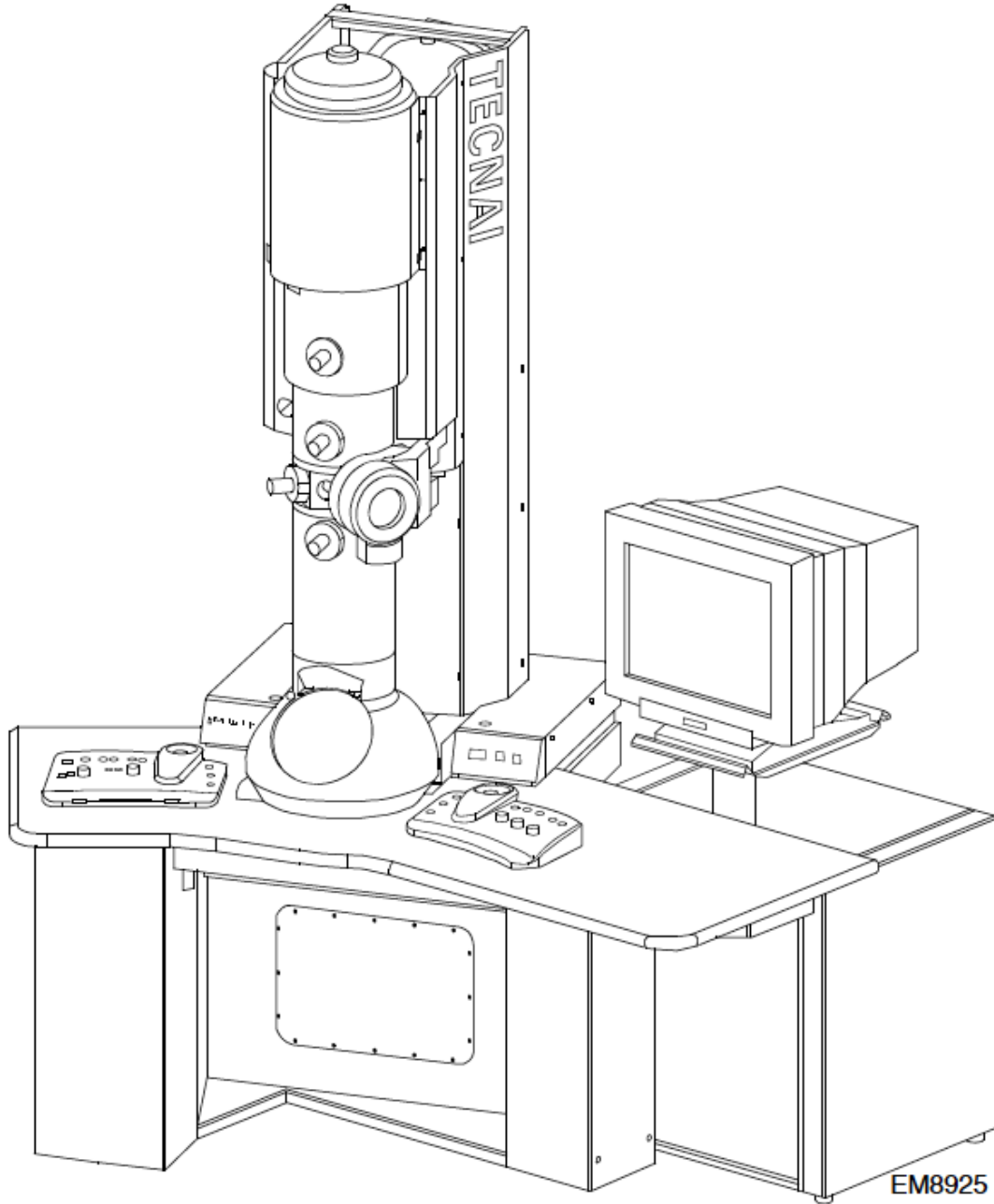


TECNAI12 TEM BRIEF MANUAL

The Tecnai12 TEM consists of electron column, vacuum system and computer control interface. Below are discussed the main features of the three components.



Emergency controls

The T12 microscope is equipped with several emergency controls, located in a separate panel on the right-hand side of the column support. These emergency controls have the following functions (from left to right): The Vacuum on / off and HT Enable controls provide safety and at the same time allow switching the HT on through software.

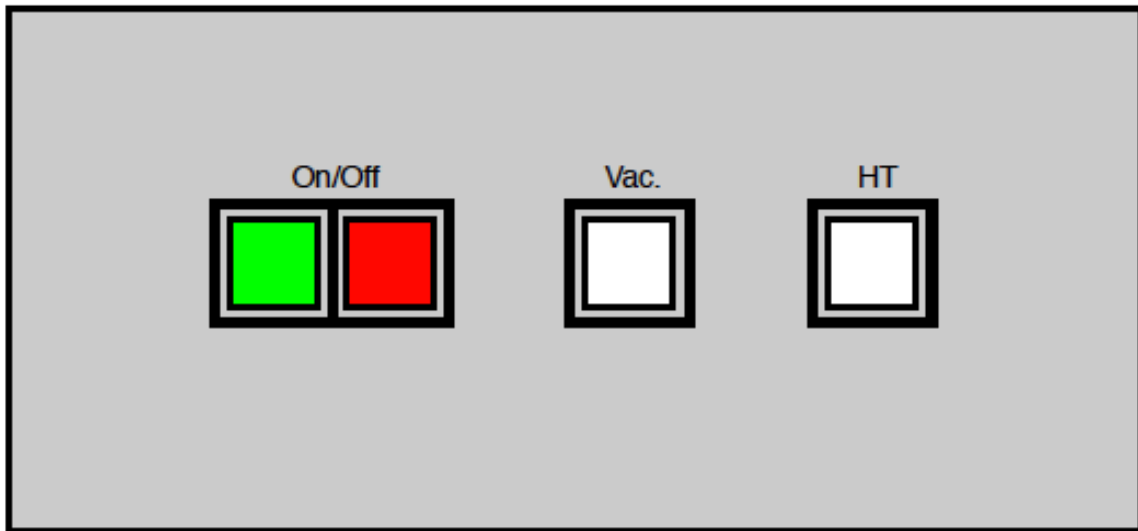
Label Color Function

ON Green - Switches power supply to the microscope on, lit when microscope is off

