



Product Information  
Version 2.2

## ZEISS MultiSEM Research Partner Program

The World's Fastest Scanning Electron Microscopes



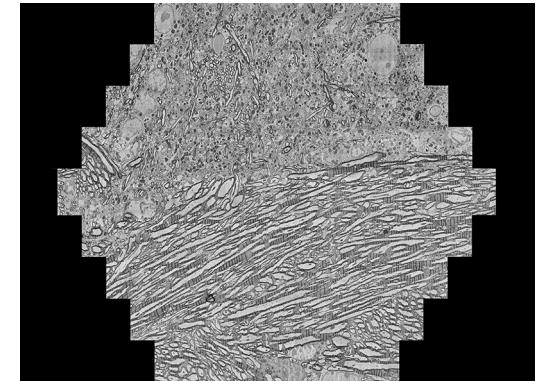
# Revolutionize the Speed of Electron Microscopy with ZEISS

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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 runs 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 in 1.3 s.  
Sample: courtesy of J. Lichtman, Harvard University, Cambridge, MA, USA

## Research Partner Program

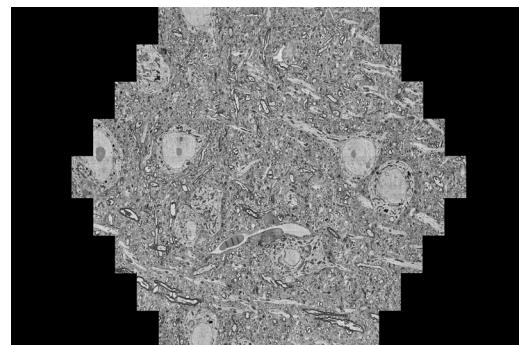
For the first time ZEISS offers you access to a groundbreaking technology at an early stage in the development process. The ZEISS MultiSEM Research Partner Program is meant for early adopters who want to profit from the opportunities of new technologies. Working in a close relationship with you, we want to explore new territory. Are you ready to take the next step?

# Simpler. More Intelligent. More Integrated.

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## Highest-ever Acquisition Speed at Nanometer Resolution

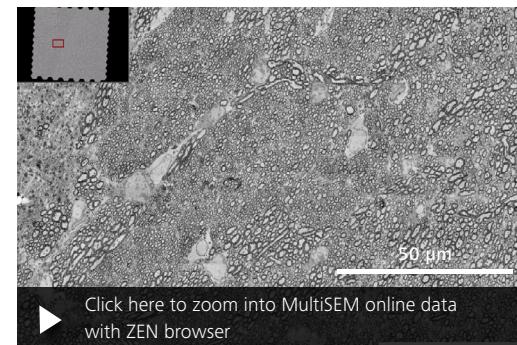
Multiple electron beams working in parallel give you unprecedented gross imaging speed. Acquiring an area of 1 cm<sup>2</sup> at 4 nm pixel size takes less than 3 hours imaging time. This unique speed now enables imaging of large volumes ( $> 1 \text{ mm}^3$ ) at nanometer resolution. Optimized detectors collect the secondary electron signals very efficiently, providing you with high contrast images at low noise levels.



Mouse brain 50 nm thick section image acquired in 1.3 s covering a field of view of 110  $\mu\text{m}$  x 100  $\mu\text{m}$ . Sample: courtesy of J. Lichtman, Harvard University, Cambridge, MA, USA

## 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 x 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.

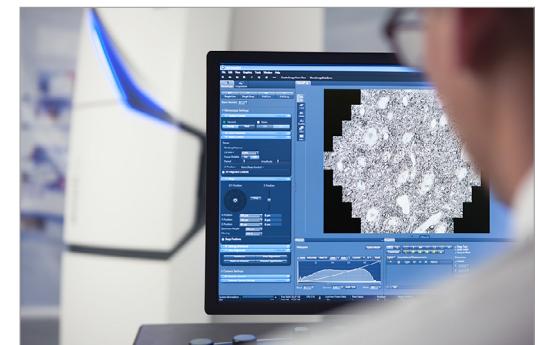


Click here to zoom into MultiSEM online data with ZEN browser

Mouse brain section, area 1 mm<sup>2</sup> imaged by automated data acquisition at 4 nm pixel size totaling 100 GByte of data. Sample: courtesy of J. Lichtman, Harvard University, Cambridge, MA, USA

