

testo DiSCmini – Diffusion Size Classifier miniature

Product information 2017

Silvia López Vidal

Directora de I+D de IONER

slopez@ioner.net

Contents

- ❖ **testo DiSCmini overview**
- ❖ **Operating principle**
- ❖ **Instrument specs**
- ❖ **Data handling**
- ❖ **Performance**
- ❖ **Applications**
- ❖ **References**



testo DiSCmini overview

We measure it. **testo**

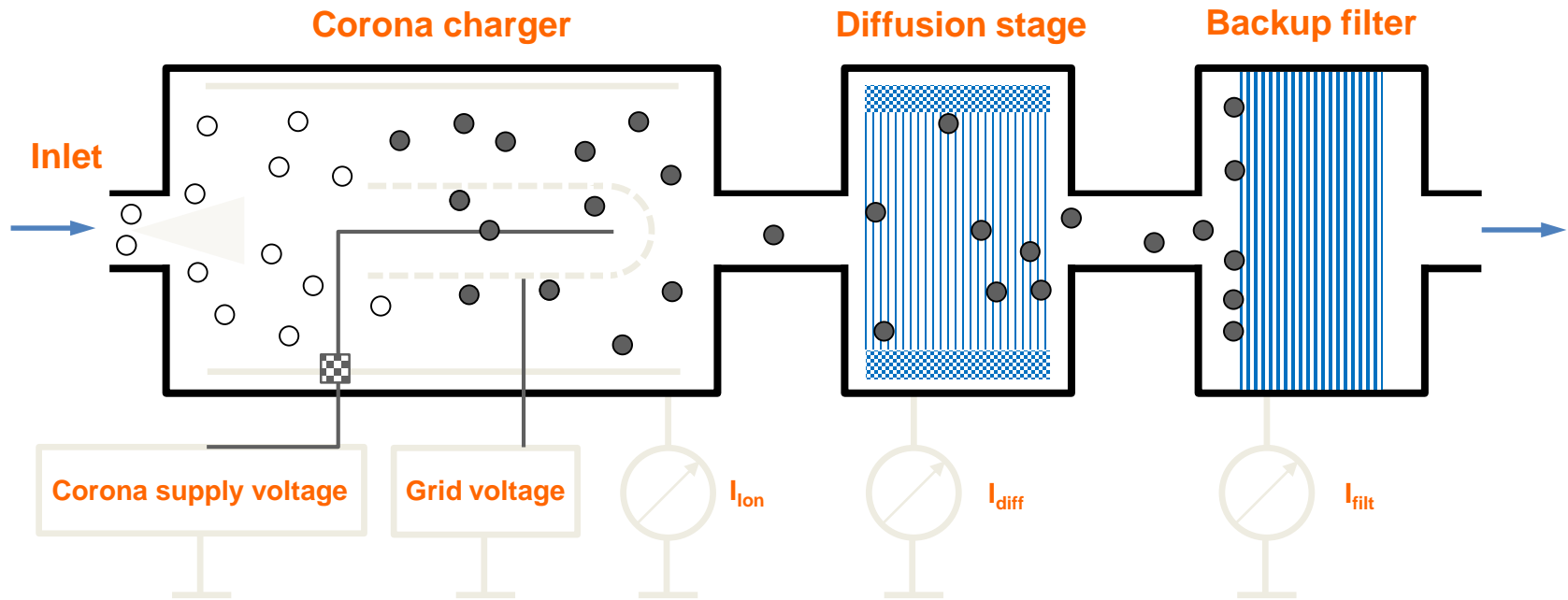


Small is Beautiful

DiSCmini. The smallest particle number counting instrument on the market

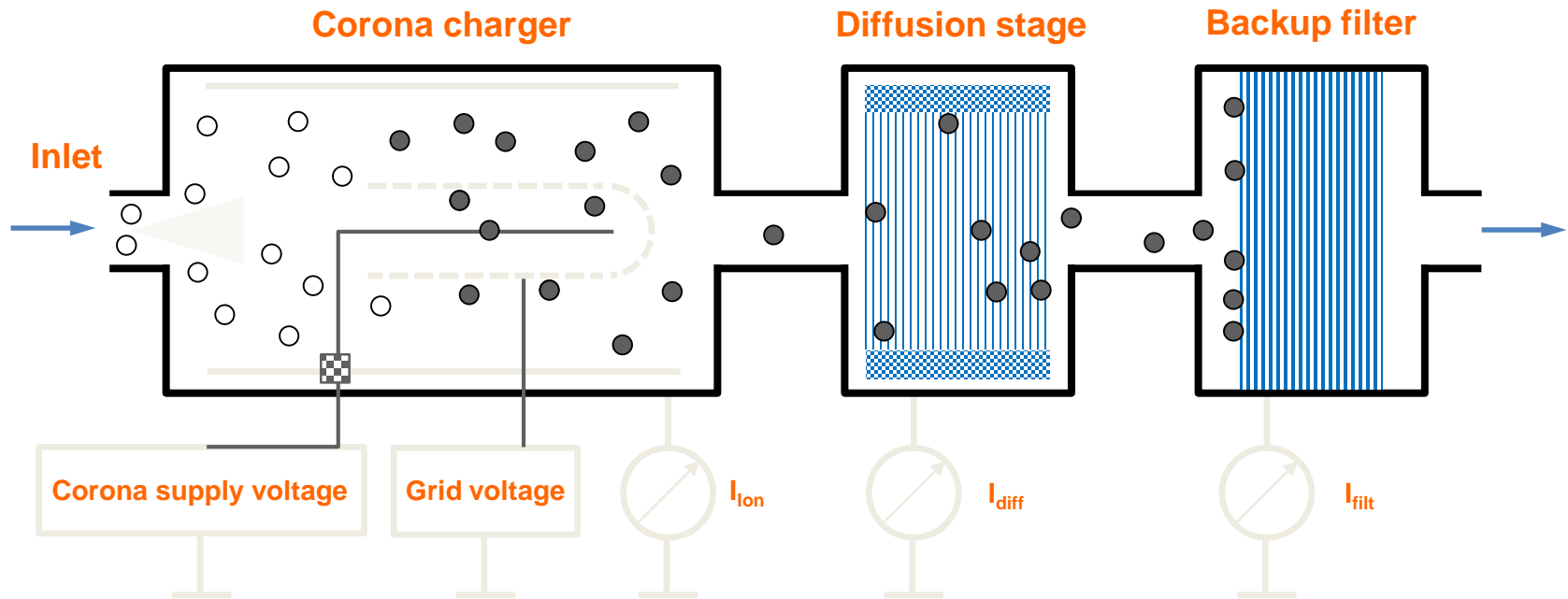
- The Diffusion Size Classifier DiSCmini is a comparatively simple and robust instrument which can determine three quantities simultaneously with a high time resolution of 1s:
 - Particle number concentration: 1E3 to 1E6 pt/ccm
 - Average particle diameter: 10 to 300 nm
 - Lung-deposited surface area: $\mu\text{m}^2/\text{cm}^3$
- The instrument is based on charging and current detection, there is no working fluid like in a CPC.

Operating principle



- Particles are labeled with positive charges in a unipolar charger, so that they can later be detected by the current they induce
- Particles are deposited by diffusion in a "diffusion stage" and detected as an electrical current $D=I_{diff}$
- Remaining particles end up in a filter stage and also produce an electrical current $F=I_{filt}$
- DiSCmini measures both currents D and F simultaneously, with 1s time resolution

Operating principle



- Diffusion stage penetration is size-selective
- Measured ratio $D/F = I_{diff} / I_{filt}$ → particle diameter
- Charge per particle is a function of particle diameter → once the particle diameter is known, DiSCmini computes the particle number from the total current $I_{diff} + I_{filt}$ and the flow rate
- Diffusion charger DC signal correlates well with lung-deposited (alveolar or tracheobronchial) surface area

Operating principle



<http://ioner.eu/portfolio/discmini/>

Instrument specs

Specifications	
Mean particle size	10...300nm (modal diameter)
Particles counted	10....700 nm
Particle concentration	Detectable particle concentrations depend on particle size and averaging time. Typical values are given below. 20nm: 2E3...1E6 pt/ccm 100nm: 5E2...5E5 pt/ccm
Accuracy	±30% in size and number typical; ±5E2/ccm absolute in number.
Time resolution	1 second
Dimensions	180 x 90 x 42,5 mm
Weight	0,7 kg



Instrument specs

Operating conditions	
Flow rate	1,0 L/min +/- 0,1 L/min
Pressure	800...1100 mbar abs ambient Δp max. at inlet: +/- 20 mbar
Temperature	10...30 °C; Relative humidity <90 %
Power requirements	The battery charger is compatible with the any 100-120 volt or 200-240 volt 50/60 Hz AC wall outlet
Battery lifetime	8 hours typical; varies with ambient temperature. Charging time 2-4 hours depending on charger and status of battery



