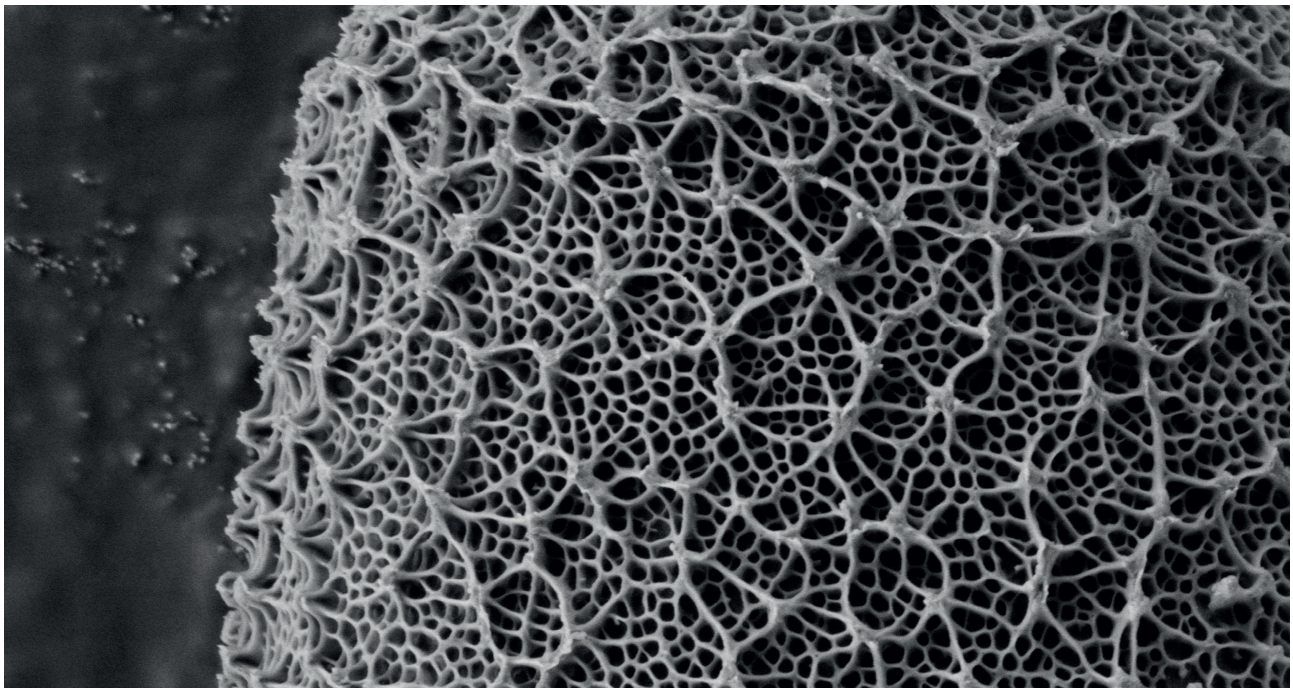

Software Manual

SmartSEM V06.01

Operating Software for ZEISS Scanning Electron Microscopes

ZEISS SmartSEM
Operating Software for Scanning Electron Microscopes

Original Instructions

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1 About This Document

Welcome to the SmartSEM Software Manual.

This manual is part of the FIB-SEM workstation, hereinafter referred to as the "microscope". Read the instructions carefully. Keep the manual nearby the microscope and hand it over to future owners of the microscope.

The manual is designed for operators who have been trained to operate the microscope by a ZEISS service representative. Basic operator training and safety instructions will be provided within the scope of initial start up by ZEISS. Operators of the microscope must not deviate from the instructions provided in this manual.

It is assumed that the operator is familiar with Windows based programs.

This manual contains the following chapters:

Chapter	Content
About this Document	Explains the function and structure of this manual.
Safety	Summarizes important safety details.
Software Description	Provides an overview of the user interface.
Starting SmartSEM	Contains information about starting the software.
Imaging Using the Electron Beam	Describes how to obtain and process images using the electron beam.
Managing Users	Shows how to manage users.
Customizing SmartSEM	Shows ways to customize SmartSEM.
Working with Additional Application Software	Describes how to work with related software or how to remotely control the microscope.
Backing up/Restoring Data	Shows how to back up or restore data.
Software Reference	Provides details on the control elements sorted alphabetically by applications and use cases.
Troubleshooting	Describes common issues and how to resolve them.
Glossary	Lists important technical terms.
Index	Lists keywords to help you find relevant information quickly.

1.1 Text Conventions and Link Types

The following conventions are used in this manual:

Text Conventions

Convention	Meaning
■ Click **Start** ■ Push the **STANDBY** button ■ Press **Enter** on the keyboard	The name of a control element is written in bold letters.
Press **<Ctrl+Alt+Del>**	Press multiple buttons on the keyboard at the same time.
Select **Tools > Goto Control Panel > Airlock**	Follow a path in the software.
`Input` text	The font `Courier` highlights text to be entered by the user.

Link Types

Link Type	Meaning
See *Safety Instructions and Additional Information* [▶ 14].	Leads to the chapter Safety Instructions and Additional Information.

1.2 Safety Instructions and Additional Information

The safety instructions in this manual follow a system of risk levels that are defined as follows:

DANGER

Risk of injury

DANGER indicates an imminently hazardous situation which, if not avoided, will result in death or serious injury.

WARNING

Risk of injury

WARNING indicates a potentially hazardous situation which, if not avoided, could result in death or serious injury.

CAUTION

Risk of injury

CAUTION indicates a potentially hazardous situation which, if not avoided, may result in minor or moderate injury.

NOTICE

Risk of property damage

NOTICE indicates a property damage message.

INFO

INFO indicates useful additional information and tips that can help you to make your daily work easier. There is no risk for health or property involved.

1.3 Related Documents

Instruction Manual of the Microscope

For information on the microscope hardware, refer to the instruction manual of the microscope.

Electronic Manual of the Microscope

All information contained this manual as well as the information contained in the instruction manual of the microscope is integrated in the Electronic Manual.

Instruction Manual for Options

For detailed information regarding optional accessories, refer to the respective instruction manual.

Product Specification and Installation Requirements

For details on technical data, refer to the documents Product Specification and Installation Requirements.

Material Safety Data Sheets

Material safety data sheets (MSDS) of chemicals used in combination with the microscope are contained in the document folder delivered with the microscope.

2 Safety

2.1 Intended Use

The SmartSEM software is intended for the operation of ZEISS FESEMs and FIB-SEMs such as the MERLIN and Crossbeam series.

The SmartSEM software has to be run exclusively on a personal computer delivered by ZEISS. Any other applications are not allowed.

Regarding operation of the microscope, the following regulations must be met:

- Only operate the microscope according to the operating conditions after correct installation by a ZEISS service representative.
- The microscope is only to be used by operators who have been trained by a ZEISS service representative. Basic operator training and safety instructions will be provided within the scope of the initial start-up by ZEISS. Make sure that everyone who operates the microscope only performs the tasks for which he/she is trained.
- Operators of the microscope must not deviate from the instructions provided in this manual.
- Only perform preventive maintenance tasks described in this manual. All tasks of maintenance, service, and repair not described in this manual have to be performed by an authorized ZEISS service representative.
- The microscope is to be used in a laboratory environment for commercial and scientific purposes only.

Using the microscope for any other purpose is not allowed and can be hazardous.

3 Software Description

3.1 User Interface

3.1.1 User Interface

The following screenshot indicates the main elements of the SmartSEM user interface:

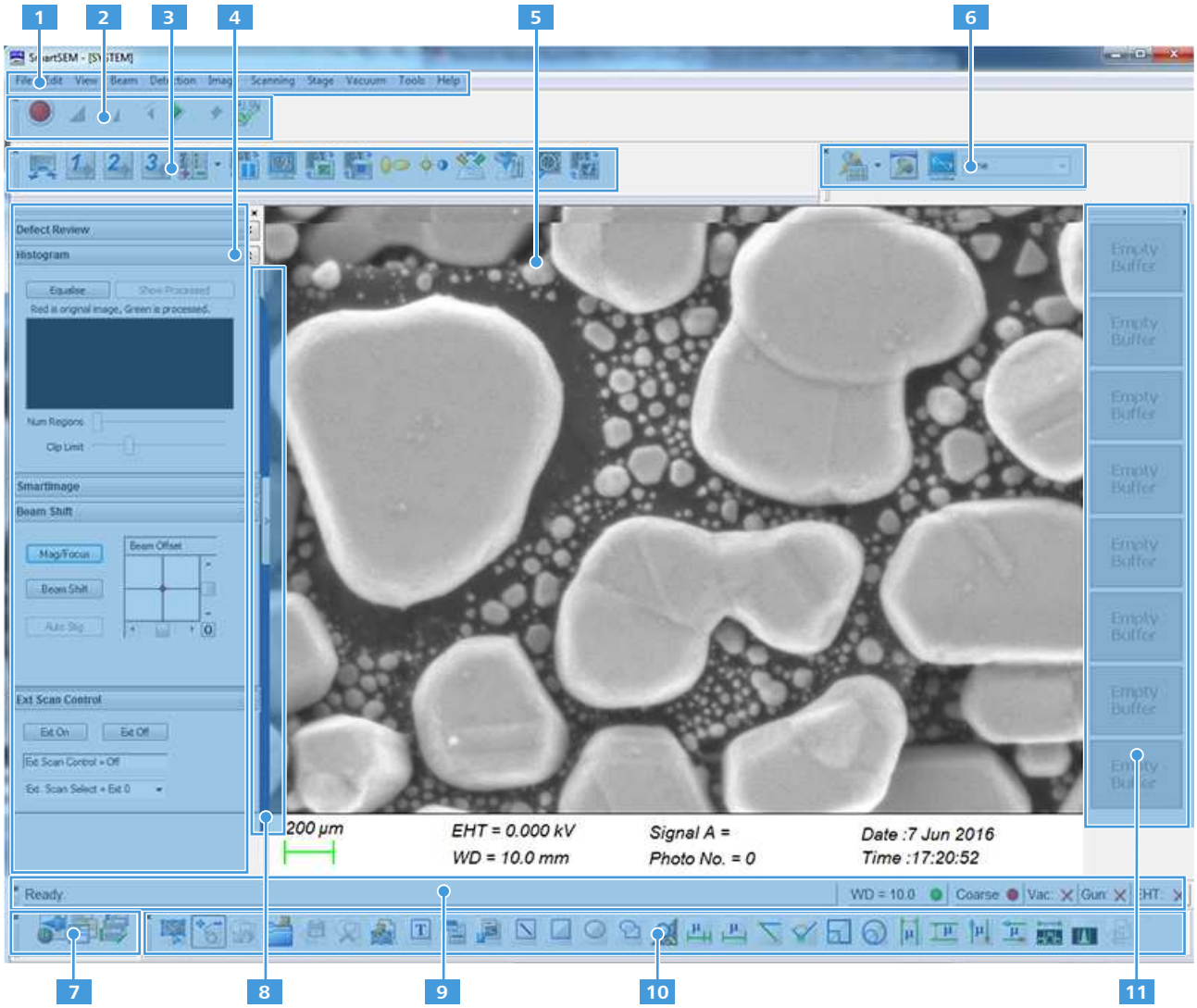


Fig. 3.1: Screen layout of the user interface

1. **Menu Bar**
   Enables you to access to SmartSEM features via sub-menus.
2. **AVI Toolbar**
   Contains the controls to set up, record and playback video sequences of scanned images.
3. **Toolbar**
   Provides quick access to SmartSEM tools.
4. **Docking Panel**
   Enables you to arrange frequently used SmartSEM panels for convenient access.
5. **Image Area** with **Data Zone**
   Displays image information and acquisition parameters from the microscope.
6. **FIB Toolbar**
   Contains the controls to configure the FIB column.
7. **Mini Bar**
   Provides quick access to recently used dialogs and to the recipe management.
8. **Panel Configuration Bar**
   Enables you to choose the panels to be placed in the **Docking Panel**.
9. **Status Bar**
   Displays the current machine state and contains the **SEM Control Buttons**.
10. **Annotation Bar**
    Enables you to add information to the SEM image and provides several measurement functions.
11. **Thumbnails Panel**
    Displays thumbnail views of the contents of the eight image buffers.

3.1.2 Menu Bar

The **Menu Bar** gives you easy access to SmartSEM features via sub-menus.

The following sub-menus are available:

Parameter	Description
File menu	Lists options for working with recipe files, images, and annotations. You also log off or exit the system from this menu.
Edit menu	Lists options for working with look-up tables (LUT), for configuring the **Toolbar** and for working with annotation tools. It also displays clipboard copying and pasting options.
View menu	Lists options for controlling the display of various screen elements such as toolbars and dialog boxes, aids to image measurement such as crosshairs or a graticule, and options to add a **Data Zone** to a displayed image.
Beam menu	Lists options for directly controlling the electron beam on/off state, for configuring gun settings, setting the EHT target, and shifting the beam.
Detection menu	Enables you to switch between (or mix) detector signals and TV inputs (e.g. chamberscope) and dynamically control a multi-segment BSD (if fitted).

Parameter	Description
Image menu	Lists options for working with the display of the scanned image, including image processing steps like noise reduction, filtering and FFT. For example, you can freeze an image during scanning, copy the scanned image to one of eight image buffers.
Scanning menu	Lists options to select scan speeds and store resolution, to switch between display modes, to display a profile scan as well as a surface scan, and to change dynamic focus settings.
Stage menu	List options for initializing the stage, and for controlling stage movement using a number of configurable features.
Vacuum menu	Lists options to control the vacuum status for pumping or venting the chamber, and to control variable pressure (VP) mode.
Tools menu	Provides access to user and administrator configuration screens plus a range of useful facilities such as image and movie capture and macro editing.
Help menu	Provides easy access to the SmartSEM online help.

3.1.3 Toolbar

Most **Toolbar** icons can be assigned twice. The different functions and parameters can be activated by pressing the left mouse button or the scroll wheel/the central mouse button. When moving the cursor across an icon, a tool tip displays information about the different assignments.

You can customize the **Toolbar** by adding or removing macros and commands.

The following tools are available:

Icon	Tool Tip Text	Left Mouse Button	Mouse Scroll Wheel
	Specimen Change/ Vacuum Control	Enables you to prepare the specimen change.	Calls the **Vacuum** Tab of the **SEM Controls** panel.
	Pix Avg 1/ Cont Avg 2	Pixel averaging at scan speed 2	Continuous frame averaging at scan speed 2
	Pix Avg 3/Cont Avg 4	Pixel averaging at scan speed 3	Continuous frame averaging at scan speed 4
	Pix Avg 6/Cont Avg 6	Pixel averaging at scan speed 6	Continuous frame averaging at scan speed 6
	Faster/Slower	Sets a higher scan speed.	Sets a lower scan speed.

Icon	Tool Tip Text	Left Mouse Button	Mouse Scroll Wheel
	Freeze:Unfreeze/ Scanning	Freezes/unfreezes the image.	Calls the **Scanning** tab in the **SEM Controls** panel.
	Normal/Scanning	Normal screen mode (Scan range displayed over the complete monitor).	Calls the **Scanning** tab in the **SEM Controls** panel.
	Reduced Raster/ Apertures	Switches between reduced scan and normal screen mode.	Calls the **Column** tab in the **SEM Controls** panel.
	ChamberScope/ Detector Control	Activates the CCD TV camera. Mouse button assignment: brightness/contrast	Calls the **Detectors** tab in the **SEM Controls** panel.
	Stigmation/ Alignment	Activates the reduced raster. Mouse button assignment: StigX, StigY/ Focus	Opens the **Focus Wobble** dialog.
	Brightness + Contrast/Toggle ABCC	If AutoBC is deactivated in the detector window, the mouse button assignment is switched to brightness/contrast. If the AutoBC function is activated, the mouse button assignment is switched to GAIN/OFFSET.	Switches from **AutoBC** = ON (mouse button assignment GAIN/ OFFSET) to **AutoBC** = OFF (mouse button assignment brightness/contrast) and back.
	Toggle INLENS:SE2/ Detector Control	Switches between In-lens and SE2 detector.	Calls **Detectors** tab in the **SEM Controls** panel.
	Magnification + Focus/ Auto Focus + Stig	Mouse button assignment: magnification/focus	Calls Auto Focus and Auto Stigmator algorithm.
	Beam Shift/Rotate dialog	Assigns the **Beam Offset** function to the left mouse button.	Opens the **Rotate / Tilt** dialog.
	Go Back to scanning in SmartSEM	Toggles between SmartFIB and SmartSEM	
	Save four full frame images out of Quad Mode	Enables you to save four full frame images out of Quad Mode	
	Toggle Crosshairs	Enables you to toggle the crosshairs display.	

3.1.4 Image Area

The **Image Area** is used to display scanned images or a TV image.

The **Image Area** can be split into two or four zones using the **Split** or **Quad** modes of the **Scanning** menu. For information on the recording parameters, the **Data Zone** can be displayed in the lower part of the **Image Area**.

The following symbols can be displayed in the **Image Area**:

Symbol	Description
	Image modifications are applied only to the zone marked with this symbol.
	Indicates that image modifications are applied to both zones simultaneously.
	Indicates that the image has been frozen.
	Indicates that the image has been saved.
	Indicates that the image has been saved by using the **Image Capture** mode.

3.1.5 Mini Bar

The **Mini Bar** provides quick access to recently used dialogs and to the recipe management.

The following functions are available:

Icon	Function
	Provides quick access to **Pump/Vent** as well as **EHT On/EHT Off** and **Gun ON/Off** function.
	Provides quick access to recently used functions.
	Provides quick access to stored recipes.

3.1.6 Panel Configuration Bar

The **Panel Configuration Bar** enables you to choose the panels to be placed in the **Docking Panel**. The panels are displayed in a list box.

A double-click with the left mouse button launches a panel as a separate element. A double-click with the right mouse button docks/undocks a panel directly to the **Panel Configuration Bar**.

3.1.7 Status Bar

The following screenshot indicates the main elements of the **Status Bar**:

1 **Command Status**
Displays results e.g. Done, Ready, Aborted, etc, and user instructions when executing a command.

2 **Progress Bar**
Displays the progress of a dynamic process.

3 **Parameter Control**
Displays parameters which can be adjusted by dragging the mouse in the **Image Area**. The parameter label identifies the parameter being adjusted, and the mouse button to be pressed when dragging.

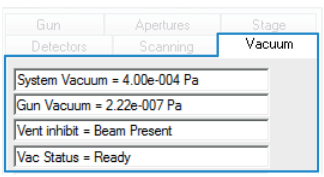
4 **Resolution**
Enables you to toggle parameter adjustment between **Coarse** and **Fine**.

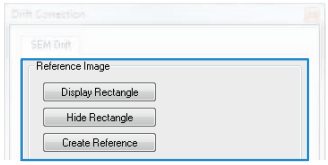
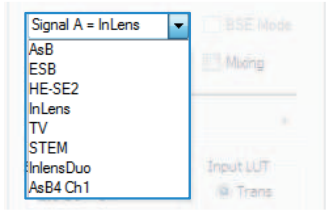
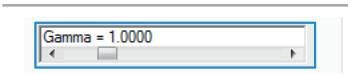
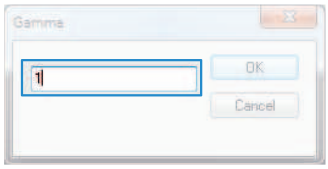
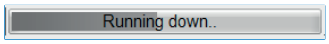
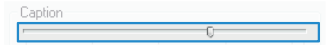
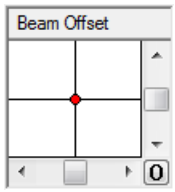
5 **SEM Control** Buttons
Enable you to pump and vent the SEM, and to control the gun operation and the EHT beam.

– Macro Label
Indicates the number of active macros.

3.2 Graphical Control Elements

The following graphical control elements are used in the SmartSEM GUI.

Screenshot	Control Element	Function
	Tab	Provides a group of graphical control elements.

Screenshot	Control Element	Function
	Section	Forms a group of control elements with related functions.
	Button	Enables you to start an action.
	Checkbox	Enables you to activate or deactivate a function.
	Drop-down list	Enables you to select the desired element.
	Radio button	Enables you to activate the desired option.
	Scroll bar	Enables you to adjust a value by moving the scroll bar or pressing the arrow button until the desired value is set.
	Readout	Displays the status of a system entity. Enables you to select an action or a value by opening a dialog with an input field.
	Input field	Enables you to enter the desired value .
	Progress bar	Displays the progress of an action.
	Slider	Enables you to adjust the corresponding function.
	Navigation box	Provides visual indication of the range and current value of one- and two-dimensional parameters such as **Beam Offset** or **Stigmation**.

3.3 Mouse Adjustment

Choosing the correct mouse type is important for the correct button assignment.

The button assignment changes depending on whether the 3 button standard mouse or the 3 button "wheel" mouse is chosen. The assigned mouse type is displayed as a symbol in the **Image Area**. If desired, you can disable the mouse symbol.

Access: **Menu Bar > Tools > Configure Mouse Adjust**

3.4 User Access Levels

The user access level defines which parameters are displayed for selection purposes, e.g. in the status window or annotation parameter selection.

SmartSEM distinguishes four user access levels. Depending on the user access levels, different parameters are accessible. User profiles are defined by the administrator.

Access: **Menu Bar > Tools > Administrator**

User Access Level	Description
Novice	Only the items assigned to the novice category are accessible. These include most frequently used parameters.
Expert	Items assigned to the novice and expert category are accessible. These include parameters useful for advanced operators.
Administrator	The **SmartSEM Administrator** is part of the SmartSEM program suite, which enables you to create users and assigning certain privileges to them. The **SmartSEM Administrator** is protected by an administrator password.
Service	All items are accessible, also including infrequently used items and calibrations.

3.5 Licenses

Software licenses are used to enable specific functionalities in the SmartSEM XB software. Some licenses are provided as standard with a specific model of FESEM, others are purchased as options.

When the FESEM is delivered, the standard and the additionally purchased licenses are already installed.

License	Sales Code	Part No.	Description
-	IA	-	Enables image analysis operations.
-	QUAD	-	Enables quad mode on Crossbeam 550.
-	HIGH_KV	-	License introduced for SUPRA 25 to allow 30 kV operation
16 Bit TIFF	TIFF16	348224-6052-000	Enables you to save *.tiff images with a gray value depth / gray level depth of 16 bit.
3DBSD	3DBSD	351434-6116-000	License for 3DSM
3D reconstruction	3D_ RECONSTRUCT	348224-6073-000	Enables you to create a 3D visualization of the bulk structure of a specimen based on a series of cross sections.
Adjustable Reduced Raster	REDUCED	350076-0372-000	Enables you to use a scan window with variable size and position. Especially recommended for the adjustment of parameters such as focus or stigmator.
Advanced Measurement	MEASA	348224-6011-000	Provides further measuring possibilities such as measuring of rectangles, inserting horizontal/vertical measuring lines.
Analytical I/F Particle Scan Application	PARTICLE	348224-6032-000	Specific software for automatic particle analysis. Requires particular hardware.
API (Application Programming Interface)	STDAPI	348224-6036-000	Enables you to control SmartSEM via external programs, e.g. 3D EDS software.
Automated Image Acquisition	AUTO_IMG_ ACQ	351434-6206-000	Enables you to use automated imaging.
AVI Capture	AVI	348224-6056-000	Enables you to capture image sequences and store them in an *.avi file.

License	Sales Code	Part No.	Description
Cell Counting Software	CELL-COUNTING	348224-6078-000	Enables you to count cell arrays. Requires particular hardware.
Centre Feature/ Stage Map	CENTRE	348224-6005-000	Enables you to use the point centering (Centre Point) and feature centering (Centre Feature) functions, and the "stage overview map" (Stage Map) function.
Colour Mode	COLOURMODE	348224-6074-000	Enables functionality that converts the signal from different signal sources in real time and displays it live in false colors without losing important information.
Compucentric Stage Software	COMPU	348224-6030-000	Compucentric software enabling tilt/rotation-eucentric control and horizontal alignment of a non-eucentric stage.
Customer Calibration Privilege	CUSTOMER_CALIB _PRIV	351434-6133-000	Enables you to change service calibration parameters.
Cut & Paste	CLIP	350076-0370-000	Enables you to copy and insert SEM images to and from the buffer store.
Defect Review	DEFECT-REVIEW	351434-6024-000	Enables you to find defects on a wafer or a mask based on the results from KLA Tencor results file. The defect review dialog enables you to open a wafer defect file (.rff/.001) and view the defect list (with associated images) and file header details. Requires: License STAGEREG 348224-6029 Useful: License CENTRE 348224-6005
Drift Corrected Frame Averaging / Integration	DRIFT_ CORRECTED_ AVG	351434-6205-000	Enables drift compensated frame integration and averaging.
Drift Correction	DRIFT-CORR	348224-6058-000	Image analysis software to compensate for image drift by beam shift control. Requires additional hardware. Requires the MIL dongle.
Dual Channel	DUAL-CHANNEL	348224-6062-000	Enables the display of two different detector signals in different SmartSEM windows.
Dual Magnification	DUALMAG	348224-6003-000	Enables a user defined area on the left hand half of a split screen display to be zoomed from 1x to 10x.

License	Sales Code	Part No.	Description
			Images from different detectors can be displayed at different magnifications.
Dynamic Focus	DYNFOCUS	350076-0364-000	Enables a dynamic adaptation of the focus to tilted specimen surfaces during beam passage.
Extended Voltage Range	EXVOLTS	348224-6042-000	Acceleration voltage range maximum is set to 40 kV (without this license only max. 20 kV can be set).
FIB API Dev Kit	FIB_API_DEV_KIT	348224-6109-000	Enables you to use the FIB Visual Basic API.
FIB low energy mode	FIB-LOW-ENERGY	348224-6060-000	Enables you to work with FIB EHT values less than 5 kV.
Fisheye	FISHEYE	348224-6080-000	Enables you to acquire a fisheye image of the specimen holder and the interior of the specimen chamber.
FTP Remote Archiving	REMARCH	348224-6038-000	Enables you to send files to a FTP server or network printer.
Graticule	GRATICULE	350076-0379-000	Enables you to display a grid on the screen with a line distance between 50 and 512.
High Current Mode	HIGH-CURRENT	348224-6048-000	Special control of the electron optics to increase the specimen current.
Image Maths	IMMATH	348224-6013-000	Enables mathematic manipulation of the content of the image memory, e.g. by using Kernel functions, by adding or subtracting images or by detecting gray levels.
Image stitching license	IMAGESTITCH	351434-6113-000	SmartStitch is a standalone application for producing tiled images or montages from a set of individual overlapping images captured via SmartSEM.
Input Gamma	GAMMALUT	348224-6009-000	Enables the input LUT function to individually adjust the characteristic input line of a detector.
Input Signal Invert	INVERT	350076-0367-000	Enables you to invert the signal using the input LUT.
Knights Camelot Integration	KNIGHTS CAMELOT	351434-6043-000	Knights Camelot software is a CAD navigation tool for locating specific features on a semiconductor die. It works by registering the specimen with the design of the die to enable the CAD image and SEM images to be synchronized to the same field of view. It is also possible to overlay the image with parts of the design.

License	Sales Code	Part No.	Description
Large Beamshift	LARGE-BEAMSHIFT	348224-6072-000	Enables you to work with an expanded beam shift (+/- 100 µm in X and Y). Requires particular hardware.
Low Voltage Working	LOWVOLTS	348224-6041-000	Acceleration voltage range minimum is set to 0.1 kV (without this license only 0.5 kV can be set).
Mineralogic	MINERALOGIC	351434-6220-000	The Mineralogic user interface enables you to setup and carry out automated petrological analysis. The Mineralogic application is designed to quantify gathered Energy Dispersive X-ray (EDS) spectra to classify minerals based on the mineral stoichiometry and produce mineral maps. Additional scan modes and image processing allows flexible analysis and the ability to target areas and phases of interest.
Piezo Integration	PIEZO-INTEGRATION	348224-6075-000	Enables you to integrate a Piezo stage.
Plasma Cleaning	PLASMA	351434-6177-000	Enables software control of the plasma cleaner.
Remote SEM	REMOTESEM	348224-6057-000	Enables remote operation of the microscope using the Windows Remote Desktop Connection feature.
RS232 Remote Control	REMCON	348224-6014-000	Enables remote operation and interrogation of the FESEM via serial communication (RS 232).
Scan Rate Expansion	SCANEXP	350076-0358-000	Enables 15 different scan speeds. Without this license, three scan speeds are available.
Scan Rotation	SCANROT	350076-0359-000	Enables electronic rotation of the image by changing the scan direction.
Signal Mixing	SIGMIX	350076-0350-000	Enables continued mixing of two detector signals in the range between 0 and 100%.
SmartBrowse	SMARTBROWSE	351434-6144-000	Enables you to sort images by various parameters, such as stage position or detector used.
Smart Stage Mapping	SMART-STAGE-MAPPING	348224-6081-000	Enables a calibration routine that optimizes the stage accuracy
SmartImage Enhancement	SMARTIMAGE	348224-6077-000	Enables the SmartImage image processing dialog (noise reduction and contrast enhancement).
SmartSEM Report Generator	REPORT_GENERATOR	351434-6092-000	Enables a Microsoft Office add-in ribbon that imports *.cztiff images and can read the tags so users can create reports. The *.cztiff images can be created by previous software versions.

License	Sales Code	Part No.	Description
Split	SPLIT	350076-0360-000	Enables you to work with a split screen.
Spot Mode	SPOT	350076-0383-000	Enables spot positioning of the electron beam on a given spot of the specimen.
Stage Coordinate store and recall	STAGECO	348224-6006-000	Enables saving stage coordinates together with the magnification and the working distances. The stage can automatically be driven to these positions.
Stage Fine Step	FINESTEP	348224-6050-000	Enables more precise movement of the stage.
Stage Registration	STAGEREG	348224-6029-000	Enables users to define specific coordinate systems for the specimen stage.
Stage Scan	STAGESCAN	348224-6007-000	Enables you to scan an exactly defined series of regularly distributed image fields.
Stage Survey Mode	SURVEY	348224-6040-000	Enables you to set magnifications and working distances for two different working modes automatically.
Static Stereo	STATIC-STEREO	348224-6076-000	Enables you to generate stereo pair images
Tilt Compensation	TILTCOMP	350076-0362-000	Enables correction of perspective foreshortening occurring when scanning tilted specimens.
User Accounting	ACCOUNT	348224-6031-000	Automatic registration of special parameters during a working session to enable the instrument administrator to trace who worked on the SEM/ FESEM. For each user, the number of saved *.tiff images, output photos and prints is saved.

3.6 Dongles

To operate the software, a SmartSEM 6.01 dongle has to be installed. For using the optional drift correction license (DRIFT-CORR), an additional dongle (called MIL dongle) is required.

INFO

If a dongle is lost, contact your local ZEISS service representative to order a new dongle. Microscope type and serial number have to be mentioned in the order.

3.7 SmartSEM Program Suite

The SmartSEM Program Suite comprises the EM server, which implements the internal communication between control software and microscope hardware, plus several programs and utilities.

The main purpose of the SmartSEM Program Suite is to access all necessary microscopy parameters and software features to capture SEM data and optimize image acquisition.

Access: **Windows start menu > Programs > SmartSEM**

Program	Description
ChamberScope	Enables you to display the chamberscope image and the detector image at the same time. Option, requires particular hardware.
FTP Image Archiving	Enables you to transfer data via FTP. License: REMARCH
ReadMe	Contains important information on the currently installed version.
RemCon32	Serial interface for remote operation via RS232, e.g. for EDX License: REMCON
SampleHolderGallery	Enables you to inspect the dimensions of all possible specimen holders as well as to set the dimensions of the custom specimen holders. Enables you to activate the available specimen holders for SmartSEM.
SEM Drift Correction	Enables you to compensate for the drift of the specimen by using a reference image and by controlling the beam shift. License: DRIFT-CORR
Slideshow speed setting	Enables you to adjust the slideshow speed for the Windows Photo Viewer.
SmartSEM Administrator	Enables you to manage user profiles and configure instruments.
SmartSEM User Interface	Main software application
SmartSEM User Accounting	Enables you to record important information during individual working sessions, e.g. logon/logoff time, number of TIFF files exported etc.
Release Notes	Contains an overview of all SmartSEM versions including new developments and specific details.

Access: **Windows start menu > Programs > SmartSEM Service**

Program	Description
Calibration Wizard	Service activities, for ZEISS service representatives only
Gun Monitor	Enables you to monitor important parameters of the SEM/FESEM.
GUN Service	Service activities, for ZEISS service representatives only
Piezo Configurator	Service activities, for ZEISS service representatives only
Service Centre	Provides an overview of the state of the SEM/FESEM.
Smart Stage Mapping	Service activities, for ZEISS service representatives only
Stage Administrator	Service activities, for ZEISS service representatives only
Upgrade Scangen Firmware	Service activities, for ZEISS service representatives only
Upgrade Server Database	Service activities, for ZEISS service representatives only
SmartBackup Tool	Service activities, for ZEISS service representatives only
Merlin Alignment Wizard	Service activities, for ZEISS service representatives only
Merlin Database Wizard	Service activities, for ZEISS service representatives only

4 Starting SmartSEM

Procedure

1. Power up the computer and log on.
2. Start the SmartSEM user interface via the **ZEISS SmartSEM** icon on the desktop.

   Alternatively, select **Programs > SmartSEM > SmartSEM User Interface** from the Windows start menu.

   The EM Server opens while loading various drivers. The EM Server implements the internal communication between software and hardware of the microscope.

   The **EM Server Log On** dialog is displayed.
3. Enter the user name and password.
4. Click **OK**.

   The SmartSEM user interface opens and is ready to operate the microscope.

4.1 Calling Up the Help

There are different ways to access topics in the Online Help.

Function	Menu	Shortcut	Control Elements
Startup page	Help	F1	-
Table of Contents	Help > Contents	Ctrl+F1	-
Context-sensitive	-	■ Shift+F1 ■ F1 on focus	Question mark icon in the main window and in modal dialogs

Detailed information about using the help system is given in the Online Help directly.

5 Imaging Using the Electron Beam

5.1 Obtaining a First Image

Overview The procedure contains the following steps:

- *Preparing the Specimen Holder* [▶ 33]
- *Loading the Specimen Chamber* [▶ 35]
- *Locating the Specimen* [▶ 37]
- *Switching On the Gun* [▶ 38]
- *Switching On the EHT* [▶ 39]
- *Generating an Image* [▶ 40]
- *Optimizing the Image* [▶ 41]
- *Saving the Image* [▶ 43]

5.1.1 Preparing the Specimen Holder

Parts and Tools

Designation	Part no.
Allen key, 1.5 mm	Delivered with the microscope
Stub	Delivered with the microscope
Tweezers for specimen	Delivered with the microscope
Specimen holder	Delivered with the microscope
If necessary: carbon tape, conductive carbon, adhesive metal tape or similar	-
Appropriate specimen (with conducting properties, e.g. gold on carbon)	-
Lint-free gloves	-

Safety Information

NOTICE

Risk of property damage: Contamination caused by fingerprints

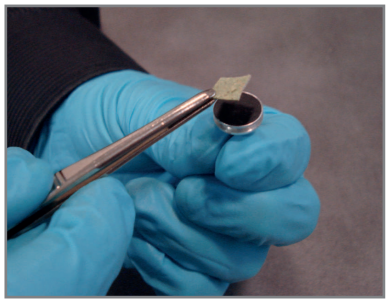
Contamination caused by fingerprints can lead to vacuum deterioration or prolonged pumping times.

- Always wear lint-free gloves when touching the specimen, specimen holder or stage.

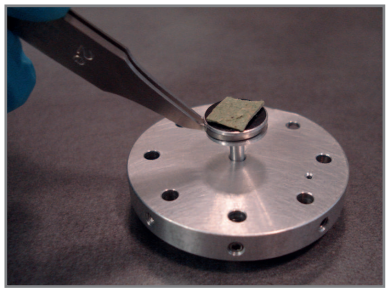
Procedure

1. To attach a specimen to the stub, use conductive carbon, adhesive metal, carbon tape or similar.

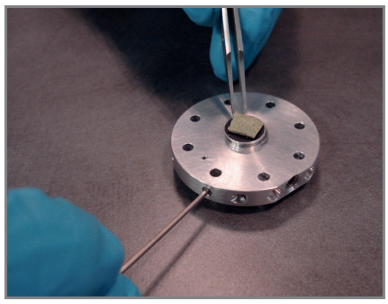
   Ensure that the specimen area that you want to analyze is in proper contact with the stub.



2. To insert the stub into the specimen holder, use tweezers.



3. To fix the stub to the specimen holder, tighten the location screw with the Allen key.



4. Note down which fix position is occupied by the specimen.

5.1.2 Loading the Specimen Chamber

Purpose

INFO

If your microscope is equipped with the optional airlock, use the airlock for loading the specimen chamber. For more information refer to the respective instruction manual.

Safety Information

⚠ WARNING

Suffocation hazard: Lack of oxygen

Gaseous dry nitrogen is used to ventilate the specimen chamber during specimen exchange. Inhaling nitrogen may cause unconsciousness.

- During specimen exchange, keep the chamber door open as short as possible.
- Do not inhale the air from within the specimen chamber.
- Ensure that the area around the microscope is sufficiently ventilated.
- If you begin to experience symptoms of asphyxia (for example: rapid breathing, loss of mental alertness and/or muscular coordination, depression of sensations, emotional instability, fatigue) leave the room immediately and inform the facility's safety officer.

⚠ CAUTION

Risk of injury: Moving the specimen stage

Fingers can be trapped by the moving specimen stage.

- Always close the chamber door before you move the specimen stage.

⚠ CAUTION

Risk of injury: Closing the chamber door

Fingers can be pinched when closing the chamber door.

- Use the door handle to close the chamber door.
- Ensure not to get your fingers caught in the chamber door gap.

NOTICE

Risk of property damage: Short working distance

When opening the specimen door, the microscope or specimen can be damaged if the specimen stage is at a short working distance.

- Always move the specimen stage to a long working distance before opening the chamber door.

Prerequisites

- The SmartSEM user interface is started.
- The stage is initialized.

Procedure

1 Verify that the **Crossbeam SEM Control** panel is displayed in the user interface.

1. From the **Menu Bar**, select **Tools > Goto panel** .

   The **Panel Configuration Bar** is displayed. It contains an alphabetical list of functions.

2. Double-right-click **Crossbeam SEM Control**.

   The **Crossbeam SEM Control** panel is added to the docking panel.

2 Activate the TV mode and **Data Zone** and drive the stage to a low position.

1. In the **Crossbeam SEM Control** panel, select the **Imaging** tab.
2. In the **Detector / Active Channel** section, select **TV** from the **Signal A** drop-down list.

   The inside of the specimen chamber is visible in the **Image Area**.
3. In the **Crossbeam SEM Control** panel, select the **Stage** tab.
4. Activate the **Track Z** checkbox.

   The current working distance (WD) is displayed in the **Data Zone**.
5. If the **Data Zone** is disabled, enable it via **Menu Bar > View > Data Zone > Show Data Zone**.
6. Use the dual joystick to drive the specimen stage downwards to a low position.

   NOTICE Observe the stage movement via camera to avoid crashing.

3 Ventilate the specimen chamber.

1. In the **Crossbeam SEM Control** panel, select the **Vacuum** tab.
2. Click **Vent**.

   The **Vent** message box is displayed.
3. To start ventilating, click **Yes**.

   The specimen chamber is purged with gaseous nitrogen.

4 Load the specimen chamber.

1 Carefully open the chamber door.

2 If a specimen holder is mounted onto the specimen stage, remove it by sliding it out of the dovetail rails.

3 Mount the prepared specimen holder by sliding it into the dovetail rails.

Make sure that the dovetail is placed in the correct orientation so that the flat side of the dovetail of the specimen holder is flush with the milled edge of the specimen stage.

4 Carefully close the chamber door.

The specimen holder and the specimen inside the chamber are visible in the **Image Area**.

5 Pump the specimen chamber.

1 In the **Crossbeam SEM Control** panel, select the **Vacuum** tab.

2 Click **Pump**.

Several vacuum status messages display the current vacuum levels.

As soon as the appropriate vacuum level is achieved, the vacuum status message **Vac Status = Ready** is displayed.

This may take up to 5 minutes.

5.1.3 Locating the Specimen

Safety Information

NOTICE

Risk of property damage: Driving the stage

While the stage is driven manually, there is a risk of damaging the objective lens and/or the specimen.

- Ensure not to hit the objective lens while driving the stage.
- Monitor the moving stage in TV mode.
- To stop the moving stage immediately, press **<F12>** or press the **Break** push button of the control panel.

Procedure

1 Position the stub under the electron beam.

1 From the **Menu Bar**, select **Stage > Navigation**.

The **Stage Navigation** panel is displayed. It contains two schematics of the specimen chamber.

The upper schematic shows a lateral view of the specimen stage.

The lower schematic shows a plan view of the stage with the different stubs.

Alternativley, you can access the **Stage Navigation** panel via **Panel Configuration Bar > Stage Navigation**

2 Click **Settings**.

The **Stage Nav Settings** dialog is displayed.

3 In the **Stage Nav Settings** dialog, click **Show Gallery**.

The **Sample Holder Gallery** dialog is displayed.

4 In the **Sample Holder Gallery** dialog, double-click the specimen holder you are using.

5 Activate the **Is Available** checkbox.

6 Close the **Sample Holder Gallery** dialog.

7 Close the **Stage Nav Settings** dialog.

8 In the lower schematic of the **Stage Navigation** panel, spot the stub with the specimen you want to observe.

9 To drive the stub directly under the electron beam, double-click the stub.

2 Move the specimen to the proper height.

1 In the **Stage Navigation** panel, drag the **Zoom View** slider to the right end, so that the schematics are zoomed in.

2 In the **Crossbeam SEM Control** panel, select the **Imaging** tab.

3 In the **Detector / Active Channel** section, select **USB TV1** from the **Signal A** drop-down list.

The inside of the specimen chamber is visible in the **Image Area**.

4 Use the dual joystick to carefully move up the stage so that the stub you are using is in the center of the upper schematic.

NOTICE **Observe the camera image in order not to crash into the pole piece.**

5.1.4 Switching On the Gun

Safety Information

NOTICE

Risk of property damage: Schottky field emitter

If the Schottky field emitter is switched on and off too frequently or inappropriately, its lifetime is reduced.

- Avoid switching off the gun during the working week.
- Use Standby mode for the weekend or a break of up to a week.
- When using the Standby mode, enable the **Partial Vent on Standby** function.

Prerequisites

- The chamber and the gun head have been evacuated.

Procedure

1. In the right part of the **Status Bar**, verify whether the gun is switched on or off.

   If Gun: ✓ or All: ✓ is displayed, the gun is already switched on and you can skip the following steps.

   If Gun: ✗ is displayed, the gun is switched off.

2. In the **Crossbeam SEM Control** panel, select the **Vacuum** tab.

3. Verify that the **EHT Vac ready** readout is **EHT Vac ready = Yes**.

   If not, the correct vacuum is not achieved. Check if the **Pump** procedure has been completed.

4. In the right part of the **Status Bar**, click Gun: ✗.

   The pop-up menu for Vacuum, Gun and EHT activation is displayed.

5. Click **Gun On**.

   The gun runs up.

   This may take up to 5 minutes.

5.1.5 Switching On the EHT

Purpose

When you switch on the EHT, the gun starts emitting electrons.

Prerequisites

- The chamber and the gun head have been evacuated.
- The gun has been switched on.

Procedure

1. Set the acceleration voltage.

   1. In the **Crossbeam SEM Control** panel, select the **Control** tab.
   2. Double-click the **EHT Target** readout.

      The **EHT Target** window is displayed.
   3. In the input field, enter `10` and click **OK**.

2. Switch on the EHT.

   1. In the right part of the **Status Bar**, click EHT: ✗.

      The pop-up menu for Vacuum, Gun and EHT activation is displayed.
   2. Click **EHT On**.

      The EHT runs up to 10 kV.

      In the right part of the **Status Bar**, the Vacuum, Gun and EHT status buttons merge to All: ✓.

5.1.6 Acquiring an Image

Purpose

INFO

The following procedure describes the best way to quickly obtain an image without the control panel. You can also use the control panel to adjust magnification/focus and brightness/contrast.

