INTRODUCTION TO THE XL30-FEG SEM

All software used to control the microscope runs in the MS-Windows environment. This environment is loaded on the Windows2000 operating system. However, it is not really necessary to familiarize oneself extensively with the Windows environment because the instrument is automatically configured in the proper way on start-up. Access to main program "Microscope Control" is gained after successfully logging into an authorized user account. During start-up the microscope is automatically addressed and loaded with software. In this way the main program "Microscope Control" will become available.

1. THE USER INTERFACE

The user interface of the XL30-FEG consists of a monitor on which the microscope image is displayed. Graphic control functions are overlaid on top of this image. The controls can be accessed using the mouse. Some functions are also available via keyboard commands or by clicking on the buttons in the button bar, located just below the menu bar. The complete image area is always visible and the software controls as well as the data bar are located above, next to and below the image, respectively.

1.1 The mouse

The mouse is the main device for selecting functions or changing parameters. When the mouse is moved over the tabletop and no buttons on the mouse are pressed, a cursor moves across the screen.

The mouse has two buttons: the left button is used in conjunction with data on the monitor, and is used to select and change parameters of the microscope, or to enter a specific operating mode. Some parameters can be changed continuously by using the corresponding adjuster (similar to a 'hardware shift-potentiometer') in the control area. Once the cursor is somewhere on this adjuster, pressing the left mouse button will 'lock' the cursor into the adjuster. Now the parameter can be changed by a left/right mouse movement, with full attention on the actual image. Only when the left mouse button is released is the cursor set free again.

The right button is always used for focusing only. When the right button is pressed (with the cursor somewhere on the image) the cursor shape changes to a double arrow pointing left and right. With the button held in, a horizontal movement of the mouse results in a focus change of the image. As soon as the button is released, the focus is set to the selected value.

1.2. The monitor

On the monitor, the control facilities and data display for the microscope are displayed graphically and are superimposed on the microscope image. For control and display of data the following groups are available (see also Figure 1 .1):

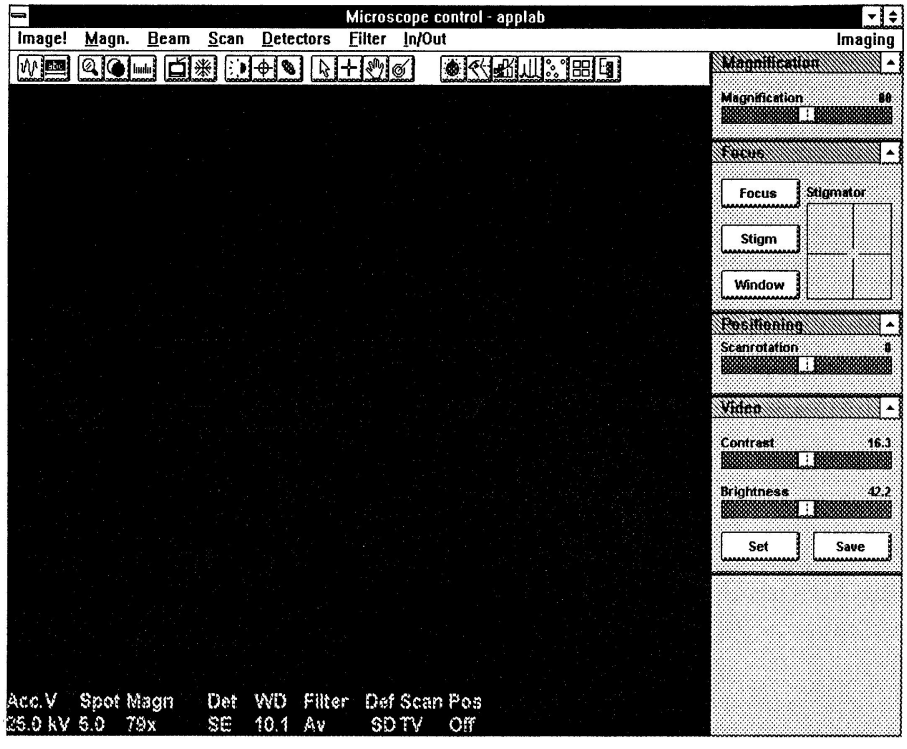


Figure 1.1

- **The data bar:** The complete data bar can be switched on or off. If selected, the data bar shows an on-line display of the momentary value of the main microscope parameters. Two types are available:

  a photo data bar, containing data that will be recorded on a micrograph: the applied high tension, the spot size, the magnification, the detector, the working distance and the exposure number. Each item can be individually switched on or off.

  a 'real-time' data bar that shows some additional information, mainly referring to the applied scan mode and the frame store operation. This data bar is very useful during operation because it shows the actual instrument status.

