FRITSCH

FRITSCH · PARTICLE SIZING

PRODUCTOVERVIEW

SIZING · LASER DIFFRACTION

For over 25 years, FRITSCH has remained one step ahead in the area of laser particle sizing. In 1985, we revolutionised measurement precision by introducing the concept of laser diffraction in a convergent laser beam with the patented FRITSCH measurement process. This process has now become the international standard for easy, fast and reliable particle size analysis. Benefit from the practical experience and technical superiority achieved in a quarter century of work in laser particle sizing.

F R I T S C H . O N E S T E P A H E A D .

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www.fritsch-laser.com

STRENGTHS THAT MATTER

- **High measurement precision**
- **Consistent reproducibility**
- **Reliable comparability**
- **Short measuring times**

The various models of the FRITSCH ANALYSETTE 22 are used around the world in production testing and quality control as well as in research and development. With short analysis times, consistently reproducible and reliably comparable results, they offer decisive advantages in the precise determination of particle sizes for a wide range of applications. Flexible, efficient and reliable.

QUALITY AND TECHNOLOGY FROM GERMANY

All key components of the FRITSCH Laser Particle Sizers are manufactured entirely in Germany. The final production takes place exclusively at our own plant at our headquarters in Idar-Oberstein. With strict quality controls and the special attention to detail of a traditional family-owned company. Something you can really depend on.

Most current Measurement Precision according to ISO 13320

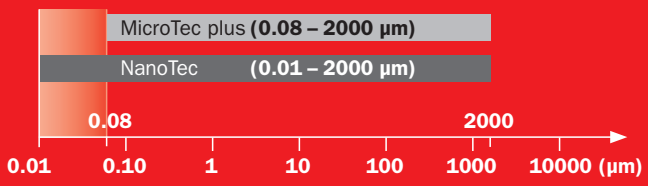
All FRITSCH Laser Particle Sizers meet the most recent and future international standard ISO 13320 with regard to measurement precision and reproducibility. For absolutely reliable precision and comparability (see page 20).

ANALYSETTE 22 MicroTec plus – The compact all-round-laser for all fields of application

ANALYSETTE 22 NanoTec – High-end instrument for measurements down to the nano range

TWO MODELS FOR ALL APPLICATIONS

Choose between the new **ANALYSETTE 22 MicroTec plus**, which covers all typical measurement tasks with an extra-wide measuring range, or the **ANALYSETTE 22 NanoTec**, the high-end instrument for measurements down to the nano range, depending on your particular needs. With the patented measurement design for maximum precision and sensitivity for the smallest particles through the measurement of the backward scattering in a second laser beam, a movable measuring cell and an ingenious detector geometry.



The Laser Diffraction Concept

Laser diffraction/laser scattering is the most efficient process available today to determine particle size distributions in a wide measuring range from approximately 10 nm up to several millimetres. The sample is either dispersed dry as a powder in the free air jet or wet as a suspension in a closed liquid circulation system. Your advantages: very short measuring times, time-saving automated processes, high precision, consistent reproducibility and flexible options for processing of the results.

WORLDWIDE SERVICE

Yet another key advantage of FRITSCH: personal consultation and comprehensive service from our experts – practically anywhere in the world.

www.fritsch-laser.com

FREE SAMPLE MEASUREMENT

Send us your sample for a free and non-binding particle size analysis – just by following the three easy steps at www.fritsch-laser.com. The result will speak for itself.

ON-SITE TEST IN THE MOBILE LABORATORY

Test our Laser Particle Sizers in the FRITSCH laboratory bus – just schedule an appointment and we will stop by.

MAINTENANCE AND REPLACEMENT PARTS SERVICE

Ask your local FRITSCH representative about the special maintenance contract for your ANALYSETTE 22 and learn about the practical online maintenance. We also offer a delivery guarantee for all important spare parts for at least 10 years – for maximum investment security.

CONSULTATION, TRAINING, WORKSHOPS

We will advise you on all technical application questions: by phone or personally. We also share our expertise at regular workshops and seminars – on your site or at convenient locations worldwide. Ask us about them!

Close and personal: Consultation, training, workshops

Simply request it: Free sample measurement

We will visit you: On-site test in the FRITSCH laboratory bus

BENEFIT FROM OUR EXPERIENCE!

For all questions regarding FRITSCH laser particle sizing and its possible applications, please feel free to contact our expert Dr. Günther Crolly at:

+49 67 84 70 138 · crolly@fritsch-laser.com

We look forward to hearing from you!

ANALYSETTE 22 MicroTec plus

COMPACT SIZE – COMPACT PRICE

- **Extra-wide measuring range 0.08 – 2000 µm**
- **Especially high measurement precision**
- **Revolutionary dual-laser-technology**
- **Practical modular system**
- **Quick change between wet and dry measurement**
- **Variable suspension volume with the wet dispersion unit**
- **Simple cleaning**
- **Small footprint**

Discover with the new ANALYSETTE 22 MicroTec plus the new generation of FRITSCH Laser Particle Sizers: the compact all-round-laser for all typical applications – and the new standard in price and performance.

With the **ANALYSETTE 22 MicroTec plus**, particle measurement becomes a simple matter – for professionals as well as for any employee, with only brief instructions, for instance in merchandise receipt or shipping departments. Therefore, it is the ideal instrument at an attractive price for handling your own quality and production control. Even for small and medium-sized companies. Just ask us – we will be glad to advise you. And it‘s worth making a comparison!

VARIABLE MEASURING RANGE

With the **ANALYSETTE 22 MicroTec plus**, you can easily and fully automatically choose between two individual measuring ranges or combine the two into a third option. Your advantage: maximum flexibility and a total measuring range of 0.08 µm – 2000 µm in a single instrument with an outstanding resolution of up to 108 measuring channels.

Greater certainty by performing your own quality control – just one of many applications

The **ANALYSETTE 22 MicroTec plus** is the ideal starter instrument if you are considering handling your own quality control of not only outgoing but also incoming goods. From the experiences of our customers, we know that this investment quickly pays for itself – in better products and flawlessly delivered raw materials!

