

## UFIPOLNET: Concentration of Particle Number Distributions at 4 Stations in Europe

H. Gerwig et al.



GSF – Forschungszentrum  
für Umwelt und Gesundheit  
in der Helmholtz-Gemeinschaft



# UFIPOLNET: Concentration of Particle Number Distributions at 4 Stations in Europe

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- 1. UFIPOLNET**
- 2. Objectives**
- 3. Background: Why UFP, UFP in Dresden**
- 4. UFP 330 Method and Sampling**
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- 7. Summary**

# UFIPOLNET

**EU LIFE Environment project  
UFIPOLNET**  
**Ultrafine particle size distributions  
in air pollution monitoring networks**

12-2004 – 11-2007 (3-2008)

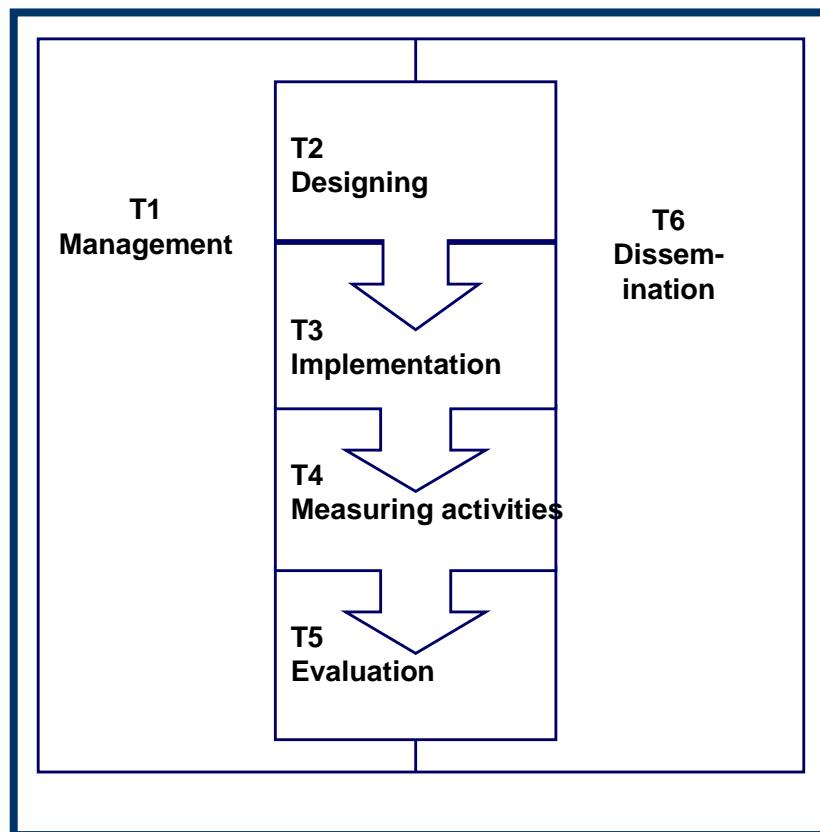
7 partners, LfUG lead partner



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# OBJECTIVES



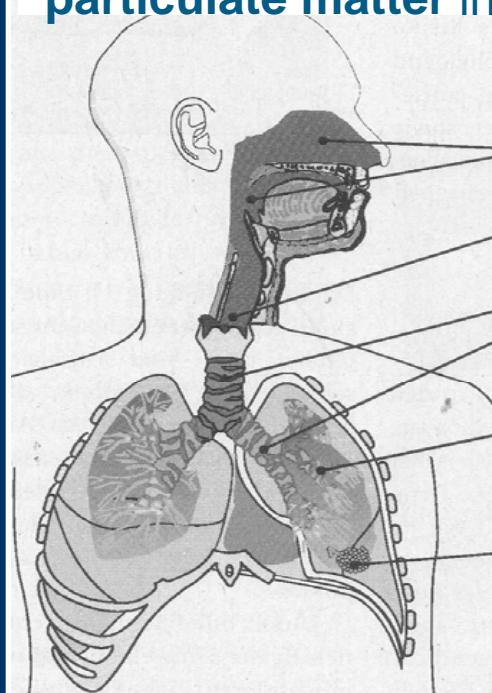
- **6 tasks** to reach objectives
- **instrument** for ultrafine particle size distributions
  - **affordable and easy to use**
  - Suits **routine measuring networks**
  - **environmentall** friendly:
    - No butanol or radioactive waste
    - reduced data amount
    - range: **20 - 500 nm**
    - **same sampling** conditions
- 5 years measurements
- **evaluation**, test of long term stability
- **Contact with interested groups**, like CAFE-Working group and VDI

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# WHY ULTRAFINE PARTICLES?

size dependent  
depth of penetration of  
**particulate matter** into human



Nachrichten aus der Chemie | 51 | Dezember 2003 | www.gd

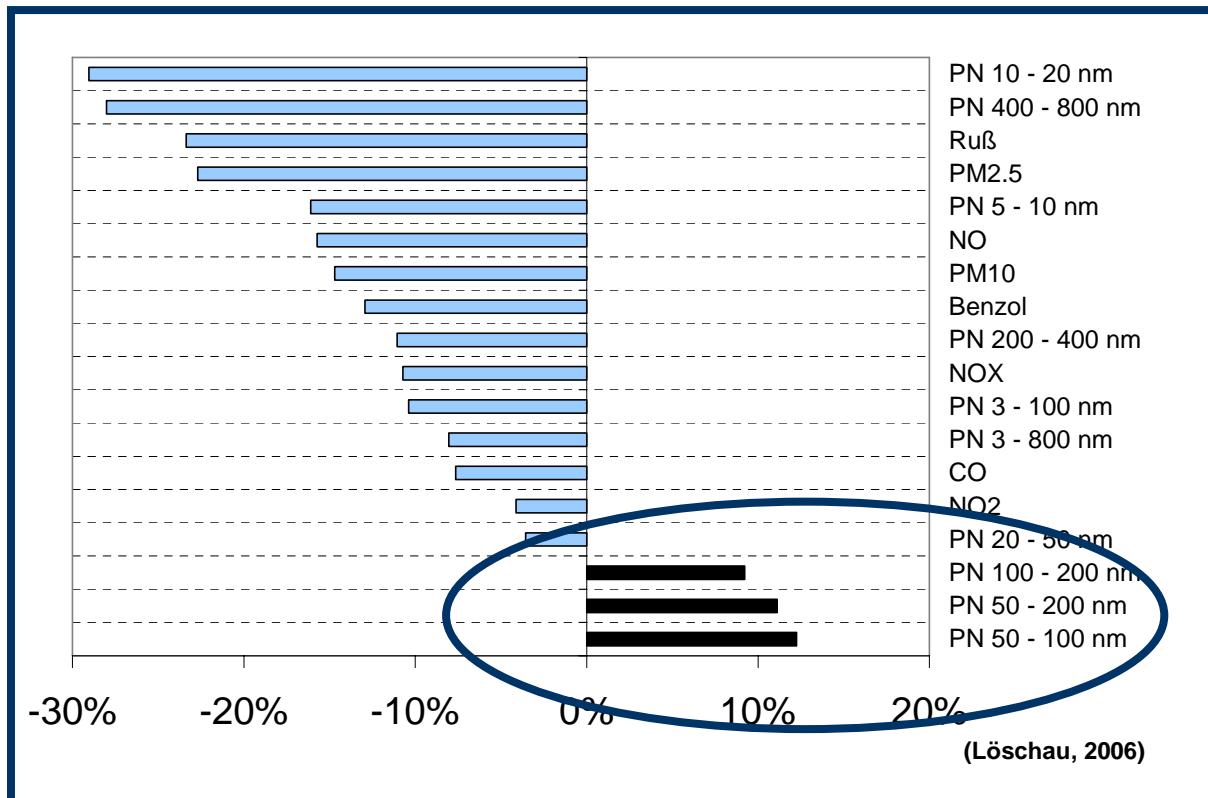
- Epidemiological studies show relationships:  
**PM10 / adverse health effects**
- Studies show since 1990 a **decline** of **PM10** in Western + Central Europe
- **EU directive EU/1999/30** to reduce PM10 **in force**

