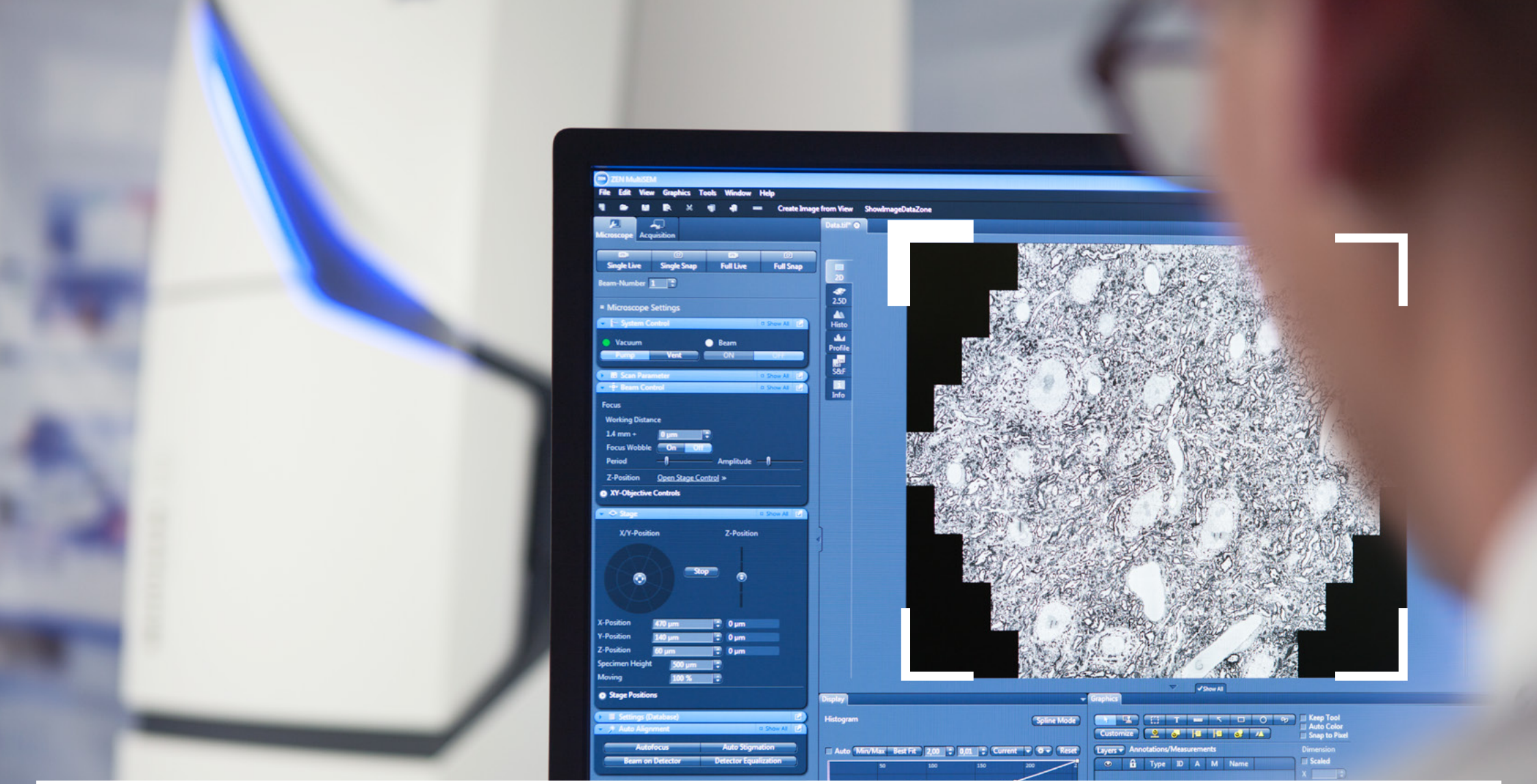


ZEISS MultiSEM

The World's Fastest Scanning Electron Microscopes

zeiss.com/multisem

ZEISS

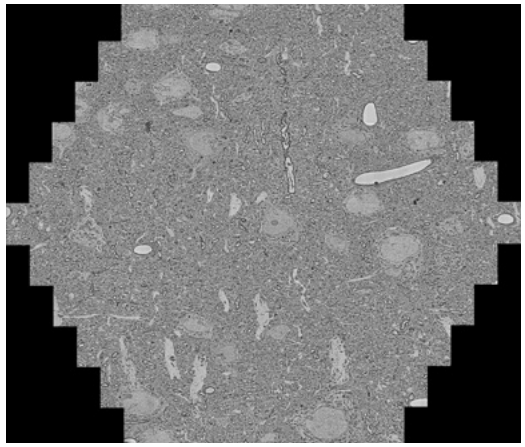
Seeing beyond

Revolutionize the Speed of Electron Microscopy with ZEISS

Unleash the speed of this unique scanning electron microscope and start thinking about new dimensions. Now, at last, you can image huge samples at nanometer resolution, driven by the unrivalled acquisition speed of MultiSEM.