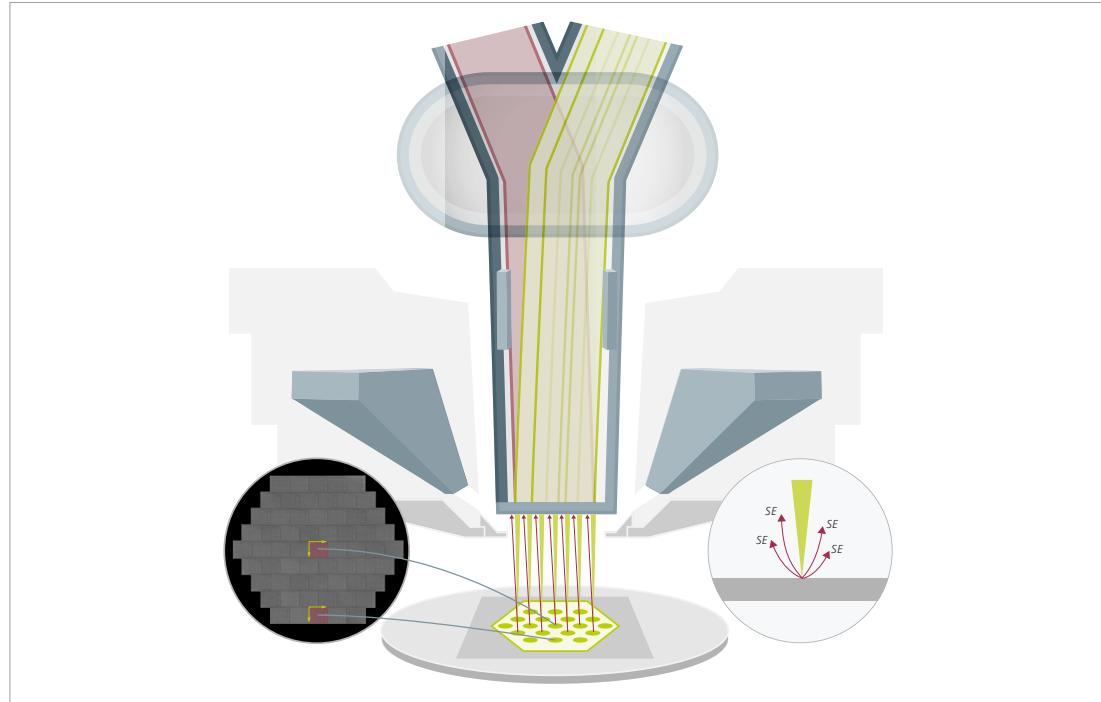
## Another First: Electron Microscopy with ZEN Imaging Software

By introducing ZEN to MultiSEM, we bring the standard software for all ZEISS imaging systems 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.

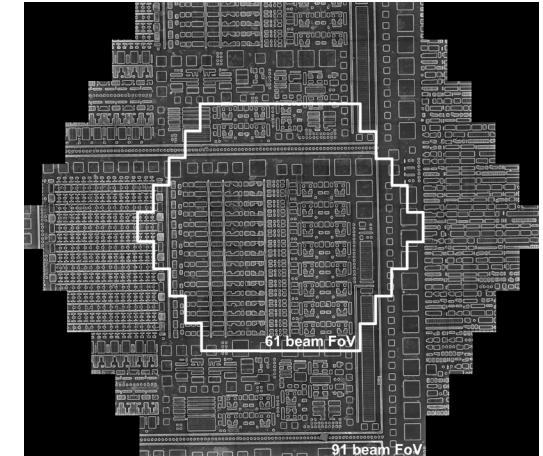


# Your Insight into the Technology Behind It

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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, which increases the total imaging speed. Image acquisition and workflow control are fully separated in the MultiSEM system.



Two MultiSEM versions are currently available. MultiSEM 505 with 61 beams in parallel offers high imaging speed at top resolution while the new MultiSEM 506 with 91 beams at higher beam current is the world's fastest scanning electron microscope.

