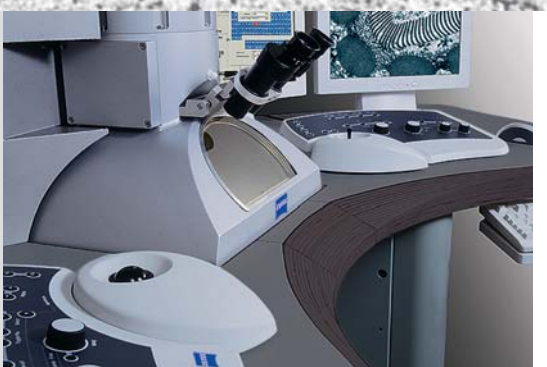
LIBRA® 120 PLUS

Versatile Analytical EFTEM Workhorse for All Kind of Applications and Rapid Analytics



ZEISS

We make it visible.

Carl Zeiss NTS – Nano Technology Systems

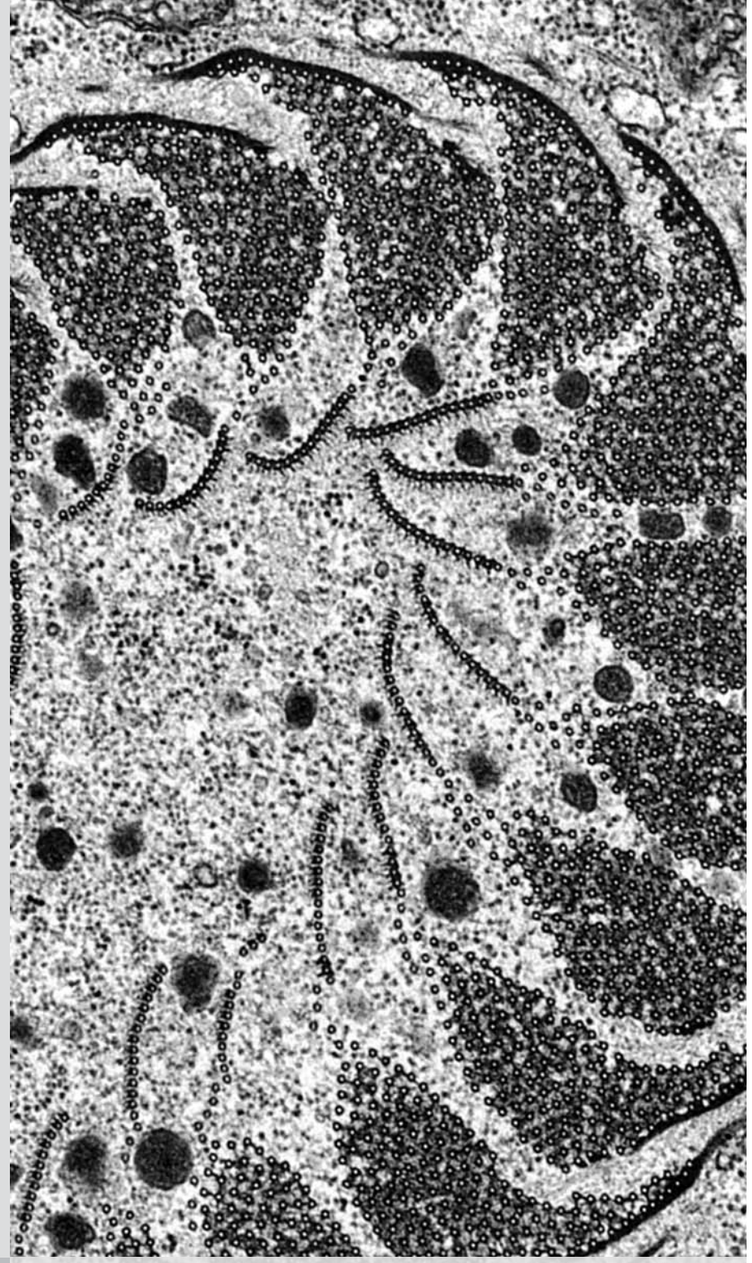
Maximum Information – Maximum Insight

More than 160 years of experience in optics has laid the foundation for pioneering electron and ion beam microscopes from Carl Zeiss. Superior integration of imaging and analytical capabilities provides information beyond resolution, unlocking the best kept secrets of your sample.

With a broad technology portfolio Carl Zeiss provides instruments both tailored to your requirements and adaptable to your evolving needs. With our highly versatile application solutions we endeavor to be your partner of choice.

Regional demo centers provide you with access to our applications expertise developed in collaboration with world-class partners in industry and academia. Global customer support is provided by the Carl Zeiss Group together with an extensive network of authorized dealers.

Our mission at all times: Maximum Information – Maximum Insight.



SEM
Scanning Electron Microscopes

FE-SEM
Field Emission - Scanning Electron Microscopes

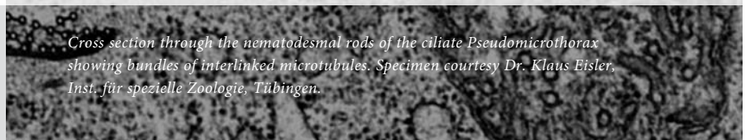
HIM
Helium Ion Microscopes

CrossBeam®
CrossBeam® Workstations (FIB-SEM)

TEM
Transmission Electron Microscopes

LIBRA® 120 PLUS

Enjoy the imaging quality, analytical power, flexibility and ease of use of a modern EFTEM.
Take advantage of class leading electron optics with in-column filter technology.



Cross section through the nematodesmal rods of the ciliate Pseudomicrothorax showing bundles of interlinked microtubules. Specimen courtesy Dr. Klaus Eisler, Inst. für spezielle Zoologie, Tübingen.

LIBRA® 120 PLUS

Flexibility tuned to your needs

Versatile Koehler Illumination system.
Automatic, reproducible and optimized illumination conditions for TEM, Spot, STEM, Low Dose and diffraction.

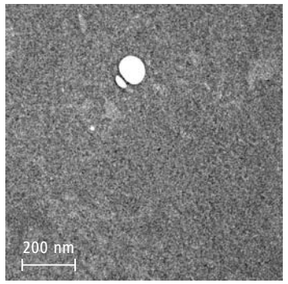
In-column OMEGA energy filter.
Crisper images with enhanced contrast. Highly resolved fast analytics at excellent sensitivity with ESI and EELS.

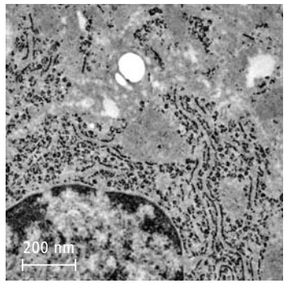
Open detector strategy.
All kinds of image documentation supporting the full range of cameras and detectors.

Elemental analysis by EDX.
Complementary analytical capabilities in addition to fully integrated EELS and ESI/EFTEM.

TMP based completely oil-free vacuum system.
For high specimen throughput, lowest contamination rates and extremely fast pumping cycles.

Future assured solution.
WinTEM™ GUI and flexible upgrade paths for detectors, imaging and vacuum systems.





HCI contrast tuning of unstained biological specimen (see page 16).

