



Product Information
Version 3.3

ZEISS Particle Analyzer

Analyze Tiny Particles: Accurately and Reproducibly



Secure Comprehensive Quality into the Nano Range

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- › The Applications
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Particle Analyzer is a milestone for your quality control in the area of component and oil cleanliness. Choose between three systems: with the cost-effective stereo microscope SteREO Discovery.V8 you measure particles down to 20 μm ; with the fully motorized zoom microscope Axio Zoom.V16 down to 5 μm and with the fully motorized light microscope Axio Imager 2 down to 2 μm . Particle Analyzer software supports the standards for cleanliness testing ISO 16232, VDA 19.1, and oil analysis DIN 51455, ISO 4406, ISO 4407, NAS 1638 and SAE AS 4059. With the system solutions from ZEISS, you ensure that the required microscope settings are always selected correctly. You receive reliable, reproducible results nearly independent of the user carrying out the analysis. By carrying out correlative particle analyzes, you expand the depth of information contained within your findings to include the results of element and materials characterization.



Simpler. More Intelligent. More Integrated.

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Reproducible Results:

Your Needs Determine the Tool

The motorized microscope systems of your Particle Analyzer ensure that your settings are always correct – from the contrast method and selection of objectives, to the camera's exposure time and illumination settings. In conjunction with the automatic image analysis in AxioVision, you get reliably reproducible results. Itemized by quantity and size ranges, you can classify by metallic, non-metallic particles and fibers.

Easy Operation:

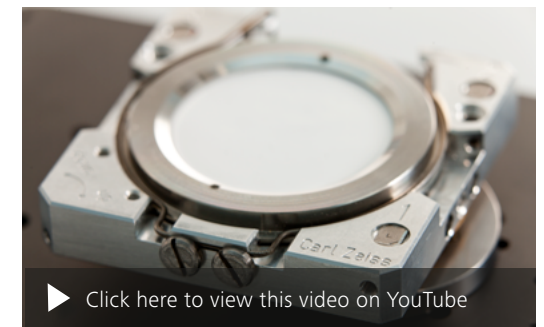
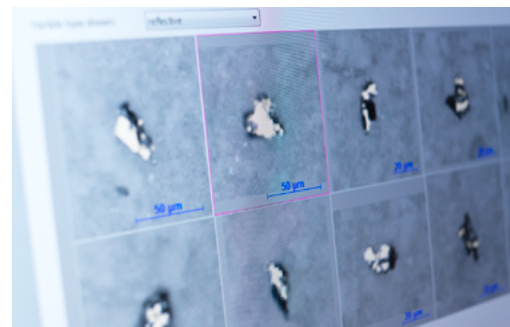
Based on Your Work Processes

The workflow of your Particle Analyzer is adaptable to your routines. You start the analysis, create a report, and archive it all with only a few clicks. You collect the results in a manner that is fit for real-world use: the system shows you all size classifications and cleanliness levels at a glance. In the gallery and evaluation view, you gain a quick overview of all particle types: metallic, non-metallic and fibers. You can relocate interesting particles at the touch of a button. Use the convenient revision mode whenever you want to reclassify particle types or edit particles. Use the particle height measurement to gain additional information of your particles.

Correlative Particle Analysis:

Shed Light on Your Material's Properties

Correlative particle analysis adds the results of your analysis with an electron microscope to the information gained from your analysis with a light microscope. At the touch of a button you can relocate particles found with the light microscope on the electron microscope. With the light microscope you can record the quantity, size distribution and morphology of your particles. You can differentiate between metallic and non-metallic particles. With the electron microscope and energy dispersive spectroscopy, you also learn the elemental composition broken down by percent and the resulting material classification of your particles.



Your Insight into the Technology Behind It

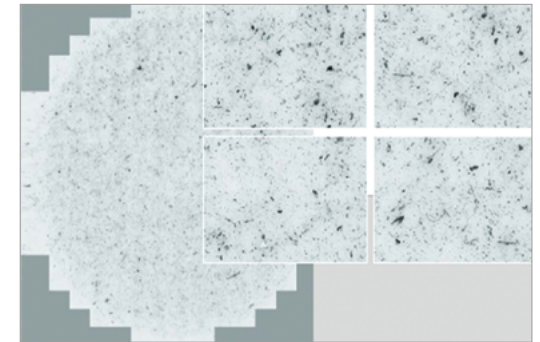
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MosaiX

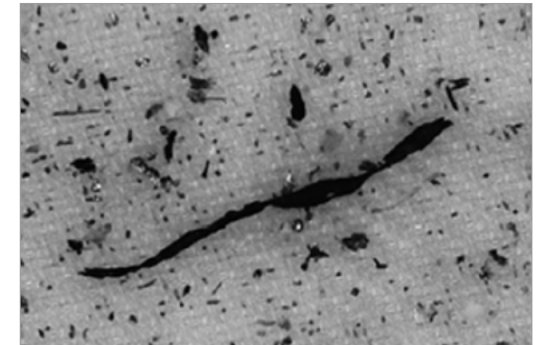
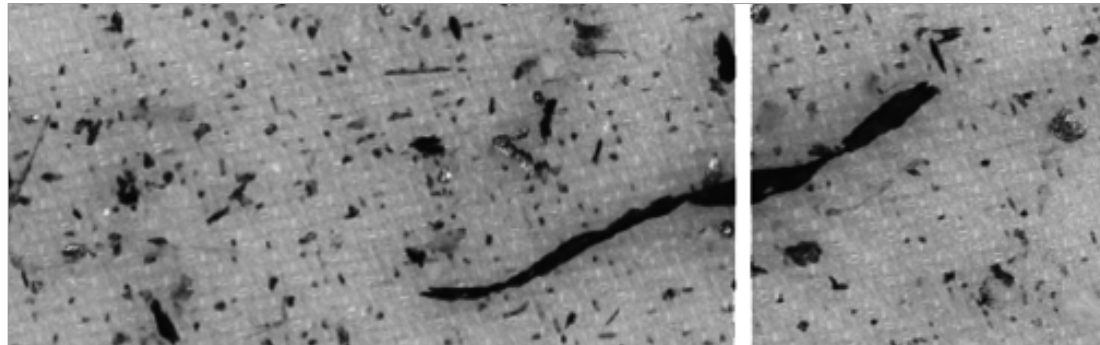
The technical cleanliness of components is a core quality feature. Therefore the accurate determination of the size distribution and type of residual dirt particles introduced with the component is decisive for the approval process.

