GRIMM

continuous research

THE ULTIMATE
NANO Particle Counters and Sizers




Ultrafine Particle Monitoring Systems for Aerosols in Industry and Research

2014

www.GRIMM-aerosol.com

GRIMM and Nanoparticles

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Dear customer,

for more than 30 years GRIMM provides you with high-quality instruments for counting and sizing airborne particles.

Our product range contains a wide variety of portable and stationary instruments which can be used for many different applications.
Due to their versatility, our systems measure indoors and outdoors, in public buildings and production halls, in the Himalayan mountains, the jungles and deserts, as well as on airplanes and ships.
One of our latest developments, GRIMM's new non-radioactive neutralizer, enables safe SMPS measurements without having any legislative restrictions.

Of course our instruments also provide you with scientific data in your laboratory, and numerous comparisons have proven the reliability of the measurements.

GRIMM manufactures particle counters and sizers as well as particle generators for a size range from 0.8 nanometer to greater than 30 micrometer. For an overview, please refer to our catalogs for the Environmental Dust Monitors, and the Portable Indoor Dust Monitors.

Typical applications are:

- Inhalation & exposure studies
- Environmental & climate studies
- EURO V diesel and gasoline engine emission measurements
- Work place monitoring
- Health effect studies
- Nanotechnology process monitoring
- Aircraft measurements
- Fundamental aerosol research
- Mobile aerosol studies
- Studies on nanoparticle growth, coagulation & transport
- Filter testing
- Printer emission studies
- Roadside monitoring

Production Staff in Pouch

Traditionally, gravimetric monitoring was used to classify ambient particles. In 2006 GRIMM acquired European approval for the EDM 180 spectrometer, establishing optical particle counting as alternative method for obtaining an accurate representation of ambient particles.

With advances in science the focus shifted to finer aerosol size fractions such as $PM_{2.5}$, PM_1, or alveolic particles, and finally to nanoparticles.

How small nanoparticles really are, is illustrated in the picture below: A nanometer relates to a meter the same way as a hazelnut to earth.

When inhaled, nanoparticles or ultrafine particles deposit deep in the lung, and the potential health risks are the subject of many scientific studies and media reports.

The GRIMM particle counters and sizers allow continuous and real-time analysis at workplaces and in the environment. Many scientific studies using GRIMM products contribute to the understanding of how aerosols influence our world.

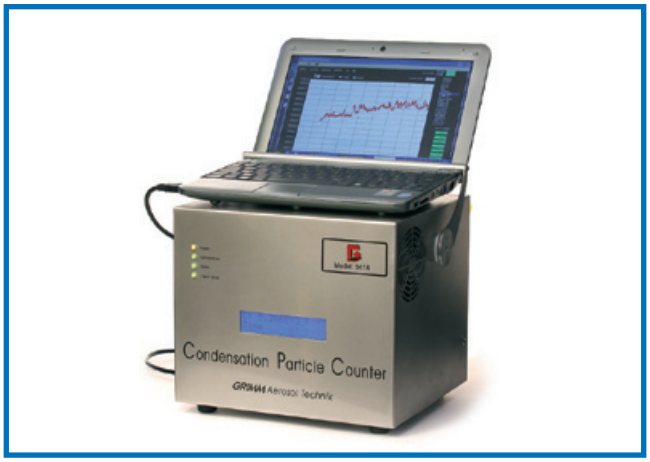
One main focus of GRIMM is to provide the best customer service. Just give us a call or visit our website and a friendly GRIMM specialist will advise you with the best solution for your application.

GRIMM is your all-in-one solution provider for the measurement of airborne particles - indoor and outdoor!

Detecting and Sizing Airborne Nanoparticles

Detecting Airborne Nanoparticles – Two Methods

Since the intensity of scattered light decreases with the sixth power of the particle size, standard optical light scattering systems cannot detect particles below 0.1 µm.



Condensation Particle Counter (CPC)

In a CPC, nanoparticles are enlarged by condensation.
The sample air passes through a heated saturator where it is enriched with butanol vapor. After cooling down in the condenser, the now supersaturated vapour condenses on the particles that act as condensation nuclei.
The resulting droplets are large enough to be detected by optical light scattering.

