AirMonTech

Urban AirQuality Monitoring: Current Possibilities and Future Needs

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

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www.airmontech.eu

WP2 Background (1)

AQ monitoring

optimize

Limits kept?

NO

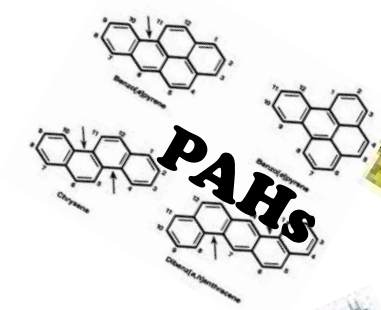
YES

EXTEND?

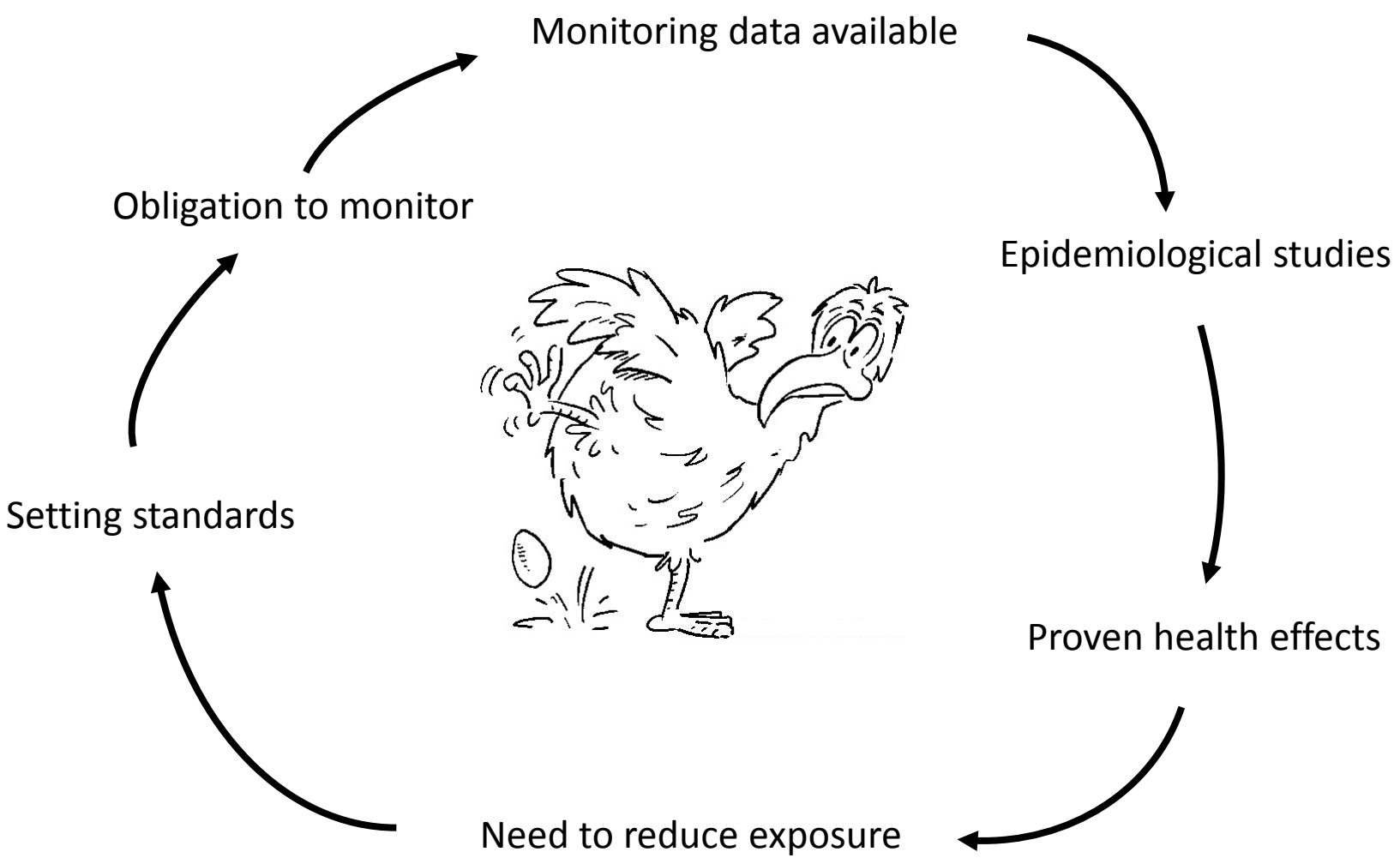
Sources?

