SEM Image Preferences

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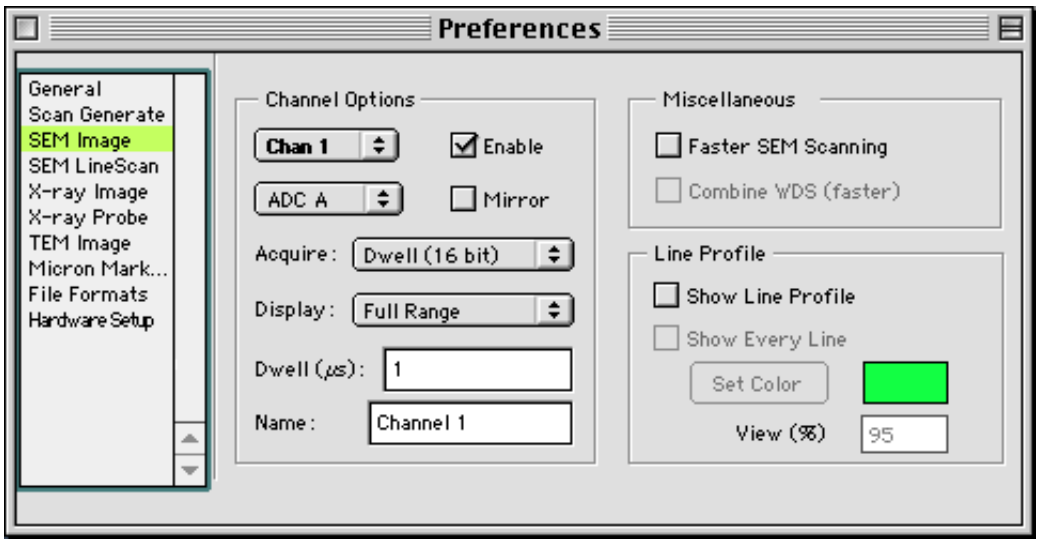
current for: v1.5.6

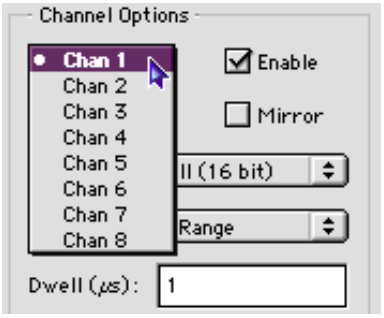
The SEM Image Preferences panel is shown below:



Other Preferences

General
Scan Generate
• SEM Image •
SEM Linescan
X-ray Image
X-ray Probe
TEM Image
Micron Marker
File Formats
Hardware Setup

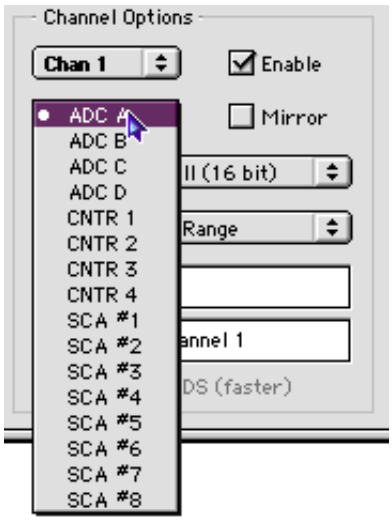
- ***Channel Options***
  - ***Logical Channel and Enable***. Logical channels are numbered **Chan 1 - Chan 8** and define which channels appear on the monitor:



To make a channel appear on the screen, check its **Enable** box. To make the image go away, uncheck its **Enable** box. Each of the logical channels has a default physical channel, acquire mode, and display mode assigned to it. These can be changed according to the user's preference.

  - ***Physical Channel***. Physical channels are the actual analog or digital signal inputs to the 4pi

system:



There are 4 analog inputs labeled **ADC A - ADC D**, 4 TTL counter inputs labeled **CNTR 1 - CNTR 4**, and 8 SCA inputs labeled **SCA 1 - SCA 8**.

The analog channels are typically connected to detectors such as a secondary electron or backscattered electron detectors and are used by the 4pi hardware and software to generate **digital images**. Other types of signal sources include absorbed current or cathodoluminescence. The customer must supply access to the appropriate analog signal sources. Often these connections are available via panels supplied by the microscope manufacturer and are terminated with BNC or other standard connectors; however, this may not be the case if the microscope is not configured for external scan control. 4pi can help determine the configuration and make suggestions, but it is ultimately the customer's responsibility to verify configuration with the maker of the microscope. In principle, these details were resolved during the ordering of your 4pi equipment.

