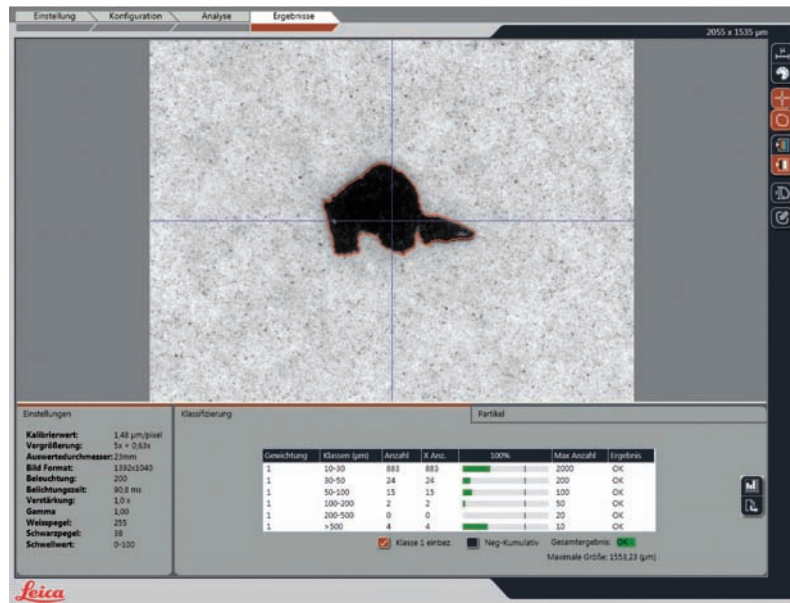
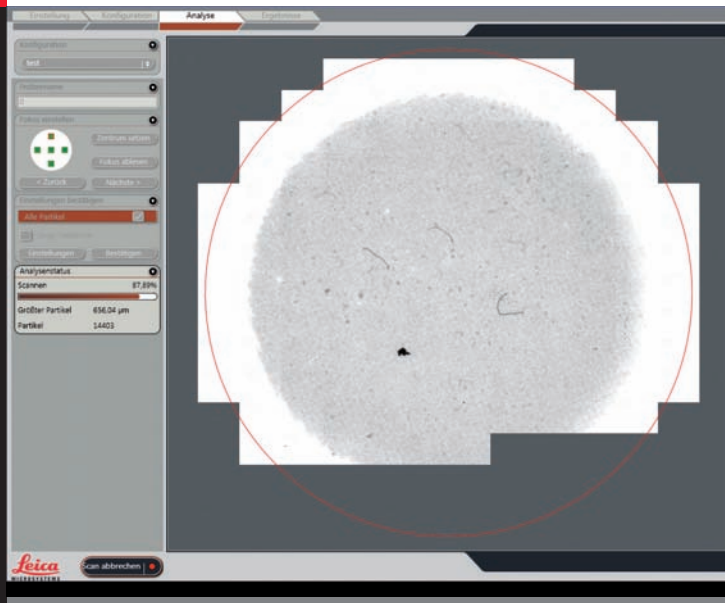


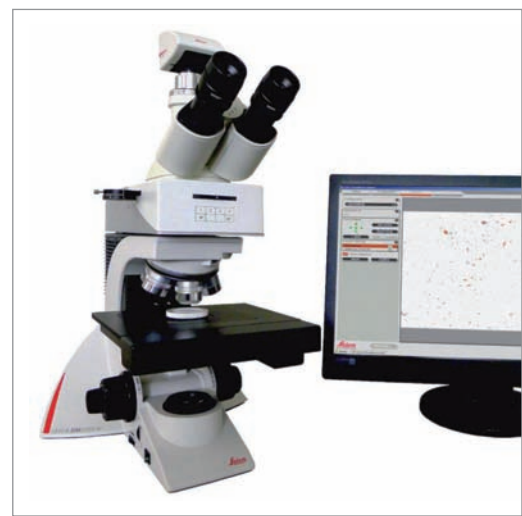
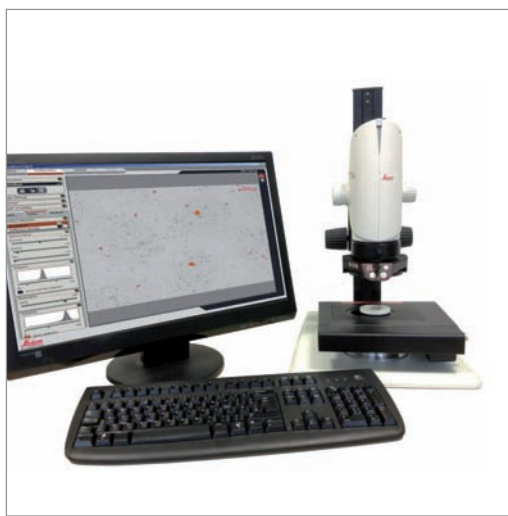
Living up to Life