- **The menu bar:** The main controls of the microscope are displayed in the menu bar (see Fig. 1 .1). Apart from Image! Each selected menu item reveals a 'pull-down' menu. The actual setting of the parameter is indicated by a selection sign V. By moving the pointer to the desired selection and clicking the left mouse button, the new selection is activated. The various pull-down menus are described in chapter 2: Microscope Functions.

- **The button bar:** The button bar (see Fig. 1.1) serves two purposes. Firstly it contains buttons to select or deselect dedicated microscope functions. Secondly the control areas (see item ("The control areas") can be selected using the appropriate button.

  Whenever a function or control area has been selected, the corresponding button will be highlighted, showing that it is active. Buttons that activate an automated procedure will not be highlighted.

  The button bar is configured from left to right as follows:

- PRINT
  Sends image to the printer.
- VIDEOSCOPE
  Toggle button: Switches the display of the videoscope on or off, showing the video intensity along the currently scanned horizontal line.
- DATA MODE
  Toggle button: Rotation button with three modes:
- No display;
- Display of photo data bar (button highlighted);
- Display of 'real time' data bar (button highlighted).

- POWERZOOM
  Activates and stops power zoom function.
- MEASUREMENT
  Toggle button: Switches the measurement dialogue box on measurements or off for making on-screen measurements.
- TV/SS
  Toggle button for scan rate: TV (button highlighted) / previously selected slow scan.
- FREEZE/UNFREEZE
  Toggle button to freeze (button highlighted) or unfreeze the contents of the microscope frame store.
- AUTOMATIC C&B
  Activates the automatic contrast and brightness routine .
- AUTO FOCUS
  Activates the auto focus routine.

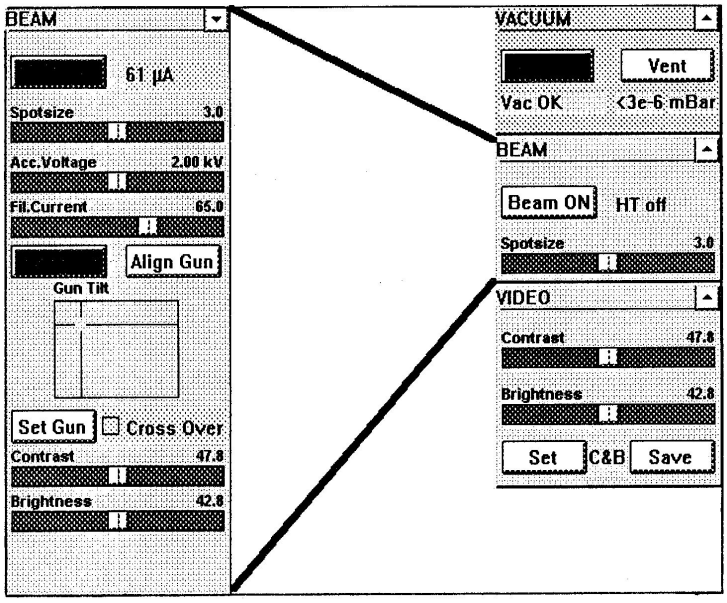
- AUTO STIGMATOR
  Activates the auto stigmator routine.
- NO POSITION
  Pressing this button switches off the dedicated position modes. The standard Windows icon (arrow) will be displayed.
- GET
  Selects stage GET mode.
- SHIFT
  Selects beam SHIFT mode.
- SETTINGS
  This button selects control area Settings.
- IMAGING
  This button selects control area Imaging.
- IMAGE MANIPULATION
  This button selects control area Image Manipulation.
- ADJUSTMENTS
  This button selects control area **Adjustments**
- **The control areas:** The controls of a complete scanning electron microscope are divided into 4 main sections, representing the main phase: in a microscopy session and allowing continuous change of parameters. The sections are named: Settings, Imaging, and Image manipulation. A 4th section, Adjustments, is used for fine-tuning of the electron optical parameters of the column and is not a part of the routine operation. The name of the active control area is displayed in the menu bar.

