



Software Manual
ZEISS SmartSEM v7.02
GeminiSEM



ZEISS SmartSEM v7.02

Original Manual

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1 General Information

Welcome to the SmartSEM Software Manual.

This manual is part of the scanning electron microscope (SEM), 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 startup 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.

1.1 Text Conventions and Link Types

Explanation	Example
Software controls and GUI elements.	Click Start .
Hardware controls and elements.	Press the Standby button.
Key on the keyboard.	Press Enter on the keyboard.
Press several keys on the keyboard simultaneously.	Press Ctrl + Alt + Del .
Follow a path in the software.	Select Tools > Goto Control Panel > Air-lock .
Text to be entered by the user.	Enter <i>example.pdf</i> in this field.
Anything typed in literally during programming, for example macro codes and keywords.	Enter <code>Integer</code> in the console.
Link to further information within this document.	See: <i>Text Conventions and Link Types</i> [▶ 9].
Link to a website.	https://www.zeiss.com/corporate/int/home.html

1.2 Explanation of Warning Messages and Additional Information

DANGER, WARNING, CAUTION, and NOTICE are standard signal words used to determine the levels of hazards and risks of personal injury and property damage. Not only the safety and warning messages in the **Safety** chapter are to be considered also all safety and warning messages in other chapters. Failure to comply with these instructions and warnings can result in both personal injury and property damage and involve the loss of any claims for damages.

The following warning messages indicating dangerous situations and hazards are used in this document.

DANGER

Type and source of danger

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

WARNING

Type and source of danger

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

CAUTION

Type and source of danger

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

NOTICE

Type and source of danger

NOTICE indicates a potentially harmful situation which, if not avoided, may result in property damage.

Info

Provides additional information or explanations to help operator better understand the contents of this document.

1.3 Further Applicable Documents

Also take note of the following documents:

- Brochures and Certificates** For brochures, ISO certificates, CSA certificates, and EU declarations of conformity ask your ZEISS Sales & Service Partner.
- Installation Requirements** For more details on technical data, refer to the corresponding Installation Requirements.
- Safety Data Sheets** Observe the enclosed safety data sheets. The instructions and guidelines given in the respective safety data sheets must be complied with.
- Microscope** For information about the microscope, refer to the Instruction Manual of the microscope.
- SmartFIB Software Manual** For detailed information on how to use the SmartFIB software for ion beam exposure, refer to the SmartFIB software manual.
- System and third-party Components, Accessories** Information about the individual components, enhancements, and accessories can be obtained from your ZEISS Sales & Service Partner. Also refer to the documentation of third-party manufacturers.

1.4 Calling up the Help

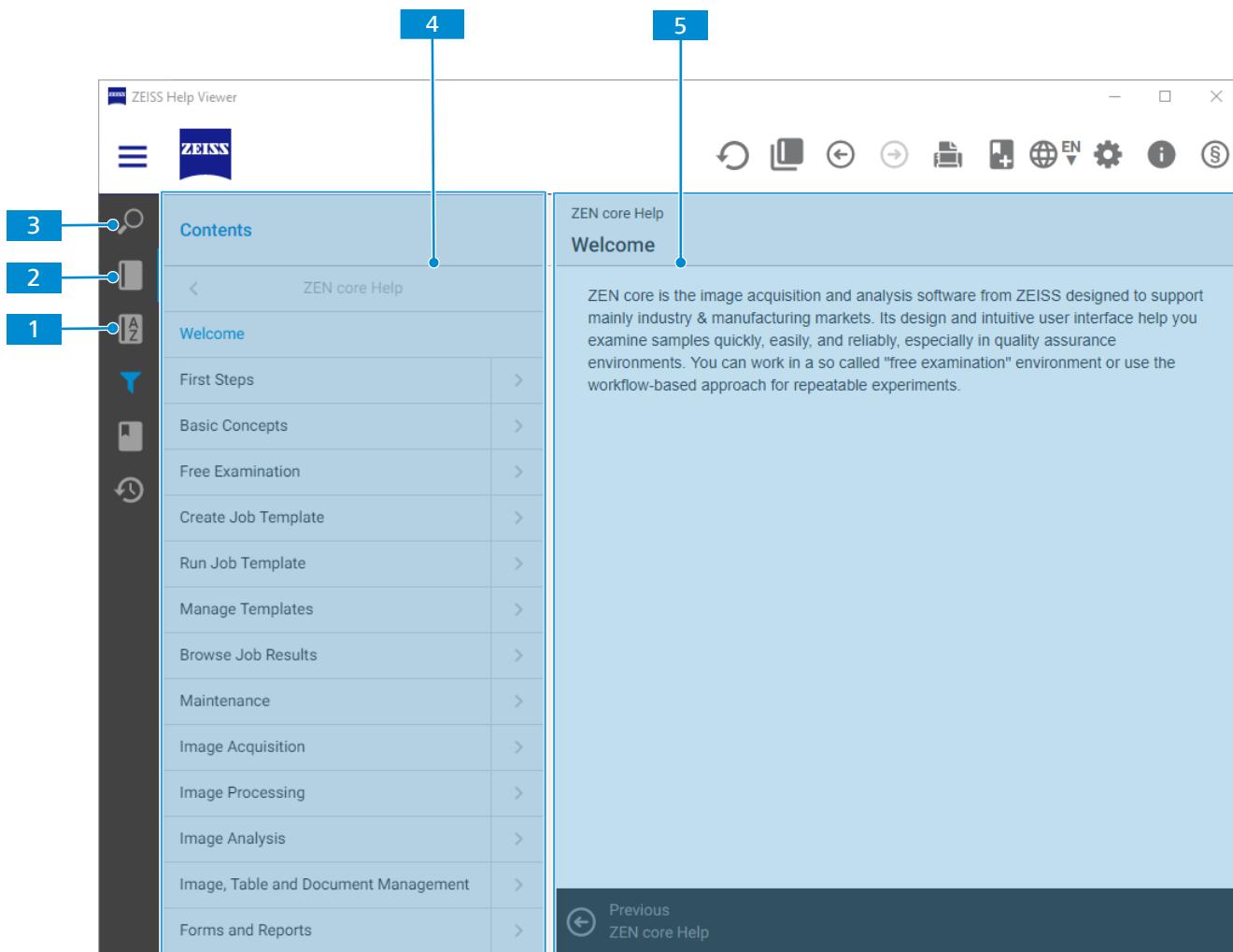
To call up the documentation,

- in the software open the menu **Help > Contents....**
- in the software press **F1**.
- in the Windows file browser go to **\Program Files\Carl Zeiss\ZEN 2\ZEN 2 (blue edition)\Manuals**.

Additionally click on the **question mark** symbol **?** in the **Title bar**. The cursor then appears as a question mark symbol. Then click on an area in the software which you want to get help for. If there is a related help topic available, it will open directly.

ZEISS Help Viewer User Interface

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



1 Index

List of keywords to help you find topics and content quickly.

2 Topics

Contains the structure tree with a list of all the topics.

3 Search

Search through the entire text.
It supports partial strings but not wildcards.

4 Structure tree

Enables you to navigate through topics sequentially. A > indicates a topic has subtopics.

5 Content panel

1.5 Contact

If you have any questions or problems, contact your local ZEISS Sales & Service Partner or one of the following addresses:

Headquarters

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Fax: +49 3641 64 3439

Email: info.microscopy.de@zeiss.com

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The ZEISS Portal (<https://portal.zeiss.com>) offers various services that simplify the daily work with your ZEISS systems (machines and software). It is constantly improved and extended to meet your needs and requirements better.

ZEISS Sales & Service Partner

You can find a ZEISS Sales & Service Partner in your area under <https://www.zeiss.com/microscopy/int/website/forms/sales-and-service-contacts.html>.

Service Germany

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Email: service.microscopy.de@zeiss.com

2 Safety

2.1 Intended Use

The SmartSEM software is intended for the operation of ZEISS SEMs.

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

Regarding the operation of the microscope and its safety instructions, please refer to the according instruction manual. Please do not use the electron microscope and its software before you have understood the safety instructions of the electron microscope and all attached add-ons.

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

3 Software Description

3.1 SmartSEM User Interface

The SmartSEM software graphical user interface (GUI) allows you to monitor and operate most of the active components of the microscope.

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

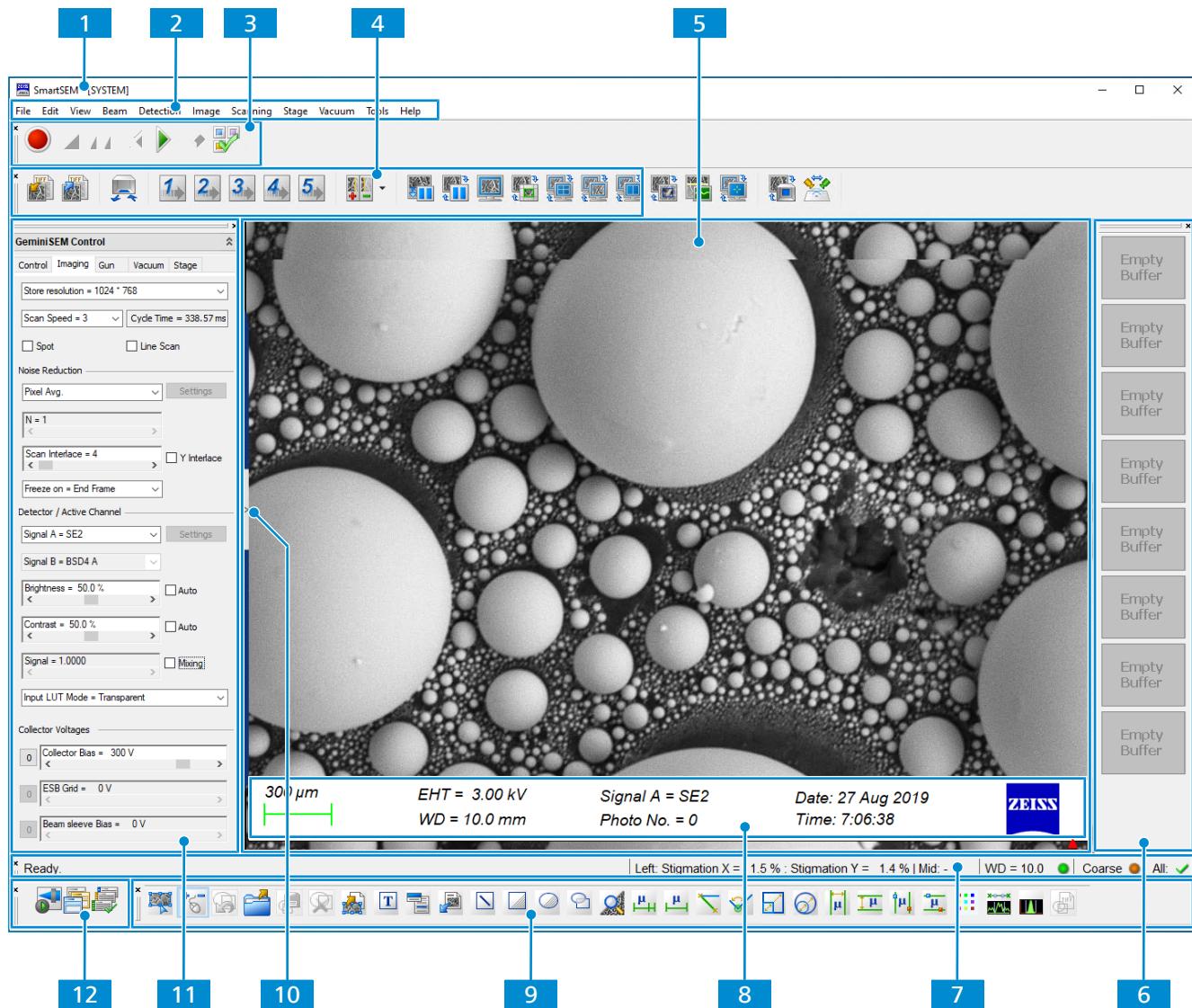


Fig. 1: Main sections in the SmartSEM user interface

1 Title Bar

Displays the name of the user interface and the logged-on user.

2 Menu Bar

Enables you to access SmartSEM features via sub-menus.

3 AVI Toolbar

Contains the controls to set up, record, and playback video sequences of scanned images.

4 Toolbar

Provides quick access to SmartSEM tools.

5 Image Area with Data Zone

Displays image information and acquisition parameters from the microscope.

6 Thumbnails Panel

Displays thumbnail views of the contents of the eight image buffers.

7 Status Bar

Displays the current machine state and contains the **SEM Control Buttons**.

8 Data Zone

Displays image information and acquisition parameters from the microscope.

9 Annotation Bar

Enables you to add information to the SEM image and provides several measurement functions.

10 Panel Configuration Bar

Enables you to choose the panels to be placed in the **Docking Panel**.

11 Docking Panel

Enables you to arrange frequently used SmartSEM panels for convenient access.

12 Mini Bar

Provides quick access to recently used dialogs and to the recipe management.

3.1.1 Menu Bar

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

The following sub-menus are available:

Menu	Description
File	Lists options for working with recipe files, images, and annotations. You also log off or exit the system from this menu.
Edit	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	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	Lists options for directly controlling the electron beam on/off state, for configuring gun settings, setting the EHT target, and shifting the beam.
Detection	Enables you to switch between (or mix) detector signals and TV inputs (e.g. chamberscope) and dynamically control a multi-segment BSD (if fitted).
Image	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	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	List options for initializing the stage, and for controlling stage movement using a number of configurable features.
Vacuum	Lists options to control the vacuum status for pumping or venting the chamber, and to control variable pressure (VP) mode.

Menu	Description
Tools	Provides access to user and administrator configuration screens plus a range of useful facilities such as image and movie capture and macro editing.
Help	Provides easy access to the SmartSEM online help.

3.1.2 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
	Load TIFF Image	Calls the Import TIFF window.	–
	Save TIFF/TIFF Export Dialog	Saving an image as TIFF file with the agreed settings.	Calls the Export TIFF window.
	Specimen Change/Vacuum Control	Enables you to prepare the specimen change.	Calls the Vacuum Tab of the GeminiSEM Control panel.
	Pix Avg 1/Cont Avg 2	Pixel averaging at scan speed 1	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
	Pix Avg 9/Frame Int 5	Pixel averaging at scan speed 9	Frame averaging at scan speed 5 (image is frozen after scan)
	Frame Int 7/Frame Int 8	Frame averaging at scan speed 7 (image is frozen after scan)	Frame averaging at scan speed 8 (image is frozen after scan)
	Faster/Slower	Sets a higher scan speed.	Sets a lower scan speed.
	Freeze on end	Image is frozen at the end of the frame	–
	Freeze:Un-freeze/Scanning	Freezes/unfreezes the image.	–
	Normal/Scanning	Normal screen mode (Scan range displayed over the complete monitor).	–

Icon	Tool Tip Text	Left Mouse Button	Mouse Scroll Wheel
	Reduced Raster/ Column Control	Switches between reduced scan and normal screen mode.	–
	Quad Mode	Switches between quad mode and normal screen mode.	–
	Dual channel	Activates the dual channel mode: two live full frame im- ages with different detectors are displayed.	–
	Split Screen/Detec-tors	Switches between split screen and normal screen mode.	–
	Dual Magnifica-tion/Detectors	Switches between dual magni-fication and normal screen mode.	–
	Linescan	Switches between linescan and normal screen mode.	–
	Spot Mode	Switches between spot mode and normal screen mode.	–
	ChamberScope/ Detector Con-trol	Activates the CCD TV camera. Mouse button assignment: brightness/contrast	–
	Toggle IN- LENS:SE2/De-tector Control	Switches between InLens and SE detector.	–
	Auto Focus and Stigmation	A drop-down list gives access to: <ul style="list-style-type: none">▪ Coarse Autofocus: Use this function when the image is more than 1 mm away from focus▪ Fine Autofocus: Use this function when the image is less than 1 mm away from focus▪ Auto Stigmation: Use this function to correct for astigmatism (only use when close to focus)▪ Auto Wobble: Auto func- tion to align apertures	–

3.1.3 Docking Panel

Access: **Menu Bar > View > Toolbars**

The docking panel, also referred as panel bar, is a convenient placement area for frequently used SmartSEM panels, for example the GeminiSEM Control panel.

Several SmartSEM panels may be docked on the docking panel at the same time.

Individual panels are expanded when in use, to show their contents. The same panel can be collapsed when not in use to allow more space to expand other panels.

While the docking panel is displayed, the **Panel Configuration Bar** is attached to the side of the docking panel.

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
	The green anchor symbol is displayed when using functions that divide the image area into different zones, e.g. the functions Split , Windowing , or Dual Magnification . 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 **Docking Panel**.

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.

3.1.8 Thumbnails Panel

Access: **Menu Bar > View > Thumbnails**

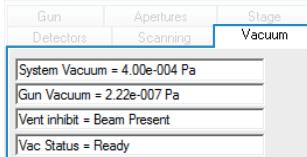
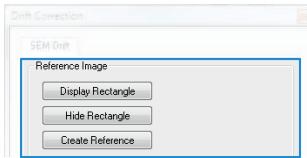
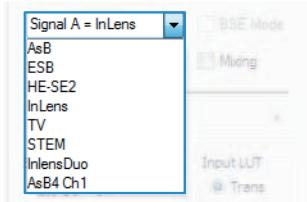
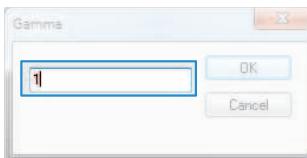
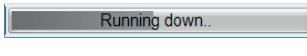
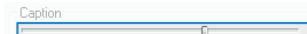
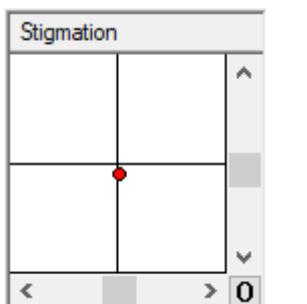
The Thumbnails panel provides access to eight storage buffers which are used to temporarily store image data captured from the Image Store.

The bar is divided into eight panels representing the eight buffers. When an image is loaded from the Image Store into a buffer, a reduced image is displayed in the Thumbnails panel.

Images stored in the buffers can be loaded back into the store to view again in detail, or to print or export. This makes the Thumbnails panel a convenient way of capturing a number of images with different settings, to compare them before making choices about which to save or print, or to use them to identify similarities in specimens.

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.
	Section	Forms a group of control elements with related functions.
	Button	Enables you to start an action.
	Check-box	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 Shift 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 and User Privileges

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

SmartSEM distinguishes different user access levels. Depending on the user access level, 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.
Service	All items are accessible, also including infrequently used items and calibrations.

Additional to the user access levels there are user privileges which are part of the user profile:

User Privilege	Description
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.
Gun Align	Enables the user to modify the alignment of the electron beam.
Gun Off	Enables the user to switch off the field emission filament.
Stage Initialise	Enables the user to initialize the motorized stage.
Supervisor	Enables the user to perform the following actions: <ul style="list-style-type: none"> ▪ Start the Administrator, create and edit users ▪ Set User Max EHT ▪ Modify the filament current ▪ Set up, edit, and delete global stage coordinates ▪ Save common macros and toolbars ▪ Save common recipes

User Privilege	Description
	<ul style="list-style-type: none"> ▪ 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
Vent	Enables the user to vent the specimen chamber.

3.5 Licenses

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

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

License	Sales Code	Part No.	Description
3DBSD	3DBSD	351434-6116-000	License for 3DSM
Analytical I/F Particle Scan Application	PARTICLE	348224-6032-000	Specific software for automatic particle analysis. Requires particular hardware.
Auto Calibration Routine	AUTO_CAL	348224-6085-000	Auto Calibration Routine
Auto wobble	AUTO_WOBBLE	351575-6409-000	Enables the auto wobble function.
Automated Image Acquisition	AUTO_IMG_ACQ	351450-6205-000	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.
Cell Counting Software	CELL-COUNT-ING	348224-6078-000	Enables you to count cell arrays. Requires particular hardware.
Customer Calibration Privilege	CUS-TOMER_CALIB_PRIV	351434-6133-000	Enables you to change service calibration parameters.
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

License	Sales Code	Part No.	Description
Drift Correction	DRIFT-CORR	348224-6058-000	Image analysis software to compensate for image drift by beam shift control. Requires additional hardware.
Dual Image	DUAL IMAGE	3482234-6047-000	Dual Image - Win2K Uniplinth only.
FTP Remote Archiving	REMARCH	348224-6038-000	Enables you to send files to a FTP server or network printer.
Image Deconvolution	IMAGE_DE-CONVOLUTION	351434-6279-000	Enables you to use the image deconvolution function.
Image stitching	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.
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.
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.
OptiProbe	OPTIPROBE	348224-6079-000	Allows automatic setting of the probe current. Requires particular hardware.
Parallax Auto Focus	PARAL-LAX_AUTO_FOCUS	351575-6408-000	Enables the advanced parallax auto focus algorithm. If it is not present the standard auto focus algorithms are used. It is only available on GeminiSEM 360 and GeminiSEM 560.
Piezo Integration	PIEZO-INTEGRATION	348224-6075-000	Enables you to integrate a Piezo stage.

License	Sales Code	Part No.	Description
Plasma Cleaner	PLASMA	351434-6177-000	Enables software control of the plasma cleaner.
Smart Stage Mapping	SMART-STAGE-MAPPING	348224-6081-000	Enables a calibration routine that optimizes the stage accuracy.
SmartBrowse	SMARTBROWSE	351434-6144-000	Enables you to sort images by various parameters, such as stage position or detector used.
SmartImage Enhancement	SMARTIMAGE	348224-6077-000	Enables the SmartImage image processing dialog (noise reduction and contrast enhancement).
Stage Navigator	NAVIGATOR	351434-6109-000	Enables more precise movement of the stage.
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
Tandem Decel	TANDEM DECEL	351434-6244-000	Enables you to apply stage biasing to decrease the electron landing energy for improved image quality.
Tandem Decel (US)	TANDEM DECEL US	351434-6245-000	Enables you to apply stage biasing to decrease the electron landing energy for improved image quality.

3.6 Dongles

To operate the software, a SmartSEM 7.02 dongle has to be installed.

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 > SmartSEM**

Program	Description
ChamberScope	Enables you to display the chamberscope image and the detector image at the same time.
OptiProbe Calibration	Enables you to calibrate the OptiProbe option.
ReadMe	Contains important information on the currently installed version.
Release Notes	Contains an overview of all SmartSEM versions including new developments and specific details.
RemCon32	Serial interface for remote operation via RS232, e.g. for EDX License: REMCON
SampleHolder-Gallery	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 Accounting	Enables you to record important information during individual working sessions, e.g. logon/logoff time, number of TIFF files exported etc.
SmartSEM User Interface	Main software application

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

Program	Description
Calibration Wizard	Service activities, for ZEISS service representatives only
GeminiSEM Alignment Wizard	Service activities, for ZEISS service representatives only
Gun Monitor	Enables you to monitor important parameters of the microscope.
GUN Service	Service activities, for ZEISS service representatives only
Service Centre	Provides an overview of the state of the microscope.
Smart Stage Mapping	Service activities, for ZEISS service representatives only
SmartBackup Tool	Service activities, for ZEISS service representatives only
Stage Administrator	Service activities, for ZEISS service representatives only
Upgrade Server Database	Service activities, for ZEISS service representatives only

4 Starting the Software

- Procedure**
1. Power up the computer and log in.
 2. Start the SmartSEM user interface via the **ZEISS SmartSEM** icon on the desktop.
Alternatively, select **Windows start menu > SmartSEM > SmartSEM User Interface**.
 - 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 Starting the Online 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	–	<ul style="list-style-type: none"> ▪ 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.

4.2 Keyboard Shortcuts

The following keys are shortcut keys and have special meaning.

Shortcut	Function
<F2>	Toggles Tool Bar on/off
<F2 + SHIFT>	Hysteresis removal
<F3>	Closes all windows except the Tool Bar and Status Bar
<F3 + SHIFT>	Toggles PC Plane ON/OFF
<F4>	Step to next Magnification Table entry, or Undo Centre Feature Magnification
<F4 + CTRL>	Step to previous Magnification table entry
<F4 + SHIFT>	Exit from Magnification Table mode
<F5>, <F5 + SHIFT>	User defined macros
<F6>, <F6 + SHIFT>	
<F7>, <F7 + SHIFT>	
<F8>, <F8 + SHIFT>	
<F9>	Keys help (displays this information)

Shortcut	Function
<F11>, <F11 + SHIFT>	User defined macros
<F12>, <F12 + SHIFT>	Aborts Stage Movement
<TAB>	Toggle coarse/fine
<CTRL + TAB>	Performs Centre Point
<CTRL + SHIFT + TAB>	Performs Centre Feature
<HOME>	Resets Beam Shift to zero
<SCROLL LOCK>	Toggles Freeze/Unfreeze
<PAUSE>	Causes currently executing macro to continue
<*>	Performs Find Image function
<CTRL + 2>	Loads Second Image Window from display
<CTRL + A>	Switches Annotation panel ON
<CTRL + B>	Display Toolbar View dialog
<CTRL + D>	Toggle Data Zone ON/OFF
<CTRL + E>	Calls the Export TIFF dialog
<CTRL + F>	Starts Auto Focus fine
<CTRL + SHIFT + F>	Starts Auto Focus coarse
<CTRL + G>	Switches GeminiSEM Control Panel ON
<CTRL + I>	Switches SEM Status Panel ON
<CTRL + M>	Switches to Annotation and inserts Point to Point Marker
<CTRL + ALT + M>	Enable/Disable the Movable Crosshairs Marker
<CTRL + ALT + F>	Enable/Disable Mouse Following for Movable Crosshairs Marker
<CTRL + O>	Calls the Import TIFF dialog
<CTRL + P>	Performs the Print Image function
<CTRL + S>	Calls the Export TIFF dialog to save the image
<CTRL + ALT + S>	Performs Auto Astigmatism Correction
<CTRL + SHIFT + S>	Performs Auto Astigmatism Correction with Auto Focus
<CTRL + T>	Calls Text Annotation
<CTRL + V>	Displays the Vacuum status information
Keypad <+>	Faster Scan
Keypad <->	Slower Scan

Shortcut	Function
ARROW Keys	Refer to Use of ARROW Keys
Image Buffer keys	Refer to Image Buffer
<SHIFT> and double click	Performs Centre Point function

5 Imaging Using the Electron Beam

5.1 Acquiring an Image

Info

Mobile phones in the microscope room can cause image quality infringements and in worst case workflow interruptions.

This section describes basic procedures to obtain an image using the SE detector. To simplify the procedure, the description uses the GeminiSEM Control panel and status bar functions in the SmartSEM software.

This procedure consists of the following steps:

1. *Preparing the Specimen Holder* [▶ 30]
2. *Loading the Specimen Chamber* [▶ 32]
3. *Locating the Specimen* [▶ 35]
4. *Switching on the Gun* [▶ 36]
5. *Switching on the EHT* [▶ 36]
6. *Acquiring an Image* [▶ 37]
7. *Optimizing the Image* [▶ 39]
8. *Saving the Image* [▶ 41]

5.1.1 Preparing the Specimen Holder

Parts and Tools

- ☛ Hex key, 1.5 mm
- ☛ Stub (delivered with microscope)
- ☛ Conducting tape: carbon tape, conductive carbon, adhesive metal tape, or similar
- ☛ Tweezers
- ☛ Stub pliers
- ☛ Lint-free gloves

⚠ WARNING

Biological hazards

Biological substances may pose a threat to the health of humans and other living organisms.

- ▶ Keep a logbook of the biological substances loaded into the microscope and show it to the ZEISS service representatives before they perform any work on the microscope.

⚠ WARNING

Aggressive or toxic chemicals

Aggressive or toxic chemicals can cause chemical burns.

- ▶ When handling aggressive or toxic chemicals, wear suitable protective clothing, gloves, and eye/face protection.
- ▶ Do not eat, drink, or smoke while handling toxic chemicals.
- ▶ Refer to local safety regulations.
- ▶ Read and follow the instructions in the material safety data sheet of the chemical. The material safety data sheet can be obtained from the supplier of the chemicals.

NOTICE**Environmental risk due to disposal of aggressive or toxic chemicals**

When disposing of aggressive or toxic chemicals, there is a threat of damage to the environment.

- ▶ When disposing of waste that has been generated during a service operation (e.g. used rotary pump oil), comply with all national and local safety and environmental protection regulations.

NOTICE**Contamination caused by fingerprints**

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

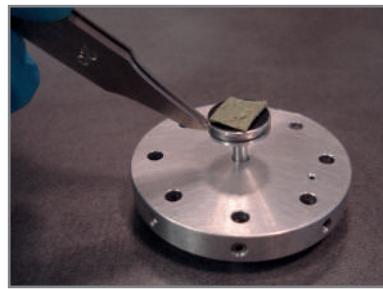
- ▶ Always wear lint-free gloves when touching the specimen, specimen holder, or stage.

Prerequisite ✓ Appropriate specimen (with conducting properties, e.g. gold on carbon)

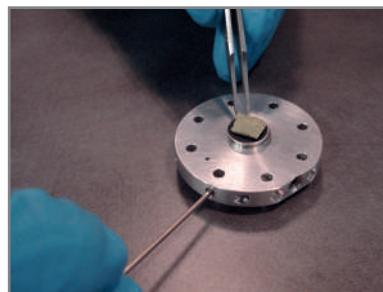
Procedure 1. To attach a specimen to the stub, use tweezers and conductive carbon, adhesive metal tape, carbon tape, or similar. Ensure that the specimen area that you want to analyze is in proper contact with the stub.



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



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



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

5.1.2 Loading the Specimen Chamber

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.

This procedure consists of the following steps:

1. *Displaying the GeminiSEM Control Panel [▶ 32]*
2. *Driving the Stage to a Low Position [▶ 32]*
3. *Venting the Specimen Chamber [▶ 33]*
4. *Installing the Specimen Holder [▶ 33]*
5. *Evacuating the Specimen Chamber [▶ 34]*

5.1.2.1 Displaying the GeminiSEM Control Panel

Prerequisite ✓ The SmartSEM user interface is started.

Procedure 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 GeminiSEM Control.
→ The GeminiSEM Control panel is added to the docking panel.

5.1.2.2 Driving the Stage to a Low Position

⚠ CAUTION

Moving the specimen stage

Fingers can be trapped by the moving specimen stage.

- ▶ Always close the chamber door before moving the specimen stage.
- ▶ To remove parts fallen into or near to the stage use a tool (e.g. tweezers) instead of your fingers.

Prerequisite ✓ The stage is initialized.

Procedure 1. In the GeminiSEM Control panel, select the Imaging tab.
2. 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**.
3. In the GeminiSEM 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 deactivated, activate 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.

5.1.2.3 Venting the Specimen Chamber

⚠ WARNING

Suffocation hazard due to lack of oxygen

Gaseous dry nitrogen is used to vent the specimen chamber during specimen exchange. Inhal-
ing 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 insta-
bility, fatigue) leave the room immediately and inform the facility's safety officer.

Procedure

1. In the GeminiSEM Control panel, select the **Vacuum** tab.

2. Click **Vent**.

→ The **Vent** message box is displayed.

3. To start venting, click **Yes**.

INFO: If the **Stage is not initialized** system message is displayed, refer to *Initializing the Stage* [▶ 263].

→ The specimen chamber is purged with gaseous nitrogen.

5.1.2.4 Installing the Specimen Holder

⚠ WARNING

Suffocation hazard due to lack of oxygen

Gaseous dry nitrogen is used to vent the specimen chamber during specimen exchange. Inhal-
ing 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 insta-
bility, fatigue) leave the room immediately and inform the facility's safety officer.

⚠ CAUTION

Moving the specimen stage

Fingers can be trapped by the moving specimen stage.

- ▶ Always close the chamber door before moving the specimen stage.
- ▶ To remove parts fallen into or near to the stage use a tool (e.g. tweezers) instead of your
fingers.

⚠ CAUTION

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**Short working distance**

When opening the chamber door, the microscope or specimen can be damaged if the specimen stage is at a short working distance. If a BSD detector is inserted, it can be damaged as well.

- ▶ Always retract any retractable detectors before opening the chamber door.
- ▶ However, in NanoVP and XVP mode, the beamsleeve should stay inserted.
- ▶ Always move the specimen stage to a long working distance before opening the chamber door.

NOTICE**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. 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. Install 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**.

5.1.2.5 Evacuating the Specimen Chamber**Procedure**

1. In the GeminiSEM 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

This procedure consists of the following steps:

1. *Positioning the Stub under the Electron Beam [▶ 35]*
2. *Moving the Specimen to the Proper Height [▶ 35]*

5.1.3.1 Positioning the Stub under the Electron Beam

NOTICE

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 dual joystick panel.
- ▶ Manually lower the stage before you open the chamber door. Alternatively, activate the **Z move on Vent** checkbox in the **Stage** tab of the GeminiSEM Control panel.

- Procedure**
1. In the **Stage Navigation Bar**, select **Stage Sideview** from the upper drop-down list and **Stage Topview** from the lower drop-down list.
INFO: To open the **Stage Navigation Bar**, navigate to **View > Toolbars** and activate **Stage Navigation Bar (for Widescreen users)**. Alternatively, you can access the **Stage Navigation Bar** via **Stage > Navigation**.
 2. Click **Settings**.
→ The **Stage Navigation Settings** dialog is displayed.
 3. In the **Stage Navigation Settings** dialog, click **Show Holder Gallery**.
→ The **Sample Holder Gallery** dialog is displayed.
 4. In the **Sample Holder Gallery** dialog, select the installed specimen holder.
 5. Activate the **Is Available** checkbox.
 6. Close the **Sample Holder Gallery** dialog.
 7. Close the **Stage Navigation Settings** dialog.
 8. In the **Stage Topview** section of the **Stage Navigation Bar**, spot the stub with the specimen you want to observe.
 9. To drive the stub directly under the electron beam, double-click the stub.

5.1.3.2 Moving the Specimen to the Proper Height

- Procedure**
1. In the **Stage Navigation Bar**, drag the **Zoom View** slider to the right end, so that the schematics are zoomed in.
 2. In the GeminiSEM 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

NOTICE

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, activate the **Partial Vent on Standby** function.

Prerequisite ✓ 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. Follow the operating steps within this chapter.
2. In the GeminiSEM 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** and monitor the gun vacuum.
 - The gun runs up.
 - This may take up to 5 minutes.

5.1.5 Switching on the EHT

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

⚠ WARNING

Radiation hazard due to X-rays

X-rays are generated inside the microscope during operation. This is unavoidable because electrons are accelerated by voltages up to 30 kV.

- ▶ Do not remove any parts around the column and chamber that are essential for radiation protection.
- ▶ Use genuine ZEISS parts exclusively.
- ▶ Ensure that all local safety and X-ray protection regulations are met.
- ▶ Only authorized ZEISS service representatives are allowed to service the microscope.

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

Procedure

1. In the GeminiSEM 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**.

4. In the right part of the **Status Bar**, click .
→ The pop-up menu for vacuum, gun, and EHT activation is displayed.
5. 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 .

5.1.6 Acquiring an Image

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 aperture alignment, magnification/focus and brightness/contrast.

This procedure consists of the following steps:

1. *Selecting the Central Aperture | Gemini 1 Column and Gemini 3 Column [▶ 37]* or *Selecting the Gun Mode | Gemini 2 Column [▶ 37]*
2. *Selecting the SE Detector [▶ 37]*
3. *Setting a Fast Scan Speed [▶ 37]*
4. *Setting a Low Magnification [▶ 38]*
5. *Adjusting Brightness and Contrast [▶ 38]*
6. *Visualizing Details on the Specimen Surface [▶ 38]*

5.1.6.1 Selecting the Central Aperture | Gemini 1 Column and Gemini 3 Column

- Procedure**
1. In the GeminiSEM Control panel, select the **Control** tab.
 2. In the **Beam** section, from the **Aperture** drop-down list, select aperture no. 1.
→ The central aperture is set.

5.1.6.2 Selecting the Gun Mode | Gemini 2 Column

- Procedure**
1. In the GeminiSEM Control panel, select the **Control** tab.
 2. In the **Beam** section, select **Imaging**.
→ The gun mode is set.

5.1.6.3 Selecting the SE Detector

- Procedure**
1. In the GeminiSEM 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 SE detector to obtain the first image. This detector provides a good signal-to-noise ratio even at long working distances.

5.1.6.4 Setting a Fast Scan Speed

- Procedure**
1. In the GeminiSEM Control panel, select the Imaging tab.
 2. From the **Scan Speed** drop-down list, select **Scan Speed = 2**.
- INFO:** The lower the scan speed number, the faster the electron beam scans across the specimen. Scan Speed = 2 allows you to get an image quickly.

5.1.6.5 Setting a Low Magnification

Procedure 1. In the **Toolbar**, select the Magnification+Focus/Auto Focus+Stig icon.



- The **Status Bar** displays the values for magnification and focus.
- **INFO:** If the **Magnification/Focus** icon is not displayed in your toolbar, then you may either create this icon via **Edit > Toolbar...** or you may instead use the control panel to adjust the magnification.
- 2. In the **Status Bar**, click **Left: Mag =**.
- The **Mag** window is displayed.
- 3. In the **Mag** input field, enter **500**.
- 4. Click **OK**.
- The magnification is set to **Mag = 500 x**.

5.1.6.6 Setting a Long Working Distance

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

- The **WD** window is displayed.
- 2. In the **WD** input field, enter **10**.
- 3. Click **OK**.
- The working distance is set to **WD = 10 mm**.

5.1.6.7 Adjusting Brightness and Contrast

Procedure 1. In the GeminiSEM Control panel, select the Imaging tab.

- 2. Activate the **Auto** checkbox next to the **Auto B Target** = scroll bar.
- 3. Activate the **Auto** checkbox next to the **Auto C Target** = scroll bar.
- After a few seconds the brightness and contrast are adjusted to the optimal value automatically.

5.1.6.8 Visualizing Details on the Specimen Surface

Procedure 1. Select a detail on the specimen surface.

- 2. Verify the **Magnification/Focus** function is activated.



- 3. 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**.
- 4. 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**.
- 5. Adjust contrast and brightness again.

5.1.7 Optimizing the Image

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.

This procedure consists of the following steps:

1. *Adjusting the Magnification* [▶ 39]
2. *Moving the Field of View at High Magnifications* [▶ 39]
3. *Limiting the Scan Field* [▶ 40]
4. *Aligning the Aperture* [▶ 40]
5. *Selecting the Scan Speed* [▶ 40]
6. *Correcting Astigmatism* [▶ 41]

5.1.7.1 Adjusting the Magnification

Procedure

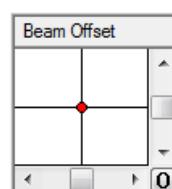
1. To switch to the Fine mode, in the **Status Bar**, click **Coarse** .
→ The **Coarse**  button changes to **Fine** .
2. Step by step, raise the magnification up to Mag 50,000 x and focus in between.
To adjust the magnification and the focus, hold down the left mouse button or the mouse wheel, respectively, and drag the mouse within the **Image Area**.

5.1.7.2 Moving the Field of View at High Magnifications

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

Procedure

1. In the GeminiSEM Control panel, select the Control tab.
2. In the **Alignment** section, click Beam Offset.
3. To shift the beam, in the Beam Offset navigation box, use the scroll bars or the red marker.



5.1.7.3 Limiting the Scan Field

Prerequisite ✓ Adjusting the size and position of the small frame (reduced raster) requires the license REDUCED.

Procedure 1. In the **Toolbar**, click the Reduced Raster/Column Control icon.



→ A small scan frame is displayed. This frame defines the specimen area to be scanned by the electron beam.

→ 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.

5.1.7.4 Aligning the Aperture

Info

Alternatively to aligning the aperture manually, use the Auto Wobble function via toolbar icon.

Procedure 1. In the GeminiSEM Control panel, select the Control tab.

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

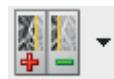
INFO: Focus wobble is a function that sweeps the acceleration voltage. If the aperture is misaligned, a lateral and vertical shift can be observed.

→ The **Focus Wobble** window is displayed.

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 **Aperture Align** 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 deactivate focus wobble.
→ The **Focus Wobble** window closes.
8. Refocus the image.

5.1.7.5 Selecting the Scan Speed

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



Alternatively, in the GeminiSEM Control panel, select the Imaging tab, and from the **Scan Speed** drop-down list, select **Scan Speed = 7**.