Electron Optics

Electron optical column

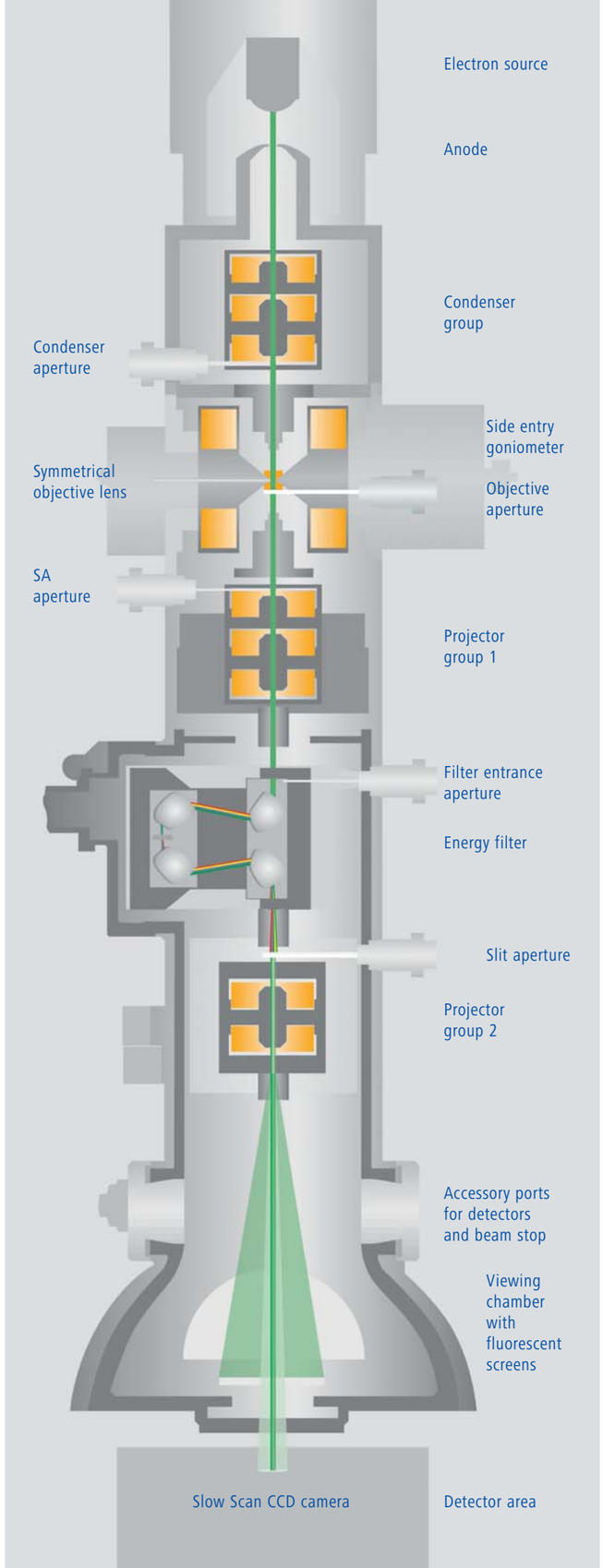
The superior electron optical column design concept from the predecessor instrument with its digital control of all lenses was consistently redefined in the **LIBRA® 120 PLUS**. It incorporates the proven in-column OMEGA energy filter and the four lens Koehler condenser system. Further improvements were achieved with regard to lower aberration coefficients of the objective lens, new lens coils, stability of electronics, and an even more versatile and stable condenser and slit aperture. The schematic design and beam path with the energy slit aperture in place is shown to the right.

Objective lens

The Koehler Illumination system allows a constant imaging of the cross over into the front focal plane of the objective pre-field lens without the need for an additional mini lens to achieve parallel illumination in every specimen point of the sample. The condenser aperture defines the illuminated area and objective lens currents can stay unchanged for spot, diffraction and wide-field imaging mode, enabling a reproducible and fast change of operation modes without time consuming realignments. The sample is always positioned on the eucentric axis of the stage, which is at the same time the symmetrical area of the objective lens. Its large pole piece gap allows for high tilt angles, the use of various detectors and/or additional anticontamination devices for cryo microscopy.

Imaging system

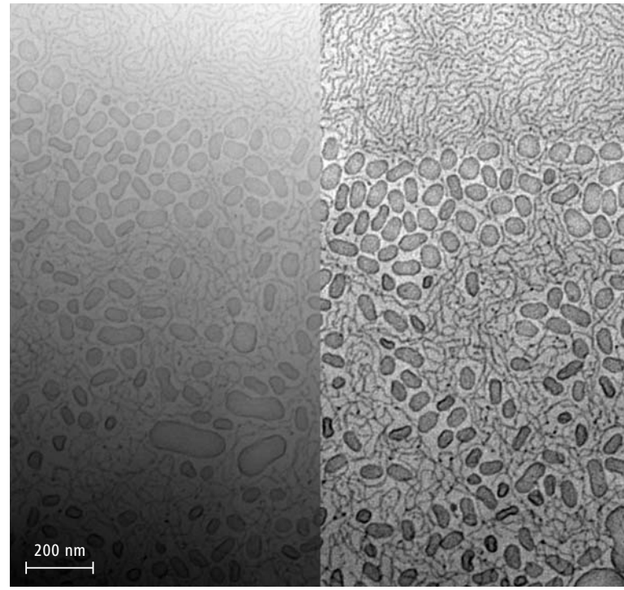
The first projector lens group in front of the OMEGA filter consists of 3 lenses and magnifies the first intermediate image or the first diffraction image into the stationary entrance image plane of the energy spectrometer. The second projector lens group with two lenses is arranged behind the OMEGA filter. It images the filtered image, respectively diffraction pattern, or the energy loss spectrum onto the luminescent screen or any other image detector e.g. SSCCD-camera, imaging plate, TV or sheet film camera.



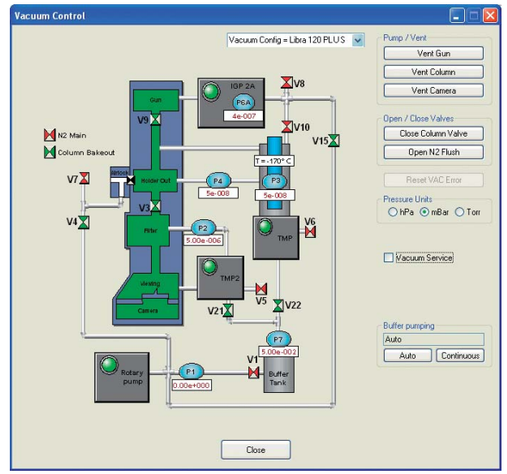
Vacuum Technology

Efficiency and cleanliness of the vacuum system nowadays is a must have criterion for high performance TEMs.
In the **LIBRA® 120 PLUS** this is realized by implementation of state-of-the-art vacuum technology e.g. only oil-free pumps, durable separation valves and extra large cross sections to ensure short pumping times. Thus, evacuation of the airlock during specimen exchange is done in less than 15 seconds.
The intelligent software control system manages a powerful oil free scroll pump, a buffer tank for the pre-vacuum, plus one fast and very efficient turbo molecular pump (TMP) for the column, energy filter and viewing chamber area with sheet film or SSCCD camera. An integrated LN_2 cooled cold trap, which is also connected to the anti-contamination device of the objective area completes the vacuum system. This concept provides a completely dry vacuum in all column areas. Safety features, automation and an energy saving mode ensure highest reliability combined with an upgrade option for the extended vacuum configurations.

Three development stages of the vacuum system are available:
The Standard configuration is based on a dry scroll pre-pump and a split flow turbo pump. This configuration, which allows a separation of the column/gun area to the viewing chamber achieves a vacuum better than 5x10-7 hPa in the gun area. It is recommended for basic TEM applications in case the **LIBRA® 120 PLUS** is equipped with a tungsten filament.
The Differential pumping system is based on the standard configuration. It includes an additional separation valve between the objective and the gun area plus an ion getter pump for the gun. This is required for LaB_6 operation and all applications related to the higher sensitivity, stability, and coherency of this emitter type, as e.g. ESI, EELS, tomography and low dose applications.
The Extended differential configuration additionally includes a second turbo molecular pump and a variety of extensions to provide the best possible vacuum performance in the objective area for all contamination sensitive applications like STEM, EDS & Cryo. Included are additional measuring gauges and a temperature read out unit for the anticontamination device in order to monitor the status of the vacuum, as well as the possibility to bake out the whole adsorption trap system in the pumping distributor and objective area complex to ensure lowest ice and hydrocarbon contamination rates over time.



Cryo-TEM micrograph of a block-copolymer micellar suspension.
Right half of image is digitally processed to enhance contrast and remove thickness variation in the frozen suspension.
Image by courtesy of M. Drechsler, E. Egbali & H. Hoffmann, Univ. Bayreuth.



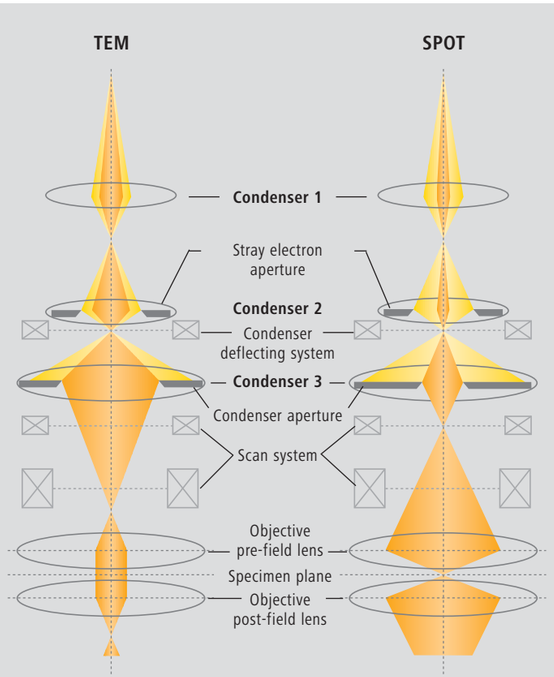
Control window of the extended differential vacuum pumping system.

Koehler Illumination System

Illumination concept invented by ZEISS

In the **LIBRA® 120 PLUS** the optimized Koehler illumination system comprises 4 lenses: Condenser 1 to 3 and condenser objective (C-O) pre-field lens, several deflection and scanning coils, and 1 (optionally 2) multi-hole condenser apertures plus one single-hole aperture in a drift-minimised (optionally motorised) aperture drive.

