Teneo VS

Highest quality isotropic 3D data from large sample volumes

Teneo VS™ is a novel serial block-face imaging solution that combines mechanical and optical sectioning using FEI's proprietary multi-energy deconvolution technology to facilitate automated acquisition of large sample volumes at isotropic resolution.

Improving large-volume SEM by combining serial block-face imaging with Multi-Energy Deconvolution

Unraveling complex 3D architecture of cells and tissues in their natural context is crucial for the structure function correlation in biological systems. In recent years, there have been considerable advances in SEM-based methods for 3D reconstruction of large tissue volumes. Serial Block-Face SEM (SBF-SEM) combines *in situ* sectioning and imaging of plastic embedded tissue blocks within the SEM vacuum chamber in a fully automated fashion for reconstruction of large tissue volumes. Until now, the axial resolution was limited by the minimal section thickness that can be cut from the block-face; however, with a combination of SBF-SEM and Multi-Energy Deconvolution SEM (MED-SEM), the Teneo VS now enables large-volume imaging with truly isotropic 3D resolution.

Truly isotropic 3D data

Teneo VS offers a novel solution to improve the axial resolution by combining mechanical sectioning with optical sectioning, realized by FEI's proprietary MED-SEM. Following *in situ* sectioning of the block-face using a diamond knife, the freshly exposed tissue is imaged several times using increasing accelerating voltages.

These images are subsequently used in a deconvolution algorithm to derive several optical subsurface layers, forming a 3D subset. By repeating this cycle, Teneo VS offers isotropic datasets with less than 10 nm z-resolution.

KEY BENEFITS

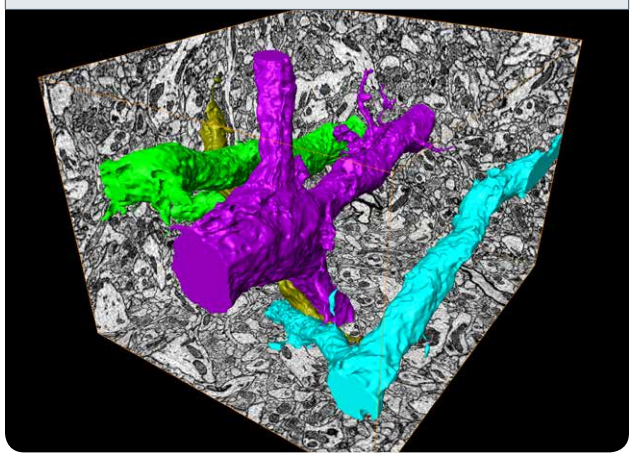
Truly isotropic 3D data from large volumes: Excellent z-resolution from Multi-Energy Deconvolution SEM combined with the efficiency of *in situ* sectioning.

Highest contrast and resolution on all samples: Highest contrast and optimal SNR with in-lens detector for high vacuum (HiVac) mode, as well as dedicated detector for optimal resolution and charge mitigation in low vacuum mode (LoVac).

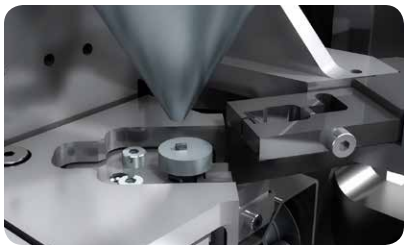
Simple switch between normal SEM use and serial block face imaging: Compact, stage-mounted microtome allowing easy exchange.

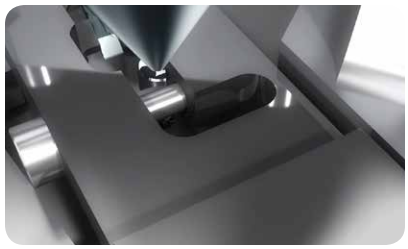
Instant productivity for all operators: High degree of automation and design for ease-of-use adding to operator efficiency and enabling greater experimentation.

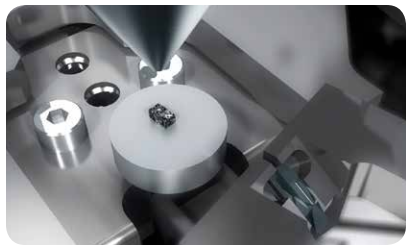
Workflow solutions with increased efficiency and accuracy: Fast identification of regions of interest using CLEM approaches and large volume coverage with automated multi-tile set runs.