MultiSEM is designed for continuous, reliable 24/7 operation. Simply set up your high-throughput data acquisition workflow. Then get on with your day while MultiSEM takes high contrast images all by itself – no supervision needed.

MultiSEM uses ZEN imaging software, so you can control this powerful microscope in an intuitive yet flexible way. Automated tuning routines make sure you achieve the best high resolution data.



Mouse brain section, image acquired using ZEISS MultiSEM 506 with 91 beams and at 4 nm pixel size. The hexagonal field of view (FoV) is 165 µm wide. Sample: courtesy of J. Lichtman, Harvard University, Cambridge, MA, USA

Leading Edge Science

ZEISS offers you access to a groundbreaking technology for a rapidly developing application space. Take profit from the opportunities of a new technology and become member of a worldwide growing community at the forefront of science.

By providing individual application support and a Premium Service concept, we help you to explore new territory. Are you ready to take the next step?

Simpler. More Intelligent. More Integrated.

Highest-ever Acquisition Speed at Nanometer Resolution

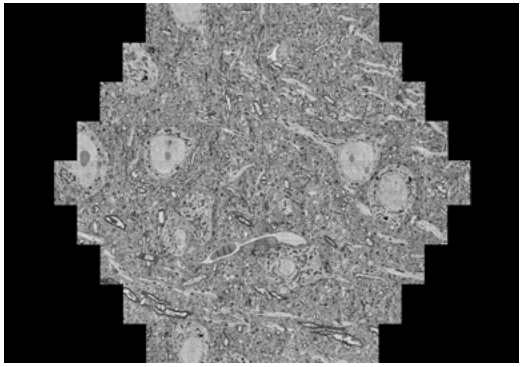
Multiple electron beams working in parallel give you unprecedented gross imaging speed. Acquiring an area of 1 mm² at 4 nm pixel size takes only a few minutes of imaging time. The unrivaled imaging speed of more than 1 TB per hour enables imaging of large volumes (> 1 mm³) at nanometer resolution. Optimized detectors collect the secondary electron signals very efficiently, providing you with high contrast images at low noise levels.

Electron Microscopy of Huge Samples

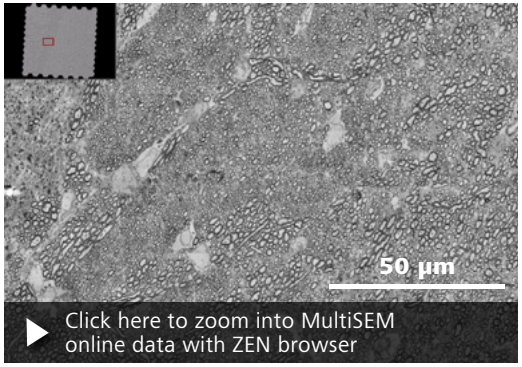
MultiSEM is built for continuous 24/7 operation and equipped with a sample holder covering an area of 10 cm × 10 cm. That means you no longer have to sacrifice sample size for nanometer resolution. You can finally image the entire sample and discover everything you need to answer your scientific questions. With automated acquisition protocols to enable large area imaging, you will get the detailed full picture, without losing the macroscopic context.

Electron Microscopy with ZEN Imaging Software

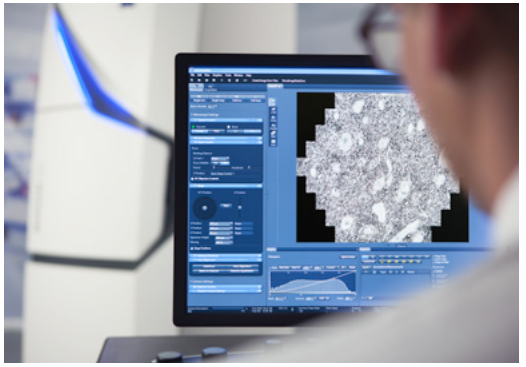
By introducing ZEN to MultiSEM, we bring the standard software for ZEISS light microscopes to the world of electron microscopy. ZEN lets you control MultiSEM in a straightforward, intuitive way. Smart auto-tuning routines support you as you capture optimal images with high resolution and quality. You quickly and easily set up even complex automated acquisition procedures, adapted and tuned to your sample imaging. ZEN for MultiSEM also masters the high speed required for continuous, parallel image recording. An open application programming interface (API) is provided for flexible and fast application development.