Using a dedicated deflection system the Automated Illumination System (AIS) selects the appropriate condenser aperture depending on the chosen magnification in order to always guarantee a homogeneous and completely illuminated viewing screen. A manual selection (MIS) to restrict the field of illumination for low dose or diffraction applications is also possible.



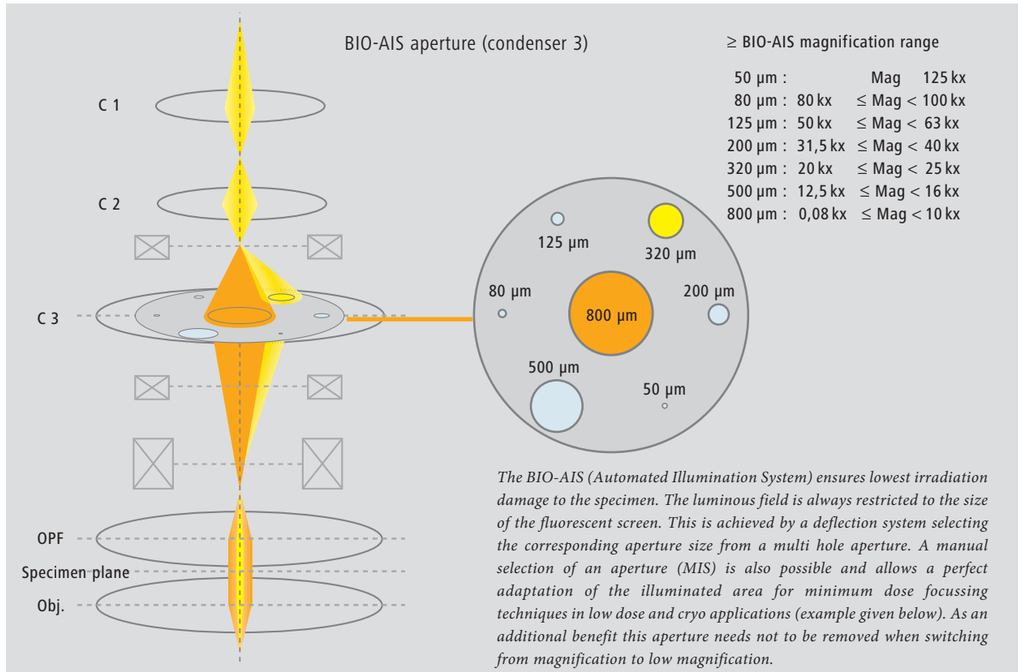
Scheme of Koehler Illumination in bright-field and spot mode.

Features and benefits

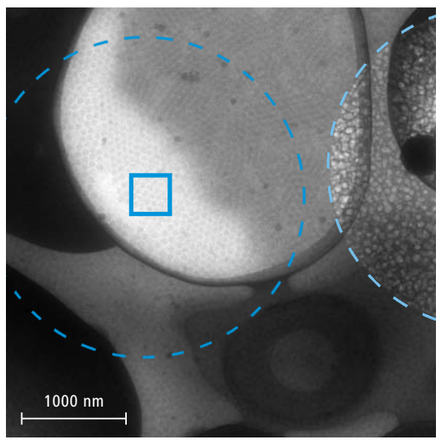
Optimum image quality is only possible if the illumination system provides high performance together with maximum flexibility. Only the well-proven and patented Koehler illumination system provides the following outstanding features:

- Absolutely homogeneous wide-field illumination, regardless of the operation mode of the emitter.
- Optically correct illumination with strictly parallel beam incidence to all object points even with the beam shifted or tilted. No image distortions (stigmatism, defocus) due to oblique illumination.
- Possibility to adjust the illuminated area and the illumination aperture angle (brightness) independently of each other. The brightness can be adjusted in 22 defined and reproducible steps, allowing an automatic accurate dose calibration.
- Optimum specimen protection by an automatic, magnification-dependent selection of the condenser aperture which is directly imaged onto the sample and exactly defines the illuminated area.
- Spot mode with a precisely defined spot size is realized by a simple push-button operation. Only the third condenser lens excitation has to be modified to achieve a focussed spot in the center of the illuminated area.
- No need for an auxiliary lens because the C3 lens is maintaining its focus always constant to the front focal plane of the objective pre-field lens in all illumination conditions, producing a strictly parallel illumination to the specimen.
- Automatic compensation of all illumination parameters when changing the energy loss value.
- Artefact free diffraction of illuminated areas down to 200 nm possible.

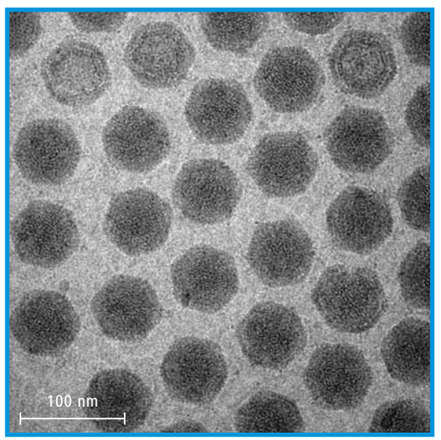
Koehler Illumination System
Built-in ease of use and versatility for less specimen damage



The BIO-AIS (Automated Illumination System) ensures lowest irradiation damage to the specimen. The luminous field is always restricted to the size of the fluorescent screen. This is achieved by a deflection system selecting the corresponding aperture size from a multi hole aperture. A manual selection of an aperture (MIS) is also possible and allows a perfect adaptation of the illuminated area for minimum dose focussing techniques in low dose and cryo applications (example given below). As an additional benefit this aperture needs not to be removed when switching from magnification to low magnification.



Frozen hydrated phages. Visualisation of the illuminated areas used for focussing and acquisition defined by a manually selected condenser aperture (blue dotted lines).
The marked area on the right was damaged by the higher electron dose used for focussing.



Low dose snapshot acquired from the blue marked area in the left image.
Dose: 1000 electrons/nm².

In-column OMEGA energy filter

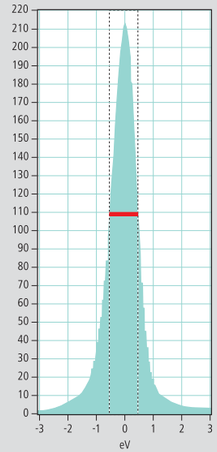
Due to its location between the two projector groups, the position of the image planes, and its symmetrical design the energy filter of the **LIBRA® 120 PLUS** (A-type, Lanio) is optimised for 2nd order aberrations. It comprises four sector magnets and only a single hexapole/quadrupole correction element, which is located in the symmetry plane of the spectrometer. A variable slit aperture is located in the energy dispersive plane in front of the second projector system. For element imaging any specific electron energy loss between 0 and 2500 eV can be choosen by a defined increase of the primary high voltage, which exactly corresponds to the energy loss of the element of interest. Therefore the path of the selected energy loss electrons is always axial, the excitation of the imaging system and the spectrometer remains constant, and the position of the slit aperture is always kept unchanged.

Since the OMEGA filter is a purely magnetic spectrometer, it has the added benefit of not imposing any limitations on the accelerating voltage of the microscope.
It comes with

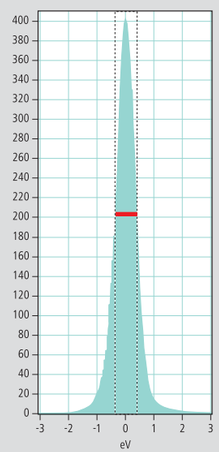
- a lifetime alignment
- does not require any special operator skills
- allows automatic recording of spectra

LIBRA® 120 PLUS
Energy Resolution

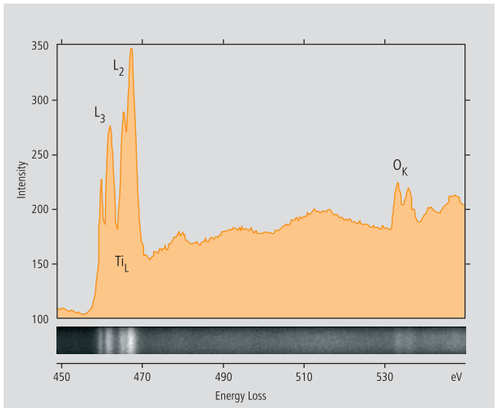
0.99 eV	0.76 eV
Tungsten	LaB_6
2.5 sec	10 sec



120 kV
2 µA emission current
3.1 A filament heating current



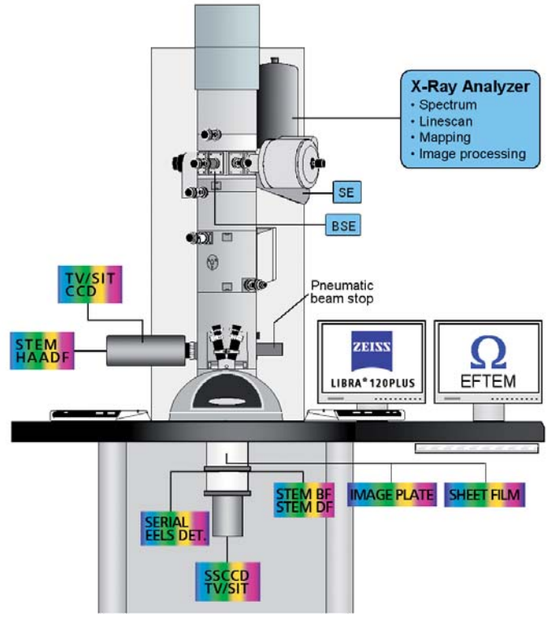
120 kV
1 µA emission current
3 A filament heating current



Parallel EELS of Titanium dioxide (TiO_2). Spectrum densitogram with image of the spectrum, as recorded by SSCCD-camera.
Note the excellent energy resolution (split peaks of both Ti-L_3 and -L_2).

