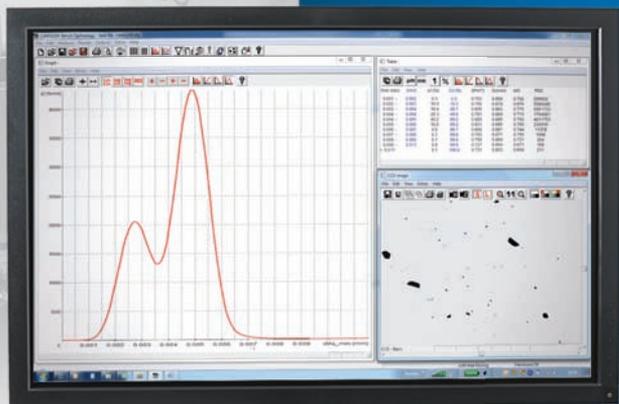


x [mm]	SPHT	n
0.023	1.0009	140
0.989	1.0111	191
1.145	1.0179	131
1.219	1.0092	169
1.326	1.0006	502
1.594	1.0000	4753
1.863	1.0006	3653
2.289	1.0377	110
2.423	1.0703	47
2.686	1.1424	26

Particle Analyzer CAMSizer XT

Particle Size and Particle Shape Analysis
with dynamic image analysis

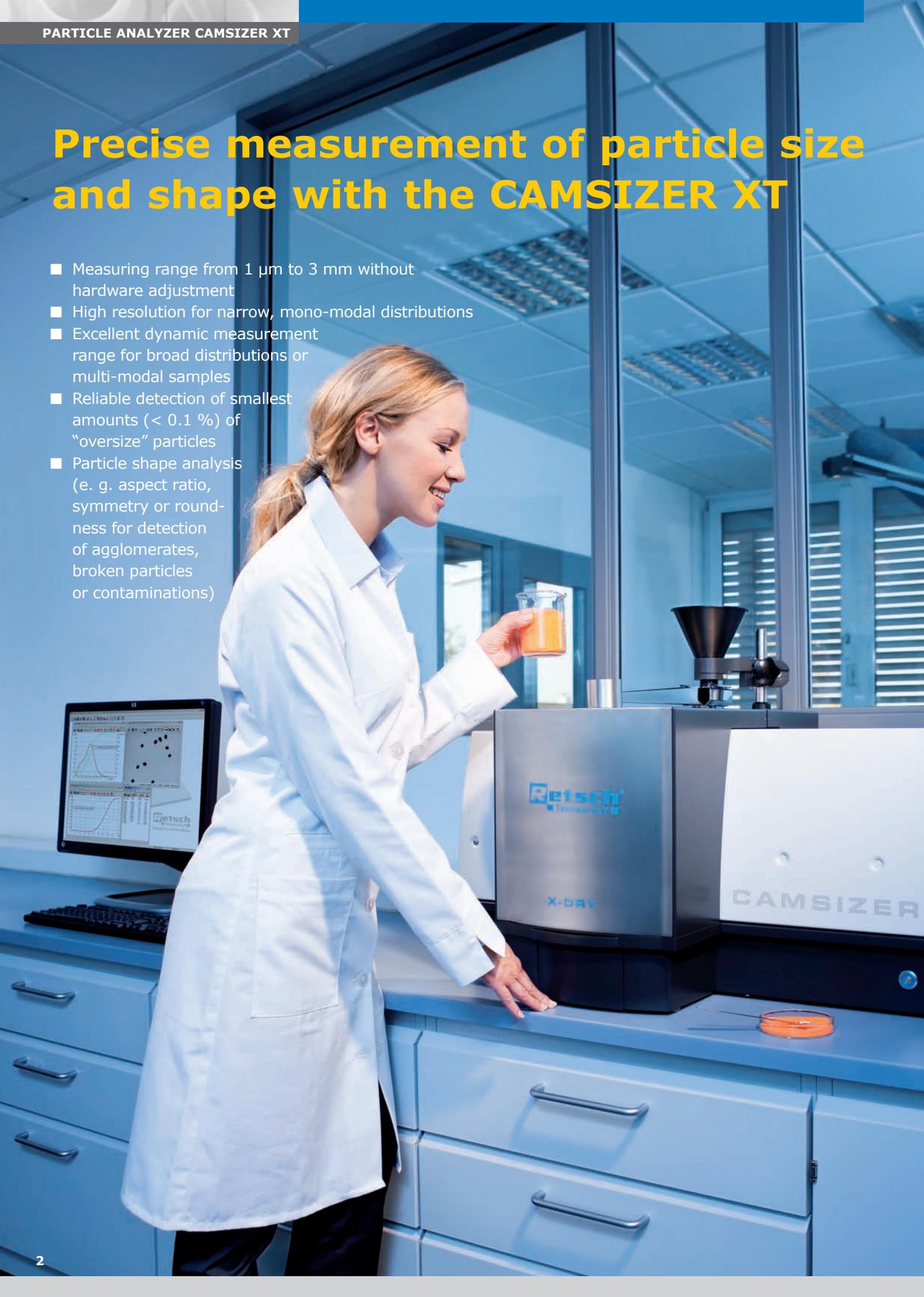
Measurement of fine powders,
granules and suspensions
in a range from 1 μ m to 3 mm



Retsch[®]
TECHNOLOGY
Solutions in Particle Sizing

Precise measurement of particle size and shape with the CAMSIZER XT

- Measuring range from 1 μm to 3 mm without hardware adjustment
- High resolution for narrow, mono-modal distributions
- Excellent dynamic measurement range for broad distributions or multi-modal samples
- Reliable detection of smallest amounts (< 0.1 %) of "oversize" particles
- Particle shape analysis (e. g. aspect ratio, symmetry or roundness for detection of agglomerates, broken particles or contaminations)



Product videos at
www.retsch-technology.com

Particle Analyzer CAMSIZER XT

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Measuring range
 from 1 μm to 3 mm



Experts for Particle Measurement Technology

Retsch Technology's core competence is to combine innovative technology for particle characterization and quality control with a maximum of operating convenience.