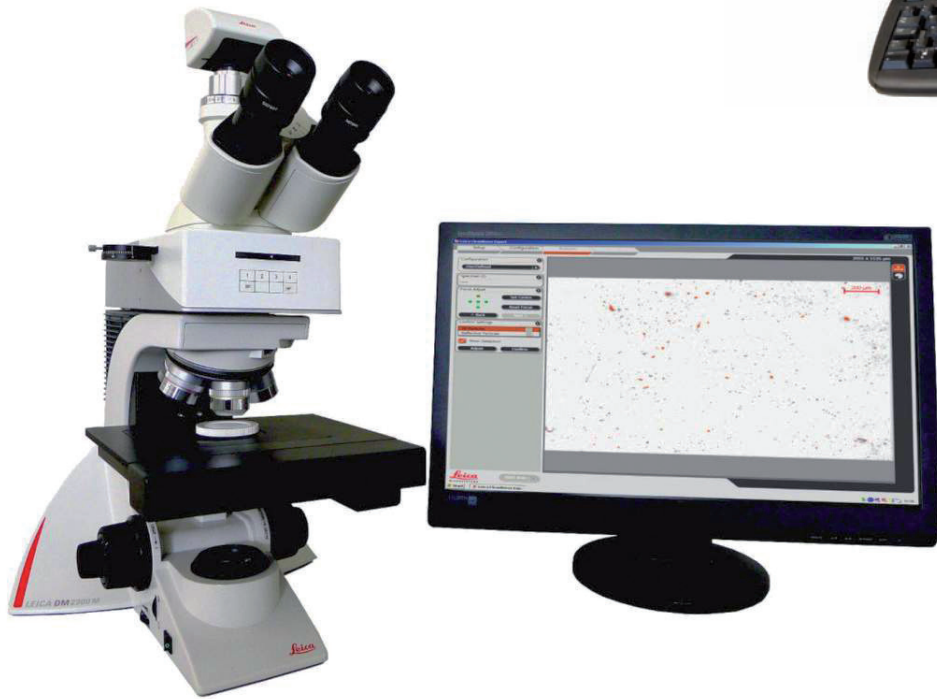
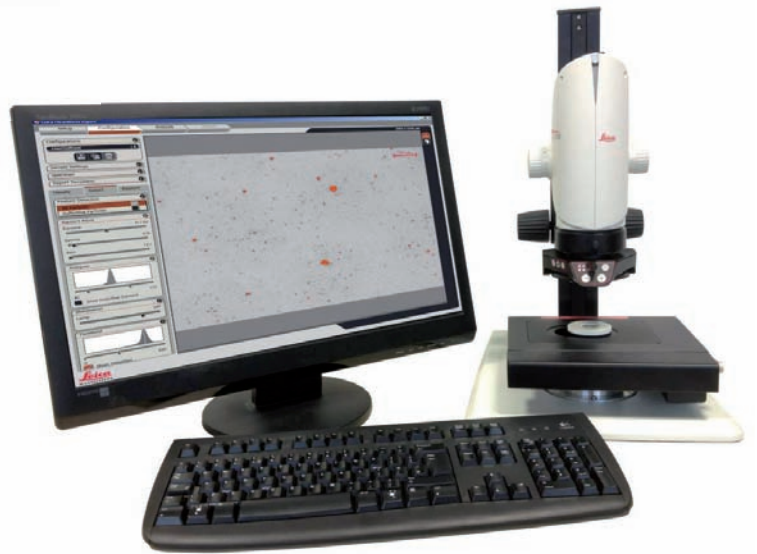
**Leica**  
MICROSYSTEMS



# Quality Counts

Quality Assurance with Leica Cleanliness Expert  
Microscope Software for Quality Assurance





# Quality Counts

Manufacturers need to assess the cleanliness and integrity of components and liquids to ensure a safer, defect-free end product. Microscopic analysis of cleanliness is an essential workflow step in modern manufacturing processes, especially when complex systems as gearboxes, turbines or engines are assembled using various components from multiple suppliers. The quality, durability, and life cycle of a final product depend on the quality and characteristics of the material, fitting tolerances, and overall cleanliness of a surface or particle load. A defect in a single component can lead to the breakdown of the entire end product.

Leica Cleanliness Expert microscope software is a quantitative quality assurance system that allows you to monitor, analyze, and document component quality during the manufacturing process and before a component is integrated with an end product. Leica Cleanliness Expert is ideal for all applications involving particle classification and characterization on circular shaped substrates. The software typically supports users in the automotive, galvanic, and aviation sectors, as well as the pharmaceutical industry. It is particularly useful to conduct analyses when hydraulic fluids are concerned.