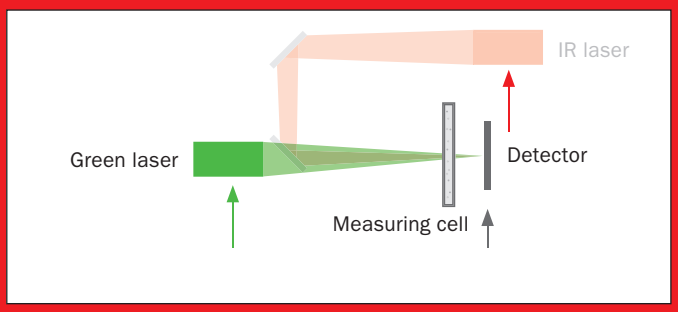
ANALYSETTE 22 MicroTec plus – Practical modular system with separate dispersion units

REVOLUTIONARY SOLUTION:

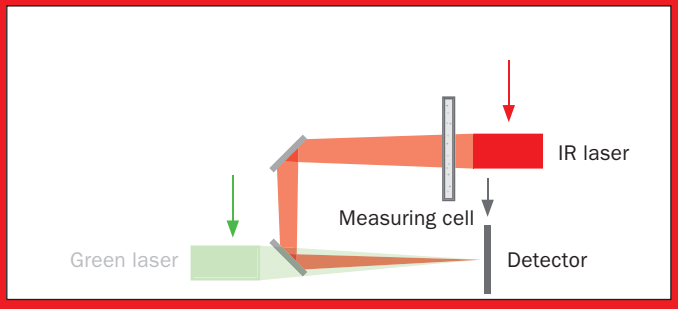
DUAL-LASER-TECHNOLOGY

In the **FRITSCH ANALYSETTE 22 MicroTec plus**, a semiconductor laser with green light carries out the measurement of small particles while an infrared-semiconductor laser handles large particle size ranges. Both lasers can be optimally aligned extremely quickly and independently of each other through lateral motion. Your advantage: the ideal wavelength for every particle size and an ideal combination of large measuring range, outstanding resolution and small footprint that distinguish the **ANALYSETTE 22 MicroTec plus** from other instruments.

Brilliant FRITSCH idea: with redirection of the long-wave-length red laser beam, the **ANALYSETTE 22 MicroTec plus** allows for maximum measurement precision even for large particles within a compact unit. To switch to measurement of small particles in the short-wavelength green laser, the detector and the laser source are simply moved as a unit – the measuring cell remains fixed in place.



Measurement design for the lower particle size range



Measurement design for the upper particle size range

ANALYSETTE 22 MicroTec plus

Perfect Dispersion – Maximum Flexibility

Any particle size measurement is only as good as its dispersion. For this reason, we place great importance on this aspect and bring all our experience to bear.

We developed the **ANALYSETTE 22 MicroTec plus** as an especially practical modular system with perfectly conceived units for dry and wet dispersion or for combination with a small volume wet dispersion unit. All dispersion modules can be connected to the measuring unit individually or in combination and can be easily changed over or added for new measurement tasks. With standard programmes for simple operation, completely open programmability for maximum flexibility, especially fast and efficient cleaning as well as many other advantages that simplify your work and ensure the quality of your measuring results. One step ahead.

PRACTICAL FAST-SWITCH-SYSTEM

The measuring cells of the new **ANALYSETTE 22 MicroTec plus** are located in practical cartridges that can be easily exchanged when switching between wet and dry measurements – without changing any hoses or modifying the instrument! This system also makes child's play of cleaning the measuring cell. Plus, whenever you are not using the cartridge, it can be easily stored within the respective dispersion unit. Perfectly neat and tidy!

Well-conceived: easy storage of the measuring cell in the dispersion unit

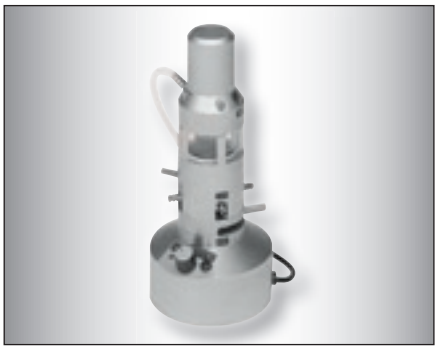
FULL PROGRAMMABILITY

In addition to the standard programmes, the dispersion process of the **ANALYSETTE 22 MicroTec plus** can be fully custom-programmed to perfectly satisfy your requirements. For example, you can programme in loops for the automatic inspection of the dispersion state in reference to the dispersion duration. Or after adding the sample, you can select a defined delay, during which the sample is completely broken down into its primary grains with the help of ultrasound. Your advantage: a completely new level of freedom in structuring the entire dispersion process.

The **practical dry dispersion unit** for the **ANALYSETTE 22 MicroTec plus** will arrive on the market in **summer of 2009**.

Illuminated ultrasonic bath

Simple cleaning: Protection ring and wave trap are easily removable



Small volume wet dispersion unit

WET DISPERSION UNIT

Your Advantages

- Time-saving Fast-Switch-System for the measuring cells
- Extremely flexible programmability of the dispersion process for maximum flexibility
- Variable suspension volume with 3 different amounts of liquids standardly
- Also benzine, alcohol and many organic solvents according to ITC can be used as suspension liquids as a standard feature
- Illuminated ultrasonic bath for enhanced monitoring of the dispersion
- Freely adjustable ultrasonic-intensity for optimal dispersion
- Powerful centrifugal pump for the optimal transport of even heavy particles with a high density
- Rinsing cycle adaptable to the sample material

Small Volume Wet Dispersion Unit

With a suspension volume of 100 ml, it is ideal for measuring in solvents or measuring of expensive samples in a measuring range of 0.01 – 600 µm. Especially practical: the transparent glass container for observing the sample and rinsing of the measurement circuit by a single-lever valve (4/2-way ball valve). The output of the centrifugal pump can be adjusted for gentle transport of the sample. All parts coming into contact with the liquid are made of steel, Viton and glass, which are resistant to typical solvents.

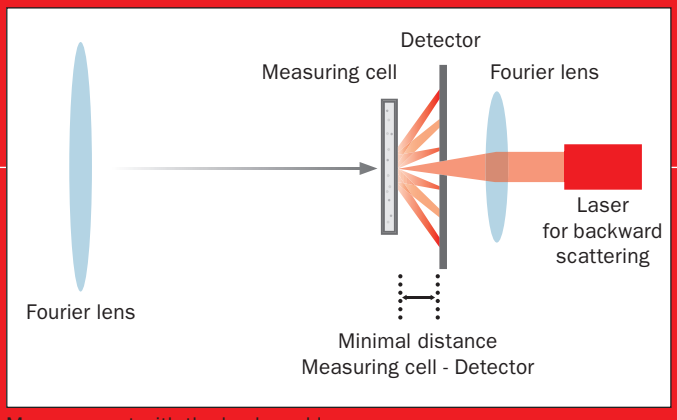
ANALYSETTE 22 NanoTec

HIGH-END DOWN TO THE NANO RANGE

- **Fast, automatic particle size analysis**
- **Measuring range 0.01 – 2000 µm**
- **Unique FRITSCH ZOOM-technology**
- **Size distribution and shape analysis in a single measurement**
- **Effective, automatic cleaning of the measurement circuit**
- **Wet and dry measurement in the same instrument**
- **Fully-automatic switching between dispersion units**
- **Rinsing without dead spaces with 4/2-way valve**
- **Space-saving design with vertically positioned optical system**

