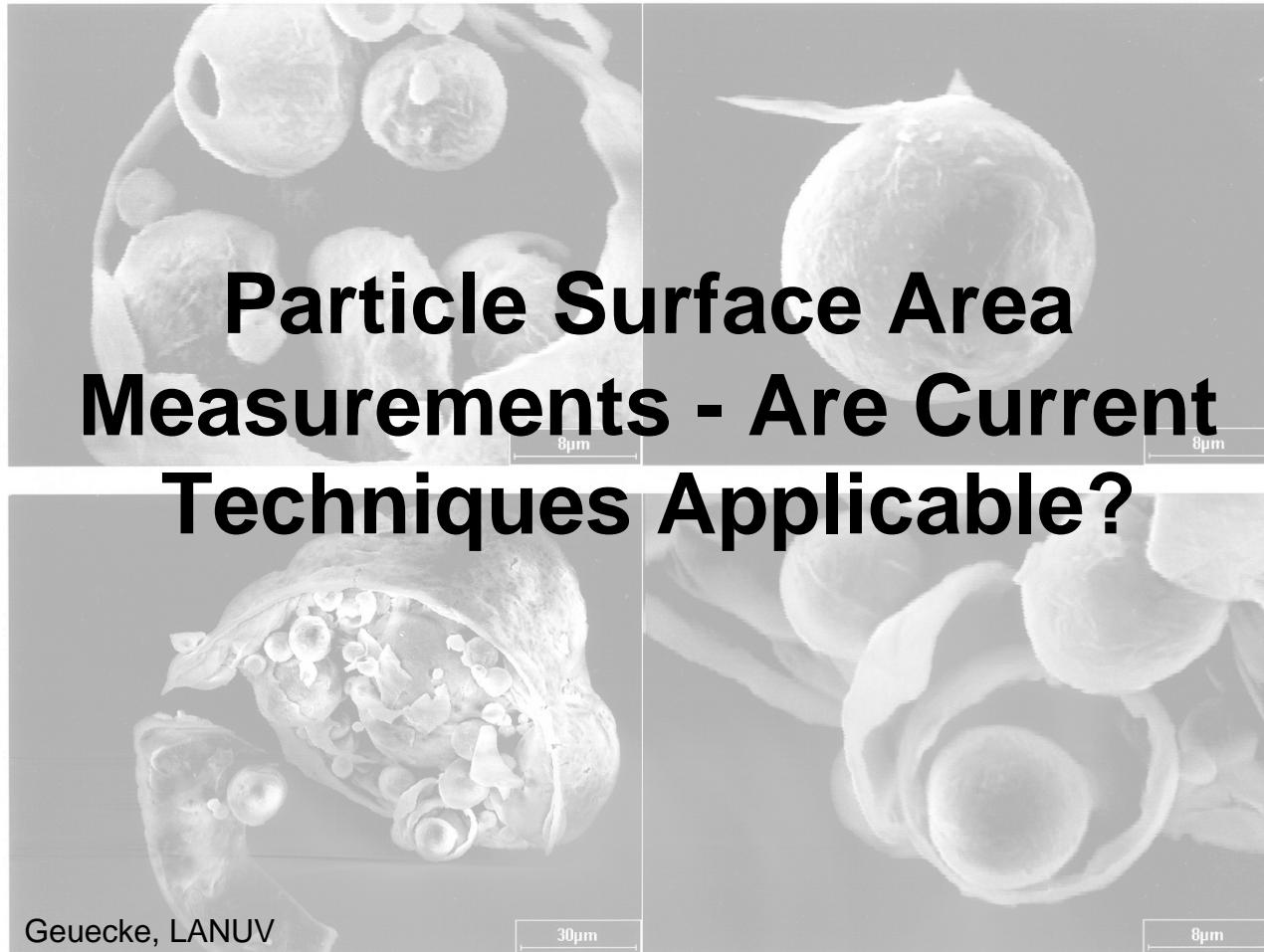


Thomas A. J. Kuhlbusch,
Christof Asbach, Heinz Kaminski



Current & Future Air Quality Monitoring
14th & 15th December 2010

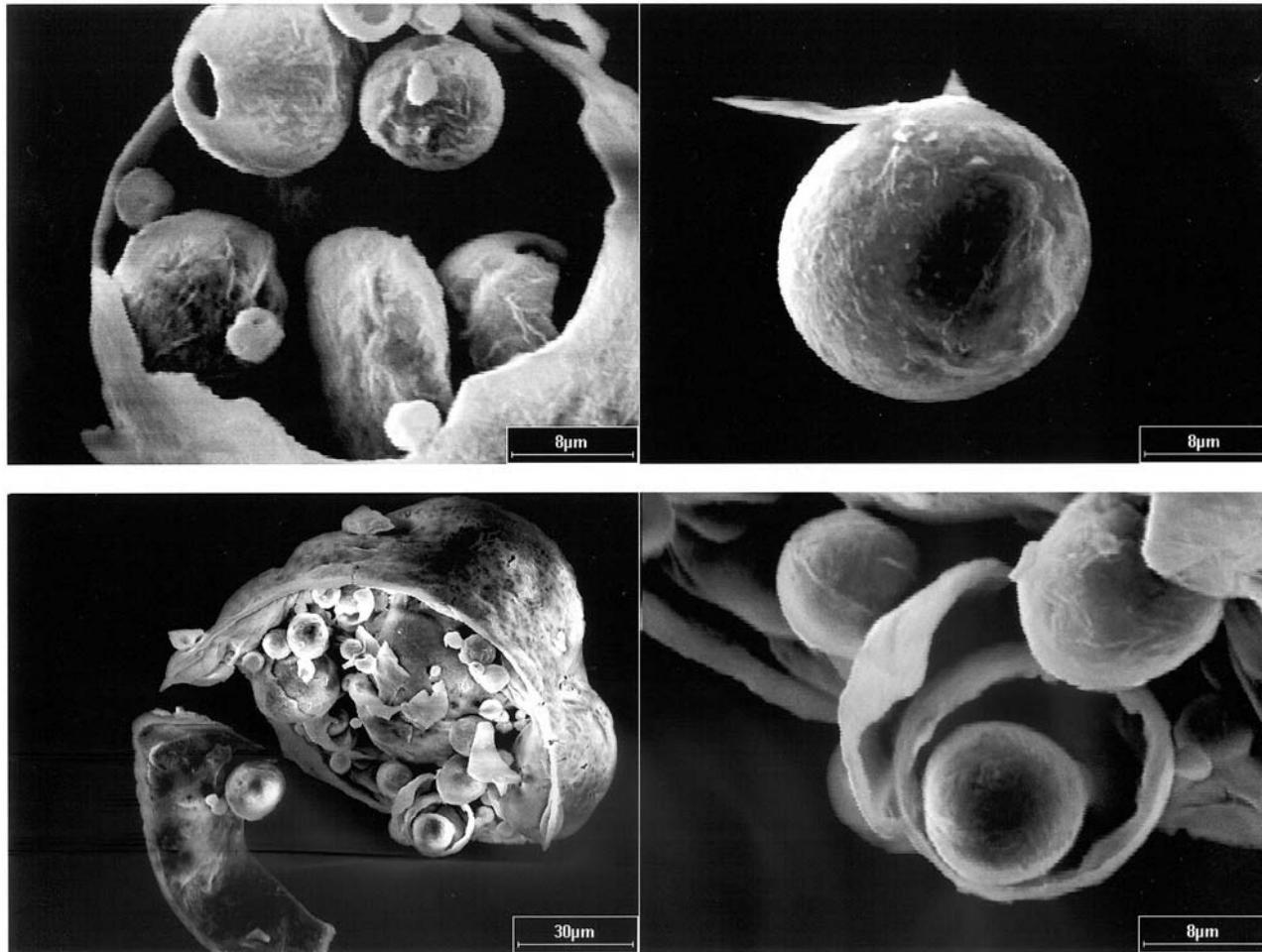


*IUTA e. V., Duisburg,
Germany*

*Air Quality &
Sustainable
Nanotechnology Unit*

UNIVERSITÄT
DUISBURG
ESSEN

Particle surface area concentrations



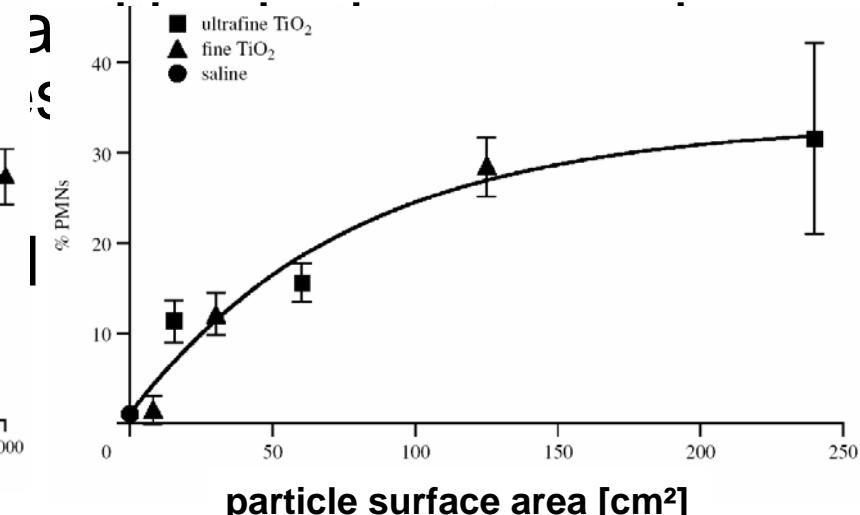
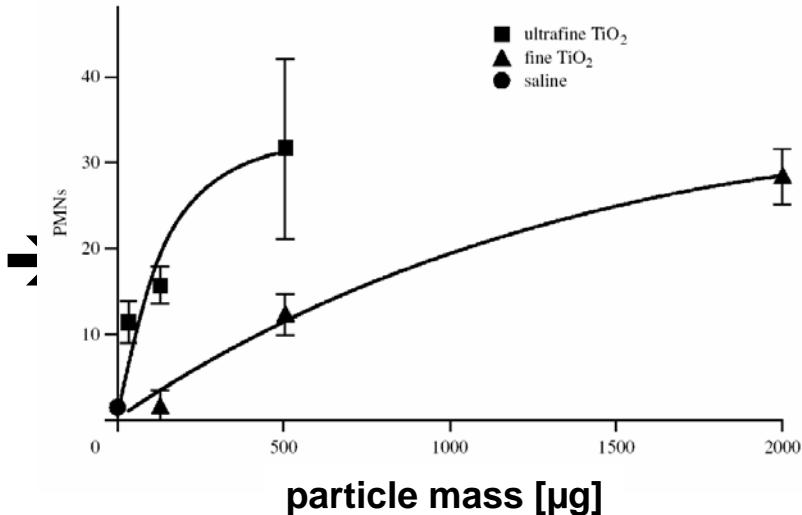
Geuecke, LANUV

Structure

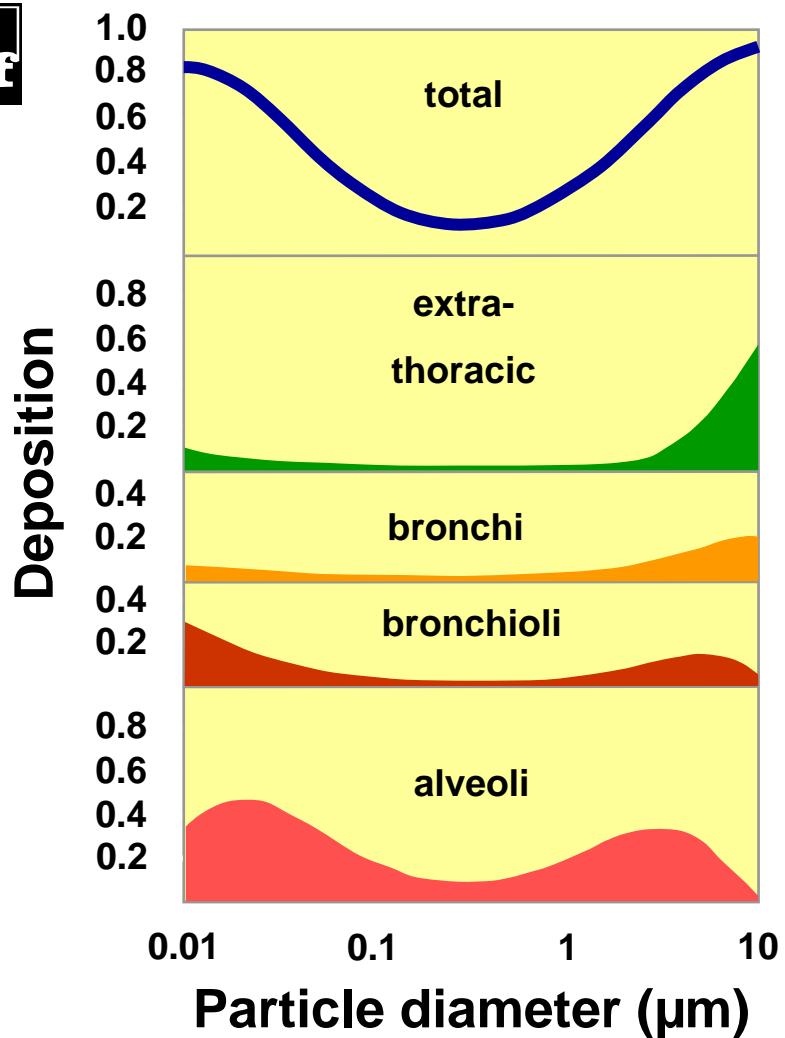
- Background
 - Why particle surface area?
 - Internal dose
- Particle surface area measurements –
1.5 years of measurement
- Siting and measurement devices
- “Surface area” with NSAM
- “Surface area” with SMPS
- Comparison NSAM/SMPS surface area
and UFP number concentrations
- Wrap-up

Background – Why particle surface area?

- Nanoscale particles (UFP und NP) can penetrate deep into the human lung and cause adverse health effects
(Dockery *et al.*, 1993; Oberdörster *et al.*, 2000 & 2004; Kreyling *et al.*, 2002)
- Several studies have shown that health effects seem to correlate best with particle surface area deposited in the lung
(Oberdörster *et al.*, 1995, 1996, 2000; Donaldson *et al.*, 1998)
- UFP/NP have a high surface area to volume ratio

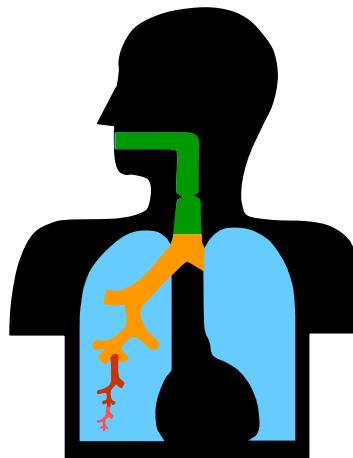


Particle deposition in lungs of adults



ICRP 66 (1994); MPPDep (2000)

