

APEX User Manual

EDAX APEX™



EDAX
AMETEK
MATERIALS ANALYSIS DIVISION

Octane Elite

The game changing advancements in the Octane Elite SDDs take detector technology to the next level. This line of detectors incorporates a new silicon nitride window, which offers remarkable improvements in low energy sensitivity for light element detection and low kV microanalysis.



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EDAX Inc.
Ametek Materials Analysis Division

Table of Contents

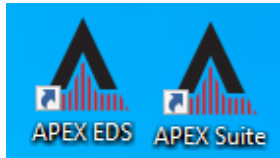
Introduction to APEX	4
Launching APEX	4
Layout Overview	6
Icons	9
Application Menu	9
Collection Toolbar	11
Status Bars	13
File Menu	14
User Profile Preferences	16
The Project Tree	21
Project Tree Panel	21
Project Tree Function Icons	22
Project, Sample, and Print Icons	23
The Project Icon	24
The Sample Icon	26
The Print Icon	27
Collection Modes	28
Multi-User Mode	30
Check for Updates	33
Image and Data Collection	34
Image and Data Collection	34
Image Collection	35
Spectrum Collection and Settings	37
Linescan Collection and Settings	39
X-Ray Map Collection and Settings	44
Map Collection and General Settings	44
ROI Display, Custom ROI and Changing Elements While Mapping	50
Live NET and ROI Map Options	52
Smart Phase Mapping	54
Montage Mapping	56
Drift Correction	61
Scan List	64
Batch Mode	65
Data Analysis and Display	67
Quant View Window	68
Quant View Window Introduction	68
Advanced Quantitative Methods	76
Spectrum View	81
Peak ID	81
Spectrum View Toolbars	83
Vertical Toolbar	84
Spectrum Pop-Up Menu	89
Spectrum View Advanced Settings	90
Additional Spectra Overlay Methods	94
Spectrum View Color Settings	95
Multi-Spectra View	98
Linescan View-> Image Window	102
Multi-map View Window	104
Mapping Pop-Up Menu	106
Review Mode and Toolbars	110

Spectrum Review	111
Spectrum Auto Processing	111
Spectrum Matching	114
Linescan Review	119
Mapping Review	121
Reporting and Printing	124
Report Generation: Live Mode	124
Auto Report	128
Spectrum or Linescan Report: Review Mode	129
X-Ray Map Report: Review Mode	133
Print Results	134
Advanced Settings	135
Detector Cooling and Slide Control	135
Microscope Column and Stage Control	137
Spectral Calibration	139
APEX Tutorial Slide	142

Introduction to APEX

Launching APEX

From the windows desktop double click on the APEX™ application icon to start the software. APEX EDS is the EDS-only version and APEX Suite is combined EDS and EBSD.



(The APEX™ icons)

The application splash screen will start and display the EDAX License information as shown below.