↑ **Volume reconstruction of a mouse brain acquired with combination of SBF-SEM and MED-SEM, imaged under high vacuum conditions.** The block-face was imaged in BSE mode at varying accelerating voltage ranging from 1.2 – 3.1 kV isotropic resolution of 10 × 10 × 10 nm pixels (x,y,z) 1040 slices (physical + optical ones) @ 50 nm (physical slices), Volume 15.00 µm × 12.9 µm × 10.4 µm (1040 slices) or 18.7 µm × 15.5 µm × 6.8 µm (680 slices). Sample courtesy of P. Laserstein and P. Bastians, Helmstaedter Lab, MPI Brain Research, Germany.







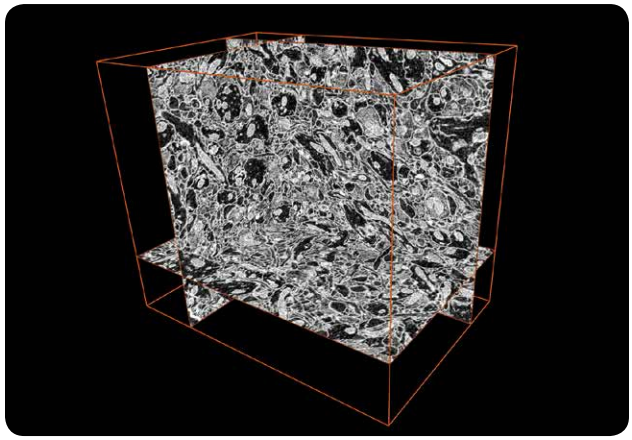
↑ **Microtome cutting motion. A.** Sample is lowered, then knife moves over the sample **B.** On the back stroke, sample is raised to the specified section thickness to be cut **C.** Ultrathin section is cut on the back stroke.

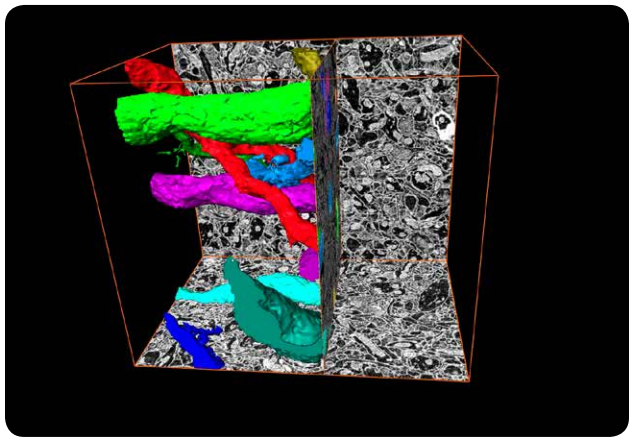
Flexibility and ease-of-use with exceptional performance

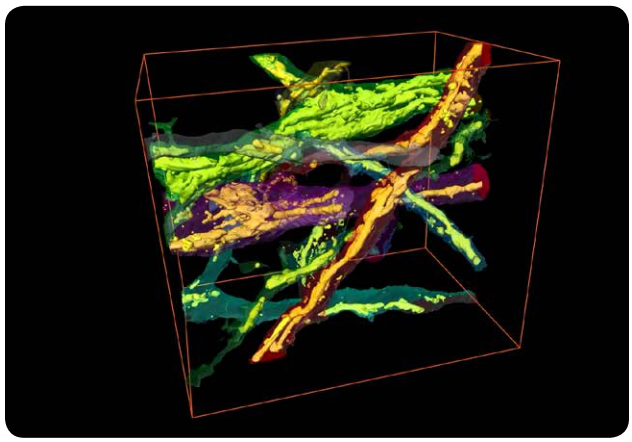
Teneo VS is developed on a brand new SEM platform based on the FEI NiCol™ electron column recently introduced with the Scios™ DualBeam™. The system is equipped with a versatile in-lens and in-column detection system providing exceptional contrast. A choice of high resolution HiVac operation or dedicated LoVac-mode makes it ideal for changing sample requirements and challenging samples. Fully automated column alignments limit the need for highly trained operators to adjust settings, while predefined use cases for common applications give instant productivity for all users. Teneo VS's versatility extends to alternative use of the SEM by allowing quick swap of the compact, stage-mounted microtome, enabling fast changeover between routine SEM and serial block-face SEM.