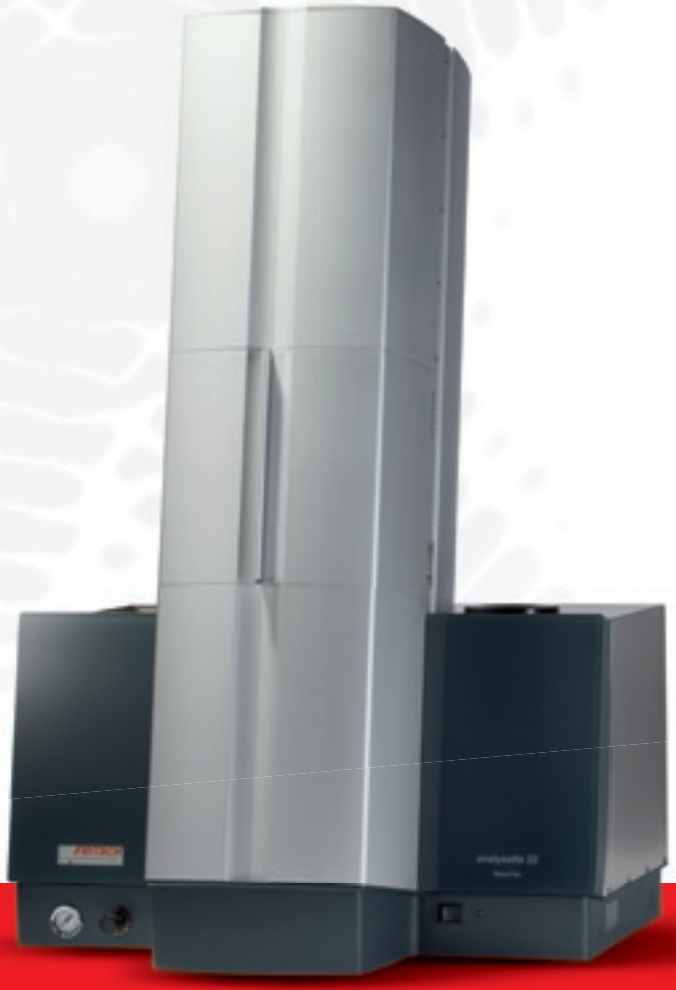
With a measuring range from 0.01 µm to 2000 µm, the ANALYSETTE 22 NanoTec is the ideal, universally applicable Laser Particle Sizer for the effective and reliable determination of particle size distributions. With the unique FRITSCH ZOOM-technology, it can be quickly and easily adapted to any sample and guarantees maximum resolution for perfect, reliable results down to the nano range.

BRILLIANT FRITSCH SOLUTION: MEASUREMENT WITH BACKWARD SCATTERING



Measurement with the backward laser

To extend the particle size determination down to the nano range, it is necessary to detect the light that scatters backward. And the FRITSCH solution for this is simply brilliant. In order to make use of the backward scattering in the measurement, FRITSCH was the first company in the industry to introduce a second laser beam. The sample is positioned directly in front of the detector. The second laser beam now irradiates the sample through a micro-hole in the **centre of the detector** and the **backward scattered light** is directly measured with high resolution. This enables the enormous large measuring range of the **ANALYSETTE 22 NanoTec** with a lower measuring limit of approximately 0.01 µm. The total measurement range of 0.01 to 1000 µm can be very easily shifted to 15 - 2000 µm through use of the beam expansion. Perfectly designed!



Compact Form

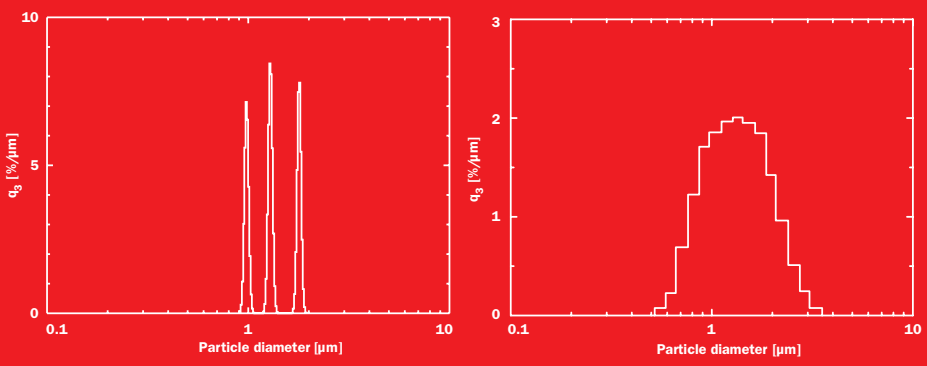
The optical bench of the **ANALYSETTE 22 NanoTec** is made of particularly high-quality components and designed vertically as a very effective space-saving measure.

FRITSCH PATENT: MAXIMUM RESOLUTION DUE TO THE ZOOM-FUNCTION

Only in the **ANALYSETTE 22 NanoTec from FRITSCH** can you freely move the measuring cell within the beam path during the measurement (see figure on p. 26). Your advantage: easy, infinitely adjustable adaptation of the measurement range to the sample and up to 520 effective measuring channels for an extremely high resolution. A patented solution!

Application example: measured particle size distribution of a mixture of three different latex samples

The diameters of the three individual components were 0.98 µm, 1.32 µm and 1.86 µm. The measurement shown on the right was performed with only one cell position (56 measuring channels), the left with 9 cell positions (465 measuring channels). The result: Outstanding resolution for analysis of even the finest details within a particle size distribution.



Measurement: 9 cell positions
465 measuring channels

Measurement: 1 cell position
56 measuring channels

ANALYSETTE 22 NanoTec

Sophisticated Dry and Wet Dispersion

In the ANALYSETTE 22 NanoTec as well, sophisticated dispersion units ensure perfect, simple and fast dispersion of your sample. The housing offers space for two dispersion units that can each be freely configured. It is possible to use the wet or dry dispersion units individually, both units together with a fast, automatic switching between them or as well as in combination with a small volume wet dispersion unit integrated into the instrument as a second unit, or separately connected as a third, external unit. Exactly according to your needs.

DRY DISPERSION UNIT

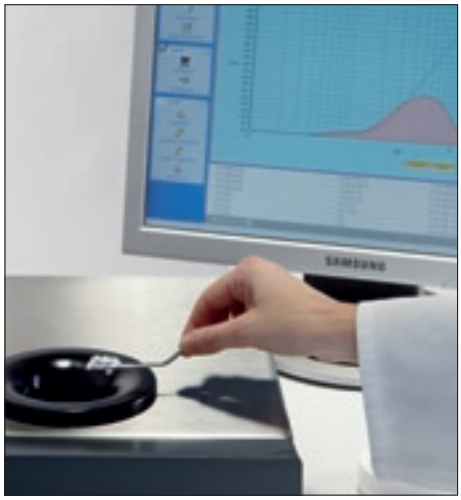
Your Advantages

- Measuring range 0.1 – 2000 µm
- Preparation of agglomerates through mechanical and pneumatic forces
- Dosed sample feeding by an amplitude-controlled vibratory feeder
- Control of the entire functional process by an integrated microprocessor
- Fully automatic measurement processes can be freely programmed and saved
- Dispersion in a two-phase annular gap nozzle through air fins with aerodynamic wave formation at the nozzle outlet and high flow speed in the nozzle channel
- Automatic exhaustion of the analysed sample with vacuum pressure

Note: To operate the dry dispersion unit, a connection for compressed air, that is free of oil, water and particles with a pressure of at least 5 bars and an air volume of at least 8 m^3/h is required. An external exhaust system is required to vacuum the sample material and can be ordered with the instrument as a FRITSCH accessory.