→ The scan speed is set to **Scan Speed = 7**.

2. Bring the image into focus.

5.1.7.6 Correcting Astigmatism

- Procedure**
1. Ensure that the **Reduced Raster** function is 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. You can move the stage or shift the beam for this purpose.
 3. In the GeminiSEM Control panel, select the Control tab.
 4. Click Stigmator.
 5. In the **Stigmation** navigation box, use the scroll bars or the red marker to obtain the sharpest possible image.
INFO: The specimen detail should just be pulsating without shifting.
INFO: To obtain optimum results, alternately correct focus and astigmatism.
 6. To deactivate the reduced raster, in the **Toolbar**, click the Reduced Raster/Column Control icon.

5.1.8 Saving the Image

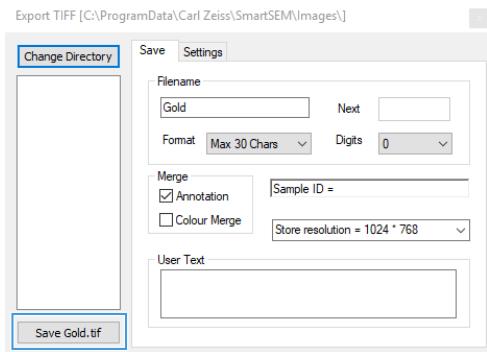
- Procedure**
1. In the **Toolbar**, click the **Freeze:Unfreeze/Scanning** icon.



→ 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 file name in the **Filename** input field.
6. Click **Save <file name>.tif**.
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

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 GeminiSEM 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 5×10^{-9} mbar.
 2. To display the **System Vacuum** and the **Gun Vacuum** in another pressure unit (*mbar, Pa, Torr*), select the desired pressure unit from **Menu Bar > Tools > User Preferences > User > Pressure Units** and confirm with **OK**.

5.2.1.2 Venting the Specimen Chamber

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 vented.

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

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



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

- Switch off the EHT. In the GeminiSEM Control panel, select the **Vacuum** tab and click the **Vent** button.

5.2.1.3 Venting and Evacuating During Specimen Exchange

For specimen exchange you can use the change macro to vent and pump the specimen chamber.

- Procedure** 1. In the **Toolbar**, click the Specimen Change/Vacuum Control icon to start the change macro.



- The EHT is switched off. The specimen chamber is vented.
2. Carefully open the chamber door, exchange the specimen, and close the chamber door.
→ The macro message **Press OK to Pump** is displayed.
3. Click **OK**.
→ The specimen chamber is pumped and the ETH is switched on.

5.2.1.4 Evacuating the Specimen Chamber

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/Vacuum Control icon.



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

The EHT is switched on.

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



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

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

5.2.1.5 Using the Quiet Mode (Optional)

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.

- Prerequisite** ✓ The optional Quiet Mode hardware is installed.

- Procedure** 1. In the GeminiSEM 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

NOTICE

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, activate the **Partial Vent on Standby** function.

Prerequisite ✓ 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. Follow the operating steps within this chapter.
 2. In the GeminiSEM 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** and monitor the gun vacuum.
 - The gun runs up.
 - This may take up to 5 minutes.

5.2.2.2 Switching off the Gun

NOTICE

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, activate 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**.
 3. Wait until the gun has ramped down.
 - This may take up to 5 minutes.

5.2.3 Controlling the EHT

5.2.3.1 Switching on the EHT

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

WARNING

Radiation hazard due to X-rays

X-rays are generated inside the microscope during operation. This is unavoidable because electrons are accelerated by voltages up to 30 kV.

- ▶ Do not remove any parts around the column and chamber that are essential for radiation protection.
- ▶ Use genuine ZEISS parts exclusively.
- ▶ Ensure that all local safety and X-ray protection regulations are met.
- ▶ Only authorized ZEISS service representatives are allowed to service the microscope.

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

- Procedure**
1. In the GeminiSEM 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**.
 4. In the right part of the **Status Bar**, click 
→ The pop-up menu for vacuum, gun, and EHT activation is displayed.
 5. 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 

5.2.3.2 Switching off the EHT

- Procedure**
1. In the right part of the **Status Bar**, click 
→ 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 | Gemini 1 Column and Gemini 3 Column

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

For the Gemini 1 column, two types of multihole aperture are available:

- 20 nA high resolution configuration

Multihole aperture type	Probe current	Typical application
7 hole aperture	3 pA to 20 nA	High resolution

- 100 nA high current configuration

Multihole aperture type	Probe current	Typical application
6 hole aperture	6 pA to 100 nA	High current

* Calibration value: deviation of 10 % possible

Info

To change the installed configuration of the microscope, contact your local ZEISS service representative.

Procedure

1. From the **Menu Bar**, select **View > SEM Status**.
→ The **SmartSEM Status** dialog is displayed.
2. In the **Select** tab, click **Aperture Type**.
3. Select the **Display** tab.
→ The parameter **Aperture Type** is displayed.

5.3.1.2 Determining the Installed Aperture Configuration | Gemini 2 Column

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

For the Gemini 2 column, three different column configurations are available:

- 40 nA high resolution configuration

Anode aperture diameter	Probe current	Typical application
55 µm	3 pA to 40 nA	High resolution and most analytical applications

- 100 nA high current configuration

Anode aperture diameter	Probe current	Typical application
90 µm	3 pA to 100 nA	Combined high resolution and analytical investigations with high throughput

- 300 nA high current configuration

Anode aperture diameter	Probe current	Typical application
150 µm	3 pA to 300 nA	Special high-current applications

* Calibration value: deviation of 10 % possible

Info

To change the installed configuration of the microscope, contact your local ZEISS 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. Select the **Display** tab.
→ The parameter **Aperture Size** is displayed.

5.3.1.3 Selecting the Gun Mode

The microscope can operate in different gun modes:

- **Normal**
- **Imaging**
- **Analytic**

Normal Gun Mode In Normal gun mode, the temperature of the Schottky emitter (gun / filament) and the extraction voltage are optimized for a long lifetime of the Schottky emitter. Normal gun mode is suitable for most applications.

Imaging Gun Mode In Imaging gun mode, the temperature of the Schottky emitter and the extraction voltage are reduced in comparison to the Normal gun mode. This leads to a reduction of the energy spread of the primary electrons. Overall, the probe current in Imaging gun mode is about half the probe current in Normal gun mode.

Imaging gun mode is especially useful at low kV or at high magnifications to reduce chromatic aberration and to achieve a better resolution. Switching from Normal gun mode to Imaging gun mode is useful for reducing the probe current without any need for beam adjustments.

Analytic Gun Mode In Analytic gun mode, the temperature of the Schottky emitter and the extraction voltage are increased. This leads to a higher probe current. Overall, the probe current in Analytic gun mode is about twice the probe current in Normal gun mode.

The Analytic gun mode is especially useful for applications which require high intensities (e.g. WDX).

Info

After switching the gun mode, you can immediately work with the selected gun mode. For applications, which require a high probe current stability, wait 24 hours until a stability of 0.2 %/h is reached. It is recommended not to change the gun mode during quantitative specimen analysis.

- Procedure**
1. From the **Menu Bar**, select **Tools > User Preferences**.
→ The **User Preferences** dialog is displayed.
 2. Select **User > Expert Gun Mode**.
 3. Click in the **Value** field and select **Yes**.
 4. Close the **User Preferences** dialog.

5. In the **Panel Configuration Bar**, double-click GeminiSEM Control.
6. In the GeminiSEM Control panel, select the **Control** tab.
7. In the **Beam** section, click one of the following buttons:
To switch to Imaging gun mode, click **Imaging**.
To switch to Normal gun mode, click **Normal**.
To switch to Analytic gun mode, click **Analytic**.
INFO: For maximum probe current, also check the alignment of the gun.
INFO: If you use the Analytic gun mode, then the lifetime of the emitter is reduced.

5.3.1.4 Setting the Probe Current

With the Gemini 2 column, 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.

The **Optimum** probe current switches to a cross over free condenser setting and achieves the highest resolution. This setting is effective for high magnifications.

Lower probe currents are suitable for beam sensitive specimens.

Info

The lowest probe current can be achieved in **Imaging** gun mode.

For improved resolution, **Optimum** probe current and **Imaging** gun mode can be combined.

Info

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

Procedure

1. In the GeminiSEM 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.

5.3.1.5 Measuring the Probe Current

Measuring the probe current using the Faraday cup ensures that the current displayed in the software equals the incident probe current. 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.

Info

The specimen current (absorbed current) is the fraction of the incident probe current (beam current) that hits the specimen and is not emitted as secondary electrons, backscattered electrons, or transmitted electrons. In case there is no other signal emission from the specimen, the specimen current equals the incident probe current that hits the specimen.

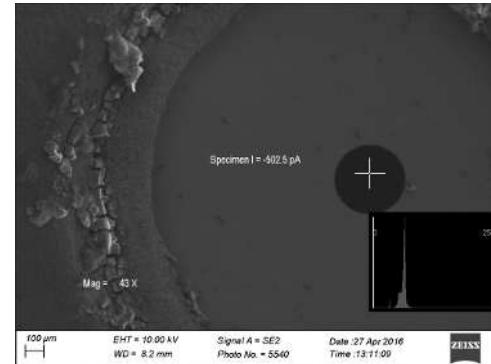
Parts and Tools  Faraday cup (348342-8055-000)

Prerequisite ✓ You have successfully carried out the steps described in *Acquiring an Image* [▶ 30].

Procedure

1. Load the Faraday cup into the specimen chamber. Refer to *Loading the Specimen Chamber* [▶ 32].
2. Evacuate the specimen chamber.
3. Switch on the gun. Refer to *Switching on the Gun* [▶ 44].

4. Switch on the EHT. Refer to *Switching on the EHT* [▶ 45].
5. From the **Panel Configuration Bar**, select **Specimen Current Monitor**.
→ The **Specimen Current Monitor** window is displayed.
6. Activate the **Stage Bias** checkbox.
INFO: If the **Stage Bias** checkbox is activated, a small negative bias voltage is applied to the specimen stage. This enhances the sensitivity for touch alarm, especially for weakly conducting specimens. In some special cases (e.g. very low EHT values), it may be necessary to deactivate the Stage Bias option and set the stage potential close to zero.
7. Deactivate the **Touch Alarm Disable** checkbox.
INFO: The **Touch Alarm Disable** option connects the stage potential with low impedance to the ground. This may be required with the usage of micromanipulators. Activating this checkbox disables both, touch alarm and specimen current measurement.
→ This activates the touch alarm that helps to avoid collisions of the stage.
8. Move the stage to the position of the Faraday cup.
9. Acquire an image of the Faraday cup.
10. Activate the **Spot** checkbox.
→ Green crosshairs are displayed on the image. These crosshairs indicate the position of the beam spot.
11. 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.



5.3.1.6 Blanking the Beam

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 GeminiSEM Control panel, select the **Control** tab.
 2. In the **Beam** section, activate the **Blank** checkbox.

5.3.1.7 Changing the Extractor Voltage

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 probe 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.

Info

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 maximum 500 V.

Prerequisite ✓ 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**.

5.3.1.8 Modifying the Probe Current Continuously (License: OPTIPROBE)

Info

OptiProbe allows you to continuously adjust the probe current. The function automatically selects a suitable aperture and the current mode while the extractor voltage is adjusted to meet the probe current selected by the user.

Info

After cathode replacement or after re-alignment of the electron optical column, OptiProbe has to be calibrated.

Prerequisite ✓ Requires the licenses OPTIPROBE and HIGH VOLTAGE.

✓ Particular hardware and the specimen current amplifier are installed.

Procedure 1. In the GeminiSEM Control panel, select the **Gun** tab.

2. Activate the **OptiProbe** checkbox.

3. Use the **I Probe** slider to set the desired probe current.

→ As soon as the probe current adjustment is finished, the **OptiProbe Status** readout changes from **Busy** to **Ready**.

→ The probe current displayed in the **I Probe** readout corresponds to the actual probe current ($\pm 15\%$).

4. To deactivate the function, deactivate the **OptiProbe** checkbox.

INFO: If **OptiProbe** is deactivated, the **I Probe** readout continues to indicate the actual probe current ($\pm 15\%$).

5.3.2 Selecting the Aperture

With a Gemini 1 column, you can control the probe current by changing to a different aperture within the multihole aperture.

Depending on your configuration (20 nA configuration or 100nA configuration) different apertures are available.

The default aperture (central aperture / (1) 30 µm Aperture) has the optimum convergence angle for the primary beam and the best resolution. The default aperture is suitable for most applications.

Small apertures are suitable for high-resolution imaging or current-sensitive specimens.

A larger aperture generates a larger probe current and is used for applications that require a high beam brightness, e.g. EDX.

Changing to a smaller/larger aperture will reduce/increase the convergence angle accordingly. This could lead to decrease in resolution.

Procedure

1. In the GeminiSEM Control panel, select the **Control** tab.
2. In the **Beam** section, select an aperture from the **Aperture** drop-down list.
3. To double the probe current, activate the **High Current** checkbox.

INFO: **High Current** is recommended for large apertures (60 and 120 µm). For small apertures the depth of field increases.

INFO: **High Current** is not available for the standard aperture.

5.3.3 Selecting the Column Mode

With the Gemini column, different column modes are available.

Column Mode	Description
Normal	Standard imaging and analytical mode with high flexibility for different applications.
Overview	<p>The electron optics is set to a landing energy of 100 V, enabling large field of view. On GeminiSEM 560, the EHT in Overview mode can be tuned within a larger range.</p> <p>The image is distorted, but is useful for navigating the specimen.</p>
Low Mag	<p>Only available for GeminiSEM 560.</p> <p>The image distortions in Low mag mode are very small in comparison to Overview mode.</p> <p>This enables precise measurement at low magnifications.</p> <p>The field of view in Low Mag mode is much smaller than in Overview mode at long working distances.</p>

Procedure

1. In the GeminiSEM Control panel, select the **Control** tab.
2. In the **Column** section, select between:
Normal, **Overview**, and **Low Mag**
INFO: **Low Mag** is only available for GeminiSEM 560.
INFO: If magnification is displayed with a large error in overview mode, check stage height calibration and specimen height calibration. Expected magnification error is up to about 10 % in overview mode.

5.3.4 Re-adjusting the Beam via Offset Correction

5.3.4.1 Performing an Offset Correction

When you change SEM parameters such as EHT or probe current, you obtain a small offset due to the hysteresis of the magnetic lenses. For the highest reproducibility of the beam settings you can perform an offset correction, which sets the magnetic lenses into their initial magnetization.

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 GeminiSEM Control panel, select the **Control** tab.
 2. Click **Offset Cor.**
→ SmartSEM calibrates the beam path.

5.3.4.2 Activating the Auto Offset Correction

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 GeminiSEM 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

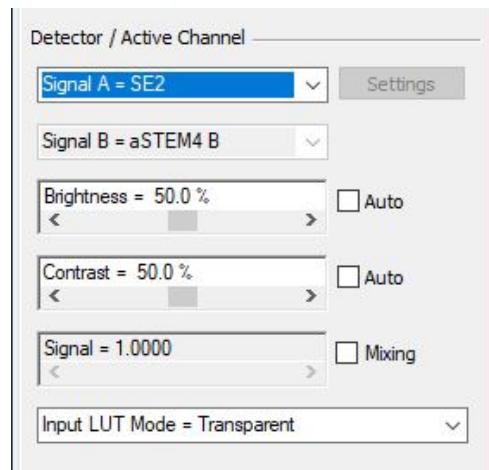
5.4.1.1 Selecting a Detector

You need to select an appropriate detector depending on the application and the pressure mode. In addition to the standard SE detector, several optional detectors are available.

For information on special set-up procedures for the detectors, refer to:

- *Setting the InLens SE Detector [▶ 54]*
- *Setting the SE Detector [▶ 54]*
- *Setting the VPSE Detector [▶ 55]*
- *Setting the C2D Detector [▶ 56]*
- *Setting the AsB Detector [▶ 57]*
- *Setting the AsB4 Detector [▶ 58]*
- *Setting the aBSD/aBSD-LH/VP-BSD Detector [▶ 60]*
- *Setting the HT BSD Detector [▶ 62]*
- *Setting the Sense BSD Detector [▶ 63]*
- *Setting the YAG BSD Detector [▶ 64]*
- *Setting the EsB Detector [▶ 64]*
- *Setting the SCD Detector [▶ 65]*
- *Setting the aSTEM Detector [▶ 66]*
- *Setting the CL Detector [▶ 67]*

- Procedure**
1. Select the Imaging tab of the GeminiSEM Control panel.
 2. Select the detector from the **Signal A** drop-down list.



5.4.1.2 Setting the InLens SE Detector

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

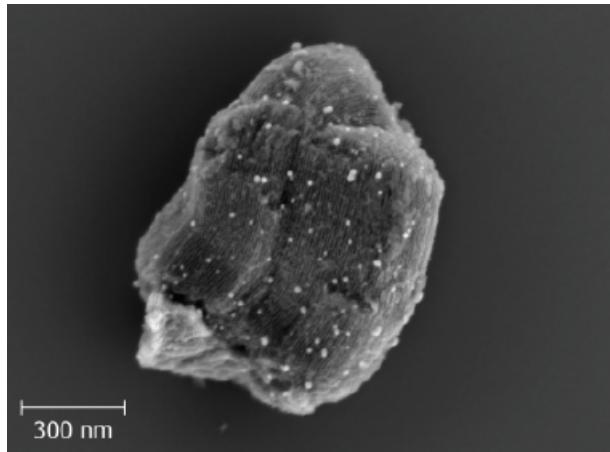


Fig. 2: Silver nanoparticles embedded in zeolite, imaged at 1.5 kV.

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 SE detector.

Procedure

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

5.4.1.3 Setting the SE Detector

The SE detector collects the SE signal, highlighting the topography of the specimen.

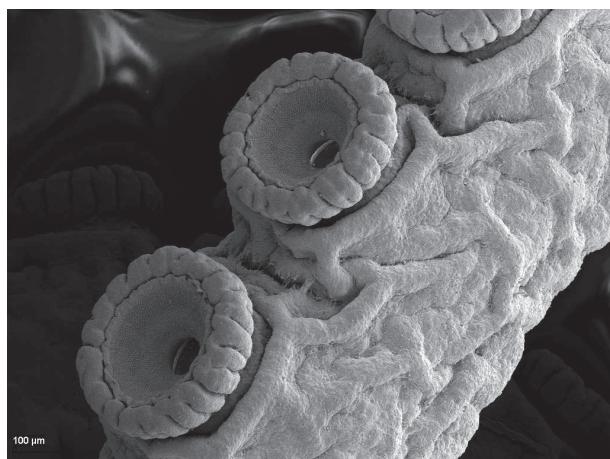


Fig. 3: An eledone tentacle

The following settings are recommended for the SE detector:

EHT	Typical WD	Collector Voltage
500 V – 5 kV	2–8 mm	<ul style="list-style-type: none"> ▪ Adjustable from –250 V to +400 V ▪ Standard applications: +300 V
5 kV – 30 kV	min. 6 mm	<p>At a high magnification, you can optimize the image by varying the collector voltage.</p> <ul style="list-style-type: none"> ▪ Pseudo-backscattered (BSE) image: –250 V to –50 V <p>This produces a topographic image of the specimen with no material contrast.</p>

Procedure

1. In the GeminiSEM 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.

Info

For detailed information on working with the SE detector refer to *Acquiring an Image* [▶ 30].

5.4.1.4 Setting the VPSE Detector

The VPSE detector is designed for VP applications. The VP mode enables analyzing and imaging of non-conducting, strongly gassing or moist specimens without any need for specimen preparation.

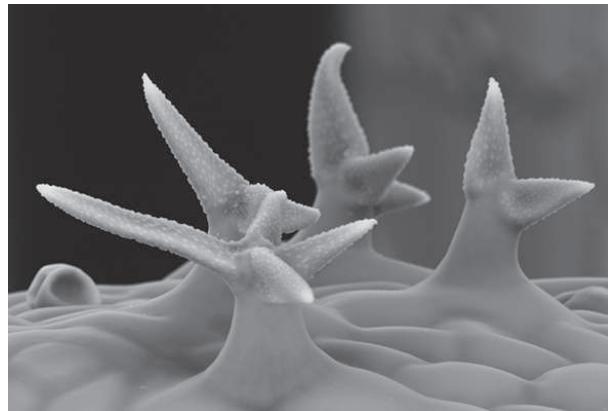


Fig. 4: A rosemary leaf.

The following settings are recommended for the VPSE detector:

EHT	Typical WD	Collector Voltage
1 kV – 30 kV	7–10 mm	<ul style="list-style-type: none"> ▪ Adjustable from 0 V to 1000 V ▪ Standard applications: 300 V ▪ Use a high collector voltage at low chamber pressures (<20 Pa) ▪ Beamsleeve bias should be set to 0 V

Prerequisite ✓ The microscope is operating in VP vacuum mode.

Procedure

1. In the GeminiSEM Control panel, select the Imaging tab.
2. From the **Signal A** drop-down list, select **VPSE G4**.

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 the C2D Detector

The C2D detector collects gas cascade electrons produced by C2D bias-accelerated secondary electrons in the chamber under VP conditions.

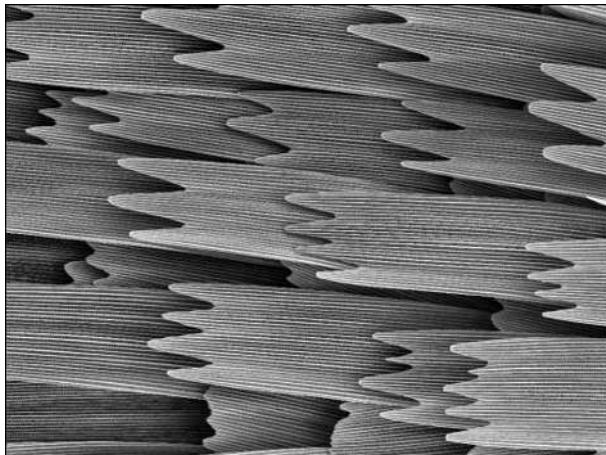


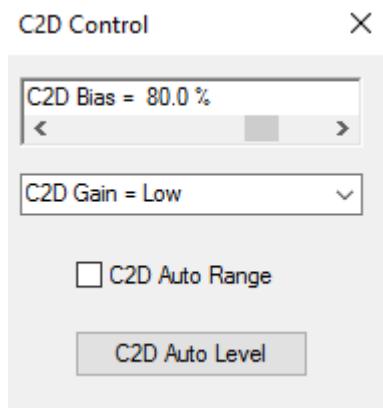
Fig. 5: C2D image of a moth

The following settings are recommended for the C2D detector:

EHT	Typical WD	Detector Settings
1–30 kV	7–10 mm	<p>C2D Bias</p> <ul style="list-style-type: none"> ▪ Adjustable from 0 % to 100 % ▪ Typical: 80 % <p>A too high bias causes electrical breakdown in the detector. If you observe bright lines or flashing in the image reduce the C2D Bias until the artifacts disappear.</p> <p>Beamsleeve bias should be set to 0 V</p> <p>To reduce image disturbances, do not use scan speeds faster than 4.</p>

Procedure

1. In the GeminiSEM Control panel, select the Imaging tab.
2. From the **Signal A** drop-down list, select **C2D F2**.
3. Open the **Panel Configuration Bar**.
4. Double-click **C2D Control** to open the **C2D Control** panel.



5. Select **C2D Gain = Low**.
6. Adjust the **C2D Bias** scroll bar to 80 %. This is usually a good start value.

7. Click **C2D Auto Level**.
→ The brightness offset is cancelled out and the image is readjusted to a centered histogram at a brightness value of 50 %.
8. Adjust the contrast of the image.
9. If your image is still too noisy, increase **C2D Bias** or increase **C2D Gain**.
10. Adjust the EHT and working distance (WD) according to the suggestions in the table in order to optimize the image.

5.4.1.6 Setting the AsB Detector

The AsB detector is optionally available.

The AsB detector enables four outputs that can be used either for compositional imaging or for topographical imaging.

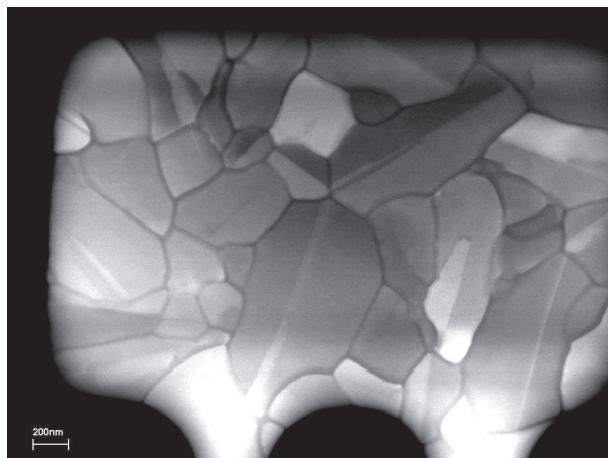


Fig. 6: The crystalline structure of a silicon device

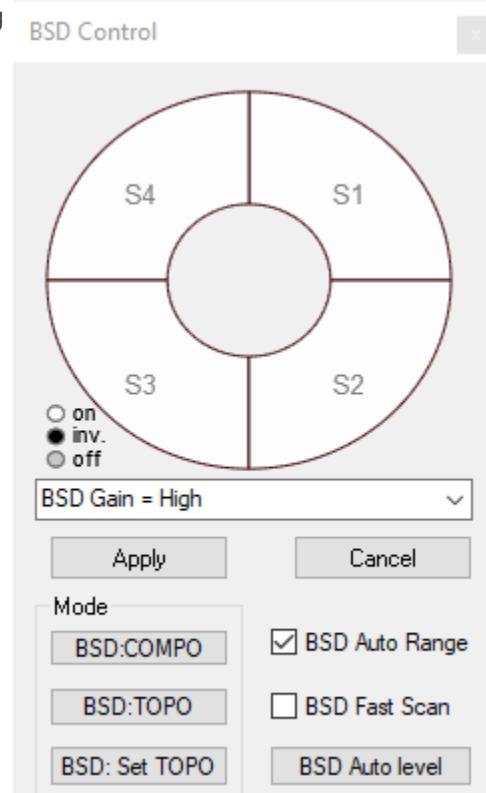
The following settings are recommended for the AsB detector:

EHT	Typical WD	Detector Settings
1.5 kV – 30 kV	3–10 mm	<ul style="list-style-type: none">▪ Use compositional mode for obtaining an image that is high in atomic number contrast.▪ Use topography mode for showing surface details.▪ Use individual settings for channeling contrast.

Procedure

1. In the GeminiSEM Control panel, select the Imaging tab.
2. From the **Signal A** drop-down list, select AsB.
3. To open the **Panel Configuration Bar**, from the **Menu Bar**, select **Tools > Goto Panel**.
→ The **Panel Configuration Bar** is displayed. It contains an alphabetical list of functions.
4. Double-click **BSD Control**.
→ The **BSD Control** dialog is displayed.

- In the upper section, the **BSD Control** dialog displays the four quadrants/outputs.



5. Click a quadrant symbol to toggle its status between on (white), inverted (black), and off (gray).
6. To confirm the settings, click **Apply**.
7. To choose the respective mode, click **BSD: COMPO** or **BSD: TOPO**.
The default setting for BSD is **BSD: COMPO**. All four segments are set to **on** and an image is obtained, which is high in atomic number contrast.
8. If you want to change the default setting to **BSD: TOPO**, click **BSD: Set TOPO**.
9. From the **BSD Gain** drop-down list, select the appropriate BSD Gain:
Low, Medium, High, or Very High.
The BSD Gain depends on the signal strength.

5.4.1.7 Setting the AsB4 Detector

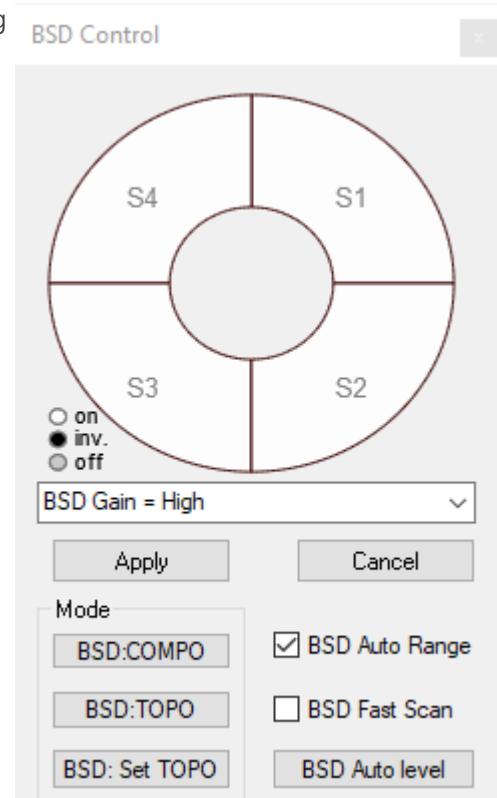
The AsB4 detector is optionally available. When ordered this detector replaces the AsB detector.

The AsB4 detector enables four parallel outputs for simultaneous compositional and topographical imaging. Each of the four channels can be selected separately.

The following settings are recommended for the AsB4 detector:

EHT	Typical WD	Detector Settings
1.5 kV – 30 kV	3–10 mm	<ul style="list-style-type: none"> ▪ Use compositional mode for obtaining an image that is high in atomic number contrast. ▪ Use topography mode for showing surface details. ▪ Use individual settings for channeling contrast.

- Procedure**
1. In the GeminiSEM Control panel, select the Imaging tab.
 2. From the **Signal A** drop-down list, select **AsB4 Ch1**.
 3. From the **Tool Bar**, select **Quad Mode**.
 4. To open the **Panel Configuration Bar**, from the **Menu Bar**, select **Tools > Goto Panel**.
→ The **Panel Configuration Bar** is displayed. It contains an alphabetical list of functions.
 5. Double-click **BSD Control**.
→ The **BSD Control** dialog is displayed.
→ In the upper section, the **BSD Control** dialog displays the four quadrants/outputs.



6. Set mode of the quadrants: Click a quadrant symbol to toggle its status between on (white), inverted (black), and off (gray).
7. To choose the respective mode, click **BSD: COMPO** or **BSD: TOPO**.
The default setting for BSD is **BSD: COMPO**. All four segments are set to **on** and an image that is high in atomic number contrast is obtained.
8. If you want to change the default setting to **BSD: TOPO**, click **BSD: Set TOPO**.
9. From the **BSD Gain** drop-down list, select the appropriate BSD Gain:
Low, Medium, High, or Very High.
The BSD Gain depends on the signal strength.

5.4.1.8 Setting the aBSD/aBSD-LH/VP-BSD Detector

The aBSD/aBSD-LH/VP-BSD detector is a pneumatically retractable backscattered electron detector which is inserted below the objective lens and is used for high efficiency and angle selective material characterization.

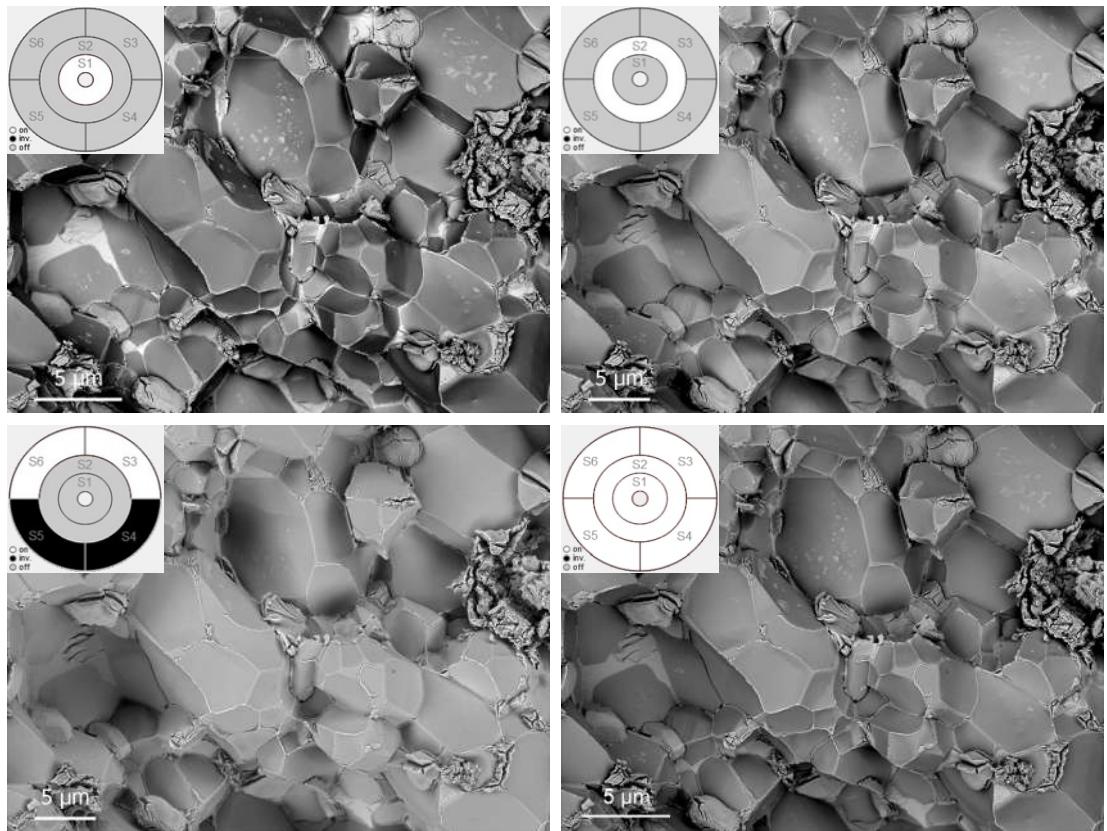


Fig. 7: BSE images of NdFeB magnet surface showing different contrast on different segments of the aBSD detector. The inner segment S1 shows strong material contrast (top left). The middle segment S2 shows combined material contrast and topography (top right). The outer segment S3-S6 shows mainly topography (bottom left). The final image shows the combined signal of all segments (bottom right).

The following settings are recommended for the aBSD/aBSD-LH/VP-BSD detector:

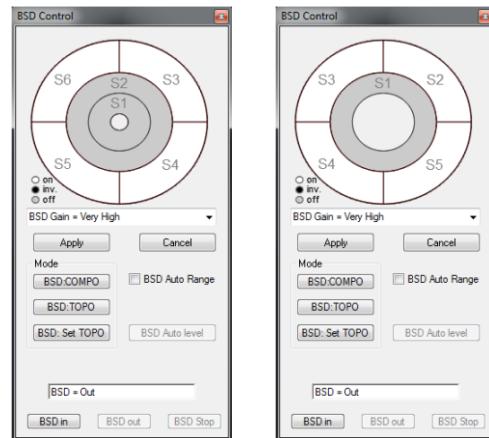
EHT	Typical WD	Detector Settings
0.5–30 kV	5–12 mm	<p>Compositional mode for obtaining an image that is high in atomic number contrast</p> <p>Use topographic mode for showing surface details</p> <p>Use individual settings for channeling contrast</p> <p>Make use of different concentric rings of the detector to get angular resolved BSE images</p> <p>Use high or very high detector gain for low accelerating voltage and/or low beam current</p> <p>The EHT should be bigger than 2 kV to achieve a significant detection efficiency.</p>

Procedure 1. From the **Panel Configuration Bar**, select **BSD Control**.

The **BSD Control** panel enables you to change the polarity of the segments, select BSD modes, and set the BSD gain.

→ The **BSD Control** panel is displayed.

The **BSD Control** panel looks slightly different for the aBSD detector (left) and the aBSD-LH/VP-BSD detector (right).

2. In the **BSD Control** panel, click **BSD in** to insert the detector.

→ The stage is lowered by 20 mm to give space for the detector to be inserted.

→ The detector is inserted.

3. In the GeminiSEM Control panel, select the Imaging tab.

4. From the **Signal A** drop-down list, select **BSD1** or **BSD4 A** depending on your detector type and configuration.

INFO: A refers to the video channel. B, C, and D are also available if you have the four-channel version.

5. Adjust the EHT and the working distance (WD) according to the suggestions in the table in order to optimize the image.

6. In the **BSD Control** panel, click a quadrant symbol to toggle its status between on (white), inverted (black), and off (gray).7. To choose the respective mode, click **BSD: COMPO** or **BSD: TOPO**.

The default setting for BSD is **BSD: COMPO**. All six segments (S1–S6, aBSD) or five segments (S1–S5, aBSD-LH/VP-BSD) are set to **on** and an image that is high in atomic number contrast is obtained.

The default mode for **BSD: TOPO** is S1 off, S2 off, S3 on, S4 on, S5 inv and S6 inv (aBSD) or S1 off, S2 on, S3 on, S4 inv and S5 inv (aBSD-LH/VP-BSD).

8. If you want to change the default setting to **BSD: TOPO**, click **BSD: Set TOPO**.9. From the **BSD Gain** drop-down list, select **Low**, **Medium**, **High**, or **Very High**.

INFO: Since the detector has a limited speed, it is recommended to use scan speed 6 or higher (slower), especially at small magnifications. The lower the gain is, the faster is the detector.

5.4.1.9 Setting the HT BSD Detector

The High Temperature BSD detector is a pneumatically retractable backscattered electron detector which is inserted below the objective lens and is used for high efficiency material characterization of heated specimens.

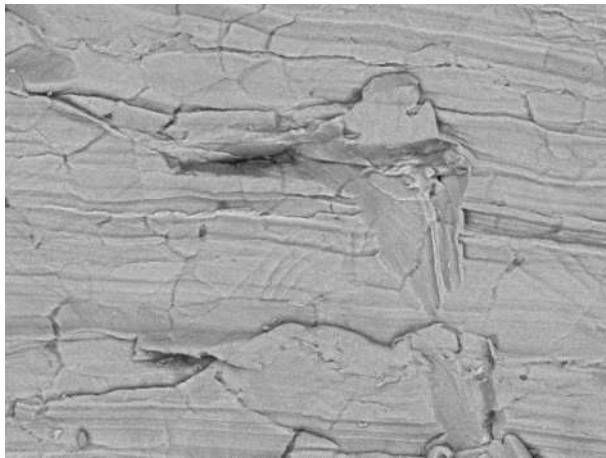


Fig. 8: Specimen at 800 °C acquired with HT BSD Detector

The following settings are recommended for the HT BSD detector:

EHT	Typical WD	Detector Settings
5–30 kV	10 mm	HT BSD Filter settings: <ul style="list-style-type: none">▪ Scan speeds up to 9: Fast filter▪ Scan speeds 9 to 12: Fast filter or Medium filter▪ Scan speeds 12 to 15: Medium filter or Slow filter

- Procedure**
1. From the **Panel Configuration Bar**, select **HT BSD Control**.
→ The **HT BSD Control** panel is displayed.
 2. In the **HT BSD Control** panel, click **HT BSD In** to insert the HT BSD detector.
→ The stage is lowered by 20 mm to give space for the detector to be inserted.
→ The detector is inserted.
 3. In the GeminiSEM Control panel, select the **Detectors** tab.
 4. From the **Signal A** drop-down list, select **HT BSD**.
 5. Adjust the EHT, the working distance (WD) and the **HT BSD Filter** according to the suggestions in the table in order to optimize the image.
INFO: Higher EHT and higher probe current give a better signal.

5.4.1.10 Setting the Sense BSD Detector

The Sense BSD detector is a pneumatically retractable backscattered electron detector that is inserted below the objective lens and is used for high-efficiency material characterization of biological specimens.

