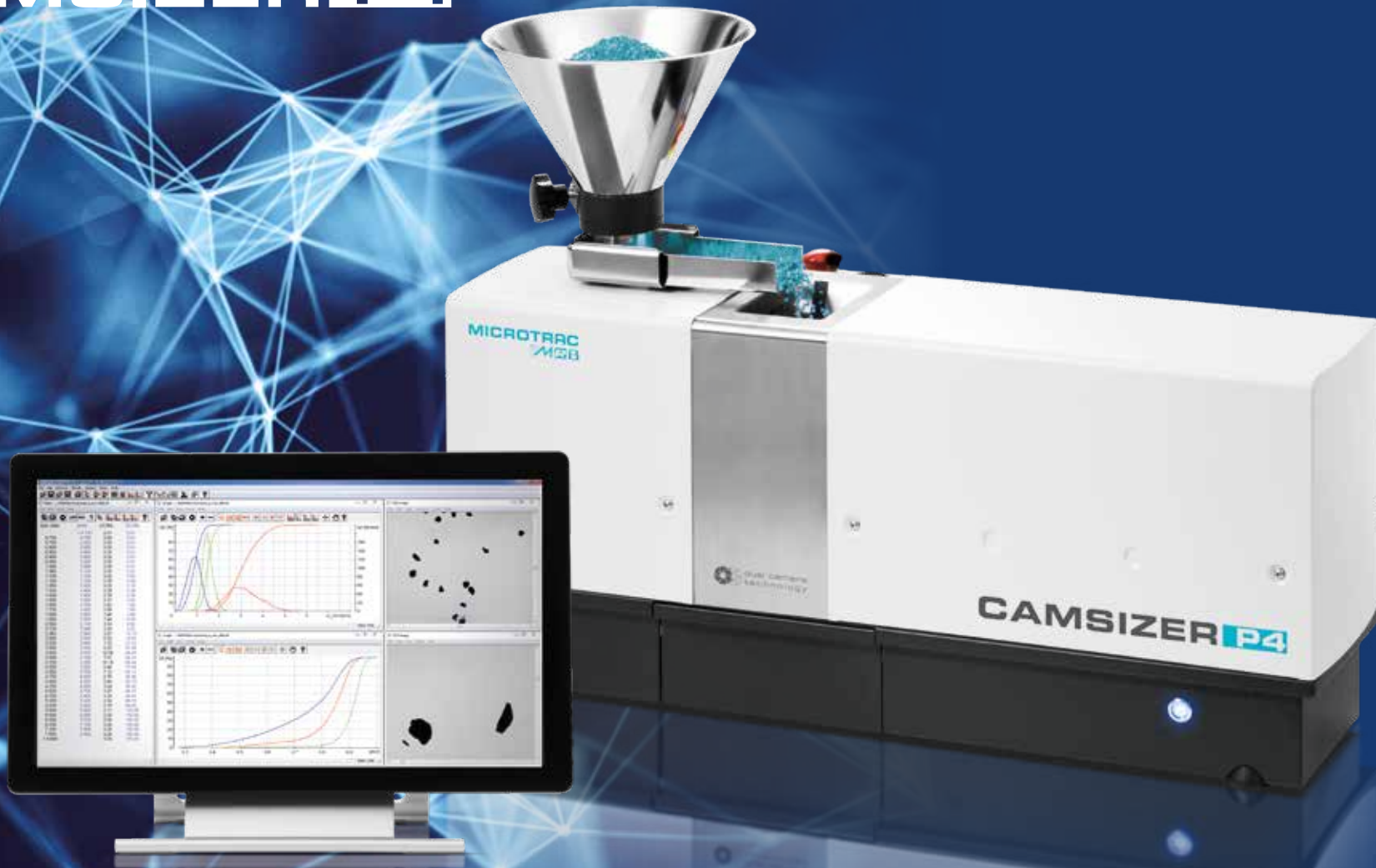Particle size and shape characterization by
Dynamic Image Analysis

CAMSIZER P4

MICROTRAC MRB
PARTICLE CHARACTERIZATION

MICROTRAC MRB

CAMSIZER P4

dual camera technology

Microtrac MRB – Particle Characterization at Its Best

Comprehensive analysis of granules, powders and suspensions

Microtrac MRB is your superior partner for the characterization of disperse systems. We provide our customers with advanced technologies to obtain consistently reliable results. Innovation and quality form the basis of our success.

Microtrac MRB offers three product lines with competence centers on three continents:

Scattered Light Analysis: Microtrac MRB is a leading supplier of laser diffraction systems (static light scattering), a versatile method for particle size determination. The portfolio also includes dynamic light scattering instruments perfectly suited for the characterization of nano particles. The development and production site for this product line is located in Pennsylvania, USA.