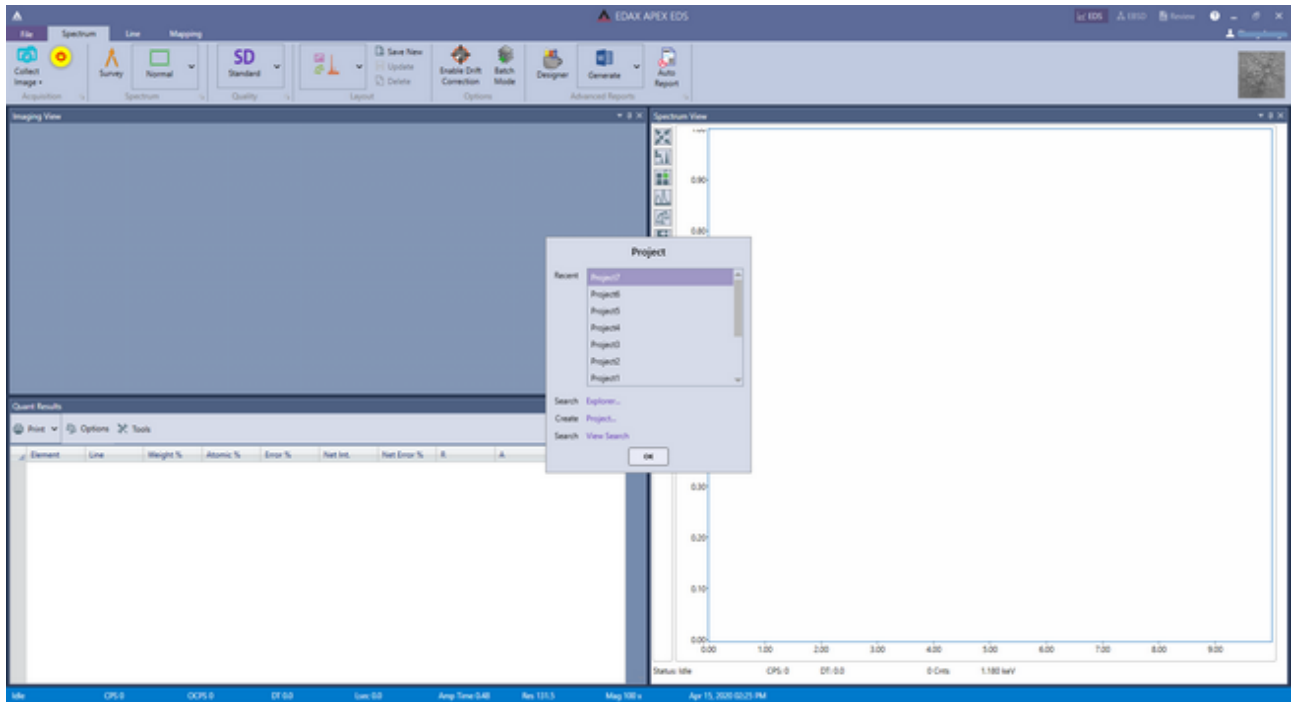


(APEX™ Launch Screen)

When the application is ready, the startup window shown below will be displayed where an existing project can be selected to review or examine data, or a new project can be created.

To create a new project, click Create>Project. Then, the project can be named or left as the default: "New Project," then click OK. To change modes between EDS, EBSD and Review, click on the desired button in the top right of APEX window title bar.

Cooling will be turned on automatically for the EDAX Element detector while the user can enable and disable cooling for other detector types. Cooling will always be turned off if the computer is rebooted or turned off. If the detector is not cooled down when the software starts, the cooling must be turned on by clicking the Detector Cooling icon on the Collection Toolbar. For advanced detector cooling and slide control settings, refer to [Detector Cooling and Slide Control](#).



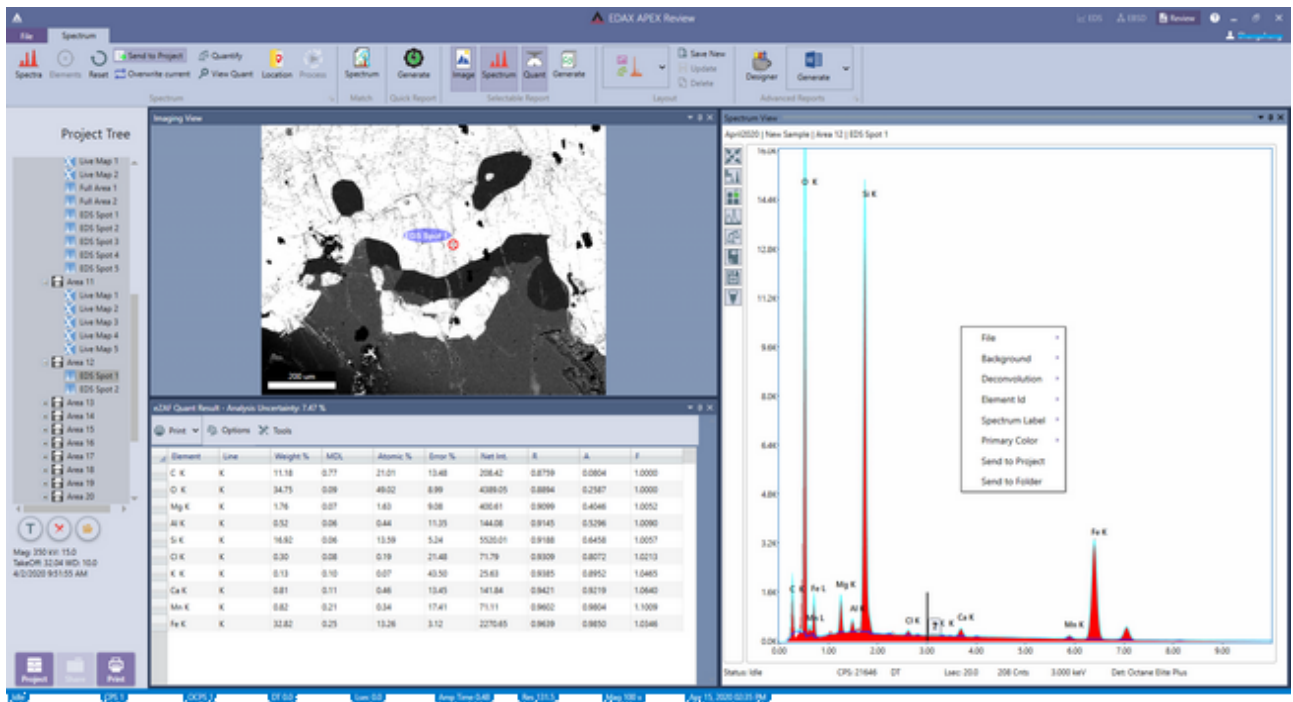
(APEX™ Application Screen)

