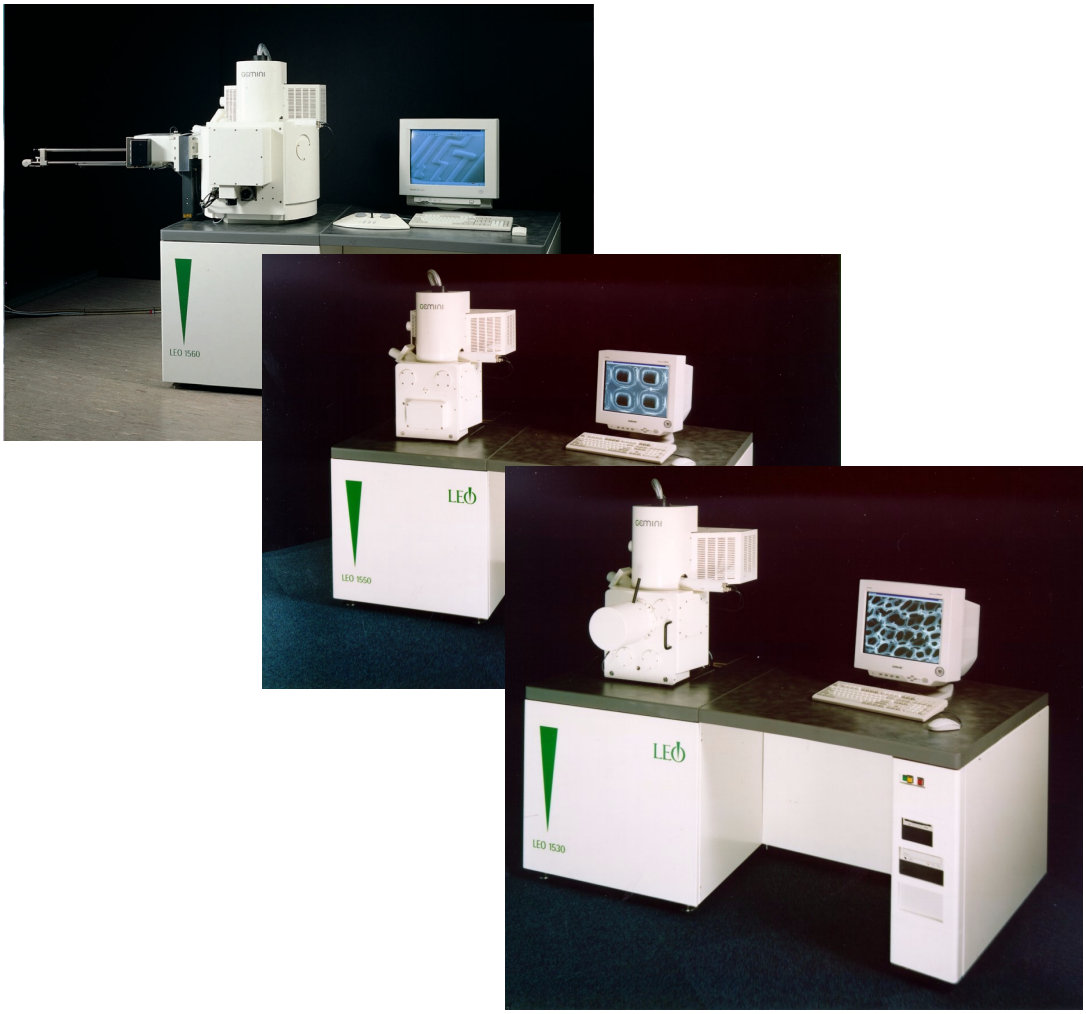
Software Control LEO 15XX
Manual

(LEO 32 V 02.03)



LEO

The power to resolve

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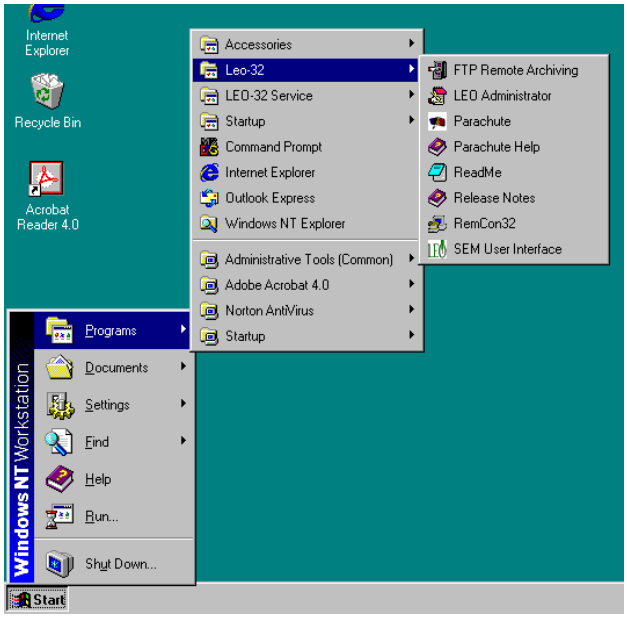
1 Introduction

The scanning electron microscope LEO 15XX is a fully computer controlled instrument. All operations, settings and functions necessary for the handling of the microscope are controlled by use of a keyboard and a mouse. Using fiber-optic cables, entered commands are transmitted to the electronic system.
Control of the stage is by a dual joystick providing control of all motorized axes of the stage. Optionally, a hard panel provides control of the stage. (see 9.1). Additionally the hard panel provides the advantage that setting and adjustment of important parameters such as magnification and focus, stigmator or beam alignment is possible using two potentiometers (encoders).
The LEO 32 Software is a special communication and control program running under the Windows® 98 or Windows® NT (2000) operating systems and following the normal rules for Windows® applications.
The different functions, parameters or windows can be opened or activated using a Pop-Up Menu (see 3) or using a toolbar (see 4.2).
Starting the software is by a double-click with the left mouse button on the  icon in the Windows® user interface or by clicking, ***START→ PROGRAMS→ LEO- 32 → SEM USER INTERFACE***.

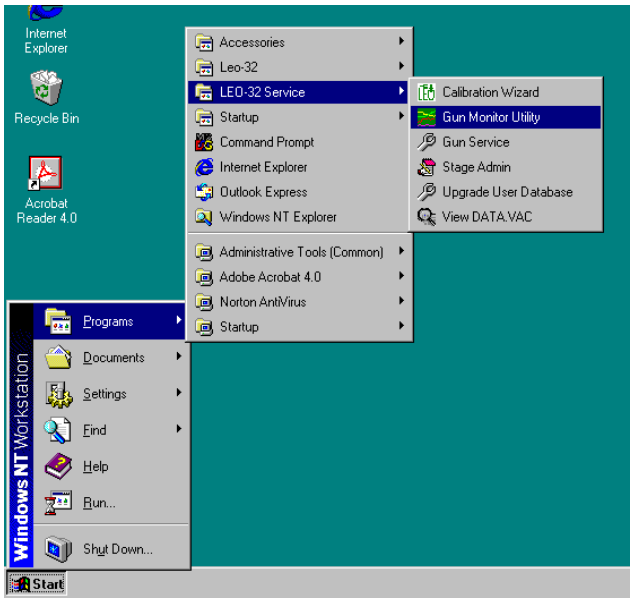


After starting the LEO software, the LEO server, realizing the internal communication between software and hardware, will load the different drivers. Each specific user logs on with his user name and the password established by the administrator. If the user name and the password are entered correctly, the LEO 32 user interface will start with the corresponding user specific configurations.
The server will remain active even after closing the user interface. The communication between hardware and software will only end after finishing Windows® or after closing manually.

If you want to install new user software on the computer you should inform your service engineer. Make sure that the LEO server of the LEO-32 software is closed before installing further software components (e.g. Word, Excel, Power Point etc.). Before starting a new installation routine, it is

recommended to restart Windows® .
Do not forget that the LEO 15XX has been developed as a scanning electron microscope. The integrated personal computer should mainly be used for the installation of control software and for the storage of images. The installation of other software components may cause problems in individual cases.

Apart from the LEO user interface, other programs can be started using the Windows® paths ***START→ PROGRAMS→ LEO-32*** or ***START→ PROGRAMS→ LEO-32 Service.*** Some of these programs are only available to LEO Service, e.g. calibration of the instruments or to set or control special parameters. Other programs are available to the specific user and can be considered as help programs for special applications of the scanning electron microscope. The different programs are explained as follows:



LEO- 32→ FTP Remote Archiving (optional software)
Program to send saved SEM images to another computer or printer using a network.

LEO- 32→ LEO Administrator
Starts the LEO Administrator. By means of this administrator, it is possible to install or edit new user directories (for further information see 2).

LEO- 32→ Read Me
Shows the Read Me file which contains important details on the current LEO software.

LEO- 32→ Release Notes
Gives an overview on all LEO software versions with their new developments and special details.

LEO- 32→ RemCon32
Special program to support communication using the serial interface (for more information see 9.4).

LEO- 32→ SEM User Interface
Starts the LEO user interface.

LEO- 32 Service→ Calibration Wizard
Program for the calibration of the scanning electron microscope. This program is only available to LEO service personnel.

LEO- 32 Service→ Convert DATA.VAC
Conversion of the file “data.vac” to a more recent version, necessary for the upgrade from the 16-Bit version to the 32-Bit software version.

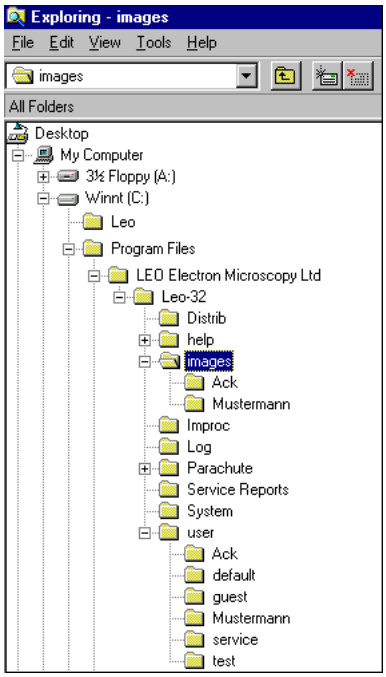
LEO- 32 Service→ Gun Monitor Utility
This program monitors parameters of the scanning electron microscope Gun in the form of a diagram (for more detailed information see 9.3).

LEO- 32 Service→ Gun Service
Program for setting and adjusting of the filament, only available to LEO Service personnel.

LEO- 32 Service→ Stage Admin
Program for setting and adjusting the motorized stage, only available to LEO Service personnel.

LEO- 32 Service→ Upgrade User Database
Program to adjust an old user data file to a new LEO-32 software version.

LEO- 32 Service→ View DATA.VAC
Shows the contents of the file "data.vac". All calibration and configuration data of the SEM are stored in this file.



You will find the complete LEO software in two main folders on the hard disk. These folders are C:\LEO and C:\Program Files\LEO (LEO Electron Microscopy Ltd). The folder C:\LEO contains mainly calibration and initialization files for the LEO software. One of the most important files in this directory is the file **data.vac** as it contains all calibration data of the scanning electron microscope. It is recommended to back up the contents of this file to the hard drive or to a disk to protect the stored data. The directory C:\Program Files\LEO (LEO Electron Microscopy Ltd) contains the complete program. The subdirectories **\user** contain the different user directories that the administrator can help to set up and edit (see 2.1.). These directories contain all user specific data and configurations.. The directory **\images** contain image files for the specific users to store the images.

To ensure safe running of the control software, **no modifications** should be made to directories and files of the LEO software with the exception of the files and subdirectories in **C:\Program Files\Leo\Leo32\images** and **C:\Program Files\Leo\Leo32\user** where user specific and temporary modifications may occur. Always make a back up to protect the stored data before deleting files or directories.

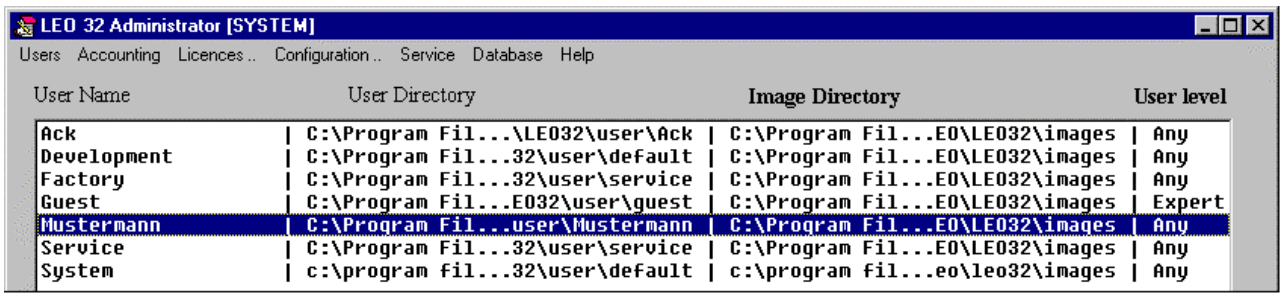
2 The Administrator

The Administrator provides for establishing different user directories, editing existing folders and user configurations. A user directory contains frequently modified configuration parameters of the LEO-32 user interface and system software files for specific users. Each specific user has his own directory for configuration parameters, toolbar, menus, data zones, operation modes, etc. Each user interface will thus load with the user specific configuration settings.

2.1 Setting the User Directories

After the installation, the user directories should be set up by the person responsible for the system or the service engineer. The Administrator is opened using the Windows® Overlay as follows:
START→ PROGRAM→ LEO 32→ LEO ADMINISTRATOR.
Once the program begins loading, you will be prompted to enter a name and a password. Log on is possible with the user name SERVICE and the current service password or with the user name SYSTEM. Click on OK to confirm.

After the first set-up, a password only known to the Administrator should be established for SYSTEM. This password can be reestablished in case it is forgotten.



The Administrator panel is now visible, and the user lists are displayed.

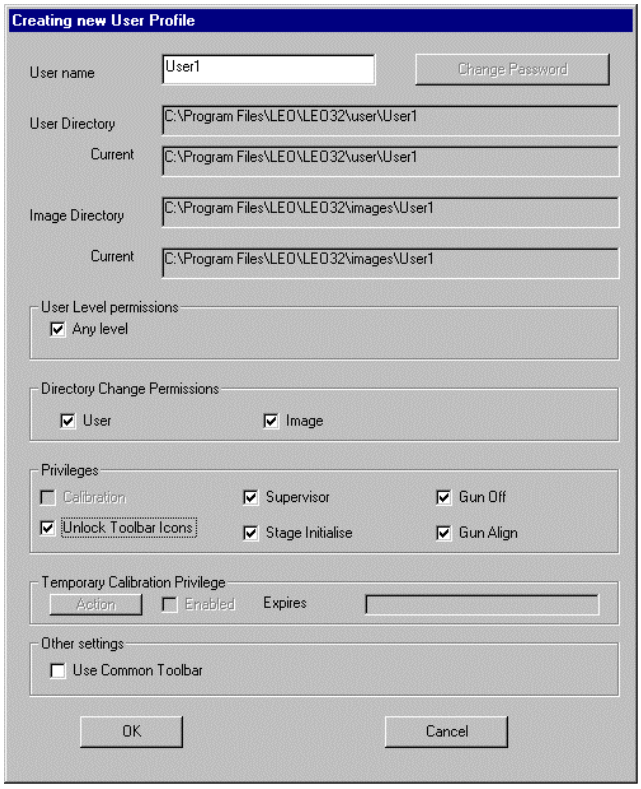
Creating a New User:

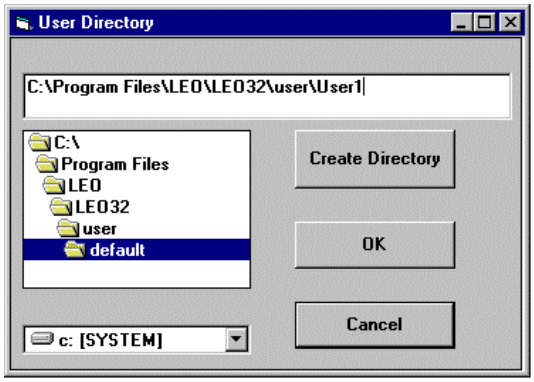
⇒ Pop-Up Menu ***USERS→ NEW***: displays a window that allows the creation of new user directories and modification of existing user directories.
⇒ Enter a user name in ***User Name*** (it is recommended to use short forms)
⇒ To create a user directory, click on the gray box behind ***User Directory***. Now select a specific directory, or create a new directory. All user specific configurations, e.g. toolbar, data zone, stage coordinates etc. will be saved and loaded into this directory. To create a directory " User1", replace "default" by "User1". Click on "***Create Directory***" to install this directory on the hard drive.
⇒ Create an image directory by clicking on the gray box behind ***Image Directory***. Now select a specific directory or create a new directory (see ***User Directory***). All stored images will be filed in this directory.
⇒ Setting user levels: The level of access can be set to Novice, Expert, Full and Any Level. These privilege and permission levels refer to the number of enabled SEM parameters (see 4.4). "Any level" will allow access to all available parameters. The other levels only enable access to a certain number of privileges and permissions
⇒ Enabling different permissions, i.e. permission to switch off or adjust the filament, to initialize the stage, to act as a supervisor or to edit the toolbar.

It is recommended SUPERVISOR only be assigned to a restricted number of authorized users. SUPERVISOR is allowed to start the administrator and establish or edit new user directories. Furthermore, the user can adjust or activate the following SEM parameters:

* USER MAX EHT (setting of user specific peak values for the acceleration voltage
* Filament Current (modification of the filament current)
* Bake out (setting and start of the bake out for the IGP)
* Activation of *LEAVE GUN ON AT SHUTDOWN*, *PARTIAL VENT ON STANDBY*, *Z MOVE ON VENT*, *PROTECT Z and EHT OF @ LOG OFF*.

⇒ OTHER SETTINGS: Use Common Toolbar, if this control window is activated, a standard toolbar (COMMON.UTB) from the directory "C:\Program Files\Leo\Leo32\User" will load when loading the user interface. If not, the specific toolbar from the corresponding user interface will load.





After setting the different configurations, the window can be closed by clicking on OK. Now the new user interface will be displayed in the user access window. The password for the user will be his user name. To change this password, the specific directory must be opened again using ***FILE→ EDIT.***

Editing a user password:

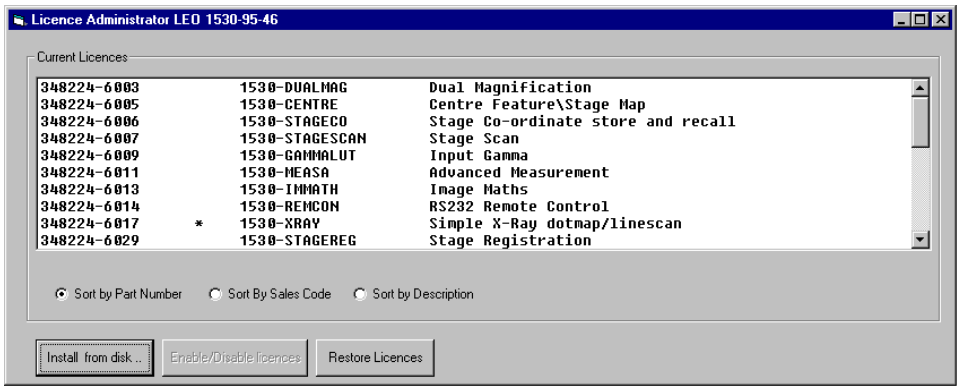
⇒ Select the corresponding user directory in the user access window
⇒ Pop-Up menu ***USER→ EDIT***
⇒ Activate ***Change Password***
⇒ Enter and verify the desired password (at least three letters!)

2.2 Deleting User Directories

To delete a user name from the Administrator, the user name to be deleted has to be activated in the user access window (click on user name with the left mouse button). Then select ***Delete*** in the ***USER*** menu. After confirmation of the command, the user name will be deleted from the Administrator. Access will no longer be possible with this user name and the corresponding password. However, the established user directories and the corresponding files will not be deleted automatically from the hard drive. If necessary, these files and directories must be deleted afterwards using Windows® Explorer.

2.3 Installing and Editing Software Licenses

The software licences can be opened with the menu LICENCES. A window with all installed software licences will be displayed. This window allows the administrator to disable certain software options or to enable disabled options. New licences can be installed. Click on "***Install from disk***" to select the path containing the licence file. The licence files will have the name "Mwk????.LIC". After selection of the file and clicking on "***Install***" the licences will be implemented to the system. .

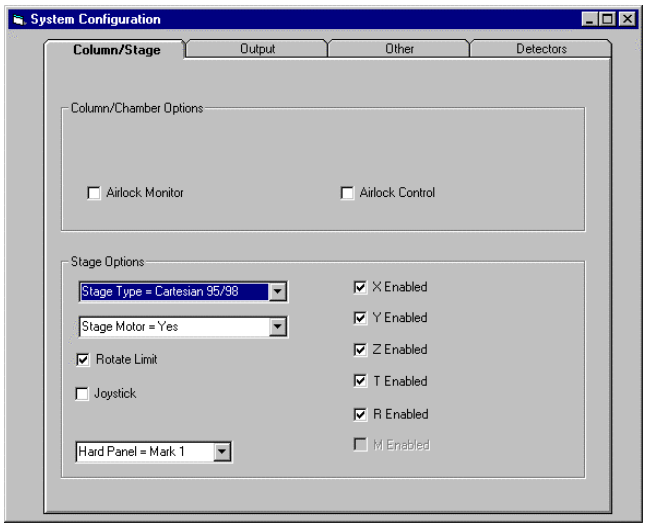


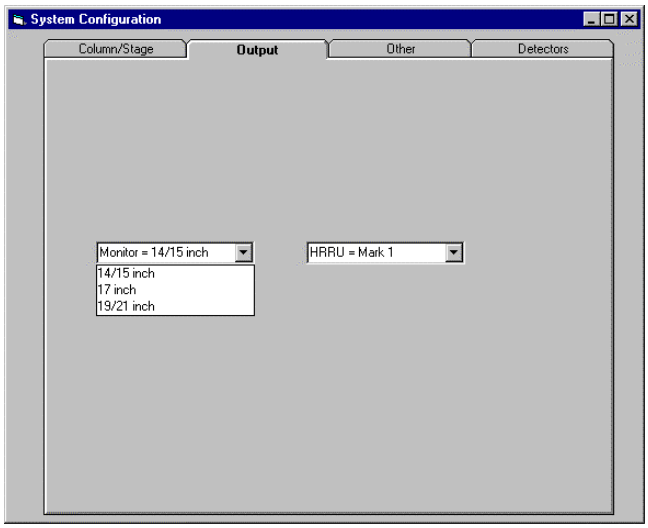
2.4 System Configuration

The menu CONFIGURATION displays or edits the current system configuration. This includes available detectors, monitor size, kind and motorization of the stage, kind of the photo unit and other relevant system configurations. Adjustments are only necessary after reinstalling or deleting hardware components.

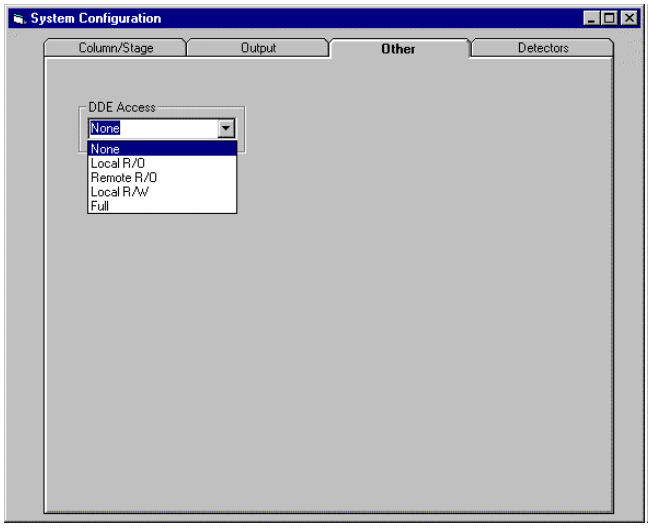
This menu contains important system settings, only authorized persons (service engineer) should make modifications.

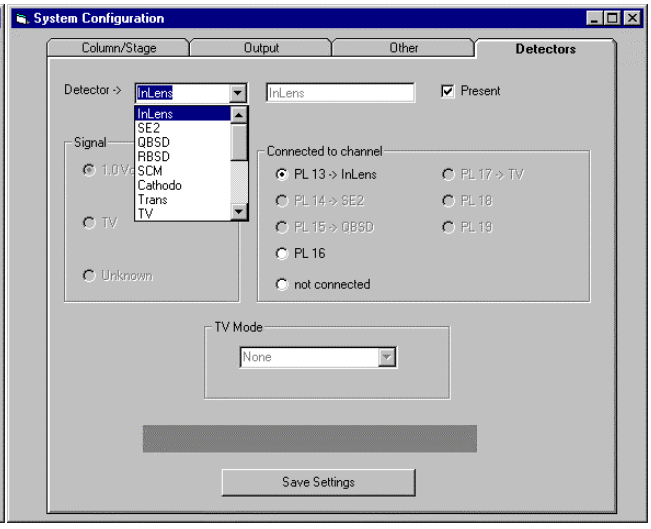
The menu **CONFIGURATION** is subdivided into four index cards. The file card ***Column / Stage*** controls parameters of the stage control and of the sample airlock, if available. The installation of a sample airlock must be communicated to the system by activating ***Airlock Monitor***. If the airlock can be controlled using the LEO software, ***Airlock Control*** must also be activated. This allows control the airlock using the menu Airlock in the LEO user interface (see 9.2.).
Stage Options selects the installed motorized stage. If there is a rotation limit switch on the stage, this option can be selected by clicking on ***Rotate Limit.***. The control boxes ***X,Y,Z,T,R*** and ***M-Enabled*** indicate the motorized axes of the stage and allow switching off the axes ***Z,T*** and ***R (M.)***. Select the control module by clicking on ***Joystick*** or ***Hard Panel=Mark1,*** depending on whether a joystick or/and hard panel is adapted.
The output media can be selected on the index Tab ***Output.*** The first step is to adjust the adapted monitor. Depending on its size, selection is possible between ***14/15 inches***, ***17 inches*** and ***19/21 inches***. This value influences the calculation of the magnification that refers to the monitor. If a high-resolution record unit has been installed, it can be selected by clicking on ***HRRU=Mark1***.





The index Tab ***Other*** allows the level of DDE support (Dynamic Data Exchange) to be set. Standard is DDE Access = None. The setting of this level depends on the other programs installed on the computer (e.g. special image storage programs) interactively reading data from the LEO software using the DDE support. Upon request, a list of all DDE commands applicable to the LEO software is available.
All detector parameters can be set using the index Tab ***Detectors.*** The different detectors are selected by clicking on ***Detector→*** and can be activated or deactivated by clicking on ***Present***. When a new detector is installed, ***Connected to channel*** shows a list of the channels to which the detector may be assigned. You will then have to select the corresponding channel. If a camera is installed on the instrument, it can be selected using the selection ***TV*** and be assigned to the corresponding channel. Set the corresponding camera mode using ***TV Mode.*** Possible selections are CCD, PAL and NTSC. Modifications to the detector or to the camera settings can be stored by clicking the key ***Save Settings.***

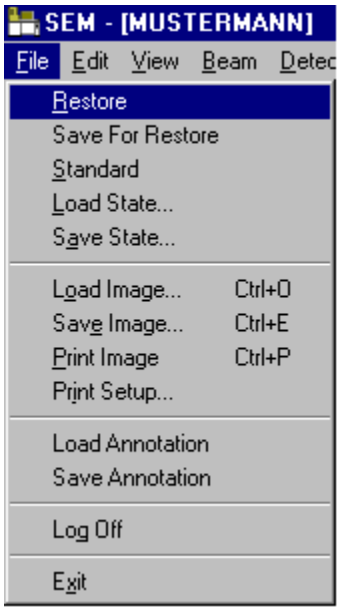




3 The Pop-Up Menu

As is the practice in other Windows® programs, the different menu windows necessary to work with the software can be opened using a Pop-Up menu. To allow an efficient handling, related commands are combined in separate menu topics. Below you will find the description of these items. Wherever a more detailed explanation is necessary, we refer to the corresponding information in the manual.

3.1 Menu: FILE



The menu item "File" contains mainly options for storing and editing images, closing the software and setting special instrument configurations

3.1.1 Restore- Save For Restore- Standard

Restore:

Loading and Processing the Macro "Restore4.mlc" from the corresponding user interface (see 4.1.3).

Save For Restore:

The selection of this command allows the storage of the respective instrument configuration (acceleration voltage, magnification, focus etc.) in the "Restore4.mlc" macro in the current user directory. Any already existing macro will be replaced. If no "Restore4.mlc" macro exists in the current user directory, it will be set up and the current parameters will be stored in it.

Standard:

A standard configuration is set on the instrument (acceleration voltage = 5kV, working distance = 12mm, aperture = 30µm, smallest magnification). If the filament or EHT are switched off, this routine loads the acceleration voltage or the filament startup parameters. At the same time you will be asked if the stage is to be initialized if it has not been up to now.

Load State- Save State:

Load State...: Loading special instrument configurations (see 4.1.4.)

Save State...: Saving special instrument configurations (see 4.1.4).

3.1.2 Load Image- Save Image

Load Image...: Loading TIFF images into the LEO user interface (see 4.5.3)

Save Image...: Saving images in TIFF format (see 4.5.1).

3.1.3 Print Image- Print Setup

Print Image: Printing the current image on the default printer as defined in Windows®

Print Setup...: Loading the Print Setup. Settings such as page size and printer are possible (see 4.8).

3.1.4 Load Annotation- Save Annotation

Load Annotation: Loading measurements and annotations saved using “Save Annotation” as a file in the respective user directory (see 4.7).

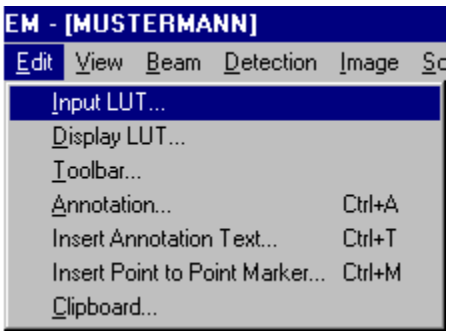
Save Annotation: Saving highlighted measurements and annotations as a separate file in the current user directory (see 4.7).

3.1.5 Log Off- Exit

Log Off: Exiting the LEO user interface and all other LEO applications such as the program “RemCon32”. The LEO server remains active.

Exit: Exiting the LEO user interface. The LEO server remains active. You will be asked whether other LEO applications are to be closed. If you answer “Yes”, the result will be the same as with “Log Off”. If you answer “No”, only the LEO user interface will be exited, all other LEO applications remain logged on.

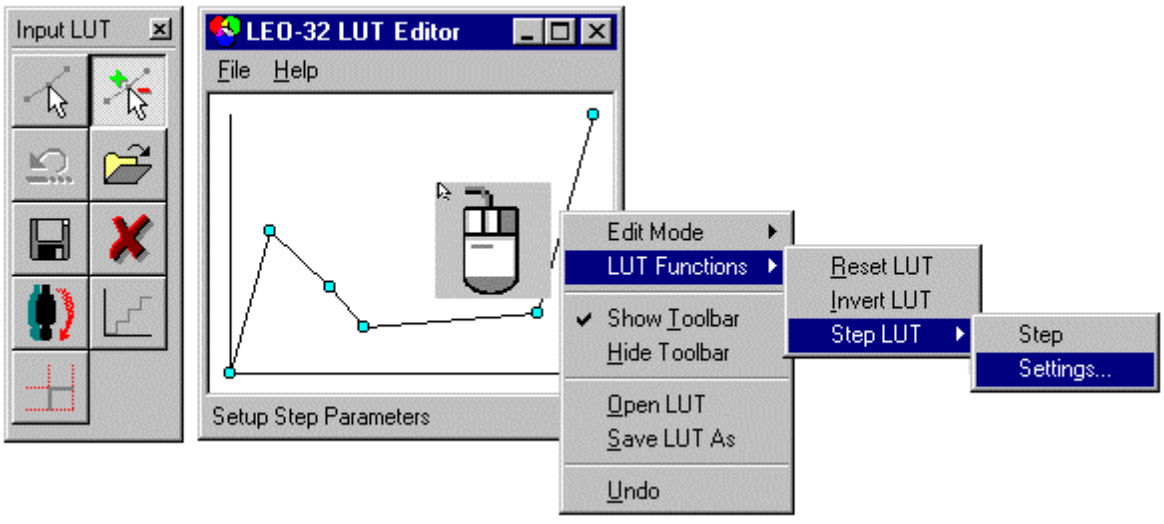
3.2 Menu: EDIT



The menu "Edit" provides processing of current and stored images as well as custom tool bar design. Processing includes editing brightness and contrast, insertion of measurements and texts and copying images using the clipboard. By clicking on ***Toolbar*** the current toolbar can be individually designed and modified.

3.2.1 Input LUT: (Requires the Licence: GAMMALUT)

Modifications of the Input LUT affects the current live image. Independent to the signal setting for brightness and contrast (see 4.3.1), an individual adjustment of the transfer characteristic is defined. This option is useful if a perfect, linear illumination of the image is difficult or impossible. In these special cases you may try to optimize the illumination by adding or displacing discrete points of the LUT or by adding a step function.
After loading the Input LUT a toolbar and a graph are displayed showing the signal transfer characteristic. This characteristic represents the coordinates of the input gray level. In the simplest case it is a straight line connecting the points (0,0) and (255,255). Processing this straight line is by adding or displacing different points.
The different functions can be selected in the toolbar or by clicking the right mouse button within the graph window. The displayed selection menu will show the different functions. This menu also allows to switch the toolbar on or off (***SHOW TOOLBAR*** **-** (***HIDE TOOLBAR***).



Below you will find the different functions of the Input LUT.

Displacing and deleting points in the signal transfer characteristic.
(Displacing: Position the mouse cursor on to the point and displace with the pressed left mouse button.
Deleting: Position the cursor close to the point and press the middle mouse button.

Adding and deleting points in the signal transfer characteristic (Adding: Position the mouse cursor within the graph field and click the left mouse button / Deleting: Position the cursor close to the point and click

on the middle mouse button)

Cancel the last modification of the Input LUT

Loading special Input LUT settings and applying these settings to the current image

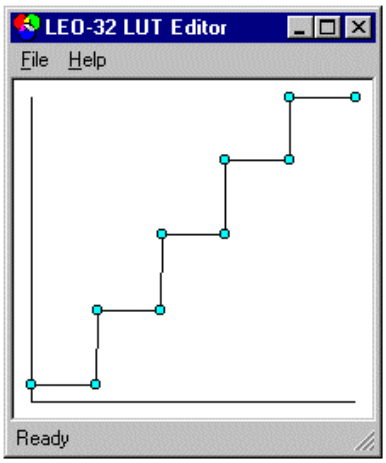
Saving special settings of the Input LUT

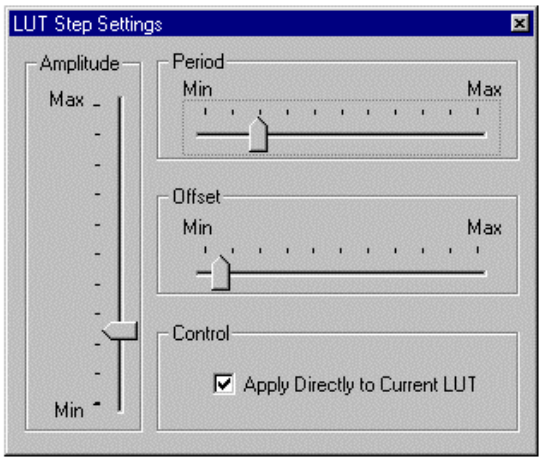
Returning the Input LUT to the basic status (linear characteristic)

Inverting the current signal transfer characteristic

Adding a step function as signal transfer characteristic. By doing so, the signal transfer characteristic will be transformed to a regular sequence of gray values. The amplitude of each step, the position of the first step (Offset) and the number of steps (period) can be set separately. It is possible to continue to modify the curve by adding or displacing different points.

Loading the window ***LUT Step Settings*** to set offset, amplitude and period for the step function.





3.2.2 Display LUT

By means of Display LUT modifications of the current live image and of stored images are possible. You will find more detailed information on the different functions in 4.6.

3.2.3 Toolbar

Loading the toolbar editor provides; custom design to the current toolbar, save or load a user custom or standard toolbar. (see 6.5).

3.2.4 Annotation- Insert Annotation Text- Insert Point to Point Marker

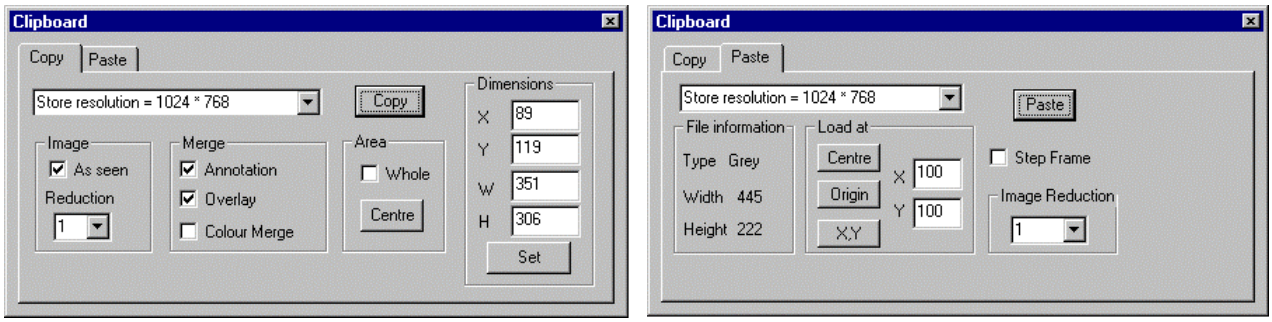
Annotation: Opening the toolbar for annotation , measurements, etc. to the image (see 4.7).

Insert Annotation Text: Loading the text editor for adding annotations to the image (see 4.7).

Insert Point-to-Point Marker: Loading the toolbar for the annotation and immediate addition of a point-to-point measurement to the current image (see 4.7).

3.2.5 Clipboard (Requires the Licence: CLIP)

Similar to other Windows® applications, the menu ***"Clipboard"*** allows copying images to the Windows®-specific Buffer store or adding images from the buffer store to the LEO user interface. The image will not be stored in a storage medium such as a hard drive or disk, but the contents of the memory will be stored in the main memory of the computer. The contents will therefore be available to any other Windows® application which has access to the buffer store. This allows copying SEM images or clippings without storage from intermediary memory to other programs. Furthermore, SEM images contained in the Clipboard can be added to a stored image.



By means of the index Tab **"Copy"** SEM images or clippings can be copied to the intermediary memory. The control box "Store Resolution" displays the store resolution of the image and allows modifications.. Clicking the key ***Copy*** will start the copying procedure.

Control Surface ***IMAGE*****:**

Processing images is possible by means of the Display LUT (see 4.6). If ***AS SEEN*** is activated, the edited monitor content will be copied to the intermediary memory. If not, the gross data will be used. By selecting ***REDUCTION,*** the image can be sent to the image store in a reduced size. Selection is possible between 1 (original size) and 8.

Control Surface ***MERGE***:

ANNOTATION:
Data zone and annotations and measurements etc. will be copied to the intermediary memory together with the image.

OVERLAY:
Copies only the data zone together with the image to the intermediary memory.

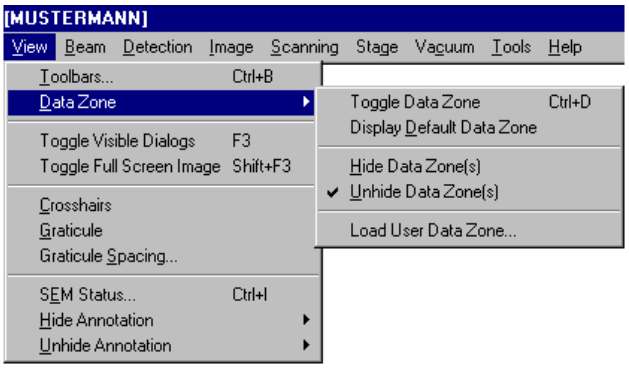
COLOR MERGE:
Must be activated to copy colored annotations or measurements together with the color to the intermediary memory. This will reduce the number of grays (256) of the image by 20 gray scales as this storage area is necessary for the storage of the ANNOTATION information. If ***Color Merge*** is not activated, the colors will be converted in gray scales.

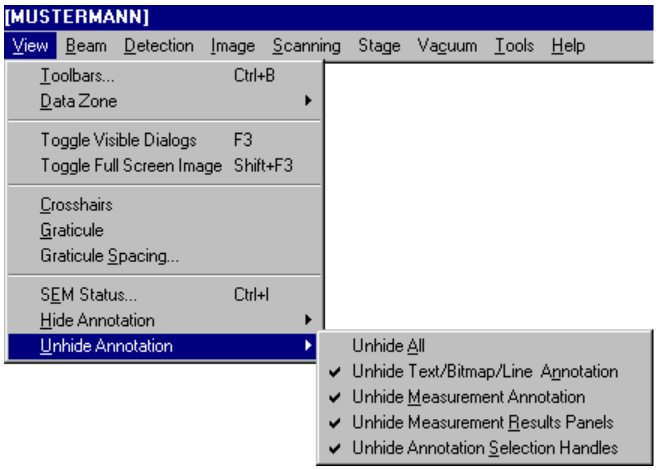
Control Box ***DIMENSIONS***:

This list indicates the upper left (X, Y) as well as width (W) and height (H) of the area to be copied. If ***WHOLE*** is selected in ***AREA***, upper left will always be 0,0 and the size will be identical to the set ***STORE RESOLUTION***. It is also possible to copy only a clipping of the image after entering the respective parameters in ***DIMENSIONS.*** Click on ***SET*** to display the grid on the image in size and position corresponding to the clipping to be copied. Size and position of the grid can also be set by using the mouse. By clicking on ***ANNOTATION*** (see 4.7) it is possible to select an image area to be saved to the intermediary memory. To do so, click on the symbol  . Then the corresponding area can be selected by clicking on the left mouse button. The selected area will be centered on the screen by clicking ***Center***.
By switching to the index Tab **"Paste**", insertion of images and clippings from the intermediary memory is possible. The box ***FILE INFORMATION*** displays size and type of the image stored in the intermediary memory. Clip on ***IMAGE REDUCTION*** to select a reduction factor if a reduced image is to be loaded into the image memory. This enables an image-in-image presentation or a composition of 4, 9, 16 etc. images to one entire image. Depending on the reduction factor, the size of the grid will be displayed on the screen. This grid shows position and format of the image to be loaded. The position of the grid on the screen can be determined by clicking on ***CENTER***, ***ORIGIN*** (upper left) or ***X ,Y*** (free positioning). Selecting ***X, Y*** results in free positioning of the grid with the mouse. Click ***Paste*** to insert the selected image into the corresponding position. It is recommended to activate ***STEP FRAME*** to display i.e. 4 images in one entire image, the images being thus automatically positioned correctly (see 4.5.3). Click on ***ORIGIN*** before selecting ***STEP FRAME.***

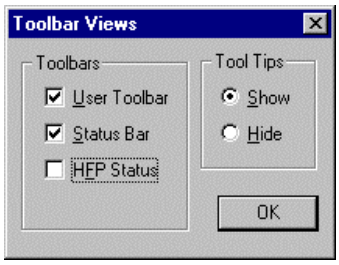
3.3 Menu: VIEW

The functions in ***VIEW*** refer mainly to the design of the LEO user interface. By clicking on ***VIEW*** it is possible to switch on or off the toolbar and the status bar, to load markers like grid or cross hairs or to display different data zones. It is also possible to switch on or off a certain group of measurements and annotations. The SEM status window can be opened, listing user specific parameters which can be modified interactively.



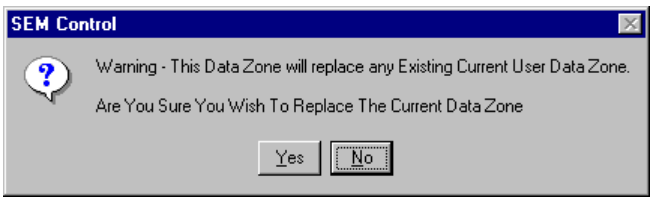


3.3.1 Toolbars- DataZone

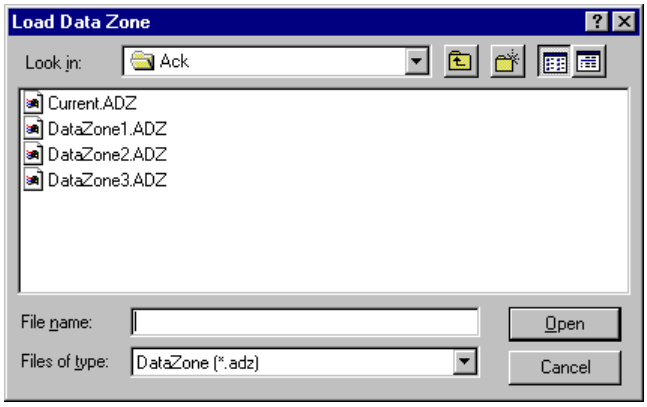


The key combination ***CTRL + B*** or the selection of ***Toolbars...*** opens the window ***Toolbar Views***. Select ***User Toolbar***, ***Status Bar*** or ***HFP Status*** (hard panel) to activate or deactivate the ***toolbar***, ***status bar*** or ***HFP Status***. The status bar for the hard panel shows the current active selection for the encoders (potentiometers). Clicking ***Tool Tips*** switches on (***Show***) or off (***Hide***), the short explanation of the different toolbar icons. This short explanation will be displayed if the mouse cursor is situated on one of the toolbar icons.

A showing or hiding of the current data zone is possible by using the key combination ***CTRL + D*** or by clicking on ***Toggle Data Zone***. The file ***CURRENT.ADZ*** in the current user directory will load, displaying design, size, position and parameters of the data zone. Selecting the function ***Display Default Data Zone*** will load the standard data zone (***DATAZONE.ADZ***) from the directory ***C:\Program Files\Leo\Leo32\distrib.*** You will be asked whether you want to replace the current data zone.



Answering "YES" will replace the current data zone with the standard data zone.If "NO", the current data zone will remain. The functions ***Hide*** **and** ***Unhide Datazone(s)*** will also show or hide the data zone.



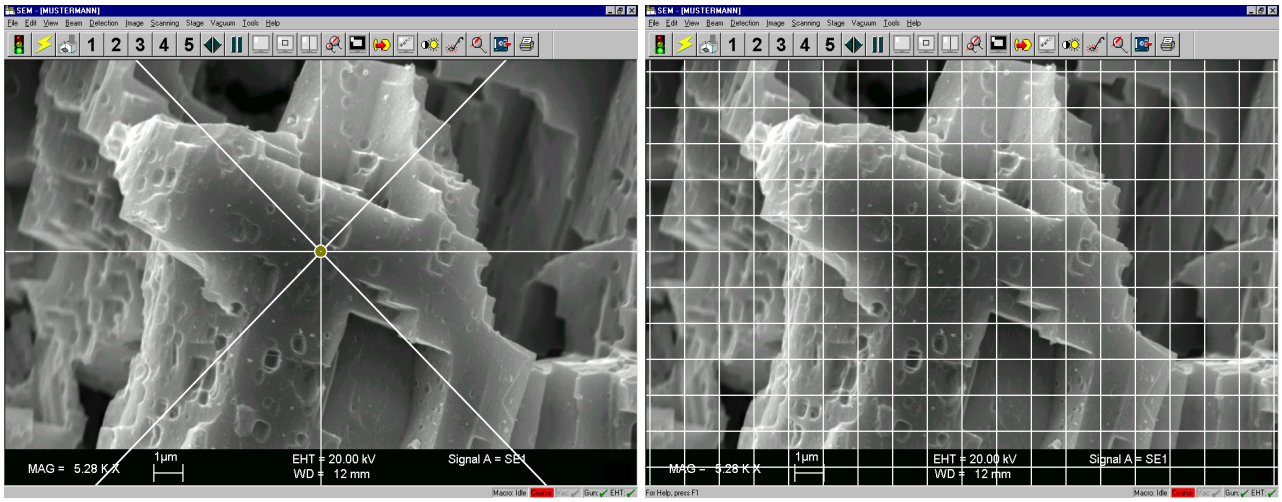
Loading a user specific data zone can be done using ***Load User Datazone...*** The different data zones in the current user directory will thus be displayed. You will find detailed information on the set-up of user specific data zones in 4.7.4. By selecting one of the listed files and clicking on Open, the respective data zone can be loaded into the LEO user interface. You will be asked again whether you want to replace the current data zone with the selected one. Answering "YES" will replace the current data zone. Answering "NO" will save the current data zone as an annotation. The loaded data zone will be converted to the file ***CURRENT.ADZ*** and can be switched on or off by pressing on ***CTRL + D.***

3.3.2 Toggle Visible Dialogs- Toggle Full Screen Image

Pressing the key ***F3*** or clicking on ***Toggle Visible Dialogs*** switches off the opened windows and toolbars (Input LUT, Annotation etc.) of the LEO user interface . A second clicking or pressing the key ***F3*** will result in a reactivation of the deactivated windows.
To switch off the Windows® interface, i.e. the Pop-Up menu, the toolbar, the statusbar and the HFP status bar, use the function ***Toggle Full Screen Image*** or the key combination ***Shift + F3.*** Repeating this function opens the Windows® interface again.