The image above (graphics processor chip) compares the fields of view of the two MultiSEM versions – 108 µm width for MultiSEM 505 and 198 µm width for MultiSEM 506. Therefore, MultiSEM 506 covers more than three times the area with just a single scan.

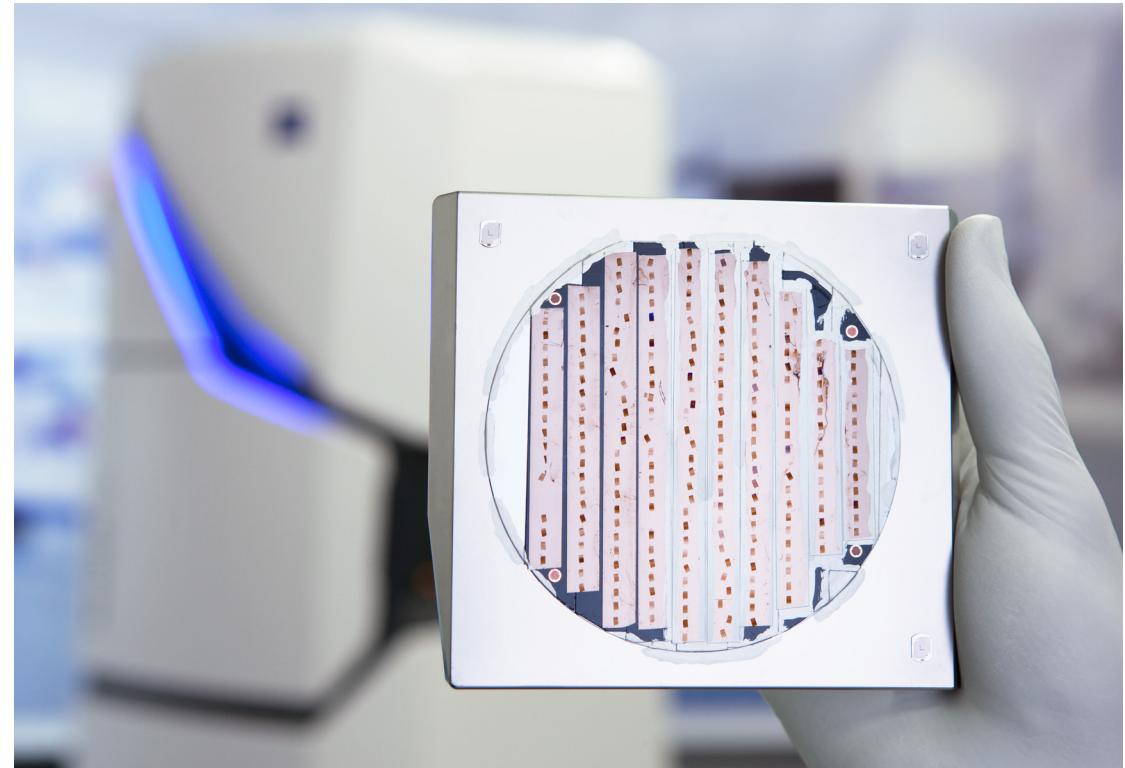
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## Your Integrated Workflow for Acquisition of Large Volumes

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

With the 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. All planning and setting-up the acquisition workflow can be done in a single graphical control center. Automated section detection supports you in identifying and targeting your regions of interest in a very efficient way.

