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testo DiSCmini – Diffusion Size Classifier miniature

Silvia López Vidal, PhD

Directora de I+D de IONER

slopez@ioner.net

Contents

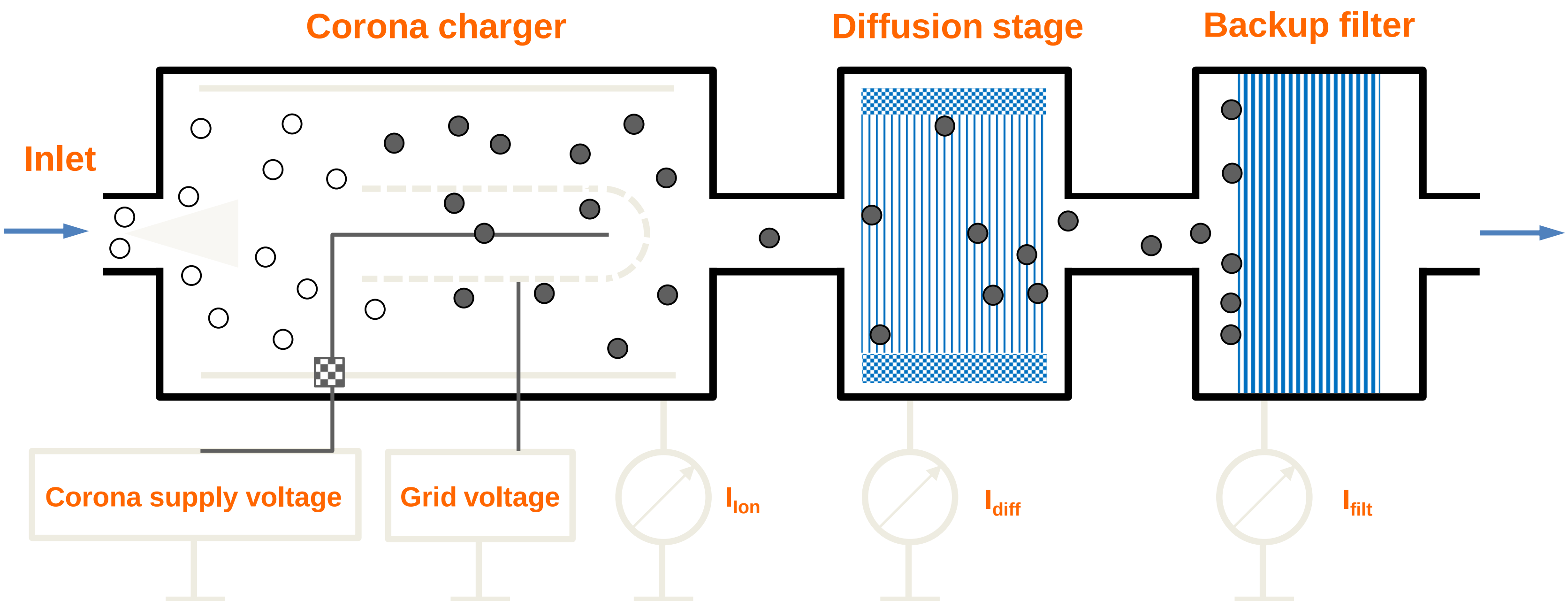
testo DiSCmini overview

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: µm2/cm3
- The instrument is based on charging and current detection, there is no working fluid like in a CPC.