Workflow solutions for increased productivity

Teneo VS is controlled by a single integrating software interface, MAPS, that permits convenient importing of images from CorrSight or any other light microscope. Direct correlation and targeting of particular regions of interest (e.g. based on fluorescence staining) is straightforward and easy. The final results can be easily visualized and analyzed using the world's leading 3D imaging software, Amira™ for Life Sciences. This powerful SW package can be used to directly import the data produced by Teneo VS not only for processing, but more importantly for visualization and analysis, making it one of the most powerful tool sets available on the market.







↑ **Volume reconstruction of a mouse brain acquired with combination of SBF-SEM and MED-SEM, imaged under high vacuum conditions.**

Hardware Specifications

NICol UHR Non-Immersion FESEM Column

- High-resolution field emission-SEM column, with high-stability Schottky field emission gun
- Source lifetime 12 months
- Auto bakeout, auto start, no mechanical alignments
- Automated heated apertures
- Continuous beam current control and optimized aperture
- Double stage scanning deflection
- Dual objective lens combining electromagnetic and electrostatic lenses
- Beam current range: 1 pA to 400 nA
- Landing energy range: 20 eV – 30 keV*
- Accelerating voltage range: 350 eV – 30 keV
- User guidance and column presets

Electron Beam Resolution at Optimum Working Distance

- High-vacuum imaging

At optimum WD:

- 0.8 nm at 30 keV STEM
- 1.0 nm at 15 keV
- 1.4 nm at 1 keV

Chamber

- Left to right: 379 mm
- Analytical working distance: 10 mm
- Ports: 21

Detectors

- Serial block face imaging detector; T1 segmented lower in-lens detector
- STEM retractable segmented detector (BF, DF, HADF, HAADF)*
- IR-CCD
- Additional detectors available

STAGE SPECIFICATIONS WITHOUT MICROTOME INSTALLED	
Type	Eucentric goniometer stage, 5-axes motorized
XY	110 × 110 mm
Repeatability	<2.0 µm (at 0° tilt)
Motorized Z	65 mm
Rotation	n × 360°
Tilt	-15° / +90°
Max. sample height	Clearance 85 mm to eucentric point
Max. sample weight	500 g in any stage position (up to 2 kg at 0° tilt)
Max. sample size	150 mm with full rotation (larger samples possible with limited rotation)

MICROTOME SPECIFICATIONS	
Section thickness	Effective slice thickness using MED ≥ 10 nm
Cutting speed	User defined: 0.1 – 1 mm/sec Recommended speed: 0.1 – 0.5 mm/sec
Cutting window	2 mm
Sample Z travel range	1.3 mm

Vacuum System

- Complete oil-free vacuum system
- 1 × 220 l/s TMP
- 1 × PVP-scroll
- 3 × IGP
- Chamber vacuum (high vacuum) < 6.3 × 10-6 mbar (after 72 hours pumping)
- low-vacuum mode up to 50 Pa for charge compensation of non-conductive samples
- Evacuation time: ≤ 3.5 minutes

Sample Holders

- Standard multi-purpose holder, unique mounting directly onto the stage, hosts up to 18 standard stubs (Ø12 mm), three pre-tilted stubs, two vertical and two pre-tilted row-bar holders* (38 degrees and 90 degrees)
- Each optional row-bar accommodates 6 S/TEM grids
- Wafer and custom holders*

Supporting Software

- "Beam per view" graphical user interface concept with up to 4 simultaneously active views
- FEI SPI™, iSPI™, iRTM™ for advanced real-time SEM process monitoring and end-pointing
- Image registration
- Navigation montage
- Image analysis software
- Undo / Redo functionality
- User guidance