Image analysis: With the CAMSIZER series Microtrac MRB provides high-quality systems for the determination of particle size and particle shape based on imaging techniques. These image analyzers are developed and manufactured in our competence center in Haan, Germany.

Surface and porosity measurement: Specific surface, BET value and porosity of powders are determined by gas adsorption. The competence center for this product line is located in Osaka, Japan.

As part of the Verder Scientific Group we offer worldwide support through a network of subsidiaries and distributors.

CAMSIZER Series

High-resolution image analysis of particle size and particle shape

With the CAMSIZER X2 and CAMSIZER P4 Microtrac MRB sets standards in Dynamic Image Analysis. Thanks to the unique two-camera principle both instruments provide quick analyses with excellent accuracy and reproducibility over an extremely wide measuring range.

This makes the CAMSIZERs ideally suited for routine analysis as well as quality control applications. Thanks to a powerful evaluation software which provides a multitude of valuable information and measurement parameters, the analyzers are also suitable for usage in R&D applications.

The latest development, the CAMSIZER M1, measures particles based on static image analysis. This method is particularly suitable for the highly precise determination of the size and shape of very small particles in the low micron range.

- ▶ CAMSIZER X2: Dynamic Image Analysis of powders and suspensions
- ▶ CAMSIZER P4: Dynamic Image Analysis of free-flowing bulk materials
- ▶ CAMSIZER M1: Static image analysis of very fine materials
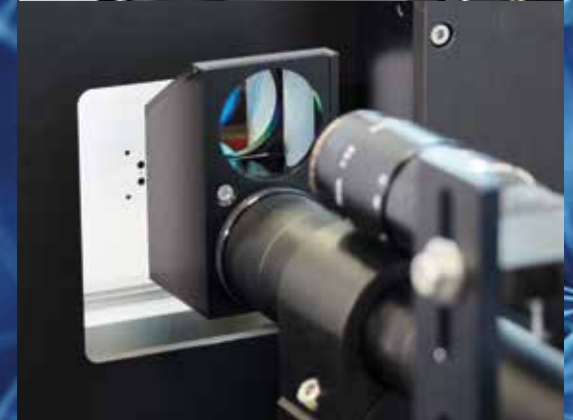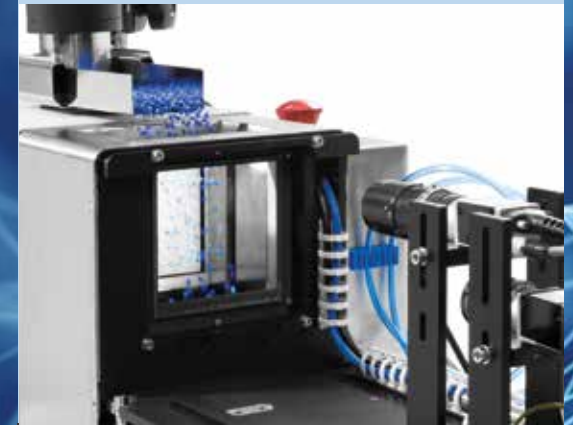
CAMSIZER P4

Complete Quality Control of Bulk Materials

The CAMSIZER P4 analyzes particle size and shape of dry, free flowing bulk materials in a size range from **20 μm to 30 mm**. The software-controlled feed chute conveys the sample to the measurement zone, ensuring **uniform sample feed** and consistent analysis conditions. The particle stream passes an **ultra-bright planar LED stroboscopic light source**; the resulting shadow projections are captured and evaluated by a camera system.

The particles fall freely during analysis, so the procedure is **contact-free and non-destructive**.

The CAMSIZER P4 provides extremely sharp images and determines a variety of different size and shape parameters for each detected particle.

Analysis of hundreds of thousands or even millions of individual particles guarantees results with high statistical reliability. The typical measurement time is only **1 to 3 minutes** with **60 images** being evaluated **per second** in real time.

Particle Analyzer CAMSIZER P4

- ▶ Particle size and particle shape analysis from 20 µm to 30 mm without hardware adjustments
- ▶ Broad dynamic range for measuring wide particle size distributions
- ▶ High resolution for narrow mono-modal or multi-modal distributions
- ▶ 100% detection of oversized grains
- ▶ Fully comparable to sieve analysis results
- ▶ A wealth of evaluation options (different size models, a variety of shape parameters, particle library, single frame evaluation, etc.)
- ▶ Outstanding reproducibility
- ▶ Evaluation of 60 images / s in real time
- ▶ Powerful LED light source
- ▶ Virtually maintenance-free

Superiority by Design

ADVANTAGE CAMSIZER P4:
The hopper height and the speed of the sample feed are software-controlled which guarantees consistent measurement conditions and outstanding reproducibility.