The TTL counter signal inputs may be connected to pulse outputs from a WDS *(Wavelength Dispersive Spectrometer)* or EELS *(Electron Energy Loss Spectrometer)* pulse-height analyzer electronics, and are used by the 4pi hardware and software to generate image maps. Counter signals must be TTL-compatible five volt logic signals, and the pulses may be either positive- or negative-going. The customer must supply access and BNC terminations to TTL pulse outputs from their electronics. The Spectral Engine II hardware can accurately count pulse rates from the sub-Hertz range up to several hundred kilohertz or even higher in certain circumstances. Such broad dynamic range can create a number of issues with respect to map acquisition and display (for example, ensuring that there are sufficient counts to be visible, while not overflowing the 8- or 16-bit registers). Contact 4pi support for more information.

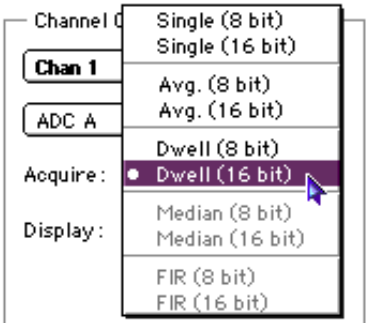
The SCA channels are data pathways from the EDX to the imaging (SEM) side of the SEII circuitry. SCA channel configuration and use is covered in ROI options, in the X-Ray Image Preferences.

Any physical channel can be assigned to any logical channel for acquisition in any order (there is one exception to this rule if you are acquiring WDS maps using the Combine WDS switch).

- ***Mirror***. For each channel, the **Mirror** setting defines black and white. Leaving mirror unselected defines a pixel value of zero as black, with higher pixel values shading toward white. Selecting mirror reverses this definition. Set the mirror setting so that the acquired digital image and the microscope CRT image are alike.

- ***Acquire***. This menu selects the type of averaging, if any, and the pixel data depth. Modes

include **Single**, **Average**, and **Dwell** (see Dwell below for further explanation).



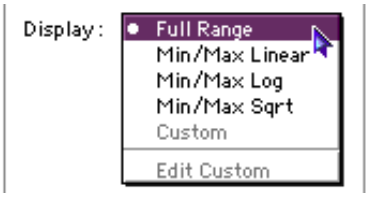
Pixel data depths currently supported are either 8- or 16-bit, unsigned. Acquired data is scaled for display in the image window according to the Display setting, but all ADC, Counter, and SCA data are **acquired** in 16-bit mode. (The SEII hardware is capable of preserving up to 40 bits per pixel if your application requires this precision. Contact 4pi support for details).

If **16-bit** mode is selected, the data are presented on screen **as is** (65,536 levels). If **8-bit** mode is selected, the data are handled as follows (if **all** channels are in 8-bit mode, certain transfer economies are leveraged for somewhat faster scanning):

- **ADC**: the **upper** 8 bits of the 16-bit word are retained and displayed. In other words, the number of grey levels in the image are reduced from 65536 to 256: black stays black (0-255 map to 1), white stays white (65280-65535 maps to 255), and grays are rounded down to the nearest grey level. The image should not visibly change unless your display is capable of more than 256 grey levels (i.e., a greater than 24-bit color video card).

- **CNTR** or **SCA**: the **lower** 8 bits of the 16 bit word are retained and displayed. Choose enough bits to accommodate the expected number of counts per pixel. At 8 bits this is 255 counts— any more and the count "wraps around" to zero. So if you have more than 255 counts per pixel in any pixel, choose 16 bit. However, if the number of counts is low relative to 65535 then the pixels may be too dark to see if you are using a black background, or too light to see if you are using a white background. If so, choose a different Display setting to make them visible. To determine approximately how many counts you will have per pixel, multiply the count rate from the source by the Dwell time for the channel.

◦ ***Display***. In real-time, this setting scales the data in the preview windows, and applies it to the acquired images as well.



Note: the actual data are never modified. Only raw original data are saved to disk.

- ***Full Range:*** The raw data are displayed without any scaling. Be careful here, images with pixel data whose values are relatively close to zero will not be visible against the background.

- ***Max/Min Linear:*** In real-time the image linearly rescales to the largest and smallest pixel data values acquired **thus far**. Be careful here also, if the data are not well understood, odd effects may appear. This mode is important for WDS and SCA mapping, where low count rates can require long dwell times in order to present a signal. This mode allows one to quickly see whether there is a changing signal for long-dwell images or maps.

- ***Max/Min Log:*** Similar to Max/Min Linear except that it scales using the natural logarithm of the data values.

- ***Max/Min Sqrt:*** Similar to Max/Min Linear except that it scales using the square root of the data values.

- ***Edit Custom:*** Allows the user to define arbitrary types of display scaling.