The product line for particle characterization covers a size range from 0.3 nm to 30 mm. The instruments, which operate with different measurement techniques, allow for analyses of particle size and particle shape of suspensions, emulsions, colloidal systems, powders, granules and bulk materials.

Retsch Technology offers individual support through a worldwide agency network. Samples can be analyzed with the suitable method and instrument at the company's application laboratory in Haan, providing existing and potential customers with tailor-made solutions for their specific application.

Together with our sister company Retsch GmbH we offer a complete product line for sample preparation of solids (size reduction, sample division, analytical sieve shakers).

One measurement method, two application fields

Digital dynamic image processing with the CAMSIZER and the CAMSIZER XT

The CAMSIZER XT is the latest member of the CAMSIZER-family of dynamic image analysis instruments. Both CAMSIZER and CAMSIZER XT are based on the same proven patented two-camera system. More than 500 CAMSIZER systems installed worldwide are measuring particle size distribution and shape of pourable bulk materials in the range from 30 μm to 30 mm. Even the first units, which were commissioned more than 12 years ago, still deliver reliable and accurate results – day by day. Where the CAMSIZER is optimized for the detection of relatively large, free flowing particles, the CAMSIZER XT has been developed for the measurement of finer powders and agglomerated particles. This refers to both the optical components and the sample feeding and particle dispersion systems. The CAMSIZER XT features interchangeable module options for dry and wet samples, thus offering more flexibility to meet the requirements of

Measuring range
 from 30 μm to 30 mm



the finer powders. Both instruments operate with the same reliable and comprehensive software. **Depending on the particle size and the degree of agglomeration, either the CAMSIZER or alternatively the CAMSIZER XT represent the optimum solution for your particular sample and your analytical requirements.**

The Particle Analyzer CAMSIZER XT



Benefits at a glance

- Digital image processing with patented two-camera system (according to ISO 13322-2)
- Wide dynamic measuring range from 1 μm to 3 mm
- State-of-the-art optical system with ultra-strong LEDs for highest resolution and excellent depth of focus
- Reliable detection of smallest amounts of "undersize" and "oversize" particles
- Particle shape analysis (e. g. aspect ratio, symmetry or roundness for detection of agglomerates, broken particles and contaminations)
- Very short measurement time of 1 – 3 minutes
- Excellent reproducibility
- Modular system "X-Change" for dry and wet measurement
- Measurement results are 100 % compatible to sieve analysis (optionally)

The quality control of fine powders can be substantially improved with the CAMSIZER XT: More precise and faster analysis of particle size and particle shape helps to improve product quality, reduce rejects and save costs.

The CAMSIZER XT is an advancement of the well-proven optical measurement system CAMSIZER for finer samples. It not only features newly developed optics with a higher resolution but also enhanced options for sample feeding. Fine particles tend to agglomerate which makes it difficult to detect the geometric dimensions of each individual particle. It is therefore beneficial to have various possibilities of feeding the sample to the measurement area, finding for each material the best way to separate the agglomerates without destroying the primary particles.

The CAMSIZER XT provides flexible solutions: from the free fall mode, which is the most gentle method for the material,

to air pressure dispersion with adjustable pressure and variable nozzle geometry and, additionally, a wet module in which particles are dispersed in liquids, optionally by an ultrasonic probe.

IDEAL FOR:

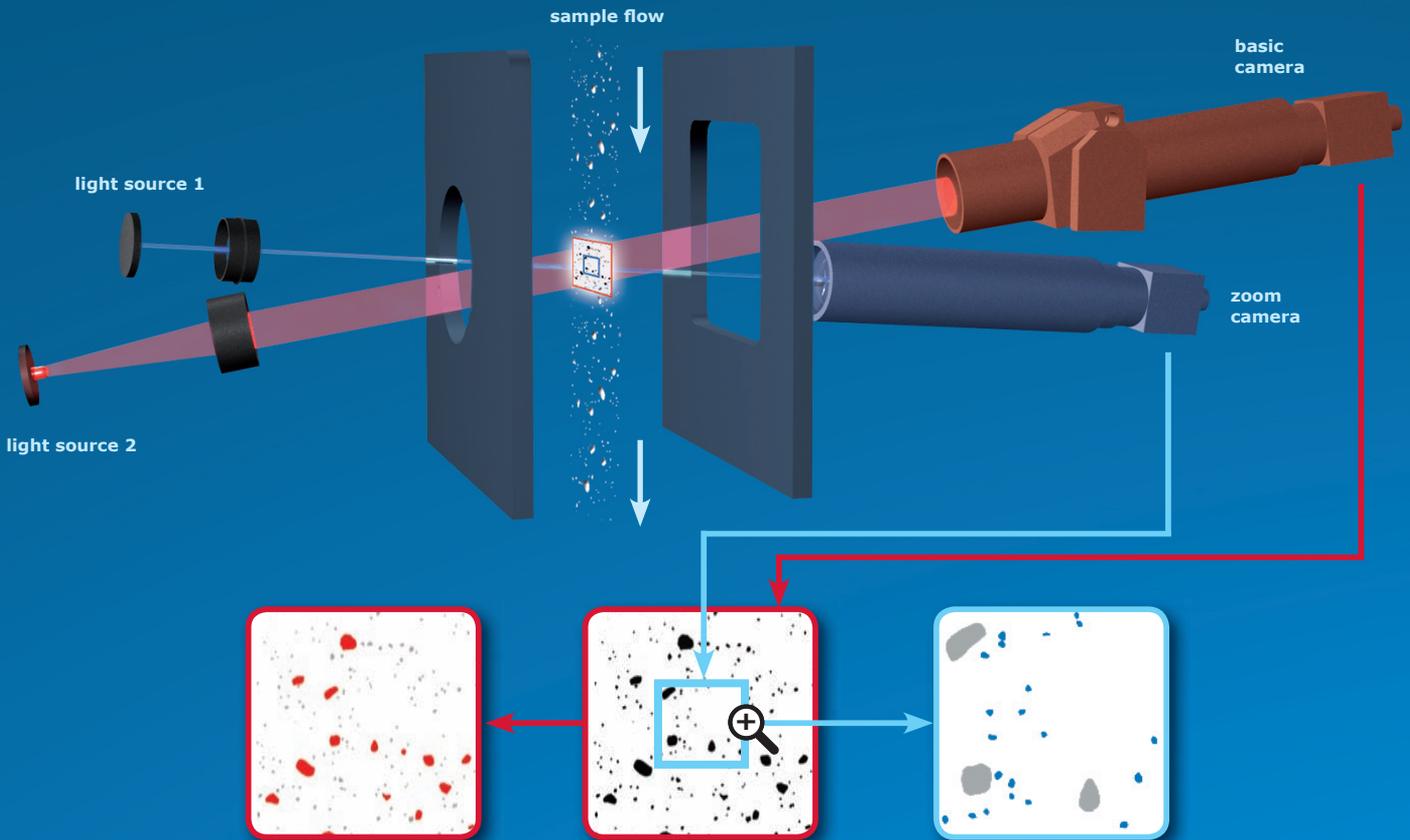
- Pharmaceutical powders, granules and fine pellets
- Pulverized and granulated food
- Detergent powder and raw materials
- Plastic powders (also with electrostatic charge)
- Metal and ore powders
- Abrasives (medium-sized and small grit)
- Fine sands and cement
- Fine wood fibers
- Fine plastic fibers

Certified calibration standard

Recalibrating the CAMSIZER XT is a matter of seconds with the help of a highly precise ($\pm 0,1 \mu\text{m}$) reference object, made by electron beam lithography, which simulates differently sized particles. This allows fully traceable and verifiable calibration and calibration status recording.



The patented measurement principle



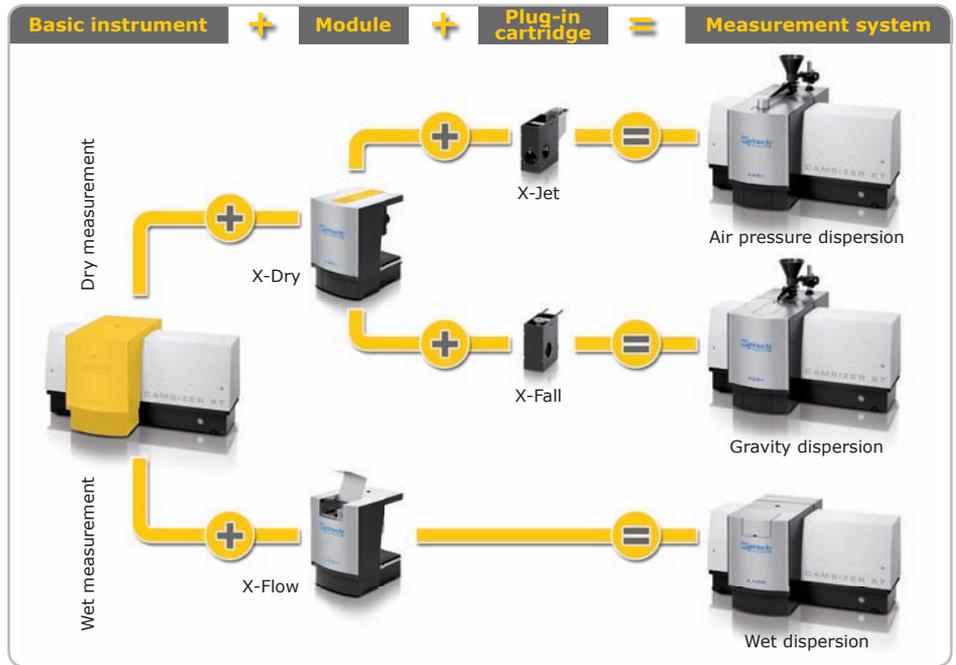
The patented measurement principle is fairly simple: Dispersed particles pass in front of two bright, pulsed LED light sources. The shadows of the particles are captured with two digital cameras. One camera is optimized to analyze the small particles with high resolution, the other camera detects the larger particles with good statistics, due to a large field of view. Each camera is illuminated by one LED with optimized brightness, pulse length and field of illumination. To cover a small measuring window of limited space with two light sources, optics and cameras, the **X-Technology** was developed: the optical paths of both cameras intersect in the measurement area. Particle size and particle shape are analyzed with a user-friendly software which calculates the respective distribution curves in realtime.