Mouth-breathing



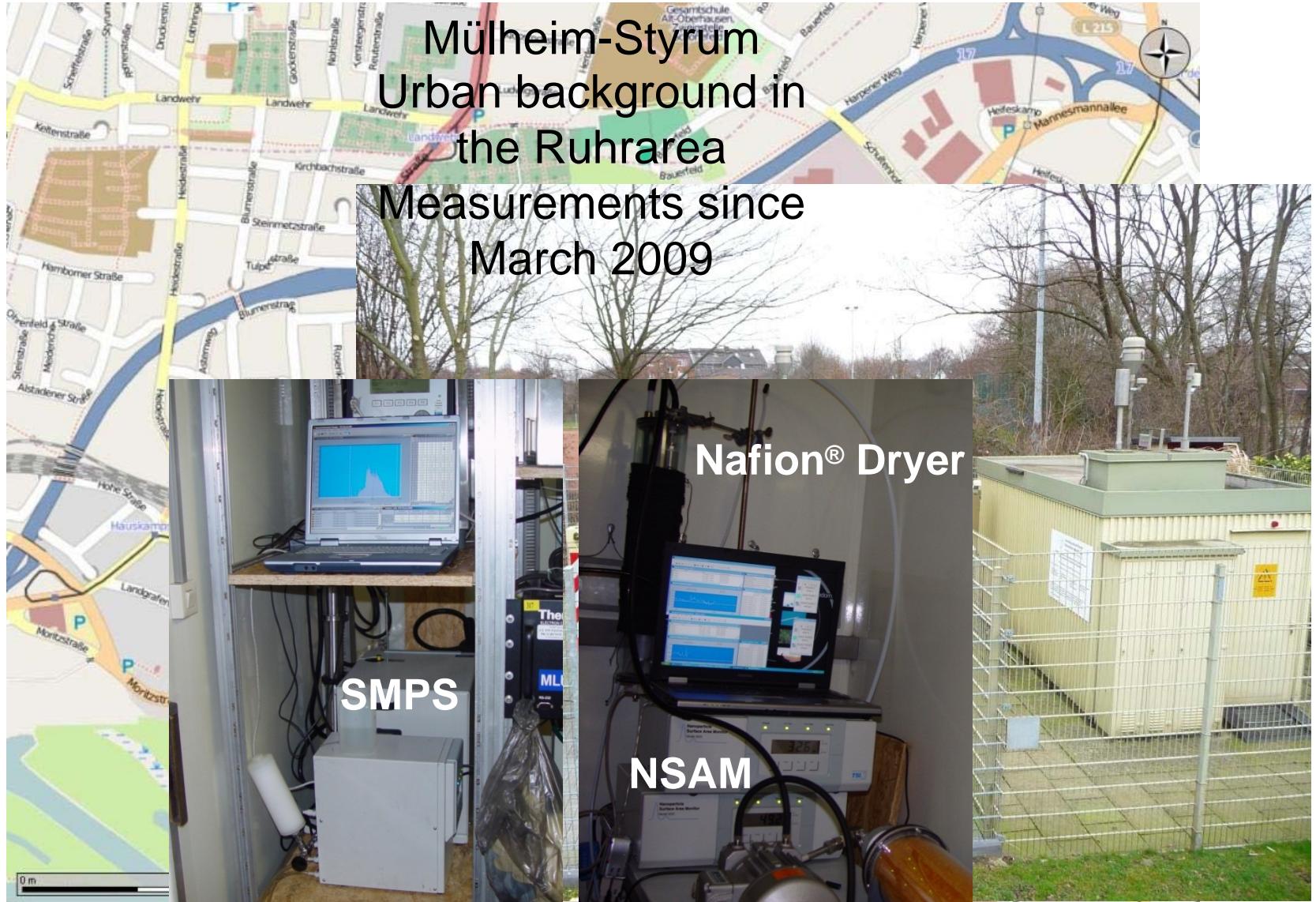
Particle density: 1 g/cm³
 Respiratory flow rate: 300 cm³/s
 Breathing at rest cycle period : 5 s

Internal dose

$$D = f \cdot V_{Breath} \cdot C_{Lung} \cdot t$$

D	Internal Dose for surface area [μm ²]
f	Breathing frequency [1/min]
V_{Breath}	Tidal Volume [cm ³]
C_{Lung}	Lung deposited surface area concentration [μm ² /cm ³]
t	Exposure time [min]

Measurement Site

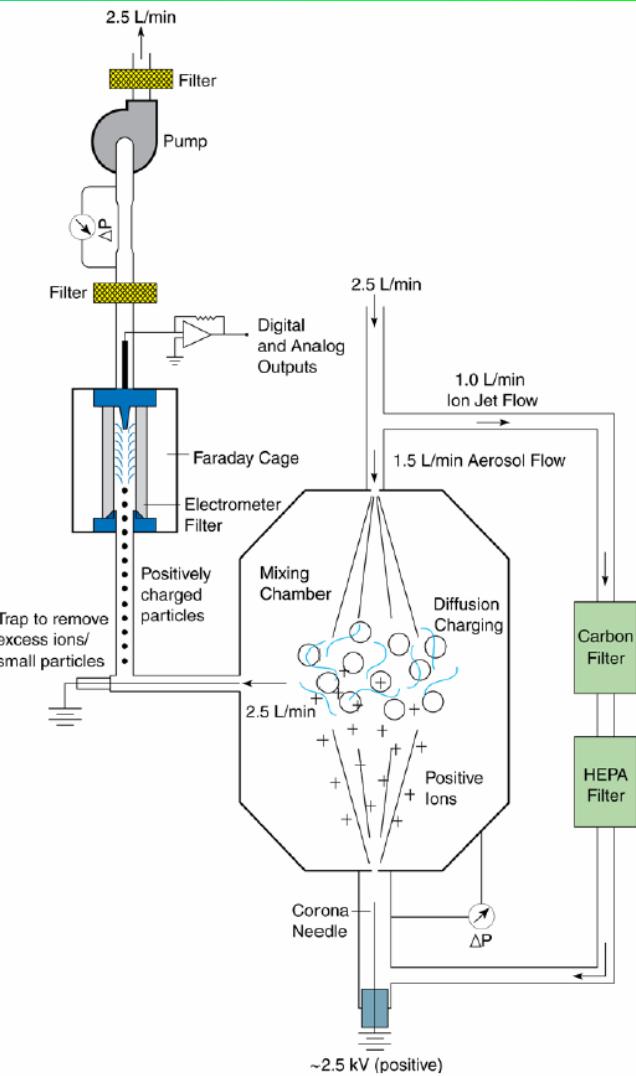


Instrumentation NSAM

Instrumentation to determine lung deposited surface area directly

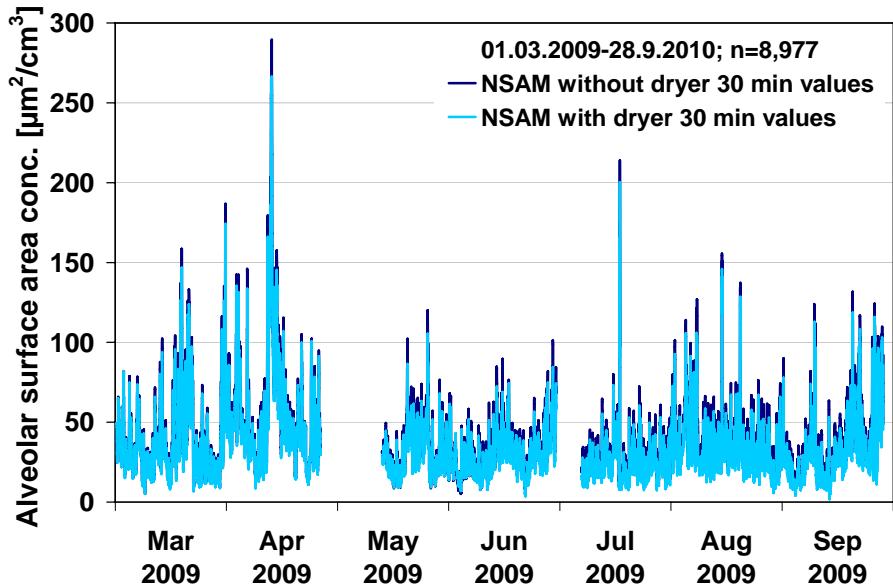
- Nanoparticle Surface Area Monitor NSAM, TSI model 3550
- Measures particle surface area, deposited in alveolar or tracheobronchial region
- Principle:
 - Removes all particles above 1 μm
 - Charges particles due to diffusion in opposed flow charger
 - Removes ions and manipulates particle deposition in ion trap
 - Deposits charged particles and measures current
- Can be extended to also measure other fractions of lung deposition for different human beings