Data handling

Particle number concentration [pt/cm³]

N 15269 pt

Average particle diameter [nm]

Size 52 nm

25%

Battery life for 8 h of mobile measuring

Press to display lung-deposited surface area concentration (alveolar)



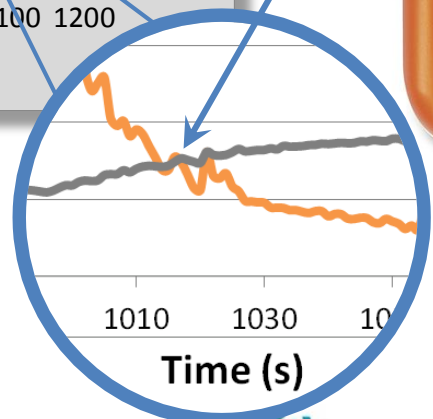
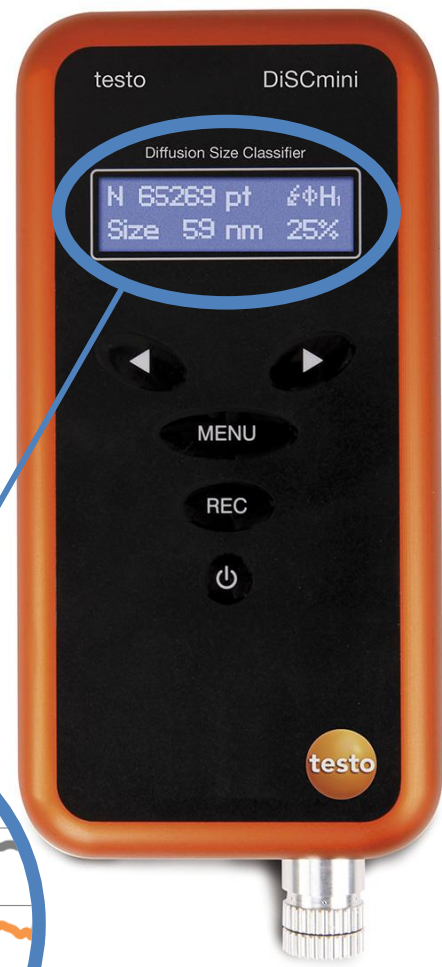
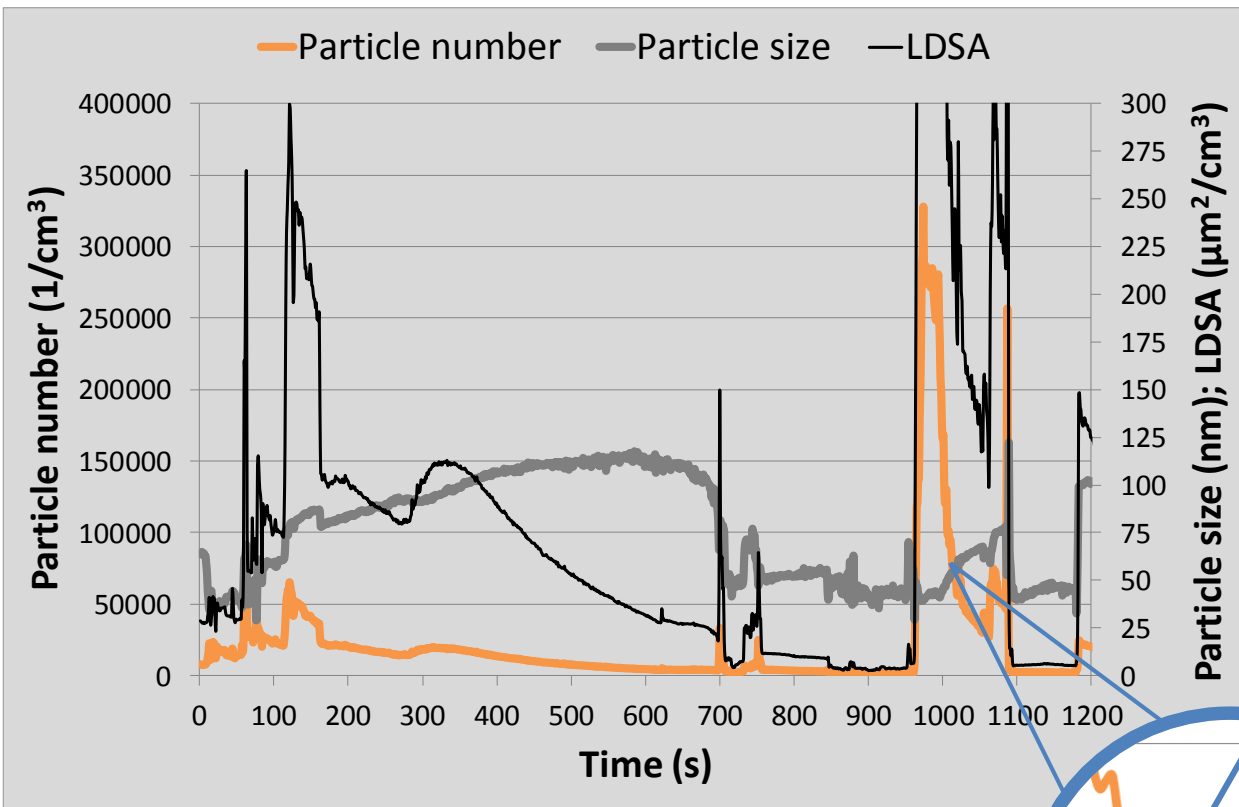
Easy recording on «Secure Digital Memorycard»



DISCmini Data Import



Performance: particle characterization

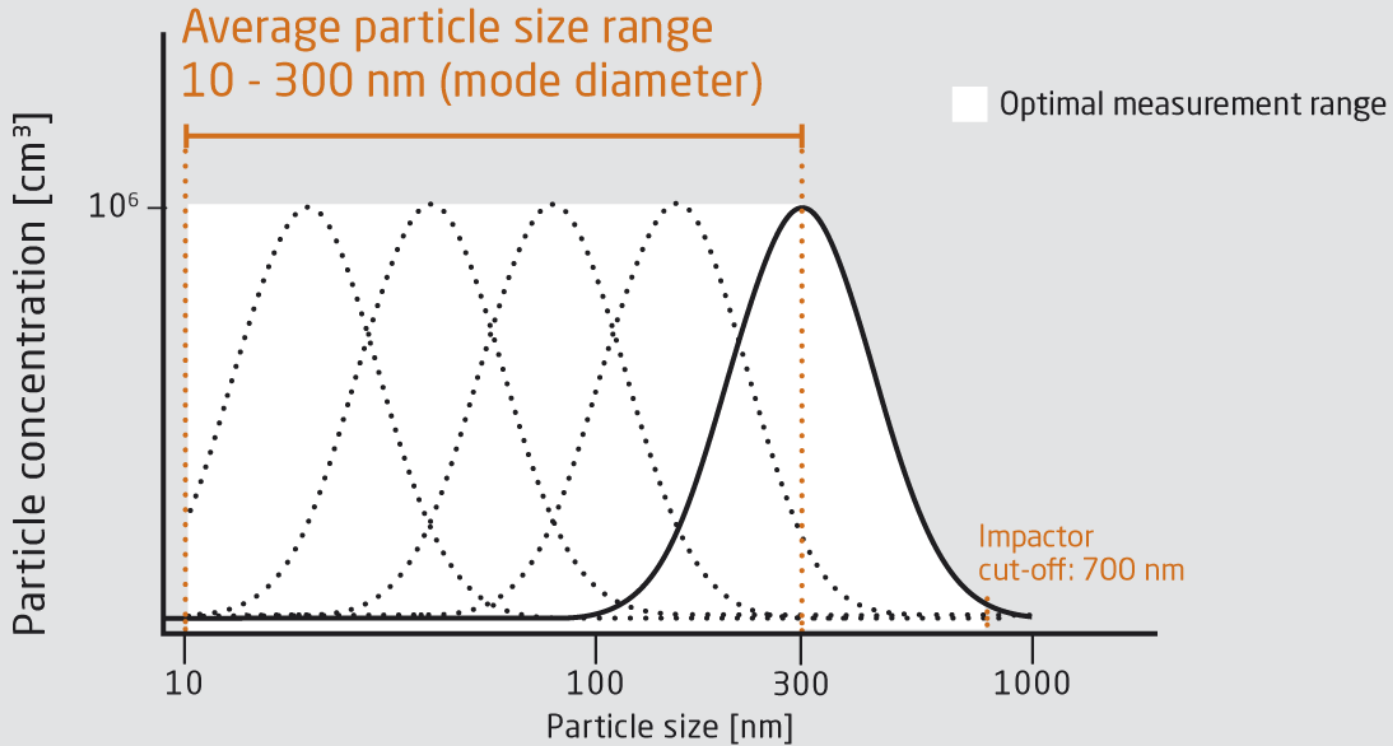


testo DiSCmini features:

- ❖ Simultaneous particle number concentration, size and LDSA
- ❖ Wide particle number concentration range
- ❖ 1 Hz resolution
- ❖ High sensitivity

Performance: measurement range

Measurement Range



Particle size 10 - 700 nm

Detection limits: average diameter: ~10 - 300 nm (mode diameter)
particle number: ~10³ - 10⁶ pt/ccm

Application examples

- Ambient work area monitoring
- Personal exposure monitoring
- Point source location monitoring
- Background/baseline monitoring
- Engineering studies
- Etc.....