# Experience Creates Reliability

As system components continuously decrease in size, we have adapted and improved our cleanliness monitoring systems and analytical software packages in close collaboration with leading industry representatives to ensure that we meet your current and future needs. For instance, the publication of VDA 19 in 2002 and the release of ISO 16232 in 2007 ignited discussion among our automotive industry customers about the new requirements and improvement possibilities for technical cleanliness analysis. Leica Microsystems actively participated in this discourse about the revision of VDA 19 and draft of DIN 51455: Liquid mineral oils – determination of particle number and particle size in oils.

As a provider of inspection systems for cleanliness analysis, Leica Microsystems offers the right solutions. Users benefit from the reliable results. You will receive information about:

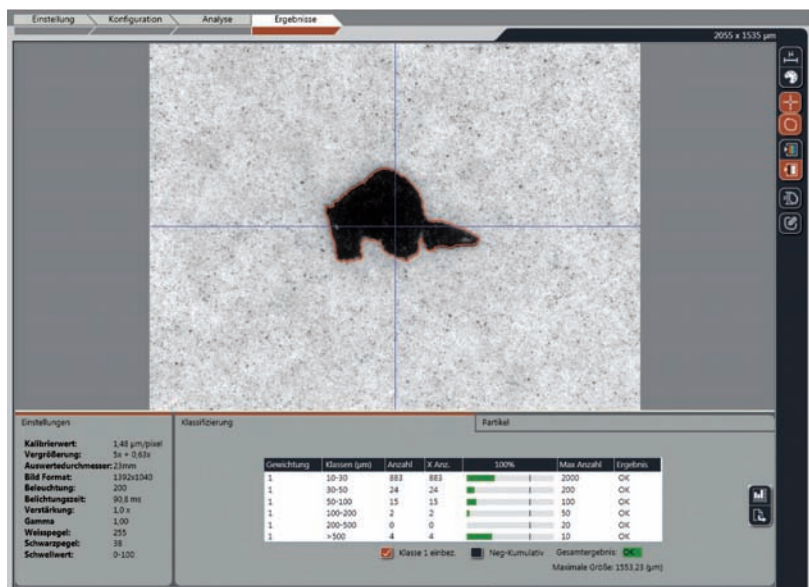
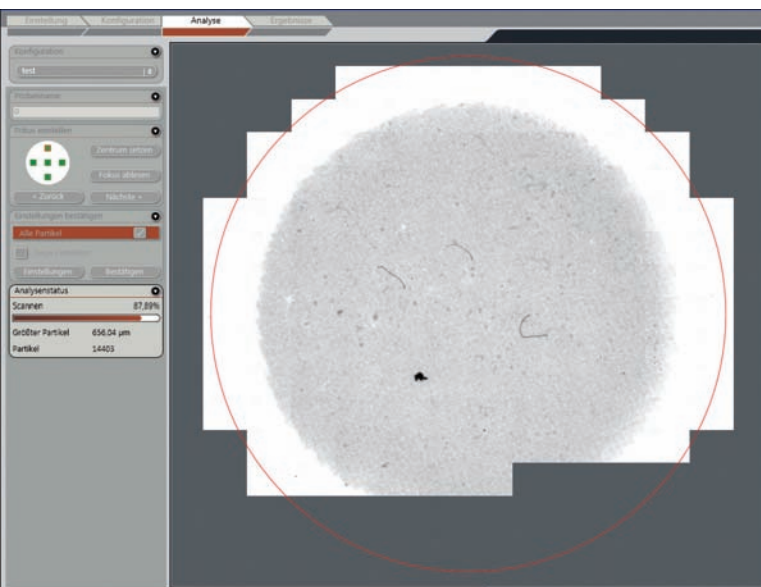
- › Number of particles -> overall degree of contamination
- › Particle size (length, breadth and height) -> damage potential of a single particle
- › Material of the particles (reflective or non-reflective, therefore metallic or plastic) -> general damage potential of the particle load as well as damage potential of a single particle
- › Differentiation between particles and fibers -> damage potential of a single particle and source of contamination

Depending on the analyzed product the importance of the above mentioned points may vary. This is why Leica Cleanliness Expert offers flexible configuration and a number of local, national, and international standards such as ISO 16232, VDA 19, and ISO 4406 according to which the analysis can be performed.

# Precise Measurement with Leica Cleanliness Expert

During the measurement process, Leica Cleanliness Expert creates an overview image of the entire filter, and counts and displays the number of particles, as well as continuously updating data about the length of the largest detected feature. Users can zoom in on the overview image as it is built. This gives an indication of

the filter preparation, imaging quality, and the presence of very large fibers and particles. You can run reports on the counted particles in various ways – according to user defined classifications required by local factory standards or according to ISO 16232 / VDA 19 classification with fixed classes.



## Accurate measurement of particle length and breadth

Depending on the ambient conditions in which the end product is used, for example injection pumps, valves, ball bearings, etc., all particle dimensions are taken into account for an estimation of safety risk potential.