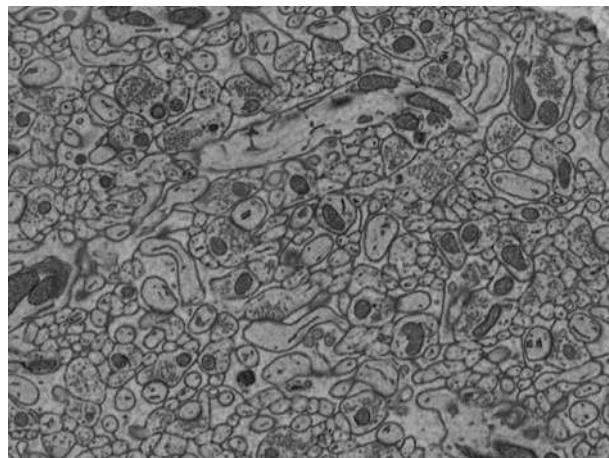


Fig. 9: Rat brain imaged at 2 kV

The following settings are recommended for the Sense BSD detector:

EHT	Typical WD	Detector Settings
1.5–7 kV	4–6 mm	Maximum allowed EHT is 7 kV Current: 200–1000 pA Scanspeed: 4–10

Procedure

1. From the **Panel Configuration Bar**, select **Sense BSD**.
The **Sense BSD** panel enables you to change the polarity of the segment and set the BSD gain.
→ The **Sense BSD** panel is displayed.
2. In the **Sense BSD** panel, click **Insert** to insert the Sense BSD detector.
NOTICE **Risk of collision: The stage is not lowered when the Sense BSD detector is inserted. Ensure that there is enough space between the specimen and the objective lens to insert the detector. Observe the detector movement via camera to avoid a collision.**
→ The detector is inserted.
3. In the GeminiSEM Control panel, select the **Detectors** tab.
4. From the **Signal A** drop-down list, select **Sense BSD**.
5. Adjust the EHT, the working distance (WD), the current, and the scanspeed according to the suggestions in the table to optimize the image.
6. In the **Sense BSD** panel, click the segment S1 to toggle its status between on (white), inverted (black), and off (gray).
7. From the **BSD Gain** drop-down list, select **Low, Medium, High, Very High, or Ultra high**.
Alternatively, select the **Auto Gain Range** checkbox.
INFO: Since the detector has a limited speed, it is recommended to use scan speed 4 or higher (slower), especially at small magnifications. The lower the gain is, the faster the detector is.

5.4.1.11 Setting the YAG BSD Detector

NOTICE

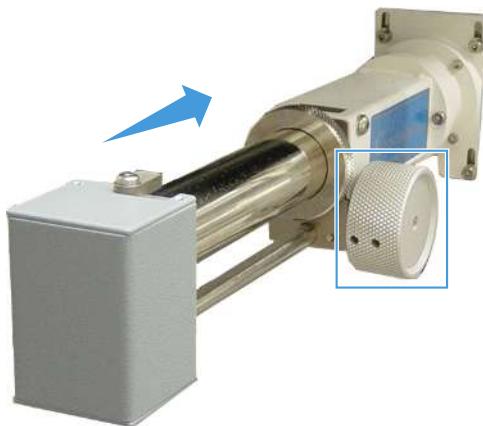
Inserting the YAG BSD detector

When you manually insert the detector, there is a risk to damage the YAG BSD detector.

- ▶ Use the chamberscope image to observe if there is enough space between the objective lens and the specimen.
- ▶ If there is not enough space between the objective lens and the specimen, then lower the stage position before you insert the detector.
- ▶ Insert the YAG BSD detector carefully and observe the moving YAG BSD detector via the chamberscope.

Procedure 1. Insert the detector.

If there is any resistance, make sure the silver knob is untightened.



2. In the GeminiSEM Control panel, select the **Detectors** tab.
3. From the **Signal A** drop-down list, select **YAG BSD**.
4. To optimize the image, adjust brightness and contrast. There are no further parameters to change.
5. After use, retract the detector.

INFO: Because of the detector's weight, there is only little risk for it to accidentally slide in. Therefore, you do not have to fix the silver knob.

5.4.1.12 Setting the EsB Detector

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.

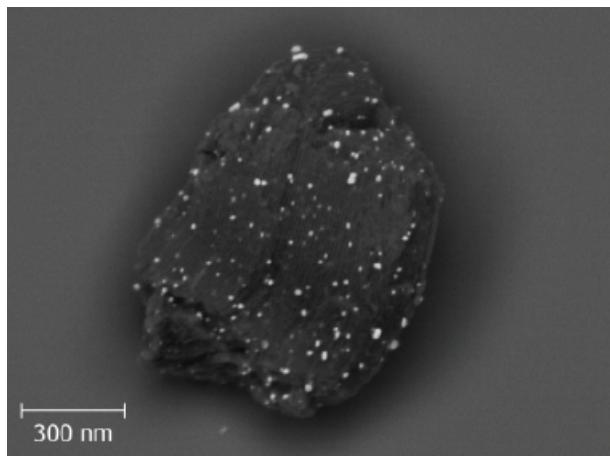


Fig. 10: Silver nanoparticles embedded in zeolite, imaged at 1.5 kV

The following settings are recommended for the EsB detector:

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 GeminiSEM Control panel, select the Imaging tab.
 2. From the **Signal A** drop-down list, select **ESB**.
 3. Adjust the EHT, working distance (WD), and EsB Grid according to the suggestions in the table in order to optimize the image.

5.4.1.13 Setting the SCD Detector

The SCD detects the current absorbed in the specimen. A highly sensitive amplifier is connected to the specimen, measuring the sum of incoming PEs and outgoing SEs and BSEs for each image pixel.

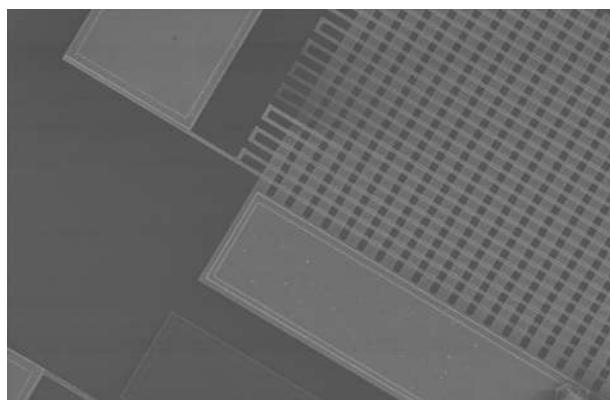


Fig. 11: Silicon chip

The following settings are recommended for the SCD detector:

EHT	Typical WD	Settings
10–30 kV	5–10 mm	Scanspeed: 8 and higher Primary current: appr. 1 nA

- Procedure**
1. In the GeminiSEM Control panel, select the Imaging tab.
 2. From the **Signal A** drop-down list, select **SCD**.

3. Adjust the EHT, working distance (WD), scan speed and primary current according to the suggestions in the table in order to optimize the image.

5.4.1.14 Setting the aSTEM Detector

The aSTEM detector is used for compositional imaging or topographical imaging of ultrathin specimens. The aSTEM detector is available either with one video output channel (aSTEM1) or with four video output channels (aSTEM4). The aSTEM detector is optionally available.

The aSTEM detector is equipped with several separate diode segments. The signals of the segments can individually be added to or subtracted from the output signal in order to allow different STEM imaging modes, e.g. bright field (BF) or oriented dark field (ODF). The most commonly used STEM imaging modes are predefined and can be selected from a drop-down menu in the **STEM Control** panel.

The following figure shows an oriented darkfield (ODF) image captured with an aSTEM4 detector (left) and an ODF image showing real information about bending and lattice defects within each fiber (right).

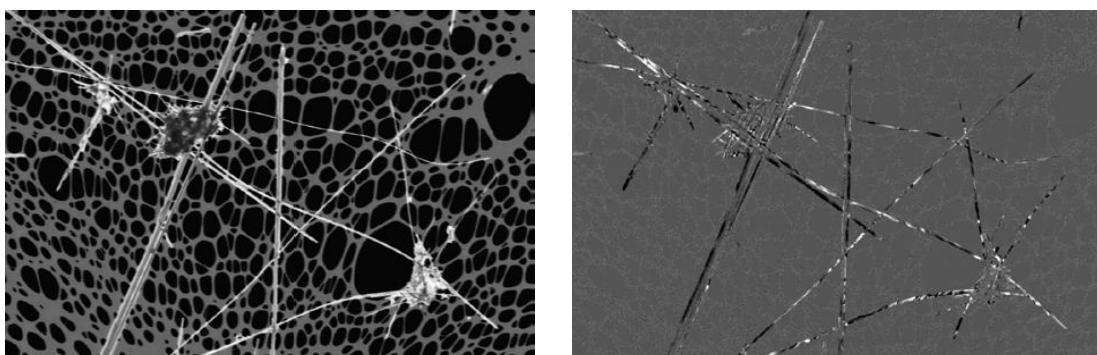


Fig. 12: Asbestos, oriented darkfield (ODF) images captured with an aSTEM4 detector

STEM Control for 5 diode segments	STEM imaging mode	Output signal
	BF	S1
	DF	S2 + S3
	ODF	S2 – S3
	ODF90°	S3 – S2
	ODF + BF	S1 + S2 – S3
	ODF90° + BF	S1 – S2 + S3
	BF + DF	S1 + S2 + S3
	ADF	S2 + S3 + S4
	HAADF Middle	S4
	HAADF outer	S5
	HAADF	S4 + S5
	User defined name	Custom combination of segments
	Active segments with +/- signs	Custom combination of segments. "+" on, "-" inverted

NOTICE**Motorized specimen stage**

Risk of damaging the detector when operating the motorized specimen stage.

- ▶ Retract the detector head completely after you have finished the work with the detector.

Procedure

1. In the **GeminiSEM Control** panel, select the **Imaging** tab.
2. For displaying several channels of a aSTEM detector simultaneously, from the **Menu Bar**, select **Scanning > Quad Mode**.
 - The **Image Area** is divided into 4 zones.
To select a detector for a zone, click in the zone.
An anchor symbol is displayed in the selected zone.
3. From the **Signal A** drop-down list, select a STEM detector, e.g. **aSTEM1**.
4. In the **Panel Configuration Bar**, double-click **STEM Control**.
To open the **Panel Configuration Bar**, from the **Menu Bar**, select **Tools > Goto Panel**.
 - The **STEM Control** dialog is displayed.
In the upper section, the **STEM Control** dialog displays the status of the diode segments.
The status is either on (white), inverted (black), or off (gray).
5. Either select a STEM imaging mode from the **STEM Seg. Mode** drop-down list or click a custom selection of diode segments to toggle its status between on, inverted, and off.
6. Set the **Gain range**.
Select between **Low**, **Medium**, **High**, or **Very High**.
7. For displaying several channels of a aSTEM detector simultaneously, repeat steps 3 to 6 for the other display zones.

5.4.1.15 Setting the CL Detector

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.

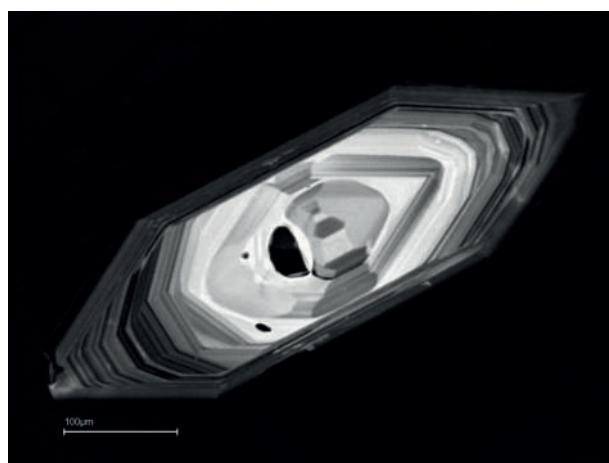


Fig. 13: Zircon grains

Info

The CL signal is usually very weak and the resolution of the CL image is much worse than an SE image.

- ▶ Use the SE detector to navigate and focus before acquiring CL images.

The following settings are recommended for the CL detector:

EHT	Typical WD
5 kV – 30 kV	6–10 mm (min. 4 mm)

- Procedure**
1. In the GeminiSEM Control panel, select the Imaging tab.
 2. From the **Signal A** drop-down list, select **CL**.
 3. Adjust the EHT and the working distance (WD) 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)

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.

Prerequisite ✓ Requires the license SIGMIX.

- Procedure**
1. In the GeminiSEM 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** scroll bar 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

The windowing function enables you to display two different detector signals on the same 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:
Zone = 0: Outside the reduced raster
Zone = 1: Inside 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)

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

Prerequisite ✓ Requires the license SPLIT.

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

→ Alternatively, in the **Toolbar**, click the **Split Screen** icon.



→ 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)

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.

Prerequisite ✓ 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.

3. To quit the Dual Channel function, from the **Menu Bar**, select **Image > Dual Channel**.

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

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.

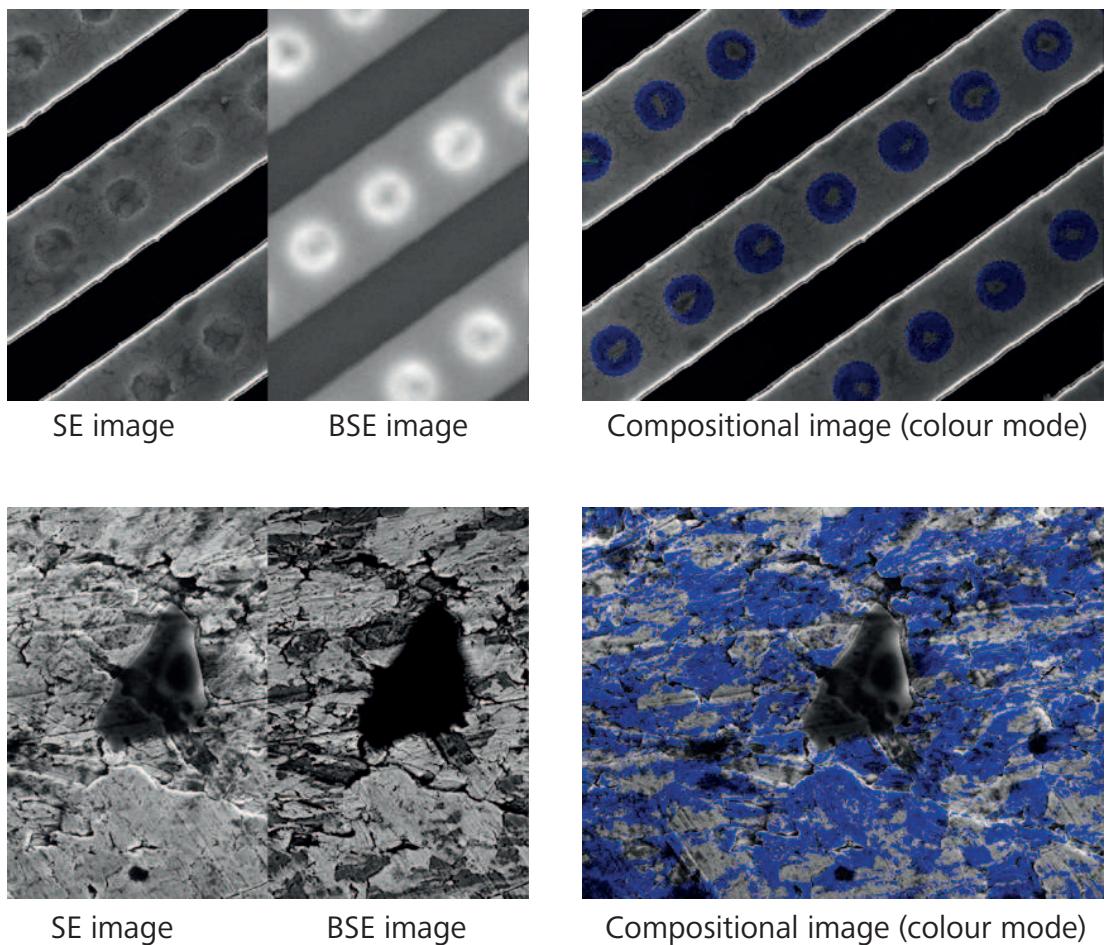


Fig. 14: Signals from two detectors in Split mode (left) and Color mode (right)

Prerequisite ✓ Requires the license COLOUR MODE.

- Procedure**
1. From the **Panel Configuration Bar**, select **Colour Mode**.
→ The **Colour Mode** window is displayed.
 2. From the **Colour Mode** drop-down list, select **Colour Mode = 2 LUT**.
→ This activates the **Signal B** drop-down list and the **RGB** checkboxes in column 1 and 2.
 3. From the **Signal A** and **Signal B** drop-down lists, select the desired detectors.
 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)

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.

Prerequisite ✓ Requires the license DUALMAG.

- Procedure**
1. From the **Menu Bar**, select **Scanning > Dual Mag**.
→ Alternatively, in the **Toolbar**, click the **Dual Magnification** icon.

 - 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.
- 3. 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.
- 4. 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.



- 5. To select the active zone, displace the anchor symbol via drag and drop.
- 6. 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

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**
1. From the **Menu Bar**, select **Detection > TV Inputs > USB TV2**.
 - Alternatively, in the GeminiSEM Control panel, select the Imaging tab. From the **Signal A** drop-down list, select **USB TV2**.

5.4.3 Setting Scan Parameters

5.4.3.1 Selecting a Scan Speed

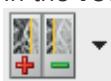
A focused beam of electrons is scanned across the specimen.

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.

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

5.4.3.2 Scanning a Small Frame (Reduced Raster)

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.

Info

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.
- ▶ If you use the reduced raster function during EDX detection, then select scan speed 5 or higher (slower).

Prerequisite ✓ Adjusting the size and position of the small frame (reduced raster) requires the license REDUCED.

Procedure 1. In the **Toolbar**, click the Reduced Raster/Column Control icon.



- A small scan frame is displayed. This frame defines the specimen area to be scanned by the electron beam.
- 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.

5.4.3.3 Scanning a Line

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.

NOTICE

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**.

- Alternatively, in the **Toolbar**, click the **Linescan** icon.



- 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 and 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)

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.

NOTICE

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.

Prerequisite ✓ Requires the license SPOT.

- Procedure**
1. From the **Menu Bar**, select **Scanning > Spot**.
 - Alternatively, in the **Toolbar**, click the **Spot Mode** icon.

 - 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**.
 - Alternatively, in the **Toolbar**, click the **Spot Mode** icon.

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

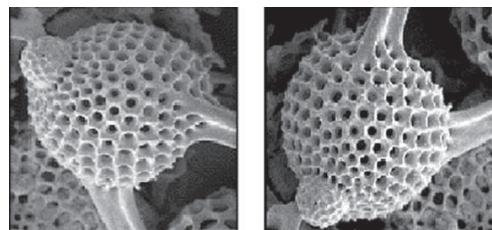
5.4.3.5 Rotating the Image (License: SCANROT)

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

Prerequisite ✓ 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 rotation 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

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

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. From the **Menu Bar**, select **Tools > Run A Macro**.
2. From the drop-down list, select **TB MAG_FOCUS** and confirm with **OK**.
3. 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. From the **Menu Bar**, select **Tools > Run A Macro**.
2. From the drop-down list, select **TB MAG_FOCUS** and confirm with **OK**.
3. 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

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

Prerequisite ✓ 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

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 GeminiSEM Control panel, select the **Imaging** tab.
 2. In the **Detector / Active Channel** section use the respective scroll bars to adjust brightness and contrast.

Alternatively, from the **Menu Bar**, select **Tools > Run A Macro**. From the drop-down list, select **TB BRI/CONT** and confirm with **OK**. The mouse assignment is indicated in the **Status Bar**. To adjust the brightness, hold the left mouse button and drag. To adjust the contrast, hold the middle mouse button and drag.

5.4.6.2 Automatically Adjusting Brightness and Contrast

- Procedure**
1. In the GeminiSEM 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

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.

Info

Alternatively to aligning the aperture manually, use the Auto Wobble function via toolbar icon.

- Procedure**
1. In the GeminiSEM Control panel, select the Control tab.
 2. In the **Alignment** section, click **Focus Wobble**.
INFO: Focus wobble is a function that sweeps the acceleration voltage. If the aperture is misaligned, a lateral and vertical shift can be observed.
→ The **Focus Wobble** window is displayed.
 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 **Aperture Align** 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 deactivate focus wobble.
→ The **Focus Wobble** window closes.
 8. Refocus the image.

5.4.8 Correcting Astigmatism

5.4.8.1 Setting the Stigmator Manually

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

- Procedure**
1. Ensure that the **Reduced Raster** function is 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. You can move the stage or shift the beam for this purpose.
 3. In the GeminiSEM Control panel, select the Control tab.
 4. Click Stigmator.
 5. In the **Stigmation** navigation box, use the scroll bars or the red marker to obtain the sharpest possible image.
INFO: The specimen detail should just be pulsating without shifting.
INFO: To obtain optimum results, alternately correct focus and astigmatism.
 6. To deactivate the reduced raster, in the **Toolbar**, click the Reduced Raster/Column Control icon.

Alternatively, from the **Menu Bar**, select **Tools > Run A Macro**. From the drop-down list, select **TB STIGMATION** and confirm with **OK**. The mouse assignment is indicated in the **Status Bar**. To adjust stigmation, hold the left mouse button and drag.

5.4.8.2 Using the Auto Stigmation Function

If Autofocus does not improve image quality, perform auto stigmation.

Auto stigmation uses a reduced raster to optimize the stigmation.

- Procedure**
1. In the **Toolbar**, from the **Auto Function** drop-down list, select **Auto Stigmation**.



Alternatively, press **<Ctrl+S>** to start the function.

5.4.9 Checking SEM Parameters

5.4.9.1 Displaying SEM Parameters

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. From the **Menu Bar**, select **View > SEM Status**.
→ The **SmartSEM Status** window is displayed.
 2. To display a parameter, select the **Select** tab and click the parameter you wish to be displayed.
→ The parameter is displayed in the **Display** tab.
 3. To change the setting of a displayed parameter:
Select the **Display** tab.
Double-click the parameter name.
 4. To load a saved combination of parameters:
Select the **File** tab.
Click **Load**.
Select the file.
 5. To save a selected combination of parameters:
Select the **File** tab.
Click **Save As**.
Enter a file name and confirm.
 6. To delete the complete list of parameters:
Select the **File** tab.
Click **Clear Display**.

5.4.9.2 Recording SEM Parameters

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 **SmartSEM Service > Gun Monitor**.
→ The **Gun Monitor** is displayed.
 2. To start the record, in the **Toolbar**, click the **Start Monitoring** icon.

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

 4. 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.
 5. In the **Toolbar**, click the **Select parameters** icon.

 6. → The **Parameter Setup** window is displayed.
 7. To add channels in addition to the six default channels, select them from the drop-down list.
 8. To select/deselect the channels to be displayed, activate/deactivate the respective checkboxes.
 9. To change the color, click in the respective color square.
 10. 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.
 11. To switch between linear and logarithmic scale, activate/deactivate the respective checkbox next to the **Min. Value/Max. Value** input field.
 12. 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

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 microscope: 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.

CAUTION

Moving the specimen stage

Fingers can be trapped by the moving specimen stage.

- ▶ Always close the chamber door before moving the specimen stage.
- ▶ To remove parts fallen into or near to the stage use a tool (e.g. tweezers) instead of your fingers.

NOTICE

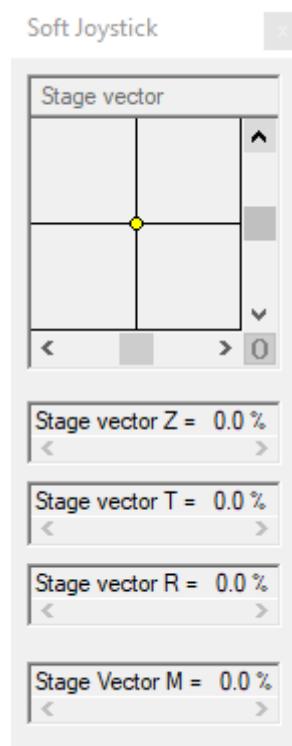
Driving the stage

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 yellow marker of the **Stage vector** 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

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

The crosshairs can be displayed over the entire **Image Area** or in the form of a small cross in the center of the **Image Area**.

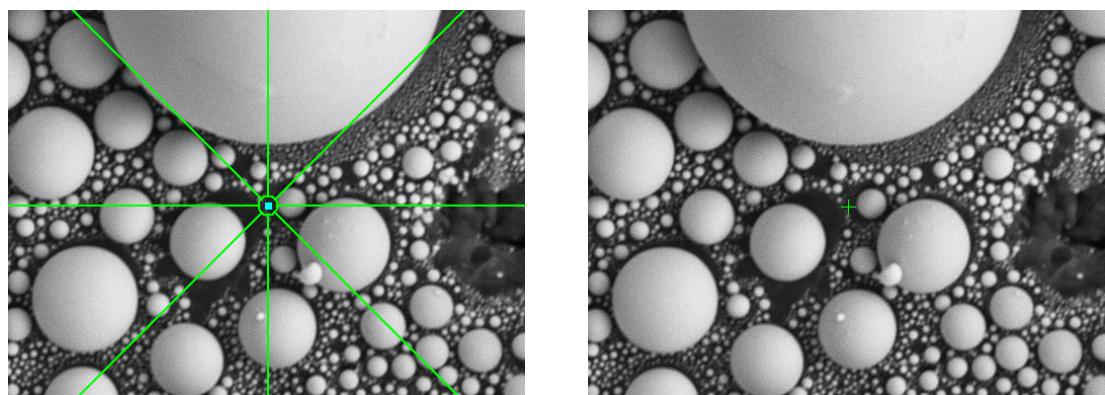


Fig. 15: Large crosshairs (left) and small crosshairs (right)

Procedure

1. From the **Menu Bar**, select **View > Crosshairs**.
 - Crosshairs are displayed in the **Image Area**.
 - In the submenu, **Crosshairs** is activated.
2. To toggle between small and large crosshairs:
Click the crosshairs to select them.
Double-click the crosshairs to change their appearance.
3. To deactivate the crosshairs, select **View > Crosshairs** again.

5.5.2.2 Displaying Movable Crosshairs

Crosshairs help you assess the relative position of features in the **Image Area**.

In contrast to the regular crosshairs, the movable crosshairs can be moved across the **Image Area**. You can change the moveable crosshairs from their regular appearance to mouse following mode. In their regular appearance, you can click and drag the movable crosshairs within the **Image Area**. In mouse following mode, the crosshairs continuously follow the mouse pointer.

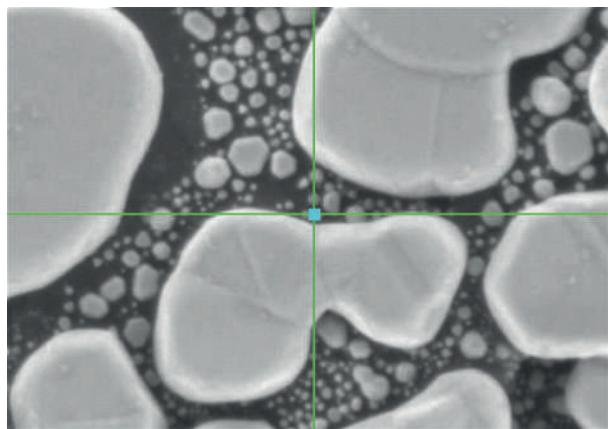


Fig. 16: Movable crosshairs

- 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 toggle between regular appearance and mouse following mode:
Click the movable crosshairs to select them.
Press **<Ctrl + Alt + F>** to turn the mouse following mode on or off. Alternatively, select **Properties > Turn mouse following on or off** from the context menu.
 4. To deactivate the movable crosshairs, select **View > Movable Crosshairs** again.

5.5.2.3 Displaying Graticules (License: GRATICULE)

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.

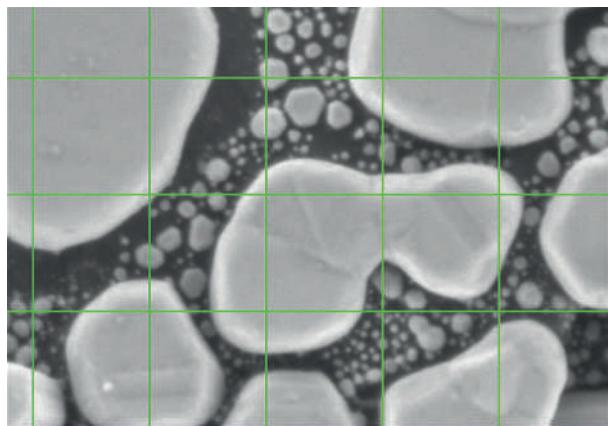


Fig. 17: Graticules

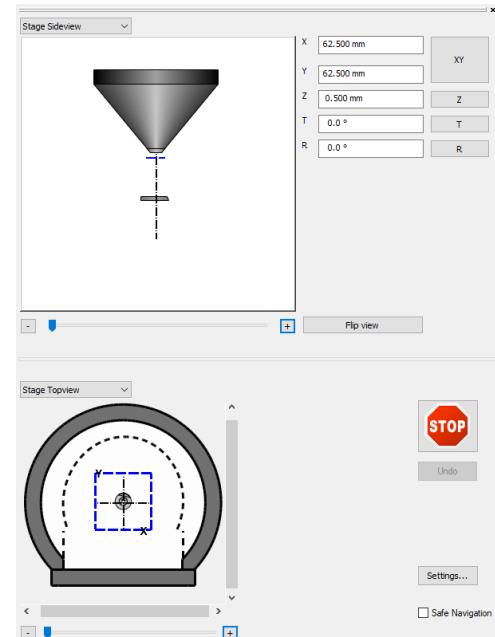
- Procedure**
1. From the **Menu Bar**, select **View > Graticules**.
 - Graticules are displayed in the **Image Area**.
 - In the submenu, **Graticules** is activated.
 2. To change the spacing between the graticule lines, select **View > Graticules Spacing**.
 3. Enter a value and click **OK**.
 4. In order to deactivate the graticule, select **View > Graticules** again.

5.5.3 Monitoring the Stage via the Stage Navigation Bar

The Stage Navigation Bar enables you to control and monitor the movements of the stage. For this purpose, the Stage Navigation Bar provides a view of the chamber including the objective lens as well as the stage with specimen holder and specimen.

Procedure

1. Select the specimen holder you are using.
Refer to *Adding a Specimen Holder* [▶ 82].
2. In the **Stage Navigation Bar**, select **Stage Sideview** from the upper drop-down list and **Stage Topview** from the lower drop-down list.
INFO: To open the **Stage Navigation Bar**, navigate to **View > Toolbars** and activate **Stage Navigation Bar (for Widescreen users)**. Alternatively, you can access the **Stage Navigation Bar** via **Stage > Navigation**.



3. Change the view as required.
To zoom in and out, use the +/- slider at the bottom of the **Stage Navigation Bar**.
To change the detail, use the scroll bars next to the schematics.

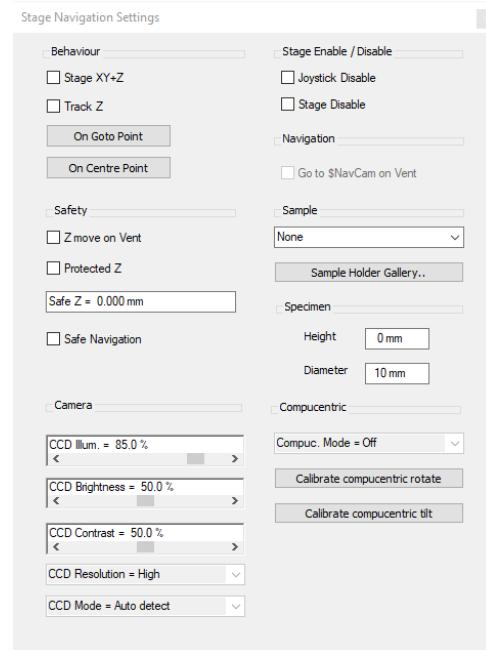
5.5.4 Adding a Specimen Holder

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 Bar**.

Procedure 1. In the **Stage Navigation Bar**, click **Settings**.

INFO: To open the **Stage Navigation Bar**, navigate to **View > Toolbars** and activate **Stage Navigation Bar (for Widescreen users)**. Alternatively, you can access the **Stage Navigation Bar** via **Stage > Navigation**.

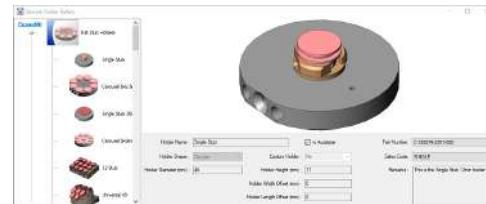
→ The **Stage Navigation Settings** dialog is displayed.



2. In the **Stage Navigation Settings** dialog, click **Sample Holder Gallery**.

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

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



3. In the **Sample Holder Gallery** dialog, click the specimen holder you are using.

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

4. Activate the **Is Available** checkbox.

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

6. Close the **Stage Navigation Settings** dialog.

→ The schematics in the **Stage Navigation Bar** show the used specimen holder.

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

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

Overview This procedure consists of the following steps:

1. *Saving and Editing Stage Positions (License: STAGECO) [▶ 83]*
2. *Recalling Stage Positions (License: STAGECO) [▶ 84]*

5.5.5.1 Saving and Editing Stage Positions (License: STAGECO)

To save and edit stage positions, you can either use the **Stage Navigation Bar** or, as an alternative, the **Stage Points List** window.

⚠ CAUTION

Moving the specimen stage

Fingers can be trapped by the moving specimen stage.

- ▶ Always close the chamber door before moving the specimen stage.
- ▶ To remove parts fallen into or near to the stage use a tool (e.g. tweezers) instead of your fingers.

Prerequisite ✓ Chamber door is closed.

✓ Requires the license STAGECO.

Procedure 1. Drive the stage to the position to be stored.

2. In the **Stage Navigation Bar**, select **Points List** from the drop-down list.

INFO: To open the **Stage Navigation Bar**, navigate to **View > Toolbars** and activate **Stage Navigation Bar (for Widescreen users)**.

INFO: Alternatively, use the **Stage Points List** window via **Stage > Store / Recall**.

→ The **Points List** dialog is displayed.



3. To change the coordinate system (if required), refer to *Changing the Coordinate System* [▶ 84].

4. To enter the current stage position, click **Add**.

→ The **Label Request** window is displayed.

5. Enter a name and click **OK**.

→ The stage position is displayed in the stage list readout.

6. To edit a stage position, mark the position and click **Edit**.

7. To delete a stage position, mark the position and click **Remove**.

INFO: If you use the **Stage Points List** window, then click **Del** instead of **Remove**.

5.5.5.1.1 Changing the Coordinate System

- Procedure**
1. Open the **Stage Points List** window via **Stage > Store / Recall**.
 2. From the **Stage List** drop-down list, select a coordinate system.
To use the stage coordinate system, select **Stage**.
To use a previously defined user-specific coordinate system, select the respective **Reg** number.

5.5.5.2 Recalling Stage Positions (License: STAGECO)

CAUTION

Moving the specimen stage

Fingers can be trapped by the moving specimen stage.

- ▶ Always close the chamber door before moving the specimen stage.
- ▶ To remove parts fallen into or near to the stage use a tool (e.g. tweezers) instead of your fingers.

- Prerequisite**
- ✓ Chamber door is closed.
 - ✓ Requires the 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

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 GeminiSEM 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 Shift at High Magnifications

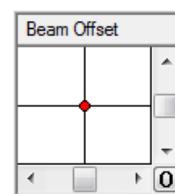
The **Beam Shift** function is helpful when moving the **Image Area** at very large magnifications. At this magnification range, it is generally difficult to exactly position an image feature by driving the stage. Therefore, the image of the specimen can be moved by shifting the electron beam instead of displacing the specimen itself. The electron beam can be shifted by several μm depending on the tool type and operating conditions.

Info

The beam shift may compromise the optical performance of the microscope. We recommend to use the beam shift only at very large magnifications. For the best resolution, zero the beam shift.

- Procedure**
1. In the GeminiSEM Control panel, select the Control tab.

2. In the **Alignment** section, click Beam Offset.
3. To shift the beam, in the Beam Offset navigation box, use the scroll bars or the red marker.



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

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.

Overview This procedure consists of the following steps:

1. *Setting up Drift Compensation [▶ 85]*
2. *Setting Parameters and Creating a Reference Image [▶ 85]*
3. *Applying Drift Correction [▶ 86]*

5.5.8.1 Setting up Drift Compensation

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.

Prerequisite ✓ Requires the license DRIFT-CORR.

- Procedure**
1. From the Windows start menu, select **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.
 3. 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.
 4. 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.
 5. If you wish to hide the frame, click **Hide Tool**.

5.5.8.2 Setting Parameters and Creating a Reference Image

- Procedure**
1. Drift Max. Pix. Error = 1 to 4
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.

2. Drift Max. Tries = 5 to 15
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.
3. Drift Min. Conf. = 40 % to 60 %
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.

5.5.8.3 Applying Drift Correction

Procedure 1. 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)

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

Overview This procedure consists of the following steps:

1. *Calibrating the Stage Center (License: COMPU) [▶ 86]*
2. *Calibrating the Compucentric Height (License: COMPU) [▶ 88]*
3. *Activating the Compucentric Software Functions (License: COMPU) [▶ 89]*
4. *Aligning an Image Feature Horizontally [▶ 89]*

5.5.9.1 Calibrating the Stage Center (License: COMPU)

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.

⚠ CAUTION

Moving the specimen stage

Fingers can be trapped by the moving specimen stage.

- ▶ Always close the chamber door before moving the specimen stage.
- ▶ To remove parts fallen into or near to the stage use a tool (e.g. tweezers) instead of your fingers.

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

Procedure

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

→ The **Initialise Stage** window is displayed.

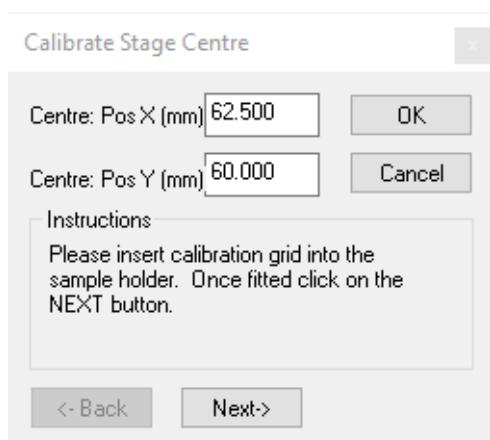
2. Click **Yes**.

→ 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**.

→ The stage is initialized.

→ A magnification of 30 x is automatically set.

→ Crosshairs are displayed.

5. Find a striking feature on the specimen surface that is positioned not too far away from 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)

If you want to tilt the specimen ecentrically or if you want to rotate a tilted specimen ecentrically, 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.

⚠ CAUTION

Moving the specimen stage

Fingers can be trapped by the moving specimen stage.

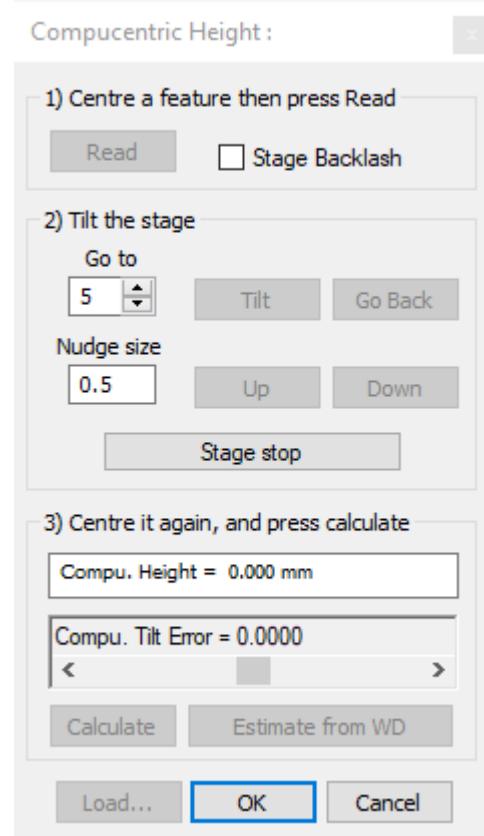
- ▶ Always close the chamber door before moving the specimen stage.
- ▶ To remove parts fallen into or near to the stage use a tool (e.g. tweezers) instead of your fingers.

- Prerequisite** ✓ 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.

Follow the steps on the panel.



2. Center a feature and click **Read**.
3. Tilt the stage.
4. Center the feature again and click **Calculate**.
5. To confirm, click **OK**.

5.5.9.3 Activating the Compucentric Software Functions (License: COMPU)

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.

⚠ CAUTION

Moving the specimen stage

Fingers can be trapped by the moving specimen stage.

- ▶ Always close the chamber door before moving the specimen stage.
- ▶ To remove parts fallen into or near to the stage use a tool (e.g. tweezers) instead of your fingers.

NOTICE

Risk of collision when using the joystick

There is a risk of damaging the objective lens and/or the specimen.

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

Prerequisite ✓ The stage center is calibrated.

✓ The compucentric height is calibrated.

Procedure 1. In the GeminiSEM 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* [▶ 246].

5.5.9.4 Aligning an Image Feature Horizontally

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.

