
Image SXM

This is a version of the public domain image analysis program NIH Image that has been extended to handle the loading, display and analysis of scanning microscope (SXM) images from the following systems:

- Burleigh Instruments
- Digital Instr NanoScope II
- Digital Instr NanoScope IV
- DME Rasterscope
- DME Surface Data File
- Gatan DigitalMicrograph
- JEOL JSM
- JEOL WinSem
- JEOL WinSPM
- JPK Instruments
- Klocke Atomikro
- Leica TCS
- LEO SEM
- Molecular Imaging PicoScan
- NanoMagnetics Instr SPMSIF
- Nanonics Imaging
- Nanotec Electronica WSxM
- Noran Instruments Vantage
- NT-MDT
- Omicron VakuumPhysik
- Omicron SCALA
- Oxford Instr TOPSystem
- Park Scientific Instr HFS-LIF
- Park Scientific Instr HDF
- Philips SEM
- Quesant Instruments
- RHK Technology SPM-32
- RHK Technology XPM Pro
- Seiko Instruments (SIINT) SPI
- SPECS STM Aarhus
- ThermoMicroscopes
- TopoMetrix SPMLab
- Unisoku
- Vacuum Generators SAM
- WA Technology
- Zeiss LSM

SXM = SAM, SCM, SEM, SFM, SLM, SNOM, SPM or STM. The following image formats are also supported:

- AVI movies
- Bio-Rad
- FITS astronomical images
- Hamamatsu Image Sequence
- Nikon NEF raw DSLR images
- Omicron SPA-LEED
- PDS planetary images
- Pentax PEF raw DSLR images
- SBIG astro CCD camera
- Targa TGA
- UBM area profile images
- Wyko OPD images

Different versions of Image SXM are optimised for specific types of Mac and are labelled:

- | | | |
|----------------------|--|--|
| U : Universal | For any Mac | (also suitable for Mac emulators) |
| F : FPU | For 68K Macs that have a floating point unit | (such as Mac II, Quadra, ...) |
| P : PowerMac | PowerPC code for PowerMacs only | (also called the pre-Carbon version) |
| C : Carbon | Carbon version of the PowerMac application | (for Mac OS 9 and Mac OS X) |

(Note that the **M** version is the **F** and **P** versions merged into a single file)

The current version of the installer contains the Carbon (C) application. Feedback from users indicates that the Universal (U) version is used only with Mac emulators, the FPU (F) version is essentially redundant and the pre-Carbon (P) version is used only with localised versions of Mac OS 8 or 9. If you want any of these versions, go to the Image SXM web page and follow the 'Installer archive' link.

The SXM routines were integrated into the Pascal source code of NIH Image v1.62 using the Metrowerks CodeWarrior 8 compiler and ResEdit. Image SXM was compiled on a G4 running Mac OS X 10.4.8 and has been tested on a Mac Ilfx, Quadra 800, G3, G4, G5 and various PowerBooks and MacBooks running versions of the Mac OS from OS 9.1 to OS X 10.4.9.

Information about the latest version of Image SXM can be found on the web: <http://www.ImageSXM.org.uk>

From 1993 to 2006, Image SXM was available as a download from the graphics directory of the Info-Mac archive. Sadly, the Info-Mac archive is no longer operating and so to check which is the latest version, and how to download a copy, see the Image SXM web page at <http://www.ImageSXM.org.uk>.

If you use Image SXM, then please fill in and return the 'User Feedback' form in the Help menu to feed back to me information about who you are, where you work, the SXM system that you use (if appropriate) and the Mac on which you run Image SXM (the Mac information will be inserted automatically). This feedback will help me in the development of future versions.

The SXM procedures and functions that have been added to NIH Image are outlined in the following pages (the routines that were part of the original NIH Image are covered in the 'NIH Image Manual' in the Documentation folder). More information can be found in the 'SXM History' and 'SXM PreHistory' files.

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File / Open or Open As Text...

loads and displays an image (TIFF, PICT, SXM, ...) or a text file (macro, convolution kernel) or other files such as look-up tables (LUTs) or preferences files. Press the option key to open the selected file(s) and displays the contents as text.

File / Browse...

displays reduced-size SXM images as a montage. If a file or folder has not been selected previously then a folder must be selected. When a browse window is full the user has the option of cancelling, continuing or printing the window. Double-clicking on an image will load that image into a separate window. When saving a browse window ('Browse in xxx'), an additional data file ('Data xxx') is saved which contains information such that, when the browse window is reloaded, double-clicking will still work. The two files must stay together, but need not be in the same folder as the images browsed. Option-clicking an image deselects it, indicated by the image being greyed-out. If the option key is pressed then 'Browse Selected Images...' will create a browse window with only the selected images displayed.

File / Import or Import Options... or Import ROI Stack

imports image data with user-specified image width, height, bit depth, etc. Press the option key to set the Import options. If a rectangular region of interest (ROI) is selected in a stack window then this menu item changes to 'Import ROI Stack' and a stack is created by importing the image data corresponding to the ROI.

File / Export or Export Options...

exports the current image (or selection) as raw pixel data or text. Measurements, plot profiles, I-V spectra, user data arrays, etc, can be exported to a text file. Press the option key to set various options for formatting the text file such as the addition of column headers, the inclusion of tabs and the precision of the output data.

Edit / Undo or Redo or Undo Options...

allows the user to access multiple levels of undo/redo. This menu item defaults to 'Undo'; press the shift key to change this to 'Redo'; press the option key to change the number of undos and the undo buffer size.

Edit / Undo History

lists the available undo/redo operations. Selecting the menu item indicated by the letter 'U' is equivalent to 'Undo'. Similarly, 'R' for 'Redo'. Selecting a menu item below 'U' or above 'R' will perform multiple undos or redos, respectively.

Edit / Invert Selection

changes the selection from all pixels inside the current region of interest (ROI) to all pixels outside.

Options / Color Tables / Digital Instr or Save Digital Instr

allows the user to select a colour table used by Digital Instruments software (18 of the 26 colour tables are defined initially). If the option key is pressed then the submenu changes to 'Save Digital Instr' and the current colour table can be assigned to the menu item selected (with a change of name if desired). It is not advisable to change the resource ID of the colour table unless you know what you are doing.

Options / Propagate / Region Of Interest

copies the current region of interest (ROI) selection to all open images. If an image is a different size to the one from which the ROI is copied, then the ROI is placed at the same position relative to the top left corner of the image window. Note that the ROI is copied, not the image contained within that ROI.

contd...