If the particles are transported via fluids, they will be aligned with the flow direction. If the particle-loaded fluid has to pass a bottleneck, calculating the breadth of a particle can be more important than its length.

With Leica Cleanliness Expert, you can set up independent size classifications that sort the detected features according to length and breadth.

ISO 16232 Classes

By Length & Breadth

Length Breadth

| Size Class | Size x ( $\mu\text{m}$ ) |
|------------|--------------------------|
| B          | 5 x < 15                 |
| C          | 15 x < 25                |
| D          | 25 x < 50                |
| E          | 50 x < 100               |
| F          | 100 x < 150              |
| G          | 150 x < 200              |
| H          | 200 x < 400              |
| I          | 400 x < 600              |
| J          | 600 x < 1000             |
| K          | 1000 x                   |

Smallest class to be measured

B  C  D  E

User Defined Classes

By Length & Breadth

Length Breadth

| Limit ( $\mu\text{m}$ ) | Particles |
|-------------------------|-----------|
| 10                      | 2000      |
| 30                      | 200       |
| 50                      | 100       |
| 100                     | 50        |
| 200                     | 20        |
| 500                     | 10        |

Add Delete

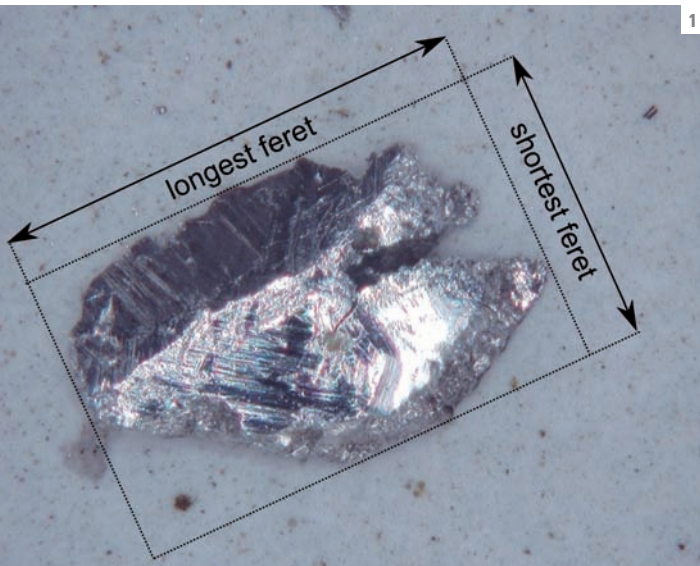
Use Contamination Number

Use Negative Cumulative

Full Volume (l):

Used Volume (l):

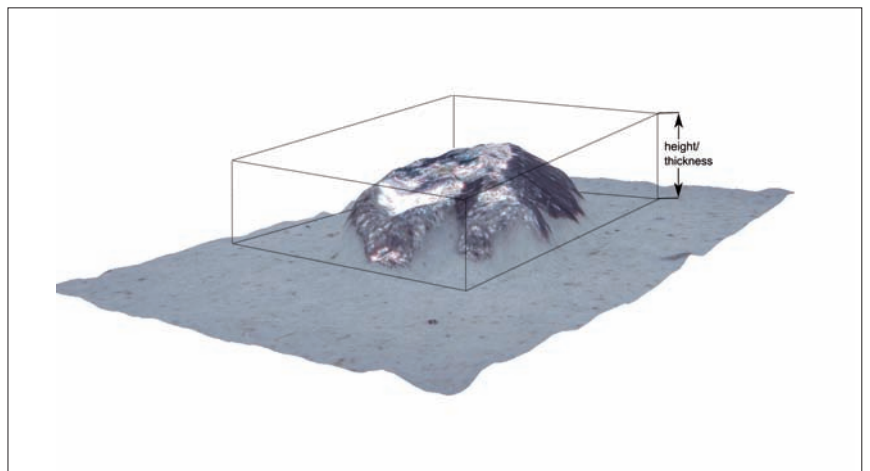
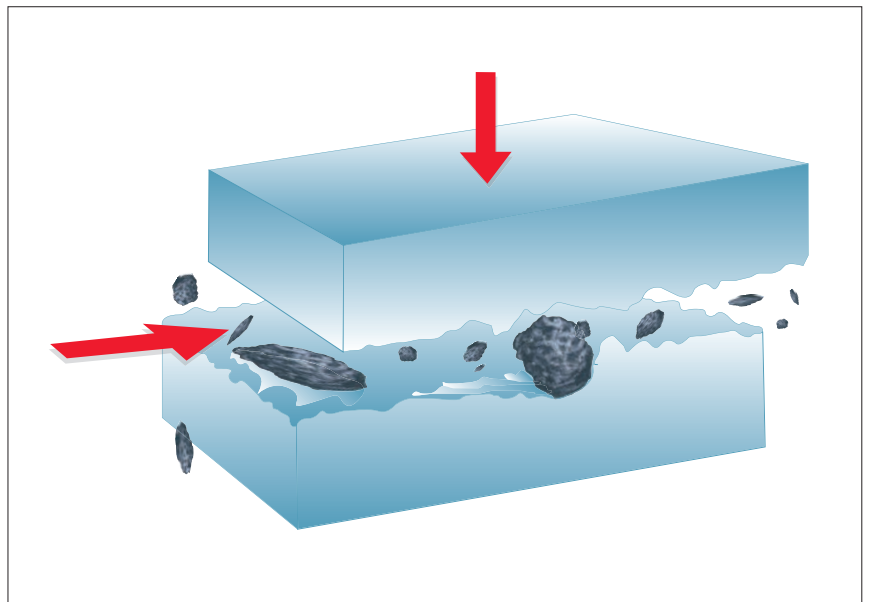
1 Determination of particle length and breadth by feret measurements