Modular design for optimum measurement conditions

The CAMSIZER XT's "X-Change" system offers three alternative dispersion methods, allowing the selection of the optimum method for each sample type.

- Air pressure dispersion
- Gravity dispersion
- Wet dispersion

The modules/plug-in cartridges are easily exchanged in one minute allowing for a comfortable switching between dispersion methods. Watch the video on www.retsch-technology.com/camsizerxt to see how easily the "X-Change" system is handled.



Air Pressure Dispersion with "X-Jet"

Measuring range from 1 µm to 1.5 mm

Particles under pressure

The dispersion, that means the separation of the particles when passing through the measurement area, is a crucial precondition for a correct measurement of the particles. Thanks to the flexible pressure adjustment of the "X-Jet" plug-in cartridge each material can be measured under optimum conditions.

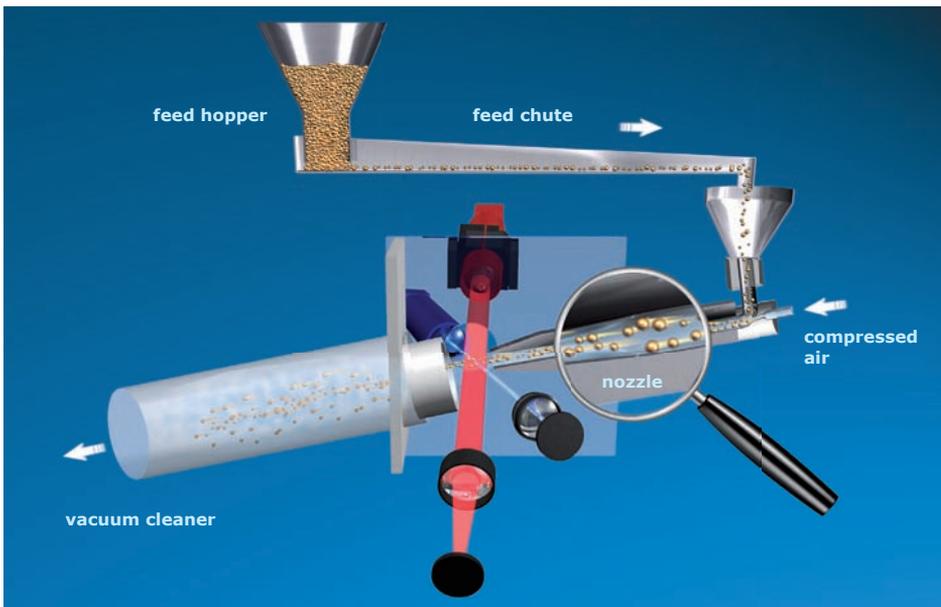
Small particles have a relatively large surface area but small weight, which increases the effects of Van-der-Waals forces or electrostatic charges, leading to aggregation and clumping of particles. When passing through the nozzle, the sample material is dragged along by the compressed air

and submitted to shear forces which break up agglomerations. These effects are enhanced by increasing pressure, separating even very strong agglomerates.

Too much pressure, however, can be counter-productive: the shear forces can destroy the primary particles thus "grinding" the particles inside the nozzle. With the dynamic image processing method it is possible to detect broken particles by analyzing the particle shape, and then re-adjusting the pressure as required. Other measurement methods, such as laser diffraction, for example, use similar dispersion principles; however, they do not provide particle shape analysis as a feedback signal.

The sample is collected in a vacuum cleaner after the measurement. If the sample material needs to be recovered for further analysis, an optional cyclone is available.

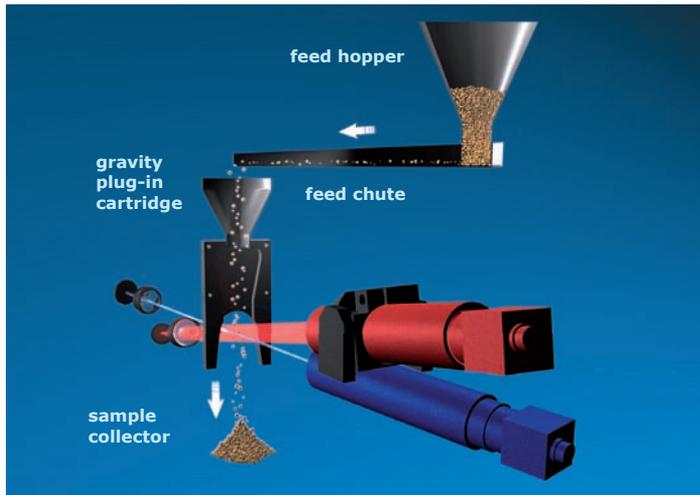
Although the air pressure dispersion accelerates the particles to up to 50 m/sec, the patented two-camera system ensures that wide particle size distributions as well as narrow, mono-modal samples below 10 microns are analyzed accurately.