Wet and Dry Dispersion in Combination

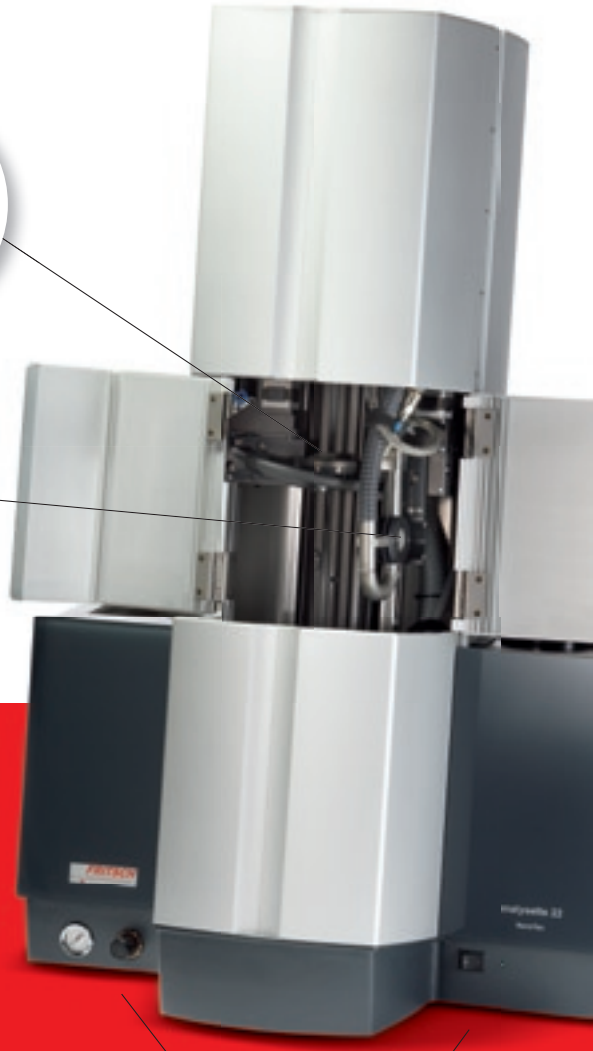
Especially practical: if you frequently switch between wet and dry dispersion in your applications, you can equip the two dispersion unit mounts in your **ANALYSETTE 22 NanoTec** with a wet and a dry dispersion unit. The desired dispersion type is selected easily, quickly and automatically by a software command without the need for any physical adjustments.



Simple feeding of the sample into the ultrasonic bath of the wet dispersion unit

Measuring cell for wet dispersion

Measuring cell for dry dispersion



Position of the dry (left) and wet (right) dispersion units in the **ANALYSETTE 22 NanoTec**

WET DISPERSION UNIT

Your Advantages

- Measuring range 0.01 – 2000 µm
- Closed circuit with a total volume of approx. 500 ml
- Very powerful centrifugal pump with variable pump speed
- 80 W ultrasonic emitter for dispersion of even difficult samples
- 4/2-way valve for fully automatic and efficient rinsing of the suspension without dead spaces after completion of the measurement
- All parts in contact with liquid are made of stainless steel, Viton, glass and polyamide
- All functions can be controlled by computer

Small Volume Wet Dispersion Unit

With a suspension volume of 150 ml, the small volume wet dispersion unit is ideal for measurement of expensive samples or for measurements in solvents in a measuring range of 0.01 - 2000 µm. Rinsing is performed fully automatically by a motor-driven 4/2-way ball valve with low consumption and no residue. The output of the extremely powerful centrifugal pump for gentle transport of the sample can be controlled. All parts in contact with liquid are made of stainless steel, Teflon, Viton and glass. The matching measuring cell is also included.

ANALYSETTE 22 Software

The Right Programme for Perfect Analysis

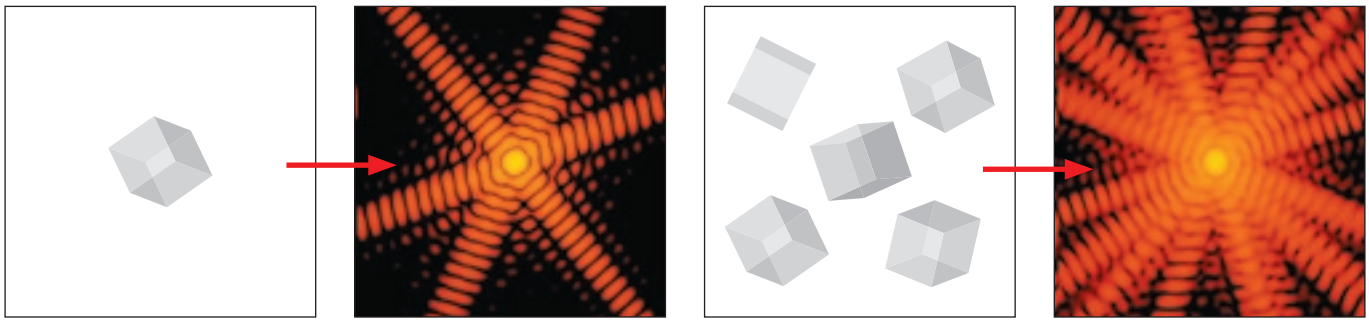
For the control, recording and evaluating of your measuring results, all Laser Particle Sizers of the ANALYSETTE 22 series are delivered automatically with the matching software which guides you through the entire measurement process in an easy-to-learn and largely self-explanatory manner. Simple, flexible, reliable.

FRITSCH MaS control SOFTWARE

The special FRITSCH MaS control software is based on a relational database in which all user entries, parameters and results are securely stored and safe from manipulation. The layout of your measuring reports can be freely defined with the practical report generator – exactly according to your needs. The integration into a local computer network is also a simple matter. Your advantage: all measuring data can be conveniently analysed on different computers.

THE FACTS

- Analysis according to Fraunhofer or Mie theory
- Control of the measurement process via SOPs
- Individual reports and layouts
- Comparison and min-max curves
- Freely selectable user values issued in a table format
- Statistical evaluation
- Capability for determination of the particle shape (elongation ratio)
- Manual entry of comparison data is possible
- Consideration of sieving results
- Conversion of the results to other methods of measurement
- Data export to Excel™
- SQL database
- Freely definable interfaces
- CFR 21 part 11 included as a standard feature
- Intuitive operation via central navigation area
- Easy-to-learn thanks to use of the Microsoft Office standard
- User interface multi-lingual



Diffraction pattern of a cube

Diffraction pattern of 5 cubes

Only with the **ANALYSETTE 22 NanoTec** can the information contained in the diffraction patterns also be used for particle shape analysis.