Short-term Actions

Long-term actions



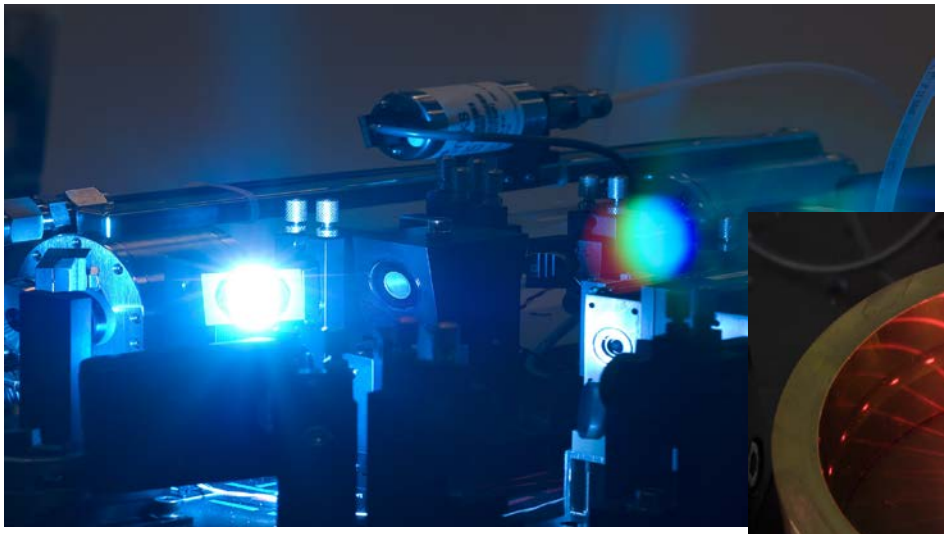
WP2 Background (2)

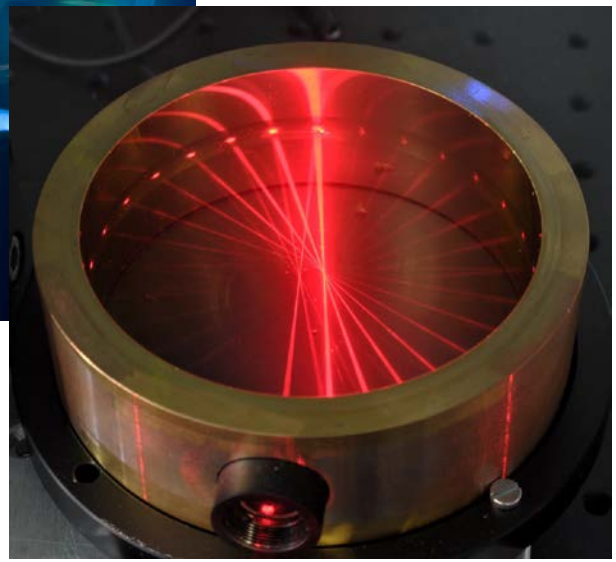


WP 2 Questions

- Are there new technologies available for the established (regulated) metrics?
- Can emerging, potentially relevant metrics be monitored?
- Any other instrumental trends that may support AQ monitoring or promote new monitoring approaches/strategies?

New Technologies for current metrics: Gaseous Pollutants (1)





EMPA

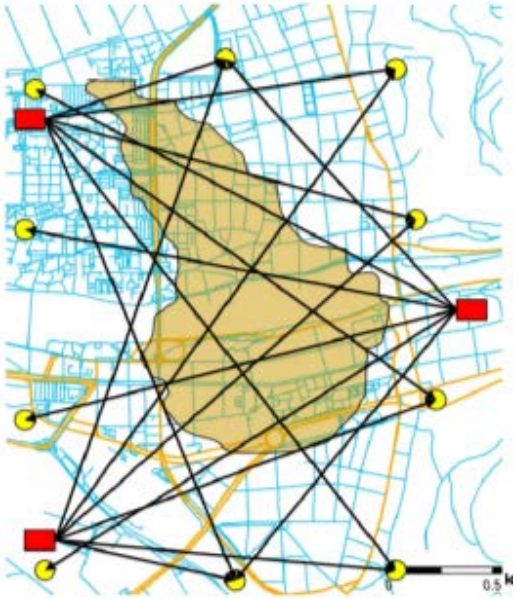
Materials Science & Technology

- Laser-based instruments (QCL, TDLAS, DOAS):