ADVANTAGE CAMSIZER P4:
Powerful long-life ultra-bright LED stroboscopic light source ensures high-resolution, distortion-free images.

ADVANTAGE CAMSIZER P4:
Compressed-air flushing via Venturi nozzle prevents contamination by dust particles.

ADVANTAGE CAMSIZER P4:
The dust-proof housing of the CAMSIZER P4 makes it suitable for use in a production environment. Thanks to its robust construction it is also not sensitive to vibrations.

ADVANTAGE CAMSIZER P4:
Patented dual camera technology provides highest accuracy over the entire measuring range.

ADVANTAGE CAMSIZER P4:
Contact-free, non-destructive measurement which permits sample recovery and reuse. Variable sample volumes.

MICROTRAC

CAMSIZER P4

CAMSIZER P4 Highlights

1. Calibration within seconds with a highly precise, certified calibration reticle

2. Typical measurement time of 1 to 3 minutes

3. Reliable results thanks to analysis of large particle number

Extremely Wide Measuring Range due to Dual Camera Technology

Microtrac MRB's unique dual camera technology is a landmark in the development of Dynamic Image Analysis. By simultaneously employing two cameras with different magnifications, extremely wide dynamic measuring ranges are archieved. This is accomplished without hardware adjustments or modifications and without compromising accuracy. Each camera is specialized for one measuring range.

The ZOOM camera analyzes fine particles with highest precision whereas the BASIC camera detects the larger particles with excellent statistics. A special algorithm combines the information provided by both cameras and delivers the exact size distribution in a possible range of more than three decades!

This arrangement resolves a significant drawback of many image analysis systems that employ only one camera, e. g. microscopes. Such instruments either cannot correctly report the fine particles in wide size distributions, or the large particles are not captured due to the small field of view.
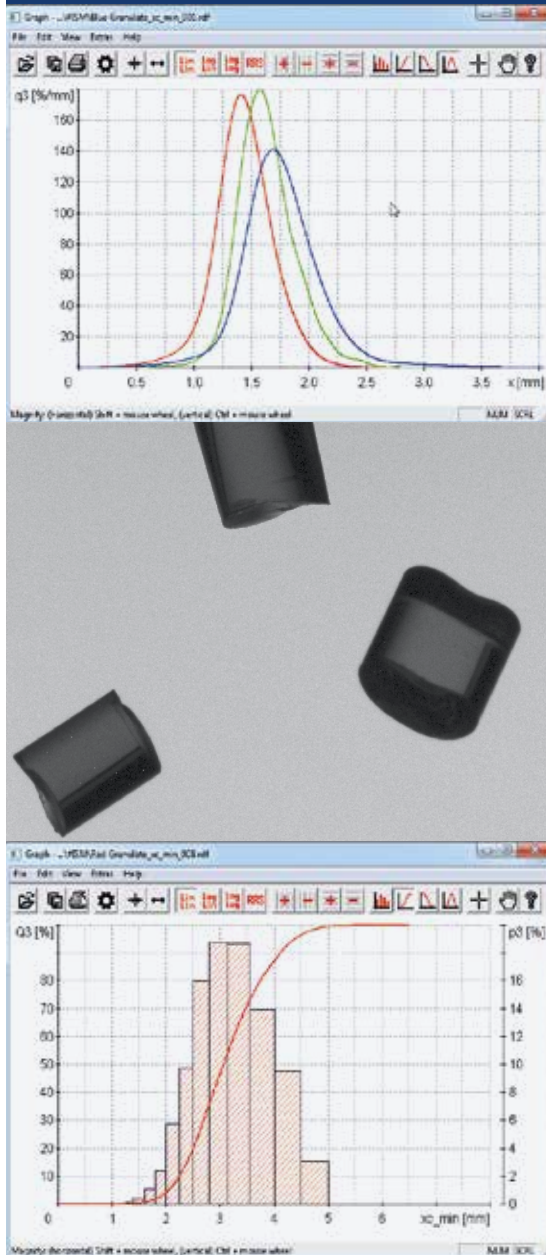
dual camera technology

Measurement Principle

Two cameras operate during measurement:
the BASIC camera (red) analyzes the larger particles,
the ZOOM camera (blue) captures the small particles.
This procedure ensures optimum measurement
conditions for all particle sizes in a distribution.
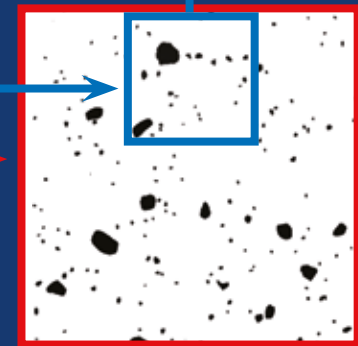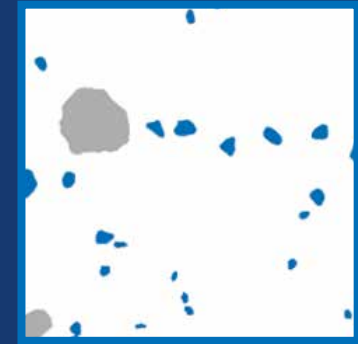
Powerful Measurement and Evaluation Software