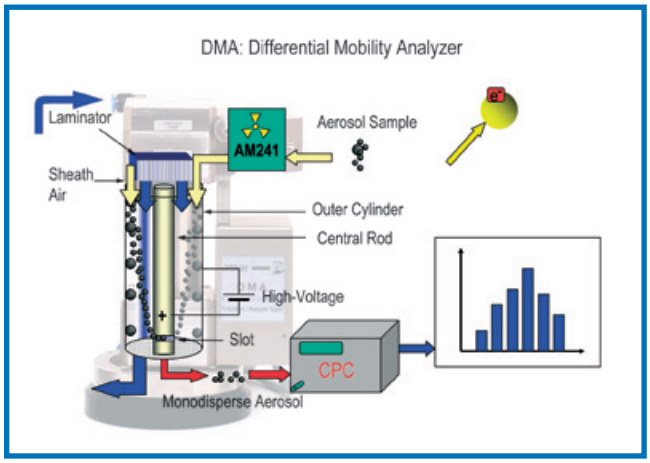
Faraday Cup Electrometer (FCE)

Nanoparticles are collected on a filter in a Faraday Cup. The particles deposit their charge on the filter and initiate a small current that is converted to a voltage using a high impedance resistor. This is an absolute and fast method with $T_{10\text{-}90}$ = 88 ms to measure nanoparticle concentrations. No consumables are necessary.

Sizing Airborne Nanoparticles

Differential Mobility Analyzer (DMA)

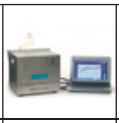
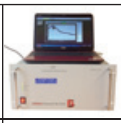
A DMA sizes nanoparticles by their mobility in an electric field. Negatively charged particles are attracted by a positive electrode and for a given voltage, only particles of a certain mobility pass through the DMA via an exit slit in the positive electrode. These particles are then counted by a CPC or FCE. By stepping through the voltage from 10,000 V to 5 V a particle size distribution is obtained.



The DMA can also be used to generate monodisperse aerosols if operated at a fixed voltage.

CPC Overview, Mobile Particle Counters & Sizers

GRIMM CPC line-up

	Mobile	Stationary						Sky	UFP	PMP	
											
CPC model	**5.403**	**5.410**	**5.412**	**5.414**	**5.416**	**5.420**	**5.421**	**5.410-Sky**	**5.412-7**	**5.430**	**5.431**
Short description	**All-inclusive portable CPC**	**Counter only, for external pumps**	**Counter only, incl. sample pump**	**Counter with SMPS cabability, incl. sample pump**	**All-inclusive stationary CPC**	**All-inclusive CPC for 19" racks**	**Counter only, incl. sample pump for 19" racks**	**CPC-Core for aerospace applications and aerosol monitoring independent from air pressure**	**Counter only, incl. sample pump for UFP applications, ONLY as complete 465 system**	**PMP-CPC, counter only, for automotive applications**	**PMP-CPC, counter only, incl. sample pump, for automotive applications**
Max. concentration [1/ccm] Single count mode	20,000	100,000	100,000	150,000 (0.3 lpm) 100,000 (0.6 lpm)	150,000	150,000	150,000	100,000	150,000	50,000	50,000
Max. concentration [1/ccm] Photometric mode	10^7	10^7 (3)	10^7 (3)	10^7 (3)	10^7 (3)	10^7 (3)	10^7 (3)	10^7 (3)	10^7 (3)	--	--
D50 [nm]	4.5 (1)	4.1 (1)	4.1 (1)	4.1 (1)	4.1 (1)	4.1 (1)	4.1 (1)	4.1 (1)	7 (1)	23 (2)	23 (2)
Sample flow [cm]	0.3	0.6	0.6	0.3 & 0.6	0.3	0.3	0.3	0.6	0.3	0.6	0.6
SMPS option	yes	--	--	yes	yes	yes	--	--	--	--	--
Battery	yes	--	--	--	--	--	--	--	--	--	--
Internal sample pump	yes	--	yes	yes	yes	yes	yes	yes (3)	yes	--	yes
Internal sheath air pump	yes	--	--	--	yes	yes	--	--	--	--	--
Internal tank	yes	--	--	--	--	--	--	--	--	--	--
Netbook included	yes	yes	yes	yes	yes	yes	yes	optional	optional	--	--
Port for external sensors	yes	yes	yes	yes	yes	yes	yes	--	--	--	--
Size (h × w × d) [cm]	22 × 26 × 30	23 × 25 × 29	23 × 25 × 29	23 × 25 × 29	40 × 25 × 29	22.1 × 48.3 (19") × 41	22.1 × 48.3 (19") × 41	on request	on request	23 × 25 × 29	23 × 25 × 29

(1) Measured with Ag particles (2) Measured with soot particles (3) Optional

Mobile CPC

GRIMM's mobile Condensation Particle Counters (CPCs) provide the users with a truly portable, all-in-one solution to reliably measure nanoparticles in aerosols. The instruments contain pumps, butanol tank, battery, memory and intelligent parameter monitoring for possible remote operation.