## Ultrafine Particles (< 100 nm = UFP):

- Particle number concentrations of partly **raised** during winter periods 1991 – 1999 in Erfurt (Cyrys et al. 2002) and 2001 - 2005 Dresden (Löschau 2006).
- show **effects in toxicological studies**, via lung into bloodstream
- **EU wants** more spatial and time scale **information** about
- are measured in **only a few routine measuring stations** in Europe.

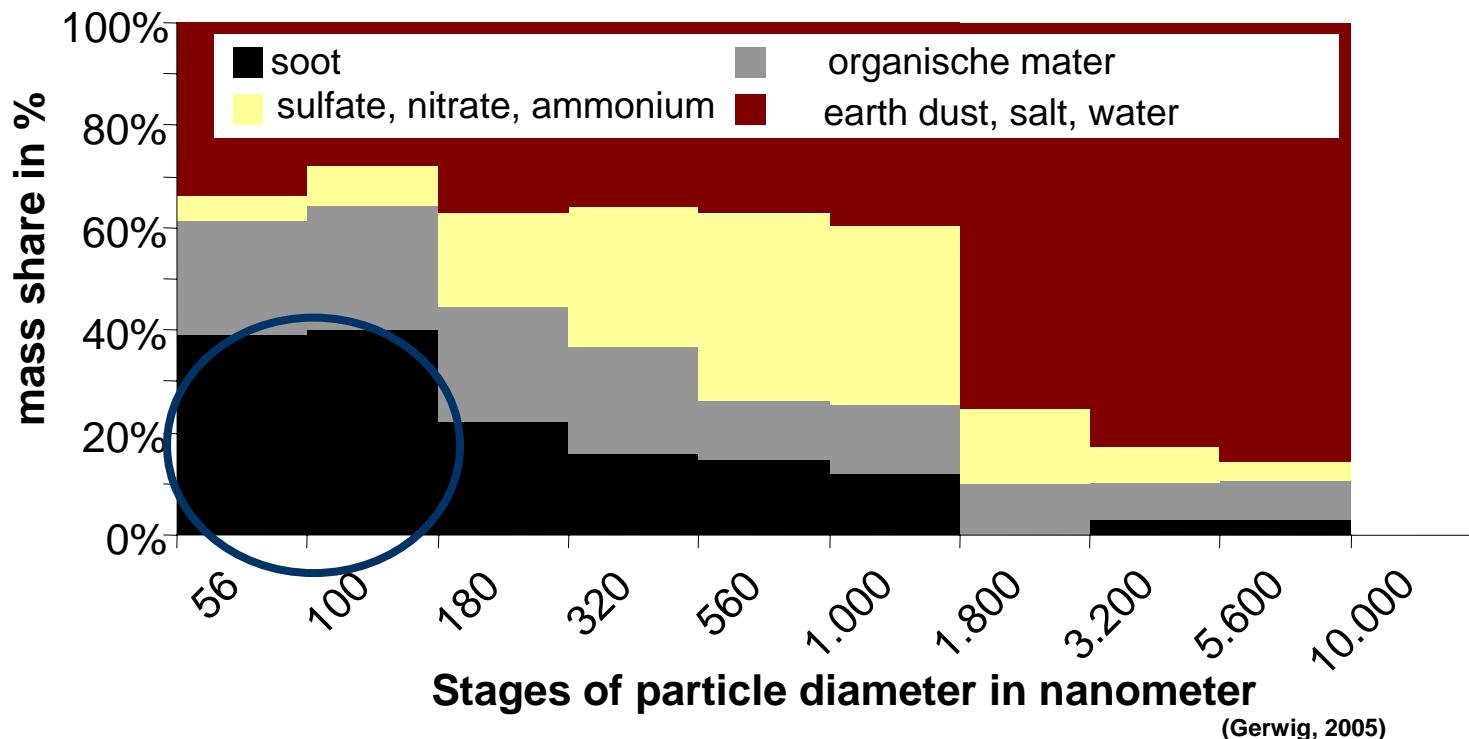
# Past Particle measurements in Dresden – particle number distributions

Change of PN-concentrations from 8/2002 to 8/2005



- higher Particle conc. **50 – 200 nm**
- **higher share of diesel-cars** (30% now)
- **maximum number of diesel soot at diameter 60-100 nm**