OFF Red - Switches power supply to the microscope off, lit when microscope is on

Vacuum White - Vacuum on / off

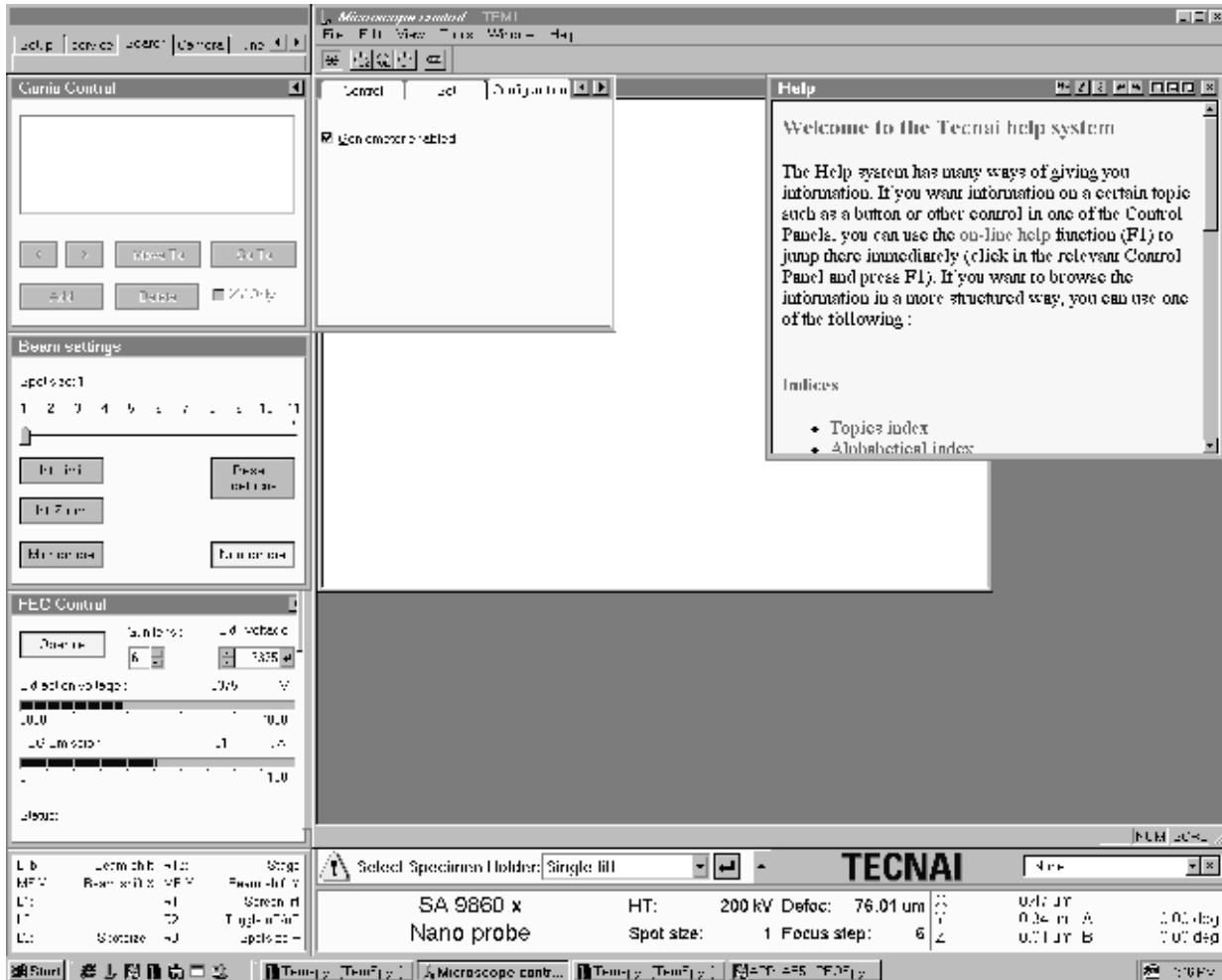
HT White - Enables/disables HT on (if this is off, HT cannot be switched on)



1. User Interface

The Tecnai12 control computer application runs in Windows environment. Access to the Tecnai microscope requires login to the control computer. The user interface of the control software contains a number of Windows control elements like control panels, buttons, etc. We can divide these into different categories:

- The **Main program**. This consists of the program title, menu bar and toolbar.
- The **Control panels**. These are sets of controls that belong together and that are displayed in a fixed window
- The **Information panels**. These consist of a set of windows displayed near the bottom of the screen.
- The empty area to the right is reserved for data like images, spectra, etc.



Toolbar

The user-configurable toolbar contains a number of icons that provide quick access to microscope functionality. To change the toolbar, select Tools, Customize from the menu.

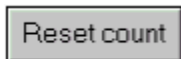
Workset tabs

At the top left of the user interface is a small window containing a (user-defined) number of tabs. Each of these tabs controls access to a number of Control panels (typically a set of three). Click on any of the of tabs to access it workset.