The resolution for recording small particles recommended in current technical guidelines automatically leads to the fact that only a very small section of a sample can be reproduced in

an individual image. With the particle analyzer system solution, you use motorized stages to analyze your samples, you record individual images, and then stitch them all together to form a large MosaiX image. Special image analysis and processing algorithms ensure that particles spread across two images or small particles on the edge of an image are correctly recorded, analyzed, and measured.



Residual particles on the filter membrane; mosaic image comprised of over 200 individual images; microscope: Axio Imager 2; objective: EC Epiplan-NEOFLUAR 5x/0.13; camera: AxioCam MRc

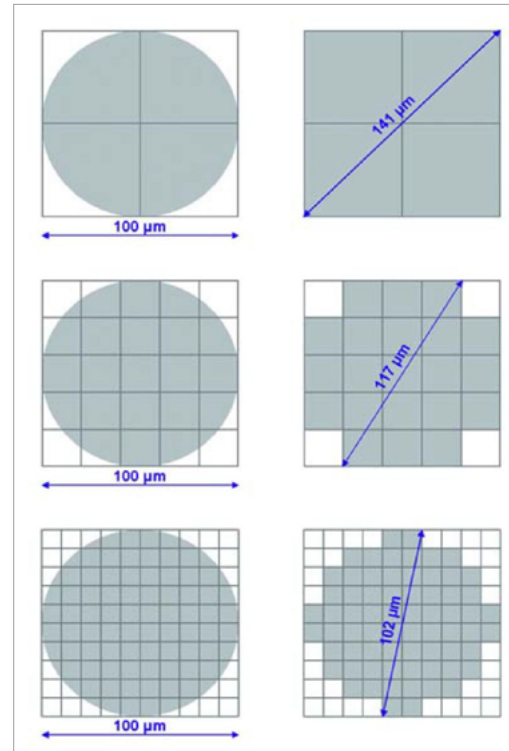


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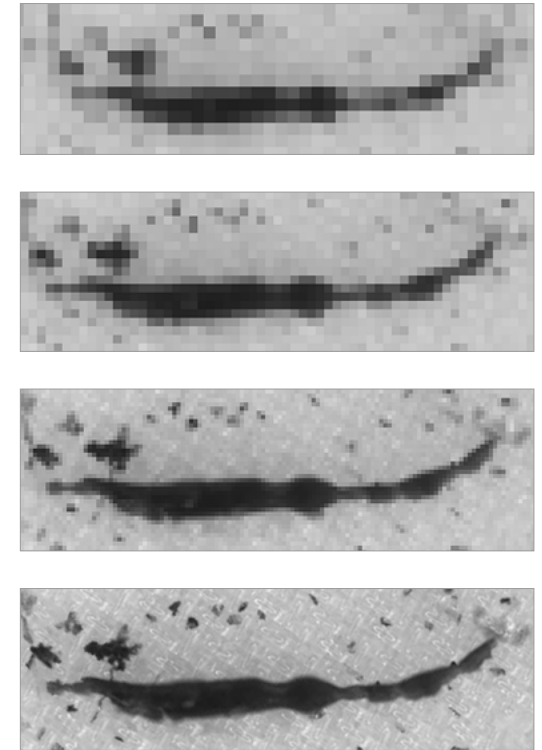
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Resolution: Theoretical Basics

The higher the resolution, the more accurate the presentation of your image. The higher the resolution, the larger the image size, and as a result, the time required to conduct the analysis. The theoretical foundation for the minimum resolution is set forth in the Nyquist–Shannon sampling theorem. The smallest detail to be resolved must be sampled with at least two pixels. When analyzing a circle, this means the circle would be sampled with four pixels. The result in the image would be a square. If the circle had a diameter of $100\ \mu\text{m}$, the analysis of the largest diameter would result in a value of $141\ \mu\text{m}$ – the analysis would be conducted with an error of over 40%. That's why some guidelines require the sampling of the smallest particle to be carried out with 10 pixels – the result of the square analysis would be $102\ \mu\text{m}$, with an acceptable error of 2%.



Impact of the selected resolution on the accuracy of the analysis; Left: Circle with a diameter of $100\ \mu\text{m}$ sampled with two, five, and ten pixels; Right: Results of the analysis of the largest diameter



Improving the presentation of a particle by increasing the resolution

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Microscope and Camera Resolution

A camera only ever sees a portion of a sample. But ideally, the microscope's entire intermediate image should be reproduced directly on the camera's chip. In a light microscope, this intermediate image has a diameter of 18, 20, 23, or 25 mm. The sensors are usually much smaller, however. As a result, only a portion of the image visible through the eyepieces is recorded by the camera and displayed on the monitor. For example, a 1/2" CCD chip with an 8 mm diagonal only records 1/8 of the area of 18 mm. The resolution plays a key role when recording and analyzing microscopic images. In this context, a differentiation is made between the microscope's resolution and the camera's resolution. The microscopic or optical resolution at the object level describes the ability to

differentiate between fine structures, i.e. the smallest perceptible distance between two points. In contrast, the camera or image resolution describes the number of pixels which comprise a digital image. The higher the image resolution, the more detailed the presentation of the microscopic image, and the more accurate the results of the analysis. The ideal resolution for a lossless image depends on the resolution of the objective used and the camera adapter. In this context, two pixels are needed to display each pair of lines reproduced by the objective. If a camera adapter is used with image-narrowing optics, this must be factored into the calculation. The calculation of the required resolution at the object and sensor level is based on the following formulas:

$$\text{Resolution at the object level } (\mu\text{m/LP}) = \frac{0.33}{\text{Numeric aperture}}$$
$$\text{Resolution at the sensor level } (\mu\text{m/LP}) = \frac{\text{Resolution Object level} \times \text{Magnification Zoom factor} \times \text{Magnification factor Camera adapter}}$$