NOTICE

Specimens with different height

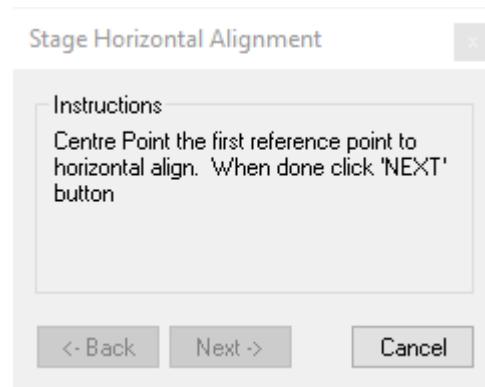
The stage automatically moves after you click **Finish**. If the specimens vary in height, then there is a risk of damaging the microscope.

- ▶ Only use specimens of the same height.

Prerequisite ✓ 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)

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**.

⚠ CAUTION

Moving the specimen stage

Fingers can be trapped by the moving specimen stage.

- ▶ Always close the chamber door before moving the specimen stage.
- ▶ To remove parts fallen into or near to the stage use a tool (e.g. tweezers) instead of your fingers.

Prerequisite ✓ 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)

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**.

⚠ CAUTION

Moving the specimen stage

Fingers can be trapped by the moving specimen stage.

- ▶ Always close the chamber door before moving the specimen stage.
- ▶ To remove parts fallen into or near to the stage use a tool (e.g. tweezers) instead of your fingers.

Prerequisite ✓ 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)

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

⚠ CAUTION

Moving the specimen stage

Fingers can be trapped by the moving specimen stage.

- ▶ Always close the chamber door before moving the specimen stage.
- ▶ To remove parts fallen into or near to the stage use a tool (e.g. tweezers) instead of your fingers.

Prerequisite ✓ Requires the license CENTRE.

Procedure 1. Select a low magnification.

2. Move the stage to the relevant specimen area.

→ This setting is used as stage map.

3. To change to split 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 **Panel Configuration Bar**, select **Stage Scanning**.

→ The **Stage Scanning** window is displayed.

→ The left zone (zone 0) is frozen and serves as an overview.

5. In the **Stage Scanning** window, click **Setup Wizard**.

→ The **Define Scan Fields Wizard** window is displayed.

6. Follow the instructions of the wizard.

5.5.12 Scanning Defined Image Fields (License: STAGESCAN)

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.

Prerequisite ✓ 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)

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

Overview This procedure consists of the following steps:

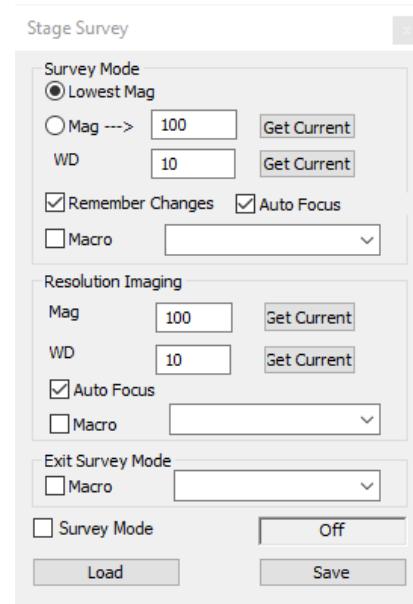
1. *Defining the Survey View* [▶ 92]
2. *Defining the Detail View* [▶ 93]
3. *Executing a Macro when Quitting Survey Mode (Optional)* [▶ 93]

5.5.13.1 Defining the Survey View

Prerequisite ✓ Requires the license SURVEY.
✓ The stage is initialized.

Procedure 1. To set a wide field of view, set a low magnification and 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. To automatically set the lowest possible magnification, activate the **Lowest Mag** radio button.
5. To use the current magnification and WD settings, click the **Get Current** buttons. Alternatively, manually enter the desired values.
6. 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.
7. To start an automatic focus adjustment after start of the respective operation mode, activate the **Auto Focus** checkbox.
8. To execute a macro when switching to **Survey Mode**, activate the **Macro** checkbox and select a macro from the drop-down list.

5.5.13.2 Defining the Detail View

Procedure

1. To change the field of view, set a higher magnification and a smaller working distance.
2. Adjust the **Resolution Imaging** settings.
In the **Mag** input field, enter the desired value or click **Get Current**.
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.

5.5.13.3 Executing a Macro when Quitting Survey Mode (Optional)

Procedure

1. To execute a macro when quitting survey mode, 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

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.

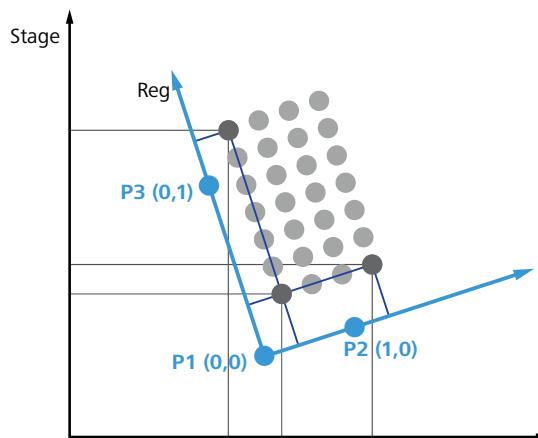


Fig. 18: Stage coordinate system (black) and coordinate system defined via stage registration (blue)

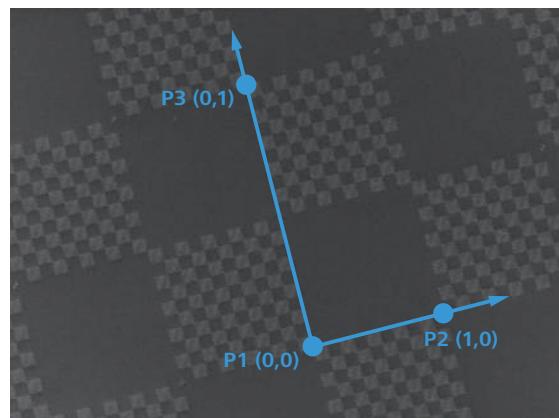


Fig. 19: Application example

- Prerequisite**
- ✓ 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**.

5.5.15 Stage Navigation via Overview Image

You can load an overview image of the specimen holder into the software and use this overview image to navigate the stage.

You can acquire the required overview image either with the optional Stage Navigation Camera or with your own external camera.

Stage Navigation Camera The Stage Navigation Camera is an optional component of the microscope. This camera can either be installed at the top edge of the chamber door or at the airlock.

If the camera is installed at the chamber door, then you can acquire an overview image of the specimen holder when the chamber door is opened.

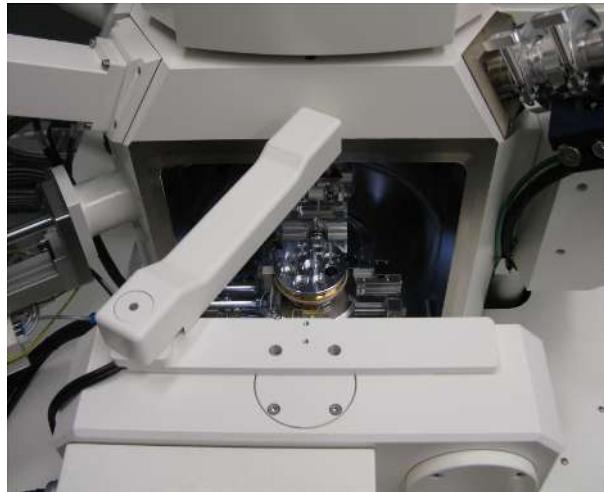


Fig. 20: Stage Navigation Camera

If the camera is installed at the airlock, then you can acquire an overview image of the specimen holder when the airlock door is opened.

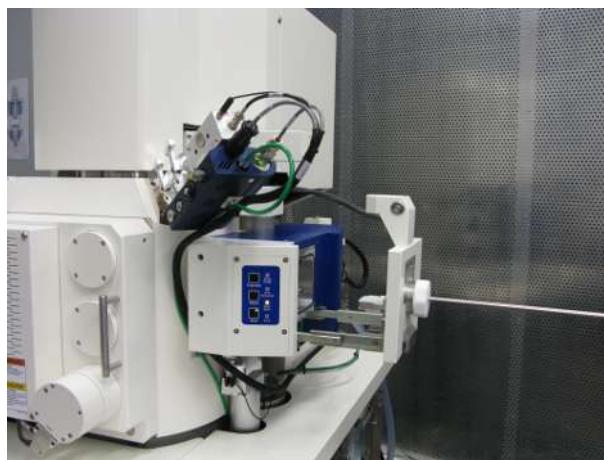


Fig. 21: Navigation camera at the airlock

The acquired overview image can then be used to navigate the stage.

External Camera You can use your own camera to acquire the overview image for stage navigation. In this case, you need to perform a three-point calibration or a one-point registration after you load the overview image into the software. This calibration is required to map the stage coordinates to the image coordinates.

5.5.15.1 Changing the Default Position of the Stage Navigation Camera

Info

A changed default position affects all users.

⚠ CAUTION

Moving the specimen stage

Fingers can be trapped by the moving specimen stage.

- ▶ Always close the chamber door before moving the specimen stage.
- ▶ To remove parts fallen into or near to the stage use a tool (e.g. tweezers) instead of your fingers.

⚠ WARNING

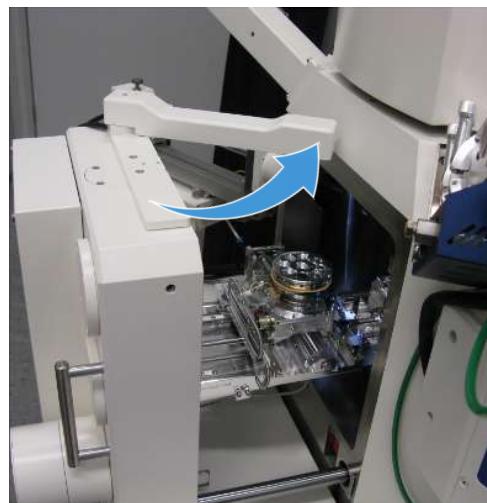
Suffocation hazard due to lack of oxygen

Gaseous dry nitrogen is used to vent the specimen chamber during specimen exchange. Inhal-
ing 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.

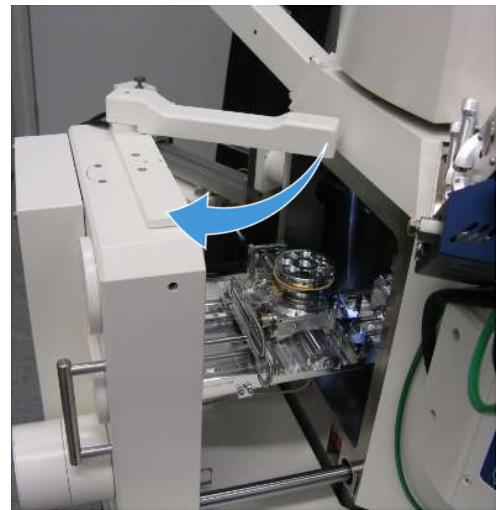
- Prerequisite** ✓ The stage navigation camera is mounted at the chamber door.
✓ The door of the specimen chamber is open.

- Procedure**
1. To open the **Stage Navigation Bar**, navigate to **View > Toolbars** and activate **Stage Navigation Bar (for Widescreen users)**. Alternatively, you can access the **Stage Navigation Bar** via **Stage > Navigation**.
→ The **Stage Navigation Bar** is displayed.
 2. Turn the navigation camera inwards to its active position.
→ The stage automatically moves to the **\$Nav-Cam** position and an image is acquired automatically.



3. In the **Stage Navigation Bar**, select **Image Navigation** from the drop-down list and click the **Camera** button (not the drop-down arrow).
→ The **Camera Capture** window with a live view of the camera is displayed.

4. Move the stage to the desired default position.
5. Turn the navigation camera back out.



6. In the **Stage Navigation Bar**, select **Points List** from the drop-down list.
7. Select **\$NavCam** and click **Remove**.
8. To enter the current stage position, click **Add**.
→ The **Label Request** window is displayed.
9. Enter the name **\$NavCam** and click **OK**.
INFO: The new position must be called **\$NavCam** to be the default position.
10. Insert a specimen.
11. Carefully close the chamber door.
12. Evacuate the specimen chamber.
13. Switch on the EHT and the gun.
14. Acquire an image.
15. Perform a three-point calibration.
16. Check that the navigation coordinates are correct:
Move around the specimen.
Make sure that the positions are accurate.
17. In the **Stage Navigation Bar**, select **Image Navigation** from the drop-down list and select the drop-down arrow next to **Register**.
18. Select **Save registration data**.
19. Overwrite the file **NavCam.crf** in **C:\ProgramData\Carl Zeiss\SmartSEM** to update the default registration file for the new **\$NavCam** position.

5.5.15.2 Using the Stage Navigation Camera for Navigation

CAUTION

Moving the specimen stage

Fingers can be trapped by the moving specimen stage.

- ▶ Always close the chamber door before moving the specimen stage.
- ▶ To remove parts fallen into or near to the stage use a tool (e.g. tweezers) instead of your fingers.

CAUTION

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.

WARNING

Suffocation hazard due to lack of oxygen

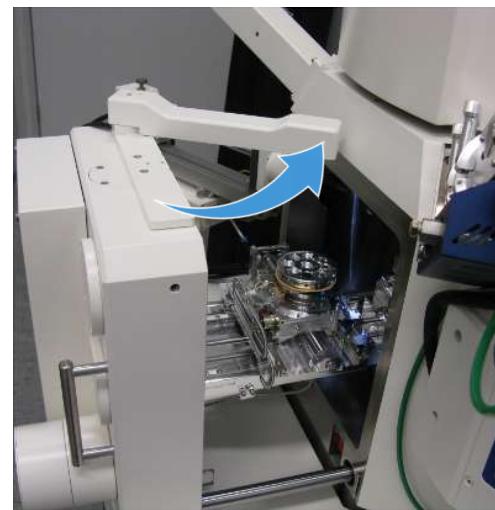
Gaseous dry nitrogen is used to vent the specimen chamber during specimen exchange. Inhal-
ing nitrogen may cause unconsciousness.

- ▶ 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 insta-
bility, fatigue) leave the room immediately and inform the facility's safety officer.

Prerequisite ✓ The stage navigation camera is mounted at the chamber door.

- Procedure**
1. To open the **Stage Navigation Bar**, navigate to **View > Toolbars** and activate **Stage Navigation Bar (for Widescreen users)**. Alternatively, you can access the **Stage Navigation Bar** via **Stage > Navigation**.
→ The **Stage Navigation Bar** is displayed.
 2. In the **Stage Navigation Bar**, click **Settings** and activate the **Go to \$NavCam on Vent** checkbox.
 3. Vent the specimen chamber.
→ Since you have activated the **Go to \$NavCam on Vent** checkbox, the stage now auto-
matically moves to the \$NavCam position.
INFO: To maintain navigation accuracy, do not move the stage after it has moved to the
\$NavCam position.
 4. Open the door of the specimen chamber.
 5. Insert the desired specimen holder with specimens.

6. Turn the navigation camera inwards up to its end position. The camera should lock in place automatically.

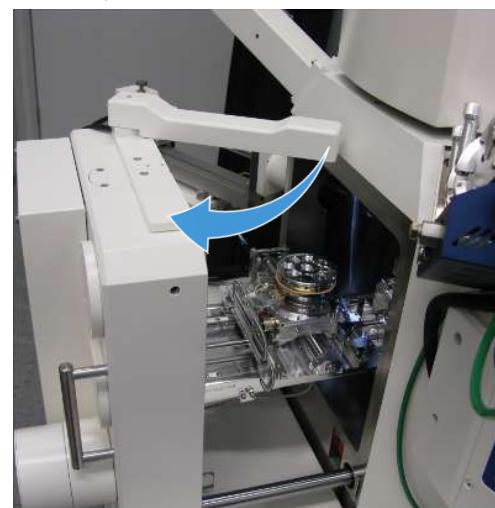


7. Keep your hand away from the camera arm and wait a few seconds.

INFO: The camera uses ambient light for illumination. The flashing light is only for indication that the image has been taken. If the image quality is poor, then increase the illumination brightness in your lab.

→ A flash is visible and an image is acquired automatically.

8. Turn the navigation camera back out.



9. Close the chamber door.

10. Evacuate the specimen chamber.

11. Switch on the EHT and the gun.

↳ You can now navigate the stage by double-clicking in the overview image.

Info

If you changed to a different \$NavCam position or removed spacers on the stage, then it is highly recommended that a new \$NavCam and corresponding three-point registration is done to maintain navigation accuracy.

5.5.15.3 Using the Navigation Camera at the Airlock for Navigation

When you use a navigation camera at the airlock for navigation, then you first need to unload the old specimen from the chamber. Then you can insert the new specimen into the airlock, acquire the overview image, and introduce the new specimen into the chamber.



Fig. 22: The navigation camera at the airlock

This procedure consists of the following steps:

1. *Unloading the old Specimen from the Chamber [▶ 100]*
2. *Acquiring an Overview Image [▶ 103]*

5.5.15.3.1 Unloading the old Specimen from the Chamber

WARNING

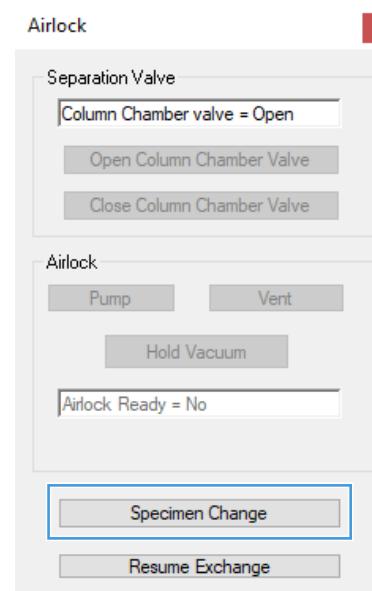
Suffocation hazard due to lack of oxygen

Gaseous dry nitrogen is used to vent the specimen chamber during specimen exchange. Inhal-
ing nitrogen may cause unconsciousness.

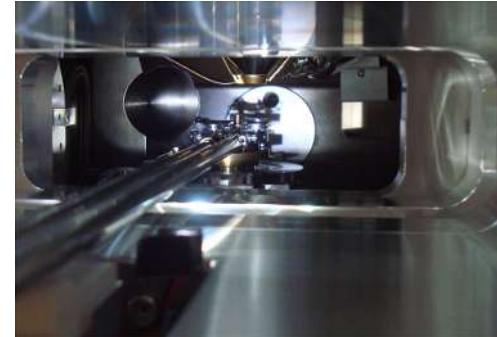
- ▶ During specimen exchange, keep the chamber door open as short as possible.
- ▶ Do not inhale the air from within the specimen chamber.
- ▶ Ensure that the area around the microscope is sufficiently ventilated.
- ▶ If you begin to experience symptoms of asphyxia (for example: rapid breathing, loss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

- Procedure**
1. To open the **Stage Navigation Bar**, navigate to **View > Toolbars** and activate **Stage Navigation Bar (for Widescreen users)**. Alternatively, you can access the **Stage Navigation Bar** via **Stage > Navigation**.
→ The **Stage Navigation Bar** is displayed.
 2. From the **Panel Configuration Bar**, select **Airlock**.

3. In the **Airlock** panel, click **Specimen Change** to start the pre-defined macro.



4. To transfer the specimen holder from the specimen chamber into the airlock, insert the airlock rod.



5. Turn the knob clockwise to attach the specimen holder to the airlock rod.



6. Retract the airlock rod.



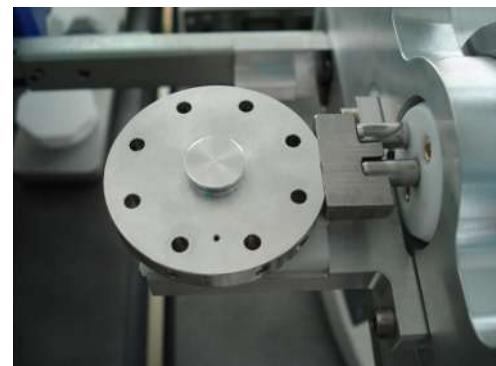
7. On the control panel of the airlock, press **Vent**.



8. Take hold of the airlock handle and open the airlock door.

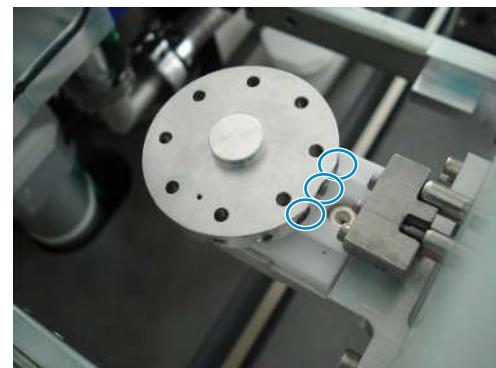


9. Turn the knob counter-clockwise and detach the specimen holder from the airlock rod.



10. Remove the specimen holder from the dovetail.

11. Mount the exchange specimen holder onto the dovetail. Ensure that the airlock rod mount faces the threaded rod.

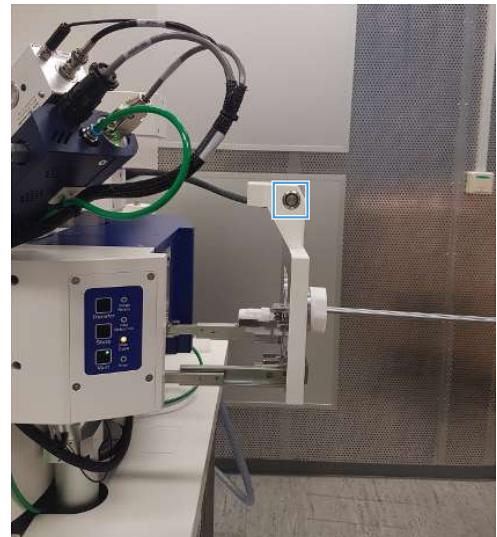


12. Attach the specimen holder to the airlock rod by turning the knob clockwise.

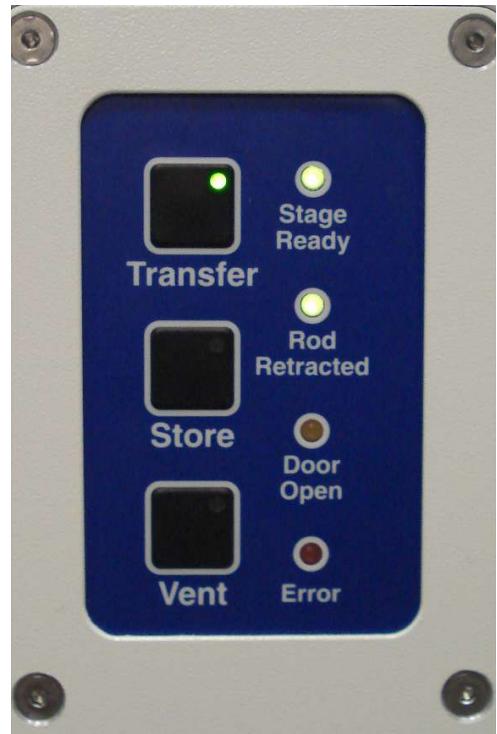
5.5.15.3.2 Acquiring an Overview Image

Procedure

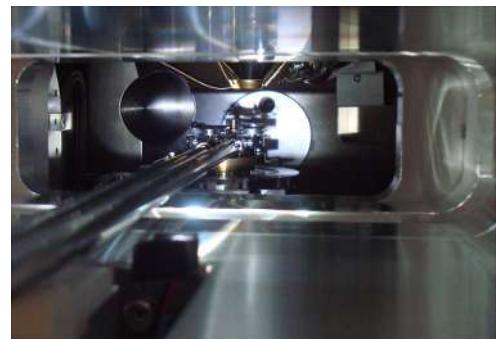
1. Check that the airlock rod is fully retracted.
2. Press the button of the navigation camera at the airlock.



3. Wait until the image is acquired and displayed in the **Image Navigation** section of the **Stage Navigation Bar**.
4. Close the airlock door.
5. On the control panel of the airlock, press **Transfer**.



6. To transfer the specimen holder, insert the airlock rod into the specimen chamber.
→ The specimen holder slides into the dovetail at the specimen stage.



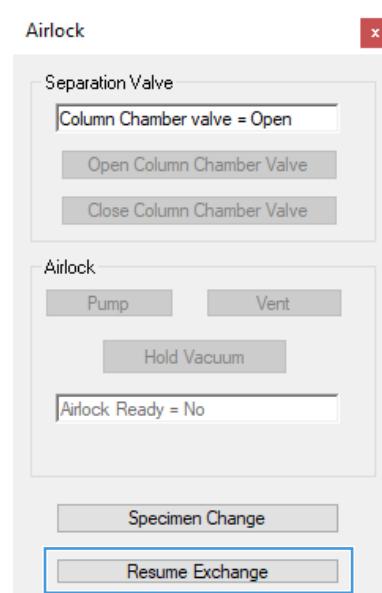
7. Turn the knob counter-clockwise in order to detach the specimen holder from the airlock rod.



8. Retract the airlock rod.



9. In the **Airlock** panel, click **Resume Exchange** to start the pre-defined macro.



10. Switch on the EHT.

↳ You can now navigate the stage by double-clicking in the overview image.

5.5.15.4 Using an External Camera for Navigation

You can use your own camera to acquire the overview image for stage navigation.

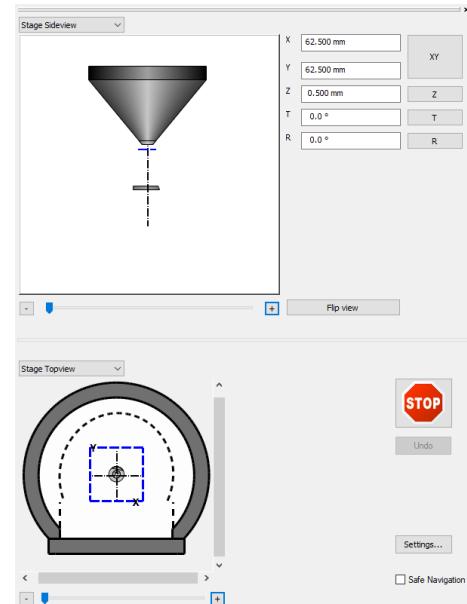
Overview This procedure consists of the following steps:

1. *Acquiring an Overview Image with an External Camera [► 105]*
2. *Performing a Three-Point or One-Point Calibration [► 105]*

5.5.15.4.1 Acquiring an Overview Image with an External Camera

Procedure 1. To open the **Stage Navigation Bar**, navigate to **View > Toolbars** and activate **Stage Navigation Bar (for Widescreen users)**. Alternatively, you can access the **Stage Navigation Bar** via **Stage > Navigation**.

→ The **Stage Navigation Bar** is displayed.



2. In the GeminiSEM Control panel, select the **Stage** tab.
3. Use the dual joystick to drive the stage downwards to a low position.
Alternatively, use the soft joystick via **Tools > Goto Panel > Soft Joystick**.
NOTICE **Observe the stage movement via camera to avoid crashing.**
4. Vent the specimen chamber.
5. Open the door of the specimen chamber.
6. Insert the desired specimen holder with specimens.
7. Use an external camera to acquire an overview image of the specimen holder.
INFO: Center the camera lens over the specimen holder.
8. Close the chamber door.
9. Evacuate the specimen chamber.
10. Transfer the image to the PC.
11. In the **Stage Navigation Bar**, select **Image Navigation** from the drop-down list.
12. Click on the **Camera** drop-down list and select **Image**.
13. Select the image that you acquired with the camera.
→ The image is displayed in the **Stage Navigation Bar**.
14. Switch on the EHT and the gun.

5.5.15.4.2 Performing a Three-Point or One-Point Calibration

If you use your own camera to acquire an overview image, you need to perform a three-point calibration after you load the overview image into the software. This calibration is required to map the stage coordinates to the image coordinates.

For the calibration, select three distinct positions on your specimen holder. These positions should be easily visible both in the optical overview image and the microscope image. The accuracy is best, if the calibration points are distant from the center of the specimen holder and in opposite directions.

The one-point registration is a quick way to adjust the current registration to different specimens. The current registration is the factory-set standard registration, if you have not changed the registration. The standard registration is done on the stubs of a carousel holder and is loaded on each start of SmartSEM.

Prerequisite ✓ You have acquired an overview image with your own (external) camera.

Procedure 1. To open the **Stage Navigation Bar**, navigate to **View > Toolbars** and activate **Stage Navigation Bar (for Widescreen users)**. Alternatively, you can access the **Stage Navigation Bar** via **Stage > Navigation**.

→ The **Stage Navigation Bar** is displayed.

2. In the **Stage Navigation Bar**, select **Image Navigation** from the upper drop-down list.

3. Click the **Register** button.

→ The **Registration** window is displayed.

4. In the **Registration** window, activate the **Crosshairs** checkbox.

5. For a **One-Point Registration**, from the **One Point Registration Mode** drop-down list, additionally select **Offset** or **Scaling**.

INFO: **Offset** corrects an x and y offset between a feature centered in the microscope image and the same feature in the overview image.

INFO: **Scaling** corrects the parallactic error of the camera due to different specimen heights. **Scaling** is useful, if the specimen has a very different height compared to the current registration.

6. Acquire a microscope image with the SE detector.

7. Optimize the microscope image.

8. In the **Stage Navigation Bar**, double-click a position on the schematic view of the specimen holder.

The schematic view of the specimen holder helps in rough navigation to a characteristic feature on the specimen.

→ The stage automatically moves to this position.

9. Precisely center the characteristic feature in the microscope image.

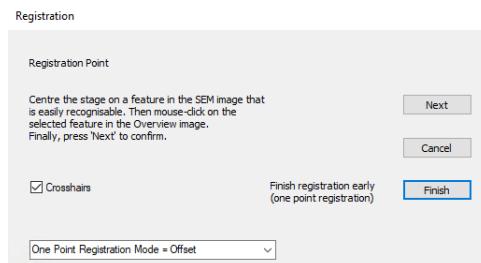
Use the schematic for rough navigation and the joystick to find the detail.

10. In the overview image, click on the same image feature that you have centered in the microscope image.

→ Red crosshairs are displayed on this feature.

11. For a **Three-Point Registration**, in the **Registration** window, click **Next** and repeat steps 8 to 10 for two further image features.

12. Click **Finish** and confirm.



13. Save the *.tif file of the overview image.

14. Click **Save Registration Data** and save the *.crf file.

↳ You can now navigate the stage by double-clicking in the overview image.

5.6 Improving the Image

5.6.1 Using Automated Functions

5.6.1.1 Automated Functions

Automated functions help to improve image quality.

Info

The automated functions work best with low noise images.

If the automated functions fail because of noisy images:

- ▶ Reduce scanspeed or increase beam current.
- ▶ To improve scanning time, you can decrease the size of the reduced raster.

5.6.1.2 Using the Coarse Autofocus Function

Use Coarse Autofocus to focus the specimen after evacuating the specimen chamber.

Prerequisite ✓ EHT is on.

- ✓ ROI is positioned below objective lens.
- ✓ Working distance is smaller than 20 mm.
- ✓ Magnification is sufficiently low (100 x or less).
- ✓ Specimen is in the field of view of the chamber camera.

Procedure 1. In the **Toolbar**, from the **Auto Function** drop-down list, select **Coarse Autofocus**.
If the **Auto Function** icon is not displayed in the **Toolbar**, add the icon to the **Toolbar**. Refer to *Adding an Icon* [▶ 157].



- The function adjusts contrast and brightness.
- The function sweeps the focus to find and approach the best focus.

2. If the function fails, decrease the working distance or scan speed or increase the primary current and repeat the procedure.

5.6.1.3 Using the Fine Autofocus Function

Use Fine Autofocus if the region of interest (ROI) is not in focus at the magnification for image acquisition.

There are different modes for **Fine Autofocus**:

- Reduced raster based auto focus
Small images in the center of the screen are scanned for focusing.
The scan speed is controlled by the parameter **Autofunction Scanrate**.
- Line based auto focus
A horizontal line at the top end of the screen is scanned for focusing.
The scan speed is controlled by the parameter **Autofunction Scanrate**.
- Parallax auto focus
A reduced raster is scanned for focusing.
The function uses the present scans speed, if it is between 5 and 10.

If the scan speed is out of this range, it is set to 5 or 10, respectively.

The focus is calculated by using image shifts.

- Prerequisite**
- ✓ ROI is focused at low magnification.
 - ✓ Magnification for image acquisition is set.
 - ✓ ROI is centered in the image.
 - ✓ For parallax auto focus: brightness and contrast are set.
 - ✓ For parallax auto focus: an unfocused feature is within the reduced raster.
 - ✓ For parallax auto focus: reduced raster is activated and adapted to a potential feature.
 - ✓ For parallax auto focus: start with low magnification (100–500 x) and increase in steps up to 10.000 x.

- Procedure**
1. To change the mode for Fine Autofocus, select **View > Sem Status** and adjust the parameter **Autofunction Scanrate**.

Alternatively, press **<Ctrl+I>** to start the function.

2. In the **Toolbar**, from the **Auto Function** drop-down list, select **Fine Autofocus**.
If the **Auto Function** icon is not displayed in the **Toolbar**, add the icon to the **Toolbar**. Refer to *Adding an Icon [▶ 157]*.



Alternatively, press **<Ctrl+F>** to start the function.

- The function adjusts contrast and brightness.
- The function sweeps the focus to find and approach the best focus.

3. If the function fails, check whether a feature is visible, reduce magnification, reduce scan speed or increase primary current and repeat the procedure.

5.6.1.4 Using the Auto Stigmation Function

If Autofocus does not improve image quality, perform auto stigmation.

Auto stigmation uses a reduced raster to optimize the stigmation.

- Procedure**
1. In the **Toolbar**, from the **Auto Function** drop-down list, select **Auto Stigmation**.



Alternatively, press **<Ctrl+S>** to start the function.

5.6.1.5 Using the Auto Wobble Function

Use Auto Wobble, if the image is moving while changing focus.

Auto wobble uses a reduced raster and the present scan speed, if it is between 5 and 10.

- Procedure**
1. In the **Toolbar**, from the **Auto Function** drop-down list, select **Auto Wobble**.



5.6.2 Using the Image Deconvolution Function

At the resolution limit of the microscope, i.e. at high magnifications or large frame stores, the size of one image pixel becomes equal to or smaller than the beam spot size on the specimen. At these conditions, the optical aberrations (lens imperfections) dominate the remaining blur of the image. Since the properties of the lenses are known from measurements or simulations, the blur, which results from the finite beam size, can be removed and a sharper and less noisy image can be deduced from the raw image data.

- At low magnification conditions where the beam spot is well within one image pixel, the image deconvolution cannot improve the image quality and returns the same image.
- Sufficient signal-to-noise ratio in the input image is required for good results.
- The quality of the output image is governed by how accurately the sigma value matches the reality.
- The computation time scales with the number of pixels. It may take a while for large image frame stores.

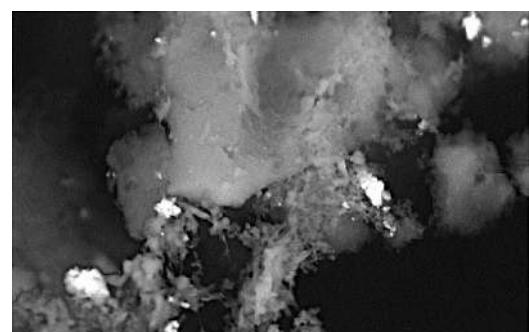
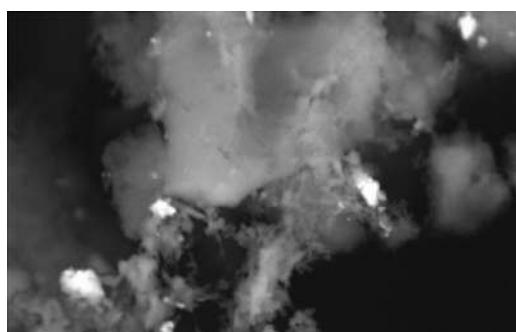


Fig. 23: BSD image before image deconvolution (left) and after image deconvolution (right)

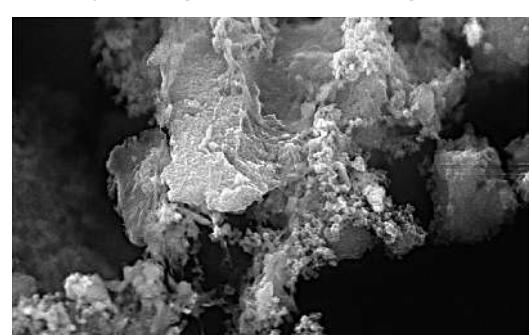
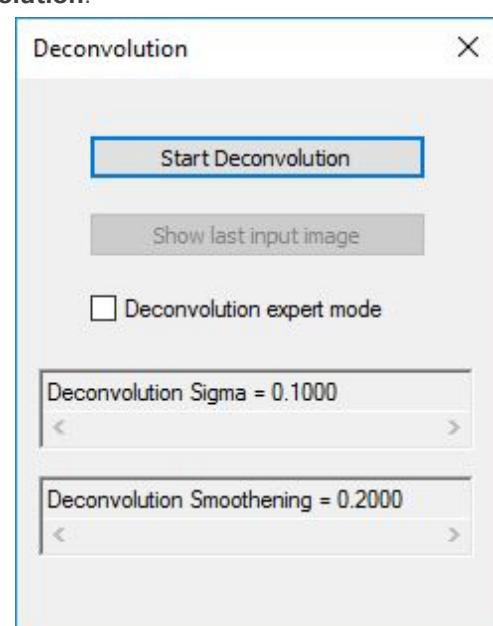


Fig. 24: SE image before image deconvolution (left) and after image deconvolution (right)

Procedure 1. In the **Panel Configuration Bar**, select **Deconvolution**.

→ The **Deconvolution** window is displayed.



2. Optionally, activate the **Deconvolution expert mode** checkbox. Vary the profile width step by step via the parameter **Deconvolution Sigma**. If oscillations become visible at the edges of the image, then your sigma value is already too large. The parameter **Deconvolution Smoothening** stabilizes the signal-to-noise ratio. Keep the smoothening as low as possible.
3. Acquire an image and freeze it or load a previously taken image.

4. To execute the image deconvolution, click **Start Deconvolution**.
 - The image deconvolution algorithm is executed and an improved image is calculated.
 - To compare the original image with the result after the deconvolution, click **Show last input image**.

5.6.3 Improving Image Quality via Noise Reduction

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 *Scanning | Noise Reduction Methods [▶ 207]*.

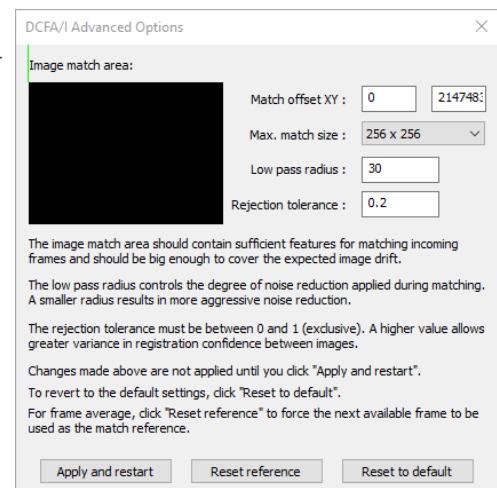
Procedure

1. In the GeminiSEM 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:
Double-click the **N** readout and set a value between 1 and 256.
From the **Scan Speed** drop-down list, select a scan speed.
5. If you have selected one of the drift-compensated noise reduction methods, refer to *Using Drift-Compensated Noise Reduction Methods [▶ 111]*.

5.6.3.1 Using Drift-Compensated Noise Reduction Methods

Procedure 1. In the **Noise Reduction** section, click **Settings**.

- 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**.

5.6.4 Imaging a Tilted Specimen

5.6.4.1 Using Dynamic Focus (License: DYNFOCUS)

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

Info

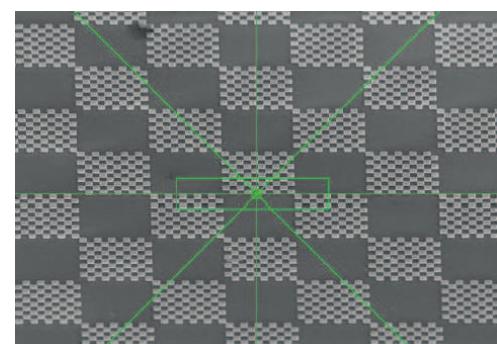
The best application of the dynamic focus is only possible with tilted plane specimens. If the specimen presents strong differences in height (topography) or different inclinations of slope, the depth of focus must be optimized as well.