Complex task with a quick and easy solution

All parameters at a glance: Dynamic Image Analysis provides a wealth of information about the sample material to be analyzed. The high-performance CAMSIZER software measures dozens of parameters from every single particle and presents the results in a clearly structured, standard-compliant measurement report.

Functions like the comprehensive export option and the generation of synoptical tables or trend analyses are routine. Also storage and automatic monitoring of predetermined product specifications are part of the software. Password protection prevents undesired modifications of measurement settings; hence, analyses may also be carried out by non-technical staff.

The CAMSIZER software is easily adapted to customer requirements:

- Display of size and shape distributions as graphs or tables
- Up to 3000 freely selectable measurement classes
- Statistic data analysis
- Comparative tables and trend analyses
- Clearly structured measurement protocols
- Different password-protected user levels provided
- LIMS connection standard
- 21 CFR part 11 compliant software version available
- Automatic testing of specifications
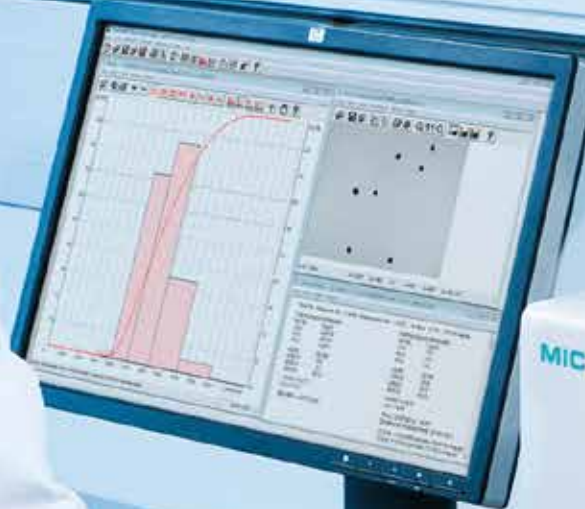
Particle Size and Particle Shape Parameters

## Detailed evaluation – optimum results

Imaging techniques are the only methods able to detect the various dimensions of irregularly shaped particles. Whereas technologies like laser diffraction or sieve analysis merely ascertain the equivalent spherical diameter, the CAMSIZER P4 additionally measures length and width of every single particle in one analysis. During measurement, each particle projection is scanned in up to 64 directions, thus allowing for shape analysis with high resolution. Shape parameters from ISO 9276-6 include, among others, aspect ratio (width/length), circularity, sphericity, symmetry, compactness, roundness, and convexity.
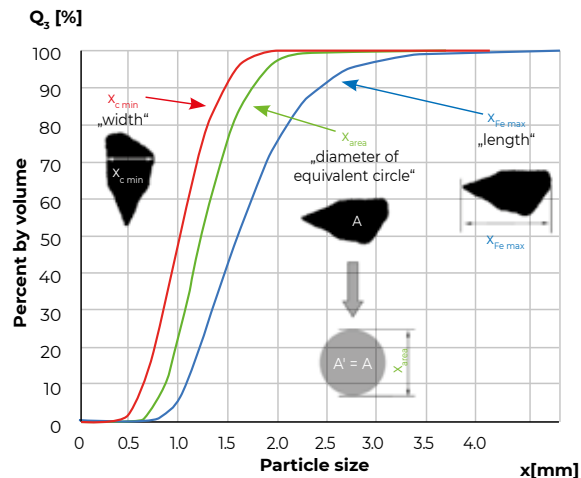
DIA may use different size definitions