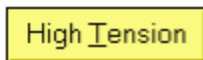
1.1 Windows controls

The user interface of the Tecnai microscope contain a number of Windows control elements which are listed below.



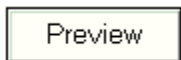
Button

Press it to have the program to something. If the function cannot be done under the current conditions, the button is greyed.



Three-state button

In addition to the normal and greyed states, this button has a yellow state which indicates that the function is on.



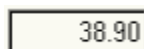
Four-state button

In addition to the normal and greyed states, this button has a white state which indicates that the selection is on and a yellow state which indicates that the selection is on and the function is active.



Label

Simple text in a window. Display only.



Edit

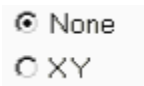
Allows insertion of text or numbers. Only used if there is some other way of having the program act on the change.



Check box

Selects (a cross is displayed in the square) or deselects a particular option. It also works when you click on the

caption of the check box (so not only when you click inside the box itself).



Radio buttons

Makes a selection from a series of mutually exclusive options. Clicking an unchecked option, checks that options and unchecks all others. Also works when you click on the caption of a radio button (so not only when you click on the circle itself).



Drop-down list

A list of items from which a selection can be made. In order to save space, the whole list only becomes visible when the arrow on the right is clicked. If text or a value can be entered at the top line, it is called a drop-down combo box.



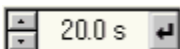
Spin buttons

Change a number up or down by clicking on the up or down buttons. The numbers will spin faster if you keep one of the buttons pressed instead of giving single clicks.



Enter button

Confirm changes by pressing the enter button (pressing the button on the keyboard does the same).



Spin-enter-edit

An edit control with spin buttons to change the value and an enter button to confirm the change (after which the program will act on it). The enter button indicates the status of the value. When the enter button is enabled, the value has been changed but not yet updated in the microscope (the update is done by pressing the enter button). When the enter button is disabled, the value indicated is the same as that on the microscope. When you use the spin buttons the value is directly transmitted to the server and the enter button will remain disabled. When you change the value by typing, the enter button will become enabled and you have to force the update by pressing the enter button.



Spin-label

A control with an indicated value and spin buttons. Here the value can only be changed with the spin buttons.



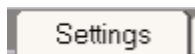
Track bar

Drag the grey handle to another setting to change a value. You can also click to the left or right of the handle to make it jump one step.



Progress bar

Displays progress of a process or the current status as a fraction of the total range.



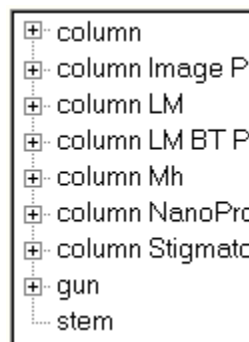
Tab

Allows selection of one of a series of displays.



Bitmap button

A button with a picture on it. These are used for the flap-out buttons, but also in toolbars, etc. They usually work the same as normal buttons, except that some toolbars buttons are flat (only show their outline when the cursor hovers above them) and can show an 'on' state by remaining 'pressed down'.



Treeview

Display a list of items, some of which (marked by a '+' sign) can be expanded to show their sub-items, and so on. Expansion happens when you click on the '+' (it will contract again when you click on the '-' sign that will take the place of the '+'). Alternatively you can expand by double-clicking on the caption (not double on the '+', that expand and contracts again). Select an item by clicking on the caption.



Popup menu

A single-column menu that becomes visible when the right-hand mouse button is clicked.



Splitter

A bar separating two areas in a window that allows changing the size of the two areas. The cursor shows two lines drawn apart by two arrows.

Popup panels

At the bottom right-hand side of the screen (right next to the microscope name) is a drop-down list box with a small 'x' button next to it (in other views than the standard frame it may be located elsewhere on the screen).



The drop-down list gives access to Control panels that will be displayed in the corner just above the list box itself. The selection of these 'popup' panels includes a number of Control panels that cannot be assigned to worksets (because of their size). The selection also includes those Control panels that are not currently visible on the screen. This means, for example, that you can have the microscope display the Plate camera control panel to have rapid access to the plate-camera settings, without changing from the current workset tab. As soon as the workset tab is changed to one containing the panel visible as a popup, the popup panel will disappear.

Special popup panels

Three popup Control panels are worth mentioning here since they can only be accessed in the popup because they are too large to fit inside the space normally reserved in the worksets for Control panels: the Vacuum overview, the Workspace lay-out and the System Status. The on-line help for these panels is once again accessible by clicking in them and pressing F1.

Display

The microscope user interface provides a series of panels containing microscope status information. These cover the binding display, message area and microscope status display.

Binding display

The binding display panel shows how the user-assignable knobs and buttons on the left-hand and right-hand Control Pads are linked to microscope functions.

LTb:	Beam shift	RTb:	Stage
MF X:	Beam shift X	MF Y:	Beam shift Y
L1:		R1:	Screen lift
L2:		R2:	Toggle uP/nP
L3:	Spotsize -	R3:	Spotsize +

Messages

Messages by the microscope are shown in a dedicated part of the information area (above the status panel that typically contains the magnification and operating mode). Messages can have three different levels. Since only one message can be displayed at a time, important (higher level) messages will displace simple information messages.



Status displays

Up to three status display panels (in the minimum-size info area view this number is reduced to one). These status display panels can display a wide range of user-selectable microscope settings.