Application examples

Process or location	Concentration (particles/cm ³)	Particle size (nm)
outdoor, office	up to 10.000	
silicon melt	up to 100.000	280-520
metal grinding	up to 130.000	17-170
soldering	up to 400.000	36-64
plasma cutting	up to 500.000	120-180
bakery	up to 640.000	32-109
airport field	up to 700.000	< 40
welding	100.000 – 40.000.000	40-600





Application #1: Air quality monitoring

Swiss TPH



Swiss Tropical and Public Health Institute
Schweizerisches Tropen- und Public Health-Institut
Institut Tropical et de Santé Publique Suisse

Associated Institute of the University of Basel

Epidemiology and Public Health
Environmental Exposures and Health

ETH Conference on Combustion Generated Nanoparticles, June 25-27, 2012


Commute exposure to ultrafine particles (UFP) in the city of Basel, Switzerland

Martina Ragetti, Harish C. Phuleria, Charlotte Braun-Fahrländer, Elisabetta Corradi, Christian Schindler, Mark Davey, Nino Künzli

Commute exposure to ultrafine particles: Areas of interest



Health effects & exposure assessments

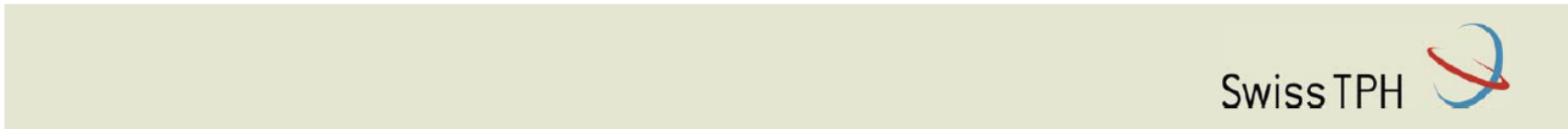


Spatial exposure differences

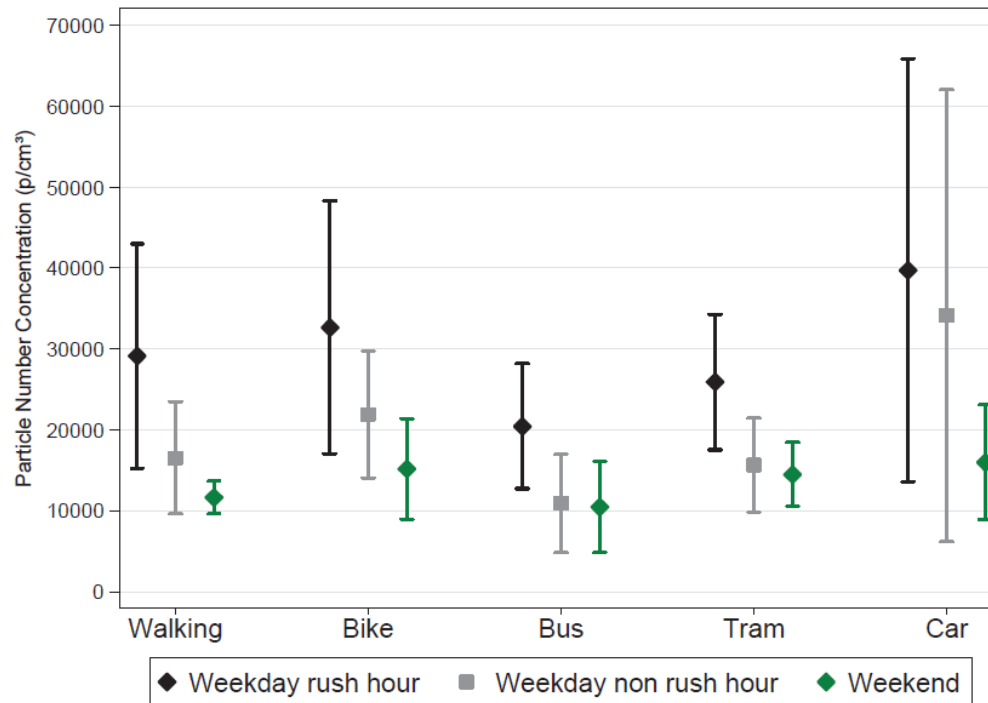
Exposure determinants



Application #1: Air quality monitoring



Particle Number Concentration by mode of transport & time of the day/week (mean \pm SD)



18 sampling days (6 weekends, 18 weekdays) in spring & fall 2011
275 trips, based on individual trip medians

Our UFP measurements in Basel suggest...



- Higher exposure levels for **car** (40'000 particles), **bicycle** and **walking** (29'000-33'000 particles) compared to public transport (21'000-26'000 particles)



- Commuting by bike contributes to **daily exposures**, especially in winter (21%)



- **Avoiding main streets** reduce commute exposure **by one half**

Application #2: Personal exposure

We measure it. 

Christof Asbach



Personal exposure to nanoscale particles in everyday life

Institut für Energie- und Umwelttechnik e.V.

Air Quality & Filtration

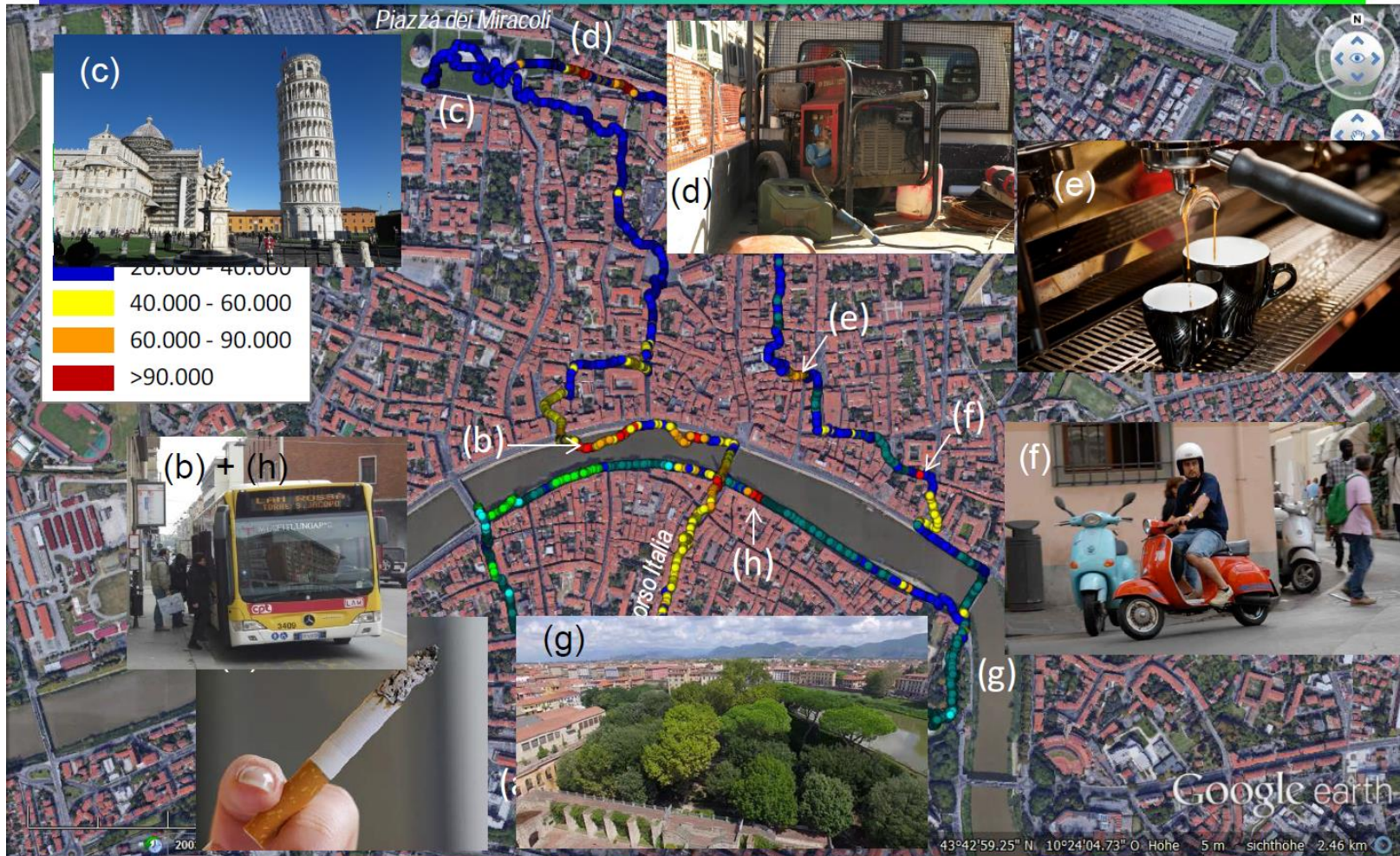
nanolndEx final workshop
Berlin, May 31st, 2016