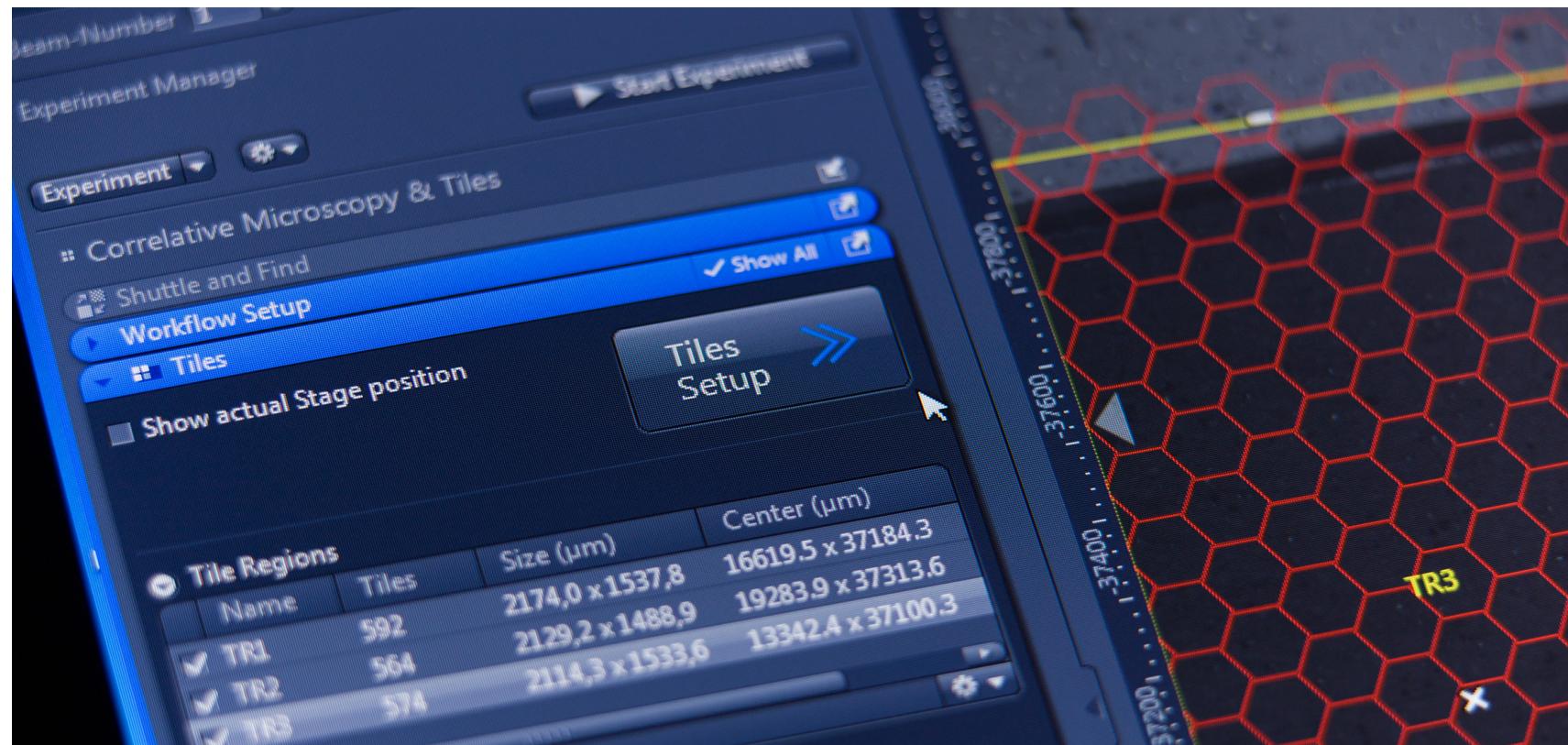


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MultiSEM is the first electron microscope to run ZEN imaging software as a user interface. ZEN not only gives you a perfect overview of all required parameters, it also supports you with smart auto-tuning procedures.

Automated routines are used for tuning the microscope, saving user interaction time and allowing automated data acquisition protocols. ZEN for MultiSEM also masters the high speed required for continuous, parallel image recording. An application programming interface (API) is provided for flexible and fast application development, giving you access to most microscope parameters and auto-tuning routines.