To calculate the required minimum number of pixels for lossless image recording, the length and width of the camera's sensor are both divided by the resolution at the sensor level, and the result is then multiplied by two.

$$\text{Number of pixels X} = \frac{2 \times \text{Sensor length } (\mu\text{m})}{\text{Resolution at the sensor level } (\mu\text{m/LP})}$$
$$\text{Number of pixels Y} = \frac{2 \times \text{Sensor width } (\mu\text{m})}{\text{Resolution at the sensor level } (\mu\text{m/LP})}$$

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Microscope	Magnification Factor	Numeric Aperture	Resolution at the Object Level [μm/LP]	Resolution at the Sensor Level [μm/LP]	Number of Pixels X	Number of Pixels Y	Objective
Axio Imager 2	1.25	0.03	11.0	13.8	1232	1029	EC Epiplan-NEOFLUAR
	2.50	0.06	5.5	13.8	1232	1029	
	5.00	0.13	2.5	12.5	1360	1136	
	10.00	0.25	1.3	13.0	1308	1092	
	20.00	0.50	0.7	14.0	1214	1014	
Axio Zoom.V16	1.50	0.070	4.8	7.2	2361	1972	Apo Z 1.5x
	3.00	0.124	2.7	8.1	2099	1753	
	6.00	0.218	1.5	9.2	1848	1543	
	7.50	0.262	1.3	9.6	1771	1479	
	12.00	0.358	0.94	11.2	1518	1268	
	15.00	0.371	0.90	13.6	1250	1044	
SteREO Discovery.V8	1.00	0.022	15.0	15.0	1133	947	PlanS 1.0x
	2.00	0.039	8.5	17.0	1000	835	
	4.00	0.067	4.9	19.6	867	724	
	5.00	0.079	4.2	21.0	810	676	
	8.00	0.116	2.8	22.4	759	634	
	Camera	Sensor size		Camera adapter			
	AxioCam ICc 5	2/3"; 8.5 mm (L) × 7.1 mm (W)		1.0 ×			

The tables show microscope and image resolutions for selected figures from the Axio Imager 2 light microscope, the Axio Zoom.V16 zoom microscope, and the SteREO Discovery.V8 stereo microscope. The resolution at the object level represents the smallest distance between two lines that the respective objective or zoom optics can resolve. The columns "pixel X" and "pixel Y" show the minimum number of camera pixels required for an optimal camera image at the respective level of magnification.

Tailored Precisely to Your Applications

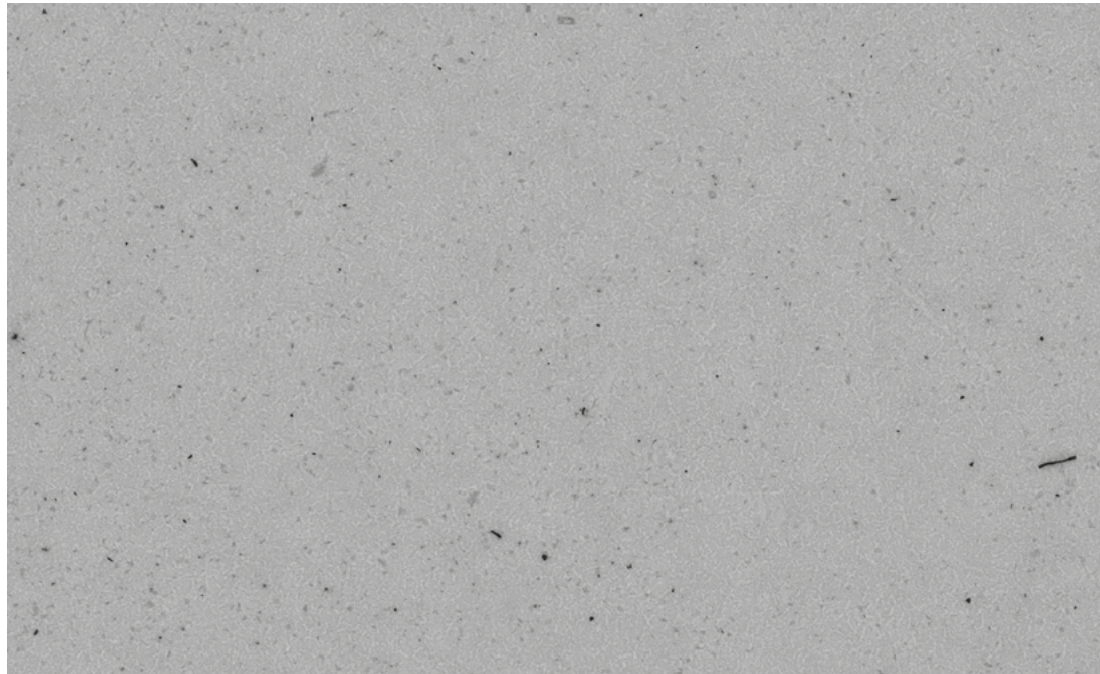
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Typical Applications; Typical Samples	Task	ZEISS Particle Analyzer Offers
Technical Cleanliness	Evaluating the technical cleanliness of engine components	Automatic analysis of the particulate contamination on membrane filters supporting ISO 16232, VDA 19.1 and internal standards after adjustment. Determining the quantity, particle size distribution, morphology and type (metallic, nonmetallic particles and fibers).
	Material classification by correlative light/electron microscopy	Upon adding the AxioVision correlative particle analyzer software module: Automatic retrieval of selected particles with the electron microscope, previously analyzed by the light microscope. Automatic EDX analysis of preselected, metallic particles. Combined light microscope/electron microscope report of results with element composition and material classification.
Oil Analyses	Evaluating of oil cleanliness in fresh and used oils and lubricants	Automatic analysis of the particulate contamination on membrane filters supporting DIN 51455, ISO 4406, ISO 4407, NAS 1638 and SAE AS 4059 and internal standards after adjustment. Determining the quantity, particle size distribution and morphology.
Generic Particle Analysis	Object detection and classification	Automatic sample analysis. Object classification by quantity, size distribution, morphology, and color