UNIVERSITÄT
DUISBURG
ESSEN

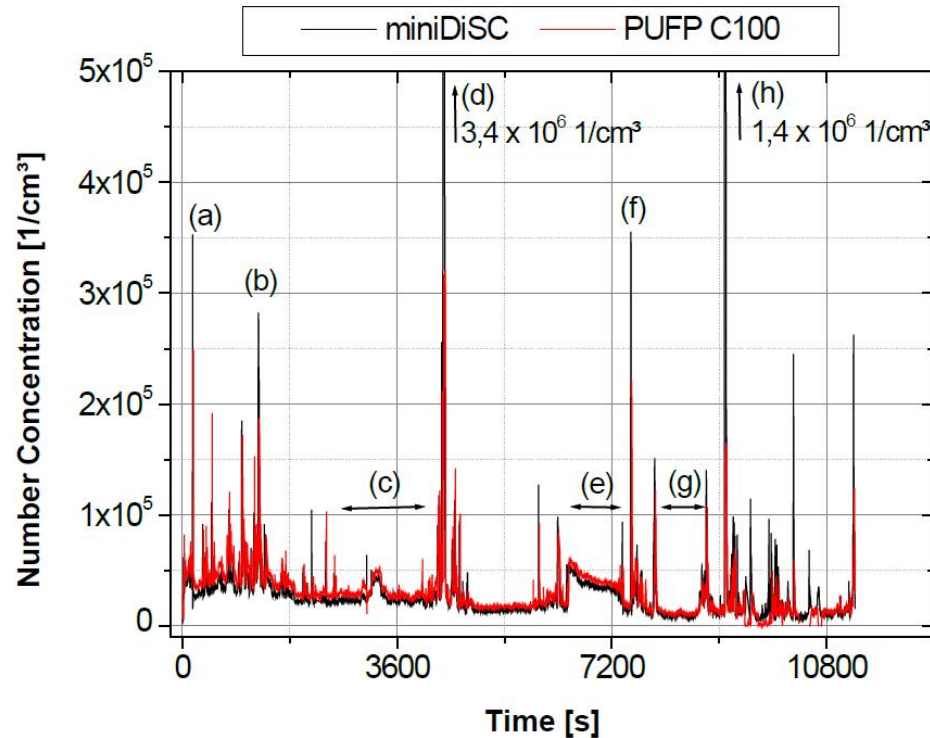
Offen im Denken

Application #2: Personal exposure

Sightseeing tour in Pisa



Number concentrations in Pisa



Piazza dei Miracoli



miniDiSC: $26,940 \pm 6,570 \text{ 1/cm}^3$
 PUF C100: $33,000 \pm 7,190 \text{ 1/cm}^3$

Giardino Scotto



miniDiSC: $9,230 \pm 1,310 \text{ 1/cm}^3$
 PUF C100: $11,970 \pm 1,580 \text{ 1/cm}^3$

Asbach and Todea, *Gefahrstoffe – Reinhaltung der Luft* (in preparation)

Application #3: Occupational exposure monitoring

- **Field measurements in facilities manufacturing and processing ceramic materials**

Mar Viana

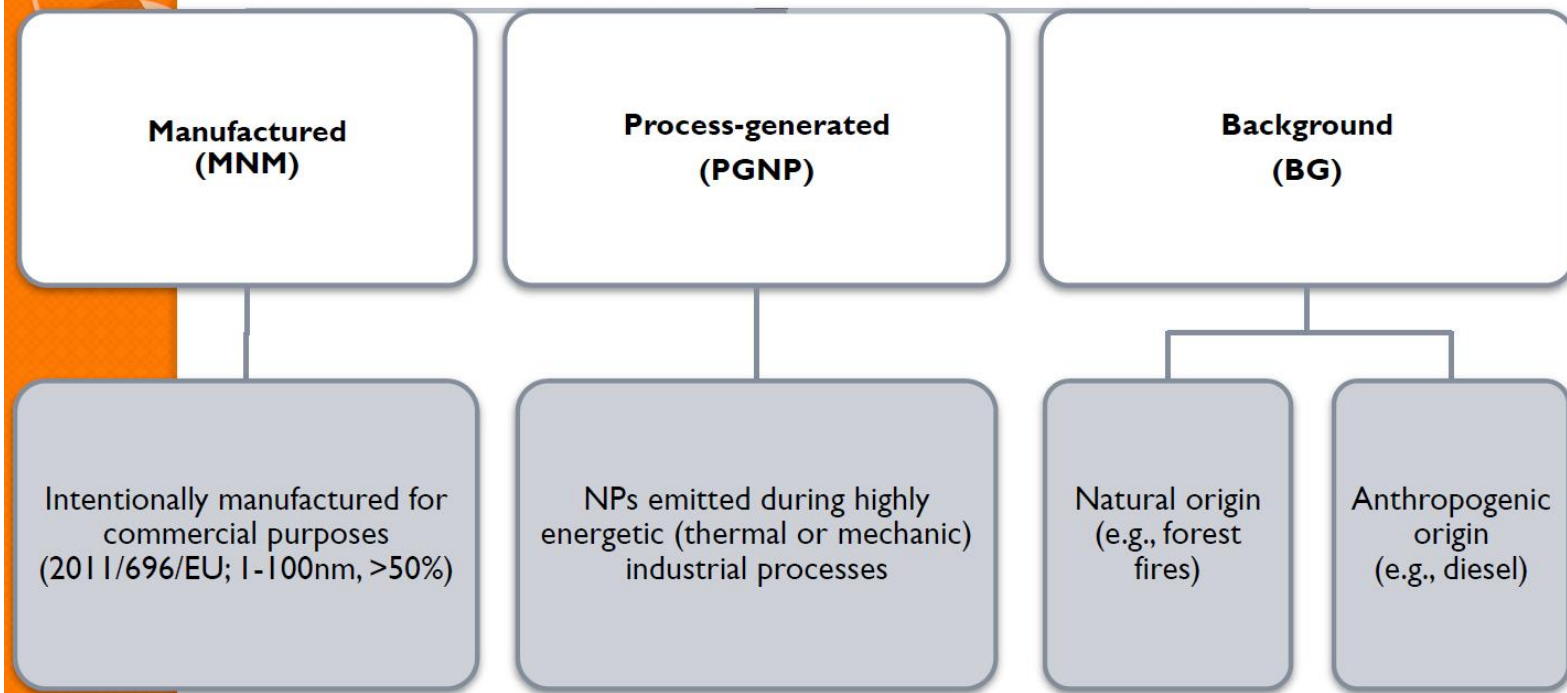
IDAEA-CSIC

mar.viana@idaea.csic.es


Application #3: Occupational exposure monitoring




NP types




Measurement strategy




Outdoor




Plasma chamber




DiscMini
(10 - 700 nm)



NanoScan SMPS
(10 to 420 nm)



TEM
samples



Breathing zone



CPC TSI 3775
(4-1500 nm)



DiscMini
(10 - 700 nm)



Grimm 1.108
(300 to 20 000 nm)