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Layout Overview

The title of the window displays which mode APEX™ EDS is in. It has two states: a live collection window, and a review window. EDAX APEX™ EDS is the data collection window, while EDAX APEX™ Review is where you can review all types of data and produce reports. Click the EDS icon or Review icon on the top right corner to switch between the two modes.

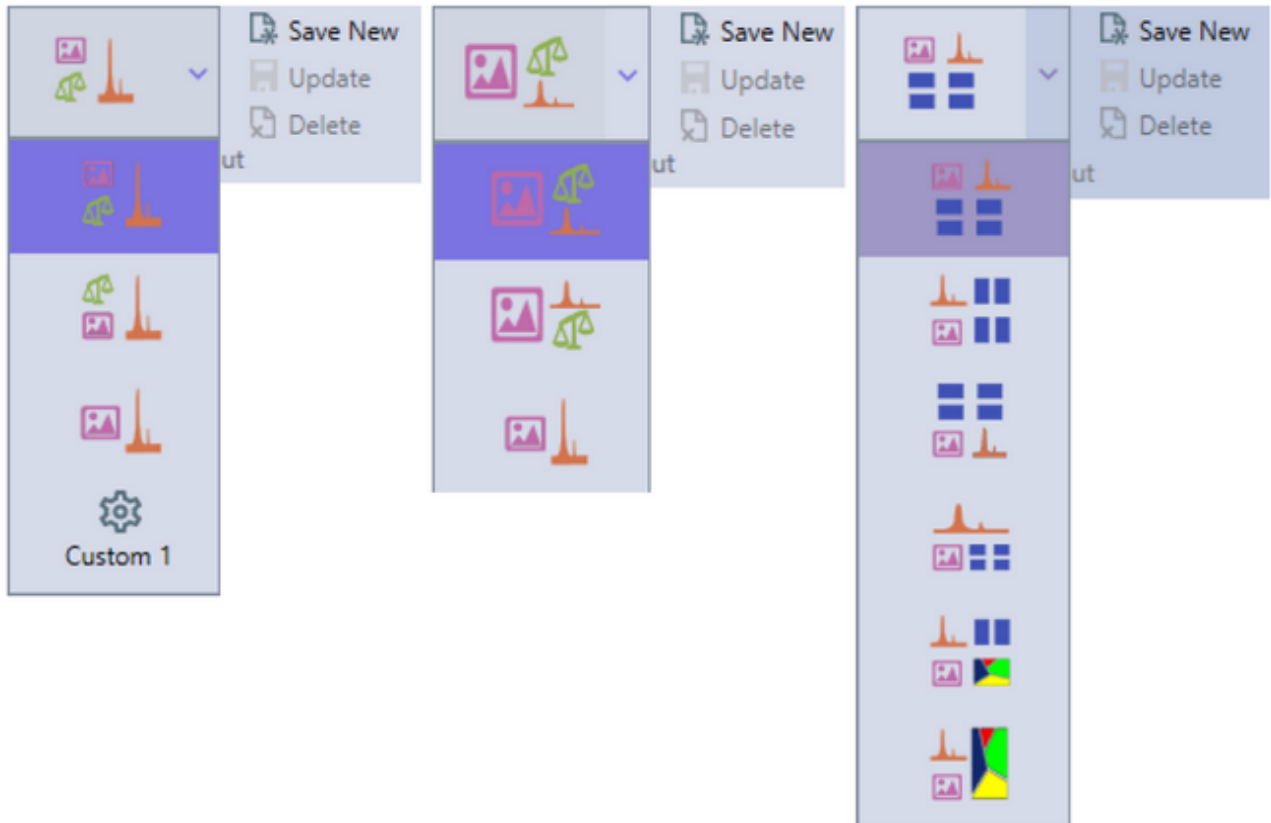
- One of the many powerful features of the APEX™ EDS is the two windows in which you can collect and review data simultaneously.
- Users can choose from the preset layouts or create custom layouts using the Layout Toolbar.