# PAST PARTICLE MEASUREMENTS IN DRESDEN – CHEMICAL COMPOSITION



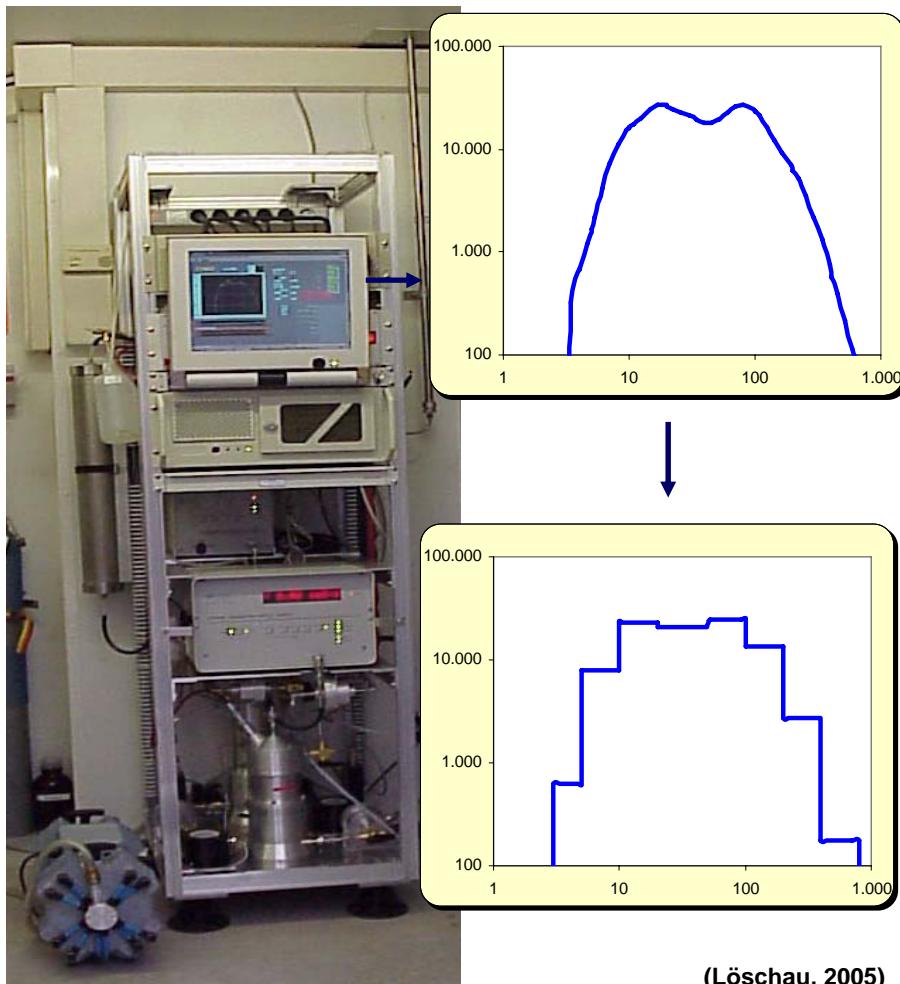
**PM10** < 10 µm

high share of earth crust, salt, ammonium, nitrate und sulphate

**ultrafine dust** < 0,1 µm (100 nm)

mainly soot (40%) + organic substances (20%)

# REFERENCE INSTRUMENT



- **2001 - now in Dresden**
  - **Twin-DMPS =**  
Two Differential Mobility  
Particle Sizer
  - IfT-Leipzig
  - **3 - 800 nm**  
(20 – 800 nm  
und 3 – 20 nm)
- Reduction for database of routine measuring network:**

- half hour average
- 8 Particle size classes

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# UFP 330 – IMPLEMENTED IN DRESDEN



Dresden: UFP 330, TOPAS (middle)  
and reference Twin-DMPS, IFT (right),  
07.02.2007, photo: Gerwig

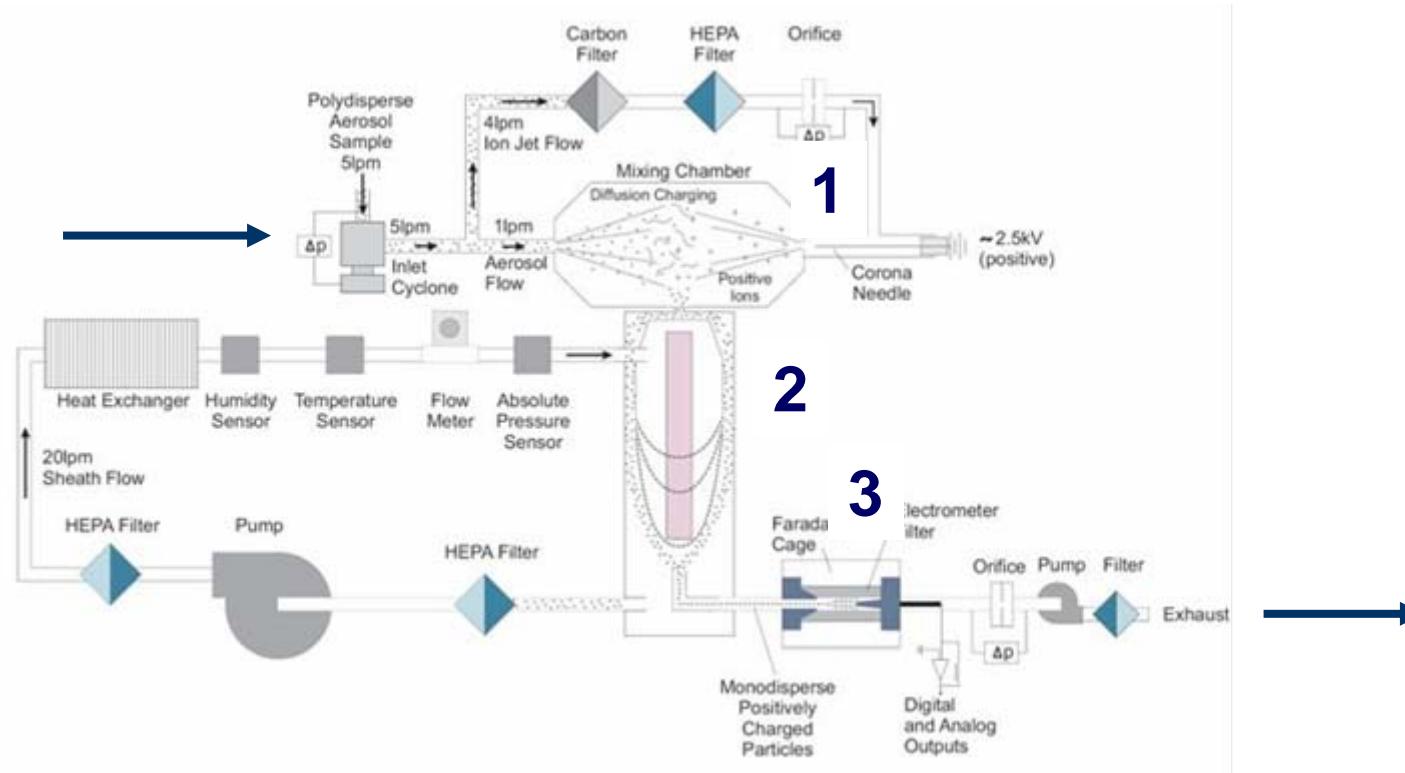
- **6 Particle size classes**  
UFP1-6  
 $>20|>30|>50|>70|>100|>200-500\text{ nm}$
- **half hour average in database**  
since 24-Jan 2007
- **Build in routine measurement network** of Saxony in Dresden
- **evaluated** particle size and particle number concentration (CNC) for need of changing filters etc. **every month**
- stability of measurements  $> 80\%$
- **Maintenance** intervall  
about  $> 3$  months