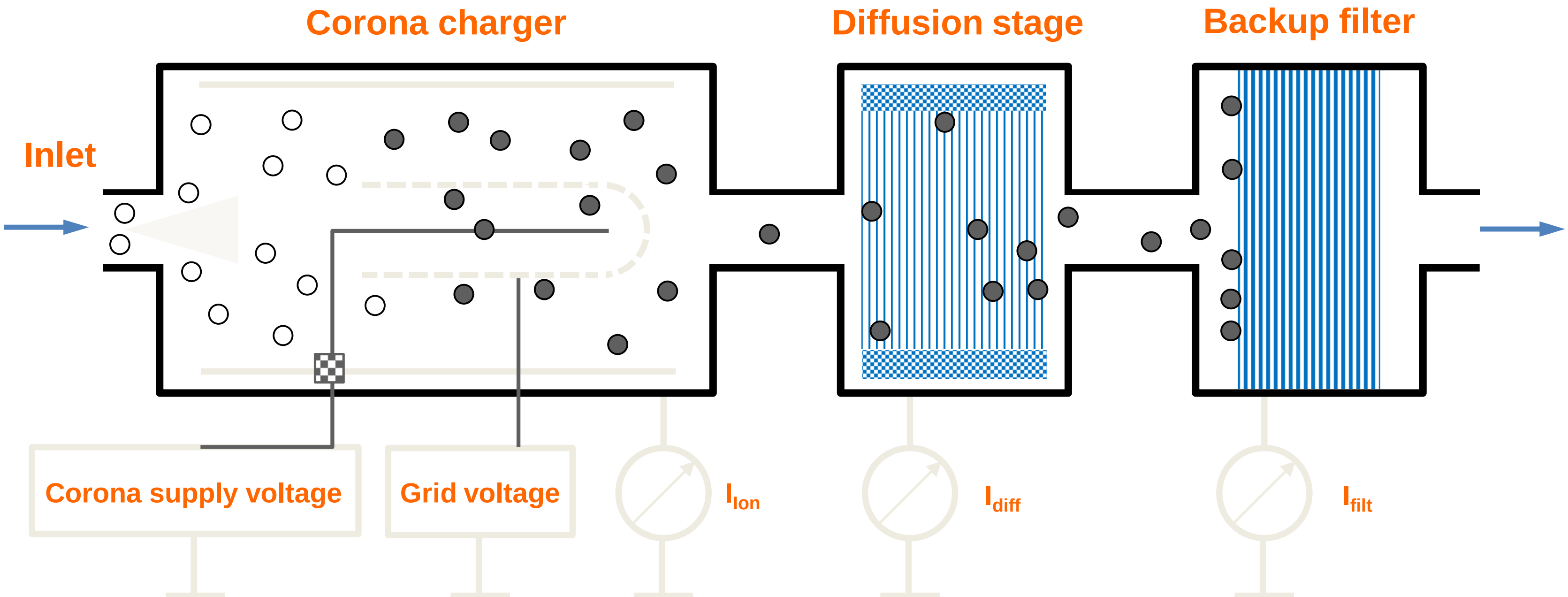
Operating principle

We measure it. testo



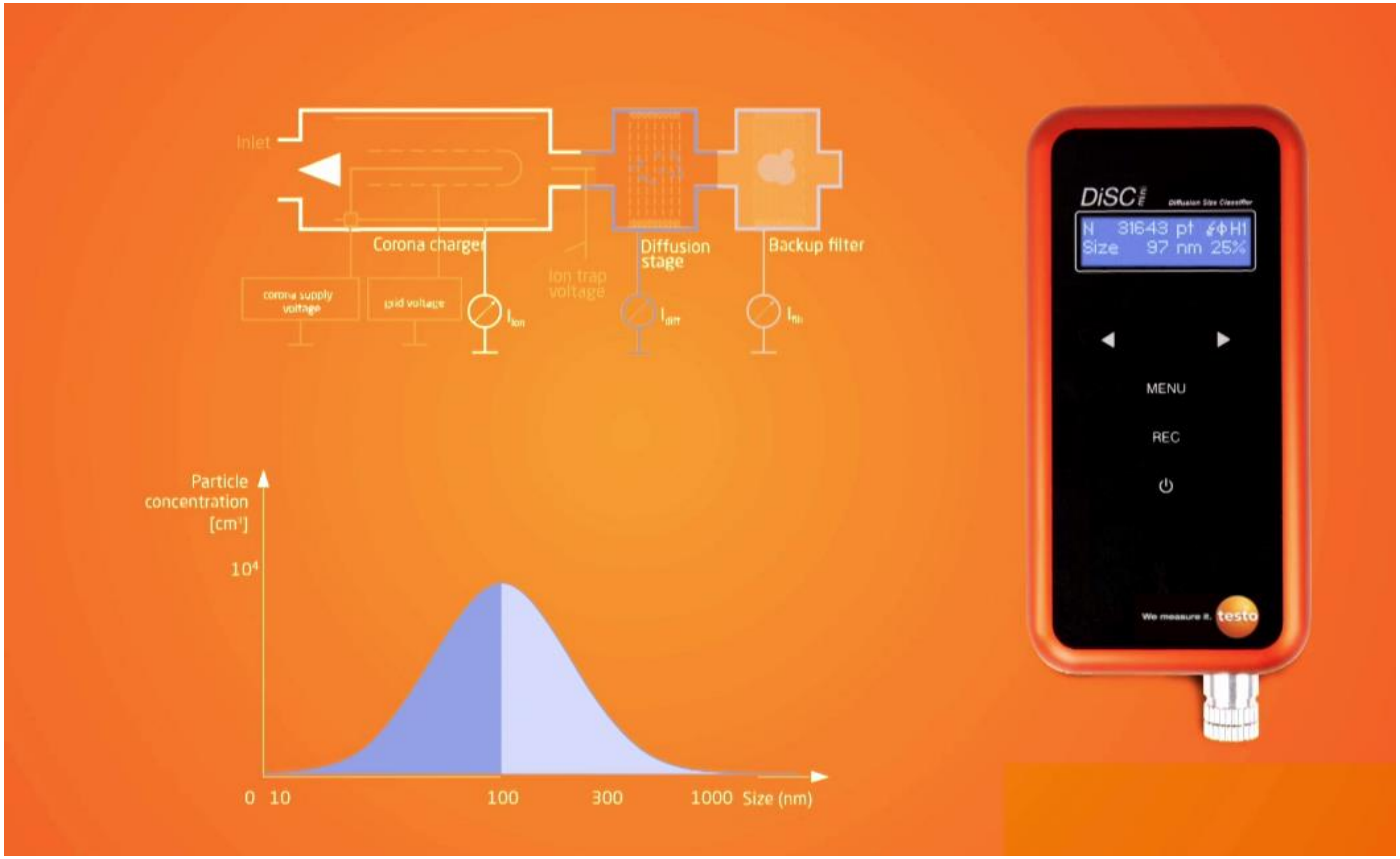
- Particles are labeled with positive charges in a unipolar charger, so that they can later be detected by the current they induce
- Particles are deposited by diffusion in a "diffusion stage" and detected as an electrical current $D=I_{diff}$
- Remaining particles end up in a filter stage and also produce 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]

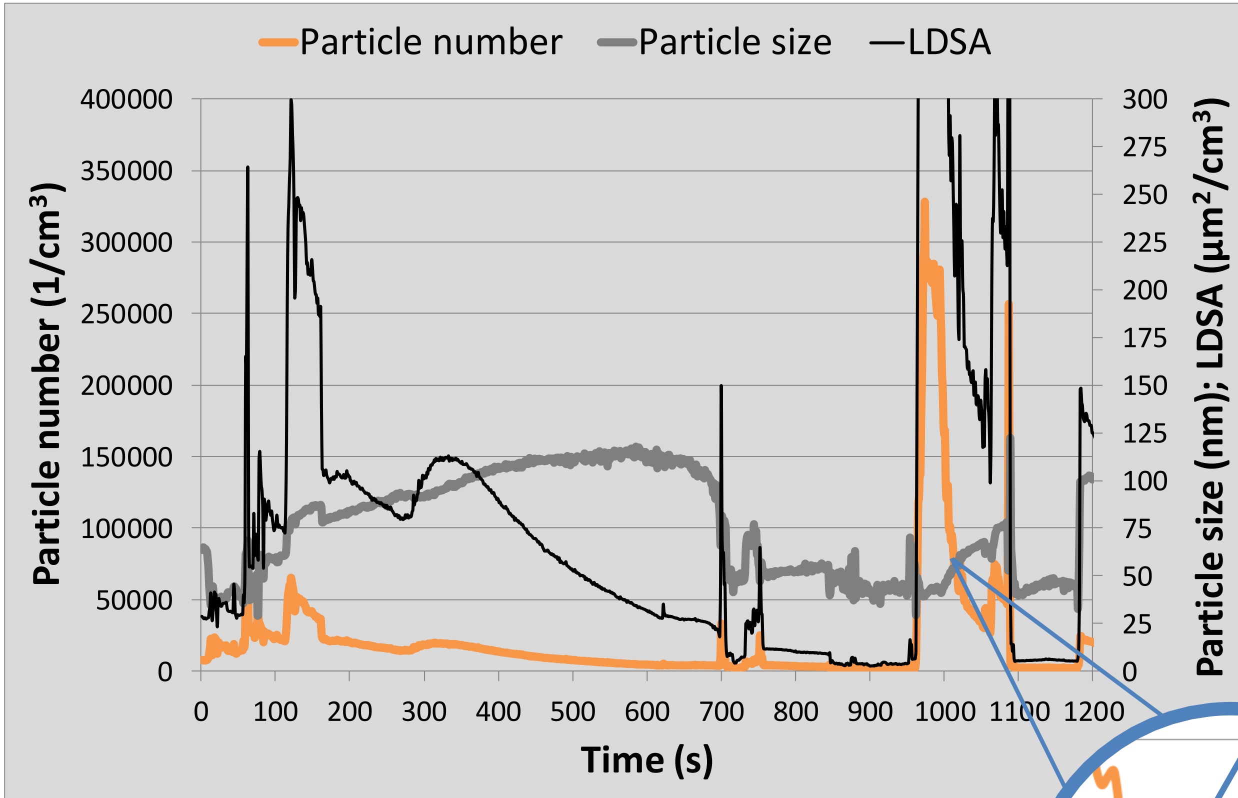
Average particle diameter [nm]

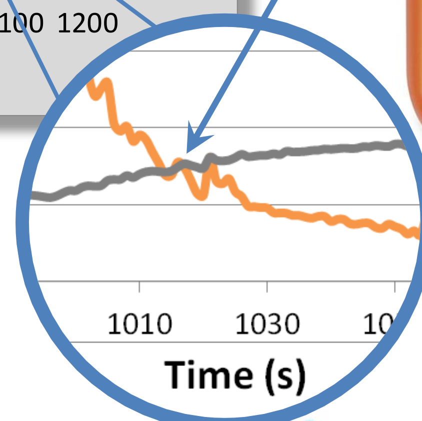
Press to display lung-deposited surface area concentration (alveolar)

Battery life for 8 h of mobile measuring

Easy recording on «Secure Digital Memorycard»