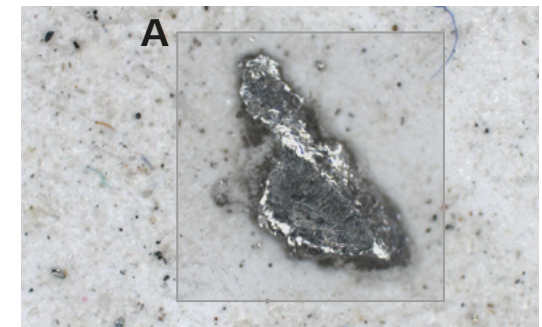
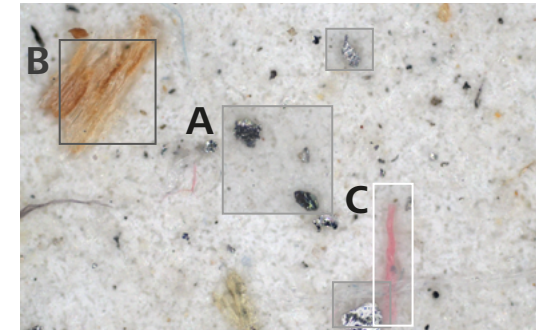
Expand Your Possibilities

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Membrane Filter with Particle Load



Residual dirt particles on a membrane filter. Microscope: Axio Imager 2, objective: EC Epiplan-NEOFLUAR 10x/0.25



Membrane filter with different particle types

- A: Metallic particles
- B: Non-metallic particle
- C: Fiber

ZEISS Particle Analyzer at Work

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Correlative Particle Analysis: More Knowledge. Higher Quality.

Characterize process-critical particles. Systematically identify killer particles – Correlative Particle Analyzer combines your data from light and electron microscopy.

Completely characterize residual dirt particles. With correlative particle analysis from ZEISS you start the analysis with the light microscope. You can retrieve and characterize preselected, metallic particles in a fully automated process using electron microscopy and EDX. Correlative Particle Analyzer automatically documents the combined results from both the light microscopic and electron microscopic analysis; you receive an informative report at the touch of a button.

As an experienced user, you can inspect the results of the light microscopic and electron microscopic analysis on a combined overview screen. With Correlative Particle Analyzer, your results will be available up to ten times faster than first conducting a complete analysis with a light microscope and then subsequently with an electron microscope. You can systematically focus on potentially process-critical particles. The complementary material characterization from both microscopic worlds gives you added security.

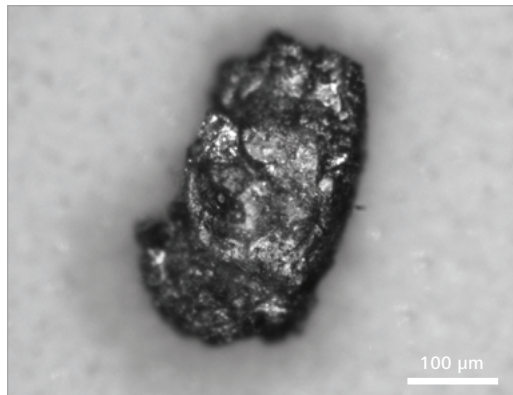


Image of a metallic particle from a light microscope

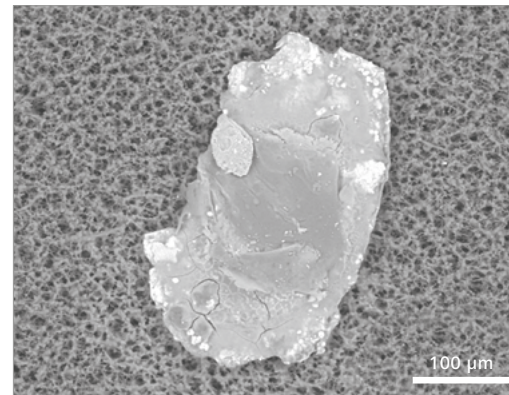
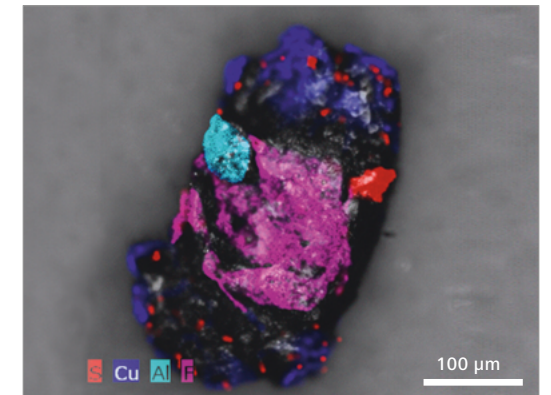


Image of the same metallic particle from an electron microscope



Overlay of the images from both systems; chemical element composition via EDX analysis; graphical EDX overlay prepared with Bruker Esprit software

