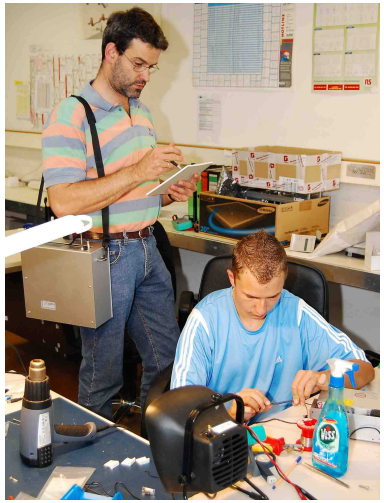
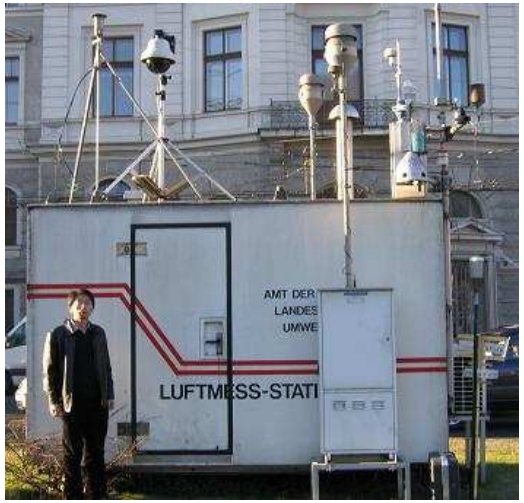
A fast measuring method for airborne nanoparticles





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Principle of the NanoCheck

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You can see it at the booth of ENVItech Bohemia s.r.o.

Problems of Nanoparticle Detection

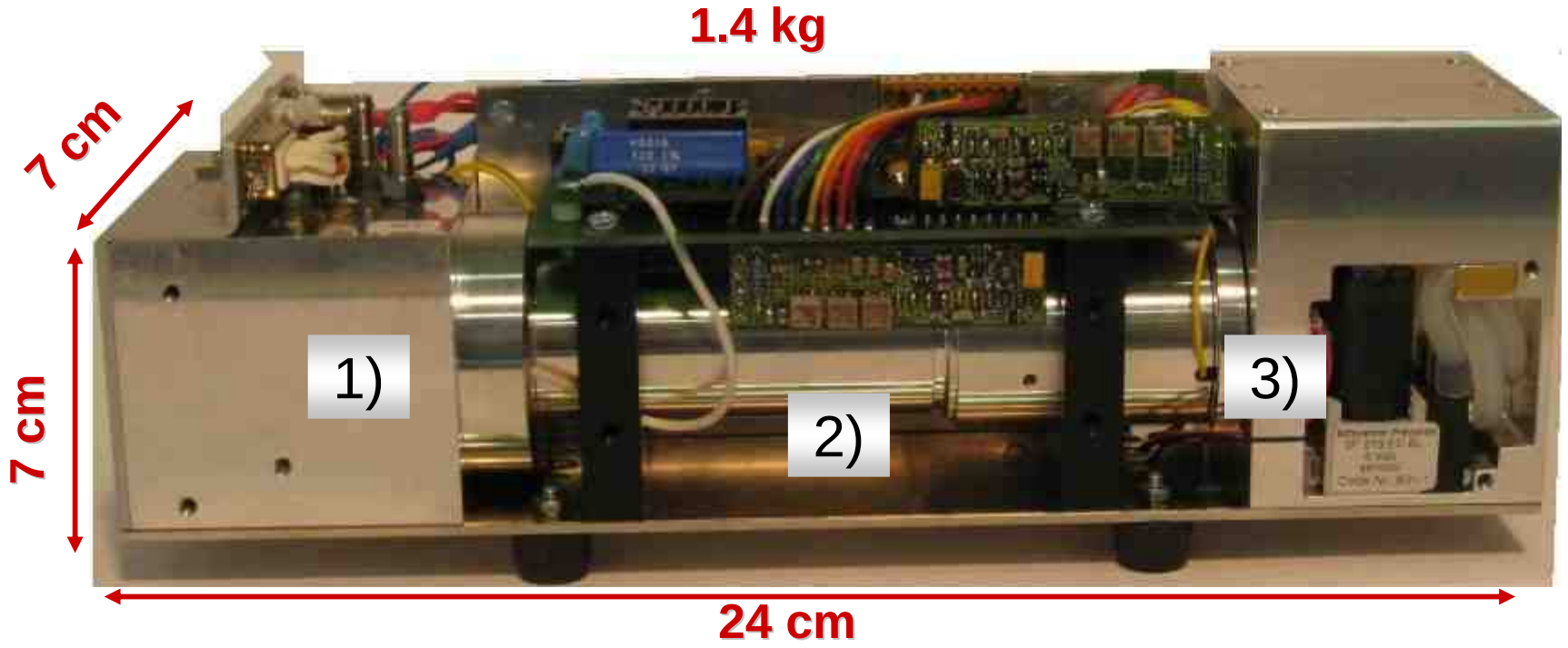
Intensity of scattered light decreases with the sixth power of the particle size => optical light scattering systems cannot detect particles below about 0.1 µm.

Nanoparticles contribute little to PM10 or PM 2.5 => Gravimetric techniques are inadequate to monitor Nanoparticles.

Established system with Condensation Particle Counters or Faraday Cup Electrometers for particle detection are rather large and expensive.