SIZE AND SHAPE ANALYSIS IN A SINGLE STEP

Measurements with the **ANALYSETTE 22 NanoTec** supply additional information about the particle shape in addition to the particle size distribution. With a detector especially designed for this purpose, it is possible to determine the relationship between the maximum and minimum average diameter – provided that the particles are not too small. This is a simple and reliable procedure that can be used, for example, if it is necessary to ensure that the particles are precisely spherical for use in a specific manufacturing process.

The FRITSCH software of the **ANALYSETTE 22** is compatible with WINDOWS Vista, XP and 2000. The software can be run on a Windows-PC with at least 500 MB of free hard drive space, 1 GB RAM, 2.4 GHz processor and a free USB-interface (MicroTec plus) or RS232-interface (NanoTec).

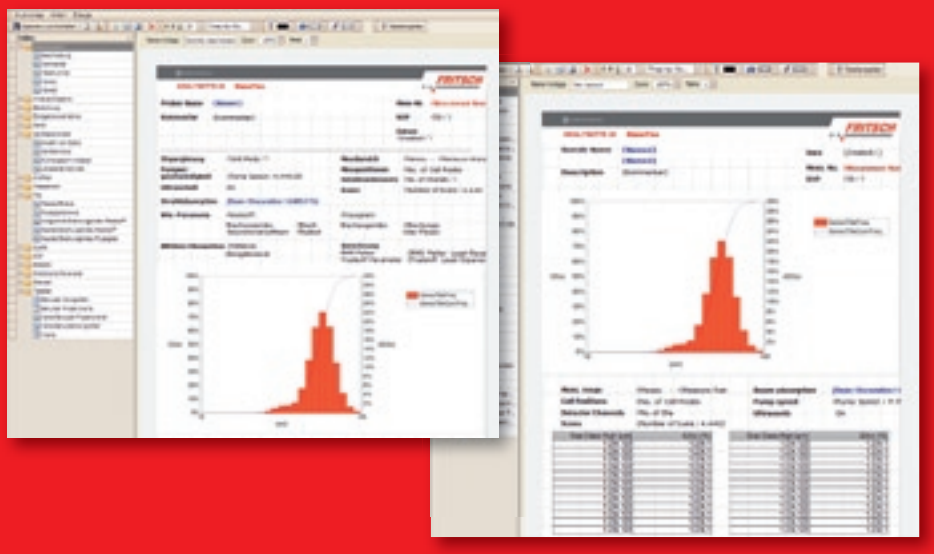
ANALYSETTE 22 Software

Extremely Simple Operation via Standard Operating Procedures – SOPs

An ANALYSETTE 22 can be used safely and faultlessly by anyone after only brief instruction. There is no need for expert knowledge or complex training thanks to the use of Standard Operating Procedures – SOPs for short – by the MaS control software. SOPs allow the entire measuring process for different sample types to be defined in advance according to specifically adapted measurement regulations. The actual measurement is then performed largely automatically. Especially safe: Selected elements in an SOP can also be locked out for specific user groups so that no alteration by the user is possible during performance of the measurement. Simply reliable.

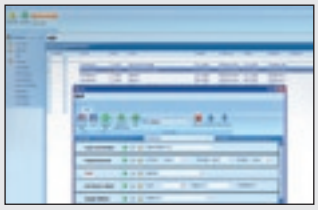
FLEXIBLE REPORT GENERATOR

In addition to integrated standard reports, the freely editable FRITSCH report generator offers flexible options for displaying the measuring results according to your individual needs. The reports can integrate graphs as well as all measuring parameters, statistical values or selected measured values. All results and templates are stored in an SQL database that is tamper-proof.



Easy Measurement in 5 Steps

You simply select the desired SOP and feed the sample into the ANALYSETTE 22 – the rest of the measurement takes place fully automatically.

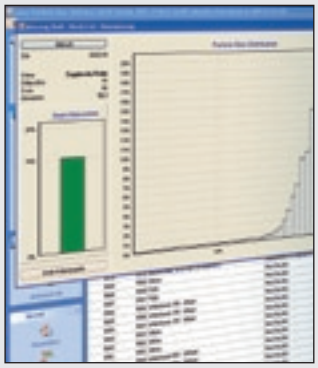


1. Selection of the Standard Operating Procedure (SOP)

After selecting the SOP, a background measurement without sample material is performed automatically. This identifies any contamination of the measuring cell, allowing this to be factored out in the subsequent analysis.

2. Adding the Sample

After the automatic prompt, the sample material is introduced. Depending on the material, particle size and dispersion unit used, the required sample volume lies in the range from one milligram to approximately 500 milligrams.

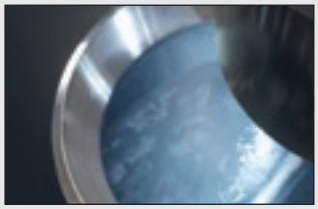


3. Automatic Start of the Measurement

The beam absorption of the laser is displayed during the feeding of the sample. As soon as this is sufficiently high (green bar), the measurement starts automatically after a brief delay: the measuring cell is moved to the correct position and the preconfigured number of measurement values are recorded. The entire measurement, including any time required for moving the measuring cell during the measurement, takes between 20 to 30 seconds for most applications. The dispersion time before start of the measurement can be freely configured.

4. Fully Automatic Analysis

Even the analysis of the measuring data takes place fully automatically according to the diffraction theory selected by the user – Mie or Fraunhofer. The result is displayed directly on the screen and can be printed out as a report and saved to the database. A subsequent recalculation with any altered physical parameters is possible at any time.



5. Fully Automatic Cleaning

It can already be configured within the SOP that the dispersion unit should be fully automatically emptied, rinsed and refilled with clean liquid after completion of the measurement so that the instrument is ready for the next measurement.

ONE STEP AHEAD.

ISO 13320

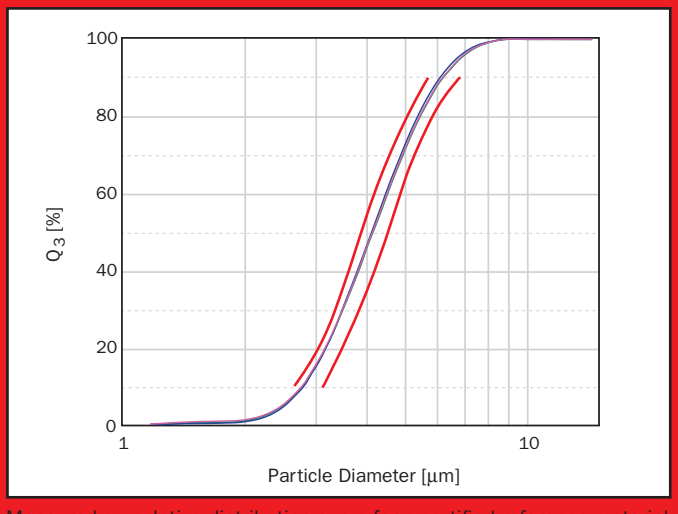
Guideline for Measurement of Particle Size Distribution with Laser Particle Sizers

Repeatability and accuracy of measuring results are of central importance in practical applications. In this regard, you can rely on the inspection of all FRITSCH Laser Particle Sizers according to ISO 13320 Particle Size Analysis – Laser Diffraction Methods. ISO 13320 lays down minimum standards, which are significantly exceeded by all FRITSCH instruments, and regulates their simple verification.