ZEISS Particle Analyzer at Work

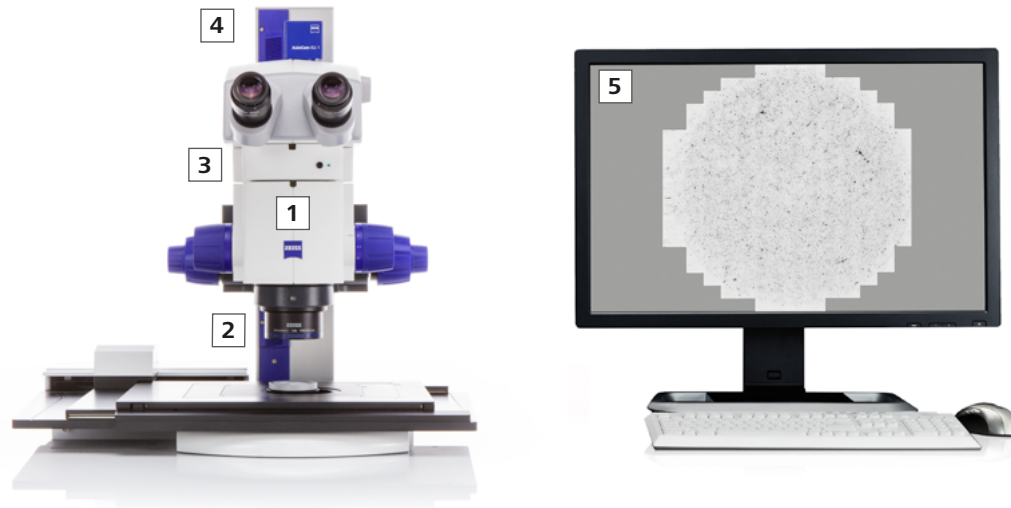
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Typical Applications	Task	Solution
Image Recording	Z-Stack and EDF	<ul style="list-style-type: none"> ■ AxioVision Z-Stack module and Extended Focus
Image Processing, Image Analysis, and Measuring	Segmentation, binary image processing	<ul style="list-style-type: none"> ■ AxioVision Interactive Measurement module: determination of object-describing parameters such as size, with the help of an analysis wizard; completion of the analysis tasks in a fixed order; presentation of the results in an easy-to-read list of results
	Automatic measurement	<ul style="list-style-type: none"> ■ AxioVision AutoMeasure Plus module: easily create automatic analysis routines for an unlimited number of images yourself
	Interactive measurement	<ul style="list-style-type: none"> ■ AxioVision AutoMeasure Plus module: easily create automatic analysis routines for an unlimited number of images yourself
	Analyze layer thickness	<ul style="list-style-type: none"> ■ AxioVision Layer Thickness Measurement module: analyze simple and complex layers; identify layers by color value or gray scale; precise, individual, and automatic calculation of the course of measuring axis for each layer, regardless of the number of layers; presentation of results in an easy-to-read report with sample data and findings such as maximum and minimum axis length, mean value, and standard deviation
	Analysis of grain size supporting with ASTM E 112, ASTM E 1382, DIN EN ISO 643	<ul style="list-style-type: none"> ■ AxioVision Grains module: variable methods of standard-supporting grain size analysis: automatic reconstruction of grain boundaries and determination of individual grain sizes; semiautomatic linear intercept methods; comparison of structural and reference series images
	Analysis of phases and porosity	<ul style="list-style-type: none"> ■ AxioVision Multiphase analysis module: analysis of samples' phase distribution; measurement of size, shape, and orientation; easy-to-read documentation in percentage of total area, as classified particle size, or as a comparison
	Comparative examination of materialographic samples using a microscope with reference series	<ul style="list-style-type: none"> ■ AxioVision Comparative Diagrams module: convenient, interactive on-screen assessment of structural parameters; the ability to create your own reference series; easy-to-read results using a table with reference series numbers for each image as well as statistical evaluations; output of the structural image with superimposed reference series image
Analysis of graphite particles in cast iron supporting EN ISO 945-1 or SAE J 1887	<ul style="list-style-type: none"> ■ AxioVision Graphite module: fully automated determination and classification of size and shape of graphite in cast iron supporting EN ISO 945-1 as well as nodularity of vermicular graphite pursuant to SAE J 1887 	
Determination of steel cleanliness supporting EN 10247, DIN 50602, ASTM E45, ISO 4967, JIS G 0555, GB/T 10561; determination of the content of non-metallic inclusions	<ul style="list-style-type: none"> ■ AxioVision NMI module: steel cleanliness analysis supporting current international standards; result overview, inclusion classification; selection of various gallery views with all analysis; storage and management of all analysis data such as charts, images, reports, testing procedures in the asset archive 	

Your Flexible Choice of Components

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Particle Analyzer System ZEISS SteREO Discovery.V8



1 Microscope

- SteREO Discovery.V8 for particle size $\geq 20 \mu\text{m}$; recommended system for standard analysis according to VDA 19.1

2 Objective

- Achromat S 1.0x

3 Illumination and Contrast

- CL 6000 LED (cold light)
- Brightfield, polarization

4 Camera

- AxioCam ICc 1 (1.4 megapixel color camera)

5 Software

- AxioVision
- AxioVision Particle Analyzer Projects
- AxioVision MosaIX
- AxioVision Commander

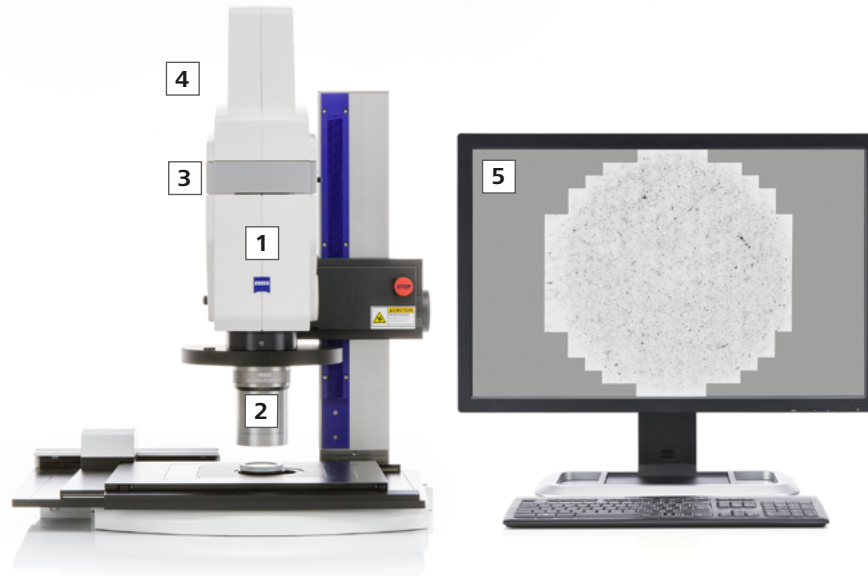
Accessories

- Calibration standard for particle analysis (with certificate, if so desired)
- Stage micrometer (with certificate, if so desired)
- Plate carrier and specimen holder for round particle filters