Mouse brain section (50 nm thick) image acquired in 1.3 s with a MultiSEM 505 covering a hexagonal field of view of 108 µm × 94 µm. Sample: courtesy of J. Lichtman, Harvard University, Cambridge, MA, USA

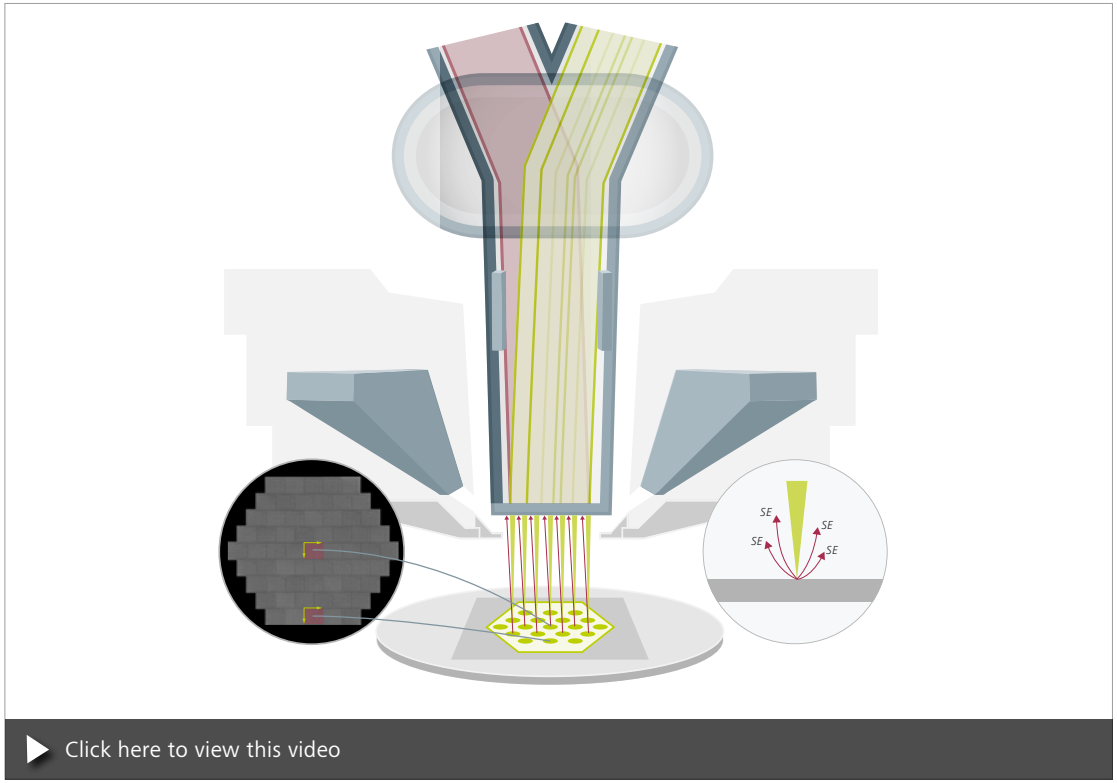


Mouse brain section, automated image acquisition of 1 mm² at 4 nm pixel size totaling 100 GB of data. Sample: courtesy of J. Lichtman, Harvard University, Cambridge, MA, USA



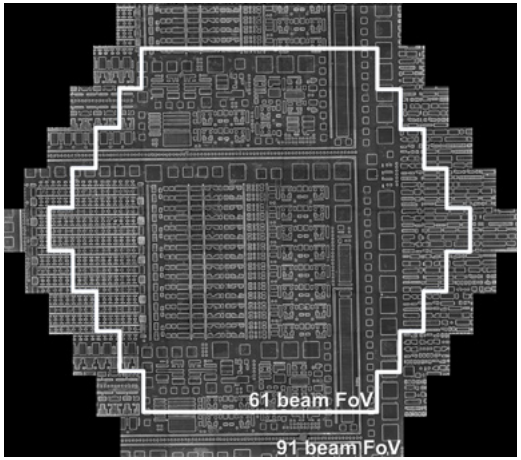
ZEN imaging software is used to control the MultiSEM.

Your Insight into the Technology Behind It



Click here to view this video

MultiSEM achieves high imaging speed by employing multiple electron beams and detectors in parallel. The key to this approach is a finely tuned detection path (red) collecting a large yield of secondary electrons used for imaging with a multiple detector array. Each beam carries out a synchronized scanning routine at one sample position, resulting in a single sub-image. The electron beams are arranged in a well-characterized hexagonal pattern. By merging all sub-images together, the final, full image is formed. A parallel computer setup is used for fast data recording ensuring high total imaging speed. Image acquisition and workflow control are fully separated in the MultiSEM system to guarantee full performance.



