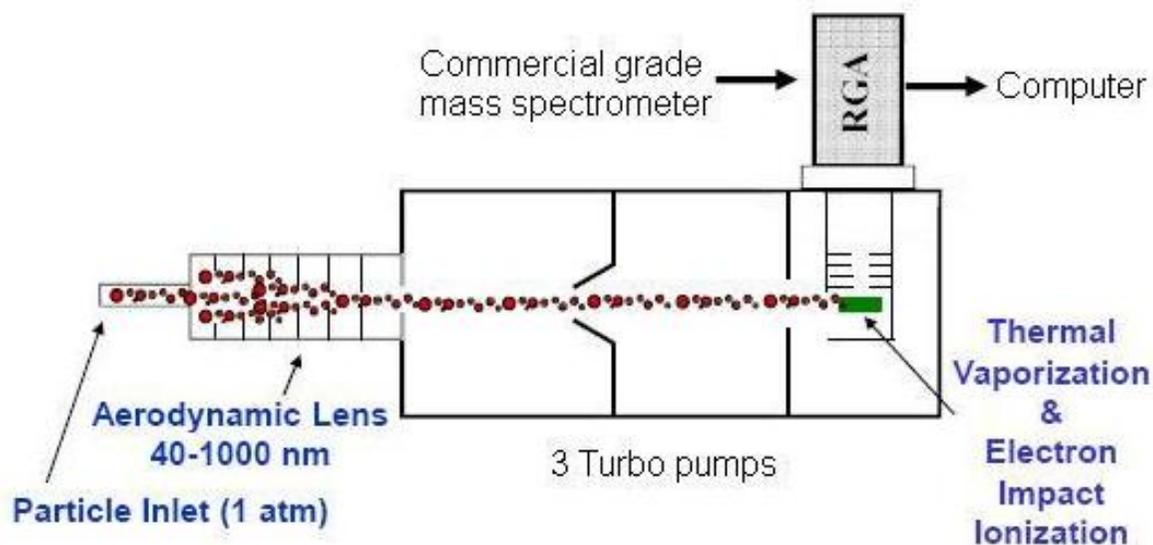


5 min sampling,  $dp(\text{min}) \sim 60 \text{ nm}$   
 LOD (Cu,  $dp$  ca. 100 nm):  $\sim 80 \text{ ng/m}^3$



<http://www.aerodyne.com/products/aerosol-chemical-speciation-monitor>

<http://cires.colorado.edu/~jose/ams.html>



L.N. Ng et al.: Aerosol Science and Technology,  
Volume 45 (2011) , pp. 770-784(15)

No size data as in AMS, with Quadropole: 0-200 amu range

In development:

ccTOF-ACMS with higher mass range, higher time resolution, higher sensitivity

**Example for ACSM field Data:**

**Y. L. Sun et al.,** Atmos. Chem. Phys. Discuss., 11, 25751–25784, 2011

## Water soluble gases and/or particle compounds



URG 9000 IC

Taken from URG web site



MARGA

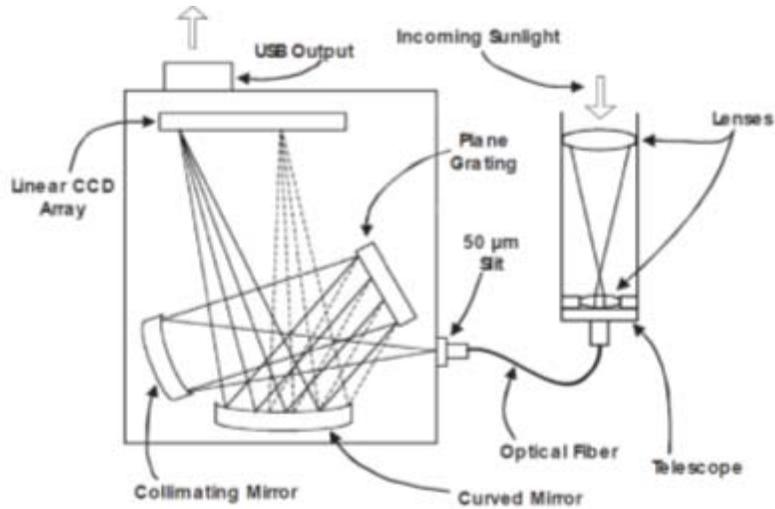
Taken from Applikon web site



PILS-IC

Taken from Metrohm web site

## MINI-DOAS (open path)



Galle et al. J. Volcanology and Geothermal Research, 119:241-254.