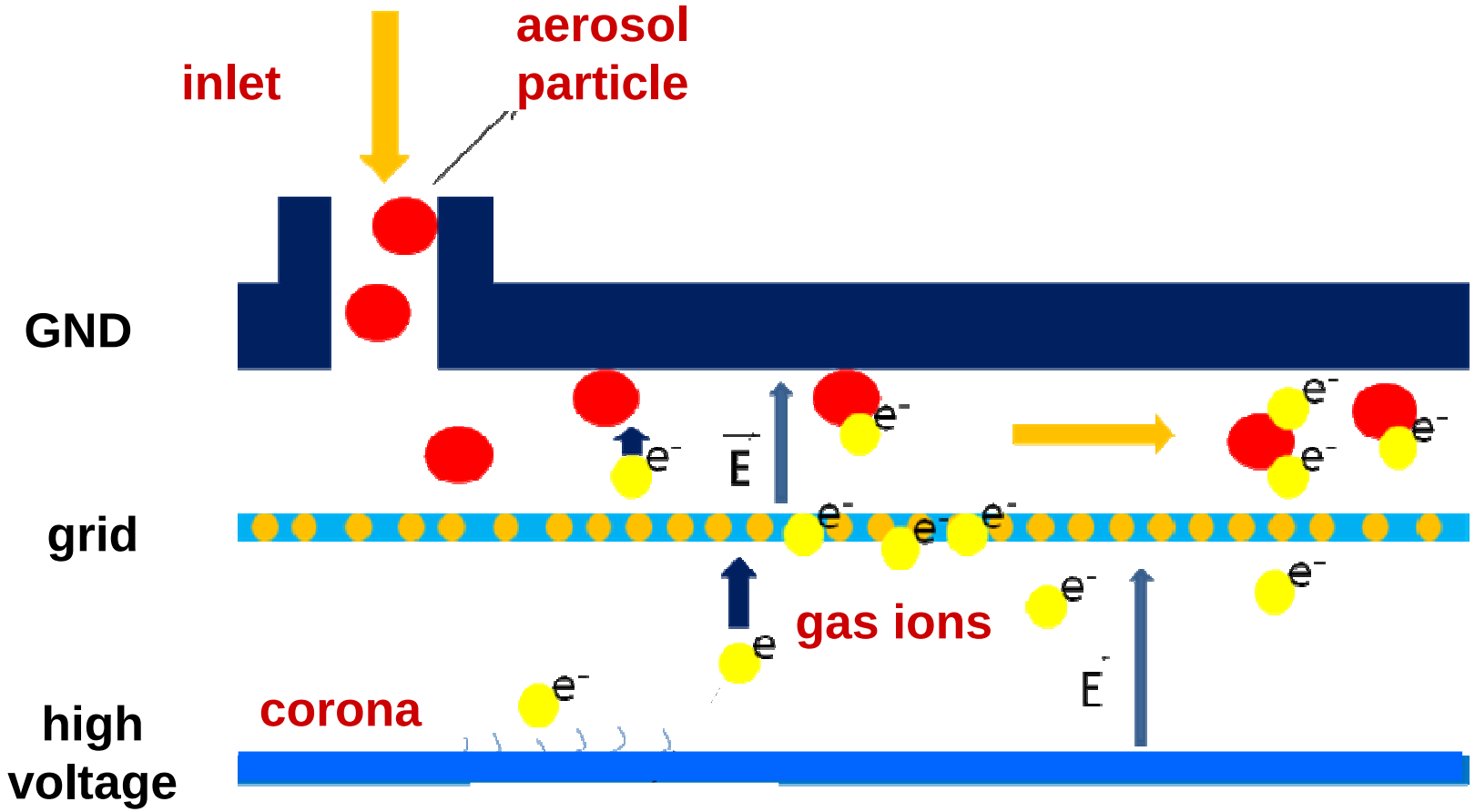
The three Elements of the NanoCheck

The system combines:

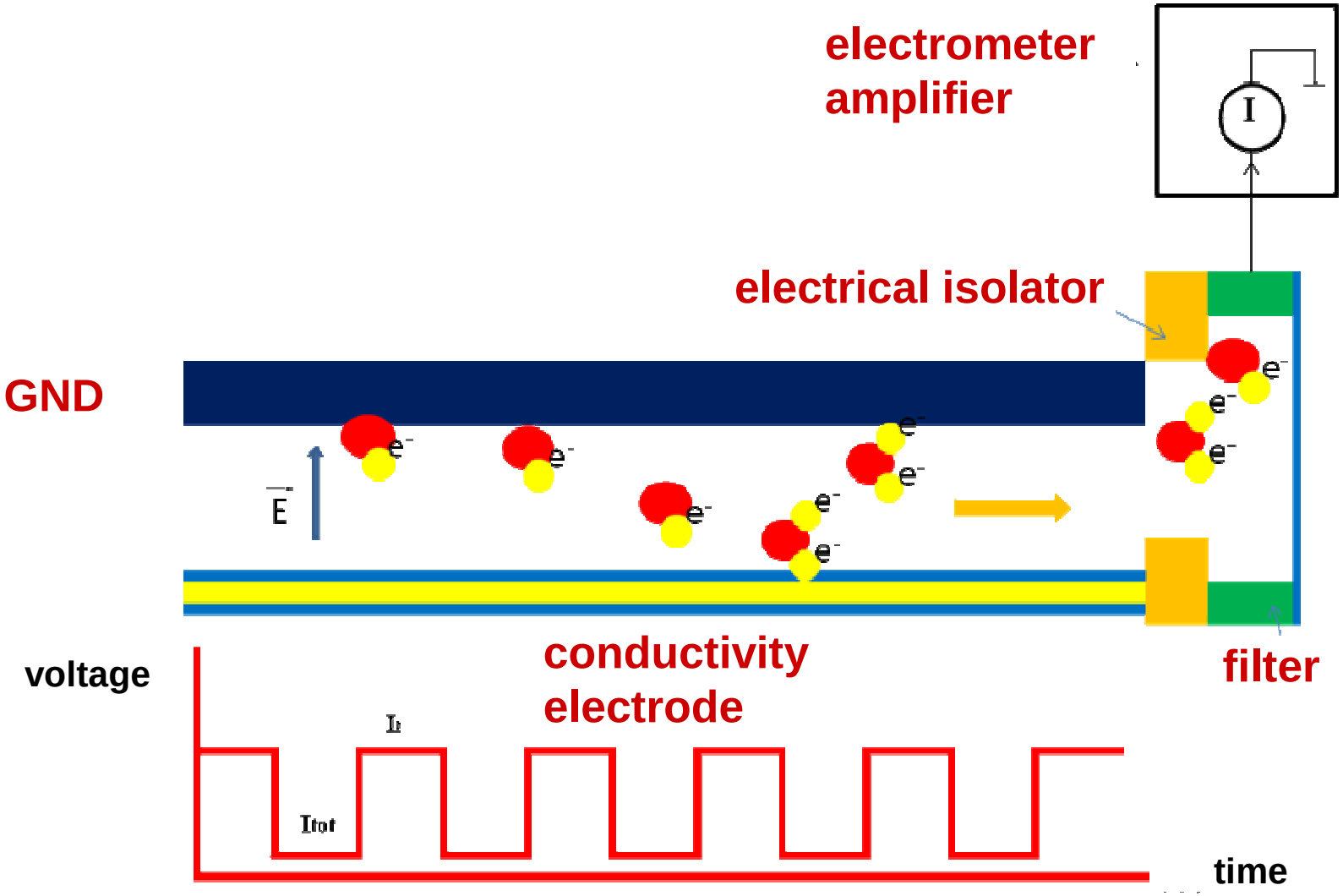


- 1) an unipolar electrical **diffusion charger**
- 2) a **condenser** with time multiplexed voltage
- 3) and a **faraday cup electrometer**

Element 1: Diffusion Charger



Element 2: Condenser



Element 3: Faraday Cup Electrometer

3) The faraday cup electrometer detects the charges carried by the aerosol particles. The raw signal is a current with and without conductivity electrode (I_{wE} and I_{tot}).

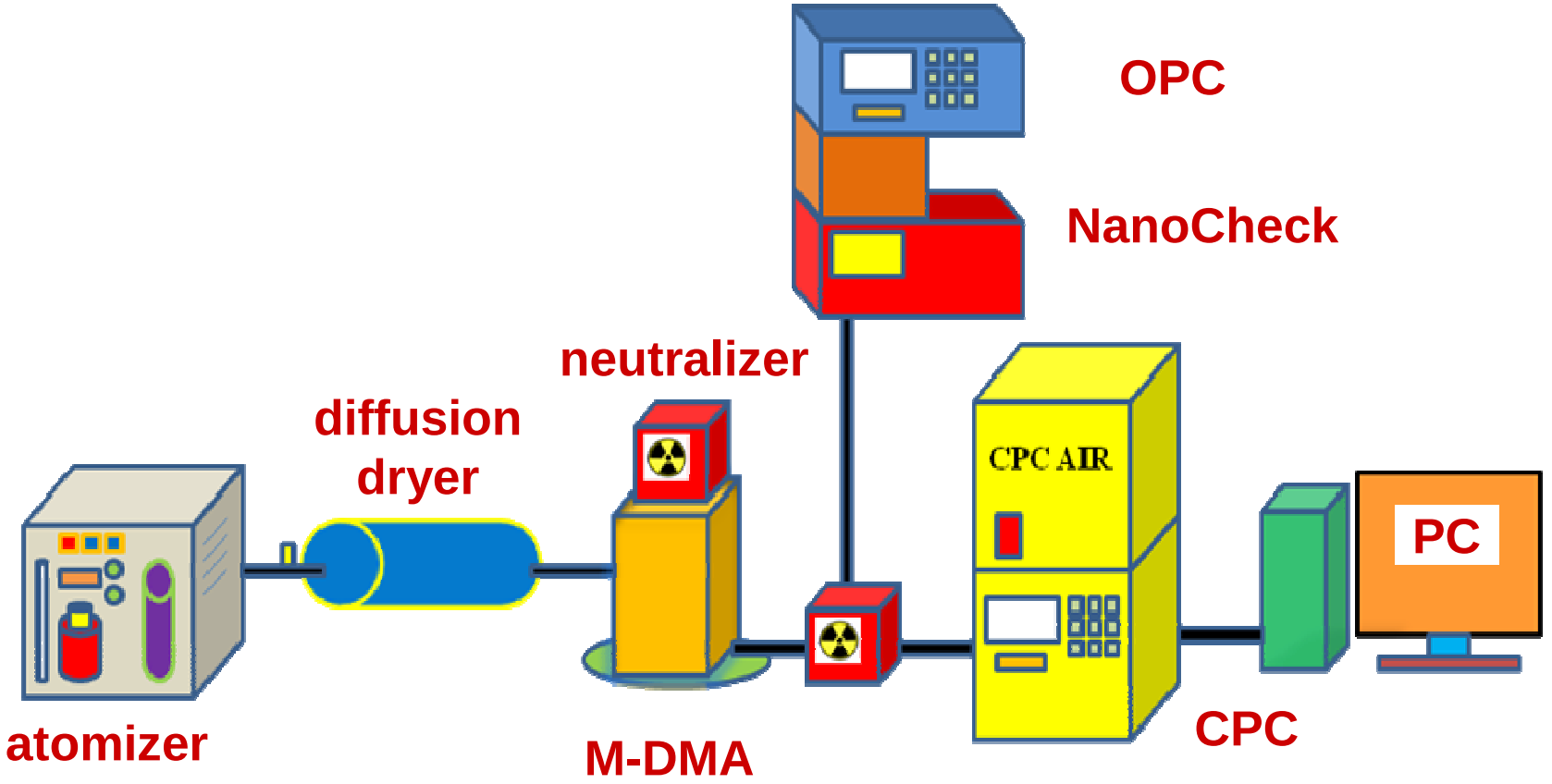
- 1) an unipolar electrical diffusion charger
- 2) a time multiplexed conductivity measurement
- 3) and a **faraday cup electrometer**