SA 97000 x TEM Bright field	HT: 190 kV Defoc: -13.00 um Spot size: 3 Focus step: 5
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1.2. Control panels

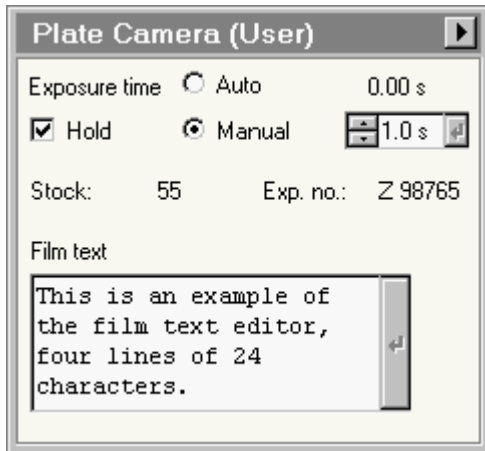
Control panels are small windows, typically arranged in sets of three above one another on the left-hand side of the screen (some Control panels are double-height and can therefore only be combined with one additional panel). Each Control panel contains a coherent set of microscope controls (like vacuum system, electron gun or stigmators). The combination of up to three Control panels forms a workset, defined by name and accessible through a tab in the workset selection window above the Control panels themselves.

The rationale behind the Control panels is very simple. They are meant to give rapid access to elementary (often-used) microscope functionality. Selection of microscope settings (used much less often) is not accessible through the Control panels themselves but is 'hidden' away conveniently in flap-outs.

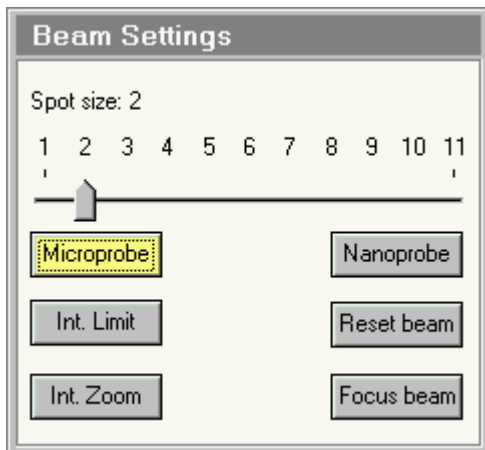
Panel flap-out

Some Control panels (like the Beam Settings Control panel) are simple and have no 'hidden' settings. Other panels are equipped with so-called flap-outs: additional panels that appear to the right of the main panel. Panels with flap-outs are recognizable by the flap-out arrow button at their top right.

When the flap-out button is pressed, the flap-out panel appears. This panel has one or more panels itself, combined through the use of tabs. Click on a tab to access that particular panel. If the total series of tabs doesn't fit in the panel, left-right arrow buttons at top right allow shifting of the whole series of tabs to left or right.



The Plate camera Control panel with the flap-out button (arrow pointing to the right at top right).



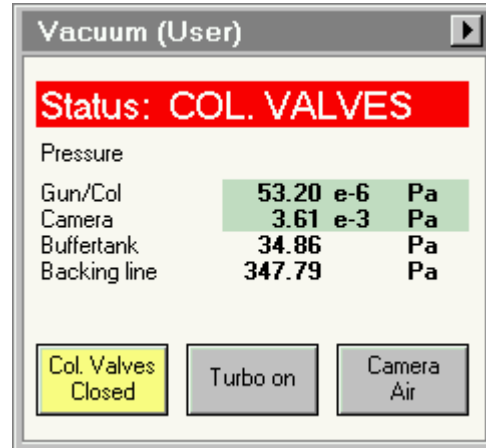
The Beam settings Control panel.

1.2.1 Vacuum (User)

The Vacuum Control Panel.

The Vacuum Control Panel gives an overview of the vacuum status of the microscope and provides access to a few, often-used vacuum-control functions. A more detailed vacuum overview is also available.

Note: Vacuum terminology tends to be confusing. People talk about high or ultra-high vacuum when they mean very low pressures. Where it could be confusing, vacuum status will therefore be referred to as 'good' or 'poor'.



Status

The status line of the Vacuum Control panel displays the status of the vacuum in words. Examples of status values are ready, off, stand-by, and start up. A green status display is used for ready, red status displays for not ready. In the example above, the display indicates that the Column Valves are closed.

Column Valves Closed

The Column Valves Closed button closes and opens the two valves in the column separating the column from the projection chamber (V4) and the column from the gun (V7). These two valves are always opened and closed together. The high tension and filament can remain on when opening and closing these valves. The functionality of the button is chosen such that it highlights (yellow) when the column valves are closed (as a warning that the beam will not be visible). The same is indicated, when possible, by the status display.

It is good practice to keep these valves closed whenever the microscope is not actively used, to keep the column vacuum at its optimum condition and prevent air from entering the gun area during specimen exchange.

1.2.2 Filament (User)

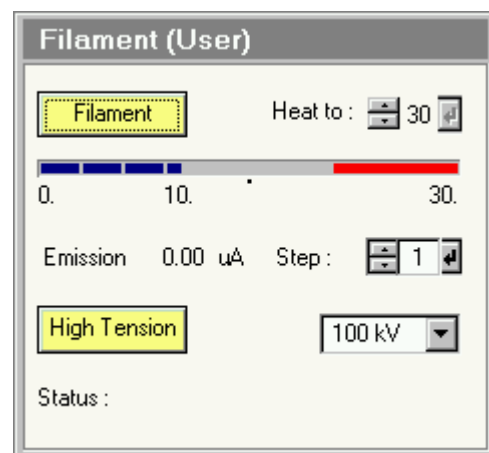
The Filament Control Panel.

The Filament Control Panel displays settings and allows control over the filament (W/LaB₆) and high tension settings.