Prerequisite ✓ Requires the license DYNFOCUS.

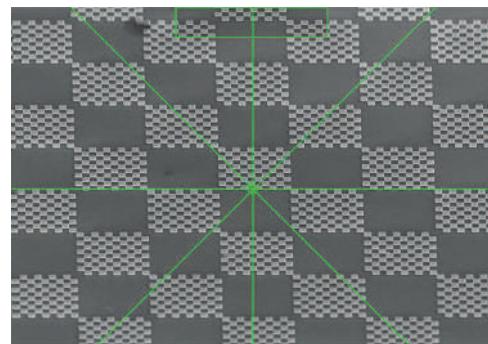
Procedure 1. In the **Toolbar**, click the Reduced Raster/Column Control icon.



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

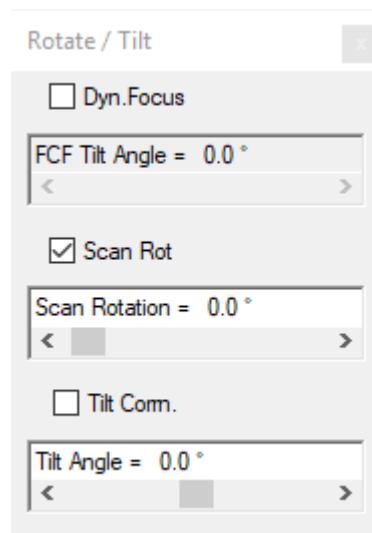


4. From the **Menu Bar**, select **View > Crosshairs**.
5. Adjust the best possible focus in the reduced raster.
6. Move the reduced raster to the very top or bottom of the **Image Area**.



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 scroll bar 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.

5.6.4.2 Optimizing the Image of a Tilted Specimen (License: TILTCOMP)

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

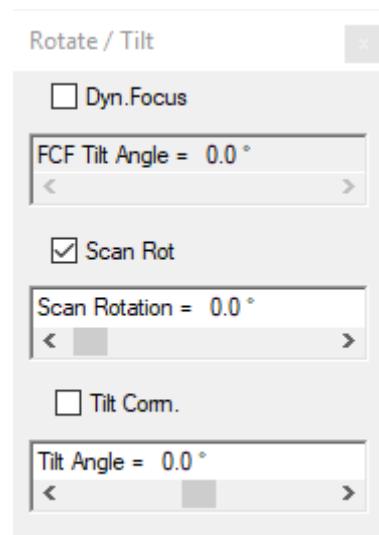
If you use an extremely tilted specimen, you need to adjust the dynamic focus as well.

Prerequisite ✓ Requires the license TILTCOMP.

Procedure

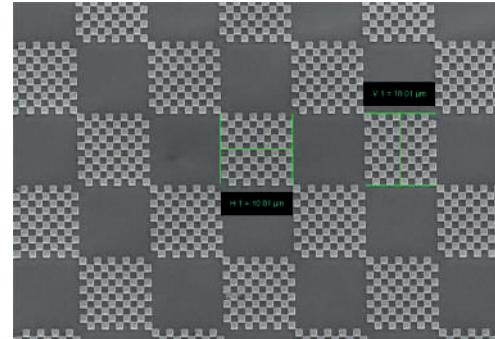
1. Ensure that the specimen surface is tilted such that live image is tilted in Y direction.
2. From the **Menu Bar**, select **Scanning > Rotate / Tilt**.

→ 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**.

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



5.6.5 Improving Image Illumination via Look Up Tables (LUT)

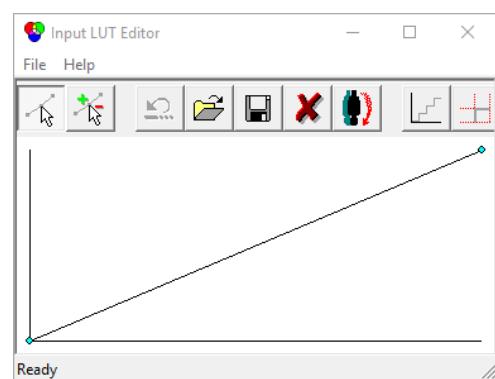
5.6.5.1 Editing a Live Image (Input LUT)

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

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



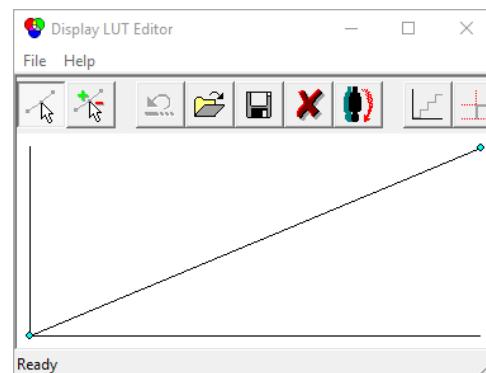
5.6.5.2 Editing a Saved Image (Display LUT)

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 > Display LUT**.

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



5.6.6 Applying Image Processing (License: IMMATH)

The functions in Image Processing offer the possibility of mathematically manipulating the image content pixel-by-pixel by using the grey value (0=black, 255=white). Different filter functions, basic mathematic operations, and the detection of grey values can be used.

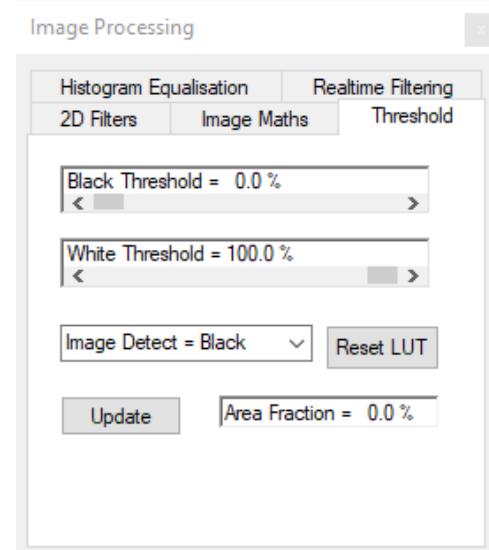
5.6.6.1 Setting up the Gray Value Detection

Prerequisite ✓ 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** dropdown list.

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

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

Grey: Each pixel in the Image Store with a value greater than the black threshold and less than 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**.

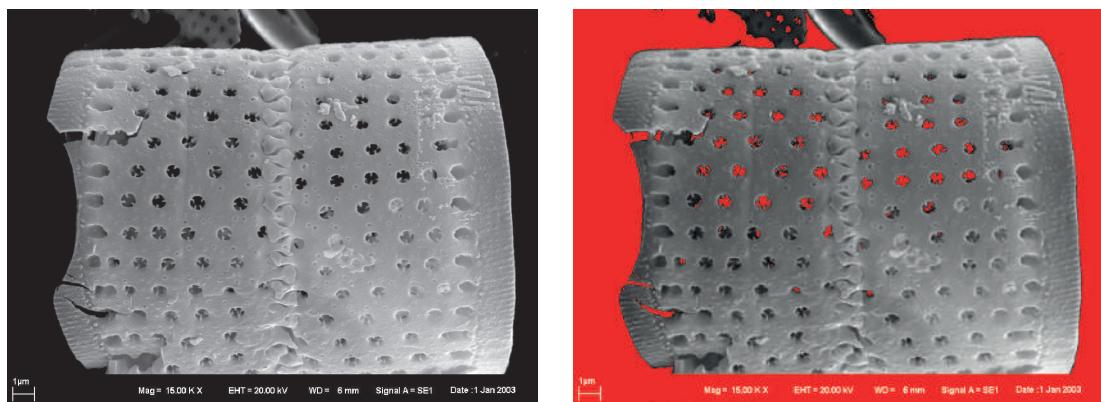


Fig. 25: Image before gray value detection (left) and after gray value detection with black threshold (right).

Info

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

5.6.6.2 Creating a Stereo Image

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°.

Info

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

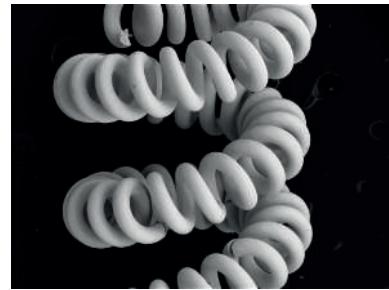
Overview This procedure consists of the following steps:

1. *Acquiring the First Image of a Stereo Pair [▶ 116]*
2. *Acquiring the Second Image of a Stereo Pair [▶ 116]*
3. *Calculating the Stereo Image [▶ 117]*

5.6.6.2.1 Acquiring the First Image of a Stereo Pair

Prerequisite ✓ Requires the license IMMATH.

- Procedure**
1. To display crosshairs, from the **Menu Bar**, select **View > 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.

5.6.6.2.2 Acquiring the Second Image of a Stereo Pair

Prerequisite ✓ Requires the license IMMATH.

- Procedure**
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°. Compensate for the move of the specimen by moving the stage in Y-direction. Always place the striking detail back to the center of the crosshairs.
 5. 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.
 6. Rotate the image by 90° by means of the scan rotation function.
 7. Freeze the image.

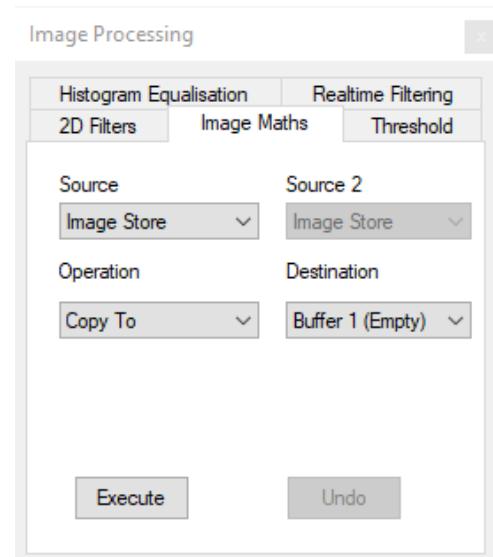


8. Save the image without data zone or annotations.

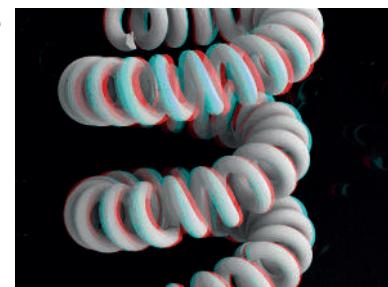
5.6.6.2.3 Calculating the Stereo Image

Prerequisite ✓ Requires the license IMMATH.

- Procedure**
1. From the **Menu Bar**, select **Image > Image Processing**.
→ The **Image Processing** panel is displayed.
 2. Select the **Image Maths** tab.



3. From the **Source** drop-down list, select **Image Store**.
4. From the **Operation** drop-down list, select **Copy To**.
5. From the **Destination** drop-down list, select **Buffer 1**.
6. Click **Execute**.
→ The first image is reloaded and copied to buffer store 1.
7. From the **Source** drop-down list, select **Image Store**.
8. From the **Operation** drop-down list, select **Make Stereo Pair**.
9. From the **Source 2** drop-down list, select **Buffer 1**.
10. From the **Destination** drop-down list, select **Image Store**.
→ The second image is reloaded and copied to the image store.
11. Click **Execute**.
→ Both images are combined with a color code and displayed on the monitor.



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

5.6.6.3 Optimizing the Image Contrast via Histogram Equalization

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.

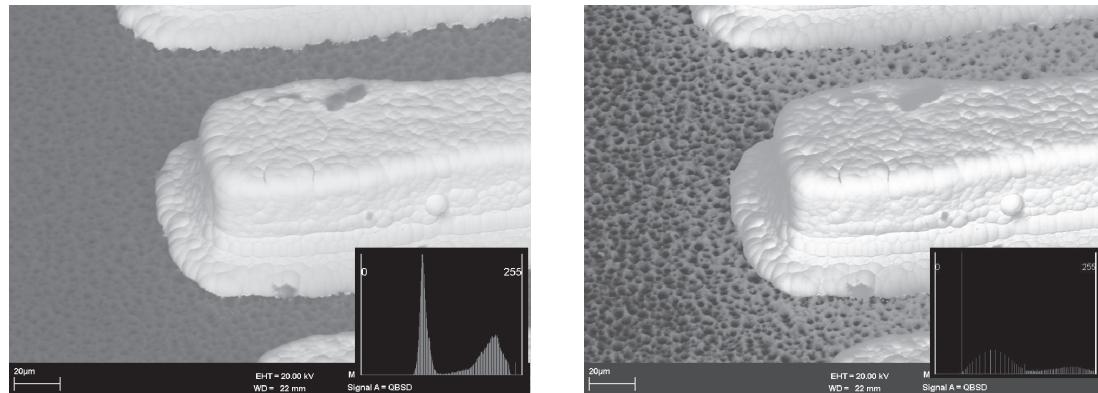
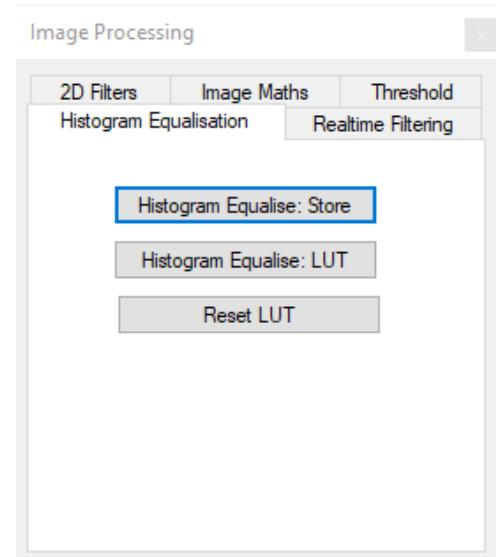


Fig. 26: Example of the effect of a histogram equalization. Left: Image before processing. Right: Image after processing

Prerequisite ✓ Requires the license IMMATH.

- Procedure**
- From the **Menu Bar**, select **Image > Image Processing**.
→ The **Image Processing** panel is displayed.
 - Select the **Histogram Equalisation** tab.



- To improve the image contrast by calculating the gray scale distribution, click **Histogram Equalise: Store**.
→ The image is frozen.
- To generate an image transformation using a display LUT, click **Histogram Equalise: LUT**.
INFO: To reset the calculated display LUT, click **Reset LUT**.

5.6.6.4 Optimizing the Image Contrast via the Histogram Panel

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

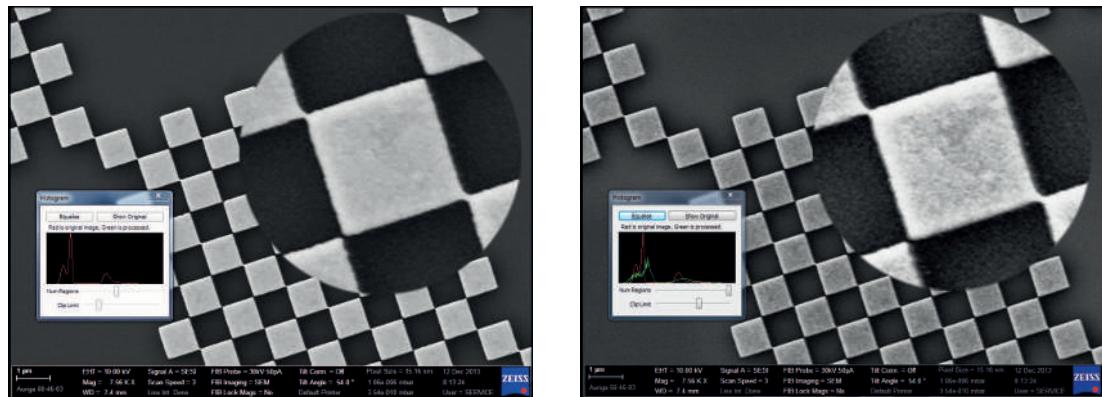
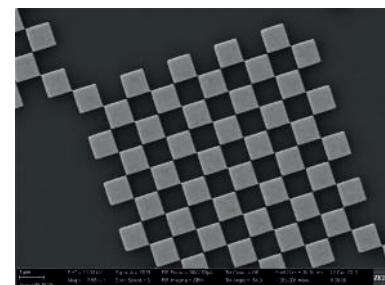


Fig. 27: Example of the effect of the CLAHE algorithm. Left: Image before processing. Right: Image after processing

Prerequisite ✓ Requires the license IMMATH.

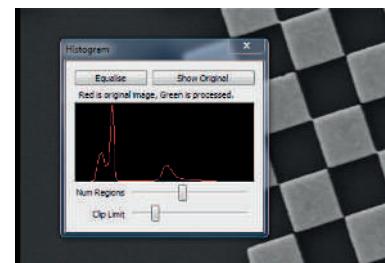
Procedure

1. Obtain an image.
2. Stop the scan.



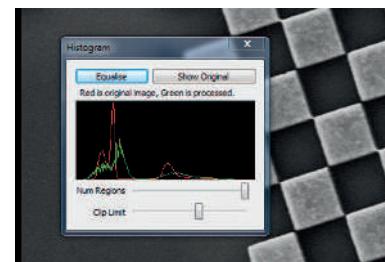
3. From the **Panel Configuration Bar**, select **Histogram**.

- The **Histogram** panel is displayed.
- The red graph represents the original image histogram.



4. Click **Equalise**.

- The processed image is displayed.
- The green graph represents the processed image histogram.



5. To further optimize the image, refer to *Finetuning the Image Contrast* [▶ 120].

5.6.6.4.1 Finetuning the Image Contrast

Info

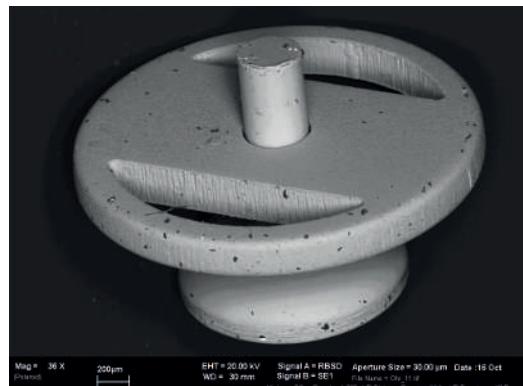
Several iterations may be necessary to achieve the best result.

Procedure

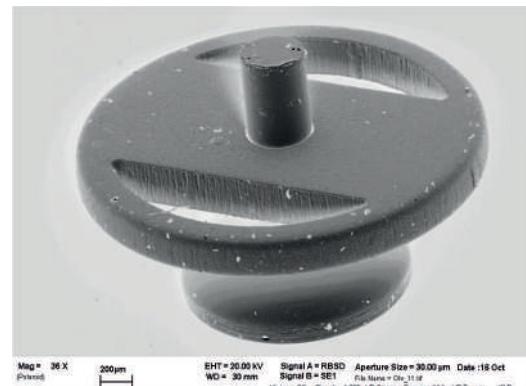
1. In order to switch between the original and the processed image, click **Show Processed / Show Original**.
2. Adjust the **Num Regions** slider.
INFO: CLAHE optimizes the contrast in subdivisions of the total image first and then computes an average from these regions. The **Num Regions** slider indirectly defines the size of these regions. To find the optimal value, consider the size of relevant structures on the specimen.
3. Adjust the **Clip Limit** slider.
INFO: All information above this limit value is clipped and therefore not visible in the equalized image.
4. Click **Equalise**.

5.6.6.5 Using 2D Filters

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

Fig. 28: Examples of the effect of 2D filters

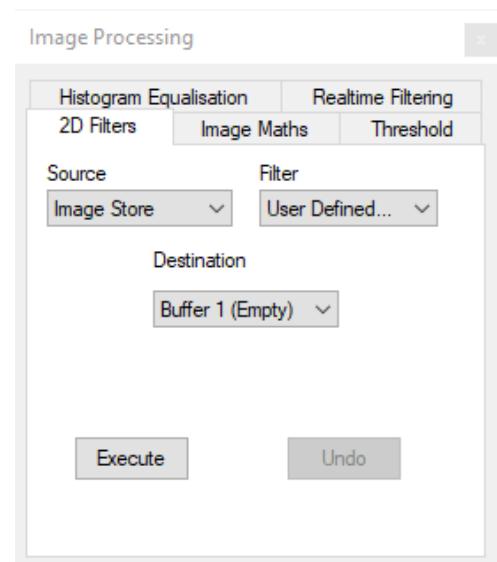


After application of Edge Detect filter

Prerequisite ✓ 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.

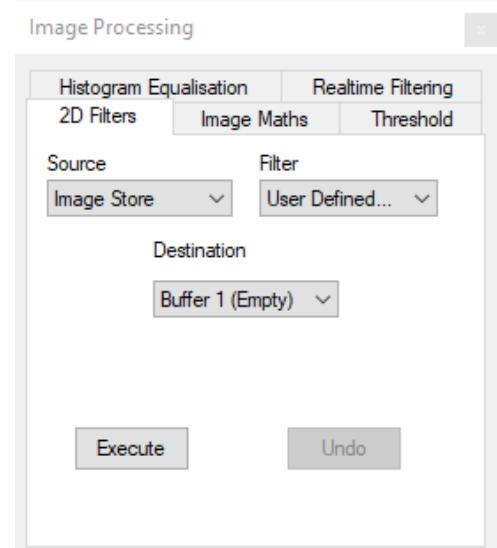


3. From the **Source** drop-down list, select the source of the image to which you wish to apply the transformation.
4. From the **Filter** drop-down list, select a filter.
For more information on filters, refer to *SEM | Image Processing | Filtering [▶ 223]*.
5. From the **Destination** drop-down list, select the destination.
6. To start the image processing, click **Execute**.
7. In order to cancel the last calculation, click **Undo**.

5.6.6.6 Defining User Specific Filters

Prerequisite ✓ 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**.

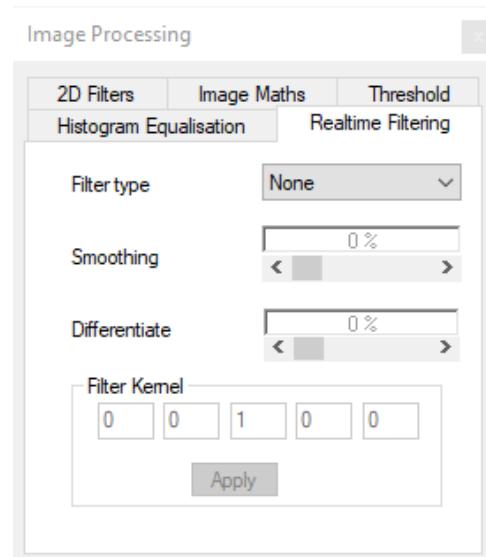
5.6.6.7 Using Realtime Filtering

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.

Prerequisite ✓ 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 list, select the appropriate filter type.
For more information on the filter type, refer to *SEM | Image Processing | Filtering* [▶ 223].

5.6.7 Working with Variable Pressure

VP mode offers the possibility of analyzing and mapping non-conducting, strongly gassing or moist specimens without any need for specimen preparation.

Info

When working with Nano VP mode or XVP mode, a beamsleeve aperture has to be inserted.

Info

In Standard VP mode and XVP mode, InLens SE, EsB, and SE detector cannot be used.

Info

In NanoVP mode, the SE detector cannot be used.

Mode	Beamsleave aperture	Booster	Chamber Pressure
High Vacuum HV	None	On	< 10 ⁻² Pa
Standard VP	None	Off	5–60 Pa

Mode	Beam leave aperture	Booster	Chamber Pressure
Nano VP	800 µm	On	5–40 Pa
	350 µm	On	5–150 Pa
XVP	800 µm	Off	5–150 Pa
	350 µm	Off	5–500 Pa

Tab. 1: VP configuration

5.6.7.1 Changing to Standard VP Mode

Info

If the VP system has not been used for several days, start with moderate pressure up to 30 Pa for the first 10 minutes.

Afterwards the vacuum system is conditioned and the VP mode can be used with its full range.

Info

A higher pressure can be set within a few seconds. Achieving a lower pressure may require some more time, because the specimen chamber has to be evacuated by the pre-vacuum pump.

Prerequisite ✓ The microscope is operating in HV vacuum mode.

- Procedure**
1. In the GeminiSEM Control panel, select the Control tab.
 2. In the **Variable Pressure** section, click **VP**.
 - The acceleration voltage decreases to zero, the column chamber valve and the Turbo isolation valve close, the Roughing backing valve and the Gas flow valve open.
 - The pressure in the specimen chamber is increased until the selected value is reached.
 - The system sets the chamber pressure to the value displayed in the **VP Target** field. If you have not changed it, it is the value of the last VP session.
 - The transition is indicated in the status bar of the SmartSEM software.
 - The acceleration voltage is activated and the column chamber valve opens.
 3. Wait until the system is ready for VP operation and **Chamber Status = At VP** is displayed.
 - This takes approximately 30 s.
 4. To change the chamber pressure, use the **VP Target** scroll bar.
Alternatively double-click into the **VP Target** field, enter desired pressure value and click **OK**.
Refer to *Working with Variable Pressure* [▶ 122] to determine the correct pressure value.

5.6.7.2 Using Nano VP or XVP Mode

5.6.7.2.1 Mounting a Beamsleeve Aperture for Nano VP or XVP Operation

When working with Nano VP mode or XVP mode, either a 350 µm or 800 µm pressure limiting beamsleeve aperture has to be inserted under the objective lens.

Select the correct beamsleeve aperture according to the table below. Only when mounting the correct aperture, it is possible to switch on the beam booster and set the maximum chamber pressure.

Beamsleeve aperture	Mode and chamber pressure	Application
No beamsleeve	<ul style="list-style-type: none"> ▪ VP: up to 60 Pa ▪ Nano VP: not available ▪ XVP: not available 	Maximum field of view configuration with the VPSE detector.
350 µm	<ul style="list-style-type: none"> ▪ Nano VP: up to 150 Pa ▪ XVP: up to 500 Pa 	High resolution configuration for lowest skirt effect and highest chamber pressure.
800 µm	<ul style="list-style-type: none"> ▪ Nano VP: up to 40 Pa ▪ XVP: up to 150 Pa 	Large field of view configuration with medium chamber pressures.

Parts and Tools	Designation	Part no.
	Beamsleeve Accessory Kit included with VP option	349553-8012-000
	Plastic tweezers	-



Fig. 29: Beamsleeve aperture kit, 350 µm beamsleeve aperture (black O-ring), 800 µm beamsleeve aperture (green O-ring).

⚠ WARNING**Suffocation hazard due to lack of oxygen**

Gaseous dry nitrogen is used to vent the specimen chamber during specimen exchange. Inhal-
ing 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 insta-
bility, fatigue) leave the room immediately and inform the facility's safety officer.

⚠ CAUTION**Moving the specimen stage**

Fingers can be trapped by the moving specimen stage.

- ▶ Always close the chamber door before moving the specimen stage.
- ▶ To remove parts fallen into or near to the stage use a tool (e.g. tweezers) instead of your
fingers.

⚠ CAUTION**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**Wrong aperture**

Setting the wrong aperture could damage the microscope.

- ▶ Always set the correct aperture size.

Procedure

1. From the **Menu Bar**, select **Tools > GoTo Panel**.
→ The **Panel Configuration Bar** is displayed. It contains an alphabetical list of functions.
2. Double-click **Beamsleeve Configuration**.
→ The **Beamsleeve Configuration** wizard is displayed where you have to set the aperture
size.
3. Follow the instructions of the **Beamsleeve Configuration** wizard.
4. Insert the pneumatic stop onto the beamsleeve
slide.



5. Click **Next**.

- The system is vented.
- The beamsleeve is inserted, but not fully so that you have access to the beamsleeve aperture inside the specimen chamber.

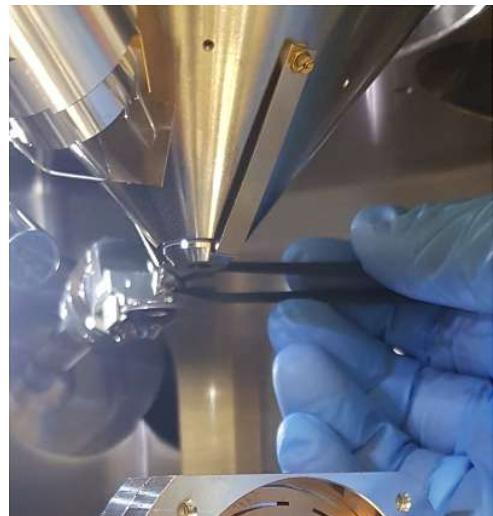


6. Open the chamber door.

If there is already a beamsleeve aperture in, use plastic tweezers to carefully take it out. Return the aperture to the beamsleeve aperture kit. It is not possible to insert another aperture at the same time.

NOTICE Be careful not to touch the objective lens or parts inside the specimen chamber. Wear gloves and forearm protectors.

7. Use plastic tweezers to carefully take the correct beamsleeve aperture (350 µm or 800 µm) out of the beamsleeve aperture kit. Carefully insert the beamsleeve aperture.



8. Close the chamber door.

9. In the **Beamsleeve Configuration** wizard, select the beamsleeve aperture you just have installed.

10. Click **Finish**.

- The beamsleeve is retracted and the system is pumping.

11. Remove the stopper from the slide.

5.6.7.2.2 Aligning the Beamsleeve Aperture

After you have installed a beamsleeve aperture you should center it with the **Beamsleeve Alignment** window.

This procedure consists of the following steps:

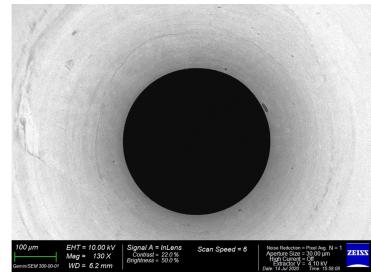
1. *Inserting the Beamsleeve Aperture* [▶ 127]
2. *Measuring the Size of the Beamsleeve Aperture* [▶ 127]
3. *Centering the Beamsleeve Aperture* [▶ 127]

5.6.7.2.2.1 Inserting the Beamsleeve Aperture

- Procedure**
1. From the **Menu Bar**, select **Tools > Goto Panel**.
→ The **Panel Configuration Bar** is displayed. It contains an alphabetical list of functions.
 2. Double-click **Beamsleeve Alignment**.
→ A window is displayed which shows you an example of a centered beamsleeve aperture.
 3. Click **Beamsleeve In**.
→ The beamsleeve aperture is automatically inserted.

5.6.7.2.2.2 Measuring the Size of the Beamsleeve Aperture

- Procedure**
1. Take an InLens image of the beamsleeve with a low magnification at EHT > 5 kV.



2. To display crosshairs, from the **Menu Bar**, select **View > Crosshairs**.
3. In the **Annotation Bar**, click the **Radial Measure** icon and measure the diameter.



5.6.7.2.2.3 Centering the Beamsleeve Aperture

- Procedure**
1. Center the beamsleeve aperture with the help of the x- and y-alignment knobs at the beamsleeve mechanic behind the microscope.
 2. In the **Beamsleeve Alignment** window, click **Beamsleeve Out**.
→ The beamsleeve aperture is retracted.
 3. Click **Beamsleeve In** to insert the beamsleeve aperture again.
 4. Check the alignment of the inserted beamsleeve aperture again.
You will observe that the aperture is not centered anymore. This is due to friction that occurs during insertion.
 5. Use the x- and y-alignment knobs again: Align the beamsleeve aperture in a way so that it will be centered after the next insertion.
 6. Retract and insert the beamsleeve aperture again and check that it is correctly centered.
→ If the aperture is centered after the insertion, then it is correctly aligned.
 7. Close the **Beamsleeve Alignment** window.

5.6.7.2.3 Ideal Working Conditions in Nano VP or XVP Mode

When you work in Nano VP you have to control three bias voltages:

- Beamsleeve bias
- VPSE/C2D collector bias
- EsB grid

The EsB grid does not influence other detectors, but beamsleeve bias and VPSE/C2D collector bias influence each other. When beamsleeve bias is on, gas cascade electrons are guided into the column and can therefore not be detected by the VPSE/C2D detector. Beamsleeve bias may limit your VPSE/C2D detector efficiency.

In case you would like to optimize VPSE/C2D efficiency, set the beamsleeve bias to 0 V.

When VPSE/C2D collector bias is on, gas cascade electrons are guided to the VPSE/C2D detector and can therefore not be detected by InLens SE detector or EsB detector. Additionally changing VPSE/C2D collector bias may result in a beam shift because of the side mounted VPSE/C2D detector. VPSE/C2D collector bias may limit your InLens SE detector or EsB detector efficiency.

In case you would like to optimize InLens efficiency, set VPSE/C2D collector bias to zero.

All bias voltage supplies have protective circuits to prevent serious damage to the system.

However, when you see arcing (bright stripes in electron image, light flickering in chamberscope), reduce VPSE/C2D collector bias or beamsleeve bias.

Beamsleeve bias acts as an additional lens and influences the focus of the objective lens. This is automatically corrected by the SmartSEM software.

At low voltages and not perfectly flat and horizontally aligned specimens this correction may need refinement by adapting the focus of the objective lens with the focus knob.

Every time the beamsleeve aperture is inserted, a leak test is done automatically. In case the leak test fails because the beamsleeve aperture is not vacuum tight fitted to the objective lens for some reason, the system is going back to High Vacuum mode and an error message occurs in SmartSEM: "Beam sleeve is not vacuum tight. System is going back to HV mode".

In Nano and XVP mode, the vacuum system permanently monitors the pressures in the microscope. If a leak at the beamsleeve aperture occurs it is immediately detected and the EHT will be shut down automatically, the system is going back to High Vacuum mode and an error message occurs in SmartSEM: "Beamsleeve is no longer vacuum tight. System is going back to HV mode".

In case you get the error message "Beamsleeve is no longer vacuum tight. System is going back to HV mode":

- Check if the slide can freely move to insert the beamsleeve completely and inspect the O-ring at the beamsleeve.
- If the error still exists, contact your local ZEISS service representative.

The following settings are recommended for the Nano VP/XVP Mode:

Parameter	Ideal	Ultimate	Limits
EHT	3 kV – 20 kV	1 kV – 30 kV	Maximum WD at 1 kV is 7.5 mm Skirt effect increases with lower acceleration voltage
Primary probe current	100 pA – 200 pA	10 pA – 100 nA	Signal-to-noise ratio decreases with low currents Image resolution decreases with high current

Parameter	Ideal	Ultimate	Limits
WD	7.2 mm – 9.2 mm	6.5 mm – Z_{\max}	At WD > 12 mm In-Lens efficiency decreases
Beam Gas Path Length (BGPL)	1 mm – 3 mm	0.3 mm – Z_{\max}	Below BGPL of 1 mm incomplete charge compensation BGPL > 2 mm increasing skirt effect
Pressure	60 Pa – 80 Pa	5 Pa – 500 Pa	Trade off between skirt effect and charge compensation
Beamsleeve bias	350 V	0 V – 400 V	Discharges
Acquisition conditions	Drift compensated frame average	All	Specimen details may move due to charge buildup
Detectors	InLens (best image resolution)		150 Pa max, no topography
	EsB (discrimination of charge buildup)		Max. grid voltage 1000 V
	VPSE/C2D		500 Pa, topography
	aSTEM/VP-BSD		Efficiency of diode detectors decrease with lower accelerating voltage (70 % at 1 kV)
Field of view	350 µm or 800 µm for wide field lens 700 µm or 1600 µm for Nano-twin lens		Depending on beamsleeve aperture used and lens configuration
EDX	WD 10–12 mm; 350 µm beamsleeve aperture		

5.6.7.2.4 Changing to Nano VP or XVP Mode

NOTICE

Touch alarm is not available

In Nano VP mode touch alarm is only available when beamsleeve bias voltage reaches approximately 200 V. In XVP mode touch alarm is not available.

- ▶ Avoid a Beam Gas Path Length (BGPL) of less than 1 mm.
- ▶ Watch the moving stage in TV mode.
- ▶ To stop the moving stage immediately, press **F12** or press the **Break** push button of the dual joystick panel.

Info

A higher pressure can be set within a few seconds. Achieving a lower pressure may require some more time, because the specimen chamber has to be evacuated by the pre-vacuum pump.

Procedure

1. In the GeminiSEM Control panel, select the **Control** tab.
2. In the **Variable Pressure** section, click **Nano VP** or **XVP** to start the pre-defined macro. The macro automatically performs the following actions:
 - If EHT is on, it is turned off.
 - The column chamber valve is closed.
 - The stage is moved down to give space for the beamsleeve to be inserted.
 - The beamsleeve is inserted under the objective lens.
 - The turbo pump isolation valve is closed and the gas flow valve is opened to introduce gas into the chamber.
 - A leak test is done at 30 Pa to check for vacuum tightness of the beamsleeve.
 - The EHT is turned on again, if it was on before the transition.
3. Wait until the system is ready for VP operation and **Chamber Status = At Nano VP** or **Chamber Status = At XVP** is displayed. This takes approximately 60 s.
 - The transition is indicated in the status bar of the SmartSEM software.
 - The system sets the chamber pressure to the value displayed in the **VP Target** field. If you have not changed it, it is the value of the last VP session.
4. To change the chamber pressure, use the **VP Target** scroll bar. Alternatively double-click into the **VP Target** field, enter desired pressure value and click **OK**. Refer to *Working with Variable Pressure* [▶ 122] to determine the correct pressure value.

5.6.7.3 Returning to HV Mode

HV mode is the standard mode of a FESEM. It offers the possibility of analyzing and mapping conducting specimens. In HV mode, the pressure in the specimen chamber is less than 10^{-6} mbar.

Info

When switching from VP to HV mode, the column chamber valve closes automatically, as a relatively poor vacuum is available in the specimen chamber when opening the TIV.

Prerequisite

- ✓ The microscope is operating in VP vacuum mode.

Procedure

1. In the GeminiSEM Control panel, select the Control tab.
2. In the **Variable Pressure** section, click **HV** to start the pre-defined macro. The macro automatically performs the following actions:
 - If EHT is on, it is turned off.
 - The column chamber valve is closed.
 - The gas flow valve is closed and the chamber is pumped down to 15 Pa.
 - The turbo pump isolation valve is opened.
 - The stage is moved down.
 - The beamsleeve is retracted.
 - The EHT is turned on again, if it was on before the transition.
 - The transition is indicated in the status bar of the SmartSEM software. This takes approximately 60 s. If the chamber pressure was really high before, then it takes a little bit longer.

5.7 Working with Recipes

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 This procedure consists of the following steps:

1. *Creating and Editing an Ingredient List [▶ 131]*
2. *Saving a User-Specific Recipe [▶ 131]*
3. *Saving a Common Recipe [▶ 132]*
4. *Viewing and Editing a Recipe [▶ 132]*
5. *Deleting a Recipe [▶ 133]*
6. *Executing a Recipe [▶ 133]*

5.7.1 Creating and Editing an Ingredient List

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. 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.
4. To delete a parameter, select the parameter and click **Delete Item**.
5. To change the order of the parameters, use the **Move Up** and **Move Down** buttons.
6. To insert a delay, click **Insert Delay** and enter a duration.
7. To save the ingredient list as a user-specific ingredient list, click **Save**.
8. To save the ingredient list 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**.

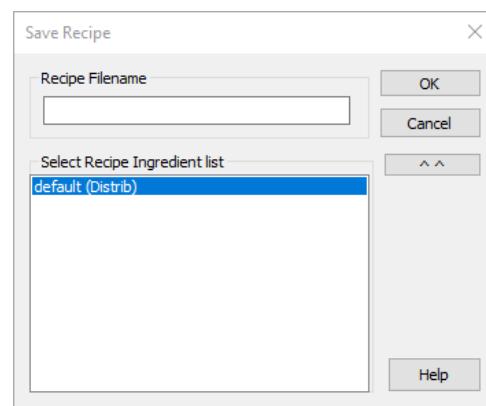
Alternatively, in the **Minibar**, click the **Recipes** icon and select **Save Recipe**.