Two MultiSEM versions are currently available. MultiSEM 505 with 61 beams in parallel offers high acquisition speed at top resolution while MultiSEM 506 with 91 beams provides an even higher imaging throughput by covering a larger area per single scan pass. MultiSEM 505 provides a data rate of up to 1 TB per hour, whereas MultiSEM 506 offers a data rate of up to 1.5 TB per hour.

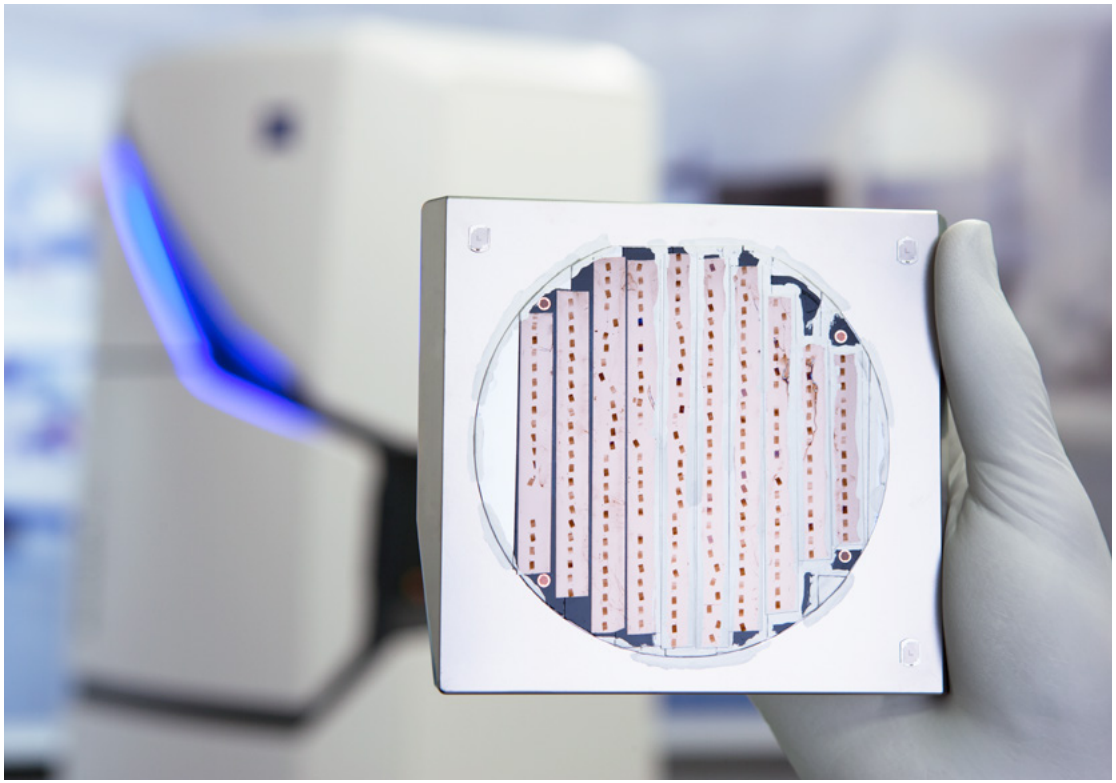
The image above (graphics processor chip) shows the fields of view of the two MultiSEM versions – MultiSEM 506 covers a 50% larger area with just a single scan pass.

Your Insight into the Technology Behind It

Your Complementary Workflow Solution for Acquisition of Serial Sections

Up to 1000 serial sections can be collected in one day by the ATUMtome, an automated tape collecting ultramicrotome. Subsequently, the tape with sections is mounted on a silicon wafer and can be imaged with a ZEISS light microscope using ZEN imaging software and Shuttle & Find.

By taking a light microscope overview image you can plan your experiment and navigate easily on your sample within the MultiSEM using the same ZEN software user interface. For planning and setting-up the acquisition workflow only one graphical user interface is needed. Automated section detection supports you in identifying and targeting your regions of interest in a very efficient way.

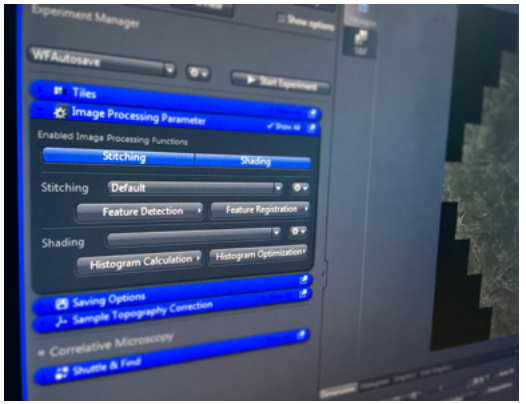


Your Insight into the Technology Behind It

Automated Section Detection
ZEN for MultiSEM employs a section detection algorithm that saves you hours of manual labor. By template matching all sections are labeled automatically and can be defined as regions of interest for the experiment setup. Selected sub-regions can be transferred from one section to all others by just one mouse click.