  For each of these sections a control area is set up that allows the user to interact with the system; this control area is located at the right side of the screen. The complete control area can be switched on or off.

  In each control area the functions of the SEM are arranged in smaller entities called groups. In Fig.1.1, the three groups 'VACUUM', 'BEAM' and 'VIDEO' are shown: together these form the control area settings. In each group one finds the controls and functions that are related to each other from an application point of view.

  The group shown in the control area only shows a limited numbered controls for that group. These are the most frequently used controls. For example, the video group (see Fig. 1.1) shows two adjusters for contrast and brightness and two buttons for the definition and execution of automatic contrast and brightness.

  The total size of the group is larger than shown on the control area. For this purpose the total group can be zoomed out to the full dimensions of the control area. This is done by clicking in the upper right corner of that group. In this mode all the controls belonging to that particular group can be manipulated (see Fig. 1.2).



- **Pull-down menu:** A pull-down menu is a group listing of available commands or settings. First select

the menu by clicking on the menu item in the menu bar, then move the cursor to the desired selection and click the left button of the mouse. If the selected setting is a parameter value, the new value is updated immediately and a check mark will appear in the pull down menu. If the selected setting is a command, a new pop-up menu or dialogue box will appear.

- **Command button:** This is a large rectangular button that carries out or cancels a function. In general the command button will have a label that describes the action. Examples: OK, Cancel, Reset.
- **List box:** The list box contains names of available: choices (e.g. file names when saving or restoring images). If the list box is too small to show all the names, the scroll facility for the vertical direction can be used for further display.
- **Text box:** A box in which information can be typed. This direct keyboard input is used to produce text such as file names, user labels (in the data bar) and specified values for certain parameters.
- **Dialogue box:** A rectangular box that appears when the system needs more information before it can carry out a command or when the system is providing certain information. The extra information can be input using option buttons, command buttons, text boxes, etc. The dialogue box can be quitted by clicking on the 'OK' button. At that moment the instrument updates all information shown in the dialogue box. A click on the 'Cancel' button results in quitting without updating the system.
- **Option button:** A small round "radio" button that selects an option when set. Within a group of related option buttons, only one selection can be made. An example of this type of button is found when clicking on menu item scan, group setting change. A list of possible line times and lines per frame then appears, each proceeded by an option button. For option buttons only one selection can be active at a time.
- **Continuous control:** A continuous control (adjuster) allows continuous change of parameters (e.g. for setting the contrast, or scan rotation). When the mouse is moved into the adjuster area of the control and the left mouse button is pressed, the mouse cursor will be 'trapped' inside the small rectangle in the center. Moving the mouse left or right will result in a change of the setting and the effect can be viewed on the image monitor. When the mouse button is released, the corresponding parameter is set to the last value.

  A few continuous controls have a logarithmic scale. This means that the transformation of mouse (and cursor) position to actual values is done using a logarithmic function. In this way movement of the cursor in the central area of the rectangle is used for fine-tuning, and placing the cursor in the area more to the left or right results in larger changes of the parameter. When a large change has to be made, release the mouse button when the setting is approximately correct; now click again and do the fine-tuning in the central area.

  Some continuous controls are two-dimensional (e.g. the stigmator). They are represented by a square region in the control area. In this square, the position of the cross-wires is related to the actual settings, the full range of the parameters being presented by the horizontal and vertical axis, respectively.

  Clicking in the square results in a display of the cursor on the full screen, next to the control area. The cursor has changed in shape and can be moved in two directions. The x, y screen values are transformed into two-dimensional information for the parameter that has to be changed. Once the proper setting has been achieved, the mouse button must be released. At that moment the values are fixed and the position of the cross-wires in the small square region in the control area is updated.

1.3. The keyboard

The keyboard has standard keys for letters and numbers and some symbols. In addition there are dedicated keys such as "Esc' arrows, +, -, Ctrl, Alt and a set of function keys F1 to F12. Standard keys are used for data input such as typing in a file name, or for text annotation on the image.
Some keys are dedicated Windows keys:

(ENTER) is the equivalent of 'OK' in a dialogue box?