Highlights

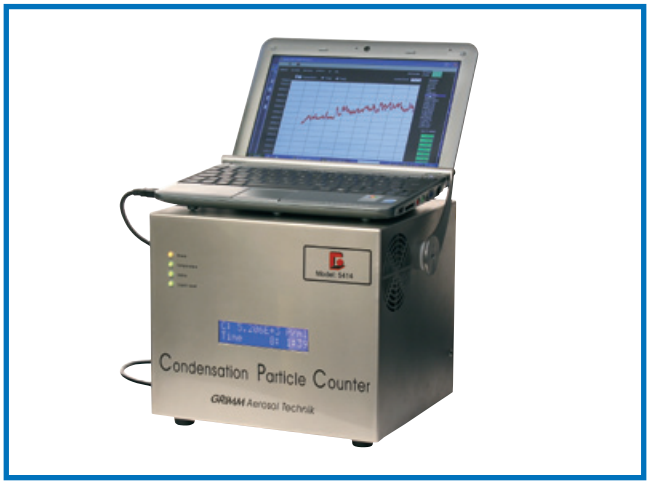
- Counts particles as small as 4.5 nm
- Real time updates (1 Hz)
- Wide concentration range up to $10^7/cm^3$
- Portable with integrated battery
- Additional analog inputs for climatic sensors
- Integrated butanol tank

Mobile SMPS+C

By adding a GRIMM Differential Mobility Analyzer the user can upgrade the CPC to a high resolution Scanning Mobility Particle Sizer (SMPS+C) that records size distributions between 5 and 1,100 nm.
This portable system can be battery-operated.

Stationary Particle Counters & Sizers, WRAS

Stationary CPC



Stationary SMPS+C: CPC with Particle Sizer

The new GRIMM stationary Condensation Particle Counters (CPCs) are designed for long-term measurements and can be configured according to your needs. They include a laptop with pre-installed software that provides a flexible user interface featuring Ethernet, wireless operation and USB data storage.

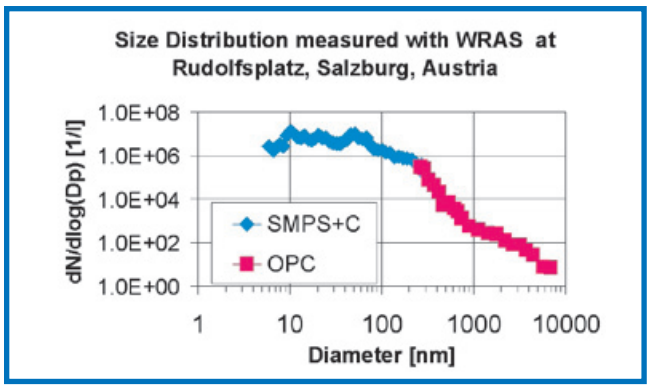
This new generation of butanol-based CPCs features an improved detection limit of 3 nm, an improved response time $T_{10\text{-}90} < 3$ seconds, and an extended single count mode up to 150,000 particles/cm³ with real-time coincidence correction. Since the saturator can be heated and cooled, the counters can be used at a wide range of ambient temperatures.

All CPCs can be transported without prior drying due to a patented shutter for the saturator.

Wide Range Aerosol Spectrometer (WRAS)

A GRIMM optical particle counter can be added to expand the SMPS system to a Wide Range Aerosol Spectrometer (WRAS) for monitoring the full size range of airborne particles.

19" rack versions of CPC, SMPS+C, and WRAS are also available for stationary installations, typically used in environmental networks, atmospheric monitoring stations, and automotive test rigs.