Gravity Dispersion with "X-Fall"

Measuring range
from 10 μm to 3 mm

All falling together



Pourable, not agglomerated samples can be analyzed by using the "X-Fall" plug-in cartridge. In this mode the particles fall from the chute through the field of view of the two cameras accelerated by gravity. Thanks to the comparably low speed of the particles, the large field of view and the high frame rate, the detection efficiency is very high, even for large particles of e. g. 3 mm. Only a few coarser particles in the sample are sufficient for the reliable, reproducible detection.

After the measurement the sample material falls into a collector box and is available for further analyses without loss or contamination.



Wet Dispersion with the "X-Flow" Module

Measuring range
from 1 μm to 600 μm

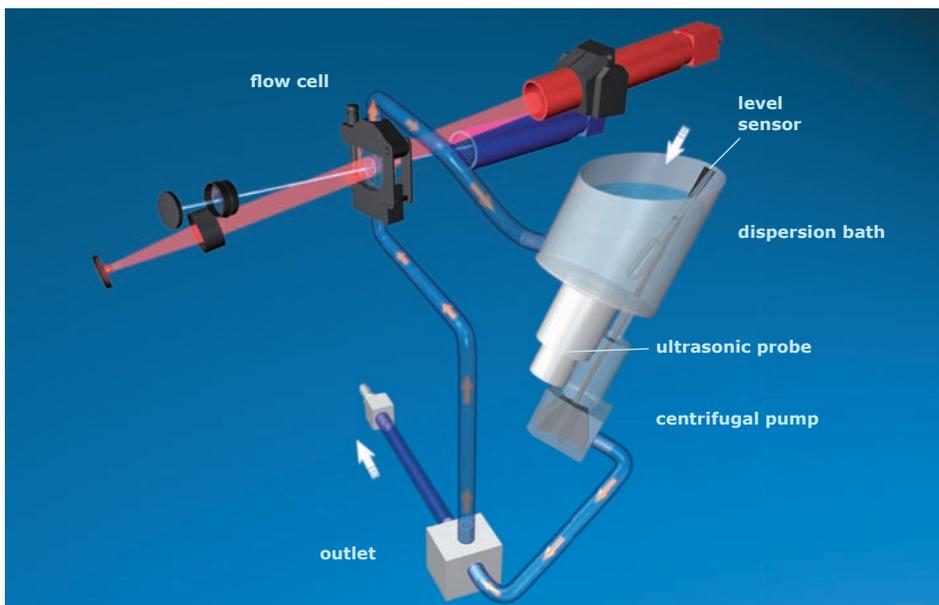
Going with the flow

The wet module "X-Flow" analyzes samples in a range from 1 to 600 microns in suspensions or emulsions. An advantage of this module is the small required sample volume. A low particle concentration in the dispersion medium of, for example, 20 mg/l is already sufficient to detect enough particles for a reproducible result

in only 1 minute. Therefore, this module is highly suitable for applications involving pharmaceuticals or explosives, when only a limited amount of sample material is available or advisable for safe operation. It can also be used for other "moist" samples including food or sand.

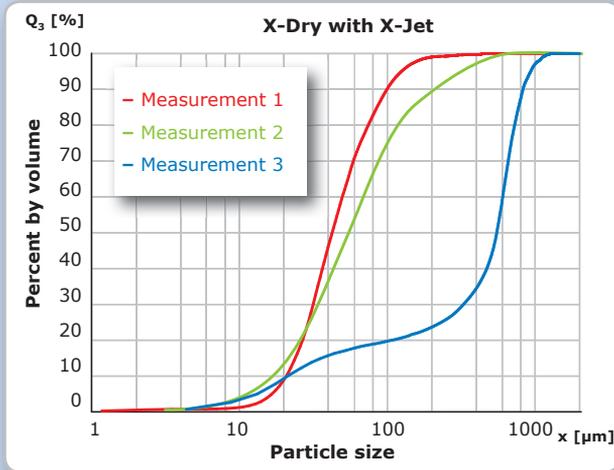
The measurement range of the "X-Flow" module starts at 1 micron. The CAMSIZER XT also analyzes particles larger than 1 mm without difficulty, provided they are kept suspended in the dispersion medium. Depending on the maximum particle size of the sample, measurement cells of up to 4 mm can be used. Agglomerates can be further separated by an integrated ultrasonic probe.

For applications with organic solvents as dispersion medium, the CAMSIZER XT is optionally available with a circulation system consisting of PTFE components and solvent-resistant seals.