NanoCheck measures: (1) Total Number Conc., (2) Mean Particle Diameter

The NanoCheck measure two currents I_{tot} and I_{wE} sequentially, $\Delta I = I_{tot} - I_{wE}$ is calculated.

I_{tot} and ΔI are used to determine a **mean particle diameter Dp**. The Dp with the measured current I_{tot} is used to calculate also the **total particle number concentration N**.

NanoCheck™ calibration setup



Aerosol generator 7.811, NaCl 1mg/10ml and 10mg/10ml with **Diffusion dryer**
M-DMA with **neutralizer** and DMA controler to generate mono disperse fractions
Nano Check with OPC and **CPC** for reference counter
PC for data logging

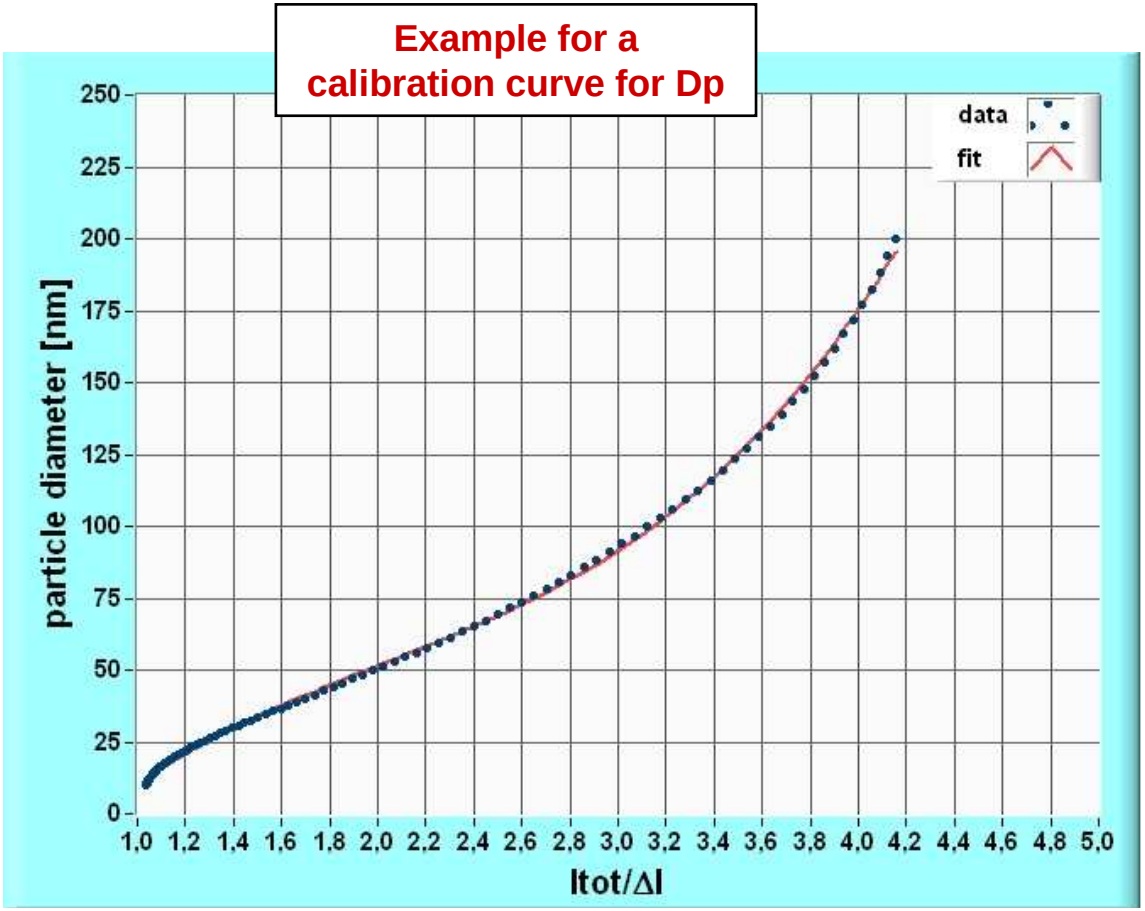
Calibration for Particle Diameter

The ratio $I_{tot}/\Delta I$ delivers the information to determine the **particle diameter**

$$d_p = function\left(k \frac{I_{tot}}{\Delta I}\right)$$

By calibrating the system with known mono-disperse particle sizes (d_p and σ), I_{tot} and ΔI are determined. The result is a relation $I_{tot}/\Delta I$ vs. d_p.

k is defined by the hardware settings, e.g. voltage of conductivity electrode, sensor geometry, particle distribution.