Filament

The Filament button switches the heating of the filament on or off. The filament button has three possible settings:

- The filament is enabled but off: the button is 'normal' grey. The Heat to step value must be other than 0 (otherwise pressing



the button has no effect).

- The filament is on : the button is yellow.
- The filament is disabled : the text in the button is grey. This typically occurs when the vacuum is not ready or the high tension is off.

When the filament heating is switched on, the filament is heated to the value indicated in the Heat to: spin-enter-edit control at a rate defined by the delay steps.

Heat to

The Heat to spin buttons change the filament heating step to which the filament will be heated. If the filament is off (Filament button is gray), any changes have no direct effect. If the filament is on (button yellow), the changes (defined by the spin buttons) are implemented once the Enter button has been pressed. Changes in heating current are executed with the delay steps defined. The Heat to value cannot exceed the filament limit set.

Emission step

The Emission Step spin buttons change the emission settings of the gun. Press the Enter button to set the new value. Possible values are in the range 1 to 6. In general, the emission should be set so as not to exceed normal filament emission values (typically 10 μ A for LaB₆).

Emission display

The emission display shows the current value of the emission current.

High tension

Pressing the High tension button switches the high tension on and off. The high-tension setting is the one shown in the drop-down list box on the right. The High tension button has three possible settings:

- The high tension is enabled but off : the button is 'normal' grey.
- The high tension is on : the button is yellow.
- The high tension is disabled : the text in the button is grey.

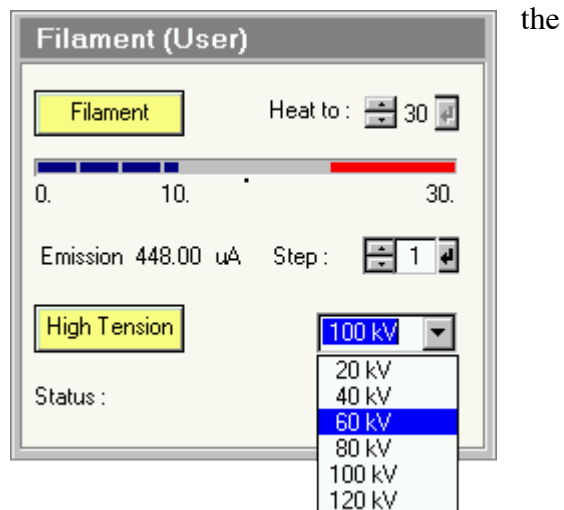
The high tension is enabled through the High tension enable button on the System On/Off Panel.

High tension setting

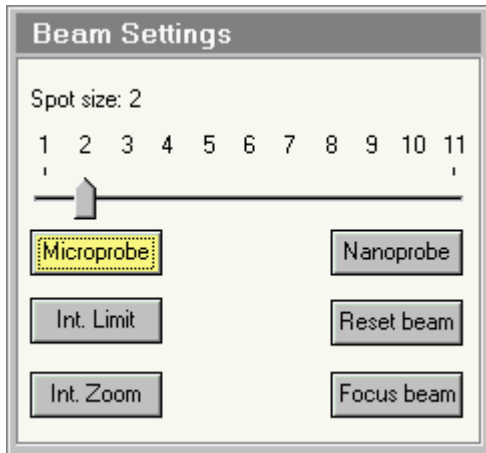
The high tension setting is by clicking in drop-down list box and selecting the required setting (a range of fixed settings, comprising 20, 40, 60, 80, 100 and 120 kV).

Status

The status displays (when relevant) waiting time before the filament has reached the status requested by the operator.



1.2.3 Beam Settings



Beam Settings Control Panel.

In the Beam Settings Control Panel various settings related to the illumination system are controlled. In addition a control is present to reset the defocus display of the system to zero.

Spot size

The Tecnai microscope has eleven fixed settings for the spot size (the first condenser lens or C1). The numbering is such that spot 1 is the largest and spot 11 is the smallest spot. The actual spot size also depends on the microscope mode, with

larger spots in the microprobe mode and smaller spots in the nanoprobe mode. The spot size is changed by moving the scale indicator along the track bar.

Microprobe / Nanoprobe

Switching between the two modes is achieved by clicking on the microprobe or nanoprobe buttons. The active mode is highlighted by the yellow color of its button.

The main characteristics of the two modes are:

Characteristic	Microprobe	Nanoprobe
Purpose	TEM imaging	Analysis, STEM, CBED
Spot size (appr.)	~1000 to 20 nm*	~50 to 1 nm*
Field of view	>largest area seen at lowest MI magnification	Appr. 1/40 of the size of the condenser aperture*
Convergence angles	Low (millirads)	High (tens of millirads)

* somewhat dependent on the type of objective lens

1.2.4 Alignment Control Panel

The alignment procedures of the Tecnai microscope are accessible through the Alignment control panel. The procedures, split into logical units such as Gun, Beam HM-TEM, Image HM-TEM, etc., are displayed in a treeview. Each procedure contains subprocedures that are accessible by clicking on the '+' in front of the procedure name (or double-clicking on the procedure name). Alignments can be stored to file and wholly or in part restored to the microscope. Each alignment part corresponds to an alignment procedure (such as Gun, HM-Beam, HM-Image, etc.). Alignments for all users are located together and listed in the list of available alignments. The controls for saving and restoring alignments are found in the Alignment File Control Panel.