## Particle height

The interaction of moving parts, for example in a turbo charger or cylinder, presents different challenges when analyzing cleanliness. The image to the right shows that determining particle length or breadth alone can be insufficient since a large, flat particle may be less dangerous than a smaller, higher particle.

With Leica Cleanliness Expert, you can also determine the height of a particle. Height measurement is among the automated functions of the software and can be used with certain microscope systems.



## Automated for simplicity and accuracy

The intuitive user interface guides you through each function, making it quick and easy to operate. Each detected feature can be defined by geometric parameters such as length, breadth, and aspect ratio, and by optical behavior (reflective or non-reflective) to distinguish fibers from compact particles.

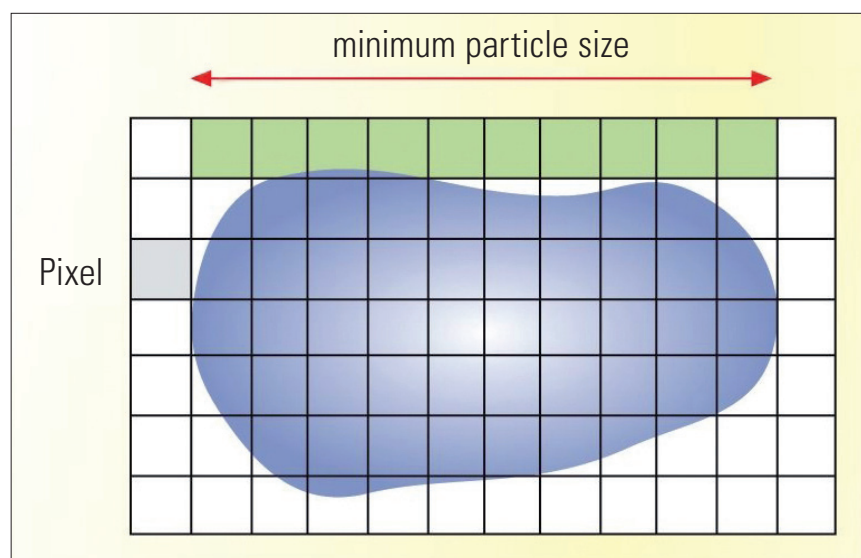
Any desired number of different settings for visualizing specific filters or samples can be stored and easily adapted to changing requirements or future needs. Leica Microsystems offers specific filter holders that complement Leica Cleanliness Expert according to your requirements.

## Calibration fits international standards

In accordance with ISO 16232, the length of the smallest particles should be rendered by at least 10 pixels in automated particle measurement.

Especially in respect to VDA 19 and ISO 16232, the used calibration value should be in adequate proportion to the optical resolution of the microscope system.

The calibration value for the particle size depends on the magnification level of the microscope, camera adapter, and pixel size of the camera.





Pixel size of camera chip/sum of magnification = calibration value

| Objective Magnification | C-Mount Mag. (Camera Adapter) | Pixel Size On Camera Chip | Calibration Factor | Calibration Factor In Binning Mode |
|-------------------------|-------------------------------|---------------------------|--------------------|------------------------------------|
| 2.5x                    | 0.7x                          | 3.2 µm                    | 1.83 µm/Pixel      | 3.66 µm/Pixel                      |
| 5x                      | 0.7x                          | 3.2 µm                    | 0.91 µm/Pixel      | 1.82 µm/Pixel                      |
| 10x                     | 0.7x                          | 3.2 µm                    | 0.46 µm/Pixel      | 0.92 µm/Pixel                      |

Example:  $3.2 \mu\text{m}/(5 \times 0.7) = 0.9 \mu\text{m}/\text{pixel}$  → in binning mode **1.8 µm/pixel**

→ When using an objective with 5x magnification, a 20 µm particle is displayed by app. 11 pixels

According to VDA 19, the 10-pixel criterion primarily applies when measuring function-critical particles.