(Asbach *et al.* (2009), *J. Nanop. Res.* **11**: 101-109)



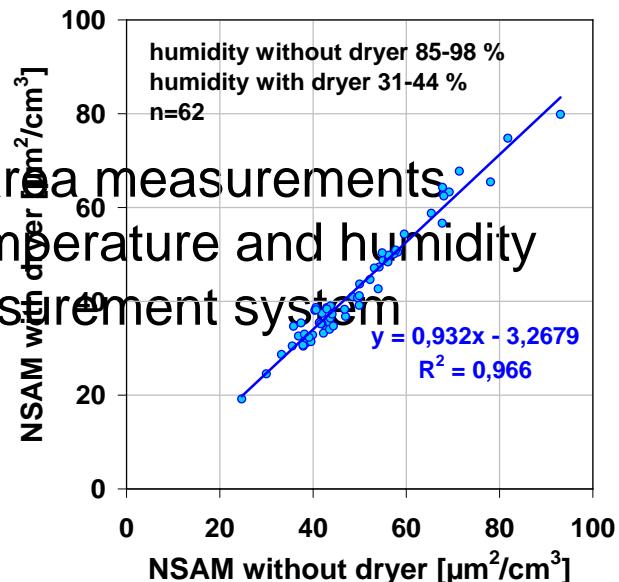
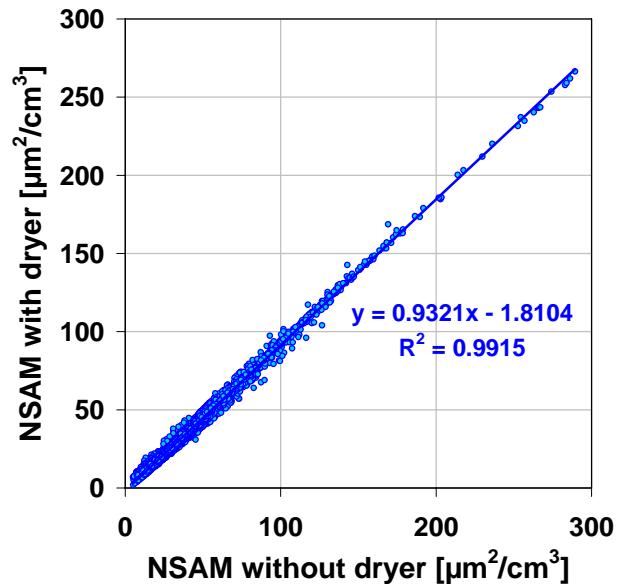
Fissan *et al.* (2006), *J. Nanop. Res.* **9**: 53-59;
Shin *et al.* (2006), *J. Nanop. Res.* **9**: 61-69

NSAM comparison with/without dryer



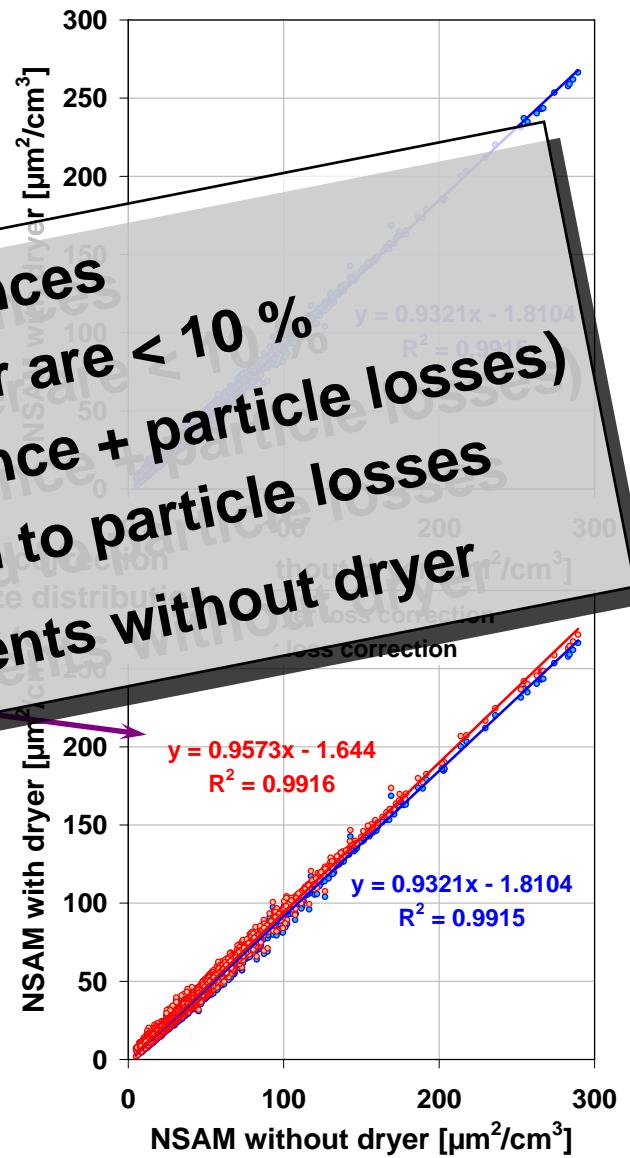
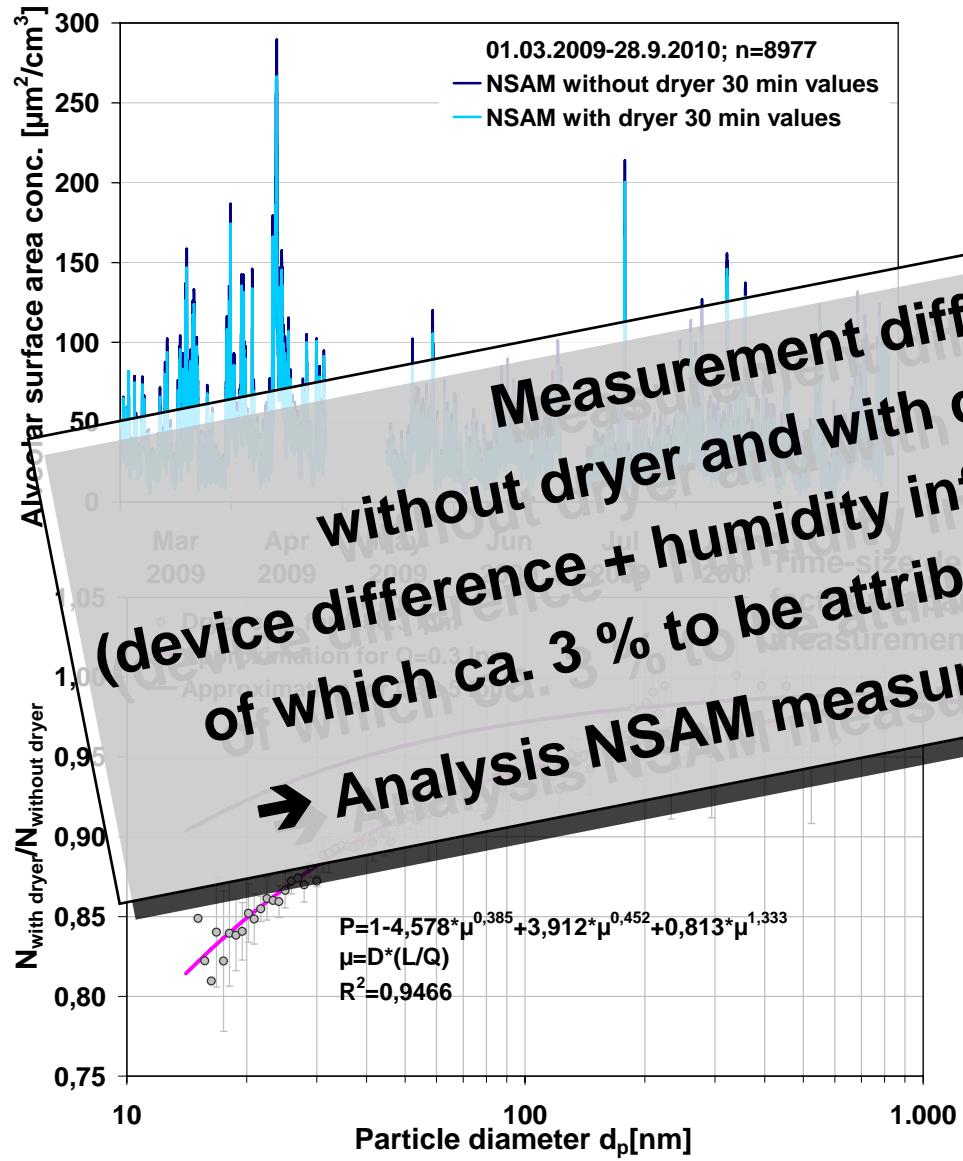
Linear regression $y=a*x+b$ of 30 min values