In-column OMEGA energy filter – Tune up all your imaging detectors

The information range offered by an EFTEM is more diversified and comprehensive than that offered by any other TEM. In order to gain optimized access to all signals various optionally available accessories can be attached to the basic **LIBRA® 120 PLUS**, e.g. slow scan cameras side and bottom mounted with image evaluation and processing software, scanning attachment and detectors, EDS system, tools for cryo and tomography, sheet film camera for use of negatives or image plates, etc.
Carl Zeiss NTS develops these accessories either independently or in close cooperation with third party suppliers and adapts them in order to provide the best performance for the requested application.



Digital STEM attachment (DSA)

In combination with the OMEGA energy filter unconventional signal detection is possible for imaging and analysis. The seamless integration of the DSA-unit into the WinTEM™ platform allows a simple switch-over from TEM-mode to the various STEM-modes. No condenser aperture exchange is necessary. Specimen position, focus and correction of astigmatism remain constant. Signals generated by interaction of the primary beam with the specimen can be detected with SE-, BF/DF- and a high efficiency HAADF-detector mounted in the wide angle port. Imaging with BF/DF- or HAADF-detectors also benefits from the previous energy filtering process, therefore signals can be detected which are not ascertainable with conventional TEMs. The signal mixer even allows the presentation of images composed by two different signals. The DSA also provides dedicated modes to control an EDS-system for element detection by means of spot analysis, mapping or line scan.

Due to the persistent integration of the OMEGA energy spectrometer into the electron optical column, energy filtered results can be obtained by means of any post-specimen detector:

- **Ω Viewing screen**
- **Ω Wide angle camera (TV rate or SlowScanCCD)**
- **Ω On-axis camera (TV rate or SlowScanCCD)**
- **Ω Sheet film negatives**
- **Ω Imaging plates**
- **Ω Serial and Parallel EELS detectors**
- **Ω STEM Brightfield/Darkfield detector**

The OMEGA energy filter causes no restrictions regarding analytics with SE, BSE or X-ray detectors.

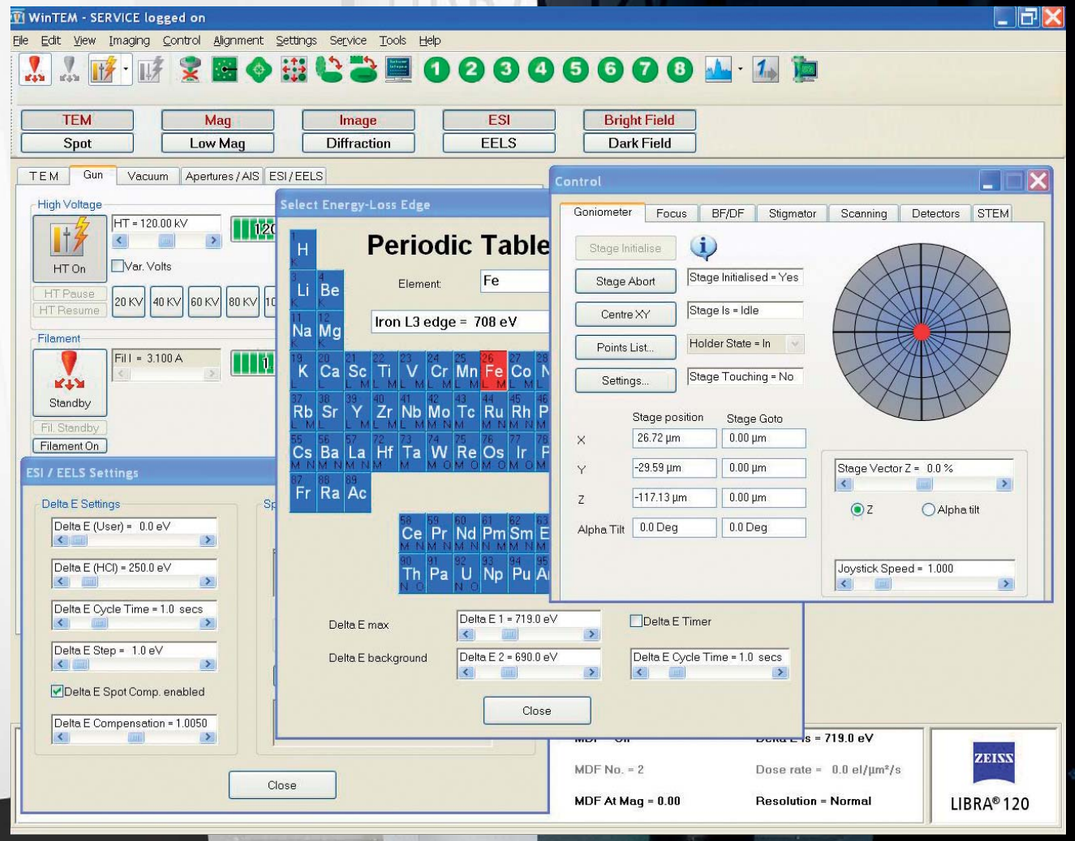
WinTEM™

Essential for the use of a modern TEM is an intuitive and ergonomic user interface.

From the first operation the **LIBRA®** series provides a superior look-and-feel which is based on the proven Graphical User Interface (GUI), successfully used for years in our various SEM and FIB instruments. The GUI is designed to give the user the freedom to focus on their research and to control a versatile EFTEM instrument even in a low-lit working environment.

Multi-user capabilities

WinTEM™ software enables the system administrator to address different levels of privileges to individual users. Individual users find their own environment after log-in with access to their settings and stored alignments or data displays.



Intuitive Instrument Control

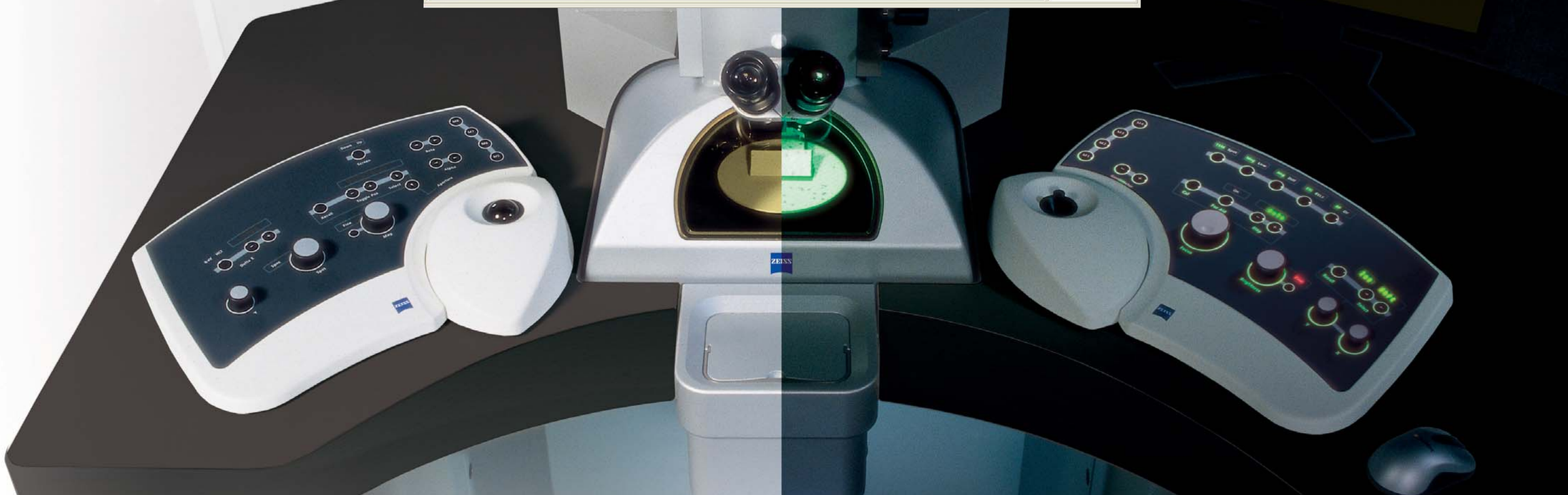
Ergonomic design

The **LIBRA® 120 PLUS** is entirely operated by two control panels which can be placed anywhere on the desktop and are adjustable to the physiognomy of each user. The backlit knobs and buttons and a special low-lit mode of the computer screen displaying values of the most important parameters in red colour on black background complete the ergonomic design of the **LIBRA®** series.