(APEX™ EDS Review Layout)

Preset Layout Options

Users have the option of choosing from multiple layouts for each mode i.e. Spectrum, Line Scan or Mapping:



(Expanded Layout Toolbar in Spectrum (left), Line Scan (center), and Mapping mode (right))

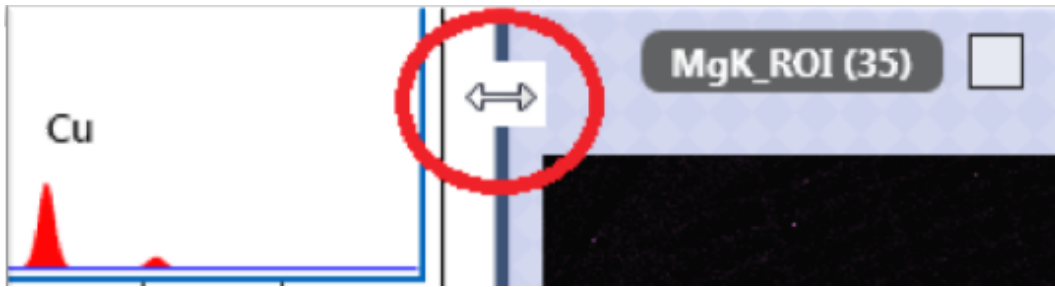
Preset Layouts Spectrum/Line Scan Mode:

- Layout 1: Image top left, quant bottom left, spectrum right half.
- Layout 2: Quant top left, image bottom left, spectrum right half.
- Layout 3: Image left half, spectrum right half.

Preset Layouts Mapping Mode:

- Layout 1: Image top left, spectrum top right, multi-map bottom.
- Layout 2: Spectrum top left, image bottom left, multi-map right half.
- Layout 3: Multi-map top, image bottom left, spectrum bottom right.
- Layout 4: Spectrum top, image bottom left, multi-map bottom right.
- Layout 5: Spectrum top left, multi-map top right, image bottom left, phase map bottom right.
- Layout 6: Spectrum top left, image bottom left, phase map right half.

To fine tune the layout of windows, move the mouse pointer over the splitter sections (see red circle in the image below) between windows to change the size of each of the windows. The individual windows can also be detached from the general user interface by clicking and dragging in the header bar of the window. The detached windows can be re-arranged independently of other windows, moved to secondary monitors, or be re-docked by moving to an edge in the user interface or hovering over one of the dock icons that show up when moving the window. A window can also be dragged onto a second window to create a tabbed layout.