Intelligent Retake Manager
ZEN for MultiSEM features a unique and intelligent data management system to ensure data completeness. Assess your data quality by using the high resolution viewer. If required, the smart retake manager supports you in setting up the follow-up experiment. Retake images are seamlessly added to the existing data set.

Image Processing and Online Analysis
The high-performance image acquisition pipeline of MultiSEM provides processing tools that run in the background during data acquisition. A flexible user interface supports image stitching for a wide range of samples.

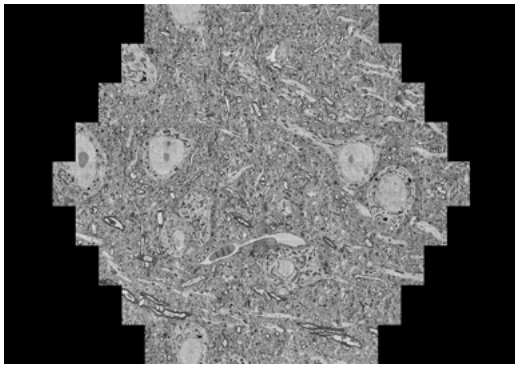


Tailored Precisely to Your Applications

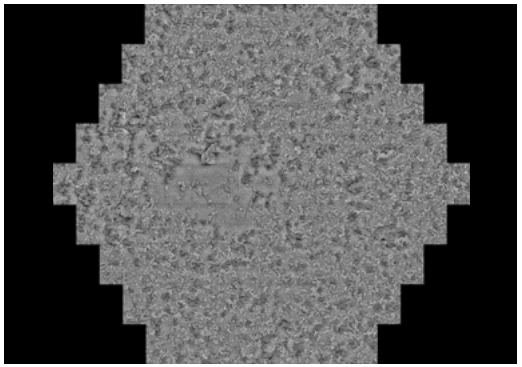
Typical Applications, Typical Samples	Task	ZEISS MultiSEM Offers
Stained Serial Sections of Brain Tissue	Capture large images of sections for subsequent 3D reconstruction needed for analysis in connectomics	Highest throughput electron microscopy at high resolution
Ultrathin Sections from Cultured Cells or Tissue Cultures	Screen through large sets of samples with different treatments and compare the results.	Larger regions of interest (ROI) in less time and for complete experimental trials, statistics become more reliable
Reverse engineering, Computer Chips, Patterned Silicon Wafers	Examine large areas with nanometer-sized structures	Imaging of entire chip surfaces in reasonable time frames
Analysis of Polished Rock Samples	Examine large sample surface areas to evaluate natural resources	Better quantitative assessment, larger ROIs, better statistics
Characterization of critical battery components	Analysis of large sample areas to quantify aging processes in batteries	Real, large-area quantitative assessment, delivering significant statistically relevant data
Resin-embedded bone samples	Analysis of cell distribution patterns on the etched surface of bulk bone samples	Retrieving contextual information about small features of interest at a macroscopic scale
Characterization of electronic components	Analysis of large sample areas to evaluate manufacturing processes	Real, large-area quantitative assessment, delivering significant statistically relevant data

ZEISS MultiSEM at Work

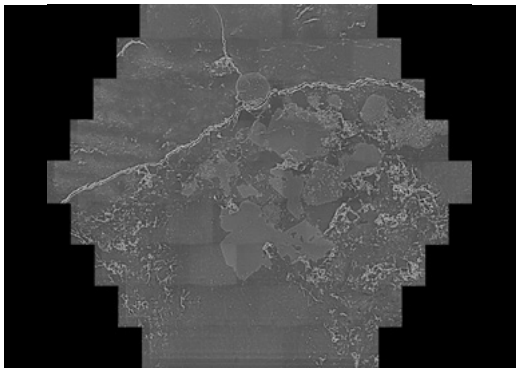
Click here to zoom into MultiSEM online data with ZEN browser



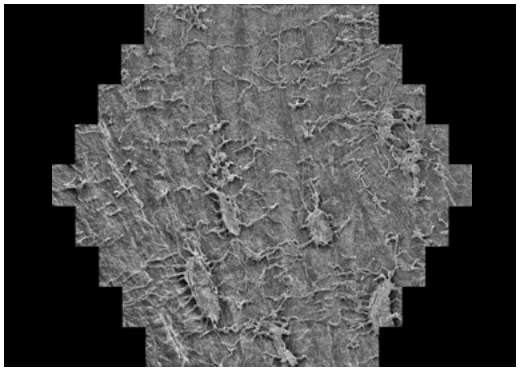
Mouse brain, 50 nm thick section. Image acquired with MultiSEM 505 covering a hexagonal field of view of 108 µm × 94 µm at 4 nm pixel size. Sample: courtesy of J. Lichtman, Harvard University, Cambridge, MA, USA.