# Measuring method and UFP 330 function

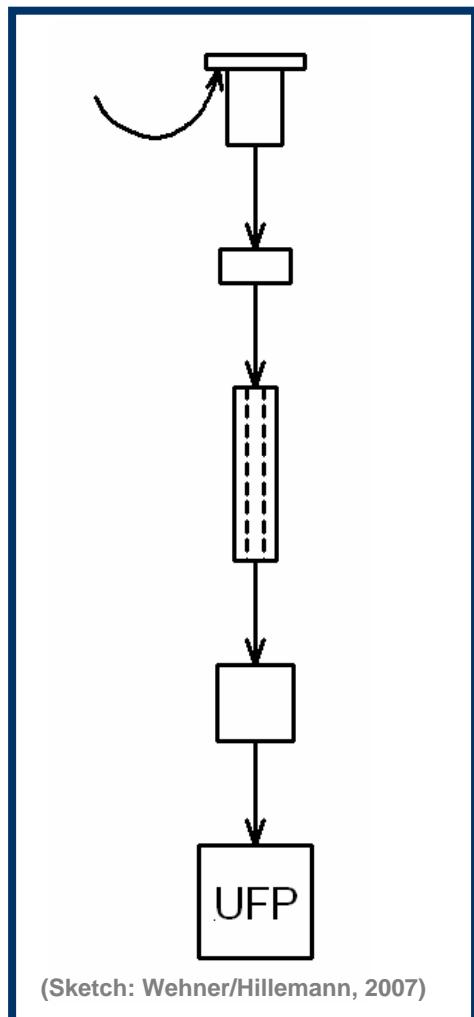
Particles are charged separated, counted + calculated per size class

- corona-jet-charger (electrical) (1)
- DMA (2)
- electrometer (3)

see Hillemann et al., Aerosol mobility spectrometry based on diffusion charging, lecture EAC Mo. 11:15



# SAME SAMPLING SYSTEM UFP 330



4 same sampling systems

- PM10 – head
- 0.5 µm cyclone
- membrane dryer
- equilisation tank
- 4 different data collecting systems
- different communication protocols

See Zschoppe et al., A new conception for environmental measurement of ultrafine particles, Poster Di: Aerosol Instrumentation



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# EVALUATION

## Comparison UFP 330 to DMPS, ambient aerosol

- **1st Comparison Leipzig:** 08 – 10/2006 4 instruments  
differences => changes in handling of instrument
- **2nd Comparison Leipzig** 01 - 2007: 3 UFP instruments
  - Correlation for each of single 6 size classes  $r = 0.83 - 0.97$  ( $a = 55 - 79\%$ )  
UFP2 – UFP5 better, worse: largest (< 200 nm), smallest (20 – 30 nm)

in Dresden 01 - 2007:

$r = 0.83 - 0.92$  ( $a = 41 - 97\%$ )

(see detailed results Dresden, Leipzig: Poster Wehner et al., 2007, The new UFP 330: Comparison with a DMPS for ambient aerosols Poster Di: Aerosol Instrumentation)

- **comparison in Dresden:** Jan 2007:  $r^2 = 0.85$  ( $r = 0.92$ ) (20 – 400 /500 nm)
- **>80% availability** at all stations
- **future:** 3rd Comparsion Leipzig 01- 2008 (long term stability)

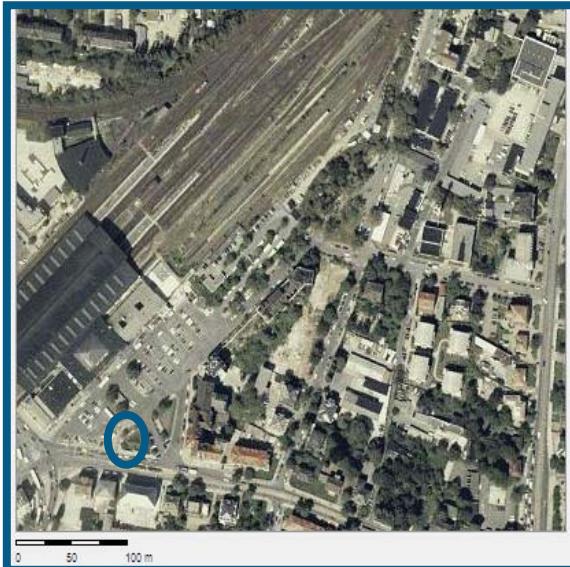
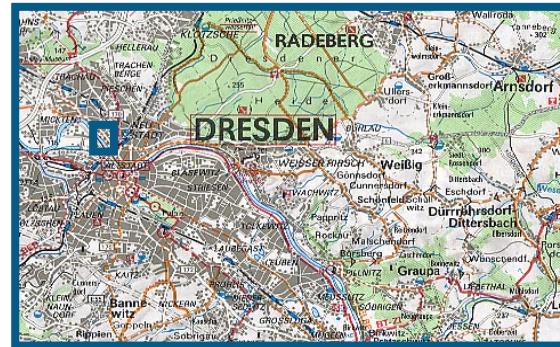


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# UFP 330 MEASUREMENTS IN DRESDEN