WIDTH / LENGTH RATIO

$$\frac{\chi_{c\,min}}{\chi_{Fe\,max}}$$
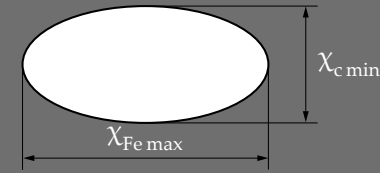
CIRCULARITY

$$\sqrt{\frac{4\,\pi\,A}{U^2}}$$

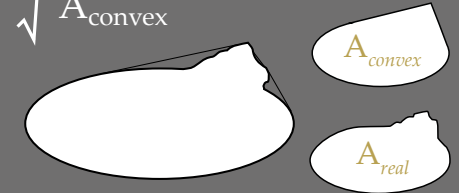### SYMMETRY

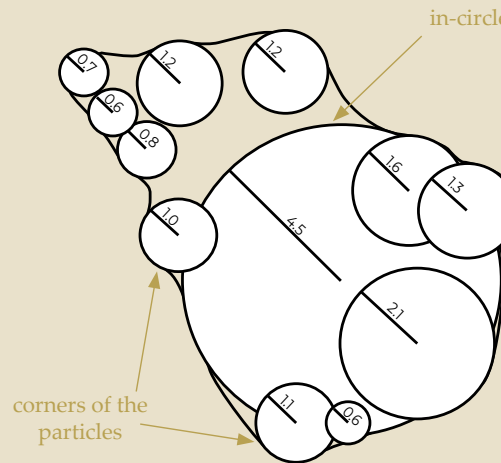$$\frac{1}{2}\left[\,1 + \min\left(\frac{r_1}{r_2}\right)\right]$$
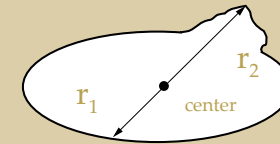
CONVEXITY

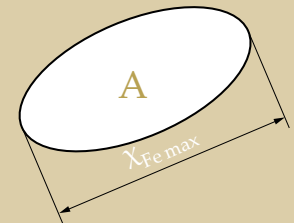$$\sqrt{\frac{A_{real}}{A_{convex}}}$$

ROUNDNESS

$$= \frac{\text{Average radius of the corners}}{\text{Radius of the in-circle}}$$

COMPACTNESS

$$\frac{\sqrt{\dfrac{4\,A}{\pi}}}{\chi_{Fe\,max}}$$

$\chi_{c\,min}$ = width
$\chi_{Fe\,max}$ = length
A = area
U = perimeter

Graphical Presentation of Image Information: Particle X-Plorer

Comprehensive particle database: evaluation of the smallest detail

The results of Dynamic Image Analysis are based on the precise measurement of hundreds of thousands to millions of single particles. The CAMSIZER P4 results provide the highest statistical reliability due to the large representative sample volumes which are analyzed. Moreover, it is possible to save and archive a representative selection of particle images including all measurement parameters from each analysis. The innovative software module Particle X-Plorer imports information on every single particle into the database which allows to find and display particles with specific characteristics or combinations of characteristics. This helps to interpret measurement results, facilitates application development and enhances understanding of the sample material under investigation. Further options of Particle X-Plorer include preparing 3D scattergrams and subsequent filtering and recalculation of the complete data sets.
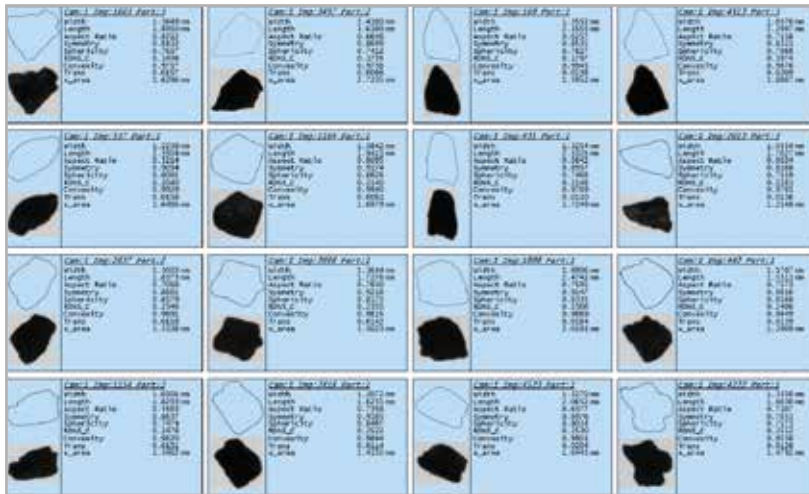
Evaluation of single particle populations
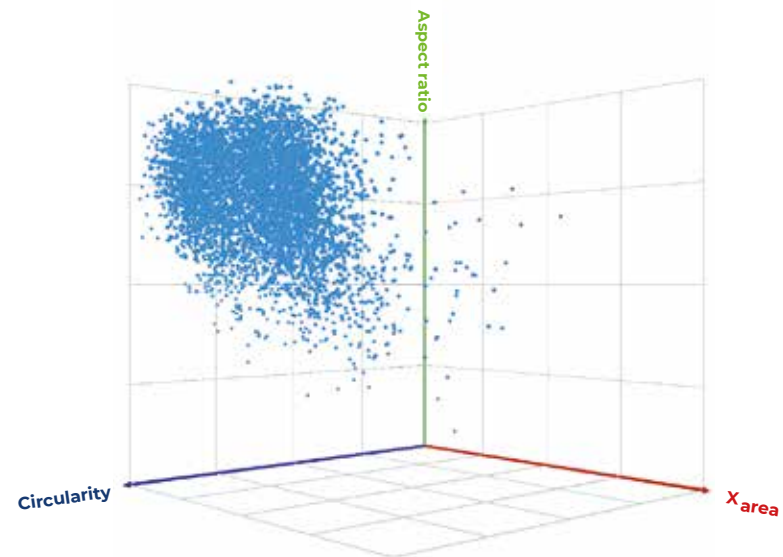
3D scattergram