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

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

3. Select the ingredient list to be used.



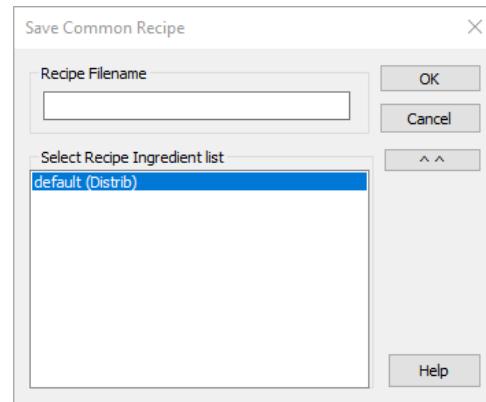
4. Enter a file name and click **OK**.

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

5.7.3 Saving a Common Recipe

Prerequisite ✓ 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

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.



A preview list is displayed, where you can omit individual parameters.

5.7.5 Deleting a Recipe

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

5.7.6 Executing a Recipe

Info

Only one recipe can be run at a time.

- Prerequisite** ✓ 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

The Annotation Bar provides several tools to add notes or graphical objects to your image.

For example, you can insert lines, arrows or texts. Moreover, it is possible to measure distances or the size of a rectangular area, the diameter of a circle or angle etc.

The image can be saved with the annotation overlaid on the image. Measurements can be performed on either saved or live image.

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

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.



or

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

5.8.4 Modifying Object Properties

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

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

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

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 the image where you wish to place the fixed micron marker.
→ The **Annotation Micron Measurement** window is displayed.
3. Enter the desired size.
4. Click **OK**.

5.8.9 Measuring Image Features

5.8.9.1 Measuring a Size

To measure the size of features, you can insert up to 30 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

To measure the angle between features, you can insert up to 30 angle measurements.

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

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 rectangle and the circle are displayed.

You can insert up to 30 linewidth measurements and 30 radial measurements.

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

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.

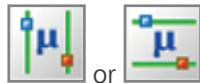
You can insert only one instance of fixed width measurement cursors and one instance of fixed height measurement cursors.

You can insert 30 instances for both types of movable cursors.

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



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



3. 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 Moving an Annotation

Procedure 1. To move an annotation to a different position, use drag & drop.

5.8.10.2 Undoing the Last Edit

Procedure 1. In the **Annotation Bar**, click the **Undo Last Edit** icon.



5.8.10.3 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.

5.8.10.4 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.



5.8.10.5 Saving Annotations

Procedure 1. In the **Annotation Bar**, click the **Save Annotation** icon.



2. Enter an annotation name.
3. Click **Save**.

5.8.10.6 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 **Open**.

5.9 Editing and Filing Images

5.9.1 Saving and Managing Images or Videos

5.9.1.1 Saving Images as TIF

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.tif**.

5.9.1.2 Saving Images as BMP or JPEG

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.
→ The **Save** button is labeled with the new 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. Click **Save file name.bmp** or **Save file name.jpg**.

5.9.1.3 Taking Videos

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 This procedure consists of the following steps:

1. *Setting AVI Options* [▶ 139]
2. *Starting the Record (License AVI Capture)* [▶ 139]

5.9.1.3.1 Setting AVI Options

Prerequisite ✓ Requires the license AVI.

- Procedure**
1. From the **Menu Bar**, select **Tools > AVI Options**.
→ The **AVI File Capture Options** dialog is displayed.
 2. To change the file name or to select another directory, click in the **Capture Filename** input field and enter the data.
As a standard, the created video is saved as a Capture.avi file in the user's current image directory.
 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 (License AVI Capture)

Prerequisite ✓ 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 **Select Folder**.
 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

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

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

Info

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

The procedure consists of the following steps:

1. *Optimizing Acquisition Parameters* [▶ 140]
2. *Selecting an Image Detail* [▶ 141]
3. *Acquiring a Large Image* [▶ 142]

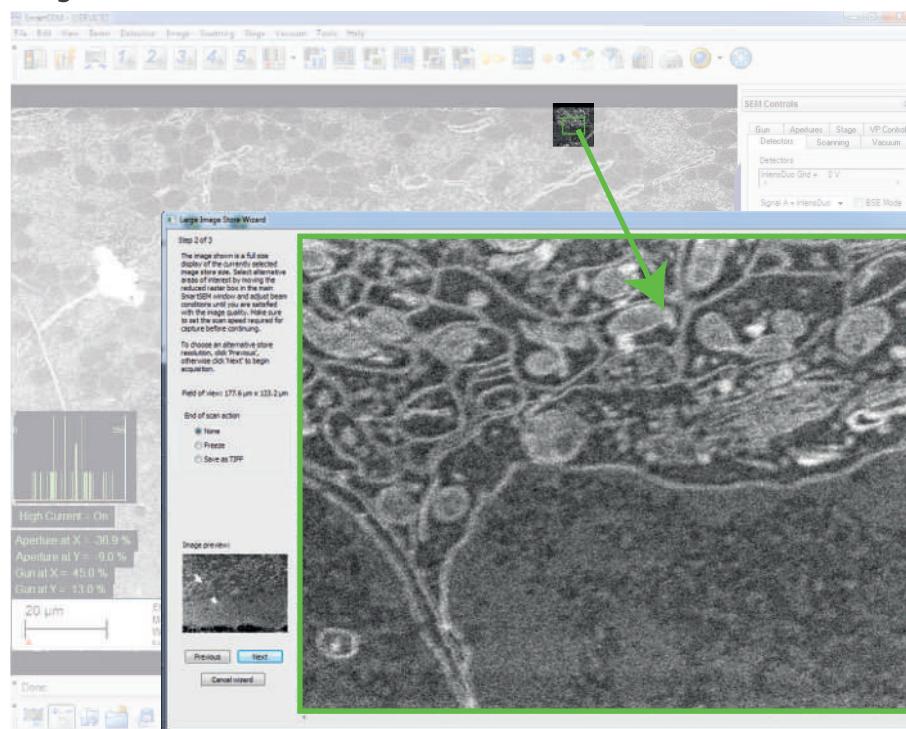
5.9.1.7.1 Optimizing Acquisition Parameters

- 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 1024 × 768 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.
INFO: Changing the magnification also changes the field of view for the final image.
→ In the **Large Image Store Wizard**, the **Field of view** readout is displayed, referring to the image visible in the total **Image Area**.

- 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.

5.9.1.7.2 Selecting an Image Detail

- Procedure**
1. 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**.



2. To change the detail displayed in the **Large Image Store Wizard**, move the green rectangle in the **Image preview** or in the SmartSEM **Image Area**.
3. To check the alignment, move the green rectangle to different areas.
4. If necessary, optimize the alignment. If you have problems to obtain satisfactory results, restart the procedure by clicking **Previous**.
5. 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.

5.9.1.7.3 Acquiring a Large Image

Procedure 1. Click **Next**.

- Step 3 of 3 is displayed.
- The selected **End of scan** action is performed.
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**.
- 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 (Lisence: CLIP)

5.9.2.1 Copying Images to the Windows Clipboard (License: CLIP)

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.

Prerequisite ✓ 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 by 20 as this storage space is required for the annotation.
- 6. Set the desired dimensions of the image and click **Set**.
- 7. To copy the image, click **Copy**.

5.9.2.2 Inserting Images from the Windows Clipboard (License: CLIP)

You can copy images to the Windows Clipboard and insert them in the image displayed in the SmartSEM **Image Area**.

Prerequisite ✓ 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 **X,Y** buttons. Selecting **X,Y** 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

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

Depending on the plasma cleaner model, T pump mode and purging are available and the **Plasma Cleaning** panel looks different.

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.

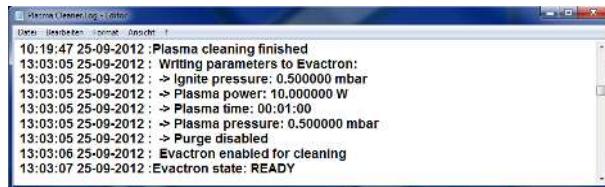


Fig. 30: Plasma Cleaner.Log

NOTICE

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.

NOTICE

Plasma cleaning

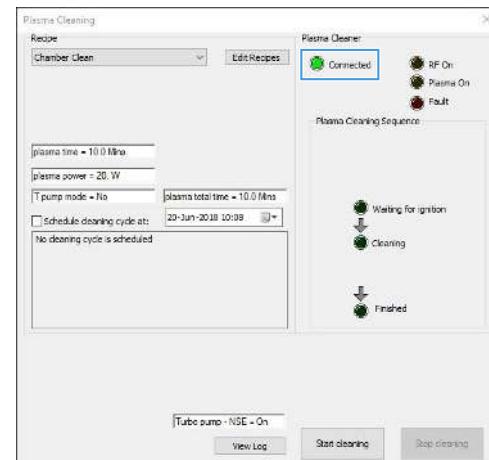
Plasma can damage sensitive specimens.

- ▶ Always test the plasma cleaner on specimens of the same material before cleaning any important specimen.

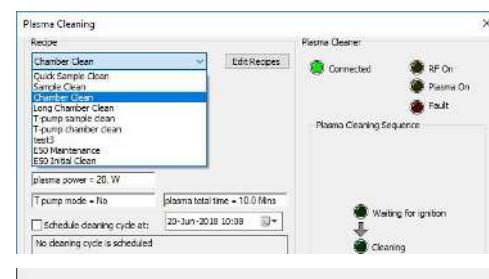
- Procedure**
1. If your microscope is equipped with the airlock, make sure that the gate valve of the airlock is closed. Do not use the airlock while using the Plasma Cleaner. For more information refer to the instruction manual of the airlock.
 2. Switch off the EHT.

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.**

3. From the **Panel Configuration Bar**, select **Plasma Cleaning**.
→ The **Plasma Cleaning** panel is displayed.
4. Check that the Plasma Cleaner controller hardware is switched on and the **Connected** LED is active in the software.



5. From the **Recipe** drop-down list, select a recipe.
INFO: There are several preset recipes for different purposes that cannot be edited. Additionally, you can create custom recipes.

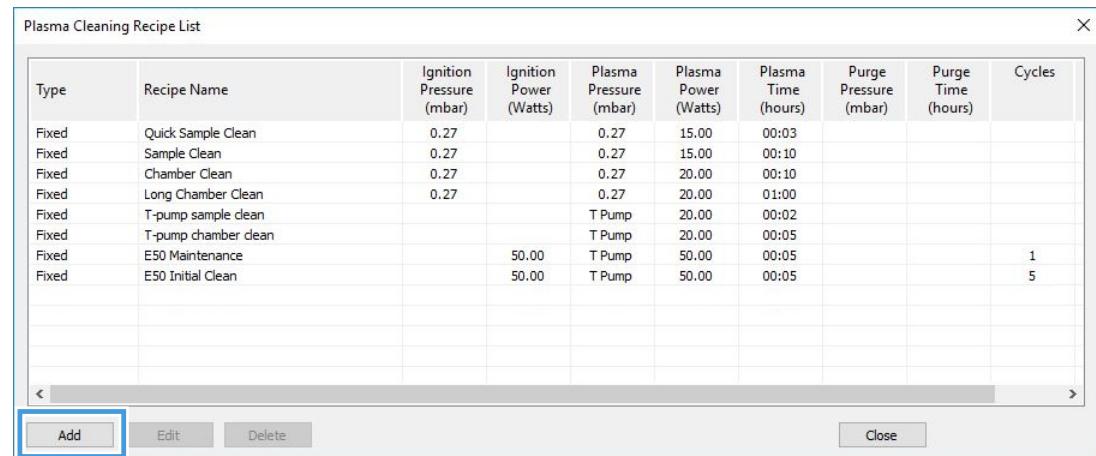


6. To start the plasma cleaning, click **Start cleaning**.
 - The current status is displayed in the **Plasma Cleaning Sequence** section.
 - If the selected recipe involves nitrogen purges, the number of purge cycles is displayed next to the flow chart. The arrow indicates which steps will be repeated.
7. Wait until the **Finished** LED is active. This indicates that the plasma cleaning process is complete.
INFO: If you wish to abort the cleaning cycle while it is still running, click **Stop cleaning**.
 - The chamber is pumped.
8. Wait until **Vac Status = Ready** is displayed in the **Vacuum** tab of the GeminiSEM Control panel.
 - The gun and the EHT can then be switched back on and you can return to regular microscope operation. Refer to *Switching on the Gun* [▶ 44] and *Switching on the EHT* [▶ 45].

5.10.2 Creating Custom Recipes

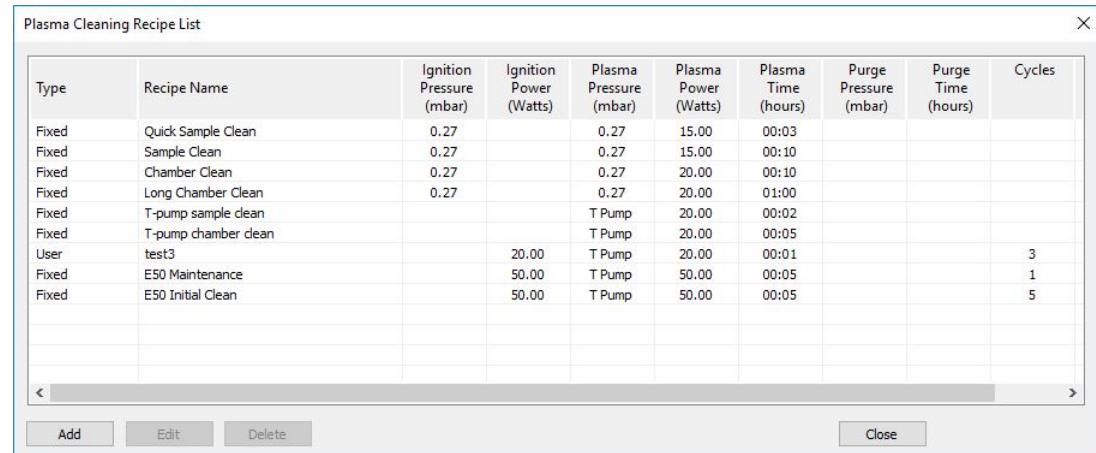
There are several preset recipes for different purposes that cover most applications. Additionally, you can create custom recipes for special purposes.

- Procedure**
- From the **Panel Configuration Bar**, select **Plasma Cleaning**.
→ The **Plasma Cleaning** panel is displayed.
 - Click **Edit Recipes**.
→ The **Plasma Cleaning Recipe List** is displayed and displays the available recipes.
INFO: The preset recipes are marked as **Fixed** in the **Type** column and cannot be edited or deleted.
 - To create a new recipe, click **Add**.



Type	Recipe Name	Ignition Pressure (mbar)	Ignition Power (Watts)	Plasma Pressure (mbar)	Plasma Power (Watts)	Plasma Time (hours)	Purge Pressure (mbar)	Purge Time (hours)	Cycles
Fixed	Quick Sample Clean	0.27		0.27	15.00	00:03			
Fixed	Sample Clean	0.27		0.27	15.00	00:10			
Fixed	Chamber Clean	0.27		0.27	20.00	00:10			
Fixed	Long Chamber Clean	0.27		0.27	20.00	01:00			
Fixed	T-pump sample clean			T Pump	20.00	00:02			
Fixed	T-pump chamber clean			T Pump	20.00	00:05			
Fixed	E50 Maintenance		50.00	T Pump	50.00	00:05			1
Fixed	E50 Initial Clean		50.00	T Pump	50.00	00:05			5

- The **Cleaning Recipe** window is displayed.
- Enter a name for the cleaning recipe.
 - Select the desired values according to your specific application.
In particular, the plasma power and the plasma time can be changed for the customized recipes.
 - If a plasma cleaner with purge option is installed and if nitrogen purge cycles are necessary, activate the **Purge** checkbox.
→ This adds additional values that can be edited.
 - If required, activate **T pump mode**.
This option provides a faster cleaning at better vacuum.
 - Once the settings are complete, click **Ok**.



Type	Recipe Name	Ignition Pressure (mbar)	Ignition Power (Watts)	Plasma Pressure (mbar)	Plasma Power (Watts)	Plasma Time (hours)	Purge Pressure (mbar)	Purge Time (hours)	Cycles
Fixed	Quick Sample Clean	0.27		0.27	15.00	00:03			
Fixed	Sample Clean	0.27		0.27	15.00	00:10			
Fixed	Chamber Clean	0.27		0.27	20.00	00:10			
Fixed	Long Chamber Clean	0.27		0.27	20.00	01:00			
Fixed	T-pump sample clean			T Pump	20.00	00:02			
Fixed	T-pump chamber clean			T Pump	20.00	00:05			
User	test3		20.00	T Pump	20.00	00:01			3
Fixed	E50 Maintenance		50.00	T Pump	50.00	00:05			1
Fixed	E50 Initial Clean		50.00	T Pump	50.00	00:05			5

- The recipe is added to the list of available recipes.
→ In the **Type** column, the new recipe is displayed as **User**, which tells you that the recipe can be edited or deleted.

5.10.3 Setting up the Schedule

If you want to schedule the next plasma cleaning, you can set up a date and time for an automated decontamination cycle.

NOTICE

Plasma cleaning

Plasma can damage sensitive specimens.

- ▶ Always test the plasma cleaner on specimens of the same material before cleaning any important specimen.

NOTICE

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. 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. To abort the countdown and start the cleaning cycle right away, click **Start Now**.

6. To abort the countdown and cancel the scheduled cleaning cycle, click **Cancel**.

7. To start the cleaning cycle as scheduled, no action needs to be taken.

5.10.4 Returning to Regular Operation

Procedure 1. If a cleaning cycle is currently running, click **Stop cleaning** to abort the cleaning cycle.

2. Close the **Plasma Cleaning** window.

→ The chamber is pumped.

3. Wait until **Vac Status = Ready** is displayed in the **Vacuum** tab of the GeminiSEM Control panel.

4. Switch on gun and EHT. Refer to *Switching on the Gun* [▶ 44] and *Switching on the EHT* [▶ 45].

6 Managing Users

6.1 Managing User Profiles

The SmartSEM software uses the **SmartSEM Administrator** window for user management. By means of the **SmartSEM Administrator** window, you can create new users and assign certain privileges to the users.

In the **SmartSEM Administrator** window the person responsible for the workstation 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

When the **SmartSEM Administrator** window 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 **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

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 **SmartSEM Administrator** window 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:

User Privilege	Description
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.
Gun Align	Enables the user to modify the alignment of the electron beam.
Gun Off	Enables the user to switch off the field emission filament.
Stage Initialise	Enables the user to initialize the motorized stage.
Supervisor	Enables the user to perform the following actions: <ul style="list-style-type: none"> ▪ Start the Administrator, create and edit users ▪ Set User Max EHT ▪ Modify the filament current ▪ 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
Vent	Enables the user to vent the specimen chamber.

Prerequisite ✓ Requires the **Supervisor** privilege.

- Procedure**
1. From the Windows start menu, select **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.
For access to all available parameters, activate the **Any Level** checkbox.
For access to a certain number of privileges and permissions, select **Full**, **Expert**, or **Novice** from the drop-down list.
14. In the **User Privileges** section, activate the desired user privileges.
15. To confirm, click **OK**.

6.1.3 Assigning or Changing a Password

Prerequisite ✓ Requires the **Supervisor** privilege.

- Procedure**
1. From the Windows start menu, select **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

Prerequisite ✓ Requires the **Supervisor** privilege.

- Procedure**
1. From the Windows start menu, select **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

Prerequisite ✓ Requires the **Supervisor** privilege.

- Procedure**
1. From the Windows start menu, select **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 microscope. The information is stored in a separate database file.

6.2.1 Creating a New Database File (License: ACCOUNT)

Prerequisite ✓ Requires the license ACCOUNT.
✓ Requires the **Supervisor** privilege or higher.

- Procedure**
1. From the Windows start menu, select **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\SmartSEMDatabase.
→ If a file has already been created, a warning message is displayed.

6.2.2 Activating/Deactivating User Accounting (License: ACCOUNT)

Prerequisite ✓ Requires the license ACCOUNT.
✓ Requires the **Supervisor** privilege or higher.
✓ A database file has been created.

- Procedure**
1. From the Windows start menu, select **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 list, select **Activate**.
→ The recording starts.
 5. In order to stop recording, select **Active > Deactivate**.

6.2.3 Deleting Session Records (License: ACCOUNT)

Enables you to delete data in the database up to a specific date.

- Prerequisite**
- ✓ Requires the license ACCOUNT.
 - ✓ Requires the **Supervisor** privilege or higher.
- Procedure**
1. From the Windows start menu, select **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)

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.

- Prerequisite**
- ✓ Requires the license ACCOUNT.
 - ✓ Requires the **Supervisor** privilege or higher.
- Procedure**
1. From the Windows start menu, select **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.
Refer to *Creating a New Owner* [▶ 151].
 5. Mark the owner in the **Owners** list.
 6. Mark an entry in the **Unassigned Accounts** field.
 7. Click .
→ The user is assigned to the respective owner.

6.2.4.1 Creating a New Owner

- Prerequisite**
- ✓ Requires the license ACCOUNT.
 - ✓ Requires the **Supervisor** privilege or higher.
- Procedure**
1. From the Windows start menu, select **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. Click **Add**.
→ The **Creating new Owner** window is displayed.
 5. Complete the input fields.
The fields **Name** and **Company** are compulsory.

6. To confirm, click **OK**.

6.2.5 Compressing the Database (License: ACCOUNT)

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.

Prerequisite ✓ Requires the license ACCOUNT.

✓ Requires the **Supervisor** privilege or higher.

Procedure 1. From the Windows start menu, select **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

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**.
→ The **User Settings** panel is displayed.
 2. Use the respective slider to adjust joystick speed, stigmator sensitivity, panel sensitivity, and aperture alignment sensitivity.
 3. To confirm, click **OK**.

7.2 Setting Mouse Adjustment Preferences

- Procedure**
1. From the **Menu Bar**, select **Tools > Configure Mouse Adjust**.
→ The **Mouse Adjustment Preferences** dialog is displayed.
 2. Adjust the settings as required.
 3. To confirm, click **OK**.

7.3 Disabling the Splash Screen on Startup

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

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

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)

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.

Prerequisite ✓ 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

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 your needs.

7.5.1 Unlocking the Data Zone

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

Prerequisite ✓ 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. To change font, size, or color, right-click the parameter.
From the context menu, select **Properties > Font**.
Make your selection and click **OK** to confirm.

7.5.3 Inserting a Logo

Logos or other images to be inserted have to be in bitmap (*.bmp) or metafile (*.wmf, *.emf) format.

Prerequisite ✓ 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

Prerequisite ✓ 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 and click **OK** to confirm.

7.5.5 Modifying Data Zone Properties

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

Prerequisite ✓ 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.

7.6.1 Changing the Order of the Icons

Prerequisite ✓ Requires the user privilege **Change Toolbar**.

- 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 Deleting an Icon

Prerequisite ✓ Requires the user privilege **Change Toolbar**.

- Procedure**
1. From the **Menu Bar**, select **Edit > Toolbar**.
→ The **Configure Toolbar** window is displayed.
 2. Select an icon.
 3. Click **Remove**.

7.6.3 Adding an Icon

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 microscope.
- **Special Functions:** comprises the Restore System Conditions and Save System Conditions routines.
- **Toggle:** comprises digital parameters which can be used as a switch.

Prerequisite ✓ Requires the user privilege **Change Toolbar**.

- 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. In the **Image** column, double-click the **No Icon** symbol.
 5. Select an icon and confirm.
→ An icon is inserted.
 6. In the **Button** column, select the mouse button you wish to use for the function.
 7. Double-click in the **Type** column.
→ The **Select Function** dialog is displayed.

8. From the **Type** drop-down list, select a type of function.
→ All functions of this type are listed in the **Name Of Function** list.
9. From the **Name Of Function** list, select the function that you wish to assign to the icon.
10. To confirm, click **OK**.
→ The function is assigned to the icon.
11. Double-click the **Tooltip Text** field and enter a help text.
12. If desired, repeat steps 6 and 11 for the other mouse button.

7.6.4 Assigning a Menu to an Icon

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.

Prerequisite ✓ Requires the user privilege **Change Toolbar**.

- 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.

7.6.5 Saving the Toolbar

Prerequisite ✓ Requires the user privilege **Change 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 **Save**.

7.7 Customizing the Magnification Display

7.7.1 Calibrating a User-specific Magnification

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.

Prerequisite ✓ 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 stigmatism.
 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:
Place the cursor into the **Image Area** and right-click.
Deactivate the **User Calibration Enable** checkbox.

7.7.2 Calibrating an Output Device

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. 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 . As the image range on the screen is 3 to 4 times as large as the Polaroid, the value X_1 is 3 to 4 times as large as the value X_2 (depending on the monitor size).

When exchanging or installing an output media on a microscope, a re-calibration is necessary if the size of the presentation or print image has been changed.

Prerequisite ✓ 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

The licenses installed on your microscope can be displayed from the SmartSEM Administrator.

Prerequisite ✓ Requires **Supervisor** privileges or higher.

- Procedure**
1. From the Windows start menu, select **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)

The program RemCon32 enables you to remotely control the microscope via the serial interface (RS232). It is possible to read or control specific parameters of the microscope. This option is especially useful if an EDX/WDX system is attached to the microscope.

Prerequisite ✓ SmartSEM is started.

- Procedure**
1. From the Windows start menu, select **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 user interface of the microscope.

8.1.2 Controlling the Microscope via a Windows Remote Desktop Connection (License: REMOTESEM)

Remote operation of the microscope is possible using the Windows Remote Desktop Connection feature.

Refer to 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)

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.

Prerequisite ✓ 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)

Defect review is used to find defects on a wafer or mask based on the results from KLA Tencor results file.

Prerequisite ✓ 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

9.1 Creating a Backup

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 **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

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 **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

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 readout	Indicates the status of the column chamber valve, which separates the gun area from the specimen chamber.
Open Column Chamber Valve button	If EHT is switched off, this enables you to open and close the column chamber valve.
Close Column Chamber Valve button	
Pump button	Evacuates the airlock chamber.
Vent button	Vents the airlock chamber: <ul style="list-style-type: none"> ▪ The gate valve is closed. ▪ The airlock chamber is vented with nitrogen.
Hold Vacuum button	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 readout	Indicates the status of the airlock.
Specimen Change button	Prepares the microscope for the specimen exchange.
Resume Exchange button	Restores the state before the specimen exchange.

10.2 Alignment | Focus Wobble

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 > GeminiSEM 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.

Parameter	Description
Wobble Fast check-box	Enables you to accelerate the wobble speed.

10.3 Alignment | Gun and Aperture

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** > GeminiSEM Control > 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

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 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.

Tab. 2: Annotation management

Reference 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.

Parameter	Description
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 Menu Bar > File > Save Annotation .

Tab. 3: Annotation handling

Reference 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	<p>Enables you to set and save graphical properties and operating options for annotations.</p> <p>The settings of the Annotations Options dialog are applied to existing annotations as well.</p> <p>The settings on this panel are saved in a user preferences file, which is automatically restored when the user logs in.</p>
Standard tab	Enables you to set the text fonts and colors for graphic and text annotations.
Measurement & Results 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 checkbox	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 checkbox	Activated: When an annotation object is created, it is automatically selected.
– Apply Object Settings to All Objects checkbox	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 define the grid settings.
– Results (Sig-Figs.) section	Defines the number of significant figures used to display distance measurements.
– Raster Lines section	Enables you to change the appearance of raster lines. INFO: Only visible if the Reduced Raster/Aperture button of the Toolbar is activated.

Parameter	Description
– Load and Save the Annotations Options	Enables you to load or create a user-defined set of annotation options by an *.anp-file.

Tab. 4: Annotations options

Reference Access: **Menu Bar > Edit > Insert Annotation Text**

Alternative access: Select the annotation and use the context menu to edit annotations.

Parameter	Description
Annotation Caption dialog	Enables you to edit a caption using plain text, common symbols, and system variables.
Caption input field	Enables you to type the text of your caption.
Word Wrap section	Activates the slider at the top of the text field, which enables you to adjust the caption width.
Insert New button	Enables you to add several captions to the overlay continuously, without closing the dialog. Each caption can be selected, moved, or changed.

Info

The context menu, the **Menu Bar**, and the **Annotations Options** dialog provide different options to handle annotations.

Reference Access: **Menu Bar > View**

Alternatively, you can click on the image and use the context menu to hide and unhide annotations.

Parameter	Description
Annotation	Enables you to toggle the display of different types of annotation in the current image.

Tab. 5: Annotation display handling

Info

The context menu and the **Menu Bar** provide different options to handle the display of annotations.

10.5 Annotations | Data Zone

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 is 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

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 > Annotation**

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 > 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.
	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 *.ann-file.
	Delete All Visible Objects	Deletes all visible annotations.

Icon	Tool Tip Text	Function
	Export Area Selection	<p>Enables you to define an image section to be saved.</p> <p>In order to save the image section, use the Properties command of the context menu.</p>

10.7 Annotations | Image Analysis

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 **Properties > Update Results** or change the **Properties > 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 > Annotation**

Icon	Tool Tip Text	Function
	Stored Vector Profile	<p>Displays the profile display along a fixed measurement line on the stored image.</p> <p>When the line is drawn, the trace on the profile display describes the gray levels along the line.</p> <p>Note that the leftmost point of the line is the leftmost position on the profile display.</p> <p>INFO: You can apply two Stored Vector Profiles.</p>
	Stored Data Histogram	<p>Displays the frequency distribution of gray values in the image via a data histogram.</p> <p>INFO: You can apply two Stored Data Histograms.</p>
	Insert TIFF Data	<p>Enables you to insert a text field for specific SEM TIFF parameters by the Annotation SEM TIFF Parameter dialog.</p> <p>INFO: Only available if a TIFF file is loaded.</p>

10.8 Annotations | Measurements

License: MEASA (for enhancing the measurement capabilities)

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 **Measurements Object Results 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 > Annotation**

Icon	Tool Tip Text	Function
	Micron Marker	<p>Enables you to add a horizontal bar which indicates the length of an object in the image.</p> <p>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.</p>
	Fixed Micron Marker	<p>Enables you to add a horizontal bar which indicates a fixed size you can determine by the Annotation Micron Measurement dialog.</p> <p>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.</p> <p>Edit the fixed micron marker to change the size.</p>
	Point to Point Measure	<p>Enables you to place a point to point marker on the image.</p> <p>The point to point measurement function comprises the following objects:</p> <ul style="list-style-type: none"> Distance between the markers: Pa <n> Angle between the line joining the markers and the direction of scan: Pb <n> Result text field <p>INFO: You can apply 30 Point-to-Point Measurements.</p>
	Angular Measurement	<p>Enables you to measure an angle between two objects.</p> <p>The angular measurement function comprises the following objects:</p> <ul style="list-style-type: none"> Measurement line: Aa <n> Reference line: Aa R <n> Result text field <p>Indicates the angle between reference line and measurement line.</p>

Icon	Tool Tip Text	Function
		<p>Each line has a marker at the end which identifies the center of rotation. Each line can be adjusted in length, angle, and position.</p> <p>INFO: You can apply 30 Angular Measurements.</p>
	Linewidth Measure	<p>The line width measurement function is a rectangle which can be adjusted in height, width, and angle.</p> <p>The line width measurement function comprises the following objects:</p> <ul style="list-style-type: none"> ▪ 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 <p>INFO: You can apply 30 Linewidth Measurements.</p>
	Radial Measure	<p>The radial measurement function is a circle which can be adjusted in diameter.</p> <p>The line radial measurement function comprises the following objects:</p> <ul style="list-style-type: none"> ▪ Diameter of the circle: Da <n> ▪ Area of the circle: Db <n> ▪ Result text field <p>INFO: You can apply 30 Radial Measurements.</p>
	Width Measurement Cursors	<p>Enables you to measure the distance for fixed width. Comprises a related pair of vertical lines. Each line can be adjusted in position.</p> <p>INFO: You can apply only one instance of Width Measurement Cursors.</p>
	Height Measurement Cursors	<p>Enables you to measure the distance for fixed height. Comprises a related pair of horizontal lines. Each line can be adjusted in position.</p> <p>INFO: You can apply only one instance of Height Measurement Cursors.</p>
	Moveable Width Cursor	<p>Enables you to measure the distance for variable width. Comprises a vertical measurement bar with variable length and position.</p> <p>INFO: You can apply 30 Moveable Width Cursors.</p>
	Moveable Height Cursor	<p>Enables you to measure the distance for variable height. Comprises a horizontal measurement bar with variable height and position.</p> <p>INFO: You can apply 30 Moveable Height Cursors.</p>

10.9 Annotations | Text and Graphic

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 > Annotation**

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.

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	
– 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	
– 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.
	By double-clicking on a defect, the 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	
– 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.
– Goto 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.

Parameter	Description
Display Image section	
– 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.
– 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	
– 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.

Reference 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: <ul style="list-style-type: none"> ▪ 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.
Position section	Enables you to change the area of the wafer map being viewed.
– Scale 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.

Parameter	Description
– ! 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

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	
– 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.
– Crosshairs checkbox	Displays the fixed crosshairs. The lines of the fixed crosshairs intersect at the center of the image.
Measure To section	
– 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	
– 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

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. Refer to *Automated Imaging | Registration* [▶ 178].

- **Setup** tab

You store images of the ROIs in a controlled way. Refer to *Automated Imaging | Setup* [▶ 180].

- **Define** tab

You define ROIs. Refer to *Automated Imaging | Define* [▶ 176].

- **Run** tab

You select detectors and execute the acquisition. Refer to *Automated Imaging | Run* [▶ 179].

10.13 Automated Imaging | Define

License: AUTO_IMG_ACQ

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 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.

Parameter	Description
– 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.
– 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.
– Mag button	Opens the Magnification dialog that enables you to define the list of possible magnifications.
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 Over-view checkbox	Sets the magnification to a predefined low value, i.e. the image is zoomed out.

Parameter	Description
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 .
– 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.

Reference Access: **Panel Configuration Bar > Automated Imaging > Define tab > 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

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 live image of the microscope.
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 live image of the microscope.
Setup 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

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.
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.

Parameter	Description
	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

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-SE.tif" <ul style="list-style-type: none">▪ ID: The Id for the set of ROIs, as entered above.▪ Region: A number for each individual ROI. Displayed in the file name e.g. as "r1".▪ Magnification: The magnification for each individual ROI. Can differ from ROI to ROI. Displayed in the file name e.g. as "m1000".▪ Detector: The detector used for the acquisition of each individual ROI. Can differ from ROI to ROI. Displayed in the file name e.g. as "SE".

10.17 Bakeout

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**.

NOTICE

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 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.

Reference Access: **Panel Configuration Bar > Bakeout**

Parameter	Description
Bakeout drop-down list	Enables you to select the bakeout duration: <ul style="list-style-type: none"> ▪ 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 readout	Indicates the current state: <ul style="list-style-type: none"> ▪ 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

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.

Reference Access: **Panel Configuration Bar > GeminiSEM Control > Control tab**

Info

For information on the optional Beam Blanker, refer to the Instruction Manual Beam Blanker delivered with the Beam Blanker.

10.19 Beam | Beam Shift

The beam shift is a function for adjusting the beam position. The beam shift function is helpful when shifting the specimen area of the image at very large magnifications. 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 shift 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

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 microscope, 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 X_1 . If the same specimen range is scanned and imaged in a Polaroid, the magnification corresponds to the value X_2 . As the image range on the screen is 3 to 4 times as large as the Polaroid, the value X_1 is 3 to 4 times as large as the value X_2 (depending on the monitor size).

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: <ul style="list-style-type: none"> ▪ Cal Mode Off: No calibration is possible. ▪ Cal Output Dev: Defines the magnification for an installed output device. 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: <ul style="list-style-type: none"> ▪ Printer: Selects the standard printer.

Parameter	Description
	<p>The default printer does not require calibration - the printer driver provides the calibration information.</p> <ul style="list-style-type: none"> ▪ Display/File: Calibrates the magnification for an output device.
Output Dev cal actual input field	<p>Enables you to enter the value (mm) of the distance between the two vertical lines on the output device by double clicking the input field.</p> <p>INFO: Only available if the Cal Output Dev mode is selected.</p>

10.21 Calibration | Probe Current

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 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 shift.
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 Calibration | Stigmator Calibration

The SEM stigmator calibration is an alignment process that enables you to remove effects caused by astigmatism. Astigmatism causes a circular beam to become elliptical. As a result, the focused live image appears to be blurred in one direction (line focus).

If the image shifts when you change the stigmator, then you need to set the stigmator balance. The calibration needs to be done for only one single probe current, e.g. 30kV:10pA.

Operating Principle The **SEM Stig Calibration** panel enables you to adjust the microscope until the image does not change anymore when you change the stigmator.

Reference Access: **Panel Configuration Bar > SEM Stig Calibration**

Parameter	Description
Wobble section	Enables you to select: <ul style="list-style-type: none">▪ Off: Stigmation off▪ Stig X: X limits can be adjusted using the navigation box▪ Stig Y: Y limits can be adjusted using the navigation box
Stig Bal Period scroll bar	Enables you to set the stigmator balance period.
Stig Bal Amplitude scroll bar	Enables you to set the stigmator balance amplitude.
Stig Centre navigation box	Enables you to adjust the stigmator in X or Y direction.
Stig Centre X radio button	The adjustments in the Stig Centre navigation box apply to the X direction. Stig Centre X is automatically selected when you select Stig X from the Wobble section.
Stig Centre Y radio button	The adjustments in the Stig Centre navigation box apply to the Y direction. Stig Centre Y is automatically selected when you select Stig Y from the Wobble section.

10.23 Clipboard

License: CLIP

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 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.

Parameter	Description
	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.
Merge section	
– 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	
– Whole checkbox	If activated, enables you to select the entire image for copying.
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 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	
– Centre button	Centers the object frame in the Image Area .
– Origin button	Repositions the object frame at the Image Area origin.
– 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.

Parameter	Description
	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.

10.24 Crosshairs

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. You can display the fixed crosshairs over the entire Image Area or as a small cross. To toggle the appearance of the crosshairs, select and double-click them.

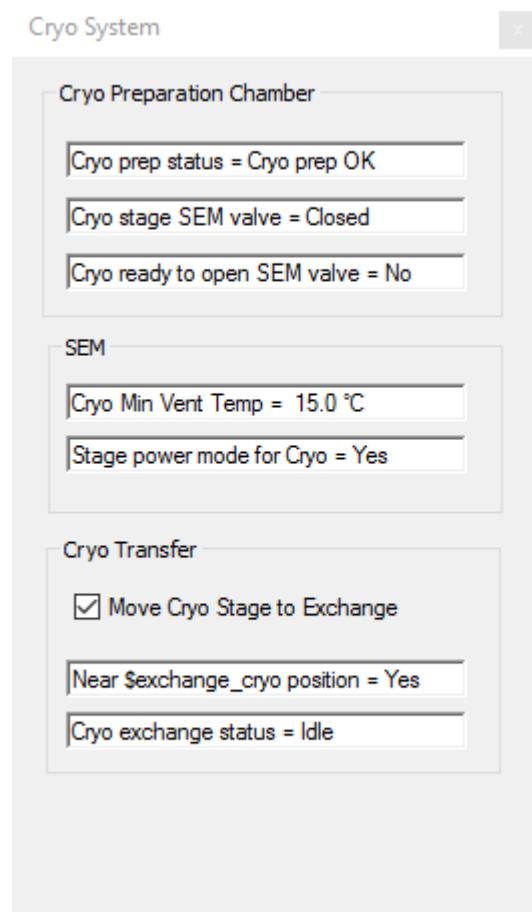
- Movable crosshairs

The lines of the movable crosshairs can be moved within the Image Area. You can move the crosshairs by dragging the handle at the center or you can use mouse following mode. To activate or deactivate mouse following mode, select the crosshairs and press **<Ctrl + Alt + F>**. Alternatively, select **Properties > Turn mouse following on or off** from the context menu.

Reference Access: **Menu Bar > View > Crosshairs**
Access: **Menu Bar > View > Movable Crosshairs**

10.25 Cryo System

The **Cryo System** panel displays the system status for working with cooled specimens.