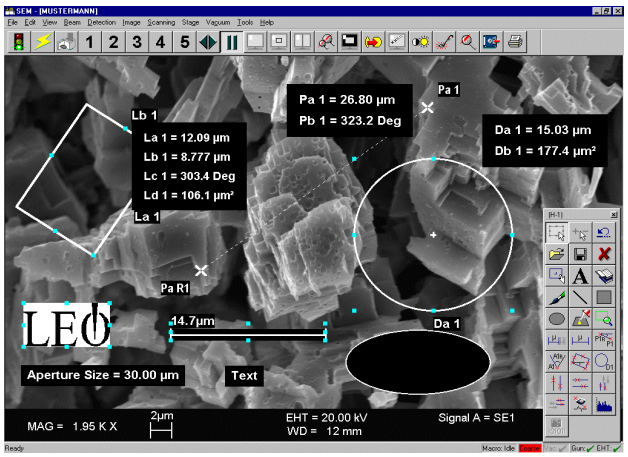
3.3.3 Crosshairs- Graticule (Requires the Licence: GRATICULE)

The selection ***View → Crosshairs*** will display an overlay on the screen that can be switched off by selecting ***View → Crosshairs*** again. It is also possible to display a grid on the monitor that will be activated by the command View -> ***Graticule***. The line distance can be entered using the function ***Graticule Spacing....*** Values between 50 and 512 (half of the screen resolution across will be displayed on the screen) are possible.



3.3.4 SEM Status- Hide/ Unhide Annotation

The ***SEM Status*** window provides the ability to list a certain number of important parameters and commands. For more detailed information see 4.4.



All selections are set to ***Unhide***

The commands ***Hide*** and ***Unhide*** allow the user to activate and deactivate specific annotation and measurement objects. Standard set-up for all objects is ***Unhide*** (visible). The image on the left shows a number of the different annotation and measurement objects. The images below show which type of objects are ***hidden*,** when selecting the specific ***Hide*** function.

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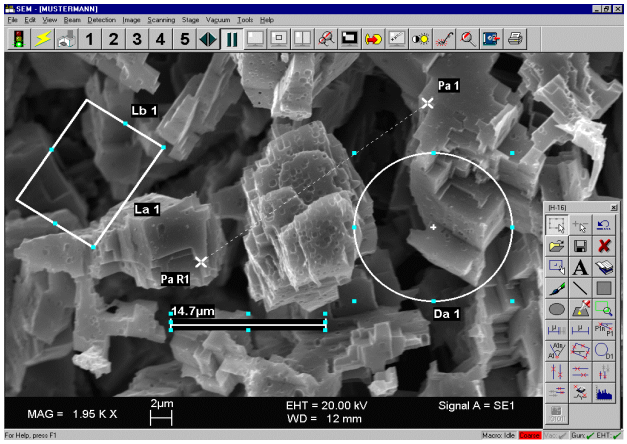
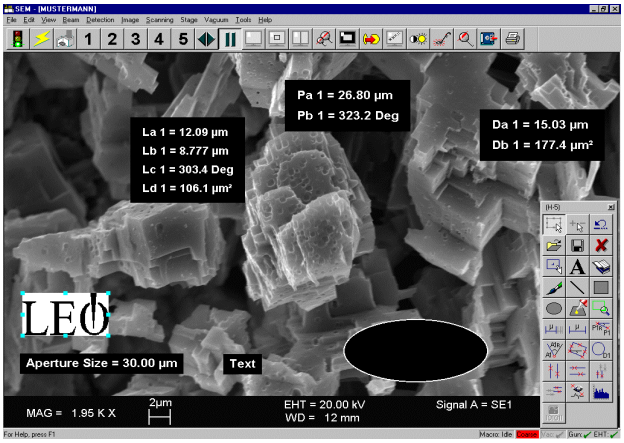
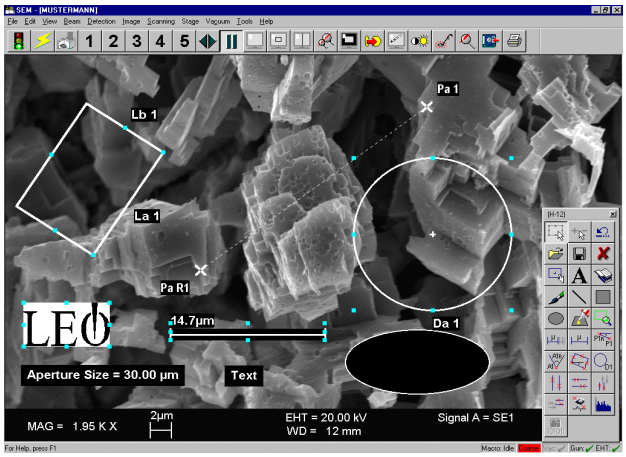


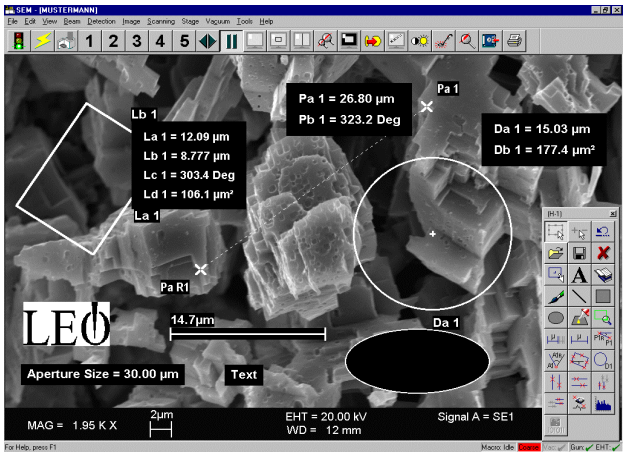
Hide Text/ Bitmap/ Line Annotation



Hide Measurement Annotation

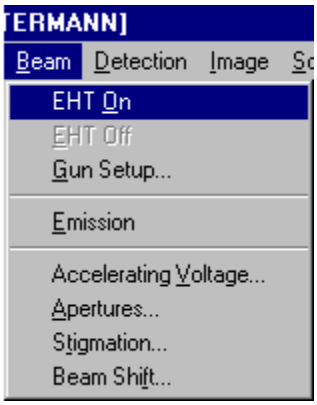


Hide Measurement Results Panel



Hide Annotation Selection Handles

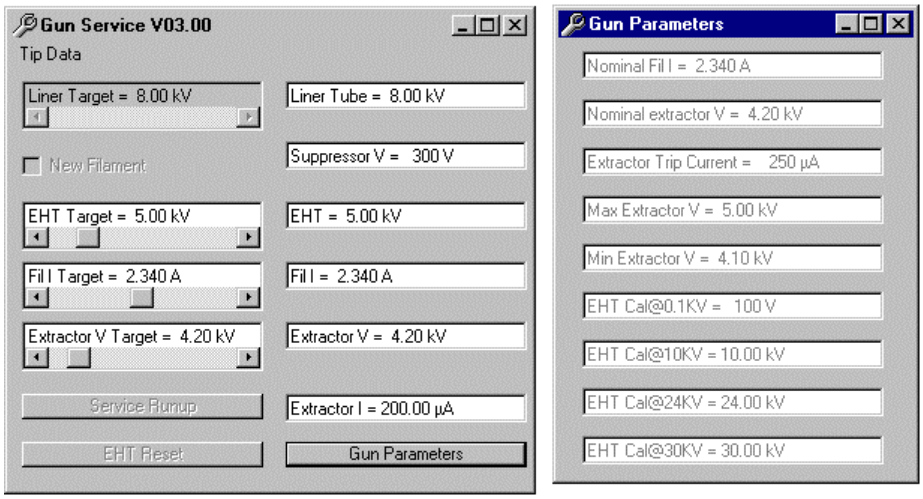
3.4 Menu: BEAM



The menu **"Beam"** contains commands and settings important for the adjustment of the electronic beam.
The commands ***EHT On*** and ***EHT Off*** will switch on or off the acceleration voltage. ***Emission*** switches over to the emission mode necessary for aligning the filament (see 4.3.5). The menu ***Accelerating Voltage...*** provides for adjusting the current acceleration voltage. Selecting the menu ***Apertures...*** will result in the activation of the ***SEM Control*** window; the tab Apertures opened (see 4.3.5).
The functions ***Stigmation...*** and ***Beam Shift...*** open separate menus to adjust the stigmator or the beam shift. Both parameters can also be set and adjusted in the ***SEM Control*** window (see 4.3.5). In both menus it is possible to activate automatic correction of the astigmatism.

3.4.1 Gun Setup

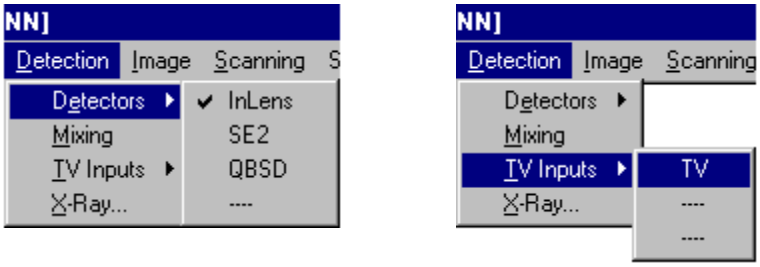
The menu ***Gun Setup*** is available, without limitats, to LEO service staff, all settings for the field emission cathode are set in this menu. Other users can open the menu but have only limited access to modify parameters.
On the left side of the window ***Gun Service*** three parameters can be set: The parameter acceleration voltage **(*EHT Target*)**, available to every user, can be modified continuously. Users (Supervisor level) have the ability to modifiy the filament heating current **(*Fil I Target*)** within certain limits. Using the slider control, the extractor voltage **(*Extractor V Target*)** can be varied within certain limits. This parameter is also available to all users.
The right side of the window shows the current values of the filament. . Clicking ***Gun Parameters*** indicates nominal, maximum and minimum values of the cathode. Modification of these values is only possible for LEO service staff.



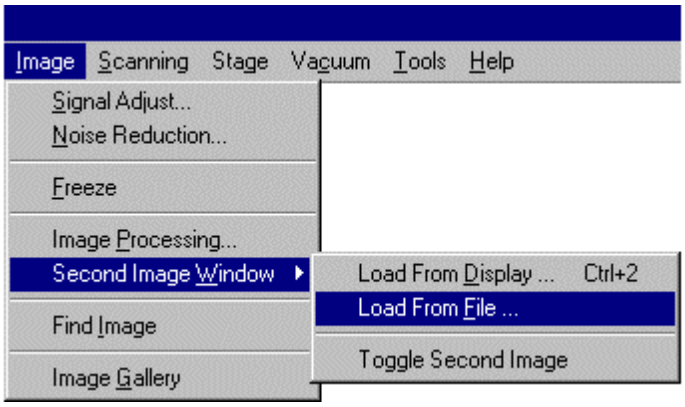
As modifications of these parameters will effect the life and the emission of the cathode, changes should only be carried out by the person responsible for the instrument after discussion with the respective service engineer.

3.5 Menu: DETECTION

The menu **"Detection"** provides selection of the different signal sources to be displayed on the monitor. ***Detectors:*** lists the different detectors available for imaging. The currently active detector has a check. On activation of the command ***Mixing*** two detector signals can be mixed. For further information on mixing of detector signals see 4.3.1. This function requires the software license SIGMIX.
If one or several TV cameras (chamber scopes) are adapted to the microscope, these cameras can be activated using the menu ***TV Inputs.***
Clicking ***X-Ray...*** will load the ***SEM Control*** window and display the index Tab ***X-Ray*** (see 4.3.7) which enables the presentation of analog EDX distribution images on the screen.

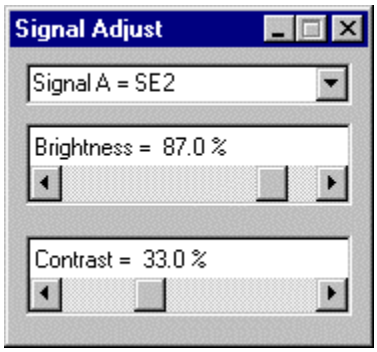


3.6 Menu: IMAGE



The menu **"Image"** contains routines and commands to be used for adjustment, optimization and processing of live or saved images. It also contains the functions ***Second Image Window*** and ***Image Gallery*** for the display and edition of stored images. The function ***Image Processing...*** can be used for image analysis.

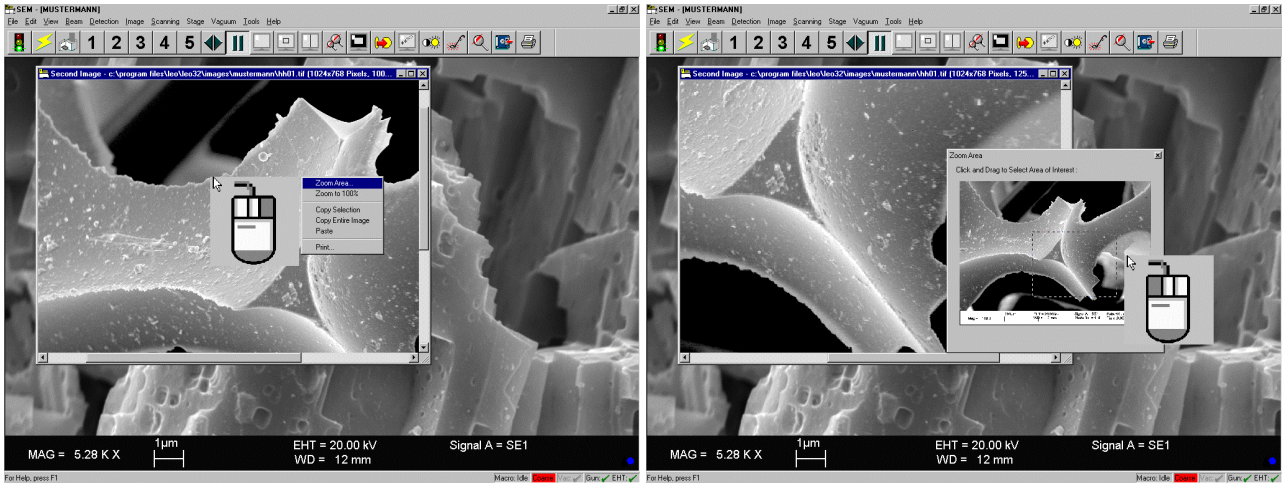
3.6.1 Signal Adjust- Noise Reduction- Freeze



The menu ***Signal Adjust*** provides the capability to adjust brightness and contrast of the current detector.
The command Noise Reduction will load the ***SEM Control*** window, index tab ***Scanning*** which displays routines to save noise reduced live images to the image store (see 4.3.2).
The command ***Freeze*** will freeze the current live image in the image store, the sample will not be scanned any more. A frozen image can be unfrozen by clicking on ***Unfreeze.***

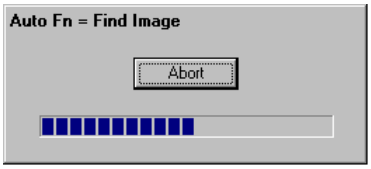
3.6.2 **Image Processing** (Requires the Licence: IMMATH)**- Second Image Window**

The menu ***Image Processing*** contains basic routines for image processing such as filters for saved images or detection of special gray values in the image. For further explanations of the different functions see 6.4.
The function ***Second Image Window*** opens a second virtual window to load saved images. It is possible either to load the current image from the screen using the command ***Load from Display...*** (or ***CTRL+2),*** or to load an image from a storage medium ***Load from file.*** The image can be moved by clicking the left mouse button and moving the mouse within the window. Clicking the right mouse button in the virtual window will open another options menu e.g. the command ***Zoom Area***. This command will load the reduced image to the window ***Zoom Area.*** Dragging the left mouse button selects a clipping area which will be displayed enlarged in the window ***Second Image.*** Once again, dragging the left mouse button will move the image to display the selected area. Images stored in the intermediary memory (see 3.2.5) can be inserted by using the command ***Paste.*** The command ***Copy Selection*** will copy the clipping in the window ***Second Image*** to the intermediary memory. ***Copy Entire Image*** copies not only the clipping but the entire image to the intermediary memory. Clicking ***Print...*** will print the image on the default printer.

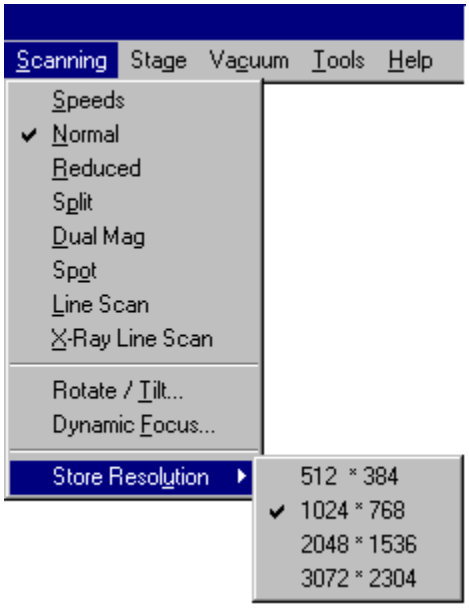


3.6.3 **Find Image- Image Gallery**

The function ***Find Image*** produces an automatic focus research in connection with changes of the magnification. If a passably focused image is displayed on the screen, clicking Abort can interrupt the function**.** This function is designed to help inexperienced users get an acceptable image on the screen as fast as possible. Fine adjustment will follow manually.
To get a rapid overview on all images contained in the respective image directory use the command ***Image Gallery*** which will display all images of the respective directory in stamp size in a separate window. You will find more detailed information on the image gallery in 4.5.4.

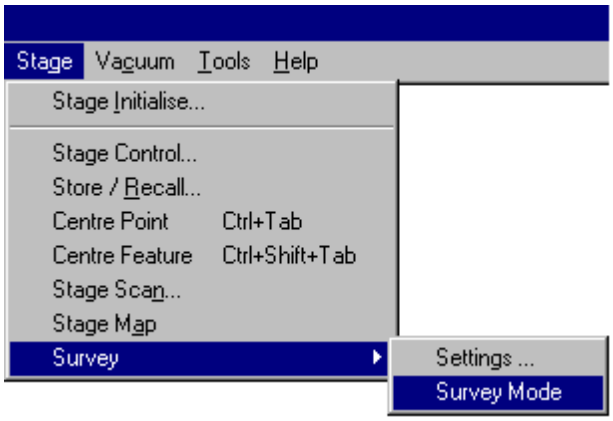


3.7 Menu: SCANNING



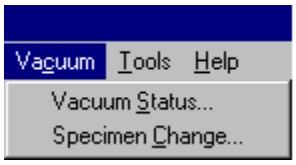
The menu **"Scanning"** contains all necessary options for scanning the sample. Clicking ***Speeds*** will open a menu for the selection of the different scanning rates. If the license SCANEXP is installed, 15 different scan rates can be selected.
The command ***Normal*** switches over to normal scan rate, which means that the scanned sample area is displayed on the total screen. However, adjustments can be done using the function ***Reduced.*** Explanations on the different special scan modes such as ***Reduced***, ***Split***, ***Dual Mag***, ***Rotate/ Tilt...*** and ***Dynamic Focus...*** are contained in 6.3
There are several other special scan rates such as ***Spot, Line Scan*** and ***X-Ray Line Scan:*** The ***Spot*** mode will freeze the image; the electronic beam can be positioned with a cross to a special sample area. This function provides point analysis, which is of importance for EDX/ WDX applications.
When using ***Line Scan,*** the sample surface will only be scanned along a line and the corresponding signal displayed in a line profile (see 4.3.2). ***X-Ray Line Scan*** has the same function with the difference that it displays the EDX signals (see 4.3.2).
Store Resolution sets the respective store resolution of the image. As a standard, processing is done with a 1024 x 768 resolution. A higher store resolution can be selected for special applications such as re-magnification of SEM images for a poster or zooming into images.

3.8 Menu: Stage



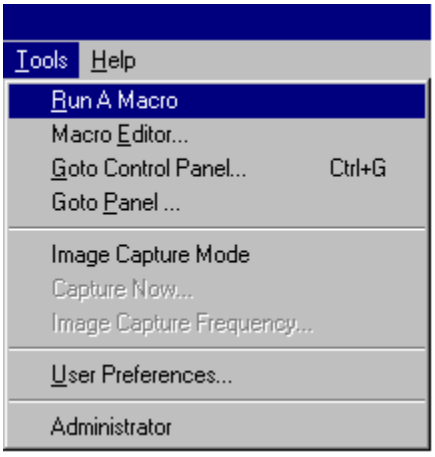
The menu **"Stage"** contains all submenus necessary for control of the motorized stage. Depending on the kind of stage and the number of installed licences, control of the stage is possible in different ways to solve user specific problems or to simplify the work.
It enables simple controls such as ***center point***, ***center feature*** or ***stage mapping***, but also complex activities such as use of the compucentric software, scanning of areas or use of the survey mode. You will find a detailed chapter (see 5) to explain these different applications.

3.9 Menu VACUUM



The commands ***Vacuum Status...*** and ***Specimen Change...*** will open the ***SEM Control***- window, index tab ***Vacuum*** which contains the most important parameters of the vacuum system. This menu also enables the venting of the sample chamber and the start of the pumping procedure. More detailed information (see 4.3.3.)

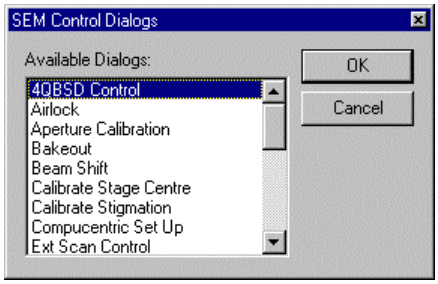
3.10 Menu: TOOLS



The menu **"*Tools*"** contains separate submenus to load and store macros, load special menu windows and grab images automatically in a defined frequency. It also allows opening the ***User Preferences*** (see 6.1) to establish special user specific settings for the LEO user interface.
Clicking on ***TOOLS→ ADMINISTRATOR*** in the LEO user interface, will start the program ADMINISTRATOR (verses ***START→ PROGRAM→ LEO-32→ LEO ADMINISTRATOR***, on the Windows® interface). Login to this program is only permitted to authorized persons (Supervisor- Privilege).

3.10.1 Run a Macro - Macro Editor

The LEO user interface contains a standard Macro Editor, which processes certain commands one after the other or in a loop. It is also possible to store special settings of the SEM in macros and to load them later on. For more detailed information on the editor see 0.



Clicking ***TOOLS→ GO TO CONTROL PANEL*** will open the ***SEM Control*** panel.
Clicking ***TOOLS→ GO TO PANEL*** will open the selection menu ***SEM Control Dialogs*** where different menus are listed. After highlighting a menu and confirming with "OK" the corresponding menu will be opened. In the table below you will find an overview of the different menus.

Available Menus	**Explanation**
4QBSD Control	Control of the various operating modes of the four quadrant BSD (see 4.3.1).
Airlock	Control of different airlock functions for sample exchange (see 9.2).
Bake out	Control of the IGP bake out, selection of the heating and cooling times (see 6.2).
Beam Shift	Control of the electronic beam shift, and auto stigmatism (see 3.4).
Calibrate Stage Center	Calibration of the stage center, essential for the use of Stage Horizontal Alignment and Compucentric Set Up (see 5.9.1).
Calibrate Stigmation	Calibration of the stigmators; (only available to LEO service staff).
Compucentric Set Up	Calibration of the tilt correction for the compucentric software (see 5.9.2).

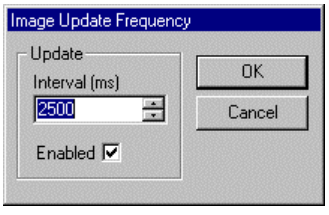
Ext Scan Control	Switching to external scan control.
Input LUT	Loads the Input LUT panel (see 3.2.1). This menu enables special adjustments of the input signal of a detector.
Magnification Calibration	Calibration of magnification to different output media (see 6.8).
Rotate/ Tilt	Displays the control panel for Tilt compensation, Dynamic focus and Scan rotation (see 6.3.5).
Signal Adjust	Adjustment of brightness and contrast for a selected detector (see 3.6.1).
Specimen Current Monitor	Displays the control panel for the specimen current monitor. Requires SCM option (see 9.7).
Stage Horizontal Alignment	This function allows the definition of a line on the stage by means of two marks. The motorized stage will rotate to place this line horizontally in the image plane. (see 5.9.3).
Stage Limits	Setting of limits for the motorized stage axes (see 5).
Stage Points List	Storing or loading saved stage positions (see 5.2)
Stage Registered Movement	Control of the stage in a user specific, defined system of coordinates (see 5.8).
Stage Registration	Definition of a user specific system of coordinates for the motorized stage by means of two or three registration marks (see 5).
Stage Scan	Imaging a sample area as a series of exactly defined, image areas (see 5.5)
Stigmation	Stigmator adjustment (see 3.4).
Water Flow/ Temperature	Window to control the cooling water circuit (see 9.6).

3.10.2 Image Capture Mode

The image displayed on the screen, (1.) Windows® Overlay (status bar, toolbar etc.) and (2.) SEM image (live image or stored image), is in fact a double image. The scan area of the Windows® Overlay is transparent. The SEM image behind the Window® interface is thus visible and can be displayed on the screen.

For example, pressing "***Print***" on the keyboard will write a bitmap of the screen content to the intermediary memory. This bitmap can be inserted into different Windows® programs. However, this image will only show the Window® Overlay. The area containing the SEM image will be displayed as a green or orange field. The reason is that the SEM image does not exist in the image store read by the Windows® System.

To avoid this effect, select ***Image Capture Mode*** which freezes the current live image and stores it together with the Windows® Overlay. This image can be inserted into other Windows® programs. The symbol for this stored image is a red triangle (π) in the lower right.



Clicking the Pop-Up menu ***TOOLS→ IMAGE CAPTURE MODE*** will activate the menus ***Capture Now...*** and ***Image Capture Frequency...***. The selection of ***Capture Now...*** will initialize the single execution of ***Image Capture Mode.*** *The* selection of ***Image Capture Frequency...*** will result in a continuous execution of this mode. This requires selection of TOOLS

→***IMAGE CAPTURE FREQUENCY.*** Enter an interval of 0.5 to 32 seconds in the field ***Interval***. Confirming with "***OK***" will close the window and execute the routine ***Image Capture Mode*** continuously in the selected intervals(e.g. every 2,5 seconds). To close the routine, select again the ***TOOLS→ IMAGE CAPTURE MODE.***.

3.11 Menu Help

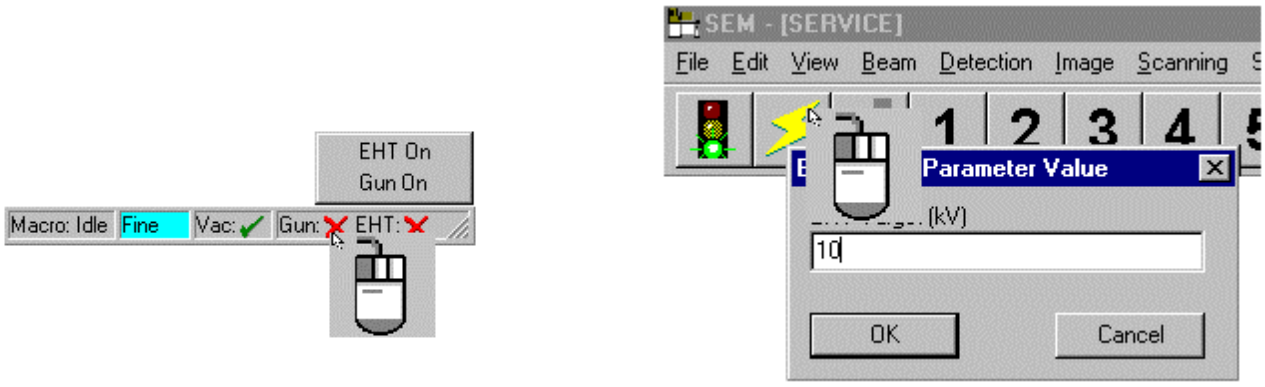
The LEO 32 interface is equipped with an extensive help. The different Help texts can be viewed using the Pop-Up menu HELP. It is also possible to select a context sensitive help. More detailed information on the different Help texts and on working with the Online Help see chapter 7.

4 The LEO 32 User Interface

All parameters of the electron microscope can be set using the LEO 32 user interface. This user interface consists of a Pop-Up menu, a status bar and a toolbar for the selection and adjustment of all functions and parameters. Selection is by clicking the left mouse button on a special menu item or by activating a symbol in the toolbar. Most of the symbols have a double assignment, which provides the ability to activate different functions or parameters by clicking the left or middle mouse button (see 4.2).

4.1 Starting the Microscope in Stand-by Mode

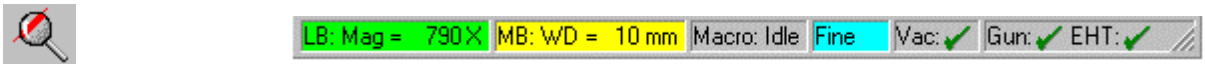
To start the microscope from stand-by mode, press the START button on the plinth panel (or computer). This boots the integrated computer and the operating system. Load the user interface by selecting ***START→ PROGRAMS→ LEO 32→ SEM USER INTERFACE,*** or double-clicking the **LEO ICON.**
The first step is to switch on the EHT (and eventually the filament). Click ***EHT*** in the status bar with the left mouse button and select ***EHT ON,*** the GUN and then EHT will switch on and run up. After run up, the red (**X**) will switch to a green (√), an accelerating voltage between 5 and 10kV should be set by clicking the EHT symbol or double clicking EHT in the DATA ZONE.

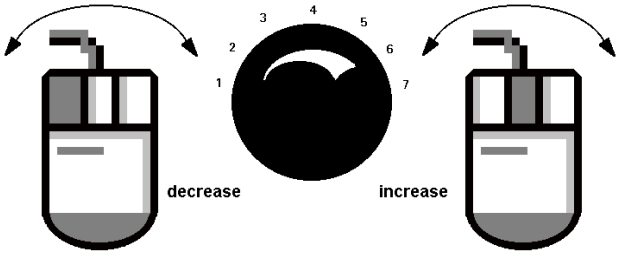


After selection of the corresponding high voltage open the SEM control window (***CTRL+G)*** *or* ***TOOLS→ GO TO CONTROL PANEL***). The index tab ***Detectors*** (see 4.3.1) enables the selection of a detector. For working distances beyond 10mm select the SE2 detector for the signal source. It is recommended that inexperienced persons have the signal set automatically at the beginning of their work by setting ***Signal Adjust*** to ***Auto BC= BC*** (see 4.3.1).

4.1.1 Setting Parameters Using the Mouse

Adjustment of the focus. Activate mouse control by clicking the magnification/focus ICON with the left mouse button. The status bar indicates the function of the mouse button. The left mouse button is for magnification and the middle mouse button for the focus (see green and yellow fields).





The alignment is done by pressing the specific mouse button and moving the moving the mouse left or right. Similar to operating a potentiometer the level increases or decreases depending on the direction of the movement. The cursor of the mouse has to be within the image area.
This concept is the same for all mouse-operated functions. Clicking on the **ICON** for **brightness/contrast** (see 4.2) will reprogram the assignment of the mouse buttons. The left mouse button will be set to control the **brightness** and the middle mouse button will be set to control the **contrast**, the status bar displays these changes. It is also possible to enter absolute values for a specific parameter. To do so, click the corresponding parameter in the status bar with the left mouse button and enter the value. Two settings are possible for the sensitivity of the mouse control: ***Coarse* and *Fine***. Switching between these settings is done by clicking Coarse/ Fine in the status bar or by using the tab key on the keyboard. The inexperienced user may want to use, at high magnifications, the fine setting of the mouse control, as the coarse setting will result in large changes with even small mouse movement.

4.1.2 Optimization of Images

After adjustment of the focus the area of interest on the sample can be selected. Depending on the kind of sample, high voltage and aperture (see 4.3.5) should be set. Adjustment of the working distance (focus) should be done depending on detector selection and high voltage.

- Imaging by means of SE2 detector: >5mm WD
- Imaging by means of In lens detector: <= 10mm WD (depending on high voltage setting)
- Imaging by means of BSE detector: 8-10 mm (Optimum of the BS electron detection)
- EDX analysis (depending on imaging angle): 9 mm WD

After optimum setting of the high voltage and the working distance for the respective sample, it will be necessary to adjust the other parameters influencing the quality of the image, such as focus, correct aperture setting and correction of the astigmatism. Brightness and contrast can be adjusted manually depending on the image. Use of a reduced scan is optional for the adjustment of focus, aperture alignment (if necessary) and stigmation.
After having reached an optimum brightness and contrast adjustment, the image will be saved into the image store by means of noise reduction (see 4.3.2) and frozen there. Freezing of the image means that the content of the image will not be updated. The electron beam will be blanked off the beam path by means of the electromagnetic aperture switch and the sample will not be scanned any more. Setting of the blanking of the electron beam is done in the ***User Preferences*** (see 6.1). The frozen image state is indicated by a blue dot (●) in the lower right corner. Frozen images can be stored in a storage medium or printed using a printer.

4.1.3 Closing the User Interface

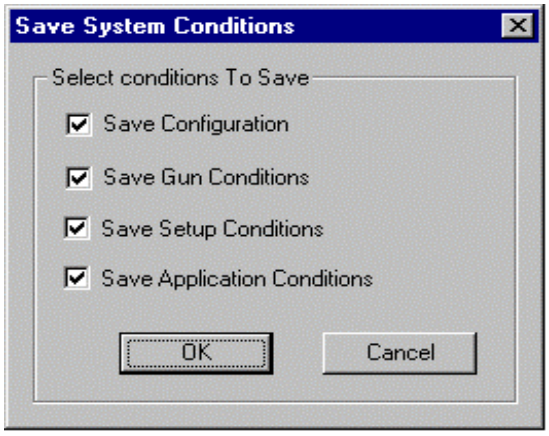
After the end of the session, the user interface can be closed by clicking ***FILE→ EXIT*** **or** ***FILE→ LOG OFF*** using the Pop-Up menu. The user will be asked whether the set parameters are to be saved. Confirming with "Yes" will store these parameters (signal source, high voltage, focus etc.) in a macro (Restore4.mlc) in the corresponding user directory. This macro can be activated later on to reset the microscope to the saved conditions. A confirmation with "Yes" should be used only if proper start up conditions are set on the microscope, i.e. high voltage, selection of a detector and appropriate adjustment of the other parameters. Activation of this macro will thus result in an immediate usability of the microscope. Clicking "No" means that no macro will be created and no existing macro will be rewritten.

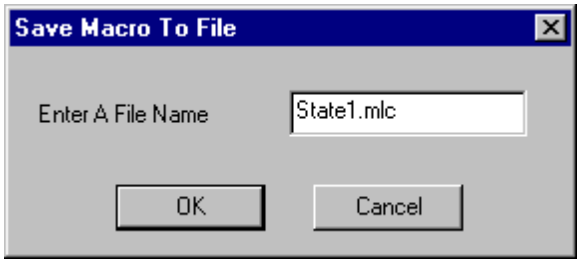
It is not necessary to close the software for short interruptions of the work on the microscope. Switching off the high voltage will be sufficient.
For longer periods, such as for the night or for the week-end, the electron microscope should be run down to the stand-by mode by first closing the user interface. After that, close the operating system Windows® and switch off the integrated computer by using the Standby button (middle yellow button) on the plinth.

The voltage can be switched off for maintenance or repair works by using the red key. This will switch off all electric or electronic components. Before switching off completely, run down the cathode manually using the user interface.

4.1.4 Saving and Loading Special Instrument Parameters

As indicated in 4.1.3, the conditions of the microscope can be saved in a macro at the end of a session. Clicking ***FILE→ RESTORE*** in the Pop-Up menu will activate this macro to reset the data saved in the macro. By doing so, the instrument will be reset to the operating conditions just used. Manual adjustment of high voltage, detector and focus will not be necessary.





It is also possible to save different special conditions while working with the microscope by opening FILE→ ***SAVE STATE...***. A window will open to determine the parameters to be stored. After confirming with "OK" the macro can be given a separate name. This macro will be saved in the corresponding user directory, allowing the storage of most instrument settings.

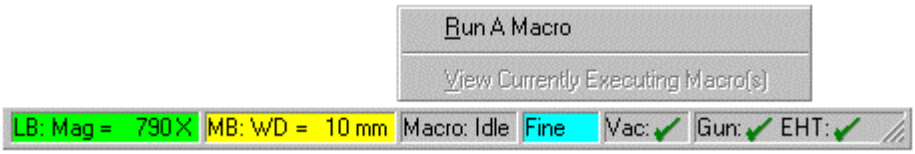
To load specific operating conditions, click ***FILE→ LOAD STATE...*** to open a list containing the different (macros) operating conditions saved in the user directory. Selecting a macro and pressing “OK” will start the macro and reset the stored parameters on the microscope.

Stage coordinates will not be saved in these conditions. Please use the window for the storage of stage coordinates as explained in 5.2.

4.2 The Standard Toolbar

The toolbar gives access to all frequently used functions and parameters. Activation of the ICONS in the toolbar is by use of the left and the middle mouse button. Dragging the mouse cursor over a ICON will display a short explanation (Tool Tip) on the function of the corresponding ICON at the lower side of the mouse cursor (see 6.5.1).

Clicking on the symbols will activate either settings or control windows. The status bar will indicate the assignment of the left and middle mouse button, such as magnification (left mouse button) and focus (middle mouse button) in the example below. The status bar also allows the activation of commands for the vacuum (VENT/ PUMP), the filament (GUN ON/ OFF) or the acceleration voltage (EHT ON/ OFF) by clicking VAC, GUN or EHT. The sensitivity of the mouse control can be set using ***FINE/ COARSE.*** Certain macros of the software can be activated by clicking the window ***MACRO: IDLE***.



Name	Symbol	Left mouse button	Middle mouse button
Restore		Loading the last condition as saved when ending the program	Opens the window to load a saved condition (Load State).
Accelerating Voltage		Setting of the desired acceleration voltage	Open of the index Tab ***Gun*** in the ***SEM Control*** window
Specimen Change		Activation of this symbol will start the pumps if the chamber is vented. Activation in operating conditions will run down the high voltage and start the venting of the chamber. A window will open allow to restart the evacuation of the chamber after exchange of the sample	Open of the index Tab ***Gun*** in the ***SEM Control*** window
Pix Avg.1/ Cont Avg. 2		Pixel averaging at scan rate 2	Continuous image averaging at scan rate 2
Pix Avg. 3/Cont Avg. 4		Pixel averaging at scan rate 3	Continuous image averaging at scan rate 4
Pix Avg. 6/ Cont Avg. 6		Pixel averaging at scan rate 6	Continuous image averaging at scan rate 6
Pix Avg. 9/ Frame Int. 5		Pixel averaging at scan rate 9	Image averaging at scan rate 5 (freezing of the image after execution)

Frame Int. 7/ Frame Int. 8		Image averaging at scan rate 7 (freezing of the image after execution)	Image averaging at scan rate 8 (freezing of the image after execution)
Faster/ Slower		Selects one faster scan rate per left mouse button click	Selects one slower scan rate per middle mouse button click
Freeze/ Unfreeze		Freezes/unfreezes an image	
Normal Mode		Normal screen mode, switch-off of the wobbler. Assignment of the mouse button: Left Mouse = Magnification/ Middle Mouse = focus	
Reduced Raster		Switches between reduced scan and normal screen mode	
Split Screen		Switches between split screen and normal screen mode	
Dual Magnification		Switches between dual magnification and normal screen mode	
Chamber scope		Activation of the CCD camera, mouse button assignment: Brightness /contrast	Open of the index tab ***Detector*** in the ***SEM Control*** window
Stigmation Alignment		Activation of a reduced scan, assignment of the mouse buttons: Left Mouse = Stig. -X, Stig. -Y/Middle Mouse = Focus	Activation of the wobbler and of reduced scan if (***Tools→ User Preferences.→ SEM Conditions→ Focus Wobble→ Reduced Raster*** is switched to ON), mouse button assignment: Left Mouse = Aperture Align XY/ Middle Mouse = Focus
Point-point text annotation		Inserts a point-to-point measurement	Opens the text editor
Toggle INLENS/ SE2		Toggles between In lens and SE2 detector	Opens the index tab ***Detector*** in the ***SEM Control*** window
Brightness/ Contrast		If Auto BC is deactivated in the Detector window, mouse assignment will be switched to brightness/contrast. If Auto BC is activated, mouse assignment will switch to GAIN/OFFSET	Switches: Auto BC=ON (mouse button assignment GAIN/OFFSET) Auto BC=OFF (mouse button assignment Brightness/Contrast)
Magnification Auto Focus/stig.		Mouse button assignment: magnification/focus	Opens the Auto Focus & Auto Stigmator algorithms

Export TIFF file		Saves the image as a TIFF file with the assigned settings	Opens the Export ***TIFF*** window
Print Image		Prints the image on the default printer	Opens the Print ***Setup*** window

4.3 The SEM Control Window

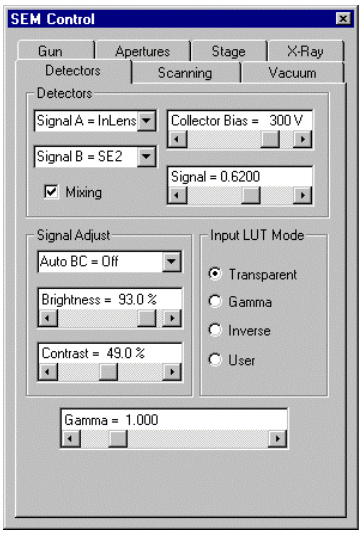
The ***SEM Control*** window contains all parameters necessary for the control of the microscope. This window provides the ability to read and set all parameters necessary for the operation of the microscope. Open this window by using the key combination **(*CTRL* + *G*)** or ***TOOLS→ GO TO CONTROL PANEL.*** This window is subdivided into seven index tabs containing the following components:

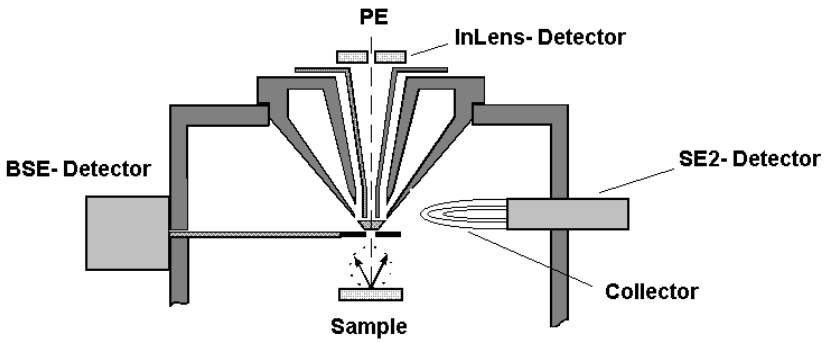
* **Detectors**: selection of the detectors, signal adjustment, mixing of signals (requires the License: SIGMIX), Gamma correction, inversion
* **Scanning**: noise reduction, scan rates, spot, live and X-ray line profile
* **Vacuum**: Start of pumping and venting, displays values on vacuum system
* **Gun**: switching on and off the acceleration voltage and the filament, important settings of the filament
* **Apertures**: selection of the aperture, alignment of the apertures and of the filament, emission mode, image optimization
* **Stage:** stage coordinates, entering relative and absolute coordinate values, special stage settings
* **X- Ray:** Setting and starting analogous EDX mappings.

Below is a more detailed explanation of these components.

4.3.1 Detectors

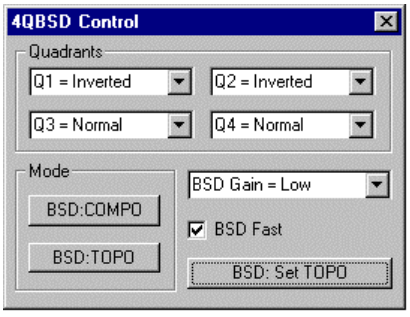
Standard equipment on the LEO 15xx (except LEO 1525) is two secondary electron detectors(in-lens and chamber (SE)). Reading and setting of all relevant detector parameters is via the index tab ***Detectors.*** The chamber SE detector, Everhart-Thornley, is suitable for the detection of SE electrons at longer working distances (> 5mm). By using the inlens detector, very good images are obtainable at low acceleration voltages. However, this detector should only be used at short working distances (<10mm). Another advantage of the Inlens detector is its high efficiency with regard to the detection of SE_1 electrons. These electrons develop in the immediate spot center. The position of the InLens detector within the beam path excludes the detection of back-scattered electrons and secondary electrons of the categories SE_2 and SE_3 . Thus, imaging with the Inlens detector will give pure information on the surface of the sample. BSE detectors of different types can be adapted optionally.

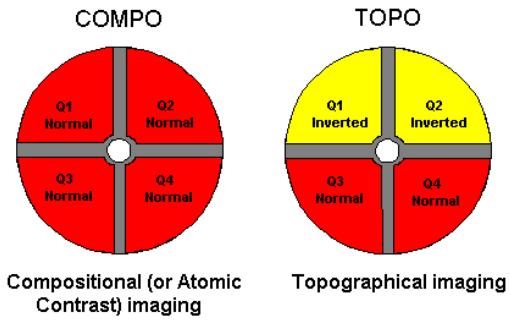




Signal A= or Signal ***B***= provides the ability to select the different detectors to be used as a signal source. ***Signal A*** will always be the active signal displayed on the screen. Activation of the control box ***Mixing*** allows mixing of two detector signals by means of the slide bar ***Signal*** in a range of 0.000 to 1.000 (0 - 100%). The example shows a 62% signal from the In-lens detector and a 48% signal from the SE2 detector.
Collector Bias will vary the collecting potential of the chamber SE2 detector between -250V -> +400V.
Signal Adjust selects the different adjustment modes for the detector signal (Auto BC=OFF: brightness and contrast must be done manually, Auto BC= ON: brightness and contrast will be set automatically by the system).
It is recommended that when beginning a work session use Auto BC and adjust brightness and contrast manually after alignment and optimization of the image.
By selecting ***Gamma*** in the control box ***Input LUT Mode*** the transfer function of the input signal can be set to non linear using the slide bar ***Gamma.*** This function is used to improve images containing a lot of information within a small number of gray scales.
Selecting ***Inverse*** in the control box ***Input LUT Mode*** will invert the input signal. By selecting ***User***, user specific settings, which can be set and saved using **EDIT→** ***INPUT LUT,*** can be applied to the input signal.

There is a separate configuration window for the four-quadrant BSE detector. This window can be opened using ***TOOLS→ GO TO PANEL→ 4QBSD CONTROL***. Each quadrant of the detector can be set to one of the three conditions ***Off***, ***Normal*** or ***Inverted***. Two predefined quadrant configurations are available. The optimum material contrast (COMPO) will be obtained by pressing the key ***BSD: COMPO*** whereas the optimum topographic contrast (TOPO) will be obtained by pressing ***BSD: TOPO***. The selection of these predefined conditions will switch the quadrants of the detector according to the illustration below. Some applications may require a change to the quadrant configuration, set the individual segment settings as required and press **BSD: Set TOPO**. These settings will be remembered and used whenever the TOPO command is given.
The control window ***BSD Gain*** shows the current Gain setting of the amplifier. If the BSD Auto Range is checked the signal contrast level automatically sets the Gain. For more precise setting of BSD contrast, deselect **BSD Auto Range** and select a Gain setting suitable for the sample. The contrast adjustment range now covers the selected gain range. The control box ***BSD Fast*** sets the bandwidth of the amplifier, it is switched on for normal visual scan rates and switched off for slower scan rates.





Illustrations with different signal sources:

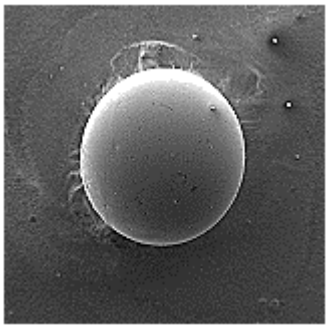


Illustration with the SE2 detector at a positive collector voltage (+ 400V). The image shows a regular illumination of the sample and bright contours (edge effect). The topography can be distinguished very well whereas the material contrast is weak.

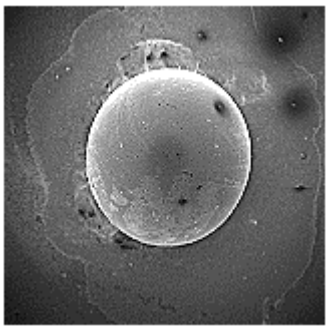
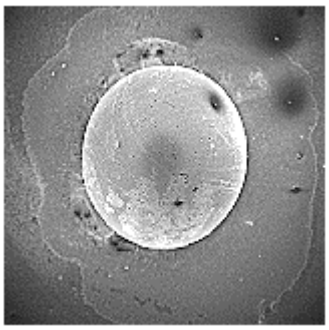
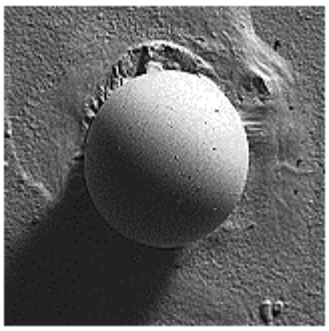


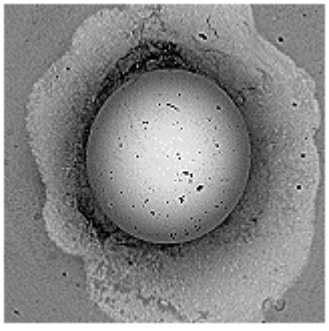
Illustration with the Inlens detector. Although the image shows a very flat illumination of the sample, structures can be recognized which could not be seen on the SE2 image. Material contrast and topography are weak..