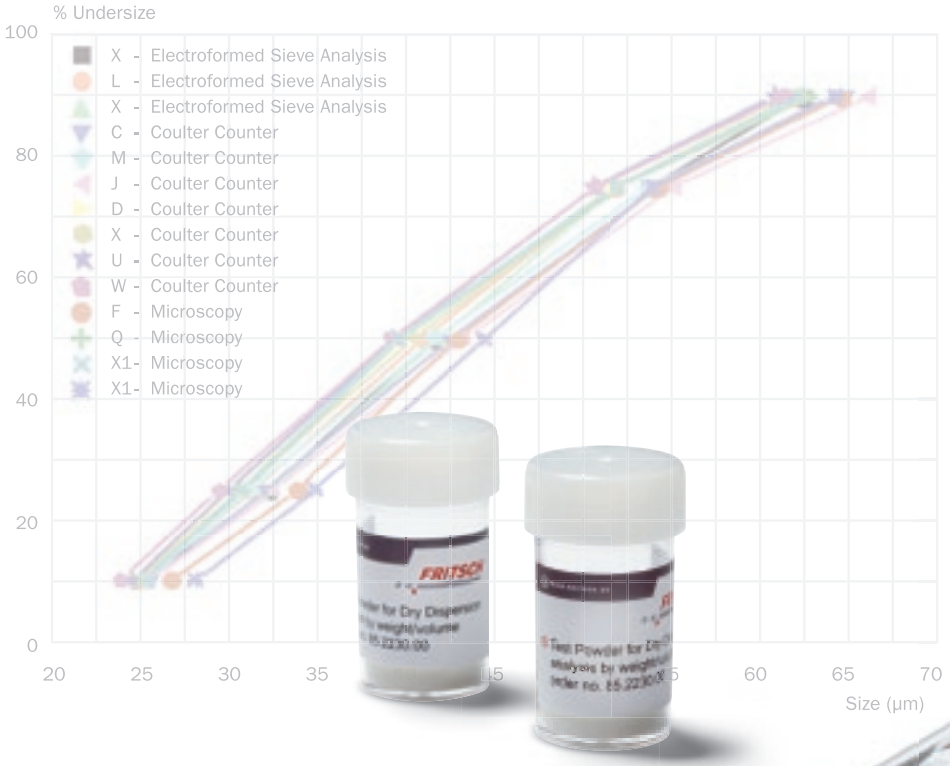
ISO 13320 defines:

- The fundamental measuring principle
- The optical arrangement of Laser Diffraction Instruments
- The key instrument parameters for users to ensure quick comparison of different instruments
- Important details on use of the physical theories of light scattering, in particular Mie theory or Fraunhofer theory
- Inspection of the minimum requirements for repeatability and accuracy with suitable standard materials

All Laser Particle Sizers from FRITSCH meet the requirements defined in the standard, for example in regard to repeatability, reproducibility and measurement precision.



Measured cumulative distribution curve for a certified reference material



Reference materials for inspecting the measuring system

REFERENCE MATERIALS

The particle size measurement using laser diffraction is based on fundamental physical relationships, meaning that calibration of the instrument is not necessary, strictly speaking. Nevertheless, the measuring instrument should be inspected regularly to ensure proper function. This is done with reference materials with a spherical shape that permits precise determination of the particle size with the help of laser diffraction.

The reference materials offered by FRITSCH are delivered along with precise dispersion and measurement instructions and are accompanied by a certificate that states the upper and lower limits of the expected particle sizes. These limit values were determined using an internationally recognised process (NIST-traceable).

TECHNICAL DATA – ANALYSETTE 22 MicroTec plus

Optical arrangement	Inverse Fourier design Movable measuring cell (FRITSCH patent) One or two measuring cell positions per measurement possible
Measuring range	0.08 – 2000 µm
Laser	Two semiconductor lasers Green (λ = 532 nm, 7 mW), IR (λ = 940 nm, 9 mW) Linear polarisation 10000 hours average lifetime Automatic shutoff when not needed
Fourier lenses	260 mm and 560 mm focal length (green or infrared) 10 mm diameter of the laser beam in the Fourier lens
Laser beam alignment	Automatic
Laser protection class	1 (according to EN 60825)
Sensor	2 segments 1 x for vertical and 1 x for horizontal direction of the laser light polarisation 57 elements
Number of particle size classes	Max. 108
Material used in sample circuit	Stainless steel, Viton, BK7 glass
Dispersion unit	Three different volumes configurable by software (300, 400 or 500 cm^3) In addition to water, all typical solvents can be used
Ultrasonic bath	36 kHz, variable output, max. 60 W
Pump	Adjustable radial pump 5.5 l/min maximum capacity (Pumping rate through entire measurement circuit)
Typical measuring time	5 – 10 s (measurement value recording of a single measurement) 2 min (whole measuring cycle)
Required computer	Standard Windows-PC, 2.4 GHz, at least 500 MB free hard drive space, 1 GB RAM, Windows 2000, XP (current service pack), Vista, USB-interface
Dimensions (w x d x h)	53 x 62 x 35 cm (measuring unit) 32 x 62 x 44 cm (wet dispersion unit)
Weight	38 kg (measuring unit) 30 kg (wet dispersion unit)

TECHNICAL DATA – ANALYSETTE 22 NanoTec

Optical arrangement	Inverse Fourier design Movable measuring cell (FRITSCH patent) Up to 10 measuring cell positions per measurement possible
Measuring range	Wet dispersion: 0.01 - 2000 µm, Dry dispersion: 0.1 – 2000 µm
Laser	Two semiconductor lasers Both red (λ = 655 nm, 7 mW) Linear polarisation 10000 hours average lifetime
Fourier lenses	500 mm and 190 mm (forward or backward laser) 10 mm diameter of the laser beam in the Fourier lens
Laser beam alignment	Automatic
Laser protection class	1 (according to EN 60825)
Sensor	2 segments 1 x for vertical and 1 x for horizontal direction of the laser light polarisation 80 elements (incl. elements for large-angle scattering and particle shape determination)
Number of particle size classes	Max. 520
Material used in sample circuit	Stainless steel, Viton, BK7 glass, polyamide
Dispersion unit	500 cm^3 volume Suitable for water 4/2-way valve
Ultrasonic bath	36 kHz, max. 80 W
Pump	Adjustable radial pump 5 l/min maximum capacity
Typical measuring time	5 – 10 s (measurement value recording of a single measurement) 2 min (typical time for whole measuring cycle – measuring time is lengthened, when more than 2 measuring cell positions are used)
Required computer	Standard Windows-PC, 2.4 GHz, at least 500 MB free hard drive space, 1 GB RAM, Windows 2000, XP (current service pack), Vista, RS232-interface
Dimensions (w x d x h)	80 x 65 x 122 cm
Weight	89 – 105 kg, depending on configuration