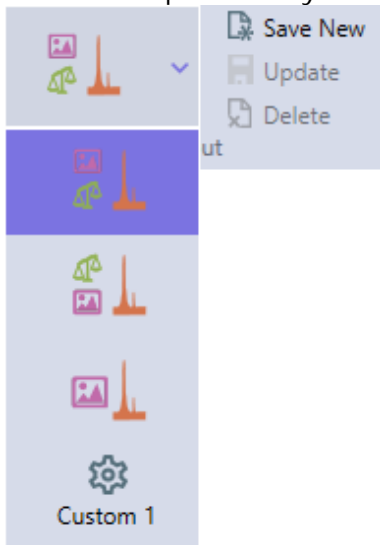


(Layout Options)

Multiple Custom Layouts

Users can create and save up to 5 layouts per mode. This means a user has the option of saving up to 15 layouts on the live side and 15 layouts on the review side.

- **Creating a Custom Layout:** To create a new custom layout, just arrange the layout the way that is desired and click the Save New button (see the image below). Once the layout is saved, a new Custom Layout icon will appear in the Expanded layout Toolbar. The Update and Delete buttons become active when a custom layout is selected. You can see a thumbnail tool tip of a custom layout by hovering over it with the mouse.
- **Updating a Custom Layout:** A custom layout can be updated to save any new arrangement that is desired just by clicking the Update button.
- **Deleting a Custom Layout:** To delete a custom layout, all that is needed is to select the custom layout and click the Delete button. The current layout will revert to the first layout in the Expanded Layout Toolbar.