Switching from sieve analysis to CAMSIZER P4 is no problem as the analyzer software is equipped with algorithms to correlate to sieve analysis. Thus, it is easily possible to replace time-consuming sieve analysis with CAMSIZER P4 without having to modify trusted quality criteria.

Applications
Optimum solutions for every industry

Many properties of bulk materials, like flowability, solubility, filtration efficiency, reactivity, abrasiveness, and taste, are significantly influenced by particle size. Therefore, particle size determination is commonly used as a part of quality control in many different industries.

Typical Applications

■ Abrasives	■ Fertilizers	■ Pharmaceutical pellets and granules	■ Sand/gravel
■ Catalysts	■ Food	■ Polymers	■ Superabsorbent
■ Chemicals	■ EPS	■ Proppants	■ Wood chips
■ Coal/coke	■ Extrudates	■ Refractory materials	and many more
■ Coffee	■ Glass / reflective beads	■ Salt/sugar	
■ Construction materials			

CAMSIZER® P4 Replaces Sieve Analysis

Faster, more precise and additional information

Sieve analysis

Effort

Great effort:
- Assemble sieve stack
- Weigh / tare each sieve
- Feed in the sample
- Start sieving machine
- Weigh each sieve
- Calculate values for each sieve
- Clean sieves

Results

Simple size distribution:
- Particle size distribution based on a few sieve fractions
- Sample fractionation
- Good reproducibility
- Established measuring technique

Benefit

Minor benefit:
- Further analysis of individual fractions possible
- Wet sieving possible

Sieve Analysis

CAMSIZER® P4

Minimum effort:
- Feed in sample
- Start measurement
- Remove sample 👍

High information content:
- Detailed particle size analysis
- Simultaneous determination of particle shape
- Highest degree of accuracy and reproducibility
- Very fast; results viewed in real time
- No random errors thanks to extremely simple handling / automatization 👍

Maximum benefit:
- Significant reduction of workload and time
- Automatic evaluation of size, shape, density, transparency and particle number
- Contact-free and non-destructive analysis
- Optimum process and quality monitoring
- Self-cleaning and virtually maintenance-free
- Recalibration within seconds 👍

CAMSIZER® P4

Superabsorbent polymers

CAMSIZER P4 replaces sieve analysis

Superabsorbent polymers can absorb large amounts of a liquid relative to their own mass. They are used in granular form, for example in baby diapers as drying agent. Particle size is an essential quality criterion with a distribution that is usually between 100 μm and 1000 μm. Small particle size equals high specific surface area, hence faster liquid absorption. The specifications are typically based on sieve analyses. The CAMSIZER P4 delivers 100 % equivalent results and can fully replace this time-consuming and error-prone technique.
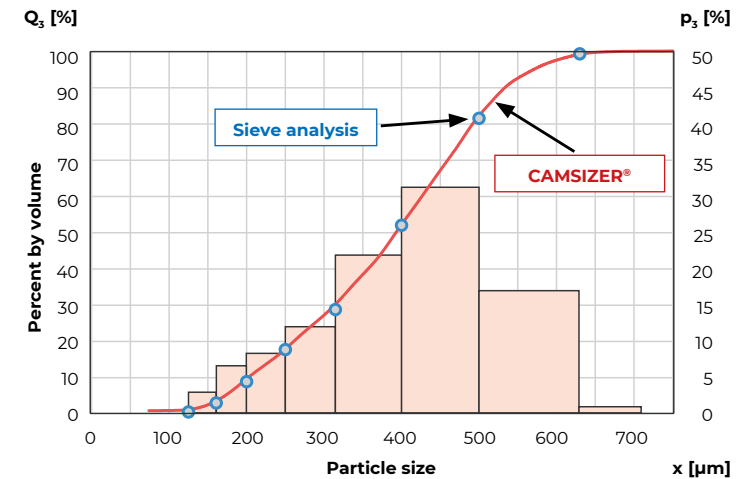
Sand