Schlesischer Platz, 50,000 cars per day, 8% heavy duty vehicles

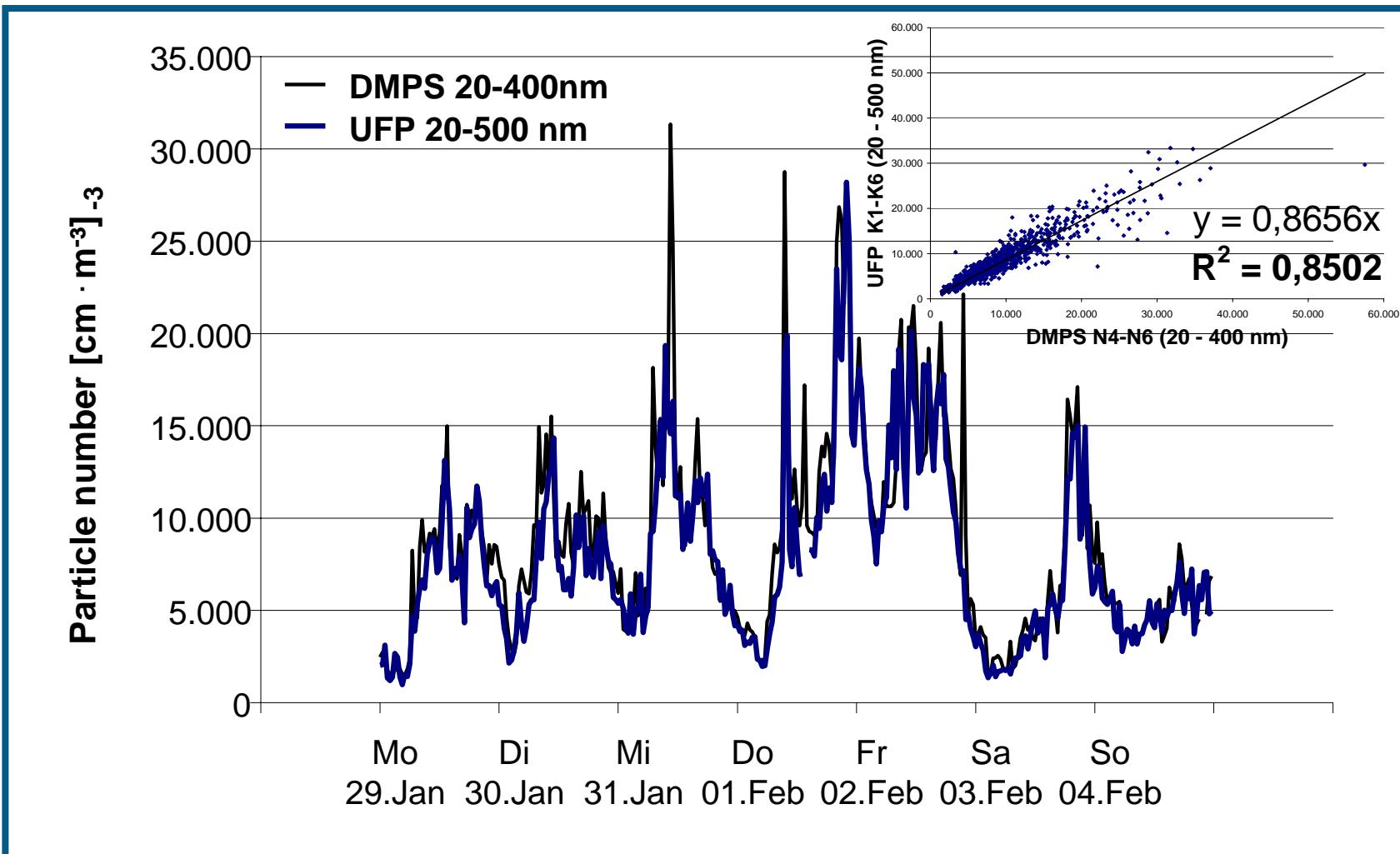


Dresden, Schlesischer Platz 2007, photo: Gerwig



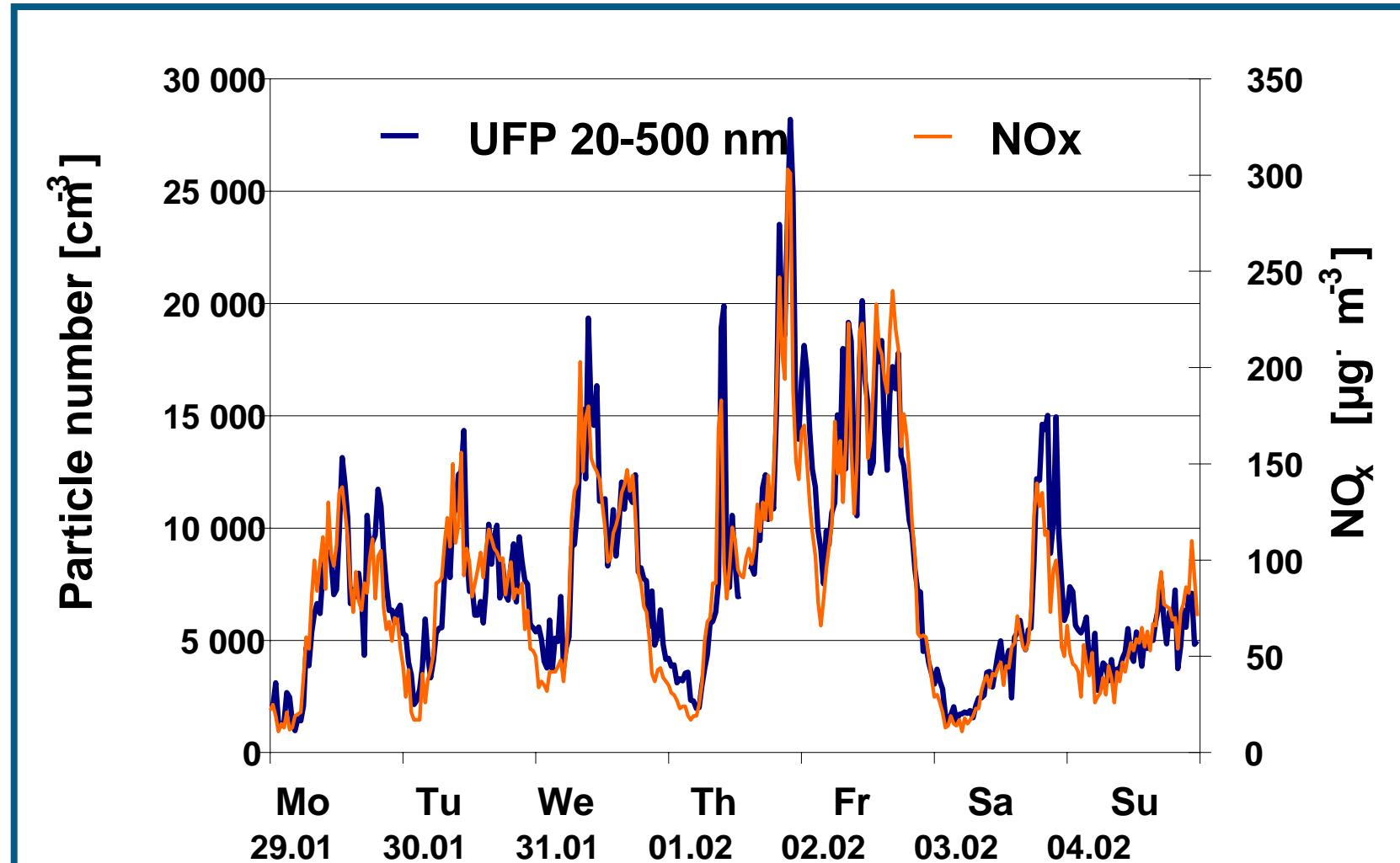
# FIRST RESULTS

Comparison UFP 330 to DMPS, Dresden (29/01 – 04/02/2007),  $r^2 = 0.85$