Procedure

1 Select column mode **High Res** and set **I Probe = 300**.

1 In the **Crossbeam SEM Control** panel, select the **Control** tab.

2 In the **Control** section, click **High Res**.

3 In the **Beam** section, double-click the **I Probe** readout.

The **I Probe** window is displayed.

4 In the input field, enter `300`.

The probe current is set to 300 pA.

2 Select the SE2 detector.

1 In the **Crossbeam SEM Control** panel, select the **Imaging** tab.

2 In the **Detector / Active Channel** section, select **Signal A = SE2** from the **Signal A** drop-down list.

INFO **We recommend using the SE2 detector to obtain the first image. This detector provides a good signal-to-noise ratio even at long working distances.**

3 Set **Scan Speed** = 1.

1 In the **Crossbeam SEM Control** panel, select the **Imaging** tab.

2 From the **Scan Speed** drop-down list, select **Scan Speed = 1**.

INFO **The lower the scan speed number, the faster the electron beam scans across the specimen.**

Scan Speed = 1 allows you to get an image quickly.

4 Set the magnification to **Mag = 500 x**.

1 In the **Toolbar**, select the **Magnification+Focus** icon.

The **Status Bar** displays the values for magnification and focus.

2 In the **Status Bar**, click Left: Mag = .

The **Mag** window is displayed.

3 In the **Mag** input field, enter `500`.

4 Click **OK**.

5 Set the working distance to **WD = 10 mm**.

1 In the **Status Bar**, click Mid: WD = .

The **WD** window is displayed.

2 In the **WD** input field, enter 10.

3 Click **OK**.

6 Adjust brightness and contrast.

1 In the **Crossbeam SEM Control** panel, select the **Imaging** tab.

2 In the **Detector / Active Channel** section, use the scroll bars to adjust brightness and contrast.

7 Visualize details on the specimen surface.

1 Select a detail on the specimen surface.

2 To adjust the magnification, hold down the left mouse button and drag the mouse within the **Image Area** in left/right direction.

The current magnification is indicated in the **Status Bar**.

3 To adjust the focus, change the working distance. Hold down the mouse wheel and drag the mouse within the **Image Area** in left/right direction.

The current working distance is indicated in the **Status Bar**.

4 Adjust contrast and brightness again.

5.1.7 Optimizing the Image

Purpose Once you have generated an initial image, you can adjust various parameters to optimize the image.

INFO

The following procedure describes the best way to quickly optimize the image without the control panel. You can also use the control panel to adjust aperture alignment, magnification/focus and brightness/contrast.

Procedure

1 Adjust the magnification in Fine mode.

1 To switch to the Fine mode, in the **Status Bar**, click Coarse .

The Coarse button changes to Fine .

2 Step by step, raise the magnification up to Mag 50.000 x and focus in between.

To adjust the magnification and the focus, hold down the left mouse button or the mouse wheel, respectively, and drag the mouse within the **Image Area**.

2 Shift the beam.

If you want to move the field of view at high magnifications, use the **Beam Offset** function instead of moving the stage.

1 In the **Crossbeam SEM Control** panel, select the **Control** tab.

2 In the **Beam Alignment** section, click **Beamshift**.

3 To shift the beam, in the navigation box, use the scroll bars or the red marker.

3 Limit the scan field by the reduced raster.

1 In the **Toolbar**, click the **Reduced Raster** icon.

A small scan frame is displayed.

The image outside the scan frame is frozen.

2 To change the position of the scan frame, click on the green border line and use the mouse to drag and drop the frame.

3 To change the size of the scan frame, click on the small blue squares on the green border line and drag them to the desired size.

4 Focus the image in the reduced raster.

4 Align the aperture.

1 In the **Crossbeam SEM Control** panel, select the **Control** tab.

2 In the **Beam Alignment** section, click **Focus Wobble**.

The **Focus Wobble** window is displayed.

INFO **Focus wobble is a function that sweeps the acceleration voltage. If the aperture is misaligned, a lateral and vertical shift can be observed.**

3 To adjust the wobble intensity, use the **Wobble Amplitude** scroll bar.

4 To accelerate the wobble speed, activate the **Wobble Fast** checkbox.

5 In the **Control** tab, click **Aperture**.

6 In the navigation box, use the scroll bars or the red marker to adjust the aperture alignment until there is no movement of the detail in X- and Y-direction.

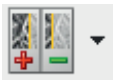
INFO **The specimen detail should just be pulsating without shifting.**

7 In the **Focus Wobble** window, click **OFF** to disable focus wobble.

The **Focus Wobble** window closes.

5 Set **Scan Speed = 7** and bring the image into focus.

1 In the **Toolbar**, from the **Faster/Slower** drop-down list, select **Scan Speed = 7**.



2 Bring the image into focus.

6 Correct astigmatism.

1 Ensure that the **Reduced Raster** function is still active.

2 Select a detail (e.g. a mark or an edge) on the specimen surface.

Ensure that the selected detail is in the raster.

3 In the **Crossbeam SEM Control** panel, select the **Control** tab.

4 Click **Stigmator**.

5 In the navigation box, use the scroll bars or the red marker to obtain the sharpest possible image.

6 To deactivate the reduced raster, in the **Toolbar**, click the **Reduced Raster** icon.

5.1.8 Saving the Image

Procedure **1** In the **Toolbar**, click the **Freeze:Unfreeze/Scanning** icon.

A red dot at the right bottom of the **Image Area** indicates that the image is frozen.

2 From the **Menu Bar**, select **File > Save Image**.

The **Export TIFF** dialog is displayed.

3 To change the save path, click **Change Directory**.

A file explorer window is displayed.

4 To confirm the selected path, click **Select Folder**.

5 Enter the filename in the **Filename** input field.

6 Click **Save**.

7 To continue imaging, click the **Freeze:Unfreeze/Scanning** icon.

5.2 Controlling the Hardware

5.2.1 Controlling the Vacuum

5.2.1.1 Checking the Current Vacuum Status

Purpose A good vacuum is essential for a high performance of the microscope, therefore it is recommended to observe the vacuum state in the specimen chamber and the gun head frequently.

Procedure

1. In the **Crossbeam SEM Control** panel, select the **Vacuum** tab.

   The **System Vacuum** readout indicates the vacuum in the specimen chamber.

   The **Gun Vacuum** readout indicates the ultra high vacuum in the gun head area, which should be less than about 5 x 10^{-9} mbar.

2. To display the **System Vacuum** or the **Gun Vacuum** in another pressure unit (*mbar, Pa, Torr*), click in the respective readout.

5.2.1.2 Ventilating the Specimen Chamber

Purpose In order to be able to open the specimen chamber for specimen exchange, the vacuum has to be broken in a controlled manner. This is done by feeding gaseous nitrogen into the specimen chamber.

Procedure

1. In the **Status Bar**, click 

.

   A pop-up menu is displayed.

2. Click **EHT Off**.

   The EHT is switched off.

   The **Vac:** button is displayed.

3. Click **Vac:**.

   A pop-up menu is displayed.

4. Click **Vent**.

   The specimen chamber is ventilated.

Alternatively, the specimen chamber can be ventilated in the following ways:

- In the **Toolbar**, click the **Specimen Change** icon.

  The EHT is switched off. The specimen chamber is ventilated.

- In the **MiniBar**, click the **Start** icon.

A pop-up menu is displayed that enables you to switch off the EHT and vent the chamber.

- In the **Crossbeam SEM Control** panel, select the **Vacuum** tab and click the **Vent** button.

5.2.1.3 Evacuating the Specimen Chamber

Purpose To continue operation after a specimen exchange, the specimen chamber has to be evacuated again.

Procedure

1. In the **Status Bar**, click **Vac:**.

   A pop-up menu is displayed.

2. Click **Pump**.

Alternatively, the specimen chamber can be evacuated in the following ways:

- In the **Toolbar**, click the **Specimen Change** icon.

  A system message is displayed. Press **OK** to pump.

- In the **MiniBar**, click the **Start** icon.

  A pop-up menu is displayed. Click **Pump**.

- In the **Crossbeam SEM Control** panel, select the **Vacuum** tab and click the **Pump** button.

5.2.1.4 Using the Quiet Mode (Optional)

Purpose The automatically controlled Quiet Mode is optionally available. It allows switching off the pre-vacuum pump after specimen exchange when the vacuum threshold is achieved. This provides a more comfortable noise level for the operator and the microscope while reducing power consumption of the pre-vacuum pump.

Prerequisites

- The optional Quiet Mode hardware is installed.

Procedure

1. In the **Crossbeam SEM Control** panel, select the **Vacuum** tab.
2. Activate the **Vac Quiet Mode** checkbox.

   The pre-vacuum pump is switched off when the vacuum threshold is achieved.
3. In order to disable the Quiet Mode, deactivate the **Vac Quiet Mode** checkbox.

5.2.2 Controlling the Gun

5.2.2.1 Switching On the Gun

Safety Information

NOTICE

Risk of property damage: Schottky field emitter

If the Schottky field emitter is switched on and off too frequently or inappropriately, its lifetime is reduced.

- Avoid switching off the gun during the working week.
- Use Standby mode for the weekend or a break of up to a week.
- When using the Standby mode, enable the **Partial Vent on Standby** function.

Prerequisites

- The chamber and the gun head have been evacuated.

Procedure

1. In the right part of the **Status Bar**, verify whether the gun is switched on or off.

   If Gun: ✓ or All: ✓ is displayed, the gun is already switched on and you can skip the following steps.

   If Gun: ✗ is displayed, the gun is switched off.

2. In the **Crossbeam SEM Control** panel, select the **Vacuum** tab.
3. Verify that the **EHT Vac ready** readout is **EHT Vac ready = Yes**.

   If not, the correct vacuum is not achieved. Check if the **Pump** procedure has been completed.

4. In the right part of the **Status Bar**, click Gun: ✗.

   The pop-up menu for Vacuum, Gun and EHT activation is displayed.

5. Click **Gun On**.

   The gun runs up.

   This may take up to 5 minutes.

5.2.2.2 Switching Off the Gun

NOTICE

Risk of property damage: Schottky field emitter

If the Schottky field emitter is switched on and off too frequently or inappropriately, its lifetime is reduced.

- Avoid switching off the gun during the working week.
- Use Standby mode for the weekend or a break of up to a week.
- When using the Standby mode, enable the **Partial Vent on Standby** function.

Procedure

1. In the right part of the **Status Bar**, click Gun: ✓ or All: ✓.
   The pop-up menu for Vacuum, Gun and EHT activation is displayed.
2. Click **Shutdown Gun**.

5.2.3 Controlling the EHT

5.2.3.1 Switching On the EHT

Purpose

When you switch on the EHT, the gun starts emitting electrons.

Prerequisites

- The chamber and the gun head have been evacuated.
- The gun has been switched on.

Procedure

1. Set the acceleration voltage.
   1. In the **Crossbeam SEM Control** panel, select the **Control** tab.
   2. Double-click the **EHT Target** readout.
      The **EHT Target** window is displayed.
   3. In the input field, enter `10` and click **OK**.
2. Switch on the EHT.
   1. In the right part of the **Status Bar**, click EHT: ✗.
      The pop-up menu for Vacuum, Gun and EHT activation is displayed.
   2. Click **EHT On**.
      The EHT runs up to 10 kV.
      In the right part of the **Status Bar**, the Vacuum, Gun and EHT status buttons merge to All: ✓.

5.2.3.2 Switching Off the EHT

Procedure

1. In the right part of the **Status Bar**, click All: ✓.
   The pop-up menu for Vacuum, Gun and EHT activation is displayed.
2. Click **EHT Off**.

5.3 Controlling the Electron Beam

5.3.1 Measuring and Controlling the Probe Current

5.3.1.1 Determining the Installed Aperture Configuration

Purpose

The achievable maximum probe current depends on the installed anode aperture. The type of aperture installed on the microscope can be determined via SmartSEM.

- Anode Aperture Diameter: 70 µm*

Configuration	Available probe currents
40 nA High Resolution	10 pA - 40 nA

- Anode Aperture Diameter: 110 µm*

Configuration	Available probe currents
100 nA High Current	10 pA - 100 nA

** Calibration value: deviation of 10 % possible*

INFO

If you wish to change the installed configuration of your microscope, contact your local service representative.

Procedure

1. From the **Menu Bar**, select **View > SEM Status**.
   The **SmartSEM Status** dialog is displayed.
2. In the **Select** tab, click **Anode Aperture Diameter**.
3. Go to the **Display** tab.
   The parameter **Aperture Size** is displayed.

5.3.1.2 Switching Between High Resolution Gun Mode and Analytic Gun Mode

Purpose In High Resolution mode, the temperature of the Schottky emitter and the extraction voltage are reduced. This leads to a reduction of the energy spread of the primary electrons. High Resolution mode is especially useful at low kV to reduce chromatic error and achieve a better resolution. Overall, the probe current in High Resolution mode is about half the probe current in Analytic mode.

INFO

It takes 12 hours until the stability of 0.2 %/h is reached.

Procedure

1. In the **Crossbeam SEM Control** panel, select the **Gun** tab.
2. To switch to High resolution mode, click **High Res Gun Mode**.
3. To return to Analytic mode, click **Analytic Gun Mode**.

5.3.1.3 Setting the Probe Current

Purpose You can set a lower probe current to analyze surface details at a high resolution or higher probe currents for analytical purposes, e.g. to analyze the material of the specimen.

INFO

The achievable maximum probe current depends on the currently selected EHT and the installed aperture configuration.

Procedure

1. In the **Crossbeam SEM Control** panel, select the **Control** tab.
2. Double-click the **I Probe** readout.

   The **I Probe** window is displayed.
3. In the input field, enter the desired value.

5.3.1.4 Measuring the Probe Current

Purpose Measuring the probe current using the Faraday cup ensures that the current displayed in the software corresponds to the actual value. The Faraday cup consists of a strongly absorbing material with a cavity covered by a small aperture. If the beam is focused in this cavity, no secondary electrons and no backscattered electrons leave the Faraday cup.

Parts and Tools

Designation	Part no.
Faraday Cup	348342-8055-000

Procedure

1. Load the Faraday cup into the specimen chamber.
2. Evacuate the specimen chamber.
3. Switch on the gun.
4. Switch on the EHT.
5. From the **Panel Configuration Bar**, select **Specimen Current Monitor**.
   The **Specimen Current Monitor** window is displayed.
6. Activate the **Stage Bias** checkbox.
   This activates the touch alarm that helps avoid collisions of the stage.
7. Move the stage to the position of the Faraday cup.
8. Acquire an image of the Faraday cup.
9. Activate the **Spot** checkbox.
   Green crosshairs are displayed on the image. The crosshairs indicate the position of the beam spot.
10. Grab the crosshairs and move them into the hole of the Faraday cup.
    The probe current is measured continuously.
    The measured probe current is displayed in the **Specimen I** readout.

5.3.1.5 Blanking the Beam

Purpose To protect sensitive specimens from the electron beam, you can blank the beam.

INFO

The following procedure does not refer to the optional Beam Blanker. For information on the optional Beam Blanker, refer to the Instruction Manual Beam Blanker delivered with the Beam Blanker.

Procedure

1. In the **Crossbeam SEM Control** panel, select the **Control** tab.
2. In the **Control** section, activate the **Blank** checkbox.

5.3.1.6 Changing the Extractor Voltage

Purpose The extractor voltage is preset by the factory or by the ZEISS service representative. Within certain limits, the operator may carefully increase the extractor voltage in order to optimize the probe current for particular applications.

INFO

Use a Faraday cup to measure the beam current when changing the extractor voltage.

INFO

The newly set extractor value is only valid for the current work session. After a restart of the SmartSEM software, the microscope restores the nominal extractor voltage.

Safety Information

NOTICE

Risk of property damage: Impaired performance and resolution of the microscope

Reducing the extractor voltage may impair the performance and resolution of the microscope.

- Avoid reducing the extractor voltage.
- If at all, reduce the extractor voltage only for a short time (1-2 h) and by a maximum of 500 V.

Prerequisites

- The user privilege **Extractor** is required to change the extractor voltage.

Procedure

1. From the **Menu Bar**, select **Beam > Gun Setup**.
   The **Gun Service** dialog is displayed.
2. To increase the extractor voltage, double-click the **Extractor V Target** readout.
   The **Extractor V Target** window is displayed.
3. Enter a higher value.
4. Click **OK**.

5.3.2 Selecting the Column Mode

Purpose With the Gemini II column, three different Column Modes are available:

Column Mode	Description
High Resolution	Imaging with maximum spatial resolution in a restricted probe current range
Analytic	Imaging in the whole probe current range
Fisheye	Imaging with a very large field of view for an overview of a specimen, the specimen holder and for navigation in the specimen chamber. Requires the optional SmartSEM software license FISHEYE.

In addition, the depth of field can be adjusted.

Procedure

1. In the **Crossbeam SEM Control** panel, select the **Control** tab.
2. In the **Column** section, click the **High Res**, **Analytic** or **Fisheye** button.
3. If you have selected the **Analytic** mode, adjust the **Depth of Field** slider as required.

5.3.3 Re-adjusting the Beam via Offset Correction

5.3.3.1 Performing an Offset Correction

Purpose When you change SEM parameters such as EHT or probe current, it is necessary to calibrate the beam path.

INFO

You can also activate the Auto Offset Correction function. If the Auto Offset Correction function is activated, SmartSEM automatically performs a calibration, e.g. after every change of EHT or probe current.

Procedure

1. In the **Crossbeam SEM Control** panel, select the **Control** tab.
2. Click **Offset Cor.**

   SmartSEM calibrates the beam path.

5.3.3.2 Activating the Auto Offset Correction

Purpose If the Auto Offset Correction function is enabled, SmartSEM automatically performs a calibration routine in order to optimize the beam path, e.g. after every change of EHT or probe current.

The calibration routine is as follows:

- The image is frozen. A red dot is displayed in the lower right corner of the **Image Area**.
- The **Auto calibration** progress bar is visible in the **Status Bar**.
- After about 4 seconds, the calibration routine is finished and the image is unfrozen again.

INFO

If you wish to change many SEM parameters at once, the automatic calibrations in between may unnecessarily lengthen the process. In this case, you can deactivate the Auto Offset Correction function and manually trigger an offset correction via **Crossbeam SEM Control > Control > Offset Cor.**

Procedure

1. From the **Menu Bar**, select **Tools > User Preferences**.
   The **User Preferences** dialog is displayed.
2. Select **User > Auto Offset Correction**.
3. To enable the **Auto Offset Correction** function, click in the **Value** field and select **Yes**.

5.4 Setting Imaging Parameters

5.4.1 Finding Appropriate Detector Settings

5.4.1.1 Setting Up the InLens SE Detector

Purpose The InLens detector collects the SE signal, acquiring mainly information about surface topography.

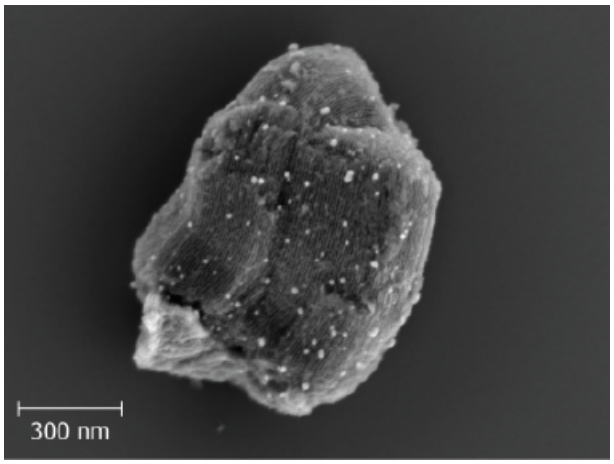


Fig. 5.1: Ag nanoparticles embedded in zeolite, imaged at 1.5 kV

The following settings are recommended for the InLens SE detector:

EHT	Typical WD	Recommended WD
20 V - 10 kV	0 - 5 mm	Short working distances are preferable for good detection efficiency
10 kV - 20 kV	2 - 5 mm	

INFO **Avoid strong specimen tilting for the InLens detector.**

Procedure

1. In the **Crossbeam SEM Control** panel, select the **Imaging** tab.
2. From the **Signal A** drop-down list, select **InLens SE**.
3. Adjust the EHT and the working distance (WD) according to the suggestions in the table in order to optimize the image.

5.4.1.2 Setting Up the SE2 Detector

Purpose The SE2 detector collects the SE2 signal, highlighting the topography of the specimen.

Fig. 5.2: Eledone tentacle

The following settings are recommended for the SE2 detector:

EHT	Typical WD	Collector Voltage
500 V - 5 kV	2 - 8 mm	■ Adjustable from -250 V to + 400 V
5 kV - 30 kV	min. 6 mm	■ Standard applications: +300 V At a high magnification, you can optimize the image by varying the collector voltage. ■ Pseudo-backscattered (BSE) image: -250 V to -50 V This produces an extreme topography but nearly no material contrasts.

Procedure

1. In the **Crossbeam SEM Control** panel, select the **Imaging** tab.
2. From the **Signal A** drop-down list, select **SE2**.
3. Adjust the EHT, working distance (WD) and collector voltage according to the suggestions in the table in order to optimize the image.

5.4.1.3 Setting Up the SESI Detector

Purpose The SESI detector is optionally available and replaces the chamber SE detector.

The SESI detector enables you to acquire both secondary electron images and FIB secondary ion images.

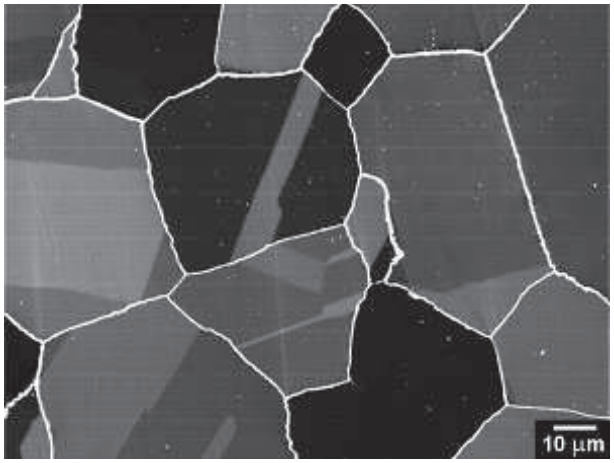


Fig. 5.3: Intergranular corrosion in an Ni based superalloy

The following settings are recommended for the SESI detector:

- Settings when working in SE mode, secondary electron imaging, **FIB mode = SEM**:

EHT	Typical WD	Collector Voltage
100 V - 30 kV	2 - 12 mm Typically 5 mm	■ Adjustable from 0 V to + 1500 V ■ Best detection: +300 V to + 400 V

- Settings when working in SE mode, secondary electron imaging, **FIB mode = FIB**:

EHT	Typical WD	Collector Voltage
2 kV - 30 kV	Coincidence point	■ Adjustable from 0 V to + 1500 V ■ Best detection: +300 V to + 400 V

- Settings when working in Ion mode, secondary ions imaging, **FIB mode = FIB**:

EHT	Typical WD	Collector Voltage
2 kV - 30 kV	Coincidence point	■ Adjustable from -4 kV to +0 kV ■ Best detection: Around -4 kV

Procedure

1. In the **FIB Toolbar**, from the **Imaging Mode** drop-down list, select an imaging mode, e.g. **FIB mode = SEM**.
2. In the **Crossbeam SEM Control** panel, select the **Imaging** tab.
3. From the **Signal A** drop-down list, select **SESI**.

   By default, secondary electrons are detected.
4. In order to detect secondary ions, in the **Imaging** tab, activate the **SESI Mode** checkbox.
5. Adjust the EHT, working distance (WD) and collector voltage according to the suggestions in the table in order to optimize the image.

5.4.1.4 Setting Up the CL Detector

Purpose

The CL detector is optionally available.

The CL detector collects visible or ultraviolet light and is especially useful for internal structural examinations of rocks, ceramics and semiconductors.

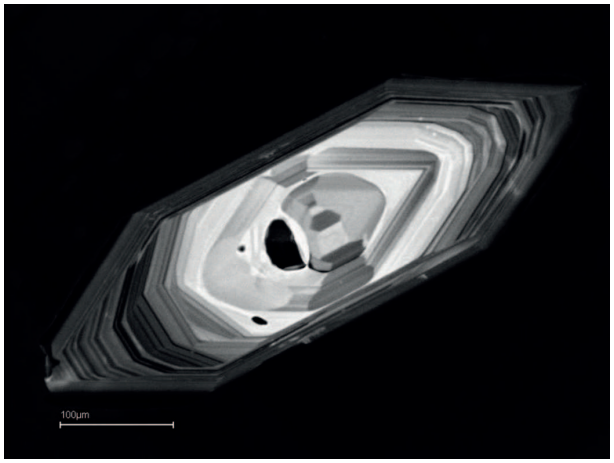


Fig. 5.4: Zircon grains

The following settings are recommended for the CL detector:

EHT	Typical WD	Collector Voltage
5 kV - 30 kV	6 - 10 mm (min. 4 mm)	■ Adjustable from -250 V to + 400 V ■ Standard applications: +300 V

Procedure

1. In the **Crossbeam SEM Control** panel, select the **Imaging** tab.
2. From the **Signal A** drop-down list, select **CL**.
3. Adjust the EHT, working distance (WD) and collector voltage according to the suggestions in the table in order to optimize the image.

5.4.1.5 Setting Up the EsB Detector

Purpose

The EsB detector can be used to collect the backscattered electrons (BSE) signal. The BSE signal contains information about the material contrast. In the final image, heavy elements are represented by brighter pixels and light elements are represented by darker pixels.

By adjusting the filtering grid, energy-selected BSE images can be obtained. If the filtering grid voltage is set to 0, SE and BSE mixed images can be acquired.

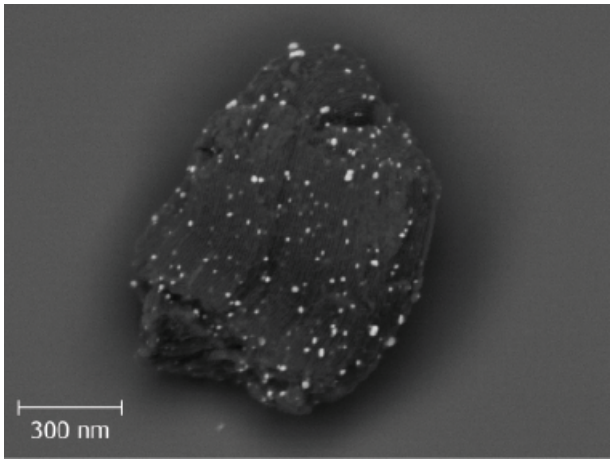


Fig. 5.5: Ag nanoparticles embedded in zeolite, imaged at 1.5 kV

EHT	Typical WD	Filtering Grid
500 V - 10 kV	0 - 5 mm	**ESB Grid > 400 V** to filter out the SE signal
20 V - 500 V	0 - 3 mm	**ESB Grid = 0 V** for use as an additional SE detector

Procedure

1. In the **Crossbeam SEM Control** panel, select the **Imaging** tab.
2. From the **Signal A** drop-down list, select **EsB**.
3. Adjust the EHT, working distance (WD) and filtering grid according to the suggestions in the table in order to optimize the image.

5.4.2 Using Advanced Detection Setups

5.4.2.1 Mixing Two Detector Signals (license: SIGMIX)

Purpose This function enables you to mix the signals of two detectors. Information registered by one detector (e.g. topographic contrast) can thus be overlaid with another detector signal to increase the information of the image.

Prerequisites

- Requires the license SIGMIX.

Procedure

1. In the **Crossbeam SEM Control** panel, select the **Imaging** tab.
2. From the **Signal A** drop-down list, select the first detector.
3. From the **Signal B** drop-down list, select the second detector.
4. Activate the **Mixing** checkbox.
5. Use the **Signal** slider to adjust the percentage of mixing between 0 and 1 (i.e. 0 to 100%).

   For example, **Signal = 0.6000** means that the image is composed of 60 % signal A and 40 % signal B.
6. To quit the mixing function, deactivate the **Mixing** checkbox.

5.4.2.2 Displaying Two Detector Signals on the Same Monitor

Purpose The windowing function enables you to display two different detector signals on the monitor without requiring an optional license.

Procedure

1. From the **Panel Configuration Bar**, select **Windowing**.

   The **Windowing** dialog is displayed.
2. Activate the **Windowing** checkbox.

   A reduced raster is displayed. There are two zones:

   1 **Zone = 0**: Inside the reduced raster

   2 **Zone = 1**: Outside the reduced raster

   Image modifications apply to the zone marked with the anchor symbol .

   
3. Assign a detector to each of the zones.
4. To displace the anchor symbol, hold the left mouse button and drag.
5. To invert the signal of the respective zone, set **Invert A = On**.
6. To quit the **Windowing** mode, deactivate the **Windowing** checkbox and close the **Windowing** dialog.

5.4.2.3 Displaying Two Image Areas (license: SPLIT)

Purpose This function subdivides the **Image Area** into two zones. Different detectors can be assigned to each zone. Each zone can be frozen individually.

Prerequisites

- Requires the license SPLIT.

Procedure

1. From the **Menu Bar**, select **Scanning > Split**.

   The **Image Area** is split into two zones.

   The anchor symbol marks the active zone to which detector selection, setting of brightness and contrast, freezing, or deleting apply.

2. To displace the anchor symbol, hold the left mouse button and drag.
3. To apply image modifications to both zones simultaneously, double-click the anchor symbol.

   The color of the anchor symbol changes.

4. To quit the Split function, from the **Menu Bar**, select **Scanning > Normal**.

5.4.2.4 Displaying Detector Signals on Two Different Monitors (license: DUAL-CHANNEL)

Purpose This function enables you to display the live image on a second monitor and to select a different signal source for each monitor. Panels can be moved to the second monitor.

Prerequisites

- Requires the license DUAL-CHANNEL.

Procedure

1. From the **Menu Bar**, select **Image > Dual Channel**.

   The anchor symbol marks the active monitor to which detector selection, setting of brightness and contrast, etc. apply.

2. To displace the anchor symbol, hold the left mouse button on the anchor while dragging it to the other monitor.

5.4.2.5 Producing Composite Images from Two Detectors (license: COLOUR MODE)

Purpose **Colour Mode** offers the possibility to convert and combine signals from two different detectors and display a live false color image without losing important information.

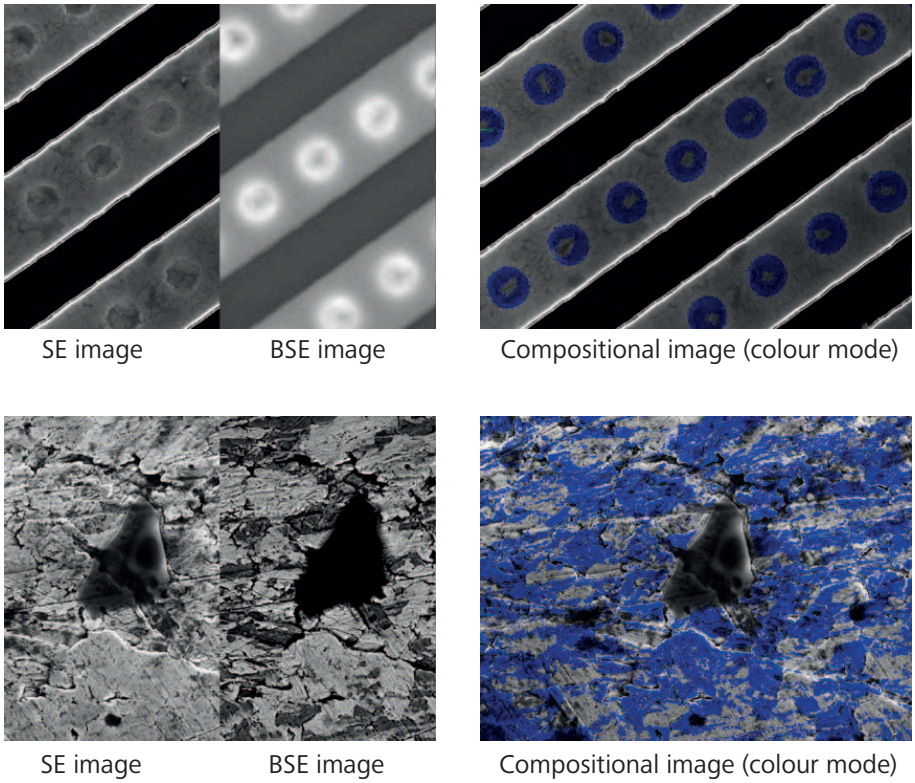


Fig. 5.6: Signals from two detectors in Split mode (left) and Color mode (right)

Prerequisites

- Requires the license COLOUR MODE.

Procedure

1. From the **Panel Configuration Bar**, select **Colour Mode**.
   The **Colour Mode** window is displayed.
2. From the **Signal A** and **Signal B** drop-down lists, select the desired detectors.
3. From the **Colour Mode** drop-down list, select **Colour Mode = 2 LUT**.
   This activates the **RGB** checkboxes in column 1 and 2.
4. Use the **RGB** checkboxes to set the colors.
5. To adjust brightness and contrast, use the respective sliders.

5.4.2.6 Simultaneously Displaying Images at Different Magnifications (license: DUALMAG)

Purpose This function enables you to zoom into an image without freezing the image at the original magnification. **Dual Mag** is recommended to accentuate a detail in an image and to simultaneously obtain a view of the specimen at a low magnification.

Prerequisites

- Requires the license DUALMAG.

Procedure

1. From the **Menu Bar**, select **Scanning > Dual Mag**.

   The **Image Area** is split up into two zones. The left zone is displayed at the current magnification.

   At the same time, a frame is displayed which defines the range to be displayed in the right zone.

2. To modify size and position of the frame, click it with the left mouse button.

   1 To change the size of the frame, place the mouse cursor on a mark.

   The frame size determines the magnification ratio between the left and the right zone.

   2 To displace the frame, place the mouse cursor between two marks.

   The anchor symbol marks the active zone to which detector selection, setting of brightness and contrast, etc. apply.

3. To select the active zone, displace the anchor symbol via drag and drop.

4. To apply image modifications to both zones simultaneously, double-click the anchor symbol.

   The color of the anchor symbol changes.

5.4.2.7 Using a Second CCD Camera

Purpose

INFO

If a second CCD camera is attached, it is usually installed as 'USB TV 2'.

INFO

You can customize the **Toolbar** so that the pre-defined TOGGLE TV macro is assigned to the **ChamberScope** icon. This makes the second CCD camera available by middle-clicking on the **ChamberScope** icon.

Procedure

- From the **Menu Bar**, select **Detection > TV Inputs > USB TV2**.

  Alternatively, in the **Crossbeam SEM Control** panel, select the **Imaging** tab. In the **Detector / Active Channel** section, from the **Signal A** drop-down list, select **Signal A = USB TV2**.

5.4.3 Setting Scan Parameters

5.4.3.1 Selecting a Scan Speed

Purpose A focused beam of electrons is scanned across the specimen.

Purpose The speed of the scan can be modified which has an influence on the speed of image generation on the one hand and the extent of image noise on the other hand.

The higher the scan speed number, the slower the scan of the specimen by the electron beam and the lower the image noise.

Prerequisites

- A selection of fifteen scan speeds requires the license SCANEXP. Without this license, only three scan speeds are available.

Procedure

1. From the **Menu Bar**, select **Scanning > Speeds**.

   The **Select Scan Speed** window is displayed.

2. Select a scan speed and click **OK**.

Alternatively, you can select the scan speed in one of the following ways:

- In the **Toolbar**, from the **Faster/Slower** drop-down list, select a scan speed.

- In the **Crossbeam SEM Control panel**, select the **Imaging** tab and use the **Scan Speed** drop-down list.

5.4.3.2 Scanning a Small Frame (Reduced Raster)

Purpose The reduced raster function enables you to scan only a small frame. This is recommended for alignment procedures such as focusing, aligning the stigmator or using the focus wobble.

> **i Note**
>
> **The reduced raster function is not synchronized with the EDX detector**
>
> When using the reduced raster function during EDX detection, there are restrictions to signal interpretation, because the scan is not synchronized with the EDX detector. This can lead to uneven signal distribution, especially at faster scan speeds.
>
> - We recommend, not to use the reduced raster function during EDX detection.

Prerequisites

- Adjusting the size and position of the reduced raster requires the license REDUCED.

Procedure

1. From the **Menu Bar**, select **Scanning > Reduced**.

   Alternatively, in the **Toolbar**, click the **Reduced Raster** icon.

   A scan frame is displayed in the **Image Area**. This frame defines the specimen area to be scanned by the electron beam.

   The image outside the scan frame is frozen.

2. Focus the image in the reduced raster.
3. If the license REDUCED is installed, you can adjust the size and position of the reduced raster.

   1 To change the position of the scan frame, click on the green border line and use the mouse to drag and drop the frame.

   2 To change the size of the scan frame, click on the small blue squares on the green border line and drag them to the desired size.

   3 Focus the image in the reduced raster.

5.4.3.3 Scanning a Line

Purpose This function is used to scan along a defined line while the image is frozen. It is recommended for measuring and adjusting signals, e.g. for optimizing brightness and contrast.

Safety Information

NOTICE

Risk of property damage: Damage to the specimen during line scan

If the electron beam scans along the same line position for a longer period of time, this can result in a scan mark on the specimen.

- When using the line scan function for image optimization, place the line scan on a specimen area close to but outside the actual area of interest.

Procedure

1. From the **Menu Bar**, select **Scanning > Line Scan**.

   The submenu **Line Scan** is enabled.

   A horizontal line is displayed together with a diagram which displays the course of the signal along this line as gray values between 0 and 255.

2. To move the horizontal line to the desired specimen area, click and drag it.
3. To change color and background of the diagram, position the mouse cursor in the diagram.
4. Click the right mouse button.

   A pop-up menu is displayed, where you can select the color of the graph and a gray background.

5.4.3.4 Scanning a Spot (license: SPOT)

Purpose

In spot mode, the electron beam is positioned on a particular spot on the specimen surface. This mode is useful in combination with an EDX/WDX system or for the measurement of the probe current.

Safety Information

NOTICE

Risk of property damage: Damage to the specimen during spot mode

If the electron beam rests at the same spot for a longer period of time, this can result in a scan mark on the specimen.

- Avoid applying spot mode to specimen areas from which you want to acquire images later on.

Prerequisites

- The license SPOT is installed.

Procedure

1. From the **Menu Bar**, select **Scanning > Spot**.

   The submenu **Spot** is activated.

   A cross is displayed on the monitor and indicates the beam position.

   The image is frozen.

2. Hold the left mouse button to drag the cross on the screen.
3. To disable the spot mode, from the **Menu Bar**, select **Scanning > Spot**.

   The submenu **Spot** is disabled and the scanning is resumed.

5.4.3.5 Rotating the Image (license: SCANROT)

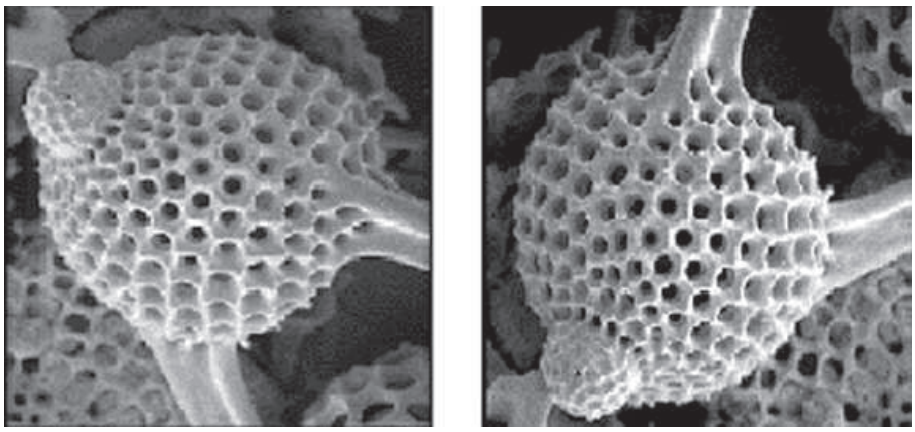
Purpose This function enables you to rotate the image electronically by rotating the scan direction.

Prerequisites

- Requires the license SCANROT.

Procedure

1. From the **Menu Bar**, select **Scanning > Rotate / Tilt**.
   The **Rotate / Tilt** window is displayed.
2. Activate the **Scan Rot** checkbox.
3. To set the desired tilt angle, double-click the **Scan Rotation** readout.
   The **Scan Rotation** window is displayed.
4. Enter the desired value and click **OK**.
   The image is rotated.



5.4.3.6 Configuring and Displaying the Scan Marker

Purpose The scan marker is a small bar on the left side of the **Image Area**, which indicates the scanned line on the monitor. This can be helpful when using slow scan speeds because the scan marker helps to see which line is currently being scanned by the electron beam. The scan marker is not recorded on the image.

INFO

The scan marker can only be displayed when you use slow scan speeds (5 - 15). At quicker scan speeds (4 and faster), it is deactivated automatically.

Procedure

1. From the **Menu Bar**, select **Tools > User Preferences**.
   The **User Preferences** dialog is displayed.
2. In the tree structure, select **SEM Conditions**.
   The corresponding parameters and entries are listed in the large field in the middle of the dialog.

INFO **To modify an entry next to a parameter, double-click it. The lower readout of the** User Preferences **dialog displays helpful information about the parameter.**

3 Set **Scan Marker Enable** to **Yes**.

4 Enter the **Scan Marker Height**.

5 Enter the **Scan Marker Width**.

6 Select the **Scan Marker Colour**.

7 To confirm the settings, click **OK**.

5.4.4 Setting the Working Distance

Purpose The working distance (WD) is the distance between the specimen surface and the end of the objective lens. The WD determines the possible resolution, the signal-to-noise ratio, the depth of focus and the lowest possible magnification (low power magnification).

Procedure

1 In the **Toolbar**, click the **Magnification+Focus** icon.

2 Hold the mouse wheel and drag the mouse in order to focus.

The current WD is indicated in the **Status Bar**.

5.4.5 Setting the Magnification

5.4.5.1 Selecting a Magnification

Procedure

1 In the **Toolbar**, click the **Magnification+Focus** icon.

2 To adjust the desired magnification, hold the left mouse button and drag the mouse.

The current magnification is displayed in the **Status Bar**.

5.4.5.2 Setting Pre-defined Magnifications

Purpose Up to ten pre-defined magnifications can be set and quickly accessed during the imaging procedure.

Prerequisites

- The magnifications have to be pre-defined in the **Magnification Table** under **Menu Bar > Tools > User Preferences**.

Procedure

1 To call the pre-set magnifications, press **<F4>**.

2 To set the next magnification value, press **<F4>**.

3 To return to the previous magnification value, press **<Ctrl + F4>**.

4 To finish the use of the Magnification Table, press **<Shift + F4>**.

The magnification is reset to the level that was active before the pre-defined magnifications were used for the first time.

5.4.6 Adjusting Brightness and Contrast

5.4.6.1 Manually Adjusting Brightness and Contrast

Purpose Changing the signal to more brightness shifts all gray levels in the image to lighter levels.

Changing the signal to more contrast expands the range of gray levels in the image.

Procedure

1. In the **Toolbar**, click the **Brightness + Contrast/Toggle ABCC** icon.

   The mouse assignment is indicated in the **Status Bar**.
2. To adjust the brightness, hold the left mouse button and drag.
3. To adjust the contrast, hold the middle mouse button and drag.

Alternatively, in the **Crossbeam SEM Control** panel, select the **Imaging** tab and use the respective sliders to adjust brightness and contrast.

5.4.6.2 Automatically Adjusting Brightness and Contrast

Procedure

1. In the **Crossbeam SEM Control** panel, select the **Imaging** tab.
2. To use Auto Brightness, activate the **Auto** checkbox next to the **Brightness** readout.
3. To use Auto Contrast, activate the **Auto** checkbox next to the **Contrast** readout.
4. Wait a few seconds until brightness and contrast are adjusted to optimal values automatically.

5.4.7 Aligning the Aperture

Purpose The alignment of the aperture in the beam path is crucial for the resolution and sharpness of the image.

The aperture alignment should be adjusted or checked anytime the aperture is changed and after major modifications of the EHT setting.