Humidity	n	a	b	R ²
all	8,977	0.93	-1.81	0.99
> 75 %	306	0.91	-5.23	0.99
> 80 %	148	0.91	-2.89	0.98
> 85 %	62	0.91	-3.27	0.97
> 90 % and container	0.98		-4.97	0.97
> 95 %	35	0.98	-4.35	0.96



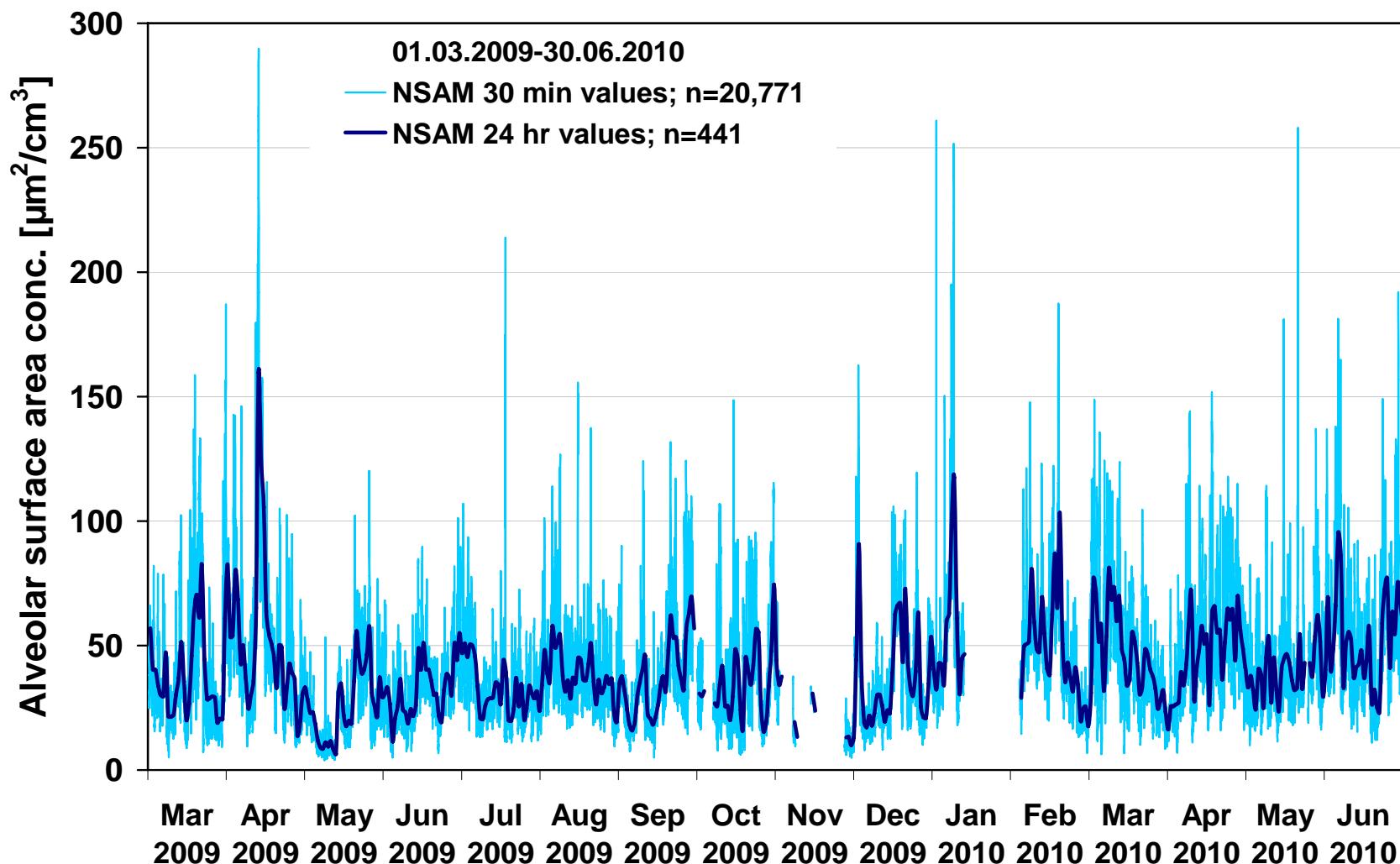
Humidity influence on particle surface area measurements:
expected mainly for summer: higher temperature and humidity
due to warming of sampled air in measurement system