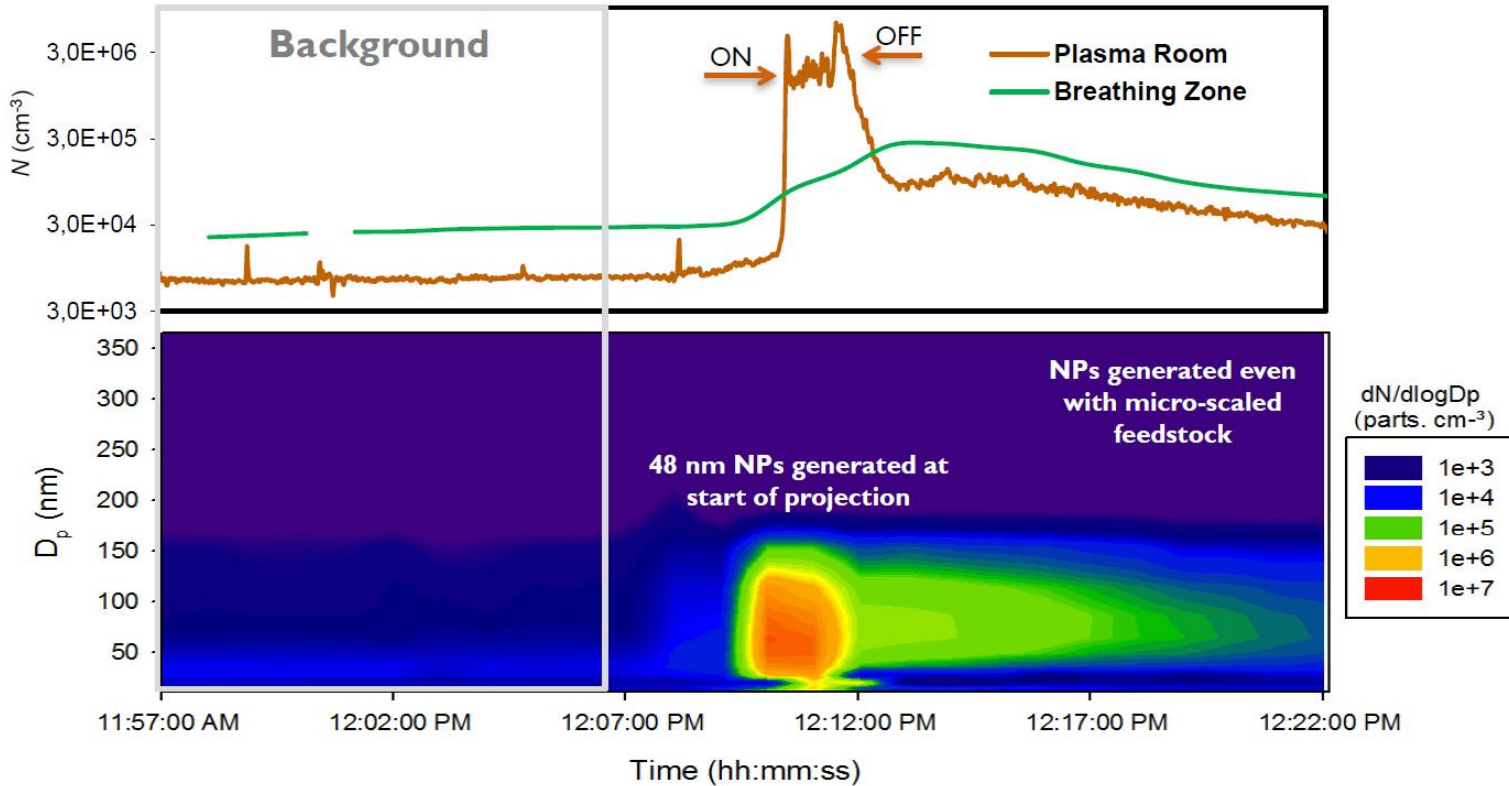


TEM
samples

- Metrics:
- Particle number
 - Mass
 - LDSA
 - Mean diameter
- Range: 5 nm – 20 µm

Results: plasma spraying

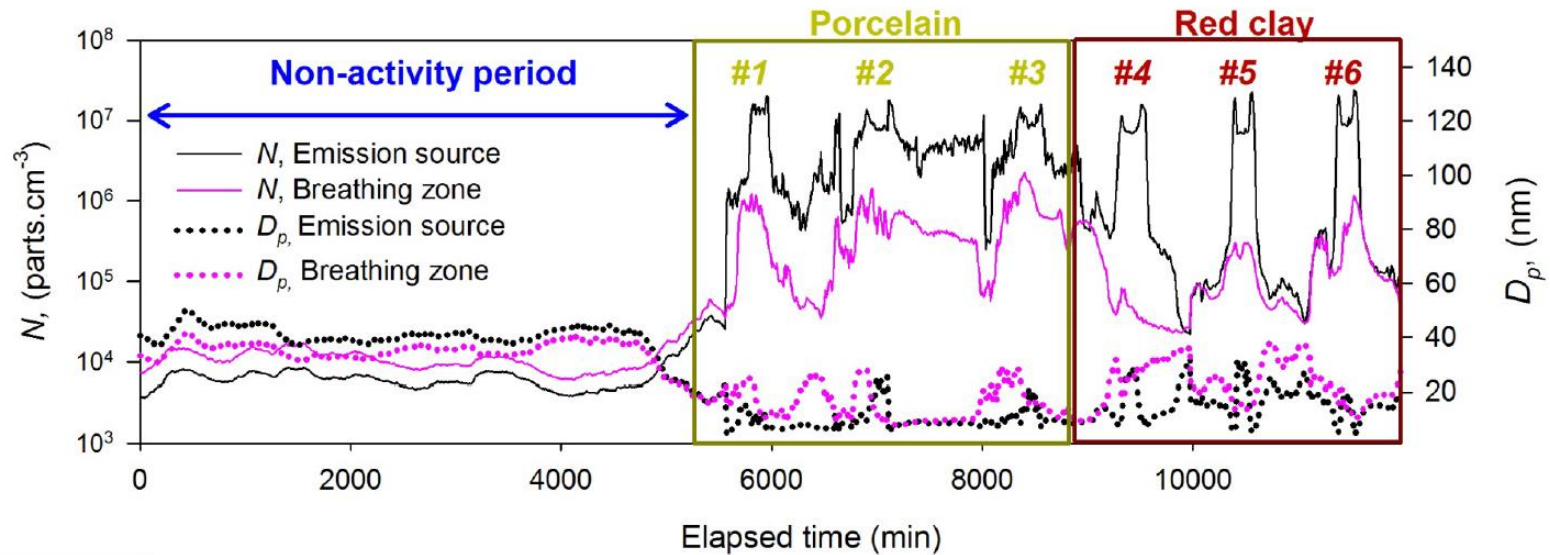
Feedstock: micro-suspension (ceramic glass powder <math><63 \mu\text{m}</math> + 1% of fluidised nano 7 nm)



Application #3: Occupational exposure monitoring



Results: tile sintering



	Source	Breathing zone
N	$>10^7/\text{cm}^3$	$>10^5/\text{cm}^3$
Dp	8-18 nm	13-27 nm

Occupational inhalation exposure assessment using DiSCmini

Joonas Koivisto, Ismo Koponen, Marcus Levin, Asger Nørgaard, Alexander Jensen, Kirsten Kling, Keld Jensen

NanoIndEx Workshop / 31.5.2016



NATIONAL RESEARCH
CENTRE FOR THE WORKING ENVIRONMENT

Application #3: Occupational exposure monitoring

Outline

- Workplace measurements using DiSCmini:
 - Handling of Nanodiamonds (NDs)
 - A handcraft workshop
 - Injection molding of car bumpers
 - Tungsten carbide-cobalt (WoCCo) sieving and milling
 - Jet engine emissions
- Summary of 8-h doses defined from DiSCmini measurements
- Biological relevance of the doses
- Summary

Exposure during handling and sieving nanodiamonds



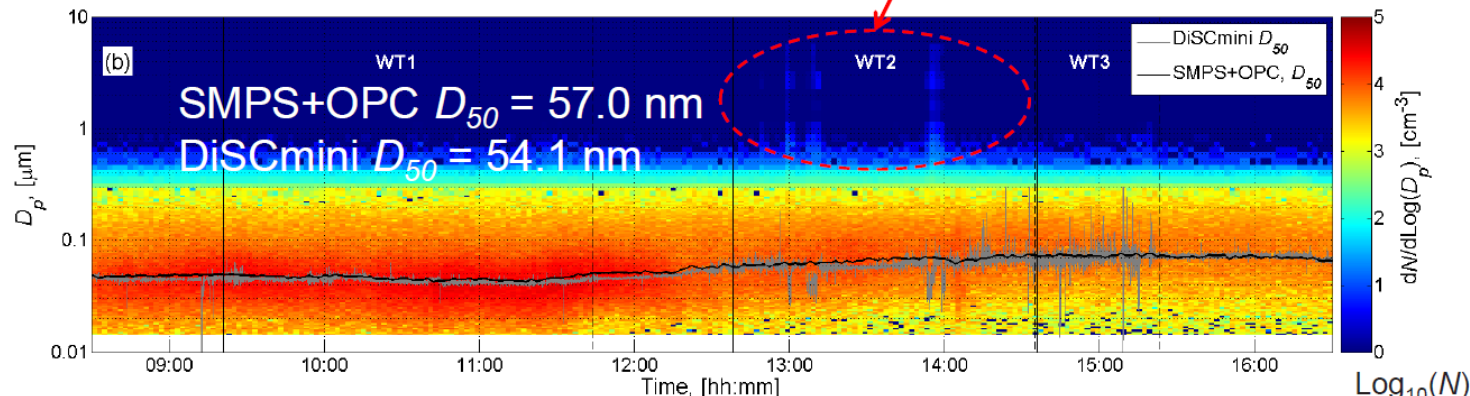
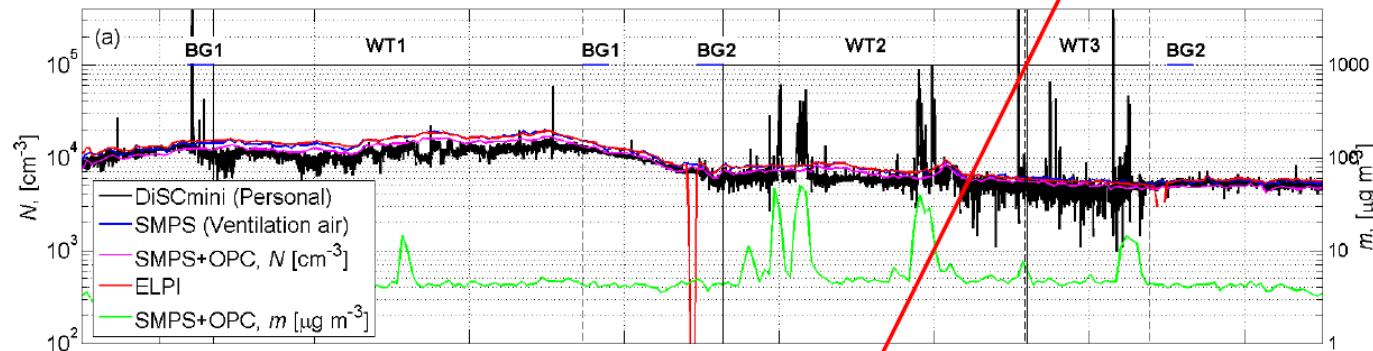
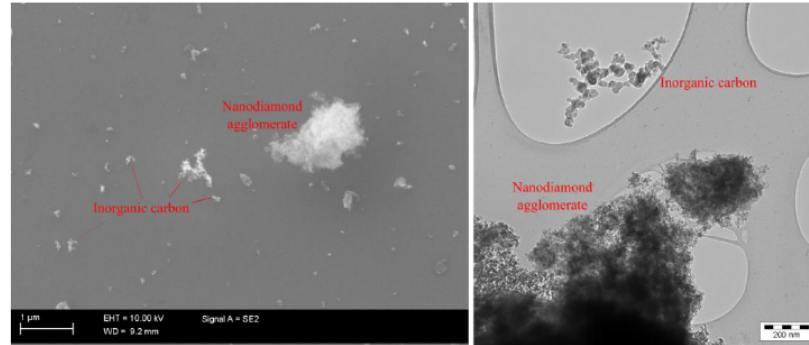
Concentration measurements:

- Breathing zone (DiSCmini)
- Background from ventilation air (SMPS)
- Work station (SMPS, DiSCmini, OPS, ELPI, ...)



Application #3: Occupational exposure monitoring

Exposure concentrations



Application #3: Occupational exposure monitoring

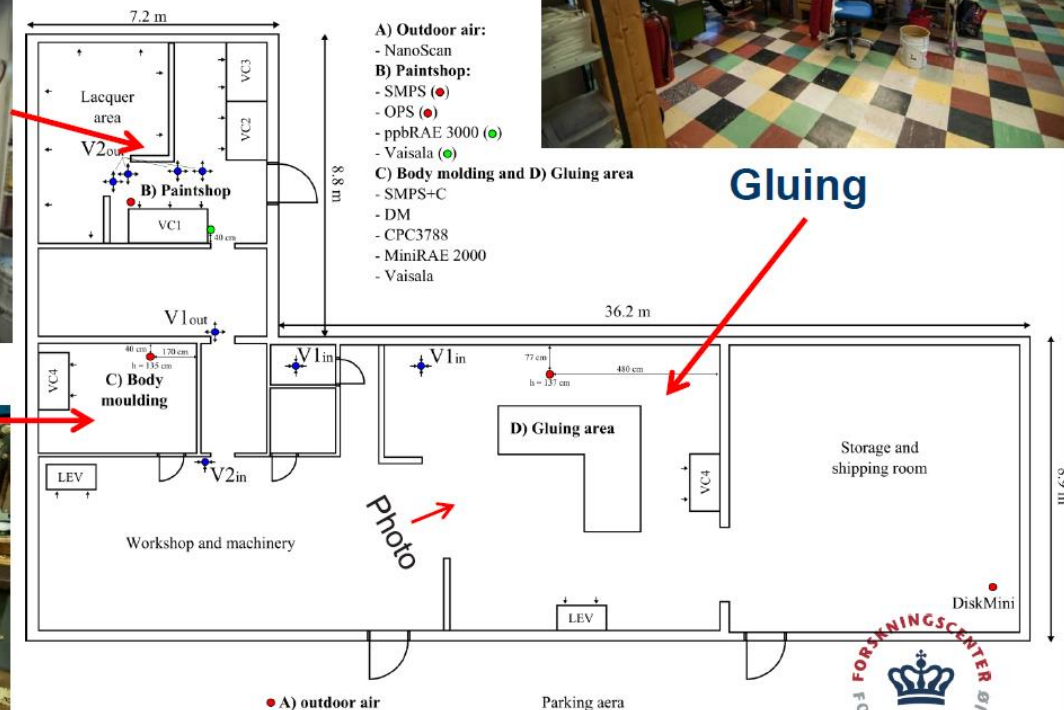
A handcraft workshop



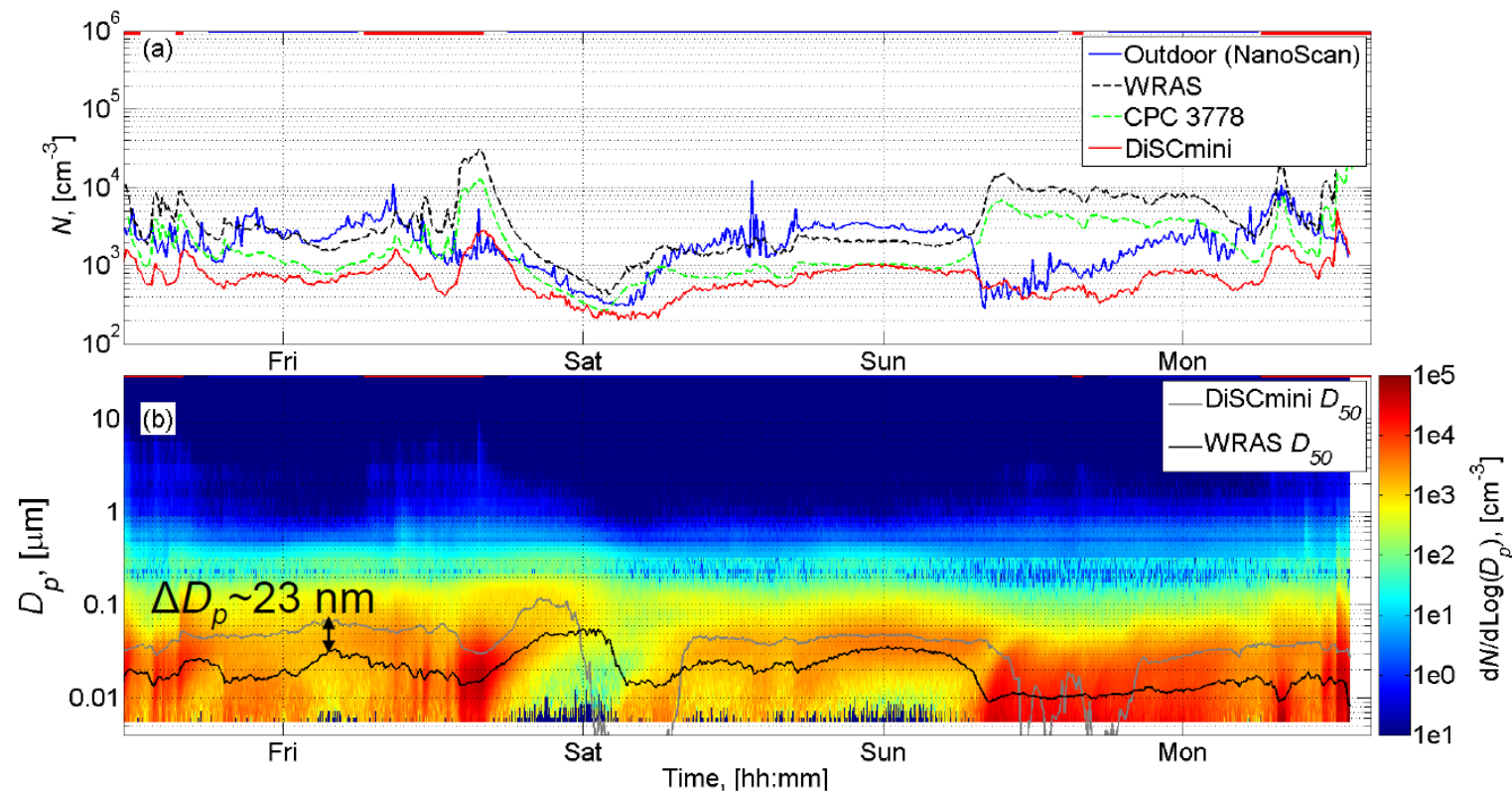
Spray painting



Polyurethane molding

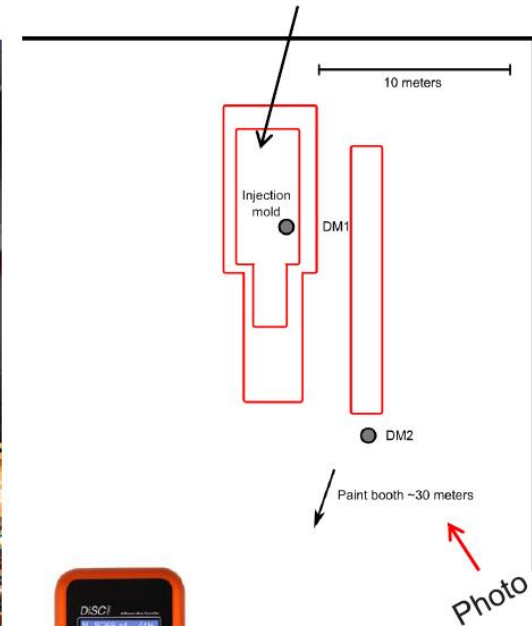


Concentrations in the gluing area



Injection molding of car bumpers

Engel 2500 tonnes injection molding machine:



Instrumentation:

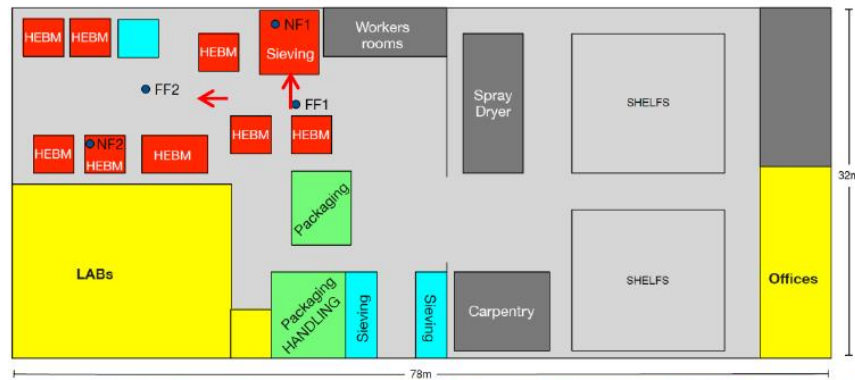
- 2 x DiSCmini (two stage diffusion charger)
- Mini Particle Sampler for microscopy analysis

Application #3: Occupational exposure monitoring

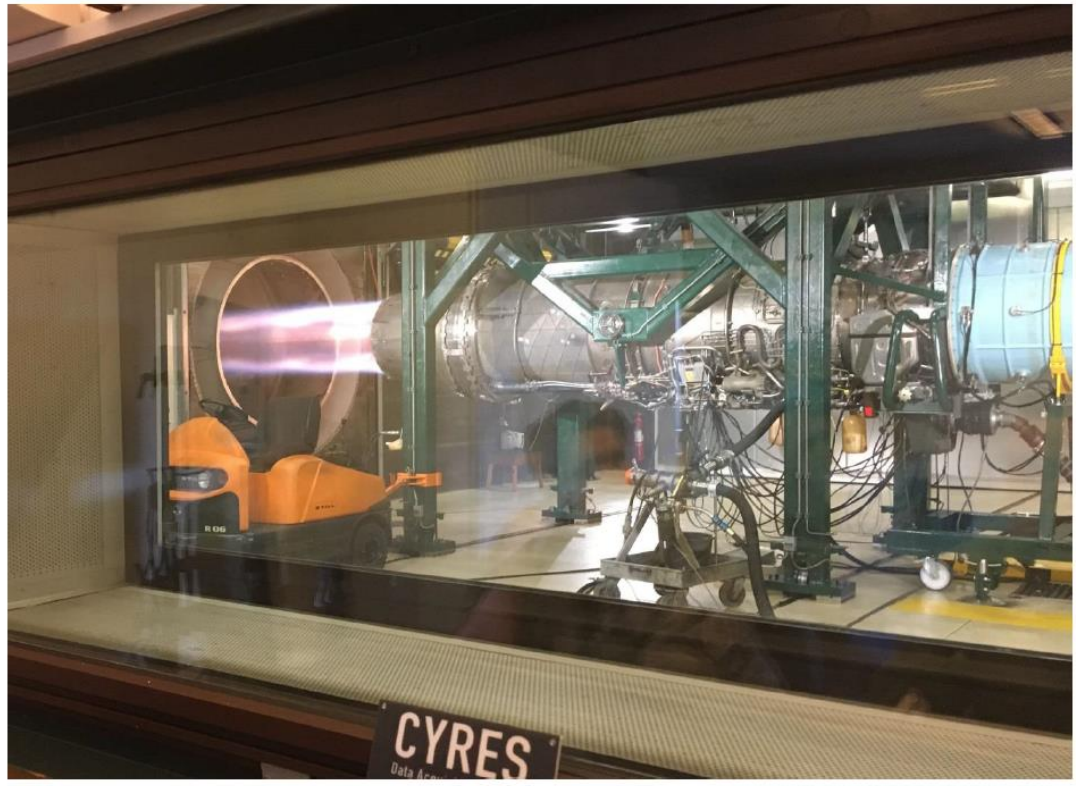
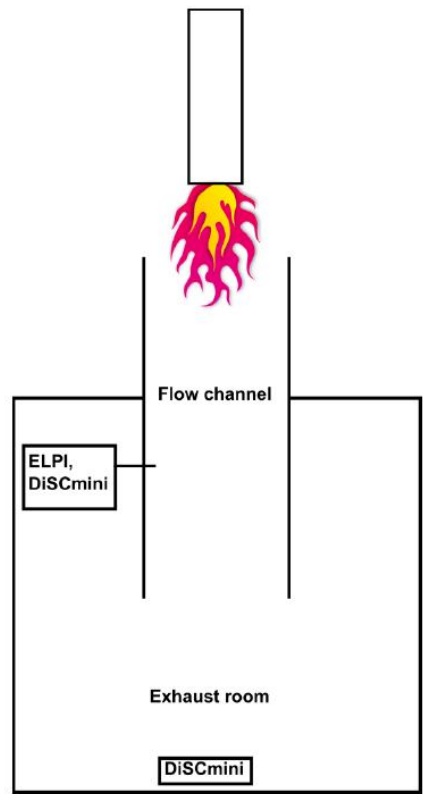
Tungsten carbide-cobalt (WoCCo) sieving and milling