## COMPASS (open path)



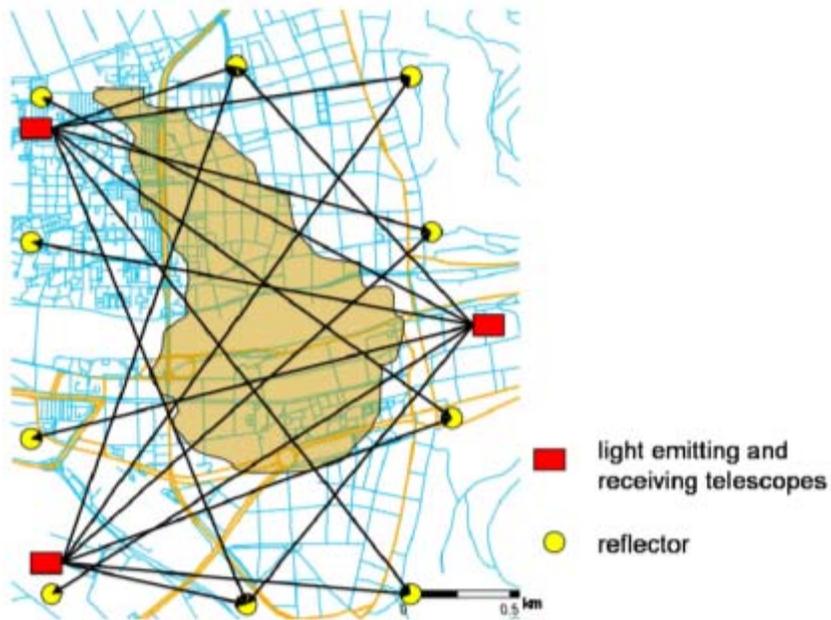
Mori et al., Bull. Volcanol. Soc. Japan 52:105-112

## MOBILE- UV-DOAS (cuvette)

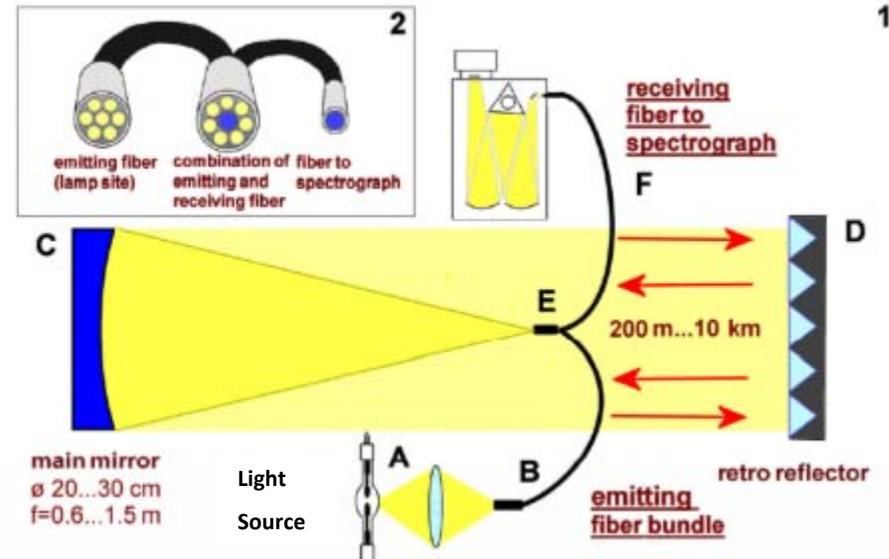


<http://www.duvastechnologies.com/>

Commercial DOAS  
(e.g. Ophis,  
Environnement SA)