Whenever the image is shifting while you are focusing, the aperture should be re-aligned.

Procedure

1. In the **Crossbeam SEM Control** panel, select the **Control** tab.
2. In the **Beam Alignment** section, click **Focus Wobble**.

   The **Focus Wobble** window is displayed.

   INFO **Focus wobble is a function that sweeps the acceleration voltage. If the aperture is misaligned, a lateral and vertical shift can be observed.**

3 To adjust the wobble intensity, use the **Wobble Amplitude** scroll bar.

4 To accelerate the wobble speed, activate the **Wobble Fast** checkbox.

5 Align the aperture.

1 In the **Control tab** of the **Crossbeam SEM Control** panel, click **Aperture**.

2 In the navigation box, use the scroll bars or the red marker to adjust the aperture alignment until there is no movement of the detail in X- and Y-direction.

INFO The specimen detail should just be pulsating without shifting.

6 In the **Focus Wobble** window, click **OFF** to disable focus wobble.

The **Focus Wobble** window closes.

7 Refocus the image.

5.4.8 Correcting Astigmatism

5.4.8.1 Setting the Stigmator Manually

Purpose Astigmatism is an aberration of lenses that can be corrected by means of the so-called stigmator.

Procedure 1 In the **Crossbeam SEM Control** panel, select the **Control** tab.

2 In the **Beam Alignment** section, click **Stigmator**.

3 In the navigation box, use the scroll bar or the red marker to adjust the stigmation.

INFO The specimen detail should just be pulsating without shifting.

Alternatively, in the **Toolbar**, click the **Stigmation/Alignment** icon.

To adjust stigmation, hold the left mouse button and drag.

5.4.8.2 Using the Auto Stigmation Function

Procedure ◆ In the **Toolbar**, middle-click the **Magnification+Focus/Auto Focus+Stig** icon.

A fine auto focus correction is performed followed by an automatic astigmatism algorithm.

5.4.9 Checking SEM Parameters

5.4.9.1 Displaying SEM Parameters

Purpose The **SmartSEM Status** window is helpful to show, edit and set frequently used parameters. It lists the operation parameters selected by the individual user.

Procedure

1 Open the **SmartSEM Status** window .

1 From the **Menu Bar**, select **View > SEM Status**.

The **SmartSEM Status** window is displayed.

2 Select the parameters to be displayed.

1 Select the **Select** tab.

2 Click the parameter you wish to be displayed.

The parameter is displayed in the **Display** tab.

3 To change the setting of the displayed parameter:

1 Select the **Display** tab.

2 Double-click the parameter name.

4 To load a saved combination of parameters:

1 Select the **File** tab.

2 Click **Load**.

3 Select the file.

5 To save a selected combination of parameters:

1 Select the **File** tab.

2 Click **Save As**.

3 Enter a file name and confirm.

6 To delete the complete list of parameters:

1 Select the **File** tab.

2 Click **Clear Display**.

5.4.9.2 Recording SEM Parameters

Purpose The **Gun Monitor** enables you to record and display important parameters of the microscope at defined intervals during operation of the SmartSEM user interface.

Procedure

1. From the **Windows Start Menu**, select **Programs > SmartSEM Service > Gun Monitor**.

   The **Gun Monitor** opens.

2. To start the record, in the **Toolbar**, click the **Start Monitoring** icon.

   Ten different channels are available, six of them are predefined to record extractor voltage, extractor current, filament current heating, gun vacuum, liner tube voltage, and acceleration voltage.

3. In the **Toolbar**, click the **Select parameters** icon.

   The **Parameter Setup** window is displayed.

4. To add channels in addition to the six default channels, select them from the drop-down list.

5. To select/deselect the channels to be displayed, activate/deactivate the respective checkboxes.

6. To change the color, click in the respective color square.

7. To enter the minimum and maximum values to be displayed in the diagram, click the **Min Value** or **Max Value** input field and change the value.

8. To switch between linear and logarithmic scale, activate/deactivate the respective checkbox next to the **Min. Value/Max. Value** input field.

9. To confirm the new settings, click **OK**.

   By clicking **Defaults** you can cancel all settings and reset them to the basic settings.

5.5 Navigating the Specimen

5.5.1 Moving the Specimen with the Soft Joystick

Purpose Alternatively to the dual joystick, you can navigate the specimen using the **Soft Joystick** panel in the software. The **Soft Joystick** panel is helpful when you wish to move a single axis without the risk of moving another axis as well.

To prevent damage, a touch alarm is integrated in the FESEM: If the specimen or the specimen holder touch the chamber walls, a detector or the objective lens, the stage is stopped immediately. An audible warning sounds and an on-screen message is displayed.

NOTICE

Risk of property damage: Driving the stage

While the stage is driven manually, there is a risk of damaging the objective lens and/or the specimen.

- Ensure not to hit the objective lens while driving the stage.
- Monitor the moving stage in TV mode.
- To stop the moving stage immediately, press **<F12>** or press the **Break** push button of the control panel.

Procedure

1. From the **Panel Configuration Bar**, select **Soft Joystick**.

   The **Soft Joystick** panel is displayed.

2. To move the specimen stage, use the respective scroll bars or the red marker of the navigation box.
3. When tilting a specimen, ensure that the specimen to be analyzed is always the one next to the objective lens.

5.5.2 Displaying Crosshairs or Graticules

5.5.2.1 Displaying Crosshairs

Purpose You can display crosshairs in the **Image Area** to help you assess the relative position of features in the image and to center features.

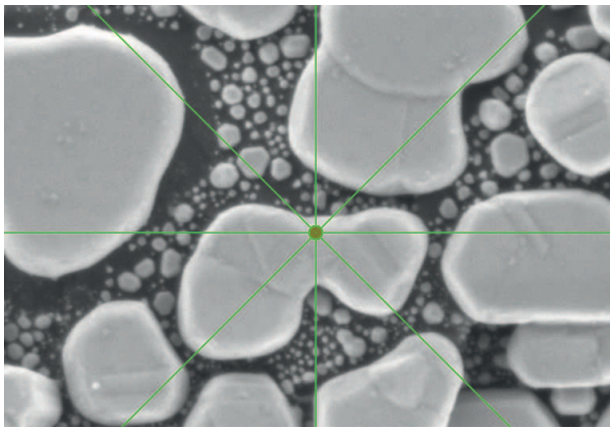


Fig. 5.7: Crosshairs

Procedure

1. From the **Menu Bar**, select **View > Crosshairs**.
   Crosshairs are displayed in the **Image Area**.
   In the submenu, **Crosshairs** is activated.
2. To deactivate the crosshairs, select **View > Crosshairs** again.

5.5.2.2 Displaying Movable Crosshairs

Purpose Crosshairs help you assess the relative position of features in the **Image Area**. In contrast to the regular crosshairs, the moveable crosshairs can be moved across the **Image Area**.

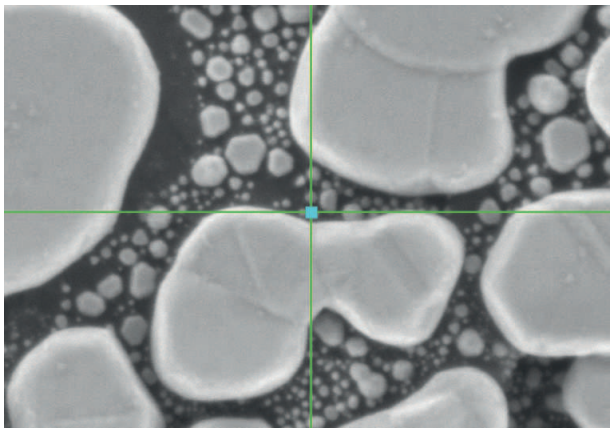


Fig. 5.8: Movable crosshairs

Procedure

1. From the **Menu Bar**, select **View > Movable Crosshairs**.
   Crosshairs are displayed in the **Image Area**.

In the submenu, **Movable Crosshairs** is activated.

2 To change the position of the movable crosshairs, drag the handle at the intersection of the crosshairs.

3 To deactivate the movable crosshairs, select **View > Movable Crosshairs** again.

5.5.2.3 Displaying Graticules (license: GRATICULE)

Purpose You can display graticules in the Image Area to help you assess the relative scale and number of features in the image. The graticule spacing can be changed as desired.

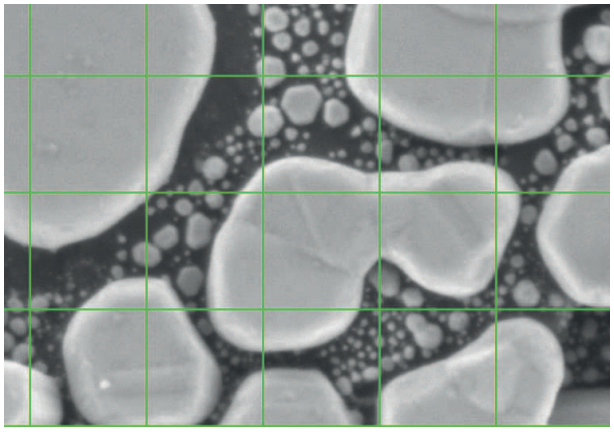


Fig. 5.9: Graticules

Procedure

1 From the **Menu Bar**, select **View > Graticules**.

Graticules are displayed in the **Image Area**.

In the submenu, **Graticules** is activated.

2 To change the spacing between the graticule lines, select **View > Graticules Spacing**.

3 Enter a value and click **OK**.

4 In order to deactivate the graticule, select **View > Graticules** again.

5.5.3 Monitoring the Stage via the Stage Navigation Panel

Purpose The Stage Navigation panel enables you to control and monitor the movements of the stage. For this purpose, it provides a view of the chamber including the SEM and FIB columns as well as the stage with specimen holder and specimen.

Procedure

1 From the **Panel Configuration Bar**, select **Stage Navigation**.

The **Stage Navigation** panel is displayed. It contains two schematics of the specimen chamber.

The upper schematic shows a lateral view of the specimen stage.

The lower schematic shows a plan view of the stage with the different stubs.

2 From the **Sample Holder** drop-down list, select your type of specimen holder.

3 Change the view as required.

1 To zoom in and out, use the **+/-** slider at the bottom of the **Stage Navigation** window.

2 To change the detail, use the scroll bars next to the plan view schematics.

3 To toggle the size of the window, click **<<**.

5.5.4 Adding a Specimen Holder to the Stage Navigation

Purpose The **Sample Holder Gallery** is a catalog of specimen holders. It enables you to select and customize the specimen holder used so that it can be displayed in the **Stage Navigation** panel.

Procedure

1 From the **Panel Configuration Bar**, select **Stage Navigation**.

The **Stage Navigation** panel is displayed.

2 Click **Settings**.

The **Stage Nav Settings** dialog is displayed.

3 Click **Show Gallery**.

The **Sample Holder Gallery** dialog is displayed.

On the left hand side, a list of icons represents the specimen holders.

4 Select the installed specimen holder.

1 If you use a standard specimen holder, select the specimen holder from the list.

The **Is available** checkbox is activated to indicate that the selected specimen holder can be installed on the system.

2 If you use a custom specimen holder, select one of the custom specimen holders and adjust the dimensions.

Activate the **Is available** checkbox.

5.5.5 Working with User-Defined Stage Positions (license: STAGECO)

Purpose Enables you to save a list of stage positions together with magnification and working distance. Thus, you can recall these positions easily.

Prerequisites

- Requires the license STAGECO.

Overview The procedure contains the following steps:

- *Saving and Editing Stage Coordinates* [▶ 77]
- *Recalling Stage Coordinates* [▶ 77]

5.5.5.1 Saving and Editing Stage Positions (license: STAGECO)

Procedure

1. Drive the stage to the position to be stored.
2. From the **Menu Bar**, select **Stage > Store / Recall**.
   The **Stage Points List** dialog is displayed.
3. From the **Stage List** drop-down list, select a coordinate system.
   1. If you wish to use the stage coordinate system, select **Stage**.
   2. If you wish to use a previously defined user-specific coordinate system, select the respective **Reg** number.
4. To enter the current stage position, click **Add**.
   The **Label Request** window is displayed.
5. Enter a name and click **OK**.
6. The stage position is displayed in the **Stage List** readout.
7. To edit a stage position, mark the position and click **Edit**.
8. To delete a stage position, mark the position and click **Del**.

5.5.5.2 Recalling Stage Positions (license: STAGECO)

Procedure

1. From the **Menu Bar**, select **Stage > Store / Recall**.
   The **Stage Points List** dialog is displayed.
2. To move the stage to a stored position, select the position from the **Stage List** readout.
3. Click **On Goto**.
4. To cancel the last stage move, click **Undo Stage Goto**.

5.5.6 Improving Stage Repeatability

Purpose The **Backlash** function compensates for mechanical play in the stage motors. It ensures that any absolute stage position is always approached from the same direction, improving the repeatability of motorized stage movement.

Procedure

1. In the **Crossbeam SEM Control** panel, select the **Stage** tab.
2. Click **Further Options**.
   A submenu is displayed.
3. Select **Backlash > On**.

5.5.7 Moving the Specimen with Beam Offset at High Magnifications

Purpose The **Beam Offset** function is helpful when moving the **Image Area** at magnifications above 100,000 x. At this magnification range, it is generally difficult to exactly position an image feature by driving the stage. Therefore, the image of

the specimen can be moved by shifting the electron beam instead of displacing the specimen itself. The electron beam can be shifted by +/- 100 µm in the X and Y directions.

Procedure

1. In the **Crossbeam SEM Control** panel, select the **Control** tab.
2. Click **Beamshift**.
3. To shift the beam, use the scroll bars or the red marker of the navigation box.

5.5.8 Compensating for Image Drift by Shifting the Beam (license: DRIFT CORR)

Purpose

The drift correction is a program to compensate for the drift of the specimen by using a reference image and by controlling the beam shift.

The drift correction has two main applications:

- Improvement of the drive precision of the stage

  When viewing a specific image section and driving the stage to another point, a drift is often observed when moving back to the previous point.

- Long-term analysis

  If an image section is scanned for a longer time, mechanical, thermal and electrical effects always cause a drift of the respective image section.

INFO

It is essential to define a striking detail as the reference image. This detail is analyzed using image analytical algorithms and serves as a basis for determining the drift correction.

Prerequisites

- Requires the license DRIFT CORR.
- Requires the Matrox Imaging Library (MIL) dongle.

Procedure

1. Open **Drift Prepare**.
   1. From the Windows start menu, select **Programs > SmartSEM > SEM Drift Correction**.

      The **SEM Drift Correction Prepare** window is displayed.
   2. Click **Display Tool**.

      A movable frame is displayed. The inside of this frame defines the reference image for the drift correction.
2. Define a detail as reference image.
   1. Change the position and size of the frame to define a striking detail as reference image.

      The reference image should have a good signal-to-noise ratio.

      Do not use **Frame Avg**, **Line Avg** as noise reduction methods.

2 In order to cancel any beam shift settings, click **Zero Beam Shift**.

INFO **This makes the maximum possible beam shift range available for the drift correction.**

3 If you wish to hide the frame, click **Hide Tool**.

3 Set the parameters.

Defines the precision of the drift correction. Indicates the largest allowed pixel distance between the current image and the corrected image. If this pixel distance is exceeded, the drift correction is not accepted.

Defines how often the algorithm tries to compensate a possible image drift by using the beam shift.

For most applications, this parameter should be set between 5 and 15.

Defines the required precision of the correlation between reference image and found image section.

For most applications this parameter should be set to 40% to 60%.

4 Click **Create Ref Image**.

A reference is acquired.

In the **SEM drift status** readout, **'Ready'** is displayed.

The button **Do SEM Drift Corrn** becomes available.

5 Click **Do SEM Drift Corrn**.

If the drift correction was successful, **'Success'** is displayed in the **SEM drift status** readout.

5.5.9 Eucentrically Driving a Non-Eucentric Stage (license: COMPU)

Purpose Compucentric software functions enable you to perform rotation-eucentric and tilt-eucentric control of a non-eucentric stage.

Prerequisites
- Requires the license COMPU.

Overview The procedure contains the following steps:

- *Calibrating the Stage Center* [▶ 80]
- *Calibrating the Compucentric Height* [▶ 81]
- *Activating the Compucentric Software Functions* [▶ 82]
- *Using Stage Horizontal Alignment* [▶ 83]

5.5.9.1 Calibrating the Stage Center (license: COMPU)

Purpose It is a prerequisite for all compucentric functions that the center of the stage rotation is accurately known. To achieve the ultimate accuracy, it may be necessary to recalibrate the rotation center each time the stage is initialized.

INFO

The calibration of the rotation center is independent of the used specimen holder and the used specimen. Therefore, this calibration can be used universally.

INFO

It is recommended that you use a single stub holder and a calibration grid or a TEM grid as specimen. The specimen must be mounted centrally on the stub.

Prerequisites
- The specimen has been loaded into the chamber.
- Requires the license COMPU.

Procedure

1. From the **Menu Bar**, select **Stage > Stage Initialise**.
   The **Stage Initialise** window is displayed.
2. Click **Yes**.
   The stage initialization progress takes a few minutes.
3. From the **Panel Configuration Bar**, select **Calibrate Stage Centre**.
   The **Calibrate Stage Centre** dialog is displayed.
   The last coordinates of the center are displayed.
4. Click **Next**.
   A magnification of 30 x is automatically set. Crosshairs are displayed.
5. Find a striking feature on the specimen surface that is positioned outside the center.

6 To move the striking feature to the center, select **Stage > Centre Point** and click the striking feature.

7 Click **Next**.

The stage is driven back to its initial position.

8 Click **Next**.

The stage rotates by 180°.

During stage rotation observe the striking feature on the specimen in order to be able to relocate it after rotation.

9 To move the striking feature to the center again, select **Stage > Centre Point** and click the striking feature.

10 Click **Next**.

The software has now calculated the new rotation center and displays the values for X and Y.

11 Click **Next**.

The stage is driven back to its initial position.

12 Set the next higher magnification (200 x).

13 Repeat the calibration procedure (steps 5 to 11).

14 Repeat the procedure for the magnifications 500 x, 1500 x, and 2000 x.

15 After calibrating the position at a magnification of 2000 x, confirm via **OK**.

5.5.9.2 Calibrating the Compucentric Height (license: COMPU)

Purpose If you want to tilt the specimen eucentrically or if you want to rotate a tilted specimen eucentrically, the software has to accurately know the distance between the rotation center of the tilt axis and the specimen surface.

This is managed by the additional calibration of the compucentric height.

INFO

As the calibrated distance depends on specimen and specimen holder, this routine must be performed separately for each specimen and specimen holder.

Prerequisites

- The specimen has been loaded into the chamber.
- Requires the license COMPU.

Procedure

1 From the **Panel Configuration Bar**, select **Compucentric Height**.

The **Compucentric Height** panel is displayed.

2 Follow the steps on the panel.

1 Center a feature and click **Read**.

2 Tilt the stage.

3 Center the feature again and click **Calculate**.

3 To confirm, click **OK**.

5.5.9.3 Activating the Compucentric Software Functions (license: COMPU)

Purpose

INFO

The more precisely and thoroughly the calibration is done, the more precisely the stage can be driven by the compucentric software.

INFO

If only the stage center has been calibrated, only rotation-eucentric control in the horizontal line (Tilt = 0) is possible.

NOTICE

Risk of property damage

Risk of malfunction of the stage when using the joystick.

- After activating the compucentric software functions, only use the **Delta** buttons in the **Stage** tab to drive the stage.

Prerequisites

- The stage center is calibrated.
- The compucentric height is calibrated.

Procedure

1 In the **Crossbeam SEM Control** panel, select the **Stage** tab.

2 From the **Compuc. Mode** drop-down list, select the desired mode.

For more information on compucentric modes, refer to *Stage* | *Stage Navigation* | *Compucentric Functions* [▶ 227].

5.5.9.4 Aligning an Image Feature Horizontally

Purpose This function enables you to automatically move an image feature in the horizontal line.

A wizard is used to drive the stage such that a linear feature on the specimen, identified by two points, is horizontal with the second of the two points visible on the screen.

Prerequisites

- The stage center is calibrated.

Procedure

1. From the **Panel Configuration Bar**, select **Stage Horizontal Alignment**.
   The **Stage Horizontal Alignment** wizard is displayed.
   Crosshairs are displayed.
2. To center the first reference point, select **Stage > Centre Point** or alternatively use the joystick.
3. Click **Next**.
4. Center the second reference point.
5. Click **Next**.
6. Click **Finish**.

5.5.10 Centering a Spot or an Area

5.5.10.1 Using the Centre Point Function (license: CENTRE)

Purpose Enables you to mark a spot in the image which is then automatically moved to the center of the **Image Area**.

INFO

If you wish to center several points in succession, activate **Menu Bar > Stage > Continuous Centre Point** before using the **Centre Point** function.

The **Centre Point** mode remains active until you right-click in the **Image Area**.

Prerequisites

- Requires the license CENTRE.

Procedure

1. From the **Menu Bar**, select **Stage > Centre Point**.
   The mouse cursor is displayed as a cross.
2. Place the cross on the relevant feature and click on it.
   The feature is moved to the center of the **Image Area**.

5.5.10.2 Using the Centre Feature Function (license: CENTRE)

Purpose Enables you to select a feature or an area in the image which is automatically centered and magnified so that the selected feature fills the complete **Image Area**.

Prerequisites

- Requires the license CENTRE.

Procedure

1. From the **Menu Bar**, select **Stage > Centre Feature**.
   The mouse cursor is displayed as a cross.
2. Click and drag the mouse to create a frame, which comprises the area of interest.
   The selected area is moved to the center of the **Image Area** and magnified.

5.5.11 Using the Stage Map Function (license: CENTRE)

Purpose Enables you to use a frozen image in the left zone as an overview for the selection of interesting features on the specimen surface.

Prerequisites

- Requires the license CENTRE.

Procedure

1. Select a low magnification.
2. Move the stage to the relevant specimen area.
   This setting will be used as stage map.
3. To change to spot mode, from the **Menu Bar**, select **Scanning > Split**.
   The **Image Area** is split into two zones, with zone 0 on the left and zone 1 on the right.
4. From the **Menu Bar**, select **Stage > Scanning**.
   The left zone (zone 0) is frozen and serves as an overview.
5. To select a feature of interest in the left zone, place the cross and click.
   In the right zone (zone 1), the selected feature is displayed.
6. Modify the image, e.g. magnify as required.

5.5.12 Scanning Defined Image Fields (license: STAGESCAN)

Purpose Enables you to scan an exactly defined series of regularly distributed image fields and to image large areas at higher magnifications, when available frame size is not sufficient. This is useful when searching for particles or other objects in a section of the specimen, as it is ensured that no part of the relevant area is omitted. Four scan patterns and several methods are available to determine the scan range.

Prerequisites

- Requires the license STAGESCAN.

Procedure

1. From the **Menu Bar**, select **Stage > Stage Scan**.
   The **Stage Scanning** wizard is displayed.
2. To start defining the stage scan fields, click **Setup Wizard**.
3. Follow the instructions given in the wizard.

5.5.13 Toggling Between Survey View and Detail View (license: SURVEY)

Purpose Enables you to save two different settings for magnification and working distance and to switch between these settings.

The following settings are available:

- **Survey Mode**
- **Resolution Imaging**
- **Exit Survey Mode**

Prerequisites

- Requires the license SURVEY.
- The stage is initialized.

Procedure

1 Set a wide field of view.

1 Set a low magnification.

2 Set a large working distance.

2 From the **Menu Bar**, select **Stage > Survey > Settings**.

The **Stage Survey** dialog is displayed.

3 Activate the **Survey Mode** checkbox.

4 In the **Stage Survey** dialog, adjust the **Survey Mode** settings.

1 To automatically set the lowest possible magnification, activate the **Lowest Mag** radio button.

2 To use the current magnification and WD settings, click the **Get Current** buttons.

You can also manually enter the desired values.

3 Activate the **Remember Changes** checkbox.

When switching to Survey Mode, especially for the first time, it may be necessary to adjust focus.

When **Remember Changes** is activated, the new working distance as a result of focusing will replace the target WD in the settings.

4 To start an automatic focus adjustment after start of the respective operation mode, activate the **Auto Focus** checkbox.

5 To execute a macro when switching to **Survey Mode**, activate the **Macro** checkbox and select a macro from the drop-down list.

5 Change the field of view.

1 Set a higher magnification.

2 Set a smaller working distance.

6 Adjust the **Resolution Imaging** settings.

1 In the **Mag** input field, enter the desired value or click **Get Current**.

2 In the **WD** input field, enter the desired value or click **Get Current**.

3 If you wish to start an automatic focus adjustment after the respective operation mode, activate the **Auto Focus** checkbox.

4 To execute a macro when switching to **Resolution Imaging**, activate the **Macro** checkbox and select a macro from the drop-down list.

7 Optional: Execute a macro when quitting **Survey Mode**.

1 In the **Exit Survey Mode** section, activate the **Macro** checkbox.

2 Select a macro from the drop-down list.

5.5.14 Defining a User-Specific Coordinate System

Purpose Enables you to define a user-specific 2D coordinate system based on three reference points. Within this coordinate system, the stage can be moved to user-defined coordinates on the specimen while the stage coordinates are calculated automatically.

It is possible to create up to nine different coordinate systems.

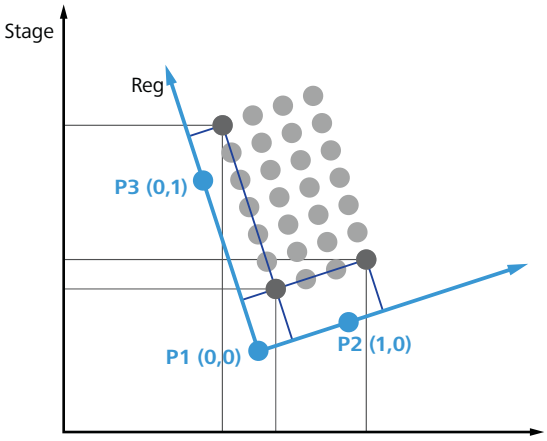


Fig. 5.10: Stage coordinate system and coordinate system defined via stage registration

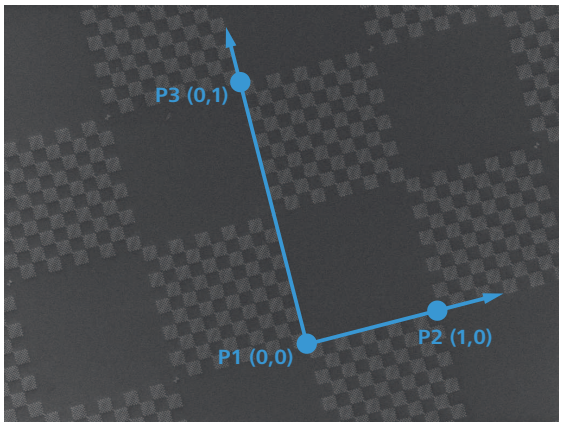


Fig. 5.11: Application example

Prerequisites

- Requires the license STAGEREG.
- The stage is initialized.

Procedure

1. Load a suitable specimen, e.g. a test grid (chessy).
2. From the **Panel Configuration Bar**, select **Stage Registration**.
   The **Stage Registration** dialog is displayed.
3. From the **Stage List** drop-down list, select the **Reg** number to which you wish to assign the new coordinate system.
4. In the **Registration Details** section, enter a name in the **Name** input field.
5. Click **Setup Registration**.
   The **Stage Registration** wizard is displayed.
6. To display the crosshairs, activate the **Crosshairs** checkbox.
7. Select and center a registration point on the specimen.
8. Click **Next**.
9. Enter the coordinates to be assigned to the registration point.
10. Repeat steps 7 to 9 for the second registration point.
11. Repeat steps 7 to 9 for the third registration point.
12. Click **Finish**.

5.6 Improving the Image

5.6.1 Improving Image Quality via Noise Reduction

Purpose

The signal entering the image processor is made up of two components: image and noise. Image is the signal of interest and correlates with the object being scanned, noise is random in nature. Therefore, by averaging multiple scans of the same area, the signal can be reinforced, while the noise can be reduced. This is the basis on which the noise reduction works.

The signal-to-noise ratio is an important factor for image quality. It does not only depend on the parameters EHT, aperture size, and working distance, but also on the dwell time of the electron beam per image spot.

To reduce the noise level of an image, you can do the following:

- Increase the dwell time of the electron beam per pixel
- Scan the respective specimen spot several times and integrate the generated signal

The various noise reduction methods are each divided into two categories:

- **Averaging:** The signal is acquired a number of times. Each time a signal is acquired it is proportionally mixed (averaged) with the already stored signal. The parameter **N** defines the number of signals to be averaged.

  This method enables you to acquire high quality images with regular specimens that can tolerate longer dwell times without getting damaged.

- **Integration:** The signal is acquired a number of times. Each time a signal is acquired it is added to the already stored signal. The parameter **N** defines the number of signals to be summed up (integrated).

  This method enables you to assemble an image if very high scan speeds are used and a single scan yields a very noisy image. This is necessary for beam sensitive materials, which cannot tolerate longer dwell times.

You can find details about the different methods in the *Software Reference* [▶ 185].

Procedure

1. In the **Crossbeam SEM Control** panel, select the **Imaging** tab.
2. In the **Noise Reduction** section, from the **Freeze on** drop-down list, select one of the following modes:

   Command: Causes an immediate freeze of the current zone (the whole image in normal mode) if you click **Freeze**.

   End Frame: Causes the zone to freeze at the end of the current frame.
3. From the **Noise Reduction** drop-down list, select a noise reduction mode.
4. If you have selected **Frame Avg.** or **Drift Comp. Frame Avg.**, do the following:

   1 Double-click the **N** readout and set a value between 1 and 256.

2 From the **Scan Speed** drop-down list, select a Scan Speed.

5 If you have selected one of the drift-compensated noise reduction methods, do the following:

1 Activate the **Show drift compensation options** checkbox.

The **DCFA/I Advanced Options** dialog is displayed. A description for each drift correction parameter is given in the dialog.

2 Change the drift correction parameters according to your needs.

To find an ideal setting, you may need to experiment.

3 Click **Apply and restart**.

5.6.2 Imaging a Tilted Specimen

5.6.2.1 Using Dynamic Focus (license: DYNFOCUS)

Purpose The dynamic focus allows the dynamic adaptation of the focus to tilted specimen surfaces.

INFO

The best application of the dynamic focus is only possible with tilted plane specimens. If the specimen presents strong differences in height (topography) or different inclinations of slope, the depth of focus must be optimized as well.

Prerequisites

- Requires the license DYNFOCUS.

Procedure

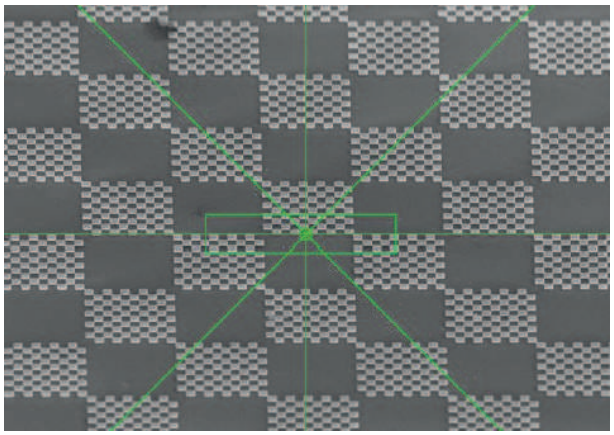
1 In the **Toolbar**, click the **Reduced Raster** icon.

A frame is displayed in the **Image Area**, which defines the specimen area to be scanned by the electron beam.

The image outside the scan frame is frozen.

2 Click on the small blue squares on the green border line and drag them to the desired size.

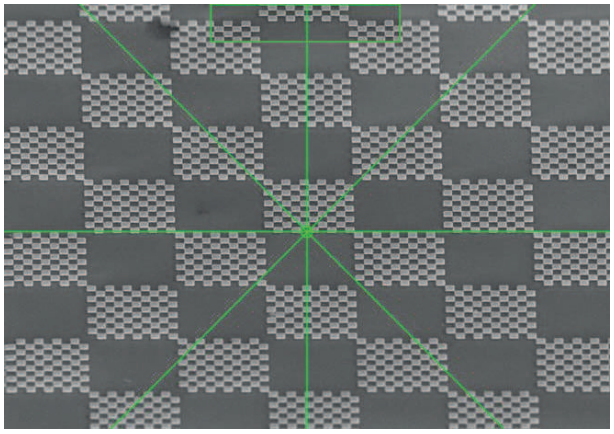
3 Place the frame in the center of the **Image Area**.



4 From the **Menu Bar**, select **View > Crosshairs**.

5 Adjust the best possible focus in the reduced raster.

6 Move the reduced raster to the very top or bottom of the **Image Area**.



7 Set a slow scan speed (9 or higher).

8 From the **Menu Bar**, select **Scanning > Dynamic Focus**.
The **Rotate / Tilt** dialog is displayed.

9 Activate the **Dyn. Focus** checkbox.

10 Use the **FCF Setting** slider to adjust optimum sharpness in the reduced raster.
Do not modify the normal focus (mouse wheel).

11 From the **Menu Bar**, select **Scanning > Normal**.
This is to acquire the complete image while using a slow scan speed.

12 Store the image.

13 Deactivate the **Dyn. Focus** checkbox.

5.6.2.2 Optimizing the Image of a Tilted Specimen (license: TILTCOMP)

Purpose At a high tilt angle, the scanning electron beam covers a larger part of the specimen in tilt direction than perpendicular to the tilt direction. As a result the image is distorted. This function enables you to correct the perspective foreshortening caused by the scan of a tilted specimen.

INFO

If you use an extremely tilted specimen, you need to adjust the dynamic focus as well.

INFO

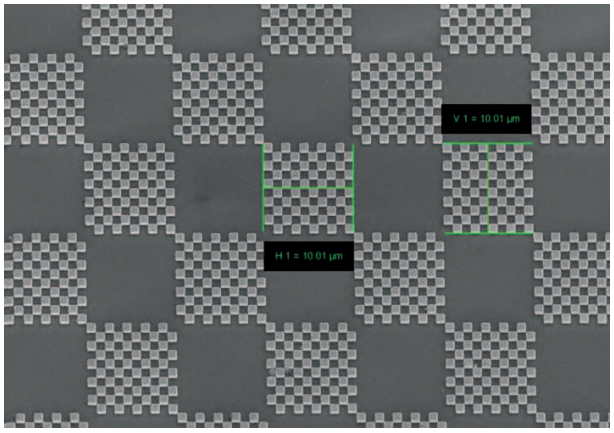
- To measure the height, enter **Tilt Angle = 90 °**.

Prerequisites

- Requires the license TILTCOMP.

Procedure

1. Ensure that the specimen surface is tilted such that live image is tilted in Y direction.
2. From the **Menu Bar**, select **Scanning > Rotate / Tilt**.
   The **Rotate / Tilt** dialog is displayed.
3. Activate the **Tilt Corrn.** checkbox.
4. Double-click the **Tilt Angle** readout.
   The **Tilt Angle** window is displayed.
5. Set the desired tilt angle and click **OK**.



5.6.3 Improving Image Illumination via Look Up Tables (LUT)

5.6.3.1 Editing a Live Image (Input LUT)

Purpose Using look-up tables (LUT) is recommended when the illumination of an image using a linear characteristic line is very difficult or impossible. In these cases, you can try to obtain better illumination of the image by adding or displacing discrete points of the characteristic line or by adding a step function.

The Input LUT is used to perform a translation of the input signal as defined by the pattern loaded into the LUT. Modifications of the Input LUT affect the live image.

Procedure

- From the **Menu Bar**, select **Edit > Input LUT**.

  The **Input LUT Editor** window is displayed.

5.6.3.2 Editing a Saved Image (Display LUT)

Purpose The Display LUT is used to edit a SEM image, e.g. by subsequent coloring, modification of brightness and contrast, inversion or addition of a gamma function. These settings affect the saved image as well as the live image.

Procedure

1. Load a saved image.
2. From the **Menu Bar**, select **Edit > Input LUT**.

   The **Display LUT Editor** window is displayed.

5.6.4 Applying Image Processing

5.6.4.1 Setting up the Gray Value Detection

Prerequisites

- Requires the license IMMATH.

Procedure

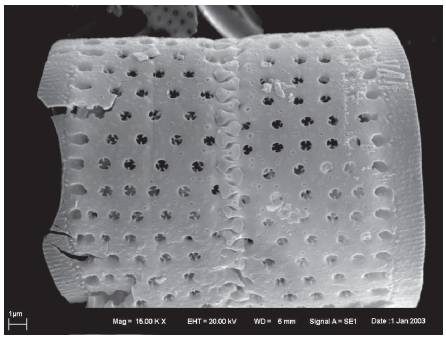
1. From the **Menu Bar**, select **Image > Image Processing**.

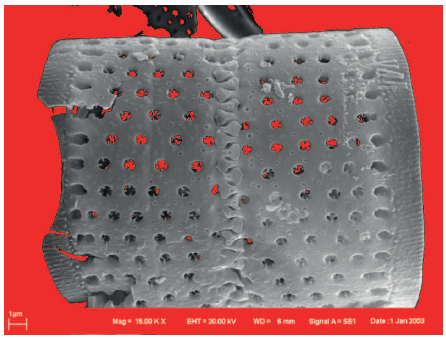
   The **Image Processing** panel is displayed.
2. Select the **Threshold** tab.
3. To set the type of threshold, select **Black**, **White**, or **Grey** from the **Image Detect** drop-down list.

   Black: Each pixel in the Image Store with a value inferior to the black threshold is colored red.

   White: Each pixel in the Image Store with a value inferior to the white threshold is colored red.

   Grey: Each pixel in the Image Store with a value superior to the black threshold or inferior to the white threshold is colored red.
4. To select the threshold for black, use the **Black Threshold** scroll bar.
5. To select the threshold for white, use the **White Threshold** scroll bar.
6. To calculate the area fraction of certain gray values colored red in the image, click **Update**.





INFO

If stored images contain annotations or measurements, the gray values of these annotations are included in calculation and presentation.

5.6.4.2 Creating a Stereo Image

Purpose The creation of stereo images enables you to obtain images showing a 3D effect.

INFO

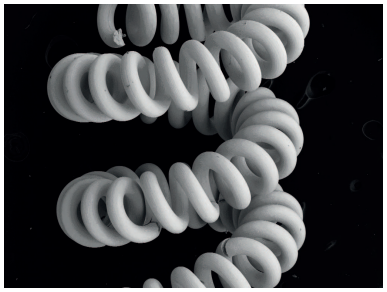
It is required that you take two images of the same specimen at the same magnification but at a different tilt angle. Depending on magnification and topography of the specimen, the difference of the tilt angle should be 2° to 15°.

Prerequisites

- Requires the license IMMATH.

Procedure

1 Take the first image.



1 Display crosshairs.

2 To ease navigation, move a striking detail to the center of the image.

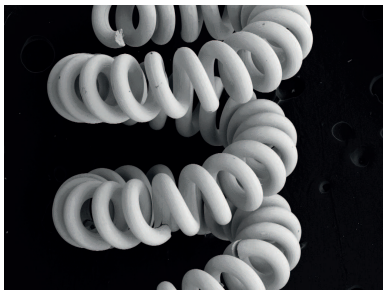
3 Set the desired magnification.

4 Rotate the image by 90° by means of the scan rotation function.

5 Freeze the image.

6 Save the image without data zone or annotations.

2 Take the second image at a different tilt angle.



1 Unfreeze the image.

2 Deactivate scan rotation.

3 Display crosshairs.

4 Tilt the stage step by step.

INFO **In most cases, the tilt angle between the two images should differ by 2° to 15°.**

5 Compensate for the move of the specimen range by moving the stage in Y-direction. Always place the striking detail back to the center of the crosshairs.

6 When reaching the required tilt angle, reset the focus by driving the stage in Z direction.

INFO **By tilting the specimen, the focus has been changed as well.**

7 Rotate the image by 90° by means of the scan rotation function.

8 Freeze the image.

9 Save the image without data zone or annotations.

3 From the **Menu Bar**, select **Image > Image Processing**.

The **Image Processing** panel is displayed.

4 Select the **Image Maths** tab.

5 Reload the first image.

1 From the **Source** drop-down list, select **Image Store**.

2 From the **Operation** drop-down list, select **Copy To**.

3 From the **Destination** drop-down list, select **Buffer 1**.

4 Click **Execute**.

The image is copied to buffer store 1.

6 Reload the second image.

1 From the **Source** drop-down list, select **Image Store**.

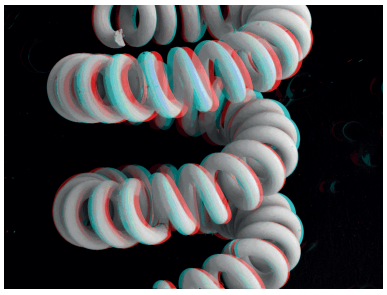
2 From the **Operation** drop-down list, select **Make Stereo Pair**.

3 From the **Source 2** drop-down list, select **Buffer 1**.

4 From the **Destination** drop-down list, select **Image Store**.

5 Click **Execute**.

Both images are combined with a color code and displayed on the monitor.



7 If the images are not exactly congruent, use the sliders **Stereo Merge** and **Stereo Tilt** to adjust X- and Y-directions.

INFO

Stereo glasses are required to be able to recognize the 3D effect in the color image.

5.6.4.3 Optimizing the Image Contrast via Histogram Equalization

Purpose This function enables you to perform a non-linear contrast optimization of the image. Ranges with frequent gray values are enlarged while ranges with rare gray values are compressed. Certain image structures can thus be accentuated whereas other structures are reduced so that the total impression of the image is modified.

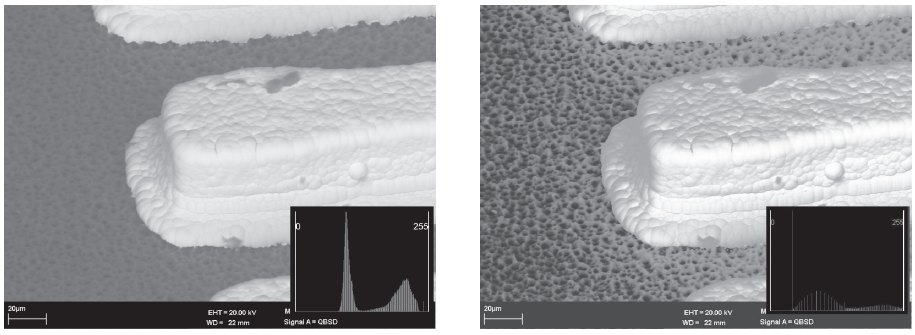


Fig. 5.12: Example of the effect of a histogram equalization. Left: Image before processing. Right: Image after processing

Prerequisites ■ Requires the license IMMATH.

Procedure **1** From the **Menu Bar**, select **Image > Image Processing**.

The **Image Processing** panel is displayed.

2 Select the **Histogram Equalisation** tab.

3 To improve the contrast via histogram equalization, you can choose one of the following options:

1 To improve the image contrast by calculating the gray scale distribution, click **Histogram Equalise: Store**.

The image is frozen.

2 To generate an image transformation using a display LUT, click **Histogram Equalise: LUT**

INFO **To reset the calculated display LUT, click** Reset LUT.

5.6.4.4 Optimizing the Image Contrast via the Histogram Panel

Purpose The **Histogram** panel uses the Contrast Limited Adaptive Histogram Equalisation (CLAHE) algorithm. It is different from the **Histogram Equalisation** tab in the **Image Processing** panel, which performs a regular adaptive histogram equalization.