Performance: particle characterization

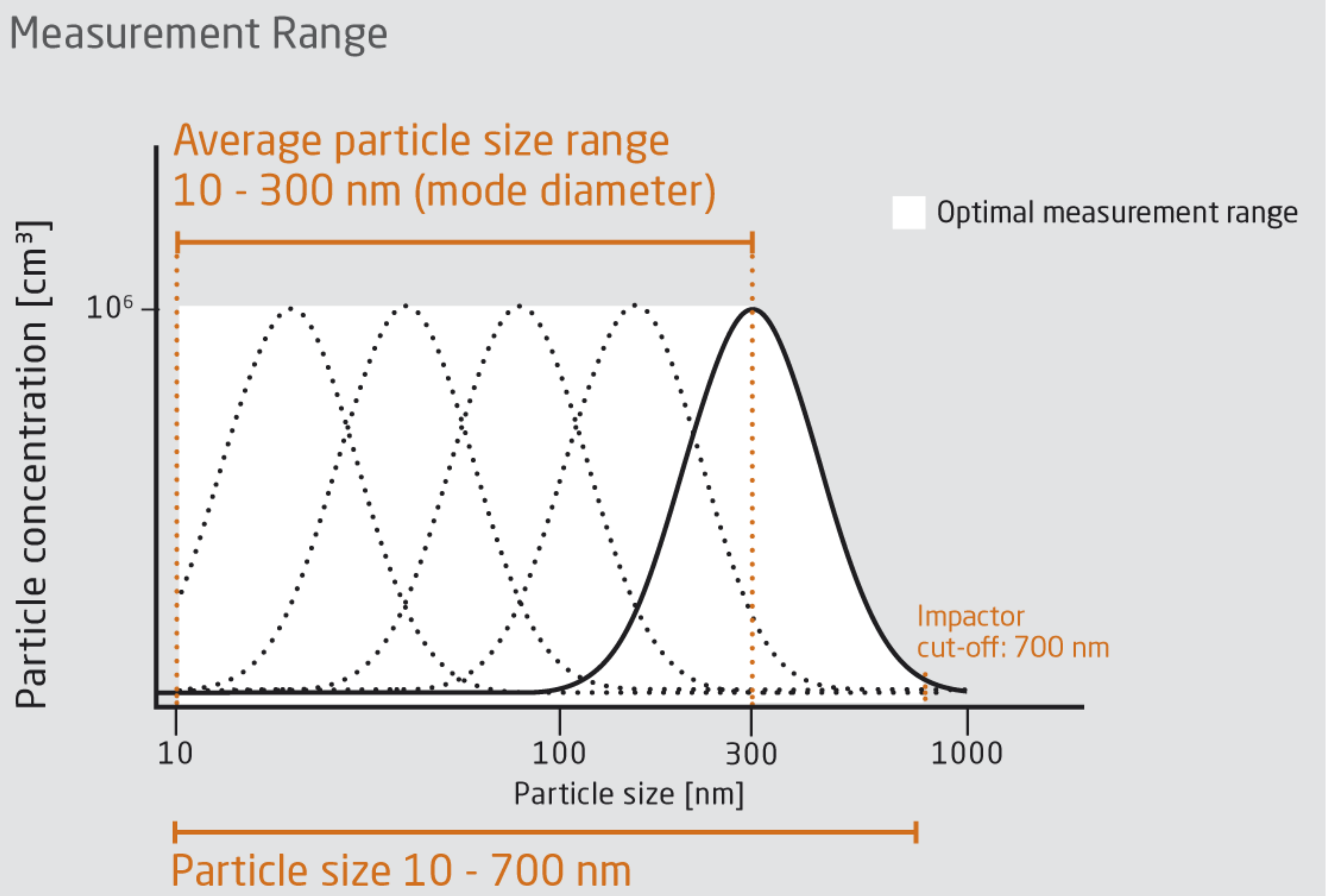




testo DiSCmini features:

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

Performance: measurement range



Detection limits: average diameter: ~10 - 300 nm (mode diameter)
particle number: $\sim 10^3 - 10^6$ pt/ccm

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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/cm³)	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 Ragettli, Harish C. Phuleria, Charlotte Braun-Fahrländer, Elisabetta Corradi, Christian Schindler, Mark Davey, Nino Künzli

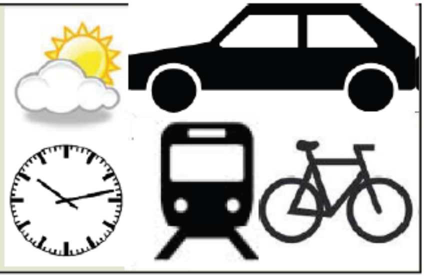
Application #1: Air quality monitoring

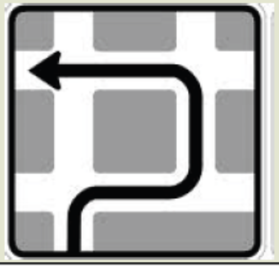
Swiss TPH

Commute exposure to ultrafine particles: Areas of interest

Health effects & exposure assessments

Exposure determinants





Spatial exposure differences

Application #1: Air quality monitoring

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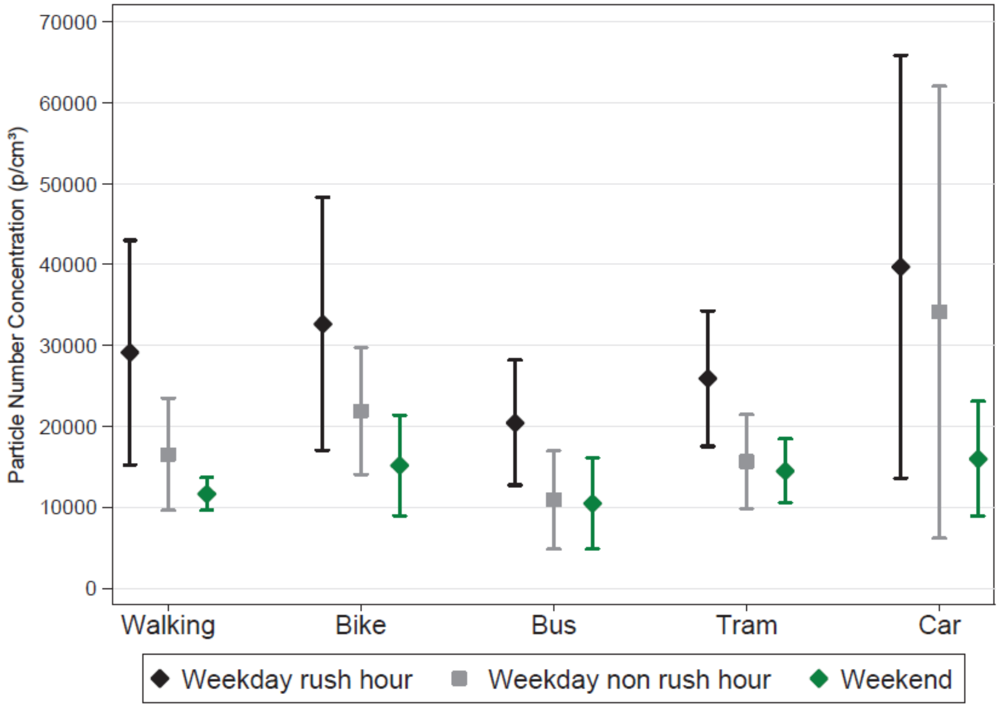
Swiss TPH

Particle Number Concentration by mode of transport & time of the day/week

(mean ± SD)