(ESC) is the equivalent for the 'Cancel' button?
(TAB) is the step key to focus on one of the items in a dialogue box?
(ALT) in combination with a character opens the pull-down menu in the active application (underlined characters in the menu items).
(ALT)(TAB) with these keys (the ALT key being held down while pressing the TAB key), MS-Windows shows the last used application program (MS-Windows version 3.1). When successively pressing the TAB key (holding the ALT key in) all applications that are resident will be shown one by one. If the required application is shown, the ALT key simply has to be released, and the selected application becomes active again.

- In addition the following keys have dedicated functions in the microscope control software:

(+ on numeric pad) increase magnification by a factor of 2, never exceeding the maximum magnification, indicated with a beep.
(- on numeric pad) reduce magnification by a factor of 2, never exceeding the minimum magnification, indicated with a beep.

In the microscope control program the function keys have dedicated microscope functions. A table for the function keys indicates the function of each key. The function keys can only be operated if the microscope control program is the active application.

(F1) HELP: Toggle key: Switches the display of the meaning of the function keys on or off (software table).
(F2) IMAGE ONLY: Toggle key: Switches the display of the control area on or off.

(F3) VIDEOSCOPE: Toggle key: Switches the display of the videoscope on or off, showing the intensity along a horizontal line.

(F4) DATA MODE: Rotation key with three positions:
- display of photo data bar
- display of 'real time' data bar
- no data bar display

(F5) POWERZOOM: Activates and stops the power zoom function

(F7) MEASUREMENT: Toggle key: Switches the measurement dialogue for doing on-screen measurements
on or off.

(F8) TV/SS: Toggle key for scan rate: TV / fastest slow scan.

(F9) ACB: Starts the automatic contrast and brightness routine

(F10) AUTO-STIG: Starts the automatic stigmator control routine

(F11) AUTO-FOCUS: Starts the automatic focus routine

(F12) POSITION MODE: Rotation key with four positions:
- SHIFT mode switched on
- GET mode switched on
- Track mode switched on
- No positioning mode switched on

1.4. The control panel

The control panel on the left side of the tabletop contains 5 pushbuttons. The ON/OFF buttons are used to switch the entire microscope on or off. The STABDBY button is used to set the microscope in stand-by mode for a partial switch oft of the instrument. The VACUUM and HIGH TENSION buttons are hardware enable / disable buttons. They are checked by software before the start of the pump cycle for the vacuum and switching of the high tension, respectively. Only when they are in the done position (illuminated), vacuum and HT control via the mouse interface is possible.

Note: The OFF button is only used to completely switch off the instrument or as an emergency button. It should not be used in a regular way to switch off the instrument in the middle of microscope operation.

1.5. Stage controls

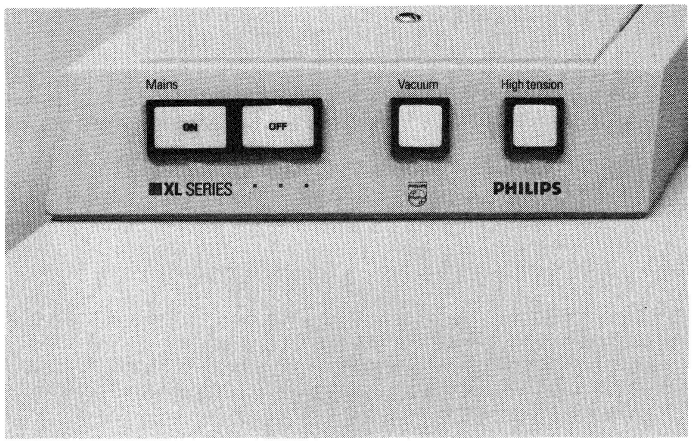
The XL30 has a manual stage as standard. Sample translation, rotation, tilt and the height setting are performed manually. The actual tilt value is shown by a scale on the door and the actual working distance is given in the data bar (assuming the image is in focus). Additionally there is a lock mechanism to increase the stability of the stage. This is especially useful when operating in the high magnification range.

2 MICROSCOPE FUNCTIONS

This section describes all available controls in full detail. Both the software controls, the actual buttons on the control panel, and the internal and external stage controls are presented. Their functions are explained and related functions and controls are discussed.

2.1 CONTROL PANEL

The control panel is situated at the left-hand side of the tabletop. It contains pushbuttons for switching the instrument on and off and enabling buttons for computer control of vacuum and high tension. For LaB6 and FEG instruments a fifth button allows switching of the instrument to a stand-by mode.