For other particle measurements, the requirement can be attenuated to five times the value of the resolution.

$d$  (Optical resolution) =  $\lambda/2nA$  (numerical aperture)

| Objective                                    | Numerical Aperture | Optical resolution at 550 nm |
|--|--------------------|------------------------------|
| 5x   | 0.15               | 1.83 µm                      |
| 10x  | 0.3                | 0.92 µm                      |
| <b>Typical values for zoom-based systems</b> |                    |                              |
| 1x   | 0.075              | 3.67 µm                      |
| 1x   | 0.082              | 3.35 µm                      |

Example:  $550/(2 \times 0.15) = 1833 \text{ nm}$  → **1.83 µm** →  $5 \times 1.83 = 9.15 \mu\text{m}$

→ When using the attenuated requirements (five times the value of the resolution) and using an objective with 5x magnification (with given resolution of 1.83 µm), a 10 µm particle can be detected according to VDA 19 and ISO 16232 recommendations.

# Choose the System that Meets your Requirements

The flexibility of Leica Cleanliness Expert mirrors the diversity of modern applications and needs. Different requirements concerning particle size, shape, type, classification, normalization, and the used standard (local, national or international) can be covered by the analysis system.

Leica Microsystems offers different systems depending on user-specific needs.

Automotive



Hydraulic fluids



Pharmacy



## Complex analyses with Leica Cleanliness Expert and the Leica DM4000 M LED or Leica DM6000 M

### SYSTEM FEATURES:

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Our customers use this system because of its capabilities to measure particle length, breadth, and height. Especially for pneumatic hydraulic systems, the third dimension is highly important. The coded, motorized microscope features reduce user influence to a minimum. System settings are fully reproducible and ensure that the system can also be used for other applications.

- › High optical performance by using objectives with high numerical aperture for the analysis
- › ISO conformed detection of particles down to 5  $\mu\text{m}$
- › Height evaluation of particles estimates overall risk potential
- › Reproducible illumination, contrast, and camera settings for comparable measurements
- › Automatic storage of all relevant system and analysis parameters for each configuration
- › Minimal user interaction
- › Automatic differentiation between reflective (metallic) and non-reflective (plastic) particles
- › Coded/motorized microscope system
- › Due to the intelligent store and recall functions, it can also be used for other microscopic applications such as metallography
- › Sustainable system with high magnification and low calibration values for future requirements of minimum particle size



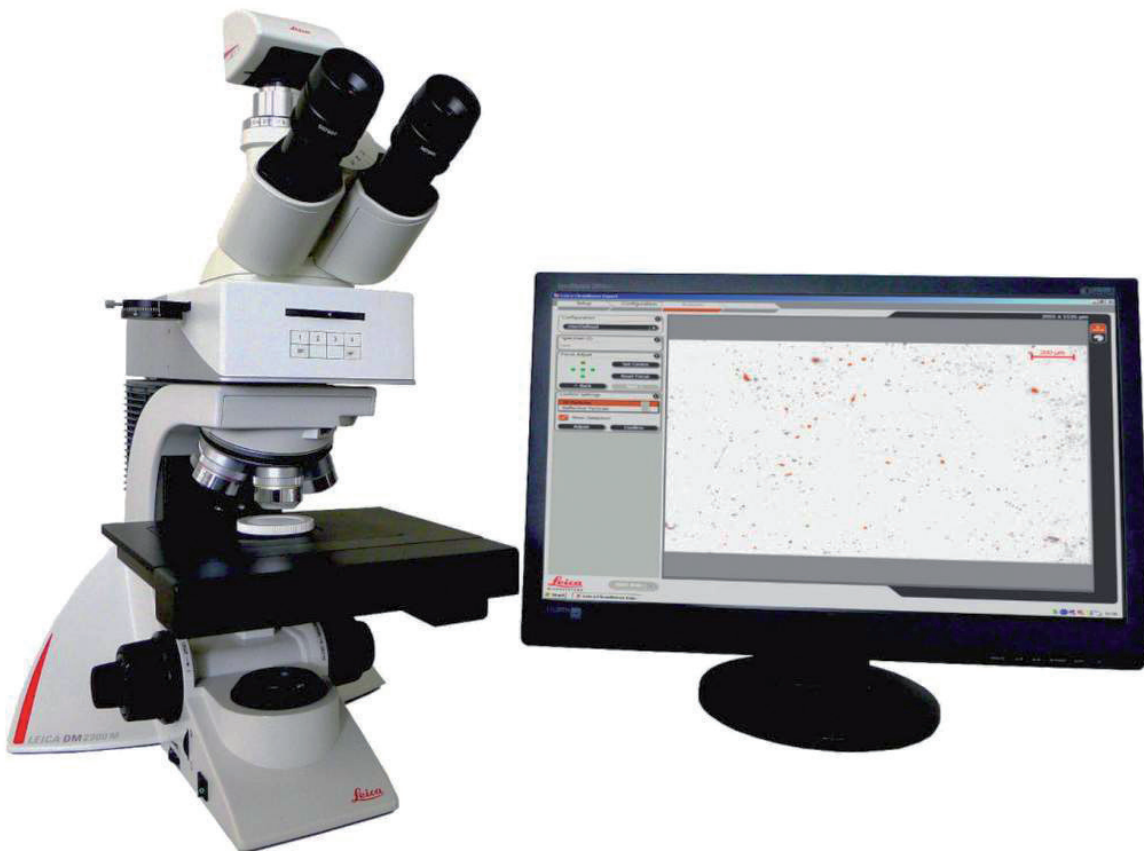
## Leica Cleanliness Expert in combination with the Leica DM2700 M compound materials microscope