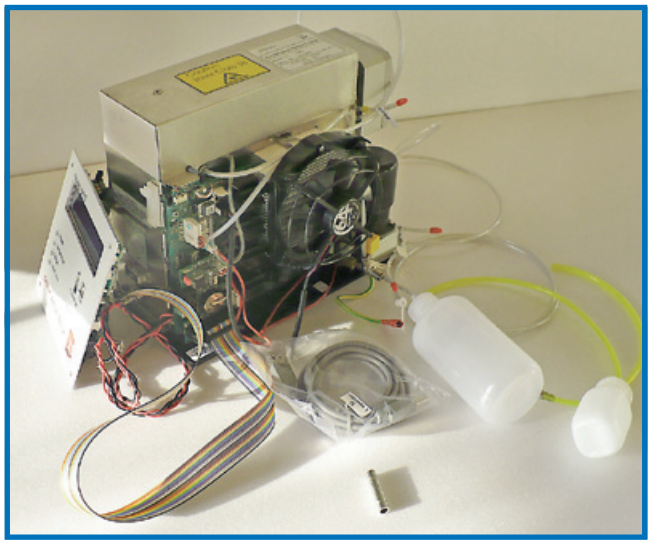
Particle Counters for Special Applications

PMP-CPC for Automotive Emission

High accuracy stationary particle counter for automotive emission measurements in compliance with the GRPE particle measurements program (PMP) for EURO 5 Regulation 83, featuring a D_{50} of 23 nm.

Ultra Fine Particle (UFP) Counter for Environmental Measurements

For environmental applications, the modified CPC 5.412 with a cut-off at 7 nm is built into a mobile mini housing and is offered as complete stand-alone **Monitoring System EDM 465 UFPC** (please refer to our Environmental catalogue).



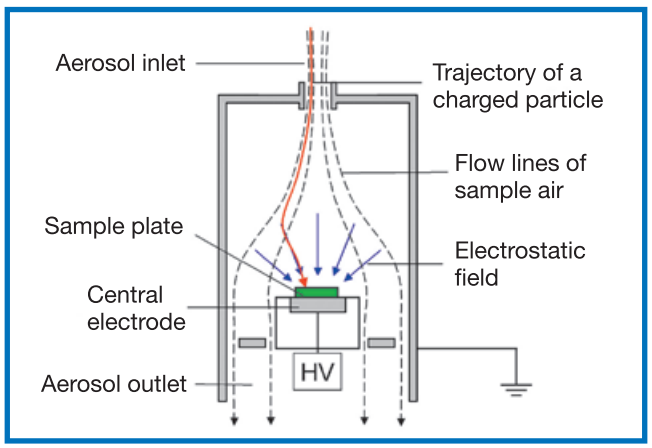
Sky-CPC for Aerospace Applications

Based on the CPC model 5.410, the model 5.410-Sky may be used for aerosol monitoring indpendent from air pressure, e.g. for installations at aircrafts for climate or environmental research.

Sampling of Nanoparticles

Electrostatic Precipitator

The model 5.561 electrostatic precipitator is used to collect samples from nano- to micrometer-sized aerosols. The aerosol enters the precipitator and an adjustable high voltage is applied to the central electrode in order to attract the charged particles onto the sampling plate. The samples are suitable for a variety of common analytical tools like optical light microscopes, scanning electron microscopes (SEM), atomic force microscopes (AFM), total reflection x-ray fluorescence (TXRF), proton induced x-ray emission (PIXE), or energy dispersive x-ray spectroscopy (EDX).

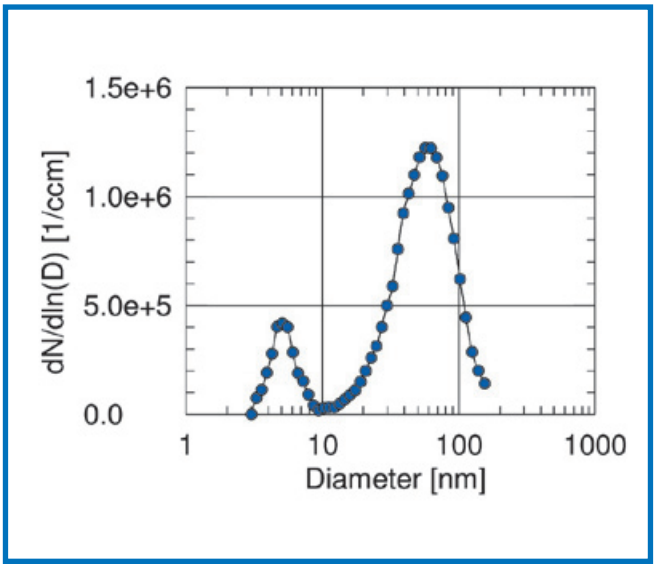


Electrometer based Particle Sizers

SMPS+E

The combination of a DMA with a Faraday Cup Electrometer (FCE) is a Scanning Mobility Particle Sizer (SMPS+E) for fast measurements with the following advantages:

- size range (< 0.8 – 1,100 nm)
- concentration range ~10,000 p/cm³ to 100,000,000 p/cm³
- pressure range 400 to 1,100 hPa



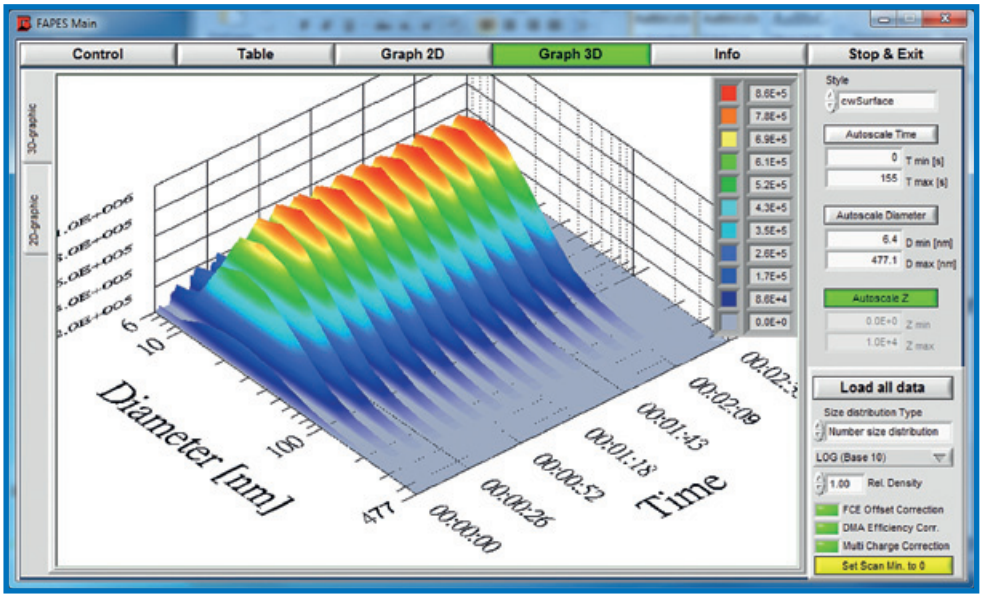
Fast Aerosol Particle Emission Spectrometer (FAPES)

For ultrafast aerosol measurements in the automotive industry GRIMM has developed the Fast Aerosol Particle Emission Spectrometer (FAPES); a battery of 12 DMAs combined with high performance Faraday Cup Electrometers (FCE).

- transient measurements with 25 channels updated every 100 milliseconds
- virtually no internal contamination

Measurement in 10 Hz

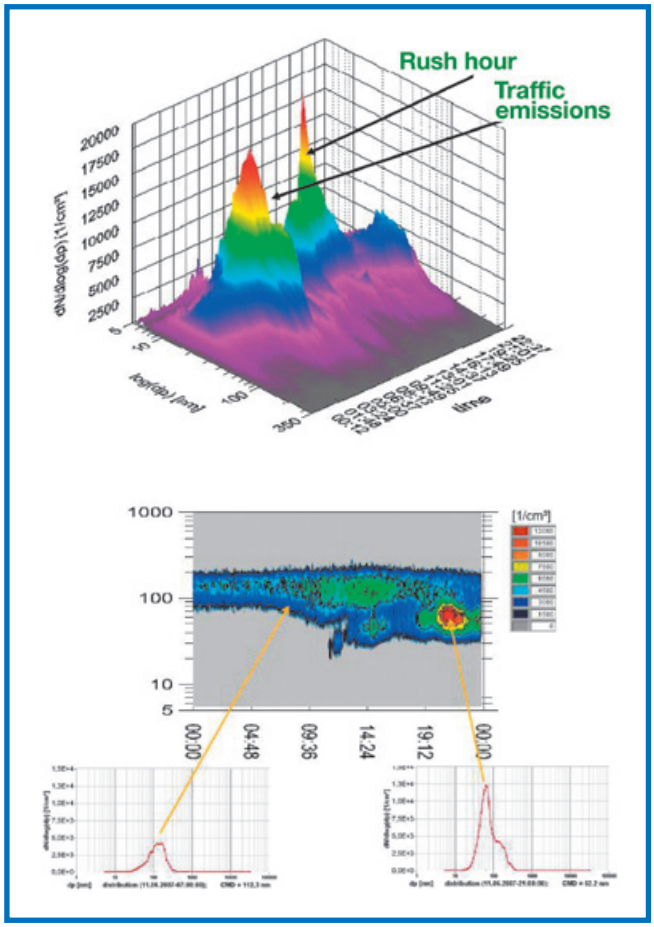
- accuracy unmatched by any other instrument commercially available
- bipolar charger to achieve well defined Fuchs-Wiedensohler charging probabilities with a low amount of multiple charged particles
- thus good size classification even for larger particles