Software architecture and remote control

The WinTEM™ control software is based on a proven client server architecture. The EM server controls and maintains the status of the EFTEM. User (client) interaction is performed via the WinTEM™ GUI and the two hardware control panels.

For remote control a documented „.Net" application programming interface (API) for networked remote operation is available. High speed access of the instrument opens a complete new range of applications from linking the EFTEM to different laboratories, to real-time control checks and analysis by the Carl Zeiss NTS Service Center.

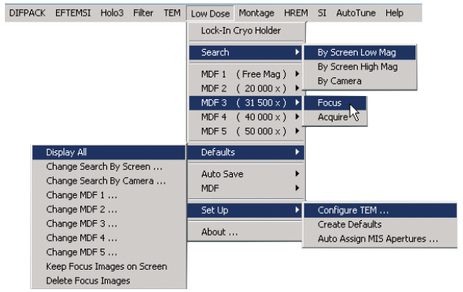


TEM Automation

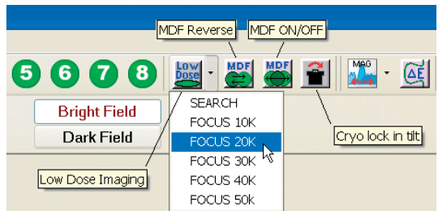
Digital image recording has opened up a new world for Transmission Electron Microscopy.

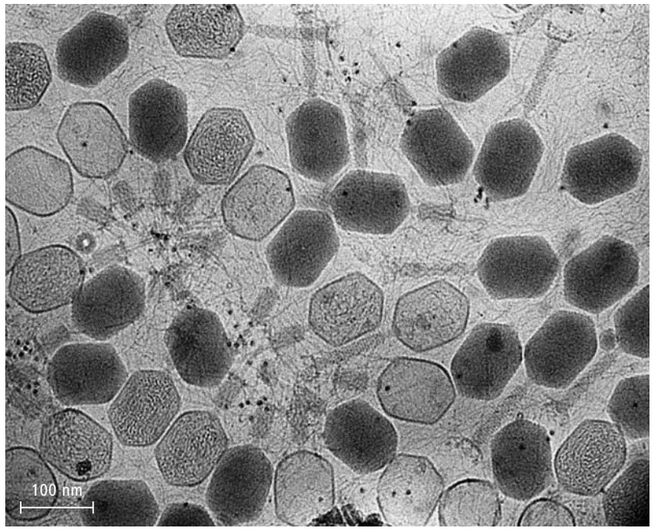
As a fully digitised microscope the **LIBRA® 120 PLUS** offers all options for external control. Thus, experts as well as less experienced users obtain perfect results more precisely, easily and much faster by using auto-focussing, auto-stigmation or other sophisticated auto-alignment tools. Since practically all parameters of the **LIBRA® 120 PLUS** can be controlled even complex experiments can be automated, which frees users from TEM alignment and allows them to concentrate on the sample/experiment.

With TEM automation the possibilities for perfect results with the **LIBRA® 120 PLUS** are only limited by imagination.



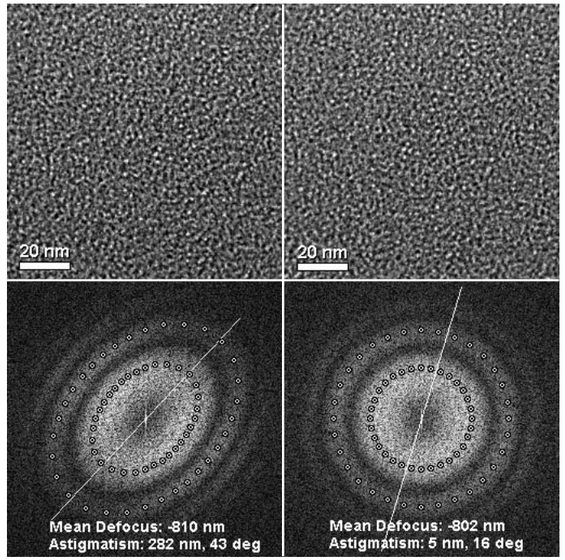
Control of Low Dose acquisition parameters from external software or by macros in WinTEM™.

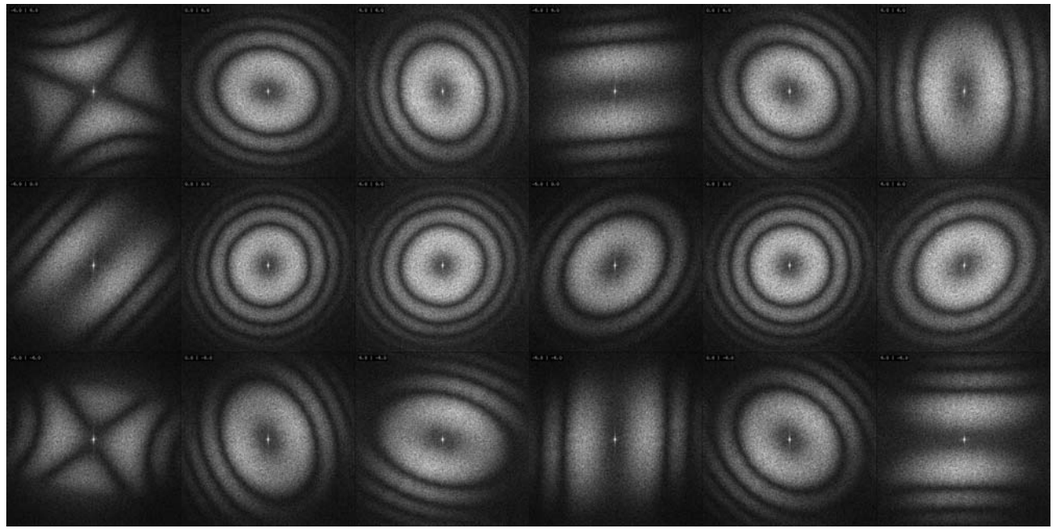




T4 Bacteriophage, frozen hydrated. TEM mag 30 k, zero loss filtered.
Specimen courtesy: Dr. J. Dubochet.

Auto-stigmation on amorphous carbon (at 163 kx). By evaluation of the FFT and auto-tuning the ***LIBRA® 120 PLUS****, astigmatism was reduced to 5 nm in less than 5 seconds.*



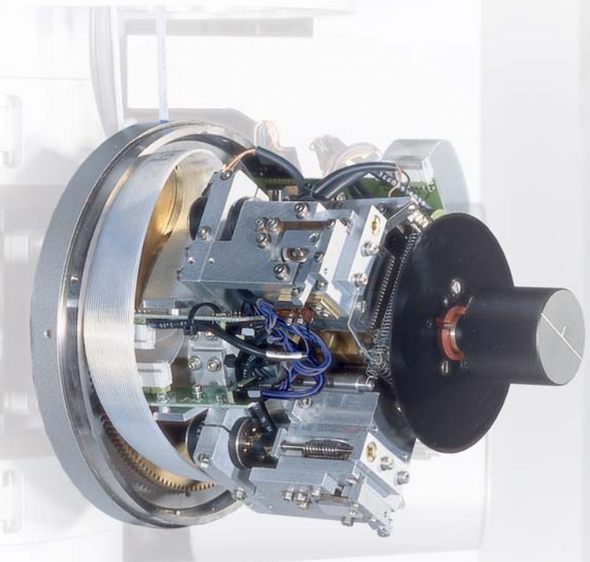


Comafree alignment using the tilt induced astigmatism method. The right tilt tableau at 6 mrad beam tilt shows the improvement by the auto-alignment (120 kV, 163 kx, 5 µA emission, 0.5 mrad illumination angle). Alignment was performed in less than 10 sec.