Reliable detection of oversize particles

Sand and gravel are among the most important natural resources. The various application fields of sand result in a great variety of requirements with regard to particle size distribution and particle shape. This example shows a sand sample with wide size distribution as well as material with tight fractions and the corresponding sieve analysis results. The results of the two measurement techniques are readily comparable. The sample with narrow distribution contains a few oversized particles which the CAMSIZER P4 reliably detects. This helps to quickly recognize defects or wear of the production sieves.
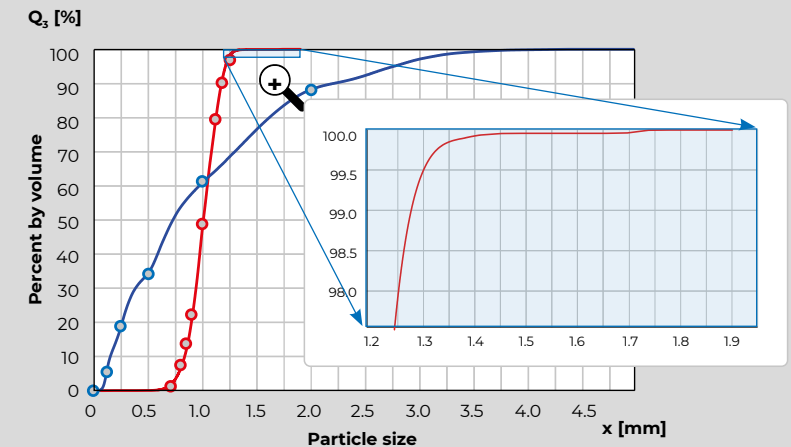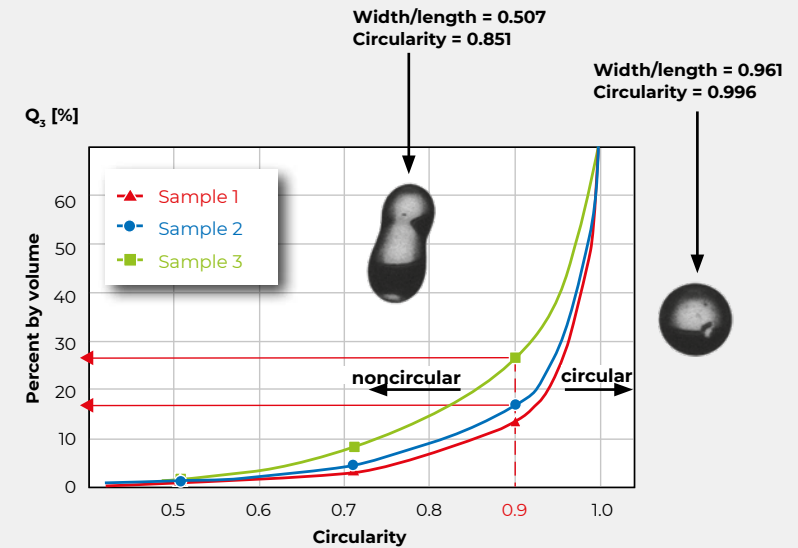
Glass beads

## Shape analysis of reflective beads

Glass beads are used, for example, in road markings to ensure high retro-reflectivity. Fused or deformed beads reduce the reflectivity and thus harm the product quality. The CAMSIZER P4 is able to measure the percentage of defective beads with highest accuracy. The graphic illustrates the circularity of three different glass bead samples. Sample 1 and 2 have less than 20 % of non-round particles (circularity < 0.9) whereas sample 3 contains almost 30 %. The image on the right shows a perfectly circular and a noncircular (defective) bead with the corresponding shape parameters.

Width/length = 0.507
Circularity = 0.851

Width/length = 0.961
Circularity = 0.996

Q_3 [%]

- Sample 1
- Sample 2
- Sample 3

noncircular ← → circular

Circularity

Pharmaceutical granules and pellets

Reliable process control

The CAMSIZER P4 is ideally suited to characterize the growth of granules and pellets. The results provide information about the thickness and homogeneity of coatings, dust fractions or oversize (agglomerates). This information is the basis for the prediction of such complex parameters as the release rate of an active ingredient from the granule in the human body. The example shows the initial material and four coating steps (two repeated measurements for each). Even the last process step with a coating thickness of only 2.5 µm is reliably detected thanks to the extremely good reproducibility.