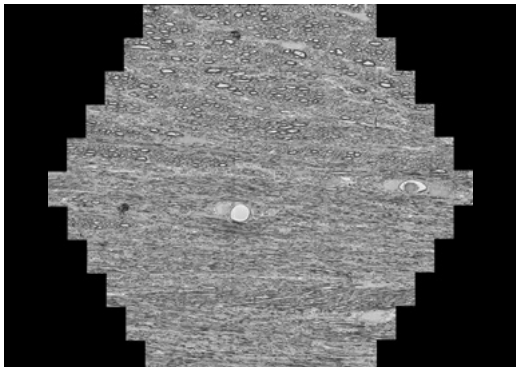
Separator foil of a cycled battery with precipitates from the anode side. Image acquired with MultiSEM 505 at low landing energy of 1 keV and 4 nm pixel size, covering a field of view of 108 µm × 94 µm. Sample: courtesy of U. Golla-Schindler and T. Bernthaler, Hochschule Aalen, Aalen, Germany.



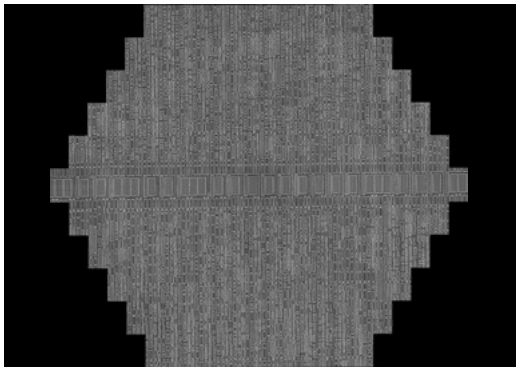
High maturity shale rock sample with broad ion beam milled surface. Image acquired with MultiSEM 505 at 4 nm pixel size, field of view is 108 µm × 94 µm. Sample: courtesy of L. Hathon, University of Houston, Houston, TX, USA.



Femoral neck sample, PMMA embedded, surface-polished and selectively etched to carve out osteocytes, hidden within the bone matrix before. Image acquired with MultiSEM 505 at 12 nm pixel size, field of view is 135 µm × 117 µm. Sample: courtesy of M. Knothe Tate, University of New South Wales, Australia, and Ulf Knothe, Cleveland, OH, USA.



Mouse brain, 50 nm thick section. Image acquired with MultiSEM 506 covering a hexagonal field of view of 165 µm × 143 µm at 4 nm pixel size. Sample: courtesy of J. Lichtman, Harvard University, Cambridge, MA, USA.



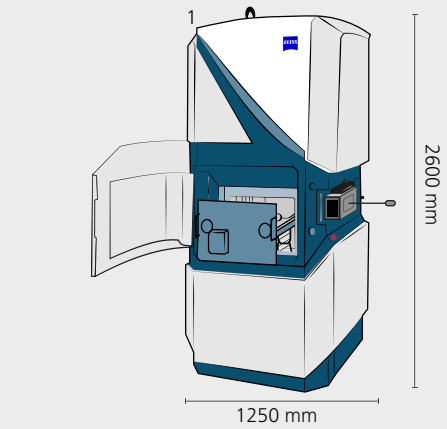
65 nm technology node graphics processor integrated circuit, stripped to its silicon substrate with HF acid etching. Image acquired with MultiSEM 506 at 4 nm pixel size, covering a hexagonal field of view of 165 µm × 143 µm.