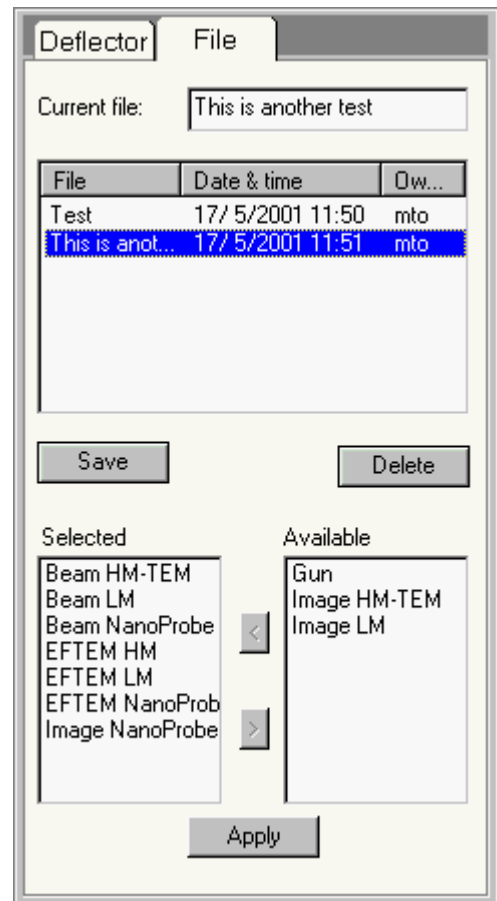
Alignment file

The Alignment File Control Panel.

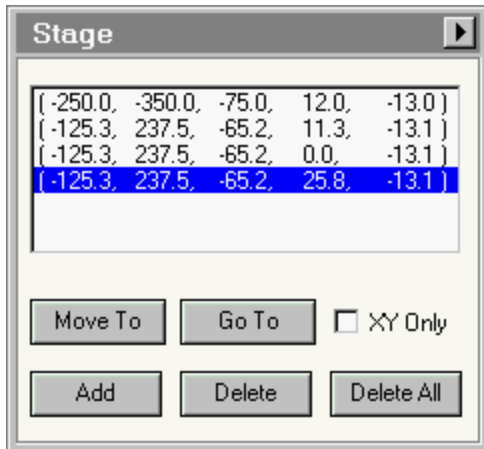
The Alignment File Control Panel contains the controls for saving alignments to and loading them from file. Alignments can be stored to file and wholly or in part restored to the microscope. Each alignment part corresponds to an alignment procedure (such as Gun, HM-Beam, HM-Image, etc.). Alignments for all users are located together and listed in the list of available alignments.

There are a few simple rules concerning alignments:

- You can load any alignment present in the list.
- You can create any number of alignments yourself.
- You can delete your own alignments (and the supervisor can delete all alignment files).
- You cannot delete alignments from another user.
- You cannot overwrite alignments from another user (which would effectively be the same as deleting it and using the same name for your own alignment).



1.2.5 Stage



The Stage Control Panel.

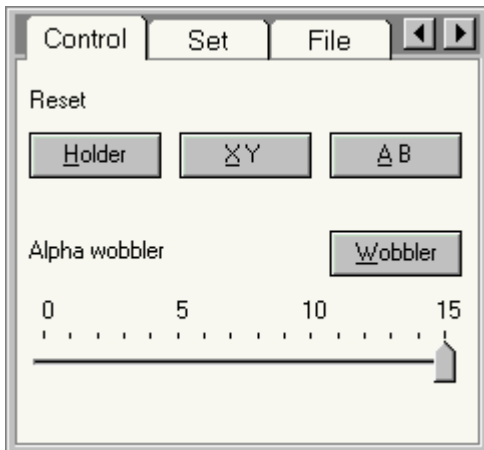
The Stage Control Panel displays and allows control over specimen-stage positions. The positions stored can be saved to (or loaded) from file using the Stage File control panel in the Stage Control panel flap-out.

Position list

The position list displays the specimen-stage positions stored. The list shows columns with X, Y, Z, a and b values (the latter only in case of a double-tilt holder). Positions can be added, deleted, saved in or reloaded from file, and moved to. Positions are selected by clicking with the mouse (or, if the list has the Windows focus - that is, it is the last Windows item used - the arrow keys of the keyboard can also be used to step through the list).

XY only

Move To's and Go To's can be done for all five axes together or only for XY. The check box XY only defines which of these methods will be used (XY only on means that only X and Y will be changed). An example of the use of the all-axes method would be tilting to different zone axes on a single crystal, whereas XY only could be used to move to different X-Y positions stored at the currently active tilt settings.



Stage flap-out

Pressing the arrow button displays the flap-out containing the Control, Set, File and Enable control panels.

Stage Control

The Stage Control Control Panel.

The Stage Control Control Panel provides control over stage settings.

The Stage Enable Control Panel.

The Stage Enable Control Panel provides a control

for enabling/disabling the CompuStage.

The Stage File Control Panel.

The Stage File Control Panel allows saving and reloading of stage positions to and from file. The positions are those as listed in the positions list of the Stage Control Panel.

The Stage Set Control Panel.

The Stage Set Control Panel allows control over specimen-stage positions by entering stage-axis values.

1.3 HELP

On-line Help

Each Control panel has its own on-line help, accessible by clicking somewhere inside the Control panel, and then pressing F1. The Alignments Control panel and Direct Alignments Control Panel additionally have on-line help pages for each of the alignment subprocedures or direct alignments.

Help window

The Help window, used for displaying the on-line help, is displayed in the area reserved for data (the empty area in the user interface). When F1 is pressed in the Tecnai user interface the help window becomes visible near the top left of the screen. Four views of different sizes are selectable through small buttons at the top of the Help window.

How does on-line help work?The on-line help system consists of a series of html (Hypertext Mark-up Language: Internet browser) files. The contents of these files are displayed in the on-line help window of the Tecnai user interface

1.4 System settings and logging off

When you log off from the microscope (close the Tecnai User Interface) you will be asked if you wish to save system settings or not. What are these 'system settings'? They are not the changes you have made to the Tecnai User Interface layout like the selection of control panels and their arrangement over the tabs and the color selections made in Workspace Layout. Those changes are saved immediately as you make them.