➔ potential for improved detection limits, better selectivity, multi-gas measurements,

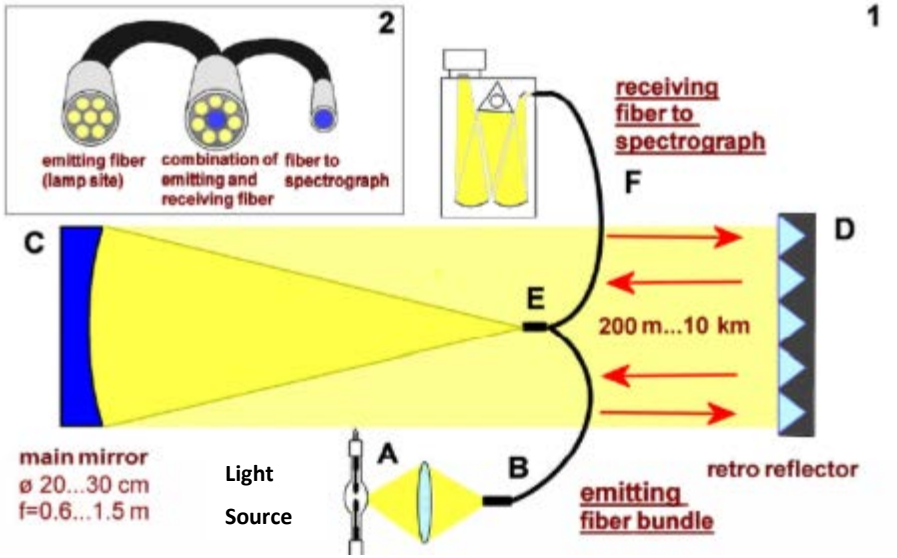
New Technologies for current metrics: Gaseous Pollutants (2)

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



•Open Path DOAS

➔ tomographic maps of city's Air Quality



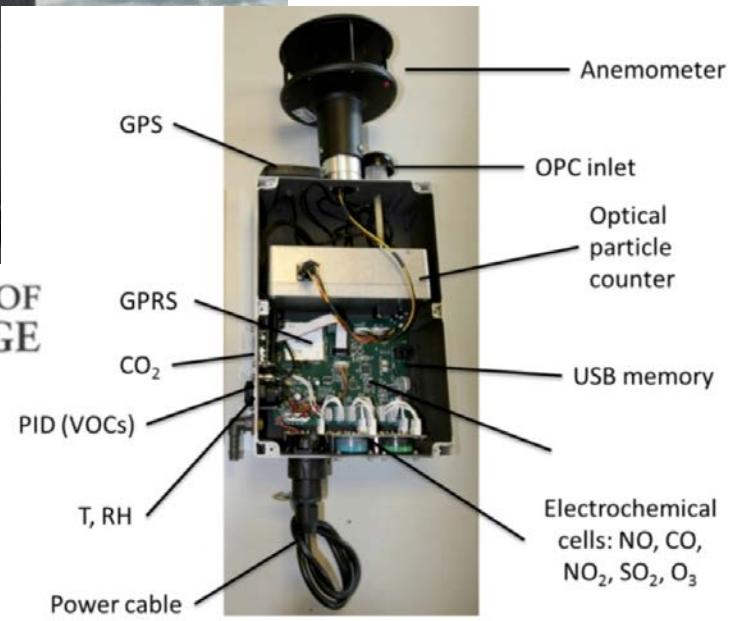
New, compact long-path DOAS
(Fibre bundles, LEDs)

Pöhler, D. Dissertation Uni Heidelberg
http://www.ub.uni-heidelberg.de/archiv/10996

New Technologies for current metrics: Gaseous Pollutants (3)