Options / Save ROI

saves the current region of interest (ROI) into one of the storage locations selected from the submenu. The submenu item will then change to show the type of ROI and the ROI width x height (rect), radius (circle) or length (line) in pixels. Note that the ROI is saved, not the image contained within that ROI.

Options / Restore ROI or Clear ROI

restores the saved region of interest (ROI) to the current image. Press the option key to change this menu item to 'Clear ROI', allowing individual locations to be cleared so that new ROIs can be saved.

Options / SXM Preferences...

presents a dialog box from which all the preferences can be set for 3d Plots, comments, batch file conversion, exporting, importing, look-up tables, measurements, particle analysis, printing, plotting profiles, handling SAM, SEM, SPM and SXM images and STS spectra. (shortcut: cmd-option-O)

Options / Session Log or Close Session Log

creates a text window that records image loading, processing, and saving operations and the corresponding window name. If the limit of 32K characters is reached then either (i) the text is saved and a new window created, or (ii) the first entries are deleted. The default action is the first, but can be changed by pressing the option key when 'Session Log...' is selected. If a Session Log window is open, then this menu item changes to 'Close Session Log'.

Process / FFT / Select Largest Square

selects the largest power-of-two-sized square that fits in the image. This ensures that the selection, or an image produced by duplicating the selection, can have its FFT calculated.

Process / FFT / Select Longest Line

selects the longest power-of-two-sized line that fits in the image. This ensures that a profile made using such a line can have its FFT calculated.

Process / FFT / Autocorrelation

displays the autocorrelation function of images and line profiles. For images, this is equivalent to the macro command of the same name supplied with NIH Image. If a line selection has been made on an image, or if the current window is a profile plot or an FFT of a profile, then the autocorrelation of the profile will be calculated and displayed.

An autocorrelation of a line profile can be treated in the same way as a profile plot or an FFT of a profile:

1. If the line selection is nudged using the cursor keys or moved using the mouse, then the autocorrelation window will update in real time.
2. Autocorrelation windows can be copied using 'Duplicate' and saved as PICT or TIFF images.
3. Autocorrelation data can be saved to a text file using 'Export...'

contd...

Process / FFT / Make LEED into FFT

converts a low-energy electron diffraction (LEED) image into an FFT, thus enabling the display of frequency and period values in the Info window (as for any 'normal' FFT). The LUT of the LEED image will be inverted if necessary. An inverse FFT is not applied to the resultant FFT.

Process / FFT / Inverse FFT of LEED

converts a low-energy electron diffraction (LEED) image into an FFT and then applies an inverse FFT operation. The LUT of the LEED image will be inverted if necessary.

Notes on Inverse FFTs of LEED patterns

1. For best results, the LEED pattern should be of high contrast and centred in a large image window.
2. If the LEED pattern is not positioned symmetrically, the IFFT will have bands across the image.
3. If the LEED spots are not sharp, the IFFT will have high contrast only in the central region.

Process / Differential

applies a convolution kernel which is equivalent to differentiating the image. The local gradient (top-left to bottom-right) is calculated for each pixel and scaled such that zero gradient is in the middle of the LUT. Press the option key to expand the scale by a factor of x3.

Process / Curvature

applies four convolution kernels in succession (equivalent to calculating the curvature in the horizontal, vertical, and two diagonal directions) and then adds the resulting images together. The curvature values are truncated above zero to enhance regions with high negative curvature (ie, it enhances 'mountains' and suppresses 'valleys'). This procedure is used by the 'DNA Strand Lengths...' analysis procedure.

Process / Unsharp Mask

applies a convolution filter which is equivalent to subtracting a smoothed copy of the image from the original image. The kernel used is 11x11 unless a modifier key is pressed: option = 7x7, shift = 15x15.

Process / Hough Transform...

calculates the Hough transform of the image for circles of a specified radius. Press the option key to bypass the dialog box.

Analyze / ShowResults or Analyze Results

displays the results of the 'Measure' or 'Analyze Particles' routines in the Results window. Press the option key to change the menu item to 'Analyze Results', which calculates (i) the nearest neighbour (nn) distances between the particles found using the 'Analyze Particles' routine, (ii) the standard deviation of the nn distance, (iii) the mean azimuthal direction of the nn (x axis = 0°, y axis = 90°), and (iv) the anisotropy of the particle distribution (random = 0, fully aligned = 1). These values are displayed in the Info window and in the Session Log. Also displays histograms of the particle size (diameter), area and height distributions.

Analyze / Show Histogram

transfers the histogram data to a plot window, in addition to displaying the histogram window, if the option key is pressed. The plot can be customised using the Profile Plot Options by double-clicking in the plot window.

Analyze / Preset Scale

sets the spatial calibration of an image to one of eight preset values listed in the submenu. Press the option key to save the current calibration as one of the preset values. Press the shift key to clear one of the preset values.

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Analyze / Gradient Values...

calculates the local gradient at each pixel of the image and creates a stack of two images, the first displaying the magnitude of the gradient (0°-90°) and the second the uphill direction (0°-360°) relative to a chosen cardinal point. Moving the cursor over the first image produces a display in the Info window of both the gradient and direction. The number of neighbouring pixels used to calculate the gradient can be set (from 1 up to half of the smallest dimension of the ROI). If a ROI is too close to the edge of the image to calculate a slope over the number of pixels specified, then the ROI will be reduced in size as necessary. Press the option key to bypass the dialog box.

Analyze / Gradient Histogram...

creates a 2d histogram of the x and y gradients of the pixels in a rectangular region of interest (ROI). The number of neighbouring pixels used to calculate the gradient can be set (from 1 up to half of the smallest dimension of the ROI). If a ROI is too close to the edge of the image to calculate a slope over the number of pixels specified, then the ROI will be reduced in size as necessary. Axes corresponding to zero gradient can be added to the histogram. Press the option key to bypass the dialog box.

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Analyze / Radial Distribution

creates a profile plot which is the average of 360 line profiles obtained from line selections arranged radially from the centre of the image. The number of data points in the plot is one less than half of the number of pixels in the image width or height, whichever is the smaller. Press the option key to click on a pixel to define the point about which the distribution is calculated. The number of data points in the plot will be reduced accordingly.

Analyze / Azimuthal Distribution

creates a profile plot in which each data point is the average of the data points for a line selection arranged radially from the centre of the image. The azimuthal angle is zero along the positive x axis, increasing towards the positive y axis. Press the option key to click on a pixel to define the point about which the distribution is calculated.

Analyze / Specialist Analysis / Image Correlation

creates a plot of the correlation between the intensities of pixels in the first image in a stack and those in the second. The value of a pixel in the correlation plot indicates the number of image pixels that have a given value in the first image (x-axis) and the second image (y-axis) at the same position in each image.