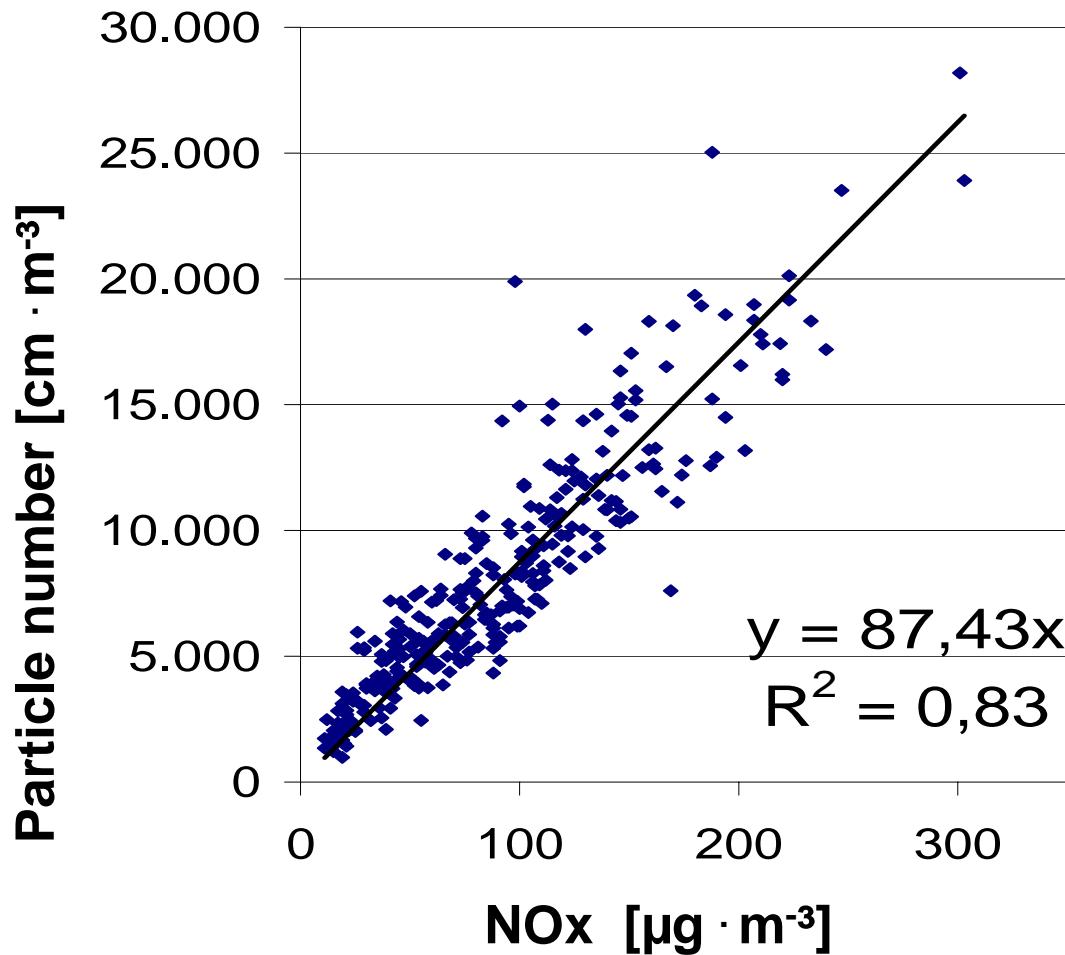
# FIRST RESULTS

Comparison to NOx Dresden (29/01 – 04/02/2007),  $r^2= 0.85$



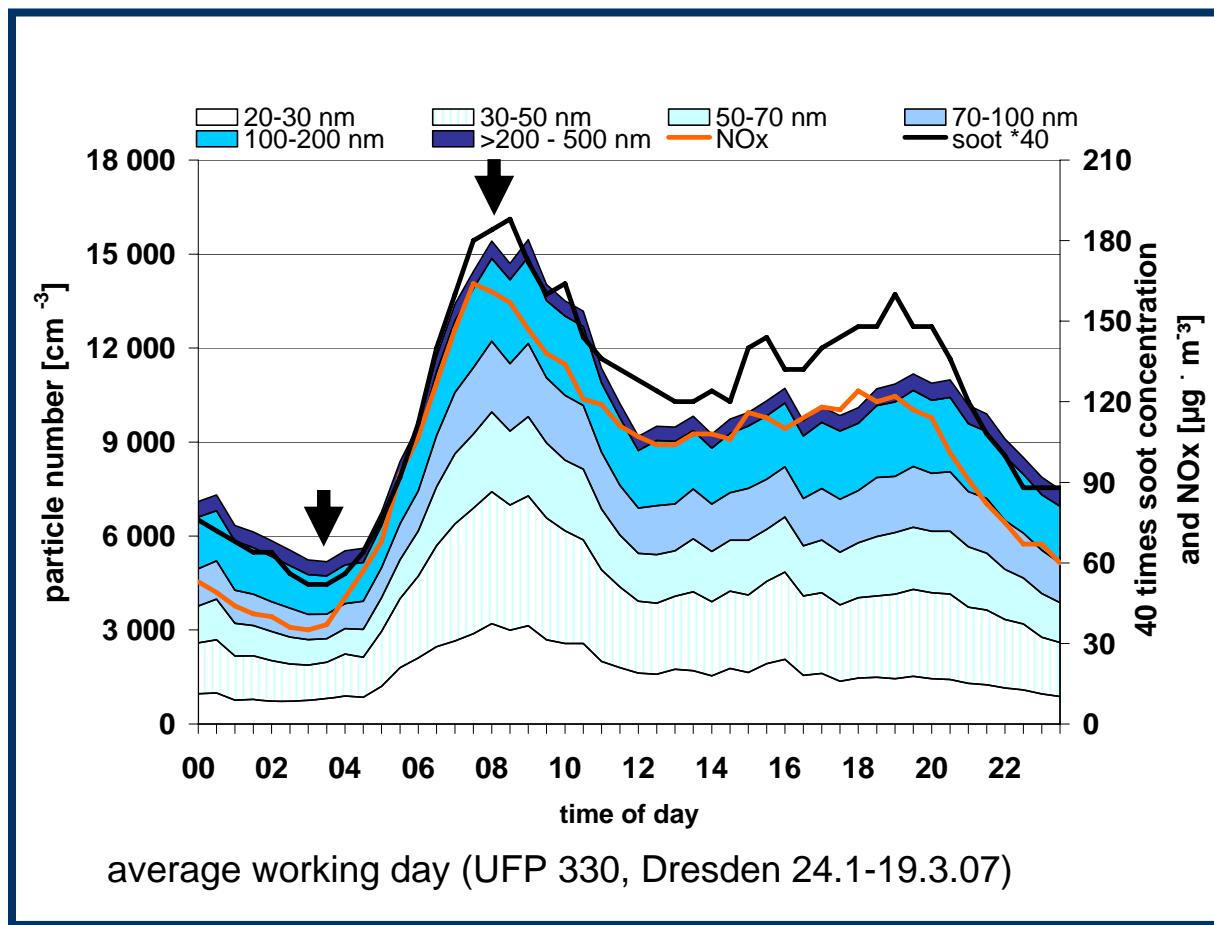
# FIRST RESULTS

## Correlation UFP to NOx Dresden (29/01-05/02/2007)



# FIRST RESULTS

Average working day (Mo-Fr) UFP, NOX, soot Dresden, (24/01-19/03/2007)