What is saved under system settings is the following:

Column

- Operational settings (modes, spotsizes, intensity,...)
- Normalization settings

Detectors

- Detector selection
- Contrast, brightness and filter settings per detector
- CCD acquisition settings

Knobs

- User settings on L1..L3, R1..R3
- User settings on the Multifunction knobs
- User settings on the trackballs

Vacuum

- Vacuum display units
- Airlock time

2. Control Pads

The control pads are physical control boards which contain knobs and buttons for manual control of essential microscope functions.



Left-hand Control Pad

The left-hand Control Pad (called that way because it will normally be to the left of the microscope column) contains a track ball, a number of buttons and turn (rotary) knobs, and two tilt switch controls. The functions of some of these controls can be reprogrammed by software. In the overview below the 'standard' functionality is therefore indicated.

Control	Default function
Exposure	Executes (or interrupts) a TEM exposure
Stigmator	Makes stigmator active or inactive
α tilt	Changes α tilt of stage up or down
β tilt	Changes β tilt (only for double-tilt holders) up or down
Track ball	Beam shift
Multifunction +/-	Changes step size of Multifunction knobs
Multifunction X	Variable
Intensity Fine/Coarse	Switches Intensity between Fine-Medium-Coarse
Intensity	Changes Intensity setting
User button L1	None
User button L2	None
User button L3	Spot size - (to a larger spot size)

Right-hand Control Pad

The right-hand Control Pad contains a track ball, and a number of buttons and turn (rotary) knobs. The functions of some of these controls can be reprogrammed by software. In the overview below the 'standard' functionality is therefore indicated.

Control	Default function
User button R1	Screen lift
User button R2	Switch microprobe <-> Nanoprobe
User button R3	Spot size + (to a smaller spot size)
Track ball	Stage X,Y
Z-axis	Changes Z position of stage up or down
Eucentric focus	Sets objective lens focus for eucentric height / Diffraction focus
Wobbler	Switches wobbler on or off
Diffraction	Switches between Image and Diffraction
Dark Field	Switches between Dark Field and Bright Field
Focus step	Changes the step size of the Focus control
Focus	Changes the focus
Magnification	Changes magnification or camera length up or down
Multifunction Y	Variable



3. Apertures

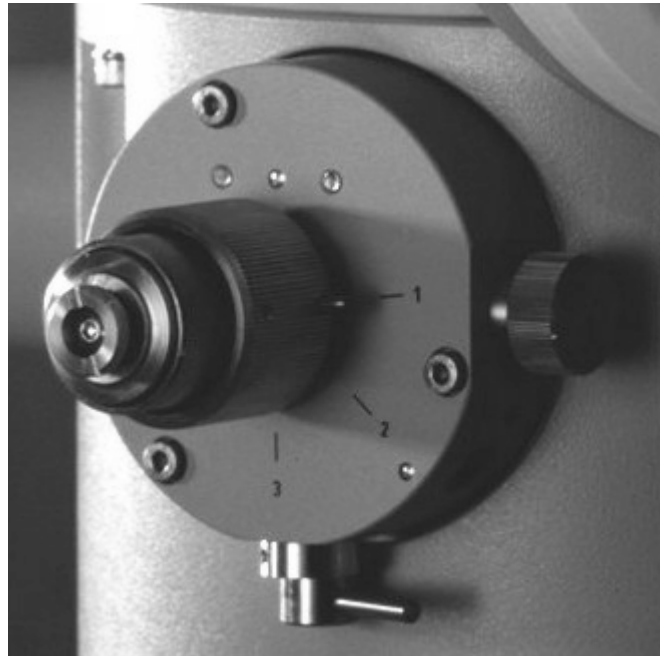
The microscope column is equipped with three aperture controls, from top to bottom:

- Condenser aperture
- Objective aperture
- Selected-area aperture

Operation

Sideways retraction

Apertures so equipped can be retracted sideways out of the beam by a lever mounted at the underside of the aperture mechanism. Rotate the lever to the right to remove the aperture out of the beam, turn it to the left to insert it in the beam. Aperture mechanisms without the lever either cannot be removed from the beam at all (condenser apertures) or require retraction with the aperture selection ring (retraction along the aperture holder axis).



Aperture selection

Turn the large ribbed ring (closest to the column) clock-wise or anti-clockwise to select a different aperture. The small pin on the side of the ring points to the aperture number. Positions 4 to 1 are the real aperture positions.

4. CompuStage

The CompuStage is a motor-driven goniometer that provides computer-controlled movement of the specimen on five axes (X, Y, Z, α , β). The CompuStage consists of the following elements:

- Hardware (the goniometer), including motor drives and position-measuring system.
- Control electronics, including a dedicated microprocessor.
- CompuStage server software which provides the link between the user interface (software and hardware controls like the track ball for X-Y motion) and the CompuStage microprocessor.
- Hardware controls, consisting of a track ball for X-Y motion and pressure-sensitive up-down switches for Z, α and β .
- User interface software with translates operator input into goniometer actions.

Stage movement

The specimen stage movement is controlled by a track ball (normally the right-hand one, but the assignment can be changed by the user) and/or by Multifunction knob. The movement has two modes of operation:

- The track ball (discontinuous movement) mode.

The 'joy stick' (continuous movement) mode.

Speed control

The speed of movement of the stage is related to three parameters :

- The speed value setting (1 to 9) as defined by pressing the left- (speed down) and right-hand (speed up) track ball buttons.
- The current magnification.