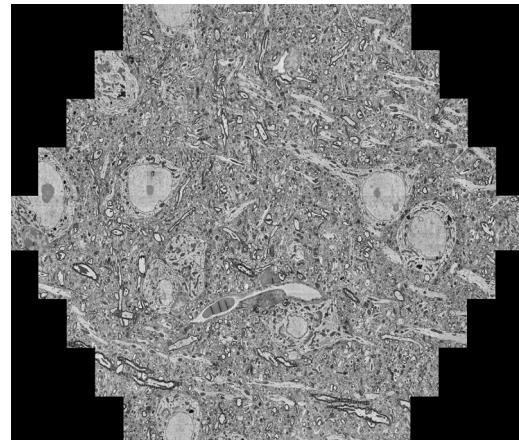
# Tailored Precisely to Your Applications

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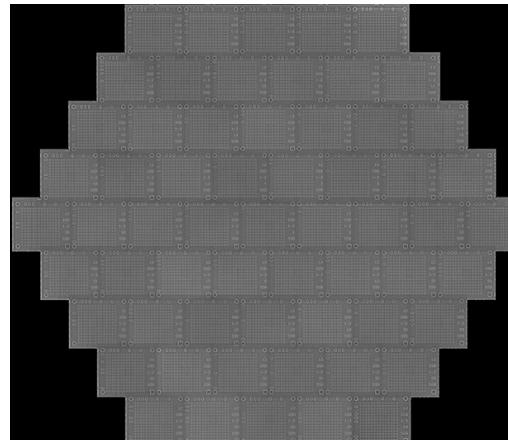
Typical Applications, Typical Samples	Task	ZEISS MultiSEM Offers
Stained Serial Sections of Brain Tissue	Capture large images of sections for subsequent 3D registration and reconstruction needed for analysis in connectomics	Highest throughput electron microscopy at high resolution
Ultrathin Sections from Cultured Cells or Organotypic 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
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

# ZEISS MultiSEM at Work

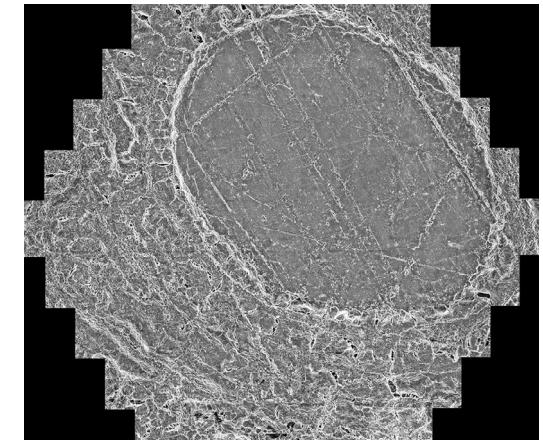
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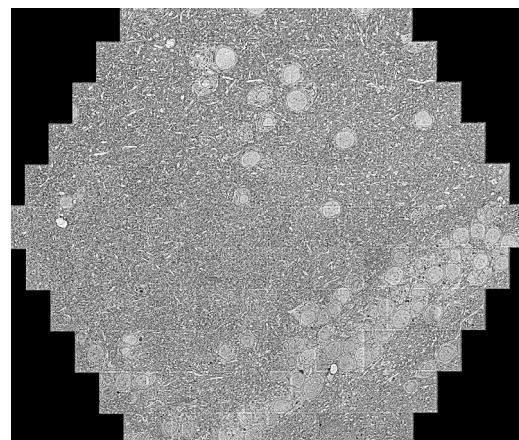
Mouse brain, 50 nm thick section, image acquired with MultiSEM 505 in 1.3 s covering a hexagonal field of view of 108 µm x 94 µm at 4 nm pixel size. Sample: courtesy of J. Lichtman, Harvard University, Cambridge, MA, USA



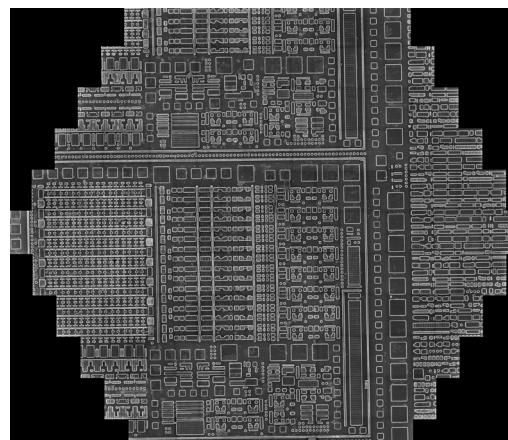
Silicon test sample with nanometer-sized structures imaged with MultiSEM 505. Excellent contrast properties of the etched silicon surface allow full speed scanning resulting in 0.8 s acquisition time.