2.2 PARAMETERS IN THE DATA BAR

The data bar is superimposed on the bottom of the image, and shows the main microscope parameters: it represents an on-line display of the momentary value of these parameters. If the control area is not visible, the data bar also shows the automatically scaled micron marker and the typed-in user-label (Image Only function selected by F2).

2.2.1 Types of data bars

Two types of data bars are available and selection between them can be made either by function key F4, or by the menu item 'Databar', in the menu bar item 'In/Out'. By successively pressing the F4 key the data bar mode can be set to:

- **OFF**: No databar is visible and nothing will be printed out on the micrograph.

- **PHOTO**: a photo data bar, containing data that will be recorded on a micrograph (photo camera output).

The full photo data bar shows the following data:

Automatically scaled micron marker with readout.

Acc.V: Accelerating Voltage in kV: three relevant digits. Below 1 kV the unit scales to V and the value is again given in three digits (resulting in a minimum step of 1 V).

Spot: Spot size in the range 1.0 to 9.9 for W and LaB6 systems. For FEG 1.0 to 7.0.

Magn: Magnification (integer).

Det: Active detector e.g. SE, BS, CL.

WD: Free working distance in mm = distance between specimen and final lens. (This value is only correct if the image is in focus).

Exp: Exposure number. This is an integer in the range 0 to 9999. The exposure number is automatically incremented each time the photo's procedure is started.

User label: (up to 28 characters).

2.3 MENU BAR FUNCTIONS

The menu bar contains the most commonly used microscope controls, accessible in the form of pull-down menus. They are arranged from left to right in logical order of use, from image forming to image recording.

The following pull-down menu items are available:

- **Magn**. : to select from a list of magnifications
- **Beam** : selection of High Tension and spot size
- **Scan** : for selection of scan times and scan mode
- **Det.** : for selection of detector
- **Filter** : deletion of frame store mode of operation
- **In/out** : for storage of image and data

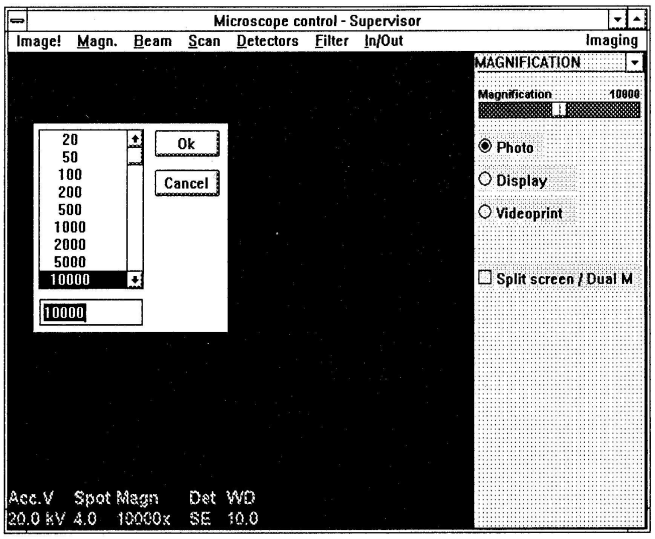
Both in the menu bar and in the pull-down menus some item names are directly followed by an exclamation mark, e.g. Photo! When such items are selected, the microscope will directly start a procedure and no additional choice has to be made.

2.3.1 Magnification

The '**Magn**' pull-down menu allows selection of a magnification value from a list of pre-defined values. If the current value is in the list, it is indicated by a check mark. Selecting one of the preset magnifications results in a change of magnification on the screen. The pull-down menu disappears.

Note: - The magnification can also be changed by using the (+) and (-) buttons on the numeric keypad.

- The magnification can be changed continuously in the Imaging control area, Magnification controls group



The last menu item in the list is 'Change', which allows the list of preset values to be changed. An edit box appears on the screen and the list is displayed. One of the values represents the focus and its value is also shown in the edit box below the list. By clicking on one of the other values in the list, the focus will change accordingly and the corresponding value appears in the edit box Modifications of the list are made as follows:

- Type the desired magnification in the text area
- A click on the 'OK' button will stop the editing and update the list with the new value. Note that the values in the list are automatically arranged top-down from small to large. The pull-down menu will disappear.
- If more values have to be edited, the mouse can be used to directly click on another value in the list. The previous value is updated; focus will go to the new value, which also appears in the edit box. The new value can be typed in again. In this way the whole list can be modified without leaving the dialogue box.