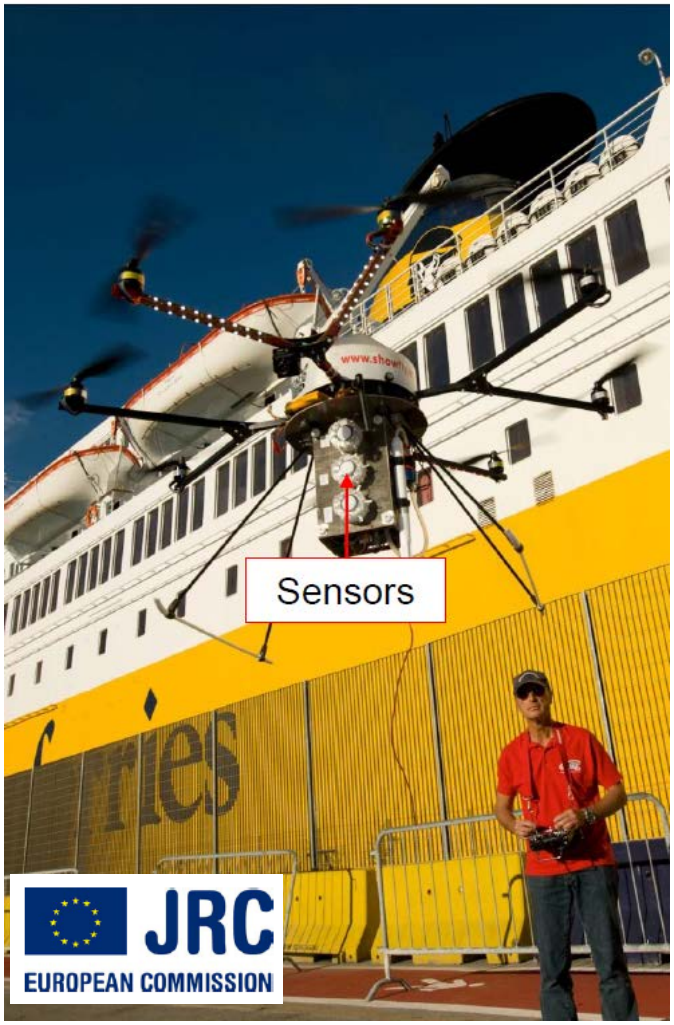
UNIVERSITY OF CAMBRIDGE

Sensor Network at Heathrow Airport



- Solid State Sensors

➔potential for extended spatial monitoring, mapping, improved exposure assessments, airborne measurements (source tracking)



Plume tracking by unmanned aerial vehicles

New Technologies for current metrics: Particles

FIDAS (Palas)
PNC, Mass
(PM1, 2.5, 4, 10, TSP)
LED light scattering

APM2 (COMDE)
Mass PM2.5/10
Light Scattering
(Nephelometer)

SHARP (Thermo)
Mass; Nephelometry + ß-Absorption

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

Light-scattering instruments

➔real-time measurements of PM mass and size distributions
(equivalence tests passed or ongoing)

New, alternative particle metrics (1)

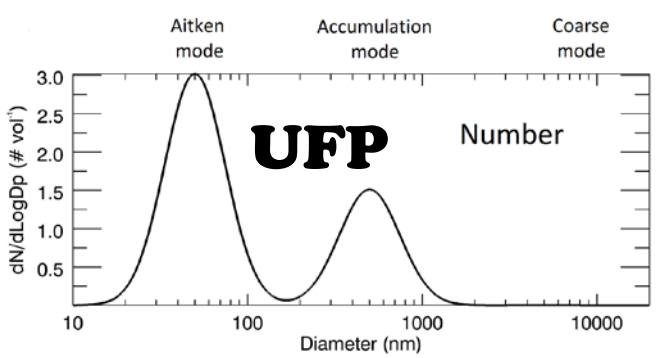


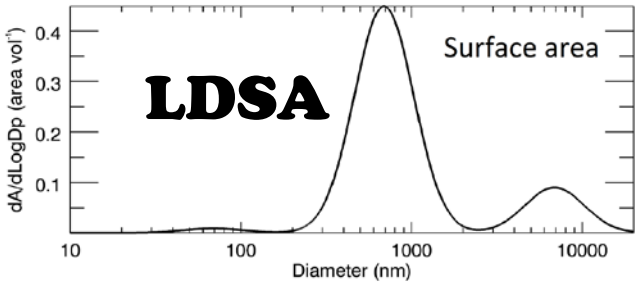
Photo: Chuck Sarnoski & Betsy Frey Delaware DNREC / DAQ
http://www.marama.org/presentations/2012_Monitoring/frey-sarnoski-ultrafine-mon2012.pdf