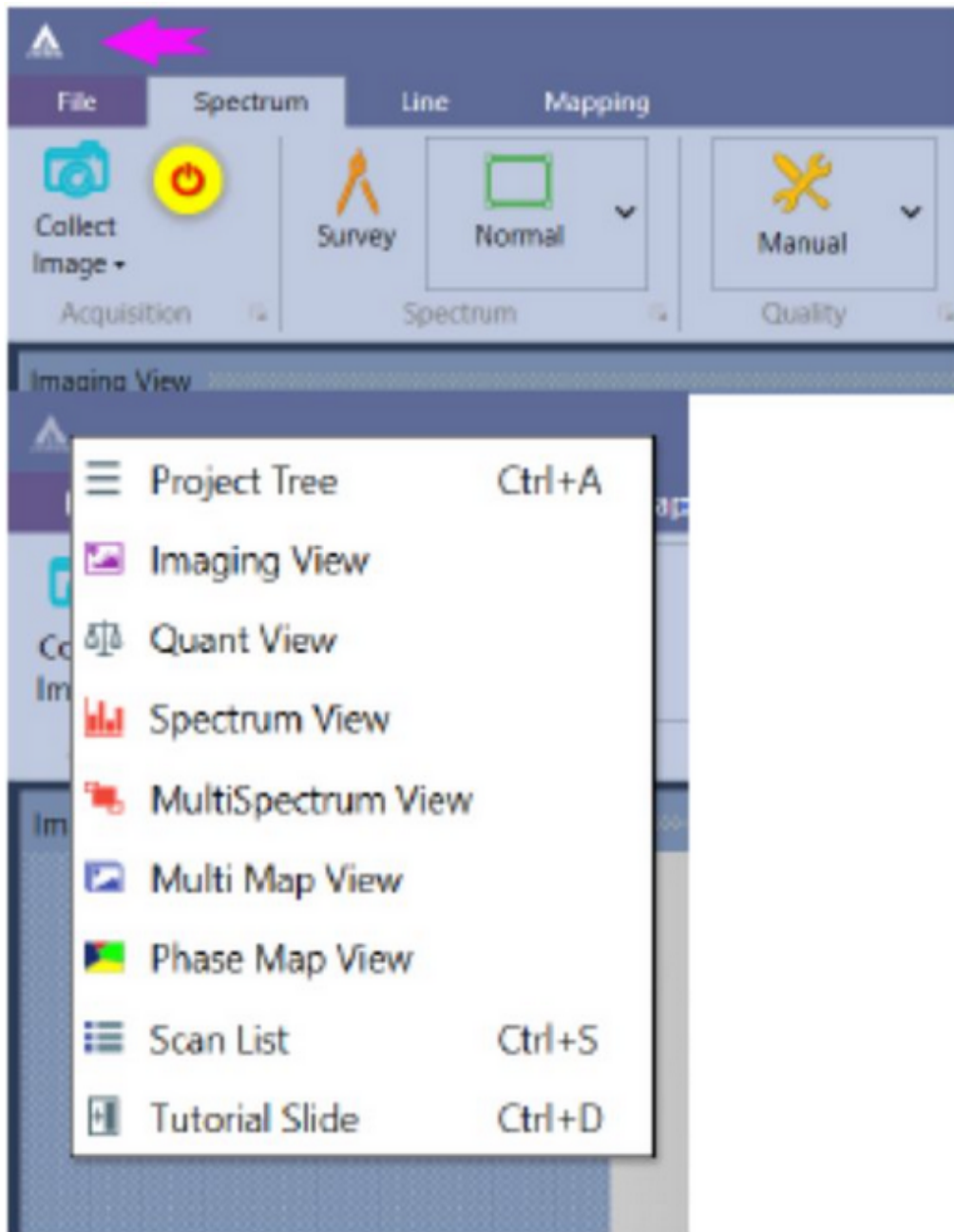


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Icons

Application Menu

APEX™ EDS application menu items are available through a single button on the top left of the application. This menu allows access to familiar controls like the Project Tree, the Scan List, the Tutorial Slide, and the dockable windows such as the Imaging View.





(Application Menu).


The Application Menu shown below allows the user to show or hide different view panels in order to easily view spectra, quant, and mapping results. As APEX™ EDS can display live quant results while data is being collected, these icons are especially useful.

Description of the Application Menu icons:

Show/Hide the APEX™ [Project Tree Panel](#) 

Show/Hide the Image Panel 

Show/Hide the Quantification Panel 

Show/Hide the Spectrum Panel 

Show/Hide the MultiSpectrum Panel 

Show/Hide the MultiMap Panel 

Show/Hide the Phase Map Panel 

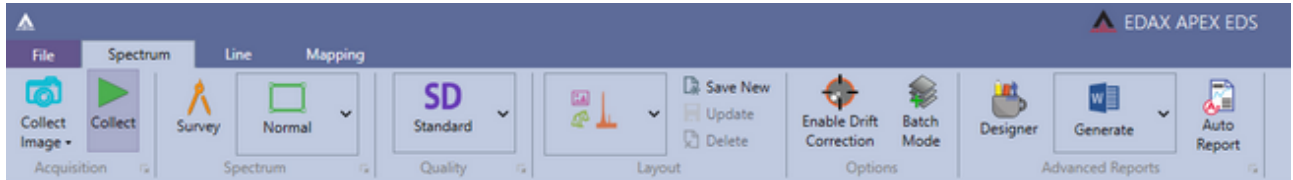
Show/Hide the [Scan List](#) 

Show/Hide the [Tutorial Slide](#) 

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Collection Toolbar

APEX EDS 2.0 utilizes a tabbed layout or Ribbon to organize its functionality and feature sets. The image shown here is the Collection Toolbar for the Spectrum Mode. If the detector is not cold the second icon will be Detector Cooling which will be replaced by the Data Collection Start/Stop icon once detector is ready.



(Collection Toolbar for the Spectrum Mode)

Description of the Collection Toolbar icons:



The [Image Collection](#) Icon



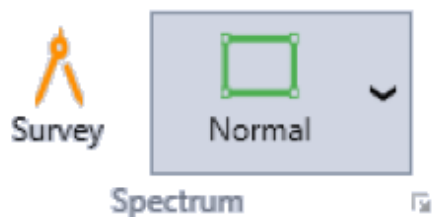
The Detector Cooling Icon



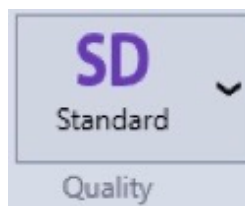
The Data Collection Start/Stop Icon



The [Collection Mode](#) Tabs



The [Spectrum Mode](#) Icons

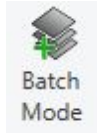


The Collection Quality Icon



Enable Drift
Correction

The [Drift Correction](#) Icon

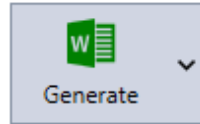


Batch
Mode

The [Batch Mode](#) Icon



Designer



Generate

Reports



Auto
Report

The [Report Generation](#) Icons



Auto
Report

The [Auto Report](#) Icon

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Status Bars

Main Status Bar

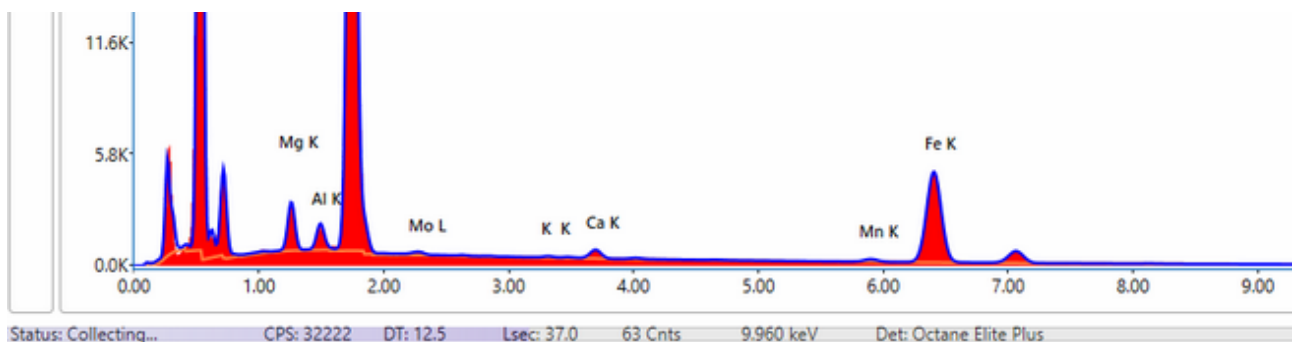
The Main Status Bar is located at the bottom of the main user interface. The display of the main status bar can be customized in [User Preferences](#). Available options are:

- CPS: The EDS Detector input counts per second.
- OCPS: The EDS Detector Output counts per second.
- DT: The Dead Time percentage (updated once per second).
- Lsec: The live time (in seconds) for the current acquisition.
- Amp Time: The current amp time selection in μ seconds.
- Res: The detector resolution at Mn $k\alpha$ for the selected amp time.
- eV/Ch: Channel/bin width of the spectrum in eV.
- Take Off: The calculated X-ray take off angle based on intersection distance, working distance, tilt and elevation angle.
- WD: Working distance of the microscope.
- Mag: Magnification of the microscope.
- HT: High Tension/acceleration voltage of the microscope.
- Date and Time: Current date and time.

There are four different colors used for the status bar, indicating the status of the software. The bar is **blue** when the software is idle, **orange** when data is being collected, **purple** when an image is being collected, and **red** if there is a network communication problem.

Spectrum Status Bar

The Spectrum Status Bar is located at the bottom of the Spectrum View window. There are three possible status displayed: Collecting, Idle, and Identifying Elements. During acquisition it displays what task the detector is completing and how far along the task is via a progress bar. It also displays important information about the collection settings and conditions. Additional information can be seen by hovering over the spectrum status bar.



(The Spectrum Status Bar (During Collection))

- CPS: The EDS Detector total counts per second.
- DT: The Dead Time percentage (updated once per second).
- Lsec: The live time (in seconds) for the current spectrum.
- Cnts: The intensity (in counts) at the energy cursor position.
- keV: The energy (in keV) at the energy cursor position.
- Det: The model type of the EDS Detector.

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File Menu

APEX 2.0 utilizes a ribbon File Menu which brings up a sub-page. To access the File Menu, click the User Profile Icon in the top right on the screen, and then click Account.



(User Profile Icon)

The sub-page is a full screen page with its own set of tabs. There are three tabs on this sub-page: Info, Account and Options.

Info Tab

The info tab allows the user to view license information; view help files or [check for software updates](#).