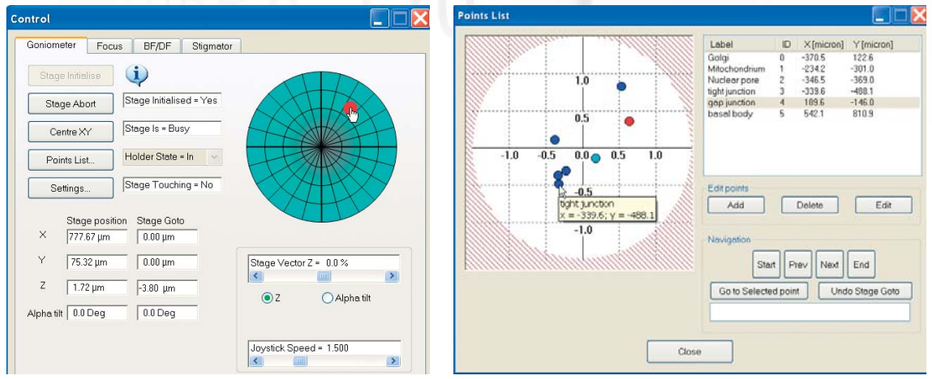
High Precision Engineering and Output

Goniometer stage and holders

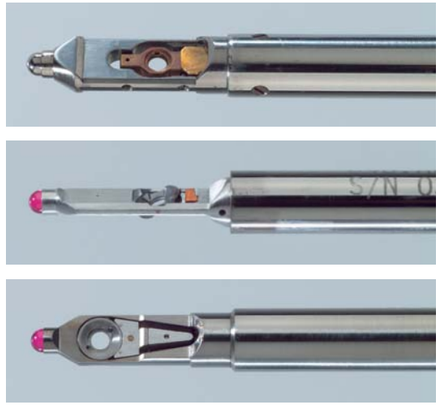
Precise and reliable control of various holders is guaranteed by the fully eucentric 5-axes goniometer stage. Tracking and relocation of stored positions is ensured by software or smooth and comfortable joystick-control.
Movements in X- and Y-direction are magnification compensated, whereby the overall sensitivity can be widely adapted to the individual operator's needs. Various holders e.g. cryo-transfer, double-tilt analytical, rotation or double-tilt liquid nitrogen holders are available.



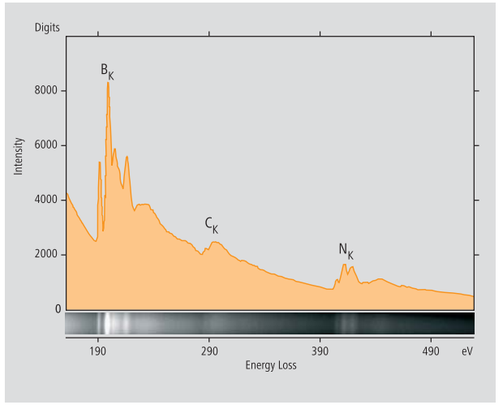
Precision made by ZEISS.
Mechanics of the reliable goniometer stage of the ***LIBRA® 120 PLUS****.*



WinTEM™ Goniometer Control window and Points List window with visualized grid and labels for strored specimen positions.



Tips of special holders (cryo-transfer, double-tilt and rotation). The standard holder delivered with the instrument is a high-tilt double specimen holder.



Parallel EELS spectrum of boron nitride and image of spectrum as recorded by SSCCD-camera (1024 channels, spec. mag. 125x).

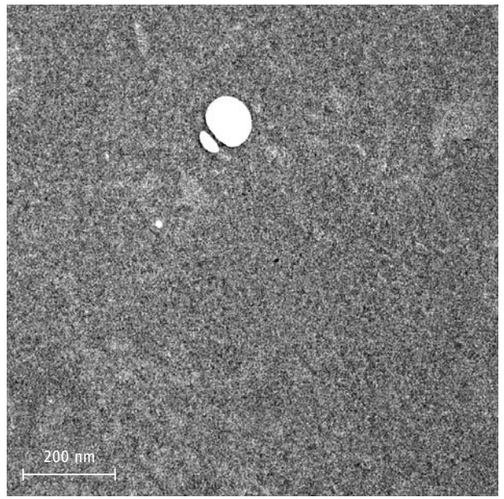
Digital electronics with sub-ppm stability

An important part for utmost stability is the entire electronic system. To attain enduring sub-ppm stability, brand new electronics have been developed, using only high end components, and resulting in a highly integrated and modular electronic system with only 4 (5 with DSA unit) boards. Special attention was given to improve stability of the numerous sources controlling objective lens, filter supply and multi-pole correctors.

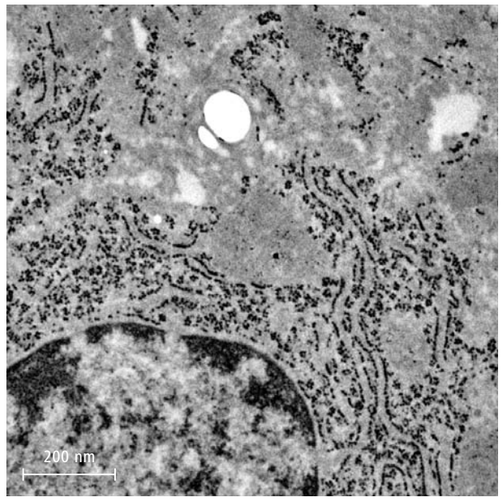
The components used in the **LIBRA® 120 PLUS** are the same as those implemented in the **LIBRA® 200FE** and the SESAM/UHRTEM instruments (SESAM = Sub eV Sub Angstrom Microscope, UHRTEM = Ultra High Resolution Transmission Electron Microscope).
Modular design rules and CAN-bus technology facilitates permanent monitoring of all sources and thus ensures robustness and simplifies service.

Applications
HCI – High Contrast Imaging

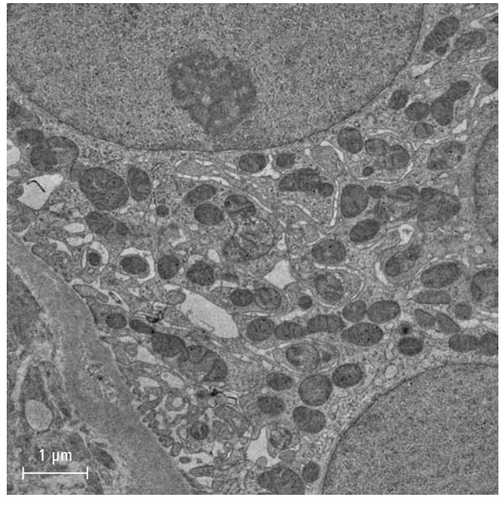
Conventional bright-field image (unfiltered).

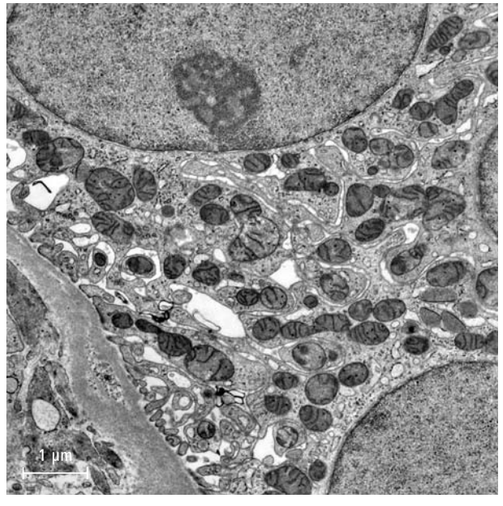


Filtered image of the same specimen area (contrast inverted).



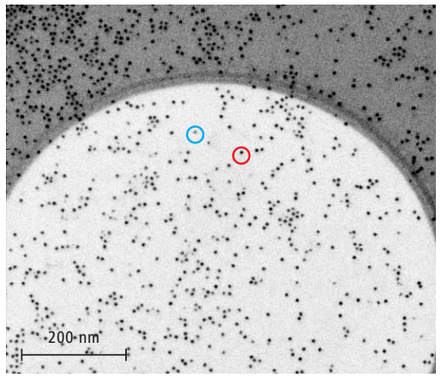
Contrast enhancement with OMEGA filter (HCI - High Contrast Imaging, energy filtering at 250 eV).
Specimen: stomach tissue (badly preserved); no staining, no osmium fixation.