UFIPOLNET

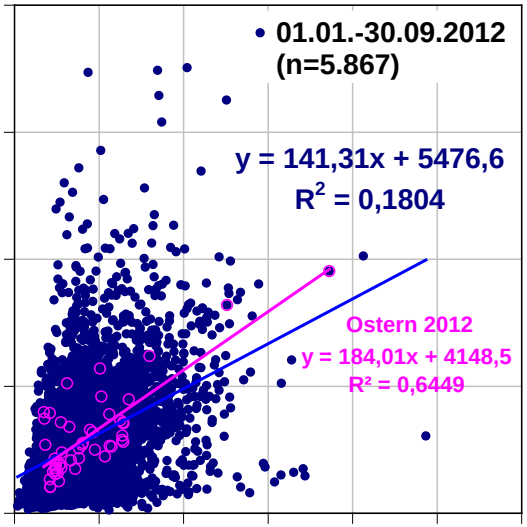
UFIREG

Ultrafine particles

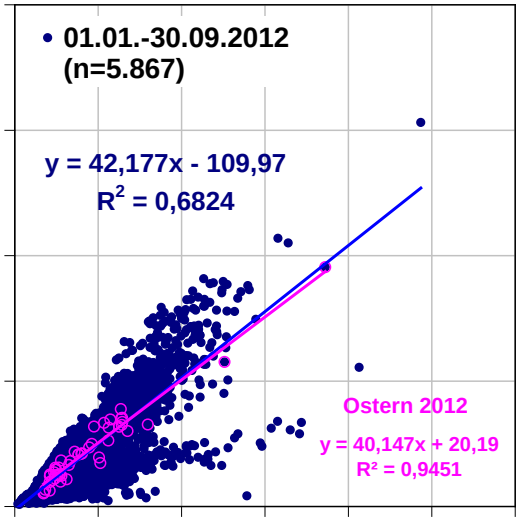
an evidence based contribution to the development of regional and European environmental and health policy



UFP vs. LDSA



Accumulation mode vs. LDSA



New, alternative particle metrics (2)

Black Carbon (BC)

Thermochemical Classification	Molecular Structure	Optical Classification
Elemental Carbon (EC)	*Graphene Layers (graphitic or turbostratic)*	Black Carbon (BC)
Refractory Organics	*Polycyclic Aromatics, Humic-Like Substances, Biopolymers, etc.*	Colored Organics
Non-Refractory Organics (OC)	*Low-MW Hydrocarbons and Derivatives (carboxylic acids, etc.)*	Colorless Organics (OC)