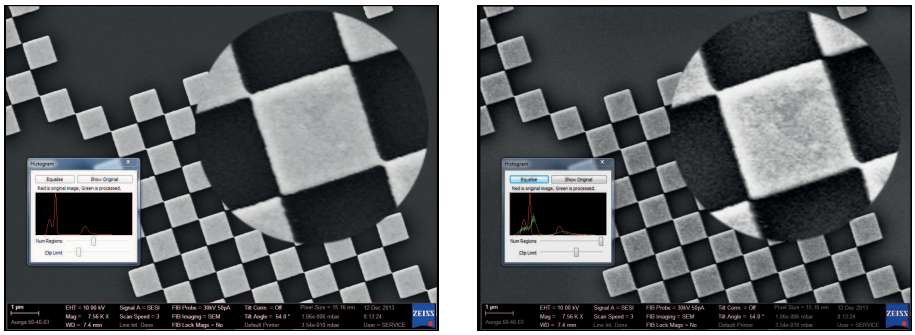


Fig. 5.13: Example of the effect of the CLAHE algorithm. Left: Image before processing. Right: Image after processing

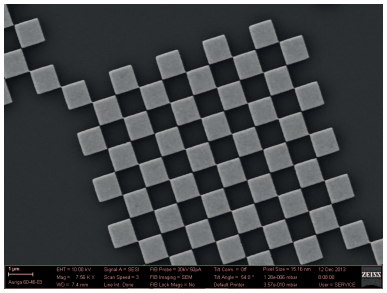
Prerequisites

- Requires the license IMMATH.

Procedure

1 Obtain an image.

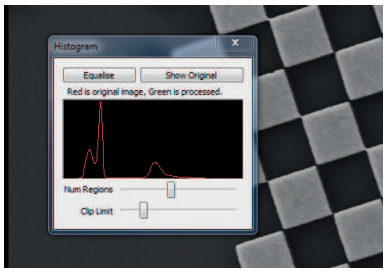
2 Stop the scan.



3 From the **Panel Configuration Bar**, select **Histogram**.

4 The **Histogram** panel is displayed.

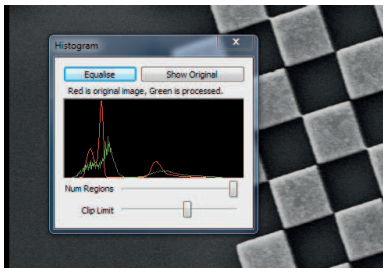
The red graph represents the original image histogram.



5 Click **Equalise**.

The processed image is displayed.

The green graph represents the processed image histogram.



6 To further optimize the image, perform the following steps.

Several iterations may be necessary to achieve the best result.

INFO In order to switch between the original and the processed image, click Show Processed / Show Original**.**

1 Adjust the **Num Regions** slider.

INFO CLAHE optimizes the contrast in subdivisions of the total image first and then computes an average from these regions. The Num Regions **slider indirectly defines the size of these regions. To find the optimal value, consider the size of relevant structures on the specimen.**

2 Adjust the **Clip Limit** slider.

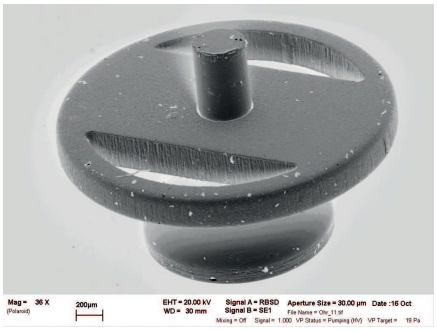
INFO All information above this limit value is clipped and therefore not visible in the equalized image.

3 Click **Equalise**.

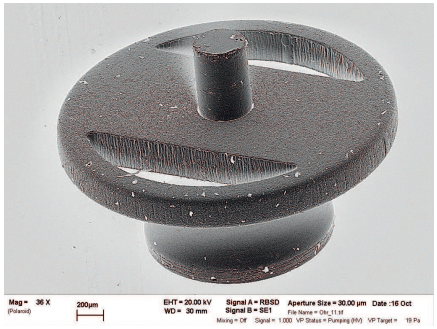
5.6.4.5 Using 2D Filters

Purpose The 2D Filters function enables you to apply a selection of filter kernels to the image in the Image Store.

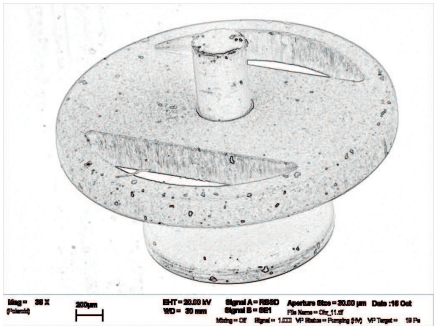
Original image



Inverted image



After application of Sharpen filter



After application of Edge Detect filter

Fig. 5.14: Examples of the effect of 2D filters

Prerequisites

- Requires the license IMMATH.

Procedure

1. From the **Menu Bar**, select **Image > Image Processing**.
   The **Image Processing** panel is displayed.
2. Select the **2D Filters** tab.
3. From the **Source** drop-down list, select the source of the image to which you wish to apply the transformation.
4. From the **Filter** drop-down list, select a filter.
   For more information on filters, refer to *SEM | Image Processing | Filtering* [▶ 205].
5. From the **Destination** drop-down list, select the destination.
6. To start the image processing, click **Execute**.
7. In order to cancel the last calculation, click **Undo**.

5.6.4.6 Defining User Specific Filters

Prerequisites

- Requires the license IMMATH.

Procedure

1. From the **Menu Bar**, select **Image > Image Processing**.
   The **Image Processing** panel is displayed.
2. Select the **2D Filters** tab.
3. From the **Filter** drop-down list, select **User Defined**.
4. To start the image processing, click **Execute**.
   INFO **If no user-specific filters are defined, a warning message is displayed. To confirm the message, click** OK**.**
   The **Apply User Defined Filter** window is displayed.
5. Select **New**.
   The **Edit User Defined Filter** window is displayed.
6. Create a new filter by means of the **Filter Kernel Matrix**.
7. Enter a **Filter Name** and click **OK**.

5.6.4.7 Using Realtime Filtering

Purpose

The function Realtime Filtering enables you to mathematically manipulate the image during recording. This feature recalculates the gray value of a pixel based on the gray values of the neighboring pixels.

Prerequisites

- Requires the license IMMATH.

Procedure

1. From the **Menu Bar**, select **Image > Image Processing**.
   The **Image Processing** panel is displayed.
2. Select the **Realtime Filtering** tab.
3. From the **Filter type** drop-down menu, select the appropriate filter type.
   For more information on the filter type, refer to *SEM* | *Image Processing* | *Filtering* [▶ 205].

5.7 Working with Recipes

Purpose Recipes are used to save a set of SEM parameters which are ideal for a certain type of specimen. When this type of specimen needs to be re-analyzed in the future, the SEM parameters can be recalled by opening the saved recipe. Only fine adjustments should then be required.

The first step is to create an ingredient list that defines the parameters to be saved in the recipe.

In the next step, recipes can be saved and executed. Any user can save their own recipes that are available only to them. Moreover, an Expert user (Supervisor privilege) can set the SEM parameters for a range of applications and save them as a common recipe that is available to all users. This can be helpful for Novice users.

Overview The procedure contains the following steps:

- *Creating and Editing an Ingredient List* [▶ 100]
- *Saving a User-Specific Recipe* [▶ 101]
- *Saving a Common Recipe* [▶ 101]
- *Viewing and Editing a Recipe* [▶ 102]
- *Deleting a Recipe* [▶ 102]
- *Executing a Recipe* [▶ 102]

5.7.1 Creating and Editing an Ingredient List

Purpose The ingredient list defines the contents of the recipe, i.e. the combination of saved parameters.

Procedure

1. From the **Menu Bar**, select **File > Recipe Management > Ingredient File Editor**.

   The **Recipe Ingredient List Editor** is displayed.

2. If you wish to use an existing ingredient list as the basis for your list, click **Load File** and select the respective file.

3. Adjust the ingredient list as required.

   1. To add a parameter, click **Insert Parameter** and select the parameter from the list in the **Select Parameter** window. You can also use the search field at the bottom of the window.
   2. To delete a parameter, select the parameter and click **Delete Item**
   3. To change the order of the parameters, use the **Move Up** and **Move Down** buttons.
   4. To insert a delay, click **Insert Delay** and enter a duration.

4. Save the ingredient list.

1 To save it as a user-specific ingredient list, click **Save**.

2 To save it as a common ingredient list, click **Save To Common**.

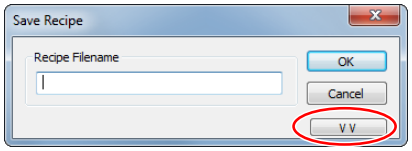
5.7.2 Saving a User-Specific Recipe

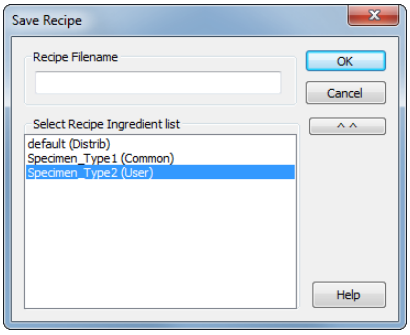
Procedure

1 From the **Menu Bar**, select **File > Save Recipe**.

The **Save Recipe** window is displayed.

2 To display the available ingredient lists, click the **VV** button.





3 Select the ingredient list to be used.

4 Enter a file name and click **OK**.

INFO **It is recommended to select a file name which enables you to clearly identify the exact type of specimen.**

Alternatively, in the **MiniBar**, click the **Recipes** icon and select **Save Recipe**.

5.7.3 Saving a Common Recipe

Prerequisites

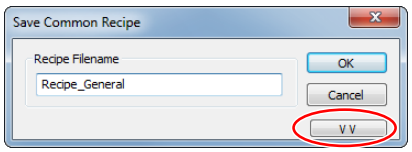
- Requires the **Supervisor** privilege.

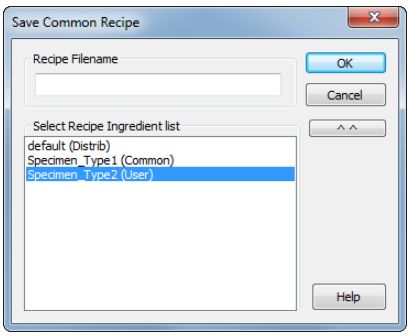
Procedure

1 From the **Menu Bar**, select **File > Recipe Management > Save Common Recipe**.

The **Save Common Recipe** window is displayed.

2 To display the available ingredient lists, click the **VV** button.





3 Select the ingredient list to be used.

4 Enter a file name and click **OK**.

INFO **It is recommended to select a file name which enables you to clearly identify the exact type of specimen.**

5.7.4 Viewing and Editing a Recipe

Purpose In order to check the content of a recipe, you can display a list of saved parameters.

Procedure

1. From the **Menu Bar**, select **File > View/Edit Recipe**.
   The **Select Recipe** window is displayed, containing a list of existing recipes.
2. Mark the recipe you wish to view and click **OK**.
   The content of the recipe is displayed.
3. In order to edit one of the recipe parameters, double-click the parameter.

Alternatively, in the **MiniBar**, click the **Recipes** icon and click the **...** button next to the recipe name in the **Recent** or **All Available** section.

5.7.5 Deleting a Recipe

Procedure

1. From the **Menu Bar**, select **File > Recipe Management > Delete Recipe**.
   The **Delete Recipe** window is displayed.
2. Mark the recipe you wish to delete.
3. Click **OK**.

5.7.6 Executing a Recipe

Purpose

INFO

Only one recipe can be run at a time.

Prerequisites

- A common recipe or a user-specific recipe is saved.

Procedure

1. From the **Menu Bar**, select **File > Execute Recipe**.
   The **Select and Execute Recipe** window is displayed.
2. Mark the recipe you wish to run.
3. In order to omit a particular parameter on the list, deactivate the respective checkbox.
4. Click **Execute**.

Alternatively, in the **MiniBar**, click the **Recipes** icon and select the recipe name in the **Recent** or **All Available** section.

5.8 Annotating Images

5.8.1 Adding Text

Procedure

1. In the **Annotation Bar**, click the **Annotation Text** icon.

2. Click the image where you wish to place the text.

   The **Annotation Caption** dialog is displayed.

3. Enter the text and click **OK**.

5.8.2 Modifying Text Properties

Purpose You can change e.g. font, font style, background style, and background color of the text.

Procedure

1. To mark the text box, click into the existing text.
2. From the context menu, select the **Properties** you wish to modify.

5.8.3 Adding Geometrical Objects

Procedure

1. In the **Annotation Bar**, click the desired annotation icon.

2. Click the image where you wish to place the object.

5.8.4 Modifying Object Properties

Purpose You can e.g. display a direction arrow at a line, change line settings, background style, and background color.

Procedure

1. Click the object you want to modify.
2. From the context menu, select the **Properties** you wish to modify.

5.8.5 Adding EM Parameters

Procedure

1. In the **Annotation Bar**, click the **EM Parameter** icon.

2. Click the image where you wish to insert the EM parameter.

   The **Annotation SEM Parameter** panel is displayed.

3. Select the parameters to be inserted.
4. To insert the value without the parameter name, activate the **Omit Parameter Name** checkbox.

5 Click **OK**.

5.8.6 Adding a Bitmap or Metafile

Procedure

1 In the **Annotation Bar**, click the **Insert User Bitmap or Metafile** icon.

2 Click the image where you wish to place the object.

The **Insert User Bitmap or Metafile** dialog is displayed.

3 Select the bitmap or metafile.

4 Click **Open**.

5.8.7 Displaying Zone Magnification

Purpose Zone magnification enables you to show the magnification of a selected zone, which can be helpful when the magnifications of different zones are not the same.

Procedure

1 In the **Annotation Bar**, click the **Zone Magnification** icon.

2 Click the zone of interest.

The magnification of this zone is displayed.

5.8.8 Adding Micron Markers

5.8.8.1 Using a Micron Marker

Purpose A micron marker is a horizontal bar that indicates the size of an object in the image. Above the bar, its length is displayed.

The micron marker is self-sizing as the bar has minimum and maximum lengths. If the magnification is changed such that these limits would be exceeded, the length represented by the bar is changed to a whole number which permits the bar to be within limits.

Procedure

1 In the **Annotation Bar**, click the **Micron Marker** icon.

2 Click the image where you wish to place the micron marker.

The micron marker annotation can be picked up and dragged into the required position.

3 Ensure not to place the annotation over another zone.

5.8.8.2 Using a Fixed Micron Marker

Purpose The fixed micron marker represents a fixed dimension, and can therefore extend off the screen if the magnification is too large or can shrink to a single pixel length if the magnification is too low. Editing the fixed micron marker enables you to change the size.

Procedure

1. In the **Annotation Bar**, click the **Fixed Micron Marker** icon.

2. Click where you wish to place the micron marker.

   The **Annotation Micron Measurement** window is displayed.

3. Enter the desired size.
4. Click **OK**.

5.8.9 Measuring

5.8.9.1 Measuring a Size

Purpose To measure the size of features, you can insert up to ten point-to-point measurements.

Procedure

1. In the **Annotation Bar**, click the **Point to Point Measure** icon.

2. Click the image and keep the left mouse button pressed while drawing a line across the feature you wish to measure.
3. Release the left mouse button.

   The measurement is displayed as a text adjacent to the object.

5.8.9.2 Measuring an Angle

Purpose To measure the angle between features, you can insert up to two angle measurements per image.

Procedure

1. In the **Annotation Bar**, click the **Angular Measurement** icon.

2. Click the image where you wish to measure the angle.
3. Click the side of the angle and drag to move its position.

   The measuring angle is displayed.

5.8.9.3 Measuring a Length or an Area

Purpose You can use the linewidth measurement to draw a rectangle or the radial measurement to draw a circle. The dimensions and the area of the circle and the rectangle are displayed.

You can insert up to four radial measurements and two linewidth measurements per image.

Procedure

1. In the **Annotation Bar**, click the **Linewidth Measure** icon or the **Radial Measure** icon.

2. Click the image where you wish to measure an object.
3. Click the annotation and drag in order to adjust the size of the rectangle or the circle as required.

   In case of the linewidth measurement, the width and height of the rectangle, the area of the rectangle and the tilt angle are displayed in the **Image Area**.

   In case of the radial measurement, the diameter and the area of the circle are displayed in the **Image Area**.

5.8.9.4 Measuring Distances

Purpose You can choose between two types of cursors to measure width and height: fixed measurement cursors spanning the entire **Image Area** or movable cursors with an adjustable length.

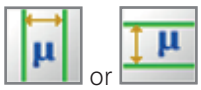
You can insert only one instance of fixed width measurement cursors and one instance of fixed height measurement cursors per image.

You can insert ten instances for both types of movable cursors.

Procedure

1. In the **Annotation Bar**, select the desired icon.

   1 To insert cursors spanning the entire **Image Area**, click the **Width Measurement Cursors** icon or the **Height Measurement Cursors** icon.



   2 To insert cursors with an adjustable length, click the **Moveable Width Cursors** icon or the **Moveable Height Cursors** icon

2. To move the cursor, click the cursor line and hold the left mouse button.

5.8.9.5 Displaying or Hiding Measuring Parameters

Procedure

1. Double-click the line, angle, length or area you have measured.
   The **Measurement Object Results Panel Parameters** box is displayed.
2. In order to hide a parameter, select it in the **Current Selection** list and click **Remove**.
3. In order to display a parameter, select it in the **Available Parameters** list and click **Add**.
4. Click **OK**.

5.8.10 Editing Annotations

5.8.10.1 Hiding or Displaying Annotations

Procedure

1. From the **Menu Bar**, select **View > Annotation**.
   The **Annotation** submenu is displayed.
2. In order to hide an annotation parameter, deactivate the parameter in the list.
3. In order to display an annotation parameter, activate the parameter in the list.

5.8.10.2 Deleting Annotations

Procedure

1. Click the annotation object or text.
2. Select **Delete** from the context menu or press the **Delete** key.

Alternatively, in the **Annotation Bar**, click the **Delete All Visible Objects** icon, to delete all annotations.

5.8.10.3 Saving Annotations

Procedure

1. In the **Annotation Bar**, click the **Save Annotation** icon.
   
2. Enter an annotation name.
3. Click **OK**.

5.8.10.4 Loading Annotations

Procedure

1 In the **Annotation Bar**, click the **Load Annotation** icon.

The **Load Annotation** dialog is displayed.

2 Select an annotation.

3 Click **OK**.

5.9 Editing and Filing Images

5.9.1 Saving and Managing Images or Videos

5.9.1.1 Saving Images as TIF

Purpose

After optimizing and freezing the image, it can be saved as a *.tif (Tagged Image Format) file.

It is possible to save an image with different settings depending on your requirements. In general, **Grey** is recommended.

INFO

Images saved as color images (24 Bit Color) cannot be reloaded to the SmartSEM user interface, but they can be implemented to most Windows user programs.

INFO

When selecting 16 Bit Grey, no annotations, measurements, or data zones are saved.

Procedure

1 From the **Menu Bar**, select **File > Save Image**.

The **Export TIFF** dialog is displayed.

2 In the **Save** tab, enter a file name in the **Filename** input field.

The **Save** button is labeled with the new file name.

Alternatively, select a file name from the list.

3 If the image is part of a series of images with the same file name, select the numbering to be added to the file name.

4 From the **Store Resolution** drop-down list, select the resolution of the image file.

5 You can also add text in the field **User Text**.

This text will be displayed when selecting a file in the **Load Image** dialog.

6 Select the **Settings** tab.

7 Select the image mode.

8 Set the image dimensions.

9 Click **Save 'file name'**.

5.9.1.2 Saving Images as BMP or JPEG

Purpose It is possible to save SEM images as a *.bmp or *.jpeg file. When using these formats, the SEM images are always saved as gray images with the respective palette. You cannot save the image in color.

INFO

Images in *.bmp and *.jpeg format cannot be reloaded to the SmartSEM user interface. Besides, it is not possible to save additional information with the image.

INFO

Depending on the image content of the respective image, quality and information may be lost even when saving images at high level of *.jpeg quality (75-95).

Procedure

1 To open the context menu, right-click within the **Image Area**.

2 Select **Send to > BMP file** or **Send to > JPEG file**.

The **Export BMP** or **Export JPEG** dialog is displayed.

3 In the **Save** tab, enter a file name.

4 Select the **Settings** tab.

5 Set the image dimensions.

6 When saving the image as *.jpeg, enter a value for **JPEG Quality**.

The value can be between 5 and 95. The smaller the value, the higher the compression (reduced storage space) and the lower the quality of the image.

A default value of 75 is set for **JPEG Quality**. In most cases, this value represents a good compromise between compression of the storage space and quality of the image.

7 Select the **Save** tab.

8 Enter a file name.

9 Click **Save 'file name'**.

5.9.1.3 Taking Videos

Purpose The function AVI Capture Mode enables you to take video sequences in order to show dynamic processes. The video can be played using the SmartSEM user interface or any other video player capable of playing AVI.

Overview The procedure contains the following steps:

- *Setting AVI Options* [▶ 110]
- *Starting the Record* [▶ 110]

5.9.1.3.1 Setting AVI Options

Prerequisites

- Requires the license AVI.

Procedure

1. From the **Menu Bar**, select **Tools > AVI Options**.

   The **AVI File Capture Options** dialog is displayed.

   As a standard, the created video is saved as a Capture.avi file in the user's current image directory.
2. To change the file name or to select another directory, click in the **Capture Filename** input field and enter the data.
3. Set the maximum file size (max. 2047 MB).
4. In order to save annotations or measurements together with the video, activate the **Annotation Merge** checkbox.
5. If specific video codecs have been installed under the operating system, these codecs can be selected via **Compression**.
6. To set the number of images to be saved, enter a value in one of the **Capture every** input fields.

   INFO **The smaller the number, the smoother the video plays but the faster the file size grows.**
7. To confirm, click **OK**.

5.9.1.3.2 Starting the Record

Prerequisites

- Requires the license AVI Capture.

Procedure

1. From the **Menu Bar**, select **Tools > AVI Capture**.

   The **AVI Toolbar** is displayed.
2. To start recording, click the **Start AVI Capture** icon.

5.9.1.4 Loading Images

Procedure

1. From the **Menu Bar**, select **File > Load Image**.
   The **Import TIFF** dialog is displayed.
2. Click **Change Directory** and select the desired directory.
3. To confirm, click **OK**.
4. To select an image, double-click it.
5. In order to return to the live image, from the **Menu Bar**, select **Scanning > Normal**.

5.9.1.5 Viewing Saved Images

Purpose To gain an overview of the saved images, you can display them as thumbnails in an explorer window. From this window, you can select individual images you wish to view.

Procedure

1. From the **Menu Bar**, select **Image > Image Gallery**.
   The file explorer is displayed.
2. To view an image, double-click it.

5.9.1.6 Printing Images

Procedure

1. From the **Menu Bar**, select **File > Print Image**.
   The **Print Setup** dialog is displayed.
2. In order to print annotations and measurements together with the image, activate the **Annotation and Measurement** checkbox.
3. In order to print color annotations or measurements, activate the **Colour Merge** checkbox.
4. In the **Size** section, select the size of the printed image.
5. If you activate **Zoom**, also enter a zoom factor and select the position on the sheet (**Top**, **Middle** or **Bottom**).
6. To select the printer, click **Printer**.
7. To start the printing process, click **Print**.

5.9.1.7 Using the Large Image Store Wizard

Purpose The **Large Image Store Wizard** guides you through a process with three main steps to obtain images with high pixel resolution.

INFO

No annotations can be saved when using the Large Image Store Wizard.

Procedure

1. From the **Panel Configuration Bar**, select **Large Image Store Wizard**.

   The **Large Image Store Wizard** is displayed.

   Step 1 of 3 is displayed.

   In the SmartSEM **Image Area**, an image with the resolution of 1024x768 is continuously scanned and displayed.

   The image in the **Image Area** equals the field of view that the final image will cover.

2. Optimize the image, e.g by adjusting the magnification and the focus, aligning the aperture and adjusting the scan speed.

   In the **Large Image Store Wizard**, the **Field of view** readout is displayed, referring to the image visible in the total **Image Area**.

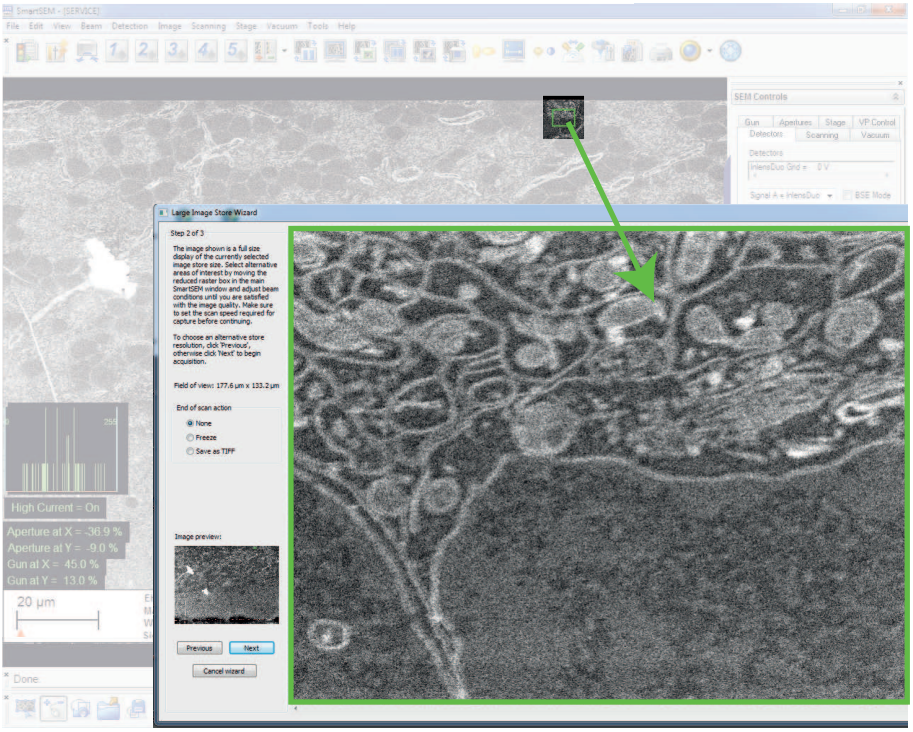
   INFO Changing the magnification also changes the field of view for the final image.

   In addition, the available store resolutions and the pixel size for each store resolution are displayed. The colored bar to the right helps you to select a suitable store resolution. Resolutions marked in red and yellow can also be selected, but these resolutions do not provide an optimal image quality. However, the colored bar can only give you a hint on the technical possibilities to exclude resolutions that are too high for the selected area.

3. To continue, select a store resolution from the list and then click **Next**.

   Step 2 of 3 is displayed.

   An **Image preview** is displayed at the bottom left of the **Large Image Store Wizard**. The **Image preview** represents the total area that is also visible in the SmartSEM **Image Area**. A green rectangle represents the area of interest that is currently displayed in the **Large Image Store Wizard**. To change the detail displayed in the **Large Image Store Wizard**, the green rectangle can be moved in the **Image preview** or in the SmartSEM **Image Area**.



4 To check the alignment, move the green rectangle to different areas.

5 If necessary, optimize the alignment. If you have problems to obtain satisfactory results, restart the procedure by clicking **Previous**.

6 Select an **End of scan** action:

None: after the scan is complete, the scan restarts at the beginning.

Freeze: after the scan is complete, the scan is stopped.

Save as TIFF: after the scan is complete, the image is automatically saved to the user's image directory with the last used Export TIFF settings.

7 Click **Next**.

Step 3 of 3 is displayed.

Depending on the selected store resolution, the acquisition can take several minutes. You can observe the process by moving the green square in the image preview to a region that is already displayed. If you need to stop the scan to change any settings, you can go back to step 2 by clicking **Previous**.

The selected **End of scan** action is performed.

If you have selected **Save as TIFF**, a message is displayed to confirm that the image has been saved.

5.9.2 Working with the Windows Clipboard (license: CLIP)

5.9.2.1 Copying Images to the Windows Clipboard (license: CLIP)

Purpose You can copy images from SmartSEM to the Windows clipboard and insert them in other programs with access to the Windows clipboard without prior storage. This can be helpful, e.g. when preparing presentations.

Prerequisites

- Requires the license CLIP.

Procedure

1. From the **Menu Bar**, select **Edit > Clipboard**.

   The **Clipboard** dialog is displayed.

2. Select the **Copy** tab.
3. From the **Store Resolution** drop-down list, select the storage resolution.
4. To save the data zone, annotations and measurements together with the image, activate the **Annotation** checkbox.
5. To save color annotations or measurements together with the image, activate the **Colour Merge** checkbox.

   INFO **The number of gray values (256) of the image is reduced to 20 as this storage space is required for the annotation.**

6. Set the desired dimensions of the image and click **Set**.

5.9.2.2 Inserting Images from the Windows Clipboard (license: CLIP)

Purpose You can copy images to the Windows Clipboard and insert them in the image displayed in the SmartSEM **Image Area**.

Prerequisites

- Requires the license CLIP.

Procedure

1. From the **Menu Bar**, select **Edit > Clipboard**.

   The **Clipboard** dialog is displayed.

2. Select the **Paste** tab.

   The **File information** section displays the size and type of the image in the clipboard.

   A shaded frame in the **Image Area** represents the position and dimension in which the image will be pasted.

3. From the drop-down list, select the **Image Reduction** factor.

   The size of the shaded frame in the **Image Area** changes accordingly.

4. To change the position of the shaded frame, use the **Centre**, **Origin**, and **XY** buttons.

   Selecting **XY** enables you to freely position the shaded frame by means of the mouse.

5. To compose one image out of four images, click **Origin** and activate the **Step Frame** checkbox.

6 To insert the image, click **Paste**.

5.10 Using the Optional Plasma Cleaner

5.10.1 Activating the Plasma Cleaner

Purpose

The Plasma Cleaner is an optional accessory that allows you to decontaminate the specimen chamber and any loaded specimens. The plasma is fully contained in the Plasma Cleaner unit. The radicals migrate into the specimen chamber and chemically react with unwanted hydrocarbons.

After a plasma cleaning cycle, the specimen surface provides optimal imaging conditions even at very low imaging voltages.

INFO

You can view a log file that contains all relevant events concerning the Plasma Cleaner via **Panel Configuration Bar > Plasma Cleaning > View Log**. The log file can be used for troubleshooting and to determine when the next plasma cleaning process should be scheduled.

Safety Information

NOTICE

Risk of property damage: Damage to the specimen due to plasma cleaning

Plasma can damage sensitive specimens.

- Always test the plasma cleaner on specimens of the same material before cleaning any important specimen.

NOTICE

Risk of property damage: Damage to the specimen or vacuum system due to gases

Unstable pressure or unwanted reactions between the plasma and gases injected into the chamber can damage the specimen or the vacuum system.

If a gas injection system or the charge compensation function are active, the gas injection affects the pressure range and can create unwanted reactions between the plasma and the injected gas.

- Make sure the chamber pressure is stable during plasma cleaning.
- Do not use the GIS or the charge compensator when using the plasma cleaner.

Procedure

1. If your microscope is equipped with the airlock, make sure that the gate valve of the airlock is closed. Do not use the airlock while using the Plasma Cleaner.

   For more information refer to the instruction manual of the airlock.

2. Switch off the EHT.

3. **NOTICE The pressure range applied during plasma cleaning can damage the electron source. To protect the electron source from the harmful pressure range, close the column chamber valve.**

   1 In the **Crossbeam SEM Control** panel, select the **Vacuum** tab.

   2 Click the **Column Chamber valve** readout and set it to **Closed**.

4. From the **Panel Configuration Bar** bar, select **Plasma Cleaning**.

   The **Plasma Cleaning** panel is displayed.

5. Check that the Plasma Cleaner controller hardware is switched on and the **Connected** LED is active in the software.

6. From the **Recipe** drop-down list, select a Recipe.

   There are five preset recipes for different purposes that can not be edited. Additionally, you can create custom recipes.

7. To start the plasma cleaning, click **Start cleaning**.

   The plasma cleaning process starts.

   The turbo pump is slowed down by 10 nitrogen impulses.

   The specimen chamber is vented for 40 seconds.

   The turbo pump is switched off.

   The current status is displayed in the **Plasma Cleaning Sequence** section.

   If the selected recipe involves nitrogen purges, the number of purge cycles is displayed next to the flow chart. The arrow indicates which steps will be repeated.

8. Wait until the **Finished** LED is active.

   This indicates that the plasma cleaning process is complete.

   The chamber is pumped.

   INFO If you wish to abort the cleaning cycle while it is still running, click Stop cleaning.

9. Wait until **Vac Status = Ready** is displayed.

   The Gun and the EHT can then be switched back on and you can return to regular microscope operation.

5.10.2 Creating Custom Recipes

Procedure

1. From the **Panel Configuration Bar**, select **Plasma Cleaning**.

   The **Plasma Cleaning** panel is displayed.

2. Click **Edit Recipes**.

   The **Plasma Cleaning Recipe List** opens and displays the available recipes.

   INFO **The five preset recipes can not be edited or deleted. To determine whether a recipe can be edited, check the respective entry in the Type column.**

3. To create a new recipe, click **Add**.

   The **Cleaning Recipe** window opens.

4. Enter a name for the cleaning recipe.

5. Select the desired values according to your specific application.

6. If nitrogen purge cycles are necessary, activate the **Purge** checkbox.

   This will add additional values that can be edited.

7. Once the settings are complete, click **OK**.

   The recipe is now added to the list of available recipes.

   In the **Type** column, the new recipe will be displayed as **User**, which tells you that the recipe can be edited or deleted.

5.10.3 Setting up the Schedule

Safety Information

NOTICE

Risk of property damage: Damage to the specimen due to plasma cleaning

Plasma can damage sensitive specimens.

- Always test the plasma cleaner on specimens of the same material before cleaning any important specimen.

NOTICE

Risk of property damage: Damage to the specimen or vacuum system due to gases

Unstable pressure or unwanted reactions between the plasma and gases injected into the chamber can damage the specimen or the vacuum system.

If a gas injection system or the charge compensation function are active, the gas injection affects the pressure range and can create unwanted reactions between the plasma and the injected gas.

- Make sure the chamber pressure is stable during plasma cleaning.
- Do not use the GIS or the charge compensator when using the plasma cleaner.

Purpose If you want to schedule the next plasma cleaning, you can set up a date and time for an automated decontamination cycle.

Procedure

1. From the **Panel Configuration Bar**, select **Plasma Cleaning**.

   The **Plasma Cleaning** panel is displayed.

2. To select a date for your cleaning schedule, click the **Calendar** icon.

3. In the input field on the left side of the **Calendar** icon, enter a time.

4. Activate the **Schedule cleaning cycle at:** checkbox.

   The cleaning cycle schedule is now active. 30 seconds before the scheduled cleaning cycle, a countdown will be displayed to inform you that a cleaning cycle is about to start.

5. You have the following options:

   1 To abort the countdown and start the cleaning cycle right away, click **Start Now**.

   2 To abort the countdown and cancel the scheduled cleaning cycle, click **Cancel**.

   3 To start the cleaning cycle as scheduled, no action needs to be taken.

6 Managing Users

6.1 Managing User Profiles

The SmartSEM software uses the **SmartSEM Administrator** for user management. By means of the **SmartSEM Administrator**, you can create new users and assign certain privileges to the users.

The **SmartSEM Administrator** creates the various user directories and edits existing folders and user configurations. A user directory is a closed data path which saves frequently modified configuration parameters of the SmartSEM user interface and system software files for the various users.

If each user has their own directory for configuration parameters, the software can be configured in such a way that toolbar, menus, data zones, etc. meet the specific requirements of each user. Thus, there is no need to reconfigure the user interface each time SmartSEM is started.

6.1.1 Setting the Password on Initial Log-On

Purpose When the SmartSEM Administrator is started for the first time, the person responsible for the workstation must set a password.

INFO

If you lose the password, a chargeable service visit will be required.

- Record the **System** password in a safe place.

Procedure

1. From the Windows Start menu, select **Programs > SmartSEM > SmartSEM Administrator**.

   The **SmartSEM Administrator Log on** window is displayed.

2. Log on as `SYSTEM` with a blank password.

   The **SmartSEM Administrator** window is displayed.

3. To change the password, select **System** in the user list.

4. Click **Edit**.

   The **Editing User Profile** window is displayed.

5. Click **Change Password**.

6. Enter the new password. It will take effect on the next log-on.

6.1.2 Creating a New User Profile

Purpose You can create user profiles with different sets of privileges. You can base a new user profile on a user template or on an existing user and then refine the profile as desired.

INFO

Assign **Supervisor** privileges only to a restricted number of authorized users. The **Supervisor** privilege permits the user to start the Administrator and to edit or create user directories.

INFO

The default password for a new user is the user name.

The following privileges can be assigned to a user profile:

Checkbox	Privilege
Calibration	Enables the user to perform instrument calibration operations.
Change Image Directory	Enables the user to change the location where all images are saved.
Change Toolbar	Enables the user to change the toolbar.
Change User Directory	Enables the user to change the location where all user specific parameters and configurations are saved.
Extractor	Enables the user to change the extractor voltage.
FIB Probe Alignment	Enables the user to adjust the probe currents.
Gun Align	Enables the user to modify the alignment of the electron beam.
Gun Off	Enables the user to switch off the FE filament.
Mill Defaults	Enables the user to modify the default settings for FIB milling.
Stage Initialise	Enables the user to initialize the motorized stage.
Supervisor	Enables the user to perform the following actions: ■ Start the Administrator, create and edit users ■ Set User Max EHT ■ Modify the filament current

Checkbox	Privilege
	■ Set up, edit, and delete global stage coordinates ■ Save common macros and toolbars ■ Save common recipes ■ Activate **Partial Vent on Standby**, **Z Move on vent**, **Protect Z**, **Go to HV@Shutdown**, **EHT Off & Log Off** and **Leave Gun ON at Shutdown**. ■ Use the bakeout function ■ Start the FIB filament heating.
Vent	Enables the user to ventilate the specimen chamber.

Prerequisites

- Requires the **Supervisor** privilege.

Procedure

1. From the Windows Start menu, select **Programs > SmartSEM > SmartSEM Administrator**.

   The **SmartSEM Administrator Log on** window is displayed.

2. Enter the user name and password.

   The **SmartSEM Administrator** window is displayed.

3. Click **Users**.

4. Click **New**.

   The **New User** window is displayed.

5. Activate either the **Based on User Template** or the **Based on Existing User** radio button.

6. From the respective drop-down list, select a template or an existing user.

7. To confirm, click **OK**.

   The **Creating new User Profile** window is displayed.

8. Enter a **User Name**.

   INFO **The required length of the user name is 3 to 20 characters.**

9. To select a user directory for the new user, click the **...** button to the right of the **User Directory** readout.

10. Select a user directory and click **OK** to confirm.

    INFO **In the user directory, all user specific parameters and configurations such as the appearance of the** Toolbar**, the** Data Zone**, and coordinates are stored and can be loaded again.**

11 To select an image directory, click the **...** button next to the **Image Directory** readout.

12 Select an image directory and click **OK** to confirm.

INFO **In the image directory, all images of the user are saved.**

13 In the **User Level Permissions** section, set the permissions.

1 For access to all available parameters, select **Any Level**.

2 For access to a certain number of privileges and permissions, select **Full**, **Expert** or **Novice**.

14 In the **User Privileges** section, activate the desired user privileges.

15 To confirm, click **OK**.

6.1.3 Assigning or Changing a Password

Prerequisites

- Requires the **Supervisor** privilege.

Procedure

1 From the Windows Start menu, select **Programs > SmartSEM > SmartSEM Administrator**.

The **SmartSEM Administrator Log on** window is displayed.

2 Enter user name and password.

The **SmartSEM Administrator** window is displayed.

3 Click **Users**.

4 In the user list, mark the user whose password is to be assigned or changed.

5 Click **Edit**.

The **Editing User Profile** window is displayed.

6 Click **Change Password**.

The **Change password for "User name"** window is displayed.

7 Enter a new password.

INFO **The required password length is 3 to 20 characters.**

8 Type the same password in the **Verify** input field.

9 To confirm, click **OK**.

6.1.4 Modifying a User Profile

Prerequisites

- Requires the **Supervisor** privilege.

Procedure

1 From the Windows Start menu, select **Programs > SmartSEM > SmartSEM Administrator**.

The **SmartSEM Administrator Log on** window is displayed.

2 Enter user name and password.

The **SmartSEM Administrator** window is displayed.

3 Click **Users**.

4 In the user list, mark the user whose user profile is to be changed.

5 Click **Edit**.

The **Editing User Profile** window is displayed.

6 Change the settings as desired.

7 To confirm, click **OK**.

6.1.5 Deleting a User Profile

Prerequisites
- Requires the **Supervisor** privilege.

Procedure

1 From the Windows Start menu, select **Programs > SmartSEM > SmartSEM Administrator**.

The **SmartSEM Administrator Log on** window is displayed.

2 Enter user name and password.

The **SmartSEM Administrator** window is displayed.

3 Click **Users**.

4 In the user list, mark the user whose user profile is to be deleted.

5 Click **Delete**.

6 To confirm, click **OK**.

6.2 Managing User Accounts (license: ACCOUNT)

The utility **SmartSEM User Accounting** enables you to record important information during individual working sessions on the FESEM. The information is stored in a separate database file.

6.2.1 Creating a New Database File (license: ACCOUNT)

Prerequisites

- Requires the license ACCOUNT.
- Requires the **Supervisor** privilege or higher.

Procedure

1. From the Windows Start menu, select **Programs > SmartSEM > SmartSEM User Accounting**.

   The **SmartSEM Accounting Log on** window is displayed.

2. Enter user name and password.

   The **Accounting** window is displayed.

3. Click **Create**.

   An empty file ('Account.accdb') is created in the directory C:\ProgramData\Carl Zeiss\SmartSEM\Database.

   If a file has already been created, a warning message is displayed.

6.2.2 Activating/Deactivating User Accounting (license: ACCOUNT)

Prerequisites

- Requires the license ACCOUNT.
- Requires the **Supervisor** privilege or higher.
- A database file has been created.

Procedure

1. From the Windows Start menu, select **Programs > SmartSEM > SmartSEM User Accounting**.

   The **SmartSEM Accounting Log on** window is displayed.

2. Enter user name and password.

   The **Accounting** window is displayed.

3. Click **Activate**.

4. From the drop-down menu, select **Activate**.

   The recording starts.

5. In order to stop recording, click **Active > Deactivate**.

6.2.3 Deleting Session Records (license: ACCOUNT)

Purpose Enables you to delete data in the database up to a specific date.

Prerequisites

- Requires the license ACCOUNT.
- Requires the **Supervisor** privilege or higher.

Procedure

1. From the Windows Start menu, select **Programs > SmartSEM > SmartSEM User Accounting**.

   The **SmartSEM Accounting Log on** window is displayed.

2. Enter user name and password.

   The **Accounting** window is displayed.

3 Click **Delete Sessions**.

The **Delete Sessions** window is displayed.

4 In the **Delete records to** input field, enter the date.

5 To confirm, click **OK**.

6.2.4 Grouping Users (license: ACCOUNT)

Purpose In order to form groups of users belonging to the same institute or cost center, you can create a so-called owner and assign users to the owner.

Prerequisites

- Requires the license ACCOUNT.
- Requires the **Supervisor** privilege or higher.

Procedure

1 From the Windows Start menu, select **Programs > SmartSEM > SmartSEM User Accounting**.

The **SmartSEM Accounting Log on** window is displayed.

2 Enter user name and password.

The **Accounting** window is displayed.

3 Click **Owners**.

The **Account Owners** window is displayed.

4 If required, create a new owner.

1 Click **Add**.

The **Creating new Owner** window is displayed.

2 Complete the input fields.

The fields **Name** and **Company** are compulsory.

3 To confirm, click **OK**.

5 Assign a user to the respective owner.

1 Mark the owner in the **Owners** list.

2 Mark an entry in the **Unassigned Accounts** field.

3 Click  .

6.2.5 Compressing the Database (license: ACCOUNT)

Purpose When the data within the database is modified, the file will include unused sections inflating the size of the database file. Compressing the database enables you to reduce the file size.

Prerequisites

- Requires the license ACCOUNT.
- Requires the **Supervisor** privilege or higher.

Procedure

1. From the Windows Start menu, select **Programs > SmartSEM > SmartSEM User Accounting**.

   The **SmartSEM Accounting Log on** window is displayed.

2. Enter user name and password.

   The **Accounting** window is displayed.

3. To remove unused sections and errors, click **Compact**.

   A back-up copy (account.bak) is created in the directory C:\ProgramData\Carl Zeiss\SmartSEM\Database.