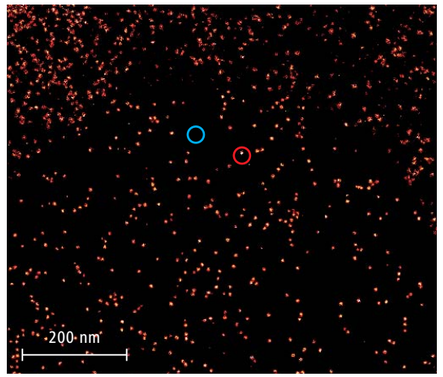


Unstained ultrathin section (50 nm) of human kidney (pathol.):
Left: Elastic bright-field image (EBF), note the considerable amount of noise.
Right: High contrast image (HCI, inverted), energy filtered at 250 eV

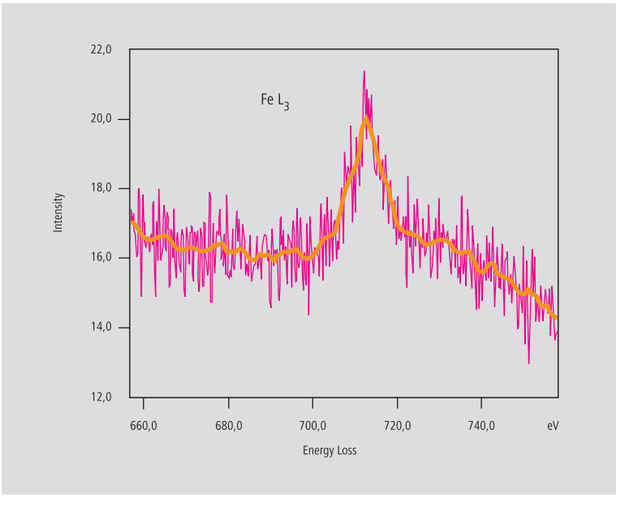
Applications
Superior detection sensitivity – ESI and EELS



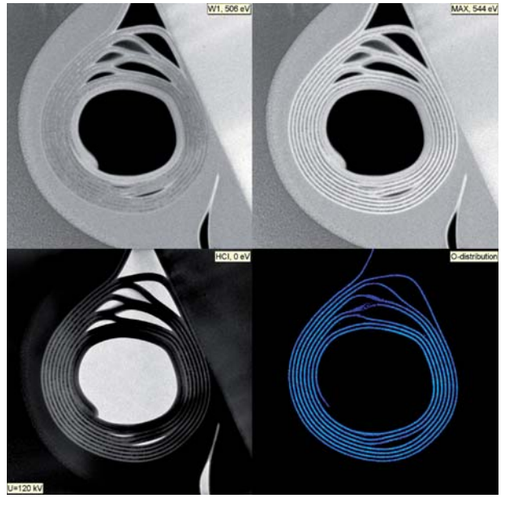
Contrast inverted HCI image (250 eV) of Ferritin and Apoferritin molecule complexes.
This image serves as a reference for the iron distribution image given (right) and the spectrum (below).



Calculated iron distribution (3-window power law method) coloured with a solaris look up table. The blue marked molecule does not contain iron and is thus identified as Apoferritin.
*The distribution image proves the high detection sensitivity of the **LIBRA® 120 PLUS** since a single Ferritin molecule contains only a few thousand Fe atoms.*

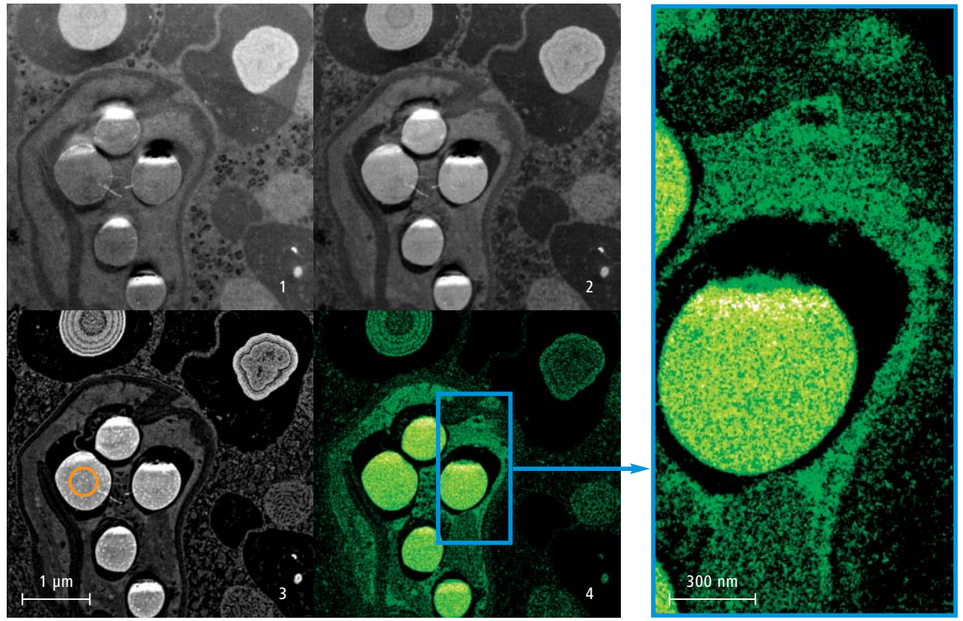


EELS spectrum acquired from the red marked Ferritin molecule.
The raw spectrum was smoothed by a mean filter (orange line).



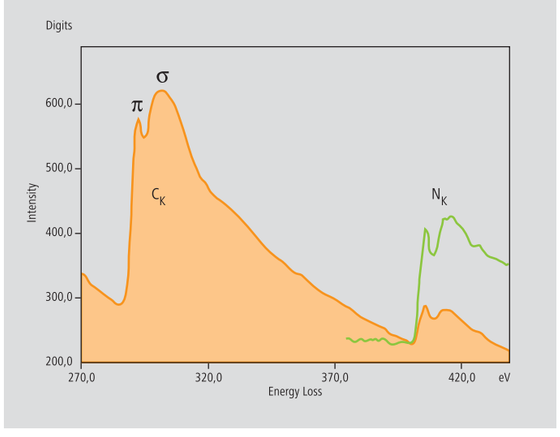
The images show crossections of Si/SiOx nanotube.
The highly strained bilayer was detached from the substrate by selective underetching and has performed several rotations on the surface driven by elastic stress release. Once optimized such rolled-up micro-/nanotubes can serve as optical ringresonators and optofluidic sensing systems (For more information, see e.g. R. Songmuang et al., Applied Physics Letters 90, 091905 (2007)).
Specimen courtesy by MPI Stuttgart, Germany.

Applications
Highly resolved elemental maps in less than a minute



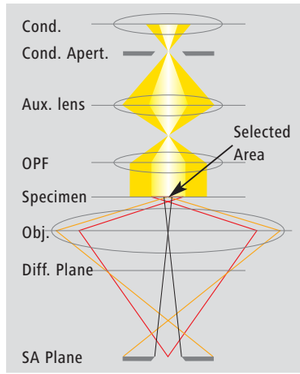
Nitrogen detection by Electron Spectroscopic Imaging (ESI).
Total acquisition time of the ESI series: 30 seconds, at a resolution of 1024 x 1024 pixels.
1) Background image (382 eV; in front of nitrogen K-edge).
2) MAX image (410 eV; most probable loss of N-K-edge).
3) HCI (250 eV); ultrastructural reference (circle marks the area of the spectrum below).
4) Net nitrogen distribution, calculated using 3-window power law method (Egerton); total calculation time <1 second.

Specimen: Euplotes spec. (ciliate) by courtesy of Inst. Spec. Zoology, University of Tübingen.

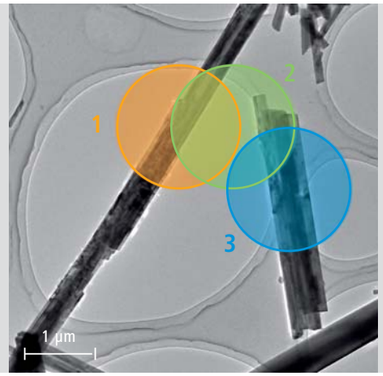


Parallel EELS spectra, recorded from the area marked in the HCI image.

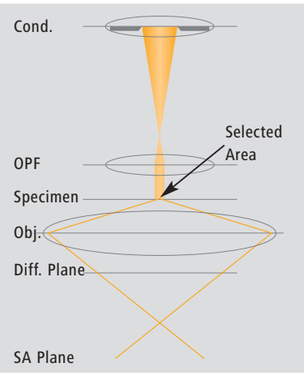
Applications
Artifact-free Selected Area Diffraction (SAD) of smallest areas



Conventional SAD diffraction.

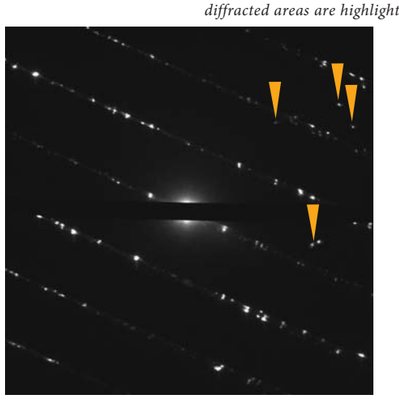


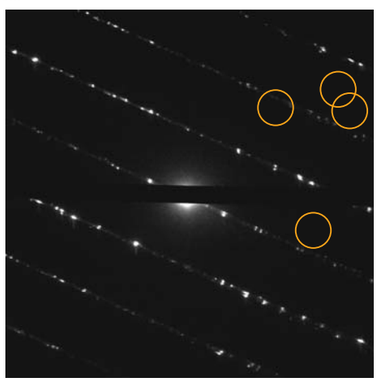
Bright-field image of Asbestos at 4 kx with marked diffracted areas are highlighted.



Koehler Illuminated diffraction.