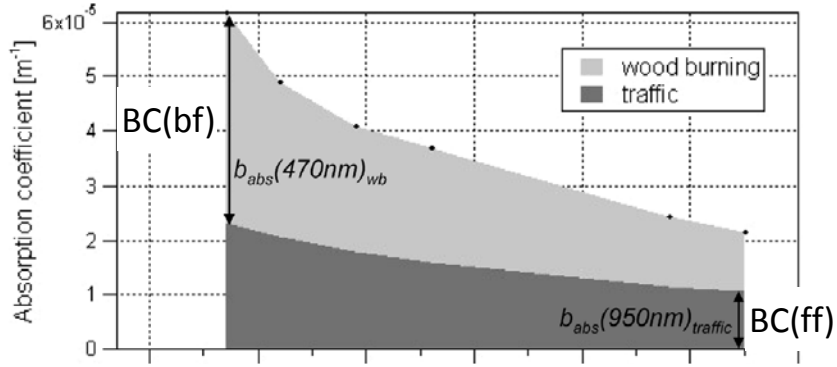
Refractiveness ↑ Specific Absorption ↑

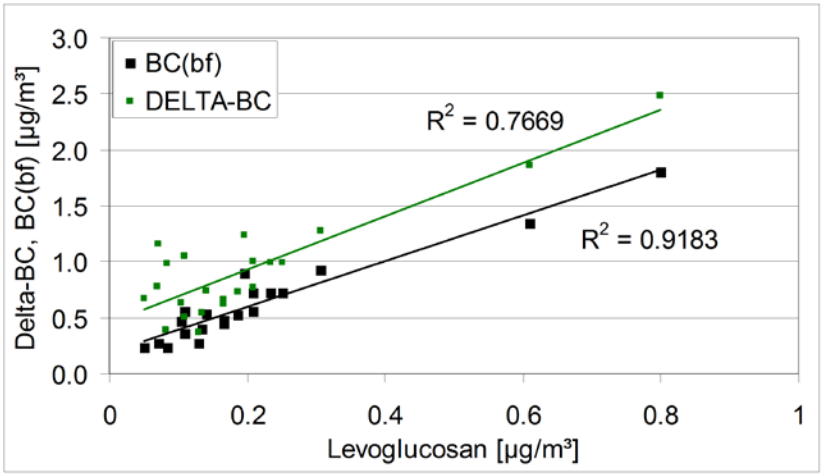
Pöschl, Anal. Bioanal. Chem. 2003

MAAP (ThermoFisher)

Photoacoustic Extinctiometer (DropletMeasurement)

Aethalometer (Magee)

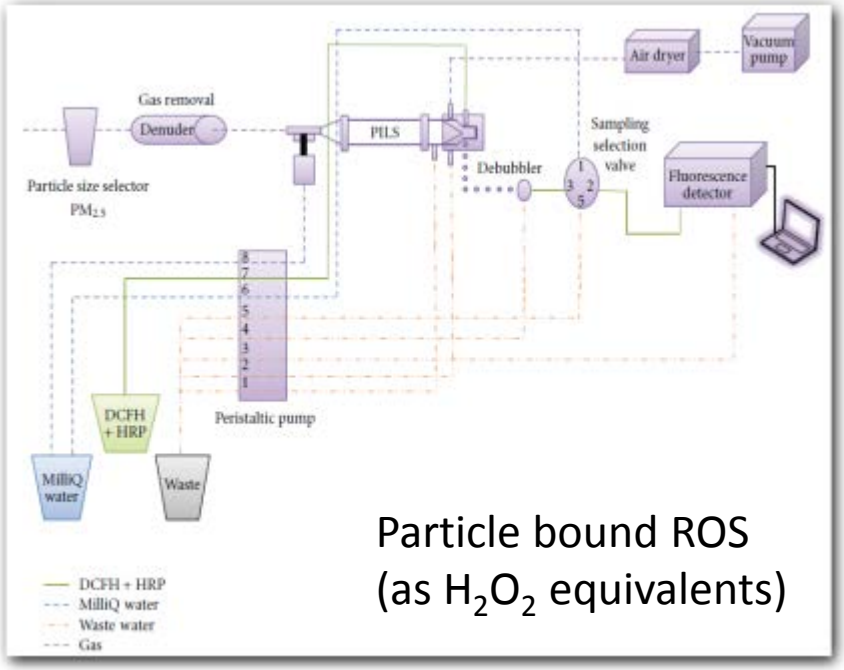




New, alternative particle metrics (3)


Photo: IUTA

Particle induced ROS (DMPO method)



Particle bound ROS
(as H_2O_2 equivalents)

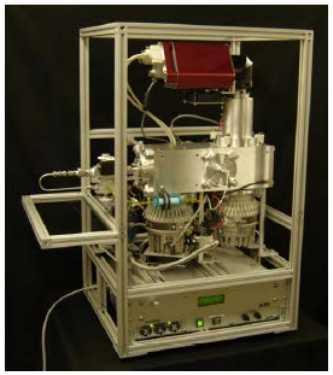
Wang et al., Journal of Toxicology, 2011

Assays with potential for automation:

OH-Radical formation:	DMPO/H_2O_2 spin-trap method (ESR)
Redox Activity:	Dithiothreitol (DTT) consumption assay
	Salicylic acid/ HPLC method

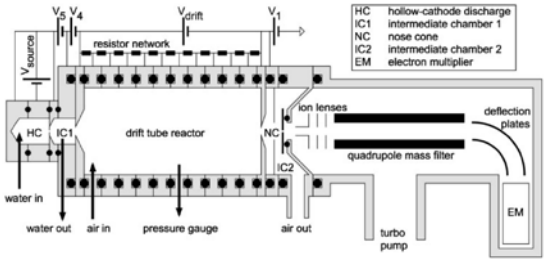
Other innovations: Automated chemical speciation

Aerosol Chemical Speciation Monitor (ACSM, Aerodyne)