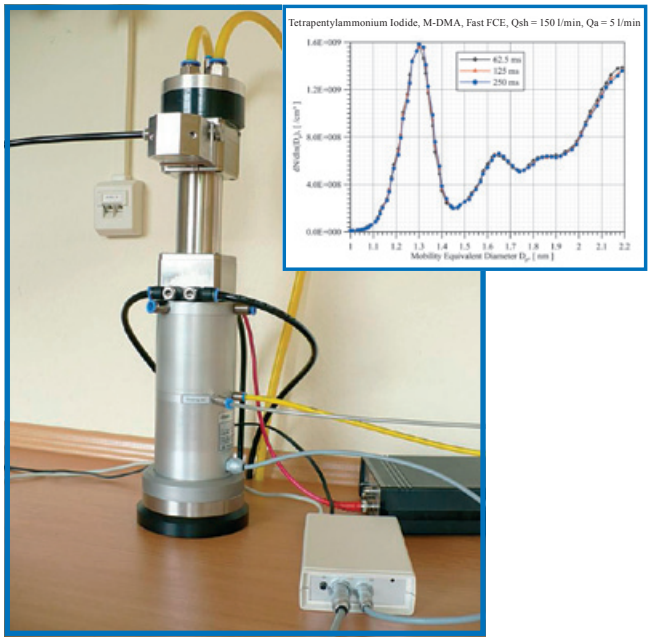


Dilution, High-Flow DMA & Software

Emission Sampling System (ESS)

The ESS is designed for hot gas sampling with gas temperatures up to 500°C. The system can be combined with all instruments for nanoparticle measurements. It comprises a 2-stage hot gas diluter, pump, filters and dryer. Operation requires power supply only. Typical applications are measurements at burners, engines, or power plants.





High-Flow DMA

With the FCE as detection system, the high-flow DMA measures size distributions of particles or ions in the nanometer range with a high size resolution. Size scans can be done in seconds with minimum diffusion losses of very small particles. This design is based on the commercial Vienna type DMAs and adapted for sheath air flows of 75 and 150 L/min.

The high-flow DMA can also be used for the generation of narrow monodisperse size distributions, for example to generate the 23 nm and 41 nm particles that are used for the calibration of PMP particle counters in automotive applications.

Software

The GRIMM Windows software for NANO devices features an intuitive user interface to control the instruments as simple as possible. It comes with an electronic version of the manual and powerful utilities for data handling.

During the measurements, corrections for diffusion losses and activation efficiency are applied in real-time. The state-of-the-art data reduction algorithms were developed by Professor Reischl, Institute of Physics, Vienna University and recently adapted to the ISO 15900 standard.

The software supports on-line logging of data and instrument parameters. The particle number distribution can be converted to surface area distribution, volume distribution, and if the density of the aerosol particles is known, to mass distribution. The data can be easily exported for further analysis.

Accessories

Annullar Dielectric Barrier Discharge (aDBD) Neutralizer

The new non-radioactive aDBD neutralizer achieves Fuchs-Wiedensohler charging probabilities using ions formed plasma and a special geometry. No licence is needed - the ideal solution particularly for mobile applications. The aDBD neutralizer is available as mobile and as 19" version.

Americium-241 Neutralizer

The well established bipolar neutralizer, designed for long-term use (half-life of Americium-241: 432.2 years). For safe handling and maintenance, the Americium is enclosed in a gold foil and well protected in a stainless steel housing. A variety of different adapter plates to fit most applications is available upon request.

Flowsplitter

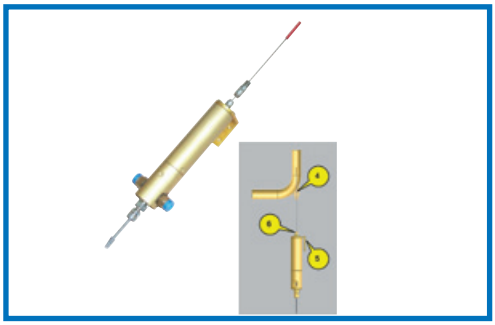
Designed for calibration setups that demand extreme accuracy, this flowsplitter with integrated mixing chamber reliably provides up to four instruments with the same aerosol concentration.