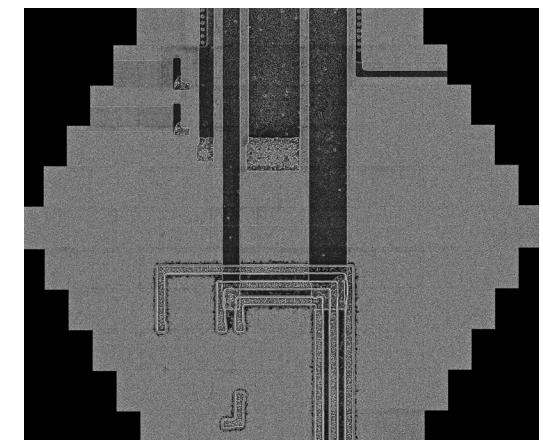
Femoral neck (PMMA-embedded and polished block face) sample showing an osteon comprising a bone capillary surrounded concentrically by osteocytes. Image acquired with MultiSEM 505 at 11.6 nm pixel size, field of view is 108 µm x 94 µm. Sample: courtesy of M. Knothe Tate, University of New South Wales, Australia, and Ulf Knothe, Cleveland, OH, USA



Zebrafish brain, 70 nm thick section, image acquired with MultiSEM 506 covering a hexagonal field of view of 198 µm x 171 µm at 4.5 nm pixel size. Sample: courtesy of C. Genoud, Friedrich-Miescher-Institute, Basel, Switzerland



65 nm technology node graphics processor integrated circuit, stripped to its silicon substrate with HF acid etching. This single, hexagonal field of view of 198 µm x 171 µm was acquired with MultiSEM 506 in 1.4 s at 5 nm pixel size



Integrated circuit coated with 20 nm Gold/Palladium (from JN-1 SEM Demonstration Specimen Kit, commercially available via Ted Pella, Inc.) Imaged with MultiSEM 506 in 1.4 s at 4.5 nm pixel size.

▶ Click here to zoom into MultiSEM online data with ZEN browser

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Accessory	Function	Technical Details
Airlock	Enables quick, manual specimen transfer ( $\leq 5$ min) into chamber. Use of airlock minimizes contamination and maximizes sample throughput	Consists of <ul style="list-style-type: none"><li>■ Airlock chamber with integrated control window &amp; panel</li><li>■ removable sample transfer rod</li><li>■ control integrated in ZEN software</li></ul>
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 <ul style="list-style-type: none"><li>■ Plasma Cleaner Eaverton Zephyr</li><li>■ Adapter kit for MultiSEM chamber</li><li>■ Control integrated in ZEN software</li></ul>
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 <ul style="list-style-type: none"><li>■ Plasma Cleaner Eaverton Zephyr</li><li>■ Multiport for MultiSEM airlock</li><li>■ Adapter Kit for Multiport</li><li>■ Control integrated in ZEN software</li></ul>
Standard Sample Holder	Flat surface holder for flexible sample mounting ( $\leq 100 \times 100 \text{ mm}^2$ )	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. $50 \times 50 \text{ mm}^2$ )	Including L-marker fiducials for Shuttle&Find functionality, dedicated slots for standard sized EM stubs (6 x 12.7 mm, 3 x 25.4 mm, 2 x 32.0 mm), 6 x silicon wafer chips (10 x 10 mm)
Multi-Purpose Sample Holder for Bioscience	For mounting standard sized EM stubs, TEM grids and ITO cover slips. Additional space for flexible sample mounting (ca. $45 \times 35 \text{ mm}^2$ )	Including L-marker fiducials for Shuttle&Find functionality, dedicated slots for standard sized EM stubs (6 x 12.7 mm, 2 x 25.4 mm, 1 x 32.0 mm), 6 x silicon wafer chips (10 x 10 mm), 8 x TEM grids and 2 x cover slips
Quiet Mode	Reduces noise level in the laboratory and reduces energy costs	Automatic switch on/off of rotary pump. Consists of a vacuum buffer tank with pirani gauge and all necessary tubes and valves
Adapter Plate for ZEISS Light Microscope	For mounting MultiSEM sample holders directly onto light microscope stage	Suitable for ZEISS Axio Imager Vario