The mixed image between Chamber SE Detector and Inlens SE Detector shows topography and fine structures. The effect can be continuously adjusted.



Imaging with the SE2 detector at negative collector voltage (-250V). Only high energetic back-scattering electrons are detected The image shows an extremely strong topography with shadows. The material constrast is almost completely absent

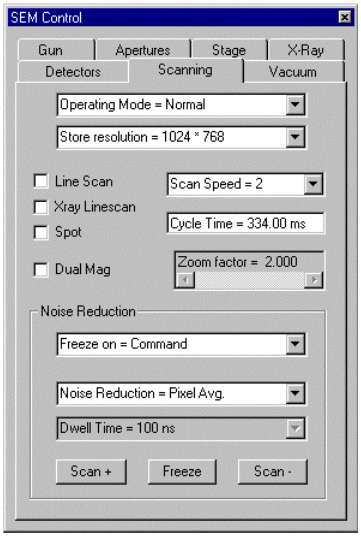


Imaging with a BSE detector. The image shows only small surface contrast, but differences in material can be distinguished very clearly. The topography is imaged weakly.

4.3.2 Noise Reduction

The index tab ***Scanning*** provides all settings for optimum scanning of the electron beam and for noise reduction as well as the selection of the different scan modes.

Operating Mode: Selection of the different screen displays (reduced scan, normal imaging, split screen, emission image)



Store Resolution:
Setting of the store resolution of the image. The following four resolutions are possible:

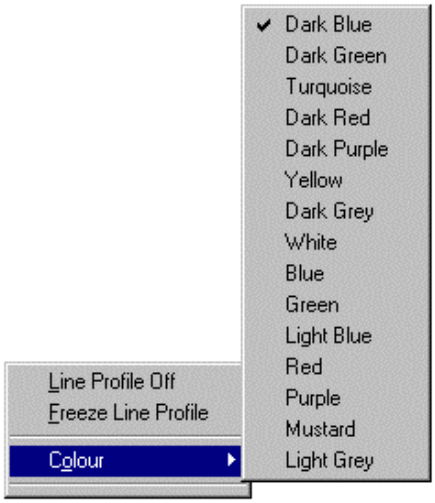
512 x 384 (required storage capacity of the image: 0,2 MB)
1024 x 768 (Required storage capacity of the image: 0,8 MB)
2048 x 1536 (Required storage capacity of the image: 3 MB)
3072 x 2304 (Required storage capacity of the image: 7 MB)

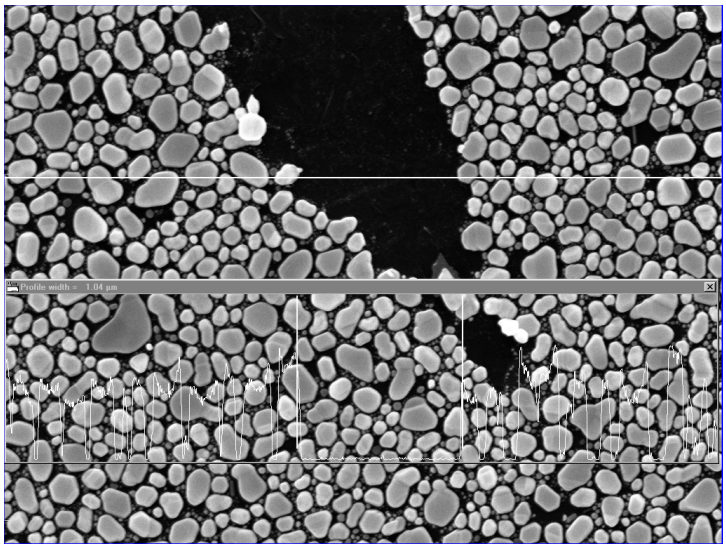
The selection of ***Store Resolution*** will produce effects on the ***Cycle Time*** and on the required storage capacity of the images to be saved.
The normal resolution,1024 x 768, provides sufficient image quality even when printing in 8½ X 11 format.

Scan Speed:
Selection of the different scanning speeds.

Cycle Time:
Indicates the time necessary to enter the complete image into the image store. This parameter depends on the selected ***Store Resolution***, ***Scan Rate, Dwell Time*** and ***Line integration*** or ***averaging*** (N value). The ***Dwell Time*** indicates the time the electron beam will remain on a pixel field (nano-second) during a scanning pass.

Line Scan:
Scanning activation of the electron beam along a defined line. The image will be frozen. A horizontal line and a histogram will be displayed on the screen indicating the course of the signal along this line.





Clicking the left mouse button on the line will allow the line to be moved to the desired sample spot. This function is useful for the measurement of certain structures by means of the signal histogram. Two vertical lines are shown within the histogram panel which can be dragged with the left mouse button. The upper left

corner of the diagram indicates the distance of these lines from each other. Clicking the right mouse button within the diagram displays a menu allowing special settings of the color of the graph and offering the ability to freeze the line profile.This profile can be saved together with the image by activating the item ***Annotation*** in the menu ***Export TIFF*** (see 4.5.1).

X-ray Linescan:
The selection of this function results in an image identical to ***line scan*** as explained above. However, this diagram displays the intensities of EDX signals along the determined line. The different EDX signals (corresponding to the energy of the selected emission line and thus to the atomic number) are defined in the respective software of the EDX system. Special types of imaging can be selected within the diagram by clicking the right mouse button.

Spot:
Selecting the Spot mode will freeze the image and display a cross on the screen. This cross can be dragged arbitrarily in the image by pressing the left mouse button. This will position the electron beam onto the selected spot. This function is intended for point analysis by means of an EDX system. .

Dual Mag:
Selection of this function will activate the clip magnification. The size of the respective clipping can be modified from 1 to 10 by means of the slide switch ***Zoom factor*** = .

Noise Reduction:

Freeze on =: Determines the method of freezing the image. Selecting ***COMMAND,*** the user will decide by pressing the key ***"Freeze"*** *or* ***"Scroll Lock"*** when the image is to be frozen. Selecting ***END FRAME,*** will result in an automatic freezing of the image after scanning one complete frame.

Noise Reduction=: selects the type of noise reduction. Selecting ***Pixel Avg.*** will use the selected SCAN RATE for the noise reduction. The higher the selected Scan ***Rate***, the slower the scanning of the corresponding sample area, thus reducing the noise level in the image. Selecting ***Frame Avg***. will provide noise reduction by taking several image frames and integrating them into the image store. When selecting this function, SCAN RATE is a pseudonym for the number of images to be integrated (see table).

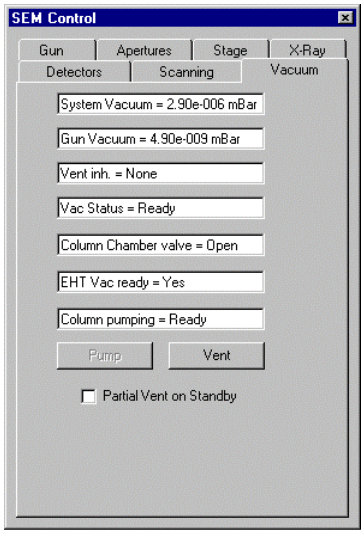
SCAN RATE	Number of images	SCAN RATE	Number of images
1	2	5	32
2	4	6	64
3	8	7	128
4	16	8	256

As already explained, ***Dwell Time*** determines how long the electron beam is to remain at a pixel position. The selections 100, 200, 400 and 800 nanoseconds are available. The image will be frozen automatically when the selected number of images has been taken and integrated. The function ***Continuous Avg***. is similar to Frame Avg., the difference being that the image is not frozen automatically. This selection will update the image store continuously. The selected number of images will be scanned continuously, the keys "***Scan+***" and "***Scan-***" allow switching to faster or slower scan speeds. Pressing the key "***Freeze***" *or* ***"Scroll Lock"*** will freeze the image in the image store and assign "***Unfreeze"*** to the key.

4.3.3 Vacuum

The index tab **"*Vacuum*"** displays the vacuum in the chamber and filament area and controls certain functions and valve settings. The pressure measuring unit can be set to Mbar, Torr or Pa within the LEO 32 software (see 6.1).
The key "***Vent***" allows venting of the chamber (with High Tension (EHT) off). After exchange of the sample, pressing the key "***Pump***" will restart the pumping procedure. If you do not want the pumps to continue working in standby mode, activate the function ***Partial Vent on Standby.*** This will result in a partial venting of the chamber when the microscope is switched off using the Standby button. Partial venting will assure that oil vapours from the roughing pump do not enter the chamber in standy mode. Starting the system by pressing the "Start" button will automatically activate the pumping procedure.

When starting the bakeout of the IGP in stand-by mode, ***Partial Vent on Standby*** MUST BE deactivated before closing the software!



System Vacuum: Vacuum in the chamber.

Gun Vacuum: Vacuum in the gun and in the liner tube. Deterioration of this vaccum to the upper 10^{-9}- level (8 γ 9 X 10^{-9} mbar), indicates a bakeout of the IGP should be performed soon (see 6.2).

Vent inh.: Status indication for the venting of the chamber.

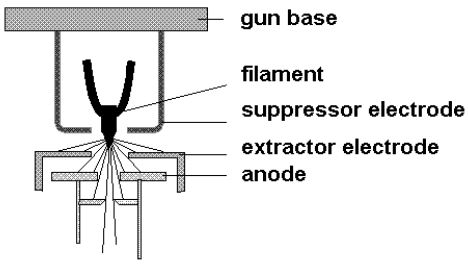
Vac Status: Status indication for the release of the vacuum (chamber).

Column Chamber valve: Indication of the position (open/closed) of the V3 valve between liner tube and chamber.

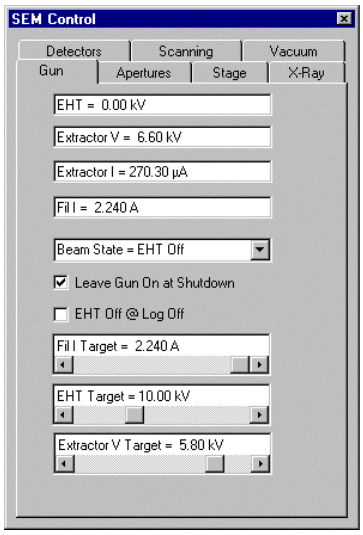
EHT Vac ready: Status indication of the high voltage release..

Column pumping: Status of the vakcuum release (gun and liner tube)

4.3.4 Cathode



A thermonic field emission cathode, Schottky emitter (ZrO/ W cathode), is used to produce the beam. This Schottky FE cathode consists of a finely etched, <100> oriented Tungsten Mono Crystal with a sintered reservoir of zirconium oxide at the shaft. The heating current (Fil. I) will diffuse the ZrO to the filament tip reducing the work potential for emission of the electrons from 4,6 eV to 2,8 eV. Depending on the filament temperature and the field strength generated at the filament tip by the tension of the extractor electrode, equilibrium will develop allowing a stable emission of the FE source.
The most important filament and high tension data as well as special presettings can be found and set in the index Tab, ***Gun*** in the ***SEM Control*** window .



EHT:
Indicates the current acceleration voltage in kV.

Extractor V:
Indicates the value of the extractor voltage.

Extractor I:
Indicates the current value of the extractor current

Fil. I:
Indicates the current value of the filament heating current

Beam State:
This menu switches on or off the EHT (***EHT ON***/***EHT OFF***). Selecting "Shutdown" will slowly shut down the filament

Activation of the control box ***Leave Gun On at Shutdown*** will exclude shutdown of the filament when closing the software and in standby mode of the system

*I*n ***Leave Gun On at Shutdown, Shutdown*** refers to exiting the LEO-32 software and setting the microscope to standby mode. In the menu ***Beam State***, ***Shutdown*** means the manual shutdown of the filament.

EHT OFF @ Log Off:
Activation of this control box will automatically switch off the EHT when closing the software, using Log ***Off*** or ***Exit.***

Fil. I Target:
The filament heating current can be modified within certain limits by means of this slide switch. When exiting the LEO-32 software, the modified value will be reset automatically to the initial value.

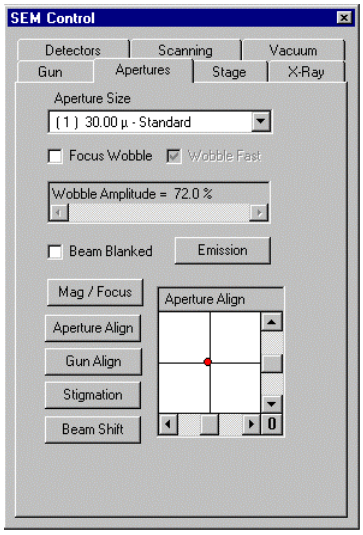
EHT Target:
This slide switch provides the ability to set the acceleration voltage continuously.

Extractor V Target:
Changing the extractor voltage as for ***Fil. I Target.***

Clicking the right mouse button in the lower right side of this window will display the menu ***User Max EHT...*** and allows the maximum value of the acceleration voltage to be set or changed. This setting requires the privilege *Supervisor* (See 2.1).

4.3.5 Apertures

This index Tab provides the ability to select the different apertures and to perform adjustments of the apertures, filament and the electron beam..



Aperture Size:
Selection of the different apertures
(1) 30 µm aperture: standard aperture to solve most microscopic and analytic problems
(2) 7.5 µm/ (3) 10 µm/ (4) 20µm apertures: apertures for highest resolution and beam sensitive samples
(5) 60 µm/ (7) 120 µm apertures: apertures for analytic problems requiring very high probe currents (e.g. EDS, EBSP).

Focus Wobble:
Activation of this control box will switch on or off the focus wobbler necessary for the exact alignment of the selected aperture in the beam path. A lateral drift of the image when adjusting the focus indicates that the beam is not passing through the aperture center. Activation of the Focus Wobbler will result in a movement of the image in vertical and horizontal direction. Perfect alignment is shown as an image which will defocus without image shift.

Aperture adjustment:
1.) Activate the control box ***Focus Wobble,*** adjust the ***Wobble Amplitude*** by means of the slide bar and adjust the Wobble frequency by activating or deactivating ***Wobble Fast***.
2.) Clicking the key ***Aperture Align***, assigns that function to the navigation box.
3.) Adjustment of the aperture in X and Y direction is by means of the slide bar in the navigation window (or by dragging the mouse, in X and Y directions with the left mouse button pressed) or (by dragging the red dot in the box with the left mouse button).
4.) Adjust both the X and Y directions until there is only pulsation of the image (no swinging to one side)
5.) Deactivate the control box Focus ***Wobble*** and refocus the image.

The optimum adjustment of the aperture in the beam path has a decisive influence on the resolution and focus of the image. The aperture should therefore be realigned when image shift is present during focusing (after an aperture change or large change in the EHT setting)

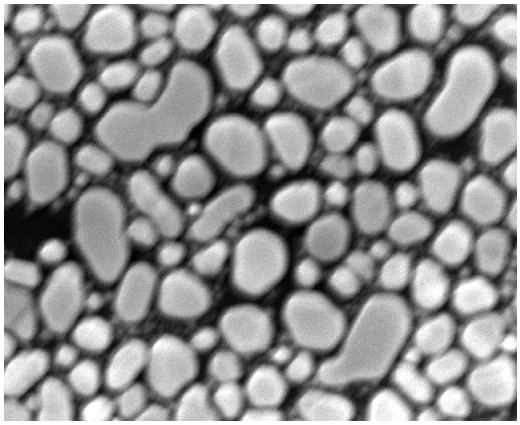
Beam Blanked:
The electron beam will be blanked off the beam path by means of the electromagnetic aperture switch (no scan of the sample).

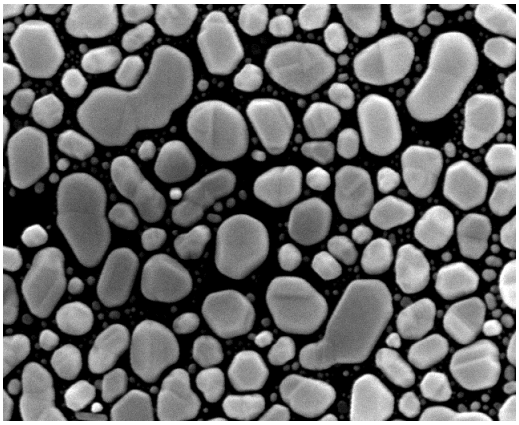
Emission:
This key activates the emission mode necessary to center the filament (SERVICE FUNCTION). The emission image and a graticule will be displayed on the screen (after activation in ***User Preferences*** see 6.1). Clicking the key ***Gun Align*** will adjust the beam profile image to the proper position by using the slide bar in the navigation window (or by dragging the red dot with the left mouse button). To do so, the aperture must be centered. Re-clicking the key "***Emission***" will switch back to normal scan mode.

The emission mode is to be used mainly by service staff. If not careful the user may miss-align the column and cause a decrease of image quality and resolution. The position of the optimum signal output does not absolutely mean that the emission image is positioned exactly in the center of the graticule.

Key *Mag/ Focus*:
Switching the mouse button assignment (left mouse button magnification, middle mouse button focus)

Key *Stigmation:*
Switching of the mouse button assignment (left mouse button Sigmation X / Stigmation Y, middle mouse button focus) and selection of the stigmator for the navigation window.
Local magnetic fields due to local electric charging on inhomogenious samples will produce an elliptic electron beam and an inexact focussing of the sample surface as the elliptic electron beam will distort the sample structure when focussing. To restore a rotation symmetry of the electron beam, an electromagnetic correction field created by the stigmator will be necessary.



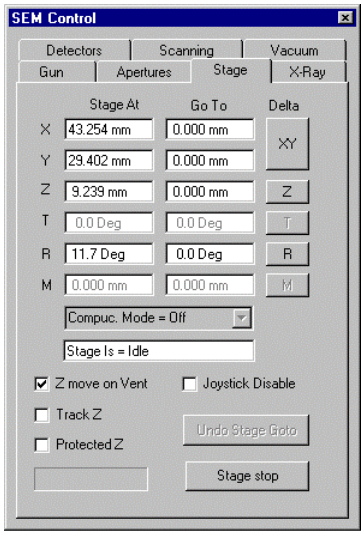


In order to obtain a correction of the astigmatism, an intermediary position between a under and over focused image will be set by means of the focus control. The structures will be unsharp in the X and Y direction. Clicking the left mouse button and dragging the mouse to the right or left or by means of the navigation system, the stigmator will be adjusted in X direction. This will be done visually to obtain an optimum imaging quality. After correct adjustment of the X direction the same will be done in Y direction (by dragging the mouse up and down).It is also possible to adjust both directions at the same time. After the correction, the image should be displayed in optimum sharpness

Key *Beam Shift:*

Switching of the mouse button assignment (left mouse button, Beam Shift X / Beam Shift Y), middle mouse button keeps the previous assignment) and selection of Beam Shift for the navigation window.
By means of Beam Shift, The electron beam can be moved in the X and Y direction by 20µm each. This function is suitable for higher magnifications when an exact positioning of the area of interest by stage movement may be difficult. However care should be taken that the stigmator may need to be readjusted if the image is moved to the limits of the shift range. (large displacement in X and Y direction).

4.3.6 Stage



This index Tab ***Stage*** displays the current position of the stage, allows a user to enter absolute and relative coordinates or to activate or deactivate special pre-settings for the stage. The column ***Stage At*** indicates the current coordinates of the different axes. To enter absolute coordinates for the stage, double-click the value of the corresponding stage axes in ***Go To*** with the left mouse button. This opens a window allowing the user to enter a new value, the stage will then move to the new position. Relative coordinates for the different axes may be entered in the column ***Delta*** by clicking the corresponding key. It is also possible to enter negative values.
The selection field ***Compuc. Mode*** activates or deactivates the compucentric operation of the stage. However, this requires the license and the calibration of this software option (see 5.9).
The window ***Stage Is =*** indicates whether the stage is idle or busy.
Clicking on "***Stage Stop***" will stop the stage immediately.

Z move on Vent:
Activation of this function will result in an automatic stage move to the lowest Z position whenever venting of the chamber is initiated.

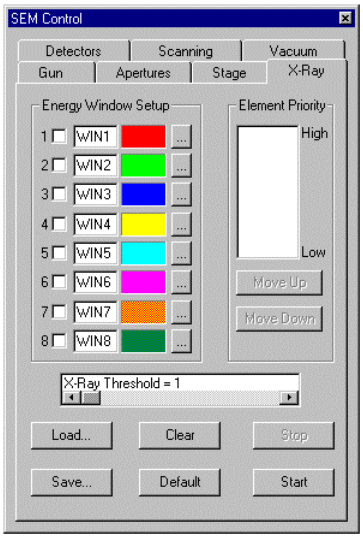
Track Z:
Selection of this function will provide automatic readjustment of the focus as the stage Z movement is changed.

Protected Z:
Activation of this function will produce automatic comparison of the current Z coordinate to the new coordinate when opening saved stage positions.. If the new Z position is higher than the current position, the X/Y/T/R coordinates will be located before moving to the new Z position. If the new Z position is lower, Z will be changed before the other coordinates.

Joystick Disable:
Switches on and off the hard panel joystick.

4.3.7 EDX Mapping (Requires the Licence: XRAY)

This Tab allows settings for binary EDX mapping and starting the record of mappings. By means of this option, scanning and imaging of binary output signals of an EDX system are possible, provided that the signal lines of the EDX system have been installed and configured correctly on the EDX interface of the SEM. Each of the regions of interest sends pulses from the EDS system for a selected energy range (the setup of the regions of interest is done through the EDS system). These pulses will be accumulated on the base of the image pixels and give information on the element mapping.
A maximum of 7 channels may be scanned and displayed on the screen simultaneously. Clicking ***Energy Window Setup*** will determine the channels to contribute to the mapping by activating the figures 1 to 8.
The windows ***WIN2*** to ***WIN8*** (***WIN1*** being reserved for simple mapping) allow asigning short names to the different channels in order to create a reference to the numbers of the energy windows used in the EDX system.
A different color may be contributed to each element to be imaged in the mapping. Clicking the keys "..." enables selection of the colors in a range of colors.



The window ***Element Priority*** displays the activated channels with their respective short names. This list determines the element priority if two or more elements appear in the same pixel. This priority will decrease towards the bottom and can be modified by selecting and short name and pressing the keys "***Move Down***" or "***Move Up***".
After assigning the channels, placing and starting the energy windows in the EDX software, pressing the key "Start" will start the scan of the mapping. .
The mappings may be saved after ending the scan process by means of the noise reduction (***Freeze***).

Key ***Load***: Loading user specific settings.
Key ***Save***: Saving user specific settings: The selected channels, the Window names, the selected colors, the element priority and the value for X-Ray Threshold will be saved

Key ***Clear***: Erasing the screen and starting another scan.

Key ***Default***: Setting of the basic condition (see above).

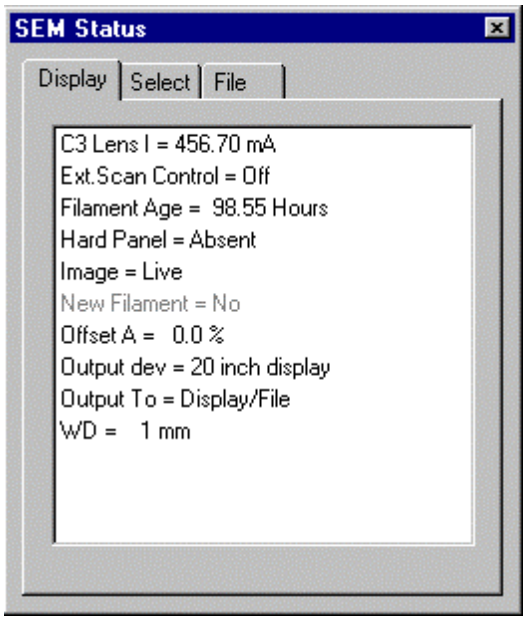
Key ***Start***: Starting the imaging.

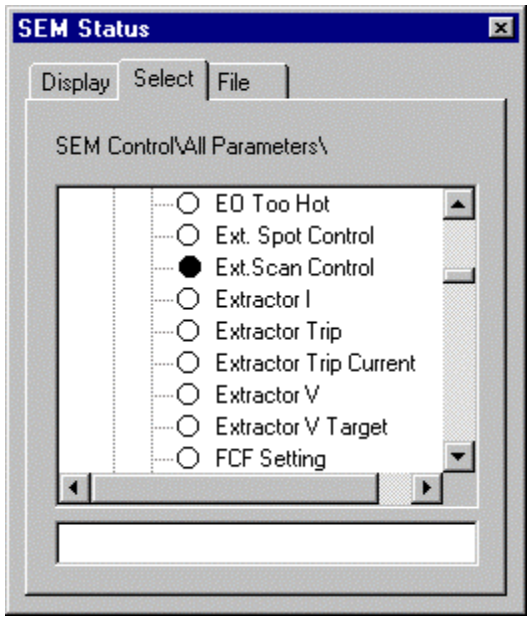
Key ***Stop***: Ending the imaging

X-Ray Threshold: Entering a threshold between 1 and 254. This value will determine the number of impulses to be sent from the EDX system before a corresponding colored image will be displayed on the screen.

4.4 The SEM Status Window

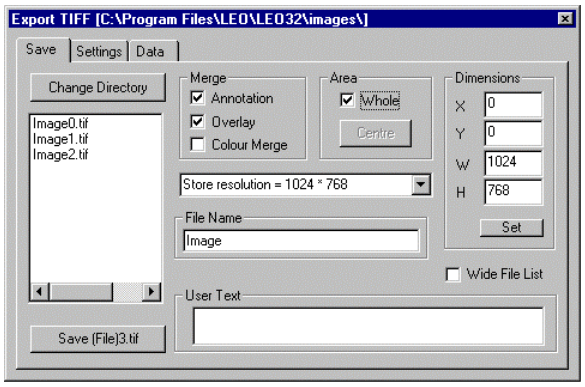
The ***SEM Status*** window provides another ability to view and set frequently used parameters. It can be opened using the Pop-Up menu ***VIEW→ SEM STATUS*** or by entering the key combination ***CTRL + I***. The status window lists combinations of operation parameters selected by the respective user. These values will be updated continuously and may be controlled interactively. Every parameter can be activated or deactivated by using the index Tab ***Select***. Furthermore, the selected composition may be saved using ***File*** in the corresponding user directory where the composition can be reloaded. This enables the user to create specific parameter lists for the most different tasks.
The parameters and functions listed in ***Display*** can be controlled interactively, i.e. that the parameter ***Ext Scan Control*** indicated in the example below can be switched from Off to On by clicking. It is also possible to enter numeric values. Double-clicking ***WD,*** for instance, enables entering a fixed working distance that may be adjusted exactly by means of the left mouse button. Several parameters are purely informative and cannot be switched or varied (e.g. ***Filament Age, Output Dev*** etc.):





4.5 Saving and Loading Images

After entering and freezing the image in the image store by means of the noise reduction, it can be stored on the hard drive or on another storage medium as a TIFF file. The window ***Export TIFF*** may be opened using the Pop-Up menu ***FILE→ SAVE IMAGE***, a right mouse click on the image ***→ Export Tiff*** or by using the key combination ***CTRL + E***.



Key: *Change Directory*:
Selection of the directory in which the images are to be filed. The list below indicates the images already saved.

*Control Box **Merge***:

Annotation:
Data zone, annotations and measurements etc. will be saved together with the image.

Overlay:
Only the data zone will be saved together with the image.

Color Merge:
Must be activated to store colored annotations or measurements together with their color in a gray image. However, this will reduce the number of grays of the image (256) by 20 gray scales, as this storage area is required for the information of the ***Annotation***.

Data zones, annotations or measurements saved together with the image will be "burnt" into the image. The image information behind the respective overlay will thus be lost.

*Control Box **Area:***

Clicking on **"WHOLE"** will save the complete image.

Control Box ***Dimensions***:

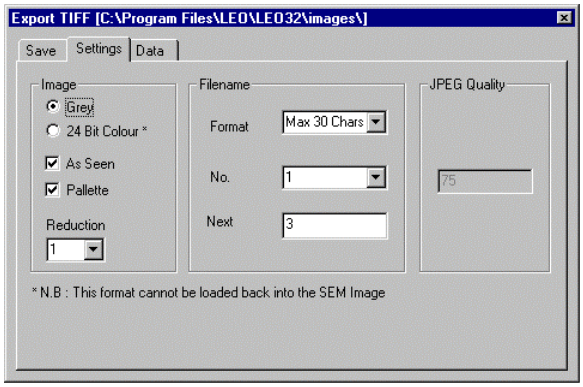
The upper left corner (X, Y), width (W) and height (H) of the image to be saved are listed. Selection of ***Whole*** in ***AREA*** will always set the upper left to 0,0; the size will correspond to the entered ***Store Resolution***. However, it is also possible to save only a clipping of the image as a file by entering the respective parameters in Dimensions**.** Clicking "***Set***" will then display size and position of the grid on the image corresponding to the clip to be saved. Size and position of this grid may be varied by using the mouse (Left mouse button). By clicking the symbol  in Annotation (see 4.7), a desired area in the image may be selected by using the mouse.

Selection ***Store Resolution:*** Clicking ***Store Resolution*** provides the ability to select the store resolution of the image.

A special name for the image to be saved can be entered in the field File ***Name***. It is also possible to add user text to the image. This text may be entered in the field ***User Text*** and will be indicated later on in the window ***Load Image*** (see 4.5.3) together with the image without the necessity to load this image in the image store. By pressing the key "***Save(file name).tif"*** the image will be filed in the storage medium together with the set parameters.

4.5.1 Special Configurations of Images to be Saved

The index Tab ***Settings*** allows special configurations concerning the format of the image and the type of file name.



Control Box ***Image:***

The image can be saved as a gray image (256 gray scales) or as a colored image (16 millions of colors) depending on the selected format (***Gray / 24 Bit Color***). Normally this configuration should be set to ***Gray*** and only be modified for special applications.

As Seen:
Reprocessing the images is possible by means of the Display LUT (see 4.6). Activation of ***AS SEEN*** will store the edited content of the screen.

Palette: Activation of this box will save the image together with the color palette. This palette will be applied automatically when reloading the image. This provides the ability to color images by means of the Display LUT although storing them as gray image. The complete color information will be saved in the palette and will therefore be available for further editing or for printing colored images.

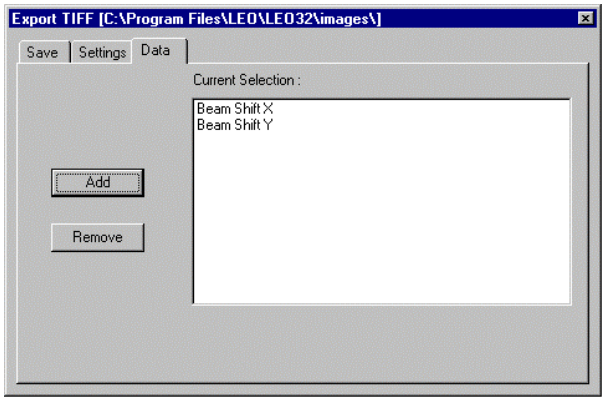
If images are saved as colored images (***24 Bit Color***) they **cannot** be reloaded back to the LEO user interface. However, it is possible to copy them to most of the Windows® user programs. If SEM images are to be colored and to be processed with the LEO user interface, it is therefore recommended to save the images as gray images with the respective color palette.

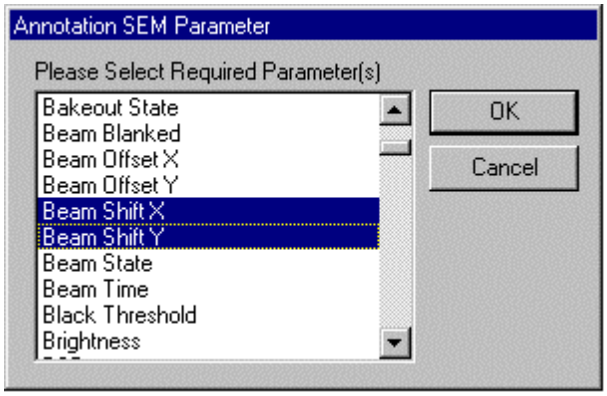
Control Box ***Filename***:

Four different formats may be selected for the file name. The selection ***Max 8 Chars*** will allow the contribution of up to 8 letters or numerals for the file name. Selecting Max ***30 Chars*** will offer the ability to enter up to 30 letters or numerals. Both settings enable the addition of a successive number to the file name. In the example above you will find a format of 30 letters. 1 has been selected for **No.** , 3 has been selected in the field next**.** That means that 29 letters are available for the file name. The 30th letter, a numeral, will be added automatically by the software, in the example above “xx...xx3.tif”. On the next save this numeral will increase by one and be xx...xx4.tif. This enables continuous saving without modification of the file name. Numbers between 0 and 7 are possible for **No.** The numeral 0 indicates that no successive number will be added. The parameter Next can be edited freely, allowing selection of the starting number as well as the rewriting of existing files.
It is also possible to choose a file name consisting only of numerals by selecting the configurations ***Photo Nr.*** and ***File Nr.*** When selecting ***Photo Nr.*** the file name will be composed of 4 numerals (XXXX.tif). The start of the successive count is set using ***NEXT***. After saving and printing an image, an addition to the selected number will take place. 7 numbers are available for the selection ***File Nr.*** where an addition will only take place if an image has been saved in a storage medium. These settings are global variables, i.e. modifications made by a user in his user directory will also influence the configurations of another user working in another directory. Filenames are always created with the entire number of digits (i.e. 0023.tif).

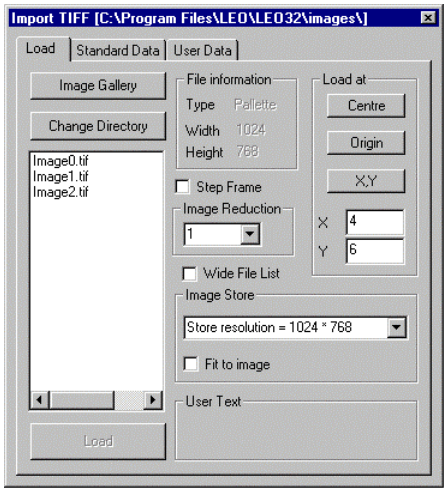
4.5.2 Saving Additional Information with the Image

The index Tab ***Data*** can establish a user specific list of parameters, which will be saved together with every image. Similar to the SEM ***Status*** window, where parameters are updated online.
The specific parameters can be selected from a list by pressing the key "***Add"***. With every image store, these parameters will be extracted from the microscope and saved together with the image. This enables the reconstruction of important data concerning the image.
Creation of this list of parameters will only be necessary once; afterwards it will be saved automatically for every image. Components can be removed from this list by pressing the key "***Remove".***



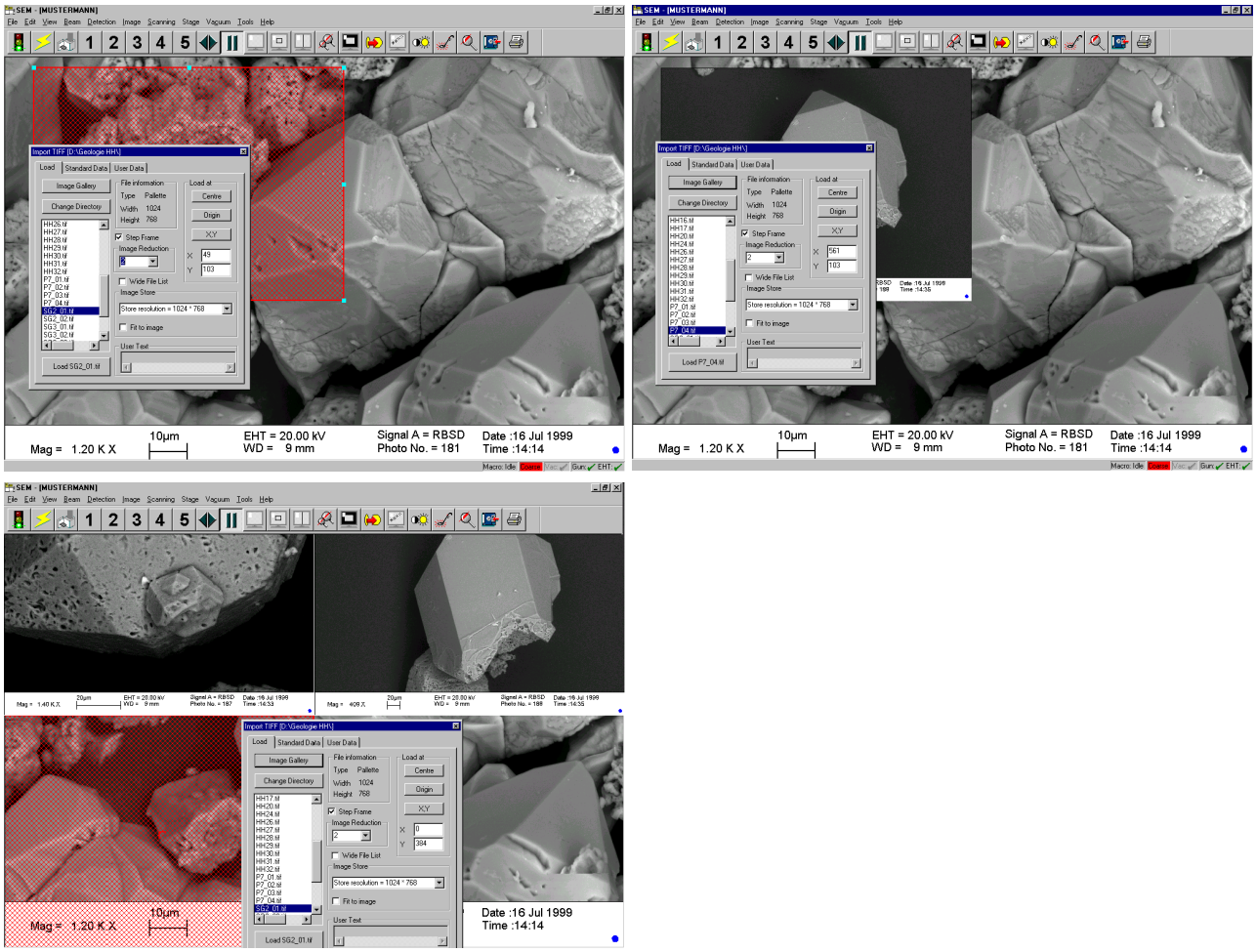


4.5.3 Loading of Images



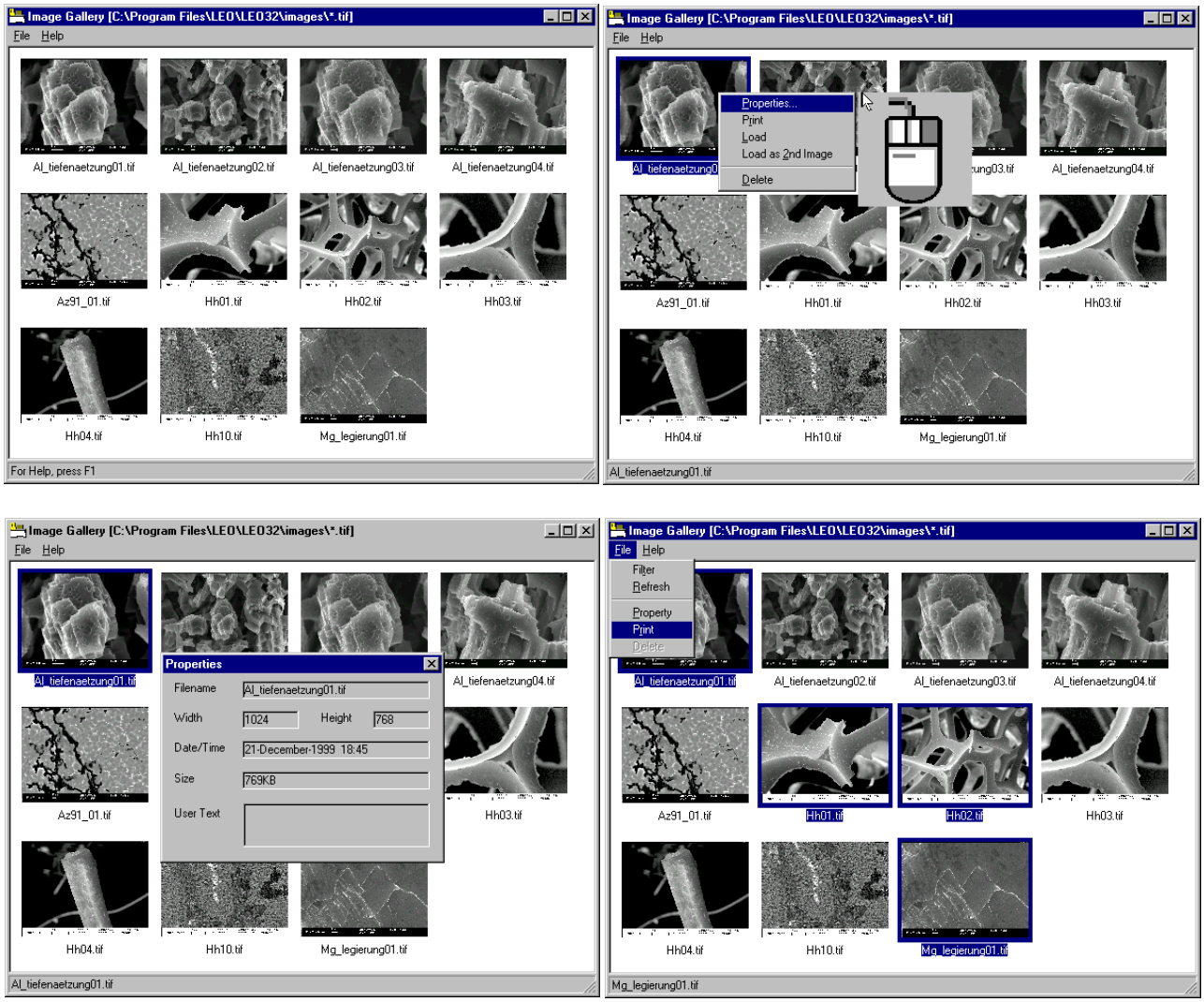
Using the window ***Import TIFF,*** TIFF images can be loaded back from any storage medium to the user interface by using the key combination ***CTRL + O***, right mouse click on the SEM image -> ***Import Tiff*** or the Pop-Up menu ***FILE→ LOAD IMAGE***. The left field lists the TIFF files contained in the respective directory. Changing of the directory is possible by clicking "***Change Directory***" if this option has been released in the Administrator (see 2.1). The field ***File Information*** indicates type and size of the selected image. If user text has been added to the image, this text will be displayed in the lower field ***User Text***.
If the image is to be saved in the image store in reduced format, the desired reduction factor can be selected in ***Image Reduction***. This provides an image-in-image display or of a composition of 4, 9, 16 etc. images in an entire image. Depending on the reduction factor, a grid will be displayed on the screen indicating the position and the format of the image to be loaded. Clicking "***Center***" "***Origin***" (upper left corner) or "***X, Y***" (free positioning) will select the position of the grid on the screen. If ***X, Y*** has been selected, the grid can be positioned freely by using the mouse. Pressing the key ***"Load"*** will insert the selected image at the corresponding position (see below).
The activation of ***Step Frame*** is recommended to represent e.g. four images as an entire image. This will automatically position the images correctly. Before loading the first image, click "***Origin***" to position the positioning frame in the upper left. Now the first of the four images can be selected and loaded using ***Load*** in reduced format. The positioning frame will then automatically go the next area. Now the second image may be selected and loaded
Activation of the control box ***Wide File List*** allows the presentation of the file names in full length (30 characters).

Store Resolution provides the ability to select the store resolution. If images with different resolution are to be loaded together, an automatic adaptation can be realized by clicking ***Fit to Image***.

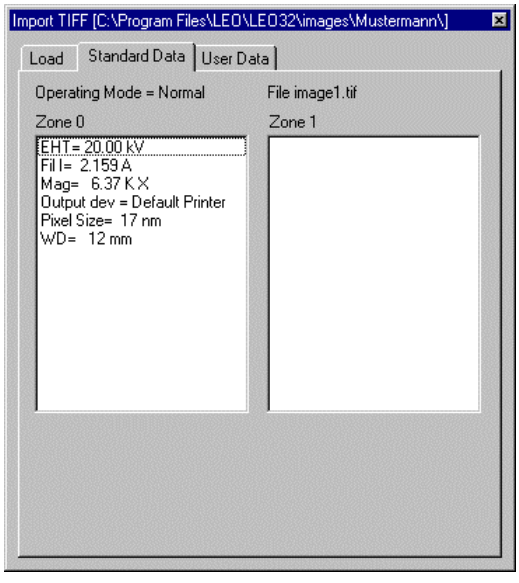


4.5.4 Image Gallery Function

The images contained in a directory can also be displayed as an album, i.e. in form of a gallery by pressing the key **"*Image Gallery*" .** The software will then control whether a gallery file (*.gal) has already been created in the corresponding image file. This file contains all information on the gallery. If such a gallery has already been created, it will be opened and eventually updated. If the software cannot find a *.gal file, the question will be displayed whether a gallery file from the user directory is to be loaded. Answering "No" to this question will result in the creation of a file ***GALLERY.GAL*** in the current image directory.
The image gallery, displaying the images in thumb-nail format with the corresponding file name, gives a rapid overview on the imges contained in the respective directory. A specific image from the gallery can be loaded by double-clicking the corresponding image. The image will thus be loaded to the image store and be displayed on the screen. Activating an image and clicking the right mouse button will open the menu ***Properties*** which displays information on the image such as store resolution, date of storage or user text. The command ***Print*** will result in printing the respective image on the default printer. By means of the command ***Load as 2nd Image*** the image may be loaded to a virtual second window (see 3.6.2). ***Delete*** will remove the corresponding image from the gallery without deleting it from any storage medium. The only effect is that the image will not be represented in the gallery any more.
It is also possible to print several images from the gallery together on one sheet. Images (not more than 6) can be selected by pressing CTRL and clicking the image with the left mouse button. These images can be printed on the default printer using the Pop-Up menu ***FILE→ PRINT***.

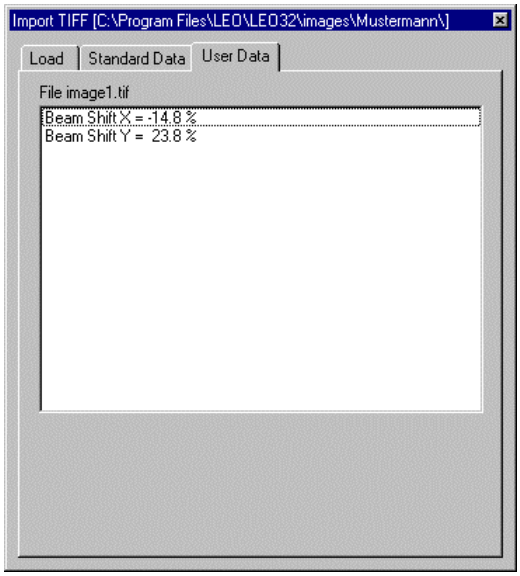


4.5.5 Extracting Stored Parameters



Special parameters, as set on the SEM at the moment of image storage, will be filed together with the image. These are the standard parameters saved automatically by the system as well as user-specific parameters which can be selected using the window ***Export TIFF*** (see 4.5.2). These parameters may be loaded by means of the index Tabs ***Standard Data*** and ***User Data*** without loading the image to the image store.

Standard parameters are the acceleration voltage (EHT), filament heating current (Fil. I), magnification (Mag), output device (Output dev), pixel size (Pixel Size) and working distance (WD). This data is stored for the corresponding zone of the image. In a Split Screen image, Zone 0 is for settings on the left half of the screen, Zone 1 for settings on the right side. In full image (normal) mode data will always be displayed in the Zone 0 field.

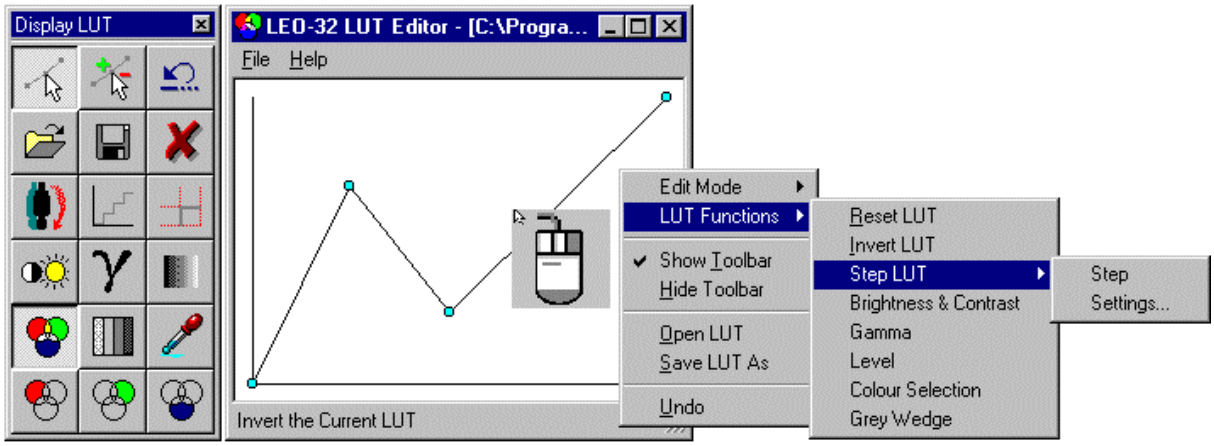


The user-specific data (***User Data***) depend on the parameters selected in the window ***Export TIFF*** (see 4.5.2).