Analyze / Specialist Analysis / Size Distribution... or ReCalc Size Dist...

calculates using Hough transforms the numbers of circles in an image with radii in a specified range. The threshold value used when counting 'particles' in the Hough transform window can be set so as to include incomplete circles (low threshold) or discriminate against artefacts (high threshold). Press the option key to bypass the dialog box. If the current window displays a Hough transform then this menu item changes to 'ReCalc Size Dist...' which allows the distribution to be recalculated for a new threshold value, entered manually or taken from the current threshold setting.

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Analyze / Specialist Analysis / DNA Strand Lengths...

calculates the length of strands of DNA molecules in SFM images. This procedure uses the 'Analyze Particles' routine with thresholds calculated from the values entered in the dialog box. If appropriate, the image is first processed using the 'Curvature' procedure. The image is then thresholded at the 'background' level entered (usually less than 50%) as a compromise between suppressing background features and fragmenting strands. The image is then smoothed (with a 5x5 Gaussian kernel) and thresholded again at the 'analyse' level entered (usually less than 50%) to rejoin fragments of strands that were fragmented by the first thresholding. After the particle analysis has been carried out, the aspect ratio of each particle is calculated and particles with values below the minimum value entered are rejected. Press the option key to bypass the dialog box. The lengths of the strands (calculated from their perimeters and areas, corrected for end effects) are displayed under the heading 'StrL' in the Results window. The threshold values are displayed in the Session Log.

Analyze / Specialist Analysis / Quasicrystal Symmetry...

finds and displays sites of local 5-fold or 10-fold symmetry. The coordinates of these sites, the radii of the pentagonal/decagonal rings of atoms found, the positions of the atoms, and the contrast levels measured are stored and displayed in the Results window. A simulation of the quasicrystal tiling can be produced by displaying either circles of the same sizes as the pentagonal/decagonal rings of atoms or circles at the atom positions (or both). The intensities of the circles displayed are proportional to the contrast levels measured. Press the option key to bypass the dialog box.

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Analyze / Specialist Analysis / Straighten Curvilinear Object

displays the selected curvilinear object, such as a chromosome, as it would appear if it was straightened out. The object can be selected by clicking on the two ends (after the menu item is selected) or by using a straight, freehand or segmented line drawn along the object (before the menu item is selected). The Session Log displays two values for the length of the straightened object: (i) the distance between the points specified by the user mouse clicks (or the start and end points of the line), and (ii) the distance between the points at which the intensity of the object has fallen to 1/e of the values at the points specified in (i). Thus, if the user selects an object by clicking on points slightly inside the ends of the object, then length (i) will be slightly less than length (ii).

Analyze / Specialist Analysis / Display Karyotype...

displays the karyotype of the chromosomes in the image. Options include straightening the chromosomes (see above), ordering the chromosomes by length, and pairing homologous chromosomes. Press the option key to bypass the dialog box.

Analyze / Specialist Analysis / Nanotube Non-Linearity

calculates a coefficient that quantifies the non-linearity, or entanglement, of features such as carbon nanotubes. Zero corresponds to a randomly entangled network; unity corresponds to a linear array of features. The coefficient and a standard deviation (error) are displayed in the Session Log.

Analyze / Specialist Analysis / Mineral Phase Analysis and Particulate Matter Analysis

calculates the relative areas of two phases (with different grey values) in SEM images of mineral grains and the area of grey particulate matter in cells imaged with a light microscope. Effective use of these routines requires some background information. Email S.D.Barrett@liv.ac.uk for details.

If a frame grabber card is detected when Image SXM launches then the **Special** menu will allow video to be captured from an analogue video source (see NIH Image manual for details). If a digital video source, such as a firewire connection to a video camera, is detected then the **Video** menu replaces the Special menu.

Video / Preview Window

opens a window showing a live preview of the video feed. The frame rate will be as fast as the Mac's cpu or bus will allow.

Video / Capture Control

opens a dialog for user control/timing of video capture.

Video / Video Settings...

allows the user to select the video standard (NTSC/PAL/SECAM) and frame rate. A live histogram and graphic indicating the extent of colour space used by the video signal are also available in this OS dialog.

Video / Capture Options...

allows the user to select:

- frame size (full/half/quarter) for capture;
- capture timing limits (between mouse clicks or for a specified time interval);
- default filenames;
- default location for saved files;
- various other default settings for capturing video.

Stacks / Windows to Stack or Windows to This Stack

creates a stack comprising all windows of the same size as the front window (all windows of different sizes are left untouched). Windows are stacked in the order in which they were created. Press the option key to change the menu item to 'Windows to This Stack', which creates a stack with the front window as the first image in the stack.

Stacks / Stack to Windows or Stack to SubStack

converts each slice in the current stack to a separate image. Press the option key to change the menu item to 'Stack to SubStack', which extracts a subset of contiguous slices from the current stack to make a new stack. The xy and z calibration of each slice is preserved. Selecting the first and last slices (the default values) makes a duplicate of the entire stack. If a rectangular region of interest (ROI) is selected then the substack is cropped to this selection.

Stacks / Average or Average Within Limits...

creates an image that is the average of all the slices of a stack. Press the option key to set (i) the range of slices over which the average is calculated, and (ii) the limits of the pixel values between which the average is calculated – pixel values outside these limits will not contribute to the average.

Stacks / RGB to 8-bit Color or RGB to 24-bit Color or RGB to 8/24-bit Color...

converts an RGB stack (comprising 3 colour slices) into an 8-bit or 24-bit colour image. Note that 24-bit images are for display only - analysis and processing operations cannot be applied to them. Press the option key to choose the default bit depth for the conversion. If this is set to 'Do Not Create', then conversion of RGB stacks to colour images will not be carried out automatically when an RGB stack is opened.

contd...

Stacks / Register... or Register XY Only

brings all the slices of a stack into registry with the current slice. If the option key is not pressed, then this is the unmodified 'Register' procedure of NIH Image. If the option key is pressed, then only xy translation, and not rotation, is carried out. Thus, only one mouse click per slice is required to identify a reference point that is common to all slices. This menu item is dimmed if the current image is not a stack.

Stacks / Auto Register

brings all the slices of a stack into registry with the current slice. This is done using cross-correlation of the slices: (i) the largest-possible FFT is taken of the current (reference) slice, (ii) for each of the other slices the FFT is taken and multiplied by the FFT of the reference slice, (iii) an inverse FFT of this product is the cross-correlation of the images, the maximum intensity of which gives the relative shift between the two images, (iv) this shift is applied to the slice to bring it into registry with the reference slice. If a power-of-two-sized square region of interest (ROI) is selected before calling this procedure, then this will be used rather than the largest possible square ROI. The shift applied to each slice is displayed in the Session Log. This menu item is dimmed if the current image is not a stack.

contd...