ORDERING DATA

Order No. **Article**

LASER PARTICLE SIZER

ANALYSETTE 22 MicroTec plus

22.8400.00 ***Measuring unit***
With USB-interface
For 100-120/200-240 V/1~, 50-60 Hz

22.8500.00 ***Wet dispersion unit***
300-500 ml ultrasonic bath, feed pump and flow measuring cell
For 100-120/200-240 V/1~, 50-60 Hz

22.8600.00 ***Dry dispersion unit***
For dispersion in a free jet with pre-dispersion
For 100-120/200-240 V/1~, 50-60 Hz
Available: mid-year 2009

Further accessories
22.8599.00 ***Small volume wet dispersion unit - EXTERNAL***
For manual change of the measuring cell
For 230 V/1~, 50-60 Hz

86.4630.00 ***Transformer***
To adapt voltage 115 V/1~ to 230 V/1~

Spare parts
22.8560.00 Flow measuring cell cpl. for inserting into the wet dispersion unit
22.8566.26 Measuring cell glass 4 mm for 22.8560.00
22.8561.00 Measuring cell glass cpl. 12 mm for 22.8560.00
84.0095.15 O-ring 64 mm x 1.5 mm for flow measuring cell
84.0315.15 O-ring 25 mm x 2.5 mm for flow measuring cell

Order No. **Article**

LASER PARTICLE SIZER

ANALYSETTE 22 NanoTec

22.2000.00 ***Combination instrument for wet and dry measurement***
For 100-240 V/1~, 50-60 Hz
22.2800.00 ***Instrument for wet measurement***
For 100-240 V/1~, 50-60 Hz
22.2900.00 ***Instrument for dry measurement***
For 100-240 V/1~, 50-60 Hz
22.2750.00 ***Instrument with small volume wet dispersion unit***
For 100-240 V/1~, 50-60 Hz

Further accessories
22.3830.00 ***Small volume wet dispersion unit - EXTERNAL***
For manual change of the measuring cell
For 100-240 V/1~, 50-60 Hz
43.9025.00 ***Exhaust system for dry measurement***
For 230 V/1~, 50-60 Hz, 1000 watt
43.9010.00 ***Exhaust system with hose and ultra-fine filter for dry measurement***
Dust category „H“ according to DIN EN 60335-2-69
For 230 V/1~, 50-60 Hz

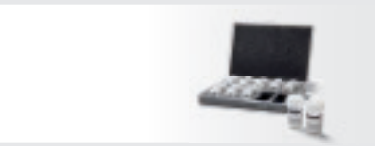
Spare parts
22.1100.00 Flow measuring cell cpl. for inserting into the wet dispersion unit
22.1105.26 Measuring cell glass 4 mm for 22.1100.00
22.1109.00 Measuring cell glass cpl. 12 mm for 22.1100.00
84.0095.15 O-ring 64 mm x 1.5 mm for flow measuring cell
84.0315.15 O-ring 25 mm x 2.5 mm for flow measuring cell

22.2009.00 Dry measuring cell cpl. for inserting into the dry dispersion unit
22.0430.26 Measuring cell glass for 22.2009.00

Order No. **Article**

LASER PARTICLE SIZER

CERTIFIED REFERENCE MATERIALS AND CERTIFICATES
ANALYSETTE 22 MicroTec plus / ANALYSETTE 22 NanoTec



Certified reference materials for performance verification
85.2220.00 Test powder for wet dispersion (Box with 10 single-shots 0.5 g)
85.2230.00 Test powder for dry dispersion (Box with 10 single-shots 0.5 g)
85.2240.00 Test suspension nano for system check (Box with 10 single-shots 5 ml)
85.2250.00 Test suspension 1 µm for system check (Box with 10 single-shots 5 ml)
85.2260.00 Test suspension 10 µm for system check (Box with 10 single-shots 5 ml)

Certificates for tests according to ISO 13320-1
96.0080.00 Performance Verification for wet dispersion
96.0081.00 Performance Verification for dry dispersion
96.1000.00 Set of IQ/OQ blank forms (standards not included)

Sample division
For representative sample division, we recommend the Rotary Cone Sample Divider LABORETTE 27 – the foundation for any precise analysis. More information is available at **www.fritsch.de**.

All FRITSCH Laser Particle Sizers include the new MaS control software. This software is also available for download from **www.fritsch-laser.com**.

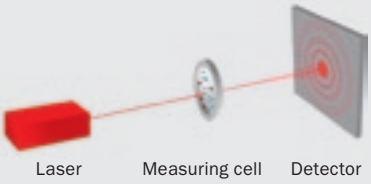
Maintenance and Recalibration of your Laser Particle Sizers on request.

Computer, colour ink jet printer and laser printer on request.

BRIEF INTRODUCTION TO LASER PARTICLE SIZE MEASUREMENT

PRINCIPLE OF LASER DIFFRACTION

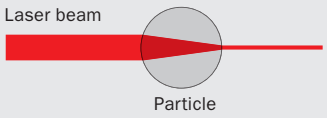
Particle measurement with laser diffraction is actually very simple: to measure the size of a particle, a laser beam is directed at it. The partial deflection of the laser light results in a characteristic, ring-shaped intensity distribution behind the sample which is measured by a specially shaped detector. The particle size is calculated based on the spacing of these rings: large particles produce closely situated rings; small particles produce more widely spaced rings. That is the principle.



BASIC CONCEPTS

The illumination of a particle with light results in various effects that collectively lead to a weakening of the light beam. This extinction is essentially the sum of absorption and deflection of the light from the original direction.

In the absorption, the particle takes up a portion of the electromagnetic energy from the light and converts it primarily into heat. This phenomenon plays a large role in Mie theory.

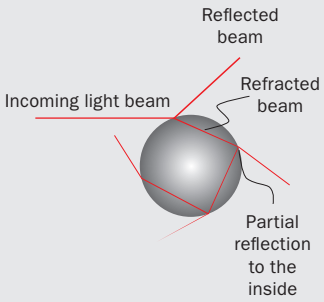


Three different effects fundamentally contribute to the deflection of the incoming light: diffraction, reflection and refraction.