- ***Dwell***. The dwell edit field varies according to the Acquire mode selected:

  - ***Dwell:*** The dwell time is the amount of time that data from the ADC are being logged while the electron beam is at a single pixel position. The minimum dwell time is 1 microsecond. The ADC converts at a rate of 10MHz, so every 1 microsecond of dwell corresponds to 10 ADC samples. For video acquisition, the maximum dwell time is 1600 microseconds (1.6ms or 16,000 readings per pixel). Note that this is not a video frame average. Publication-quality images may demand dwell times on the order of 100 microseconds; while this can create long acquire times, it compares favorably to the requirements for gated-integrator operation.

  - ***Average:*** The edit field number sets the number of samples at each pixel. The ADC samples at 10MHz, so averaging 10 samples is equivalent to a dwell of 1 microsecond. This setting can be used to get sub-microsecond dwells.

  - ***Single***: The edit field is not available. The ADC is sampled exactly once (100ns). Special routines are used to speed up the operation of the hardware in ways that cannot be applied to the above point-averaging modes. The fastest board operation is achieved in this mode, and is recommended when frame-averaging.

  If the physical channel is a TTL counter (**CNTR 1 - CNTR 4**) instead of the ADC (e.g., WDS maps), then the dwell time is the amount of time that the counters are allowed to increment. As with ADC channels, the minimum CNTR dwell time is 1 microsecond. The maximum dwell time is 16 seconds (enter as 16,000,000 microseconds — count your zeros!). We suggest that a back-of-the-envelope calculation be performed to determine if your selected dwell and measured count rate will yield any counts. Multiply the count rate from the source by the dwell time entered here to get an average number of counts per pixel. If this value is not at least one count per pixel then a longer dwell or higher count rate is necessary.

  If the physical channel is an SCA counter (**SCA 1 - SCA 8**) then the dwell time is the amount of time that the SEII MCA looks for EDX counts in the ROI defined **SCA** channels. Other considerations are the same as for the **CNTR** channels above.

- ***Name***. Use this edit field to preload the name which will appear as the title of the image window displayed on the screen, and which will be used as the default for the image file name.

Miscellaneous Options

- ***Faster SEM Scanning***. When only one ADC channel is enabled, this can be checked to invoke a DSP routine in low-level software that speeds up each linescan by a small amount (about 5% tops). If more than one channel is enabled, this feature is disabled. The advantage gained is only useful for long frame averages or short dwells; for the dwell times required to achieve publication-quality imaging, 4pi recommends this checkbox be turned off.

- ***Combine WDS***. Checking this box will cause all defined WDS channels (**CNTR 1 - CNTR 4**) to acquire simultaneously rather than sequentially. This can be up to a factor of four faster, depending on the number of defined channels. If Mirror is selected for any WDS channel then Mirror will apply to all WDS channels. The Dwell used for all WDS channels together is the largest value that has been set for any WDS channel. To use this feature all WDS physical channels **must** be defined in higher numbered Logical channels than all physical **ADC**

channels. Ignoring this sequence will not damage anything, but can generate unpredictable results. A **warning dialog** will appear for out-of-sequence definitions and will undo the changes made. This feature **cannot** be overridden. Also, **Combine WDS** cannot be checked unless at least two WDS channels are enabled, and no out-of-order execution attempt is detected. Leaving the **Combine WDS** switch unchecked allows for sequential operation, with the advantage that different Invert settings, options, and channel dwells can be defined for each channel, but at the expense of efficiency.

- ***Line Profile Options***

  - ***Show Line Profile***. Checking this box overlays a real-time graph of sequential line profiles on the image, useful for feedback on the scan and video operation. Since this graph is updated in real-time, it may jump around quite a bit because of the sample morphology. The SEM Gain and Offset potentiometers on the 4pi SIU *(Scanning Interface Unit)* directly control the magnitude and position of this signal.

    The zero of the signal is displayed at the centerline of the image. The fullscale setting can be set via the View% edit box (described below). Use the microscope **Contrast** and **Brightness** controls to set the CRT image to the desired level; the SIU can then be adjusted to set the signal shown in the line profile overlay to the desired level. Channel **ADC A** is adjusted with the SEM Gain and Offset potentiometers on the **front panel** of the SIU. The gain and offset potentiometers for the **ADC B**, **ADC C**, and **ADC D** channels are located **inside** the SIU.

    Coincident with the centerline zero level is a draggable reference line. Click your mouse within the vicinity of this line and drag. A new line will appear that can be positioned anywhere within the image. This marks the line in the image which is used for the real-time line profile overlay.

    In acquired images, the line profile can be displayed or hidden, regardless of the setting of the checkbox before acquisition, using the menu item **Options > Show Line Plot** or **Options > Hide Line Plot**.

  - ***Show Every Line***. Checking this causes a tick mark indicating the current scan-line to run on the left side of the image, giving real-time feedback on the scan position.

  - ***Set Color***. This button accesses the operating system's color-picking services, and allows the line-profile color to be set.

  - ***View %***. Enter a number between 0 and 100 to set the physical size of the line profile within the image window as a percentage of the half-height image window size. The default is 95%.