Diffusion & Sheath Air Dryer

For removing moisture from sample air we offer Silica gel-based diffusion dryers in different sizes for laboratory measurements and Nafion dryers for long-term ambient sampling.

High Pressure Diffuser

Our high pressure diffuser makes it possible to sample directly from pressurized air of up to 6 bar pressure. It features an isokinetic inlet for the high and the low pressure stage.
It is typically used by:
- manufacturers of compressors to validate oil free air generation, and
- resellers of compressors to verify proper function after service.



Temperature and humidity sensor

This sensor is designed for continuous measurements of ambient temperature and humidity. It is connected to the particle counter and automatically detected by the software. The data are logged along with the particle concentrations.

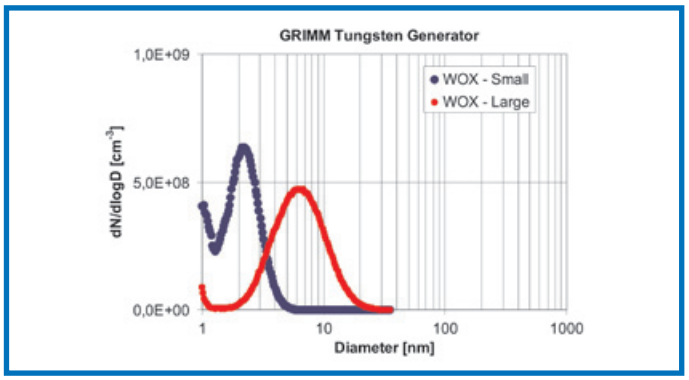
More accessories are available upon request.

Aerosol Generators

Tungsten Generator

The model 7.860 Tungsten (“WOx-1”) Generator is used to create defined particle size distributions of very small particles, typically in the range of 1.2 – 20 nm.

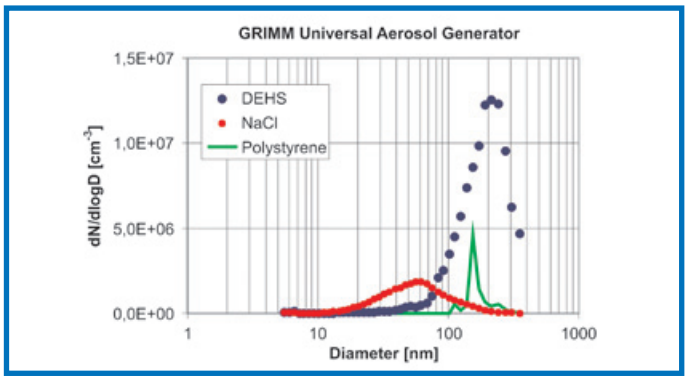
An indirectly heated Tungsten wire emits a large amount of oxide particles. Size and concentration can be set by adjusting the three air flows.



Universal Aerosol Generator

The model 7.811 atomizer type generator is designed to generate test aerosols from oils (DEHS), aqueous solutions (e.g. NaCl) and suspensions (e.g. Polystyrene).

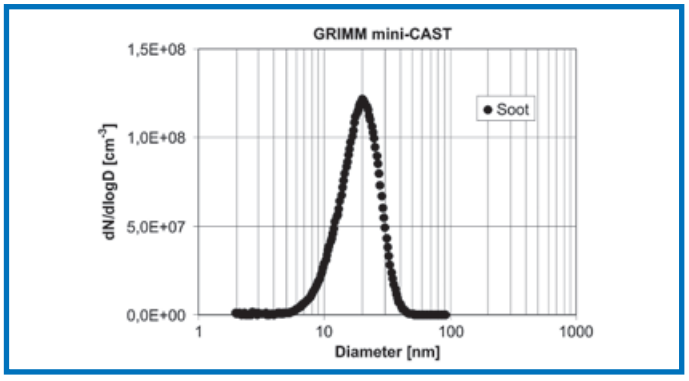
Two pumps inside the unit generate clean pressurized air for the atomizer and dried clean air for dilution. The concentration can be adjusted over a wide range by the flow rates.



GRIMM mini Soot Generator

The GRIMM mini Soot Generator (Combustion Aerosol Standard) model 7.882 produces active combustion soot particles in the nanometer size range. Since the soot particles are similar to those emitted by combustion engines, generators are often used to simulate combustion processes in a controlled environment.