   The database file is compressed.

4. If errors occur during compression, reset the original state by deleting the file 'Account.accdb' and renaming the file 'account.bak' to 'Account.accdb'.

7 Customizing SmartSEM

7.1 Customizing Joystick and Control Panel Settings

Purpose You can change the settings for joystick speed, stigmator sensitivity and the sensitivity of the control panel encoders such as the Focus encoder.

Procedure
1. In the **Panel Configuration Bar**, double-click **User Settings**.
2. The **User Settings** panel is displayed.
3. Use the respective slider to adjust joystick speed, stigmator sensitivity, panel sensitivity, and aperture alignment sensitivity.
4. To confirm, click **OK**.

7.2 Setting Mouse Adjustment Preferences

Procedure
1. From the **Menu Bar**, select **Tools > Configure Mouse Adjust**.
   The **Mouse Adjustment** dialog is displayed.
2. Adjust the settings as required.
3. To confirm, click **OK**.

7.3 Disabling the Splash Screen on Startup

Purpose By default, a splash screen is displayed while SmartSEM is loading. You can disable the splash screen.

Procedure
1. Go to the **EM Server** window.
2. From the **Menu**, select **Options > Disable Splash Screen on Startup**.
   The splash screen is disabled.

7.4 Personalizing the User Interface

7.4.1 Selecting the Language

Procedure
1. From the **Menu Bar**, select **Tools > User Preferences**.
   The **User Preferences** dialog is displayed.
2. In the tree structure, select **User > Language**.
3. From the **Language** drop-down list, select the desired language.
   INFO **At present, switching to other languages is only possible within certain limits. Help texts are available in English only.**

4 To confirm, click **OK**.

7.4.2 Selecting the Displayed Pressure Unit

Procedure

1 From the **Menu Bar**, select **Tools > User Preferences**.

The **User Preferences** dialog is displayed.

2 In the tree structure, select **User > Pressure Units**.

3 From the **Pressure Units** drop-down list, select the desired pressure unit.

4 To confirm, click **OK**.

7.4.3 Selecting the User Access Level

Purpose The selected **User Access Level** determines which parameters and commands can be accessed, e.g. in the SmartSEM Status window.

The following **User Access Levels** are available:

- **Novice**: frequently used parameters and commands are accessible.
- **Expert**: parameters and commands helpful for an advanced user are accessible.
- **Service**: all available parameters and commands are accessible.

Procedure

1 From the **Menu Bar**, select **Tools > User Preferences**.

The **User Preferences** dialog is displayed.

2 In the tree structure, select **User > Access Level**.

3 From the **Access Level** drop-down list, select the desired access level.

4 To confirm, click **OK**.

7.4.4 Entering Pre-defined Magnifications

Purpose Up to ten fixed magnifications can be entered in the **Magnification Table** for quick access during the imaging procedure.

Procedure

1 From the **Menu Bar**, select **Tools > User Preferences**.

The **User Preferences** dialog is displayed.

2 In the tree structure, click **Magnification Table**.

3 In the **Value** input field of **Magnification 1 Value**, enter the desired magnification.

4 Enter the desired magnification values for the other entries.

5 To confirm, click **OK**.

7.4.5 Tracking the User Alignment (license: USERALIGN)

Purpose The **User Align** function tracks the alignment values that each user has utilized for different operating conditions. When these conditions are used the next time, the previous alignment values are reloaded.

Values are stored in an indexed table, where the index is generated from a combination of the parameters making up the operating conditions.

Prerequisites

- Requires the license USERALIGN.

Procedure

1. From the **Menu Bar**, select **Tools > User Preferences**.
   The **User Preferences** dialog is displayed.
2. In the tree structure, select **User > User Align**.
3. From the **Enable User Align** drop-down list, select **Yes**.
4. To confirm, click **OK**.

7.4.6 Resetting Saved User Alignments

Purpose Each user can reset the indexed table that contains his or her user alignment values.

INFO

The indexed tables are automatically reset every time the cathode is changed.

Procedure

1. In the **Panel Configuration Bar**, double-click **User Settings**.
   The **User Settings** panel is displayed.
2. Click **Reset User Align**.
3. To close the panel, click **OK**.

7.5 Customizing the Data Zone

The **Data Zone** contains a special group of annotation objects which are used to indicate current parameters, such as SEM parameters, user name, time or date. You can customize the **Data Zone** to meet you needs.

7.5.1 Unlocking the Data Zone

Purpose To modify the **Data Zone**, it must be unlocked.

Procedure

1. In the **Annotation Bar**, click the **Select Annotation Object(s)** icon.
   
2. Click anywhere in the **Data Zone** to activate it.
3. Right-click the **Data Zone**.

4 From the context menu, select **Properties > Unlock this Panel**.

7.5.2 Inserting a Parameter

Prerequisites

- The **Data Zone** is unlocked.

Procedure

1 In the **Annotation Bar**, click the **EM Parameter** icon.

2 Click in the **Data Zone**.

3 From the pop-up menu, select the parameter and click **OK** to confirm.

4 Drag the new parameter to the desired position.

5 If desired, change font, size or color.

1 Right-click the parameter.

2 From the context menu, select **Properties > Font**.

3 Make your selection and click **OK** to confirm.

7.5.3 Inserting a Logo

Purpose Logos or other images to be inserted have to be in bitmap (*.bmp) or metafile (*.wmf, *.emf) format.

Prerequisites

- The **Data Zone** is unlocked.

Procedure

1 In the **Annotation Bar**, click the **Insert User Bitmap or Metafile** icon.

2 Click in the **Data Zone**.

An explorer window is displayed.

3 Select a bitmap or metafile and confirm.

4 Arrange the size and position of the inserted logo.

7.5.4 Displaying a Value without Parameter Name

Prerequisites

- The **Data Zone** is unlocked.

Procedure

1 In the **Data Zone**, click the parameter you wish to edit.

2 Right-click the parameter.

3 From the context menu, select **Properties > SEM Parameter**.

4 Activate the **Omit Parameter Name** checkbox.

7.5.5 Modifying Data Zone Properties

Purpose A number of properties can be changed for the **Data Zone** as a whole:

- Font, font style, font size and color
- Transparent or solid background
- Background color
- Line settings for the frame surrounding the **Data Zone**
- Brush settings for hatching the background

Prerequisites

- The **Data Zone** is unlocked.

Procedure

1. Click anywhere in the **Data Zone** to activate it.
2. To open the context menu, right-click the **Data Zone**.
3. Select **Properties** and click the respective property you wish to modify.

7.5.6 Saving the Customized Data Zone

Procedure

1. Click the **Data Zone** to activate it.
2. Right-click the **Data Zone**.
3. From the context menu, select **Properties > Lock this Panel**.
4. Right-click and select **Save as Data Zone**.
5. Enter a file name and save.

7.5.7 Loading the Saved Data Zone

Procedure

1. From the **Menu Bar**, select **View > Data Zone > Load User Data Zone**.
   An explorer window is displayed.
2. Select a file and confirm.

7.6 Customizing the Toolbar

The **Toolbar** is fully customizable and can be altered to fit the needs of each individual user.

INFO

Customizing the Toolbar requires the user privilege **Change Toolbar**.

7.6.1 Changing the Order of the Icons

Procedure

1. From the **Menu Bar**, select **Edit > Toolbar**.
   The **Configure Toolbar** window is displayed.
2. Select an icon.
3. To change the order, click **Move Up** or **Move Down**.
4. To insert a separator line between two toolbar icons, click **Add Separator**.

7.6.2 Adding an Icon

Purpose

In addition to the default icons contained in the Toolbar, you can add new icons and assign frequently used functions to these icons. You can assign two functions per icon: one function that is called when you left-click the icon and one function that is called when you middle-click the icon.

The following types of functions are available for assignment:

- **Commands:** comprises different commands such as 'EHT on'.
- **Dialogs:** comprises commands to call up menus and windows.
- **Macros:** comprises all macros of the standard macro library as well as individual macros which have been implemented to this library.
- **Parameters:** comprises different commands to read or set important parameters of the FESEM.
- **Special Functions:** comprises the Restore System Conditions and Save System Conditions routines.
- **Toggle:** comprises digital parameters which can be used as a switch.

Procedure

1. From the **Menu Bar**, select **Edit > Toolbar**.
   The **Configure Toolbar** window is displayed.
2. Select the row where you wish to insert the new icon.
3. Click **Add Button**.
   A new row is displayed.
4. Insert an icon.
   1. In the **Image** column, double-click the **No Icon** symbol
   2. Select an icon and confirm.
5. Assign a function.
   1. In the **Button** column, select the mouse button you wish to use for the function.
   2. Double-click in the **Type** column.
      The **Select Function** dialog is displayed.

3 From the **Type** drop-down list, select a type of function.

All functions of this type are listed in the **Name Of Function** list.

4 From the **Name Of Function** list, select the function that you wish to assign to the icon.

5 To confirm, click **OK**.

6 Double-click the **Tooltip Text** field and enter a help text.

7 If desired, repeat steps 5 and 6 for the other mouse button.

7.6.3 Assigning a Menu to an Icon

Purpose In addition to assigning a function to an icon, you can also add a menu to an icon and assign functions to the menu. In this case, the functions can be selected from a drop-down list to the right of the icon.

Procedure

1 From the **Menu Bar**, select **Edit > Toolbar**.

The **Configure Toolbar** window is displayed.

2 Double-click in the **Menu** column of the row you wish to edit.

The **Edit Button Menu** window is displayed.

3 Click **Add**.

4 In the **Function Name** column, double-click **No Function**.

The **Select Function** window is displayed.

5 From the **Type** drop-down list, select a type of function.

All functions of this type are listed in the **Name Of Function** list.

6 From the **Name Of Function** list, select the function that you wish to add to the menu.

7 To confirm, click **OK**.

In the **Edit Button Menu** window, the new menu is displayed in the list.

8 To confirm, click **OK**.

In the **Configure Toolbar** window, the **Edit Button Menu** icon is displayed in the **Menu** column.

9 If you wish to make subsequent changes to the menu, double-click the **Edit Button Menu** icon.

7.6.4 Saving the Toolbar

Procedure

1 From the **Menu Bar**, select **Edit > Toolbar**.

The **Configure Toolbar** window is displayed.

2 Click **Save**.

3 Select **Save As**.

Alternatively, if you wish to make the toolbar available to all users, select **Save As Common Toolbar**.

4 Enter a name.

5 To confirm, click **OK**.

7.7 Customizing the Magnification Display

7.7.1 Calibrating a User-specific Magnification

Purpose In the factory, ZEISS uses certified magnification standards for the calibration of magnification. However, it is possible to carry out a user-specific calibration of the magnification. This allows the comparison with other instruments or the use of specific application settings.

Prerequisites

- Requires a user profile with the calibration privilege **Magnification**.

Procedure

1 Load a calibration standard as specimen.

2 In the **User Preferences**, select the **User Access Level Expert** or **Service**.

3 Set the acceleration voltage, working distance, and aperture size typically used for your application.

4 Optimize focus and stigmation.

5 In the **Panel Configuration Bar**, double-click **Magnification Calibration**.

The **Magnification Calibration** window is displayed.

6 From the **Cal Mode** drop-down list, select **Cal User Magnification**.

Two vertical lines are displayed on the screen.

7 Click the vertical lines and use them to mark an exactly defined distance on the image.

Refer to the documents delivered with the calibration standard.

8 Click into the **Mag Cal Actual Width** field.

9 Enter the value (µm) of the distance between the two vertical lines.

10 To confirm, click **OK**.

11 Close the **Magnification Calibration** window.

12 Place the cursor into the **Image Area** and right-click.

13 Select **User Calibration Enable**.

Now, the calculation and setting of the magnification is based on the user-specific calibration. This is symbolized by an asterisk next to the micron marker in the **Data Zone**.

14 To disable the user-specific calibration:

1 Place the cursor into the **Image Area** and right-click.

2 Deactivate the **User Calibration Enable** checkbox.

7.7.2 Calibrating an Output Device

Purpose The magnification is the ratio between the edge length of the image displayed on an output device and the edge length of the scanned range on the sample. Thus, the magnification depends on the selected output device.

If a defined range of the specimen is scanned and imaged on the monitor, the magnification corresponds to the value X_1. If the same specimen range is scanned and imaged in a Polaroid, the magnification corresponds to the value X_2. The value X_2 is 3-4 times smaller than the value X_1 (depending on the monitor size), a Polaroid being 3-4 times smaller than the image range on the screen.

When exchanging or installing an output media on a FESEM, a re-calibration is necessary if the size of the presentation or print image has been changed.

Prerequisites

- The **Data Zone** is unlocked.

Procedure

1. In the **User Preferences**, select the **User Access Level Expert** or **Service**.
2. In the **Panel Configuration Bar**, double-click **Magnification Calibration**.
   The **Magnification Calibration** window is displayed.
3. From the **Cal Mode** drop-down list, select **Cal Output Dev**.
   Two vertical lines are displayed on the screen.
4. Click the vertical lines and use them to mark an exactly defined distance on the image.
   Refer to the documents delivered with the calibration standard.
5. Click into to the **Output Dev cal actual** field.
6. Enter the value (mm) of the distance between the two vertical lines.
7. To confirm, click **OK**.
8. Close the **Magnification Calibration** window.

7.8 Displaying the Installed Licenses

Purpose The licenses installed on your FESEM can be displayed from the SmartSEM Administrator.

Prerequisites

- Requires **Supervisor** privileges or higher.

Procedure

1. From the Windows Start menu, select **Programs > SmartSEM > SmartSEM Administrator**.

   The **SmartSEM Administrator Log on** window is displayed.

2. Enter user name and password.
3. To confirm, click **OK**.
4. The **SmartSEM Administrator** window is displayed showing the user list.
5. Click **Licences**.

   All installed software licenses are displayed in a window.

   The checkboxes in the **Standard** column indicate the standard licenses.

   The checkboxes in the **Enabled** column indicate which licenses are active.

6. To sort the list according to part numbers, sales codes or descriptions, click the respective column title.

8 Working with Additional Application Software

8.1 Remotely Controlling the Microscope

8.1.1 Controlling the Microscope via RS232 (license: REMCON)

Purpose The program RemCon32 enables you to remotely control the FESEM via the serial interface (RS232). It is possible to read or control specific parameters of the FESEM. This option is especially useful if an EDX/WDX system is attached to the FESEM.

Prerequisites

- SmartSEM is started.

Procedure

1. From the Windows Start menu, select **Programs > SmartSEM > RemCon32**.
2. Enter your username and password.

   The **RemCon32** window is displayed.
3. From the menu, select **Comms > Settings**.
4. Enter the port settings.
5. To open the port automatically after start-up and to minimize the window, activate the **Open port and minimise** checkbox.
6. To confirm, click **OK**.
7. To display the transmitted commands and replies, from the menu, select **Comms > Echo On**.

INFO

For test purposes it can be helpful to use RemCon 32 in local mode.

- From the menu, select **Comms > Local Mode**.
- Enter commands and queries manually.

  If correct communication is possible, the respective reply is displayed in the window and the command is executed in the FESEM user interface.

8.1.2 Controlling the Microscope via a Windows Remote Desktop Connection (license: REMOTESEM)

Remote operation of the FESEM is possible using the Windows Remote Desktop Connection feature.

See the Windows help on Using Remote Desktop Connection or contact your network administrator for information on configuring Windows Remote Desktop Connection to operate over your network.

To see the live microscope image via a remote connection, Image Capture Mode must be turned on. Image Capture Update Frequency should be set to the minimum value of 100 ms, which is only available if the REMOTESEM license is present.

Remote SEM requires a minimum of 10 Mbps network bandwidth for useable operation, but a 100 Mbps LAN connection is recommended for true real time remote operation. If bandwidth is limited, avoid fast scan rates and use reduced raster when possible to minimize network traffic.

8.2 Communicating with the Camelot Software (license: KNIGHTS CAMELOT)

Purpose The Knights Camelot software is a CAD navigation tool for locating specific features on a semiconductor die. It works by registering the specimen with the design of the die to allow the CAD image and SEM images to be synchronized to the same field of view. It is also possible to overlay the image with parts of the design.

Prerequisites

- Requires the license KNIGHTS CAMELOT.

Procedure

1. From the **Menu Bar**, select **Tools > Camelot Interface**.
   The **Camelot Properties** panel is displayed.
2. Click **Start Listening**.
   The indicated state changes from **Waiting** to **Listening**.

8.3 Reading Wafer Defect Files (license: DEFECT-REVIEW)

Purpose Defect review is used to find defects on a wafer or mask based on the results from KLA Tencor results file.

Prerequisites

- Requires the licenses DEFECT-REVIEW, STAGEREG and CENTRE.
- Requires the KLA Tencor Resultsfile Specification V1.7.

Procedure

1. In the **Panel Configuration Bar**, double-click **Defect Review**.
   The **Defect Review** dialog is displayed.
2. To select a defect file (*.rff), click **Load**.

9 Backing up/Restoring Data

When upgrading to a new PC or when reinstalling Windows on the PC, ZEN Yellow configuration and calibration data is lost. **SmartBackup** enables you to keep the data without having to recalibrate the workstation.

9.1 Creating a Backup

Purpose When upgrading to a new PC or when reinstalling Windows on the PC, SmartSEM configuration and calibration data is lost. SmartBackup enables you to keep the data without having to recalibrate the workstation.

Procedure

1. Close the **EM Server**.
2. From the Windows Start menu, select **Programs > SmartSEM Service > SmartBackup Tool**.

   The **Smart Backup Utility** window is displayed.
3. To create a backup file, click **Backup**.
4. Enter a file name.
5. Click **Save**.

9.2 Restoring Data

Purpose Once a backup has been made, it can be restored to regain the configuration and calibration data on a new PC or new Windows installation.

Procedure

1. Close the **EM Server**.
2. From the Windows Start menu, select **Programs > SmartSEM Service > SmartBackup Tool**.

   The **Smart Backup Utility** window is displayed.
3. To select a previously saved backup file, click **Restore**.
4. Select the backup file and click **Open**.
5. To confirm, click **OK**.

   The **Restore Operation** message indicates that the restore process has completed successfully.

10 Software Reference

10.1 Airlock

Purpose The airlock is attached to the specimen chamber and can be evacuated separately for specimen transfer without venting the chamber. This speeds up the exchange of specimens.

Operating Principle In SmartSEM, the airlock is controlled by the **Airlock** panel.

Reference Access: **Panel Configuration Bar > Airlock**

Parameter	Description
Column Chamber valve	Indicates the status of the column chamber valve, which separates the gun area from the specimen chamber.
Open Column Chamber Valve **Close Column Chamber Valve**	If **EHT** is switched off, this enables you to open and close the column chamber valve.
Pump	Evacuates the airlock chamber.
Vent	Ventilates the airlock chamber: ■ The gate valve is closed. ■ The airlock chamber is ventilated with nitrogen.
Hold Vacuum	The pumps of the specimen chamber are switched off, but the airlock is not vented. The vacuum in the transfer room is preserved.
Airlock Ready	Indicates the status of the airlock.
Specimen Change	Prepares the microscope for the specimen exchange.
Resume Exchange	Restores the state before the specimen exchange.

10.2 Alignment | Focus Wobble

Purpose The focus wobble is a function that sweeps the acceleration voltage. It is used to check the aperture alignment and thus to optimize the image. If the aperture is misaligned, a shift in the X and/or Y direction can be observed. Increasing the wobble speed and amplitude can help to follow the change of focus when aligning the aperture.

Operating Principle The focus wobble is controlled via the **Control** tab.

Reference Access: **Panel Configuration Bar > Crossbeam SEM Control > Control** tab

Parameter	Description
Focus Wobble button	If clicked, the focus wobble is active in a reduced raster as displayed in the **Image Area**.
Wobble Amplitude scroll bar	Enables you to change the extent of the wobble movement if the **Focus Wobble** checkbox is activated.
Wobble Fast checkbox	Enables you to accelerate the wobble speed.

10.3 Alignment | Gun and Aperture

Purpose Alignment enables you to change hardware settings of the selected microscope parameters to improve the beam path. Gun and aperture alignment is the first step in optimizing the live image.

Operating Principle With SmartSEM, you can align the gun and the aperture using the **Navigation Box** or the left mouse button.

Reference Access: **Panel Configuration Bar > Crossbeam SEM Controls > Control** tab

Parameter	Description
Gun button	Enables you to modify the alignment of the electron beam.
Aperture button	Enables you to set the aperture alignment.

10.4 Annotations

Purpose Annotations enable you to add information seen as notes or measurements to the SEM image.

Operating Principle Annotations can be added to a saved or to a live image. The image can be saved with the annotations merged onto the image.

The following kinds of annotations are provided:

- Graphic and text

  E.g. text fields, lines, or ellipses

- Measurements and results

  E.g. parameter fields or micron markers

Reference **Annotation Management**

Access: **Menu Bar > File**

Parameter	Description
Load Annotation	Enables you to select and load annotation files that you have previously saved.
Save Annotation	Enables you to name and save all or part of the annotations added to the current image.

Reference **Annotation Handling**

Access: **Menu Bar > Edit**

Parameter	Description
Annotation	Displays the **Annotation Bar**. This toolbar provides a range of features for annotating and measuring elements of the displayed image.
Insert Annotation Text	Opens the **Annotation Caption** dialog.
Insert Point to Point Marker	Places a point to point marker, and a box displaying calculated measurements, on the image. As you position either end of the marker, the system calculates the distance between the two points, and the angle of the line between the points. You can save the marker and measurements by selecting **File menu > Save Annotation**.

Reference **Annotations Options**

Access: Right-click the image > **Annotations > Annotations Options**

INFO **Only available, if the** Select Annotation Object(s) **button of the** Annotation Toolbar **is activated.**

Parameter	Description
Annotations Options dialog	Enables you to set and save graphical properties and operating options for annotations.

Parameter	Description
	The settings of the **Annotations Options** dialog are applied to existing annotations as well. The settings on this panel are saved in a user preferences file, which is automatically restored when the user logs in.
Standard tab	Enables you to set the text fonts and colors for graphic and text annotations.
Measurement & Result tab	Enables you to set the fonts and colors for measurement and result annotations.
General tab	Enables you to save and load the following options for the **Annotation Toolbar** in a user-defined *.anp-file: ■ **Enter Select Mode on New Object** Activated: By mouse click further operations on the newly created object can be applied. Deactivated: By mouse click further instances of the same object are created. ■ **Select Objects on Creation** Activated: When an annotation object is created, it is automatically selected. ■ **Apply Object Settings to all Objects** Activated: Applies the settings immediately to all instances of objects. All subsequent objects will also be created with the desired object settings. Deactivated: Applies the settings to newly created objects. ■ **Snap to Grid** section Enables you to determine whether or not an object is snapped to a grid when moved or sized. Enables you to define the grid settings. ■ **Results (Sig-Figs.)** Defines the number of significant figures used to display distance measurements. ■ **Raster Lines** Enables you to change the appearance of raster lines. **INFO** **Only visible if the** Reduced Raster/Aperture **button of the Toolbar is activated.** ■ **Load** and **Save** the **Annotation Options** Enables you to create or load a user-defined set of annotation options by an *.anp-file.

Access: **Menu Bar > Edit > Insert Annotation Text**

Parameter	Description
Annotation Caption dialog	Enables you to edit a caption using plain text, common symbols, and system variables.
Caption	Enables you to type the text of your caption.
Word Wrap	Activates the slider at the top of the text field, which enables you to adjust the caption width.
Insert New	Enables you to add several captions to the overlay continuously, without closing the dialog. Each caption can be selected, moved, or changed.

Alternative access: Select the annotation and use the context menu to edit annotations.

INFO **The context menu, the** Menu Bar **and the** Annotations Options **dialog provide different options to handle annotations.**

Reference **Annotation Display Handling**

Access: **Menu Bar > View**

Parameter	Description
Annotation	Enables you to toggle the display of different types of annotation in the current image.

Alternatively, you can click on the image and use the context menu to hide and unhide annotations.

INFO **The context menu and the** Menu Bar **provide different options to handle the display of annotations.**

10.5 Annotations | Data Zone

Purpose The **Data Zone** is an optional part of the **Image Area**. The **Data Zone** contains a special group of annotation objects which are used to display current parameters, such as SEM parameters, user name, time, or date.

Operating Principle Each user can customize the **Data Zone**. The customized **Data Zone** can be saved and loaded as an *.adz file .

Reference Access: **Menu Bar > View > Data Zone**

Parameter	Description
Show Data Zone checkbox	Enables you to display or hide the **Data Zone**.
Display Default Data Zone	Enables you to display the standard **Data Zone**. The previously used user-defined **Data Zone** will be replaced.
Load User Data Zone	Enables you to load a previously saved user-defined **Data Zone**.
Save as Data Zone	Access: context menu Enables you to save a user-defined **Data Zone**.

10.6 Annotations | Handling

Purpose The **Annotation Bar** enables you to set modes and handle the different kinds of annotations. The **Annotation Bar** provides several tools to add notes, measurements or graphical objects to your image.

Operating Principle You can click the annotation in the **Annotation Bar** and define the placement and the size in the image. The properties of the annotation can be changed via the context menu.

Reference Access: **Menu Bar > Edit > Annotations**

Icon	Tool Tip Text	Function
	Select Annotation Object(s)	Changes the mouse mode to select an annotation via mouse click. **INFO** **Only effective, if the** Enter Select Mode on New Object **checkbox is deactivated. Access:** Context menu > Annotation Options > General **tab.** Mouse mode is then set to add a selected annotation via mouse click.
	EM Mouse Control	If activated, you are able to edit the value of an existing SEM parameter annotation. If deactivated, you are able to change the kind of SEM parameter in an existing SEM parameter annotation. You insert a SEM parameter annotation via the **Annotation SEM Parameters** dialog.
	Undo Last Edit	Cancels the last step.

Icon	Tool Tip Text	Function
	Load Annotation	Enables you to load a user-defined set of annotations. **INFO You can merge the existing annotations with an already loaded set of annotations.**
	Save Annotation	Enables you to save the current set of annotations as an *.anp-file.
	Delete All Visible Objects	Deletes all visible annotations.
	Export Area Selection	Enables you to define an image section to be saved. In order to save the image section, use the **Send to** command of the context menu.

10.7 Annotations | Image Analysis

Purpose The **Annotation Bar** enables you to analyze the image with the help of different tools, comprising vector profiles, data histograms and a TIFF data overview.

Operating Principle You can click the image analysis tool in the **Annotation Bar** and define the placement and the size in the image. The properties can be changed via the context menu.

The diagrams and features for image analysis provide the following operations:

- You can update the analysis results via **Update Results** or change the **Update Frequency** via the context menu of an object.
- You can highlight a range in the diagram by clicking and dragging the cursors of the display. If you hold the shift key while dragging one cursor, both cursors move by the same amount.
- You can copy the current data of the display to the clipboard via the context menu.

Reference Access: **Menu Bar > Edit > Annotations**

Icon	Tool Tip Text	Function
	Stored Vector Profile	Displays the profile display along a fixed measurement line on the stored image. When the line is drawn, the trace on the profile display describes the gray levels along the line. Note that the leftmost point of the line is the leftmost position on the profile display. **INFO You can apply two Stored Vector Profiles per image.**

Icon	Tool Tip Text	Function
	Stored Data Histogram	Displays the frequency distribution of gray values in the image via a data histogram. **INFO You can apply two Stored Data Histograms per image.**
	Insert TIFF Data	Enables you to insert a text field for specific SEM TIFF parameters by the **Annotation SEM TIFF Parameter** dialog. **INFO Only available if a TIFF file is loaded.**

10.8 Annotations | Measurements

License: MEASA (for enhancing the measurement capabilities)

Purpose

Measurement annotations enable you to display sizes and distances for details of the image.

Operating Principle

You can click the measurement annotation in the **Annotation Bar** and define the placement and the size in the image. The properties of the annotation can be changed via the context menu.

Measurement annotations consists of two elements:

- Objects such as a line or a circle for measurement
- Text fields to display measurement results

You can edit measurement annotations as follows:

- You can click and drag the points and lines of the annotation. The respective values are calculated and displayed in the result text field.
- You can double-click the result text field and set a fixed value. The annotation changes accordingly.

  INFO For marker annotations, fixed values are not possible.
- You can double-click a line of the annotation and adjust the set of parameters that you wish to display in the result text field via the **Measurement Object Result Panel Parameters** dialog.

  INFO If the result text field includes more than two parameters, you have to remove parameters to enter fixed values for the remaining parameters.

In the description of the single parameters, the tag **<n>** is the instance identifier.

INFO The number of instances of several measurement annotation is limited.

Reference Access: **Menu Bar > Edit > Annotations**

Icon	Tool Tip Text	Function
	Micron Marker	Enables you to add a horizontal bar which indicates the length of an object in the image. The micron marker is self-sizing. The bar has minimum and maximum lengths. If the magnification is changed and these limits would be exceeded, the represented length of the bar is changed. The length is changed to a whole number within the limits of the bar.
	Fixed Micron Marker	Enables you to add a horizontal bar which indicates a fixed size you can determine by the **Annotation Micron Measurement** dialog. The micron marker has a fixed size. If the magnification is too large, the micron marker extends off the screen. If the magnification is too low, the annotation shrinks up to a single pixel length. Edit the fixed micron marker to change the size.
	Point to Point Measure	Enables you to place a point to point marker on the image. The point to point measurement function comprises the following objects: ■ Distance between the markers: **Pa <n>** ■ Angle between the line joining the markers and the direction of scan: **Pb <n>** ■ Result text field **INFO You can apply 10 Point to Point Measurements per image.**
	Angular Measurement	Enables you to measure an angle between two objects. The angular measurement function comprises the following objects: ■ Measurement line: **Aa <n>** ■ Reference line: **Aa R <n>** ■ Result text field Indicates the angle between reference line and measurement line. Each line has a marker at the end which identifies the center of rotation. Each line can be adjusted in length, angle and position. **INFO You can apply two Angular Measurements per image.**

Icon	Tool Tip Text	Function
	Linewidth Measure	The line width measurement function is a rectangle which can be adjusted in height, width, and angle. The line width measurement function comprises the following objects: ■ First side of the rectangle: **La <n>** ■ Second side of the rectangle: **Lb <n>** ■ Angle of the first side with respect to the scan direction: **Lc <n>** ■ Area of the rectangle: **Ld <n>** ■ Result text field **INFO You can apply two Linewidth Measurements per image.**
	Radial Measure	The radial measurement function is a circle which can be adjusted in diameter. The line radial measurement function comprises the following objects. : ■ Diameter of the circle: **Da <n>** ■ Area of the circle: **Db <n>** ■ Result text field **INFO You can apply four Radial Measurements per image.**
	Width Measurement Cursors	Enables you to measure the distance for fixed width. Comprises a related pair of vertical lines. Each line can be adjusted in position. **INFO You can apply only one instance of Width Measurement Cursors per image.**
	Height Measurement Cursors	Enables you to measure the distance for fixed height. Comprises a related pair of horizontal lines. Each line can be adjusted in position. **INFO You can apply only one instance of Height Measurement Cursors per image.**
	Moveable Width Cursor	Enables you to measure the distance for variable width. Comprises a vertical measurement bar with variable length and position. **INFO You can apply 10 Moveable Width Cursors per image.**
	Moveable Height Cursor	Enables you to measure the distance for variable height. Comprises a horizontal measurement bar with variable height and position. **INFO You can apply 10 Moveable Height Cursors per image.**

10.9 Annotations | Text and Graphic

Purpose Text and graphical annotations are used to highlight or to comment details of the image.

Operating Principle You can click the annotation in the **Annotation Bar** and define the placement and the size in the image. The properties of the annotation can be changed via the context menu.

Reference Access: **Menu Bar > Edit > Annotations**

Icon	Tool Tip Text	Function
	Annotation Text	Enables you to add and edit a text field via the **Annotation Caption** dialog.
	EM Parameter	Enables you to add a parameter field via the **Annotation SEM Parameter** dialog. To display a value without parameter name, activate the **Omit Parameter Name** checkbox in the **Annotation SEM Parameter** dialog.
	Insert User Bitmap of Metafile	Enables you to add a bitmap from the file system.
	Annotation Line	Enables you to draw a line.
	Annotation Rectangle	Enables you to draw a rectangle.
	Annotation Ellipse	Enables you to draw an ellipse or a circle.
	Sticky Panel	Enables you to add a rectangle to the overlay plane onto which annotation objects can be "stuck". The rectangle can be transparent or filled with a pattern. To stick an annotation to a sticky panel, move it onto the panel. **INFO Annotations only can be stuck on a sticky panel, if the** Select Annotation Object(s) **button is activated.**
	Zone Magnification	Enables you to add a read-out of the magnification of a selected zone. Reading out the magnification can be helpful when the magnifications of different zones are not the same.

10.10 Applications | Defect Review

License: DEFECT-REVIEW, STAGEREG, CENTRE, KLA Tencor Resultsfile Specification V1.7.

Purpose Defect review is an application that enables you to find defects on a wafer or a mask based on the results from a KLA Tencor defect inspection file. Thus, defects can be reviewed and precisely classified using SEM imaging and analysis in order to resolve yield issues.

Operating Principle The **Defect Review** dialog enables you to open a wafer defect *.rff or *.001 file and view the defect list with associated images and file header details.

The defects are also visualized in a defect map. After doing a three-point registration of the wafer or mask, you can navigate to individual defects by selecting them in the defect list or map.

Reference Access: **Panel Configuration Bar > Defect Review**

Parameter	Description
Defect File section	In the **Defect File** section, the following items are available: ■ **Defect file** readout Displays the name and the path of the currently loaded file. ■ **Load** button Enables you to load a defect file. ■ **Properties** button Displays the **Properties** dialog, showing the header information stored in the defect file.
Defects section	In the **Defects** section, the following items are available: ■ **Number of Defects** readout Displays the number of defects. ■ **Wafer Map** button Displays the **Wafer Map** dialog, showing the layout of the defect on the wafer. The dialog can also be used to navigate the wafer or view defect properties. ■ **Defect List** readout Displays a list of all defects in the file, if present, their associated image and several of the defects properties.

Parameter	Description
	By double-clicking on a defect, he particle is highlighted on the wafer map and then an action is performed, determined by the settings of the radio buttons below.
Action on double-click section	In the **Action on double-click** section, the following items are available: ■ **Show images** radio button If selected and if you double-click on a defect in the defects list or on the wafer map, the **Defect Images** dialog is displayed for that defect. This option is only enabled if the defect file has an associated TIFF format file. ■ **Show details** radio button If selected and if you double-click on a defect in the defects list or on the wafer map, the **Defect Properties** dialog is displayed for that defect. ■ **Go to sample location** radio button If selected and if you double-click on a defect in the defects list or on the wafer map, the stage is moved to the defect location. ■ **Auto rotate** checkbox If activated, the stage is rotated to move the target point within the stage limits before it moves X and Y to locate the defect. ■ **Use magnification** input field Enables you to enter a magnification level that is used when moving to a defect. ■ **General spiral scan** checkbox If activated, a spiral stage scan pattern is created when moving the stage to a defect. This makes it easier to search for defects if the defect positions cannot be approached with sufficient precision. The **Stage Scanning** dialog needs to be open, with a spiral stage scan pattern set up. ■ **Spiral scan radius** input field Determines how wide a search area is created for the spiral scan.
Display Image section	In the **Display Image** section, the following items are available: ■ **Width** input field Enables you to specify the width, in pixels, of the image displayed in the defect list. ■ **Height** input field Enables you to specify the height, in pixels, of the image displayed in the defect list.

Parameter	Description
	■ **Set** button Enables you to set the values entered for width and height input fields and image select spin. ■ **Image Select Spin** input field Enables you to select which image is displayed if more than one image is associated with each defect.
Stage Registration section	In the **Stage Registration** section, the following items are available: ■ **Stage Registration** button Opens the **Stage Registration** wizard that enables you to map the defect locations to the physical stage, save this mapping and reload it. It also enables the **Goto Sample Location** option as well as the field of view and stage limits markers on the **Wafer Map** dialog. ■ **Focus Mapping** button Displays the **Focus Mapping** dialog that enables you to create a map of the tilt of the specimen surface. Using this, the defect review tool can automatically adjust the focus when moving to different points on the specimen.

Access: **Panel Configuration Bar > Defect Review > Wafer Map**

Parameter	Description
Wafer Map graphic	Displays a two dimensional layout of defects on the wafer using the following color coding: ■ The colors of the dots on the wafer are determined from the defect classification. ■ **Red lines**: Indicate the stage limits ■ **Green crosses**: Indicate the location of the stage registration points/ alignment marks ■ **Blue box**: Indicates the current field of view ■ **black box/cross** marker: Indicates the particle that is currently selected in the list
Legend list	Displays the meanings of the colors of the defects. By double-clicking on a classification you can change the selected color.

Parameter	Description
Position section	Enables you to change the area of the wafer map being viewed. In the **Position** section, the following items are available: ■ **Scal Factor** input field Determines the zoom level of the wafer map. ■ **+** button Multiplies the scale factor by 1.6, zooming into the current location. ■ **-** button Divides the scale factor by 1.6, zooming out from the current location. ■ **1:1** button Centers the wafer map and makes it fill the window. ■ **!** button Applies the scale factor entered by the user in the scale factor box. ■ **Centre X** and **Y** input fields Display the wafer coordinates of the center of the wafer window. ■ **Visible W** and **H** readouts Display the width and height of the **Wafer Map** window in wafer coordinates.

10.11 Applications | Long Distance Measurement

Purpose Long distance measurement enables you to measure distances between two points on the specimen that cannot be seen in a single field of view.

Operating Principle The recorded points can be checked. The measurement will track the stage movement, e.g. a measuring point is set to the current stage position.

Reference Access: **Panel Configuration Bar > Long Distance Measurement**

Parameter	Description
Measure From section	In the **Measure From** section, the following items are available: ■ **Use Current** button Applies the first point of interest after centering it in the image. ■ **Goto** button Enables you to check the recorded point of interest.

Parameter	Description
	■ **Crosshairs** checkbox Displays the fixed crosshairs. The lines of the fixed crosshairs intersect at the center of the image.
Measure To section	In the **Measure To** section, the following items are available: ■ **Use Current** button Applies the second point of interest after centering it in the image. ■ **Goto** button Enables you to check the recorded point of interest. ■ **Track Stage** checkbox Tracks the stage movement, i.e. the **Measure To** point is set to the current stage position.
Measurement section	In the **Measurement** section, the following distances can be displayed: ■ **Separate Distances** radio button Displays the measured distance as separate X, Y, and Z distances. ■ **Combined X & Y** radio button Displays the measured distance as combined X and Y distances. ■ **Combined X, Y & Z** radio button Displays the measured distance as combined X, Y, and Z distances, which enables the measurement of the straight line between the two points. ■ **X** / **Y** and **Z Distance** readout Displays the distance between the two points of interest.

10.12 Automated Imaging

License: AUTO_IMG_ ACQ

Purpose The purpose of the **Automated Imaging** function is to handle and acquire multiple ROIs automatically from a specimen.

Operating Principle **Automated Imaging** is configured in four consecutive steps.

Each step is represented by one of the following tabs in the **Automated Imaging** dialog:

- **Registration** tab: You set up a stage registration between the image and the stage.
- **Setup** tab: You store images of the ROIs in a controlled way.

- **Define** tab: You define ROIs.
- **Run** tab: You select detectors and execute the acquisition.

10.13 Automated Imaging | Define

License: AUTO_IMG_ ACQ

Purpose In the **Define** tab, you determine the ROIs, i.e. the specimen regions to be acquired. The ROIs are displayed in a list and in the overview image. Thus all regions are accessible and easy to handle.

Reference Access: **Panel Configuration Bar > Automated Imaging > Define** tab

Parameter	Description
Light Background checkbox	If activated, a blue frame is displayed and indicates the size and position of the current live image (field of view) with respect to the overview image.
Regions of interest section	
Delete All button	Deletes all previously defined ROIs.
Replicate All button	Copies an ROI to another stub. Only available if a holder for multiple specimens is used. You can select from a list of available stubs.
Generate button	Generates a ROI from the current scan. The current stage position and magnification are used. If **Light Background** is activated, the blue frame at its current position and magnification is added to the list of ROIs.
Load button	Loads ROIs and adds them to the list.
Save button	Saves one or more ROIs to a storage location. To save multiple ROIs, use the *CTRL* key and mouse to select them in the list or in the live image.
Undo button	Undoes the last change made to the ROIs.
Drag button	Enables you to move the overview image while the ROIs remain in position on the screen. The position of the ROIs changes with respect to the overview image.
Edit button	Enables you to modify the size and position of a ROI by selecting and modifying its frame.
Add button	Enables you to add a rectangular-shaped ROI. The aspect ratio cannot be changed.

Parameter	Description
Mag button	Opens the **Magnification** dialog that enables you to define the list of possible magnifications.
Multi checkbox	If activated, you can automatically generate a set of ROIs. Each ROI corresponds to one of the magnifications that were defined via the **Magnification** dialog. To generate the set of ROIs, click at any position in the overview image. The set of ROIs is generated around that position.
Stub section	
Stub drop-down list	If a holder for multiple specimens is used, you can select the stub, i.e. the specimen.
Name input field	Enables you to enter a meaningful name for the current stub, e.g. the type of specimen.
Set name button	Saves the name that you entered above.
Show checkbox	If activated and if a stub holder is used, the number of the current stub is displayed below the field of view that is displayed in the overview image.
Zoom checkbox	If activated, the overview image is zoomed out and all ROIs are visible. The ROI that is currently selected from the **Region/Stub/FOV** list is highlighted.
Magnification section	
Mag readout	Displays the current field of view magnification. To change the magnification, double-click the readout. The **Width** is adjusted automatically.
Width readout	Displays the current field of view width. To change the field of view width, double-click the readout and enter the width in micrometers. The magnification **Mag** is adjusted automatically.
Quick Overview checkbox	Sets the magnification to a predefined low value, i.e. the image is zoomed out.
Boundary section	The **Boundary** functions enable you to automatically generate a series of ROIs based on a shape that you draw in the overview image. Each ROI corresponds to one FOV, i.e. a specimen area that can be acquired at a time. The size of one ROI or FOV depends on the current magnification. You can control the automatic ROI generation by the type of shape that you draw and additional settings that are described below.
Drawn button	Enables you to draw a line and thus define a series of ROIs that cover the line completely. You start the generation of the ROIs by clicking **Create ROIs**.

Parameter	Description
Rectangle button	Enables you to draw a rectangle and thus define a series of ROIs that cover the rectangle completely. You start the generation of the ROIs by clicking **Create ROIs**.
Circle button	Enables you to draw a circle. You start the generation of the ROIs by clicking **Create ROIs**.
Random ROIs checkbox	If activated, you can define the number of ROIs that are generated along the drawn line or inside the drawn rectangle or circle. If the number is lower than the number of ROIs required to cover the line, circle, or rectangle, the ROIs are distributed randomly.
Create ROIs button	Creates ROIs automatically, that are based on the drawn shapes, the magnification, and, if activated, on the **Random ROIs** feature.
Delete last button	Deletes the last drawn shape.
Edit checkbox	Enables you to edit a drawn shape.

Access: **Panel Configuration Bar > Automated Imaging > Define > Region/ Stub/FOV** list

Parameter	Description
Region tab	Displays the numbers that identify the ROIs.
Stub tab	Displays the stub under investigation. Stubs are used if the overview image was taken from a holder that supports multiple pieces of specimen. Such a piece of specimen is called stub. Each stub is identified by an individual number.
FOV tab	Displays the field of view (FOV) at which the ROI is acquired.

10.14 Automated Imaging | Registration

License: AUTO_IMG_ ACQ

Purpose The registration for automated imaging is the allocation of a user-specific 2D coordinate system to an image. This registration enables you to automatically acquire the ROIs defined in the overview image.

Operating Principle To enable automated imaging, you can load an overview image from a variety of sources and then set-up a stage registration between the image and the stage.