NSAM comparison with/without dryer: Particle losses

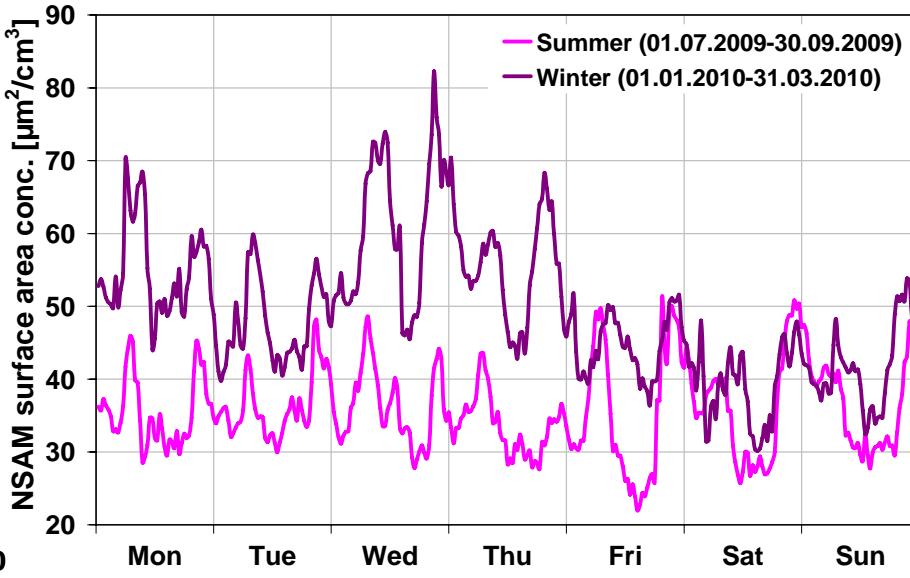
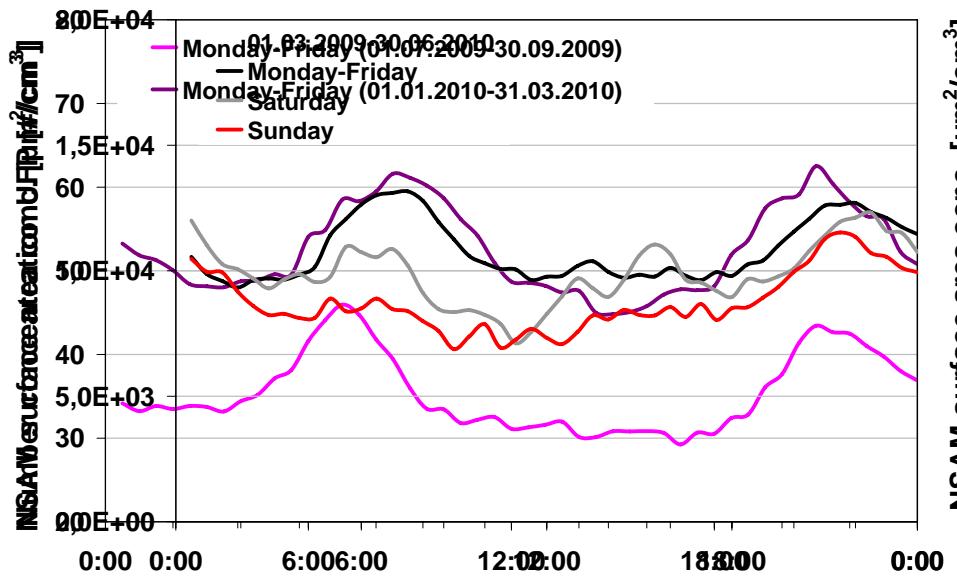
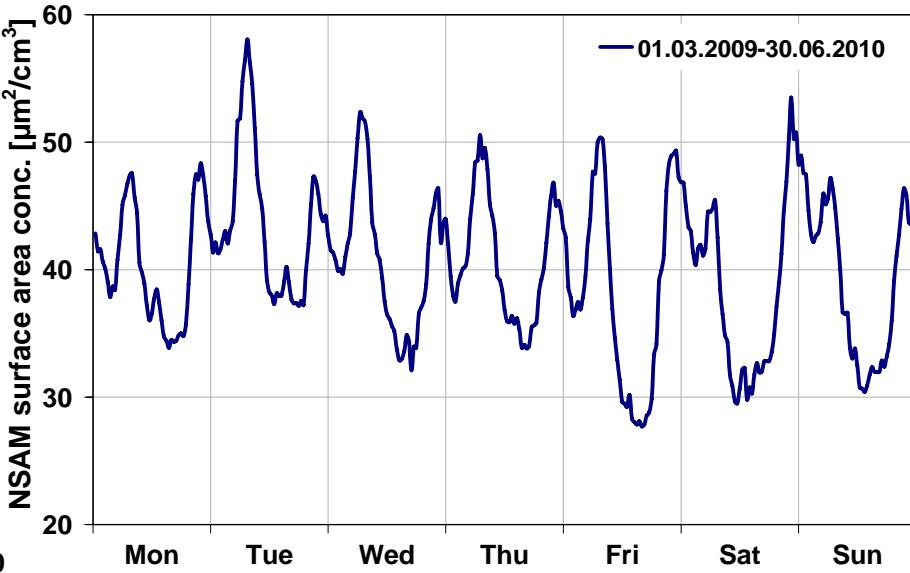
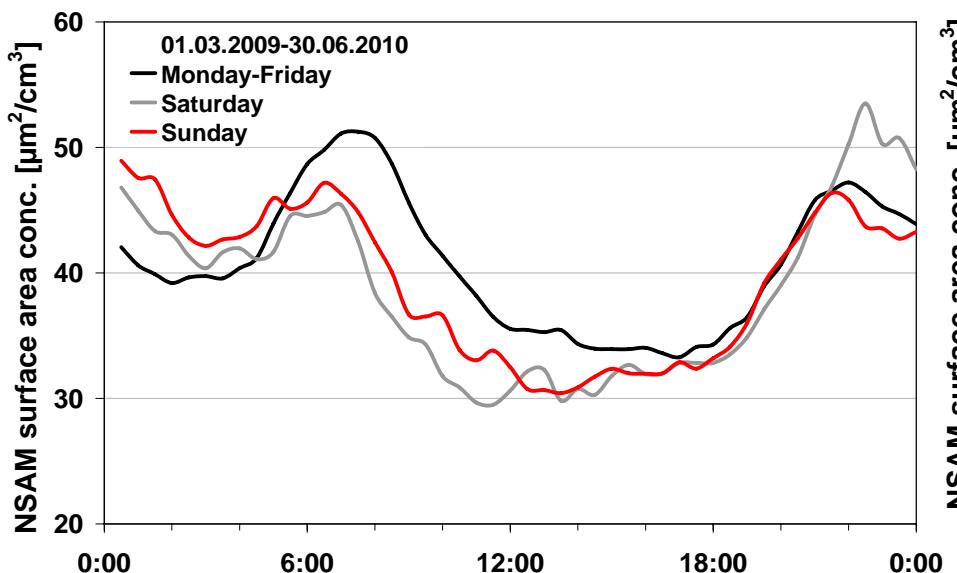


Measurement differences
 without dryer and with dryer are < 10 %
 (device difference + humidity influence + particle losses)
 of which ca. 3 % to be attributed to particle losses
 → Analysis NSAM measurements without dryer