Key features

1 Wide dynamic measurement range



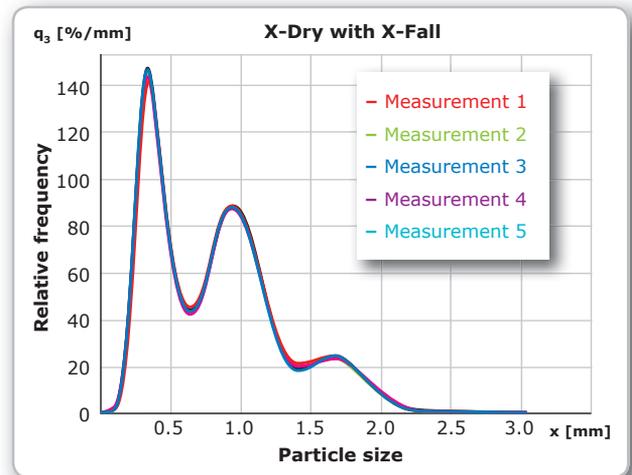
Example: Coffee

Thanks to the patented two-camera principle, the CAMSIZER XT offers excellent resolution for fine particles as well as outstanding statistics for large particles which is crucially important for the detection of small amounts of oversized particles. The graphic shows a comparison between three differently ground coffee powder samples. The red curve represents a narrow size distribution while the green curve shows a much larger amount of over- and undersized grains. The blue curve is a mixture, showing a significant amount of coarse particles even larger than 1 mm. An exceeding amount of fines in the coffee powder could result in blocked filters, while too coarse particles release less flavor into the brew, which makes the coffee taste less strong and aromatic.

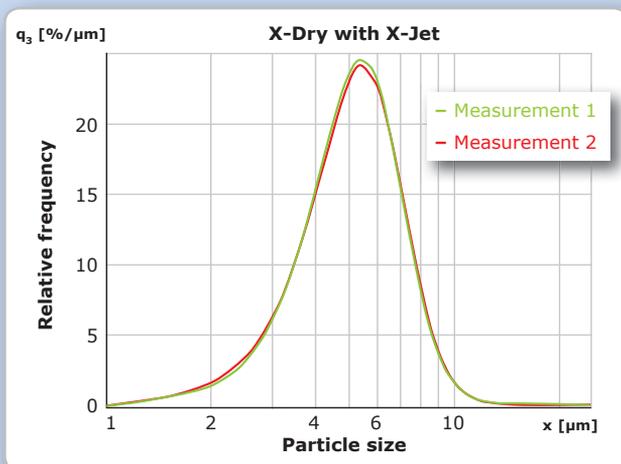
2 Outstanding repeatability and reproducibility

Example: Glass beads

The large image area of the patented two-camera system guarantees detection of the full width of the particle stream. The result is outstanding repeatability, even for small sample volumes. The graphic shows 5 successive measurements of a tri-modal mixture of glass beads in the size range between 50 microns and 1.5 mm. Each measurement took approx. 2.5 minutes, with about 5,000,000 detected particles each, and is almost exactly identical to the other curves. Furthermore, every CAMSIZER XT is calibrated with a certified, NIST traceable reference standard and the operation is simplified by employing Standard Operating Procedures. This not only optimizes the repeatability of the results in the same lab, but also the reproducibility of measurements taken at different facilities all over the world.



3 High resolution for narrow distributions



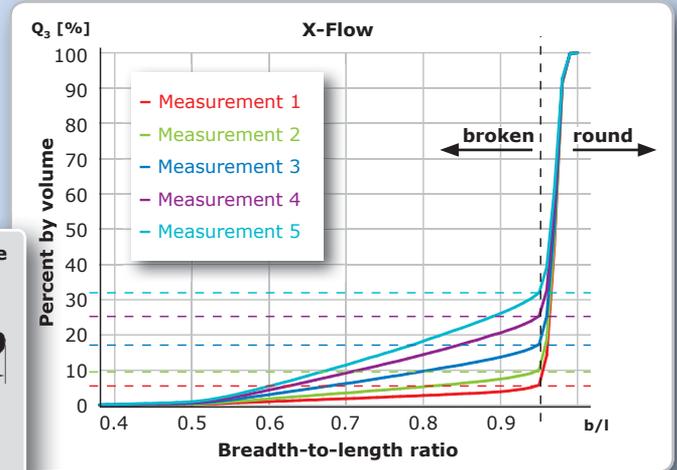
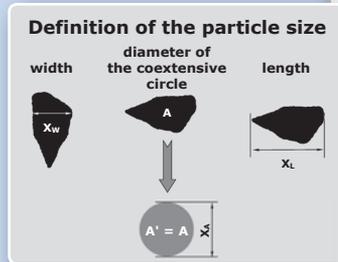
Example: Abrasives (microgrits)

For the production of abrasives, the amount of oversized and undersized particles has to be analyzed particularly accurately. The oversized particles could create scratches in the polished surfaces whereas the undersized material requires more adhesive to bind the abrasive grains on a substrate. The X-Jet plug-in cartridge allows for the precise and reproducible analysis of fine powders down to 1 micron. The graphic shows a silicon carbide SiC microgrit sample with a size distribution at the lower end of the CAMSIZER XT measuring range, between 1 and 12 microns. The precise determination of the size distribution guarantees an optimum between abrasion rate and surface roughness.

