Challenges and Applications of Particle Measurement Technology

The challenges and applications of particle measurement technologies clearly specified over the last few years and with it the demands of the used technology. While formerly it was basically only about monitoring airborne particles it nowadays became more and more important to determine the causes of the particle exposure. This knowledge is essential when effective steps against particle exposure have to be initiated.

GRIMM’s spectrometer line complies with following important demands of modern particle measurement technology:

- Simultaneous information about particle number, size, and mass
- Apportionment of the particle mass in single particle mass fractions
- Measurements with a high temporal resolution (few seconds)
- Reliable technology with very low maintenance
- High sensitivity and low detection limits

Typical applications of the GRIMM aerosol spectrometers are:

- Indoor air quality
- Working places
- Industrial production facilities
- Emission monitoring
- Process gas monitoring
- Aerosol research
- Cause analysis

World’s Most Popular Portable
31 Channel Airborne Particle Counter
and Respective Mass Sizers
with Integrated Sampling Filter

30 years of scientific experience & research
TAKE THE BEST - FORGET THE REST
**Applications:**
- Monitoring of: Workplaces, Production Filters, Product control
- All types of aerosol research
- Measuring oil mist and droplets at machines
- Filter efficiency tests
- Inhalation studies
- Characterization of Nano structured materials

**Advantages:**
- Real-time sampling
- 8h battery capacity
- 11 channels <1μm
- Data output as mass fraction, count concentration
- Sample collection on detachable PTFE filter
- Wireless data transmission
- Portable with battery; total weight 2.4 kg
- Simple operation

**Monitoring of:**
- Workplaces
- Production Filters
- Product control

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**Mass size distribution**

**High-resolution aerosol measurement featuring Dual Technology**

This proven portable aerosol spectrometer model 1109 measures airborne particles in sizes ranging from 0.25 μm to 32 μm in 31 different size channels in real-time and supplies these values as particle number concentration and particle mass. The 1109 is a robust, compact, and extremely universal instrument providing precise data.

The classic basic model 1108 offers 15 size channels capturing particles within size ranges 0.3 μm to 20 μm.

All measured particles are collected on a detachable 47 mm PTFE filter inside the instrument (Dual Technology) and are thus available for further chemical, microscopic or gravimetric examinations.

As can be seen in the above picture, additional sensors to measure humidity, temperature, flow velocity and air pressure can be hooked up to the instrument. Special inlet probes permit a correct sampling of flowing gases and in technical applications.

All data are stored on a removable storage card and are available online via the RS-232 interface at all times.

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**Specifications**

**Nominal operation 1109 (and 1108)**
- Power supply: Battery 12V/2.1Ah, for 7 to 8 hours of continuous operation
- Power pack: 18 VAC 95-250V, 47-63 Hz, protection rating II (shock-proof)
- Frequency: 0 Hz, maximum current: 2.5 A
- Maximum operating height: 1000 m. Heights of up to 5000 m with volume flow control, adjustable via PC
- Temperature range: +4 to +40°C
- Storage and transport: -20 to +50°C
- Relative humidity: relative humidity < 95% (non-condensing)
- Storage and transport: relative humidity < 90% (non-condensing)
- Pressure range: <120 hPa, corresponding to approx. 1000m above sea level.

In case of excess pressure or longer measuring periods with high negative pressure, use the possibility of sample air return.