4.6 Finishing Images by Means of Display LUT

Opening the LUT Editor by using the Pop-Up menu ***EDIT→ DISPLAY-LUT***. The Display LUT allows reprocessing of SEM images, e.g. by subsequent coloration, modification of brightness and contrast, inversion or insertion of Gamma function. These settings will effect stored as well as live images.
After opening ***Display-LUT,*** a toolbar will be displayed together with a graph representing the LUT. The transfer characteristic symbolizes the allocation of an input signal to a defined gray value. In the simplest case it will be a straight line connecting the points (0,0) and (255,255). This straight line may be processed by adding or displacing different points. It is also possible to refer certain operations to defined parts of the curve or to bend the complete curve by using the Gamma function.
The different functions can be selected using the toolbar or by clicking the right mouse button within the graph window. By doing so, a menu will be displayed which allows selection of the different functions. Using this menu, it is also possible to switch on (***Show Toolbar)*** or off ***(Hide Toolbar)*** the toolbar.

As modifications of the LUT will affect the stored as well as the live image, the Editor should be reset to the basic settings using Reset ***LUT*** before working again on a live image.



Below, you will find an explanation of the different functions of the Display LUT.

Moving and deleting points in the transfer characteristic
(Moving: Position the mouse cursor to the point and displace by pressing the left mouse button. Deleting: Position the mouse cursor close to the point and delete by pressing the middle mouse button.)

Adding or deleting points in the transfer characteristic (Adding: Position the mouse cursor within the graph field and press the left mouse button. Deleting: Position the cursor close to the point and press the middle mouse button).

Undoing last modification of the Display LUT

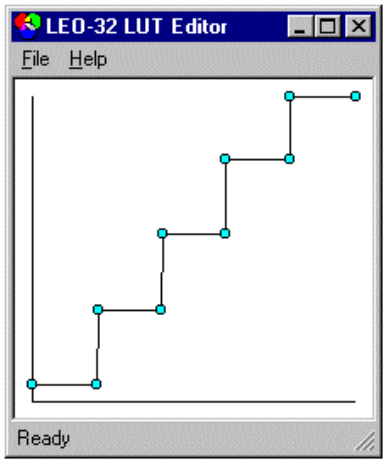
Loading special Display LUT settings and applying these settings to the actual image

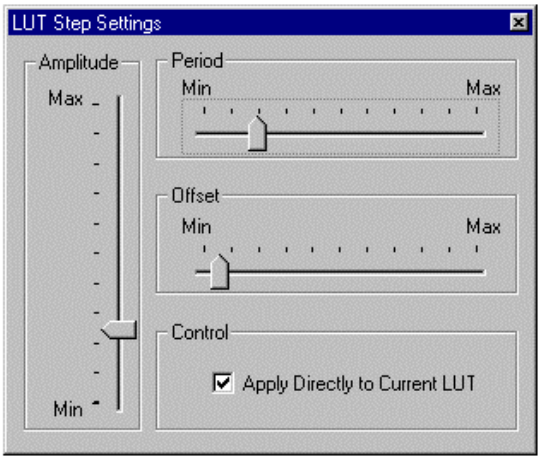
Saving special settings of the Display LUT

Resetting the Display LUT to the basic settings (use of the original data)

Inverting the actual transfer characteristic

Inserting a step function as transfer characteristic. This will change the transfer characteristic into a regular sequence of gray scales. The height of each step (Amplitude), the position of the first step (Offset) and the number of steps (Period) can be adjusted separately. It is also possible to continue to modify the curve by adding or moving different points.

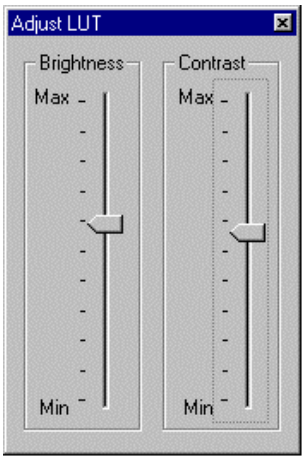


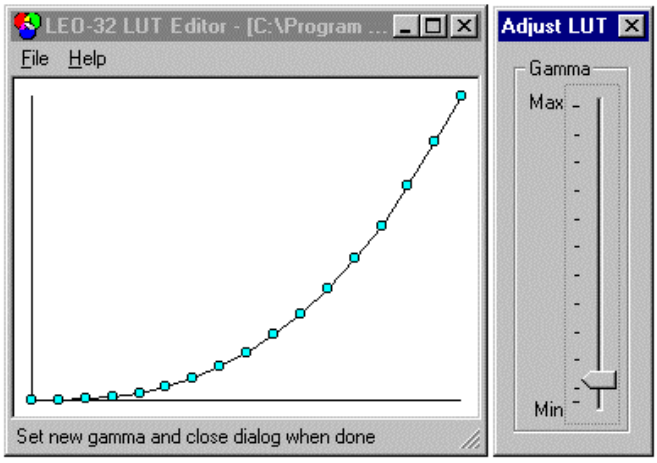


Opening the window ***LUT Step Settings*** to adjust Offset, Amplitude and Period for the step function.

Editing brightness and contrast.

The Gamma option enables the definition of the transfer characteristic as a curve to enlarge lower or higher gray scales. This function may be used to improve images containing a lot of detailed information within a few gray scales.

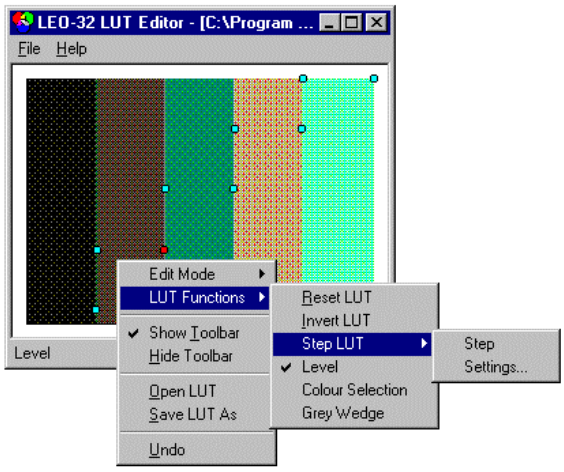


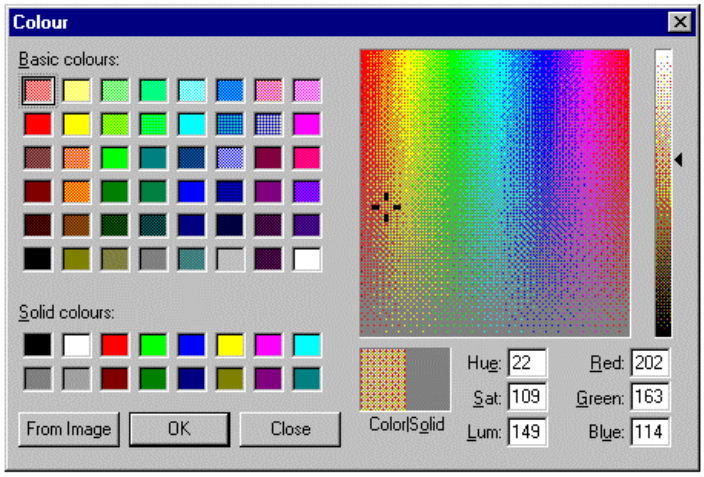


Inserting a gray wedge (continuous distribution of the gray scales from white to black) as an actual image to adjust special output devices.

Switching from RGB- to gray scale LUT.
The LUT Editor includes three transfer characteristics, one for every video color (red, green and blue). If these three graphs are identical, the image will be displayed as a single color (gray) on the screen. Switching to RGB LUT enables a separate modification of every graph of the different three colors so that the complete image can be displayed in color.

False color display
By means of this function different colors can be assigned to different gray scales. Before opening this function, a step function should be set. After adjustment of amplitude, offset and period switching to the false color display is possible. The colors of the different zones can now be edited freely. To select a special color, double-click the corresponding zone to open a pallet of colors where the desired color may be selected. By pressing the key ***"From Image",*** it is also possible to select a gray scale or color in the image which can be inserted to the corresponding zone.





Setting the level of a point in the transfer characteristic, to do so, it is necessary to select a point in advance.

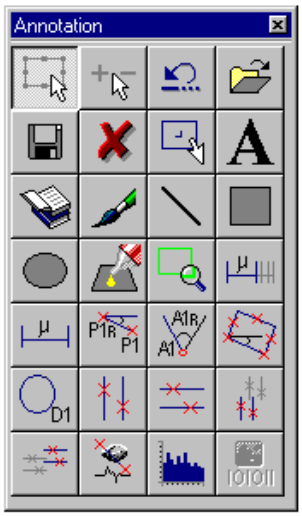
Switching from gray scale LUT to RGB LUT and selection of the transfer characteristic for the color red. All subsequent modifications of this transfer characteristic will only refer to the color red.

Switching from gray scale LUT to RGB LUT and selection of the transfer characteristic for the color green. All subsequent modifications of this transfer characteristic will only refer to the color green.

Switching from gray scale LUT to RGB LUT and selection of the transfer characteristic for the color blue. All subsequent modifications of this transfer characteristic will only refer to the color blue.

4.7 Image Annotation and Measuring

The window for annotation and measuring can be opened using the Pop-Up menu ***EDIT→ ANNOTATION*** or by means of the key combination ***CTRL / A***. This window and its functions provide various image measurement functions and the insertion of text and SEM parameters. Measuring may be done on the saved image as well as on the live image. Inserted SEM parameters will be updated and can be stored as a file applicable to another image later on. Below you will find the explanation of the different functions.



Selection of measuring and annotation options using a mouse-click

Switching to adjustment of SEM parameters using a mouse-click

Undoing the last action

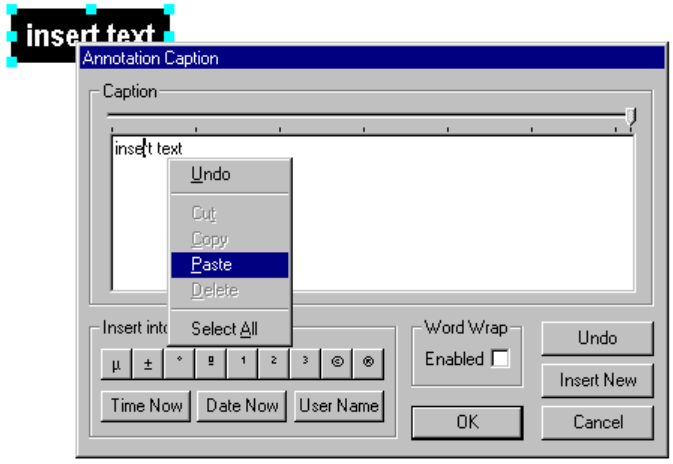
Loading saved measurements, texts, parameters etc. and applying these functions to the actual image content

Saving measurements, annotations etc.

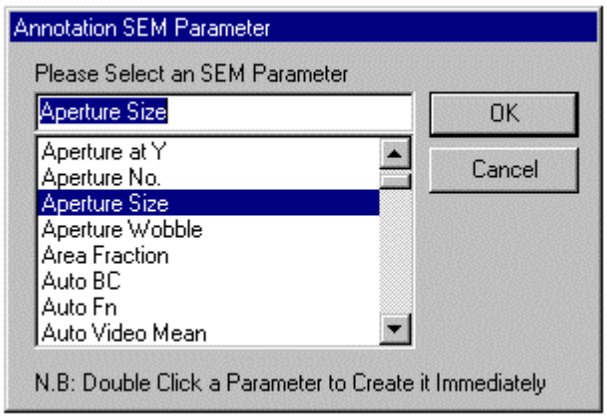
Deleting all overlays (measurements, annotations etc.) on the screen

Selection of a determined zone of the image, which is to be saved as a file when opening TIFF Export.

Open of the text editor to insert texts and numbers to the image. It is also possible to insert date, time and respective user name into the image. Texts which have been written in other word processing programs and which have been copied to the intermediary store using "***Copy***", can be inserted into the text by clicking the right mouse-button within the text field and selecting "***Insert***". Frequently used special characters are listed and can be copied to the text by pressing the corresponding key. Selecting ***Word Wrap*** will allow a defined overrun by displacing the upper slider.



Opening the SEM parameter list. Most parameters of the SEM can be selected from a list and inserted into the SEM image. It is possible to update these parameters continuously or to modify them interactively. These parameters are particularly important for the individual design of the data zone.

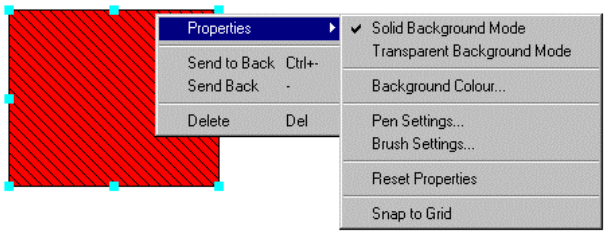


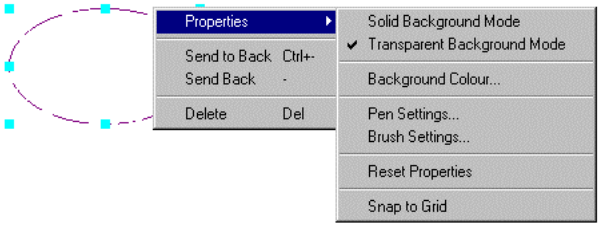
Inserting bitmaps and metafiles into the image. Select the symbol with the left mouse button→ Position the mouse cursor within the image where the graph is to be inserted and press the left mouse button. (e.g. to add company logos to the data zone).

Inserting a line into the SEM image. Activate the symbol with the left mouse button→ Drag the line with pressed left mouse button. These lines may be appropriate to assign annotations to certain zones within the SEM image. Form and color of the different lines may be chosen individually by selecting the respective line with the left mouse button and pressing the right mouse button to open the corresponding menu.

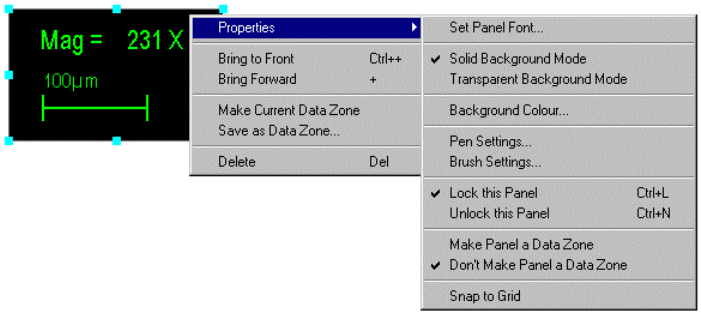
Inserting a quadrangle. Activate the symbol with the left mouse button→ drag the quadrangle by pressing the left mouse button. Color design, thickness and form of the line can be selected using a menu to be opened by means of the right mouse button.

Inserting a circle or an ellipse. Activate the symbol with the left mouse button→ Drag the circle/ellipse by means of the pressed left mouse button. Color design, thickness and form of the line can be selected using a menu to be opened by means of the right mouse button.





Inserting an annotation panel, which may contain several SEM parameters or texts. After selecting size and shape of this annotation panel, the different texts and parameters can be copied to this field. After doing so, the annotation field must be activated with the left mouse button. By pressing the right mouse button, a menu will open to select the different settings. If the field is locked by ***Lock this Panel***, the elements contained in the field will form one unit which can only be moved completely. It is also possible to define such an annotation panel as data zone by selecting ***Make Panel a Data Zone***.

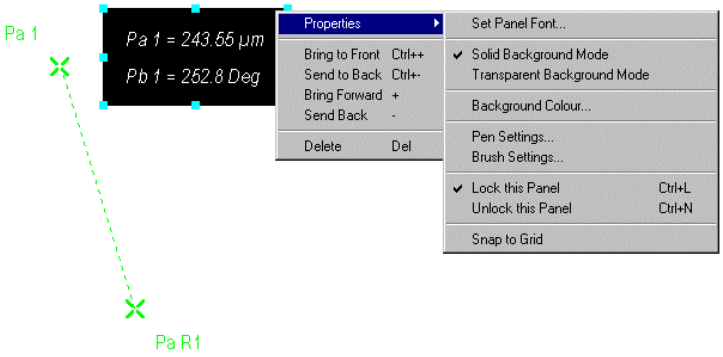


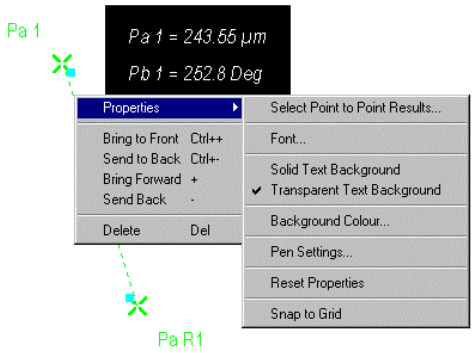
Inserting a zone magnification. This is especially useful for a split screen presentation, as the magnification value will be calculated depending upon which half the panel is placed.

Inserting of a variable µ-marker (automatic setting, adjusting for magnification)

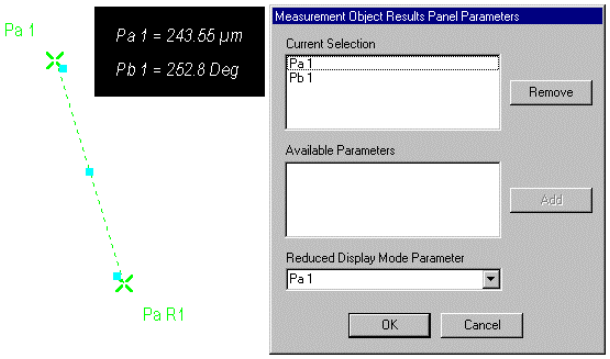
Inserting a fixed µ-marker (size to be selected by the respective user)

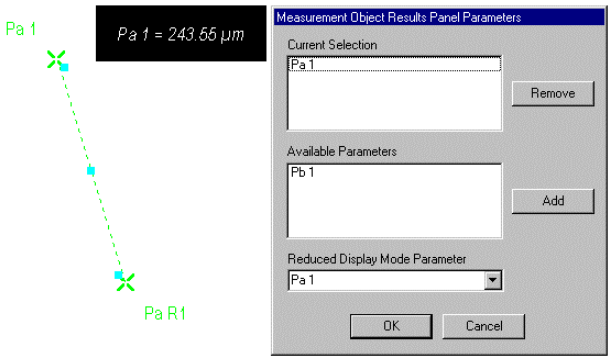
Insertion of a point-to-point-measurement into the SEM image. The settings for the result window and for the measuring line can be selected using a menu which can be opened by marking the corresponding object with the left mouse button and pressing the right mouse button. The selection menu for the measuring line allows defining the presentation of the results.

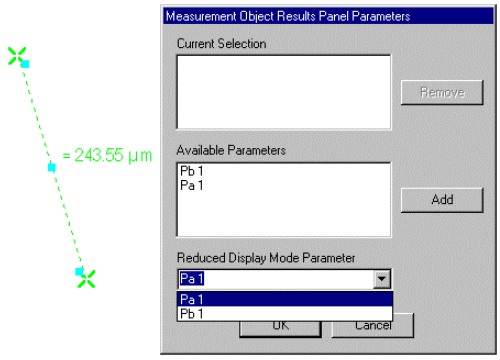




Select Point to Point Results. If all parameters are listed in the window ***Current,*** the results will be displayed in an annotation panel (see below). Depending on the parameters copied, using ***Remove,*** to the lower window ***Available Parameters,*** the number of parameters listed in the annotation panel will be reduced. If all parameters are removed from the window ***Current Selections,*** the result will be displayed close to the measuring line. The parameter to be presented as a result can be selected using the window ***Reduced Display Mode Parameter***.







Insertion of an angle measurement. The settings for the lines and the result window are fixed in the same way as for the point-to-point measurement.

Inserting a quadrangle measurement. The settings for the lines and the result window are fixed in the same way as for the point-to-point measurement.

Inserting a circle measurement. The settings for the lines and the result window are fixed in the same way as for the point-to-point measurement.

Insertion of vertical measuring lines. The settings for the lines and the result window are fixed in the same way as for the point-to-point measurement.

Inserting horizontal measuring lines. The settings for the lines and the result window are fixed in the same way as for the point-to-point measurement.

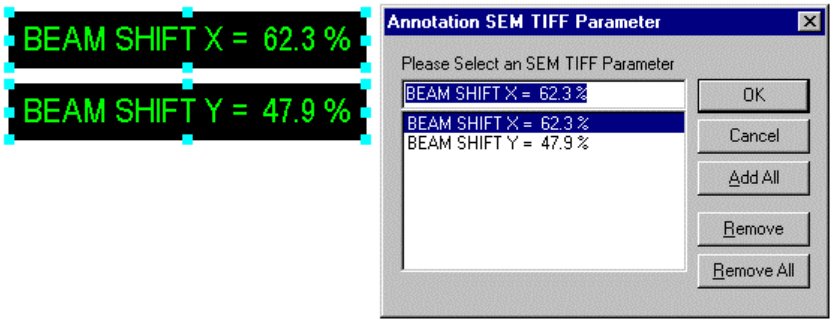
Inserting vertical adjustable measuring lines. The settings for the lines and the result window are fixed in the same way as for the point-to-point measurement.

Inserting horizontal adjustable measuring lines. The settings for the lines and the result window are fixed in the same way as for the point-to-point measurement.

Inserting a gray scale line profile. Measuring by means of the profile is possible.

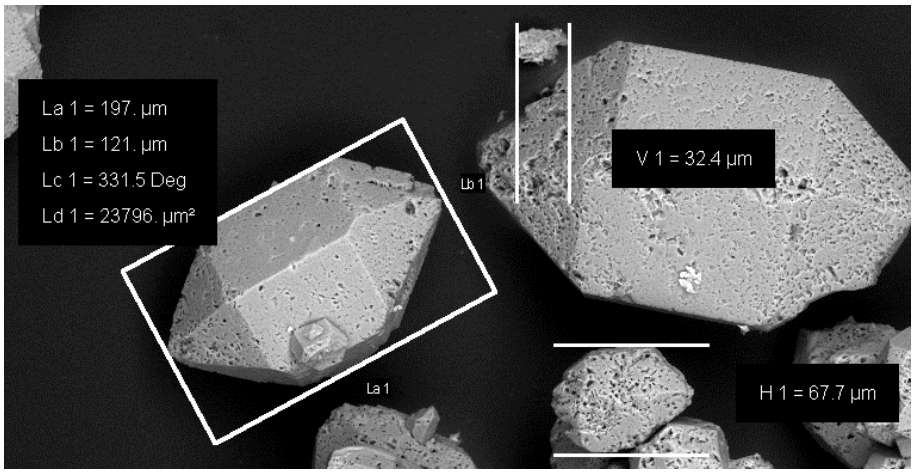
Inserting a gray value histogram.

Inserting user data. This function is only active if user data have been saved together with the image (see TIFF-EXPORT → DATA) see 4.5.2

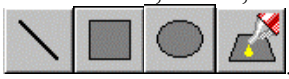


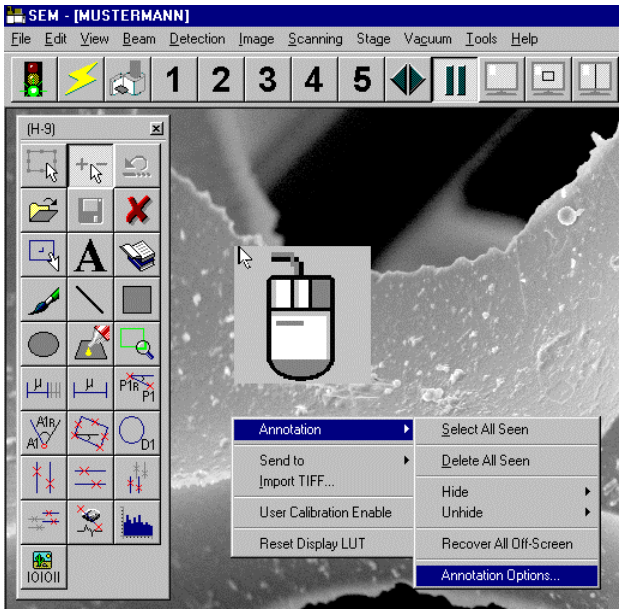
4.7.1 Expanded Measuring Capabilities: (Requires the Licence: MEASA)

The horizontal and vertical adjustable measuring lines and the quadrangle measuring are part of the advanced measuring option. The quadrangle measuring enables displaying and measuring both side lengths as well as the angle to the horizontal line and the surface.
Furthermore, with the option "MEASA" four circle measurements are available instead of the default two measuring possibilities. The point-to-point measurement can be opened up to 10 times. The default version allows only two open. The adjustable measuring lines can also be opened up to 10 times (default: 2 open).

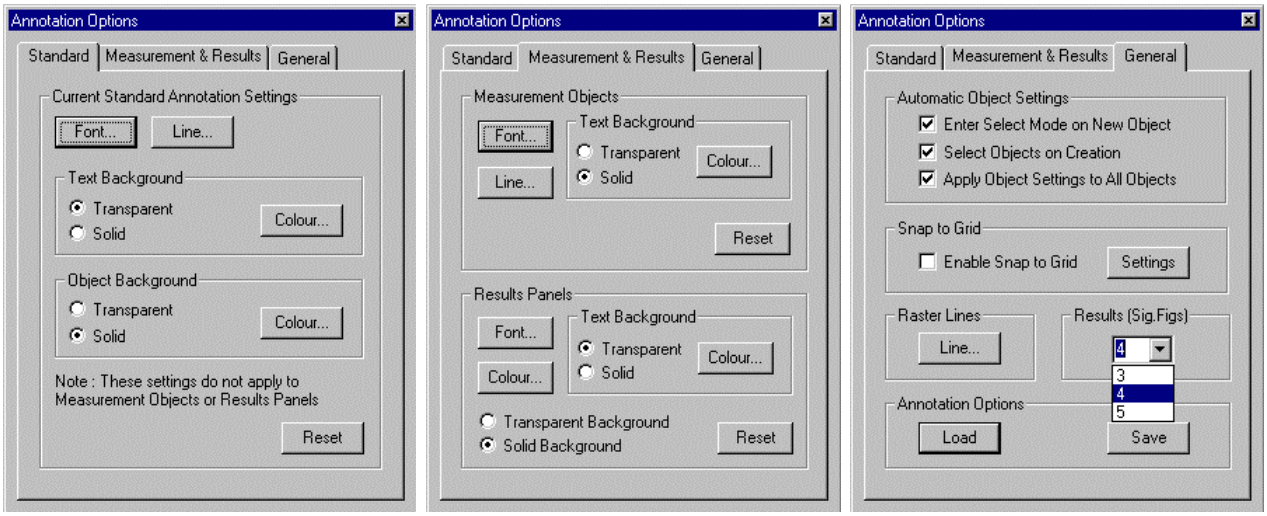


4.7.2 Basic Settings for Measurements, Annotations and Overlays

The user may fix pre-settings for the different measurements, annotations and for the Windows® overlays (Spot, Reduced Raster, etc.). These settings will define format and color of the different objects.
The window, ***Annotation Options,*** can be opened by pressing the right mouse button within the image panel. Before doing so, it is important to activate the ***Annotation Toolbar.*** The window ***Annotation Options*** is subdivided into three index cards. The index Tab ***Standard*** allows pre-settings for the text editor,  , the SEM parameters  , the USER data  and the different graph functions.  .
Using ***Font***, font type, size and color of characters can be selected. In ***Text Background*** you may chose whether the respective text is to be displayed with a transparent or a solid background. When selecting ***Solid*** the corresponding background color may be chosen using ***Colors...*** Using the key "***Line***" thickness, color and kind of line for the graph objects may be selected. In the same way as for the texts, ***Object Background*** allows to define whether the objects are to be filled with a color (solid) or not (transparent).
By clicking "***Reset***" all settings will be undone to return to the basic settings.
The index Tab ***Measurement & Results*** enables the settings for the measured objects. Each measuring function includes the measuring object with annotation (e.g. a circle with the denomination Da1) and the window displaying the results of the measurement. For both objects, ***Measurement Objects*** and ***Results Panels*** make available the corresponding settings. Using ***Font,*** font type, color, style and size of the characters may be selected. Depending on the background selected for the



annotation (transparent or with a background color), this setting will be done using ***Text Background.*** Pressing the key "***Line...***" allows the selection of kind of line, thickness and color of line, of the measured object. The key "***Reset***" will undo all settings in ***Measurement Objects*** and return to the basic settings.
Using ***Results Panels*** identical settings can be fixed for the results. The key "***Font***" will also refer to font type, size, style and color of the character of the results. Again, a transparent or solid background for this annotation may be selected using ***Text Background.*** The complete background of the results will be selected using ***Transparent Background*** and ***Solid Background.*** The respective background color may be chosen by means of the key "***Colors...***". By clicking "***Reset***", the settings of ***Results Panels*** will be undone to return to the basic settings.



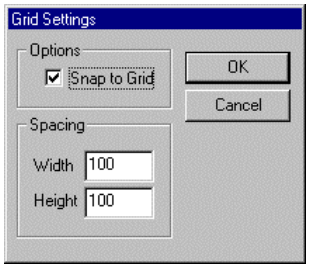
The index Tab ***General*** allows setting of the Windows® overlay, positioning and editing the objects and the kind of numeric result presented. It also provides the ability to save the different pre-settings in a file in the corresponding user directory.

Automatic Object Settings allows the activation of three basic settings.

* ***Enter Select Mode on New Object:*** After opening a function in the toolbar, the mode will automatically switch to edit.  If several measurements are to be inserted one after the other, this setting should be deactivated. Thus, the respective function will remain active and switching to edit or another function will have to be done manually.

* ***Select Objects on Creation***
  After opening a function in the toolbar, the corresponding object will immediately be marked. This enables an immediate opening of the settings for this object by clicking the right mouse button.

* ***Apply Object Settings to All Objects***
  The settings selected in the index cards ***Annotation Options*** will immediately be applied to the objects (even to those already selected). If this box is deactivated, the new settings will only be active after opening a function of the toolbar.



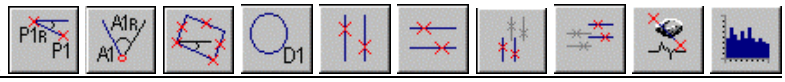
The box ***Snap to Grid*** allows the alignment of the respective objects by means of a grid. Settings for this grid will be made by pressing the key "***Settings***". For the width, values between 2 and 1024 are possible, for the height, values between 2 and 768 may be selected.

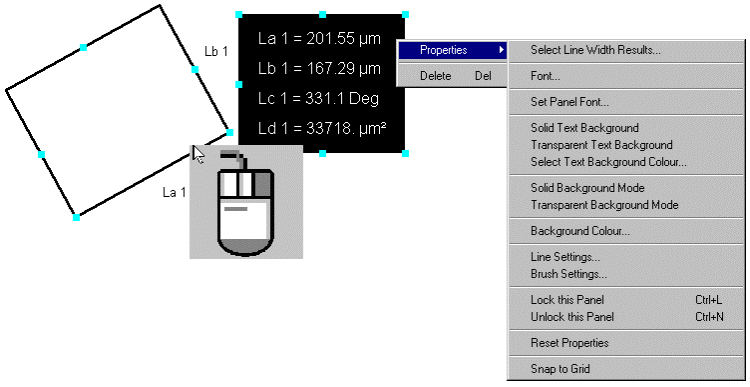
Raster Lines allows the setting of the kind of line, thickness of line and color of line for the functions ***Spot***, ***Reduced Raster***, ***Split Screen***, ***Dual Mag***, ***Crosshairs*** and ***Graticule.*** The respective setting will be valid for all these functions.
The setting in ***Results (Sig. Figs)*** will define the maximum number of figures for the display of the result of the distance measurement. Selection is possible between 3, 4 and 5. For the µm range, not more than 3 figures after the decimal point are possible. That means that a distance measurement of 3,452µm will only be displayed with 4 figures in spite of a setting of 5 in the box ***Results (Sig. Figs***. In the nm range, no figures at all will be displayed after the decimal point.

All settings in the menu ***Annotation Options*** will automatically be saved in the file "CURRENT.ANP" in the respective user directory. It is also possible to save the different settings in a separate file by using the key "***Save***". After assigning a file name, the file will be saved in the actual user directory. This file and the corresponding settings can be reloaded to the LEO user interface using the key "***Load***". However, by doing so, the actual file "CURRENT.ANP" will be updated with the new settings.

4.7.3 Editing, Storing and Loading Measurements and Annotations

Form, size, position and color of the different measuring, graphic or annotation objects may be varied individually. The procedure is always the same: First, mark the corresponding object with the left mouse button, then open the respective menu by pressing the right mouse button. It is also possible to mark a group of objects by keeping the key ***CTRL*** or ***SHIFT*** pressed and marking the different objects by pressing the left mouse button. Another option is to insert a quadrangle by dragging the left mouse button after selecting  . All objects within this selected zone will be marked.
Below you will find the explanation of the most important commands to edit the mesuring, annotation, graphic objects and µ marker.

- Measuring objects 



Select Line Width Results...:
Provides selection of the parameters to be displayed in the annotation panel.

Font...:
Provides selection of letter font, color and size of characters for the line annotations La1 and Lb1.

Set Panel Font...:
Provides selection of letter font, color and size of characters for the annotation panel of the results.

Solid Text Background:
Provides selection of the background color for the line annotations La1 and Lb1

Transparent Text Background:
Provides selection of a transparent background for the line annotations La1 and Lb1.

Select Text Background Color...:
Provides selection of the background color for the line annotations La1 and Lb1.

Solid Background Mode:
Provides selection of the background color for the annotation panel of the measuring results.

Transparent Background Mode:
Provides selection of a transparent background for the annotation panel of the measuring results.

Background Color...:
Provides selection of the background color for the annotation panel of the measuring results.

Line Settings...:
Provides selection of kind, color and thickness of line for the mesuring quadrangle.

Brush Settings...:
Provides selection of a pattern for the background color.

Lock this Panel:
Locking the annotation panel for the measuring results. That means the four results La1, Lb1, Lc1 and Ld1 will be defined as one unit and will be processed identically when editing and positioning.

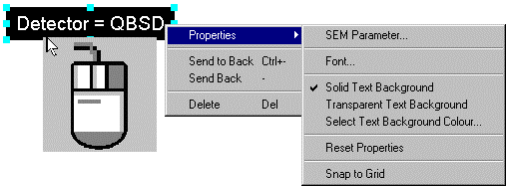
Unlock this Panel:
Unlocking the annotation panel. This enables the extraction of single results (e.g. Lb1) from the annotation panel for separate editing and positioning.

Reset Properties:
Resetting all settings to the basic properties.

Snap to Grid:
Provides alignment of an object by means of a grid. The size can be determined using Annotation ***Options*** (see 4.7.2).

Delete Del:
Deleting the measured object.

- Annotation Objects 



SEM Parameters...:
Selection of the parameters to be displayed (e.g. detector)

Font...:
Provides selection of letter font, color and size of characters for the displayed parameter.

Solid Text Background: Provides activation of the background color for the annotation panel.

Transparent Text Background:
Provides activation of a transparent background for the annotation panel.

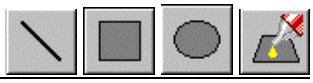
Select Text Background Color...:
Provides selection of the background color for the annotation panel.

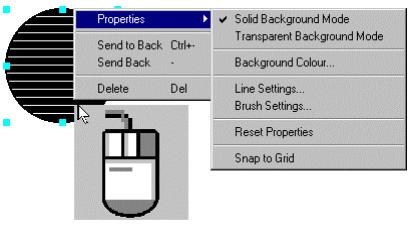
Reset Properties:
Resetting all settings to the basic properties.

Snap to Grid:
Provides alignment of an object by means of a grid. The size may be determined using ***ANNOTATION OPTIONS*** (see 4.7.2).

Send to Back:
If several objects are superimposed or overlapped, the corresponding objects can be moved to the background or to the foreground using ***Send to Back*** or ***Bring Forward***.

Delete:
Deleting the object.

- Graph objects 



Solid Background Mode:
Activating the solid filling color for the graph object.

Transparent Background Mode:
Provides activation of a transparent background for the graph object

Background Color...:
Provides selection of the filling color for the graph object.

Line Settings...:
Selection of the kind, color and thickness of line for the graph object.

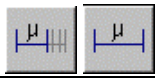
Brush Settings...:
Provides selection of a pattern for the filling color.

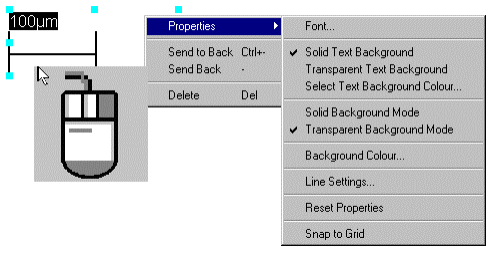
Reset Properties:
Resetting all settings to the basic properties.

Snap to Grid:
Provides alignment of an object by means of a grid. The size may be determined using ***ANNOTATION OPTIONS*** (see 4.7.2).

Send to Back:
If several objects are superimposed or overlapped, the corresponding object can be moved to the background or to the foreground using ***Send to Back*** or ***Bring Forward*** .

Delete:
Deleting the object.

- µ- Marker 



Font...:
Selection of letter font, color and size of characters for the annotation of the µ marker..

Solid Text Background:
Activating the background color for the annotation of the µ marker.

Transparent Text Background:
Provides activation of a transparent background of the µ marker.

Select Text Background Color...:
Provides selection of the background color for the annotation panel of the µ marker.

Solid Background Mode:
Provides activation of the background color for the µ marker.

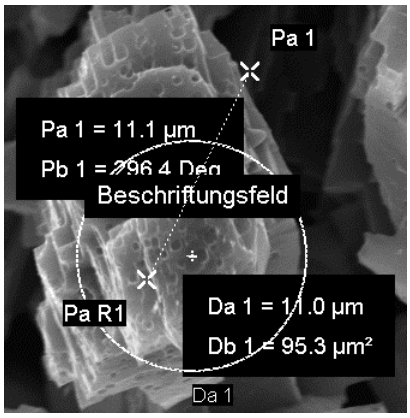
Transparent Background Mode:
Provides activation of the transparent background for the µ marker.

Background Color...:
Provides selection of the background color for the µ marker.

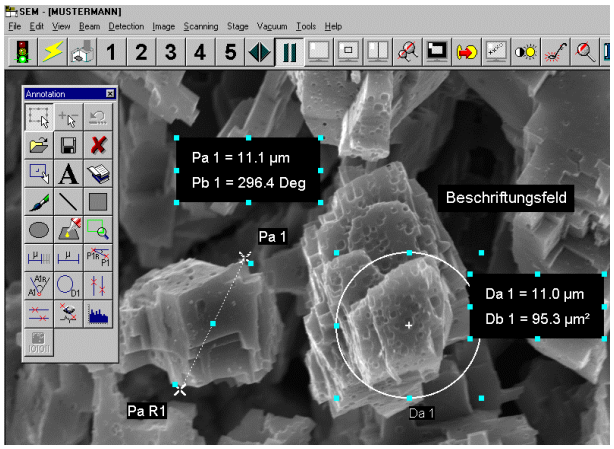
Line Settings...:
Selection of kind, color and thickness of line for the µ marker.

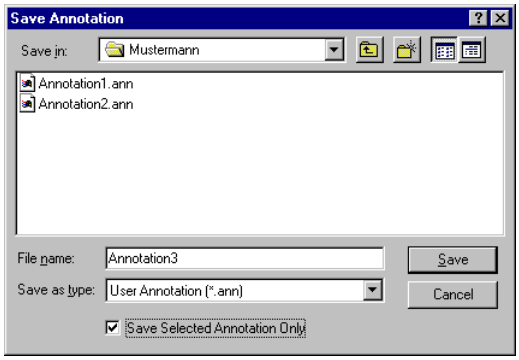
Reset Properties:
Resetting of all settings to the basic properties.

Snap to Grid:
Provides alignment of an object by means of a grid. The size may be determined using ***ANNOTATION OPTIONS*** (see 4.7.2).



If several objects are superimposed or overlapped, the selection of ***Send Back*** and ***Send to Back*** as well as ***Bring Forward*** and ***Bring to Front*** determines which object is going to be moved to the background or the foreground.
The different measurement, graphic and annotation objects can also be stored in a file  . When loading this file later on to a live or saved image,  , the measuring values will automatically be updated. By doing so, the different objects need not be reopened and reformatted. This results in a considerable simplification of the work with the ***Annotations***, if certain objects must be opened frequently.
If the control box ***Save Selected Annotation Only*** is activated, only the marked objects will be saved in a file. If not, all opened objects will be saved. Saving will be in the actual user directory.





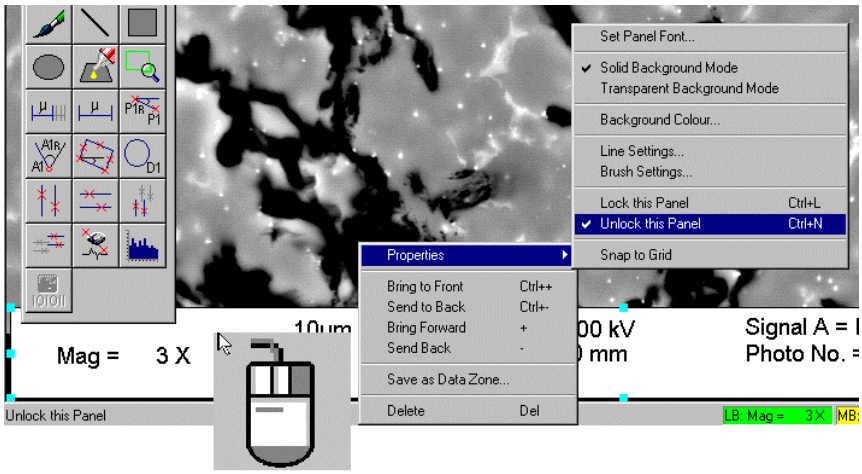
4.7.4 Setting and Editing the Data Zone

The datazone is a useful tool for the presentation of important image data and the output of this data together with the image. The software provides a standard datazone which can always be used, assuring that even newly installed users will have a datazone although no user datazone has been created. In this case, the default datazone will load. After closing the LEO user interface, a file “CURRENT.ADZ” will be created in which the datazone will be stored and which can be used when starting the software again. Basically, there are two ways to create a datazone: The first is to load the default datazone, to change it according to the user’s specifictions and to save it again as “CURRENT.ADZ” in the actual user directory. The secons is to create a completely new datazone and to save it with a new name.

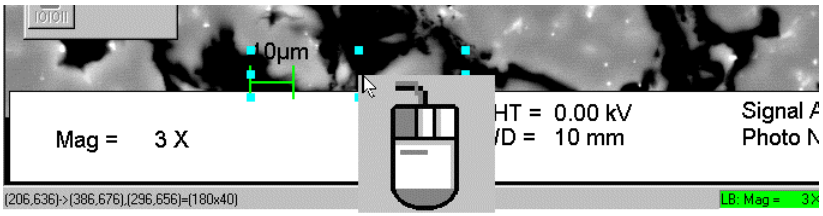
The key combination ***CTRL + D*** or the Pop-Up Menu ***VIEW→ DATA ZONE→ TOGGLE DATA ZON***E will always load the file “CURRENT.ADZ” in the current user directory. If this file does not exist in the actual user directory, the standard data zone will load.

- **Editing the Standard Data zone or an Already Existing Data zone**

1.) Open the data zone using *CTRL + D* or using the Pop-Up menu *VIEW→ DATA ZONE→ DISPLAY **DEFAULT DATA ZONE***



2.) Open the ***Annotation Toolbar*** by means of the key combination ***CTRL + A*** or using the Pop-Up menu ***EDIT→ ANNOTATION...***
3.) Mark the data zone (light blue squares) with the left mouse button; activate the menu by means of the right mouse button and select the command ***Unlock this Panel***
4.) Now different elements can be extracted from the datazone or newly created elements added.

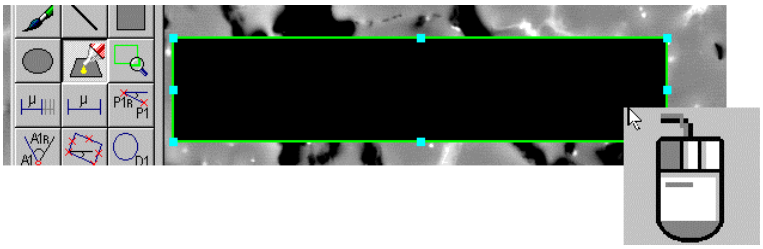


5.) Mark the complete datazone (no single elements), (light blue squares) with the left mouse button and open the menu by means of the right mouse button.
6.) If you want to change the color of the datazone, the respective color can be selected using the command ***Background Color...*** . If you need a uniform letter font for all elements in the datazone, setting is possible using ***Set Panel Font...*** .
7.) Select the command ***LOCK THIS PANEL***. Now the datazone is locked and can be activated or deactivated by means of the key combination or using the Pop-Up menu. When closing the LEO user interface, the settings of the datazone will be saved in the file "CURRENT.ADZ" in the current user directory.

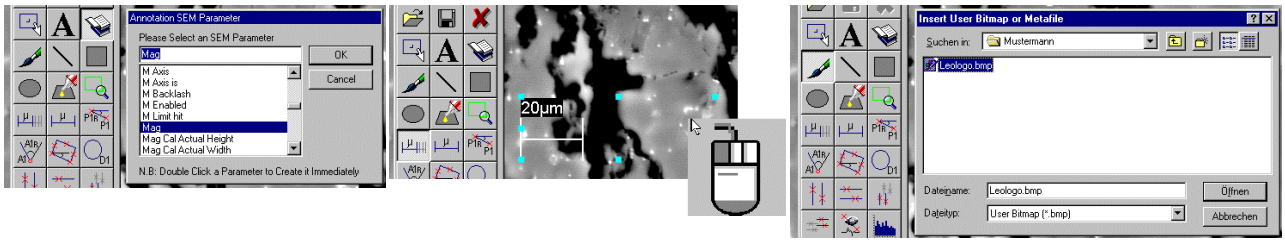
- **Creating a New Datazone**

1.) Open the Annotation Toolbar using the key combination ***CTRL + A*** or using the Pop-Up menu ***EDIT→ ANNOTATION...***

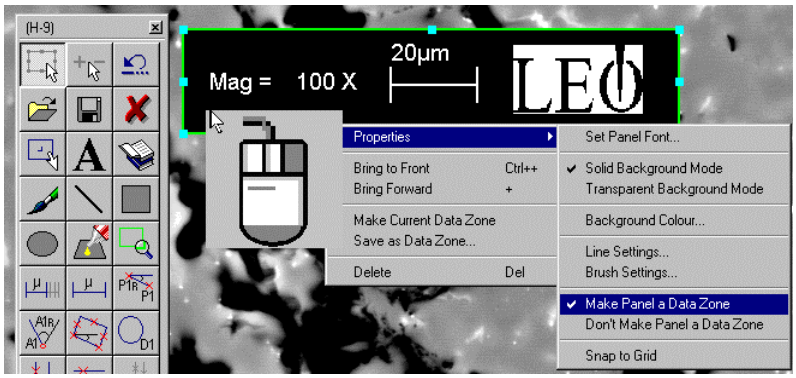
2.) Select ***Sticky Panels***  in the toolbar and drag the desired annotation panel by means of the pressed left mouse button.



3.) Insert the corresponding parameters to the datazone, e.g. magnification by selecting  in the menu SEM parameters, a µ marker using  or a logotype by means of the function 

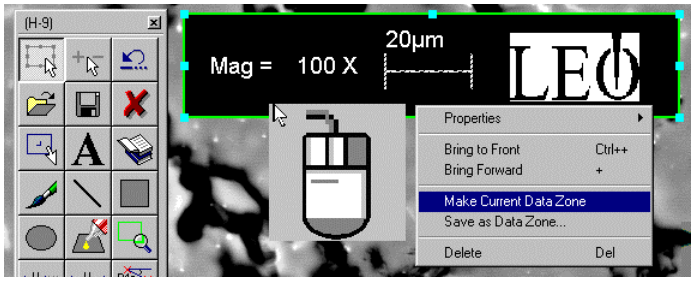


4.) Formatt the different parameters in color, font and size (see 4.7) and drag into the annotation panel.

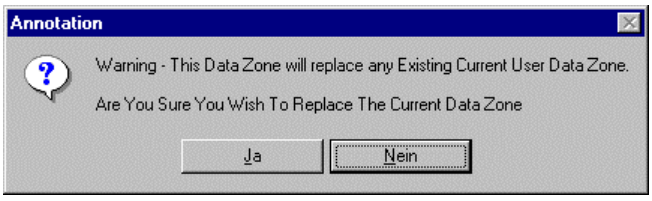


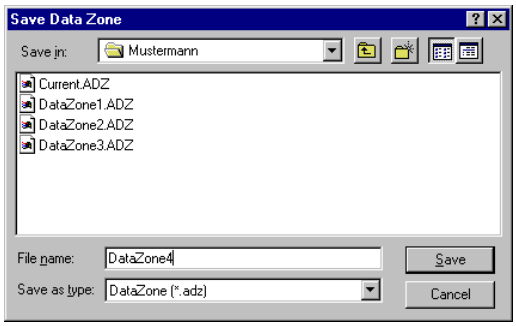
5.) Mark the complete annotation panel (no single elements) and open the menu by pressing the right mouse button.