- To understand the **diffraction** it is necessary to imagine the light beam as a broad wave front. When this wave front encounters a particle, new waves are produced at its edges which run in different directions. The overlapping (interference) of the many new waves results in a characteristic diffraction pattern behind the particle which is uniquely determined by the diameter of the particle. Its exact progression is described by Fraunhofer theory.

- The **reflection** occurs mostly on the surface of a particle – according to the law which states: angle of incidence is equal to angle of reflection. This portion of the scattered light cannot be used for particle size determination.

- **Refraction** involves the changing of the light beam direction at a transition between two materials with different indexes of refraction. A light beam that hits a rain drop, for example, is first refracted toward the middle of the drop and then repeatedly reflected into the drop again upon encountering the drop‘s outer edge. A portion of the light also escapes the drop during each reflection.

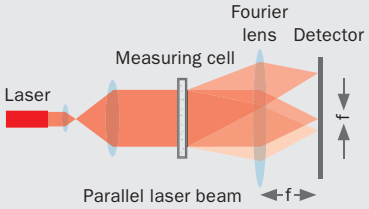


DESIGN OF A LASER PARTICLE SIZER

A significant component of every Laser Particle Sizer is the Fourier lens that focuses the scattered light of the laser within the beam path onto the detector. Its position defines the key difference between a conventional design and the Inverse Fourier design.

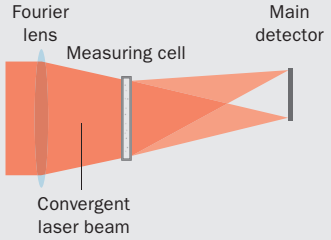
- **Conventional Design**

  In the conventional arrangement, the Fourier lens is situated between the detector and the measuring cell, through which a wide, parallel laser beam passes. The disadvantage: only a limited particle size range can be detected, and in order to change the measurement, it is necessary to change the lens and adjust it very precisely. Also, the ability to measure large scattering angles for particularly small particles is severely limited.



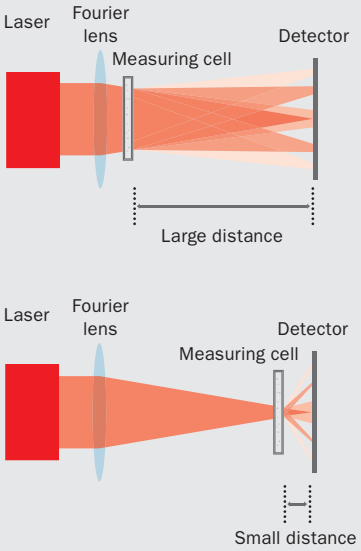
- **FRITSCH Technology: Inverse Fourier Design**

  25 years ago, FRITSCH was the first company in the industry to bring a revolutionary alternative to the conventional design onto the market in the form of a convergent laser beam: by positioning the Fourier lens in front of the measuring cell, a convergent laser beam passes through the measuring cell. The scattered light is focused directly onto the detector without additional optical elements. This design is now in widespread use, and most manufacturers use a main detector for capturing the small scattering angles for measuring of large particles. For the large scattering angles of small particles, a side detector system must then be integrated, generally consisting of only a few detector elements. FRITSCH has progressed another step further.

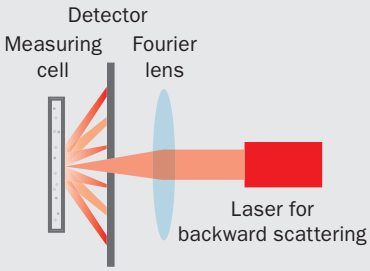


- **The FRITSCH ZOOM-Patent**

  For infinite adjustment of the measuring range for each individual sample and to achieve a particularly high resolution, FRITSCH has developed the patented principle of movable measuring cells. With this practical ZOOM-function, you can easily move the measuring cell between the Fourier lens and the detector. If it is positioned far from the detector, the weakly scattered light covers the entire detector and uses all channels for the measurement. In this way, a course-grained material can be measured optimally. If the measuring cell is positioned close to the detector, the strongly scattered light beams of small particles are captured by the detector with the full resolution. If necessary, up to 10 positions **(ANALYSETTE 22 NanoTec)** can be combined together so that the entire measuring range is measured with an effective total of 520 detector channels. The result: A measured particle size distribution with outstanding resolution.



- **FRITSCH Technology: Simple Measurement of the Backward Scattering**
  Another advantage of the FRITSCH patent: the measuring cell can be positioned directly in front of the detector to measure the very small particles below 100 nanometres (nm) of particle diameter. Through a small opening at the centre of the detector, the sample is irradiated by a second laser beam from behind and the backward scattered light can be captured with the full resolution of the detector under very favourable geometric conditions. The result: a very efficient and precise measurement of the backward scattering without complicated coordination of various detector systems.



THEORIES FOR ANALYSIS

The actual result of a particle size measurement is only created through analysis with the supplied FRITSCH software. Depending on the particle properties and requirements, two common analysis theories are used for this: Fraunhofer theory for larger particles when their exact optical parameters are unknown and Mie theory for the smallest particles with known optical parameters. It is very easy to select both theories in the FRITSCH MaS control software.

The Fraunhofer Theory

Fraunhofer theory describes the portion of light deflection that occurs exclusively as a result of diffraction. If light encounters an obstacle or an opening, this results in diffraction and interference effects. If the incoming light is parallel (even wave fronts), this is referred to as Fraunhofer diffraction. This is always the case if the light source is located at infinity or is "shifted" there by a lens. Since for sufficiently large particles the light deflection is dominated by diffraction, Fraunhofer theory can be used for particle size distribution down to the lower micrometre range. One major advantage of Fraunhofer theory lies in the fact that no knowledge of the optical properties of the examined material is required.

$$I(\theta) = |U(\theta)|^2 = I_0 \left[\frac{2J_1(kr \sin\theta)}{kr \sin\theta} \right]^2$$

The Mie Theory

For particles with diameters that are not significantly larger than the wavelength of the light used, the Mie theory is applied for the analysis of the measurements. This theory was developed at the start of the 20th century by Gustav Mie and is the complete solution of the Maxwell equations for the scattering of electromagnetic waves by spherical particles. It can be used to analyse the characteristic intensity distributions for even very small particles, which, in contrast to Fraunhofer theory, are not restricted to scattering angles of less than 90° (forward scattering). In fact, scattering angles of greater than 90° also occur (backward scattering). In order to be able to use the intensity distribution for the calculation of the particle size, determined in this manner, the refraction index and absorption index of the sample must be known with the Mie theory in contrast to the Fraunhofer theory. The FRITSCH software includes a comprehensive database containing the refraction indexes of numerous different materials.

$$\begin{pmatrix} E_{1s} \\ E_{2s} \end{pmatrix} = \begin{pmatrix} S_1(\theta) & 0 \\ 0 & S_2(\theta) \end{pmatrix} \frac{e^{i(kr-\omega t)}}{ikr} \begin{pmatrix} E_{1i} \\ E_{2i} \end{pmatrix}$$

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