Reference Access: **Panel Configuration Bar > Automated Imaging > Registration** tab

Parameter	Description
Manual Registration section	Enables you to set the registration manually.
Image button	Loads an externally generated image from a file that is used for defining the ROIs. This image is used as an overview image and can be considerably larger than the field of view of the microscope's live image.
Camera button	Opens the **Camera Capture** dialog. Enables you to capture an image of the specimen via an installed camera and to use this picture to define the ROIs. This image is used as an overview image and can be considerably larger than the field of view of the microscope's live image.
Edit button	Starts the **Stage Registration** wizard. As a result, the image coordinates are mapped to the stage coordinates. This enables the automated imaging of the ROIs.
Clear reg button	Cancels any previous registration between image and stage.
Load reg button	Loads a previously saved stage-image registration from a storage location.
Save reg button	Saves the current stage-image registration to a storage location.
Auto Registration section	Enables you to set the registration automatically.
Current SEM Image button	Uses the current SEM image for registration. This works automatically since stage position, scan rotation, and magnification are known to the software.
Registration Image section	Enables you to save the registration image.
Save Image button	Saves the current registration image to a storage location, including the registration data.

10.15 Automated Imaging | Run

License: AUTO_IMG_ ACQ

Purpose The **Run** tab enables you to select detectors and execute the acquisition.

Reference Access: **Panel Configuration Bar > Automated Imaging > Run** tab

Parameter	Description
Detectors multi-selection list	Enables you to define the detectors that you wish to use for acquiring the ROIs.

Parameter	Description
Auto focus at every n-th field checkbox	Enables you to perform an auto focus for every n-th ROI during acquisition. For a low number, the acquisition takes longer. A low number is recommended for a specimen that displays a high degree of topography, i.e. it differs considerably in height at different positions. For a high number, the acquisition is faster. A high number is recommended for a specimen that displays a low degree of topography, i.e. it is the same height across the entire surface.
Run button	Starts the automatic acquisition of a set of ROIs.

10.16 Automated Imaging | Setup

License: AUTO_IMG_ ACQ

Purpose The **Setup** tab enables you to store the image files in an ordered manner.

Operating Principle You define file name conventions and the storage location.

Reference Access: **Panel Configuration Bar > Automated Imaging > Setup** tab

Parameter	Description
Id input field	Use a meaningful name for the set of ROIs you wish to acquire, e.g. the name or type of the specimen. Each ROI is stored as an individual TIF file.
Image Directory button	Defines the storage location for the TIF files that contain the ROIs. The ROIs are stored according to the pattern ID-ROI-Magnification-Detector.tif, e.g. "ID1-r1-m1000-SE2.tif" ■ ID: The **Id** for the set of ROIs, as entered above. ■ Region: A number for each individual ROI. Displayed in the filename e.g. as "r1". ■ Magnification: The magnification for each individual ROI. Can differ from ROI to ROI. Displayed in the filename e.g. as "m1000". ■ Detector: The detector used for the acquisition of each individual ROI. Can differ from ROI to ROI. Displayed in the filename e.g. as "SE2".

10.17 Bakeout

Purpose Bakeout is the heating of the UHV chamber of the gun head to reduce contamination. If the gun head is completely decontaminated, a good vacuum can be constituted.

The bakeout can be applied e.g. after opening the UHV chamber or a bad vacuum remains after longer periods of shut down.

Operating Principle Baking out the gun head requires the **Supervisor** privilege and user access level **Service**.

Reference Access: **Panel Configuration Bar > Bakeout**

Parameter	Description
Bakeout drop-down list	Enables you to select the bakeout duration: ■ **Quick:** 2 h heating / 1 h cooling ■ **Overnight:** 8 h heating / 2 h cooling ■ **Weekend:** 40 h heating / 3 h cooling ■ **User:** To be defined by the operator.
Bakeout State drop-down list	Indicates the current state: ■ **Idle** ■ **Heating** ■ **Cooling**
Bakeout Start button	Starts the bakeout procedure.
Bakeout Cancel button	Aborts the bakeout procedure.
Time Remaining progress bar	Indicates the remaining bakeout duration.
State readout	Displays information about the bakeout state.
Parameter readout	Displays parameters, such as the heating/cooling parameter set.

10.18 Beam | Beam Blanking

Purpose The beam blanking is a function to interrupt the electron beam without switching the EHT off. This enables you to protect sensitive specimens.

Operating Principle You can activate the beam blanking via the **Blank** checkbox. If the **Blank** checkbox is activated, the electron beam is removed from the beam path, the specimen is not scanned any more. This function blanks/unblanks the beam with the scanning coils in the column. The optional Beam Blanker is not controlled by this checkbox.

Access: **Panel Configuration Bar > Crossbeam SEM Control > Control**

INFO **For information on the optional Beam Blanker, refer to the Instruction Manual Beam Blanker delivered with the Beam Blanker.**

10.19 Beam | Beam Offset

Purpose The beam offset is a function for adjusting the beam position. The beam offset function is helpful when shifting the image's specimen area at magnifications above 100,000 x. At this magnification range, it is generally difficult to exactly position an image feature by driving the stage. Therefore, the image of the specimen can be moved by shifting the electron beam instead of displacing the specimen itself.

Operating Principle The electron beam can be shifted in the X and Y directions using the navigation box or via the corresponding dialog in the **Status Bar**, to help pinpoint specific areas of the scanned image.

Reference Access: **Panel Configuration Bar > Beam Shift**

Parameter	Description
Mag/Focus button	Enables you to adjust magnification and working distance. Assigns magnification to the left mouse button and working distance to the middle mouse button.
Beam Shift button	Enables you to set the beam offset using the navigation box or the corresponding dialog available via the **Status Bar**. Assigns beam shift X and Y to the left mouse button.
Auto Stig button	Enables you to automatically adjust the stigmator coils to correct astigmatism in the image.

10.20 Calibration | Magnification Calibration

Purpose The magnification is the ratio between the edge length of the image displayed on an output device and the edge length of the scanned range on the specimen. When exchanging or installing an output media on a FESEM, a re-calibration is necessary if the size of the presentation or print image has been changed.

Operating Principle In the factory, ZEISS uses certified magnification standards for the calibration of magnification. However, it is possible to carry out a user-specific calibration of the magnification. This will allow the comparison with other instruments or the use of specific application settings.

If a defined range of the specimen is scanned and imaged on the monitor, the magnification corresponds to the value X1. If the same specimen range is scanned and imaged in a Polaroid, the magnification corresponds to the value X2. The value X2 is 3-4 time inferior to the value X1 (depending on the monitor size), a Polaroid being 3-4 times smaller than the image range on the screen.

INFO **The calibration of an output device is restricted to the user preferences** Expert **or** Service**.**

Reference Access: **Panel Configuration Bar > Magnification Calibration**

Parameter	Description
Cal Mode drop-down list	Enables you to select the calibration mode: ■ **Cal Mode Off**: No calibration is possible. ■ **Cal Output Dev**: Defines the magnification for an installed output device. ■ **Cal User Magnification**: Enables you to define a user-specific magnification. ■ **Cal I Probe**: Calibrates the probe current. In order to execute the calibration, click the **OK** button or select **OK** in the **Cal Mode** drop-down list after a mode is selected.
Output To drop-down list	Enables you to select the output device: ■ **Printer**: Selects the standard printer. The standard printer is only available in the **Cal I Probe** mode The default printer does not require calibration - the printer driver provides the calibration information. ■ **Display/File**: Calibrates the magnification for an output device.
Output Dev cal actual input field	Enables you to enter the value (mm) of the distance between the two vertical lines on the output device by double clicking the text on the output device. **INFO** **Only available if the** Cal Output Dev **mode is selected.**

10.21 Calibration | Probe Current

Purpose Probe current calibration quantifies the electron current on the specimen for a certain gun and column setup.

Operating Principle In order to calibrate the probe current, the Faraday cup specimen is used and the electron beam is focused onto it.

The **Probe Current Calibration** panel enables you to adjust the microscope until the actual value of the beam current equals the set value.

Reference Access: **Panel Configuration Bar > Probe Current Calibration**

Parameter	Description
Specimen I readout	Displays the actual probe current that is incident onto the specimen.
Spot checkbox	If activated, any beam scanning is deactivated. You can move the beam to the required position via beam offset.
Cal I Probe button	Initiates the set-actual comparison for the probe current and adjusts the microscope settings accordingly.
Save button	Stores the latest calibration in the software. This calibration is used until you perform and save a new calibration.
Cancel button	Restores the previous calibration if you have performed a calibration and not yet saved it.
I Probe Cal slider	Enables you to set the probe current for the calibration procedure. For optimum results, set a probe current equal to the beam current that you intend to use for future measurements.
High Resolution Mode checkbox	If activated, the high resolution mode of the column is calibrated. The software can store two calibrations in parallel: one for analytic mode and one for high resolution mode.

10.22 Clipboard

License: CLIP

Purpose The clipboard is a tool for copying images to the Windows buffer. The copied image can be used for other Windows applications with access to the buffer store. SEM images or sections of images can thus be copied to other programs without prior storage, e.g. for presentation purposes. Conversely, SEM images in the clipboard can be added to the stored image.

Operating Principle The clipboard is controlled via the **Clipboard** panel.

The **Clipboard** panel consists of two tabs:

- **Copy** tab

  You can use this tab to merge annotations, or to crop or scale down the size of the image before copying. You can also reduce or increase the resolution of the Image Store and thus alter the pixel density before copying.

- **Paste** tab

  You can use this tab to reduce the size of the image and specify an exact position for pasting. You can also reduce or increase the resolution of the image before it is loaded into the Image Store.

Reference **Copy tab**

Access: **Menu Bar > Edit > Clipboard > Copy** tab

Parameter	Description
Store Resolution drop-down list	Enables you to select a different store resolution. This alters the pixel density of the image in the Image Store.
Copy button	Enables you to copy the image to the clipboard.
Reduction drop-down list	Enables you to select the reduction factor. The list displays reduction factors 1 to 8, with factor 1 representing no reduction. The size of the object frame is reduced or enlarged according to the selected reduction factor.

Parameter	Description
Merge section	In the **Merge** section, the following items are available: ■ **Annotation** checkbox: Enables you to merge the annotation overlay with the image when copying. If you wish to include annotations to indicate the magnification level of a copied image, then, to avoid ambiguity, use a micron marker rather than the EM magnification parameter. ■ **Colour Merge** checkbox: Enables you to preserve the annotation colors when merging. If the checkbox is deactivated, the annotation is converted to a corresponding gray level and then merged.
Area section	In the **Area** section, the following items are available: ■ **Whole** checkbox: if activated, enables you to select the entire image for copying. If the checkbox is deactivated, you can alter the dimensions and position of the object frame (see **Dimensions** below). ■ **Centre** button: Positions a reduced object frame in the center of the image.
Dimensions section	Enables you to set the new position of the object frame after manually typing in **X**, **Y**, **W** (width), and **H** (height) values.

Reference **Paste tab**

Access: **Menu Bar > Edit > Clipboard > Paste** tab

Parameter	Description
Store Resolution drop-down list	Enables you to select a different store resolution. This alters the pixel density of the image when it is loaded into the Image Store. Increasing the **Store Resolution** reduces the size of the object frame. Decreasing the resolution enlarges the object frame unless it is already at maximum.
Paste button	Enables you to paste the image. The pasted image fills the object frame.
File Information readout	Displays information about the main parameters of the image.
Load at section	In the **Load at** section, the following items are available: ■ **Centre** button: Centers the object frame in the **Image Area**. ■ **Origin** button: Repositions the object frame at the **Image Area** origin.

Parameter	Description
	■ **X, Y** button: Move the object frame to the position entered in the X and Y input fields. You can also drag the object frame using the mouse.
Step Frame checkbox	Enables you to repetitively paste the image at stepped intervals in the **Image Area**, based on the image dimensions. If activated, the object frame moves to the next step position after the image is pasted.
Image Reduction drop-down list	Enables you to select the reduction factor. The list displays reduction factors 1 to 8, with factor 1 representing no reduction. The size of the object frame is reduced or enlarged according to the selected reduction factor.

10.23 Crossbeam SEM Controls

Purpose **Crossbeam SEM Controls** enable you to view and control the operating state of SEM devices and to set operating parameters.

Operating Principle The **Crossbeam SEM Control** panel comprises five tabs for central access to the main SEM functions. Several functions can also be accessed in an alternative way.

Reference Access: **Panel Configuration Bar > Crossbeam SEM Control**

Parameter	Description
Gun tab	Enables you to monitor and operate the electron gun.
Control tab	Enables you to use the following functions: ■ Select the column mode ■ Align the gun beam ■ Correct astigmatism
Stage tab	Enables you to view the current position and status of the stage, and to control stage movement.
Imaging tab	Enables you to use the following functions: ■ Select a noise reduction method ■ Assign a detector to the Image Store input signal ■ Adjust brightness, contrast and gamma settings ■ Select an Input LUT
Vacuum tab	Displays parameter readouts related to column and chamber vacuum and enables you to pump and ventilate the specimen chamber.

10.24 Crosshairs

Purpose The crosshairs can be displayed in the **Image Area** to help the user assess the relative position of objects in the image.

Operating Principle Two types of crosshairs are available:

- Fixed crosshairs

  The lines of the fixed crosshairs intersect at the center of the image.

  Access: **Menu Bar > View > Crosshairs**

- Movable crosshairs

  You can move the crosshairs dragging the handle at the intersection of the crosshairs.

  Access: **Menu Bar > View > Movable Crosshairs**

10.25 Detectors

Purpose In order to use the different kind of signals of the scanning process for imaging purposes, you need to select appropriate detectors.

Operating Principle The narrowly bundled beam of primary electrons generates different signals on the specimen surface, which can be detected by appropriate detectors.

If different internal detectors are installed and the software is loaded, you select the desired one and can adjust the signals or mix the signals. Via the LUT editor, you can apply color or gray transformation in different modes.

In the specimen chamber, a camera is mounted to monitor the interior of the chamber.

Reference Access: **Panel Configuration Bar > Crossbeam SEM Control > Imaging** tab

Detector / Active Channel section

Parameter	Description
Signal A drop-down list	Enables you to select the active signal of a detector or camera to be displayed on the monitor.
Signal B drop-down list	Enables you to select the signal of a detector to be mixed with signal A.
Settings button	Enables you to edit the settings of the currently selected detector. Only available for certain detectors.
SESI Mode checkbox	Enables you to toggle between secondary electron and secondary ion detection of the SESI detector. If activated, secondary ions are detected. Only available for the **SESI** detector.

Parameter	Description
Brightness scroll bar	Enables you to adjust the brightness manually. Only available if the **Auto** checkbox to the right of the scroll bar is deactivated.
Contrast scroll bar	Enables you to adjust the contrast manually. Only available if the **Auto** checkbox to the right of the scroll bar is deactivated.
Auto checkboxes	Enable the Auto Brightness or Auto Contrast functions which automatically adjust brightness or contrast to the target values set with the scroll bars.
Auto B Target scroll bar	Enables you to set the target value for the Auto Brightness function. Only available if the **Auto** checkbox to the right of the scroll bar is activated.
Auto C Target scroll bar	Enables you to set the target value for the Auto Contrast function. Only available if the **Auto** checkbox to the right of the scroll bar is activated.
Mixing checkbox	Enables signal mixing and detector assignment to signal B. When the feature is enabled, a portion of signal B is mixed with signal A before the signal is fed to the Image Store. Requires the SIGMIX license.
Signal scroll bar	Enables you to set the percentage of signal A while mixing. Only available if the **Mixing** checkbox is activated.
Input LUT Mode drop-down list	Controls the input signal transformation of the input signal before it reaches the Image Store. Four different transformation modes can be applied: ■ **Transparent** The Input LUT pattern is set to linear so that the signal passes through the LUT unchanged. ■ **Gamma** mode The Input LUT is set according to the Gamma parameter. This is used to increase the contrast in an image if a large part of the image detail is contained in a small interval of gray levels. Gamma values < 1 enhance details in dark regions and reduce details in bright regions. Gamma values > 1 have the inverse effect. To set the **Gamma** value, use the **SmartSEM Status** dialog accessible via **Menu Bar > View > SEM Status** . ■ **Inverse** mode The linear Input LUT is inverted so that the signal passes through the LUT with inverted contrast.

Parameter	Description
	■ **User** mode The input signal transformation is applied based on a user-defined LUT. When this option is selected, the **LUT Editor** is displayed, and you can define your own LUT patterns.

Alternative access: Detector selection, TV input selection and mixing function can be alternatively accessed via **Menu Bar > Detection**.

Collector Voltages section

INFO The parameters to be set in this section vary depending on which detector is selected.

Parameter	Description
Collector Voltage scroll bar	Enables you to set the collector bias voltage.
CCD Illum. scroll bar	Enables you to set the brightness of the CCD illumination.
ESB Grid scroll bar	Enables you to set the filtering grid voltage.
Beam sleeve Bias scroll bar	Enables you to set the beamsleeve bias voltage.

10.26 Detectors | BSD

Purpose The BSD is a pneumatically retractable Back Scattered Detector that is used for high efficiency and angle selective material characterization.

Operating Principle The BSD uses back-scattered electrons to detect contrast between areas with different chemical compositions. Detection of up to 4 channels in parallel is possible.

The BSD is adjusted by the **BSD Control** panel.

Reference **BSD Control**

Access: **Panel Configuration Bar > BSD Control**

Parameter	Description
Interactive schematics of the four quadrants	Enables you to set the mode of the detector fields by mouse click as follows: ■ **+** symbol Indicates the normal mode.

Parameter	Description
	■ **-** symbol Indicates the inverted mode. ■ no symbol Indicates that the detector field is disabled.
Apply button	Applies the settings.
BSD Gain drop-down list	Selects one of the following gain ranges: ■ Low ■ Medium ■ High ■ Very high
BSD:COMPO button	Enables you to activate compositional mode. All quadrants are in normal mode.
BSD:TOPO button	Enables you to activate topography mode. The two upper quadrants are displayed in inverted mode
BSD: Set TOPO button	Enables you to change the settings for topography mode.
BSD Auto Range checkbox	If activated, the gain is set automatically based on the signal contrast.
Equalise B/C button	Harmonizes brightness and contrast automatically.
Lock B/C checkbox	Locks the given brightness and contrast values.

10.27 Detectors | Output Configuration

Purpose Detector output configuration enables you to select the scan source and video out signal for external detector outputs on the system.

Operating Principle On each detector board, two detector outputs are fitted. Each can be configured as signal A, signal B or a specified detector name, e.g. InLens. Using the **Detector Signal Out Configuration** panel, a separate configuration can be selected for internal scan and each of the 4 external scan inputs.

Reference Access: **Panel Configuration Bar > Detector Signal Out Configuration**

Parameter	Description
Internal, **Ext 0 - Ext 3** tab	Enables you to select the scan source.
Video Out drop-down lists	Enables you to select the signal depending on the selection in the other **Video Out** drop-down lists. **INFO** **A detector signal can only be assigned to one** Video Out**.**

10.28 Detectors | SCD

Purpose The SCD detector is a stage current detector.

Operating Principle The **SCD Control** panel enables you to set detector gain according to the selected probe current.

Reference Access: **Panel Configuration Bar > SCD Control**

Parameter	Description
SCD Gain drop-down list	Enables you to select the gain range for the current. If the probe current is low, choose a high range. If the probe current is high, choose a low range.
SCD Auto Range checkbox	If activated, the gain is set automatically based on the signal contrast.
SCD Auto Level button	Enables you to set the gain automatically based on the current signal strength.

10.29 Detectors | STEM

Purpose The STEM detector is used to acquire images with diffraction contrast and compositional contrast.

Operating Principle The STEM detector catches electrons that are transmitted through an ultra thin specimen and weakly scattered electrons with a small range of angles. Depending on the material, electrons are scattered under different angles and can be detected by a STEM detector placed below the specimen. Electrons scattered under low angles are detected in the center of the STEM detector and give a bright field image. Electrons scattered under higher angles are detected by outer areas of the STEM detector and produce dark field images.

The STEM detector is adjusted by the **STEM Control** panel.

Reference Access: **Panel Configuration Bar > STEM Control**

Parameter	Description
Interactive schematics of the sections	Enables you to set the mode of the detector fields by mouse click as follows: ■ White background Indicates the normal mode. ■ Black background Indicates the inverted mode.

Parameter	Description
	■ Gray background Indicates that the detector field is disabled.
STEM Seg. Mode drop-down list	Enables you to activate one of the standard modes, including **BF** (bright field), **DF** (dark field), **ODF** (oriented dark field) and **HAAD** (high angle annular darkfield) The configuration of the sections in the selected mode is displayed in the schematics.
Save button	Enables you to save the STEM settings in a *.stem file.
Load button	Enables you to load a *.stem file from the file system.
Clear button	Enables you to reset the STEM settings.
Gain Range section	Enables you to activate one of the following gain ranges: ■ Low ■ Medium ■ High ■ Very high
Auto Gain Range checkbox	If activated, the gain is automatically set based on the signal contrast level.
Lock B/C checkbox	Locks the given brightness and contrast values.
Insert button	Pneumatically inserts the detector.

10.30 Detectors | Windowing

Purpose The windowing function enables you to display two different detector signals on the monitor.

Operating Principle The windowing function separates the **Image Area** in two zones by the reduced raster. Image modifications apply to the zone marked with the anchor symbol. Via the **Windowing** dialog, you can also invert the respective zone.

Reference Access: **Panel Configuration Bar > Windowing**

Parameter	Description
Windowing checkbox	If enabled, the windowing function is active.
Zone readout	Enables you to select the active zone via double-click: ■ **Zone 0:** Outside the reduced raster ■ **Zone 1:** Inside the reduced raster

Parameter	Description
	Image modifications apply to the zone marked with the anchor symbol.
Signal A drop-down list	Enables you to select the detector signal.
Invert A readout	Activates/deactivates the inversion of the signal of the respective zone via double-click.

10.31 Graticule

Purpose The graticule is useful for assessing relative scale and numbers of objects in the image.

Operating Principle The graticule spacing can be changed as desired.

Reference Access: **Menu Bar > View > Graticule Spacing**

Parameter	Description
Graticule space dialog	Enables you to set the distance between the graticule lines. Value range: 50 - 512.

10.32 Gun and EHT

Operating Principle When the filament current is switched on, the filament is heated up until the EHT target is reached. The electrons are extracted and accelerated onto the specimen.

The gun is controlled by the **Gun** tab and the **Status Bar**. The gun alignment is controlled by the **Control** tab.

Reference **EHT**

Access: **Menu Bar > Beam**

Parameter	Description
EHT On	Switches on the EHT. If the beam has been switched off, then the filament current is switched on and the beam is run up to the EHT target.
EHT Off	Enables you to switch off the EHT, leaving the filament current switched on. Although the beam is switched off and the EHT is at zero, the gun remains active until shutdown.
Acceleration Voltage	Enables you to alter the EHT target.

The EHT can be alternatively accessed in the following ways:

- **Status Bar**
- **Panel Configuration Bar > Crossbeam SEM Control > Control** tab

Reference **Gun**

Access: **Panel Configuration Bar > Crossbeam SEM Control > Gun** tab

Parameter	Description
EHT readout	Displays the current acceleration voltage. As the beam is running up, the EHT value increases until the EHT target value is reached.
Extractor V readout	Displays the current value of the extractor voltage.
Ext I Monitor readout	Displays the current value of the extractor current.
FIL I readout	Displays the current value of the filament heating current.
Leave Gun On at Shutdown checkbox	If activated, the gun stays on when closing the SmartSEM software and changing to STANDBY mode.
EHT Off @ Log Off checkbox	If activated, the EHT is automatically shut down when the SmartSEM software is closed.
Fil I Target scroll bar	Enables you to set the filament heating current.
Extractor V Target scroll bar	Enables you to adjust the extractor voltage. **INFO** **Requires the user privilege Extractor.**
High Res Gun Mode button	Activates the high resolution gun mode, which reduces the temperature of the Schottky field emitter as well as the extraction voltage. This leads to a reduction of the energy spread of the primary electron. This mode is especially useful at low EHT values to reduce the chromatic error of the FESEM, leading to better resolution. The probe current in high resolution gun mode is about half of that in analytic gun mode.
Analytic Gun Mode button	Activates the analytic gun mode, which is useful for analysis tasks that do not require high resolution.

Reference Access: **Panel Configuration Bar > Crossbeam SEM Control > Control** tab

Parameter	Description
Gun Align button	Enables you to set the gun alignment using the navigation box.

Gun Service panel

Access: **Menu Bar > Beam > Gun Setup**

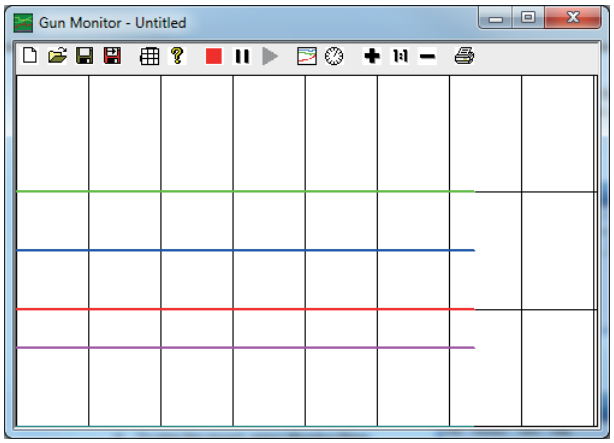
This submenu is reserved for the ZEISS service representative in order to set specific gun parameters.

Each Schottky emitter has its individual values for filament heating current and extractor voltage. The respective values are set by the ZEISS service representative after the cathode has been changed.

NOTICE **Modifications of the filament heating current affect emitter life and resolution. Therefore, any modification must be discussed with the local ZEISS service representative in advance.**

10.33 Gun Monitor

Purpose The **Gun Monitor** enables you to record and display important parameters of the SEM/FESEM at defined intervals.



Operating Principle Eight channels are available for display and recording. Six channels are predefined:

- Extractor voltage
- Extractor current
- Filament current heating
- Gun vacuum
- Liner tube voltage
- Acceleration voltage

You can change and define the channels as required.

Reference Access: **Windows start menu > Programs > SmartSEM Service > Gun Monitor**

Icon	Tool Tip Text	Function
	File new..	Clears the current data and displays the **Parameter Selection** dialog.
	Export data to .csv	Exports the data as a *.csv file.
	Viewing options	Opens the **Display Options** dialog, where you can define settings for the grid, scrolling, and stop/start.
	Select Parameters	Opens the **Parameter Setup** window, where you can define settings for the display, e.g. select the parameters to be displayed.
	Change monitoring interval	Opens the **Set Interval** window, where you can change the monitoring interval.

10.34 Live Image | Optimization

Operating Principle For the live image optimization, you have to adjust the following parameters:

- Magnification
- Focus
- Stigmation

Yon can activate the adjustment by clicking the respective button in the **Control** tab of the **Crossbeam SEM Control** panel, in the **Beam Shift** panel or in the **Toolbar**.

Reference **Magnification and Focus**

Access: **Panel Configuration Bar > Beam Shift**

Parameter	Description
Mag/Focus button	Enables you to adjust the magnification and the focus. To adjust the respective parameter, hold the respective mouse button and drag the mouse within the **Image Area**. The current parameter value and the mouse button assignment are displayed in the **Status Bar**.

Alternatively, you can activate the adjustment by clicking the **Magnification+Focus** button in the **Toolbar**.

Stigmation

Access: **Panel Configuration Bar > Crossbeam SEM Controls > Control** tab

Parameter	Description
Stigmation button	Enables you to adjust the stigmation. To adjust the stigmation, use the scroll bars or the red marker in the navigation box. Alternatively, hold the left mouse button and drag the mouse within the **Image Area**. The current parameter value is displayed in the **Status Bar**. **INFO Instead of manually adjusting the stigmation, you can use the auto stigmation function available in the** Beam Shift **panel.**

Alternatively, you can activate the adjustment by clicking the **Stigmation** button in the **Toolbar**.

10.35 Macros

Purpose Macros enable you to automatize repetitive tasks.

Operating Principle Macro execution can be initiated via the following ways:

- The user interface
- Special function keys
- Macro buttons on dialogs
- Toolbar icons
- The **Macro Editor**

Any number of macros can run simultaneously, however only one copy of a macro can be executed at a time. Information concerning running macros is displayed in the **Status Bar**.

Macros can be created, edited and debugged in the **Macro Editor**.

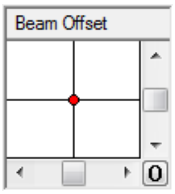
Reference For macros, the following parameters are available:

Parameter	Description
Macro Selection panel	Access: **Menu Bar > Tools > Run A Macro** Enables you to select a macro to run.

Parameter	Description
Macro Editor	Access: **Menu Bar > Tools > Macro Editor** Displays the **Macro Editor**. For more information on how to create and edit macros refer to the Instruction Manual EM Macro Editor.

10.36 Navigation Box

Purpose The navigation box provides visual indication of the range and current value of one- and two-dimensional parameters such as beam offset or stigmation.



Operating Principle The edges of the navigation box represent the limits of the variable range, e.g. -100%, +100%. The crosshairs indicate the center of the box, not necessarily the center of the range.

The current parameter value is indicated by a red marker. The parameter value can be adjusted by dragging the marker to the required position, moving the scroll bar, and clicking the arrows, respectively. The exact value is displayed in the **Status Bar**.

Value changes entered via the dialog box available in the **Status Bar** are synchronized in the navigation box.

You can add frequently used positions of the red marker to a **Predefined List**. The **Predefined List** is saved for each parameter aligned via the navigation box. The user-defined **Predefined Lists** are saved in the user directory and available on each login.

Reference For the navigation box, the following parameters are available:

Parameter	Description
Readout	Displays the name of the adjustable parameter.
Horizontal scroll bar	Enables you to adjust the X value.
Vertical scroll bar	Enables you to adjust the Y value.
0 button	Enables you to set parameter(s) to zero.

Reference **Predefined List**

Access: *Shift* + right click on the navigation box

Parameter	Description
Add input field and button	Enables you to enter a name and add the current position to the list.
Auto Add button	Enables you to add the current position to the list. A name for the position is generated automatically.
Goto button	Sets the red marker to the position defined with the selected point.
Undo all button	Resets the value defined before using the navigation box.

10.37 Plasma Cleaning

License: Plasma Cleaning

Purpose The plasma cleaner enables you to decontaminate the specimen chamber and any loaded specimens.

After a plasma cleaning cycle, the specimen surface provides optimal imaging conditions even at very low imaging voltages.

Operating Principle The plasma cleaner generates reactive gas-phase radicals in a plasma. This plasma is fully contained in the plasma cleaner unit. The radicals migrate into the specimen chamber and chemically react with unwanted hydrocarbons.

Reference Access: **Panel Configuration Bar > Plasma Cleaning**

Parameter	Description
Recipe section	Enables you to select a recipe for execution and to monitor its values. The recipe defines a specific set of parameters to decontaminate the specimen chamber. The **Schedule cleaning cycle at** option enables you to set up a time schedule for plasma cleaning. **INFO 30 seconds before the scheduled cleaning cycle a countdown is displayed. You can start the cleaning immediately or cancel.**

Parameter	Description
Plasma Cleaner section	Enables you to monitor the state of plasma cleaning. In the **Plasma Cleaner** section, the following items are available: ■ **RF On** status indicator Indicates that a plasma cleaning cycle is running and the radio frequency is on, which is necessary for the plasma to start. ■ **Plasma On** status indicator Indicates that a plasma cleaning cycle is running and plasma has ignited.
Plasma Cleaner Sequence section	Displays the steps of the currently running plasma cleaning cycle and their completion status. In the **Plasma Cleaner Sequence** section, the following items are available: ■ **View Log** button Opens the log file. ■ **Start cleaning** button Starts a plasma cleaning cycle using the current settings. ■ **Stop cleaning** button Stops the currently running plasma cleaning cycle and pumps the chamber.

10.38 Plasma Cleaning | Recipes

License: Plasma Cleaning

Purpose For plasma cleaning, different settings are required for the different kinds of specimen. You can save the sets of parameters for typical use-cases in recipes or use predefined recipes, e.g. long or quick chamber clean.

Operating Principle To execute plasma cleaning, a recipe for plasma cleaning is necessary. Use the **Plasma Cleaning** dialog to access the **Plasma Cleaning Recipe List**, where the recipes are listed. Select a recipe in the **Plasma Cleaning Recipe List** to edit or add new ones.

Reference **Plasma Cleaning Recipe Management**

Access: **Panel Configuration Bar > Plasma Cleaning > Edit Recipes**

Parameter	Description
Plasma Cleaning Recipe List dialog	Enables you to select a recipe for plasma cleaning. Indicates the set of parameters for recipes of the following types: ■ **Fixed:** Not editable and not deletable ■ **User:** Editable and deletable
Plasma Power (Watts) column	For plasma operating power, up to 20 Watts can be selected.
Plasma Time (hh:mm) column	For recipes without nitrogen purge, **Plasma Time** equals **Total Time**.
Purge Time (hh:mm) column	Displays the time span for each nitrogen purge.
Cycles column	Displays the number of cycles. One cycle consists of plasma cleaning and a nitrogen purge. This value is only present if the recipe includes one or more nitrogen purges.
Total Time (hh:mm) column	Displays the total time required to run the recipe. **Total Time** is determined by the values **Plasma Time**, **Purge Time,** and **Cycles**.

Reference **Plasma Cleaning Recipe Handling**

Access: **Panel Configuration Bar > Plasma Cleaning > Edit Recipes > Add/Edit**

Parameter	Description
Cleaning Recipe dialog	Enables you to configure a user-defined recipe for plasma cleaning or to edit an existing user-defined recipe.
Recipe name input field	Enables you to enter a name for your new recipe or to change the name of a recipe.
plasma ignition pressure scroll bar	Enables you to set the pressure at which the plasma cleaner is ignited.
plasma power input field	Enables you to set the power at which the plasma is generated. **Plasma power** can be set between 5 W and 20 W. The default value is 15 W.
plasma pressure scroll bar	Enables you to select the chamber pressure that is maintained while the plasma is active.
plasma time input field	Enables you to select the duration of one plasma cleaning cycle.

Parameter	Description
plasma total time readout	Displays the summed up time of all plasma cleaning cycles. Equals the **number of cleaning cycles** multiplied by the **plasma time**.
N2 Attached readout	Displays information whether the nitrogen supply is attached or not.
Purge checkbox	Activates the purge of the chamber. After each plasma cleaning cycle the chamber is purged with nitrogen in order to remove any residue of the plasma cleaning process. **INFO** **Only available if the nitrogen supply is attached.**
purge time input field	Enables you to select the duration of one purge cycle. **INFO** **Only available if** Purge **is selected.**
number of cleaning cycles input field	Enables you to set the number of plasma cleaning cycles. The above settings are identical for each cycle. **INFO** **Only available if** Purge **is selected.**
T pump mode checkbox	Activates the use of turbo pump to generate the vacuum.

10.39 Scanning | Additional Parameters

Purpose Scanning parameters are used to define the way an image is build up. Optimizing the scanning parameters enables you to obtain a sufficient resolution without damaging the specimen.

Operating Principle Selecting a higher resolution increases the pixel density of the Image Store, resulting in sharper image definition but a larger file size.

Reference Access: **Panel Configuration Bar > Crossbeam SEM Control > Imaging**

Parameter	Description
Store resolution drop-down list	Enables you to select a predefined store resolution. The **Store resolution** affects the cycle time of a scan. **INFO** **The number of available resolutions depends on the selected scanning mode.**
Scan Interlace scroll bar	Enables you to define the interlace factor as an integer value. Every n-th line is scanned per cycle.

Parameter	Description
Y Interlace button	Activates line interlaced scanning. Alternating rows of pixels are scanned in each cycle, depending on the selected interlace factor. Interlace is used e.g. in order to achieve a high durability of the specimen.

Access: **Menu Bar > Imaging**

Parameter	Description
Dual Channel	Enables you to display detector signals on two different monitors.
Realtime FFT	Calculates a Fast Fourier transformation of the scanned image.

10.40 Scanning | External Scan Control

Purpose The external scan control enables you to control the beam by external applications e.g for EDX.

Reference Access: **Panel Configuration Bar > Ext Scan Control**

Parameter	Description
Ext On button	Switches on the external scan control.
Ext Off button	Switches off the external scan control.
Ext. Scan Control readout	Indicates if external scan control is switched on or off.
Ext. Scan Select drop-down list	Enables you to select the desired external scan device.

10.41 Scanning | Noise Reduction

Purpose Noise reduction methods help you to increase image details and to reduce image noise.

Operating Principle The speed of the scan has an influence on the speed of image generation on the one hand and the extend of image noise on the other hand. The higher the scan speed number, the slower the scan of the specimen by the electron beam and the less the noise of the image.

Reference Access: **Panel Configuration Bar > Crossbeam SEM Control > Imaging**

Parameter	Description
Scan Speed drop-down list	Enables you to view and change the current **Scan Speed**. The **Scan Speed** is the fundamental noise reduction parameter which defines how long the beam dwells on a pixel. The dwell time and the number of scan speeds are variably defined for every noise reduction method. **INFO In order to enhance the number of scan speeds to 15, the license SCANEXP is required.**
Cycle Time read-out	Displays the duration of one cycle, depending on the selected **Scan Speed** and store resolution.
Noise Reduction drop-down list	Enables you to select a noise reduction method. The parameter field below enables you to select the respective parameter for the selected noise reduction method.
Settings button	Enables you to edit settings for the selected noise reduction method if applicable.
Dwell time drop-down list	Enables you to select the scan speed.
Scan Interlace scroll bar	Enables you to define the interlace factor as an integer value. Every n-th line is scanned per cycle.
Y Interlace checkbox	Activates line interlaced scanning. Alternating rows of pixels are scanned in each cycle, depending on the selected interlace factor. Interlace is used e.g. in order to achieve a high durability of the specimen.

Alternative access: **Menu Bar > Image > Noise Reduction**

10.42 Scanning | Noise Reduction Methods

Purpose Noise reduction methods enable you to quickly access different noise reduction strategies.

Operating Principle The signal entering the image processor is made up of two components: image and noise. Image is the signal of interest and correlates with the object being scanned, noise is random in nature. Therefore, by averaging multiple scans of the same area, the signal is reinforced, while the noise is reduced.

The various noise reduction methods are each divided into two categories:

- **Averaging:** The image is continuously scanned. If you want to stop the scan, you have to do it manually.
- **Integration:** One image is scanned and then the image automatically freezes.

Reference Access: **Panel Configuration Bar > Crossbeam SEM Control > Imaging > Noise Reduction** drop-down list

Method	Description
Frame Avg. (Frame Average)	Averaging of two or more consecutive frames: Frames are scanned continuously and the image is formed as the average of a number of successive frames. The live signal is proportionally mixed with the stored signal so that the image reflects the average of the recent frames. The proportion of live to stored can be adjusted with the parameter N which represents the number of frames to be averaged. Frame averaging is used to reduce random noise. It can be selected with any scan speed but is generally most useful at the faster speeds where a larger amount of noise reduction can be obtained without introducing a long cycle time.
Frame Int. (Frame Integrate)	Addition of two or more consecutive frames. The image automatically freezes at the end of the integration cycle. The scan speed defines the time to complete a frame and the noise reduction parameter N defines the number of frames to integrate. Frame integration is used to enhance contrast and reduce noise. It is useful when applied to beam sensitive materials, since the image can be obtained while the beam remains scanning quickly and not allowed to dwell too long on any point of the specimen. In this mode, the image is formed as the average of a number of successive frames. Not suitable when specimen drift occurs.
Line Int. (Line Integrate)	Each line is scanned a number of times before the scan moves on. The average line signal is stored and displayed. The noise reduction parameter N defines the number of times a line is averaged before moving to the next line.
Line Avg. (Line Average)	The image is built up by averaging a number of lines. Each line is scanned a number of times before the scan moves on. The average line signal is stored and displayed. Line average is used, when the result of the noise reduction needs to be seen without waiting for the cycle to complete. The line average is suitable for most applications.
Pixel Avg. (Pixel Average)	A single frame is scanned.

Method	Description
	The frame time is controlled by the scan speed parameter as follows (100 x 2^{n-1}): ■ Scan Speed Max: 25 ns per pixel ■ Scan Speed 0: 50 ns per pixel ■ Scan Speed 1: 100 ns per pixel ■ Scan Speed 2 : 200 ns per pixel ■ Scan Speed 3 : 400 ns per pixel ■ Scan Speed 4 : 800 ns per pixel ■ Scan Speed 5 : 1.6 µs per pixel ■ Scan Speed 6 : 3.2 µs per pixel ■ Scan Speed 7 : 6.4 µs per pixel ■ Scan Speed 8 : 12.8 µs per pixel ■ Scan Speed 9 : 25.6 µs per pixel ■ Scan Speed 10 : 51.2 µs per pixel ■ Scan Speed 11 : 102.4 µs per pixel ■ Scan Speed 12 : 204.8 µs per pixel ■ Scan Speed 13 : 409.6 µs per pixel ■ Scan Speed 14 : 819.2 µs per pixel ■ Scan Speed 15 : 1.6384 ms per pixel The pixel average method is suitable for specimens with good electric and thermal conductivity.
Continuous Avg. (Continuous Average)	Displays an image within which each pixel is measured repeatedly and the average signal displayed. Frames are scanned continuously and the image is formed as the average of a number of successive frames. The pixel time is determined by the dwell time parameter, which can be selected. The number of frames is determined by the scan speed (2^n). ■ Scan Speed 1: Average of 2 frames ■ Scan Speed 2: Average of 4 frames ■ Scan Speed 3: Average of 8 frames ■ Scan Speed 4: Average of 16 frames ■ Scan Speed 5: Average of 32 frames

Method	Description
	■ Scan Speed 6: Average of 64 frames ■ Scan Speed 7: Average of 128 frames ■ Scan Speed 8: Average of 256 frames The continuous average method is mostly used for stable, conductive specimens where the beam has little or no damaging effect on the specimen.
Drift Comp. Frame Int. (Drift Compensated Frame Integration)	The advantage of Drift Compensated Frame Integration over regular Frame Integration is the intelligent algorithm that identifies drift by comparing images. The drift is then compensated for. This method is ideal for customers with sub-optimal installation sites, e.g. vibrations. Select a high scan speed to be able to see the effect. All necessary microscope settings have to be made before using this noise reduction method. Otherwise, this mode will try to compensate for all changes that have been made afterwards. Here, the scan automatically stops at the end of the frame.
Drift Comp. Frame Avg. (Drift Compensated Frame Averaging)	The advantage of Drift Compensated Frame Averaging over regular Frame Integration is the intelligent algorithm that identifies errors by comparing images. These errors are then removed. Therefore, this method is also suitable when stage drift occurs. Another benefit of this method is that it simplifies focusing of fast-charging specimens at high scan speeds. A moving average of N frames is calculated. All microscope settings (focus, beam shift etc.) can be changed. If the difference between two images is too big, all previous frames are discarded and the process begins anew. This method is ideal for customers with sub-optimal installation sites, e.g. vibrations. Select a high scan speed to be able to see the effect. All necessary microscope settings have to be made before using this noise reduction method. Otherwise, this mode will try to compensate for all changes that have been made afterwards. The drift compensated frame averaging method does not work in reduced raster mode.
	Alternative access: **Menu Bar > Image > Noise Reduction**

10.43 Scanning | Rotation/Tilt

Available with the following licenses:

- License: DYNFOCUS
- License: TILTCOMP
- License: SCANROT

Purpose **Rotate/Tilt** enable you to adjust the scanning settings for a tilted specimen without image distortion and to rotate an image to improve the focusing of an area on a specimen.

Operating Principle The following functions are controlled via the **Rotate/Tilt** dialog:

- Dynamic focus
- Tilt correction
- Rotate Scan

Reference **Dynamic Focus**

Access: **Menu Bar > Scanning > Dynamic Focus > Rotate/Tilt** dialog

Parameter	Description
Dyn.Focus checkbox	Activates the dynamic focus. The dynamic focus enables you to adapt the focus to tilted specimen surfaces.
FCF Setting scroll bar	Frame Corrected Focus (FCF) enables you to adjust the dynamic focus to bring the extremes of a tilted specimen into focus.

Reference **Tilt Correction**

Access: **Menu Bar > Scanning > Rotate / Tilt > Rotate/Tilt** dialog

Parameter	Description
Tilt.Corrn. checkbox	Activates tilt correction. If a specimen presents a high tilt angle, the electron beam scans a larger part of the specimen in tilt direction to reduce distorted.
Tilt Angle scroll bar	Enables you to adjust the tilt angle, in order to correct the foreshortening effect of highly tilted specimens.