6.) Click ***PROPERTIES→ LOCK THIS PANEL*** and then ***PROPERTIES→ MAKE PANEL A DATA ZONE***.



7.) There are two methods to convert the annotiation panel into a data zone. The commaand ***Make Current Data Zone*** replaces the contents of the file **"CURRENT.ADZ"** with the actual settings. A window opens, asking if one wishes to replace the data zone. Selecting ***Yes*** removes the old data zone from the monitor. Selecting ***No*** keeps the old data zone on the screen, however only as a normal annotation field. The new data zone may be switched on and off via the Pop-Up menu or ***CTRL + D***.





8.) The second way is to save the datazone using the command ***Save as Data Zone*** with an own file name. It may be reloaded later on using the Pop-Up Menu ***VIEW→ DATA ZONE→ LOAD USER DATA ZONE...*** (see 3.3.1).

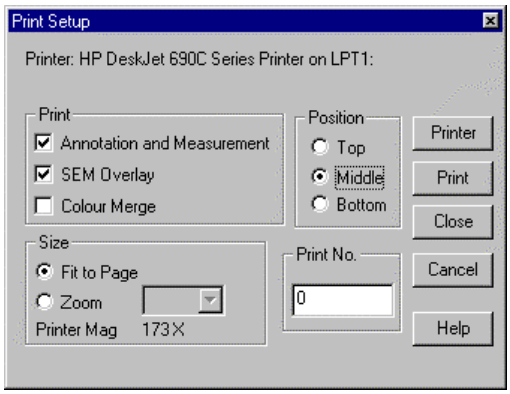
4.8 Editing Images on the Default Printer

Frozen or stored images which are reloaded to the image store using ***FILE→ LOAD IMAGE...*** can be edited to the standard printer using the command ***FILE→ PRINT SETUP...***. It is also possible to reach the following window by pressing the right mouse button within the image area and selecting ***SEND TO→ PRINTER***.
In this panel, the settings in size, position and design of the image to be printed can be entered.

Control Box *Print Setup*:

ANNOTATION AND MEASUREMENT:
Printing the data zone as well as measurements, annotations etc. together with the image

SEM Overlay:
Printing the data zone together with the image.



Color Merge:
Must be activated if colored annotations or measurements are to be printed. The number of gray scales (256) will be reduced by 20 when printing the image.

Control Box ***Size***:

Fit to Page:
Adjusting the image to the maximum width of the page.

Zoom:
Entering a reducing factor for the printout of the respective image. The respective magnification under consideration of the reduction will be displayed using ***Print Mag Ref.***

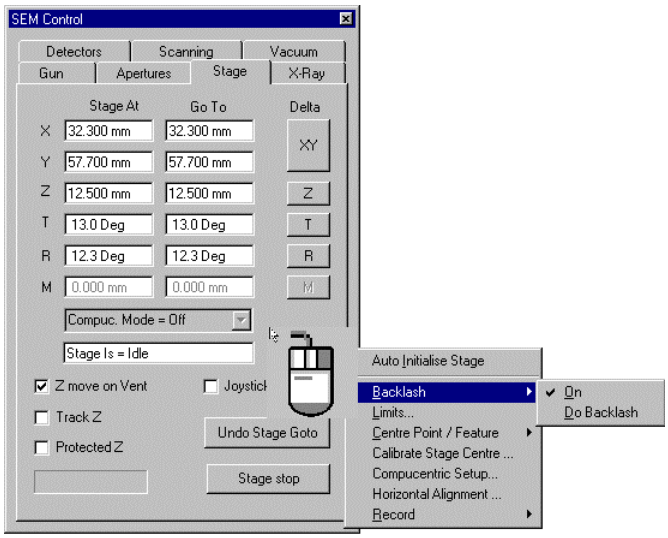
Control Box ***Position***:

TOP: Printout of the image on the top of the page.
MIDDLE: Printout of the image in the middle of the page.
BOTTOM: Printout of the image on the bottom of the page.

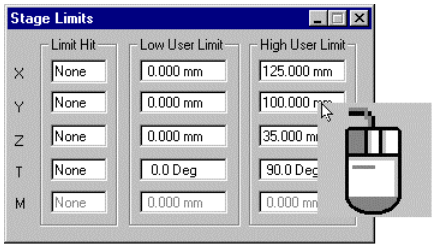
In ***Print No.,*** A number may be entered for the printout. This number increases automatically by one at every printout. This parameter is a global variable and valid for all users. It may also be selected using SEM Parameter (see 4.7.4) and, e.g., be added to the data zone.

Using the key "***Printer***" the printer used as output media will be selected. Pressing the key "***Print***" will start the output.

5 Stage Functions



The different stage functions can be opened using the Pop-Up menu ***STAGE.*** Many of the different routines are not implemented by default in the user interface and therefore require a license.
Entering absolute and relative coordinates and setting of certain presettings is done by using ***SEM Control*** -Tab ***Stage*** (see 4.3.6). In this window it is also possible to open special functions by pressing the right mouse button in the lower right part of the window. Using ***Backlash,*** the backlash correction for the motorized stage may be activated or deactivated. A selection of the axes where a backlash correction is to be done can be preset in ***User Preferences*** (see 6.1). Using the command ***Do Backlash*** a single backlash correction can be performed.



It is possible to limit the travel of the different motorized axes of the stage. This is especially useful when working with very big samples or if options have been adapted to the SEM, which may affect the travel of the stage. By assigning defined minimum (***Low User Limit***) and/or maximum values (***High User Limit***), the travel may be limited and collisions prevented. After opening the function ***Limits...*** a window will open indicating the lower and upper limits of the different axes. By double-clicking the left mouse button on one of these values, a new value may be entered. These limits are user-specific values and will be saved separately for every user.

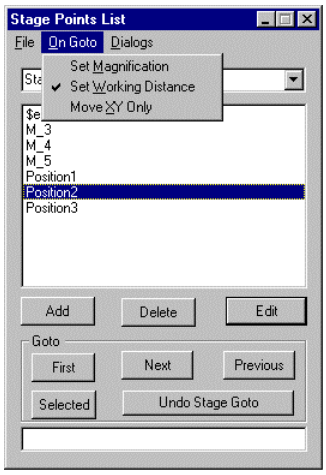
5.1 Initializing the Stage (STAGE INITIALISE)

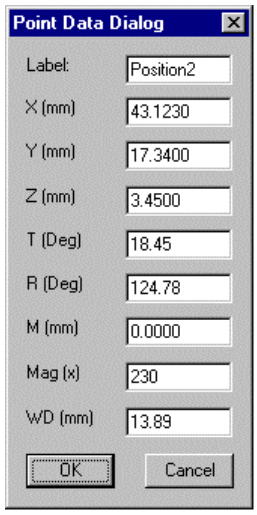
If the instrument has been switched off completely (red key) or if the stage loses its initialization for another reason, the stage must be re-initialized using the Pop-Up menu ***STAGE→ STAGE INITIALISE*** or by opening ***SEM Control*** - Tab ***Stage***. The stage can also be initialized by pressing the right mouse button within the lower right part of the window and selecting the command ***Auto Initialize Stage.*** The stage will be driven to the limit switch to define the point of origin. Afterwards, the stage will automatically drive back to the central position.

Even if the initialization has not been lost, it may be useful to re-initialize the stage in order to ensure exact driving of the stage.

5.2 Storing of Stage Coordinates (STORE/ REOPEN)

This software enables storing stage positions together with magnification and working distance, so that the user can drive to these positions later on. The window is opened using the Pop-Up menu ***STAGE→ STORE/ RECALL***
Each position can be given a symbolic annotation. If the current magnification and working distance are to be stored together with the position, activate the parameters ***Set Magnification*** and ***Set Working Distance*** in the field ***On Go To***. Activating the parameter ***Move XY Only*** will result in displacing only the X and Y coordinates of the stage.





When storing the actual stage position, the coordinates of the current position may be assigned a separate name which will be displayed in the stage points list by pressing "***Add***". It is also possible to edit the different storage parameters subsequently by selecting the corresponding name in the list and pressing the key "***Edit***". Deleting positions in this list is done in the same way, by pressing the key "***Delete***".
Moving to special storage positions is done by using the key in the control panel ***Go To*** or by double-clicking the specific position with the left mouse button.

First:
Moves to the coordinates of the first assigned position in the list

Next:
Moves to the coordinates of the next position in the list.

Previous:
Moves to the coordinates of the previous position in the list.

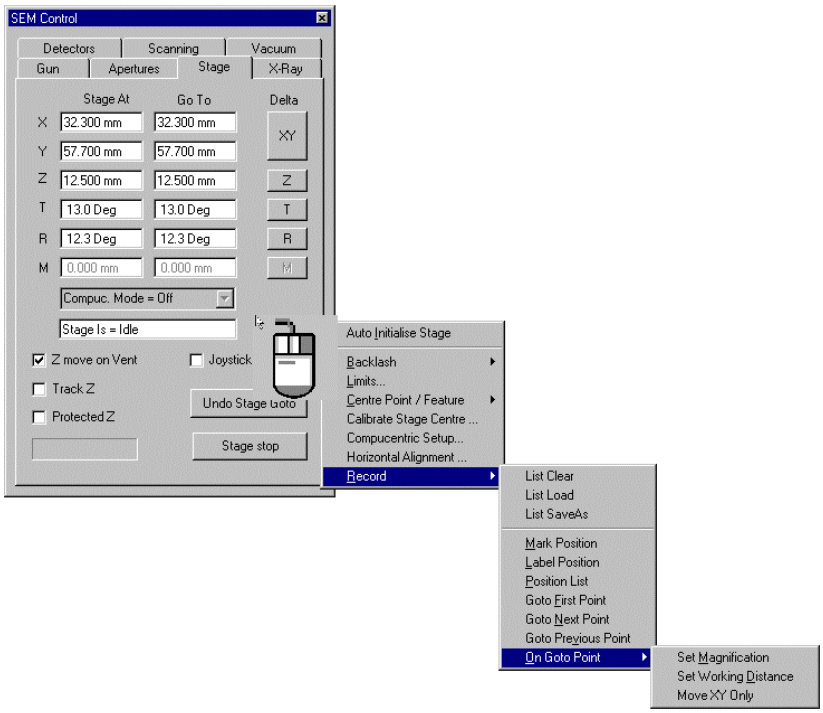
Selected:
Select a special position in the list by means of the left mouse button. After pressing the key "***Selected***", the stage will drive to the coordinates of this position. The respective magnification and the working distance will be set on the microscope.

Undo Stage Go To:
Undoing the last stage movement..

The positions grouped in the list can be stored as a file using the Pop-Up menu ***FILE→ SAVE*** and be reloaded using ***Load***.

If you experience problems when driving the stage to the co-ordinates, you should check whether the parameter ***Move XY Only*** has been deactivated in ***On Go To*** .

Another way to save stage coordinates is to open the ***SEM Control*** window and to open the sub-menu ***Record*** by pressing the middle mouse button (see above).



List Clear:
Deleting various positions from the list.

List Load:
Loading coordinates from a separate file.

List Save As:
The annotations contained in the stage point's list may be saved as a separate file in the respective user directory.

Mark Position:
The coordinates as well as magnification and working distance (if activated) of the corresponding position will be added to the list with the annotation "M_X" without assigning a special name. The letter "X" stands for a consecutive number, which will be increased by one at every open.

Label Position:
Assigning an individual annotation for the actual position.

Position List:
Opening the window ***Stage Points List*** (see above).

Go To First Point:
Drives the stage to the first position in the list.

Go To Next Point:
Drives the stage to the next position in the list.

Go To Previous Point:
Drives the stage to the previous position in the list.

On Go To Point:
Setting additional information, which is to be saved together with the coordinates for the actual position.

The stage point's list is user-specific and will be saved separately for every individual user. It is also possible to introduce **global positions**, which will be available for all users. This can be useful for working with a sample air-lock to save the respective stage position for the transfer of the sample. These positions will always be created with the annotation **"$ + Name"** (e.g. $exchange). Creating global positions requires the privilege "Supervisor" (see 2.1) .

5.3 Centering a Point (CENTER POINT)

This function enables the user to mark an object within the image panel which will be driven automatically to the center of the image. After selecting this function using the Pop-Up menu ***STAGE→ CENTER POINT*** or the key combination ***CTRL + Tab***, a cross will be displayed on the screen which can be positioned by means of the mouse. After selection of a point center by pressing the left mouse button.

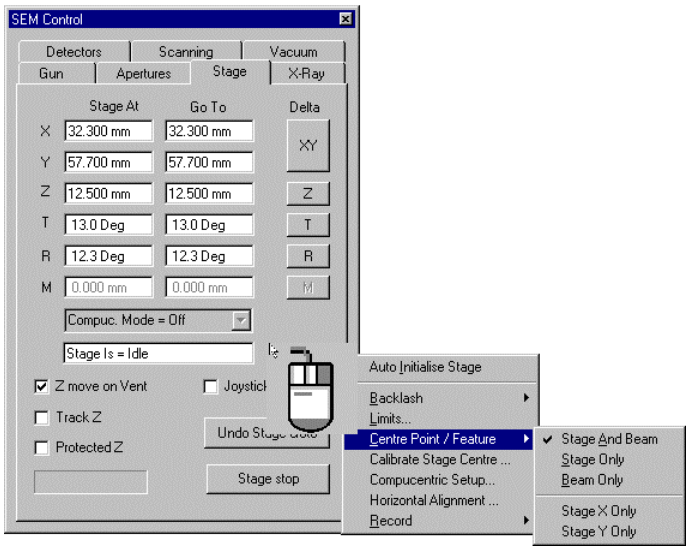
5.4 Centering a Feature (CENTER FEATURE)

This function enables the user to select a feature in the image area which will be centerd and magnified automatically so that the corresponding feature will fill the complete image panel. Selecting this function using using the Pop-Up menu ***STAGE→ CENTER FEATURE*** or by means of the key combination ***CTRL + Shift +Tab***. A cross will be displayed on the screen which can be positioned by means of the mouse. By pressing the left mouse button, a frame may be created. When releasing the mouse button, the content of this frame will be centered and magnified.

There are three different setup selections for the functions Center Point and Center Feature. The *Beam Shift* or the *Stage* may be used for centering. It is also possible, depending on the magnification ,to use both. The selection will be done using the ***SEM Control***- Tab ***Stage***. Press the right mouse button in the lower right part of the window. This will open a menu where the different possibilities can be selected in ***Center Point/ Feature*** .

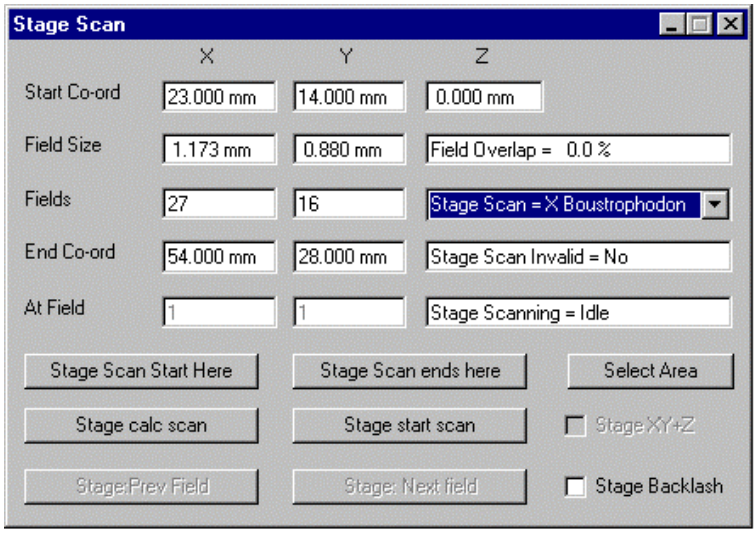
Stage And Beam:	Use of stage and ***Beam Shift*** for centering.
Stage Only:	Use of the stage for centering.
Beam Only:	Use of ***Beam Shift*** for centering.

For special applications (see 5.9.2) it may be advisable to use only one axis (X orY) for centering. This may be performd by selecting ***Stage X Only*** or ***Stage Y Only***.

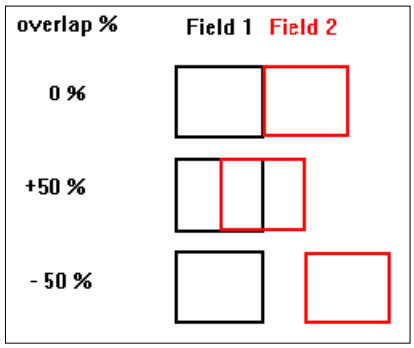


5.5 Scanning a Field (STAGE SCAN) (Requires the License: STAGESCAN)

This software option allows the examination of a sample area as a series of exactly defined, regularly dispersed image fields. This function is particularly suitable to tracking particles or other objects in a large sample area, as it will ensure that no part of the interesting zone will be omitted. The function may be opened using the Pop-Up menu ***STAGE → STAGE SCAN***. This will open the window represented below to select the different settings for the fields and to start the function.
Four scanning patterns and several methods to determine the scanned area are available. After selecting the scanning pattern, position and size of the fields, the fields can be scanned by using different commands. The scanning pattern will determine the sequence of the scanned fields.



FIELD OVERLAP:



Start Co-ord:
Indicates the XYZ position where the scanning of the fields will start. If the command ***Stage Start Scan*** has been selected, the stage will drive to this position. The values may be entered manually (by clicking the corresponding field with the left mouse button), by using ***Select Area*** (selection by means of Center Feature) or by using ***Stage Scan Start Here***.

Field Size:
The parameters X and Y will define the size of a single field. These values can be entered manually (by clicking the corresponding field with the left mouse button) or by selecting the command ***Stage calc Scan***.

Fields:
The parameters X and Y will define the number of fields which the stage will scan in the respective direction for the whole pattern. These values may be entered manually (by clicking the corresponding field with the left mouse button) or by selecting the command ***Stage calc Scan***.

End Co-ord:
Indicates the XYZ position where the scanning of the fields will end. The values can be entered manually (by clicking the corresponding field with the left mouse button), by using ***Select Area*** or by using ***Stage Scan ends here***.

At Field:
The parameters X and Y will indicate the field in the pattern where the stage is positioned at present. These parameters may be used in annotations (see 4.7) or can be saved as user-specific parameters together with the image. To do so, the SEM parameters ***Stage at Field X*** and ***Stage at Field Y*** must be selected in the parameter list (see 4.5.2).

.Field Overlap =:
This parameter can be set manually. It is used in the function ***Stage calc Scan*** to fix the scale ov overlapping between the fields.

Stage Scan =:
Clicking this control field will select the respective scan pattern.

Scan Pattern												
X Boustrophedon			X- Scan			Y Boustrophedon			Y- Scan			
1	2	3	1	2	3	1	6	7	1	4	7	
6	5	4	4	5	6	2	5	8	2	5	8	
7	8	9	7	8	9	3	4	9	3	6	9	

Stage XY+Z:
Is necessary for the use of the ***Tilt Compensation***. If the control box is deactivated, the stage will not move in Z direction. If the control box is activated, the stage will move in Z direction in relation to the Z start coordinate if a movement in tilt direction is performed.

Stage Backlash:
Activating this control box will result in a stage backlash correction with any stage movement

Stage Scan Start Here:
By pressing this key, the actual stage coordinates will be taken as start coordinates.

Stage Scan ends here:
By pressing this key, the actual stage coordinates will be taken as end coordinates.

Select Area:
This function is used to set the start and end coordinates if the complete scanned area is visible at a suitable small magnification. To select the area, press this key and continue as explained in 5.4.

Stage calc Scan:
This function makes the following calculations:
* The fields will be calculated by means of the actual magnification in relation to start and end coordinates (in consideration of the field overlapping).
* The number of fields will be calculated by means of the start and end coordinates and the field size.

Stage star scan:
Pressing this key will start the scan mode. The stage moves to the start position (Field 1/1).

Stage Prev Field:
Pressing this key will drive the stage back to the previous field in the scan pattern.

Stage Next Field:
Pressing this key will drive the stage forward to the next field in the scan pattern.

<u>There are different methods to determine the scan area:</u>

1.) Start and end coordinates are entered manually. Using ***Stage calc Scan*** a calculation will be made using the actual magnification.

2.) Start coordinates, field size and number of fields are entered manually. Using ***Stage calc Scan*** the end coordinates will be calculated.

3.) Drive the stage manually to the position where the scan is to be started. By selecting ***Stage Scan Start Here*** the actual coordinates will be taken as start coordinates. The end coordinates may be selected in the same way. After doing so, it is possible to select a magnification as suitable for the individual problem. Selecting ***Stage calc Scan*** will result in calculation of field size and number of fields.

4.) If the complete scanned area is visible at a suitable lower magnification, the interesting area can be selected using ***Select Area*** (use of ***Center Feature***). Then a magnification may be selected which is necessary for the individual problem. By selecting ***Stage calc Scan*** the field size and number of fields will be calculated.

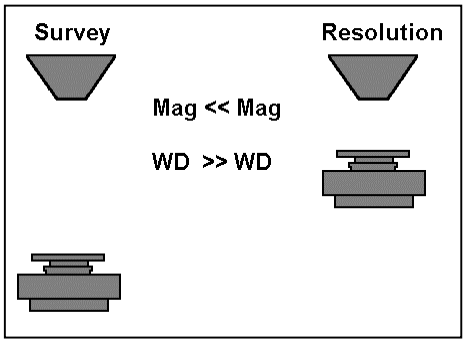
5.6 Stage Map (Requires the License: CENTER)

This function provides the use of a frozen image in Zone 0 as an overview mapping for the selection of stage positions. Before opening this function, the interesting sample area should be moved to and be displayed in a suitable low magnification.. This setting will be the overview map. After setting and adjusting the desired area, select the ***Split Screen***- mode using the Pop-Up menu ***SCANNING→ SPLIT*** or using the corresponding symbol in the toolbar. Then, the function Stage Map can be activated using the Pop-Up menu ***STAGE→ STAGE MAP.*** This will freeze the left part of the screen. The mouse cursor on the left half will be displayed as a cross. Moving the mouse cursor to the right screen will allow the adjustment of magnification, focus etc. Then returning to the left screen, the cursor will again form a cross. Now the interesting points on the sample feature can be selected by pressing the left mouse button. The selected position will be displayed in the right part at the selected magnification.
End this mode by selecting ***Normal*** in the Pop-Up menu ***SCANNING*** or by activating the corresponding symbol in the toolbar.

Zone 0: Frozen image with map magnification. Select interesting positions by means of mouse cursor: 	Zone 1: Active image with individually selected magnification. Mouse cursor: 

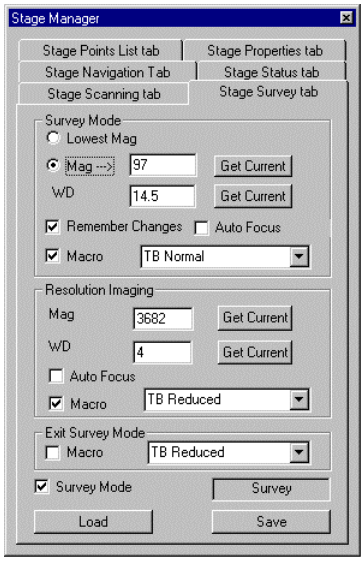
5.7 Survey Mode (Requires the License: SURVEY)

The ***Survey Mode*** provides the capability to save two microscope settings regarding magnification and working distance and to switch between these two settings. Example: For low mag. scanning of samples it may be necessary to select a longer working distance. By doing so, a lower magnification can be set which allows the imaging of large areas of the sample surface and to select certain interesting zones within this area. After selection of such a zone, it will have to be examined at higher magnification to distinguish detailed information. For higher magnification, it may be useful to select a smaller working distance in order to improve the signal / noise ratio and the total imaging quality. This means that you need two working conditions, which differ in magnification and the working distance settings (in relation with the Z movement of the stage). The ***Survey Mode*** can be used to automate these two settings.



Before switching between the two modes, the settings for the working modes ***Survey Mode*** (high working distance, small magnification) and ***Resolution Image*** (small working distance, high magnification) will have to be set.

The window ***Stage Survey tab*** can be opened using the Pop-Up menu ***STAGE→ SURVEY→ SETTINGS...*** or using ***STAGE→ STAGE CONTROL...*** and selection of the index Tab ***Stage Survey tab***



The following procedure is recommended for defining both settings:

1.) Set a low magnification and a large working distance on the microscope and open of the window ***Stage Survey tab***.

2.) In the upper part of the window, the settings for ***Survey Mode*** may be defined now. Clicking the keys "***Get Current***" will enter current values for magnification and working distance. It is also possible to enter the desired values manually. When selecting. ***Lowest Mag***, the system will automatically set the smallest possible magnification.

3.) Now a higher magnification should be set at small working distance (modification of the Z drive of the stage). These values can be entered by pressing the key ***"Get Current".***

4.) The selection of additional functions is possible for both modes. Selecting ***Auto Focus*** will result in an automatic focus adjustment after activation of the respective operation mode (***Survey Mode*** or ***Resolution Image***). It is also possible to select certain macros, which will have to be processed after setting the corresponding operation mode. In the upper example, a reduced scan (see macro: TB Reduced) will automatically be displayed in the operation mode ***Resolution Image***. When switching back to ***Survey Mode***, the normal mode (screen displays the complete scanned area) will be re-set automatically. If a macro has been activated in ***Exit Survey Mode,*** it will be processed automatically when finishing the ***Survey Mode*** (remove of the check in the box ***Survey Mode***).

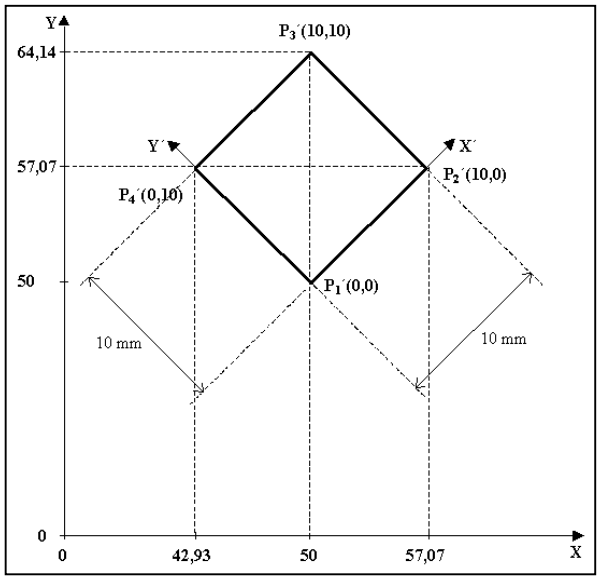
Working with the window Stage Survey tab:

After setting both operation modes, the Survey mode can be activated using the Pop-Up menu S***TAGE→ Survey→ Survey Mode*** or by activating ***Survey Mode*** (put a check) in the above window. This will set the corresponding magnification, the working distance and drive the stage to the respective Z coordinate. In this survey mode, interesting sample zones can be examined. When opening ***Center Point*** (see 5.3) or ***Center Feature*** (see 5.4), the stage will be moved to the Z coordinate of the operation mode ***Resolution Image*** after execution of the corresponding function. At the same time, the corresponding magnification and the working

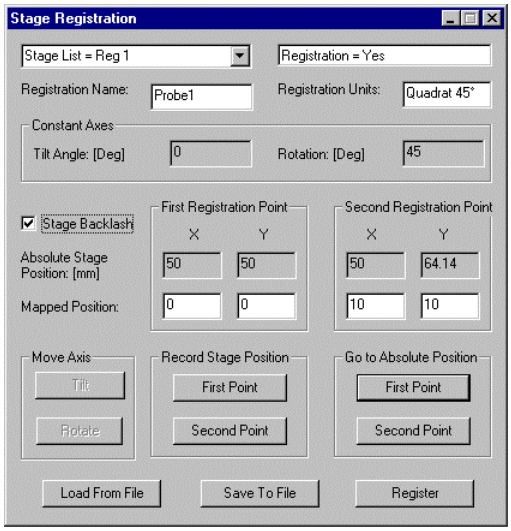
distance will be set automatically. If additional functions have been defined for this mode, these functions will be processed automatically after selection of the settings for ***Resolution Image.*** In the example above, the macro "TB Reduced" would be activated to display a reduced scan.
To switch back to the operation conditions of the ***Survey Mode***, press the function key ***F4***. Now it will be possible to research an interesting area and to switch to the operation mode ***Resolution*** Image by using ***Center Point*** or ***Center Feature***.
End the ***Survey Mode*** by using the Pop-Up menu ***STAGE→ Survey→ Survey Mode*** or by deactivating ***Survey Mode*** (remove check) in the above window. If a macro has been selected and activated in the window ***Stage Survey tab*** in ***Exit Survey Mode***, this macro will be processed now. In the above example no macro would be executed as the macro "TB Reduced" has been selected no check has been entered in the control box " ***Macro".***

5.8 Stage Registration (Requires the License: STAGEREG)

For special samples or tasks, the software option ***Stage Registration*** provides the user the ability to create a unique coordinate system in the horizontal axis using two reference points. Within this coordinate system, it is possible to drive to separate sample zones or to save certain stage positions.
The new coordinate system is defined in the window ***Stage Registration***. The stage can be moved in the user-specific system using the window ***Stage Registered Movement***. Both windows will be opened using the Pop-Up menu ***TOOLS→ GO TO PANEL*** or using ***Dialogs*** in the window ***Stage Points List*** (see 5.2). Creating and working with user-specific coordinate systems will be explained in the following example.

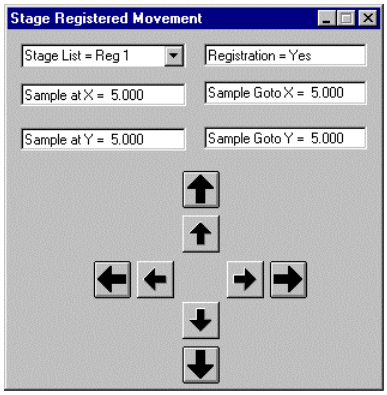


The sample is a square with a side length of 10mm. This square will be turned 45° in the scan direction and will be used as the limit for the new coordinate system.
After opening the window ***Stage Registration***, the annotation ***Reg1*** will be selected in the list ***Stage List=***. This label identifies the user-specific coordinate system. The software allows the definition of up to 9 different systems (***Reg1- Reg9***).
Individual names for the sample and the coordinate system may be entered in the fields ***Registration Name:*** and ***Registration Units:***
First, drive the first point of the sample (P_1), by means of the joystick, to the center of the screen. Pressing the key "***First Point***" in ***Record Stage Position*** will define the first reference point.
The corresponding absolute coordinates of this point will be indicated in ***Absolute Stage Position: First Registration Point*** (example: X= 50, Y= 50). If the actual rotation and tilt values differ from those listed in the field ***Constant Axis*** you will be asked whether the new values shall be taken. Answer this question with "***Yes***".



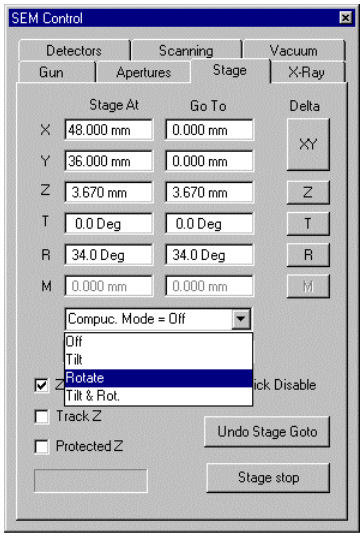
Now center the second reference point ($P_3´$) by means of the joystick. Press the key "***Second Point***" in the field ***Record Stage Position*** to load these values.
The actual values will be displayed in ***Absolute Stage Position:/ Second Registration Point*** (in the example: X= 50, Y= 64,14). By doing so, both reference points of the new coordinate system are defined.
Now the software needs the relative start and end coordinates of the new system as a calculation base. In the above example the new coordinate system is to begin at X´= 0/ Y´= 0 and to end at X´= 10/ Y´= 10 (see $P_3´$). These values must be entered in the fields ***Mapped Position.*** ***First Registration Point*** will thus be the origin coordinates (0,0) and ***Second Registration Point*** the maximum values for X and Y (10,10). When pressing the key "***Register***" the software will try to perform a coordinate transformation with the entered values. If a correct calculation is possible, this will be indicated in the upper part of the window with ***Registration= Yes***.

Now stage control is possible using the window ***Stage Registered Movement.*** If the stage is to move to the center of the new coordinate system, click ***Sample Go To X*** with the left mouse button to enter 5 for the X and Y coordinates. This will drive the stage to the absolute position X= 50 Y= 57,07, that means to the center of the square. If you want to go to P_3' , enter ***Sample Go To X= 10*** and ***Sample Go To Y= 10***. Entering ***Sample Go To X= 1*** and ***Sample Go To Y= 1*** will drive the stage 1mm in X‘ and 1mm in Y‘ direction. If smaller steps are necessary you may enter the values X=100 and Y=100 (instead of X=10 Y=10) in the field ***Second Registration Point*** as ***append Position***. Re-clicking the key “***Register***” and entering ***Sample Go To X= 1*** and ***Sample Go To Y= 1*** would move the stage by 100µm in X´ and Y‘ direction in the new coordinate system.
Control of the stage is also possible by using the arrow keys in the window ***Stage Registered Movement***. Clicking the big arrow key will result in a 10 steps‘ movement in the corresponding direction. The small arrow keys will displace the stage by one step each.
Selecting ***Stage List=Reg1*** in the window ***Stage Points List*** will save stage positions so that the stage may drive to these positions later on.



The settings of the new coordinate system may be saved in the window ***Stage Registration*** by selecting “***Save To File***”. By doing so, a file name can be assigned to save the settings in this file. When reloading settings to the application by clicking “***Load From File***” it is possible to drive to the positions for the constant axes T and R by pressing the keys “***Tilt***” and “***Rotate***” in the field ***Move Axis***.

5.9 Compucentric Software (Requires the License: COMPU)



The compucentric software provides rotation-eucentric or tilt-eucentric control if the stage is not eucentric. This control refers to driving the stage to absolute and relative coordinates using the ***SEM Control*** window ***Stage*** (see 4.3.6) and to the use of the function ***Stage Horizontal Alignment*** (see 5.9.3). When examining a sample area, which is not placed in the rotation center of the sample stage, the interesting sample area will shift on rotation of the stage. The Compucentric software will try to compensate this shift by adjusting the X and Y coordinates. A similar condition will appear when tilting the sample. If the interesting zone of the sample is placed exactly in the center of the screen, a tilt upwards or downwards from the horizontal line can be watched. This tilt can also be compensated within certain limits when using the compucentric software.
Before starting to work with this software a calibration of the rotation center of the stage (***Calibrate Stage Center***) and of the sample height is necessary (***Compucentric Set Up***). Both calibrations are done using two separate menus. The rotation center must be setup at every stage initialization (see 5.1). The calibration of the sample height from the tilt axis is sample-specific and must therefore be adjusted for each sample. After performance of the calibrations, it is possible to select the corresponding operation mode using ***Compuc. Mode=*** in the ***SEM Control***- window ***Stage*** (see above).

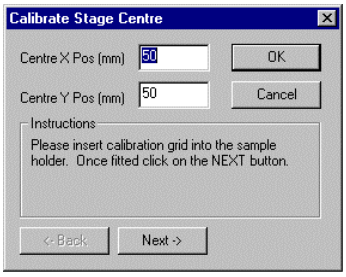
Off:	Switching off the compucentric software
Tilt:	tilt-eucentric control of the stage by the software
Rotate:	rotation-eucentric control of the stage by the software
Tilt & Rot:	tilt- and rotation-eucentric control of the stage by the software

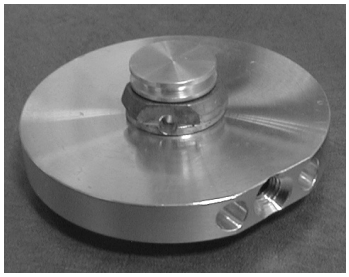
If calibration is only done for the rotation center (***Calibrate Stage Center***), rotation-eucentric control of the stage is only possible in the horizontal line (tilt = 0). This is also valid for stages without motorized tilt axis (e.g. LEO 1530). In these cases, adjustment of ***Calibrate Stage Center*** will be done at a 0° tilt. Rotation-eucentric control will be possible in these operation modes.

Below you will find the explanation of both calibration routines.

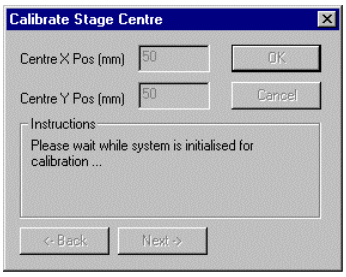
5.9.1 Calibrate Stage Center

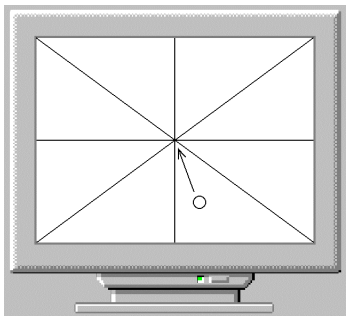
Open ***Calibrate Stage Center*** by using the Pop-Up menu ***TOOLS→ GO TO PANEL...*** or using the ***SEM Control*** window ***Stage*** and clicking the right mouse button within the lower right part (see 5.4). When calibrating, a distinguishable point positioned within the image field will be driven to the center of the scan area. After a 180° rotation of the stage the same dot will be re-centered. The software will then calculate the rotation center of the stage using the difference of both positions to the scan center. The calibration may be repeated for different magnifications (30X, 200X, 500X, 1500X and 2000X).



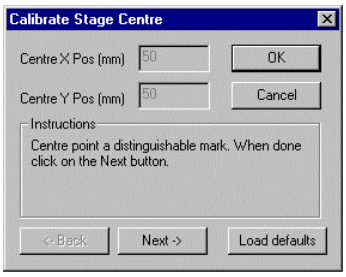


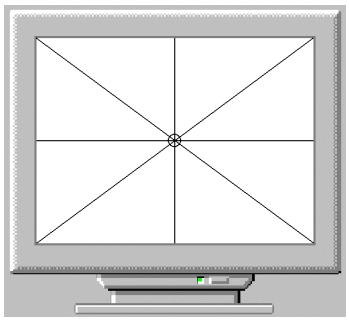
For the calibration a ***single sample holder*** should be used. It is recommended to use a calibration grid or a TEM grid sample.
After opening the calibration routine a window will open where the last measured values for the center can be entered in the upper part. The stage will be initialized when pressing the key "***Next***". The stage will then drive to the X and Y values as entered above.



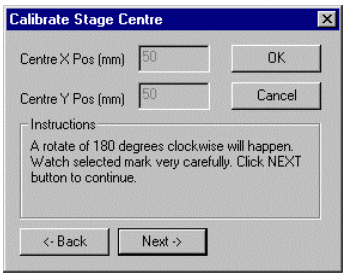


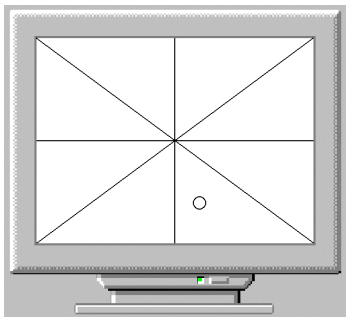
After initialization, the magnification will automatically be set to 30X and a graticule will be displayed on the screen. Now a distinguishable point positioned outside the center should be selected within the imaging area.



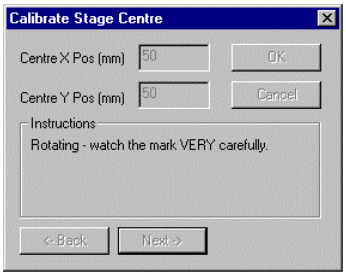


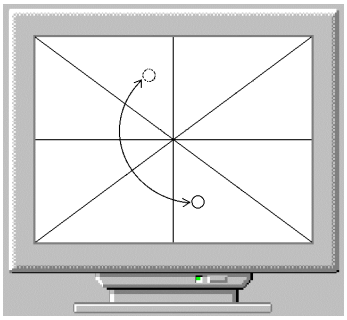
Move the distinguishable point to the center by means of the joystick or using ***Center Point***. Clicking "***Next***" will drive the stage to the start position.



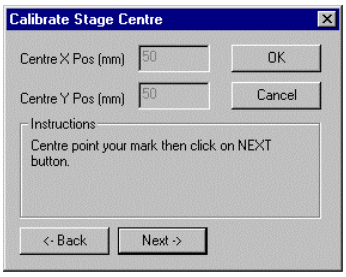


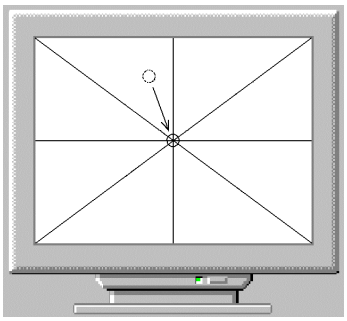
Click "***Next***" to rotate the stage by 180°.



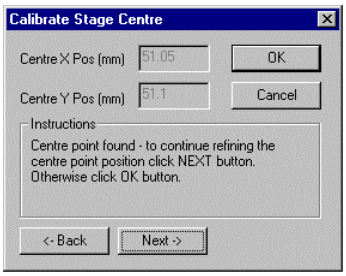


Observe the mark carefully during the rotation of the stage to identify it easily after the rotation.





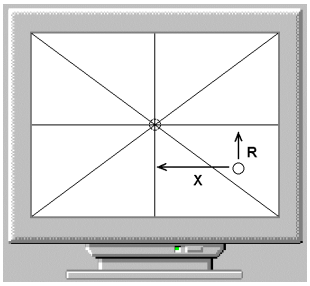
Re-center the distinguishable point by using the joystick or the function ***Center Point***. After centering, confirm with "***Next***".



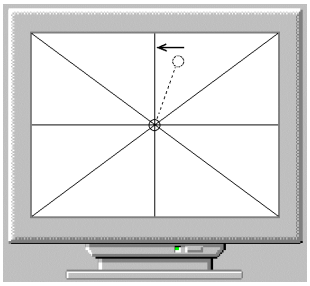
The software has now calculated the new rotation center and will indicate the values for X and Y in the upper part of the window.
Clicking "***Next***" will return the stage to the start position and the next calibration can be performed at the next higher magnification (200X). This procedure may be repeated for the magnifications 200X, 500X, 1500X and 2000X.
When clicking "***OK***" the calculated values will be used for the stage control. The calibration routine is finished.

5.9.2 Compucentric Set Up

Open ***Compucentric Set Up*** by using the Pop-Up menu ***TOOLS→ GO TO Panel...*** or using the ***SEM Control***- window ***Stage*** and clicking the right mouse button in the lower right part (see 5.4). When calibrating, a distinguishable point positioned within the imaging area will be driven to the center of the scan area by means of the X-axis and the rotation (move to the horizontal line). After a 2° stage tilt the same point will be re-centered using **only** the Y-axis. The software will calculate the tilt center of the stage in regard to the sample height by using the difference of both positions to the scan center. As the tilt center depends on the respective sample height, the calibration ***Compucentric Set Up*** will have to be performed for each sample.
The calibration can be repeated for different tilt angles (2°, 8°, 15°, 30° and 45°).

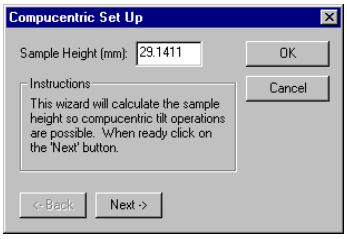


When centering a distinguishable point, only the X-axis must be used for the horizontal shift. Adjustment of this setting is possible with the joystick or by means of the function ***Center Point***. The software will automatically switch to ***Stage X Only*** (see 5.4).
Vertical shifts are only allowed by use of the rotation. To ensure a correct calibration, **changes of the Y coordinate are prohibited**.

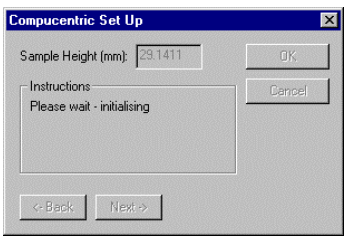


Due to mechanical tolerances, a centered point may drift when tilting from the vertical line. As with the second cycle (8° tilt) this drift can be compensated by means of the function ***Compu. Tilt Error***.
To ensure a correct calibration, **this drift must not be corrected by means of the X coordinate.**

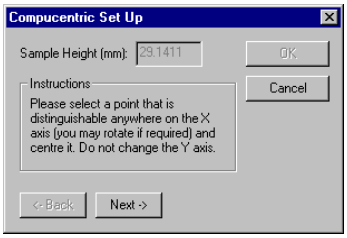
The calibration of ***Compucentric Set Up*** can only be done after calibration of ***Calibrate Stage Center*** (see 5.9.1)!



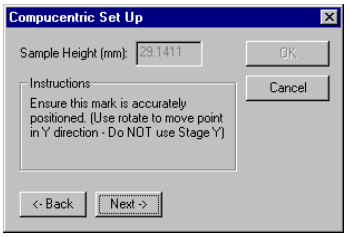
After opening the routine ***Compucentric Set Up*** a window will be displayed indicating in the upper part in ***Sample Height (mm)*** the distance of the sample surface to the center of the tilt axis (calculated value of the last calibration). This value will be calculated by the software using the calibration. It is specific for the respective sample. If the value is known and if no modifications have been performed on the microscope (installation of a spacer), the value may be entered manually. The calibration can be finished by clicking "***OK***". To start a new calibration, click "***Next".***



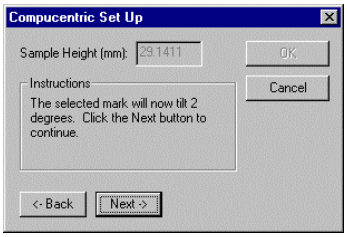
The sample stage will now drive to the Y coordinate of the rotation center. The tilt will be 0°. A small magnification (30X) will automatically be set on the microscope and a graticule will be displayed on the screen.



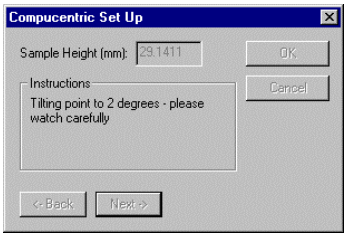
Now the calibration sample must be moved to the scan area by means of the X and R coordinates. . Position a distinguishable point in the center of the scan field. After positioning clicking "***Next***" will continue the calibration.
Be extremely careful not to move the Y-axis of the stage but only the X and R axes.



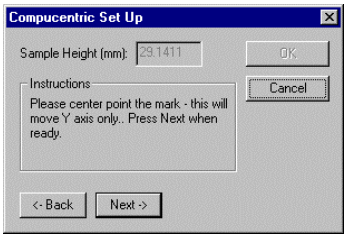
A higher magnification (500X) will automatically be set on the microscope to ensure that the point has been centered accurately. Fine adjustment by means of X and R axis is possible.
After positioning, continue the calibration by clicking "***Next"***.



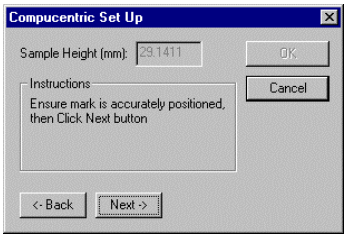
The magnification will automatically be reduced on the microscope. Clicking the key "***Next***" will result in a 2° tilt.



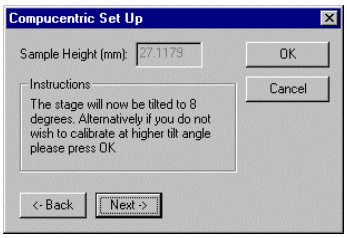
Tilt will be 2°. The centered point will drift upwards on the screen.



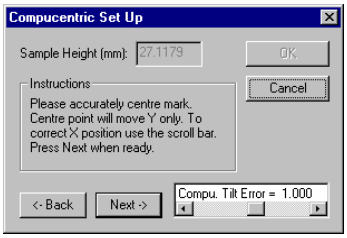
The distinguishable point must be positioned back to the center by using only the Y coordinate of the stage. Use of the joystick and of the function ***Center Point*** (***Stage Y Only*** will be set automatically by the software) is possible.
After centering, clicking the key "***Next***" will continue the calibration.



A higher magnification (500X) will automatically be set on the microscope to ensure that the point has been centered accurately. An eventual fine adjustment by means of the Y-axis is possible.
After positioning clicking "***Next***" will continue the calibration.

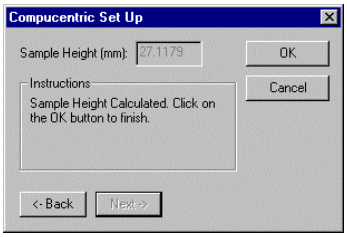


The software has calculated ***Sample Height*** and indicates the new value in the upper part of the window. If the calibration is to be ended after the first iteration (2°) the window may be closed by clicking. To continue the calibration, click the key "***Next".***



If you want to use the compucentric software also for higher tilt angles, it is recommended to perform the calibration for the next higher tilt angles, too The stage is to be tilted to 8° now. An eventual drift from the vertical line can be corrected by means of the scroll bar ***Compu. Tilt Error***. Clicking the key "Next" will continue the calibration for the following tilt angles in the same way as explained above.