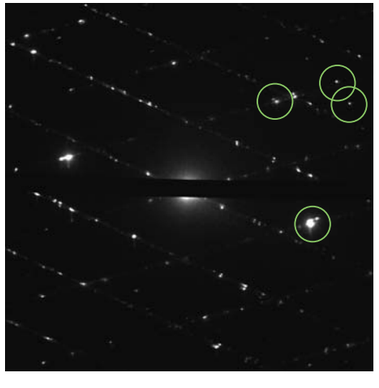
Conventional SAD from area 1. Note: Additional diffraction spots not visible in the neighboring diffraction pattern. These spots are caused by the extended illuminated specimen area. Due to chromatic aberration of the objective lens diffraction spots from outside the selected area pass the SAD aperture (red beam path).

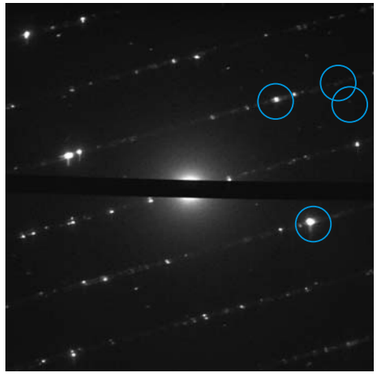




Koehler illuminated diffraction pattern from area 1. Since only the marked area is illuminated, the diffraction image only shows diffraction spots from the chosen asbestos particle.

Koehler illuminated diffraction pattern from area 2. Diffraction pattern showing a mixture of diffraction patterns coming from the two adjacent asbestos particles. The marked spots proof their origin from outside area 1 selected by the SAD aperture in the upper image.

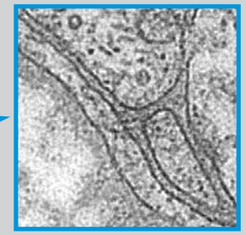




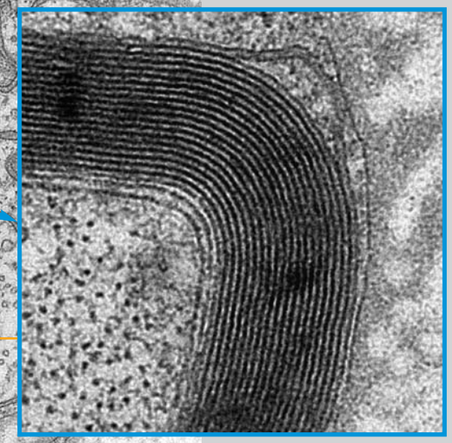
Koehler illuminated diffraction pattern from area 3. Clearly separated diffraction spots from the chosen asbestos particle.

Applications
Digital Image Montage

High resolution digital cameras enable imaging of fine structured details. Conventional b/w negative film is no longer required. Immediate control of results saves time and supports the operator's continuous workflow.



Even in the overlap area of 4 adjacent images the digital image shows a perfect match.

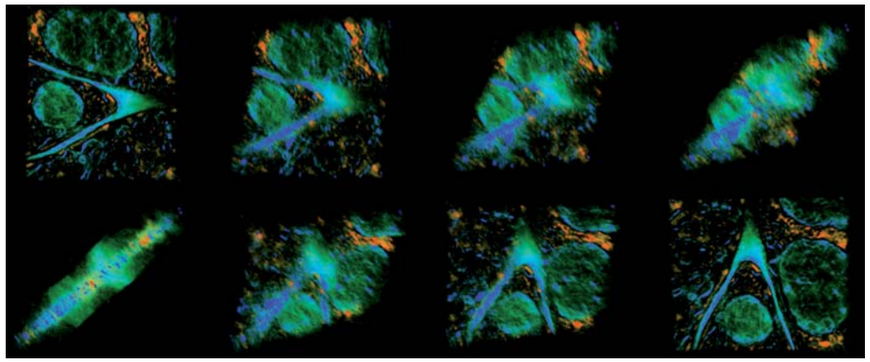


Specimen: peripheral nerve of rat.

Montage image of nine 2k x 2k individual images automatically acquired and spliced together by image analysis software. The final image has a resolution of 5800 x 5800 pixels.

Applications
Digital Recording and 3D Visualization

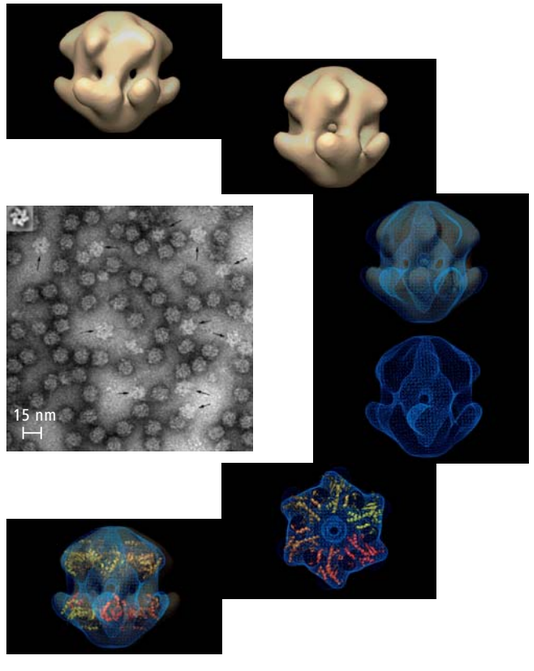
To gain access to all advantages offered by an EFTEM, a high end image processing system combined with an appropriate SSCCD-camera is required. With such systems images or spectra are immediately visible and can be stored, processed or evaluated further. Carl Zeiss NTS offers a wide range of premium SSCCD-cameras from various manufacturers perfectly integrated into the **LIBRA®** and WinTEM™ platform.



Different angles of view, selected from a 3D volume reconstruction of a botanic specimen (leaf of Arabidopsis spec.)

Thanks to the in-column concept even large specimen areas can be filtered and are visible on the fluorescent screen. Extremely large accessory ports allow a long distance to the last projector cross-over of SSCCD-cameras installed in this position. Thus, in a **LIBRA® 120 PLUS** distortion-free and seamlessly aligned montages of such large areas can be obtained even by wide angle CCD cameras. For highest resolution of details however, the SSCCD-camera should be mounted on-axis underneath the viewing chamber. The additional tubus magnifications can be completely compensated for by the **LIBRA®**'s built-in overview system, which allows the operator to continuously zoom the final image down to one tenth of the original magnification.

In order to fully support, the wide variety of features of this unique EFTEM, special attention has been paid to provide a seamless integration of software packages from several leading suppliers. The standard software can be completed with additional modules for convenient and very fast evaluation of images or spectra. These and additional software modules can take control of almost all **LIBRA® 120 PLUS** parameters e.g. for process automation, TEM alignment, and acquisition and evaluation of element distribution images, energy loss spectra or stage movement series (e.g. tomography).



Rendered 3D structure and model of type III Glutamin Synthetase obtained by single particle reconstruction from negative stain preparations of GlnA.
Image and 3D models courtesy J.M. van Rooyen, V.R. Abratt, and B.T. Sewell, Univ. Cape Town.

Technical Data

LIBRA®120 PLUS Essential Specifications	
Acceleration Voltage	40 - 120 kV in 20 kV steps (10 kV steps, optional)
Illumination System	Highly flexible advanced Koehler illumination system
Objective Lenses	Truly symmetrical condenser - objective type **Resolution** Point - Point: 0.34 nm Information Limit: <0.20 nm STEM: <1.50 nm (with LaB_6)
Spectrometer	Lifetime factory aligned in-column OMEGA type Dispersion: 1.17 µm/eV @ 120 kV Energy resolution: <1.5 eV Distortion: <±1.0 % Acceptance angle: 80 mrad at DE = 6 eV Isochromaticity: <1.0 eV in 2.5 cm ≥ at final image plane
Specimen Stage	5-axes fully eucentric goniometer Tilt range α/β: ±75° / ±30°
Imaging System	Magnification zoom for imaging, diffraction and spectroscopy with 5 projector lenses and OMEGA spectrometer.
Magnification	TEM: 8 - 630,000 x STEM: 50 - 1,000,000 x EELS: 20 - 315 x
Modes of Operation	EFTEM: Global and elastic BF/DF/Low Dose (elemental and structure sensitive contrast) Analysis: EELS, ESI, Image EELS, Spectrum Imaging, EDS Diffraction: Global and elastic SAED, CBED, LACBED, micro-ED STEM: SE, BSE, HAADF, BF, DF, EDS
Vacuum System	Completely oil-free with integrated cold-trap ● Pre-vacuum scroll pump with buffer reservoir ● Split-flow TMP for viewing chamber, filter, specimen and emitter ● Differential system with gun separation valve and IGP for emitter area (optional) ● Contamination minimized system with second TMP for viewing chamber and filter (optional)
System Control	WinTEM™ Graphical User Interface (GUI) with Windows®XP, operated by mouse, keyboard and dedicated control panels.

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