### SYSTEM FEATURES:

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This advanced imaging system measures particle length, breadth, and height where coded or motorized microscope functions – except for the scanning stage and motorization of the focus drive – are not required. The high resolution optics ensure that particles down to 5  $\mu\text{m}$  can be measured. Information about the third dimension is also gained.

- › High optical performance by using objectives with high numerical aperture for the analysis
- › ISO conformed detection of particles down to 5  $\mu\text{m}$
- › Height evaluation of particles to estimate overall risk potential
- › Differentiation between reflective (metallic) and non-reflective (plastic) particles
- › Automatic storage of magnification and camera settings for each configuration
- › Manual microscope system can also be used for metallography or other microscopic applications
- › Sustainable system with high magnification and low calibration values for future requirements of minimum particle size



## An ideal solution for detecting large particles: the Leica DMS300 Cleanliness Expert or Leica DMS1000 Cleanliness Expert

### SYSTEM FEATURES:

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The Leica DMS-based Cleanliness Expert systems are ideal for the measurement of particle length and breadth as well as for differentiating between reflective and non-reflective particles. The compact digital microscope systems are available in two configurations:

1.) manual zoom

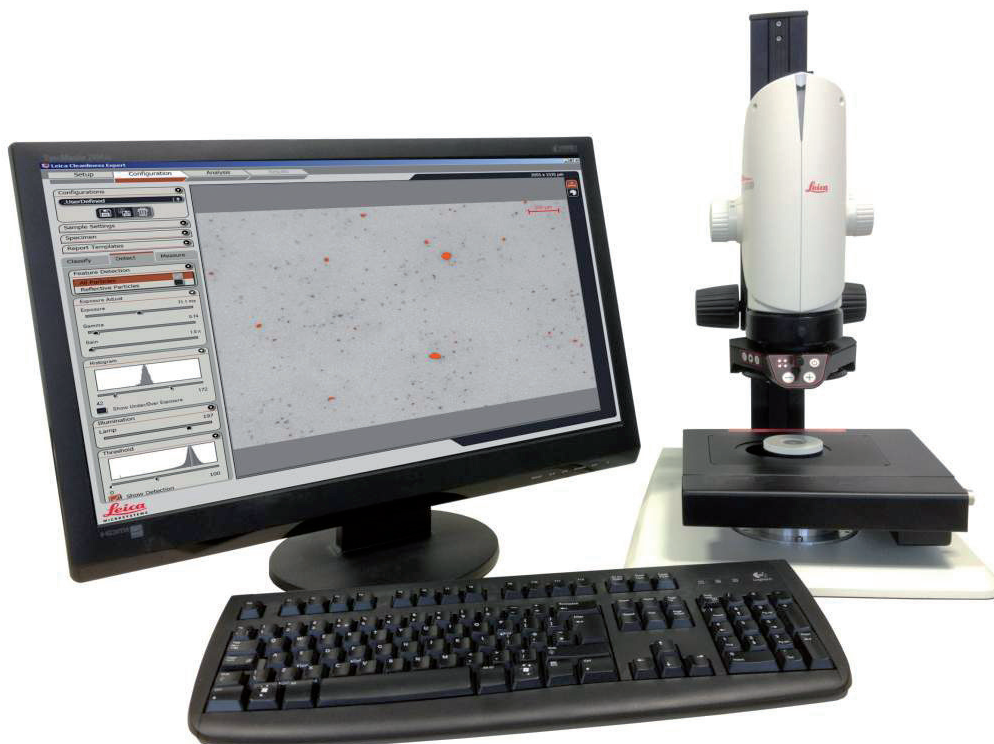
(Leica DMS300 Cleanliness Expert),

2.) coded version

(Leica DMS1000 Cleanliness Expert).

Click stop positions can be activated in both versions.