Reference **Scan Rotation**

Access: **Menu Bar > Scanning > Rotate / Tilt > Rotate/Tilt** dialog

Parameter	Description
Scan.Rot checkbox	Activates scan rotation. This function enables you to rotate the image electronically by rotating the scan direction.
Scan Rotation scroll bar	Enables you to rotate the scan. The scan rotates the image around the center of the **Image Area**.

10.44 Scanning | Scanning Modes

Available with the following licenses:

- SPLIT (only for Split mode)
- SPOT (only for Spot mode)
- QUAD (only for Quad mode)
- DUALMAG (only for Dual Mag mode)
- REDUCED (only for Reduced mode)

Purpose Scanning modes enable you to acquire an image of the same specimen with different detectors.

The modes correlate with specific scanning parameters, that you set individually.

Reference Access: **Menu Bar > Scanning**

Parameter	Description
Normal mode	The **Normal** mode is the complete view on the **Image Area**. The scanned image fills the **Image Area**.
Reduced mode	The **Reduced** mode is the view on a section of the **Image Area**, bordered by a frame. The live image is displayed in a frame inside the **Image Area**. The frame can be resized and positioned anywhere on the image. While reduced mode is selected, the **Image Area** outside the frame is frozen.
Split mode	The **Split** mode is a split view on the **Image Area**. The **Image Area** is split into two zones, with Zone 0 on the left and Zone 1 on the right. Different detectors can be assigned to each zone and each zone can be frozen independently of the other.

Parameter	Description
Dual Mag mode	The dual magnification mode is a split view on the **Image Area** that enables you to view part of the image in Zone 0 at an increased magnification in Zone 1. The area to be enlarged and thus the magnification factor is determined by a frame displayed in Zone 0.
Quad mode	The **Quad** mode is a split view on the **Image Area**. The **Image Area** is subdivided into four zones. Different detectors can be assigned to each zone. Quad mode is only provided for the following store resolutions: ■ 1024x768 ■ 2048x1536 ■ 3072x2304
Spot mode	The **Spot** mode is the view on a single pixel in the **Image Area**. **Spot** mode is used in conjunction with either **Normal** or **Reduced** mode. The image is frozen and the beam scans a single pixel area on the specimen. The spot is indicated by a marker which is dragged to move the spot location.
Line Scan mode	The **Line Scan** mode is the view an a single line on the **Image Area**. **Line Scan** mode is used in conjunction with normal mode. A single line is repeatedly scanned on the specimen, and a profile of the signal intensity is displayed in a profile window. The position of the line can be adjusted by dragging. While line scan mode is selected, the image outside the line is frozen. **INFO Line scan mode requires a store resolution up to and including 6144x4608.**
	The scanning modes can be alternatively accessed in the following ways: ■ **Toolbar** ■ **Panel Configuration Bar > Crossbeam SEM Control > Imaging** tab ■ Context menu in the **Image Area**

10.45 SEM | Alignment | Drift Correction

License: DRIFT CORR

Purpose The drift correction has two main applications:

- Improvement of the drive precision of the stage

  When viewing a specific image section and driving the stage to another point, a drift is often observed when moving back to the specific point.

- Long-term analysis

  If an image section is scanned for a longer time, mechanical, thermal, and electrical effects always cause a drift of the respective image section.

Operating Principle For drift correction, you have to find a striking detail of the specimen to be defined as a reference image. This detail is used to automatically readjust the stage at certain intervals.

Reference Access: **Panel Configuration Bar > Drift Correction**

Parameter	Description
Display Rectangle button	Displays a movable frame. The image range inside the frame defines the reference image for the drift correction.
Hide Rectangle button	Hides the movable frame.
Create Reference button	Enables you to acquire a reference image based on the current settings.
SEM drift status readout	■ **No reference**: Reference has not yet been set. ■ **Busy**: Busy creating reference. ■ **Ready**: Reference has been created. The **Do SEM Drift Corrn** button is activated automatically.
Do SEM Drift Corrn button	Starts the SEM drift correction.
Drift Max. Pix. Error scroll bar	Determines the largest admissible pixel distance between the current image and the reference image.
Drift Min. Conf scroll bar	Enables you to set the minimum confidence level for the correctness of returned drift values. **INFO The minimum confidence should not lie under 25%. Very high values make it unlikely that an image would match with that strength of correlation.**
Drift Max. Tries scroll bar	Enables you to set the maximum number of tries when comparing the current image and the reference image. If more tries are required to find a matching image, then the system assumes that the drift correction is not working and ignores it until the next drift interval.

Parameter	Description
Default Settings button	Restores the default settings.
Periodic Drift Correction checkbox and **Period(s)** input field	Enable you to schedule a periodic drift correction. A drift correction is carried out every time the set time span in seconds has expired. Only available after a reference has been created.
Beam Shift section	In the **Beam Shift** section, you can control the following items: ■ **X /Y** readouts: Display the current beam shift. ■ **Zero Beam Shift** button: Sets the X/Y beam shift to zero. ■ **Go to Reference** button: Moves the specimen stage to the reference point.
Use Stage checkbox	If activated, only the stage is used for drift correction. If deactivated, stage and beam offset are used.
Field Search checkbox	If activated, the reference point is searched in a larger field outside the rectangle. Recommended in case of stronger drift.
Auto Brightness checkbox	If activated, the **Auto Brightness** is activated to optimize image recognition.

10.46 SEM | Image Acquisition | Color Mode

Purpose The color mode enables you to convert and combine signals from two different detectors and display a live false-color image.

Operating Principle The **Signal A** detector determines the overall level of the displayed signal. The **Signal B** detector determines the color. Typically, the **Signal B** detector is a backscattered electron detector providing information about the material composition of the specimen.

Reference Access: **Panel Configuration Bar > Colour Mode**

Signal A **Section**

Parameter	Description
Signal A drop-down list	Enables you to select a detector for signal A.
Brightness A scroll bar	Enables you to set the brightness of signal A.
Contrast A scroll bar	Enables you to set the contrast of signal A.

Signal B **Section**

Parameter	Description
Signal B drop-down list	Enables you to select a detector for signal B.
Brightness B scroll bar	Enables you to set the brightness of signal B.
Contrast B scroll bar	Enables you to set the contrast of signal B.

Colour Mode **Section**

Parameter	Description
Colour Mode drop-down list	Enables to select the color mode: ■ **Off**: No color mode is used. ■ **2 LUT**: Two different colors are used depending on whether the value of a pixel is greater than or less than 127. The two colors are chosen using the **RGB** checkboxes labelled 1 and 2. ■ **4 LUT**: Four different colors are used, one each for pixels in the range 0-63, 64-127, 128-191 and 192-255. The four colors are chosen using the **RGB** checkboxes labelled 1, 2, 3 and 4.
RGB checkboxes	If activated, the corresponding color is used in the **2 LUT** or **4 LUT** color mode.

10.47 SEM | Image Acquisition | Histogram

Definition The image histogram is a graphical representation of the intensity distribution of an image. The intensity is represented by the pixel value. For each pixel value, the number of pixels in an image is counted. In the image histogram, the horizontal axis represents the pixel value and the vertical axis represents the number of pixels with that pixel value.

Purpose The **Histogram** function is used to improve contrast in images.

Operating Principle By improving the local contrast of an image, image details can be emphasized.

The **Histogram** function uses an adaptive method to compute several histograms, each corresponding to a distinct section of the image, and uses them to redistribute the lightness values of the image.

For optimized representation of the specimen, the distribution of pixel values should cover the full width of the histogram at fast scan speeds.

Reference Access: **Panel Configuration Bar > Histogram**

Parameter	Description
Equalise button	Displays the equalized image in the **Image Area**. The image is automatically frozen.
Show Original / Show Processed button	Toggles between the original and the processed image in the **Image Area**.
Num Regions slider	Sets the number of regions for calculating a new histogram of the frozen image displayed on top of the original histogram.
Clip Limit slider	Sets the limit value for the clipping of image content. All information above this limit value is clipped and therefore not visible in the equalized image.

10.48 SEM | Image Acquisition | Image Files

Purpose Image files enable you to store previously acquired and /or processed images together with your annotations.

Operating Principle Acquired images can be saved as *.tif files to a storage location. For quick access, images can be copied to the buffers displayed in the **Thumbnails Panel**.

Reference Access: **Menu Bar > Image**

Parameter	Description
Copy To	Enables you to select the buffer the image is to be copied to. ■ **Buffer 1** to **Buffer 8** Enables you to store the image in the respective buffer. ■ **Next Buffer** Enables you to store the image in the next empty buffer. ■ **Merge Annotation** Enables you to merge the annotations of all images stored in the buffers.
Copy From	Enables you to select the buffer from which the image is loaded.
Find Image	Activates an automatic procedure which uses a combination of auto focus and changes in magnification to find a reasonable image.

10.49 SEM | Image Acquisition | Image Files | Export

Purpose Exported image files can be saved as *.tiff, *.jpg or *.bmp files.

Operating Principle Prior to exporting the file, you can set preferences for naming the file, and choose what information to merge with the file.

You can also choose the color settings and dimensions of the image.

Access: Right-click the image > **Send to**

Reference Save **tab**

Parameter	Description
Filename input field	Enables you to enter the file name. Use a unique file name each time, or set up a numbered series using the same file name.
Format drop-down list	Enables you to choose a pre-defined format for the file name, or to select the maximum number of characters If you choose **Photo No.**, **File No.** or **Sample ID**, a sequential number is used instead of a file name.
Next input field	Enables you to enter the next digit to be appended to the file name in a numbered series of files. **INFO** **Not available if 0 is selected in the Digits drop-down list.**
Digits drop-down list	Enables you to set the number of digits to be appended to the file name in a numbered series of files.
Merge section	In the **Merge** section, you can activate the following items: ■ **Annotation** checkbox: Merges annotation and measurement objects with the image when it is exported. ■ **Colour Merge** checkbox: Merges a colored annotation with the gray scale image, keeping the colors intact.
Sample ID input field	Enables you to enter a specimen ID.
Store Resolution drop-down list	Enables you to change the image resolution.
User Text input field	Enables you to add a comment to the export file.

Settings **tab**

Parameter	Description
Image section	In the **Image** section, the following items are available: ■ **Grey** radio button: Enables you to save the image as an 8 bit image (256 gray values). Colored SEM images which you wish to modify later within the SmartSEM user interface should be saved as gray images together with the respective color palette. ■ **24 Bit Colour *** radio button: Enables you to save the image using 16 million colors. This format cannot be imported back at a later date. ■ **16 Bit Grey **** radio button: Enables you to save the image as a 16 bit image (65536 gray values). Exclusively reserved for later image modification by means of commercial programs. ■ **Palette** checkbox: Enables you to export the color palette with the file. **INFO** **Only available for the export of *.tiff files.**
Reduction drop-down list	Enables you to partially reduce the image before export, using the selected reduction factor for the frame size.
Dimensions section	In the **Dimensions** section, the following items are available: ■ **X, Y** input fields: Enable you to enter the **X** and **Y** coordinates for the selected frame. ■ **W, H** input fields: Enable you to enter width and height values for the selected frame. ■ **Set** button: Applies the new size and position of the selected frame.
Area section	In the **Area** section, the following items are available: ■ **Whole** checkbox: If activated, enables you to export the whole image. If deactivated, only the selected frame is exported. ■ **Centre** button: Centers the object frame in the image.
JPEG Quality input field	Enables you enter the quality of your jpeg file. By default, a value of 75 is set. **INFO** **Only available for the export of *.jpeg files.**

Alternative access: *.tiff files can alternatively be exported via **Menu Bar > File > Save Image**

10.50 SEM | Image Acquisition | Image Files | Import

Purpose Importing images enables you to select and load an image file to be displayed in the **Image Area**.

INFO **Only images saved in *.tif format can be displayed.**

Reference Access: **Menu Bar > File > Load Image**

Parameter	Description
Load tab	Use the controls in this area to position the frame where the image will be loaded.
File information readout	Displays basic information about the image: ■ *.tif file type, e.g. **Grayscale** or **Palette** ■ Image dimensions in pixels.
Load at section	In the **Load at** section, the following items are available: ■ **Centre** button: Centers the frame inside the image. ■ **Origin** button: Positions the frame at the top left corner of the image. ■ **X, Y** buttons: Position the frame at the coordinates entered in the **X** and **Y** input fields, relative to the top left corner of the image.
Image Reduction drop-down list	Adjusts the size of the frame before loading the image, 8 representing the highest degree of reduction and 1 representing no reduction. The frame size changes dynamically as different reduction values are selected. The frame size automatically adjusts when a different image resolution is selected.
Image Store drop-down list	Enables you to select a different resolution.
Fit to Image checkbox	Automatically increases the store resolution if the image is too large to load at the current resolution.
Step Frame checkbox	If activated, the image frame steps to the next frame position after the image is loaded. The step is based on the current frame size. The frame size should be reduced if stepping is to be used.
User Text readout	Displays the comment added when exporting the image.
Standard Data tab	Displays the standard set of system data that was embedded when exporting the currently selected file.
Operating Mode readout	Displays information whether the image was acquired using **Normal**, **Reduced**, or **Split** mode .

Parameter	Description
File readout	Displays the file name of the selected image .
Zone 0 output field	Displays the data regarding the full **Image Area** when **Normal** or **Reduced** operating mode is selected, or the left hand half of the image when **Split** operating mode is selected.
Zone 1 output field	Displays the data regarding the right hand half of the **Image Area** when **Split** operating mode is selected.
User Data tab	Displays annotations added by the user, which are embedded in the image file when it is exported.

Alternative access: Right-click the image > **Import TIFF**

10.51 SEM | Image Acquisition | Large Image Store Wizard

Purpose The **Large Image Store Wizard** enables you to define ROIs and to obtain images at a high pixel resolution from the current FOV of the scanned image of a specimen.

The wizard provides previews, where you can optimize the alignment of a ROI in a simple way. By the variable selection of high resolutions, you can zoom and search in an image to obtain a ROI.

Operating Principle After selecting a resolution for the high resolution image, the size of the ROI is displayed in a preview. You can move the ROI or change the resolution during processing and toggle between the steps of the wizard to optimize the image acquisition.

Reference Access: **Panel Configuration Bar > Large Image Store Wizard > Step 1 of 3**

Parameter	Description
Field of view	Displays the size of the currently selected FOV in µm. In the SmartSEM **Image Area**, an image with the resolution of 1024x768 is continuously scanned and displayed. The image in the main window equals the FOV that the final image will cover.
Store resolution	Enables you to select a store resolution and the corresponding pixel size.
Image preview	Displays a preview of the currently selected ROI.
Next button	Continues with the next step. **INFO** **If no resolution is selected, this button is grayed out.**

Access: **Panel Configuration Bar > Large Image Store Wizard > Step 2 of 3**

Parameter	Description
End of scan action section	In the **End of scan action** section, the following items are available: ■ **None** checkbox If activated, the scan continues after completion. ■ **Freeze** checkbox If activated, the scan stops after completion. ■ **Save as TIFF** checkbox If activated, the image is automatically saved to the user's image directory with the last used export *.tif settings.
Image preview	Displays the ROI as a green rectangle in the large image. The FOV and the rectangle represent the image displayed in the **Image Area**. To change the detail displayed in the large image, move the green rectangle in the in the image preview or the **Image Area**. To check the alignment, move the green rectangle to different areas. If necessary, optimize the alignment. If you have problems to obtain satisfactory results, restart the procedure by clicking Previous.
Next button	Starts the image acquisition for the ROI. Depending on the selected store resolution, the acquisition might take several minutes.

Access: **Panel Configuration Bar > Large Image Store Wizard > Step 3 of 3**

Image acquisition is being performed. You can observe the process by moving the green rectangle in the **Image preview** to a region that is already displayed. If you need to stop the scan to change any settings, click **Previous**.

The selected **End of scan action** will be performed. If you have selected **Save as TIFF**, a message that the image has been successfully saved is displayed.

10.52 SEM | Image Acquisition | LUT

Definition The LUT (look-up table) is a file that contains information for the color output of live images or saved images.

Purpose The LUT is used to change the relation of a pixel color or gray level value at the input of the LUT to the pixel color or gray level value at the output of the LUT.

A LUT can help improve the illumination of an image if a linear characteristic does not yield satisfactory results. In these cases you can try to improve the illumination of the image by adding or displacing discrete points of the characteristic line or by defining a step function.

Operating Principle There are two types of LUTs:

- Input LUT, file extension *.ulu (user-defined look-up table)

  Modifications of the input LUT affect the live image.

- Display LUT, file extension *.olt (output look-up table, output LUT) or *.dlu (defined look-up table).

  Modifications of the display LUT affect the saved image as well as the live image.

10.53 SEM | Image Acquisition | LUT | Display LUT

Definition The display LUT is a file that contains information for the color output of live or saved images.

Purpose The display LUT is used to transform the output signal from the image store to the display. The chosen settings affect the saved image as well as the live image.

Operating Principle The display LUT is used to perform a transformation on the output signal from the image store into the red, green, and blue signals for the display monitor as defined by the pattern loaded into the LUT.

The pattern is defined as points which can be manipulated using the **Add**, **Move**, and **Delete** functions.

Reference Access: **Menu Bar > Edit > Display LUT**

Icon	Tool Tip Text	Function
	Select Mode	Enables you to move a point on the pattern line.
	Add/Remove Points	Enables you to add or remove points.
	Step LUT	Enables you to generate a stepped pattern.
	Adjust Step LUT Settings	Enables you to dynamically adjust the amplitude, period and offset of a stepped pattern.
	Brightness and Contrast	Enables you to adjust brightness and contrast levels. A curve representing brightness and contrast levels is displayed in the editor.

Icon	Tool Tip Text	Function
		The shape and position of the curve is updated dynamically as you move the sliders. **INFO Clicking this button again resets any previous changes to the LUT pattern.**
	Gamma	Enables you to adjust the gamma, brightness, and contrast levels. A curve representing the gamma, brightness and contrast levels is displayed in the editor. The shape and position of the curve is updated dynamically as you move the sliders. **INFO Clicking this button resets any previous changes to the LUT pattern.**
	Grey Wedge	Enables you to set up and test LUT data by writing a grey wedge pattern to the image store.
	Grey (RGB) LUT	Enables you to switch the display to the gray scale LUT pattern.
	Select Level(s)	Enables you to check the color and gray scale levels at specific points in the LUT pattern. It can also be used to dynamically adjust the color or gray scale level of a selected point.
	Red LUT	Enables you to change the red LUT pattern.
	Green LUT	Enables you to change the green LUT pattern.
	Blue LUT	Enables you to change the blue LUT pattern.

10.54 SEM | Image Acquisition | LUT | Input LUT

Definition The input LUT is a file that contains information for the color output of live images.

Purpose The input LUT is used to transform the input signal from the detector to the image store. The edited input LUT affects all live images.

Operating Principle The input LUT is used to perform a transformation on the input signal as defined by the pattern loaded into the LUT. The pattern may be transparent (linear, no transformation), a gamma transformation or a user defined pattern created in the **Input LUT Editor** window.

The pattern is defined as points which can be manipulated using the **Add**, **Move**, and **Delete** functions.

Reference Access: **Menu Bar > Edit > Input LUT**

Icon	Tool Tip Text	Function
	Select Mode	Enables you to move a point on the pattern line.
	Add/Remove Points	Enables you to add or remove points.
	Step LUT	Enables you to generate a stepped pattern.
	Adjust Step LUT Settings	Enables you to dynamically adjust the amplitude, period and offset of a stepped pattern.
	Brightness and Contrast	Enables you to adjust brightness and contrast levels. A curve representing brightness and contrast levels is displayed in the editor. The shape and position of the curve is updated dynamically as you move the sliders. **INFO Clicking this button resets any previous changes to the LUT pattern.**
	Gamma	Enables you to adjust the gamma, brightness, and contrast levels. A curve representing the gamma, brightness and contrast levels is displayed in the editor. The shape and position of the curve is updated as you move the sliders. **INFO Clicking this button resets any previous changes to the LUT pattern.**

10.55 SEM | Image Acquisition | Output Device Magnification

Definition The output device magnification is the device specific image width of an image presenting system, e.g. LCD-monitor or polaroid format.

Purpose When you paste images into documents, you can also shrink or expand the image. The definition of output device magnification permits the displayed magnification to be correctly related to the final image.

You can predefine up to 5 image widths for your output devices.

Operating Principle In order to define the output device magnification, you can make a specimen image which has been subjected to your required processing and measure the width of the final image.

The different output devices and measured image width are controlled by the **Define User Output Device Magnification** panel.

Reference Access: **Panel Configuration Bar > Define User Output Device Magnification**

Parameter	Description
Define Text ID input fields	Enable you to define text to identify your virtual output device.
Define Image Width input fields	Enable you to enter measured image width.

10.56 SEM | Image Acquisition | Video Recording

Operating Principle A video sequence is recorded using the buttons of the **AVI Toolbar** and saved as an *.avi file.

Prior to recording a video sequence, you can set capture options.

A captured video sequence can be played using the buttons of the **AVI Toolbar**.

Reference Access: **Menu Bar > Tools > AVI Options**

Parameter	Description
Capture Filename input field	Enables you to set the file name. If you do not set a file name, the last previously captured file is automatically overwritten.
Max filesize input field	Enables you to set the maximum size of the file.
Annotation Merge checkbox	Enables you to record the annotations together wit the images in the *.avi file.
Compression button	Opens the **Compression** dialog which enables you to select the video compression options for the video codecs installed on the system. For optimum performance, it is recommended that **Full Frames (Uncompressed)** is selected as the compressor in most cases. After capture the file can be loaded into a 3rd party video editor and converted to a compressed format if required.
Reduction drop-down list	Enables you to select the reduction factor.
Capture every ms radio button	Enables you to set the capturing rate in ms.
Capture every frames radio button	Enables you to set the capturing rate in frames.
Defaults button	Enables you to reset all *.avi file capture options to default settings.

10.57 SEM | Image Processing

License: IMMATH

Purpose Image processing is used to emphasize details in images and to produce specific effects, for example 3D. Thus, the regions of an image that you are interested in are enhanced and can be analyzed.

Operating Principle You can apply image processing functions to a live image or a stored image. The changes are visible in the **Image Area**. Different filter functions, basic mathematic operations, and the detection of gray values can be used.

10.58 SEM | Image Processing | Filtering

License: IMMATH

Purpose Filters are used, for example, to sharpen or smooth the image. The 2D Filters function enables a selection of a kernel to be applied to the image in the source image store.

The function **Realtime Filtering** offers the possibility of mathematically manipulating the image during recording.

Operating Principle You can apply predefined and user-defined filters to the live image or to a buffered image.

Filtering is based on the evaluation of the gray value of a pixel, under consideration of the gray values of the neighboring pixels.

Reference **2D Filters**

Access: **Menu Bar > Image > Image Processing > 2D Filters** tab

Parameter	Description
2D Filters tab	Enables you to select from range of predefined and user-defined filters. The selected filter is applied to the live image or to a buffered image.
Source drop-down list	Selects the source of the image to which the transformation will be applied to.
Filter drop-down list	Selects a filter.
Destination drop-down list	Defines the destination to which the processed image is saved.
Execute button	Executes the selected operation.
Undo button	Aborts the settings.

For executing 2D Filters, the following predefined filters are available:

2D Filter	Description
User Defined	Applies user-specific filters. Via **Apply User Defined Filter** dialog you can edit, save and load your own filters. For a user-defined filter you allocate the following parameters in the **Edit User Defined Filter** dialog: ■ Filter Name ■ Filter Kernel Matrix ■ Division Factor
Smooth	Smoothes the image.
Sharpen	Sharpens the image.
Sharpen 2	Sharpens the image.
Horizontal edge	Detects horizontal edges in the image.
Vertical edge	Detects vertical edges in the image.
Edge Detect	Performs irregular edge detection by using a combined detection of horizontal and vertical edges in the image.
Edge Detect 2	Performs irregular edge detection by using a combined detection of horizontal and vertical edges in the image.
Laplacian	Detects edges in the image by realizing a Laplace transformation using the four neighboring pixels. The provided predefined kernel filter matrices are displayed below.
Laplacian 2	Detects edges in the image by realizing a Laplace transformation using the eight neighboring pixels.

The predefined 2D Filters express the following kernel filter matrices:

Smooth

$$\begin{pmatrix} 1 & 2 & 1 \\ 2 & 3 & 2 \\ 1 & 2 & 1 \end{pmatrix} /16$$

Sharpen

$$\begin{pmatrix} -1 & -1 & -1 \\ -1 & 9 & -1 \\ -1 & -1 & -1 \end{pmatrix}$$

Sharpen 2

$$\begin{pmatrix} 0 & -1 & 0 \\ -1 & 5 & -1 \\ 0 & -1 & 0 \end{pmatrix}$$

Horizontal Edge

$$\begin{pmatrix} 2 & 2 & 2 \\ 0 & 0 & 0 \\ -2 & -2 & -2 \end{pmatrix}$$

Vertical Edge

$$\begin{pmatrix} -2 & 0 & 2 \\ -2 & 0 & 2 \\ -2 & 0 & 2 \end{pmatrix}$$

Edge Detect

$$\left(\left| \begin{pmatrix} 1 & 2 & 1 \\ 0 & 0 & 0 \\ -1 & -2 & -1 \end{pmatrix} \right| + \left| \begin{pmatrix} -1 & 0 & 1 \\ -2 & 0 & 2 \\ -1 & 0 & 1 \end{pmatrix} \right| \right) /2$$

Edge Detect 2

$$\left(\left| \begin{pmatrix} 1 & 1 & 1 \\ 0 & 0 & 0 \\ -1 & -1 & -1 \end{pmatrix} \right| + \left| \begin{pmatrix} -1 & 0 & 1 \\ -1 & 0 & 1 \\ -1 & 0 & 1 \end{pmatrix} \right| \right) /2$$

Laplacian

$$\begin{pmatrix} 0 & -1 & 0 \\ -1 & 4 & -1 \\ 0 & -1 & 0 \end{pmatrix}$$

Laplacian 2

$$\begin{pmatrix} -1 & -1 & -1 \\ -1 & 8 & -1 \\ -1 & -1 & -1 \end{pmatrix}$$

Reference **Realtime Filtering**

Access: **Menu Bar > Image > Image Processing > Realtime Filtering** tab

Parameter	Description
Realtime Filtering tab	Enables you to apply one-dimensional filtering dynamically to a live image. The function **Realtime Filtering** offers the possibility of mathematically manipulating the image during recording. This feature is based on the evaluation of the gray value of a pixel, under consideration of the gray value of the neighboring pixels.
Filter Type drop-down list	Enables you to select the filter type.
Smoothing scroll bar	Smoothes the image.
Differentiate scroll bar	Differentiates the image.
Filter Kernel input fields	Enables you to define the coefficients for the filter kernel.

For executing Realtime Filtering, the following predefined filters are available:

Filter	Description
Smooth	Smoothes the image. Set the degree of smoothing by using the **Smoothing** scroll bar. Recommended for noisy live images.
Differentiate	Differentiates the image. Set the degree of differentiation by using the **Differentiate** scroll bar. Increases the gray value differences of the individual pixels. Accentuates fine structures and increases the focus of the image.

Filter	Description
User Defined	Applies a user-specific filter, which can be set by means of the **Filter Kernel** input fields. Being prone to interferences, this filter should not be used for very noisy images.

10.59 SEM | Image Processing | Histogram Equalization

License: IMMATH

Purpose The **Histogram Equalization** function allows a non-linear contrast optimization of the image. Ranges with frequent gray values are enlarged while ranges with rare gray values are compressed. Certain image structures can thus be accentuated whereas other structures are reduced so that the total impression of the image is modified.

Operating Principle **Histogram Equalization** uses the contents of the image store to calculate a LUT to transform the image, stretching the contrast of the image.

The equalization can either be applied to the frozen image in the store or to the live image, using the Display LUT. Filtered output can be stored in one of the image store zones, or in an empty image buffer.

Reference Access: **Menu Bar > Image > Image Processing > Histogram Equalisation** tab

Parameter	Description
Histogram Equalise: Store button	Calculates the gray scale distribution. Used for already acquired and frozen images.
Histogram Equalise: LUT button	Uses Display LUT for image transformation. Used for a live image that is being scanned.
Reset LUT button	Undoes the calculated Display LUT.

10.60 SEM | Image Processing | Image Maths

License: IMMATH

Purpose **Image Maths** functions are useful for further image enhancement, e.g. for achieving a 3D effect.

Operating Principle **Image Maths** allows for the mathematical manipulation of image content by using the kernel functions, by adding or subtracting images or by detecting gray levels. Filtered output can be stored in one of the Image Store zones, or in an empty image buffer, and can be exported as an image file.

Reference Access: **Menu Bar > Image > Image Processing > Image Maths** tab

Parameter	Description
Source drop-down list	Enables you to select the first image.
Source 2 drop-down list	Enables you to select the second image.
Operation drop-down list	Enables you to select one of the following operations: ■ **Copy To:** Copy image from source to destination ■ **Copy With Annotation:** Similar to **Copy To:** If the source is the Image Store, annotation and measurement objects are merged with the image. ■ **Exchange With:** Swap the source and destination images ■ **Add:** Add the source image to the destination image and display the result ■ **Subtract:** Subtract the destination image from the source image and display the result ■ **Min:** Display the minimum value in either the source or destination image ■ **Max:** Display the maximum value in either the source or destination image ■ **Make Stereo Pair:** Converts the source and source 2 images into a stereo pair. ■ **FFT:** Performs a fast Fourier transformation.
Destination drop-down list	Defines the buffer to which the image is stored.
Execute button	Executes the selected operation.
Undo button	Aborts the settings.

10.61 SEM | Image Processing | SmartImage

Purpose **SmartImage** is a set of advanced image processing algorithms for improving noisy and/or low contrast images.

Operating Principle This function enables you to optimize the image appearance by applying the image processing functions **Contrast**, **Topography** and **Sharpening**.

Reference Access: **Panel Configuration Bar > SmartImage**

Parameter	Description
Images	The two images on the panel display the original image (top) and the processed image (bottom). These images can be zoomed using the magnifier buttons, and the displayed area can be changed by pressing and holding the **Move Area** button, then dragging the red box which pops up.
Source and **Dest.** drop-down list	Enables you to set the source and destination buffers for the image processing.
SmartImage Contrast scroll bar	Enables you to enhance the contrast of the image, using a modified equalization routine. **INFO Over-application of contrast or topography can lead to an over-saturated output image.**
SmartImage Topography scroll bar	Enables you to enhance the topography visible in the image.
SmartImage Sharpening scroll bar	Enables you to sharpen the edges of objects in the image. **INFO Over-application of sharpening can cause artefacts (small black or white blobs) around edges.**
SmartImage Noise Reduction checkbox	Needs to be activated if the source image is noisy.
SmartImage button	Applies the final processing and copies the output to the selected buffer.

10.62 SEM | Image Processing | Threshold

License: IMMATH

Purpose The **Threshold** function is used to set threshold levels for detecting pixels matching a gray-scale range.

The**Threshold** function enables you to quickly recognize areas with pixels lying outside the defined range.

Operating Principle Each pixel in the image storage with a value outside the selected range is colored red, depending on the selected threshold type:

- **Black**: values inferior than the selected threshold value
- **White**: values inferior than the selected threshold value
- **Grey**: values superior to the black threshold or inferior to the white threshold

Reference Access: **Menu Bar > Image > Image Processing > Threshold** tab

Parameter	Description
Black Threshold drop-down list	Sets the threshold for black.
White Threshold drop-down list	Sets the threshold for white.
Image Detect drop-down list	Selects the type of threshold.
Reset LUT button	Resets the LUT.
Update button	Calculates the area fraction.
Area Fraction readout	Displays the calculated area fraction.

10.63 SEM | Images | Image Files | Print

Purpose The **Print Image** dialog enables you to select your printing preferences and print the current image.

Operating Principle You can include or exclude annotations and measurements when you print an image. Prior to printing, make sure you have set up the desired printer settings.

Reference Access: **Menu Bar > File > Print Image**

Parameter	Description
Annotation and Measurement checkbox	If activated, annotations and measurements are printed together with the image.
Colour Merge checkbox	If activated, colored annotations are merged with the gray scale image, keeping the colors intact when printing.
Fit to Page radio button	Fits the size of the image to the page.
Zoom radio button	If activated, enables the zoom function.
Zoom drop-down list	Enables you to select the zoom factor.
Printer Mag readout	Indicates the printer magnification.
Top, **Middle** and **Bottom** radio button	Enables you to select the position on the sheet.
Print No. input field	Enables you to set a number to be printed together with the image. The number is increased automatically for each further export.

Parameter	Description
Printer button	Enables you to configure the installed printer.
Print button	Prints the image.

Alternative access: **Context menu**

10.64 SEM Recipes

Definition A recipe is a file defining the specific set of parameters and state values of the FESEM.

Purpose Recipes enable you to perform repetitive tasks in exactly the same manner. E.g., if you have found a perfect set of parameters for a certain type of specimen, you can save this set of parameters to a recipe file for later use.

Operating Principle Recipes consist of two parts:

- Ingredient list

  The ingredient list defines the contents of the recipe, i.e. the combination of saved parameters. Parameters can be added and deleted.

  A parameter in a list of ingredients is undefined. To assign a value, you must create a recipe.

- Recipe File

  The recipe file contains the ingredient list together with a value that is attached to each element of the ingredient list. Recipes can be saved to a file. You can deactivate individual elements of a recipe before it is performed.

Reference **Ingredient List**

Access: **Menu Bar > File > Recipe management**

Parameter	Description
Recipe Ingredient List Editor	Enables you to load, delete and edit an ingredient file.
Insert Check button	Enables you to add a predefined check routine after a selected item in the list of ingredients, or at the end of the list if nothing is selected.
Insert Parameter button	Enables you to add a parameter to the list of ingredients. The available parameters depend on your microscope configuration.
Insert Delay button	Enables you to add a time delay after a selected item in the list of ingredients, or at the end of the list if nothing is selected. A delay can be useful if a previous parameter or check requires a settling time.

Parameter	Description
Save button	Saves the ingredient list to a file that is only available to the current user.
Save to Common button	Saves the ingredient list to a file that is available to all users of the system. **INFO** **Saving a common recipe requires the** Supervisor **privilege.**

Reference **Recipe Handling**

Access: **Menu Bar > File**

Parameter	Description
View/Edit Recipe	Displays a list of existing recipes and enables you to edit a recipe. **OK** button: Opens the parameter list of the selected recipe **INFO** **Double-click an entry to change the respective value.**
Execute Recipe	Opens the **Select and Execute Recipe** dialog: ■ **Select Recipe**: Enables you to select a recipe. ■ **Preview**: Displays a list of parameters for the selected recipe. Enables you to activate or deactivate individual parameters, before you execute the recipe. ■ **Execute** button: Runs the selected recipe.
Save Recipe	Enables you to save the current values of parameters and states as an user-defined recipe. **INFO** **To display the available ingredient lists, click the** VV **button.** The current values of the parameters and states listed in the selected ingredients list are saved in the new recipe.

Reference **Recipe Management**

Access: **Menu Bar > File > Recipe Management**

Parameter	Description
Save Common Recipe	Saves a recipe to a file that is available to all users of the system. **INFO** **Saving a common recipe requires the** Supervisor **privilege.**
Delete Recipe	Deletes the selected recipe file from the system.

Alternative access: **MiniBar**

10.65 Settings | User

Purpose The user settings enable you to adjust several values according to your individual preferences.

Operating Principle The user settings enable you to adjust the following values:

- Joystick speed
- Stigmation sensitivity
- Panel sensitivity

Reference Access: **Panel Configuration Bar > User Settings** panel

Parameter	Description
Joystick Speed scroll bar	Enables you to change the speed of the joystick.
Stig Sensitivity scroll bar	Enables you to change the sensitivity of the stigmator.
Panel Sensitivity scroll bar	Enables you to change the sensitivity of the control panel encoders such as **Focus**.
Reset User Align button	Resets the user-specific user alignment table.

10.66 Stage

Purpose The motorized eucentric specimen stage is used to navigate the specimen inside the specimen chamber.

Operating Principle The specimen stage is mounted on the chamber door. If the chamber door is closed, the specimen stage is inside of the specimen chamber.

The stage is controlled via the **Stage** menu. Prior to performing any functions, the stage has to be initialized.

Reference **Initializing the stage**

Access: **Menu Bar > Stage > Stage Initialise**

Moves the stage to known coordinates based on an initialization sequence. Ensures that absolute X, Y, and Z coordinates are correctly calibrated.

Reference **Centering a Spot or an Area / Using stage map**

License: CENTRE

Access: **Menu Bar > Stage**

Parameter	Description
Continuous Centre Point	Keeps **Centre Point** switched on.
Centre Point	Enables you to mark a spot in the image which is then automatically moved to the center of the **Image Area**.
Centre Feature	Enables you to select a feature or area in the image which is automatically centered and magnified so that the selected feature fills the complete **Image Area**.
Stage Map	Enables you to use a frozen image in the left part of the **Image Area** as an overview for the selection of interesting features on the specimen surface.

10.67 Stage | Alignment

Purpose The **Stage Horizontal Alignment** enables you to automatically move an image feature in the horizontal line.

Operating Principle A wizard is used to move the stage such that a linear feature on the specimen, identified by two points, is horizontal with the second of the two points visible on screen.

Access: **Panel Configuration Bar > Stage Horizontal Alignment**

The stage alignment can be alternatively accessed in the following ways:

- **Panel Configuration Bar > Stage Navigation > More stage functionality > Horizontal Alignment**
- **Menu Bar > View > Toolbars > Stage Navigation Bar (for wide screen users) > More stage functionality > Horizontal Alignment**

  INFO **Only available, if a wide screen monitor is used.**

10.68 Stage | Image Navigation

Purpose The image navigation enables you to navigate the stage by clicking on the image.

Operating Principle You can load an image from a variety of sources and then set-up a stage registration between the image and the stage.

There are two ways to register an image:

- Manually (**Manual Registration**)
- Automatically (**Auto Registration**)

NOTICE

Risk of collision

When using the stubscope, the stage will often be at high Z values.

- Activate the **Protected Z** checkbox and set an appropriate value for **Safe Z** whenever moving between electron axis and stubscope axis.

Reference Access: **Panel Configuration Bar > Image Navigation**

Parameter	Description
Image button	Enables you to load an externally generated image from a file.
Camera button	Opens the **Camera Capture** dialog. Enables you to capture an image of the specimen via an installed camera. This image is used as an overview image and can be considerably larger than the field of view of the microscope's live image.
Setup button	Starts the **Stage Registration** wizard. As a result, the image coordinates are mapped to the stage coordinates.
Clear Registration button	Cancels the manual registration.
Load button	Loads an image.
Save button	Saves an image.
Current SEM Image button	Loads the current SEM image for automatic registration. All parameters are known.
Save Image button	Saves the registration image.
Zoom In button	Zooms into the image.
Best Fit button	Fits the size of the image to the window.
Zoom Out button	Zooms out of the image.
Safe Navigation checkbox	If activated, **Safe Navigation** is enabled. The stage limits are dynamically modified to prevent collisions between the specimen holder and the detectors or other parts present within the chamber. Safe navigation has been extended to include movements in the Z and Tilt axes.

Parameter	Description
Protected Z checkbox	If activated, compares the current Z coordinate with the new Z coordinate when saved stage coordinates are called. If the new Z coordinate is higher than the current one, the stage drives to the new X/Y/T/R coordinates first and then to the new Z coordinate. If the new Z coordinate is lower than the current one, the stage drives to the new Z coordinate first and then to the new X/Y/T/R coordinates.
Safe Z input field	Defines the maximum Z position to be used while moving along the X and Y axes. It is recommended that you set the **Safe Z** value to the tallest specimen you have mounted.

10.69 Stage | Peltier Stage

Purpose The Peltier stage enables you to acquire images of a specimen at a defined temperature.

Operating Principle The Peltier stage is controlled by the **Peltier Stage** panel.

Reference Access: **Panel Configuration Bar > Peltier Stage**

Parameter	Description
Peltier checkbox	If activated, Peltier cooling is set to On. **INFO Only available if a Peltier cool stage is fitted and the** Peltier Fitted **checkbox in the SmartSEM administrator panel is enabled.**
Peltier Temp readout	Indicates the current temperature. **INFO Only available if a Peltier cool stage is fitted and the** Peltier Fitted **checkbox in the SmartSEM administrator is enabled.**
Peltier Target scroll bar	Enables you to adjust to the required Peltier stage temperature.

10.70 Stage | Piezo Stage

LIcense: Piezo-INTEGRATION

Purpose The Piezo stage is used for very precise positioning and recovering of a position.

Operating Principle The Piezo stage offers positioning in the nanometer range.

Reference **Positioning**

Access: **Panel Configuration Bar > Nano Motor Control**

Parameter	Description
Piezo Step Size drop-down list	Enables you to select the step size for the arrow buttons.
Arrow buttons	Enables you to move the stage in single steps of the defined size, or to continuously move the Piezo stage, when pressing one of the arrow buttons. **INFO** **Only available if the** Piezo Manual **checkbox is activated.**
Piezo Manual checkbox	Activates/deactivates the arrow buttons.
Piezo Goto X / Y readout	Enables you to enter predefined coordinates in a separate window. When clicking **OK**, the Piezo stage moves to the entered coordinates.
Fold in / **Out** button	Enables you to fold in and out the lower part of the window.
Set Exchange Position button	Enables you to set a specimen exchange position for the Piezo stage.
Piezo Initialise button	Conducts a calibration step in which the Piezo stage is moved to known coordinates. This ensures that it can be moved accurately and reproducibly to all coordinates.

Reference **Status Display**

Access: **Panel Configuration Bar > Nano Motor Control**

Parameter	Description
Piezo at X readout	Displays the current position of the Piezo stage in X direction.
Piezo at Y readout	Displays the current position of the Piezo stage in Y direction.
X/Y high/low limit hit readout	If an X/Y high/low limit is reached, a message box is displayed in red. Otherwise the box is hidden.
Piezo Exchange Defined readout	Indicates whether a specimen exchange position is defined for the Piezo stage or not. An exchange position can be set by clicking **Set Exchange Position**.

Parameter	Description
Piezo State readout	Indicates the current state of the Piezo stage: ■ **Idle**: Stage is standing still. ■ **Moving**: Stage is moving. ■ **Uninitialised**: Stage has not been initialized yet.

10.71 Stage | Point-to-Point Rotation

Purpose Rotates the stage until the specimen detail is adjusted along a user-defined line.

Operating Principle After selecting two points on the specimen, the specimen is horizontally aligned along the defined line.

INFO **For point-to point rotation to be executed, the compucentric mode for rotation and tilt has to be activated.**

Access: **FIB Toolbar > Point-to-point rotation**

10.72 Stage | Registration

License: STAGEREG

Purpose The stage registration function enables you to define parameters for a user specific 2D coordinate system.

Operating Principle In the **Stage Registration** panel, yon can define and register up to 9 alternative coordinate systems.

Reference Access: **Panel Configuration Bar > Stage Registration**

Parameter	Description
Stage List drop-down list	Enables you to select the points list you want to use. ■ **Stage List = Stage** Indicates that the current list is in absolute stage coordinates. ■ **Stage List = Reg 1 to 9** Indicates that the current list is in a user defined coordinate system (Registration List 1 to 9).
Registration State readout	Indicates the current registration state: ■ **No:** No registration data and not registered.