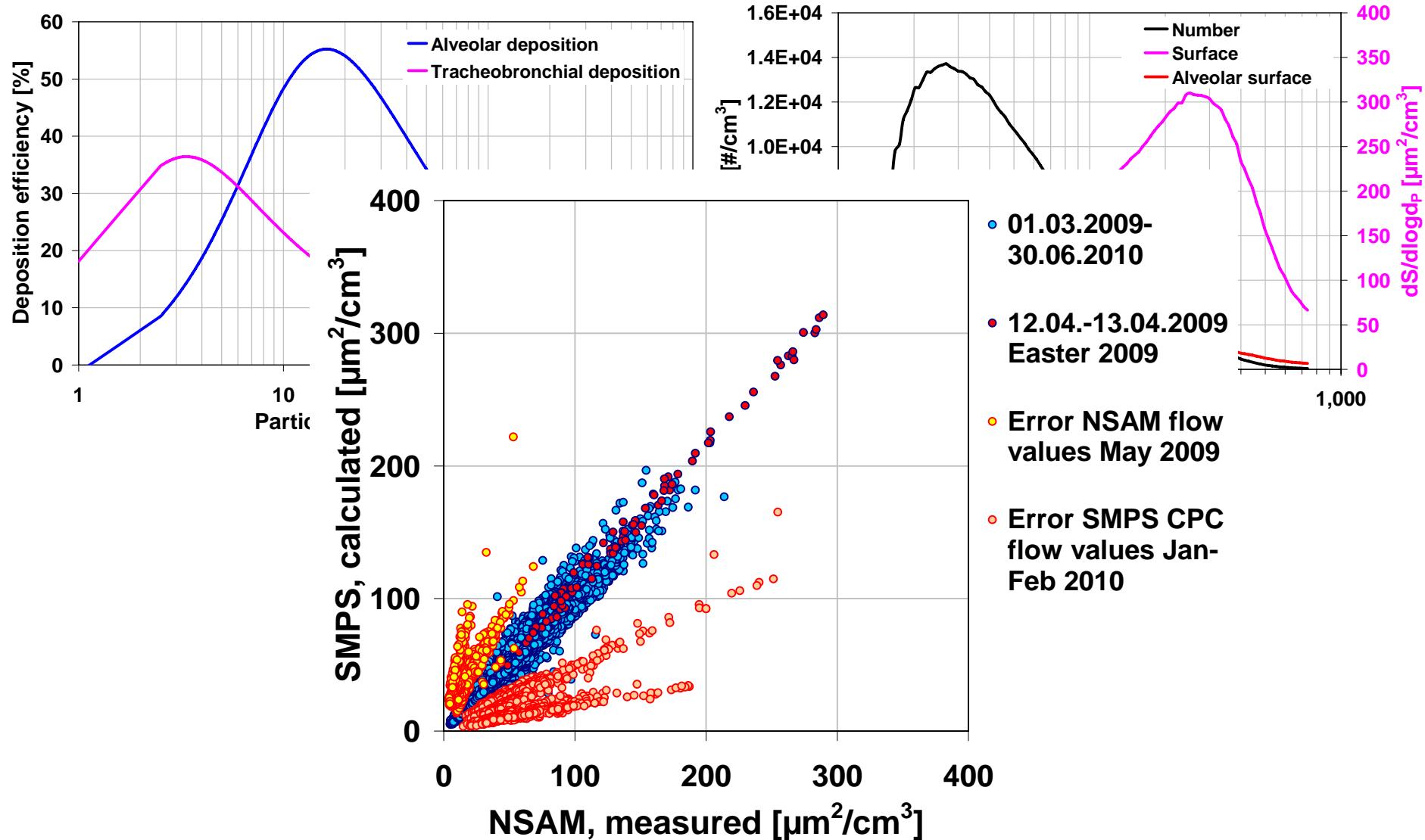
Surface measurement with NSAM



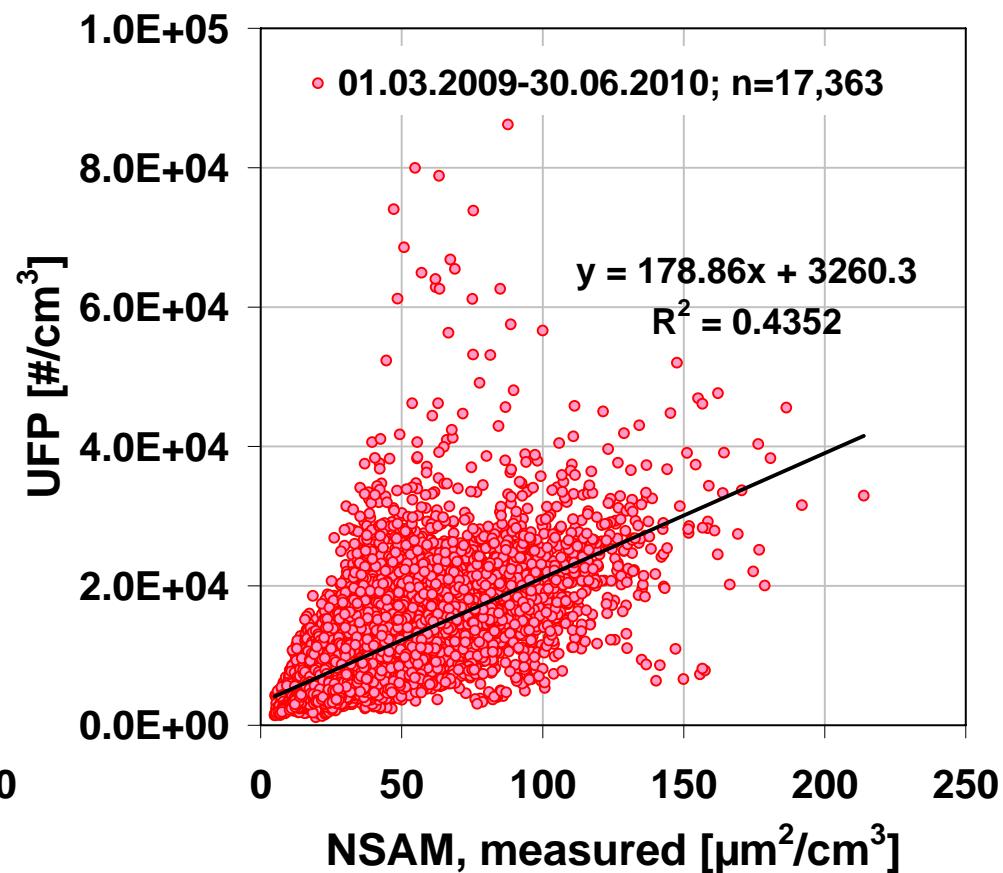
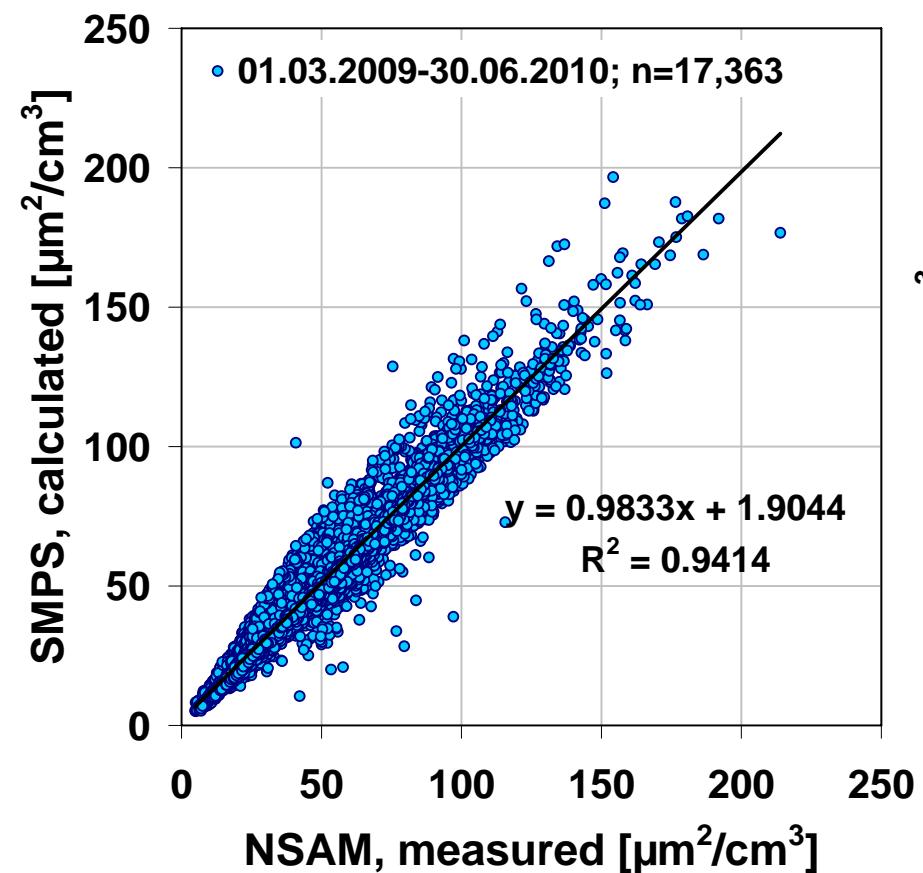
Surface measurement with NSAM