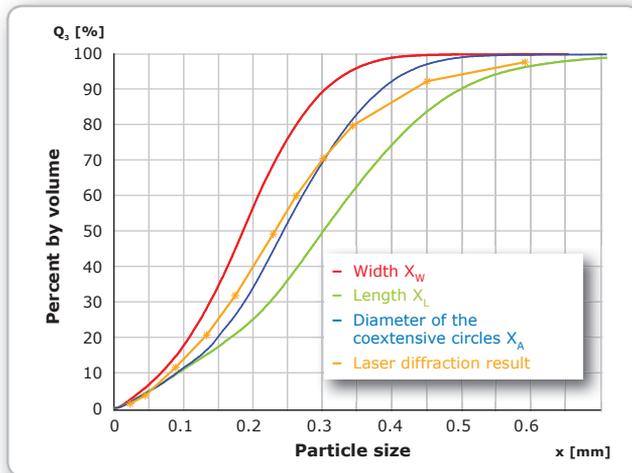
4 Particle shape analysis

Example: Catalysts

Non-spherical, broken catalyst balls can be detected by looking at parameters like the aspect ratio (width divided by length of each particle, b/l) or the symmetry. The graphic shows a series of measurements with increasing amounts of broken particles. The original material is almost perfectly round, with b/l values above 0.95 (red curve). After each treatment with ultrasound the amount of broken particles increases. The amount of broken particles can be derived directly from the graph at the threshold value of b/l equal 0.95. A picture of the particles taken by the CAMSIZER Basic camera is shown on page 10, item 9.



5 Direct analysis principle

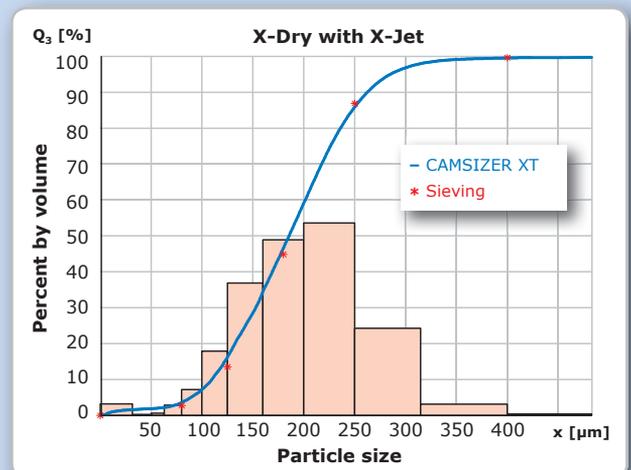


Dynamic image analysis enables simultaneous determination of the size distribution with regards to width X_w (red), length X_l (green), and average diameter X_A (blue). The orange curve shows the result of a laser particle sizer. The laser sizer results correlate well with the average diameter X_A of the image analysis. However, there are some remarkable differences: The result of the laser sizer shows a wider distribution. In the range of the large particles around 0.5 mm the graph of the laser sizer shows about 5% of oversized particles, which do not exist according to the sieve results. These are identical to the width analysis X_w of the CAMSIZER XT. The laser scattering method mixes the information obtained from the diameter and the length of the particles, and delivers a comparable result only for the rare case of round particles. The curves shown in this example are typical for non-spherical, irregular shaped particles.

6 Size results 100% compatible with sieve analysis

Example: Mineral granulate

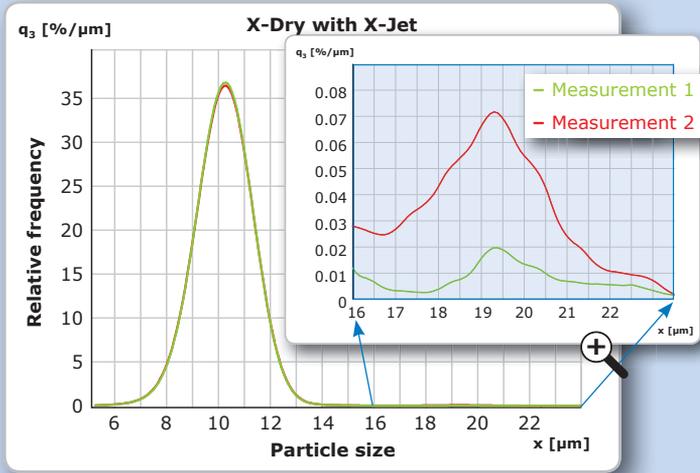
Sieve analysis results can be compared directly with the CAMSIZER XT data. The example shows the measurement of a granular mineral which is used as an animal food additive. Thanks to the perfect match between CAMSIZER XT and sieve analysis, product specifications of suppliers and customers can be directly compared even if they have been measured with different analysis techniques.



Key features

7

Reliable detection of oversized particles



Example: PMMA micro beads

The CAMSIZER XT features the latest camera technology with high frame rates and high resolution 16-bit grayscale images, to detect as many particles as possible in the shortest time. The graphic shows the comparison of two samples with different amounts of oversized particles. Sample 2 (red) contains more oversized particles at 20 microns than sample 1 (0.2%). The detection efficiency for small amounts of oversized particles is much better with the CAMSIZER XT than with any laser particle sizer (factor 100).

8

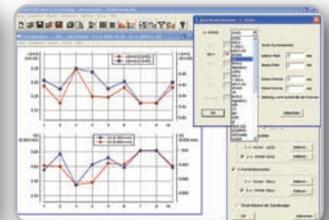
Robust hardware, easy operation for routine analyses

High speed data acquisition – more than 275 16-bit gray level images per second, with typically a few hundred particles per image – requires not only fast computer hardware, but also powerful software. The process-orientated CAMSIZER XT control and evaluation software delivers particle size distributions (volume, number, area), and all relevant calculated numbers for particle shape and particle size such as mean value, distribution width and standard deviations in real time.

Product specific settings of analysis parameters are stored as Standard Operating Procedures (SOP) which simplifies the switching between several regularly recurring sample types. The SOPs can be password-protected against manipulation, ensuring maximum data reliability thanks to consistent instrument settings and data output formats.