- › High optical performance
- › ISO conformed detection of particles down to 20  $\mu\text{m}$
- › Differentiation between reflective (metallic) and non-reflective (plastic) particles
- › Automatic storage of magnification and camera settings for each configuration
- › Compact design
- › No parallax error as on stereo microscopes, due to single beam path
- › Manual or coded optic carrier



## Functional, reliable, flexible – Leica Cleanliness Expert in a nutshell

### FUNDAMENTAL FUNCTIONALITIES

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- › User-friendly graphical user interface
- › Guided analysis workflow
- › Automatic differentiation between reflective (metallic) and non-reflective (plastic) particles
- › Length measurement
- › Breadth measurement
- › Height measurement
- › Supported standards: user-defined, ISO 16232 (VDA 19), ISO 4406, USP 788, etc.
- › Differentiation between particles and fibers

### RELIABILITY

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- › Detection in live image
- › Scaling in live image
- › Auto tracing of particles and fibers across image boundaries -> no maximum size limit for particles to be measured
- › Zoom function during scanning process
- › Size of largest detected particle is displayed and updated during scanning process
- › Number of detected particles is displayed and updated during scanning process
- › Auto leveling function for uneven filter surfaces

### FLEXIBILITY

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- › Re-positioning of detected particles after scan
- › Re-classification possibility
- › Editing function
- › Editable report format
- › Multiple measurement parameters can be added to the report

### SECURITY

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- › Different user levels
- › All hardware settings (microscope and camera) are automatically stored
- › All measurement parameters and their changes are automatically stored
- › Unauthorized changes of the configuration settings are recorded and reported
- › Reclassification and editing of the results are automatically documented
- › Traceability by auto logging function

The statement by Ernst Leitz in 1907, “*With the User, For the User,*” describes the fruitful collaboration with end users and driving force of innovation at Leica Microsystems. We have developed five brand values to live up to this tradition: Pioneering, High-end Quality, Team Spirit, Dedication to Science, and Continuous Improvement. For us, living up to these values means: **Living up to Life.**

Leica Microsystems operates globally in three divisions, where we rank with the market leaders.

#### LIFE SCIENCE DIVISION

The Leica Microsystems Life Science Division supports the imaging needs of the scientific community with advanced innovation and technical expertise for the visualization, measurement, and analysis of microstructures. Our strong focus on understanding scientific applications puts Leica Microsystems’ customers at the leading edge of science.

#### INDUSTRY DIVISION

The Leica Microsystems Industry Division’s focus is to support customers’ pursuit of the highest quality end result. Leica Microsystems provide the best and most innovative imaging systems to see, measure, and analyze the microstructures in routine and research industrial applications, materials science, quality control, forensic science investigation, and educational applications.

#### MEDICAL DIVISION

The Leica Microsystems Medical Division’s focus is to partner with and support surgeons and their care of patients with the highest-quality, most innovative surgical microscope technology today and into the future.

Leica Microsystems – an international company with a strong network of worldwide customer services:

| Active worldwide                   |      | Tel.           | Fax            |
|------------------------------------|------|----------------|----------------|
| Australia · North Ryde             | +61  | 2 8870 3500    | 2 9878 1055    |
| Austria · Vienna                   | +43  | 1 486 80 50 0  | 1 486 80 50 30 |
| Belgium · Diegem                   | +32  | 2 790 98 50    | 2 790 98 68    |
| Canada · Concord/Ontario           | +1   | 800 248 0123   | 847 405 0164   |
| Denmark · Ballerup                 | +45  | 4454 0101      | 4454 0111      |
| France · Nanterre Cedex            | +33  | 811 000 664    | 1 56 05 23 23  |
| Germany · Wetzlar                  | +49  | 64 41 29 40 00 | 64 41 29 41 55 |
| Italy · Milan                      | +39  | 02 574 861     | 02 574 03392   |
| Japan · Tokyo                      | +81  | 3 5421 2800    | 3 5421 2896    |
| Korea · Seoul                      | +82  | 2 514 65 43    | 2 514 65 48    |
| Netherlands · Rijswijk             | +31  | 70 4132 100    | 70 4132 109    |
| People’s Rep. of China · Hong Kong | +852 | 2564 6699      | 2564 4163      |
| · Shanghai                         | +86  | 21 6387 6606   | 21 6387 6698   |
| Portugal · Lisbon                  | +351 | 21 388 9112    | 21 385 4668    |
| Singapore                          | +65  | 6779 7823      | 6773 0628      |
| Spain · Barcelona                  | +34  | 93 494 95 30   | 93 494 95 32   |
| Sweden · Kista                     | +46  | 8 625 45 45    | 8 625 45 10    |
| Switzerland · Heerbrugg            | +41  | 71 726 34 34   | 71 726 34 44   |
| United Kingdom · Milton Keynes     | +44  | 800 298 2344   | 1908 246312    |
| USA · Buffalo Grove/Illinois       | +1   | 800 248 0123   | 847 405 0164   |