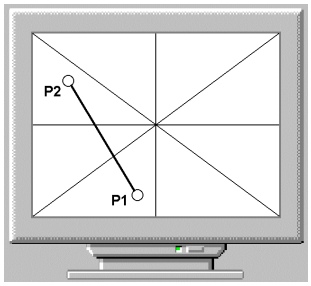
Further iterations are possible (8°, 15°, 30° and 45° tilt).



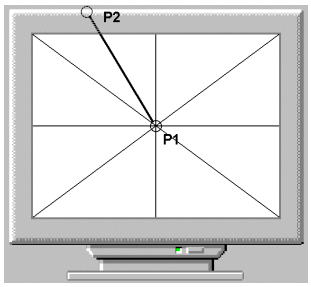
When all iterations of the calibration routine have been done, this window will open at the end of the procedure. The calibration has been completed and can be finished by clicking "***OK***".
The stage moves back to the initial position.

5.9.3 Stage Horizontal Alignment

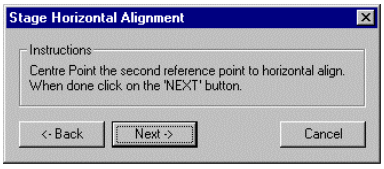
The function ***Stage Horizontal Alignment***, aligns an object imaged in the scan area automatically to the horizontal line. For this, two points of the respective object must be defined. Open this function by using the Pop-Up menu ***TOOLS→ GO TO PANEL...*** or using the ***SEM Control***- window ***Stage*** and clicking the right mouse button in the lower right part (see 5.4).
Precondition for the use of this function is the calibration of the rotation center (see 5.9.1).

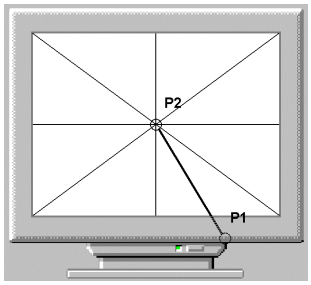


After opening this function, a graticule will automatically be displayed on the screen. One of the two points must be centered now.

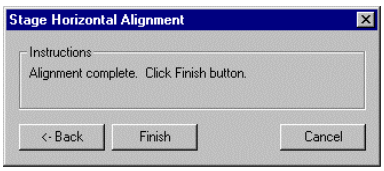


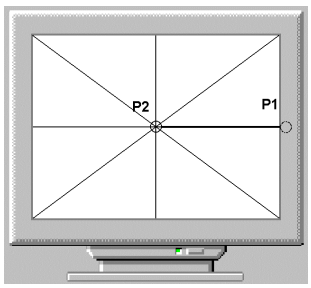
To do so, you may use the joystick or the function ***Center Point***. After centering click the key "***Next".***





Now the second reference point must be centered by using the joystick or the function ***Center Point***. After centering click "***Next".***

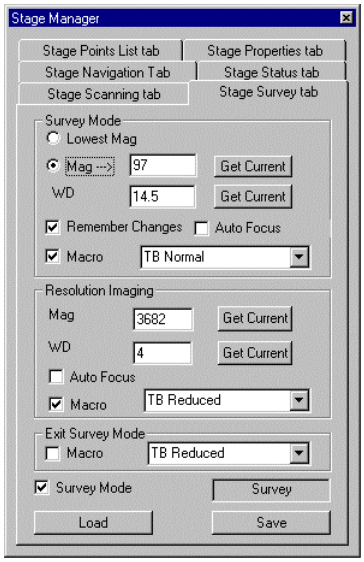




The respective object will be positioned horizontally on the screen by aligning the corresponding stage axes. The second reference point will be in the center. Finish the function by "***Finish***".

5.10 Stage Control

The window ***Stage Control*** is opened using the Pop-Up menu ***STAGE→ STAGE CONTROL***. It contains important stage functions. The window is subdivided into six index cards.



Stage Survey tab (see** 5.7**):
Definition of the ***Survey*** parameters as well as starting and ending the ***Survey Mode***.

Stage Status tab (see** 5.10.1**):
Indication of the actual stage positions, scanning of fields, absolute and relative coordinates.

Stage Navigation Tab (see** 5.10.2**):
Navigation help for the position of the sample holder in the sample chamber.

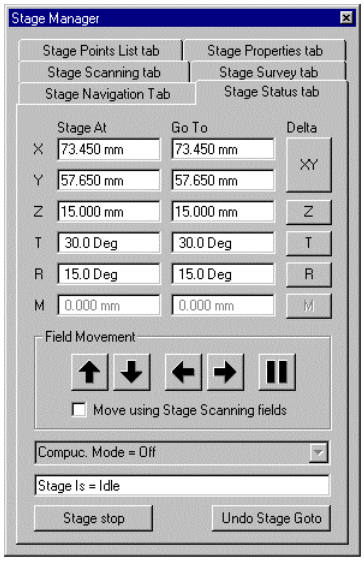
Stage Properties tab see** 5.10.3**):
Pre-settings for the motorized stage and definition of limits for the different stage axis.

Stage Points List tab (see** 5.10.4**):
Saving and scanning stage coordinates.

Stage Scanning tab (see** 5.10.5**):
Definition and scanning of special image fields.

5.10.1 Stage Status tab

The index Tab ***Stage Status tab*** contains, as does the ***SEM Control*** window ***Stage***, the values of the actual stage positions in the fields in ***Stage At***. Using ***Go To*** or ***Delta,*** absolute and relative coordinates, for the stage may be entered and scanned.



The field ***Field Movement*** allows scanning the predefined image fields of the function ***Stage Scan*** (see 5.5) by means of the arrow keys if the control box ***Move using Stage Scanning fields*** has been activated. If not, the arrow keys will refer to the respective image feature displayed on the screen. Clicking the corresponding key will displace the stage in horizontal or vertical line, dependant on the respective feature.

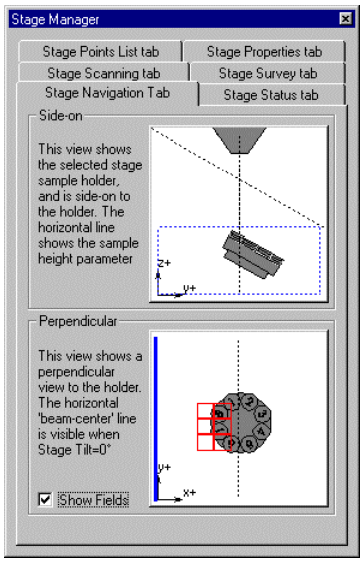
Clicking the pause key will immediately stop the stage movement.
In ***Compuc. Mode=*** it is possible to select the corresponding operation mode of the compucentric software.

The field ***Stage Is*** = defines the status of the motorized sample stage (Idle: stage at stand still, Busy: stage moving).

The movement of the stage can be stopped immediately by clicking "***Stage stop***" whereas "***Undo Stage Go To***" will undo the movement to the last position.

5.10.2 Stage Navigation Tab

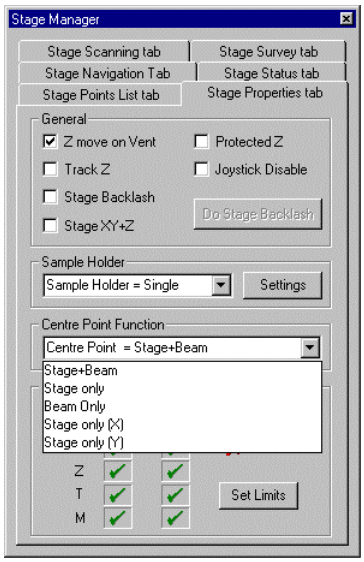
The index Tab ***Stage Navigation Tab*** provides the ability to get a visual impression of the position of the sample holder in the sample chamber and to control it in direction of the X, Y and R coordinate. The upper field ***Side-on*** shows the side view of the sample holder. The blue quadrangle symbolizes the limits of the stage for the Y and Z-axes. The tilted horizontal line indicates the sample height (settings on sample height and sample holder see 5.10.3).



The lower field ***Perpendicular*** shows the top view of the sample holder. If the stage is not tilted, the horizontal line will also be indicated. The intersection between horizontal and vertical line symbolizes the position of the electron beam on the sample holder (not displayed in the example!). Double-clicking the left mouse button on a position of the sample holder will drive this point to the intersection by means of X and Y axes. Double-clicking the middle mouse-button will drive the point to the corresponding position by means of rotation.
If limits have been set for the X and Y-axes, these will be indicated as a blue quadrangle within the field. The thick blue line shows the position of the chamber door.
If imaging fields have been defined (see 5.5), they may be indicated in the field ***Perpendicular*** by activating ***Show Fields***. The red grid will symbolize position and size of the fields in reference to the stage center.

5.10.3 Stage Properties tab

The index Tab ***Stage Properties tab*** allows different settings for the sample stage and for the sample holders. In the upper field ***General*** basic settings for the sample stage may be selected, in analogy to the ***SEM Control*** **window** ***St age*** (see 4.3.6).



Z move on Vent:
Activating this function will drive the table automatically to the lowest Z position at any venting of the chamber.

Track Z:
Activation of this function will result in the attempt to readjust the focus automatically at any change of the Z coordinate.

Stage Backlash:
Activating this control box will perform a backlash correction at any stage movement.

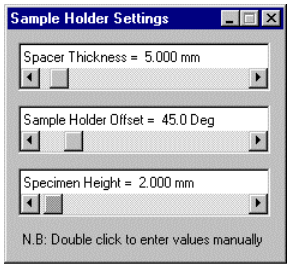
Stage XY+Z:
This setting will affect the routine ***Stage Scan*** (see 5.5). If the control box is not activated, the stage will not drive in the Z direction when scanning the different fields. If the control box is activated, a Z movement (dependant on the value ***Tilt Compensation***) will be performed in relation to the Z start coordinate if movement is in the tilt direction.

Protected Z:
If this function is activated, the actual Z coordinate will be compared to the new coordinate when loading saved stage positions. If the new Z position is higher then the actual position, the stage will first move to the

X/Y/T/R coordinates and then to the new Z position. If the new Z position is lower, the stage will first move to Z and then drive to the other axes.

Joystick Disable:
Switching on and off the joystick on the hard panel

Using ***Sample Holder=*** the adapted sample holder may be selected. This affects the kind of display in the window ***Stage Navigation Tab***. It is possible to select between ***Single*** (single sample holder), ***Multi*** (eight-fold sample holder) and ***Generic***. By means of the function ***"Settings"*** different settings for sample holder and respective sample may be entered.



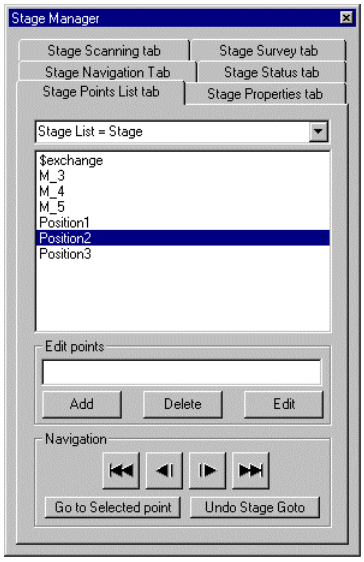
Spacer Thickness:
The entered value of the thickness of a used spacer.

Sample Holder Offset:
The entered value of the offset angle for the sample holder.

Specimen Height:
The entered value of the sample height.

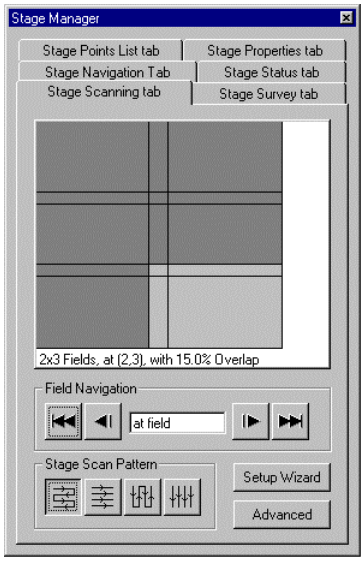
The operation mode to be used for the functions ***Center Point*** and ***Center Feature*** (see 5.4) can be selected using ***Center Point Function***.
Setting limits (see 5), for the different motorized axes of the stage is possible using ***Set Limits***.

5.10.4 Stage Points List tab

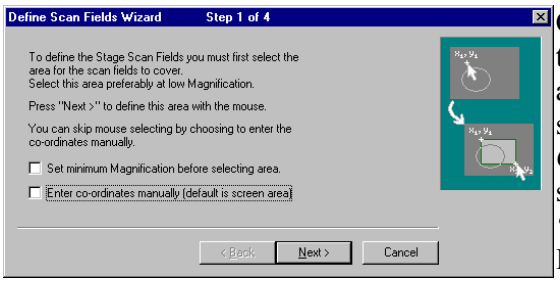


The index Tab ***Stage Points List tab*** provides the ability to drive to saved stage positions or to save new positions. New stage positions may be added to the list by clicking "***Add***", to delete or to edit a selected position from the list click "***Delete***" or "***Edit***". Moving to a saved position is possible by double-clicking the left mouse button on the corresponding annotation in the list or by using the arrow keys and the key "***Go to Selected point***" in the lower part of the window. Pressing the key "***Undo Stage Go To***" will undo the movement to the last position.

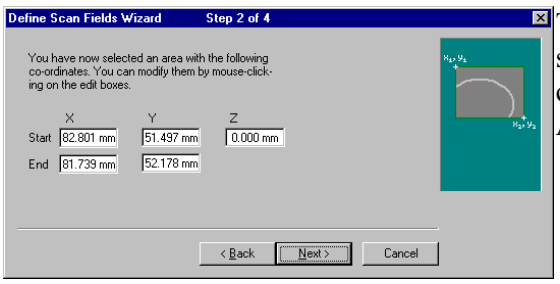
5.10.5 Stage Scanning tab



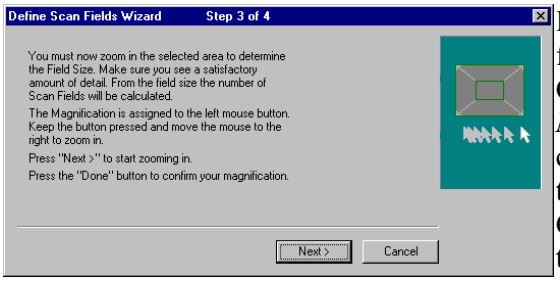
The index Tab ***Stage Scanning tab*** summarizes the different functions of the software option ***Stage Scan*** (see 5.5). The upper part will show the defined fields, horizontal and vertical lines will indicate the respective overlapping.
Driving to a special field is by double-clicking the left mouse button within the respective field in the graph or by using the arrow keys in ***Field Navigation***. Clicking the key with the double arrow will drive to the first or last field. The other two keys allow a one by one movement from field to field. It is also possible to double-click the left mouse button on ***at field*** in order to drive to a separate field by entering the X and Y position. Using ***Stage Scan Pattern*** selection of the different scan patterns is possible.
Two possibilities are available for the definition of a defined sample area and for the calculation of the fields. Clicking the key "***Advanced***" will open the window ***Stage Scan*** (see 5.5). When activating the key "***Setup Wizard***", the user will be helped to go through the definition of the fields.



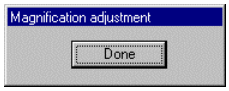
Opening the function ***Setup Wizard*** will first open a window to perform two pre-settings. Activating ***Set minimum Mag...*** and confirming with "***Continue***" will automatically set the smallest possible magnification. By means of the function ***Center Feature*** a corresponding sample feature may be selected. Selecting ***Enter co-ordi...*** and confirming with ***"Continue"*** will automatically switch to the second window. In this window the start and end coordinates of the respective sample feature will be entered manually by double-clicking the left mouse button on the corresponding figure. Clicking the key "***Continue***" will close the window and set automatically the function ***Center Feature*** on the microscope. After selection of a corresponding sample feature, the second window will be opened.

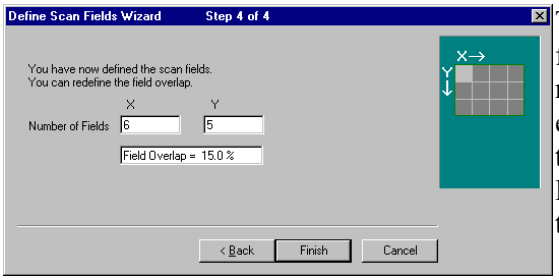


This window indicates the start and end coordinates of the sample feature. Editing the coordinates is possible by double-clicking the corresponding figure with the left mouse button. After confirming with "Continue" the next window will open.



In this window the user will find the explanation of the following procedure.
Clicking on "***Next***", will automatically assign the function ***Mag*** to the left mouse button. The actual window will be closed. Now the user may set a special magnification From this field size the number of scan fields will be calculated. .
Clicking "***Done***" will accept the magnification and switch to the next window.





The last window indicates the calculated number of scan fields in X and Y direction. When double-clicking the left mouse button on ***Field Overlap*** =, a percent value may be entered for overlapping of fields. Depending on this value there may be modifications in the number of fields.
Pressing the key "***Finish***" will finish the definition and close the window.

6 Special Applications and Settings

6.1 User Preferences

The function ***User Preferences*** provides the ability to enter special pre-settings for the user interface. The window, which is subdivided into six index cards, is opened using the Pop-Up menu ***TOOLS→ USER PREFERENCES***.

1.) ***Privileged User Directory Setup:***

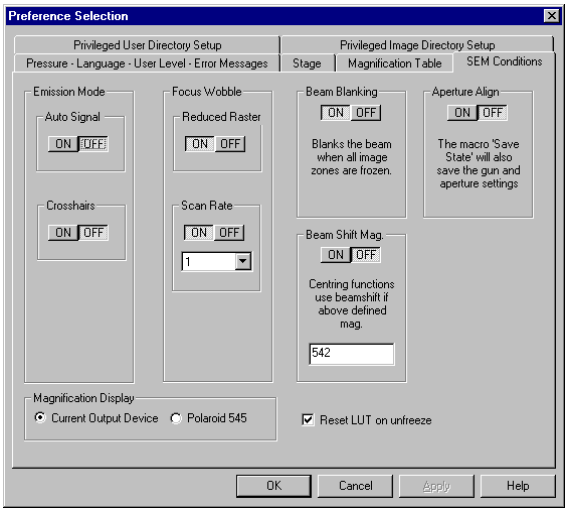
Enables modification of the user directory if this option has been authorized for the respective user in the Administrator (see 2.1). When loading user-specific parameters (e.g. Load state, Load Annotation, Macro Library etc.), this directory will be used.

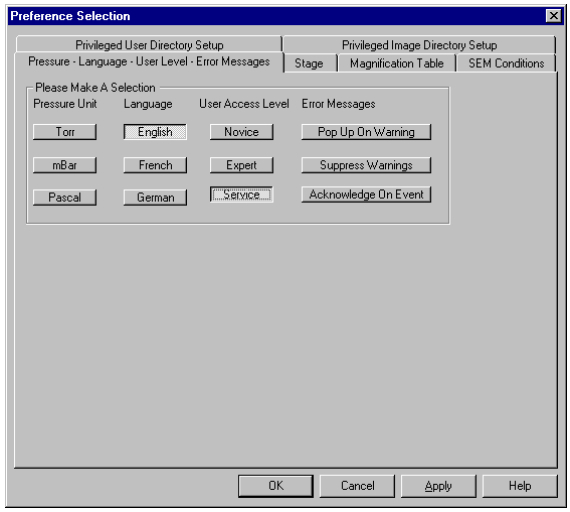
2.) ***Privileged Image Directory Setup:***

Allows modification of the image directory (see 2.1) if this option has been authorized for the respective user in the Administrator. Enables loading images from this directory or saving images to this directory.

3.) ***SEM Conditions:***

Emission Mode allows selection of automatic brightness and contrast of the detector image when switching to the emission mode. If ***Auto Signal*** is switched ***Off***, the user settings will be used for the respective detector. Selecting ***Crosshairs*** you may select whether a graticule is to be displayed automatically when selecting emission image. Two presettings are available for the focus wobbler. Activating ***Reduced Raster*** will switch automatically to the scan mode reduced scan when selecting focus wobbler. Using ***Scan Rate*** you may select the scan speed of the electron beam for scanning the sample.
When activating ***Beam Blanking*** the beam will be blanked by using the electromagnetic aperture system after freezing the image. Thus, the sample will not be scanned while the image is frozen, minimizing beam damage.





The selection ***Aperture Align*** provides the choice to select whether the settings for ***Aperture Align*** and ***Gun Align,*** of the different apertures, are to be saved when storing special instrument settings using ***Save State*** (see 4.1.4).
The selection, ***Beam Shift Mag.,*** allows pre-selection of the magnification above which the center functions ***Center Point*** and ***Center Feature*** are to be performed only by means of the beam shift.

The field ***Magnification Display*** provides the ability to select the output device for the calculation of the magnification. Selecting ***Polaroid 545*** means that the magnification index refers always to the size of a Polaroid. Modifications of the parameter ***Output to*** in the ***SEM Status***- window will therefore not affect the magnification index. If however ***Current Output Device*** has been selected, the user may decide on the output device, which the magnification shall refer to. For this purpose, the parameter ***Output to*** may be selected in the ***SEM Status***- window. Double-clicking the left mouse button on this parameter will select the respective device.

4.) ***Pressure – Language – User Level – Error Messages:***

By clicking the different selections in ***Pressure Unit*** the pressure unit may be switched to Torr, Mbar and Pascal.
In ***Language*** you may select the language to be used for the display of menus, parameters and for the navigation texts. **At present, switching to German and French is only partially possible for menus and parameters. The navigation texts are only available in English for the moment.**
The settings in ***User Access Level*** refer to the parameters and commands which can be selected e.g. in the ***SEM Status*** window (see 4.4) or using the annotations (see 4.7) .The respective level can be set by clicking Novice, Expert or Service.

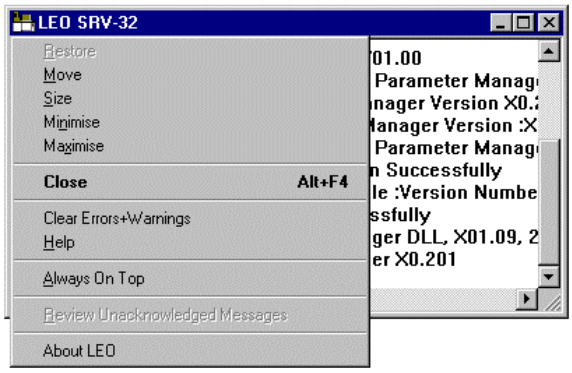
Novice:	frequently used parameters and commands.
Expert:	parameters and commands which might be useful for an advanced user
Service:	Activation of all available parameters and commands

The selections in ***Error Messages*** offer the ability to select how the software is to handle error messages

Acknowledge on event: Indication of error messages. If this key is activated, a window appears at each error indicating the error to the user. Work can only be continued after acknowledgement deactivating this key will write the respective message in a list of error messages. In the SERVER, this list can be checked using ***Review Unacknowledged Messages*** or deleted by clicking ***Clear Errors + Warnings***.

Pop Up on Warning: If this key is activated, a pop up error message will appear for each error. If not, the dialogue window will remain in the background.

Suppress Warning: If this key is activated the Warning message will be displayed in a dialog window. If the key is not activated no Warning message will appear, however a message will be written into the list of Errors and Warnings.

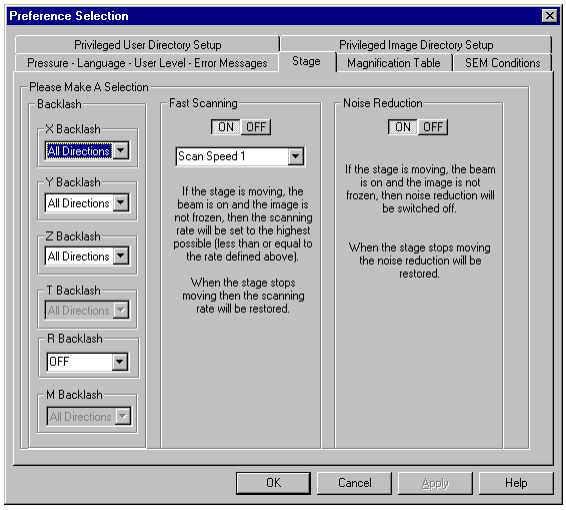


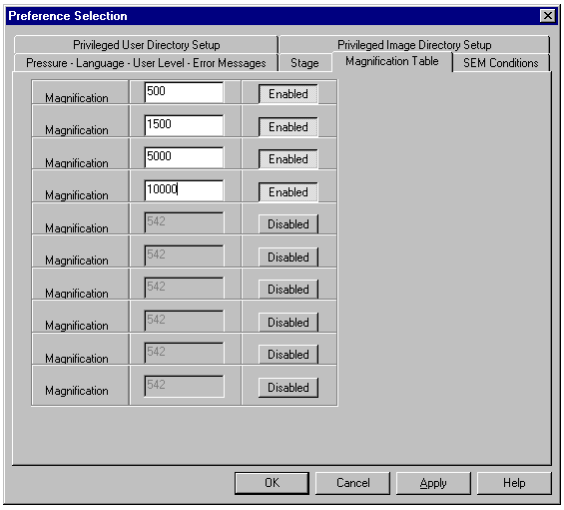
5.) ***Stage:***

The selection field ***Backlash*** allows the selection of the backlash correction for the different motorized axes. This will increase the travel precision of the stage. When scanning certain sample areas, it may be advisable to use a higher scan rate during the stage travel. If a corresponding area has been identified, you should switch back to a lower scan rate to get a noise free image. Such a presetting is available using ***Fast Scanning***. When switched ***On***, the system will switch to the scan rate selected in the selection bar whenever the stage is moved. When the stage movement stops, the scan rate will be switched back to the value set before stage movement began. The same function is valid for the use of noise reduction. (***Noise Reduction***).

6.) ***Magnification Table:***

Up to 10 fixed magnification values can be entered into the magnification table to be activated later on by clicking the key "***F4***". The system will advance continuously from one magnification to the other. Each clicking. of the key "***F4***" on the keyboard will set the next magnification value. By means of the key combination. ***Shift*** + ***F4*** operating with the magnification table will be completed and the original magnification will be reset on the microscope.





6.2 Bake out of the Ion Getter Pump (IGP)

Evacuation of the gun head is by means of a ion getter pump whose pumping ability will decrease in the course of time. Regeneration is possible by heating to increase the pumping capability. Under normal conditions, the vacuum in the gun assembly will decrease continuously. Once the vacuum has decreased to a value in the upper 10^{-9} range (8 to $9*10^{-9}$ mbar) the IGP should be baked out. This bake out procedure can only be started by authorized personnel (supervisor privilege see 2.1).

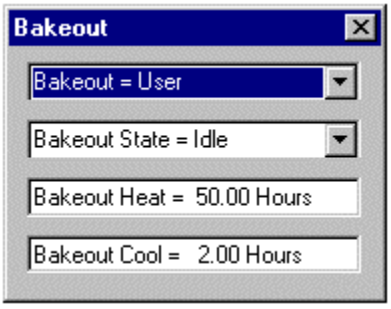
Bake out:

1.) Switch off the EHT and the gun.

2.) Remove the high voltage cable from the gun head, the EHT supply cable is attached by a plug connection locked by a black cap with bayonet joint or by four screws. To remove the cable turn the black safety cap to the left, or loosen the four screws and remove the plug straight upwards with the cable . **IN ORDER TO AVOID ANY MISALIGNMENT OF THE GUN HEAD YOU SHOULD TRY NOT TO EXERT ANY SIDE FORCE.**

3.) The cable plug on the gun head should be covered with aluminum foil to ensure the cleanliness of the gun area. It is also recommended to protect the high-tension plug on the cable, against contamination by covering it with aluminum foil or by using an antistatic bag (i.e. PCB foil packaging).

4.) Open the ***Bake out***- window using the Pop-Up menu ***TOOLS→ GO TO PANEL→ BAKEOUT***.



In the window ***Bake out*** four different bake out cycles may be selected:

Quick: 2 hours heating/1 hour cooling
Overnight: 8 hours heating/2 hours cooling
Weekend: 40 hours heating/3 hours cooling
User: Individual setting of heating and cooling time. When double-clicking the left mouse button on ***Bake out Heat*** a value between 1 and 200 hours may be entered. The same procedure is applicable for ***Bake out Cool***. Cooling periods from 1 to 5 hours will be possible.

5.) After selection of the desired bake out cycle, the bake out procedure may be started using ***Bake out State***. Start of the bake out process is only possible for users with supervisor privilege. In the ***User Preferences*** (see 6.1) the ***USER ACCESS LEVEL→ SERVICE*** must be activated.

6.) At the end of the bake out re-insert the plug into the gun head, a pin has been fitted to the plug, which will allow the cable to only fit in the correct position. After insertion of the plug the electric supply will be locked again by means of the black protection cap with bayonet joint, or the four screws. **AGAIN, BE CAREFUL NOT TO EXERT ANY SIDE FORCE ON THE GUN HEAD!**

7.) Now gun and EHT can be switched on again.

Bake out of the IGP is possible in normal operating or standby modes. If, after start of the bake out, the user interface is to be switched off and the instrument set to standby mode, deactivate the function ***Partial Vent on Standby,*** in ***Vacuum*** in the ***SEM Control*** window. When partially venting the sample chamber, the bake out procedure will automatically be stopped.

When baking out the IGP intense heat will develop. You should therefore be careful not to place any flammable objects on the protection grid behind the electron-optic column

6.3 Special Scan Modes

Different scan modes are available in the LEO 32 software, used for adjustment procedures, imaging of tilted samples or the display of different detector signals. These different options can be opened using the Pop-Up menu ***SCANNING*** or by activating the corresponding symbol in the toolbar.

6.3.1 Reduced Scan (Reduced) 

The ***reduced scan*** should be used especially for adjustments such as focusing, stigmation or for use of the focus wobbler. After selecting ***reduced scan***, a frame will be displayed on the screen. If the license REDUCED has been installed, size and position of this frame can be varied. The frame will define the area on the sample, which will be scanned by the electron beam. It can be burnt in a saved image if the control box ***Annotation*** (see 4.5) has been activated when storing the image. In the stored image, this frame will be represented as a white square.

6.3.2 Split Screen  (Requires the Licence: SPLIT)

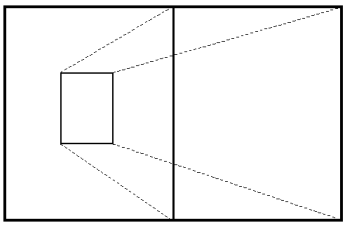
On selection of ***Split Screen,*** the image area will be subdivided in two zones. Each zone can be assigned different detectors, and each zone can be frozen independantly from the other. The anchor symbol will determine which zone detector selection, setting of brightness and contrast or the freezing/deleting will apply to. Depending upon the side where the anchor has been placed (move the anchor by holding the left mouse button and dragging the anchor to the desired side), all parameter settings will apply to this area. Double-clicking the left mouse button on the anchor symbol will assign certain settings to both zones simultaneously

 Parameter modifications will only apply to one image zone

 Parameter modifications will apply to both image zones.

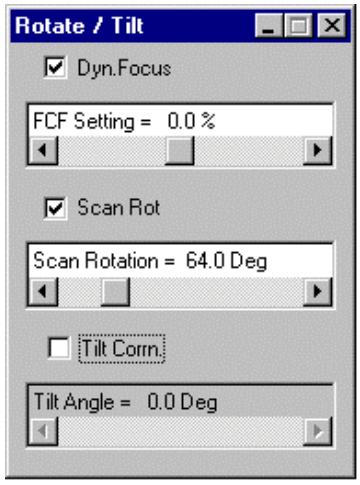
6.3.3 Magnification of a Feature (Dual Mag)  (Requires the Licence: DUALMAG)

The function ***Dual Mag*** enables the imaging of a zoomed image in the ***Split Screen*** mode without freezing the image during the basic magnification. Upon selection of this function, the screen will be subdivided into two zones and will therefore have the same appearance as ***Split Screen.*** Moving the mouse cursor to the vertical line in the center of the screen will create a double arrow. The size of the frame can be varied by holding the left mouse cursor and dragging it. In the right image field, the selected area will now be displayed in the zoomed magnification. It is also possible to change the position of the frame. Another option to enter a zoom factor is via the ***SEM Control***- window ***Scanning*** (see 4.3.2). The frame may be burnt in a stored image if the control box ***Annotation*** (see 4.5) has been activated when saving the image. This frame will be represented as a white square in the stored image.



The dual mag is useful to point out a specific detail in an image when observing an image of the sample at low magnification.

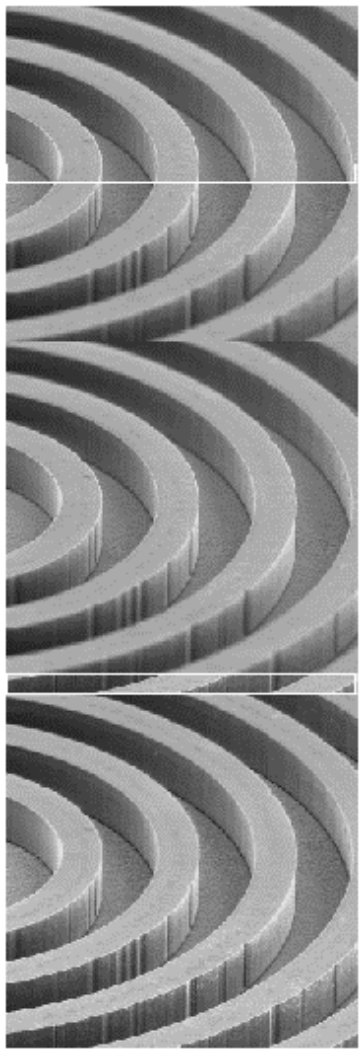
6.3.4 Dynamic Focus (Dynamic Focus) (Requires the Licence: DYNFOCUS)



The function Dynamic Focus enables a dynamic adjustment of the focus during the scanning of the beam on tilted sample surfaces. The window will be opened using the Pop-Up menu ***SCANNING→ ROTATE/ TILT*** or **→ *DYNAMIC FOCUS***. Using the control box ***Dyn. Focus*** the dynamic focus can be switched on or off. As the dynamic focus is effective in the Y image direction , the sample surface must be tilted so that the upper image border is placed at the sample point with the highest working distance, the lower image border must be positioned at the sample point with the smallest working distance. If the sample surface is not tilted in the proper direction, compensation is possible by use of ***Scan Rotation.***

Setting up Dynamic Focus:

⇒ Open and activate the function Dynamic Focus
⇒ Check if ***FCF Setting*** has been set to 0%
⇒ Select reduced scan
⇒ Adjust the reduced scan to a thin horizontal line
⇒ Adjust the focus of the image in the center of the screen (use of the hair-cross) at a slow scan rate
⇒ After focusing the image center, move the reduced scan to the upper or lower image border
⇒ Adjust the focus, of the reduced area, by means of the scroll bar ***FCF Setting*** at a slow scan rate (min. Scan Speed 10). **The normal focus must not be used for image optimization any more!**
⇒ Switch off the reduced scan and scan the entire image using noise reduction
⇒ Switch off the dynamic focus

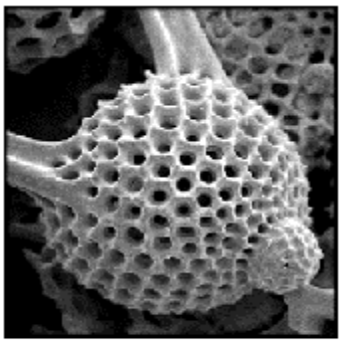


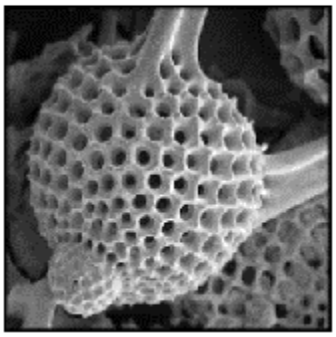
6.3.5 Tilt Correction (Requires the Licence: TILTCOMP)

This function corrects the perspective reduction caused by the scanning of tilted samples. At high tilt angles, the electron beam will scan a larger part of the sample in the tilt direction. This will result in a distortion of the image. An adjustment of the scanning amplitude in the tilt direction can compensate this effect.
As with ***Scan Rotation***, the window will be opened using the Pop-Up menu ***SCANNING→ ROTATE/ TILT***. The tilt angle correction can be switched on or off using the control box ***Tilt Corrn.*** The respective tilt angle may be entered by double-clicking the left mouse button on ***Tilt Angle*** or by using the scroll bar. . Just as for the use of the dynamic focus, you must take into consideration that the sample surface must be inclined in the screen Y direction. The adjustment will be performed in the same way as dynamic focus. For strongly tilted samples, the tilt correction should be used together with the dynamic focus.
If the sample surface contains steps or other elevations, they will be more distorted when using the tilt correction. A successful application of this function is therefore only possible with relatively flat samples

6.3.6 **Scan Ratotion** (Requires the Licence: SCANROT)

Scan Rotation allows an electronic rotation of the image by rotating the scan direction. This window may be opened by means of the Pop-Up menu ***SCANNING→ ROTATE/ TILT***. Using the control box ***Scan Rot*** the scan rotation may be switched on or off. Enter the required rotation angle by double-clicking the left mouse button on ***Scan Rotation*** or by using the scroll bar. The entered value will be saved when switching off the scan rotation and reset when switching back on.

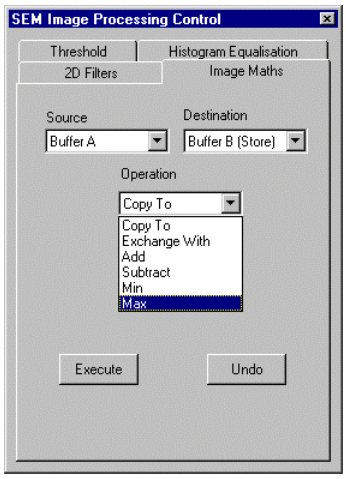




6.4 **Image Processing** (Requires the License: IMMATH)

The functions of ***Image Processing*** offer the ability to manipulate mathematically the content of the image store: e.g. by use of Kernel functions, by adding or subtracting images or by detecting gray scale distributions. They also allow simple calculations of surface fractions. Two image stores are available: Buffer A and Buffer B. The image store A is permanently displayed on the screen whereas image store B is a background store.
The window can be opened using ***IMAGE→ IMAGE PROCESSING***.

6.4.1 Manipulation of Images (Image Maths)



Click the key "***Execute***" to apply the preset operation to the respective image store. By clicking ***Undo*** the last action can be undone. Depending on the settings for ***Source*** and ***Destination***, the operations will be performed from A to B or vice versa.

Copy To: Copying the content of an image store to another image store

Exchange With:
Exchange of the contents of two image stores.

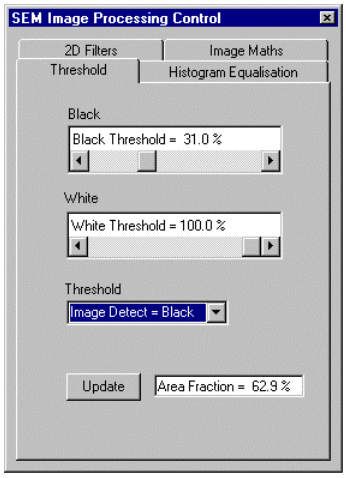
Add:
Adding the contents of both image stores. The result will be saved in image store A. If the sum of gray scales of Pixel A+B is superior to 255, 255 will be result value.

Subtract: Subtracting the content of both image stores. The result will be stored in image store A. If the difference of gray scales of Pixel A+B is inferior to 0, 0 will be result value.

Min:
Identifying the minimum of each pixel in A and B and saving in A.

Max:
Identifying the maximum of each pixel in A and B and saving in A.

6.4.2 Gray Scale Detection (Threshold)



Threshold defines the threshold criteria.. Selections are: ***Black***, ***White*** and ***Gray***.

Black:
Each pixel in the image store with a value inferior to the black threshold will be colored red. (***Black Threshold***).

White:
Each pixel in the image store with a value superior to the white threshold (***White Threshold***) will be colored red.

Gray:
Each pixel in the image store with a value superior to the black threshold and inferior to the white threshold will be colored red.

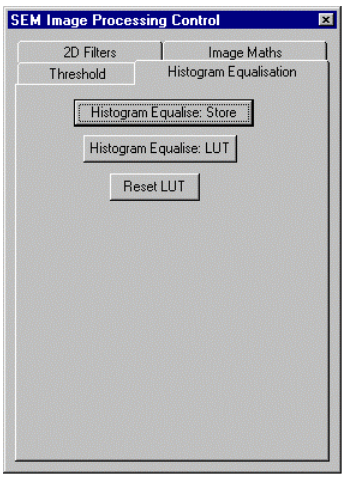
The scroll bars ***Black Threshold*** and ***White Threshold*** allow setting the threshold values for black and white.

If certain gray scales are colored red in the image, the area fraction can be calculated by clicking the key "***Update***".

If stored images are processed by means of this function which contain annotations and measurements, the gray scales of these objects will be integrated in the calculation and display.

6.4.3 Histogram Equalization

Clicking the key "***Histogram Equalization: Store***" the image store will be opened for the calculation of a gray scale distribution which will improve the contrast of the image.

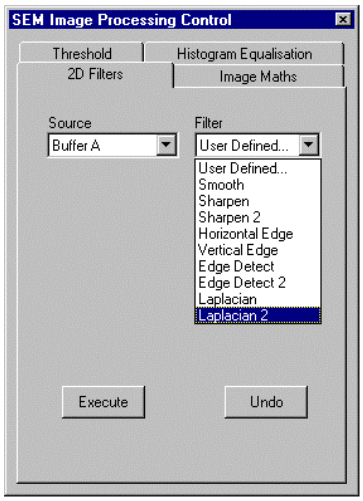


Clicking the key "***Histogram Equalization: LUT***" will transform the image by using a ***Display- LUT*** so that work can be done with a live image.

Reset LUT will reset the calculated ***Display- LUT***

6.4.4 2D Filters

The function ***2D Filters*** provides selecftion of a kernel which will be applied to the image in image store A or B. The result of this tranformation will be normalised to the gray scale range 0 to 255. All predefined kernels are based on a 3x3 matrix to which whole numbers have been assigned. Furthermore, an editor is available to define matrices up to 5x5.
Using ***Source*** the store will be selected which the transformation is to be applied to. Nine predefined filters are available. After selection of the filter start the transformation by clicking the key "***Execute***". The last calculation can be undone by pressing the key "***Undo***".



Smooth:
Will smoothen the image

Sharpen:
Will increase the focus

Sharpen 2:
Will increase the focus

Horizontal Edge:
Will detect horizontal edges in the image

Vertical Edge:
Will detect vertical edges in the image

Edge Detect:
Will execute a nondirectional edge detection by means of a combined detection of horizontal and vertical edges in the image.

Edge Detect 2:
Will execute a nondirectional edge detection by means of a combined detection of horizontal and vertical edges in the image.

Laplacian:
Will detect edges in the image by performing a Laplace transformation using the four neighbor pixels.

Laplacian 2:
Will detect edges in the image by performing a Laplace transformation using the four neighbor pixels.

<u>Pre-defined filters:</u>

Smooth

$$\begin{pmatrix} 1 & 2 & 1 \\ 2 & 3 & 2 \\ 1 & 2 & 1 \end{pmatrix} / 16$$

Sharpen

$$\begin{pmatrix} -1 & -1 & -1 \\ -1 & 9 & -1 \\ -1 & -1 & -1 \end{pmatrix}$$

Sharpen 2

$$\begin{pmatrix} 0 & -1 & 0 \\ -1 & 5 & -1 \\ 0 & -1 & 0 \end{pmatrix}$$

Horizontal Edge

$$\begin{pmatrix} 2 & 2 & 2 \\ 0 & 0 & 0 \\ -2 & -2 & -2 \end{pmatrix}$$

Vertical Edge

$$\begin{pmatrix} -2 & 0 & 2 \\ -2 & 0 & 2 \\ -2 & 0 & 2 \end{pmatrix}$$

Edge Detect

$$\left(\left| \begin{pmatrix} 1 & 2 & 1 \\ 0 & 0 & 0 \\ -1 & -2 & -1 \end{pmatrix} \right| + \left| \begin{pmatrix} -1 & 0 & 1 \\ -2 & 0 & 2 \\ -1 & 0 & 1 \end{pmatrix} \right| \right) / 2$$

Edge Detect 2

$$\left(\left| \begin{pmatrix} 1 & 1 & 1 \\ 0 & 0 & 0 \\ -1 & -1 & -1 \end{pmatrix} \right| + \left| \begin{pmatrix} -1 & 0 & 1 \\ -1 & 0 & 1 \\ -1 & 0 & 1 \end{pmatrix} \right| \right) / 2$$

Laplacian

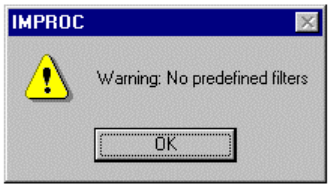
$$\begin{pmatrix} 0 & -1 & 0 \\ -1 & 4 & -1 \\ 0 & -1 & 0 \end{pmatrix}$$

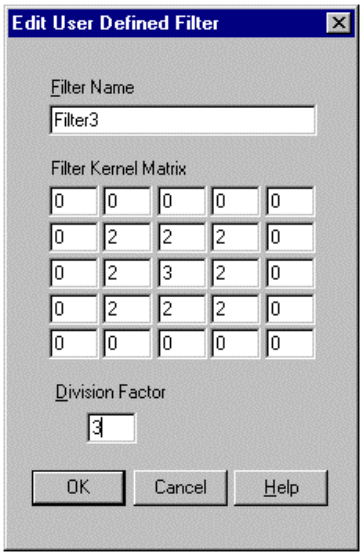
Laplacian 2

$$\begin{pmatrix} -1 & -1 & -1 \\ -1 & 8 & -1 \\ -1 & -1 & -1 \end{pmatrix}$$

If you want to use user specific filters, ***User Defined*** must be selected in the menu ***Filters***. After pressing the key "***Execute***" a list will be displayed (***Apply User Defined Filter***) indicating any already existing filters. If

no user specific filters have been defined yet, a warning message will first be displayed. After confirmation of this message the window ***Apply User Defined Filter*** will be opened where already created filters can be selected, edited or deleted and where new filters can be created by clicking the key "***New***". Each filter can be assigned a separate name. The ***Filter Kernel Matrix*** allows the user to define a new filter.

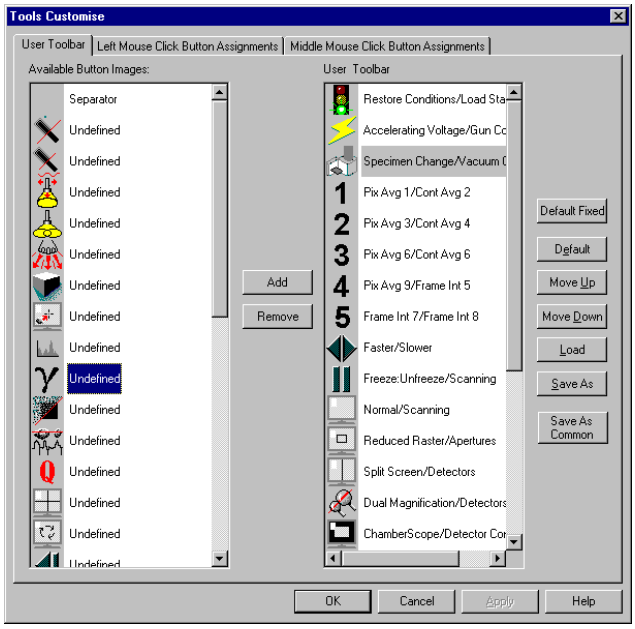


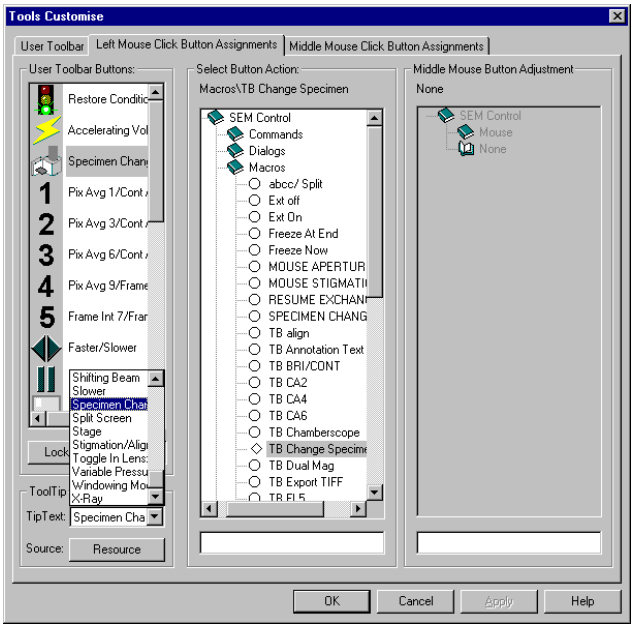


6.5 Editing the Toolbar

Editing the toolbar can be done according to customer need. The toolbar editor is opened by using the Pop-Up menu ***EDIT→ TOOLBAR***. The left list will indicate all available symbols (52 at present). The symbols of the actual toolbar will be listed in the window ***User Toolbar***. Arranging the different symbols within the toolbar is possible by selecting the corresponding symbol and clicking the "***Move Up***" or "***Move Down***". New symbols may be selected in the window ***Available Button Images*** and added to the actual toolbar by clicking ***Add***. In the same way symbols can be removed using ***Remove***.
Edited toolbars can be saved using ***Save As*** with a file name. If toolbars have already been saved as a file they can be loaded to the user interface by using ***Load***. Clicking the key "***Default***" will load the standard toolbar for the user interface.
If you want to modify the assignments of the different symbols, the corresponding configuration can be edited by selecting the index tabs ***Left Mouse Click Button Assignments*** and ***Middle Mouse Click Button Assignment***. Selecting a symbol in ***User Toolbar Buttons*** will automatically display the respective function assignment in the window ***Select Button Action***. Activating another function in the selection list will modify the assignment. It is also possible to attach a short explanation to the different symbols. This explanation will pop up for a short time below the mouse cursor when positioning it on a symbol of the toolbar. This text will give information on the actions performed on activating the corresponding symbol with the left or middle mouse button.