Tomographic DOAS measurement



New, compact long-path DOAS  
(Fibre bundles, LEDs)

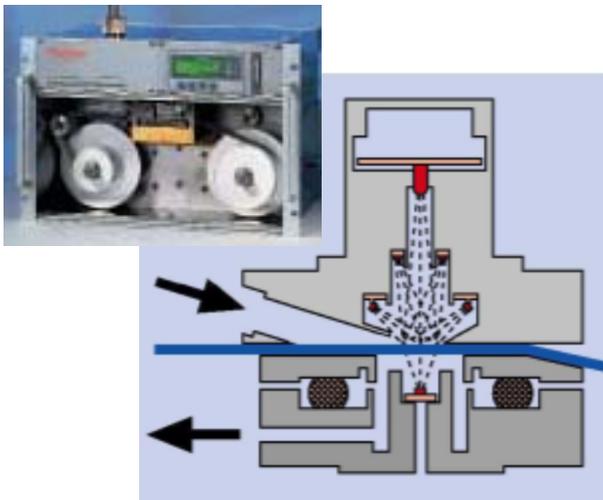




Aethalometer (Magee)



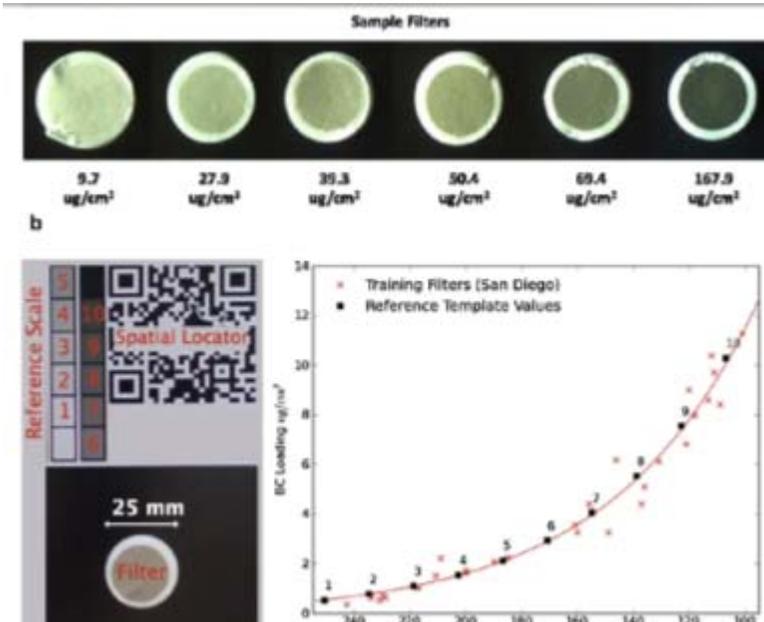
Photoacoustic Extinctionmeter  
(DropletMeasurement)



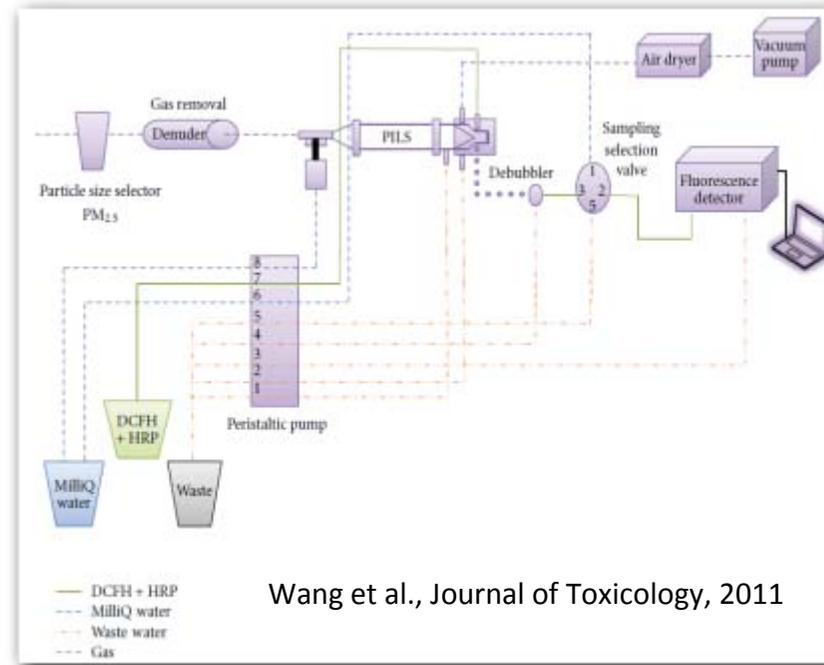
MAAP (ThermoFisher)