## Particle size distributions 20 – 500 nm

- Average working day:  
**Minimum 3:00 h**  
**Maximum 8:00 h**
- particle number concentration during average weekday shows **similar pattern like NOx and soot**

# 4 MEASURING STATIONS



**Stockholm:**  
Hornsgatan (street canyon)

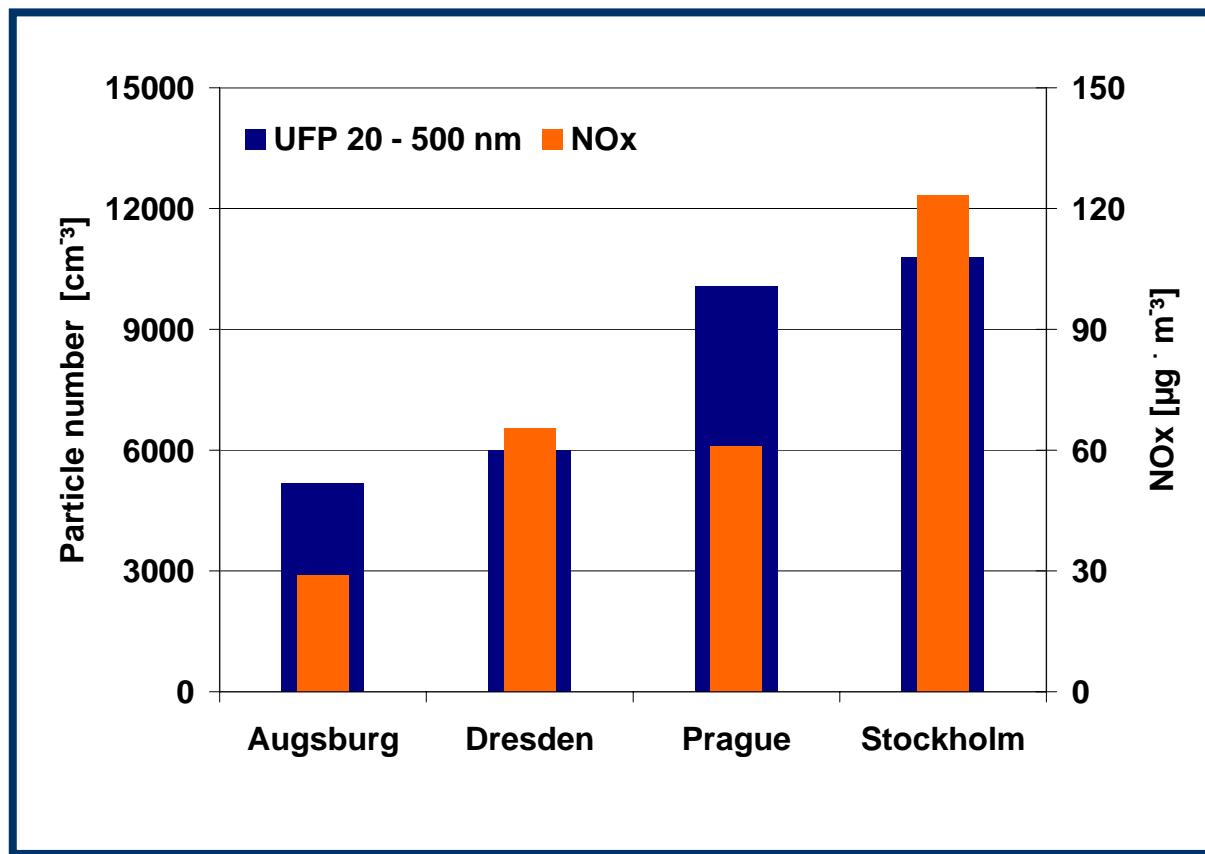
**Dresden:**  
Schlesischer Platz (main crossing)

**Prague:**  
Strahovský tunnel (above tunnel exit)

**Augsburg:**  
Friedberger Straße (urban background)

# RESULT: 4 STATIONS COMPARED

Mean **particle number** concentrations and **NOx** (1 hour basis)  
at **4 stations June 2007**



**UFP particle number concentrations:**

Augsburg < Dresden  
Stockholm = 2 \* Dresden

**NOx:**

Prague = Dresden  
Stockholm = 2\* Dresden  
Augsburg =  $\frac{1}{2}$  Dresden



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# SUMMARY

- UFIPOLNET: EU LIFE project with **7 partners** from 3 nations
- **new instrument** for particle size distributions **20 – 500 nm**
- **UFP 330** implemented since Jan 2007 **in routine measuring container Dresden + Augsburg, Stockholm, Prag** since Feb/Mar 2007
- **stability** of measurements > **80 - 90 %**
- **comparison with reference** device for sum of particles and single ranges **good**
- **long term stability test** goes on, next comparison **Jan-2008** planed
- first results:
  - **Good correlation with NOx** at traffic stations Dresden + Stockholm
  - **similar pattern UFP sum with NOx and soot** in Dresden
  - **comparable results** at 4 stations, because of **same sampling method**



## RELATED POSTER + LECTURES at EAC 2007

**T05A008** L. Hillemann et al., Aerosol mobility spectrometry based on diffusion charging  
Lecture Mo, 11:15

**T13A202** B. Wehner et al., The new UFP 330:  
Comparison with a DMPS for ambient aerosols  
Poster Di: **Aerosol Instrumentation**

**T02A048**, A. Zschoppe et al., A new conception for environmental measurement of ultrafine particles  
Poster Di: **Aerosol Instrumentation**

**T13A162** H. Gerwig et al., UFIPOLNET: Concentration of Particle Number Distributions at 4 Stations in Europe  
Poster Di : **Atmospheric Aerosols - Urban Aerosols**