18 sampling days (6 weekends, 18 weekdays) in spring & fall 2011

275 trips, based on individual trip medians

Application #1: Air quality monitoring

Swiss TPH

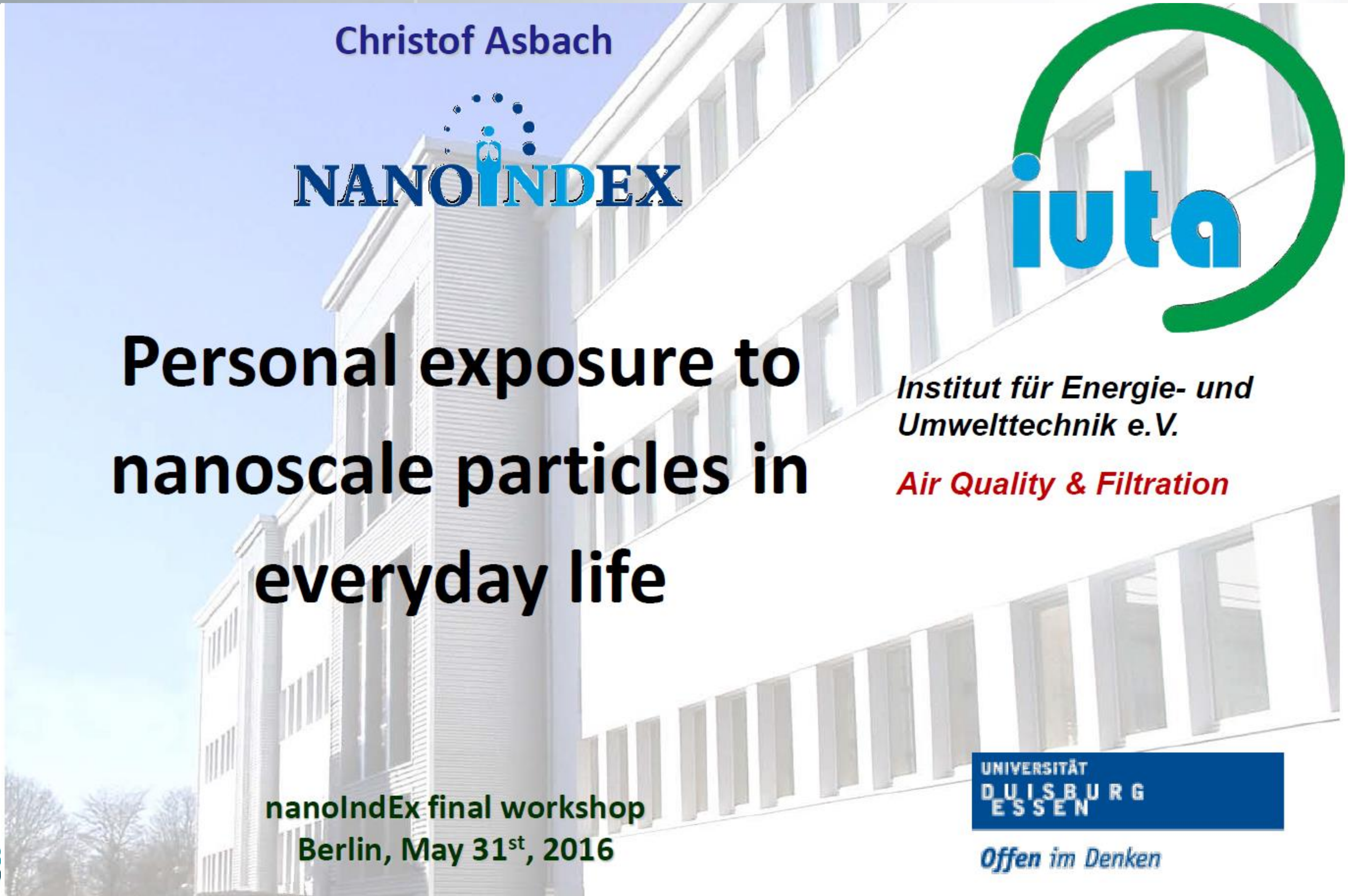
Our UFP measurements in Basel suggest…

- 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

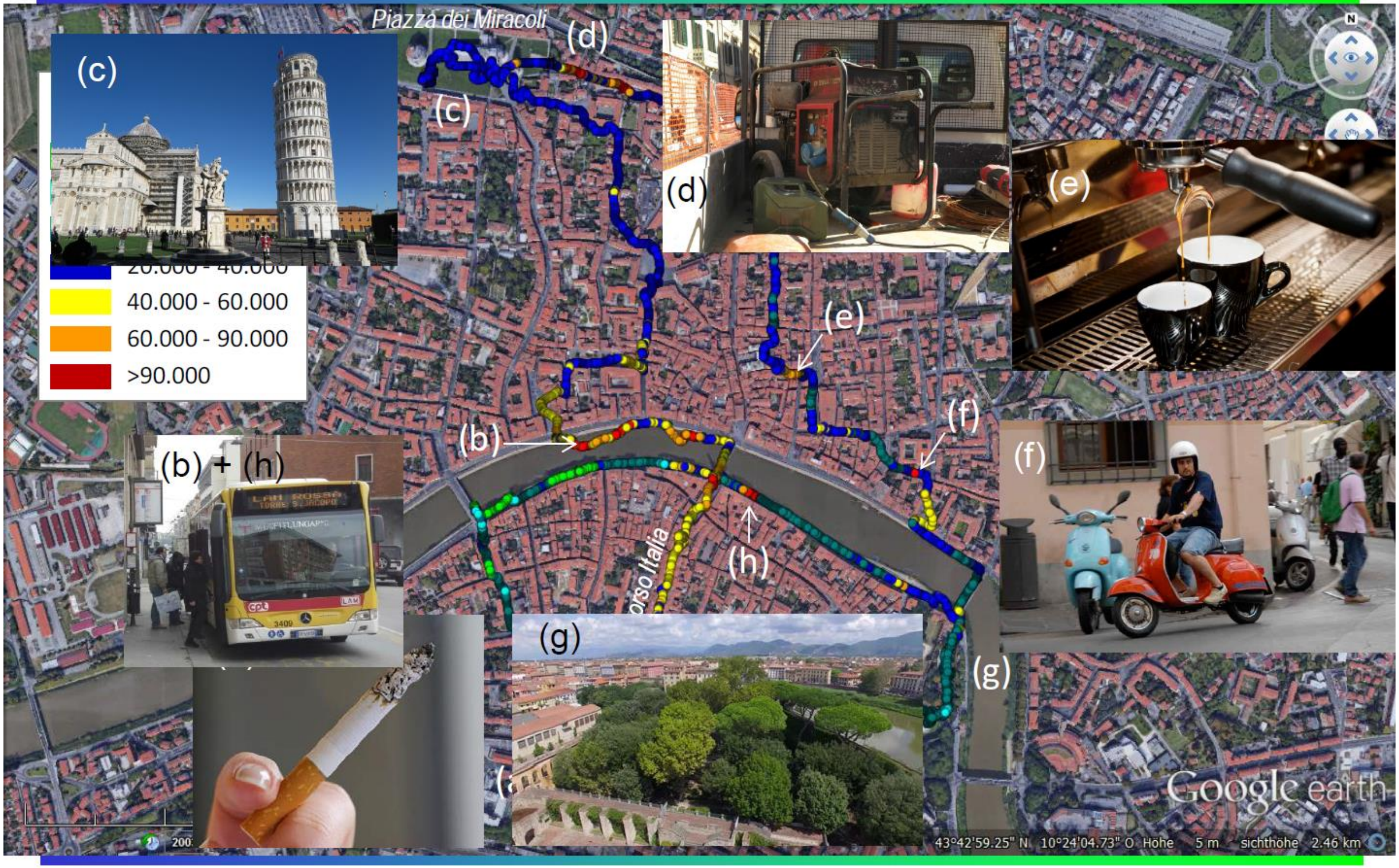
Application #2: Personal exposure



Application #2: Personal exposure

Sightseeing tour in Pisa

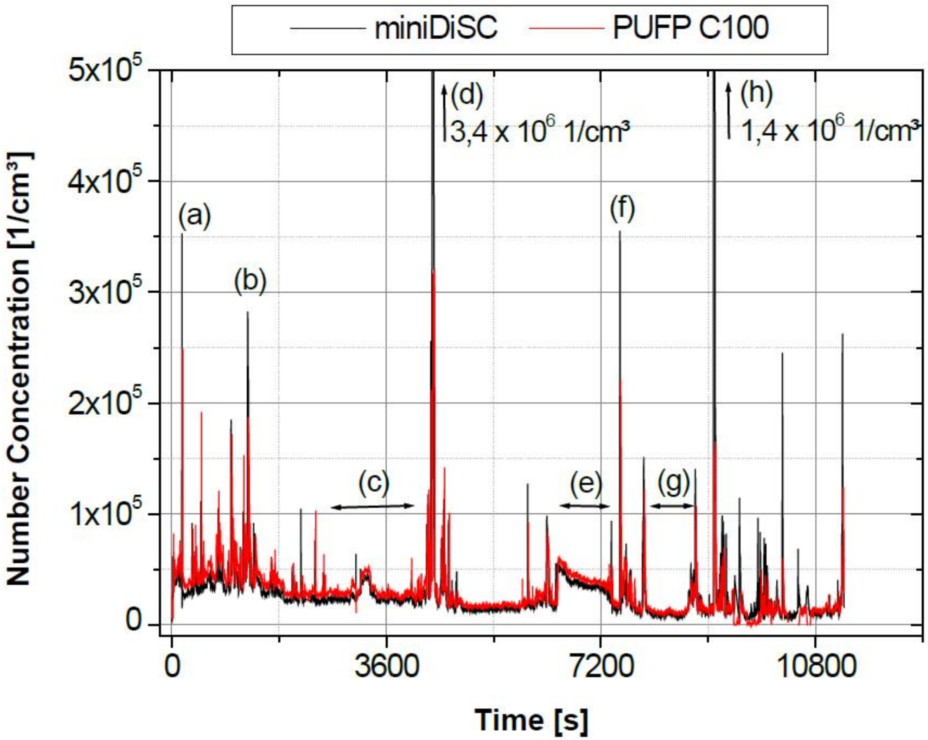
NANOINDEX iuta



Application #2: Personal exposure

Number concentrations in Pisa

NANOINDEX iuta



Piazza dei Miracoli

miniDiSC: 26,940 ± 6,570 1/cm³
PUFP C100: 33,000 ± 7,190 1/cm³

Giardino Scotto

miniDiSC: 9,230 ± 1,310 1/cm³
PUFP C100: 11,970 ± 1,580 1/cm³

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

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Field measurements in facilities manufacturing and processing ceramic materials