Explanations for the already existing symbols can be opened using the selection window ***Tip Text***. They are also listed behind each symbol in the window ***User Toolbar***. Entering new text or editing an already existing text is possible by clicking the key "***Resource***" in the window ***Tip Text***. It is recommended to separate the descriptions for left and middle mouse button by a (/).
Modifications of the toolbar will have to be confirmed by clicking "***apply***" and "***OK***" to load the respective modification to the user interface.



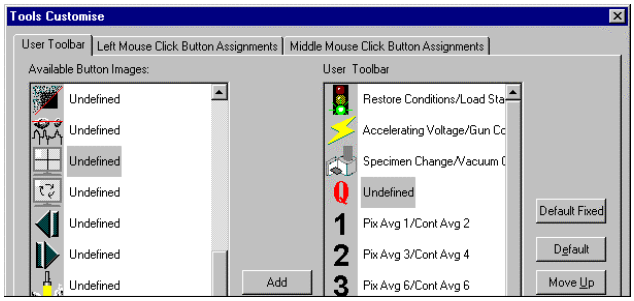


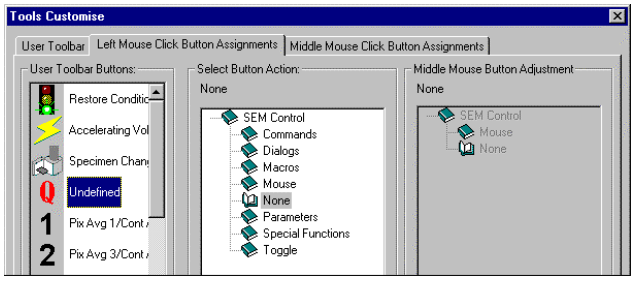
6.5.1 Setting a New Symbol (Example)

The addition of a symbol to the actual toolbar and the assignment with special routines will be explained below by means of an example. The assignment of the symbol  will be as follows:

Clicking the left mouse button: left mouse button assignment: Beam Shift
Clicking the right mouse button: Opening the 4QBSD detector window.

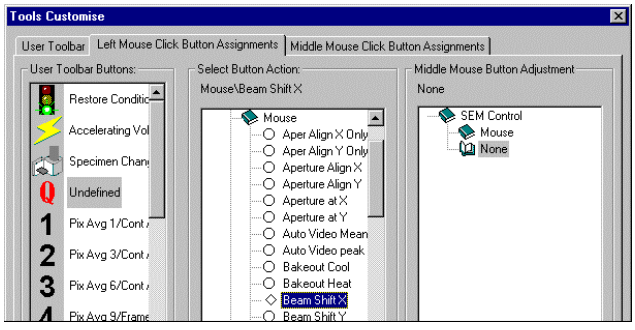
First, click the corresponding symbol in the left bar with the left mouse button and copy it to the actual toolbar by pressing the key "***Add***" . Then edit the assignment for the left mouse button by switching to the index Tab ***Left Mouse Click Button Assignments*** . In the list ***SEM Control*** you may now open the different submenus.

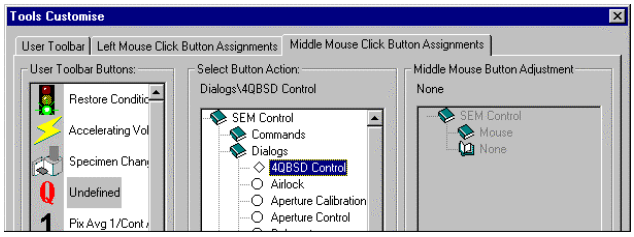




Commands: Contains various commands (e.g. EHT On, Scan Speed 3, etc.).
Dialogs: Contains the commands to open menus and windows in the LEO user interface.
Macros: Lists all macros, which are part of the standard macro library. If user macros have been implemented to the library, they will be listed in this section.
Mouse: Contains various parameters to be set or adjusted by means of the mouse.
Parameter: Lists various commands to read or set important parameters of the microscope.
Special Function: Contains the two routines ***Restore The System Conditions*** and ***Save The System Conditions*** (see 3.1.1).
Toggle: Lists digital parameters to be used as a switch (e.gScan Rot, Spot, etc.).

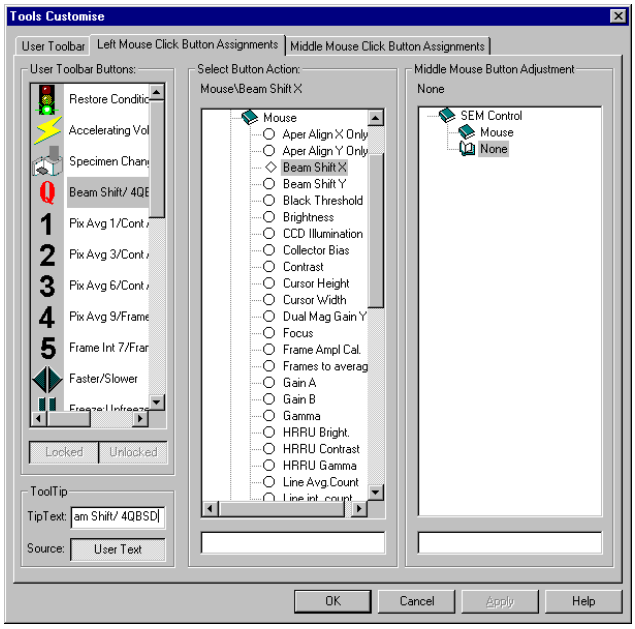
As the left mouse button shall be assigned the function Beam Shift and as this function can be performed by means of the mouse, double-click the submenu ***Mouse*** and select the listed command ***Beam Shift X***. A rhombus in front of the denomination will symbolize the selection.

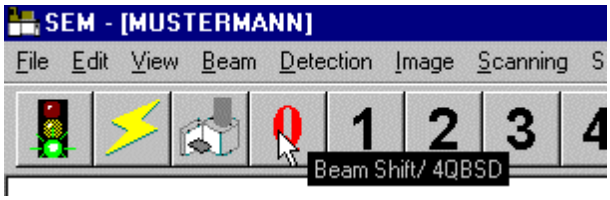




When activating the submenu ***Mouse***, the right list ***Middle Mouse Button Adjustment*** will be activated simultaneously. As many mouse functions can be aligned with only one mouse button, it is possible to assign the middle mouse button to another routine.
Now for the assignment of the middle mouse button. First, select the index Tab ***Middle Mouse Button Assignments***. Open the menu for the LEO user interface by means of the middle mouse button, open the list ***Dialogs*** and select the command ***4QBSD***. If you wish to add a short explanation for the symbol, switch to the

index Tab ***Left Mouse Click Button Assignments*** and click the key "***Resource***". This will activate the field ***Tip Text:*** where you can enter the desired explanation text (e.g. Beam Shift/ 4QBSD).
To save the modifications in the actual toolbar, close the editor by clicking ***OK***..
The symbol will now be displayed in the toolbar. By clicking it with the left mouse button, the mouse button assignment will switch to beam shift. That means that the image field can be moved when pressing the left mouse button. The middle mouse button will keep its original assignment. Clicking the symbol with the middle mouse button will display the 4QBSD menu on the screen. (see 4.3.1).





6.5.2 Use of Bitmaps as Icon Symbols

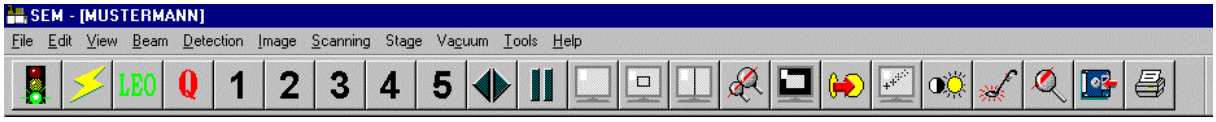
It is also possible to use bitmaps in the toolbar. Each symbol available by default in the LEO user interface has an internal number. The numeration of these symbols is listed in the table below. If you want to replace one of these symbols by bitmap, the corresponding bitmap must have the file name Tooln.bmp. The letter "n" will be the number of the replaced symbol. If you want to replace the symbol  by the symbol  the file name must be "Tool30.bmp" .
User bitmaps can be created by means of the program MS Paint part of the Windows® operating system. When creating a symbol it is important to file it with a size of 32x31 Pixel. This size can be set in MS Paint in the menu ***Image→ Attribute*** (breadth 32- height 31 Pixel). After creation of the bitmap, it must be saved as a **16-color-Bitmap**.

Depending on the settings in the Administrator (see 2.1) the bitmap will have to be copied to the following directories.

1. ***USE COMMON TOOLBAR*** is **not** activated:

a) To the corresponding user directory if the symbol shall only be available to the user.
b) To the directory "C:\Program Files\LEO\LEO32\Distrib" if the symbol shall be available to all users excepting those which must use the COMMON toolbar

2. ***USE COMMON TOOLBAR*** is activated:
   To the directory "C:\Program Files\LEO\LEO32\USER".

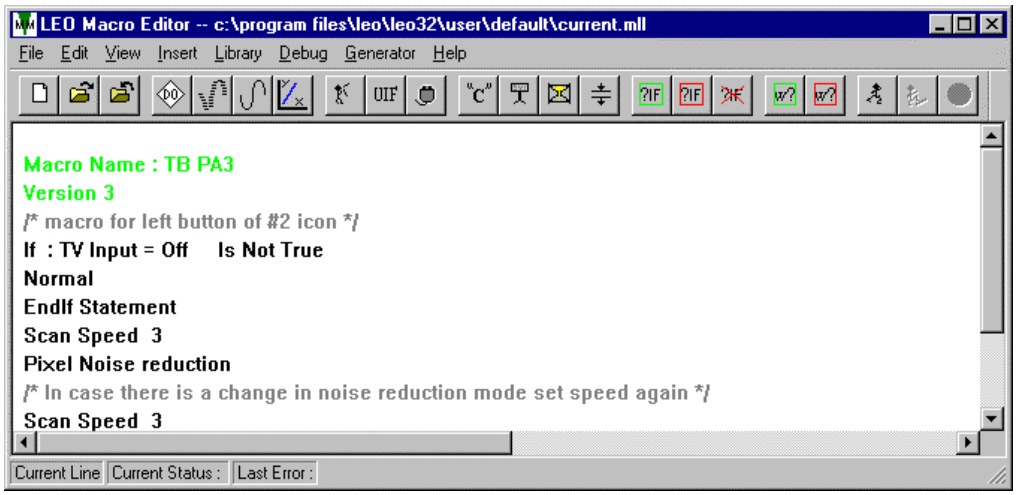


If you want to delete a symbol from the toolbar, it must be deleted in the corresponding directory. THE LEO user interface must then be started again.

	Symbol 1		Symbol 14		Symbol 27		Symbol 40
	Symbol 2		Symbol 15		Symbol 28		Symbol 41
	Symbol 3		Symbol 16		Symbol 29		Symbol 42
	Symbol 4		Symbol 17		Symbol 30		Symbol 43
	Symbol 5		Symbol 18		Symbol 31		Symbol 44
	Symbol 6		Symbol 19		Symbol 32		Symbol 45
	Symbol 7		Symbol 20		Symbol 33		Symbol 46
	Symbol 8		Symbol 21		Symbol 34		Symbol 47
	Symbol 9		Symbol 22		Symbol 35		Symbol 48
	Symbol 10		Symbol 23		Symbol 36		Symbol 49
	Symbol 11		Symbol 24		Symbol 37		Symbol 50
	Symbol 12		Symbol 25		Symbol 38		Symbol 51
	Symbol 13		Symbol 26		Symbol 39		Symbol 52

6.6 Macro- Editor

By means of macros, certain control commands and routines of the SEM can be combined in a list. When starting the macro, they will be processed one after the other. It is also possible to insert loops in a macro so that certain conditions of the microscope will first be read before starting a routine or a command.
The Macro Editor will be opened using the Pop-Up menu ***TOOLS→ MACRO EDITOR***.



Menu: File

The menu ***File*** contains commands and routines necessary for creating, editing and saving macros. A macro can be saved as a file on a storage device (***Save Macro to File***) or be implemented in the macro library (***Save Macro to Library***). The macro library contains a composition of all macros available in a specific user list. These macros may also be used for the assignment of symbols in the toolbar (see 6.5.1) and for programming function keys (see 6.6.2).

New Macro: Creating a new macro. The macro must be given a name and a version number.

Edit Macro: Editing a macro in the macro library. Selecting this menu will open a window where the corresponding macro can be selected from a list

Delete Macro: Deleting a macro in the macro library. Selecting this menu will open a window where the corresponding macro can be selected from a list

Clear Editor: Deleting the content of the Editor

Save Macro To Library: Saving the macro in the macro library

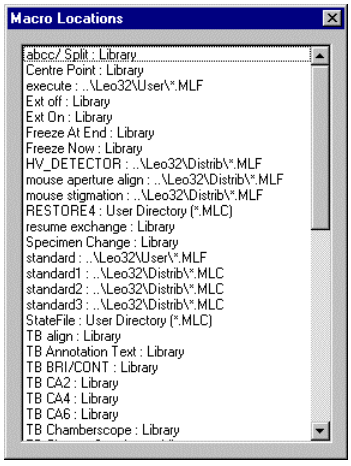
Save As Macro To Library: Saving the macro in the macro library; the corresponding macro may be assigned a new name before storing

Load Macro File: Loading a macro file from the actual user directory

Save Macro To File: Storing a macro in the actual user directory with the same name.

Save As Macro To File: Saving a macro in the actual user directory. The corresponding macro may be assigned a new name before storing

Save As Macro To Common File: If the macro is to be available to other users, it will be saved as a common macro in the directory ***C:\Program Files\Leo\Leo32\User***.



Macro Locations...:

List of all available macros in the actual user directory, the directory ***C:\Program Files\Leo\Leo32\User***, the directory ***C:\Program Files\Leo\Leo32\Distrib*** and the actual macro library (Library).

Rename Macro: Change the name of the actual macro

Print...: Printing the macro text on the standard printer

Print Setup...: Open of the printer setting

Exit: Exits the macro Editor

Menu: Edit

The menu Edit provides the ability to edit or delete different program lines, to copy the content of the macro editor to the buffer store or to insert the text in another Windows® application.

Undo: Undoing all modifications in the macro Editor since last storage

Edit Item: Editing a selected program line of the macro

Delete Item: Deleting a selected program line of the macro

Clipboard: Copying the macro text to the buffer store

Timeout...: Setting digital and analog parameters (see below) and editing of commands must be done within a certain time. If within this space of time (timeout) the corresponding parameter cannot be selected/modified or if a command cannot be edited, an inquiry will be displayed. The user will now have to decide whether he wants to exit the macro, to ignore the command and to go to the next program line or whether he wants to wait for the next timeout. Although this timeout is set to 10 seconds by default, it can be modified using the command ***Timeout...***.

Menu: View

Toolbar: Switching on and off the toolbar

Status Bar: Switching on and off the status bar

Menu: Insert

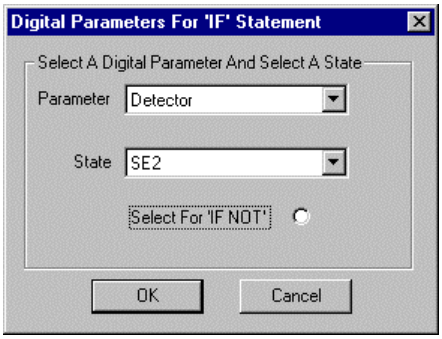
When activating the menu ***Insert***, the different program lines of a macro will be inserted. It is possible to insert commands, loops, decision structures, digital and analogous parameters or to open special window within the Leo32 user interface. Within a macro, it also provides the ability to open another macro, which is part of the macro library by clicking ***Open Macro***. Furthermore, other Windows® may be started using the command ***Execute Program.***

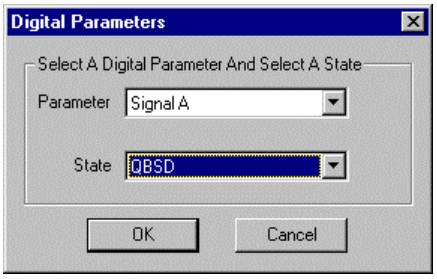
Decision Structure:

Two different kinds of loop constructions are possible. The IF THEN loop will enable a selection between different instruction sequels depending on a condition status.

IF "condition" = true (or not true: IF NOT) then
Instruction sequel A
Optional: ELSE- instruction
Instruction sequel B (for the ELSE- part of the loop)
END IF

Example:
A macro is to be created which will allow automatic switch between SE and QBSD detector. First open the Command ***New*** within the Pop-Up menu ***FILE***. Assign a name to the macro (e.g. detector). Now select the parameter ***Detector*** using ***INSERT→ DECISION STRUCTURE→ IF THEN*** and set it to SE2. This will define the condition for the If loop. The next step is to define the instruction sequel A. Using ***INSERT→ DIGITAL PARAMETER→ SET DIGITAL STATE*** the parameter ***Signal A***= will be set to ***QBSD***.





If you want, you may insert an ELSE instruction. Example: The detector QBSD has already been selected and you want to switch back to the SE detector using the macro. To do so, ***INSERT→ DECISION STRUCTURE→ ELSE***. Now the instruction sequel B can be defined (***INSERT→ DIGITAL PARAMETER→ SET DIGITAL STATE→ Signal A= SE2***). To define the end of the IF loop, select ***INSERT→ DECISION STRUCTURE→ END IF*** . Then define the end of the macro by clicking ***INSERT→ END A MACRO***.

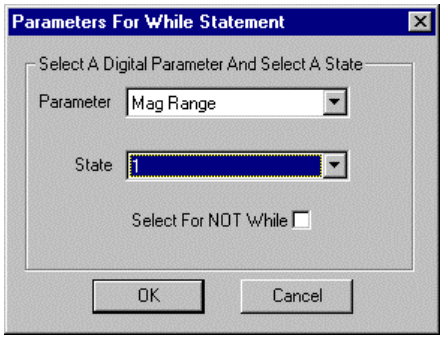
This macro can be added to the macro library by selecting ***FILE→ SAVE MACRO TO LIBRARY***. Thus, the macro can also be used for a symbol of the toolbar (see 6.5.1).

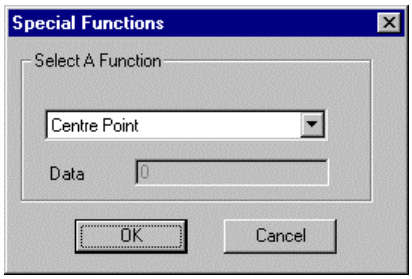
By means of the WHILE loop, a sequence of instructions can be repeated as long as an entered condition is still true.

WHILE "condition"= true (or not true: NOT WHILE) then
Instruction sequel
END WHILE

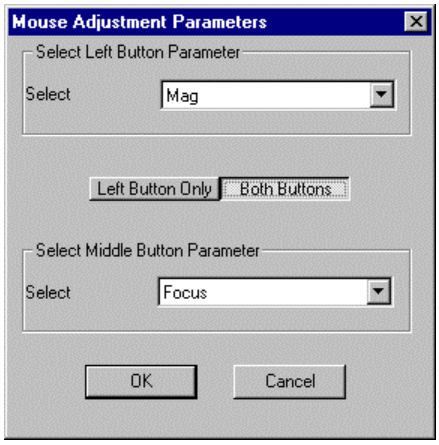
Example:
You want to create a macro switching to the function ***Center Point*** for map magnifications (Mag Range=1). After centering a point, the macro will wait a short time. In this time, the user can modify the magnification, e.g. to magnify a detail. If the magnification is still small, the system will switch again to the function ***Center Point*** , and the macro will wait again. This instruction sequel will be performed until a respective detail has been centered and magnified in a higher magnification.
First, open the Pop-Up menu ***FILE*** and select the command ***New***. Assign a name to the new macro (e.g.. Center Point). Now click ***INSERT→ DECISION STRUCTURE→ WHILE*** and select the parameter ***Mag***

Range that will be set to 1. This will define the condition for the WHILE- loop. The next step will be to define the instruction sequel. Click ***INSERT→ SPECIAL UIF FUNCTION*** and select the function ***Center Point***.

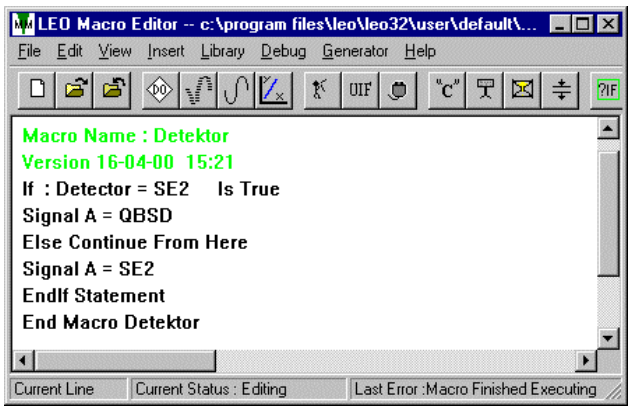


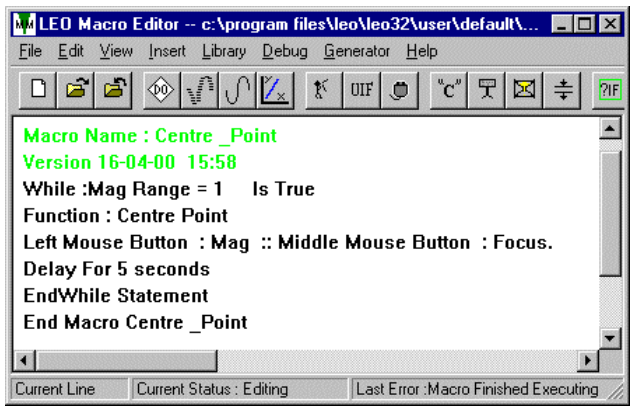


To be sure that the mouse button assignment is set to Mag/Focus, click ***INSERT→ MOUSE*** and assign the magnification to the left mouse button and the focus to the middle mouse button. Then select ***INSERT→ DELAY*** to insert a waiting cycle which will enable the user to center a point and, if necessary, to modify the magnification.



Finish the WHILE- loop using ***INSERT→ DECISION STRUCTURE→ END WHILE***.
Finally, define the end of the macro by clicking ***INSERT→ END A MACRO***. The macro can be added to the macro library using ***FILE→ SAVE MACRO TO LIBRARY***. By doing so, it will also be possible to use the macro for a symbol of the toolbar (see 6.5.1).





Digital Parameter: Inserting digital parameters in a macro.

Analogue Parameter: Inserting analogous parameters in a macro.

Command: Inserting a command in a macro.

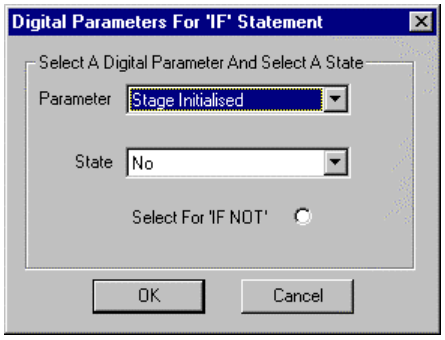
Stage: Inserting instructions for the motorised axes of the sample stage.

Panels: Opening and closing windows of the LEO 32 user interface.

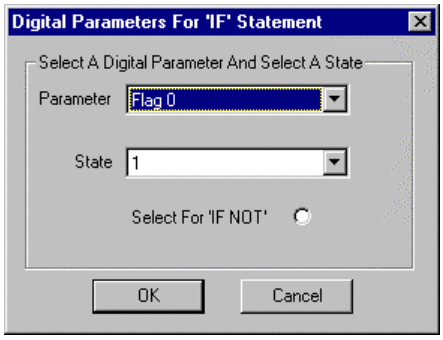
Open Macro: Opening a macro in the macro library.

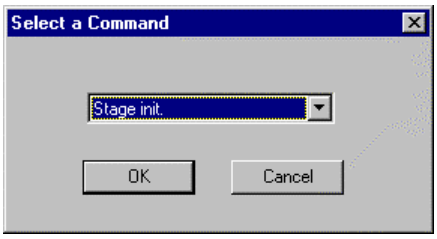
Display Message:
The Routine Display Message provides the ability to display message on the screen. After confirming this message with "***OK***" , the macro will continue to be processed. It is also possible to perform a Yes/No inquiry within this message by clicking ***Enter A Message*** and activating ***Yes No Box***. The result of this inquiry can be saved in a flag to be evaluated later on.

Example:
A macro is to be created which will first ask whether the stage has been initialised. If it is not, the user shall be asked a YES/NO inquiry . Answering "***Yes***" will initialise the stage; answering ***"No"*** will finish the macro.
First, click the Pop-Up menu ***FILE*** and select the command ***New***. Assign a name to this new macro (e.g. Display Message). Now click ***INSERT→ DECISION STRUCTURE→ IF THEN*** and select the parameter ***Stage Initialized*** which will set to NO. By doing so, the first inquiry will be realized. Now, insert the user inquiry using ***INSERT→ DISPLAY MESSAGE***. In the upper part of the panel ***Message***, you may enter a message or a question. The YES/NO inquiry will be established by activating the field ***Yes No Box***.

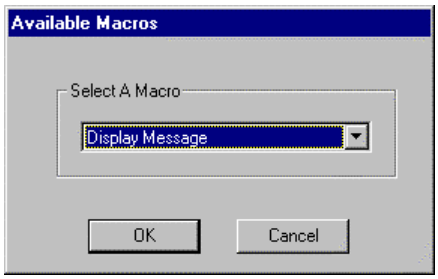


The result of the inquiry will be saved in the variable Flag 0. Using ***INSERT→ DECISION STRUCTURE→ IF THEN*** a new loop will be inserted evaluating the variable Flag 0. If Flag 0 = 1 (answering ***YES*** to the question), the stage must be initialized. Click ***INSERT→ COMMAND*** and insert the command ***Stage init***. As the macro is to stop if the answer is "***No***", an ELSE instruction will be inserted in the second IF THEN loop (***INSERT→ DECISION STRUCTURE→ ELSE***). After the ELSE- instruction, ending the macro will be inserted using ***INSERT→ END A MACRO*** . The two IF THEN loops will be closed after selecting twice, ***INSERT→ DECISION STRUCTURE→ END IF***.





Finally, define the end of the macro using ***INSERT→ END A MACRO***. The macro may be saved to the macro library by selecting ***FILE→ SAVE MACRO TO LIBRARY*** . It will thus be possible to use this macro also for a symbol of the toolbar (see 6.5.1).



Special UIF Function: Opening functions in the LEO32 user interface.

Mouse: Programming the mouse button assignment.

Knob: Programming the encoder of the hard panel (planned for Hardpanel Mark 2).

End A Macro: Inserting the instruction for ending a special macro.

Pause: Inserting a pause function in the macro. If this function is opened on processing the macro, an inquiry will be displayed. The user will have to decide whether he wants to end the macro, to ignore the command, to go to the next program line or to wait for the next timeout.

Delay: Inserting a delay loop in the macro.

Comment: Inserting a comment in the macro.

Execute Program: Open an external program using a macro.

Look Up Table: Open the ***Input-*** or ***Display-LUT*** and undoing the respective LUT.

Configuration Conditions: Inserting the ***Configuration Conditions*** in a macro.

Gun Conditions: Inserting the ***Gun Conditions*** in a macro.

Setup Conditions: Inserting the ***Setup Conditions*** in a macro.

Application Conditions: Inserting the ***Application Conditions*** in a macro.

Menu: Library

Load User Library: Loading a user specific macro library (*.MLL). The actual macro library will be replaced by this library.

Merge Libraries: Combination of the actual macro library with a user specific macro library. If both libraries contain macros with the same name, the user will be asked which macro is to be used for the new library.

Load Standard Library: Loading the standard library.

Merge Standard Library: Combination of the actual macro library with the standard macro library. Macros with the same name will be replaced by the macro in the standard library.

Save Library As: Saving the actual macro library in a file using a separate name.

Menu: Debug

Run: Starting the macro in the Editor.

Step: Processing the macro step by step in the Editor.

Continue: Going to the next instruction in the macro

Stop: Stopping the actual macro.

Stop All Macros: Stopping all running macros.

Menu: Generator

Save System Conditions: Saving the actual system settings in a file.

Menu: Help

Open of the help function.

Many functions of the Pop-Up menu can be opened using the toolbar. Below you will find a list of the different symbols.

Symbol	Explanation	Symbol	Explanation
	**Creating a new macro**		**Inserting an inquiry**
	**Loading a macro from the library**		**Inserting a delay function**
	**Saving a macro to the library**		**Inserting a delay function**
	**Inserting a command**		**Inserting an IF THEN- loop**
	**Inserting a digital parameter**		**Inserting END IF**
	**Inserting an analog parameter**		**Inserting the function ELSE**
	**Inserting an analogous pair of coordinates**		**Inserting a WHILE- loop**
	**Inserting a macro**		**Inserting END WHILE**
	**Inserting a function UIF**		**Editing a macro**
	**Inserting parameters which can be adjusted with the mouse**		**Processing a macro step by step**
	**Inserting a comment**		**Stopping the macro**

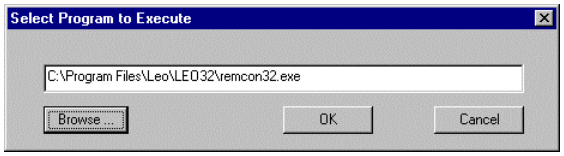
6.6.1 The Macro "START"

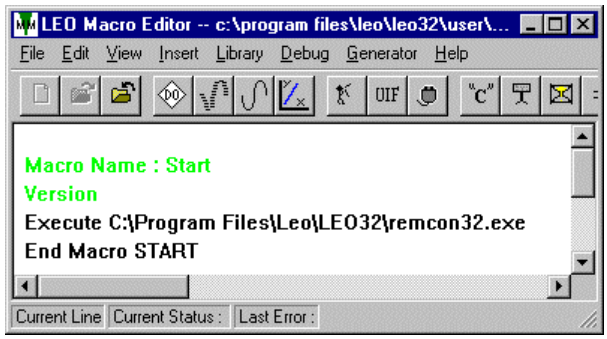
When starting the LEO user interface, the software will browse the directory ***C:\PROGRAM FILES\LEO\LEO32\USER*** for a macro with the name START.MLF. If this macro is not available, the system will search in the actual user interface. If the macro exists, it will be processed immediately after starting the LEO user interface. This enables the user to activate certain routines or external programs immediately after the start.

Example:

The external program ***RemCon32***, necessary for the communication between the SEM and another computer (e.g. EDX system) shall be opened automatically after start of the LEO user interface..

1.) Click ***FILE→ NEW*** and enter the name "START".
2.) Select ***INSERT→EXECUTE PROGRAM***. The corresponding file can be selected using ***Browse***.





3.) Select ***INSERT→ END A MACRO***.
4.) Save the macro using ***FILE→ SAVE AS MACRO TO COMMON FILE***.

The macro will now be saved in the directory ***C:\PROGRAM FILES\LEO\LEO32\USER*** as file ***START.MLF*** and will be available for each user. If only one specific user shall have access to this macro, the file must be copied to the corresponding user directory and deleted from the directory **USER**.

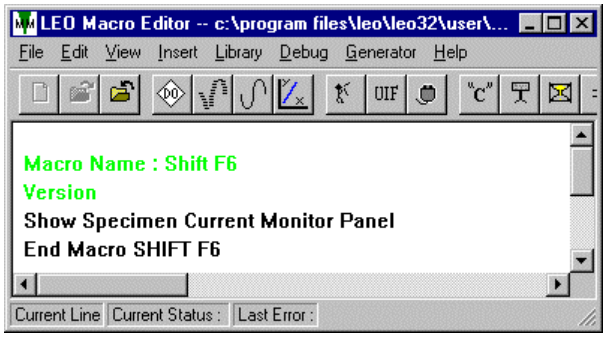
6.6.2 Assignment of Macros to Function Keys

Using the corresponding function keys of the keyboard can also open macros. For this, the macro must be assigned the name of the corresponding function key and be implemented to the macro library. The function keys ***F5 - F8*** und ***F11*** and the key combinations ***Shift*** + corresponding function key are available.

Example:

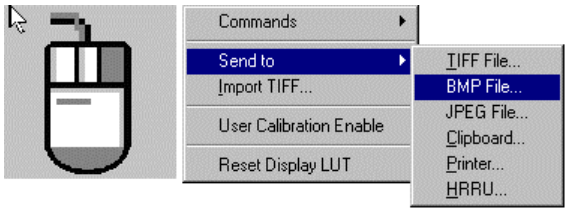
The panel ***Specimen Current Monitor*** is to be opened by using the key combination ***Shift + F6***.

1.) Open ***FILE→ NEW*** and enter the name "Shift F6".
2.) Select ***INSERT→PANELS→ SHOW PANEL→ SPECIMEN CURRENT MONITOR***.
3.) Click ***INSERT→ END A MACRO***.
4.) Save the macro using ***FILE→ SAVE MACRO TO LIBRARY***.



6.7 Saving Images in BMP and JPEG Format

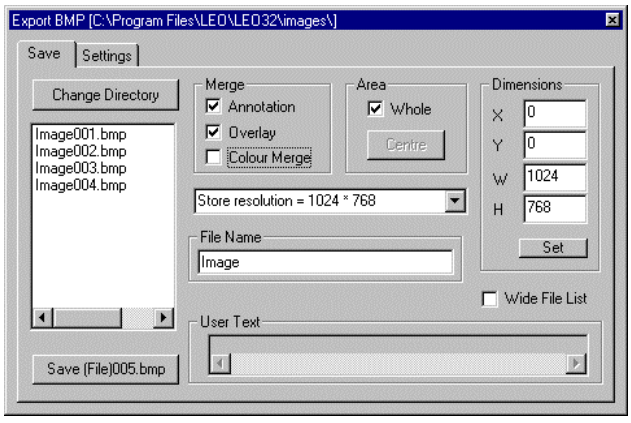
The menu for image storage in BMP and JEPG format can be opened by clicking the right mouse button within the scan area. After selection of ***Send to→ BMP File...*** or ***Send to→ JPEG File...*** the different panels will be opened. Both windows are subdivided in two index cards.
As in the panel ***Export TIFF*** (see 4.5.1), existing files will be listed in the index Tab ***Save***. A file name may be assigned and the file saved in the corresponding image directory by clicking the key "***Save***". The other settings in the fields Merge, Area and Dimensions will be as explained in 4.5.1. It is not possible to assign ***User Text*** to these formats.

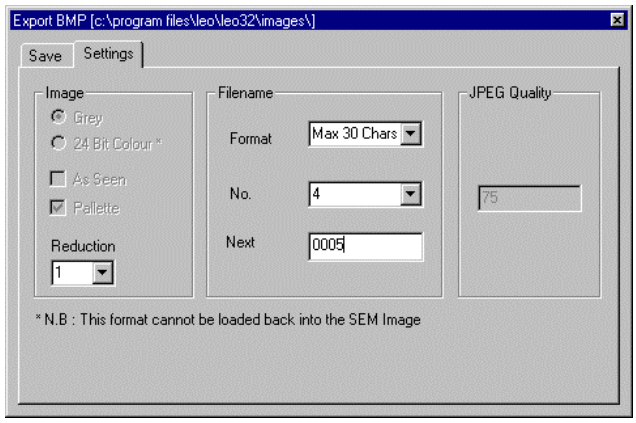


The index Tab ***Settings*** allows selection of the format of the file name as well as an eventual Reduction.
If SEM images are stored in BMP or JPEG format, they will always be saved as gray image with the corresponding pallet. Saving the image as a colored image is not possible

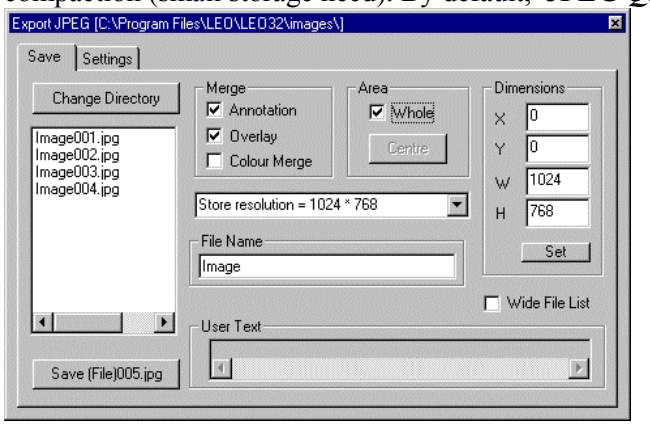
.

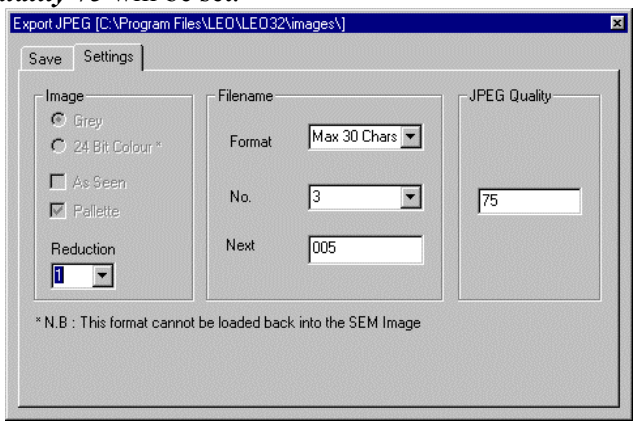
Images in BMP or JPEG format cannot be reloaded to the LEO user interface.





The field ***JPEG Quality*** allows setting a value between 5 and 95. The smaller this value, the higher the compaction (small storage need). By default, ***JPEG Quality*** 75 will be set.



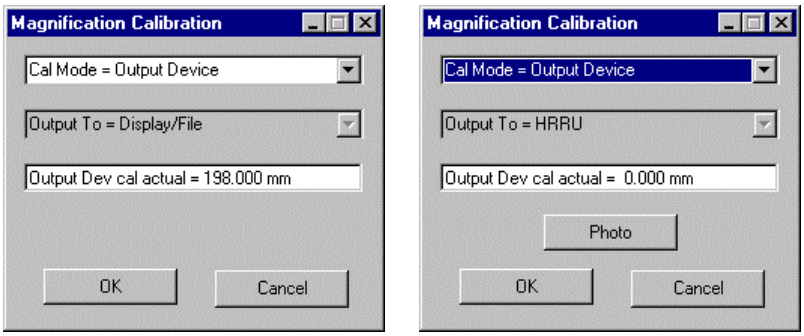


6.8 Magnification Calibration for Different Output Media

The magnification is defined as the ratio of edge length of the image displayed on an output device to edge length of the scanned area on the sample surface. This value will therefore depend on the corresponding output device. If a certain area of the sample is scanned and then displayed on the screen, the magnification will have the value X_1. If the same area is scanned and displayed on a Polaroid, this magnification will have the value X_2. Both images show the same sample area, but they have different magnifications. The value X_2 will be 3-4 times less than the value X_1 (depending on the size of the monitor), as a Polaroid will be 3-4 times smaller than the image area on a monitor.
The desired output device can be selected in the ***SEM Status***- panel (see 4.4). If the parameter ***Output to*** is listed in the index Tab ***Display***, it can be modified by clicking the left mouse button. Selection of ***Display/ File*** (screen magnification), ***HRRU*** (photo unit) and ***Printer*** (standard printer) is possible. Depending on the selected output device, the magnification will be calculated and displayed.
Another option is to open the ***User Preferences*** (see 6.1) in the index Tab ***SEM Conditions***. The field ***Magnification Display*** allows selecting the output device for the calculation of the magnification. Selecting ***Polaroid 545*** will always refer the magnification value to the size of a Polaroid. Modifications of the parameters ***Output to*** in the ***SEM Status***- window will not affect the magnification value. When selecting ***Current Output Device*** , the calculation of the magnification will refer to the corresponding output device (***Output to***).

6.8.1 Calibrate Output Device Magnification

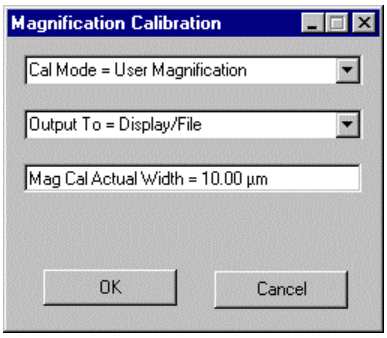
For the calibration of the output device, the menu ***Magnification Calibration*** is opened using the Pop-Up menu **TOOLS→ *GO TO PANEL→ MAGNIFICATION CALIBRATION*** to display the window represented below. Calibration can be done for the monitor and for the photo unit (HRRU). Calibrating the printer is not necessary as the software will automatically read the corresponding data in the printer driver.
First, click ***Cal Mode***= to select the setting ***Output Device***. On the screen, two vertical lines will be displayed whose position can be changed by means of the left mouse button. Click ***Output To***= to select the desired output device (***Display/ File*** or ***HRRU***). The distance of both lines will be measured. This value must be entered to the field ***Output Dev cal actual***. Clicking "***OK***" will save the calibration and close the window.
To calibrate the photo unit, select the setting ***HRRU*** in ***Output To***=. Clicking the key "***Photo***" will edit the image together with the vertical lines on the photo unit. Now the distance of both lines will be measured in the photo to enter the value in the field ***Output Dev cal actual***. Clicking the key "***OK***" will save the calibration of the photo unit and close the panel.

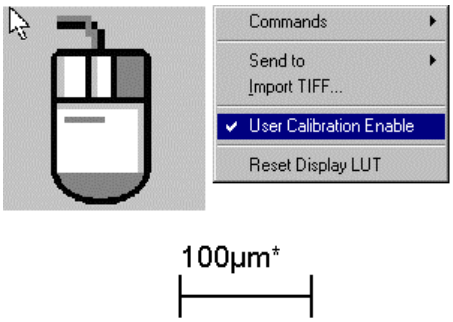


6.8.2 Calibrate User Magnification

The selection of ***User Magnification*** in the field ***Cal Mode***= provides the ability to calibrate the magnification by means of a calibration standard. These standards are available for the various magnification ranges and with different precision.

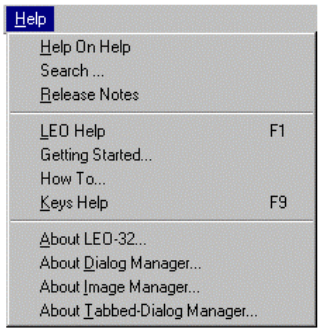
After selecting ***User Magnification*** two vertical lines will appear on the screen. These lines will be positioned in an image area where the exact distance is known (documents on standard). This distance will be entered in ***Mag Cal Actual Width***. Clicking the key "***OK***" will save the calibration and close the panel.
By default, calculation and setting of the magnification will be done when calibrating the SEM in the factory. If you want to use the user specific calibration, click the right mouse button within the scan area and select the command ***User Calibration Enable*** . Calculation and setting of the magnification will then be done using the user specific calibration. This mode is symbolised by a star on the µ marker (see below).
To switch off the user specific magnification, select again ***User Calibration Enable***.

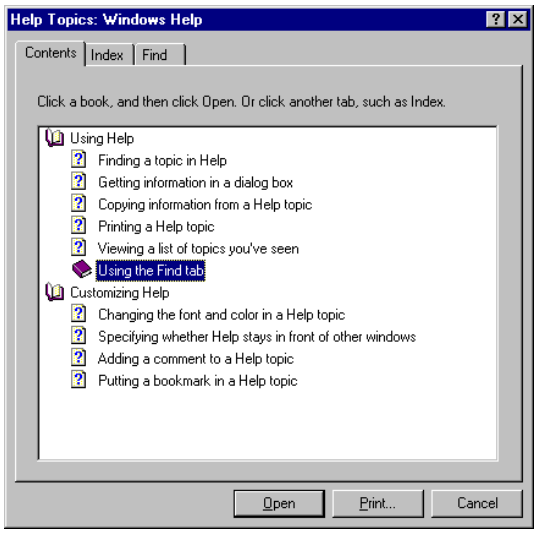




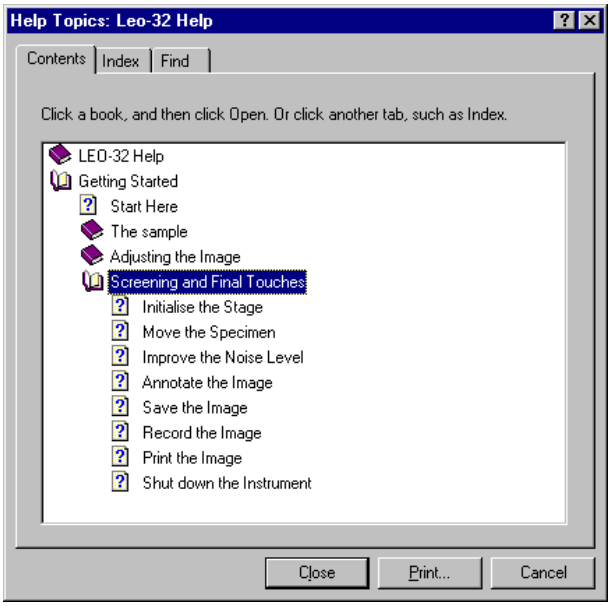
7 The Help System

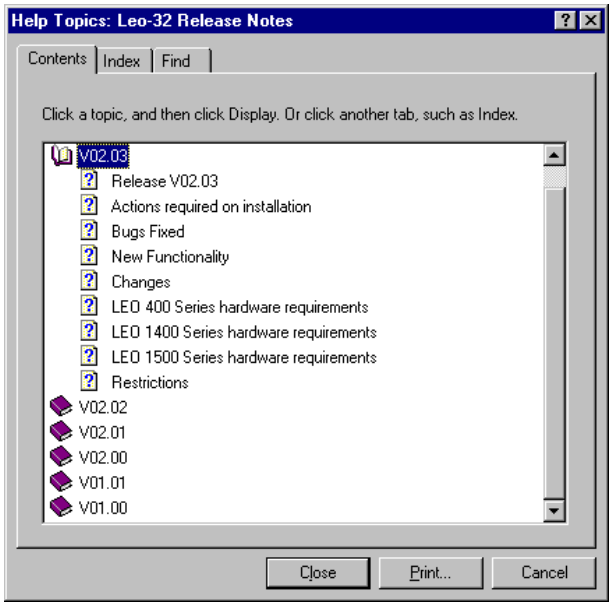
The LEO 32 user interface includes an extensive help system offering explanations on the operation of the microscope, additional options and optimization of images. There are several ways to open the help texts. Using the Pop-Up menu ***HELP*** the different help texts can be selected.
By clicking ***HELP→ HELP ON HELP*** a panel will pop up containing general explanations on the use with the help texts





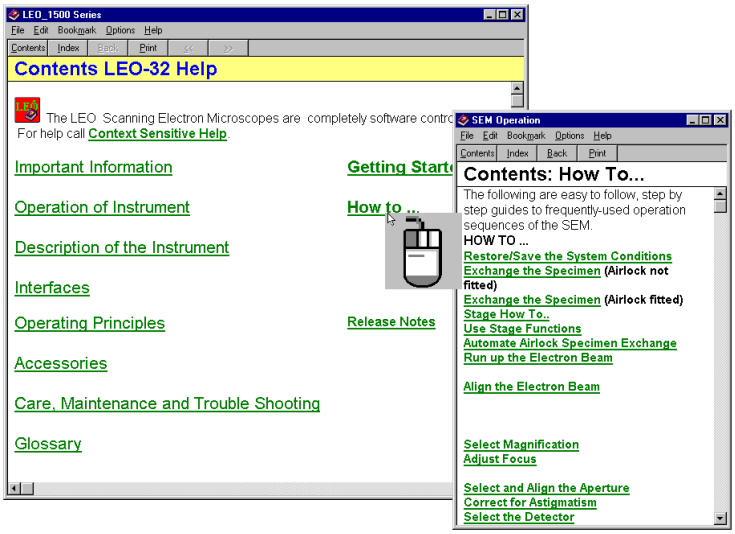
When clicking ***HELP→ SEARCH*** the window above will be opened, listing important basics on the work with the SEM in the index Tab ***Contents***. Double-clicking the left mouse button on a book symbol will list the explanations available on this subject. Opening of the corresponding help text is by clicking "***Open***". The index Tab ***Index*** contains an alphabetic list of all help texts. Clicking the index Tab ***Search*** allows browsing the help texts for a special keyword.