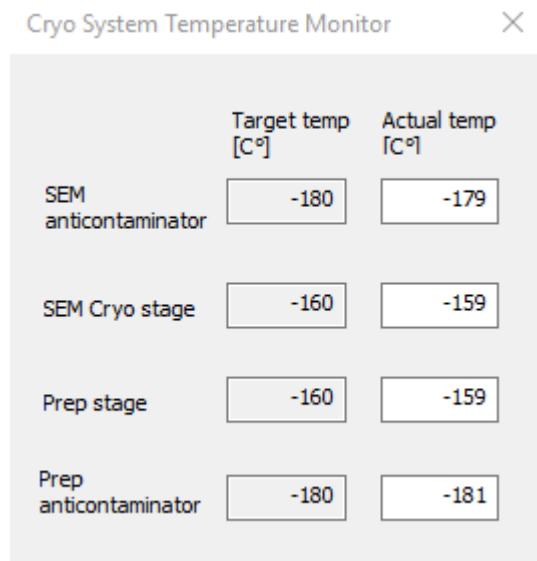
Reference Access: **Panel Configuration Bar > Cryo System**

Parameter	Description
Cryo Preparation Chamber section	
– Cryo prep status readout	Displays the status of the preparation chamber.
– Cryo stage SEM valve readout	Displays the status of the valve between preparation chamber and SEM specimen chamber.
– Cryo ready to open SEM valve readout	Indicates whether the system is ready to open the valve between preparation chamber and SEM specimen chamber or not.
SEM section	
– Cryo Min Vent Temp readout	Displays the minimum temperature for starting the venting process of the SEM specimen chamber.
– Stage power mode for Cryo readout	Indicates whether the stage power mode is active or not.
Cryo Transfer section	
– Move Cryo Stage to Exchange checkbox	Moves the cryo stage to the exchange position.
– Near \$exchange_cryo position readout	Indicates whether the cryo stage is near the exchange position or not.
– Cryo exchange status readout	Displays the cryo exchange status.

For a description of the cryo workflow refer to the Workflow Manual Cryo Workflow.

10.26 Cryo System Temperature | Monitoring

The temperature of the cryo stage is controlled via a separate monitor. The **Cryo System Temperature Monitor** provides a convenient way to additionally display the temperature in the SmartSEM User Interface.



Operating Principle The **Cryo System Temperature Monitor** displays the target and actual temperatures of the following components:

- **SEM anticontaminator**
- **SEM Cryo stage**
- **Prep stage**
- **Prep anticontaminator**

If the actual temperature is more than 2 °C higher than the target temperature, the value is displayed on a red background.

If the actual temperature is more than 2 °C lower than the target temperature, the value is displayed on a blue background.

Reference Access: **Panel Configuration Bar > Cryo System Temperature Monitor**

For a description of the cryo workflow refer to the Workflow Manual Cryo Workflow.

10.27 Detectors

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 > GeminiSEM Control > Imaging tab**

Alternative access: Detector selection, TV input selection, and mixing function can be alternatively accessed via **Menu Bar > Detection**.

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.

Parameter	Description
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.
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 license SIGMIX.
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: <ul style="list-style-type: none"> ▪ Transparent The Input LUT pattern is set to linear so that the signal passes through the LUT unchanged. ▪ Gamma 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 The linear Input LUT is inverted so that the signal passes through the LUT with inverted contrast. ▪ User

Parameter	Description
	The input signal transformation is applied based on a user-defined LUT. When this option is selected, the Input LUT Editor is displayed, and you can define your own LUT patterns.

Tab. 6: Detector / Active Channel section

Info
The parameters to be set in this section vary depending on which detector is selected.

Parameter	Description
Collector Bias 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.

Tab. 7: **Collector Voltages** section

10.28 Detectors | aBSD and BSD

The aBSD and BSD detectors are pneumatically retractable backscattered electron detectors that are used for high efficiency and angle selective material characterization.

Operating Principle The aBSD and BSD detectors use backscattered electrons to detect contrast between areas with different chemical compositions. Detection of up to 4 channels in parallel is possible.

Both types of detectors are adjusted by the **BSD Control** panel. The **BSD Control** panel looks slightly different for the different types of BSD detectors.

Reference Access: **Panel Configuration Bar > BSD Control**

Parameter	Description
Interactive schematics of the detector segments	Enables you to set the mode of the detector fields by mouse click as follows: <ul style="list-style-type: none"> ▪ White background Indicates the normal mode (on). ▪ Black background Indicates the inverted mode (inv.). ▪ Gray background Indicates that the detector field is disabled (off).
BSD Gain dropdown list	Selects one of the following gain ranges: <ul style="list-style-type: none"> ▪ Low ▪ Medium ▪ High ▪ Very high <p>Alternatively, you can change the gain via Status Bar > BSD4.</p>
Apply button	Applies the settings.

Parameter	Description
BSD:COMPO button	Enables you to activate compositional mode. All segments are in normal mode.
BSD:TOPO button	Enables you to activate topography mode. The two upper segments 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.
BSD Fast Scan checkbox	If activated, higher scan speeds are available. The diode bias of the detector is changed to create a larger band width.
Equalise B/C button	Harmonizes brightness and contrast automatically.
BSD in button	The stage moves down and the BSD detector moves in. INFO: The Undo Stage Goto button in the Stage tab of the GeminiSEM Control panel moves the stage back to the position it had before.
BSD out button	The stage moves down and the BSD detector moves out. INFO: The Undo Stage Goto button in the Stage tab of the GeminiSEM Control panel moves the stage back to the position it had before.
BSD Stop button	The BSD detector stops moving.

10.29 Detectors | CCD Camera

The chamber CCD camera (chamberscope) allows you to monitor the position of the specimen stage and particularly the distance between the objective lens and the specimen holder.

Operating Principle The **Stage Navigation Bar** enables you to set the mode of the CCD camera.

Reference Access: **Stage Navigation Bar > Settings**

Parameter	Description
CCD Illum. scroll bar	Enables you to set the illumination of the CCD camera.
CCD Brightness scroll bar	Enables you to set the brightness of the CCD camera.
CCD Contrast scroll bar	Enables you to set the contrast of the CCD camera.
CCD Resolution drop-down list	Enables you to set the resolution of the CCD camera.
CCD Mode drop-down list	Enables you to set the mode of the CCD camera. The chamber CCD camera has two illumination modes. The chamber can be illuminated either with white light or with infrared light. Infrared light gives a grayscale image, whereas white light gives a color image. <ul style="list-style-type: none"> ▪ Auto detect

Parameter	Description
	Depending on the currently active detector, the camera is set to grayscale, set to color, or switched off.
	Most chamber detectors are negatively affected by white light. If these detectors are active and white light cannot be used, the camera falls back to infrared illumination (grayscale image). For some detectors (especially BSD) even infrared light cannot be used and therefore the Auto detect switches off the camera.
	For some special applications the automatic selection may not give the optimum result. In this case, the automatic selection can be overwritten by the following manual selections:
▪ Greyscale	The camera is set to grayscale (infrared illumination).
▪ Colour	The camera is set to color (white illumination).
▪ Off	The camera is switched off.

10.30 Detectors | HT BSD

The High Temperature BSD is a retractable backscattered electron detector.

Operating Principle The HT BSD uses backscattered electrons to detect contrast between areas with different chemical compositions.

The HT BSD is adjusted by the **HT BSD Control** panel.

Reference Access: **Panel Configuration Bar > HT BSD Control**

Parameter	Description
HT BSD Temp. Actual	Displays the actual temperature of the HT BSD.
HT BSD Over	Enables you to enter the alarm temperature. If the actual temperature of the HT BSD reaches or exceeds the alarm temperature, then <ul style="list-style-type: none"> ▪ the detector is automatically retracted to prevent damage to the detector ▪ OVER TEMPERATURE is displayed in HT BSD Temp. Alarm ▪ the red error message HT BSD OVER TEMPERATURE! Auto-retracting! is displayed in the log window and a pop-up window that appears
HT BSD Critical	Enables you to enter the warning temperature. The warning temperature has to be lower than the alarm temperature. If the actual temperature of the HT BSD exceeds the warning temperature, Critical Temperature is displayed in HT BSD Temp. Alarm and the message HT BSD has entered the critical temperature region! is displayed in the log window.
HT BSD Temp. Alarm	Displays one of the following alarm status: <ul style="list-style-type: none"> ▪ Normal Temperature ▪ Critical Temperature ▪ OVER TEMPERATURE

Parameter	Description
HT BSD Filter	Enables you to select a filter from: <ul style="list-style-type: none"> ▪ Slow filter ▪ Medium filter ▪ Fast filter
HT BSD Position	Displays one of the following status of the hardware position: <ul style="list-style-type: none"> ▪ Out ▪ In ▪ Moving In ▪ Moving Out ▪ Waiting to move In ▪ Waiting to move Out ▪ Stopped
HT BSD Comms OK	Displays the status of the communication to the hardware.
HT BSD In button	Moves in the HT BSD.
HT BSD Out button	Moves out the HT BSD.
HT BSD Stop button	Stops the moving HT BSD.
HT BSD Clear Alarm State button	<p>Clears the alarm state.</p> <p>If the detector is in the alarm state and is automatically retracted, then it is necessary to clear the alarm state before the detector can be inserted again.</p>

10.31 Detectors | Sense BSD

The Sense BSD detector is a pneumatically retractable backscattered electron detector that is inserted below the objective lens and is used for high-efficiency material characterization of biological specimens.

Operating Principle The Sense BSD detector uses backscattered electrons to detect contrast between areas with different chemical compositions.

The Sense BSD detector is adjusted by the **Sense BSD** panel.

Reference Access: **Panel Configuration Bar > Sense BSD**

Parameter	Description
Interactive schematics of the detector segment	Enables you to set the mode of the detector segment by mouse click as follows: <ul style="list-style-type: none"> ▪ White background Indicates the normal mode (on). ▪ Black background Indicates the inverted mode (inv.). ▪ Gray background Indicates that the detector field is disabled (off).
BSD Gain dropdown list	Selects one of the following gain ranges: <ul style="list-style-type: none"> ▪ Low

Parameter	Description
	<ul style="list-style-type: none"> ▪ Medium ▪ High ▪ Very high ▪ Ultra high
	Alternatively, you can change the gain via Status Bar > Sense BSD .
Auto Gain Range checkbox	If activated, the gain is set automatically based on the signal contrast.
SenseBSD Position readout	Displays one of the following statuses of the hardware position: <ul style="list-style-type: none"> ▪ Out ▪ In ▪ Moving In ▪ Moving Out ▪ Stopped
Insert button	The Sense BSD detector moves in.
Retract button	The Sense BSD detector moves out.
STOP button	The Sense BSD detector stops moving. INFO: The button is dependent on the current hardware position.

10.32 Detectors | Output Configuration

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. SE2. Using the **Detector Signal Out Config** 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 Config**

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 .

10.33 Detectors | SCD

The SCD detector is a specimen 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.

Parameter	Description
	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	<p>Use this function if the signal intensity has changed significantly (e.g. if you changed to a different type of specimen or if you changed the beam current significantly).</p> <p>The Auto Level function then adapts the amplifier input level to the current signal level within a short period of time.</p> <p>You can manually execute the Auto Level function at any time. If you change the segment selection of the detector, then Auto Level is performed automatically.</p> <p>If you want to optimize the detector settings to a specific specimen position, then you can set the reduced raster to the desired position and click BSD Auto Level.</p>

10.34 Detectors | STEM

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.
Reference	The STEM detector is adjusted by the STEM Control panel.

Access: **Panel Configuration Bar > STEM Control**

Parameter	Description
Interactive schematics of the sections	<p>Enables you to set the mode of the detector fields by mouse click as follows:</p> <ul style="list-style-type: none"> ▪ White background Indicates the normal mode (on). ▪ Black background Indicates the inverted mode (inv.). ▪ Gray background Indicates that the detector field is disabled (off).
STEM Seg. Mode drop-down list	<p>Enables you to activate one of the standard modes, including BF (bright field), DF (dark field), and ODF (oriented dark field).</p> <p>The configuration of the sections in the selected mode is displayed in the schematics.</p>
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.

Parameter	Description
Gain Range section	Enables you to activate one of the following gain ranges: <ul style="list-style-type: none"> ▪ 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.

10.35 Detectors | Windowing

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: <ul style="list-style-type: none"> ▪ Zone 0: Outside the reduced raster ▪ Zone 1: Inside the reduced raster 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.

10.36 GeminiSEM Control

The GeminiSEM Control panel enables you to view and control the operating state of SEM devices and to set operating parameters.

- Operating Principle** The GeminiSEM 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 > GeminiSEM Control**

Parameter	Description
Control tab	Enables you to use the following functions: <ul style="list-style-type: none"> ▪ Select the column mode ▪ Align the gun beam ▪ Correct astigmatism

Parameter	Description
Imaging tab	Enables you to use the following functions: <ul style="list-style-type: none"> ▪ Select a noise reduction method ▪ Assign a detector to the Image Store input signal ▪ Adjust brightness, contrast, and gamma settings ▪ Select an Input LUT
Gun tab	Enables you to monitor and operate the electron gun.
Vacuum tab	Displays parameter readouts related to column and chamber vacuum and enables you to pump and vent the specimen chamber.
Stage tab	Enables you to view the current position and status of the stage, and to control stage movement.

10.37 Graticule

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.

10.38 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 of the GeminiSEM Control panel and the **Status Bar**.

The gun alignment is controlled by the **Control** tab of the GeminiSEM Control panel.

⚠ WARNING

Radiation hazard due to X-rays

X-rays are generated inside the microscope during operation. This is unavoidable because electrons are accelerated by voltages up to 30 kV.

- ▶ Do not remove any parts around the column and chamber that are essential for radiation protection.
- ▶ Use genuine ZEISS parts exclusively.
- ▶ Ensure that all local safety and X-ray protection regulations are met.
- ▶ Only authorized ZEISS service representatives are allowed to service the microscope.

Reference Access: **Menu Bar > Beam**

The EHT can be alternatively accessed in the following ways:

- **Status Bar**
- **Panel Configuration Bar > GeminiSEM Control > Control tab**

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.
Accelerating Voltage	Enables you to alter the EHT target.

Tab. 8: EHT

Reference Access: Panel Configuration Bar > GeminiSEM 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.
OptiProbe checkbox	Enables you to activate OptiProbe, which allows you to continuously adjust the probe current. Requires appropriate hardware.
OptiProbe Status readout	Displays the current OptiProbe status.
I Probe scroll bar	Enables you to change the probe current. The probe current is not displayed if the Probe Current Measurement option is not fitted and enabled.

Tab. 9: Gun

Reference Access: Panel Configuration Bar > GeminiSEM Control > **Control** tab

Info
The gun mode buttons are only available if Expert Gun Mode is set to Yes in Tools > User Preferences > User .

Parameter	Description
Imaging button	Activates the imaging 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 electrons. This mode is especially useful at low EHT values to reduce the chromatic error of the microscope, leading to a better resolution. The probe current in imaging gun mode is about half the probe current in normal gun mode.
Normal button	Activates the normal gun mode, which is for all routine work not requiring either very high resolution at low kV or very high probe currents.
Analytic button	Activates the analytic gun mode, which increases the temperature of the Schottky emitter and the extraction voltage. This leads to a higher probe current. This mode is especially useful for applications which require high intensities (e.g. WDX). The probe current in analytic gun mode is about twice the probe current in normal gun mode.

Reference Access: **Panel Configuration Bar** > GeminiSEM Control > **Control tab** > **Alignment** section

Parameter	Description
Gun button	Enables you to set the gun alignment using the navigation box.

Reference Access: **Menu Bar** > **Beam** > **Gun Setup**

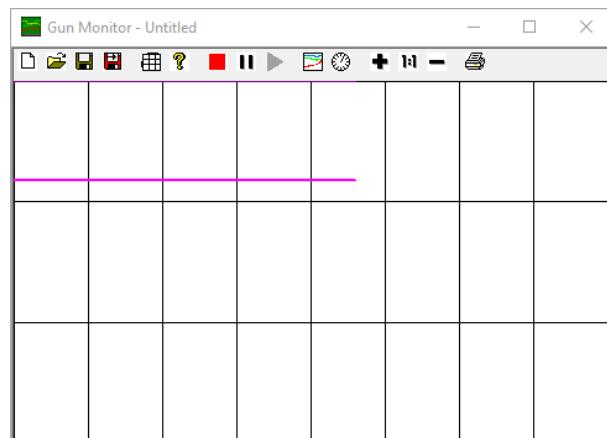
The **Gun Service** panel is reserved for the ZEISS service representative in order to set specific gun parameters.

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.**

10.39 Gun Monitor

The **Gun Monitor** enables you to record and display important parameters of the microscope at defined intervals.



Operating Principle Ten 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 > SmartSEM Service > Gun Monitor**

Icon	Tool Tip Text	Function
	File new - Clears current data and displays the parameter selection dialog	Clears the current data and displays the Parameter Setup 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.

10.40 Live Image | Optimization

Operating Principle For the live image optimization, you have to adjust the following parameters:

- Magnification
- Focus
- Stigmation

You can activate the adjustment by clicking the respective button in the Control tab of the GeminiSEM Control panel, in the **Beam Shift** panel, or in the **Toolbar**.

Reference Access: **Panel Configuration Bar > Beam Shift**

Alternatively, you can activate the adjustment by clicking Magnification+Focus/Auto Focus+Stig in the **Toolbar**.

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 .

Tab. 10: Magnification and focus

Reference Access: **Panel Configuration Bar > GeminiSEM Control > Control tab**

Parameter	Description
Stigmator button	Enables you to adjust the stigmation.

Parameter	Description
	To adjust the stigmatization, 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 stigmatization, you can use the auto stigmatization function available in the Beam Shift panel.

Tab. 11: Stigmatization

10.41 Macros

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**.

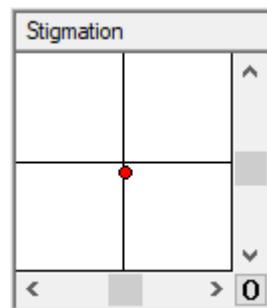
Macros can be created, edited, and debugged in the **Macro Editor**.

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.
Macro Editor	Access: Menu Bar > Tools > Macro Editor Displays the EM Macro Editor . For more information on how to create and edit macros refer to the Instruction Manual EM Macro Editor.

10.42 Navigation Box

The navigation box provides visual indication of the range and current value of one- and two-dimensional parameters such as beam shift or stigmatization.



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 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.

Tab. 12: *Predefined List*

10.43 Plasma Cleaning

License: PLASMA

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	<p>Enables you to monitor the state of plasma cleaning.</p> <p>In the Plasma Cleaner section, the following items are available:</p> <ul style="list-style-type: none"> ▪ 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 Cleaning Sequence section	<p>Displays the steps of the currently running plasma cleaning cycle and their completion status.</p> <p>In the Plasma Cleaning Sequence section, the following items are available:</p> <ul style="list-style-type: none"> ▪ 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.

10.44 Plasma Cleaning | Recipes

License: PLASMA

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**. Select a recipe in the **Plasma Cleaning Recipe List** to edit or add new ones.

Reference Access: **Panel Configuration Bar > Plasma Cleaning > Edit Recipes**

Parameter	Description
Plasma Cleaning Recipe List dialog	Enables you to select a recipe for plasma cleaning and indicates the set of parameters for recipes.
Type column	Indicates the type of the recipe: <ul style="list-style-type: none"> ▪ Fixed: Not editable and not deletable ▪ User: Editable and deletable
Ignition Pressure (mbar) column	Displays the ignition pressure.
Ignition Power (Watts) column	Displays the ignition power.
Plasma Pressure (mbar) column	Displays the pressure for the plasma.
Plasma Power (Watts) column	Displays the power for the plasma. For plasma power, up to 20 Watts can be selected.

Parameter	Description
Plasma Time (hours) column	Displays the plasma time. For recipes without nitrogen purge, Plasma Time equals Total Time .
Purge Pressure (mbar) column	Displays the pressure for each nitrogen purge.
Purge Time (hours) 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 (hours) column	Displays the total time required to run the recipe. Total Time is determined by the values Plasma Time , Purge Time , and Cycles .

Tab. 13: Plasma cleaning recipe management

Reference 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 power input field	Enables you to set the power at which the plasma cleaner is ignited.
plasma ignition pressure input field	Enables you to set the pressure at which the plasma cleaner is ignited. INFO: Only available if a plasma cleaner with purge option is installed.
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 input field	Enables you to select the chamber pressure that is maintained while the plasma is active. INFO: Only available if a plasma cleaner with purge option is installed.
plasma time input field	Enables you to select the duration of one plasma cleaning cycle.
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 .
Plasma retry count input field	Enables you to select the number of ignition attempts.
Plasma hold off time input field	Enables you to select the ignition hold time before switching to plasma cleaning settings.
Plasma interprocess time input field	Enables you to select the wait time between cleaning cycles for multiple loop cleaning runs.

Parameter	Description
number of cleaning cycles input field	Enables you to select the number of cleaning cycles.
Plasma wait time input field	Enables you to select the time for successful ignition in seconds.
Plasma retry wait time input field	Enables you to select the time between ignition attempts.
N2 Attached read-out	Displays information whether the nitrogen supply is attached or not. INFO: Only available if a plasma cleaner with purge option is installed.
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 a plasma cleaner with purge option is installed and if the nitrogen supply is attached.
purge pressure input field	Enables you to select the pressure of one purge cycle. INFO: Only available if a plasma cleaner with purge option is installed and if Purge is selected.
purge time input field	Enables you to select the duration of one purge cycle. INFO: Only available if a plasma cleaner with purge option is installed and 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 a plasma cleaner with purge option is installed and if Purge is selected.
T pump mode checkbox	Activates the use of turbo pump to generate the vacuum during a plasma clean.

Tab. 14: Plasma cleaning recipe handling

10.45 Scanning | Additional Parameters

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** > GeminiSEM Control > Imaging tab

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 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.

Reference Access: **Menu Bar > Image**

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.

10.46 Scanning | External Scan Control

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.

10.47 Scanning | Noise Reduction

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 > GeminiSEM Control > Imaging tab**

Alternative access: **Menu Bar > Image > Noise Reduction**

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.
Cycle Time read-out	Displays the duration of one cycle, depending on the selected Scan Speed and store resolution.
Freeze on drop-down list	Enables you to toggle between End Frame and Command .

Parameter	Description
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.
N scroll bar	Enables you to set the noise reduction parameter N for the selected noise reduction method if applicable.
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 dwell time.
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 check-box	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.

10.48 Scanning | Noise Reduction Methods

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** > GeminiSEM Control > Imaging tab > **Noise Reduction** drop-down list

Alternative access: **Menu Bar** > **Image** > **Noise Reduction**

Parameter	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.

Parameter	Description
	<p>The scan speed defines the time to complete a frame and the noise reduction parameter N defines the number of frames to integrate.</p> <p>Frame integration is used to enhance contrast and reduce noise.</p> <p>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.</p> <p>Not suitable when specimen drift occurs.</p>
Line Int. (Line Integrate)	<p>Each line is scanned a number of times before the scan moves on. The average line signal is stored and displayed.</p> <p>The noise reduction parameter N defines the number of times a line is averaged before moving to the next line.</p>
Line Avg. (Line Average)	<p>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.</p> <p>Line average is used, when the result of the noise reduction needs to be seen without waiting for the cycle to complete.</p> <p>The line average is suitable for most applications.</p>
Pixel Avg. (Pixel Average)	<p>A single frame is scanned.</p> <p>The frame time is controlled by the scan speed parameter as follows ($100 \times 2^{n-1}$):</p> <ul style="list-style-type: none"> ▪ 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 <p>The pixel average method is suitable for specimens with good electric and thermal conductivity.</p>
Continuous Avg. (Continuous Average)	<p>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.</p> <p>The number of frames is determined by the scan speed (2^n).</p> <ul style="list-style-type: none"> ▪ Scan Speed 1: Average of 2 frames

Parameter	Description
	<ul style="list-style-type: none"> ▪ 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 ▪ Scan Speed 6: Average of 64 frames ▪ Scan Speed 7: Average of 128 frames ▪ Scan Speed 8: Average of 256 frames
	<p>The continuous average method is mostly used for stable, conductive specimens where the beam has little or no damaging effect on the specimen.</p>
Drift Comp. Frame Int. (Drift Compensated Frame Integration)	<p>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.</p>
	<p>This method is ideal for customers with sub-optimal installation sites, e.g. vibrations.</p>
	<p>Select a high scan speed to be able to see the effect.</p>
	<p>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.</p>
Drift Comp. Frame Avg. (Drift Compensated Frame Averaging)	<p>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.</p>
	<p>Another benefit of this method is that it simplifies focusing of fast-charging specimens at high scan speeds.</p>
	<p>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.</p>
	<p>This method is ideal for customers with sub-optimal installation sites, e.g. vibrations.</p>
	<p>Select a high scan speed to be able to see the effect.</p>
	<p>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.</p>
	<p>The drift compensated frame averaging method does not work in reduced raster mode.</p>

10.49 Scanning | Rotation/Tilt

Available with the following licenses:

- License: DYNFOCUS
- License: SCANROT
- License: TILTCOMP

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**
- Dynamic focus
 - Rotate Scan
 - Tilt correction

Reference 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.

Tab. 15: Dynamic focus

Reference 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 .

Tab. 16: Scan rotation

Reference 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.

Tab. 17: Tilt correction

10.50 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)

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**

The scanning modes can be alternatively accessed in the following ways:

- **Toolbar**
- **Panel Configuration Bar** > GeminiSEM Control > Imaging tab
- Context menu in the **Image Area**

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.
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: <ul style="list-style-type: none"> ▪ 1024 × 768 ▪ 2048 × 1536 ▪ 3072 × 2304
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 on 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 6144 × 4608.

10.51 SEM | Alignment | Drift Correction

License: DRIFT-CORR

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	<ul style="list-style-type: none"> ▪ No reference: Reference has not yet been set. ▪ Busy: Busy creating reference. ▪ Ready: Reference has been created. <p>The Do SEM Drift Corrn button is activated automatically.</p>
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	<p>Enables you to set the minimum confidence level for the correctness of returned drift values.</p> <p>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.</p>
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.
Default Settings button	Restores the default settings.
Periodic Drift Correction checkbox and Period(s) input field	<p>Enable you to schedule a periodic drift correction.</p> <p>A drift correction is carried out every time the set time span in seconds has expired. Only available after a reference has been created.</p>
Beam Shift section	<p>In the Beam Shift section, you can control the following items:</p> <ul style="list-style-type: none"> ▪ 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.

Parameter	Description
	If deactivated, stage and beam shift 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.

10.52 SEM | Image Acquisition | Color Mode

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**

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.

Tab. 18: **Signal A** 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.

Tab. 19: **Signal B** section

Parameter	Description
Colour Mode drop-down list	Enables to select the color mode: <ul style="list-style-type: none"> ▪ 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 labeled 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.

Parameter	Description
	The four colors are chosen using the RGB checkboxes labeled 1, 2, 3, and 4.
RGB checkboxes	If activated, the corresponding color is used in the 2 LUT or 4 LUT color mode.

Tab. 20: **Colour Mode** section

10.53 SEM | Image Acquisition | Histogram

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.

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.

10.54 SEM | Image Acquisition | Image Files

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. <ul style="list-style-type: none"> ▪ Buffer 1 to Buffer 8 Enables you to store the image in the respective buffer. ▪ Next Buffer

Parameter	Description
	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, auto stigmatism, and changes in magnification to find a reasonable image.

10.55 SEM | Image Acquisition | Image Files | Export

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.

Reference Access: Right-click the image > **Send to**

Alternative access: *.tiff files can alternatively be exported via **Menu Bar > File > Save Image**

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: <ul style="list-style-type: none">▪ 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.

Tab. 21: **Save** tab

Parameter	Description
Image section	<p>In the Image section, the following items are available:</p> <ul style="list-style-type: none"> ▪ 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). <p>INFO: 16 bit images do not contain more visual data (only 8 bits are visible). Exclusively reserved for later image modification by means of commercial programs.</p> <ul style="list-style-type: none"> ▪ Palette checkbox: Enables you to export the color palette with the file. <p>INFO: Only available for the export of *.tiff files.</p>
Reduction dropdown list	Enables you to partially reduce the image before export, using the selected reduction factor for the frame size.
Dimensions section	<p>In the Dimensions section, the following items are available:</p> <ul style="list-style-type: none"> ▪ 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	<p>In the Area section, the following items are available:</p> <ul style="list-style-type: none"> ▪ 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	<p>Enables you enter the quality of your jpeg file. By default, a value of 75 is set.</p> <p>INFO: Only available for the export of *.jpeg files.</p>

Tab. 22: *Settings* tab

10.56 SEM | Image Acquisition | Image Files | Import

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: <ul style="list-style-type: none">▪ *.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: <ul style="list-style-type: none">▪ 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.
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.

Parameter	Description
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**

10.57 SEM | Image Acquisition | Large Image Store Wizard

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 1024 x 768 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.

Reference 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: <ul style="list-style-type: none"> ▪ None radio button If activated, the scan continues after completion. ▪ Freeze radio button If activated, the scan stops after completion. ▪ Save as TIFF radio button 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 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 .

Parameter	Description
Next button	Starts the image acquisition for the ROI. Depending on the selected store resolution, the acquisition might take several minutes.
Reference	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.

10.58 SEM | Image Acquisition | LUT

The LUT (look-up table) is a file that contains information for the color output of live images or saved images.

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: <ul style="list-style-type: none">▪ 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.
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10.59 SEM | Image Acquisition | LUT | Display LUT

The display LUT is a file that contains information for the color output of live or saved images.

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.
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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.

Icon	Tool Tip Text	Function
	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 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.

10.60 SEM | Image Acquisition | LUT | Input LUT

The input LUT is a file that contains information for the color output of live images.

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.

10.61 SEM | Image Acquisition | Output Device Magnification

The output device magnification is the device specific image width of an image presenting system, e.g. LCD-monitor or polaroid format.

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.

10.62 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.
Principle 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 Capture**

Icon	Tool Tip Text	Function
	Start AVI Capture	Starts record.
	Play Back an AVI File	Plays the saved video sequence.
	Choose Options for AVI Capture	Opens the AVI File CaptureOptions panel.
	Stop AVI Capture	Stops record.
	Pause During AVI Capture	Pauses record.
	Fast Forward AVI Playback	Fast forward during AVI play.
	Rewind During AVI Playback	Rewinds during AVI play.

- 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 with 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 dropdown list	Enables you to select the reduction factor.
Capture every ms radio button and input field	Enables you to set the capturing rate in ms.

Parameter	Description
Capture every frames radio button and input field	Enables you to set the capturing rate in frames.
Defaults button	Enables you to reset all *.avi file capture options to default settings.

10.63 SEM | Image Processing

License: IMMATH

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.

10.64 SEM | Image Processing | Filtering

License: IMMATH

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.

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

$$\left(\begin{pmatrix} 1 & 2 & 1 \\ 0 & 0 & 0 \\ -1 & -2 & -1 \end{pmatrix} + \begin{pmatrix} -1 & 0 & 1 \\ -1 & 0 & 1 \\ -1 & 0 & 1 \end{pmatrix} \right) / 2$$

Edge Detect 2

$$\left(\begin{pmatrix} 1 & 1 & 1 \\ 0 & 0 & 0 \\ -1 & -1 & -1 \end{pmatrix} + \begin{pmatrix} -1 & 0 & 1 \\ -1 & 0 & 1 \\ -1 & 0 & 1 \end{pmatrix} \right) / 2$$

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 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.

Parameter	Description
Destination dropdown list	Defines the destination to which the processed image is saved.
Execute button	Executes the selected operation.
Undo button	Aborts the settings.

Tab. 23: 2D Filters

Parameter	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: <ul style="list-style-type: none">▪ 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.
Laplacian 2	Detects edges in the image by realizing a Laplace transformation using the eight neighboring pixels.

Tab. 24: Predefined filters for 2D filtering

Reference 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 dropdown list	Enables you to select the filter type.

Parameter	Description
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.

Tab. 25: Realtime filtering

Parameter	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.
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.

Tab. 26: Predefined filters for realtime filtering

10.65 SEM | Image Processing | Histogram Equalization

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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.

10.66 SEM | Image Processing | Image Deconvolution

License: IMMATH

Image deconvolution corrects the beam profile and this way improves the image quality.

Reference Access: **Panel Configuration Bar > Deconvolution**

Parameter	Description
Start Deconvolution button	Executes the image deconvolution.
Show last input image checkbox	Shows the last input image.
Deconvolution expert mode checkbox	If activated, then the Deconvolution Sigma scroll bar and the Deconvolution Smoothening scroll bar become active. You can use these scroll bars to manually adjust certain parameters for image deconvolution. If the Deconvolution expert mode checkbox is deactivated, then pre-defined values are used for the respective parameters.
Deconvolution Sigma scroll bar	Enables you to fine-tune the spot size that is used for the image calculation.
Deconvolution Smoothening scroll bar	Parameter that enables you to improve the signal-to-noise ratio.

10.67 SEM | Image Processing | Image Maths

License: IMMATH

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: <ul style="list-style-type: none"> ▪ 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

Parameter	Description
	<ul style="list-style-type: none"> ▪ 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.

10.68 SEM | Image Processing | SmartImage

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.

10.69 SEM | Image Processing | Threshold

License: IMMATH

The **Threshold** function is used to set threshold levels for detecting pixels matching a grayscale 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 less than the selected threshold value
- **White**: values greater than the selected threshold value
- **Grey**: values greater than the black threshold and less than the white threshold

Reference Access: **Menu Bar > Image > Image Processing > Threshold** tab

Parameter	Description
Black Threshold scroll bar	Sets the threshold for black.
White Threshold scroll bar	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 read-out	Displays the calculated area fraction.

10.70 SEM | Images | Image Files | Print

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**

Alternative access: **Context menu > Send to > Printer**

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.

Parameter	Description
Printer Mag read-out	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.
Printer button	Enables you to configure the installed printer.
Print button	Prints the image.

10.71 SEM Recipes

A recipe is a file defining the specific set of parameters and state values of the microscope.

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 Access: **Menu Bar > File > Recipe management > Ingredient File Editor**

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.
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.	

Tab. 27: *Ingredient list*

Reference 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: <ul style="list-style-type: none">▪ 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 VW button. The current values of the parameters and states listed in the selected ingredients list are saved in the new recipe.

Tab. 28: Recipe handling

Reference Access: **Menu Bar > File > Recipe Management**

Alternative access: **Minibar**

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.

Tab. 29: Recipe management

10.72 Settings | User

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
- Aperture align 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 .

Parameter	Description
Aperture Align Sensitivity scroll bar	Enables you to change the sensitivity of the aperture and stigmator align knobs on the control panel.
Reset User Align button	Resets the user-specific user alignment table.

10.73 SmartSEM Administrator

SmartSEM Administrator enables you to manage user profiles and configure instruments.

Reference Access: **Windows start menu > SmartSEM > SmartSEM Administrator**

Alternative access: **Menu Bar > Tools > Administrator**

Parameter	Description
Users tab	Enables you to create new users and assign certain privileges to the users.
Licenses tab	<p>Displays all installed software licenses:</p> <ul style="list-style-type: none"> ▪ The checkboxes in the Standard column indicate the standard licenses. ▪ The checkboxes in the Enabled column indicate which licenses are active. <p>To sort the list according to part numbers, sales codes, or descriptions, click the respective column title.</p> <p>Info: Software licenses enable specific functionalities in the SmartSEM software.</p>
Detector tab	<p>Enables you to activate selected detectors.</p> <p>Enables you to enter serial numbers for USB cameras.</p>
Column/Stage tab	<p>Enables you set stage options.</p> <p>Enables you to activate optional stages.</p>
Other tab	Collection of miscellaneous system configuration options

10.74 Stage

The motorized 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.

⚠ CAUTION

Moving the specimen stage

Fingers can be trapped by the moving specimen stage.

- ▶ Always close the chamber door before moving the specimen stage.
- ▶ To remove parts fallen into or near to the stage use a tool (e.g. tweezers) instead of your fingers.

Reference 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 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.

Tab. 30: Centering a spot or an area / Using Stage Map

10.75 Stage | Alignment

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.

CAUTION

Moving the specimen stage

Fingers can be trapped by the moving specimen stage.

- ▶ Always close the chamber door before moving the specimen stage.
- ▶ To remove parts fallen into or near to the stage use a tool (e.g. tweezers) instead of your fingers.

Reference Access: **Panel Configuration Bar > Stage Horizontal Alignment**

Alternative Access: **Panel Configuration Bar > GeminiSEM Control > Stage tab > Further Options > Horizontal Alignment**

10.76 Stage | Image Navigation

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:

- Using the stage navigation camera
- Using an external camera

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.

⚠ CAUTION

Moving the specimen stage

Fingers can be trapped by the moving specimen stage.

- ▶ Always close the chamber door before moving the specimen stage.
- ▶ To remove parts fallen into or near to the stage use a tool (e.g. tweezers) instead of your fingers.

Reference Access: **View > Toolbars > Stage Navigation Bar (for Widescreen users)**

Parameter	Description
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 live image of the microscope.
Camera > Image submenu	Enables you to load an externally generated image from a file.
Camera > SEM Image submenu	Loads the current SEM image for automatic registration. All parameters are known.
Register button	Starts the Registration wizard. As a result, the image coordinates are mapped to the stage coordinates.
Register > Clear registration submenu	Cancels the manual registration.
Register > Load registration submenu	Loads a registration. The default registration loaded is NavCam.crf in C:\ProgramData\Carl Zeiss\SmartSEM.
Register > Save registration data submenu	Saves the current registration data.
Register > Save registration image submenu	Saves the current registration image.

Tab. 31: **Image Navigation**

Parameter	Description
Add button	Adds a new position to the stage points list.

Parameter	Description
Remove button	Removes a position from the stage points list.
Edit button	Opens the Point Data Dialog that enables you to edit the stage points list.
Load/Save button	The following items are available: <ul style="list-style-type: none"> ▪ Load Enables you to load a stage points list. ▪ Save As Enables you to save the stage points list in the user directory. ▪ Clear List Clears the stage points list.
Move to button	Moves the stage to the point that is selected (highlighted in blue) in the stage points list. NOTICE If the position is old, if you change the specimen or if you mount higher specimens on the specimen holder, then there is a risk of damaging the objective lens and/or the specimen.
X, Y, and Z readouts	Display the co-ordinates X, Y, and Z.
Set Magnification checkbox	If activated, also the stored magnification is set, if you drive to a stage position.
Set Working Distance checkbox	If activated, also the stored working distance is set, if you drive to a stage position.
Move XY Only checkbox	If activated, the stage only drives in X and Y direction, but not in Z direction, if you drive to a stage position.

Tab. 32: **Points List**Alternative access: **Menu Bar > Stage > Navigation**

Parameter	Description
Display	Shows the sideview of the stage.
+ button	Zooms into the image.
- button	Zooms out of the image.
Flip view button	Flips the view of the stage along the vertical axis.
X, Y, Z, T, and R input fields	Enable you to enter a stage goto value. The stage moves to this value.
XY, Z, T, and R buttons	Enable you to enter a stage delta value. The stage moves by this value.

Tab. 33: **Stage Sideview**

Parameter	Description
Display	Shows the topview of the stage.

Parameter	Description
+ button	Zooms into the image.
- button	Zooms out of the image.

Tab. 34: **Stage Topview**

Parameter	Description
STOP button	Stops the stage immediately. Alternatively, you can press the Break button on the dual joystick.
Undo button	Undoes the last stage movement.
Settings button	Opens the Stage Navigation Settings window.
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.

Tab. 35: **Bottom Right of the Stage Navigation Bar**

Reference Access: **Stage Navigation Bar > Settings**

Safety section

Parameter	Description
Z move on Vent checkbox	If activated, drives the stage to the lowest Z position when the specimen chamber is vented.
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.
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.

Navigation section

Parameter	Description
Go to \$NavCam on Vent checkbox	If activated, drives the stage to the \$NavCam position when the specimen chamber is vented. The \$NavCam position is the stage position where you can acquire an image with the stage navigation camera.

Reference Access: **Panel Configuration Bar** > GeminiSEM Control > **Stage** tab > **Image Nav**

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 live image of the microscope.
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.
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.

Parameter	Description
	It is recommended that you set the Safe Z value to the tallest specimen you have mounted.

10.77 Stage | Peltier Stage

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 stage is fitted and the Peltier Fitted checkbox in the SmartSEM Administrator panel is enabled.
Peltier Temp read-out	Indicates the current temperature. INFO: Only available if a Peltier stage is fitted and the Peltier Fitted checkbox in the SmartSEM Administrator panel is enabled.
Peltier Target scroll bar	Enables you to adjust to the required Peltier stage temperature.

10.78 Stage | Piezo Stage

License: PIEZO-INTEGRATION

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 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	Enable 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.
<< / >> 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.

Parameter	Description
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.