Mar Viana
IDAEA-CSIC
mar.viana@idaea.csic.es

CSIC
Consejo Superior de Investigaciones Científicas

Berlin, 31/05/2016
NanoIndEx Final Workshop

Application #3: Occupational exposure monitoring

CSIC

NP types

Manufactured (MNM)
Intentionally manufactured for commercial purposes (2011/696/EU; 1-100nm, >50%)

Process-generated (PGNP)
NPs emitted during highly energetic (thermal or mechanic) industrial processes

Background (BG)
- Natural origin (e.g., forest fires)
- Anthropogenic origin (e.g., diesel)




Application #3: Occupational exposure monitoring

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

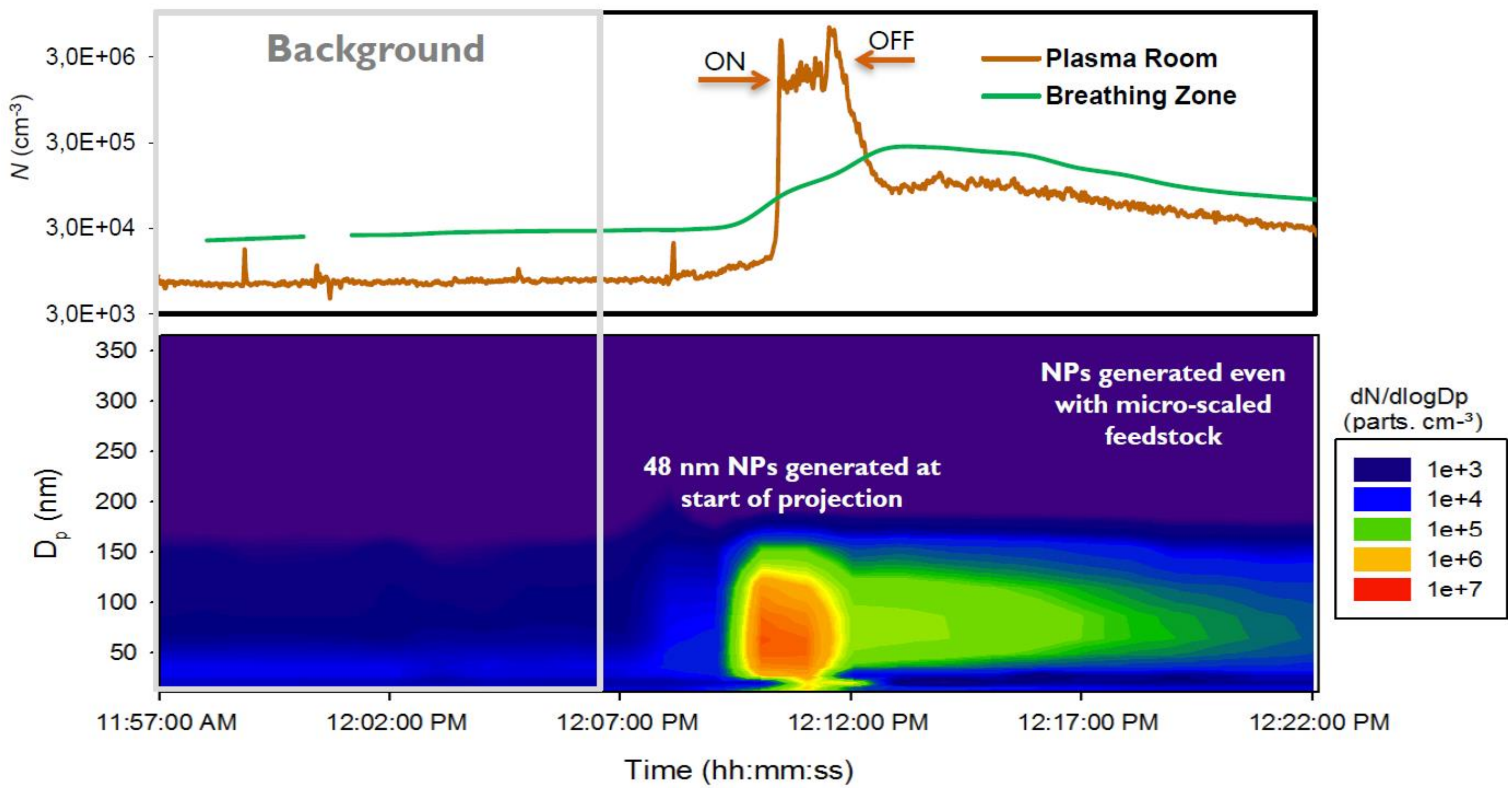
Metrics:

- Particle number
- Mass
- LDSA
- Mean diameter

Range: 5 nm – 20 µm

Results: plasma spraying

Feedstock: micro-suspension (ceramic glass powder <63 µm + 1% of fluidised nano 7 nm)