It should be noted that only integer values can be typed in and that the length of the list is fixed.

2.3.2 Beam

The Beam pull-down menu is used to select one of the preset accelerating voltages and to select the spot size. It is possible to change the preset values for the accelerating voltages.

a) **Accelerating voltage**

A preset value can be chosen by selecting one of the voltages from the menu. The last menu item in the list is '**Change**', which allows the list of preset values (not the length of the list) to be changed. An edit box appears on the screen and the list is displayed.

b) **Spot size**

The spot size can be chosen from the menu. The spot sizes are numbered from 1.0 to 7.0. Number 1.0 is the smallest spot size the instrument can generate at the selected accelerating voltage

The spot size is represented by relative numbers only. The spot size is roughly doubled per increasing step in spot size; the current of the electron beam increases roughly by a factor of 4 for each step. Spot sizes used for making images are from 1 to 6. Spot size 7, is especially made for the generation of high current beams such as those required for WDX applications.

2.3.3 Scan

The Scan pull-down menu is used to select the scan speed of the scan generator and the scan mode. The scan speed is either TV speed or one of three preset slow scan speeds. These presets can be changed using the **Change** option. In addition to the three slow scan presets, also the preset speed for photos is indicated (photo scan). Usually, a longer line time is chosen to improve the signal-to-noise ratio in the image.

The scan modes are either full frame, reduced raster (beam is only scanning in a limited area), horizontal

line scan, or no scan at all (spot mode).

The following selections can be made:

- **TV**: The scan generator starts scanning at TV speed.
- **SlowSc 1**: The scan generator is switched to the first preset slow scan speed. The slow scan presets can be changed using the Change menu item. It is recommended to preset the fastest scan speed for Slow scan 1.
- **SlowSc 2**: The scan generator is switched to the second preset slow scan speed. The slow scan presets can be changed using the Change menu item. It is recommended to preset the middle speed for Slow scan 2.
- **SlowSc 3**: The scan generator is switched to the third preset slow scan speed. The slow scan presets can be changed using the Change menu item. It is recommended to preset the lowest scan speed for Slow scan 3.
- **PhotoSc**: The scan generator is switched to the preset scan speed for photos. This Preset speed can be changed using the Change menu item.
- **FullFr**: The scan generator scans over the full frame. This is the normal scanning mode.
- **Sel. area**: The scan generator scans over a limited area of the normal raster. This results in a smaller image that is updated much faster; the surrounding image is the actual image in the frame store.
- **Hor. Line**: The image freezes and a horizontal line is shown on the display. The beam scans along this line, using the line time defined for the selected slow scan speed.
- S**pot**: The image freezes and a cross is shown in the image. The beam is fixed in the position indicated by the cross.
- **Ext. XY**: The image freezes and the scan is taken over by the external device (e.g. a microanalysis system, or external image acquisition software).

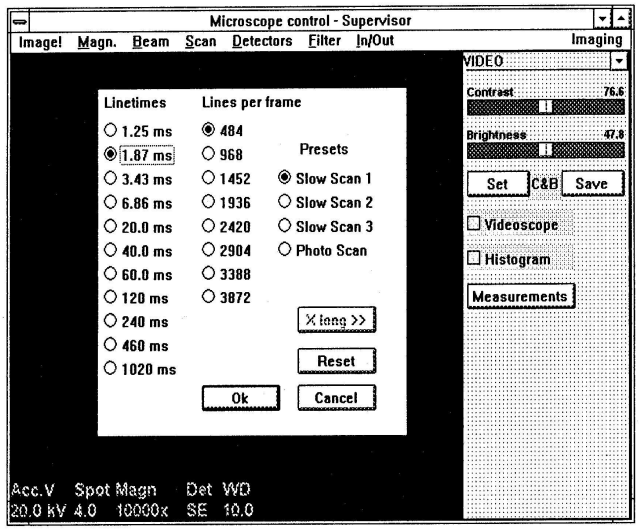


Fig. 2.3, Dialogue box showing the possible selection of line times and number of lines per frame. In this way the slow scan modes are defined.