Tab. 36: Positioning

Reference 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 .
Piezo State readout	Indicates the current state of the piezo stage: <ul style="list-style-type: none"> ▪ Idle: Stage is standing still. ▪ Moving: Stage is moving. ▪ Uninitialised: Stage has not been initialized yet.

Tab. 37: Status Display

10.79 Stage | Registration

License: STAGEREG

The stage registration function enables you to define parameters for a user specific 2D coordinate system.

Operating Principle In the **Stage Registration** panel, you can define and register up to 9 alternative coordinate systems.

Reference Access: **Panel Configuration Bar > Stage Registration**

Parameter	Description
Stage List dropdown list	Enables you to select the points list you want to use. <ul style="list-style-type: none"> ▪ 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: <ul style="list-style-type: none"> ▪ No: No registration data and not registered. ▪ Yes: Registered. ▪ Invalid:

Parameter	Description
	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.

10.80 Stage | Sample Holder Gallery

The **Sample Holder Gallery** is used to inspect the dimensions of all possible specimen holders and to set the dimensions of custom specimen 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 specimen holders, set the dimensions in the details area.

Access: **Menu Bar > Stage > Navigation > Settings > Sample Holder Gallery**

10.81 Stage | Settings

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 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 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: <ul style="list-style-type: none"> ▪ 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: <ul style="list-style-type: none"> ▪ 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 Stage Height button: The software calculates and displays the Lens to Flat value (= Spacer Thickness + Stage At Z + Holder Height + WD).
Specimen Height Calibration section	In the Specimen Height Calibration section, the following items are available: <ul style="list-style-type: none"> ▪ Specimen Height input field: Enables you to enter the specimen height.

Parameter	Description
	<ul style="list-style-type: none"> ▪ Calibrate Specimen Height button: Sets the virtual maximum height for the stage movement if Safe Navigation is enabled.
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.

Tab. 38: Stage Nav settings

Info
For certain stage types spacer functionality is not available.

Reference 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.

Tab. 39: Stage limits

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.

10.82 Stage | Stage Navigation

Operating Principle The stage can be controlled in the following ways:

- **Stage Navigation Bar**

The stage can be moved along all axes and the settings for the stage movement can be defined.

- **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.

⚠ CAUTION

Moving the specimen stage

Fingers can be trapped by the moving specimen stage.

- ▶ Always close the chamber door before moving the specimen stage.
- ▶ To remove parts fallen into or near to the stage use a tool (e.g. tweezers) instead of your fingers.

Reference Access: **View > Toolbars > Stage Navigation Bar (for wide screen users)**

Alternative access: **Menu Bar > Stage > Navigation**

Parameter	Description
Display	Shows the sideview of the stage.
+ button	Zooms into the image.
- button	Zooms out of the image.
Flip view button	Flips the view of the stage along the vertical axis.
X, Y, Z, T, and R input fields	Enable you to enter a stage goto value. The stage moves to this value.
XY, Z, T, and R buttons	Enable you to enter a stage delta value. The stage moves by this value.

Tab. 40: **Stage Sideview**

Parameter	Description
Display	Shows the topview of the stage.
+ button	Zooms into the image.
- button	Zooms out of the image.

Tab. 41: **Stage Topview**

Parameter	Description
STOP button	Stops the stage immediately. Alternatively, you can press the Break button on the dual joystick.
Undo button	Undoes the last stage movement.

Parameter	Description
Settings button	Opens the Stage Navigation Settings window.
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.

Tab. 42: **Bottom Right of the Stage Navigation Bar**

Reference Access: **Panel Configuration Bar** > GeminiSEM Control > **Stage** tab

Parameter	Description
STOP button	Stops the stage immediately. Alternatively, you can press the Break button on the dual joystick.
Stage Is readout	Indicates the current state of the stage: <ul style="list-style-type: none"> ▪ Busy Stage is moving towards the new position. ▪ Idle Stage is not moving and ready to receive position commands.
Undo Stage Goto button	Moves the stage back to the position it had before the last stage movement.
Z move on Vent checkbox	If activated, drives the stage to the lowest Z position when the specimen chamber is vented.
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.
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.

Parameter	Description
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.
Compuc. Mode drop-down list	Enables you to select the compucentric mode.
Image Nav button	Opens the Stage Nav Settings panel, which enables you to set the dimensions of the stage and its components.
Further Options button	Opens a panel for adjusting further stage options.

Reference Access: GeminiSEM Control > **Stage** tab > **Further Options**

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.
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.

Parameter	Description
	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.

Tab. 43: Additional functions

Reference 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.
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.

Tab. 44: Soft joystick

10.83 Stage | Stage Navigation | Compucentric Functions

License: COMPU

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

⚠ CAUTION

Moving the specimen stage

Fingers can be trapped by the moving specimen stage.

- ▶ Always close the chamber door before moving the specimen stage.
- ▶ To remove parts fallen into or near to the stage use a tool (e.g. tweezers) instead of your fingers.

Reference Access: **Panel Configuration Bar > Calibrate Stage Centre**

Parameter	Description
Centre: Pos X read-out	Displays the last value for X.
Centre: Pos Y read-out	Displays the last value for Y. Assigns beam shift X and Y to the left mouse button.
Instructions read-out	Displays instructions for the operator.

Tab. 45: Stage center calibration

Reference Access: **Panel Configuration Bar > Compucentric Height**

Alternative access: **Panel Configuration Bar > GeminiSEM Control > Stage tab > Further Options > 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.

Tab. 46: Compucentric height calibration, 1) **Centre a feature then press Read 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.

Parameter	Description
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.

Tab. 47: Compucentric height calibration, 2) **Tilt the stage** 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 .
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.

Tab. 48: Compucentric height calibration, 3) **Centre it again, and press calculate** section

Reference Access: **Panel Configuration Bar** > GeminiSEM Control > **Stage** tab > **Compuc. Mode** dropdown list

Parameter	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.

Tab. 49: Compucentric mode

10.84 Stage | Stage Points List

The **Stage Points List** is a list of user-defined stage positions.

The **Stage Points List** enables you to store stage positions in a list and recall the points to position the stage.

Operating Principle In the **Stage Points List**, you can save the coordinates of several points to be used in one microscope session.

In addition to the default coordinate system, you can define up to 9 alternative coordinate systems to base your point definitions on.

If an airlock is installed, the pre-defined exchange position moves the specimen holder to the position required to exchange the specimen.

⚠ CAUTION

Moving the specimen stage

Fingers can be trapped by the moving specimen stage.

- ▶ Always close the chamber door before moving the specimen stage.
- ▶ To remove parts fallen into or near to the stage use a tool (e.g. tweezers) instead of your fingers.

Reference Access: **Menu Bar > Stage > Store/Recall**

Alternative access: **View > Toolbars > Stage Navigation Bar (for Widescreen users) > Points List**

Refer to *Stage | Image Navigation* [▶ 232].

Parameter	Description
Stage List drop-down list	<ul style="list-style-type: none"> ▪ Stage This is the default coordinate system. When you select a stage point to position the stage, the used coordinate system follows the standard stage coordinates. ▪ Reg 1 to Reg 9 Enables you to define up to 9 unique coordinate systems (Reg 1, Reg 2, etc). Once an alternative coordinate system is defined, you can select the system and add points to the Stage Points List using your own coordinate system instead of the standard stage coordinates. The user-defined coordinate systems have to be registered using the Stage Registration panel.
Stage List readout	Displays the stage point parameters.
Save/Load button	<p>Opens a drop-down list:</p> <ul style="list-style-type: none"> ▪ Load Enables you to load a point list that you have previously saved. ▪ Save As Enables you to save the currently displayed point list. ▪ Clear List Enables you to delete the points in the currently displayed list.
On Goto button	<p>Opens a drop-down list to change stage point parameter options:</p> <ul style="list-style-type: none"> ▪ Set Magnification

Parameter	Description
	Enables you to toggle between setting or not setting the magnification when using Goto for a selected point.
▪ Set Working Distance	
	Enables you to toggle between setting or not setting the working distance when using Goto for a selected point.
▪ Move XY Only	
	Enables you to toggle between adjusting only the X and Y axes or all axes when using Goto for a selected point.
Add button	Adds a point to the current stage list.
Del button	Deletes a selected point from the current stage list.
Edit button	Enables you to edit the parameter definitions of a selected point in the current stage list.
Undo Stage Goto button	Stops a Stage Goto function in progress, and returns the stage to the original position.
Stage stop button	Stops a Stage Goto function in progress, leaving the stage at the current position.
First button	Moves the stage to the position defined by the first entry in the Stage Points List .
Next button	Moves the stage to the position defined by the next entry in the Stage Points List .
Prev button	Moves the stage to the position defined by the previous entry in the Stage Points List .
Selected button	Moves the stage to the position defined by the highlighted entry in the Stage Points List .

10.85 Stage | Stage Scanning

License: STAGESCAN

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.

⚠ CAUTION

Moving the specimen stage

Fingers can be trapped by the moving specimen stage.

- ▶ Always close the chamber door before moving the specimen stage.
- ▶ To remove parts fallen into or near to the stage use a tool (e.g. tweezers) instead of your fingers.

Reference Access: **Menu Bar > Stage > Stage Scan**

Parameter	Description
	Jumps to the position of the first image field.
	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.

10.86 Stage | Variable Stage Bias

Stage biasing (beam deceleration) is a method that is used for decelerating the landing energy of the electron beam by applying a negative potential to a specimen. The lower landing energy of the primary electrons provides the possibility to obtain more specimen surface detail. Better image resolutions can also be obtained at high magnifications.

For more information, refer to the Instruction Manual ZEISS Tandem Decel.

Operating Principle The **Variable Stage Bias** panel enables you to set stage bias parameters.

Reference Access: **Panel Configuration Bar > Variable Stage Bias**

Alternative access: GeminiSEM Control > **Control tab > Tandem Decel** section

Parameter	Description
Tandem deceleration checkbox	If activated, the tandem deceleration function is enabled.
Stage bias mode drop-down list	Enables you to select the desired bias voltage for Tandem Decel in discrete steps of 1 kV, 2 kV, 3 kV, 5 kV.
Beam deceleration carousel checkbox	Activate this checkbox to confirm that you use a specimen holder that is prepared for deceleration.
Stage bias Low Volts scroll bar	Enables you to set the desired bias voltage for Tandem Decel between -20 V and 20 V.

10.87 Stage Survey

License: SURVEY

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**
 Alternative access: **Menu Bar > Stage > Survey > Settings**

Parameter	Description
Lowest Mag radio button	Automatically selects the lowest magnification for the current system conditions.
Mag ---> radio button and input field	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.
Get Current button	
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.
Remember Changes checkbox	If activated, saves working distance settings that may be changed while focusing.
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 .
Exit Survey Mode section	Enables you to select the macro you wish to execute when quitting Survey Mode . The following items are available: <ul style="list-style-type: none"> ▪ Macro checkbox If activated, executes a selected macro when Survey Mode mode is quitted. ▪ Macro drop-down list Enables you to select the macro you wish to use.

Tab. 50: Survey mode

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 .

Parameter	Description
Macro drop-down list	Enables you to select the macro you wish to use.

Tab. 51: Resolution imaging

10.88 System Status | CAN Communication

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.
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.

10.89 System Status | Control Panel Status

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 Shift 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**

10.90 System Status | Movable Chamber Components

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	<p>In the Charge Compensator (CC) section, the following items are available:</p> <ul style="list-style-type: none"> ▪ CC Status readout Displays the current state of the CC. ▪ Comp.->ON button Activates the CC. ▪ Comp.->OFF button Deactivates the CC. ▪ Comp. Fitted checkbox If activated, the CC is mounted. ▪ Comp. STOP button Stops any movement of the charge compensator immediately.
Back Scatter Detector (BSD) section	<p>In the Back Scatter Detector (BSD) section, the following items are available:</p> <ul style="list-style-type: none"> ▪ 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.
Scanning Transmission Electron Microscope (STEM) section	<p>In the Scanning Transmission Electron Microscope (STEM) section, the following items are available:</p> <ul style="list-style-type: none"> ▪ 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.
Gas Injection System (GIS) section	<p>In the Gas Injection System (GIS) section, the following items are available:</p> <ul style="list-style-type: none"> ▪ 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

Parameter	Description
	<p>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.</p> <ul style="list-style-type: none"> ▪ 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: <ul style="list-style-type: none"> ▪ 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.
Stage section	In the Stage section, the following items are available: <ul style="list-style-type: none"> ▪ 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 objective lens. ▪ Stage Interlock readout Displays the lock status of the stage. ▪ Stage stop button Stops stage movement.

10.91 System Status | SmartSEM Status

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.

10.92 System Status | Specimen Current Monitor

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.
Stage Bias checkbox	If activated, a small negative bias voltage is applied to the specimen stage.
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.

10.93 System Status | Water Flow and Temperature

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 enables 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 Too Hot readout	Indicates the EO board temperature status.
Water OK readout	Indicates the water flow status.
EO Temp readout	Indicates the current EO board temperature.
EO Temp Limit readout	Indicates the EO board temperature limit. If the temperature of the EO board rises above this value, the EO board starts to overheat.
SEM Overheat readout	Indicates general overheating.

10.94 Toolbar Configuration

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.
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 .

Parameter	Description
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.

10.95 Vacuum

A good vacuum is essential for a high performance of the microscope. The specimen chamber and the gun head have to be evacuated.

Operating Principle

The **Vacuum** tab enables you to set and monitor vacuum parameters.

WARNING

Suffocation hazard due to lack of oxygen

Gaseous dry nitrogen is used to vent the specimen chamber during specimen exchange. Inhal- ing 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.

Reference Access: **Panel Configuration Bar** > GeminiSEM Control > **Vacuum** tab

Parameter	Description
Vac Status readout	Displays the current vacuum status: <ul style="list-style-type: none"> ▪ 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.

Parameter	Description
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 Aperature 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	Vents 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 vented partially when the microscope is switched to STANDBY mode. Activate the checkbox if the vacuum is OK and the microscope 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.

10.96 Vacuum | Variable Pressure

Variable Pressure (VP) mode offers the possibility of analyzing and mapping non-conductive, strongly gassing, or moist specimens without any need for specimen preparation.

Info

Only available, if the microscope is equipped with the variable pressure option.

Operating Principle The Controlling VP panel enables you to set variable pressure parameters.

Reference Access: **Panel Configuration Bar > Controlling VP**

Parameter	Description
Chamber readout	Displays the chamber pressure (in Pascals) when operating in Variable Pressure mode.
VP Target scrollbar	Allows to set the target chamber pressure when operating in Variable Pressure mode. The target pressure is displayed in Pascals.
Go To HV button	Switches to High Vacuum mode.
Go To VP button	Switches to Variable Pressure mode.
Go To XVP mode button	Switches to XVP mode.
Go To Nano VP mode button	Switches to Nano VP mode.

Parameter	Description
Collector Bias scrollbar	Sets the collector bias of the VPSE detector.
Beam sleeve Bias scrollbar	Sets the beamsleeve bias.
Reference	Access: Panel Configuration Bar > GeminiSEM Control > Control tab > Variable Pressure section
Parameter	Description
HV/VP/Nano VP/XVP buttons	Enable you to switch to the respective mode: High Vacuum (HV) mode, Variable Pressure (VP) mode, Nano VP mode, Extended VP (XVP) mode.
VP Target scrollbar	Allows to set the target chamber pressure when operating in Variable Pressure mode. The target pressure is displayed in Pascals.

10.97 Volutome

The Volutome stage is an optional stage designed to acquire three-dimensional images of specimens embedded in resin.

Reference Access: **SmartSEM Administrator** > **Column/Stage** tab.

Parameter	Description
Volutome Stage fitted	Enables you to define whether the Volutome stage is fitted. If the checkbox is activated, the SEM stage functionality is hidden in the Stage tab of the GeminiSEM Control panel.
Volutome Stage Visible	If the checkbox is activated, the Volutome Stage Fitted checkbox is displayed in the Stage tab of the GeminiSEM Control panel. This facilitates swapping the SEM stage and the Volutome stage, because you do not need to switch to the SmartSEM Administrator.

Reference Access: GeminiSEM Control panel > **Stage** tab

Parameter	Description
Volutome Stage fitted	Enables you to define whether the Volutome stage is fitted. If the checkbox is activated, the SEM stage functionality is hidden in the Stage tab of the GeminiSEM Control panel. The Volutome Stage fitted checkbox is only visible, if the Volutome Stage Visible checkbox is activated in the SmartSEM administrator.

11 Troubleshooting

The following table provides information about solving common problems.

Info		
If you cannot solve the problem or if you are unsure about a certain technical difficulty, contact your local ZEISS service representative.		
Symptom	Cause	Measure
Drift: Specimen seems to be moving.	<ul style="list-style-type: none"> ▪ Charging effects. ▪ Nonconductive specimen. 	<ul style="list-style-type: none"> ▪ Ensure proper conduction of the specimen. ▪ Optimize specimen preparation. ▪ Apply a charge compensation method.
	Stub not correctly fixed by screw.	Fix the stub correctly.
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 <i>Baking out the Gun Head</i> [▶ 267].
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 the working distance to a maximum of 7 mm.
Image shifts when you change the stigmator	Astigmatism.	Refer to <i>Calibrating the Stigmator</i> [▶ 268].
Focused live image appears to be blurred in one direction		
InLens image is noisy.	Working distance is too long.	Reduce the working distance.
No InLens image can be obtained.	EHT exceeds 20 kV.	Reduce the EHT to a maximum of 20 kV.
Low Mag mode does not work for GeminiSEM 560 with NanoVP.	The diameter of the beamsleeve aperture is not set correctly.	Set the correct aperture diameter in the Beamsleeve Configuration wizard. Refer to <i>Mounting a Beamsleeve Aperture for Nano VP or XVP Operation</i> [▶ 124].

Symptom	Cause	Measure
Microscope is dead.	Circuit breaker is tripped (lower position).	Refer to <i>Checking the Position of the Circuit Breakers</i> [▶ 269].
Stored position of the specimen stage cannot be approached correctly.	PC has crashed. Stage needs to be driven to a well-defined position.	Restart the PC. Refer to <i>Initializing the Stage</i> [▶ 263].
SE image is noisy.	Scintillator is used up.	Contact your local ZEISS service representative to have the scintillator replaced.
Specimen current is low.	Field emission gun is used up. Working distance is too short.	Contact your local ZEISS service representative to have the field emission gun replaced. Enlarge the working distance to about 5 mm or more.
Stage does not move.	Stage needs to be initialized.	Refer to <i>Initializing the Stage</i> [▶ 263].
Stored position of the specimen stage cannot be approached correctly.	Stage needs to be driven to a well-defined position.	Refer to <i>Initializing the Stage</i> [▶ 263].
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 <i>Replacing the Chamber Door Seal</i> [▶ 265].
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.
Microscope does not vent.	No nitrogen. No compressed air.	Check nitrogen supply. Check compressed air supply.
Vac ready = OK is displayed abnormally fast.	Penning gauge has not been identified correctly.	Restart the microscope. If this does not solve the problem, contact your local ZEISS service representative.
Gun vacuum is worse than 8 to 9×10^{-9} mbar.	The pumping capacity of the ion getter pump decreases in the course of time, thus deteriorating the gun vacuum.	Refer to <i>Baking out the Gun Head</i> [▶ 267].

Tab. 52: Troubleshooting

Sense BSD Detector	Symptom	Cause	Measure
	Image contrast looks wrong	Normal or inverted segment mode are swapped	Change segment mode
	Image is smeared out	Scanspeed too high	Use Scanspeed 4 or higher (slower)
	No image	Loose cable Detector is retracted	Connect and secure cable Insert detector
		Segment is off	Switch segment to on or inverted
	White or black image	Contrast or brightness wrong	Change contrast and brightness
	Detector cannot be moved	No pressured air	Connect pressured air tubes Check pressured air supply
	Detector move buttons are greyed out	Insertion rules	Check if stage is initialized Check if another detector is inserted Check GIS position
	Diagonal stripes in image	Grounding crosstalk	Connect grounding cable Check if detector cable from diode to amplifier has contact to any other cable like EHT cable
	Horizontal stripes in image	Diode leakage current too high	Contact your local ZEISS service representative
	Detector too slow or noisy compared to normal operation	Reverse bias off or bias supply malfunction	Contact your local ZEISS service representative
	Image shows topography	Malfunction of a single quadrant	Contact your local ZEISS service representative

Tab. 53: Troubleshooting

11.1 Overall System

11.1.1 Checking the CAN Communication

Checking the CAN Communication is useful if the microscope 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 microscope.
INFO: If the problem persists, contact your ZEISS service representative.

11.2 Chamber

11.2.1 Initializing the Stage

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.

⚠ CAUTION

Moving the specimen stage

Fingers can be trapped by the moving specimen stage.

- ▶ Always close the chamber door before moving the specimen stage.
- ▶ To remove parts fallen into or near to the stage use a tool (e.g. tweezers) instead of your fingers.

Prerequisite

- ✓ The specimen chamber has been evacuated, refer to *Loading the Specimen Chamber* [▶ 32].
- ✓ Requires the **Stage Initialise** privilege.
- ✓ If there are any large specimens inside the chamber, remove them before initializing.

Procedure

1. From the **Menu Bar**, select **Stage > Stage Initialise**.
→ The **Initialise Stage** window is displayed.
2. Confirm via **Yes**.
→ The stage initialization process takes a few minutes.
→ **INFO:** If initialization of the stage does not solve the stage problem, contact your local ZEISS service representative.

11.2.2 Defining the Post Initialization Position of the Stage

You can configure the position to which the stage drives after the initialization procedure. Otherwise, the stage drives to the center position.

⚠ CAUTION

Moving the specimen stage

Fingers can be trapped by the moving specimen stage.

- ▶ Always close the chamber door before moving the specimen stage.
- ▶ To remove parts fallen into or near to the stage use a tool (e.g. tweezers) instead of your fingers.

Prerequisite ✓ Requires the **Supervisor** privilege.

- Procedure**
1. From the Windows start menu, select **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.

11.2.3 Changing the Joystick TV Angle

In TV mode (chamberscope), the dual joystick and stage may appear to move in 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.

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.

⚠ CAUTION

Moving the specimen stage

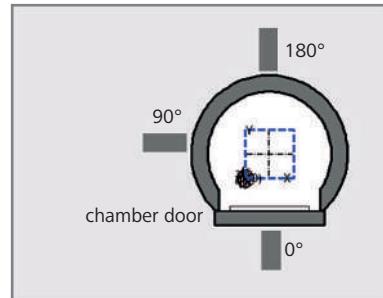
Fingers can be trapped by the moving specimen stage.

- ▶ Always close the chamber door before moving the specimen stage.
- ▶ To remove parts fallen into or near to the stage use a tool (e.g. tweezers) instead of your fingers.

Prerequisite ✓ Requires the **Supervisor** privilege.

- Procedure**
1. From the Windows start menu, select **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 Options** section, double-click the **Joystick TV Angle** input field.
 6. Enter an angle depending on the installation location of the CCD camera.
If the CCD camera is installed at the back, enter 180° .
If the CCD camera is installed at the front, enter 0° .
If the CCD camera is installed at the side, enter 90° .



11.2.4 Resetting the Touch Alarm

To prevent damage, a touch alarm is integrated in the microscope. 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.

Prerequisite ✓ 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.

11.2.5 Checking the Water Flow and Temperature

- Procedure**
1. In the **Panel Configuration Bar**, double-click **Water Flow/Temperature**.
→ The **Water Flow/Temperature** panel is displayed.
 2. Check the entries.
→ If a value is critical, it is displayed in red.

11.2.6 Replacing the Chamber Door Seal

Possible reasons for replacing the chamber door seal are the following:

- Chamber door does not close tightly
- Bad chamber vacuum

This procedure consists of the following steps:

1. *Venting the Specimen Chamber* [▶ 33]
2. *Replacing the O-ring* [▶ 266]
3. *Evacuating the Specimen Chamber* [▶ 34]

11.2.6.1 Replacing the O-ring

⚠️ WARNING

Suffocation hazard due to lack of oxygen

Gaseous dry nitrogen is used to vent the specimen chamber during specimen exchange. Inhal-
ing 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 insta-
bility, fatigue) leave the room immediately and inform the facility's safety officer.

⚠️ CAUTION

Moving the specimen stage

Fingers can be trapped by the moving specimen stage.

- ▶ Always close the chamber door before moving the specimen stage.
- ▶ To remove parts fallen into or near to the stage use a tool (e.g. tweezers) instead of your
fingers.

⚠️ CAUTION

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

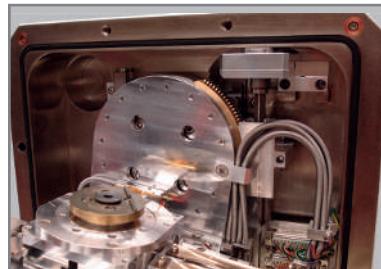
Contamination caused by fingerprints

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. Carefully open the chamber door.



2. On the inside of the chamber door, remove the chamber door O-ring.

NOTICE If you use a metal tool to remove the O-ring, then you may damage the sealing surface. If necessary, then only use a plastic or wooden tool to remove the O-ring.

3. Inspect the groove that holds the O-ring and remove any contamination.
4. Insert the new chamber door O-ring.
5. Close the chamber door.

11.3 Column

11.3.1 Baking out the Gun Head

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.

This procedure consists of the following steps:

1. *Switching off the Gun* [▶ 44]
2. *Starting the Bakeout* [▶ 267]
3. *Switching on the Gun* [▶ 36]

11.3.1.1 Starting the Bakeout

Info

You cannot work with the microscope while the bakeout procedure runs.

NOTICE

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 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.

- Prerequisite**
- ✓ Requires the **Supervisor** privilege and the user level **Service**.
 - ✓ Only advanced operators are allowed to perform the bakeout procedure.
- Procedure**
1. In the **Panel Configuration Bar**, double-click **Bakeout**.
→ The **Bakeout** dialog is displayed.
 2. 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.
 3. 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**.
 4. To start the bakeout procedure, click **Bakeout Start**.

11.3.2 Calibrating the Probe Current

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  Faraday cup (348342-8055-000)

Prerequisite ✓ The microscope has a Gemini 2 column.

- Procedure**
1. Load the Faraday cup into the specimen chamber. Refer to *Loading the Specimen Chamber* [ 32].
 2. Pump the specimen chamber.
 3. Switch on the electron beam. Refer to *Switching on the EHT* [ 36].
 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.

11.3.3 Calibrating OptiProbe

After cathode replacement or after re-alignment of the electron optic column, OptiProbe has to be calibrated. A calibration wizard facilitates the calibration procedure.

Parts and Tools  Faraday cup (348342-8055-000)

- Procedure**
1. Load the Faraday cup into the specimen chamber.
 2. Set WD = 5 mm and select spot mode.
 3. Focus the spot into the orifice of the Faraday cup.
 4. From the Windows start menu, select **SmartSEM > OptiProbe Calibration**.
→ The **OptiProbeCal** dialog is displayed.
 5. Click **OK**.
→ The **OptiProbeCal** window is displayed.
 6. To start the calibration, click **Start**.
→ The **User Action** window is displayed.
 7. Click **OK**.
→ An automatic calibration routine is performed, which takes about fifteen minutes.
→ When the calibration procedure is finished, a message is displayed.
 8. To finish the dialog, click **Yes**.
→ Now OptiProbe is ready to be used.

11.3.4 Calibrating the Stigmator

If the image shifts when you change the stigmator, then you need to set the stigmator balance. The calibration needs to be done for only one single probe current, e.g. 30kV:10pA.

The SEM stigmator calibration is an alignment process that enables you to remove effects caused by astigmatism. Astigmatism causes a circular beam to become elliptical. As a result, the focused live image appears to be blurred in one direction (line focus).

- Procedure**
1. From the **Panel Configuration Bar**, select **SEM Stig Calibration**.
→ The **SEM Stig Calibration** panel is displayed.
 2. In the **Wobble** section, select **Stig X** or **Stig Y**.
INFO: If the image appears to be blurred in X direction, then select **Stig X**.

3. Set the stigmator balance period via the **Stig Bal Period** scroll bar.
INFO: A good starting value is 1000. For higher scan speeds (slower), increase the value. For lower scan speeds (faster), reduce the value.
4. Set the stigmator balance amplitude via the **Stig Bal Amplitude** scroll bar.
INFO: A good starting value is 100 %. For bigger magnifications, decrease the value.
5. Adjust the stigmator via the **Stig Centre** navigation box.
6. If the focused live image is still blurred in one direction or the image still shifts when you change the stigmator, then repeat the procedure.

11.4 Power Circuit

11.4.1 Checking the Position of the Circuit Breakers

NOTICE

Persisting electrical problems

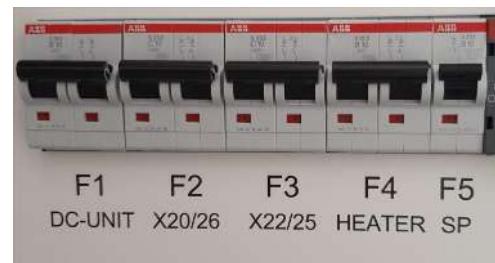
Tripped circuit breakers may be a hint for an electrical problem in the microscope.

- ▶ 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	RED (X20) & Green (X26) accessories PC, WDX, EDX, AUX 3–4
F3	10 A	Pre-Vacuum pump (X25) & Yellow (X22) accessories Aux 1-2 + 2 Spare labeled FIB, GIS (Crossbeam relevant only)
F4	10 A	Internal heaters
F5	10 A	Circuit surge protection off

Procedure

1. Check if one of the circuit breakers on the rear side of the plinth is tripped.



2. If one of the circuit breakers is tripped, push it upwards.

11.5 Detectors

11.5.1 Lubricating the Rod

The rod from the aSTEM and BSD detector mechanics and from the charge compensator mechanics need to be lubricated once a year with TEM oil 300.

- Parts and Tools**
- ☛ TEM Oil 300 (000000-0484-955)
 - ☛ Isopropanol (IPA, isopropyl alcohol)
 - ☛ Lint-free cloth
 - ☛ Lint-free gloves

CAUTION

Contact with TEM oil 300

TEM Oil 300 may be irritating to the skin and mucous membranes. The separate safety data sheet contains additional information.

- ▶ 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

Isopropanol

Isopropanol is highly flammable and irritating to the eyes.

Vapors 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

Unsuitable lubricants

When using unsuitable lubricants, the vacuum system may be contaminated.

- ▶ Only use TEM oil 300 for lubricating.

- 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.

11.6 Apertures

11.6.1 Cleaning the Beamsleeve Apertures

Info

Some particles maybe visible in the SEM image on the beamsleeve aperture, especially at the tip of the aperture. As long as these particles are not heavily charging, this will not influence your image quality or Nano VP / XVP performance.

This procedure consists of the following steps:

1. *Removing the Beamsleeve Aperture* [▶ 271]
2. *Cleaning and Re-inserting the Beamsleeve Aperture* [▶ 271]

11.6.1.1 Removing the Beamsleeve Aperture

- Procedure**
1. From the **Menu Bar**, select **Tools > GoTo Panel**.
→ The **Panel Configuration Bar** is displayed showing an alphabetical list of functions.
 2. Double-click **Beamsleeve Configuration**.
→ The **Beamsleeve Configuration** wizard is displayed.
 3. Follow the instructions of the **Beamsleeve Configuration** wizard.
 4. Carefully take out the beamsleeve aperture with the plastic tweezers from the top side.
NOTICE If you have a BSD diode installed: Do not touch the diode surface from bottom side, this will damage the diode.

11.6.1.2 Cleaning and Re-inserting the Beamsleeve Aperture

⚠ CAUTION

Isopropanol

Isopropanol is highly flammable and irritating to the eyes.

Vapors 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.

- Procedure**
1. Remove the O-ring.
 2. Put the beamsleeve aperture in a beaker glass filled with isopropanol (IPA).
 3. Put this in an ultrasonic bath at room temperature for 5 min.
 4. Carefully dry and remove remaining dust particles from the beamsleeve aperture with a pair of bellows or compressed air, but only at low pressures.

NOTICE Do not use high pressure compressed air, this can damage the hole in the beamsleeve. Only use moderate pressures below 1 bar and a distance of 5 cm.

NOTICE Do not touch the tip of the beamsleeve as it is very thin and sensitive to mechanical strain. Do not try to clean the beamsleeve aperture mechanically with the help of tools, tissues etc.

5. Put the O-ring back again onto the beamsleeve aperture.
→ It is now ready for operation.
6. Re-Insert the cleaned beamsleeve aperture.

11.7 PC

11.7.1 Maintaining the PC

It is important to periodically clean up the PC. This shortens the boot sequence and loading times. If necessary, refer to standard Windows manuals for instructions to do this.

Procedure

1. Backup the database to the server or to other storage.
2. Delete the temporary files.
3. Check for adequate free space on the hard drives.
4. Backup the log file (**EMServer.log**).
5. Erase the original log files in the **LOG** folders.
6. Check that Windows updates are applied and that service packs are applied.
INFO: Each service pack includes all the patches since the last major release.

Glossary

aBSD

An Annular Backscattered Electron Detector (aBSD) is a pneumatically retractable annular detector used to detect backscattered electrons that have been scattered under very low angles.

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.

AIC

Ampere Interrupting Capacity

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.

Aperture

Mechanical limitation of an opening oriented perpendicular to the optical axis, which filters out electrons whose trajectories (tracks) do not run close to the optical axis.

AsB

Angle-selective Backscattered

aSTEM

Annular Scanning Transmission Electron Microscopy

Astigmatism

Lens aberration that distorts the shape of the electron beam, compensated by the stigmator.

Backscattered electrons

High-energy electrons that are liberated from the specimen surface when the specimen is hit by the primary electron beam.

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) 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.

Beam booster

Anode and liner tube of the Gemini column are connected mechanically and electrically forming the beam booster. A booster voltage (U_B , liner voltage) of +8 kV is applied to the beam booster, so that a high beam energy is maintained throughout the entire column. The beam booster technique has two main advantages: It minimizes beam widening, that may occur due to stochastic electron-electron interactions. Consequently there is almost no loss in beam brightness, even at low acceleration voltages. Secondly, the beam booster technique enhances protection against external stray fields.

BGPL

Beam Gas Path Length

BSD

Backscattered Electron Detector

BSE

Backscattered Electron

C2D

Cascade Current Detector

C2DX

Extended Cascade Current Detector

CAN (Controller Area Network)

An ISO specification that defines a generic physical layer and data link medium access procedure based on non-destructive bit-wise arbitration.

CC

Charge Compensator, Charge Compensation

CCD

Charge-Coupled Device

CL

Cathodoluminescence

Condenser

Device that collects and focuses the electron beam onto the specimen.

Crosshairs

A graphical object for assessing the relative position of objects in the image.

D

Depth

Depth of field

Distance along the optical axis which an object in the specimen can be moved while remaining in focus.

Dongle

A device that is needed in order to use protected software.

DPA

Differential Pumping Aperture

EBIC

Electron Beam Induced Current

EBSD

Electron Backscatter Diffraction

EC

European Community

EDS

Energy Dispersive X-ray Spectroscopy

EDX

Energy Dispersive X-ray Spectroscopy

EHT

Extra High Tension

EIGA

European Industrial Gases Association

EM

Electron Microscope

EM server

A server that implements the internal communication between control software and microscope hardware.

EMC (electromagnetic compatibility)

Ability of equipment to function satisfactorily in its electromagnetic environment without introducing intolerable electromagnetic disturbances to other equipment in that environment.

EMO

Emergency Off

EO

Electron Optics

EP

Extended Pressure

EPD

End Point Detection

EsB

Energy-selective Backscattered

Eucentric

Type of stage, the rotation axes of which intersect in the same point. The specimen surface is located in the eucentric point, where the tilt axis meets the beam axis. This guarantees that the focus is maintained when the specimen is tilted at a certain working distance.

Extractor

Positive electrode that attracts electrons from the filament.

Faraday cup

Small insulated metal container, equipped with an aperture where electrons can enter but not escape. Used to measure the specimen current in the microscope.

FESEM

Field Emission Scanning Electron Microscope

FIB

Focused Ion Beam

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.

FTP

File Transfer Protocol

GIS

Gas Injection System

Graticules

A grid displayed over the image.

GUI (graphical user interface)

A display format that represents a program's functions with graphic images such as buttons and icons.

H

Height

HD

High Definition, an imaging component's or technique's attribute of yielding an increased amount of information per area compared to concurrent components or techniques

HV

High Vacuum

IGC

Industrial Gases Council

IGP

Ion Getter Pump

Ingredient list

A list that defines the contents of a recipe, i.e. the combination of saved parameters.

LaB₆

Lanthanum hexaboride

Look-up table

Look Up Table which can be used to improve the image illumination.

LUT

Look-up table

M

M-axis

Magnification table

Function of SmartSEM that allows you to enter fixed magnifications for quick access during the imaging procedure.

MDBS

Main Dichroic Beam Splitter

Mini bar

Part of the SmartSEM user interface which allows quick access to recently used dialogs and to the recipe management.

MSDS

Material Safety Data Sheet

OptiProbe

Optional function which allows you to continuously adjust the probe current.

PC (Personal Computer)

General-purpose computer equipped with a microprocessor and designed to run especially commercial software (such as a word processor or Internet browser) for an individual user.

PE

Protective Earth (ground)

PE

Primary Electron

Penning gauge

Device for measuring high vacuum in the vacuum system.

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.

Pre-vacuum pump

A pump for generating a pre-vacuum.

Primary electron beam

Narrowly bundled beam of accelerated electrons that hit the specimen surface.

R

R-axis (Rotation)

Recipe

Function of SmartSEM that allows you to save a set of SEM parameters which are ideal for a certain type of specimen.

Scanning mode

The scanning mode determines the fill pattern during the exposure process.

SCD

Specimen Current Detector

Schottky field emitter

Type of electron source in which emission occurs at or near the work function barrier.

Scintillator

Substance that absorbs electrons and in response, fluoresces photons while releasing the previously absorbed energy.

SE

Secondary Electron

Secondary electrons

Low-energy electrons that are emitted from the specimen surface when the specimen is hit by the primary electron beam. Secondary electrons are generated by inelastic scattering.

SEM

Scanning Electron Microscope

SESI

Secondary Electron Secondary Ion

SIMS

Secondary Ion Mass Spectrometry

SMT

Semiconductor Manufacturing Technologies

Splash screen

Animated start screen of SmartSEM.

STEM

Scanning Transmission Electron Microscope

Stigmator

Compensates astigmatism (lens aberration), so that the electron beam becomes rotationally symmetrical.

Suppressor

Electrode (anode) that suppresses unwanted thermionic emission from the shank of the Schottky field emitter.

T

T-axis (Tilt)

TEM

Transmission Electron Microscope. Microscope that examines structure by passing electrons through the specimen. The image is formed as a shadow of the specimen on a phosphorescent screen.

U

Voltage

UIF

User Interface

User

Person examining a sample under the microscope.

User preferences

Section that allows you to define user-specific pre-setting of the SmartSEM user interface e.g. language or pressure units.

VP

Variable Pressure

VPSE

Variable Pressure Secondary Electron

W

Width

W (Tungsten)

Gray-white heavy high-melting ductile hard polyvalent metallic element that is used especially in carbide materials and electrical components (such as lamp filaments) and in hardening alloys (such as steel).

WD

Working Distance. The distance from the bottom of the objective lens to the specimen when focused, as calculated by the software.

WDS

Wavelength Dispersive X-ray Spectroscopy. A method used to count the number of X-rays of a specific wavelength diffracted by a crystal.

wdx

Wavelength Dispersive X-ray Spectroscopy

WEEE

Waste Electrical and Electronic Equipment

X

X-axis

X-ray

Ionizing electromagnetic radiation of quantum energies above 100 eV corresponding to wavelengths below 10 nm. X-rays are generated during the operation of electron microscopes.

XVP

Extended Variable Pressure

Y

Y-axis

YAG

Yttrium Aluminum Garnet

Z

Z-axis

ZEISS

ZEISS is an internationally leading technology enterprise operating in the fields of optics and optoelectronics. Further information about ZEISS can be found at www.zeiss.com.

ZEISS Sales & Service Partner

The Sales & Service Partner is generally in the field for customer support in a regional area and / or a clearly defined customer group.

ZEISS service representative

Specially trained service expert, either ZEISS staff or authorized service partner of ZEISS.

Zone

Part of the image area when displaying different detector signals or image areas.

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