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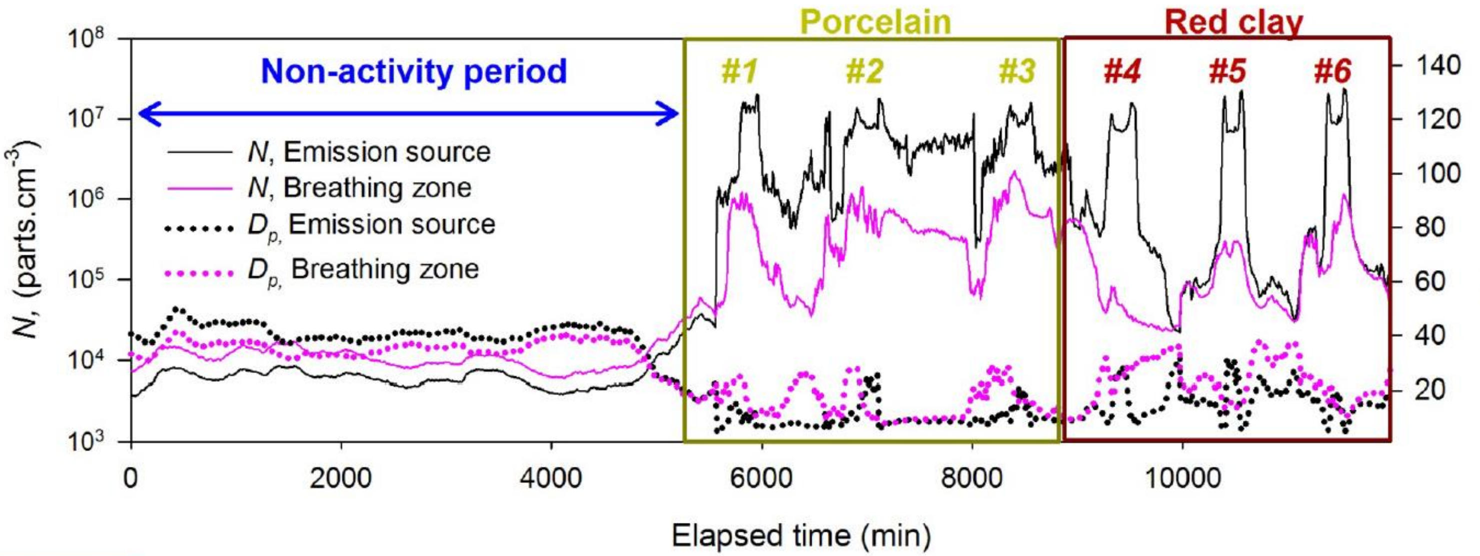
icma CSIC

Results: tile sintering



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

Application #3: Occupational exposure monitoring

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

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

Application #3: Occupational exposure monitoring

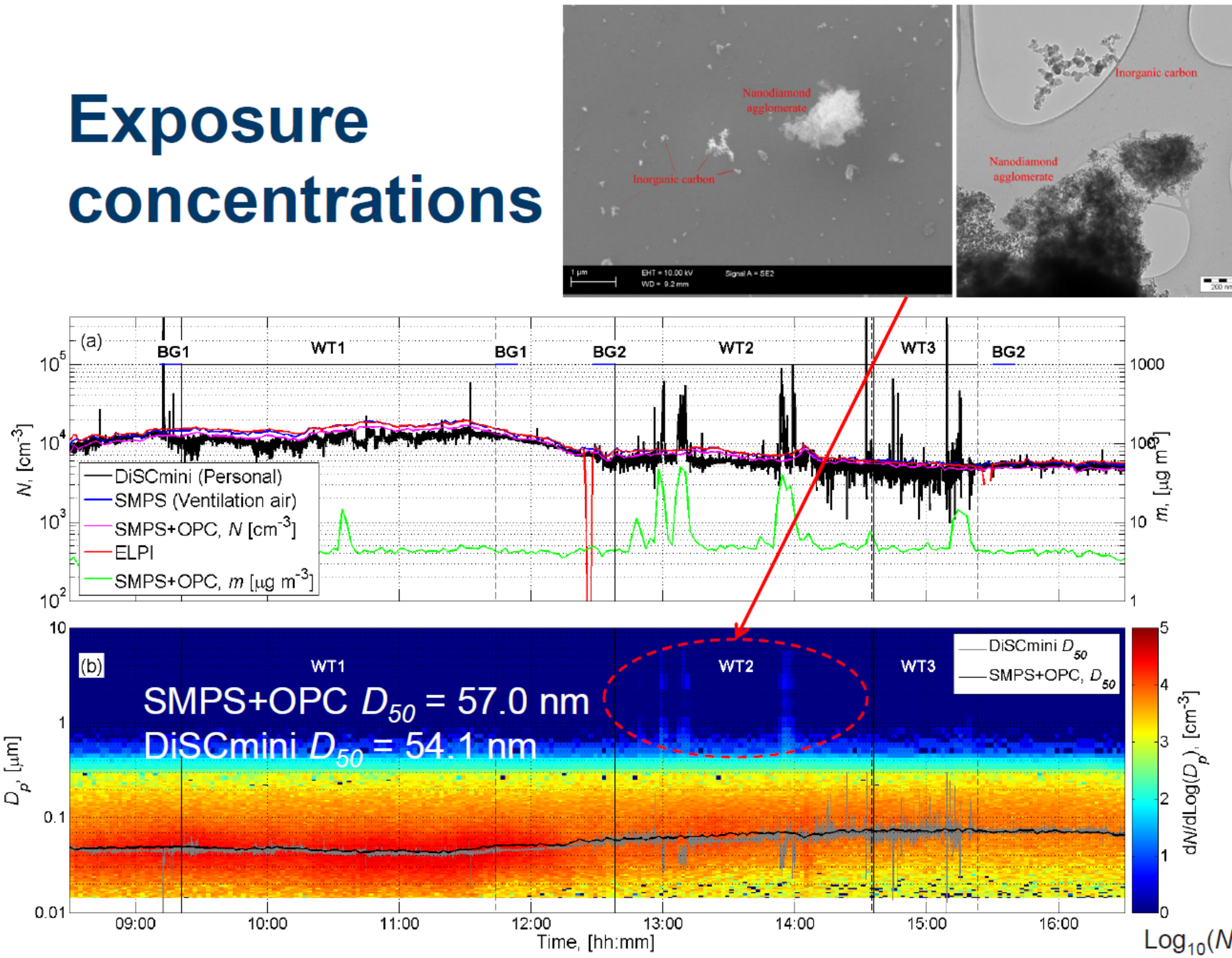
Exposure during handling and sieving nanodiamonds

Concentration measurements:

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

Application #3: Occupational exposure monitoring

Exposure concentrations

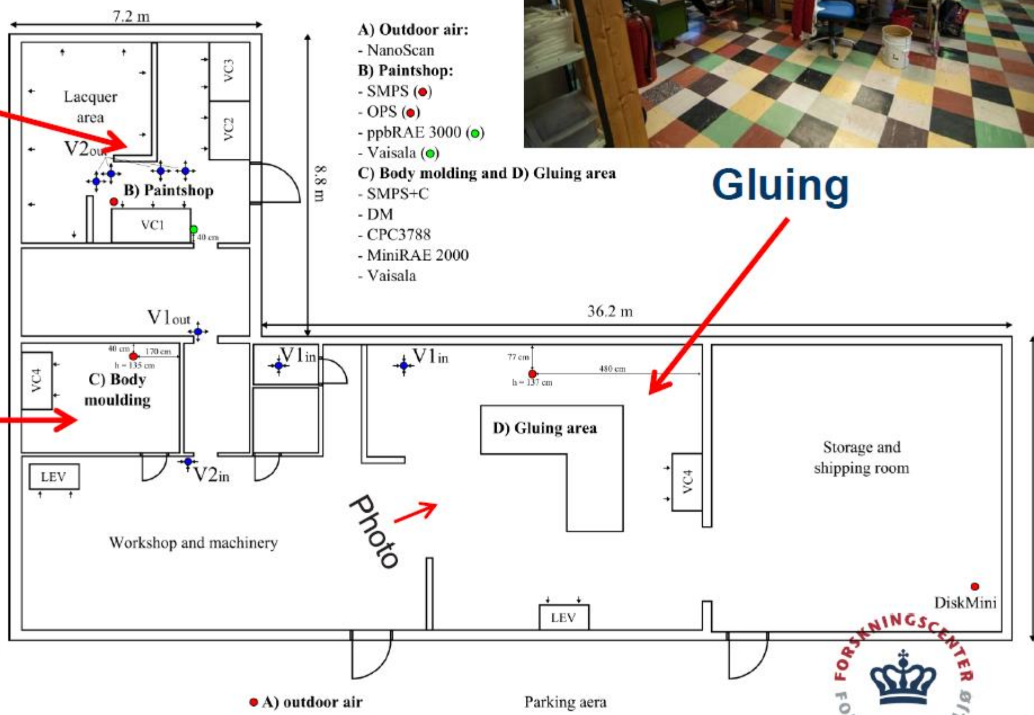


A handcraft workshop

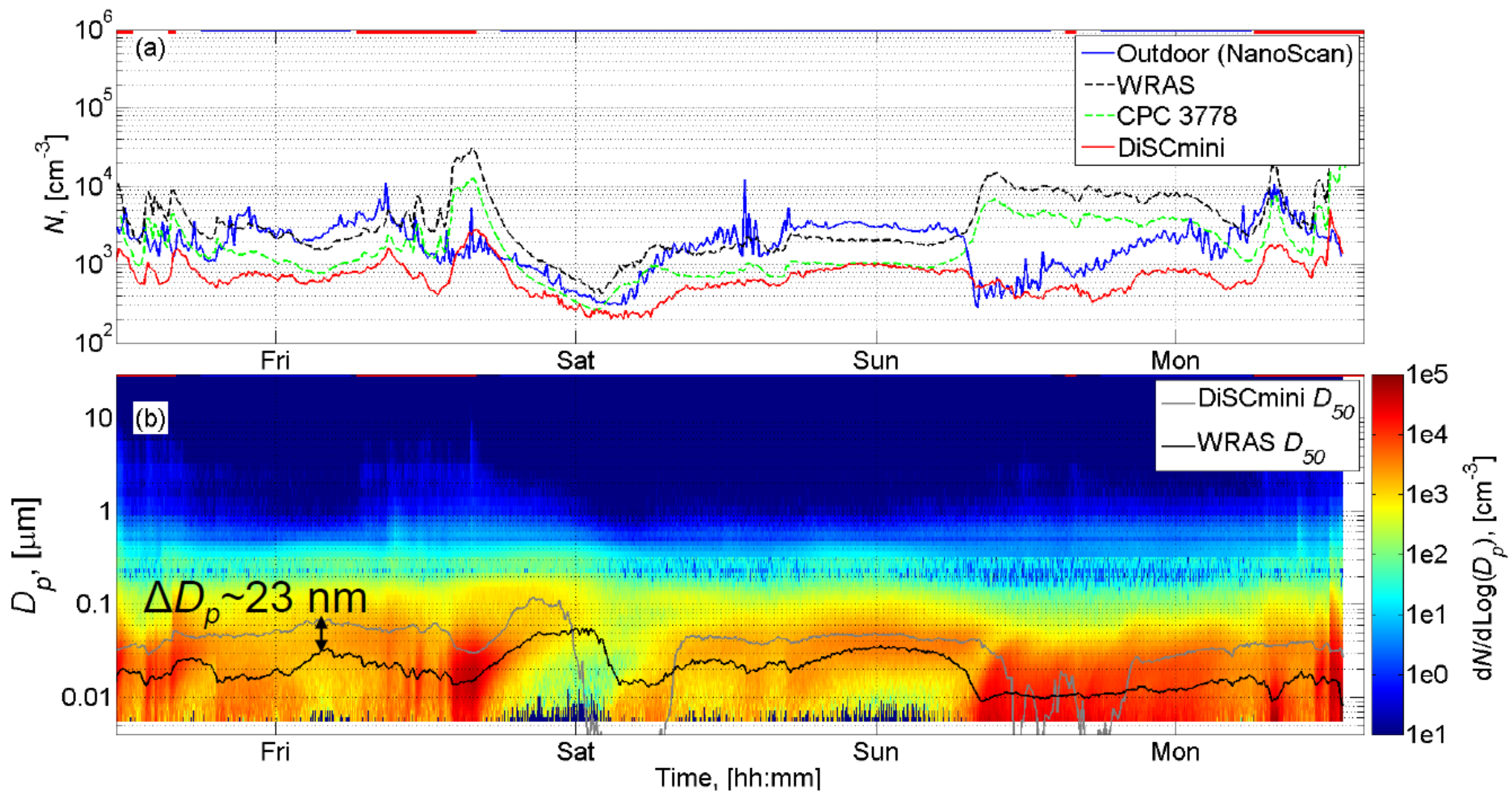
Spray painting

Polyurethane molding

Gluing

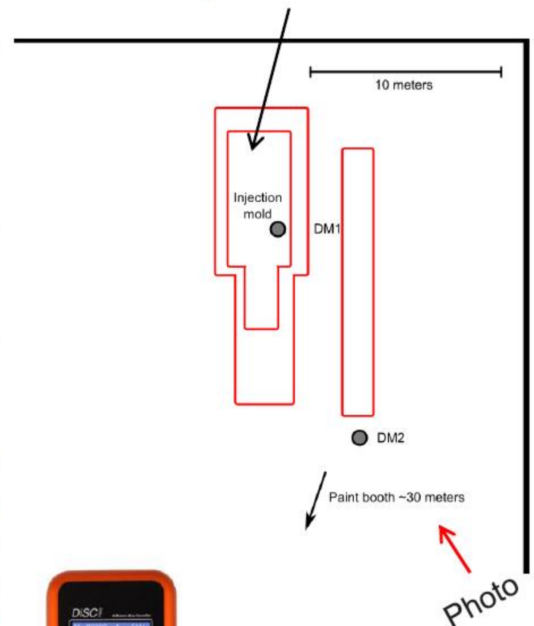


Concentrations in the gluing area



Injection molding of car bumpers

Engel 2500 tonnes injection molding machine:



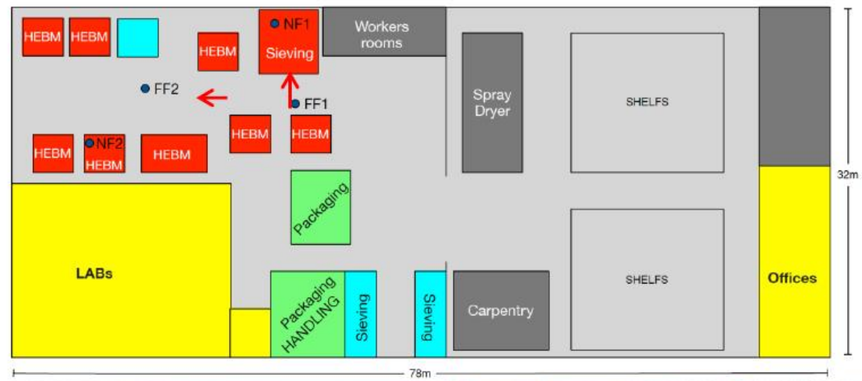
Instrumentation:

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

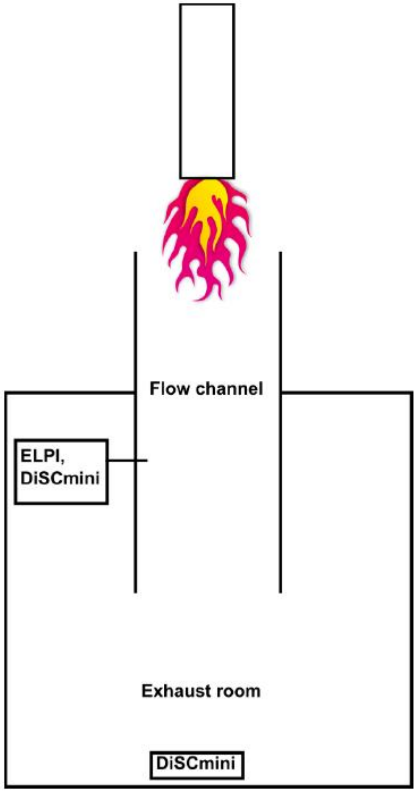
Application #3: Occupational exposure monitoring

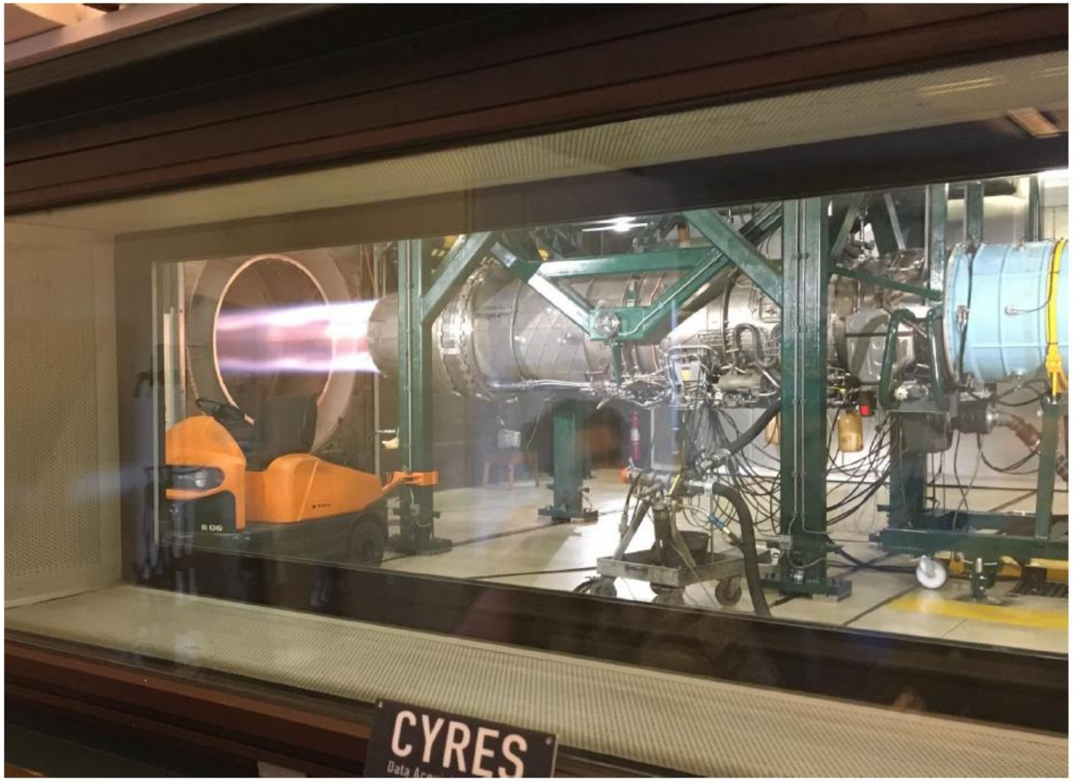
Tungsten carbide-cobalt (WoCCo) sieving and milling

Vibratory sieve shaker

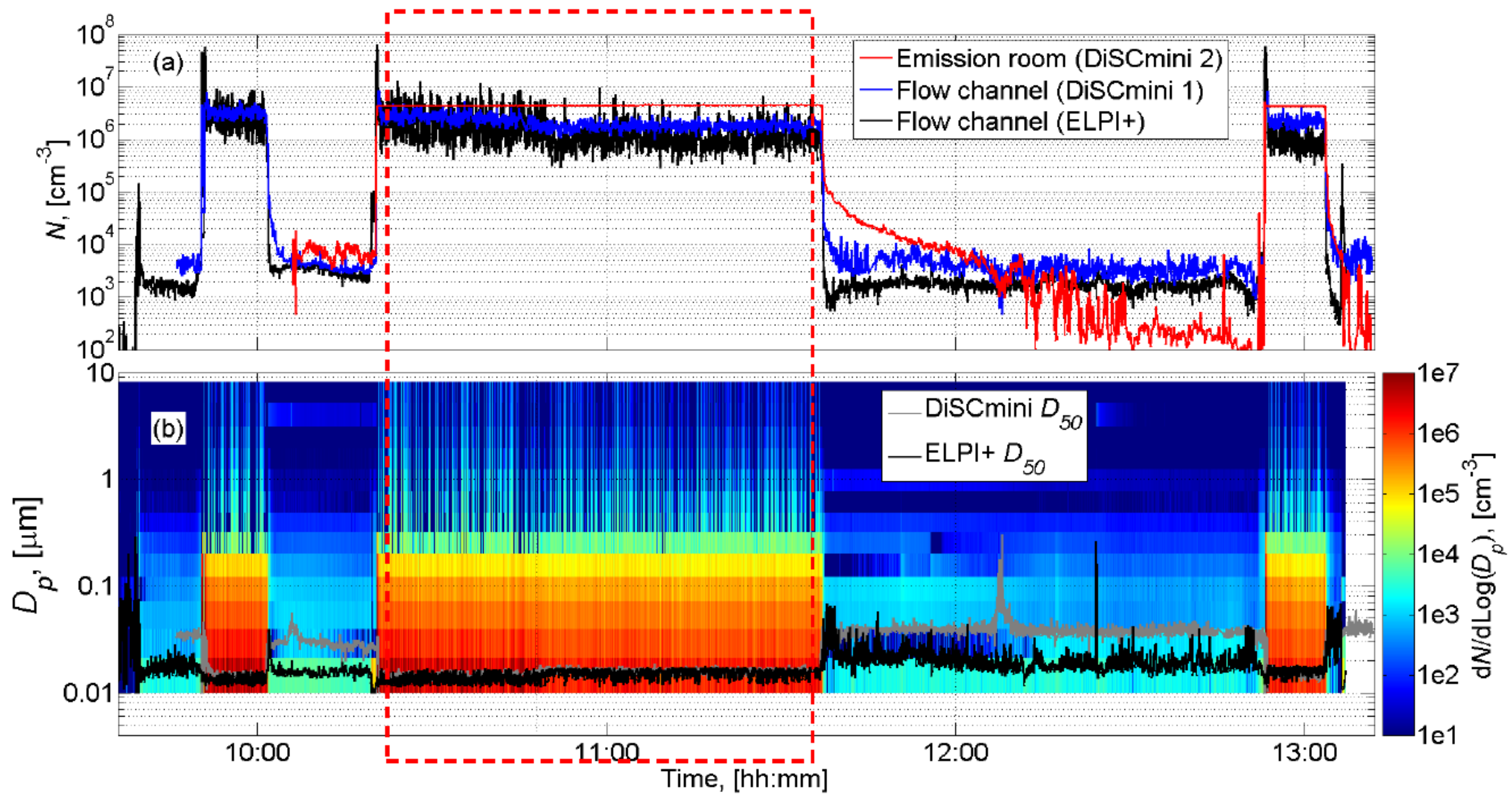


Jet engine emissions





Concentrations



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Thank you for your attention

Silvia López

+34 91 404 45 75

slopez@ioner.net

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