*Optional

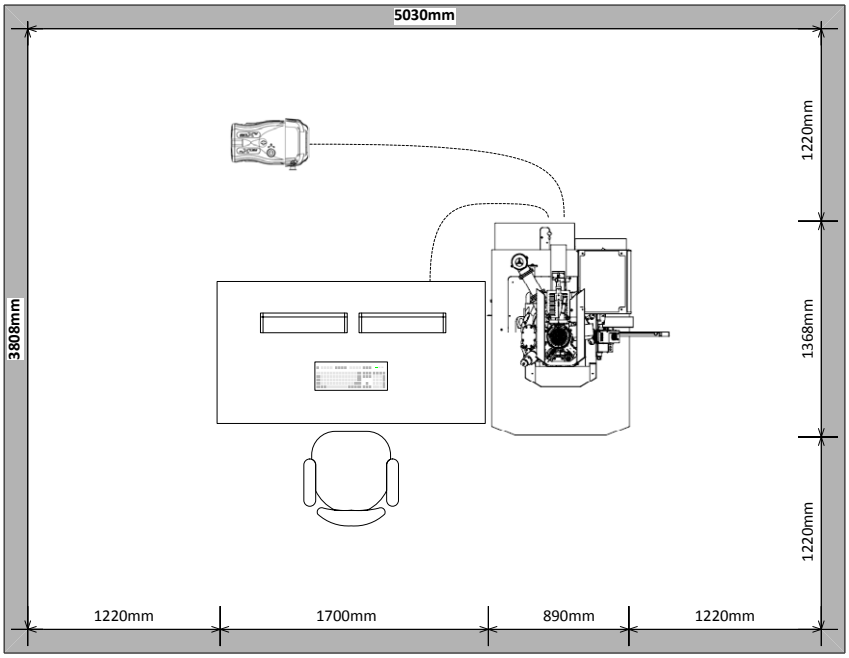


Image Processor

- Dwell time range from 0.025 – 25000 µs/pixel
- Up to 6144 × 4096 pixels
- File type: TIFF (8, 16, 24 bit), BMP or JPEG, standard
- Single-frame or 4-view image display
- SmartSCAN™ (256-frame average or integration, line integration and averaging, interlaced scanning)
- DCFI (Drift Compensated Frame Integration)
- Image registration

System Control

- 64-bit GUI with Windows 7, keyboard, optical mouse
- "Beam per view" graphical user interface concept, with up to 4 simultaneously active views
- 24-inch LCD display, WUXGA 1920 × 1200 pixels (second monitor optional)
- Optional joystick
- Optional multifunctional control panel

Accessories (Optional)

- Sample / chamber cleaning: FEI Integrated Plasma Cleaner
- Navigation: MAPS Tiling and Stitching

Software Options

- MAPS™ for automatic acquisition of large images and correlative work
- 3D reconstruction software; Amira™ for Life Sciences
- Web enabled data archive software
- Image analysis software

Documentation

- Online user guidance
- Operating instructions handbook
- Online help
- Prepared for RAPID™ (remote diagnostic support)
- Free access to FEI for Owners online resources

Warranty and Training

- 1 year warranty
- Choice of service maintenance contracts
- Choice of operation / application training contracts

Consumables (Partial List)

- Replacement Schottky electron source module
- Aperture strips for electron columns
- Diamond knife from external supplier (Diatome)

Installation Requirements

(Refer to preinstall guide for detailed data)

Power:

- Voltage: 100 – 240 V AC (-6%, +10%)
- Frequency: 50 or 60 Hz (±1%)
- Consumption: < 3.0 kVA for basic microscope
- Earth resistance: < 0.1Ω

Environment:

- Temperature: 20°C ±3°C
- Relative humidity below 80% RH
- Stray AC magnetic fields < 40 nT asynchronous, < 300 nT synchronous for line times, 20 ms (50 Hz mains) or 17 ms (60 Hz mains)
- Minimum door size: 0.9 m wide × 1.9 m high
- Weight: column console 980 kg
- Dry nitrogen
- Compressed air 4–6 bar — clean, dry and oil-free
- System chiller
- Acoustics: site survey required, as acoustic spectrum relevant
- Floor vibrations: site survey required, as floor spectrum relevant
- Optional vibration isolation table

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