Stacks / Depth Of Focus

creates an image which is a composite of the slices in a stack, calculated pixel-by-pixel according to how well each part of the image is focused. Thus, the composite image will compensate for the limited depth of focus of slices. A dialog box (suppressed if the option key is pressed) allows the user to optimise the calculation by setting the distances over which the calculation of the degree of focus is carried out. The 'near' distance should be set to the size of the smallest detail visible in a well-focussed slice. If the images contain features of a characteristic size, the 'far' distance should be set to about half of that size, otherwise it should be set equal to the 'near' distance. To work properly, the slices in the stack have to be in registry with each other (see above), as any relative translation or rotation will produced ghosting (if a weighted average is chosen) or abrupt changes in intensity (if not). Press the option key to bypass the dialog box. This menu item is dimmed if the current image is not a stack.

Stacks / Make Mosaic

makes a mosaic from the images in a stack. The overlap between adjacent images is determined by calculating the cross-correlation of one or more square sample regions. Where two, three or four images overlap, the pixel values of the mosaic are calculated to give no visible seams. If the images are rotated or distorted, then making a seamless mosaic will be impossible. There are options to set the mosaic orientation, the approximate extent of the image overlap and the number of samples to take for each overlap region. If the extent of the overlap is not known, then this can be calculated at the expense of execution speed. Increasing the number of samples for each overlap should improve the reliability of the overlap determination at the expense of execution speed. This menu item is dimmed if the current image is not a stack.

Browse Images... or Browse Selected Images...

displays reduced-size SXM images as a montage. If a file or folder has not been selected previously then a folder must be selected – this folder becomes the default folder for subsequent operations. The file name is displayed in the corner of each image. When a browse window is full the user has the option of cancelling, continuing or printing the window. Double-clicking on an image will load that image into a separate window. When saving a browse window ('Browse in xxx'), an additional data file ('Data xxx') is saved which contains information such that, when the browse window is reloaded, double-clicking will still work. The two files must stay together, but need not be in the same folder as the images browsed. Option-clicking an image deselects it, indicated by the image being greyed-out. If the option key is pressed then 'Browse Selected Images...' will create a browse window with only the selected images displayed. In addition to SXM images, this command can be used to browse PICT and TIFF images.

Display Calib Bar...

gives a dialog box with options for the style and positioning of a calibration bar. The size of the bar to be displayed is determined by the SEM magnification read from the parameter file and the selection of one of the three options in the dialog box. The colour of the bar is determined by the average shade of grey of the image area under the bar so that maximum contrast is obtained. If you want the opposite colour, just display the bar again. The font, size and style used for the bar label are set in the Options menu. In addition, the user has the option of selecting the optimum label size (a fixed proportion of the image size) in the dialog box. Press the option key to bypass the dialog box. Changes made to the image contrast and brightness settings will not affect the calibration bar. Note: If you want to do any image processing, such as executing the Smooth or Sharpen commands (in the Process menu), do so before displaying the calibration bar. This menu item is dimmed if the front window is not an SXM image window.

contd...

Enter Comments...

allows the user to enter comments which will appear above any measurements displayed in the Results window or printed out. The comments default to the front window title and the corresponding comment read from the SEM parameter file.

Phase %

is used when density slicing to calculate the percentage area of the image that has a grey level lying within the selected limits (i.e., the area % of the image that is red). The calculated value is displayed in the Info and Results windows. The Info window also displays the area % lying below and above the limits.

B&W %

is used when thresholding to calculate the percentage area of the image that is black and white. The calculated values are displayed in the Info and Results windows.

SAM Options...

allows the user to select:

- whether SAM images are loaded individually or as a set;
- auto contrast enhancement;
- auto custom LUT selection;
- auto stack of multiple images.

SEM Options...

allows the user to select:

- PAL or NTSC video standard according to the specification of their JEOL SEM;
- auto size reduction (to 20%, 25%, 33% or 50%) on loading SEM images.

3d Plot...

creates a 3d plot of the surface, allowing the user to specify the direction from which the surface is viewed. The colours used for each pixel in the 3d plot can be taken from (i) the original image LUT; (ii) a calculation of the illumination of the surface from a light source in a specified direction; or (iii) a mixture of the previous two options. Press the option key to bypass the dialog box.

The view, light and z scale parameters can be changed using the cursor keys and the option, control and shift keys, respectively. The view and light angles can also be changed by dragging the small circles of the geometry icon (in the top right of the plot window). Clicking in the square resets all the view, light and z scale parameters to their initial values. Option-clicking in the square resets the parameters to their default values. The view angle of a 3d plot can also be changed by holding down the space bar and dragging the mouse around in the plot window.

The 'High Quality/Slow Speed' option enlarges the image, makes a 3d plot, smooths the plot and then reduces the size of the plot window slightly. The result is a higher quality 3d plot, but it takes about 4 times longer to draw and requires more free memory. Unlike for the 'Low/Fast' option, the geometry of 3d plots created using the 'High/Slow' option cannot be altered using the cursor keys. I would suggest that the 'High/Slow' option is used only when you are sure of the view/light/z scale settings.

The 2d plot option, producing a conventional flat image, may be useful for mixing the image colours with shadows to obtain a better impression of the surface topography. The 4d plot option creates a 3d plot of an image with the colours of each pixel in the image tinted according to whether or not the corresponding pixel of a second image (which is assumed to have been density sliced previously) lies between the slice limits set.

contd...

Files / Change File Names...

changes Omicron STM file names by replacing the specified file identifier labels (the Omicron defaults are 'ta', 'tb', 'tp' and 'ts') with alternative strings of characters. These strings can be made the new default identifiers. This menu item is dimmed if 'Omicron' is not selected in the 'SPM Options' dialog box.

Files / Change File Types...

changes the file type ('BINA' or 'TEXT' to 'iSXM') and creator ('unix' or 'mdos' to 'Imag') of the selected files. These files can now be loaded from the Finder simply by double-clicking on either the image, parameter or spectra file. This menu item is redundant if either PC Exchange/File Exchange or Fetch are configured for SXM images (see pages 44 and 45). Changing file types of files in the System Folder or Applications folder is not permitted.