The displacement of the track ball.

Red CompuStage light

The red CompuStage light simply means that **no airlock actions** (insertion or removal) should be executed. This will happen of course while the airlock is being pumped when a holder is inserted into the microscope. It can also mean that it is unsafe to extract the holder under the current conditions (when the β tilt is more than 5 degrees or during movement the red light will also be on). In that case, the unsafe situation must be rectified before the holder can be extracted (reset β tilt to zero or wait until movement is finished).

5. Specimen holders

The CompuStage can be equipped with a variety of holders, which are inserted or removed via an airlock. Specimen holders are inserted into ultra-high vacuum and must be kept clean. Special handling instructions for specimen holders should be adhered to.

Handling instructions

Specimen holders are a bridge between the air pressure outside the column and the ultra-high vacuum inside. Their cleanliness is an important factor in keeping contamination down (specimen holders are the second-most important source of the contamination - specimens themselves are the primary source nowadays). Caution should therefore applied to handling specimen holders. The following instructions should be adhered to:

- Always use clean nylon or similar gloves when handling specimen-holder parts that enter the vacuum (that is, between the tip of the holder and the sealing O-ring).
- Clean the tip of the holder only with special cleaning fluids or with a fresh piece of window-cleaning (chamois) leather.
- Specimen, spacing washers and clamping devices should be manipulated only using pointed tweezers or the tools provided. Tools like the hex-ring tool or the needle for levering the single-tilt holder clamp should never be touched by hand on the wrong side (in the case of the hex-ring tool the use of gloves is advised because it is easy to pick it up at the wrong end). Clean the washers, tools and tweezers on a regular basis.
- The O-ring on the specimen-holder rod should be checked for possible dirt or excessive quantities of grease although it should not be completely dry. A very light coating of Fomblin grease (supplied with the microscope) is advised. Take care not apply grease to the conical part of the holder (the part between the thicker and thinner sections of the rod). The conical part is the area where the holder is 'seated' in the CompuStage. Any grease there will very likely result in drift in excess of specimen.

- When a specimen holder is not in use, insert it in the protective holder cover supplied or reinsert it into the microscope. The latter keeps the holder thermally equilibrated with the microscope and CompuStage, thereby reducing drift after holder insertion (especially if there is a considerable temperature difference between the room and the microscope column).

6. Cold Trap

The Cold Trap (also called Liquid-nitrogen cooling device or Cryo Trap) consists of a piece of metal around the specimen environment that is cooled to liquid-nitrogen temperature. The cooling is done by the liquid nitrogen in the dewar on the right-hand side of the column. Gases in the vacuum (predominantly water vapour) condense on the cold surface inside the microscope and thereby the partial pressures of these gases is reduced. Use of the cold trap is particularly effective when a holder is introduced into the microscope, because the water vapour coming in with the holder (either from the residual gases in the airlock or adsorbed on the holder surface) is trapped quickly.

To use the cooling device, first remove the dewar vessel (lift it up slightly, then tilt away at the bottom). Fill it with liquid nitrogen and replace it onto the support. **Make sure not to spill liquid nitrogen onto the viewing windows of the projection chamber as this may cause the glass to crack.**



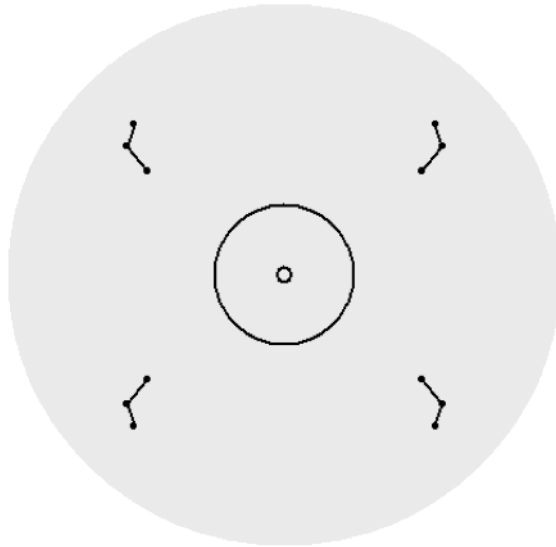
7. Viewing screens

The Tecnai microscope is equipped with two (fluorescent) viewing screens, a main screen and a focusing screen.

Main Screen

The main viewing screen has a diameter of 160 millimeters (the size of the phosphor, not including the outer rim) except on 300 kV instruments where it is 140 millimeters. The screen is equipped with markings that identify the various sizes of film as well as two circles that aid in identifying the screen center. The small circle in the center has a diameter of 5 millimeters while the larger circle has a diameter of 40 millimeters. The film size indicators take the shape of 'elbows'. Each elbow has three 'dot' markers. The dot markers on the ends closest to the screen center mark the sheet-film negative size

6.5x9 cm, while the dots on the 'elbow' itself (at the corner) marks the 3 1/4x4 inch size. The markers furthest outside are for a film type that is no longer used.



The main screen is moved up and down using a motor drive mechanism. The motor drive is under software control. One, dedicated button for moving the screen up and down is present on the left-hand side of the projection chamber (about five centimeters behind the lever for the small screen). Additionally it is possible to define any of the user buttons to have the screen lift function.

Focusing screen

The small focusing screen is moved in and out by hand with a lever mechanism on the lower left-hand side of the projection chamber. The focusing screen is used together with the binoculars.

Digital Image Acquisition

The T12 TEM is equipped with two Gatan digital cameras: the US1000 HR CCD Camera mounted below the viewing screen and the DV300 CCD camera mounted above the viewing screen on the 35mm camera port.