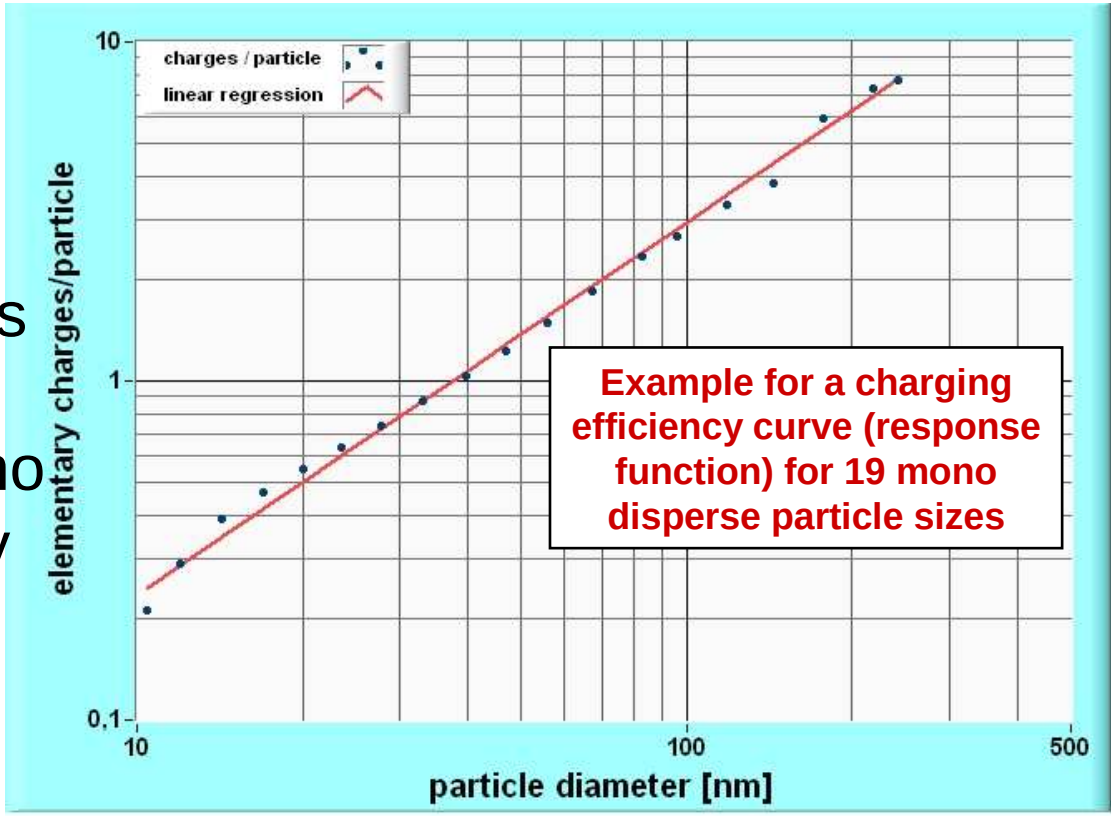


Calibration for Number Concentration

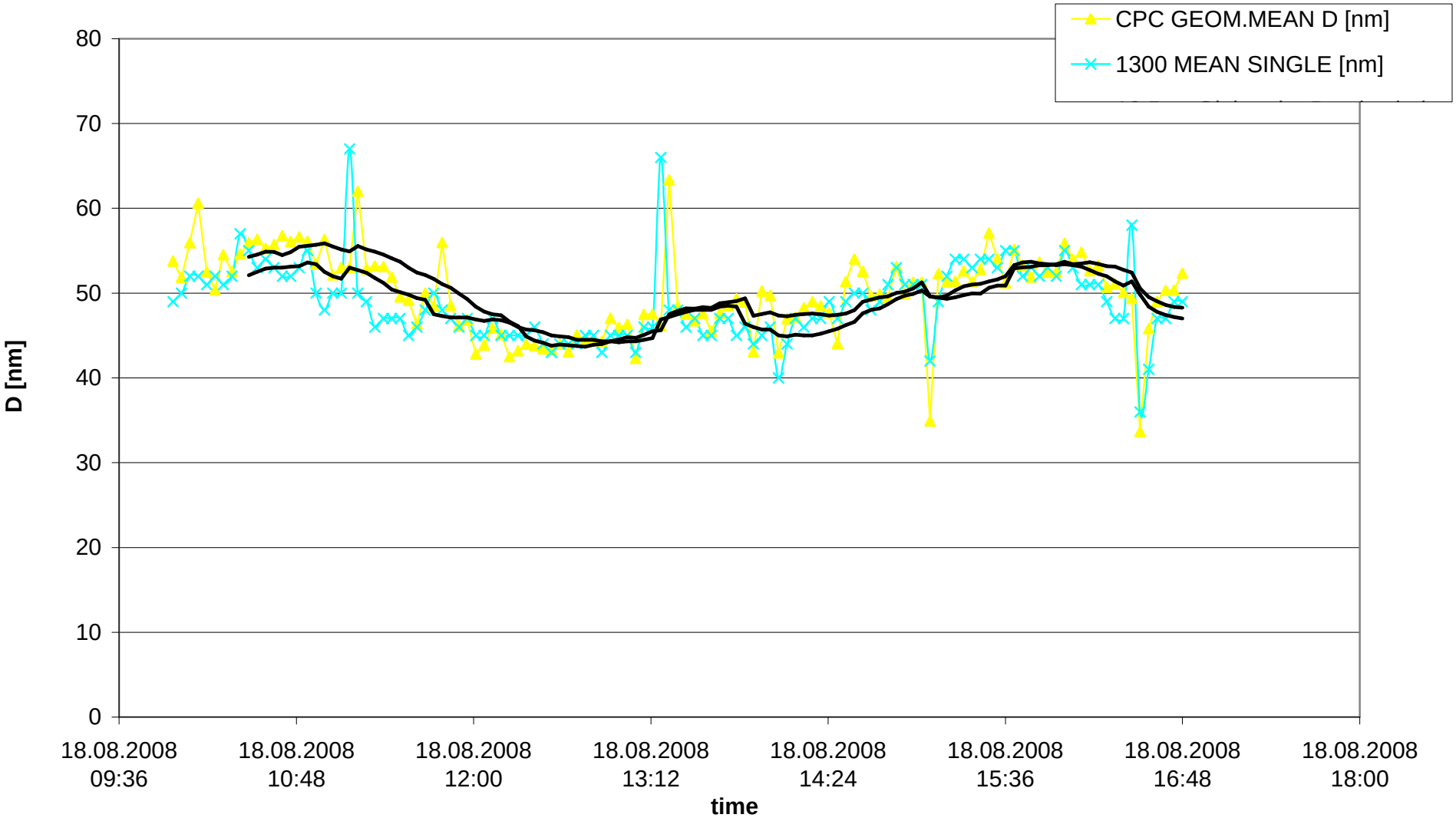
By knowing the characteristics of the diffusion charger and the particle diameter the **particle concentration** can be determined:

$$N = c \frac{I_{tot}}{d_p^{\alpha}}$$

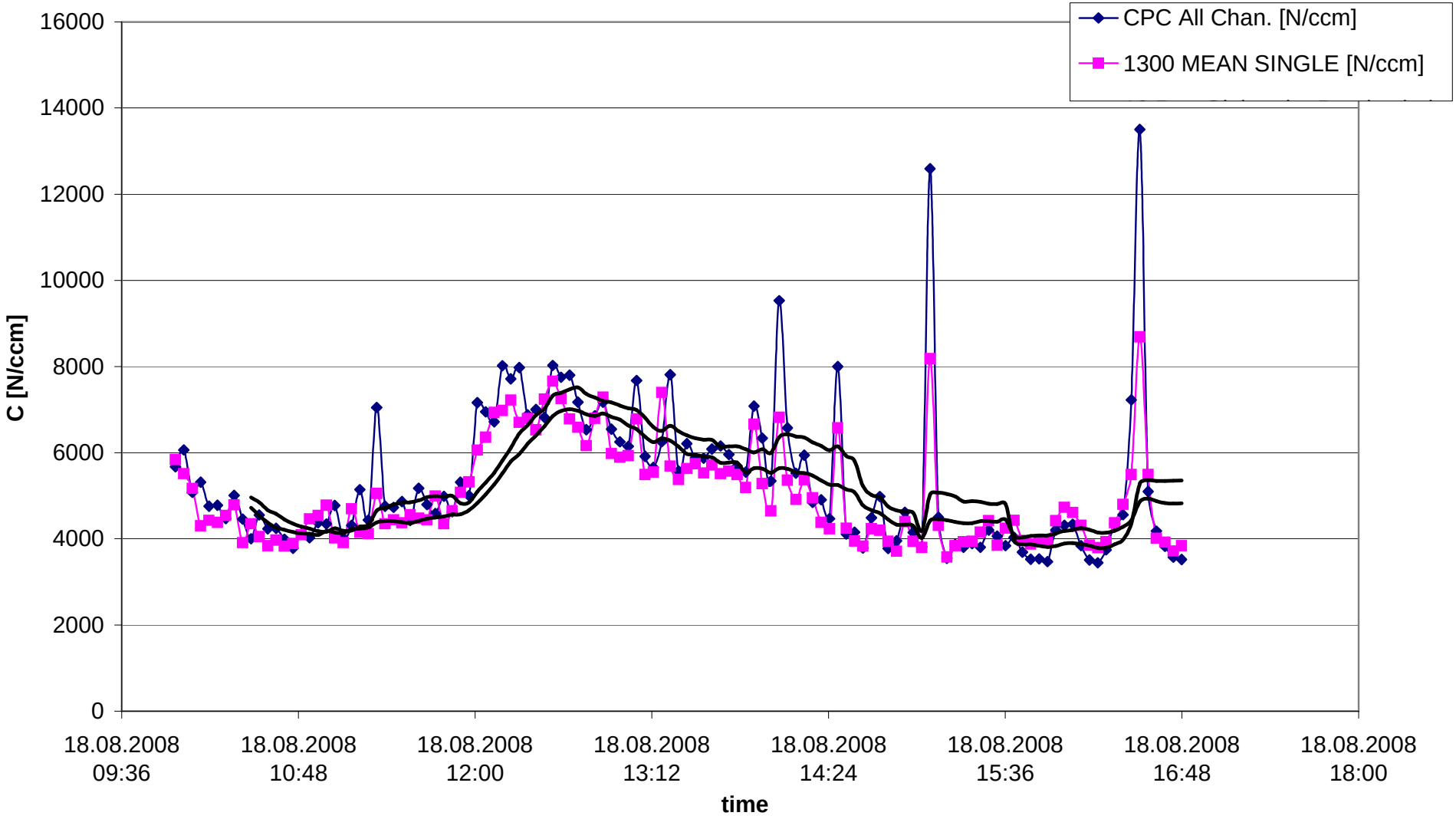
The parameter α describes the mean number of charges per particle, $q \sim d^{\alpha}$.
It is determined with 19 mono disperse calibration sizes by opearting the Nanocheck in parallel with a CPC.