**Technical data 1109 (and 1108)**
- Laser: Wavelength: l = 655 nm (1109) or 780 nm (1108), respectively
- Power: Pmax = 40mW Pnom = 0.5/30 mW CW (Multiplex)
- Size channels [μm]
  - 1109: 31 channels: 0.25/ 0.28/ 0.3/ 0.35/ 0.4/ 0.45/ 0.5/ 0.58/ 0.65/ 0.7/ 0.8/ 1.0/ 1.3/ 1.6/ 2.0/ 2.5/ 3.0/ 3.5/ 4.0/ 5.0/ 6.5/ 7.5/ 8.5/ 10/ 12.5/ 15/ 17.5/ 20/ 22.5/ 30/ 32
  - 1108: 15 channels: 0.3/ 0.4/ 0.5/ 0.65/ 0.8/ 1.0/ 1.6/ 2/ 2.5/ 3/ 3.5/ 4/ 5/ 6.5/ 7.5/ 10/ 12.5/ 15/ 17.5/ 20/ 25/ 30/ 32
- Particle concentration: 1 to 2,000,000 particles/liter
- Particle mass: 0.1 μg/m³ to 100 mg/m³
- Reproducibility: ±3% across the entire measuring range
- Aerosol volume flow: 1.2 l/min ±5% constantly controlled
- Rinsing air volume flow: 0.3 l/min constantly controlled
- Automatic cleaning in the standby mode
- Sample collector: 47 mm circular filter made of PTFE (without backing fabric)
- Operation: Via touch (key) pad or PC (software or Hyper Terminal)
- LC display: 2 x 16 alphanumerical characters
- Self-test: Automatic, following each start
- Measuring intervals: configurable: 6 s standard (for all channels); optional 1 s
- Saving intervals: configurable: 1 s to 1 h in defined intervals
- Communication: Via PC and RS-232 interface and USB
- Data output: LC display: dust mass / particle count as moving average; alarm values: battery capacity, Gravimetric factor, measuring location no., date and time. Sensor values optionally available
- Analogous inputs: 3 (0-10V). Resolution 10 bits (approx. 10 mV)
- Dimensions L x W x H: 24 x 13 x 7 [cm]
- Weight: 2.4 kg
**NanoCheck Sensor**

**Sensor for ultrafine particles**

The NanoCheck sensor is an add-on to the spectrometer; it consists of a Faraday cup electrometer with a unipolar corona charger and a controlled conductivity cell. This sensor supplies number and size information of ultrafine particles. It is very stable, has no moving parts and is designed for mobile use which makes it possible now to measure the entire aerosol in the air with one portable system.

**NanoCheck 1320**

In order to be able to measure ultrafine particles, the NanoCheck sensor 1320 offers an expansion of the measuring spectrum from 25 nm up to 250 nm giving mean particle diameter and total number concentration.

**NanoCheck 1321**

Similar to the 1320 the NanoCheck sensor 1321 offers an expansion of the measuring spectrum from 12.5 nm upwards in eight different size ranges in a concentration range of 500 to > 10 particles/cm³.

By combining this to the Spectrometer, both technologies will give you a particle size spectrum from 12.5 nm to 32 μm in 39 different size ranges.

**Dimensions:** 25 x 12 x 30 cm

**Weight:** 9.2 kg

**NanoCheck Software 1377**

Online visualization of both spectrometer data and NanoCheck data in one combined data set for easy and time effective data evaluation.

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**Carrying Adapter 1365**

To ensure a simple operation and the mobile use of both systems, we developed a carrying case with battery, power connection and integrated data acquisition. Inside this case, both systems can be operated simultaneously and the data can be synchronized in one shared file. The illustration shows a sectional view of carrying case model 1365 with the aerosol spectrometer model 1109 on top and the NanoCheck 1320 beneath it.

**Functional principle**

Each particle in the aerosol is individually detected by scattered light photometry inside an optical measuring cell.

The scattered light impulse of each individual particle is counted and based on the intensity of the scattered light signal attributed to a particle size. The aerosol spectrometer collects the particle size distribution of solid and droplet-shaped aerosol particles in many size classes and with an excellent precision. This is the basis for a correct calculation of the dust mass.

**Data acquisition and presentation**

The measured results can directly be displayed on a connected PC (netbook, laptop, etc.), stored and transmitted via LAN or WLAN.

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**Optical measuring cell**

In all GRIMM Laser Aerosol Spectrometers and dust monitoring systems, a laser diode serves as light source. The unique measuring cell disposes of a special optical detection system. The scattered light is picked up directly as well as via a specific wide angle optical system with reflector at a scattering angle of 90°. This way, the dependency of the refraction index on the measured signal is low and each scattered light intensity permits a precise determination of the particle size.

**Integrated gravimetry and rinsing air**

An internal non-pulsing and volume-flow controlled pump serves to constantly feed the aerosol across the measuring cell and a removable PTFE filter. Subsequently, this air is cleaned by passing it through a microfilter and reused as constant rinsing air. Consequently, the laser optics and other optical parts are protected against contamination.

**Calibration**

All GRIMM Aerosol Spectrometers are calibrated with polystyrene latex (PSL). The calibration curve of the spectrometer illustrates correlation between the particle size and the scattered light system - the basis for a precise particle detection and calculation of masses.