2.3.4 Detectors

The Detectors pull-down menu allows selection of the detector signal to be used for imaging. Also the mixing parameters can be set. The '**Change**' menu at the end of the list will be different for each active detector.

SE: Activates the SE detector. The SE detector will automatically be switched on and off during venting of the specimen chamber.

BSE: Activates the BSE detector. In addition a three-position switch on the detector pre-amplifier can be used. Normally this switch is in position 0. Only if the brightness adjuster in the control area does not allow sufficient reduction of brightness, should this switch be set to a position one step higher.

Mix:

SE and BSE detectors may be active simultaneously. When mix is selected, the image is formed by mixing the output signals of two detectors. The mixing ratio can be set by selecting Change.

Change if SE is selected: A dialogue box appears. It contains an adjuster to control the Grid bias voltage. When the grid bias is negative, secondary electrons are repelled from the secondary electron detector and only back-scattered electrons are detected. The bias voltage is continuously adjustable in the range -100 V to +300 V.

Change if BS is selected: A dialogue box appears, containing option buttons to select the way in which the two detector segments A and B are switched: i.e. A+B, A-B, A, or B. When both segments are switched to + a normal BSE image containing atomic weight contrast is obtained. One segment switched to + and the other to - results in a pseudo-topographical image.

2.3.5 Filter

The Filter menu allows selection of the frame store noise filtering functions.

- **Live** puts the frame store in live mode. No noise filtering is done in the frame store (only noise filtering by the normal input low pass filters, which are coupled to the applied line time).
- **Average** n selects recursive noise filtering (running average). The default number of averaging is 4 because of the best compromise between noise reduction and loss of reaction speed.
- **Integrate** n selects accumulative noise filtering.
- **Freeze** directly stops accumulation of the current image. No more information is accepted by the frame store.
- **High Def**: A click on High Def switches the frame store to high definition mode. In this mode the image is built up of 1404 x 968 pixels. It is not possible to use this mode at TV speed and only 968 or a multiple of that number of lines/frame is allowed.
- **Change** allows the number of frames for averaging and integration to be selected in a dialogue box. Proceed as follows:

2.3.5 In/Out

The In/Out menu allows all input and output actions, such as saving and retrieving images, microscope conditions, taking pictures, etc.

The following options are available:

- **Image**....

This allows storage of images on any storage device of the microscope's personal computer. Images can be stored in two ways, characterized by their extension:

- **Parameters.**. allows storage and retrieval of almost all microscope settings.

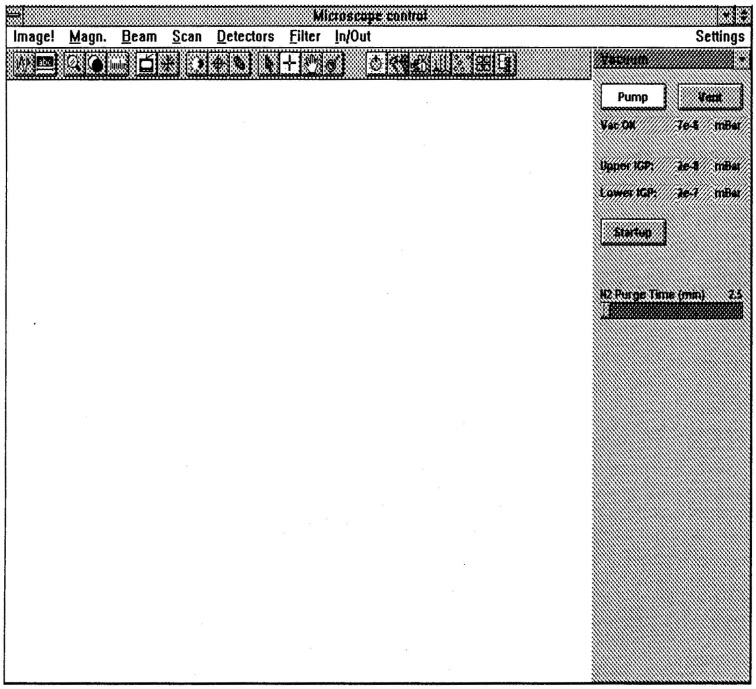
2.3.6 Control Areas

The software controls at the right of the image are located in so-called control areas. Several control areas are divided into smaller groups called control groups. A control group can be expanded to provide access to extra functions.