Validation of measured Diameters: NanoCheck vs. SMPS+C



Validation of measured Concentration: NanoCheck vs. SMPS+C



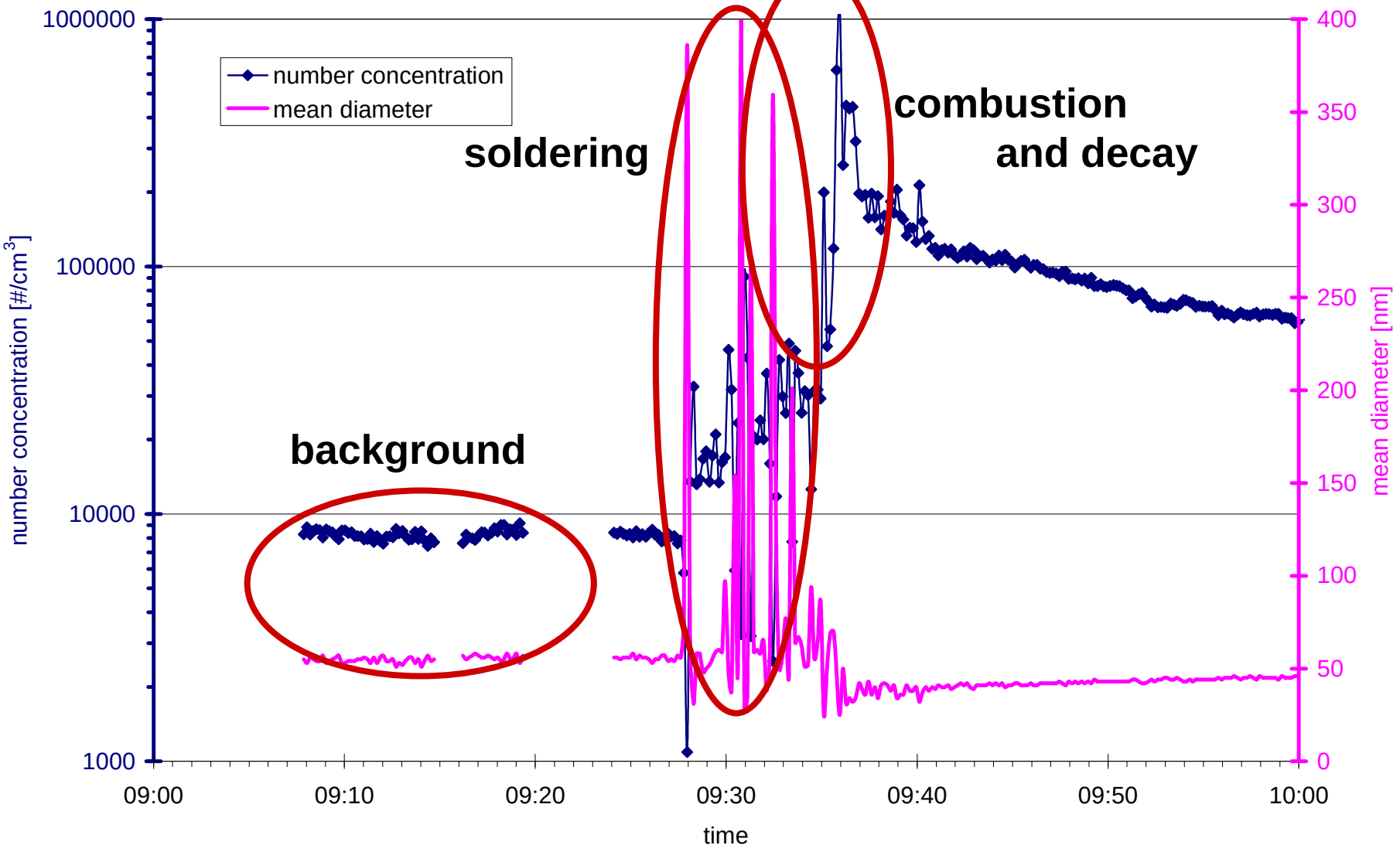
Applications (1): Mobile Indoor Measurements

The Nanocheck can be operated with any Grimm optical Aerosol Spectrometer (Type 1.108/1.109) to determine number-, surface-, and mass distributions from 30 nm to 30 µm, as well as occupational mass fractions according to EN 481 (inhalable, thoracic and alveolic)