Q_3 [%]

Percent by volume

Particle size

x [mm]
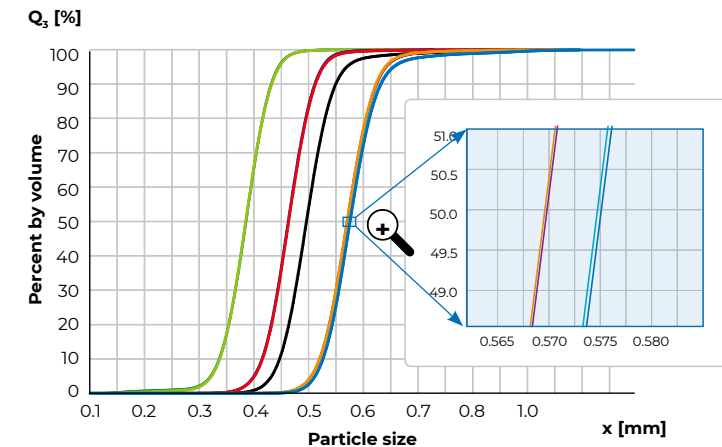
The Autosampler

CAMSIZER P4 in continuous operation

The Autosampler is a fully automatic sample feeding system for the CAMSIZER P4 which can be easily retrofitted to existing instruments. It processes up to 14 samples (extendable to 40 samples) in a row without the need for the operator's intervention. The correct measurement settings are read from the barcodes on the sample beaker. The Autosampler is suitable for continuous operation.

Accessories and Options

Optimum configuration for each application

Microtrac MRB offers various sets of feed hoppers and chutes for specific applications. With the help of the feed guides, the sample stream can be oriented in a way that, for example, longish particles like extrudates are always measured in the correct orientation. Different kinds of sample dividers provide representative sub-samples of powders, granules and many other types of bulk material prior to analysis.

CAMSIZER P4 at a glance

Technical data

CAMSIZER® P4

|	
Measurement principle	Dynamic Image Analysis according to ISO 13322-2
Measuring range	recommended range 20 µm to 30 mm (with no hardware adjustment)
Parameters	particle size, shape, density, transparency and number
Measurement	60 images/s with more than 1,300,000 pixels each (corresponds to more than 78 million pixels per second)
Measuring time	approx. 1 to 3 min (depends on required measurement statistics)
Instrument data	dimensions (H x W x D) approx. 650 x 850 x 350 mm
	weight (without PC) approx. 40 kg

The CAMSIZER P4 is CE-tested and follows the relevant guidelines and standards.
It can be supplied with software complying with FDA rule 21 CFR part 11.

AutoSampler

Compressed air supply	6-8 bar
Compressed air consumption	max. 10 l/min
Instrument data	dimensions (H x W x D) approx. 900 x 1450 x 490 mm
	weight approx. 60 kg
Sample feed	control of the conveyor belt by light beam interruption during sample container positioning, sample feed by electro-pneumatic robot arm, emergency stop-button

Fields of application

Scope and purpose	rapid and exact particle size and shape analysis of all dry, flowable bulk materials and powders
Sample material	abrasives, catalysts, chemicals, coffee, construction materials, coal/coke, fertilizer, food granulate, glass/ceramics, metal powders/silicon granulate, pesticides, pharmaceutical pellets, plastic granulate, proppants, refractory products, salt/sugar, sand, washing powder, wood chips and many more

approx. 650 mm

approx. 350 mm

approx. 850 mm
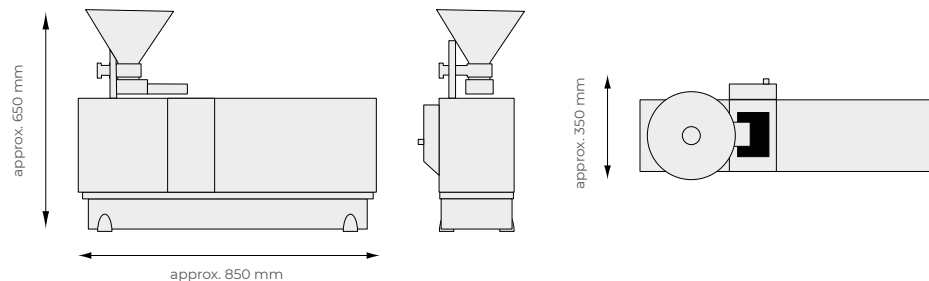
CAMSIZER X2

Microtrac MRB's CAMSIZER X2 is another powerful particle analyzer. This model is also based on the principle of Dynamic Image Analysis and uses the well-proven dual camera technology. Due to an optical system with higher resolution, the CAMSIZER X2 is optimized for analysis of fine particles, powders and suspensions. As these materials tend to agglomerate, different modules for particle dispersion are available for the CAMSIZER X2. These include dispersion by compressed air with variable pressures, wet measurement, and analysis in free fall (like CAMSIZER P4). The measurement range is from 0.8 µm to 8 mm and depends on the dispersion option.

More information at
www.microtrac.com/camsizerX2

dual camera
technology

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PARTICLE CHARACTERIZATION

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