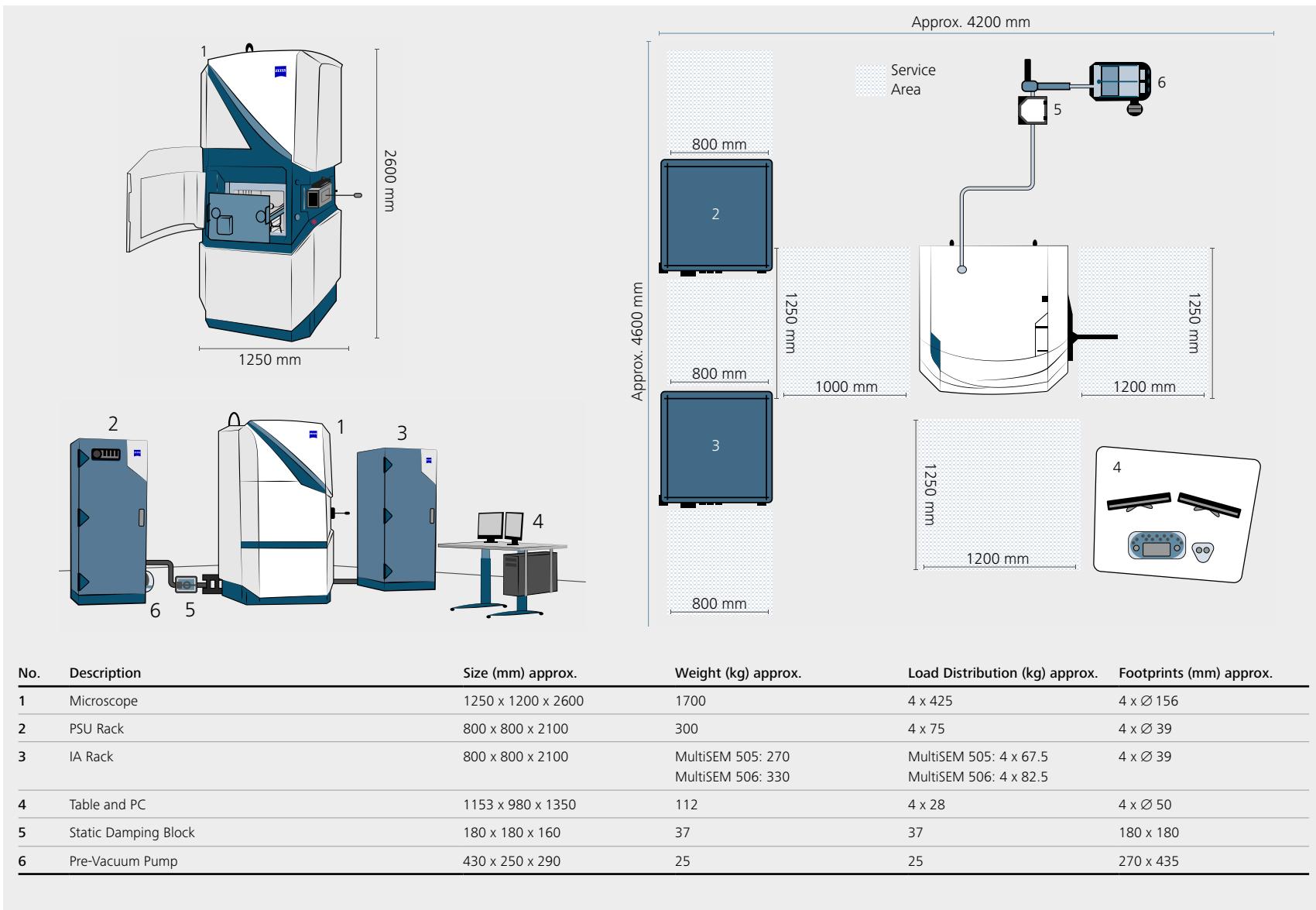
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Accessory	Function	Technical Details
<b>Workflow Add-ons</b>		
Light Microscope	Large area imaging ( $> 10 \text{ cm}^2$ ) for fast sample overview and region of interest selection. Sample positions can be accurately identified and relocated within MultiSEM	Various ZEISS microscopes can be supported for this task. ZEN blue with shuttle and find licence required. Recommended solution is ZEISS Axio Imager.A2 Vario
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