Files / Browse Images... or Browse Selected Images...

displays reduced-size SXM images as a montage. If a file or folder has not been selected previously then a folder must be selected – this folder becomes the default folder for subsequent operations. The file name is displayed in the corner of each image. When a browse window is full the user has the option of cancelling, continuing or printing the window. Double-clicking on an image will load that image into a separate window. When saving a browse window ('Browse in xxx'), an additional data file ('Data xxx') is saved which contains information such that, when the browse window is reloaded, double-clicking will still work. The two files must stay together, but need not be in the same folder as the images browsed. Option-clicking an image deselects it, indicated by the image being greyed-out. If the option key is pressed then 'Browse Selected Images...' will create a browse window with only the selected images displayed. In addition to SXM images, this command can be used to browse PICT and TIFF images.

contd...

Files / Browse Omicron...

displays a sequence of Omicron STM images as a montage. This command is for use with old-format Omicron images – use 'Browse Images...' for other SXM images. The range of file numbers and the size of the display window are selected in a dialog box. If a file or folder has not been selected previously then a folder must be selected from a second dialog box – this folder becomes the default folder for subsequent operations. The file number, image size, sample voltage and tunnelling current are displayed in the corners of each image. When a browse window is full the user has the option of cancelling, continuing (using the same window to browse more images), or printing the window. Browsing can be aborted when an image is being displayed (with cmd-period). Double-clicking on an image will load that image into a separate window. When saving a browse window ('Browse in xxx'), an additional data file ('Data xxx') is saved which contains information such that, when the browse window is reloaded, double-clicking will still work. The two files must stay together, but need not be in the same folder as the images browsed. This menu item is dimmed if 'Omicron' is not selected in the 'SPM Options' dialog box.

Files / Batch Conversion...

loads all the SXM images in a selected folder and saves them in PICT or TIFF format in either the same folder (with the file type appended to their filenames) or in a new folder.

contd...

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[next page >](#)**Files / Get Finder Comment**

gets the Finder comment of the image file (see note 1 below) and then sets the image comment equal to it. If no Finder comment exists, then the image comment is left unchanged.

Files / Set Finder Comment...

sets the Finder comment of the image file (see note 1 below) or all files in the same folder as the image file. A dialog box allows the user to select image parameters that can be concatenated with the image comment to form the Finder comment. If the option key is pressed or if the command is called from a macro then the dialog box is suppressed. The dialog box can also be accessed from the 'Comment' button in the 'SXM Preferences' dialog box.

Notes on Finder comments

1. The 'image file' referred to above is taken to be either (i) the file to which the image was saved or, if the image has not yet been saved, (ii) the file from which the image was loaded.
2. The Finder comments can be viewed by selecting 'View/as List' and selecting 'Comments' from the 'Show Columns' list in the 'View Options' dialog box.
3. In the Finder, the list of files can be sorted alphanumerically by the comments, and so consideration should be given to the order in which image parameters are concatenated to construct the comment.

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Compensation / XY Tilt Compensation

compensates for tilt of the image calculated either over the entire image (except the edges) or a selected rectangle. This menu item is dimmed if a non-rectangular region of interest has been drawn in an SPM image window.

Compensation / Quadratic Subtraction

compensates for curvature of the image using a quadratic background subtraction calculated for the entire image (except the edges). This menu item is dimmed if a region of interest has been drawn in an image window.

Compensation / 3 Point Compensation

compensates for tilt of the image using three points selected by the user. The image will be tilted such that the three points selected have the same apparent height.

Compensation / Line-By-Line Constant

compensates for irregular topography of the image using a line-by-line subtraction of a constant least-squares fit. This can also compensate for some artefacts produced by tip changes. The fit can be limited to a selected region of arbitrary shape.

Compensation / Line-By-Line Linear

compensates for tilt of the image using a line-by-line subtraction of a linear least-squares fit. This can also compensate for some artefacts produced by tip changes. The fit can be limited to a selected region of arbitrary shape.

contd...

Compensation / Line-By-Line Quadratic

compensates for tilt or curvature of the image using a line-by-line subtraction of a quadratic least-squares fit. This can also compensate for some artefacts produced by tip changes. The fit can be limited to a selected region of arbitrary shape.

Compensation / None

reopens an image with no compensation for tilt or curvature of the image.

Notes on compensation

1. The tick in the SPM/Compensation submenu indicates which mode of compensation was applied most recently to the current image. It does not necessarily indicate the compensation that will be applied when the next image is loaded (see 'SPM Options' on page 39).
2. Selective image compensation and recompensation operations can be modified using:
Option: Enhances the contrast so that the image in the region of interest uses all the greys in the LUT;
Shift: Reduces the contrast so that the entire image lies within the range of the LUT.

Dimensions / pm / Å / nm / µm

changes the display of the spatial scale to the selected units. The units for the xy scale and the z scale can be specified independently. Press the option key to affect all open images rather than just the current image. (See 'SPM Options' on page 39 to set default display units.)

Images / ReCompensate

reopens an image with the tilt compensation calculated over the selected rectangle. This menu item is dimmed if a rectangle has not been drawn in an SPM image window. Note that the option and shift keys effect recompensation (see under SPM/Compensation/None above). This menu item is now redundant due to changes made to the compensation operations, but has been left for compatibility with older versions of Image SXM.

Images / Rotate to Horizontal

rotates the image such that the line drawn becomes horizontal. This menu item is dimmed if no line is selected.

Images / Match LUTs or Change LUTs...

changes the look-up tables (LUTs) of the open image windows such that they all have the same z scale calibration (nm per grey level). This menu item is dimmed if less than two image windows are open. Press the option key to change this menu item to 'Change LUTs...' which allows the z values of the LUT limits (black and white) of all open images to be set manually. Note that changing the LUTs does not change the z values of features in the images (cf 'Set Z Scale...' on page 33).

Images / Tip Locus Effect...

compensates for the tip locus effect of a finite-radius SPM tip imaging a surface. The radius of the parabolic tip should be set to a value comparable to the apparent resolution of the image. Press the option key to suppress the dialog box allowing the tip radius to be specified. This menu item is dimmed if the current window does not contain an image that is spatially calibrated.

contd...

Images / Overlay Grid

draws a grid of parallel lines on the current image. If a rectangle or polygon region of interest (ROI) exists when this item is selected then that ROI will be used for the grid outline. The number of cells along each axis can be changed by pressing a numeric key when the cursor is placed over the top left or bottom right corners of the grid. The grid shape and size can be modified by dragging the corners of the grid. Grids can be saved, restored and propagated from one image to another in the same way as for any other ROIs. This menu item is dimmed if a ROI other than a rectangle or polygon is selected.