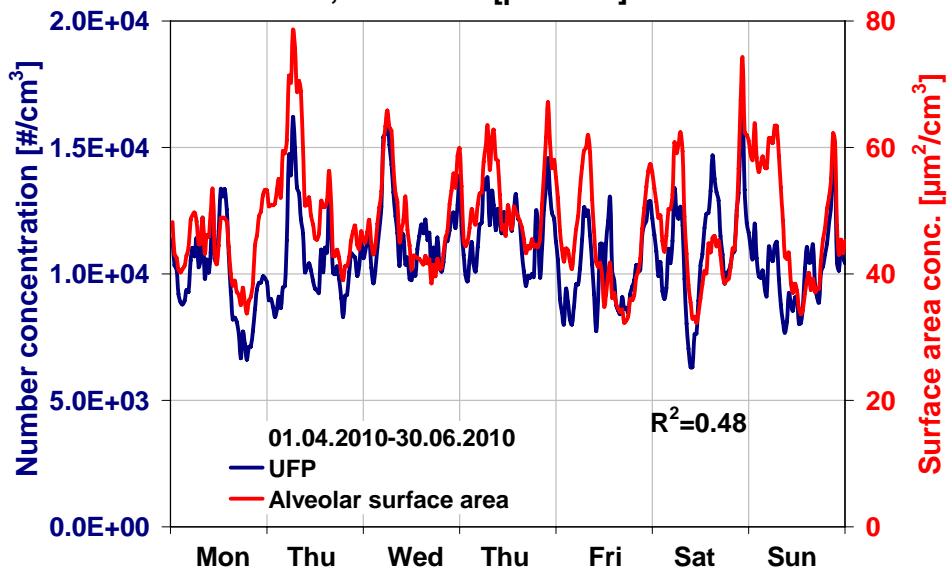
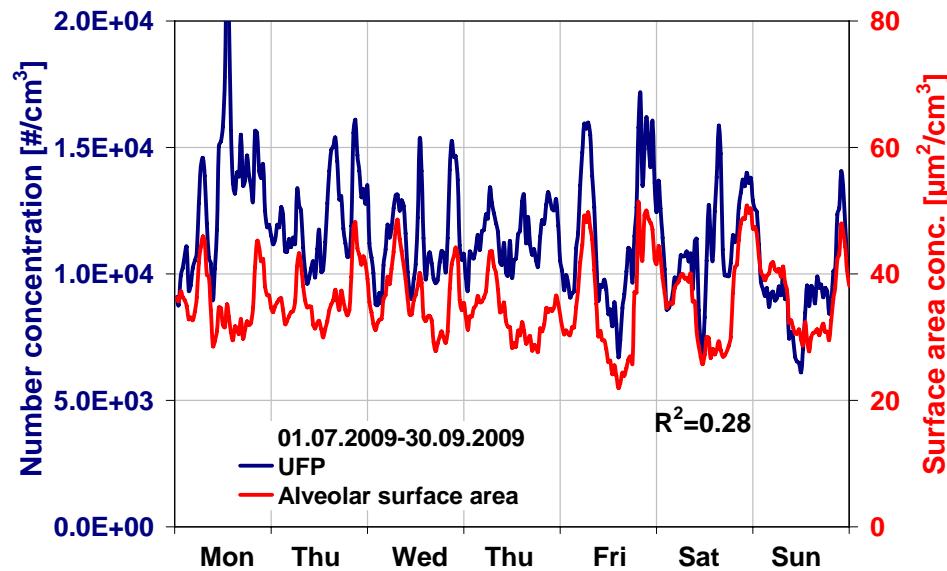
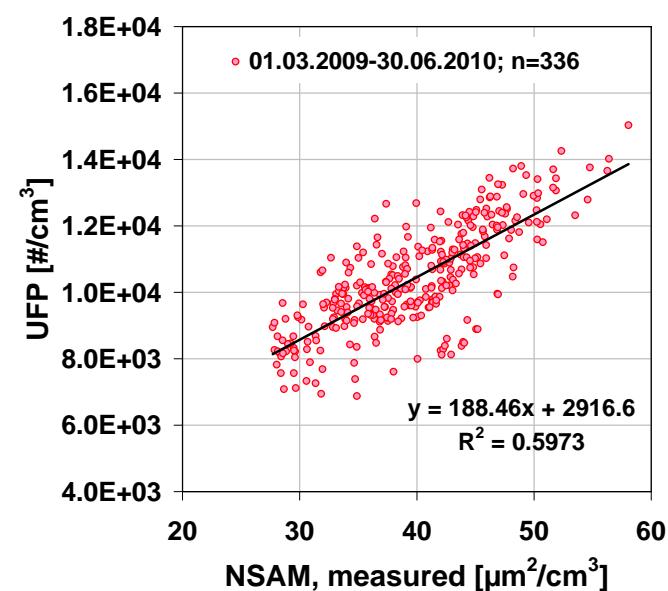
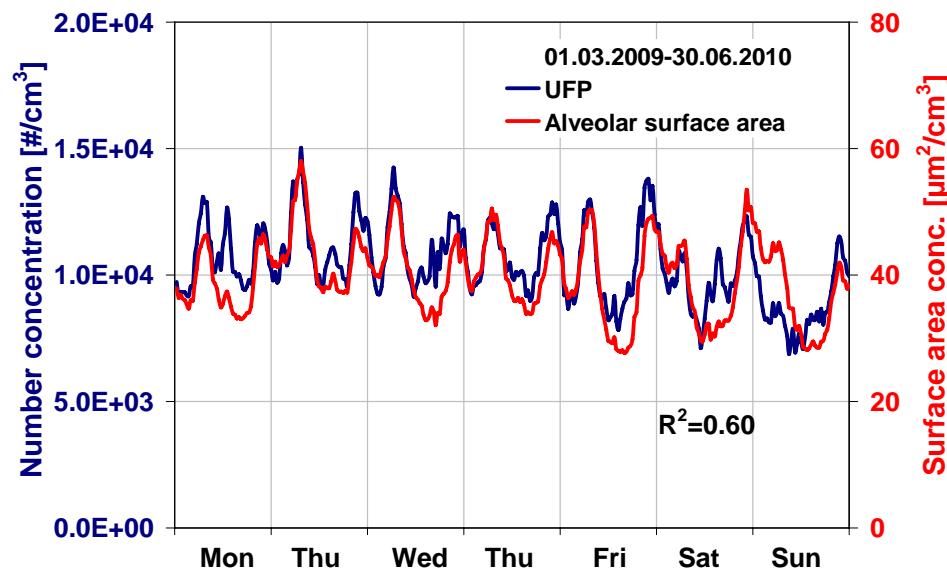
Surface measurement with SMPS



Comparison of alveolar surface area and number concentration



Comparison of alveolar surface area and number concentration



Summary

- Parallel long-term measurements of particle number size distributions and lung deposited surface area concentrations at an urban background site since March 2009
- Influence of humidity with regard to surface area: < 10%
Even at maximum rel. humidity (> 95 % r. H.) only small influence.
Humidity kept low due to activated charcoal and heating of the device for technical purposes to 45°C. May be different for other devices!!!
- The current device has shown to have **very good properties for routine monitoring**: single output value (still some limitations), reliable, online, high time resolution, “cheap”, robust and low maintenance.
- Direct surface area measurement agree too good with those calculated using SMPS-data! Why?
- UFP number concentrations and (lung deposited) surface area concentration can be viewed as independent values.
→ independent exposure metrics

Thanks!



Sponsors

Landesamt für Natur,
Umwelt und Verbraucherschutz
Nordrhein-Westfalen



Ministerium für Umwelt und Naturschutz,
Landwirtschaft und Verbraucherschutz
des Landes Nordrhein-Westfalen

Umwelt
Bundes
Amt
Für Mensch und Umwelt



M. Hildebrand and H . Fissan missing

and to you!