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Particle Analyzer System ZEISS Axio Zoom.V16



1 Microscope

- Axio Zoom.V16 for particle size $\geq 5 \mu\text{m}$; recommended system for extended analyses according to VDA 19.1

2 Objectives

- Apo Z 1.5x for particles $\geq 5 \mu\text{m}$
- PlanApo Z 0.5x for particles $\geq 20 \mu\text{m}$

3 Illumination and Contrast

- CL 9000 LED (cold light)
- Brightfield, polarization

4 Camera

- Digital tube Z 5 (integrated 5 megapixel color camera)

5 Software

- AxioVision
- AxioVision Particle Analyzer Projects
- AxioVision MosaicX
- AxioVision Commander
- AxioVision Autofocus

Accessories

- Calibration standard for particle analysis (with certificate, if so desired)
- Stage micrometer (with certificate, if so desired)
- Plate carrier and specimen holder for round particle filters

Correlative Particle Analysis

Light Microscopy:

- AxioVision Correlative Particle Analyzer, AxioVision MosaicX, AxioVision Autofocus, AxioVision Commander

Electron Microscopy:

- SmartPI, SmartSEM
- AxioVision Correlative Particle Analyzer, Particle Analyzer Projects

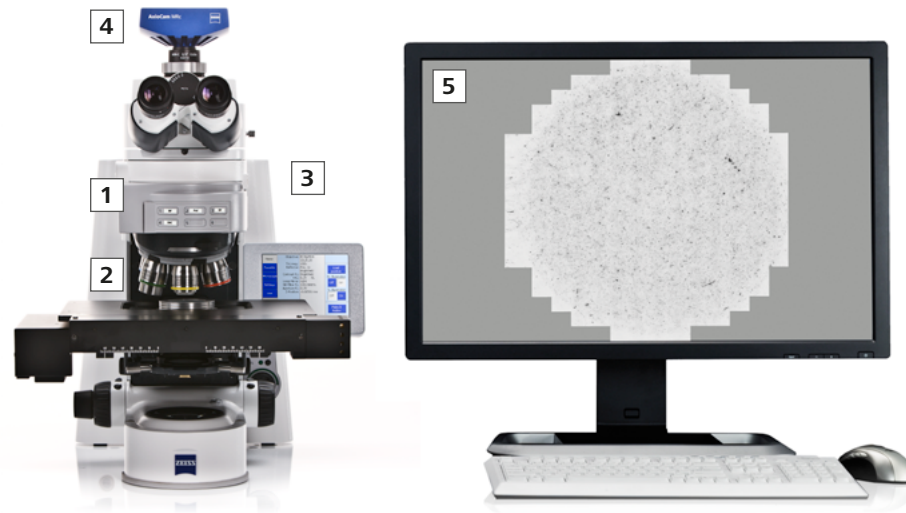
Optional:

- AxioVision Shuttle & Find
- Adapter plate "CorrMic" with SEM interface
- Adapter frame S 160x116 epi-illumination
- Specimen holder "CorrMic MAT" particle analysis
- Calibration Marker "CorrMic", 3 pieces

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Particle Analyzer System ZEISS Axio Imager 2



1 Microscope

- Axio Imager 2 for particle size $\geq 2 \mu\text{m}$; recommended system for VDA 19.1, particle height measurement and for oil analyses

2 Objective

- EC Epiplan-NEOFLUAR

3 Illumination and Contrast

- Brightfield, polarization
- HAL 100 (halogen)
- microLED

4 Camera

- Axiocam 503 color (3 megapixel color camera)

5 Software

- AxioVision
- AxioVision Particle Analyzer Projects
- AxioVision MosaiX
- AxioVision Commander
- AxioVision Autofocus

Accessories

- Calibration standard for particle analysis (with certificate, if so desired)
- Stage micrometer (with certificate, if so desired)
- Plate carrier and specimen holder for round particle filters
- Mirror testing sample

Correlative Particle Analysis

Light Microscopy:

- AxioVision Correlative Particle Analyzer, AxioVision MosaiX, AxioVision Autofocus, AxioVision Commander

Electron Microscopy:

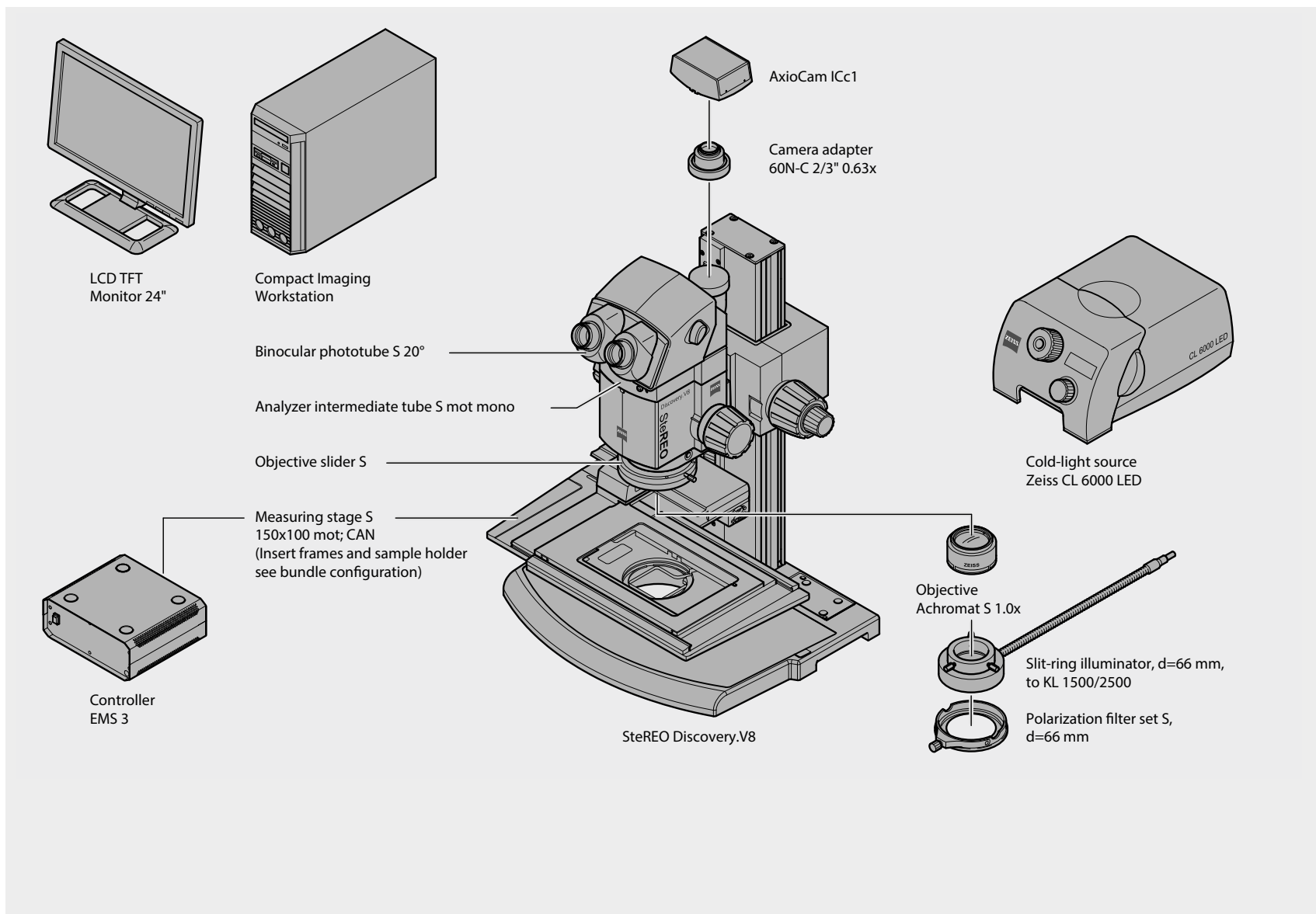
- SmartPI, SmartSEM
- AxioVision Correlative Particle Analyzer, Particle Analyzer Projects

Optional:

- AxioVision Shuttle & Find
- Adapter plate "CorrMic" with SEM interface
- Specimen holder "CorrMic MAT" particle analysis
- Calibration Marker "CorrMic", 3 pieces