NO_3^-, SO_4^{2-}, NH_4^+, Cl^-,
HOA, OOA

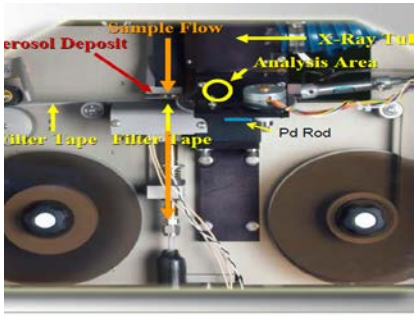
VOCs:
e.g. PTR-MS (IONICON)



Water soluble compounds (e. g. MARGA, Metrohm)

NH3, HNO3, HNO2, SO2, HCl;
NH4, SO4, NO3, Cl, Ca, Mg, Na, K

Metals and other elements:
e. g. XRF on Filter-tape (CES/Pall)

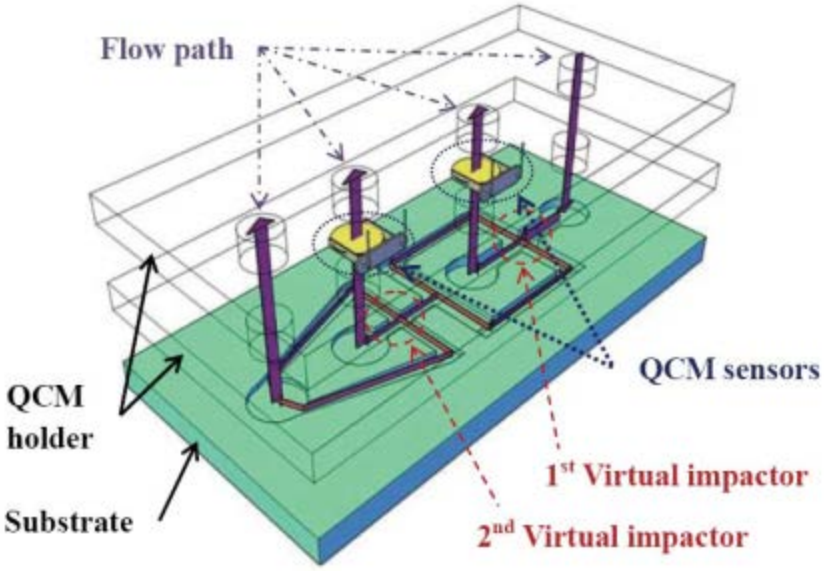


➔ Time resolved source apportionment
➔ source-related health impact assessment

Other innovations: portable monitors

Partector (naneos)
PNC, LDSA (alveol.)

MicroAeth (Magee)
BC in TSP, PM2.5



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

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

Handheld CPC (TSI)
PNC 10->1000 nm

➔ Improved
personal exposure assessment

Recent trends in instrumentation

- Improved performance by
  - new techniques
  - higher time-resolution
- Miniaturisation
  - Compact monitoring „stations“
  - portable 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

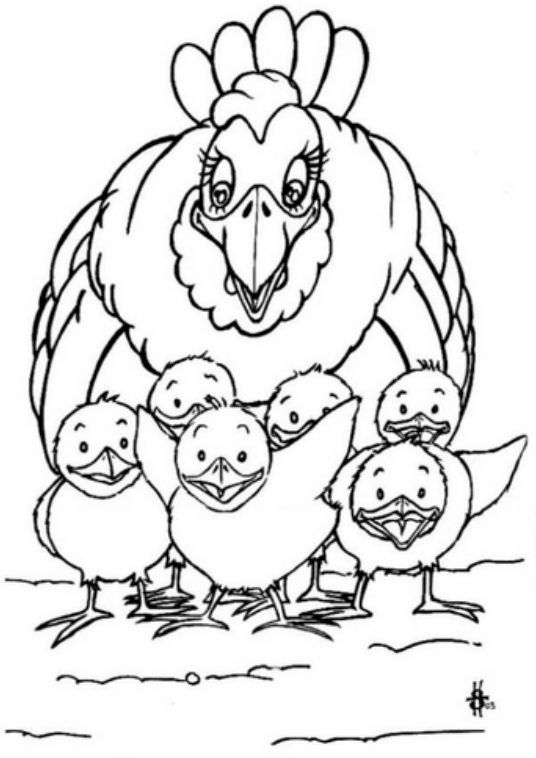
Conclusions (2)

**In addition to compliance asessment,
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 thus…

overcome the hen-and-egg-problem



Thank you for your attention! Quasstions?