Images / Display Unit Cell

displays the contents of the unit cell, defined by the grid overlay (see above), by interpolating the pixel values within each unit cell and averaging them. Press the option key to bypass the dialog box. The parallelogram defining the unit cell can be restored to the Unit Cell window (and the grid overlay to the original image window) using the 'Restore ROI' submenu. To obtain the registry of an adsorbate relative to a substrate lattice displayed in a separate image, the grid can be created and edited on the substrate image and then copied to the adsorbate image using 'Propagate/ROI' or the 'Save ROI' and 'Restore ROI' submenus. This menu item is dimmed if a grid has not been selected.

contd...

Images / Trim Image

reduces the size of an image window, trimming excess blank space surrounding an image. Press the option key to eliminate then the blank space around the image, otherwise it will be trimmed down to a 10-pixel border.

Images / Add Border...

enlarges the image window, leaving the image itself unchanged in the centre of the window. The width of the border is set in a dialog box, which can be bypassed by pressing the option key.

Images / Display Axes or Display Axes and LUT

adds a border to the image window and displays x and y axes. Press the option key to also display the look-up table (LUT) of the image. This menu item is dimmed if the current window does not contain an image that is spatially calibrated.

Calculation / Step Height

displays a plot profile, calculates the height of a step edge (together with an estimate of the error in the height) and displays the results in the Info and Results windows. If the terraces are tilted or highly corrugated on either side of the step then the step height calculated may be meaningless. If this happens then a warning is displayed in the Info window. This menu item is dimmed if no line is selected.

Calculation / Surface Area

calculates the surface area of a selected region of arbitrary shape and displays the value in the Info window, together with the selected area (xy projection) for comparison. The value of the surface area is also displayed in the Session Log. This menu item is dimmed if the current window does not contain an image that is spatially calibrated, or the selection is invalid.

Calculation / Surface Roughness

calculates the rms deviation from the mean (rms) and absolute deviation from the mean (Ra) for z values within a selected region (or the entire image if no ROI is selected). The values are displayed in the Info window (together with the max-min z values) and are also displayed in the Session Log.

Calculation / Facet Calculator

calculates the facets that form vicinal surfaces given the Miller indices of the surface, or the miscut angle and azimuth, or vice versa.

Calibration / ReCalibrate XY...

calculates and applies the rotation, magnification and skew transformations required to make the vectors drawn on the image equal to the known lattice vectors (the angle tool is used to draw the lattice vectors). The parameters may be saved for use on subsequent images. This menu item is dimmed if no angle is selected.

Calibration / Apply XY Calibration

applies the rotation, magnification and skew transformations required to correct for miscalibration of the xy axes. The parameters used are determined from a previous recalibration of an image of a known structure (see above). This menu item is dimmed if no xy recalibration has yet been carried out and no calibration file exists in the Preferences folder.

Calibration / ReCalibrate Z...

calculates the mean value of up to ten of the most recent step height measurements. The user types in the corresponding known value and the ratio of these two values is calculated and the z scale of the image rescaled accordingly.

Calibration / Apply Z Calibration

recalibrates the z scale of images using the ratio calculated by 'ReCalibrate Z' (see above). This menu item is dimmed if no z recalibration has yet been carried out.

Calibration / Set Z Scale...

sets the z scale of images by specifying the z values of the black and white pixels. Note that changing the z values of an image does not change its LUT (cf 'Match LUTs' and 'Change LUTs...' on page 29). Press the option key to bypass the dialog box.

contd...

Calibration / Calibrate Distortion or Calib Distortion (Keep Aspect)

calibrates the geometric distortion caused by viewing a surface at an angle to the normal. Examples of such distortion include low-magnification SEM images of tilted surfaces or images of a viewing screen of a TEM. The image should contain a feature known to be rectangular when viewed from the normal. The user clicks on the four corners of this feature, and from these coordinates the required correction is calculated and applied to the image. Press the option key to preserve the aspect ratio of the feature, otherwise the aspect ratio specified (see below) is used. This correction can be applied subsequently to other images (see below). This menu item is dimmed if the current window is not an image window.

Calibration / Apply Correction

applies the mapping required to correct for the geometric distortion calibrated previously (see above). This menu item is dimmed if the current window is not an image window or no calibration data exists.

Calibration / Change Aspect Ratio

allows the aspect ratio (width/height) of the rectangular feature used in geometric distortion calibration to be specified. The default value is 1.00 for square features.

Calibration / Load Calibration File... or Load Calib From Window

loads in geometric distortion calibration data saved after a previous calibration. If the current window is a text window then this menu item changes to 'Load Calib From Window'.

Calibration / Save Calibration File... or Save Calibration To Prefs

saves geometric distortion calibration data to a specified file or, if the option key is pressed, the default file 'Image SXM Geom Dist Calib' in the Preferences folder. The data from the latter file will be read automatically when Image SXM initialises. This menu item is dimmed if no calibration data exists.

Spectroscopy / Show/Hide STS Plot

displays the current STS spectrum. This is not necessary if the 'Auto Open STS Window' option is selected (see 'STS Options'). This menu item is dimmed if no STS data have been loaded.

Spectroscopy / I/V → dI/dV

toggles between the two modes of display of STS spectra. This menu item is dimmed if no STS data have been loaded.

Spectroscopy / Save As Reference

saves the current STS spectrum to act as a reference for future STS plots. This menu item is dimmed if no STS spectrum is displayed.

Spectroscopy / Subtract Reference

displays the difference between the current spectrum and the reference spectrum. This option remains on (with the menu item checked) until the menu item is selected again. This menu item is dimmed if no reference spectrum has been saved.

Notes on spectroscopy

1. Opening a file of STS data will also open the associated topographic SPM image. Opening an SPM image that has associated STS data will load and display that data (see 'STS Options').
2. STS spectra can be displayed individually by clicking on a specific pixel (using the selection tool), or displayed continuously as the cursor is moved over the image (using the crosshair tool). They can also be averaged by pressing the option key or by measuring over a region of interest.
3. If the caps lock key is down then the display of the current STS spectrum is frozen.

contd...

Spectroscopy / Make STS Map...

makes an image in which the pixel values are the STS currents at a user-specified voltage. The z scale of the images is determined by the min and max scale values set in 'STS Options' (see below). Press the option key to bypass the dialog box. When the current image is an STS map, the keyboard shortcut cmd-cursor arrow will create an STS map corresponding to the next highest or lowest voltage value. Note that this menu item is active only if the current window is an STM image with associated STS data, and is thus dimmed if the current window is an STS map.