Parameter	Description
	■ **Yes:** Registered. ■ **Invalid:** Registration data has been loaded from file but registration not yet confirmed.
Name input field	Enables you to enter the registration name to identify the entered registration data.
Units (X,Y) input field and readout	Enables you to enter the units of the coordinate system, e.g. **cells**, **inches**. If 3-point-alignment is used, different units can be specified for X and Y.
Tilt / **Rotation** readout with **Goto** buttons	Pressing these buttons will move the tilt/rotation axis to the registration value (constant axis value).
Setup Registration button	Opens the **Stage Registration** / **Stage Registered Point** wizard, where you can specify the alignment points for the user defined coordinate system.
Load From File button	Loads a registration data *.srd file.
Save to File button	Saves the registration data as an *.srd file. This saves only the registration data, not the points list.
Register button	Computes the coordinate translation information from the registration data.
Sample at X/Y readouts	Display the stage position with respect to the registered coordinate system.
Sample Goto X/Y input fields	Enable you to enter the required stage position in terms of the registered coordinate system.
Stage Backlash checkbox	Activates the backlash function which always approaches a position from the same direction of motion. This means that for motion in the opposite direction the stage first moves past the target position and then approaches the position by moving back.
Backlash Warning checkbox	If activated, a warning is given when stage movement or registration is requested and backlash correction is not switched on.
Fine Relative Movement inner arrow buttons	The inner arrows enable you to move the stage by one unit in the users coordinate system. The movement is executed in X or Y direction of the registered coordinate system.
Coarse Relative Movement outer arrow buttons	The outer arrows enable you to move the stage by ten units in the users coordinate system. The movement is executed in X or Y direction of the registered coordinate system.

10.73 Stage | Sample Holder Gallery

Purpose The **Sample Holder Gallery** is used to inspect the dimensions of all possible specimen holders and to set the dimensions of custom stage holders.

Operating Principle The **Sample Holder Gallery** comprises a product tree and a detail view. If you have mounted a specimen holder to your microscope, navigate in the product tree to the desired type and activate the **Is Available** checkbox. The **Is available** checkbox indicates that the selected specimen holder can be installed on the system.

If you use custom stage holders, set the dimensions in the details area.

Access: **Panel Configuration Bar > Stage Navigation > Settings > Show Gallery**

10.74 Stage | Sample Type Selection

License: SAMPLE_ TYPE_SELECT

Definition The **Sample Type Selection** is a collection of predefined specimen types including the appropriate settings.

Purpose The **Sample Type Selection** makes it easy to obtain an image from any specimen quickly, i.e. a reference image, without putting any effort in selecting the operating parameters, e.g. vacuum mode, accelerating voltage probe current, and detector.

Operating Principle After selecting an appropriate specimen category from the **Sample Type Selection** with associated parameters, you can subsequently improve the quality of the initial image, by modifying the imaging parameters.

Access: **Panel Configuration Bar > Sample Type Selection**

10.75 Stage | Settings

Purpose The stage settings enable you to control the stage in a defined way, using the full range of available features as required.

Operating Principle The stage settings are controlled via the following panels:

- **Stage Nav Settings**

  Enables you to define the dimensions of the stage and its components.

- **Stage Limit**

  Enables you to define the limits for the range of travel for each motorized axis of the stage individually.

Reference **Stage Navigation Settings**

Access: **Panel Configuration Bar > Stage Nav Settings**

Parameter	Description
Show Gallery button	Opens the **Sample Holder Gallery** dialog which enables you to inspect the dimensions of all possible specimen holders, set the dimensions of specimen sample holders, and select the available specimen holders.
Holder Rot. Offset scroll bar	Enables you to select the rotation offset of the specimen holder.
Stage Centre Calibration section	In the **Stage Centre Calibration** section, the following items are available: ■ **Stage Centre X** and **Stage Centre Y** readouts: Display the parameters for stage center. ■ **Calibrate Stage Centre** button: Opens the **Calibrate Stage Centre** dialog, which is used to find the exact center of the stage rotation axis.
Stage Height Calibration section	In the **Stage Height Calibration** section, the following items are available: ■ **Lens to Flat** readout: Displays the Lens to Flat distance. Once set, the Lens to Flat distance is valid with all spacers. Select the appropriate spacer thickness to set the Lens to Flat distance. ■ **Calibrate** button: The software calculates and displays the Lens to Flat value (= Spacer Thickness + Stage At Z + Holder Height + WD).
Spacer Thickness section	Enables you to select the spacer thickness either by selecting a predefined thickness or selecting **other** and entering the desired spacer thickness in the input field.
Spacer Offset section	Enables you to select the spacer offset either by selecting a predefined offset or selecting **other** and entering the desired spacer offset in the input field.

The **Stage Nav Settings** can be alternatively accessed in the following ways:

- **Panel Configuration Bar > Stage Navigation > Settings**
- **Menu Bar > View > Toolbars > Stage Navigation Bar (for wide screen users) > Additional Settings**

  INFO **Only available, if a wide screen monitor is used.**

Reference **Stage Limits**

Access: **Panel Configuration Bar > Stage Limits**

Parameter	Description
Limit Hit readouts	Display whether the stage has reached the set limit for each dimension.
Low Limit readouts	Display the user defined low limit for each dimension.
High Limit readouts	Display the user defined high limit for each dimension.
Edit Low Limit input fields	Enable you to edit the low limit for each dimension.
Edit High Limit input fields	Enable you to edit the high limit for each dimension.
R Limits Enabled checkbox	If deactivated, the limits for rotation are ignored and the rotation is continuous. If activated, the user defined limits are applied. The stage cannot be rotated further than the defined angles.
<< Basic / Advanced >> button	Enables you to show and hide the **Advanced** section. The **Advanced** section displays the system calculated limits for each axis, as a guide.

INFO **If you try to enter a value outside the physical range of a stage travel, a warning is displayed and no action is taken.**

INFO **Full protection of the high limits is only applicable after stage initialization.**

10.76 Stage | Stage Navigation

Operating Principle The stage can be controlled in the following ways:

- **Stage Navigation** panels

  The stage can be moved along all axes with the stage navigation panels and the settings for the stage movement can be defined.

  The availability of several features depends on the stage navigation panel in use.

- **Soft Joystick**

  The stage can be moved along all axes with the soft joystick.

- **Dual joystick** (hardware)

  The stage can be moved along all axes with the dual joystick.

Reference **General Functions**

Access: **Panel Configuration Bar > Stage Navigation**

Parameter	Description
Upper display	Displays the current position of the following hardware parts: ■ SEM and FIB columns ■ Specimen holder ■ Specimen
Flip sideview button	Changes the view.
Lower display	Displays the current position of the specimen on the stage.
Zoom view slider	Enables you to zoom both displays in and out.
Stage status readout and button	Displays if the stage is initialized. The stage has to be initialized each time you start the software, thus ensuring that all absolute positions will be reached exactly.
Stage Axes input fields and buttons	Enables you to enter parameter for each stage axis. The current position is displayed as a readout.
Stage Is readout	Indicates the current state of the stage: ■ **Busy** Stage is moving towards the new position. ■ **Idle** Stage is not moving and ready to receive position commands.
STOP button / **Stage stop** button	Stops the stage immediately. Alternatively, you can press the **Break** button on the dual joystick.
Z move on Vent checkbox	If activated, drives the stage to the lowest Z position when the specimen chamber is ventilated.
Track Z checkbox	If activated, automatically re-adjusts the working distance after every change of the Z coordinate, thus enabling the scanned area to stay in focus.
Protected Z checkbox	Compares the current Z coordinate with the new Z coordinate when saved stage coordinates are called. If the new Z coordinate is higher than the current one, the stage drives to the new X/Y/T/R coordinates first and then to the new Z coordinate. If the new Z coordinate is lower than the current one, the stage drives to the new Z coordinate first and then to the new X/Y/T/R coordinates.

Parameter	Description
Safe Z input field	Defines the maximum Z position to be used while moving along the X and Y axes. It is recommended that you set the **Safe Z** value to the tallest specimen you have mounted.
Safe Navigation checkbox	Activates safe navigation. The stage limits are dynamically modified to prevent collisions between the specimen holder and the chamber wall or stage door. Safe navigation has been extended to include movements in the Z and Tilt axes.
Stage XY+Z checkbox	Affects the stage scan function. If activated, Z is moved in relation to the Z start coordinate if the stage moves in tilt direction.
Joystick Disable checkbox	If activated, disables the dual joystick. Stage navigation using the software is still possible.
Stage Disable checkbox	If activated, disables the stage.
Settings /Additional Settings button	Opens the **Stage Nav Settings** panel, which enable you to set the dimensions of the stage and its components.
Sample Holder drop-down list	Enables you to select the used sample holder. Only the specimen holders previously activated in the **Sample Holder Gallery** are available.
Specimen section	Enables you to enter **Height** and **Diameter** of the specimen.
Sample Holder Gallery	Opens the **Sample Holder Gallery** dialog which enables you to inspect the dimensions of all possible specimen holders, set the dimensions of custom specimen holders, and select the available specimen holders.

Reference **Additional Functions**

Access: **Panel Configuration Bar > Stage Navigation > More stage functionality**

Parameter	Description
Backlash > On	Switches stage backlash adjustment on or off.
Backlash > Do Backlash	Carries out an immediate backlash correction, thus enabling you to compensate for the minimal stage movement in the opposite direction after the stage has been moved and stopped.
Limits	Opens the **Stage Limits** dialog where you can browse and edit user-defined stage axis limits.

Parameter	Description
Centre Point / Feature > Stage and Beam	Enables you to use beam shift and stage movement to center the image.
Centre Point / Feature > Stage Only	Only the stage is used to center the image. The beam shift remains unchanged.
Centre Point / Feature > Beam Only	Only the beam shift is used to center the image.
Centre Point / Feature > Stage X Only	For centering the image in X direction, only the stage is used.
Centre Point / Feature > Stage Y Only	For centering the image in Y direction, only the stage is used.
Compucentric Height	Opens the **Compucentric Height** dialog where you can define the settings for the compucentric stage movement.
Horizontal Alignment	Opens the **Stage Horizontal Alignment** wizard.
Points List	Opens the **Stage Points List** dialog where you can save the coordinates of several points to be used in one microscope session.
Calibrate Stage Centre	Enables you to calibrate the rotation center of the stage.
Stage Initialise	Enables you to initialize the stage. Initialization is a calibration step in which the stage is moved to known coordinates. This ensures that the stage can be moved accurately and reproducibly to all coordinates.

The stage navigation can be alternatively accessed in the following ways:

- **Panel Configuration Bar > Crossbeam SEM Controls > Stage** tab
- **Menu Bar > Stage > Navigation**
- **Menu Bar > View > Toolbars > Stage Navigation Bar (for wide screen users)**

Reference **Soft Joystick**

Access: **Panel Configuration Bar > Soft Joystick**

Parameter	Description
Stage vector navigation box	Moves the X- and Y-axes.
Stage vector Z scroll bar	Moves the Z-axis.
Stage vector T scroll bar	Moves the T-axis. The T-axis enables you to adjust the tilt.

Parameter	Description
Stage vector R scroll bar	Moves the R-axis. The R-axis enables you to rotate the stage.
Stage vector M scroll bar	Moves the M-axis.

10.77 Stage | Stage Navigation | Compucentric Functions

License: COMPU

Purpose Compucentric functions enable you to maintain the focus when the stage is tilted or rotated, even in case of a non-eucentric stage.

Operating Principle Different calibration procedures are required before the compucentric functions can be used:

- Calibrating the rotation center of the stage
- Calibrating the compucentric height, i.e. calibrating the distance between the specimen surface and the rotation center of the tilt axis

Reference **Stage Center Calibration**

Access: **Panel Configuration Bar > Calibrate Stage Centre**

Parameter	Description
Centre: Pos X readout	Displays the last value for X.
Centre: Pos Y readout	Displays the last value for Y. Assigns beam shift X and Y to the left mouse button.
Instructions readout	Displays instructions for the operator.

The stage center calibration can be alternatively accessed in the following ways:

- **Panel Configuration Bar > Stage Navigation > Settings > Calibrate Stage Centre**
- **Menu Bar > View > Toolbars > Stage Navigation Bar (for wide screen users) > Additional Settings > Calibrate Stage Centre**

  INFO **Only available, if a wide screen monitor is used.**

Reference **Compucentric Height Calibration**

Access: **Panel Configuration Bar > Compucentric Height**

1) Centre a feature then press Read section

Parameter	Description
Read button	Processes the stage coordinates.
Stage Backslash checkbox	If activated, the stage backlash function is enabled.

2) Tilt the stage section

Parameter	Description
Go to input field	Enables you to enter the tilt angle.
Tilt button	Tilts the stage by the entered angle. This is appropriate if you know that the compucentric height is close to the correct value.
Go Back button	Reverts the tilt.
Nudge size input field	Enables you to define the nudge step.
Up and **Down** buttons	Enables you to move the stage up or down until the specimen is almost at the top of the screen.
Stage stop button	Stops the stage immediately.

3) Centre it again, and press calculate section

Parameter	Description
Compu. Height input field	Enables you to enter the compucentric height.
Compu. Tilt Error scroll bar	Enables you to adjust the computed parameter in order to optimize the result.
Calculate button	Reads the X and Y coordinates for the starting tilt and for the subsequent tilt and calculates the compucentric height. **INFO** **Make sure your feature has been centered before pressing Calculate.**

Parameter	Description
Estimate from WD button	Calculates a value of compucentric height based on the working distance and the stage geometry information stored in a *.czsh file. Because of hysteresis effects and the accuracy of the focus measurement, this is an estimate only and will not by itself produce an accurate value. If you have changed the specimen thickness a lot, this will provide a value that makes it easier to use reasonable nudge and tilt values on the second step and will help save time in measuring the compucentric height. **INFO Only available, if you have used this dialog before and saved a compucentric height.**

Alternative access: **Panel Configuration Bar > Stage Navigation > More stage functionality > Compucentric Height** button

Reference **Compucentric Mode**

Access: **Panel Configuration Bar > Crossbeam SEM Controls > Stage > Compuc. Mode** drop-down list

Mode	Description
Compuc. Mode = Off	No compucentric adjustment is made.
Compuc. Mode = Rotate	Compucentric adjustment is only made when the stage is rotated.
Compuc. Mode = Tilt	Compucentric adjustment is only made when the stage is tilted.
Compuc. Mode = Rotate/ Tilt	Compucentric adjustment is made when the stage is rotated and/or tilted.

10.78 Stage | Stage Scanning

License: STAGESCAN

Purpose The stage scanning enables you to scan a defined series of regularly distributed image fields.

This is useful when searching for particles or other objects in a large area of the specimen, as it is ensured that no part of the area of interest is omitted. Four scan patterns and several methods are available to determine the scan range.

Reference Access: **Menu Bar > Stage > Stage Scan**

Icon	Function
	Jumps to the position of the first image filed.
	Moves to the previous position.
	Moves to the next position.
	Jumps to the last position.
	Enables you to select a horizontal, vertical, or concentric scan pattern as depicted on the respective button.
Setup Wizard button	Starts the **Define Scan Fields Wizard** that enables you to set up an exactly defined series of regularly distributed image fields.

10.79 Stage Survey

License: SURVEY

Purpose The **Stage Survey** panel offers the possibility to save two different settings for magnification and working distance and to switch between these settings.

Operating Principle The following settings are available:

- **Survey Mode**: provides a survey view.
- **Resolution Image**: provides a detail view.

Reference Access: **Panel Configuration Bar > Stage Survey**

Survey Mode

Parameter	Description
Lowest Mag radio button	Automatically selects the lowest magnification for the current system conditions.
Mag ---> radio button and input field **Get Current** button	Enables you to select the required magnification level manually. You can type a number in the input field or click the **Get Current** button to use the current magnification.
WD input field	Enables you to set the required working distance.

Parameter	Description
Get Current button	You can type a value in the input field or click the **Get Current** button to use the current working distance.
Remember Changes checkbox	If activated, saves working distance settings that may be changed while focussing.
Auto Focus checkbox	If activated, activates auto focus on completion of stage movement when entering **Survey Mode**.
Macro checkbox	If activated, executes a selected macro when **Survey Mode** mode is selected.
Macro drop-down list	Enables you to select the macro you wish to use.
Survey Mode checkbox	Activates the **Survey Mode**.

Resolution Imaging

Parameter	Description
Mag input field	Enables you to select the required magnification level manually.
Get Current button	You can type a number in the input field or click the **Get Current** button to use the current magnification.
WD input field	Enables you to set the required working distance.
Get Current button	You can type a value in the input field or click the **Get Current** button to use the current working distance.
Auto Focus checkbox	If activated, activates auto focus on completion of stage movement when entering **Resolution Mode**.
Macro checkbox	If activated, enables you to execute a selected macro when entering **Resolution Mode**.
Macro drop-down list	Enables you to select the macro you wish to use.

Alternative access: **Menu Bar > Stage > Survey > Settings**

10.80 System Status | CAN Communication

Purpose: The **CAN Communication** panel displays the communication states of the subsystems EHT, vacuum, and stage for diagnostic purposes.

Reference: Access: **Panel Configuration Bar > CAN Communication**

Parameter	Description
EHT Comms Fail readout	Indicates if the CAN communication with EHT unit has failed.

Parameter	Description
Vac comms fail readout	Indicates if the CAN communication with the Vac Board has failed.
Stage comms fail readout	Indicates if the CAN communication with the Stage Board has failed.

10.81 System Status | Control Panel Status

Purpose The **Control Panel Status** panel provides a quick access to the current parameter settings and enables you to search for possible trouble sources.

Operating Principle The **Control Panel Status** panel displays internal encoder values for the knobs on the control panel.

Depending on the knob used, one of the following combinations is displayed:

- Magnification / Focus
- Stigmation X / Y
- Beam Offset X / Y
- Aperture Alignment X / Y
- Brightness / Contrast
- Scan Rotation (On): Scan Rotation / Contrast
- Scan Rotation (Off): Scan Rotation (deactivated) / Contrast

Access: **Panel Configuration Bar > Control Panel Status**

10.82 System Status | Movable Chamber Components

Purpose You can use the system status to control the dependencies between the movable components, e.g. to prevent collisions between detectors or stage.

Operating Principle Movable components inside the specimen chamber are detectors, the GIS nozzle and the stage.

The stage can be navigated in all directions. The GIS nozzle and the detectors can be inserted and retracted.

The system status of movable chamber components is controlled by the **Insert Detectors Status** panel.

Reference Access: **Panel Configuration Bar > Insert Detectors Status**

Parameter	Description
Charge Compensator (CC) section	In the **Charge Compensator (CC)** section, the following items are available: ■ **CC Status** readout Displays the current state of the CC. ■ **ChargeCom->ON** button Activates the CC. ■ **ChargeCom->OFF** button Deactivates the CC. ■ **ChargeCom. Fitted** checkbox If activated, the CC is mounted. ■ **ChargeCom. STOP** button Stops any movement of the charge compensator immediately.
Back Scatter Detector (BSD) section	In the **Back Scatter Detector (BSD)** section, the following items are available: ■ **BSD Position** readout Displays the current position of the BSD. ■ **BSD in** button Retracts the BSD from the specimen chamber. ■ **BSD out** button Drives the BSD into the specimen chamber. ■ **BSD Motorised** checkbox Indicates whether the BSD detector is motorized. ■ **BSD STOP** button Stops any movement of the detector immediately.

Parameter	Description
Scanning Transmission Electron Microscope (STEM) section	In the **Scanning Transmission Electron Microscope (STEM)** section, the following items are available: ■ **STEM Position** readout Displays the current position of the STEM. ■ **STEM -> IN** button Retracts the STEM from the specimen chamber. ■ **STEM -> OUT** button Inserts the STEM into the specimen chamber. ■ **STEM Motorised** checkbox Indicates whether the STEM detector is motorized. ■ **STEM STOP** button Stops any movement of the detector immediately.

Parameter	Description
Gas Injection System (GIS) section	In the **Gas Injection System (GIS)** section, the following items are available: ■ **GIS Location** readout Displays the current location of the GIS. ■ **GIS Goto park position** button Drives the GIS into park position. ■ **GIS Stage Initialise** button Conducts a calibration step in which the GIS stage is moved to known coordinates. This ensures that the stage can be moved accurately and reproducibly to all coordinates. ■ **GIS Stop stage** button Stops the GIS stage movement. **INFO** **This does not stop an initialization sequence.** ■ **GIS Stage is** readout Displays the current state of the GIS. ■ **GIS Stage Initialised** readout Displays whether the GIS stage has been initialized. ■ **GIS Enabled** checkbox Indicates whether the GIS is enabled. ■ **GIS Goto** buttons Drive the GIS to the specified position.
Secondary GIS section	In the **Secondary GIS** section, the following items are available: ■ **Secondary GIS Location** readout Displays the current location of the secondary GIS. ■ **Secondary GIS Hardware** checkbox Registers or deregisters the secondary GIS with the software. This is independent of the actual installation of the GIS hardware. ■ **Insert Secondary GIS** button Inserts the secondary GIS into the specimen chamber. ■ **Retract Secondary GIS** button Retracts the secondary GIS from the specimen chamber.

Parameter	Description
Stage section	In the **Stage** section, the following items are available: ■ **Stage Initialised** readout Displays whether the stage has been initialized. Initialization is a calibration step in which the stage is moved to known coordinates. This ensures that the stage can be moved accurately and reproducibly to all coordinates. ■ **Stage Is** readout Displays the working status of the stage. ■ **Stage init.** button Conducts a calibration step in which the stage is moved to known coordinates. This ensures that the stage can be moved accurately and reproducibly to all coordinates. ■ **Stage Touching** readout Displays whether the stage, specimen or specimen mounting is touching the chamber or final lens. ■ **Stage Interlock** readout Displays the lock status of the stage. ■ **Stage stop** button Stops stage movement.

10.83 System Status | SmartSEM Status

Purpose The **SmartSEM Status** window is helpful to monitor or set frequently used parameters.

Operating Principle The parameters to be displayed are selected and saved in a status file (file extension *.sts). Thus, every user can save an individual file to monitor the desired parameters and display them when required.

Reference Access: **Menu Bar > View > SEM Status**

Parameter	Description
Display tab	Displays the status of the selected parameters.
Select tab	Enables you to select the parameters to be displayed.
File tab	Enables you to load, save, or delete a combination of parameters.

10.84 System Status | Specimen Current Monitor

Purpose Monitoring the probe current is useful if you want to be sure that the actual probe current matches the required value.

Operating Principle The probe current can be measured by means of a Faraday cup. This cup consists of a strongly absorbing material with a cavity covered by a small aperture. If the beam is focused in this cavity, no secondary electrons and no backscattered electrons leave the Faraday cup. The displayed current equals the incident probe current.

Reference Access: **Panel Configuration Bar > Specimen Current Monitor**

Parameter	Description
Specimen I readout	Displays the recorded probe current.
SCM Status readout	Indicates the status of the specimen current monitor.
Spot checkbox	If activated, spot mode is active, i.e. the electron beam is positioned on a particular spot on the specimen surface. For monitoring the probe current, ensure that the Faraday cup is positioned at the beam spot position. License: SPOT
Touch Alarm Disable checkbox	If activated, the touch alarm is disabled. **INFO The availability of this feature depends on the microscope in use.**

10.85 System Status | Water Flow and Temperature

Purpose The **Water Flow and Temperature** panel is used for monitoring the water flow and temperature to ensure that no overheating can occur.

Operating Principle The **Water Flow and Temperature** panel is divided into four sections that enable you to monitor the following parameters:

- Stage temperature
- EO: covers the water supply of the EO board, which is divided in the EO dynamic and the EO static
- Water flow: covers overall water flow and temperature values
- Water temperature status: summarizes all water temperature thresholds

If one of the thresholds is exceeded, the system goes into suspend mode and the panel is displayed. In suspend mode all power is switched off from the stage and the Electron Optics (EO) unit.

Reference Access: **Panel Configuration Bar > Water Flow and Temperature**

Parameter	Description
Stage Too Hot readout	Indicates the stage temperature status.
EO dynamic flow readout	Indicates the status of the EO dynamic water flow.
EO dynamic temperature readout	Indicates the status of the EO dynamic water temperature.
EO static water flow readout	Indicates the status of the EO static board water flow.
EO static water temperature readout	Indicates the status of the EO static water temperature.
Water OK readout	Indicates the water flow status.
Water flow temperature readout	Indicates the water flow temperature.
Water return temperature readout	Indicates the water return temperature.
Water in high critical readout	Indicates if the water in high critical value has been reached.
Water in low critical readout	Indicates if the water in low critical value has been reached.
Water out high critical readout	Indicates if the water out high critical value has been reached.
Water out low critical readout	Indicates if the water out low critical value has been reached.

10.86 Toolbar Configuration

Purpose Configuring the **Toolbar** is useful for quick access to frequently used functions.

Operating Principle The **Toolbar** can be modified by adding or removing icons, or by assigning different commands, functions or macros to the icons already on the **Toolbar** using the **...** button.

Reference Access: **Menu Bar > Edit > Toolbar**

Parameter	Description
Image column	Enables you to select an icon for the button.

Parameter	Description
Button column	A button can have either left-click or middle-click functionality, or both. You can assign one button function at a time. A double-click into a cell of this column enables you to select the mouse button you wish to assign a function to.
Type column	Enables you to choose the type of function to assign to the mouse button you selected.
Name column	Enables you to choose the name of function to assign to the mouse button you selected.
Tooltip Text column	Enables you to write or modify a tool tip, which is displayed whenever the cursor is moved over the icon.
Button Text column	Enables you to write or modify an icon text. The icon text is a label displayed below the icon to identify the icon function.
Menu column	Enables you to add a menu to the icon, or to modify a menu.
Move Up button	Changes the position of the icon on the toolbar.
Move Down button	Changes the position of the icon on the toolbar.
Save button	Saves the **Toolbar**.
Load button	Enables you to load a user-defined **Toolbar**.
Remove button	Enables you to remove an icon from the **Toolbar**.
Add Button button	Enables you to add an icon to the **Toolbar**.
Add Separator button	Enables you to add a separator above a selected icon.
Options button	Opens the **Global Toolbar Options** dialog.

10.87 Vacuum

Purpose A good vacuum is essential for a high performance of the FESEM. The specimen chamber and the gun head have to be evacuated.

Operating Principle The **Vacuum** tab enables you to set and monitor vacuum parameters.

Reference Access: **Panel Configuration Bar > Crossbeam SEM Controls > Vacuum** tab

Parameter	Description
Vac Status readout	Displays the current vacuum status: ■ **Vac Status = Ready** The chamber and column are at the target vacuum pressure, ready for switching on the beam. ■ **Vac Status = At Air** The chamber is vented and at atmospheric pressure. ■ **Vac Status = Pumping** The vacuum system is currently pumping the chamber and column.
EHT Vac ready readout	Indicates whether the vacuum interlock is enabled. The EHT beam cannot be run up until the interlock is enabled.
Column chamber valve readout	Indicates the position (**open/closed**) of the column chamber valve which separates cathode head and specimen chamber.
Gun Vacuum readout	Indicates the vacuum in gun head and liner tube.
System Vacuum readout	Displays the measured vacuum in the specimen chamber in millibar.
Chamber readout	Displays the chamber pressure when operating in Variable Pressure mode.
Chamber Status readout	Indicates whether the chamber is in High Vacuum or Variable Pressure mode.
Beam Sleeve readout	Indicates the state of the optional beam sleeve.
Pump button	Evacuates the specimen chamber. The button is grayed when **Vac Status** is **Ready** or **Pumping**, and while the beam is on.
Vent button	Ventilates the specimen chamber. The button is grayed when **Vac Status** is **At Air**, and while the beam is on.
Partial Vent on Standby checkbox	If activated, the specimen chamber is ventilated partially when the FESEM is switched to STANDBY mode. Activate the checkbox if the vacuum is OK and the FESEM will not be operated for a longer time, e.g. weekend. This prevents oil vapors from penetrating into the specimen chamber during STANDBY mode.
Vac Quiet Mode checkbox	Activates the Quiet mode. In the Quiet mode, the pre-vacuum pump is switched off when the vacuum threshold is achieved.

11 Troubleshooting

11.1 Overview

The following table provides hints for solving common problems. If you cannot solve the problem or if you are unsure about a certain technical difficulty, do not hesitate to get in contact with your local ZEISS service representative.

DANGER

Danger to life: Hazardous voltage inside the microscope

High voltages are present inside the microscope. Contact may cause burn or electrical shock.

- Ensure proper grounding. For more information, refer to the Installation Requirements document.
- Only authorized ZEISS service representatives are allowed to service the microscope.
- Do not try to service the microscope yourself.

Keyword	Symptom	Cause	Remedy
Drift	Specimen seems to be moving.	■ Charging effects. ■ Non-conducting specimen.	■ Ensure proper conduction of the specimen. ■ Optimize specimen preparation. ■ Apply a charge compensation method.
		Stub not correctly fixed by screw.	Fix the stub correctly.
EHT	EHT cannot be switched on.	CAN communication has failed.	Refer to *Checking the CAN Communication* [▶ 244].
	The workstation has crashed.	CAN communication has failed.	Refer to *Checking the CAN Communication* [▶ 244].

Keyword	Symptom	Cause	Remedy
FESEM	FESEM is dead.	Circuit breaker is tripped (lower position).	Refer to *Checking the Position of the Circuit Breakers* [▶ 249].
Image quality	Image quality gets worse, but there is no change in total emission current.	Field emission gun has been damaged due to arcing.	Contact your local ZEISS service representative to have the field emission gun replaced.
	Image is noisy and noise reduction methods do not help.	Field emission gun is used up.	Contact your local ZEISS service representative to have the field emission gun replaced.
	Image is bad at low EHT (e.g. 1 kV)	Working distance is too long.	Reduce working distance to a maximum of 7 mm.
In-lens image	In-lens image is noisy.	Working distance is too long.	Reduce working distance.
	No In-lens image can be obtained.	EHT exceeds 20 kV.	Reduce EHT to a maximum of 20 kV.
PC	Stored position of the specimen stage cannot be approached correctly.	PC has crashed.	Restart the PC.
		Stage needs to be driven to a well-defined position.	Refer to *Initializing the Stage* [▶ 245].
SEM Gun	Gun is switched off automatically.	Gun has been switched off automatically for safety reasons since gun vacuum is worse than 2×10^{-8} mbar	Refer to *Baking Out the Gun Head* [▶ 247].
SE2 image	SE2 image is noisy.	Scintillator is used up.	Contact your local ZEISS service representative to have the scintillator replaced.
Specimen current meter	Specimen current is low.	Field emission gun is used up.	Contact your local ZEISS service representative to have the field emission gun replaced.
		Working distance is too short.	Enlarge working distance to about 5 mm or more.

Keyword	Symptom	Cause	Remedy
Specimen stage	Stage does not move.	Stage needs to be initialized.	Refer to *Initializing the Stage* [▶ 245].
	Stage does not move accurately.	Stage needs to be initialized.	Refer to *Initializing the Stage* [▶ 245].
	Stored position of the specimen stage cannot be approached correctly.	Absolute stage movement is required. Stage needs to be driven to a well-defined position.	Refer to *Initializing the Stage* [▶ 245].
Stage/Joystick	Under TV control, the direction of dual joystick movement and direction of stage movement seem to be different.	TV joystick angle does not fit for the selected CCD camera.	Refer to *Changing the Joystick TV Angle* [▶ 246].
	Stage cannot be moved by using the joystick.	**Joystick Disable** checkbox is activated.	Deactivate the checkbox in the **Stage** tab of the **Crossbeam SEM Control** panel.
Temperature, water flow	Error message 'Stage Board too hot' (or similar) is displayed.	Flow of cooling water is not OK.	Refer to *Checking the Water Flow and Temperature* [▶ 247].
Touch alarm	Touch alarm message is displayed.	Specimen or specimen holder has touched objective or wall of the specimen chamber.	Refer to *Resetting the Touch Alarm* [▶ 247] .
Vacuum	**Vac ready = OK** is not displayed after specimen exchange.	System vacuum is bad due to a vacuum leak at the chamber door.	Check the chamber door seal for cleanliness. If required, refer to Replacing the Chamber Door Seal.
	Vac ready = OK is displayed very late after specimen exchange.	Gas ballast at rotary pump or scroll pump is activated.	Deactivate gas ballast at the pre-vacuum pump.
	FESEM does not vent.	No nitrogen.	Check nitrogen supply.
		No compressed air.	Check compressed air supply.

Keyword	Symptom	Cause	Remedy
	Vac ready = OK is displayed abnormally fast.	Penning gauge has not been identified correctly.	Restart the FESEM. If this does not solve the problem, contact your local ZEISS service representative.
	Gun vacuum is worse than 8 to 9 x 10^{-9} mbar.	The pumping capacity of the ion getter pump decreases in the course of time, thus deteriorating the Gun vacuum.	Refer to *Baking Out the Gun Head* [▶ 247].

11.2 Overall system

11.2.1 Checking the CAN Communication

Purpose Checking the CAN Communication is useful if the workstation does not react to your commands anymore.

Procedure

1. In the **Panel Configuration Bar**, double-click **CAN Communication**.
   The **CAN Communication** window is displayed.
2. If any of the values is indicated as **Yes**, make sure that all cable connections between workstation and PC are plugged in correctly.
3. If this does not help, reset the workstation as described in the instruction manual of the FESEM.

INFO

If the problem persists, contact your ZEISS service representative.

11.3 Chamber

11.3.1 Initializing the Stage

Purpose If a stored stage position cannot be approached or if the stage does not move or does not move accurately, the stage needs to be initialized.

Prerequisites

- The specimen chamber has been evacuated, see *Loading the Specimen Chamber* [▶ 35].
- Requires the **Stage Initialise** privilege.

Procedure

1. From the **Menu Bar**, select **Stage > Stage initialise**.
   The **Stage initialise** window is displayed.
2. Click **Yes**.
   The stage initialization progress takes a few minutes.

INFO

If initialization of the stage does not solve the stage problem, contact your local ZEISS service representative.

11.3.2 Defining the Post Initialization Position of the Stage

Purpose You can configure the position to which the stage drives after the initialization procedure. Otherwise, the stage drives to the center position.

Prerequisites

- Requires the **Supervisor** privilege.

Procedure

1. From the Windows Start menu, select **Programs > SmartSEM > SmartSEM Administrator**.
   The **SmartSEM Administrator Log on** window is displayed.
2. Enter user name and password.
3. To confirm, click **OK**.
   The **SmartSEM Administrator** window is displayed showing the user list.
4. Click **Column/Stage**.
5. In the **Stage Post Initialisation Position** input fields, enter the desired position.
   Alternatively, use the dual joystick to navigate to the desired position and click **Set to current position**.
6. To activate the function, activate the **Post Init. Posn Valid** checkbox.

11.3.3 Changing the Joystick TV Angle

Purpose In TV mode (chamberscope), it can occur that dual joystick and stage seem to move to opposite directions. This is because the selected CCD camera is installed at a certain angle relative to the stage. Thus, the camera shows a side-inverted view. To remedy this, you need to change the joystick TV angle setting in the software.

Prerequisites

- Requires the **Supervisor** privilege.

INFO

If you are working with two CCD cameras: The joystick TV angle can only be set for one CCD camera. When selecting the other CCD camera, you have to change the setting.

Procedure

1. From the Windows Start menu, select **Programs > SmartSEM > SmartSEM Administrator**.

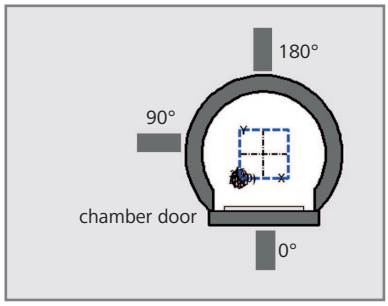
   The **SmartSEM Administrator Log on** window is displayed.

2. Enter user name and password.
3. To confirm, click **OK**.
4. The **SmartSEM Administrator** window is displayed showing the user list.
5. Click **Column/Stage**.
6. In the **Stage Options** section, double-click the **Joystick TV Angle** input field.
7. Enter an angle depending on the installation location of the CCD camera.

   1 If the CCD camera is installed at the back, enter `180°`.

   2 If the CCD camera is installed at the front, enter `0°`.

   3 If the CCD camera is installed at the side, enter `90°`.



11.3.4 Resetting the Touch Alarm

Purpose To prevent damage, a touch alarm is integrated in the FESEM. If the specimen or the specimen holder touches the chamber walls, the detectors or the objective lens, the stage is stopped immediately. An audible warning sounds and an on-screen message is displayed.

Prerequisites

- The EM Server shows the message **'WARNING Stage Touching'**.

Procedure

1. To accept the warning, click **OK**.
2. Move the stage in the reverse direction away from the touch.

11.3.5 Checking the Water Flow and Temperature

Procedure

1. In the **Panel Configuration Bar**, double-click **Water Flow and Temperature**.
   The **Water Flow and Temperature** panel is displayed.
2. Check the entries.
   If a value is critical, it is displayed in red.

11.4 Column

11.4.1 Baking Out the Gun Head

Purpose The pumping capacity of the ion getter pump decreases in the course of time, thus deteriorating the gun vacuum. This can be remedied by an ion getter pump bakeout as a regular maintenance procedure.

Safety Information

⚠ CAUTION

Risk of injury: Hot surfaces during bakeout

Parts of the enclosure in the upper range of the column may become hot during bakeout, particularly after a long bakeout cycle.

- Do not touch any parts of the cover panel.
- Do not place any combustible objects on the grids of the electron optical column during bakeout.
- After the bakeout procedure, let surfaces cool down before working around the column.
- Only advanced operators are allowed to perform the bakeout procedure.

Prerequisites

- Requires the **Supervisor** privilege and the user level **Service**.
- Only advanced operators are allowed to perform the bakeout procedure.

Procedure

1 Switch off the gun.

1 In the right part of the **Status Bar**, click All: ✓ or Gun: ✓.

The pop-up menu for vacuum, gun and EHT activation is displayed.

2 Click **Shutdown Gun**.

3 Wait until the gun has ramped down.

This may take up to 5 minutes.

2 In the **Panel Configuration Bar**, double-click **Bakeout**.

The **Bakeout** dialog is displayed.

3 Set the bakeout parameters and start the bakeout.

1 If the **Full service bakeout** checkbox is available, deactivate the **Full service bakeout** checkbox.

INFO Full service bakeout includes column heating that may lead to column misalignment.

2 From the **Bakeout** drop-down list, select a bakeout cycle.

For 2 hours heating / 1.5 hours cooling, select **Quick**.

For 8 hours heating / 1.5 hours cooling, select **Overnight**.

For 43 hours heating / 7 hours cooling, select **Weekend**.

For a cycle defined by the operator, select **User**.

3 To start the bakeout procedure, click **Bakeout Start**.

4 After bakeout, switch on the gun.

See *Switching On the Gun* [▶ 38].

11.4.2 Calibrating the Probe Current

Purpose

This function enables you to automatically calibrate the probe currents within a few minutes.

Calibrating the probe current can be necessary in the following cases:

- Before performing analytical applications (e.g. EDX, WDX)
- After changing the extractor voltage
- To improve the accuracy of the set probe current values

Parts and Tools

Designation	Part no.
Faraday Cup	348342-8055-000

Procedure

1 Load the Faraday cup into the specimen chamber.

2 Pump the specimen chamber.

3 Switch on the electron beam.

4 Set a magnification that allows transmission of the complete electron beam into the cavity of the Faraday cup through the aperture orifice.

5 In the **Panel Configuration Bar**, double-click **Probe Current Calibration**.
The **Probe Current Calibration** window is displayed.

6 Activate the **Spot** checkbox.

7 Click **Cal I Probe**.

8 To confirm, click **Yes**.

9 To store the calibration, click **Save**.

10 Deactivate the **Spot** checkbox.

11.5 Power Circuit

11.5.1 Checking the Position of the Circuit Breakers

Safety Information

NOTICE

Risk of property damage: Persisting electrical problems

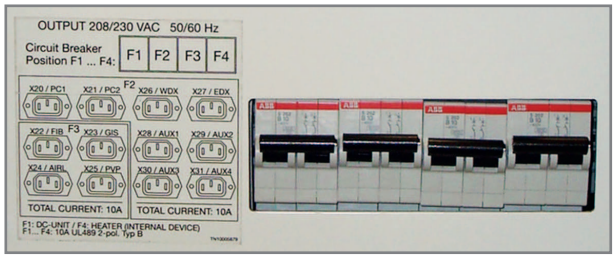
Tripped circuit breakers may be a hint for an electrical problem in the microscope.

- If a circuit breaker keeps tripping, de-energize the microscope completely and contact your ZEISS service representative for assistance.

No.	Value	Circuit
F1	10 A	Power supply unit
F2	10 A	PC, WDX, EDX, AUX 1 - 4
F3	10 A	Airlock, pre-vacuum pump
F4	10 A	Internal heaters

Procedure

1 Check if one of the circuit breakers on the rear side of the plinth is tripped.



2 If one is tripped, push the circuit breaker upwards.

11.6 Detectors

11.6.1 Lubricating the Rod

Purpose The rod from the aSTEM, BSD4 and VPSE detector mechanics needs to be lubricated once a year with TEM Oil 300.

Parts and Tools

Designation	Part no.
TEM Oil 300	0484-955
Isopropanol	-
Lint-free cloth	-
Gloves	-

Safety Information

CAUTION

Risk of injury: TEM Oil 300

TEM Oil 300 may be irritating to skin and eyes.

- Avoid contact with skin.
- Wear suitable gloves.
- In case of contact with the eyes, rinse immediately with plenty of water and seek medical advice.
- After contact with the skin, wash immediately with plenty of water and soap.

⚠ CAUTION

Risk of injury: Isopropanol

Isopropanol is highly flammable and irritating to the eyes.

Vapours may cause drowsiness and dizziness.

- Wear suitable gloves.
- Keep away from sources of ignition.
- Do not smoke.
- In case of contact with the eyes, rinse immediately with plenty of water and seek medical advice.
- Avoid contact with skin.
- Do not breathe vapor.

NOTICE

Risk of property damage: Unsuitable lubricants

When using unsuitable lubricants, the vacuum system may be contaminated.

- Use only TEM Oil 300 for lubricating the rod.

Procedure

1. Retract the respective detector.
2. Clean the rod with isopropanol with a clean, lint-free cloth.
3. Spread some drops of TEM Oil 300 across the rod.
   Use a clean, lint-free cloth.

Glossary

A

Administrator The SmartSEM Administrator is part of the SmartSEM program suite, which allows user management e.g. creating users and assigning them with certain privileges. The SmartSEM Administrator is protected by an administrator password.

Alignment marks For the execution of an Alignment process one needs to take an image which exhibits some structure characteristics with well known coordinates. This can be either specially structured adjusting aids or some distinctive features of the already patterned structures, both are referred to as Alignment marks (or simply marks) here in general.

B

Bakeout Degassing of surfaces of a vacuum system by heating during the pumping process.

Beam Blanker In order to avoid unintended exposure during standby times and beam settling times, which are necessary after large jumps (e.g. delay between elements, see: Exposure tab) it is recommended that the SEM is equipped with a fast electrostatic Beam Blanker. This devices create an electric field in the microscope column for dumping the beam somewhere in the column. The advantage of an electrostatic blanker with respect to an electromagnetic one is that the beam can be switched on and off very fast.

C

Crosshairs A graphical object for assessing the relative position of objects in the image.

D

Dongle A device that is needed in order to use protected software.

E

EM Server A server that implements the internal communication between control software and microscope hardware.

F

Faraday Cup Small insulated metal container, equipped with an aperture where electron can enter but not escape. Used to measure the specimen current in the microscope.

Focus Wobble Function that sweeps the focus of the objective lens backwards and forward through the focus on the specimen plane. When the aperture is misaligned a lateral shift is observed.

G

Graticules A grid displayed over the image.

I

Ingredient List A list that defines the contents of a recipe, i.e. the combination of saved parameters.

L

LUT Look Up Table which can be used to improve the image illumination.

M

Magnification Table Function of SmartSEM that allows you to enter fixed magnifications for quick access during the imaging procedure.

MiniBar Part of the SmartSEM user interface which allows quick access to recently used dialogs and to the recipe management.

P

Pixel time Every object that is scanned during the lithography process is composed of discrete single pixels. Thus the signal is integrated for every pixel of an image and the elements that are patterned are also composed of discrete pixels. In case of patterning the dwell time (in combination with the spacing of the pixels) determines the dose that is achieved by the exposure. Speaking of the Pixel-time therefore is not only sensible for a point element but also for every scanned object.

R

Recipes Function of SmartSEM that allows you to save a set of SEM parameters which are ideal for a certain type of specimen.

S

Scanning mode The scanning mode determines the fill pattern during the exposure process.

Splash Screen Animated start screen of SmartSEM.

U

User Preferences Section that allows you to define user-specific pre-setting of the SmartSEM user interface e.g. language or pressure units.

Z

Zone Part of the image area when displaying different detector signals or image areas.

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