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Electron Optics	MultiSEM 505	MultiSEM 506
Resolution	Average resolution of all beams @ 1.5 kV	$\leq 3.5 \text{ nm}$
Resolution Uniformity	@ 1.5 kV, standard pitch size	$\leq \pm 0.5 \text{ nm}$
Landing Energy	Range	1.0 – 3.0 kV
Beam Arrangement	Beam pattern	Hexagonal
	Number of beams	61
	Pitch size (width of single beam image)	12 $\mu\text{m}$
	Pitch uniformity	$\leq \pm 1 \%$
Field of View (FoV)	Long axis of hexagon	108 $\mu\text{m}$
Beam Current	Single beam	$\geq 570 \text{ pA}$
	Total current	$\geq 35 \text{ nA}$
	Uniformity	$\leq \pm 10 \%$
Electron Source	Filament	Schottky emitter
	Filament current stability	$\leq 1 \%$ per hour
Beam Blanker		Electrostatic beam blunker
Working Distance		approx. 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 for complete stitching	3 nm – 50 nm
Scan Arrangement		Image Tile consists of 61 Sub-Images arranged in a hexagonal pattern
		scan field of rectangular sub-images approx. 12 $\mu\text{m} \times 10.4 \mu\text{m}$
		Image Tile consists of 91 Sub-Images arranged in a hexagonal pattern
		scan field of rectangular sub-images approx. 18 $\mu\text{m} \times 15.6 \mu\text{m}$
		Adjustable overlap of adjacent scan fields

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Stage and Specimen	MultiSEM 505	MultiSEM 506
Stage	Type:	Stepper Stage
	Travel x/y/z:	130 / 130 / 36 mm
	Repeatability XY	≤± 3 µm
	Settling time	≤ 1.5 s
Specimen Requirements	Maximum size in XY	100 x 100 mm <sup>2</sup>
	Maximum height	≤ 30 mm
	Maximum flatness	≤ 500 nm / 100 µm (Peak-to-Peak)
	Maximum weight	≤ 0.2 kg
Specimen Exchange Time	via front door	typically less than 15 min
	with airlock	≤ 5 min
Software		
User Interface	ZEN for MultiSEM	
Application Programming Interface (API)	provided for custom workflow development	
Shuttle and Find Functionality	Reliable transfer of sample coordinates from different imaging modalities (e.g. light microscope or single-beam SEM)	
Key performance Indices Monitoring (KPI)	Check of all relevant system parameters such as vacuum pressures or optics alignment quality	
Parallel Software Architecture	Support for distributed image acquisition and storage	
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	Fast workflow setup for serial sections imaging	
Interaction Requirement	Max. 1 hr/24 hrs dedicated user interaction for beam alignment & calibration	

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Computer Hardware	MultiSEM 505	MultiSEM 506
Main Controller	≥ 4 core CPU (64 Bit), ≥ 8 GB DDR, ≥ 1 TB HD, min. 2 ports with 1 Gbit Ethernet	
Main Controller Operating System	Windows® 7 (64 Bit)	
Display	2 Monitors, 1900x1200 Pixel, 24"	
Image Acquisition	8 PCs, in 19" Rack	12 PCs, in 19" Rack
Image Acquisition PC	≥ 4 core CPU (64 Bit), ≥ 16 GB DDR, 1 Gbit ethernet, 10 Gbit ethernet to customer network	
Data Transfer Rate	≥ 10 Gbit ethernet	
Vacuum System		
Chamber Vacuum Pumps	Turbo molecular pump (≥ 280 l/s); oil-free Scroll Pump	
Chamber Operating Pressure	≤ 1 x 10 <sup>-5</sup> mbar	
Monitoring	Automatic monitoring of all relevant pressures	



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