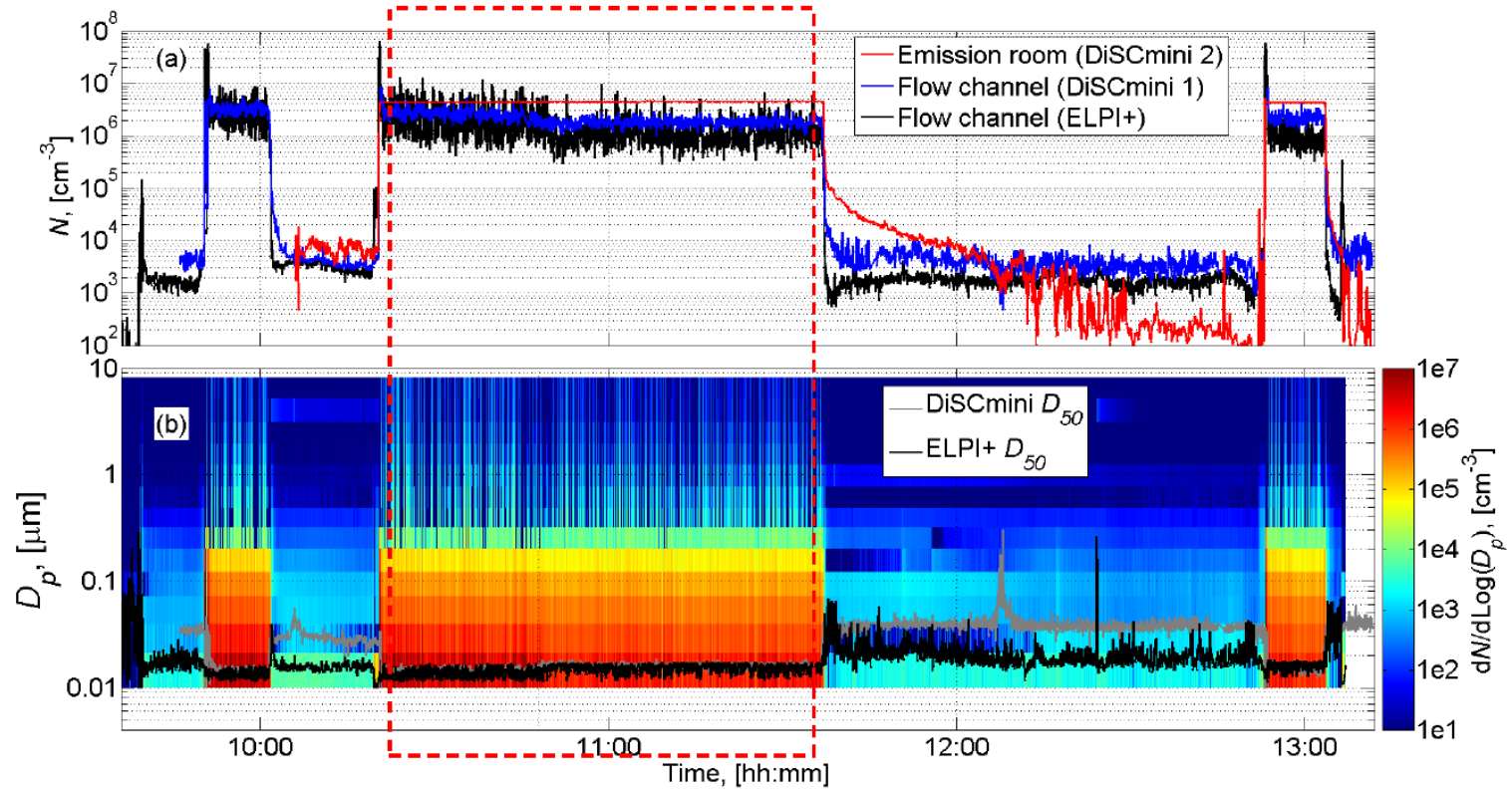
Vibratory sieve shaker



Jet engine emissions



Concentrations



References

❖ Personal exposure

- Neuberger et al. “Exposure to ultrafine particles in hospitality venues with partial smoking bans”, *Journal of Exposure Science and Environmental Epidemiology* (2013), 1–6; doi:10.1038/jes.2013.22
- Van Broekhuizen et al. “Exposure Limits for Nanoparticles: Report of an International Workshop on Nano Reference Values”, *Ann. Occup. Hyg.*, Vol. 56, No. 5, pp. 515–524, 2012; doi:10.1093/annhyg/mes043
- Koehler et al. “New Methods for Personal Exposure Monitoring for Airborne Particles”, *Curr Environ Health Rep.* 2015 December; 2(4): 399–411. doi:10.1007/s40572-015-0070-z.
- Koivisto et al. “Range-Finding Risk Assessment of Inhalation Exposure to Nanodiamonds in a Laboratory Environment”, *Int. J. Environ. Res. Public Health* 2014, 11, 5382-5402; doi:10.3390/ijerph110505382
- Sunyer et al. “Association between Traffic-Related Air Pollution in Schools and Cognitive Development in Primary School Children: A Prospective Cohort Study”, (2015) *PLoS Med* 12(3): e1001792. doi:10.1371/journal.pmed.1001792
- Rivas et al. “Child exposure to indoor and outdoor air pollutants in schools in Barcelona, Spain”, (2014) *Environment International*, doi.org/10.1016/j.envint.2014.04.009
- Rivas et al. “Outdoor infiltration and indoor contribution of UFP and BC, OC, secondary inorganic ions and metals in PM2.5 in schools”, (2014), *Atmospheric Environment*, doi.org/10.1016/j.atmosenv.2015.01.055

References

❖ Occupational Health & Safety

- Fonseca et al. “Ultrafine and nanoparticle formation and emission mechanisms during laser processing of ceramic materials”, *Journal of Aerosol Science* 88 (2015) 48–57, doi.10.1016/j.jaerosci.2015.05.013
- van Broekhuizen et al. “Workplace exposure to nanoparticles and the application of provisional nanoreference values in times of uncertain risks”, (2012) *J Nanopart Res* (2012) 14:770, doi.10.1007/s11051-012-0770-3
- Kaminski et al. “Measurements of Nanoscale TiO₂ and Al₂O₃ in Industrial Workplace Environments – Methodology and Results”, (2015) *Aerosol and Air Quality Research*, 15: 129–141, 2015, doi: 10.4209/aaqr.2014.03.0065
- Fonseca et al. “Characterization of Exposure to Carbon Nanotubes in an Industrial Setting”, (2014), *Ann. Occup. Hyg.*, 2014, 1–14, doi:10.1093/annhyg/meu110
- Fonseca et al. “Process-generated nanoparticles from ceramic tile sintering: Emissions, exposure and environmental release”, (2016), *Science of the Total Environment*, dx.doi.org/10.1016/j.scitotenv.2016.01.106
- Kocks et al. “Release of nanomaterials from ink and toner cartridges for printers”, (2015), The Danish Environmental Protection Agency, ISBN 978-87-93352-65-0
- Ho Ji et al. “Workplace Exposure to Titanium Dioxide Nanopowder Released from a Bag Filter System”, (2014), *BioMed Research International* Volume 2015, Article ID 524283, 9 pages, doi.org/10.1155/2015/524283
- Graczyk et al. “Characterization of Tungsten Inert Gas (TIG) Welding Fume Generated by Apprentice Welders”, (2015), *Ann. Occup. Hyg.*, 2015, 1–15 doi:10.1093/annhyg/mev074
- Van Landuyt et al. “Nanoparticle release from dental composites”, (2015), *Acta Biomaterialia*, doi.org/10.1016/j.actbio.2013.09.044

References

❖ Ambient air monitoring

- Kuuluvainen et al. “Lung deposited surface area size distributions of particulate matter in different urban areas”, (2016) Atmospheric Environment, doi.org/10.1016/j.atmosenv.2016.04.019
- Hasenfratz et al. "Pushing the spatio-temporal resolution limit of urban air pollution maps", PERCOM, 2014, 2014 IEEE International Conference on Pervasive Computing and Communications (PerCom), 2014 IEEE International Conference on Pervasive Computing and Communications (PerCom) 2014, pp. 69-77, doi:10.1109/PerCom.2014.6813946
- Ragetti et al. Commute exposure to ultrafine particles in the city of Basel, Switzerland, (2012), ETH Zurich NPC on Combustion Generated Nanoparticles.
- Richard et al. “Mobile measurements of number concentrations of ultrafine particles in different Swiss cities with the minidisc”, (2012) ETH Zurich NPC on Combustion Generated Nanoparticles.

❖ Instrument performance

- Fierz et al. “Design, Calibration, and Field Performance of a Miniature Diffusion Size Classifier”, (2011), Aerosol Science and Technology, 45:1, 1-10, doi: 10.1080/02786826.2010.516283
- Meier et al. “Comparative Testing of a Miniature Diffusion Size Classifier to Assess Airborne Ultrafine Particles under Field Conditions, Aerosol Science and Technology, 47:1, 22-28, DOI: 10.1080/02786826.2012.720397
- Maricq “Monitoring Motor Vehicle PM Emissions: An Evaluation of Three Portable Low-Cost Aerosol Instruments”, Aerosol Science and Technology, 47:5, 564-573, DOI: 10.1080/02786826.2013.773394

References

❖ Instrument performance

- Todea et al. “Accuracy of electrical aerosol sensors measuring lung deposited surface area concentrations” (2015), Journal of Aerosol Science, doi.org/10.1016/j.jaerosci.2015.07.003
- Viana et al. “Field comparison of portable and stationary instruments for outdoor urban air exposure assessments” (2015), Atmospheric Environment, doi.org/10.1016/j.atmosenv.2015.10.076
- Vosburgh et al. “Evaluation of a Diffusion Charger for Measuring Aerosols in a Workplace”, (2014) Ann. Occup. Hyg., 2014, Vol. 58, No. 4, 424–436 doi:10.1093/annhyg/met082
- Rostedt, et al. “Characterization and Response Model of the PPS-M Aerosol Sensor, Aerosol Science and Technology, 48:10, 1022-1030, doi: 10.1080/02786826.2014.951023
- Kaminski et al “Mathematical Description of Experimentally Determined Charge Distributions of a Unipolar Diffusion Charger, Aerosol Science and Technology, 46:6, 708-716, DOI: 10.1080/02786826.2012.659360
- Kaminski et al. “Comparability of mobility particle sizers and diffusion chargers”, (2013), Journal of Aerosol Science 57(2013)156–178, doi.org/10.1016/j.jaerosci. 2012.10.008
- Mills et al. “Comparison of the DiSCmini Aerosol Monitor to a Handheld Condensation Particle Counter and a Scanning Mobility Particle Sizer for Submicrometer Sodium Chloride and Metal Aerosols, Journal of Occupational and Environmental Hygiene, 10:5, 250-258, doi.org/10.1080/15459624.2013.769077
- Asbach et al. “Comparability of Portable Nanoparticle Exposure Monitors”, (2012), Ann. Occup. Hyg., Vol. 56, No. 5, pp. 606–621, 2012 © The Author 2012. Published by Oxford University Press on behalf of the British Occupational Hygiene Society doi:10.1093/anhyg/mes033

*Thank you for your
attention*

Silvia López



+34 91 404 45 75



slopez@ioner.net



www.ioner.eu