GRIMM’s mini Soot Generator is targeted at applications such as validating the PMP test system in automotive, filter testing, or basic research on soot formation and aging. The unit is easy to use and the mean size of the generated particles can be adjusted in a large range (~10 – 160 nm).



Company

Service

”It is not the style of clothes one wears, neither the kind of automobile one drives, nor the amount of money one has in the bank, that counts. These mean nothing.
It is simply service that measures success.“

George Washington Carver

Our team of dedicated technicians makes sure that you are never left alone with your GRIMM instrument. We believe that good customer service can only take place in a human-to-human situation. If you have a question or a problem simply contact:

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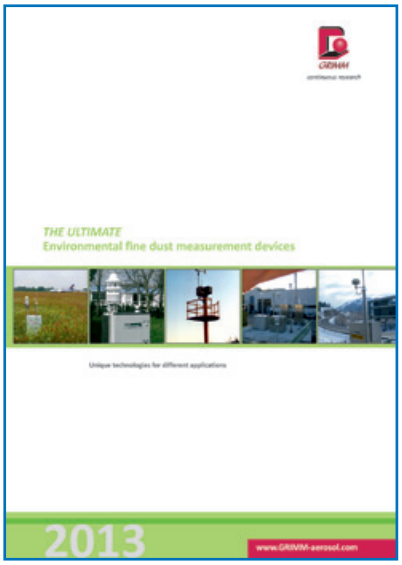
Is the application or solution you need not covered in this catalog? Please have a look at our other catalogs:

Indoor Air Quality Instruments

- Detection of single particles by light scattering
- Size range 250 nm – 32 µm
- EN 481 – alveolic, thoracic, and inhalable mass fractions
- PM_{10} (EN 12341), $PM_{2.5}$ (EN 14907), and PM_1
- Aerosol spectrometers with 31 or 15 size channels
- NanoSizer extension to count nanoparticles and to determine their active surface



Environmental Dust Monitors

- Current standards and equivalency methods for outdoor dust monitoring
- PM_{10} (EN 12341), $PM_{2.5}$ (EN 14907), and PM_1
- Portable Environmental Dust Monitor model EDM 107
- Stationary, approved Environmental Dust Monitor model EDM 180
- Environmental Wide Range Aerosol Spectrometer model EDM 665 (5 nm to >30 µm)
- NanoSizer extension to count nanoparticles and to determine their active surface

GRIMM

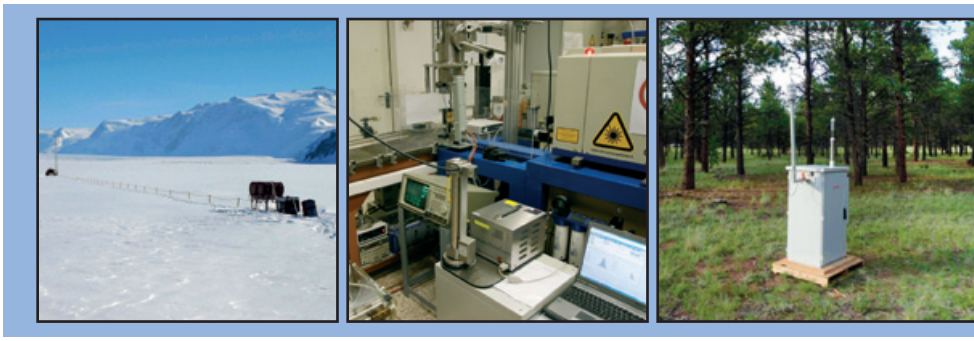
continuous research

The European Leader in Particle Measurement Technology

GRIMM Aerosol Technik GmbH & Co. KG is the No. 1 European manufacturer for accurate and reliable instruments for measuring airborne nanoparticles. The company was founded in 1981. Today it offers a complete range of products for nanoparticle generation and monitoring in industry and research.
Continuous participation in EU projects and investments in research and quality control ensure high quality scientific instruments.
Specialists inhouse will advise about the optimal instruments for particular applications, e.g. for automotive, emission, occupational health, filter efficiency and ambient air, for quality control and for pharmaceutical, atmospheric or epidemiological studies.

By the way:

For more information about environmental and **indoor air quality** measurements please ask for our respective catalogues or download them from our website!



30 years of scientific research and experience.

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For information regarding events, exhibitions or symposia please visit our homepage or call us:
Phone: +49 8654 - 578-0, Skype: ae-grimm
We´d love to talk to you, together we will find the best solution for your needs in dust monitoring

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