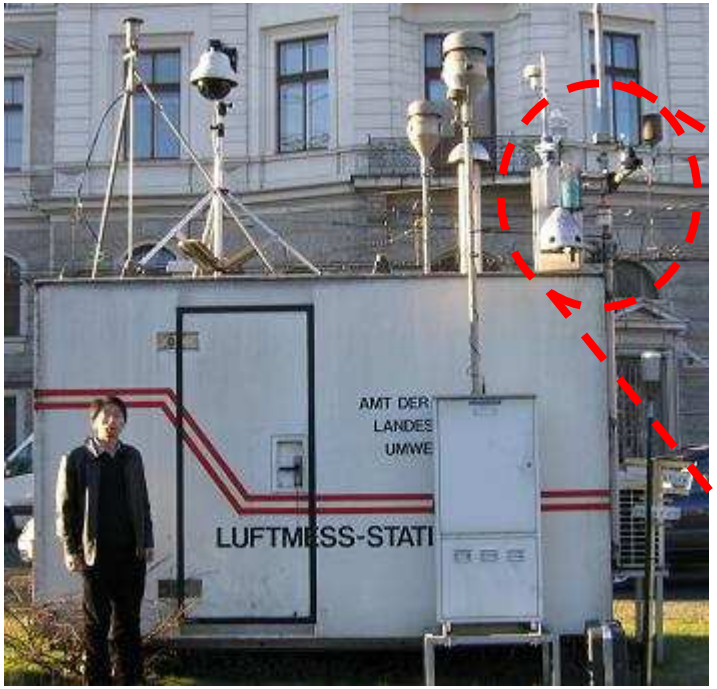
The NanoCheck model 1.320 is a European patent application for **continuous nano particle counting** and simultaneous determination of the **mean particle diameter** of the nano particle size distribution.

Example: Monitoring of Nanoparticles at workplaces

Nanoparticle Exposure during Soldering

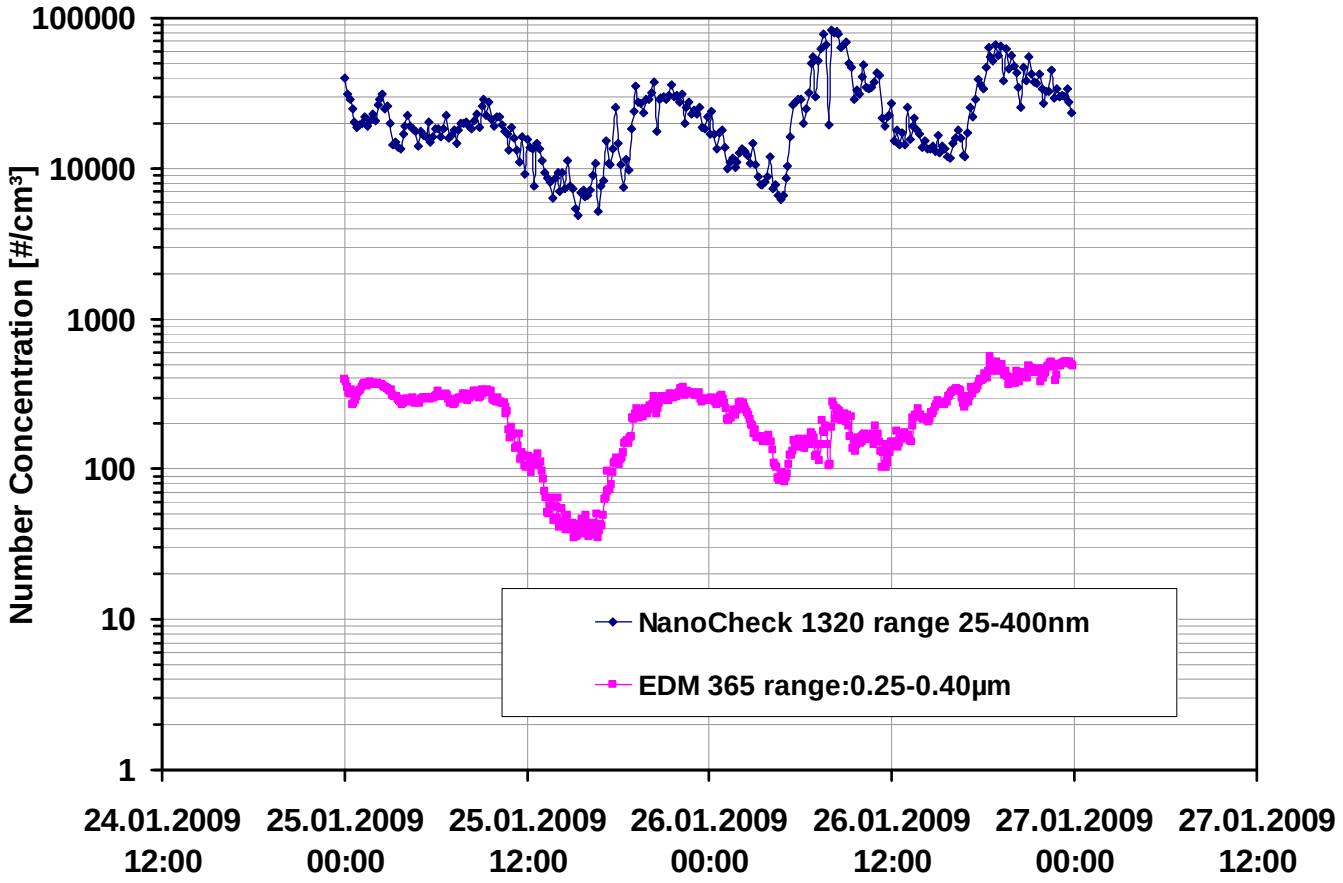


Applications (2): Outdoor Monitoring of Nanoparticles



Nanocheck

Nanoparticle Concentrations in Salzburg, Austria



Total number concentrations measured with the Nanocheck and optical aerosol spectrometer.

GRIMM-NanoCheck

- ✓ Determination of particle number-, surface-, volume- and mass distributions from 30 nm to 30 µm with a time resolution of 10s
- ✓ Occupational health monitoring (inhalable, thoracic and alveolic) according to EN 481
- ✓ Inhalation toxicology research
- ✓ Epidemiological research
- ✓ Production processes and workplace exposure monitoring
- ✓ Portable personal exposure monitoring for nanoparticles with support kit model 1300HLX

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