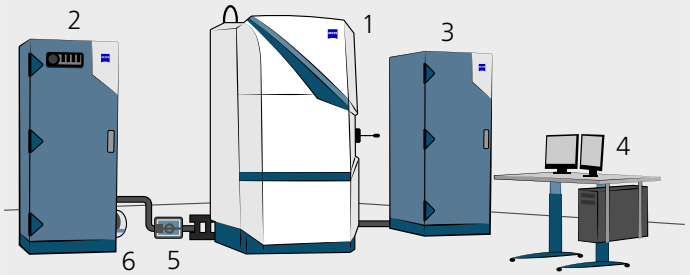
Your Flexible Choice of Components

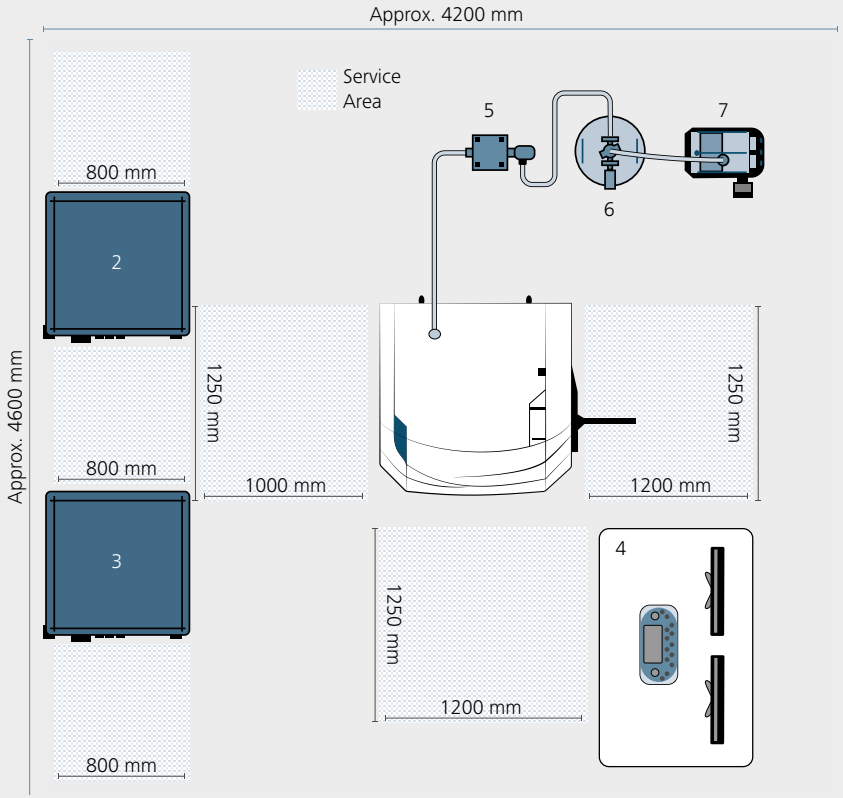
Accessory	Function	Technical Details
Chamber Plasma Cleaner	For cleaning the MultiSEM chamber. Reduction of contamination by hydrocarbons results in improved image quality and resolution	Generation of reactive gas-phase radicals removing unwanted contaminants. Consists of ■ Plasma Cleaner Evactron Zephyr ■ Adapter kit for MultiSEM chamber ■ Control integrated in ZEN software
Sample Plasma Cleaner	For cleaning and etching the sample in the airlock. Reduction of sample surface contamination results in improved image quality and resolution	Generation of reactive gas-phase radicals removing unwanted contaminants. Requires airlock. Consists of ■ Plasma Cleaner Evactron Zephyr ■ Multiport for MultiSEM airlock ■ Adapter Kit for Multiport ■ Control integrated in ZEN software
Standard Sample Holder	Flat surface holder for flexible sample mounting (≤ 100 × 100 mm²)	Including L-marker fiducials for Shuttle & Find functionality
Multi-Purpose Sample Holder	For mounting standard sized EM stubs and silicon wafer chips. Additional space for flexible sample mounting (ca. 50 × 50 mm²)	Including L-marker fiducials for Shuttle & Find functionality, dedicated slots for standard sized EM stubs (6 × 12.7 mm, 3 × 25.4 mm, 2 × 32.0 mm), 6 × silicon wafer chips (10 × 10 mm)
Multi-Purpose Sample Holder for Life Sciences	For mounting standard sized EM stubs, TEM grids and ITO cover slips. Additional space for flexible sample mounting (ca. 45 × 35 mm²)	Including L-marker fiducials for Shuttle & Find functionality, dedicated slots for standard sized EM stubs (6 × 12.7 mm, 2 × 25.4 mm, 1 × 32.0 mm), 6 × silicon wafer chips (10 × 10 mm), 8 × TEM grids and 2 × cover slips
Adapter Plate for ZEISS Light Microscope	For mounting MultiSEM sample holders directly onto light microscope stage	Suitable for ZEISS Axio Imager Vario
Vibration Isolation Platform	Damping of low-frequency building vibrations (only needed if vibration specification of installation requirements is difficult to meet at customer site)	Consists of ■ Vibration isolation platform with active regulation by control electronics ■ Modified MultiSEM housing which enables microscope installation on vibration isolation platform

Workflow Add-ons	Function	Technical Details
Light Microscope	Large area imaging (> 10 cm²) for fast sample overview and region of interest selection. Sample positions can be accurately identified and relocated within MultiSEM	Recommended microscope is ZEISS Axio Imager.A2 Vario. ZEN software (blue edition) with ZEN connect licence required.
ATUMtome	Automated sectioning and section collection of resin-embedded biological tissue	Ultramicrotome based section collection robot from RMC Boeckeler. Up to 1000 sections per day with a typical sample thickness of 30 – 50 nm