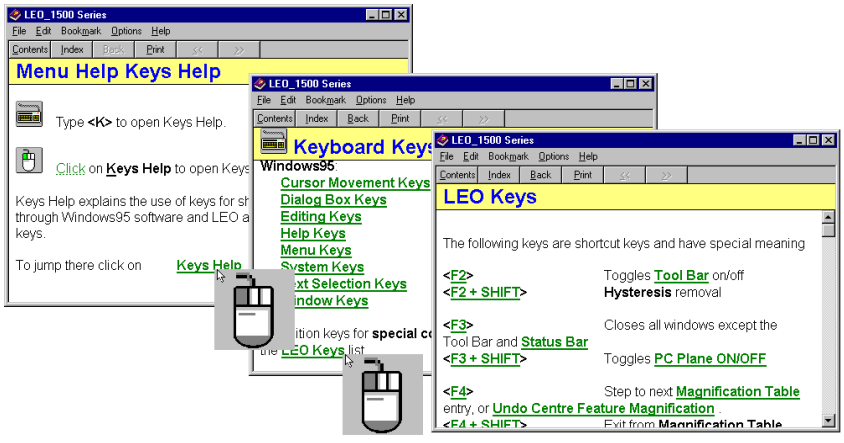


The panel ***Leo-32 Release Notes*** provides important information on the different software version. It contains the explanation of new functions, eliminated software errors and particularities of the different versions. ***Clicking the Pop-Up menu HELP -> RELEASE NOTES will open this window***.

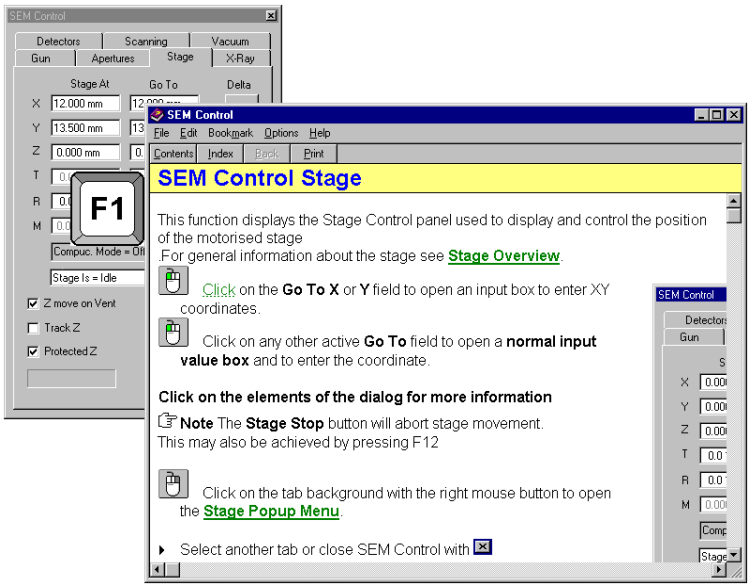
If no menus are opened in the LEO 32 user interface, opening ***HELP→ LEO HELP*** or pressing the function key "***F1***" will open the window below where the user will find basic information on the SEM and on the handling of the software. Clicking the different titles with the left mouse button will open the respective explanations.



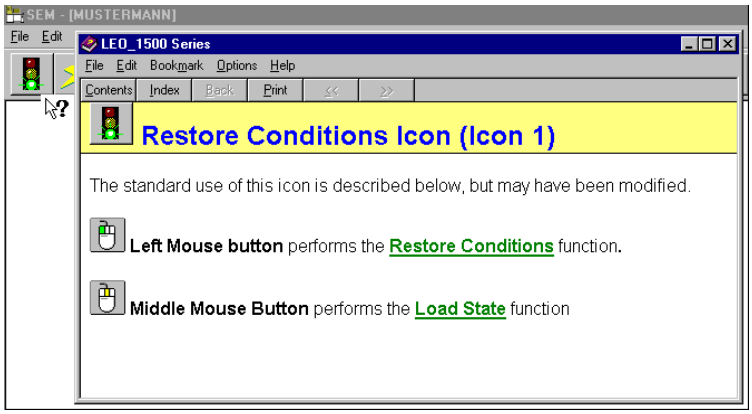
Selecting ***HELP→ KEY HELP*** or clicking the function key "***F9***" will indicate help texts for the use of the keyboard. Many key combinations are also used in the LEO 32 user interface, e.g. combinations to open menus or to start different routines. The help text ***LEO Keys*** will offer explanations for these different key combinations.



If menus are opened in the LEO 32 user interface, clicking the function key "***F1***" will open the help text for the specific menu. This provides the advantage that an explanation of the corresponding menu is now possible during the operation of the SEM. Selecting ***Option→ Keep Help on Top → On Top*** using the Pop-Up menu of the corresponding help panel will position the indicated help text in the foreground. Selecting ***Standard*** will automatically displace the help window to the background when switching to the LEO 32 user interface (clicking the menu bar or the scan area by means of the mouse); the help panel will not be displayed on the screen any more. It will appear back on the screen when clicking the Windows®- task bar or using the key combination, ALT + ***TAB.***

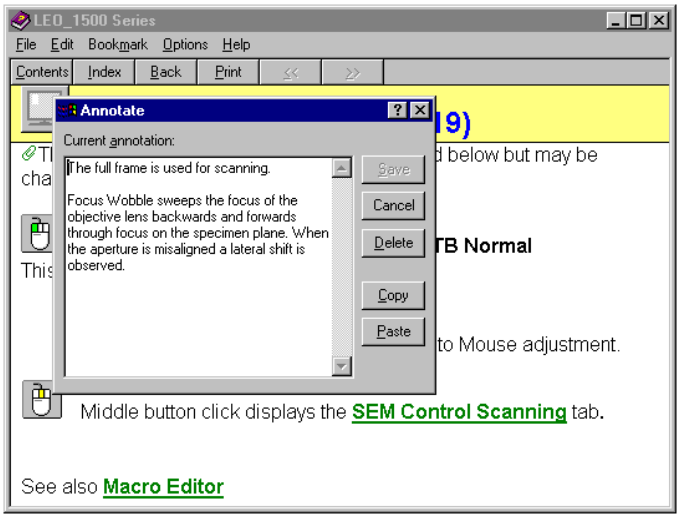


A context sensitive help for the first steps when operating the microscope are available by pressing the key combination SHIFT + ***F1***. The mouse cursor will now become a question mark. In this mode, selecting a function or a symbol with the left mouse button will display a help text of this specific symbol or menu. The context sensitive help can be switched off by pressing the key "***ESC***".



It is also possible to print the different help texts by selecting ***File→ Print Topic*** in the corresponding help panel. The text will then be printed on a standard printer. When using the key combination ***Ctrl + C*** or clicking the Pop-Up menu ***Edit→ Copy*** the help text will be copied to the buffer store to be added to other Windows® applications. Note however that only the text will be copied to the buffer store without the graphics of the respective help menu.

The different help texts may include user remarks by selecting ***Edit→ Annotate*** in the respective Pop-Up menu. You may then enter text in the window ***Annotate***. This text will be stored in the help files when pressing the key "***Save***". A little paper clip will now be displayed in the left upper corner of the window to symbolize that a remark has been entered on the respective subject. This remark is not user specific; that means any user may use it by clicking the paper clip with the left mouse button. Each user will be able to edit or delete such a remark.


LEO_1500 Series
File Edit Bookmark Options Help
Contents Index Back Print
Annotate
Current annotation:
The full frame is used for scanning.
Focus Wobble sweeps the focus of the objective lens backwards and forwards through focus on the specimen plane. When the aperture is misaligned a lateral shift is observed.
Save
Cancel
Delete
Copy
Paste
TB Normal
to Mouse adjustment.
Middle button click displays the SEM Control Scanning tab.
See also Macro Editor

8 Important Keys and Key Combinations

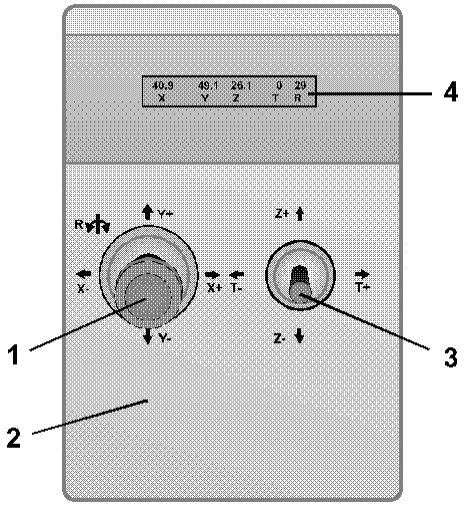
Keys	Function
F1	Opens the general help texts for the microscope
Shift + F1	Opens the context sensitive help
F2	Switching on and off the toolbar
Shift + F2	Performs a correction of the lens hysteresis
F3	Switches on and off open panels in the LEO user interface
Shift + F3	Switches on and off the PC plane
F4	Activates the magnification table, switching to the next set magnification (see 6.1)- or undoing the Center Feature magnification (When pressing the key F4 after use of the Center Feature function, the previous magnification will be reset)
F5,F6, F, F8, F11(with or without shift key)	Reserved for user macros
F9	Opens the help for keys and key combinations
F12 (with or without shift key)	Immediate stop of the sample stage
Tab	Switches between coarse and fine settings
CTRL + Tabulator	Opens the Center Point function (see 5.3)
CTRL + Shift +Tabulator	Opens the Center Feature function (see 5.4)
Home	Resetting the image shift to 0
Scroll Lock	Switching between freezing and deleeting of image store
Pause	Stopping an activated macro
*	Starts the function “Find Image”
CTRL + 2	Loads the actual image to the “Second Image Window”
CTRL + A	Opens the Annotation Panel
CTRL + B	Opens the window Toolbar View
CTRL + D	Switches ON/OFF the data zone display
CTRL + E	Opens the TIFF Export panel

CTRL + F	Performs an automatic fine focus
CTRL + Shift + F	Performs an automatic coarse focus
CTRL + G	Opens the SEM Control window
CTRL + I	Opens the SEM Status window
CTRL + M	Opens the Annotation window and starts point-to-point measurement
CTRL + O	Opens the TIFF Import window
CTRL + P	Displays the printer control window.
CTRL + S	Performs an automatic astigmatism correction.
CTRL + Shift + S	Performs an automatic astigmatism correction and a fine focus
CTRL + T	Opens the Text Editor
CTRL + V	Open the Vacuum Panel in the SEM Control window
Shift + arrow key (N)	Starts the option Stage Scan (stage will drive to the first field)
+	Increases the scan speed by one value
-	Decreases the scan rate by one value
Shift + double-clicking the left mouse button within the image	Activates the Center Point function

9 Optional Applications

9.1 Working with the Hard Panel/Joystick

By default, a joystick will be available for the control of the motorized axes of the sample stage. In the upper display the actual coordinates of the stage will be entered. By means of the left big joystick it will be possible to move the X and Y-axes. By turning the upper button the right or to the left, the rotation of the stage will be controlled. The smaller right joystick will be available for the control of the Z-axis and for the stage kilt (T). All axes are magnification compensated. When working with a lower magnification, the stage will move relatively fast. When using higher magnification, the stage will move slower. The same principle applies to the sensitivity of the joystick. When slightly moving the joystick, the corresponding axes will move slowly. On stronger movement the stage will drive faster. Simultaneous control of the different axes is also possible.

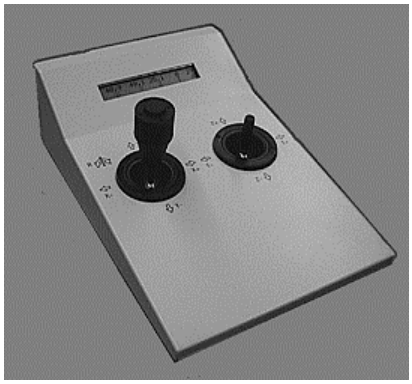


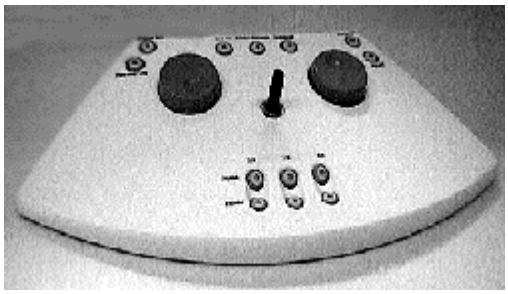
1 - Control of the X and Y axes of the stage is by moving the joystick to the corresponding direction and control of the stage rotation is by turning the joystick to the right or to the left

2 - Control console

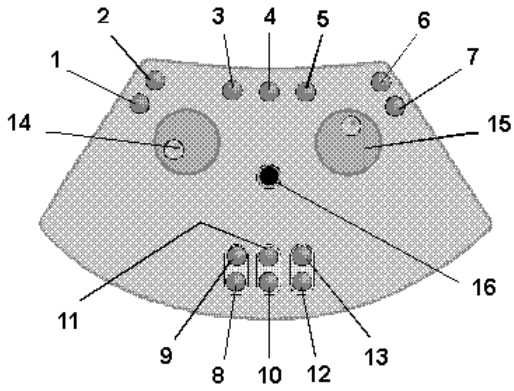
3 - Moving the Z and Tilt axes

4 - Display with the actual stage position(not on all panels)





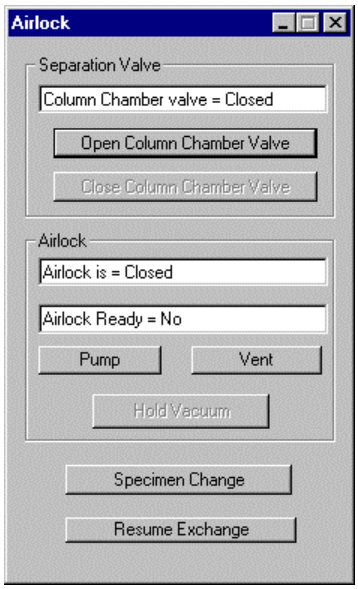
It is also possible to control the stage by means of a hard panel, which will allow control of the motorized axes of the sample stage as well as setting and alignment of special parameters by means of the potentiometer. The different functions of the hard panel will be selected by pressing different keys. This will result in a re-assignment of both potentiometers and of the joystick. The different parameters that can be set by means of the potentiometer (Encoder) (14, 15) and joystick (16) are listed below.
The functions 1 to 7 are always assigned to the potentiometers, whereas setting of the stage coordinates is possible by means of the potentiometers as well as by means of the joystick.



1 - Focus/ Magnification
2 - Stigmator X/ Y
3 - Image shift X/ Y
4 - Image Rotation fine/coarse
5 - Blocking the joystick
6 - Adjustment of the apertures X/ Y
7 - Centering the cathode X/ Y
8 - Stage axes X/ Y (Potentiometer)
9 - Stage axes X/ Y (Joystick)
10 - Stage axes Z/ T (Potentiometer)
11 - Stage axes Z (Joystick)
12 - Stage axes M/ R (Potentiometer)
13 - Stage axis R (Joystick)

9.2 Airlock

The menu ***Airlock*** is opened using the Pop-Up menu ***TOOLS→ GO TO PANEL→ AIRLOCK***. This menu is specially for SEMs with a sample airlock. In the field ***Separation Valve*** the user may control the V3 valve (isolation valve between tip area and sample chamber). When clicking on "***Close Column Chamber Valve***" the corresponding valve will be closed to be re-opened using ***Open Column Chamber Valve.*** The corresponding status will be indicated in the field ***Column Chamber valve=***. Opening the V3 valve is only possible after reaching system vacuum (sample chamber). Closing this valve is only possible after switching off the acceleration voltage.



Normally the vacuum will deteriorate due to the locking. Even after closing the separation valve between sample chamber and airlock, the turbo pump will need a certain time to pump the area of the sample chamber to a corresponding vacuum. Opening the V3 valve will only be possible after reaching this limit.

Some special sample airlocks may also be controlled using the LEO 32 user interface by clicking the field ***Airlock***. Clicking "***Pump"*** will start the pumping procedure of the airlock. When reaching the necessary vacuum, the setting ***Yes*** will be displayed in the field ***Airlock Ready=*** . It is now possible to open the separation valve between airlock and sample chamber and to exchange the samples. After closing the separation valve, the sample airlock can be vented by clicking on "***Vent***".

Some airlocks have a "Stop function". When pressing the key "***Hold Vacuum***", the pumps of the sample airlock will be switched off , but the airlock will not be vented automatically.

To enable a semi-automatic exchange of samples, the keys "***Specimen Change***" and "***Resume Exchange***" are available. Both keys will open a macro listed in the directory ***C:\Program Files\Leo\Leo32\Distrib***. These macros contain basic settings for the sample exchange. They can be edited and adapted to the requirements of the respective user and instrument.

Default parameters of the Macro "***Specimen Change***":

1. Message asking if the stage has been initialised. If not, the macro will be stopped.
2. Activating the CCD camera (if adapted)
3. Asking if the electron beam has been switched on. Yes→ Switching off the high tension. If not, the macro will be stopped.
4. Inquiry if an Airlock Control is available. Yes→ start of the pump procedure. If not, jump to the next instruction.
5. Driving the stage to the position $exchange (this global variable contains the stage position for airlocking samples)
6. Closing the V3 valve

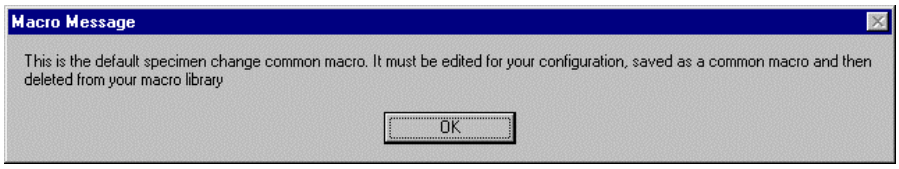
If the macro has been processed without error, the message "***Ready to exchange***" will be displayed. Now the valve between airlock and sample chamber can be opened to exchange the specimen. After doing so, close the valve and press the key "***Resume Exchange***" .

Default Processing of the Macro "***Resume Exchange***":

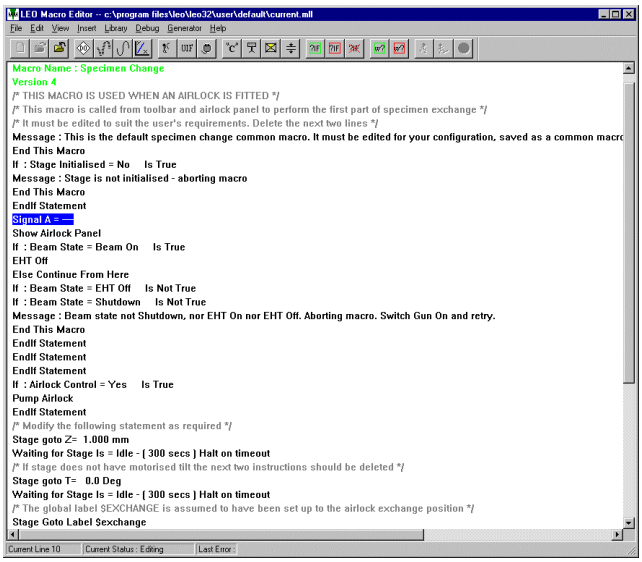
1. Finish the macro "***Specimen Change***"
2. Delay loop untill release of the vaccum (not more than 2000 seconds)
3. Opening the V3 valve
4. Venting the airlock (if ***Airlock Control*** has been installed)
5. Selection of the inlens detector as signal source
6. Closing the panel "***Airlock***"

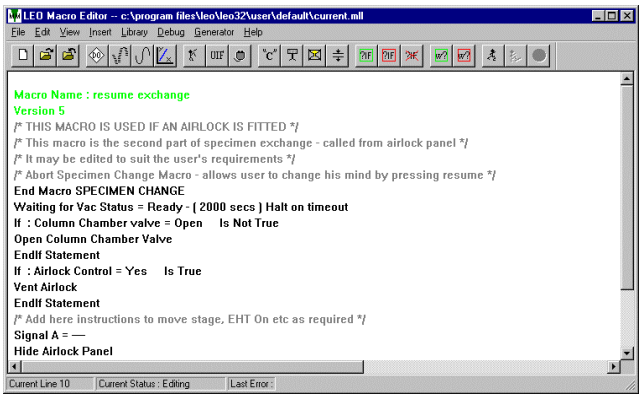
If the macro has been processed correctly, the message "***Resume completed***" will pop up. Now the acceleration voltage may be switched on to continue the work on the microscope.

On the first opening of the macro "***Specimen Change***" the message below will be displayed to inform the user that the macro must first be adapted. After clicking "***OK***" the message will be closed and the macro finished.



Editing the macro will be done using the Macro Editor by opening the Pop-Up menu ***TOOLS→ MACRO EDITOR...*** . After start of the Editor, the file "***Specimen Change.MLF***" will be loaded to the Editor using the Pop-Up menu ***File→ Load Macro File***. This file is saved in the directory ***C:\Program Files\Leo\Leo32\Distrib***.





Editing the Macro:

1.) Delete the message (Message: This is the...) and the command End This Macro in line 5
2.) Select of the CCD camera in line 10 (if adapted)
3.) Delete the command Stage Go To T= 0.0 Deg and the following delay loop in line 30 if the stage is not equipped with a motorised tilt axis
4.) Control whether the global position $EXCHANGE is available and whether it contains the correct coordinates for the airlock position (if not, the position $EXCHANGE must be set using the stage coordinate storage (see 5.2)

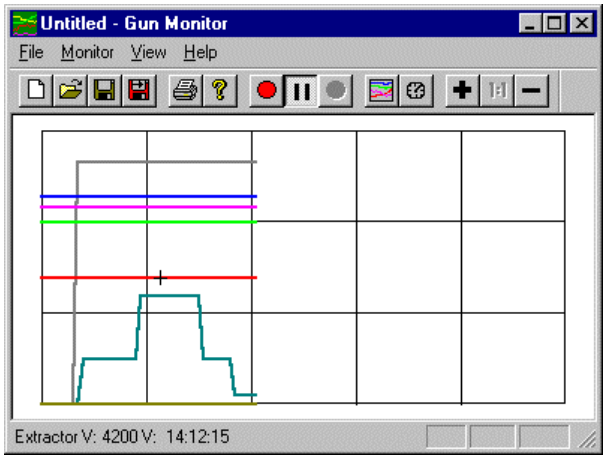
The macro "resume exchange" can also be edited by the user. It is in the same directory as the macro "Specimen Change". It will be useful for example to insert new commands as from line 13 to drive the stage to a special position or to switch on the acceleration voltage automatically.

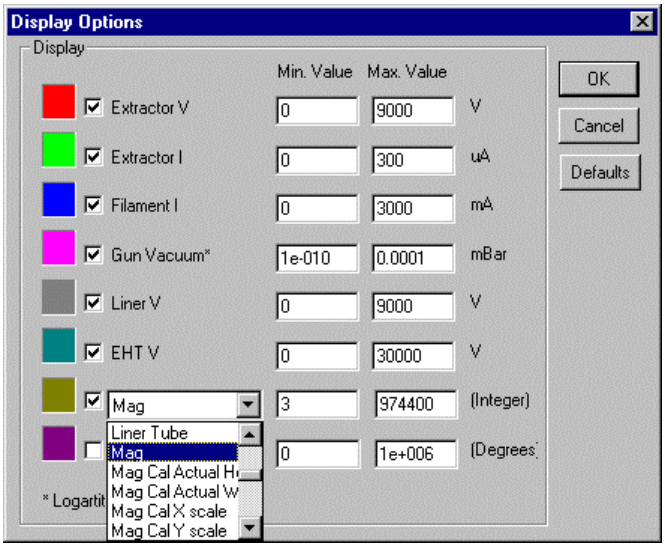
After editing a macro, it will have to be re-saved. If it is implemented to the macro library by using the Pop-Up menu ***FILE→SAVE MACRO TO LIBRARY*** , it will only be available for the respective user in his

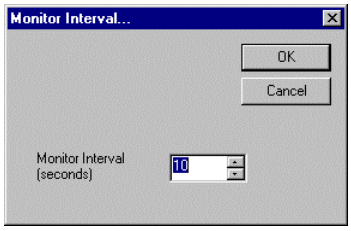
directory. If the macro is to be used by all users, it must be saved using ***FILE→ SAVE AS MACRO TO COMMON FILE***.

9.3 Gun Monitor Utility

The program ***Gun Monitor Utility*** provides the ability to record important parameters of the microscope in certain intervals when operating the LEO user interface and to display them in form of a graph. The menu may be opened using the Windows®-interface ***START→ PROGRAM→ LEO-32 SERVICE→ GUN MONITOR UTILITY***.
Clicking the Pop-Up menu ***MONITOR→ START*** will start the record. Using the window ***Display Options*** (Pop-Up menu: ***MONITOR→ OPTIONS...***) selection of the different channels and of the colors will be possible (8 channels are available). Six of the eight channels are pre-defined to record extractor voltage, extractor tension, filament heating current, vacuum in the tip area, liner tube voltage and acceleration voltage. Removing the check next to the parameter by clicking with the left mouse button will suppress the recording of this parameter. The two parameters at the end of the list may be edited freely by the user by selecting one of the parameters proposed in the respective list.
The square close to the parameter indicates the color assigned to the parameter in the diagram. Changing this color is possible by clicking on the square with the left mouse button. When doing so, a color pallet will be displayed allowing the selection of a new color. The columns ***Min. Value*** and ***Max. Value*** will indicate minimum and maximum values of the different parameters. These limits, which will affect the presentation in the diagram, can be modified manually.
After entering all settings, the panel will be closed by clicking "***OK***". Pressing the key "***Default***" will undo these settings and return to the basic condition.







The monitor interval of the different parameters can be set in the window ***Monitor Interval...*** which can be opened using the Pop-Up menu ***MONITOR→ Interval...*** or by using the corresponding symbol in the toolbar. Settings will be possible between 1 and 60 seconds. After selection of the interval, the window will be closed by clicking ***"OK".***

After starting the monitor, the different values of the parameters will be displayed in the diagram with the respective colors. The scale in the basic condition has been selected to enable the presentation of all values of the different parameters in one diagram. Placing the cursor to one of the graphs will indicate the corresponding value and the time in the lower left part of the panel ***Gun Monitor***.
The record can be stopped using the Pop-Up menu ***MONITOR→ STOP***. Selecting ***FILE→ PRINT...*** will output the diagram to the printer. The different values can be saved in a separate file by selecting ***FILE→ SAVE AS...*** in the Pop-Up menu to assign a file name. The data will then be saved in the file *.MON and can be reloaded to the program later on by clicking ***FILE→ OPEN...*** in the Pop-Up menu to be displayed as a graph again.

Another ability to save data is to click ***FILE→ EXPORT DATA***. The recorded values will then be saved to a separate *.CSV file . This file format can be read by many Windows® applications (Word, Word Pad, Excel etc.) so that the data will be available for processing in other programs. The example below shows a loaded *.CSV file in the program Word Pad.

Gun Run up Data starting Friday March 17 2000: 10:35:09

Time, Filament I, Extractor V, Extractor I, Gun Vacuum, Liner V, EHT V, Stigmation X, Stigmation Y
(Sec), (mA), (V), (uA), (mBar), (V), (V), (%), (%)

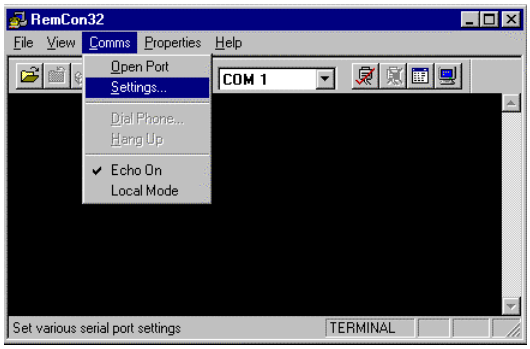
3, 2285, 4200, 200, 2.22e-006, 8000, 3000, 0, 0
6, 2285, 4200, 200, 2.22e-006, 8000, 3000, 0, 0
9, 2285, 4200, 200, 2.22e-006, 8000, 10000, 0, 0
12, 2285, 4200, 200, 2.22e-006, 8000, 10000, 0, 0
15, 2285, 4200, 200, 2.22e-006, 8000, 10000, 7.8975, -10.4325
18, 2285, 4200, 200, 2.22e-006, 8000, 10000, 9.165, -10.8225
21, 2285, 4200, 200, 2.22e-006, 8000, 10000, 16.0875, 3.705
25, 2285, 4200, 200, 2.22e-006, 8000, 10000, 21.255, 14.3325
28, 2285, 4200, 200, 2.22e-006, 8000, 10000, 21.255, 14.3325
31, 2285, 4200, 200, 2.22e-006, 8000, 10000, 21.255, 14.3325
34, 2285, 4200, 200, 2.22e-006, 8000, 7000, 21.255, 14.3325
37, 2285, 4200, 200, 2.22e-006, 8000, 7000, 56.0625, 56.16
40, 2285, 4200, 200, 2.22e-006, 8000, 7000, 56.8425, 57.0375

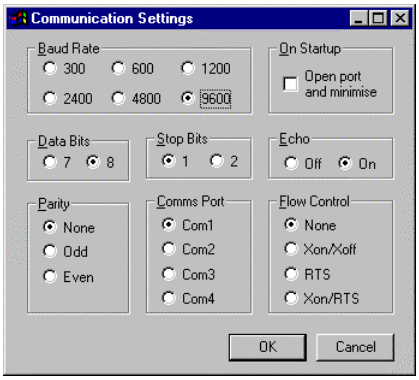
Many of the different commands and panels can be opened by means of the toolbar by clicking the symbols explained below.

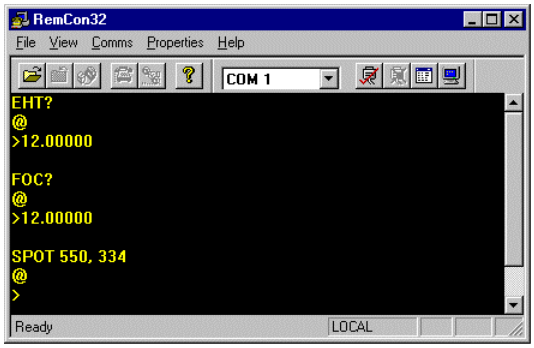
Symbol	Explanation	Symbol	Explanation
	New record of the parameters; deleting the graphics in the diagram		Interrupting the record
	Loading saved data		Starting the record
	Saving the monitored data		Opening the window ***Display Options***
	Saving the monitored data to a *.CSV file		Opening the window ***Monitor Interval...***
	Printing the diagram		(Zoom In)
	Display of the gun monitor version		Default display of the X axis
	Stopping the record		(Zoom Out)

9.4 RemCon32 (requires the license REMCON)

The program ***RemCon32*** provides the access to remote control of the SEM using a serial interface (RS232). This allows reading and controlling special parameters of the microscope. This communication is frequently utilized when using EDX/WDX systems.
When using the program ***RemCon32***, care should be taken to first start the LEO user interface, then the program ***RemCon32*** and lastly the respective control program. The program will be opened using the Windows®- plane ***START→ PROGRAM→ LEO-32→ RemCon32***. As this program is frequently used, especially if an EDX/WDX system has been adapted, it can be started automatically together with the LEO-32 user interface by modifying the macro "START" and saving it in the respective user directory (see 6.6.1).
For correct communications it is important that the settings on the selected port (serial interface COM1, COM2 etc.) are correct and that the respective port has been activated for communication. Opening of the window ***Communication Settings*** will be by using the Pop-Up menu ***COMMS→ SETTINGS***. The graph below shows the default settings for a selected port. If ***Open port and minimize*** has been selected, the port will be opened automatically on start of the program ***RemCon32***. At the same time, the window will be diminished to appear only in the Windows® task bar. Selecting ***COMMS→ ECHO ON*** will indicate the communicated commands and answers in the window ***RemCon32***.
For test purposes it may also be useful to operate the program in ***Local Mode*** by selecting the menu ***COMMS→ LOCAL MODE*** using the Pop-Up menu. By doing so, it will be possible to enter commands and inquiries manually in the panel RemCon32. If correct communication has been established, the corresponding answer will be displayed in the window or the corresponding command will be executed in the LEO 32 user interface.
The respective RS232- protocol, i.e. a list of all ***RemCon32*** commands applicable to LEO 32 software will be available on request at LEO GmbH.







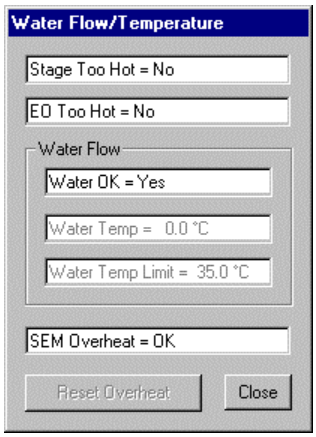
9.5 Important Software Licenses

Name of License	Description	Explanation of the License
15XX-ACCOUNT	User Accounting	Automatic registration of special parameters during a working session to enable the Administrator to retrace which user has been operating the SEM at what times. For each user, the number of saved TIFF images, output photos and prints will be saved (see 9.8).
15XX-CENTER	Center Feature/ Stage Map	Contains the two centering functions center point and center feature. It is also possible to use the function stage map (see 5.3, 5.4, 5.6).
15XX-CLIP	Cut & Paste	Copying and inserting SEM images to and from the buffer store (see 3.2.5).
15XX-COMPU	Compucentric Stage Software	Compucentric software to allow tilt-eucentric and rotation-eucentric control of a non-eucentric stage (see 5.9).
15XX-DUALMAG	Dual Magnification	This function allows the display of a zoomed image in the mode Split Screen without freezing the lower magnification image. (see 6.3.3).
15XX-DYNFOCUS	Dynamic Focus	Enables a dynamic adjustment of the focus during the beam pass on tilted sample surfaces (see 6.3.4).
15XX-GAMMALUT	Input Gamma	Release of the function Input LUT (see 3.2.1). Enables the individual adjustment of the input transfer characteristic of a detector
15XX-GRATICULE	Graticule	Inserting a graticule on the screen (see 3.3.3). The distance between the lines can be set between 50 and 512
15XX-IMMATH	Image Processing	Provides mathematic manipulation of the image store, e.g. by using Kernel functions, adding or subtracting images or by means of the detection of gray scale distribution. (see 6.4).
15XX-INVERT	Input Signal Invert	Inverting a signal by means of Input- LUT (see 3.2.1)
15XX-MEASA	Advanced Measurement	Expanded measurement possibilities such as measuring squares or inserting horizontal/vertical measuring lines (see 4.7.1).
15XX-REDUCED	Adjustable Reduced Raster	Use of a small raster window, adjustable in size and position. Useful for the adjustment of parameters such as focus or stigmator (see 6.3.1).
15XX-REMARCH	FTP Remote Archiving	Sending files to a FTP server
15XX-REMCON	RS 232 Remote Control	Reading or setting special parameters of the SEM using the serial interface (see 9.4).
15XX-SCANEXP	Scan Rate Expansion	15 different scan rates (instead of 3 by default) (see 3.7).
15XX-SCANROT	Scan Rotation	Allows an electronic rotation of the image by rotating the scan direction (see 6.3.6)
15XX-SIGMIX	Signal Mixing	Continuous mix of two detector signals in the range 0 to 100% (see 4.3.1).
15XX-SPLIT	Split Screen	When selecting the function Split Screen, the screen will be subdivided in two zones. Each zone can be assigned different detectors and each zone can be frozen independently from the other (see 6.3.2)

15XX-SPOT	Spot Mode	Spot by spot positioning of the electron beam on a defined point of the sample (see 4.3.2).
15XX-STAGECO	Stage co-ordinate store and reopen	Saving stage coordinates together with the magnification and the working distance (see 5.2). These positions can be moved to automatically.
15XX-STAGEREG	Stage Registration	Definition of user specific coordinate systems for the specimen stage (see 5.8)
15XX-STAGESCAN	Stage Scan	This software option provides the ability to examine a sample area by using a series of exactly defined, regularly dispersed image fields (see 5.5)
15XX-STDAPI	API	API OCX- protocol to write user routines in the LEO user interface by means of Visual Basic, Visual C++ and Java
15XX-SURVEY	Stage Survey Mode	To adjust automatically magnifications and working distances for two different application modes (see 5.7)
15XX-TILTCOMP	Tilt Compensation	By means of this function, it is possible to correct the perceived distortion caused when scanning tilted samples (see 6.3.5).
15XX-XRAY	Simple X- Ray dot map/ Linescan	Imaging analogous EDX mappings and lines cans (see 4.3.7).

9.6 Water Flow/ Temperature

Flow and temperature of the cooling water in the system are controlled continuously to avoid an overheating of the electronics. If the flow is interrupted or if the temperature rises beyond the set limit (***Water Temp Limit***), the system will automatically be driven to safety mode. The power supply for the stage control and the electron optic will be switched off and the window below will pop up. After eliminating the error, clicking the key "***Reset Overheat***" will reactivate the power supply for the system .
This window can also be opened using the Pop-Up menu ***TOOLS→ GO TO PANEL→ WATER FLOW/ TEMPERATURE***.



Stage Too Hot:
Indicates the electronic status for the stage. The indication "Yes" will drive the system to the safety mode.

EO Too Hot:
Indicates the electronic status for the electron optics. The indication "Yes" will drive the system to the safety mode

Water OK:
Indicates the cooling water flow. The indication "No" will drive the system to the safety mode as the flow is insufficient or has been interrupted.

Water Temp:
If the system is in safety mode, this case will indicate the actual temperature of the cooling water.

Water Temp Limit:
Indicates the limit value for the temperature of the cooling water. If this value is exceeded, the system will drive to the safety mode.

SEM Overheat:
Status indication for the temperature of the cooling water.

OK: Temperature of the cooling water is okay.

Too Hot: The temperature of the cooling water is too high; the system will drive to the safety mode.

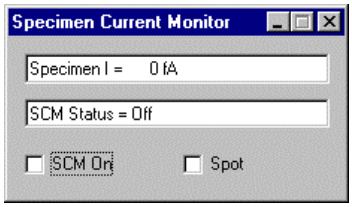
Monitor: The error has been eliminated. The system is waiting for the user to reset the safety mode.

Key Reset Overheat:
Resetting the safety mode after elimination of the error.

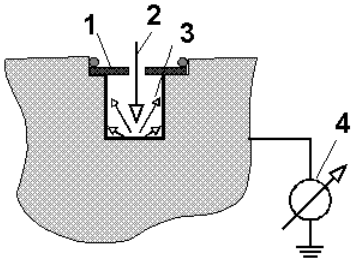
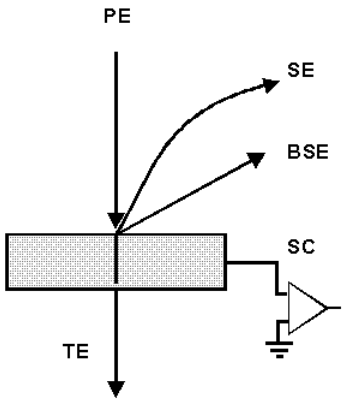
Key Close:
Closing the panel ***Water Flow/ Temperature***.

9.7 Working with the Specimen Current Monitor

A specimen current monitor option may be installed on the SEM. For the control of this current meter, the window ***Specimen Current Monitor*** is available which can be opened using the Pop-Up menu ***TOOLS→ GO TO PANEL→ SPECIMEN CURRENT MONITOR***.
When activating the control box ***SCM On***, measurements will be displayed in the field ***Specimen I =.*** The system will automatically switch to the various measuring ranges. When activating the control box ***Spot***, spot mode will be switched on (see 4.3.2).



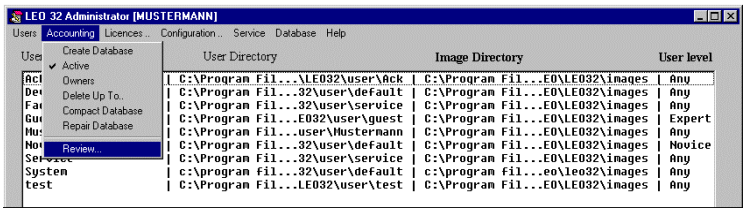
The beam current will be measured by means of a Faraday cup that consists of a strongly absorbing material (usually carbon) with a hole covered by an electron-microscope aperture (aperture 30-100µm). To measure the probe current, the magnification on the instrument is set so that the complete beam enters the hollow through the aperture opening. When switching on the ***Specimen Current Monitor,*** the grounding of the sample holder (sample stage) will be interrupted and a pico-ammeter will be inserted (***Specimen Current Monitors***). If the beam is focused into the (or spot mode is set on the) Faraday cup, the measured current will be the same as the entering beam current.
A similar measurement can be performed on real samples. To avoid strong divergences of the measured value, it is recommended to use the spot mode. The primary electron beam impinging on the sample will release interactive processes. The sample will not emit mainly SE and BSE electrons. When using very thin samples, there may also occur a transmission of single electrons. If there is no charging of the specimen, the measured current will be equivalent to the electrons absorbed in the sample (specimen current).

Measuring the beam current by means of the Faraday cup	**Measuring the beam current on a real sample**
	
1 - aperture **2** – primary electron beam **3** - Faraday cup with absorbed RE and SE electrons **4** – pico-ammeter	**PE** – primary electron beam **SE** – SE electron **BSE** – RE electron **TE**- transmitted electrons (only on very thin samples) **SC** – electrons absorbed in the sample (specimen current)
	$I_{PE}= I_{SE}+I_{BSE}+I_{TE}+I_{SC}$ $I_{SC}= I_{PE}-I_{SE}-I_{BSE}-I_{TE}$

9.8 Accounting (Requires the License: ACCOUNT)

The software ***Accounting*** provides the ability to record important information on the different working sessions on the microscope in a separate data base file. Later on the Administrator can refer to this information. It will thus be possible to document the rate of capacity utilization or to list the times of the working sessions for the different users.

The menu ***Accounting*** must be opened using the Administrator (see paragraph 2) (Supervisor privilege) and contains the following different submenus:



Create Database: Creating an empty file (account.mdb) in the directory C:\Program Files\ LEO\ LEO32\ System. If a file has already been created, a warning message will pop up.

Active: Switching on/off the record to the data base file.

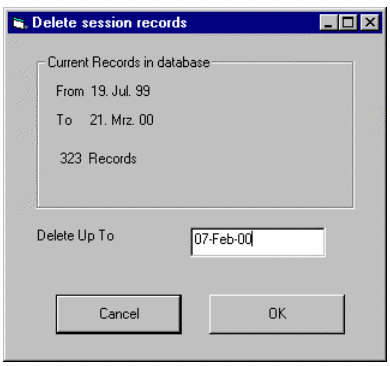
Owners: Opening the window ***Account Owners*** (see below).

Delete Up To: Deleting records from a defined date. Example: If you want to delete all records from February 06, 2000 until the generation date (July 19, 1999), enter 07-Feb-00 in the window ***Delete session records***. A safety inquiry will be displayed before deleting the data.

Compact Database: Due to the modification of data within the database, the file may get fragments using unnecessarily storage place. When opening ***Compact Database***, a defragmentation will be performed after creating a safety copy (account.bak) in the directory \LEO32\System. If errors appear on defragmentation, delete the file "account.mdb" and change the name of the file "account.bak" to "account.mdb", to reset the original condition.

Repair Database: Errors in the database may result from incomplete records caused, for example, by a software crash. The routine ***Repair Database*** will try to repair these errors in the database. After opening ***Repair Database*** you should also apply the routine ***Compact Database*** to the file.

Review: Listing the different working sessions in a separate window (see below).



9.8.1 Review

When clicking ***ACCOUNTING→ REVIEW*** a panel will be displayed listing the different records of the file "account.mdb". On each working session on the microscope, the following data will be stored: date, user name, the LEO 32 user interface starting time, the LEO 32 user interface closing time, duration of the working session, number of exposed photos, number of prints using the LEO 32 user interface, number of saved TIFF files and status of the data base record (***Normal***, ***Abnormal*** etc.). Four different status indications are possible:

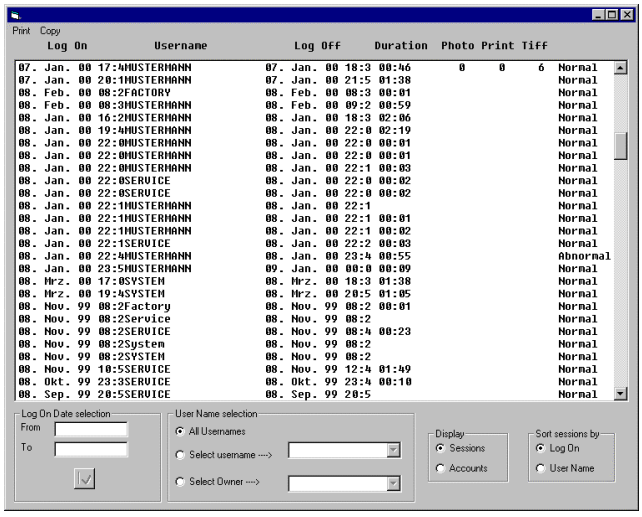
Normal: Record of the data base has been activated (√ ***Activate***); working session has been finished normally

Abnormal: Working session has been finished abnormally, e.g. due to a software crash

ON: Record of the data base switched on

OFF: Record of the data base switched off

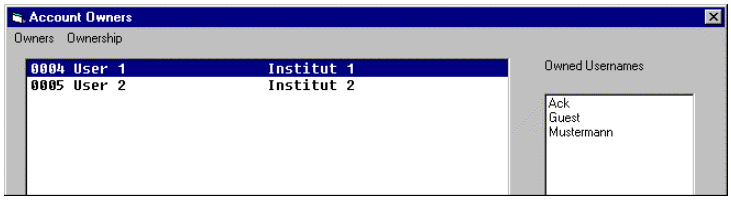
By default, the list of files will be represented as in the graph below. The different records are sorted primarily on day of working session, then month and year. Selecting ***User Name*** in the field ***Sort sessions by*** will list the files by user names.
If you only wish to indicate the total of working sessions of the different users you will have to select ***Accounts*** in the field ***Display***. This will list the different users with the respective number of working sessions, the total of working hours and the number of output photos and prints as well as the number of saved TIFF files (see right graph below).
It is also possible to list one specific user by clicking ***Select username*** and selecting a user in the field ***User Name selection***
If ***Owners*** have been defined (see 9.8.2), which may include several users, selecting a corresponding ***Owner*** in ***Select Owner***, will compose a list based on the ***Owner***.
For the selection of different periods you may use the field ***Log On Data selection***. Example: If you want a list including all working sessions from January 8, 2000 up to March 8, 2000, enter ***From*** 08-Jan-2000 and ***To*** 09-Mar-2000. Activating the green check will list the corresponding interval.

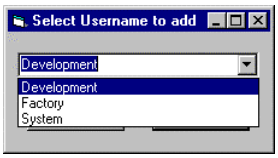


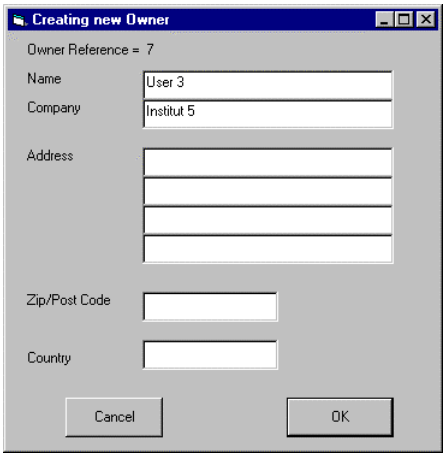
The database file "account.mdb" can be loaded and processed using other Windows© programs (e.g. Microsoft® Access). It is also possible to copy certain files to the buffer store by clicking ***COPY*** and to insert them to other programs (e.g. Microsoft® Word, Microsoft® Excel etc.). The content of the respective panel will be printed on the standard printer by clicking ***PRINT*** in the Pop-Up menu.

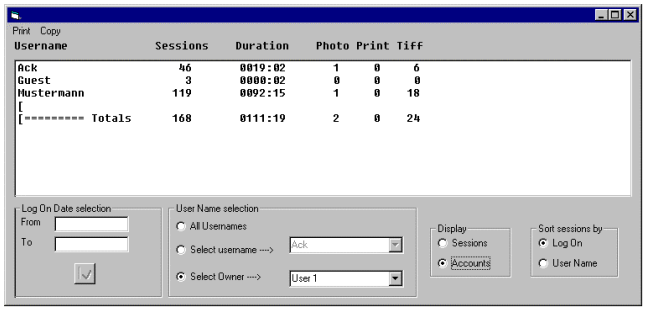
9.8.2 Owners

Different users belonging to the same institute or product unit are grouped under one ***Owner***. Each user can only have one ***Owner***. Editing an ***Owner*** is by the Pop-Up menu **ADMINISTRATOR** ***ACCOUNTING→ OWNERS***. Now the window ***Account Owners*** will be opened where already created ***Owners*** will be listed. Creating a new ***Owner*** is done using the Pop-Up menu ***OWNERS→ NEW*** . In the panel ***Creating new Owner*** it is possible to enter the complete address of the respective institute or product unit. The fields ***Name*** and ***Company*** must be filled in. Close the window by clicking "***OK***". The new ***Owner*** will now be displayed. When activating an owner (clicking the left mouse button) and selecting ***OWNERSHIP→ ADD*** using the Pop-Up menu, the different users can be selected in the window ***Select Username to add***. The users belonging to the corresponding ***Owner*** will be indicated in the list ***Owned Usernames***. If a user name is to be deleted from the corresponding ***Owner***, select the user name and delete it from the list by clicking ***OWNERSHIP→ REMOVE***.









The ***Owner*** with the name ***User 1*** contains the users ***Ack***, ***Guest*** and ***Mustermann***. When selecting ***User 1*** in the field ***Select Owner***, all working sessions of these users will be listed.

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