Spectroscopy / Make STS Stack

makes a stack of images in which each slice is an STS voltage and the pixel values are the STS currents. The z scales of each slice in the stack are set such that the min and max tunnelling current limits specified in 'STS Options' (see below) correspond to black and white, respectively. This menu item is dimmed if no STS data have been loaded or there is not enough free memory.

Spectroscopy / STS Options

allows the user to select:

- automatic load/display/rescale of STS spectra;
- min and max tunnelling current limits in STS plots;
- I/V or dI/dV mode of STS plots;
- smoothing of STS spectra;
- shifting STS spectra such that $I=0$ at $V=0$.

Parameters / Display Parameters

displays the principal parameters relating to the SPM image in the front window. This menu item is dimmed if the front window is not an SPM image window. (shortcut: cmd-option-D)

Parameters / Print Parameters or Dump All Parameters

prints out the principal parameters relating to the SPM image in the front window. If the current window displays an image from a file containing a text list of parameters then this menu item changes to 'Dump All Parameters'. The parameters are read from the corresponding file and displayed in a text window, which can then be printed if desired. This menu item is dimmed if the front window is not an SPM image window.

Parameters / List Params for File(s)...

lists the principal parameters for SPM images in a single file or for all the files in a selected folder. The list is generated in a text window, which can then be printed if desired (in landscape orientation).

Parameters / Create Image Caption

creates a text window containing a caption that can be edited. If the caption is not added to the image using 'Add Caption To Image', then it will appear below the image when it is printed. The caption can be updated automatically using the 'Auto Update Image Caption' checkbox in the 'SXM Options' dialog box. This menu item is dimmed if the front window is not an SXM image window.

Parameters / Add Caption To Image

adds a caption to the bottom of the image. If a caption has not been created using 'Create Image Caption' then the Finder comment is used as the default caption. If an image has had a caption added to it, then the caption will not appear below the image when it is printed. This menu item is dimmed if the front window is not an SXM image window. contd...

Parameters / Comments For Results...

allows the user to enter comments which will appear above any measurements displayed in the Results window or printed out. The comments default to the front window title and the comment read from the SPM file (or the SPM filename, if no such comment exists).

Parameters / Unix -> Mac

translates text from Unix format to Mac format by changing linefeed (LF) characters into carriage return (CR) characters.

Parameters / Mac -> Unix

translates text from Mac format to Unix format by changing carriage return (CR) characters into linefeed (LF) characters.

Parameters / PC -> Mac

translates text from PC format to Mac format by stripping linefeed (LF) characters from the end of each line of text.

Parameters / Mac -> PC

translates text from Mac format to PC format by inserting linefeed (LF) characters at the end of each line of text.

SPM Options...

allows the user to:

- set default xy tilt or line-by-line compensation when mapping 16-bit images to an 8-bit z scale;
- display compensation mode in window titles;
- auto stack multiple images;
- set default units used to display image dimensions (pm, Å, nm, µm);
- control loading of images from multi-image files;
- set other options relevant to specific SPM manufacturers.

SXM Options...

allows the user to:

- mute sound when splash box displayed;
- open 'Session Log' window when Image SXM launches;
- display and update 'Get Info' window when an SXM image is opened or selected;
- update image captions when an SXM image is opened or selected;
- set Finder comment when an image is saved;
- set image resolution when an image is saved as a TIFF file;
- set foreground (pen/paintbrush) and background (eraser) colours when an image is loaded;
- get Finder comment when an image is loaded;
- assign F1 to F4 function keys to macros;
- suppress warning dialogs when running macros.

Window Options...

- reduce/enlarge images larger/smaller than specified sizes when images are loaded;
- set size of borders to keep clear at edge of screen to avoid dock being covered by windows.

Resize Window

reduces or enlarges the image window size to preset values of 20%, 25%, 33%, 50%, 100%, 200% or 400%. Selection from this menu does not affect the option of auto size reduction on loading (see 'Window Options' above).

Keyboard shortcuts for menu items

cmd-option-D	= SPM / Parameters / Display Parameters
cmd-option-O	= Options / SXM Preferences...
cmd-shift-P	= File / Page Setup...

Commands for stacks

cmd-click	Selects slice dependent on position of mouse click (click-drag to animate stack)
-----------	--

Commands for FFT windows

F	Constrain the rectangle selection to be a square of size equal to an integer power of two or the line selection to be of length equal to an integer power of two
---	--

cmd-option-L	Apply low-pass filter and perform inverse FFT
--------------	---

cmd-option-H	Apply high-pass filter and perform inverse FFT
--------------	--

cmd-option-B	Apply band-pass filter and perform inverse FFT
--------------	--

[contd...](#)

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[next page >](#)**Commands for Profile Plots**

S 'Store'	Store the current profile. The number of profiles stored is shown in the Info window. There is no limit to the number of profiles that can be stored.
-----------	---

D 'Display'	Display the average of the profiles stored. The average will not be meaningful unless all of the stored profiles are from line selections of the same length.
-------------	---

H 'Step Height'	Calculate step height of average profile displayed.
-----------------	---

G 'Grid lines'	Add or remove the grid lines from the plot display.
----------------	---

option	Display profile without erasing previous profile
--------	--

Caps Lock	Set the zero of the (X,Z) values displayed in the Info window to the current values. The display changes to (dX,dY) until the Caps Lock key is released.
-----------	--

Commands for STS Plots

option	Display the running average of STS spectra
--------	--

[contd...](#)

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Miscellaneous keyboard shortcuts

cmd-option-A	Add or remove axes from a 3d Plot
cmd-option-I	Invert and apply LUT to the current image
cmd-cursor arrows	Load next or previous file in alphanumerical sequence from the same folder as the current file (numbers embedded in filenames are handled numerically rather than alphabetically). If the current window is a Browse window, then these keys will allow browsing to continue in the next or previous folder. If the current window displays an STS map, then these keys will create an STS map corresponding to the next highest or lowest voltage value.
z-click	Create a small zoom window displaying a x2 magnified region of the image centred on the cursor position
z-shift-click	Increase the zoom magnification from x2 to x4
ctrl-click	The gamma of the LUT can be set interactively by clicking and dragging in the Map window with the control key pressed. The x position of the cursor determines the gamma value (from 0.4 to 2.5, or 0.05 to 20 with the shift key pressed) which is displayed in the Info window and in the Session Log.