Technical Specifications







No.	Description	Size (mm) approx.	Weight (kg) approx.	Load Distribution (kg) approx.	Footprints (mm) approx.
1	Microscope	1250 × 1200 × 2600	1600	4 × 400	4 × ∅ 156
2	PSU Rack	800 × 800 × 2100	300	4 × 75	4 × ∅ 39
3	IA Rack	800 × 800 × 2100	MultiSEM 505: 272 MultiSEM 506: 332	MultiSEM 505: 4 × 68 MultiSEM 506: 4 × 83	4 × ∅ 39
4	Table and PC	1153 × 980 × 1350	112	4 × 28	4 × ∅ 50
5	Static Damping Block	180 × 180 × 160	13	1 × 13	180 × 180
6	Quiet mode	350 × 350 x 550	5	1 × 5	350 × 350
7	Pre-Vacuum Pump	430 × 250 × 290	25	1 × 25	200 × 180

Technical Specifications

Electron Optics		MultiSEM 505	MultiSEM 506
Resolution	Average resolution of all beams @ 1.0 kV, 1.5 kV, 3.0 kV	≤ 3.5 nm	
Resolution Uniformity	@ 1.0 kV, 1.5 kV, 3.0 kV and 12 µm pitch size	≤ ± 0.5 nm	≤ ±1 nm
Landing Energy	Range	1.0 – 3.0 kV	
Beam Arrangement	Beam pattern	Hexagonal	
	Number of beams	61	91
	Pitch size (width of single beam image)	12 µm or 15 µm (optional)	
	Pitch uniformity	≤ ±1 %	
Field of View (FoV)	Long axis of hexagon (12 µm pitch / 15 µm pitch)	108 µm / 135 µm	132 µm / 165 µm
Beam Current	Single beam	≥ 570 pA	
	Total current	≥ 35 nA	≥ 52 nA
	Uniformity	≤ ±10 %	
Electron Source	Filament	Schottky emitter	
	Filament current stability	≤ 1 % per hour	
Beam Blanker		Electrostatic beam blanker	
Working Distance		1.4 mm	
Detection		Secondary electron projection optics with high-efficiency multi detection unit	

Scanning			
Scan Rate		Max. 20 MHz per beam, different discrete scan speeds are available	
Scan Mode		Step and scan	
Pixel Size	Range at 12 µm pitch	2 nm – 20 nm	
	Range at 15 µm pitch	2.5 nm – 20 nm	
Scan Arrangement		Image tile consists of 61 Sub-Images arranged in a hexagonal pattern	Image tile consists of 91 Sub-Images arranged in a hexagonal pattern
		Adjustable overlap of adjacent scan fields	

Technical Specifications

Stage and Specimen		MultiSEM 505	MultiSEM 506
Stage	Type:		Stepper Stage
	Usable travel range x/y/z:		100 / 100 / 30 mm
	Repeatability XY		≤± 3 µm
	Settling time		≤ 1.5 s
Specimen Requirements	Maximum size in XY		100 × 100 mm²
	Maximum height		≤ 30 mm
	Maximum flatness		≤ 500 nm / 100 µm (Peak-to-Peak)
	Maximum weight		≤ 0.2 kg
Specimen Exchange Time	With airlock		≤ 5 min

Software	
User Interface	ZEN for MultiSEM
Application Programming Interface (API)	Provided for custom workflow development
Shuttle & Find Functionality	Reliable transfer of sample coordinates from different imaging modalities (e.g. light microscope or single-beam SEM)
Performance Monitoring	Check of all relevant system parameters such as vacuum pressures or optics alignment quality
Parallel Software Architecture	Distributed image acquisition
Data Base Support	Provided for workflow and data management
Automated Alignment Functions	Autofocus, auto-stigmation, detector equalization, etc.

Image Acquisition Workflow	
Graphical Experiment Setup	Image based region of interest selection
Automated Section Detection (Option)	Fast workflow setup for serial sections imaging
Interaction Requirement	Max. 1 hr/24 hrs dedicated user interaction for beam alignment & calibration

Technical Specifications

Computer Hardware	MultiSEM 505	MultiSEM 506
Main Controller		≥ 4 core CPU (64 bit), ≥ 32 GB DDR, ≥ 1 TB HD, min. 2 ports with 1 Gbit Ethernet
Main Controller Operating System		Windows® 10 (64 bit)
Display		2 Monitors, 1920×1080 Pixel, 24"
Image Acquisition	8 PCs, in 19" Rack	12 PCs, in 19" Rack
Image Acquisition PC		≥ 4 core CPU (64 bit), ≥ 32 GB DDR3, 1 Gbit Ethernet, 10 Gbit Ethernet to customer network
Data Transfer Rate to Customer Network		≥ 10 Gbit Ethernet

Vacuum System	
Chamber Vacuum Pumps	Turbo molecular pump (≥ 260 l/s); oil-free Scroll Pump
Chamber Operating Pressure	≤ 1×10^{-5} mbar
Monitoring	Automatic monitoring of all relevant pressures

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