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**Publications from more than 10 years of Grimm Aerosol Spectrometers**


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**Response function for PSL**

Online presentation with software and PC
Accessories

For standard operation of the instrument, following accessories are required:

- 1110 Lead storage battery up to 8 hours continuous operation
- 1111 Radial symmetric sampling head
- 1112C Battery charger for 220/110 V
- 1113A PTFE filter 47 mm
- 1119 Straight sampling tube, 3 cm long
- 1141 Special GRIMM communication cable RS-232 to USB
- 1142.A2 Data storage card 1 MB
- 1178 Software for data acquisition and presentation

Not depicted: Mini filter for zero-testing (1148) and carrying case (1144B).

Further accessories

For special applications, additional accessories are available e.g.:

- 1152 Isokinetic channel probe for flow velocities of 2 to 25 m/s
- 1154 Sensor for temperature, relative humidity and flow velocity
- 1158 Diffuser for compressed air lines up to a pressure of 8 bars
- 1231 NanoCheck sensor for ultrafine particles down to 25 nm
- 1xxx Diluter and more equipment refer to further data sheets.

Outdoor Areas

Performing outdoor measurement cycles the spectrometers can be operated inside our weatherproof housing model 164. The 164 combines our efficient and reliable EN & US-EPA approved GRIMM light-scattering technology for aerosol monitoring with a smart dehumidification sampling probe. The entire system has been designed for low maintenance, weighs 12 kg, features 2 carrying handles, and can be easily mounted to poles or walls. Optional sensors for meteorology (wind speed, wind direction, humidity, temperature and precipitation) are available.

The real-time data are stored in the internal memory and can be read out with the included PC software; alternatively, it can directly be uploaded to the world wide web in real-time via our Data Logger 1142 M5.

In general we recommend for outdoor measurement campaigns and long-term studies instruments from our environmental product line. They are specifically designed for PM-monitoring and provide moreover particle number concentration.

Weatherproof housing, model 164

Overview - all values in real-time

Statistics median values with box plots

Time series of mass fractions, counts, and sensor data

Distribution of number, surface, and mass

Statistics mean values with standard deviation

Statistics median values with box plots
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Software

The completely revised software 1178 was introduced in 2010 and is compatible with spectrometer models 1108, 1109, 1129 and 1209 and can be run on most Windows operating systems.

All data are presented numerically or graphically in the following formats:

- **Number distribution**: Particle count concentration in all channels shown as particles/liter
- **Mass fractions**: Occupational (inhalable, thoracic, alveolar) in µg/m³ in conformity with standard EN 481
- **Environmental (PM10, PM2.5, PM1)**
- **External sensors**: Temperature, rel. humidity, pressure, flow velocity
- **Service data**: Pump current, battery capacity, operation errors,...

The Software offers online data acquisition, the presentation of the measured values and current instrument functions.
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Sensor for ultrafine particles
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- Inhalation studies
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- Mass size distribution

Advantages:
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- 11 channels <1µm
- Data output as mass fraction, count concentration
- Sample collection on detachable PTFE filter
- Wireless data transmission
- Portable with battery; total weight 2.4 kg
- Simple operation

The smallest Aerosol Spectrometer worldwide
Models 1108 and 1109

Particle number concentration and size distribution as well as dust masses as mass fractions in real-time and at any given location

High-resolution aerosol measurement featuring Dual Technology

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  - \( P_{\text{max}} = 40\text{mW} \)
  - \( P_{\text{nom}} = 0.5/30 \text{ mW CW (Multiplex)} \)

Size channels [µm]

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1108:
- 15 channels:
  - 0.3/0.4/0.5/0.65/0.8/1.0/1.6/2/2.5/4/5/7.5/10/15/20

Particle concentration:
- 1 to 2.000.000 particles/liter
Particle mass:
- 0.1 µg/m³ to 100 mg/m³
Reproducibility:
- ±3% across the entire measuring range
Aerosol volume flow:
- 1.2 l/min ±5% constantly controlled
Rinsing air volume flow:
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Automatic cleaning in the standby mode
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Operation:
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LC display:
- 2 x 16 alphanumerical characters
Self-test:
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Measuring intervals:
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Data output:
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Sensor values optionally available
Analogous inputs:
- 3 (0-10V). Resolution 10 bits (approx. 10 mV)
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FOR YOUR NEAREST EXHIBITION, ROAD SHOW OR SYMPOSIA VISIT OUR WEB OR CONTACT US.