WWW

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



# REFERENCES

- **Gerwig 2005:** Eigenforschungs-Report über Inhaltsstoffe [www.umwelt.sachsen.de/lfug/luft-laerm-klima\\_5356.html](http://www.umwelt.sachsen.de/lfug/luft-laerm-klima_5356.html)
- **Gerwig et al (2006) Quellgruppenquantifizierung von PM10 an einer Verkehrsmessstation in Dresden;** Gerwig, H.; Bittner, H.; Brüggemann, E.; Gnauk, T.; Herrmann, H.; Löschen, G.; Müller, K. Gef. Reinhalt. Luft, 2006, 66, 175 – 180
- **Löschen, G. (2006a):** Partikelanzahl in verkehrsnaher Außenluft – Teil 1: Belastungsniveaus und Tendenz. Gefahrenstoffe – Reinhaltung der Luft 66 (2006) Nr. 10, S. 431-435
- **Löschen, G. (2006b):** Partikelanzahl in verkehrsnaher Außenluft – Teil 2: Einfluss der Meteorologie und erste Ursachenanalyse. GRdL 66 (2006) Nr. 11/12, S. 483-488
- **Birmili 2006:** Räumlich-zeitliche Verteilung, Eigenschaften und Verhalten ultrafeiner Aerosolpartikel (<100nm) in der Atmosphäre, sowie die Entwicklung von Atmosphäre, sowie die Entwicklung von Überwachung in Deutschland Umweltbundesamt, Redaktion : D. Bake Forschungsbericht 203 43 257/05 UBA-FB 000942 UBA Texte 26 – 06
- **Cyrys et al. (2002):** Cyrys, J.; Heinrich, J.; Peters, A.; Kreyling, W.; Wichmann, H. E.: Emission, Immission und Messung feiner und ultrafeiner Partikel. 7, 67-77, Umweltmed. Forsch. Prax.
- **Saxon Ministry for Social issues + LUA 2005** to ultrafine particles and health:  
s. [WWW.UFIPOLNET.EU](http://WWW.UFIPOLNET.EU), under links
- **UBA 2005:** [www.umweltbundesamt.de/uba-info-presse/hintergrund/feinstaub.pdf](http://www.umweltbundesamt.de/uba-info-presse/hintergrund/feinstaub.pdf)
- **EU to CAFE and TSAP:**  
<http://europa.eu/rapid/pressReleasesAction.do?reference=IP/05/1170&format=HTML&aged=0&language=EN&guiLanguage=en> (Sep 2005) <http://europa.eu/rapid/pressReleasesAction.do?reference=IP/06/1447&format=HTML&aged=0&language=EN&guiLanguage=en> (Okt 2006)

# Thank you for your Attention!



**UFIPOLNET is financed by the LIFE financial instrument of the  
European Community  
under No. LIFE04 ENV/D/000054**

# Additional Slides



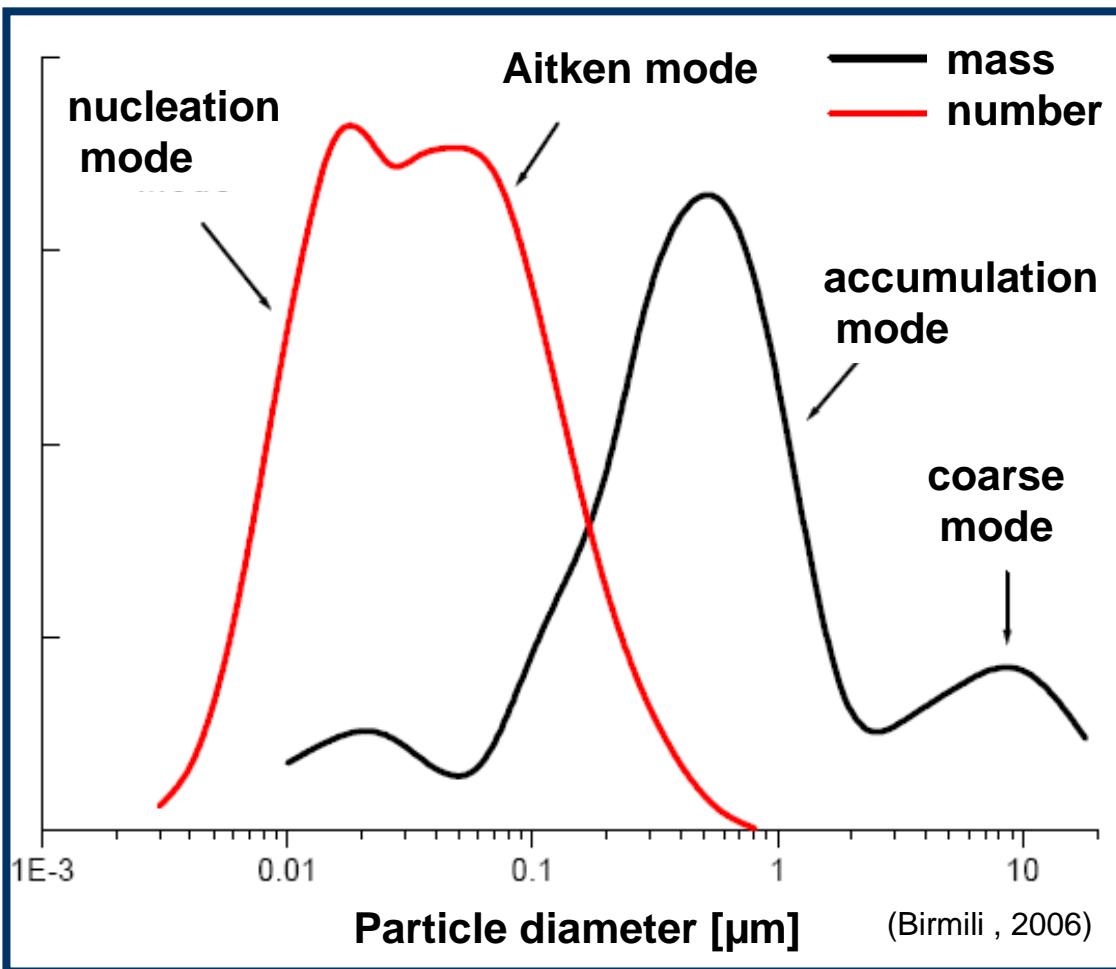
# Messmethoden und UFP 330



## Data transfer

- Single Board Computer + LCD-Display
- Standard schnittstellen:  
USB, RS 232, Firewire
- datatransfer:  
Bayern-Hessen-Protokoll; Stations-  
PC/Modem oder IP
- Measuring Network: z.B. ADVIS
- (Laptop access)

# From PM10 to UFP



- Dimension less **size distribution of particle numbers and mass** in Leipzig-Eisenbahnstraße. (Birmili , 2006)
- **Particle number highest**  $<100\text{nm}$ ,
- **Mass and volume Max at 400 nm**
- **Characterisation of UFP over particle number measurements** is most suitable
- **Particle number conc.** Is **best** to fit needs in **finacial and practical way**.