- **Settings**: Submenu: **VACUUM, BEAM, VIDEO**
- I**maging**: Submenu: **MAGNIFICATION, VIDEO**
- **Image manipulation**:
  Controls for manipulation of images, such as crisp, gamma curves, etc. and for color coding
- **Adjustments:** Controls to perform electronic alignments of the microscope

2.4 CONTROL AREA: SETTINGS

2.4.1 Submenu: Vacuum



This group is used to control the vacuum system of the FEG instrument. It will also show the status of the vacuum of the specimen chamber, the readout of the intermediate vacuum and the vacuum of the emission chamber. The control group is used during specimen exchange, and the zoomed-out group (see Figure) is used to start up the system initially.

Pump: A click on "pump" starts the ODP system evacuating the specimen chamber and allows the High Tension to be switched on when the vacuum is OK and the gun is in the operating condition. If "**Pump**" is Activated, its color will change from gray to green.

Vent: A click on "**Vent**" will slowly switch off the high tension and switch off the pumping system of the specimen chamber. The column valve will close and the specimen chamber will be vented. The actual parameters of the gun are not affected: only the High Tension is set to zero.

Nitrogen purge time

This adjuster allows selection of the time that vent-valve will be opened. The selected time (in minutes) is shown just above the adjuster.

2.4.2 Submenu: Beam

This group is used to switch on the high voltage for generation of the electron beam. The expanded group allows continuous adjustment of the accelerating voltage that might, for example, be required for optimizing the image with respect to charging. In addition, switching of the filament and gun, and manual fine-alignment of the gun tilt and gun shift is possible.

kV: A click on **kV** will slowly switch on the selected high voltage and set the system parameters according to the values saved during the alignment of the system. When activated, the color of the button will change from gray to yellow.

2.4.3 Submenu: Video

This group allows adjustment of the contrast and brightness of the active detector, and storage of a favorite image gray level distribution. Moreover, it offers an automatic procedure for adjusting contrast and brightness to obtain the previously stored, favorite setting for the gray level distribution.

Contrast: This adjuster controls the contrast (gain) of the selected detector. The contrast range is from 0 to 100.

Brightness: This is a similar adjuster to that of contrast. It controls the brightness (off-set or zero) of the selected detector. The brightness range is from 0 to 100.

Save: This function allows the storage of a favorite setting for the total gray level of the image (i.e. contrast and brightness). In this way the "general impression" of the image can be stored and used later.

Videoscope: This is a check box. When clicked on, the intensity profile along a line is overlaid on the image. The dashed lines indicate the maximum level (= white = upper level) and the minimum level (= black = lower level). The video scope is useful when checking or adjusting the contrast and brightness settings just before a micrograph is made. The videoscope can also be switched on using the function

key (F3) of the keyboard.

2.5 CONTROL AREA: IMAGING

The control area imaging is one of the main control areas used during normal instrument operation. All basic functions required for actual microscopy are grouped here. The control area is divided into two submenus, IMAGING and VIDEO. This last group, however, is an exact copy of the VIDEO group in the SETTINGS control area.

2.5.1 Submenu: IMAGING

Magnification: This adjuster allows continuous change of the magnification.

Stigmator: This is a two dimensional adjuster with a cross, that allows the stigmator setting to be changed. The cross indicates the actual setting of the stigmator. Move the arrow in the adjuster area and click with the left mouse button. The hand-cursor now appears on the full screen, and by moving left right the x-stigmator is modified. An up-down movement will change the y-stigmator. Note that the stigmator range is automatically coupled to the magnification. When the stigmator has been adjusted properly, release the left mouse button. The position of the cross in the reserved adjuster area is now updated.

2.6 CONTROL AREA: IMAGE MANIPULATION

This control area is mainly used when a proper image has already been obtained and is present in the Main memory of the microscope (either live or frozen). The control area allows manipulation of the image, such as text annotation, manipulation of image memory and digital operations on the image. This control area has no sub-groups that can be expanded.

2.7 CONTROL AREA: ADJUSTMENTS

This control area allows fine tuning of the electromagnetic system of the column, and is only used if the column has become misaligned for some reason. Misalignment is manifested by large image movements when changing focus, stigmators or high tension. It might be especially necessary to go through the alignment procedure when changing the filament (distance, position, replacement).