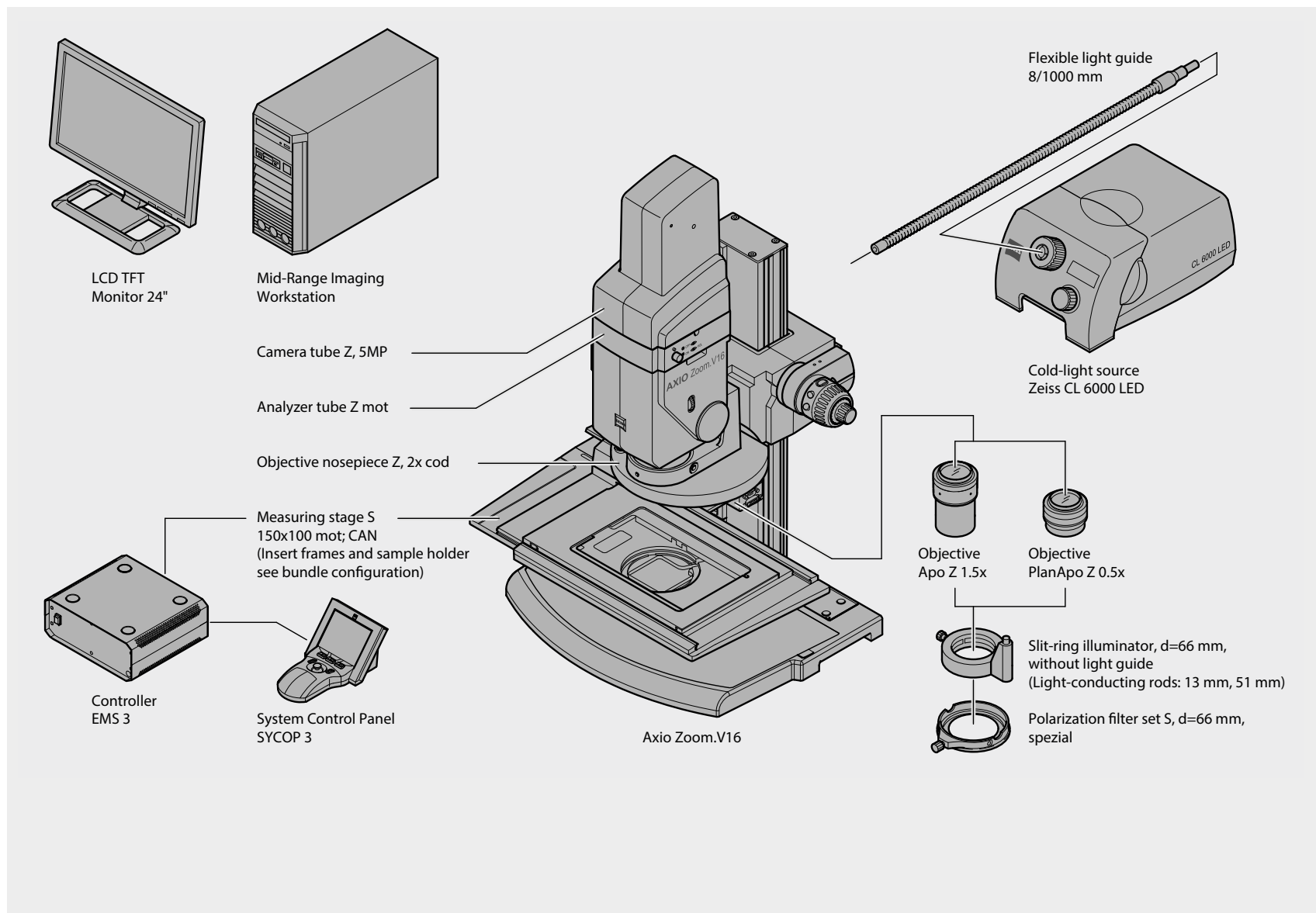
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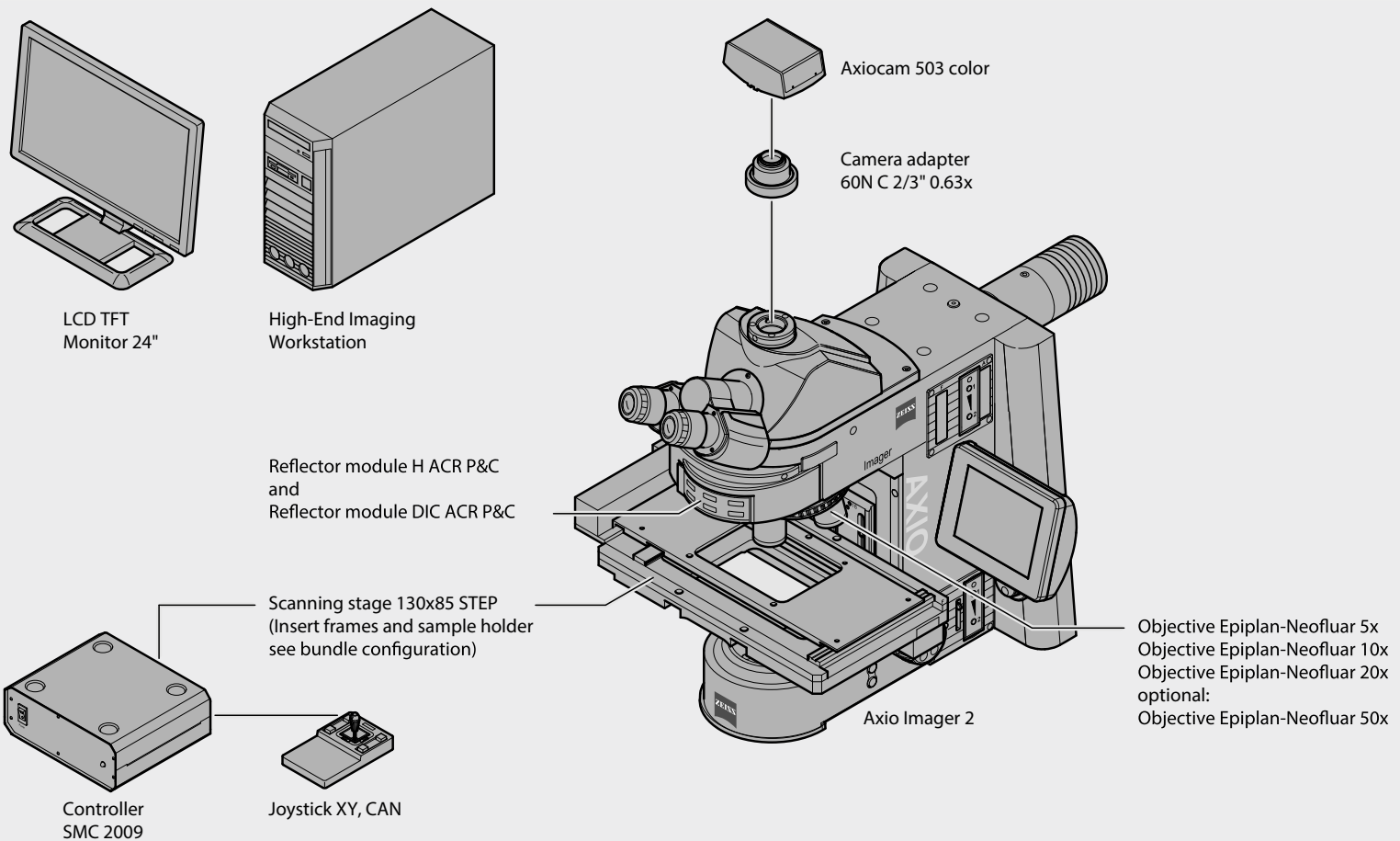
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Count on Service in the True Sense of the Word

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Because the ZEISS microscope system is one of your most important tools, we make sure it is always ready to perform. What's more, we'll see to it that you are employing all the options that get the best from your microscope. You can choose from a range of service products, each delivered by highly qualified ZEISS specialists who will support you long beyond the purchase of your system. Our aim is to enable you to experience those special moments that inspire your work.

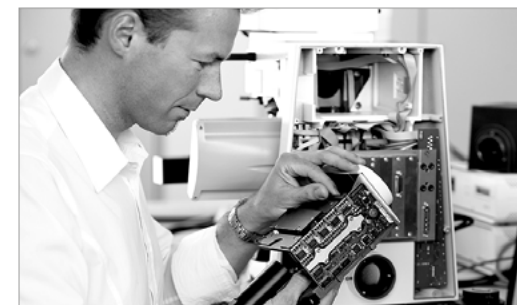
Repair. Maintain. Optimize.

Attain maximum uptime with your microscope. A ZEISS Protect Service Agreement lets you budget for operating costs, all the while reducing costly downtime and achieving the best results through the improved performance of your system. Choose from service agreements designed to give you a range of options and control levels. We'll work with you to select the service program that addresses your system needs and usage requirements, in line with your organization's standard practices.

Our service on-demand also brings you distinct advantages. ZEISS service staff will analyze issues at hand and resolve them – whether using remote maintenance software or working on site.

Enhance Your Microscope System.

Your ZEISS microscope system is designed for a variety of updates: open interfaces allow you to maintain a high technological level at all times. As a result you'll work more efficiently now, while extending the productive lifetime of your microscope as new update possibilities come on stream.



Profit from the optimized performance of your microscope system with services from ZEISS – now and for years to come.

>> www.zeiss.com/microservice



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