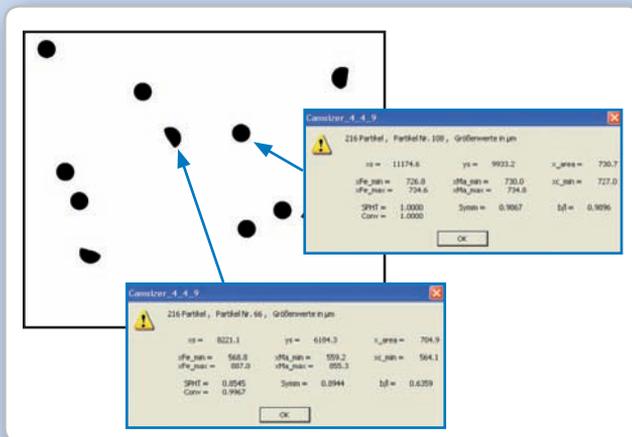
Quality control during measurement



Trend analysis of production processes

9

Analysis of individual particles



“What you see is what you get”

With the Camsizer XT software it is also possible to store and process images of individual particles. With one mouse click on the particle of choice all properties of this particle with respect to size and shape are displayed. Thus, an intuitive understanding of the results can be developed to understand which numbers correspond to “good” or “bad” particles. This is especially important for the development of new SOPs, to verify, for example, the thresholds which are set in the software to distinguish different particle types automatically. Optionally, the software can detect agglomerated particles, and factor them in the calculations accordingly, respectively also exclude them from the results.

Sieving, Laser Diffraction or Dynamic Image Processing?

A comparison of measurement techniques

Performance Features	CAMSIZER XT	Sieving	Laser Diffraction	opt. Microscope
1 Wide dynamic measurement range	++	+	++	-
2 Reproducibility and repeatability	++	+	++	-
3 High resolution for narrow distributions	++	-	-	++
4 Particle shape analysis	++	-	-	++
5 Direct measurement technique	++	++	-	++
6 Compatibility of results with other techniques	+	-	-	-
7 Reliable detection of oversized grains	+	++	-	-
8 Robust hardware, easy operation for routine analysis	++	++	+	-
9 Analysis of individual particles	+	-	-	++
10 High measurement speed, short measurement times	++	-	++	-



Specifications

Specifications CAMSIZER XT	
Measurement Ranges:	Module "X-Dry" with "X-Fall" plug-in cartridge 10 µm to 3 mm Module "X-Dry" with "X-Jet" plug-in cartridge 1 µm to 1,5 mm Module "X-Flow" 1 µm to 600 µm
Measurement principle:	Dynamic Digital Image Processing (ISO 13322-2)
Measurement time:	approx. 1 to 3 min. (depends on required measurement statistic)
Sample volume:	<20 mg - 100 g (depends on sample type and measurement mode)
Measurement speed:	>275 images/sec. each with approx. 1.3 MPixel
Width of analysis area:	20 mm (FoV)
Resolution:	1 µm
Measurement parameters:	Particle size (smallest diameter, length, mean diameter) Particle form (Aspect ratio breadth to length, symmetry, sphericity, convexity etc., acc. to ISO 9276-6)
Instrument data:	Dimensions (H x W x D) approx. 550 x 860 x 600 mm Weight (without PC) approx. 50 kg Compressed air supply approx. 5.5 - 8 bar Compressed air consumption approx. 50 - 140 l/min
The CAMSIZER XT is CE-tested and follows the relevant guidelines and standards. The vacuum cleaner is included in the delivery scope of the X-Dry module.	
Options:	Cyclone Software complying with FDA rule 21 CFR Part 11 IQ/OQ documentation acc. to GLP/GMP
Accessories:	Different hoppers and chute materials allow for adaptation of the CAMSIZER XT to the requirements of the particular sample material, depending on flowability and sample volume

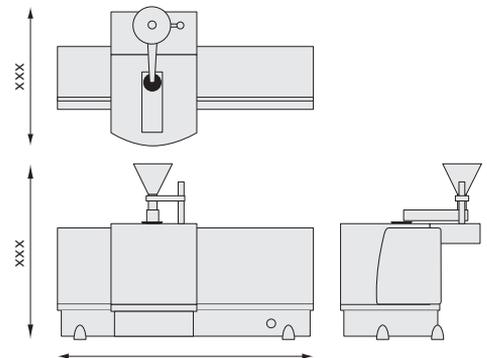


CAMSIZER XT Summary

The CAMSIZER XT analyzes the particle size and shape of fine powders, emulsions and suspensions with a particle size of 1 micron and higher with excellent statistics.

Easy operation, short measurement times and flexible dispersion options for agglomerated particles allow for routine use not only in R&D but also in quality control laboratories with high sample throughput.

Compared to other particle size analysis methods, such as laser diffraction or optical microscopes, the CAMSIZER XT excels by its direct image processing measurement principle which allows for the analysis of representative sample volumes, even with wide distributions, in a very short time. The direct principle ensures not only a better understanding of the sample quality thanks to more information (length, width, mean particle size and particle shape) but also a 100-times greater detection efficiency, e. g. for small quantities of oversized particles.



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a VERDER company

Retsch Technology – your specialist for particle analysis offers you a comprehensive range of instruments. We would be pleased to provide you with further information about our analytical instruments for size and shape measurement.