Using File Exchange

This version of Image SXM will load SXM images directly from PC disks providing that 'PC Exchange' (System 7) or 'File Exchange' (Mac OS 8 and 9) is in the Control Panels folder in the System Folder and has been configured for SXM files. To do this for JEOL SEM images:

- 1 Install Image SXM onto your hard disk
- 2 Open the 'File Exchange' control panel
- 3 Click on Add...
- 4 Type '.IMG' in the first box
- 5 Find Image SXM on your hard disk
- 6 From the file type pop-up menu, select the 'iSXM' file type
- 7 Close the 'File Exchange' window

Now any PC file that ends in '.IMG' will be treated as a file that Image SXM will recognise. If you insert a PC disk, the '.IMG' files should appear in the Finder with Image SXM icons and can be double-clicked to open in Image SXM.

Steps 3-6 can be repeated for SXM images from various manufacturers, such as:

DME Rastroscope	.IMG	LEO SEM	.TIF	Quesant Instruments	.AFM
DME Surface Data File	.SDF	Molecular Imaging	.STP	RHK Technology	.SM2
JEOL WinSPM	.TIF	NT-MDT	.MDT	TopoMetrix	.TFR
JPK Instruments	.JPK	Oxford Instruments	.TOP	Vacuum Generators	.DTI
Klocke Atomikro	.STM	Park Scientific	.HDF	WA Technology	.WAT
Leica TCS	.TIF	Philips	.IMG	Zeiss LSM	.LSM

Using Fetch

Fetch is a public domain Mac application which makes moving files from other types of computer (PCs or Unix workstations) fairly user friendly. If you use Fetch to download SXM images onto your Mac rather than using SneakerNet (floppy, Zip, USB drive, CD or DVD disk transfer) then set the Fetch preferences to save binary files with type 'iSXM' and creator 'Imag'. Once this is done, all images downloaded onto your Mac will appear automatically with Image SXM icons and can be double-clicked to open in Image SXM.

If you find that your images are downloading as text files rather than binary, then click on the 'Binary' radio button in the main window of Fetch (it is usually set to 'Automatic'). This will force Fetch to download the files as Image SXM files.

The same principles apply to other FTP applications such as Transmit.

Manufacturers A–N

Manufacturer	System	Parameters				Image Data Format					
		Text	Bin	Head	Foot	Int	Real	8	16	32	+ + / -
Burleigh	ISTM		•	•	•	•			•		•
Digital Instruments	NanoScope II-IV	•		•		•			•		•
DME	Rasterscope		•	•		•			•		•
DME	Surface Data File	•		•	•	•				•	•
Gatan	DigitalMicrograph	•			•	•			•		
JEOL	WinSem		•			•		•			•
JEOL	WinSPM		•	•		•			•		•
JEOL	JSM	•		•		•		•			•
JPK Instruments	SPM		•	•		•			•		•
Klocke	Atomikro		•	•		•		•	•		•
Leica	TCS	•			•	•		•			•
LEO	SEM		•	•		•		•			•
Molecular Imaging	PicoScan	•		•		•			•		•
NanoMagnetics	SPMSIF		•	•	•	•			•		•
Nanonics Imaging	Quartz		•	•		•			•		•
Nanotec Electronica	WSxM	•		•		•			•		•
Noran	Vantage	•	•	•		•		•			•
NT-MDT	SPM		•	•		•			•		•

Manufacturers O–Z

Manufacturer	System	Parameters				Image Data Format						
		Text	Bin	Head	Foot	Int	Real	8	16	32	+	+ / -
Omicron	Pre-SCALA		•			•			•		•	
Omicron	SCALA	•				•			•			•
Oxford Instruments	TOPSystem 3		•	•		•			•			•
Park Scientific Instr	HFS-LIF	•	•	•		•			•			•
Park Scientific Instr	HDF		•	•		•			•			•
Philips	SEM		•	•		•		•			•	
Quesant Instruments	SPM		•	•	•	•			•		•	
RHK Technology	SPM-32	•		•		•	•	•	•	•	•	•
RHK Technology	XPM Pro		•	•		•				•		•
Seiko Instruments	SPI		•	•		•			•		•	
SPECS	STM 150 Aarhus		•	•		•			•			•
TopoMetrix	SPMLab		•	•		•			•		•	
Unisoku	SPM	•				•			•		•	
Vacuum Generators	SAM		•	•		•				•		•
WA Technology	Pre-TOPSystem		•	•		•		•			•	
Zeiss	LSM		•	•		•		•			•	

Listed below are the latest versions of manufacturers' file formats that have been tested with Image SXM. If you are using a more recent version, please get in touch so that I can update this page and, if necessary, extend the code to support any changes in file format.

Burleigh Instruments	3.10	NT-MDT	.
Digital Instruments NanoScope II	.	Omicron	.
Digital Instruments NanoScope IV	5.12	Omicron SCALA	5.1
DME Rasterscope	4.10	Oxford Instruments TOPSystem	3.0
DME Surface Data File	1.0	Park Scientific HFS-LIF	.
Gatan DigitalMicrograph	3.4	Park Scientific HDF	3.2
JEOL JSM	.	Philips	.
JEOL WinSem	.	Quesant Instruments	2.0
JEOL WinSPM	4.07	RHK Technology SPM-32	3.1
JKP Instruments	1.00	RHK Technology XPM Pro	4.00
Klocke Atomikro	.	Seiko Instruments SPI	.
Leica TCS	1.00	SPECS STM150 Aarhus	2.0
LEO	.	TopoMetrix SPMLab	5.01
Molecular Imaging PicoScan	5.2	Unisoku	1.00
NanoMagnetics Instruments SIF	1.15	Vacuum Generators SAM	.
Nanonics Imaging	.	WA Technology	4.04
Nanotec Electronica WSxM	3.0	WA Technology TOPSystem	2.0
Noran Instruments Vantage	.	Zeiss LSM	1.81

Image SXM computational performance comparison

Tabulated below are the times taken to execute two typical types of image processing operation:

Mac model	FFT	Smooth	Speed
Mac Ilx	850	250	0.02
Mac Ilfx	330	95	0.06
Quadra 800	120	50	0.14
PowerMac 8100/100	17	6.4	1.0
PowerBook 1400/166	9.2	4.8	1.6
PowerMac G3/300	2.9	1.6	5.0
PowerMac G4/400	2.1	1.0	7.3
PowerMac G4/1.25 GHz	0.8	0.4	20
MacBook 2Duo/2 GHz	0.9	0.5	16

The image size is 1024 x 1024 pixels of uniform grey level. The Smooth operation is executed 10 times.

The 'Speed' column gives the speed relative to a PowerMac 8100/100, taking an average of the floating point (FFT) and integer (Smooth) performance.

The macro 'SXM Benchmark Macro' can be used to check your Mac against these benchmarks.