## Cell-Phone based BC screening

Ramanathan et al (2011) Atmospheric Environment 45, 4481-4487



## Particle bound ROS (as H<sub>2</sub>O<sub>2</sub> equivalents)



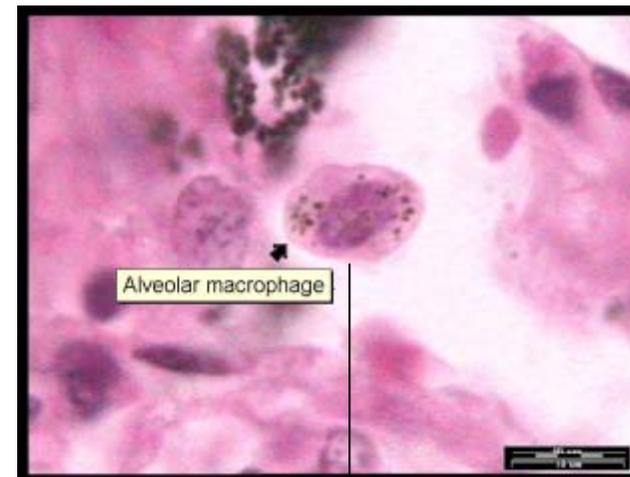
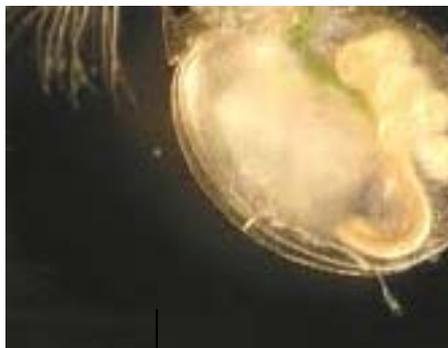
Potential for automation of procedure:

OH-Radical formation: DMPO/H<sub>2</sub>O<sub>2</sub> spin-trap method (ESR)

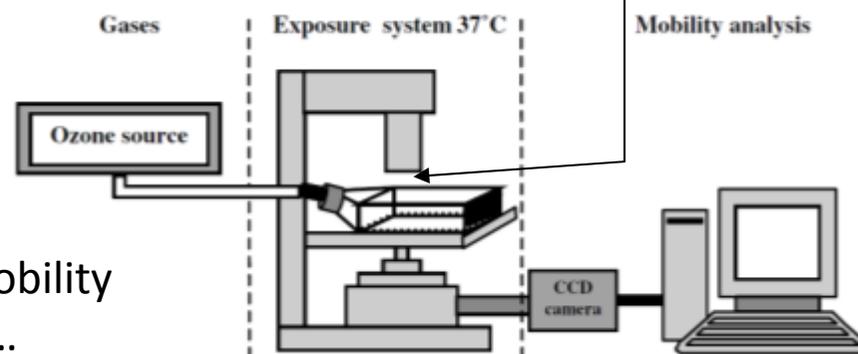
Redox Activity: Dithiothreitol (DTT) consumption assay

Salicylic acid/ HPLC method

Daphnia Magna  
for test of  
water toxicity



Monitoring of macrophage mobility  
while exposed to polluted air...



P. Laval-Gilly et al., J. Pharmacol. Toxicol. Methods, 44:483-488 (2000)

Klestad et al., Toxicology in vitro 2:199-206 (2005)

Environmental biosensor for measuring air contaminants EPO Patent EP1058849