Software Information

Copyright © EDAX Inc 2020
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Save

- APEX-EBSD
- APEX-Suite-Enhanced
- APEX-Montage-Mapping

Feature Details

- APEX-Suite
- ICDD-Materials-DB-plugin
- ICSD-Materials-DB

Check Updates

- APEX-Advanced-Reporting
- APEX-Quant-Maps-Rebuild-Package
- Apollo-XLT-Slide-Control
- APEX-EDS-Advanced-Linescan
- APEX-EDS-CPS-Mapping
- APEX-EDS-Phase-Mapping-to-Element
- APEX-Spectrum-Match
- APEX-Drift-Correction
- APEX-CompoLiveMaps

This product is licensed to:

EDAX APEX Advanced
1.9.8857.0146
Thursday, April 16, 2020

EDS Detectors

Detector

SystemID HX-1001

Analyzer Type DPP-4

Detector Type Octane Elite Plus

SG Driver

Dsp Version

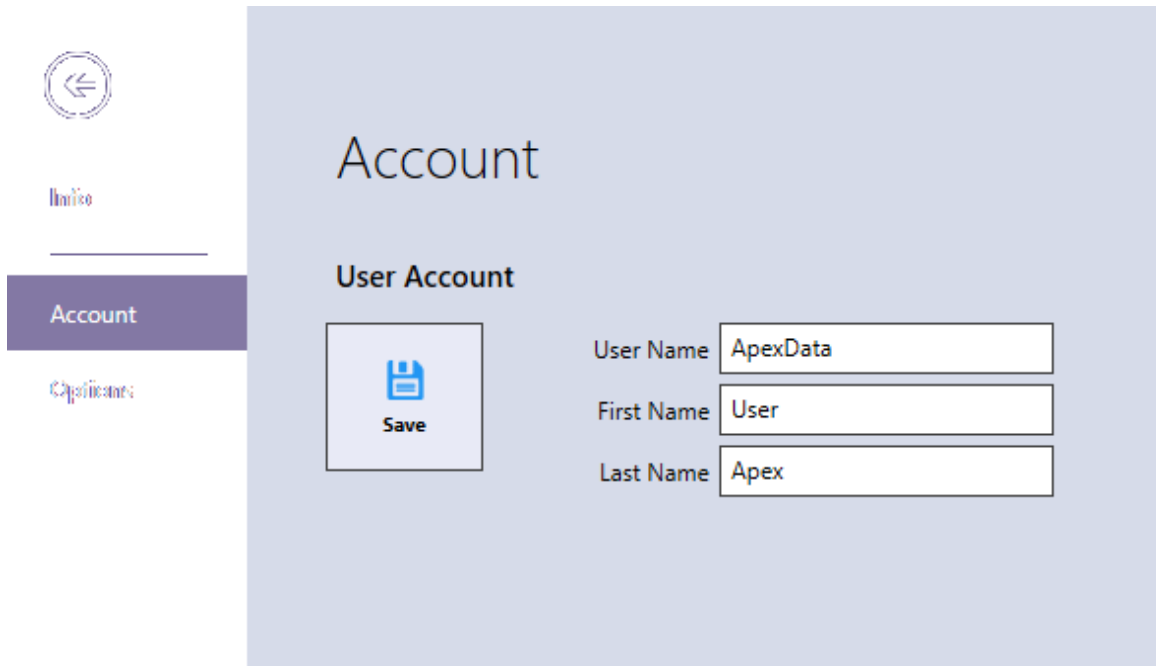
Xilinx Version App 4.0 Rev 5.15, 07/01/2013

Altera Version App 0.1 Rev 6.06, 10/04/2016

TEC Version App 1.1 Rev 3.00, 03/26/2013

Account Tab

The account tab allows a user to change their account information (first or last name). It allows an administrator to delete, update or add a new user.



The screenshot displays the 'Account' tab interface. On the left, there is a navigation menu with a back arrow icon, 'Home', 'Account' (highlighted), and 'Options'. The main content area is titled 'Account' and contains a 'User Account' section. This section features a 'Save' button with a floppy disk icon. To the right of the button are three input fields: 'User Name' with the value 'ApexData', 'First Name' with the value 'User', and 'Last Name' with the value 'Apex'.

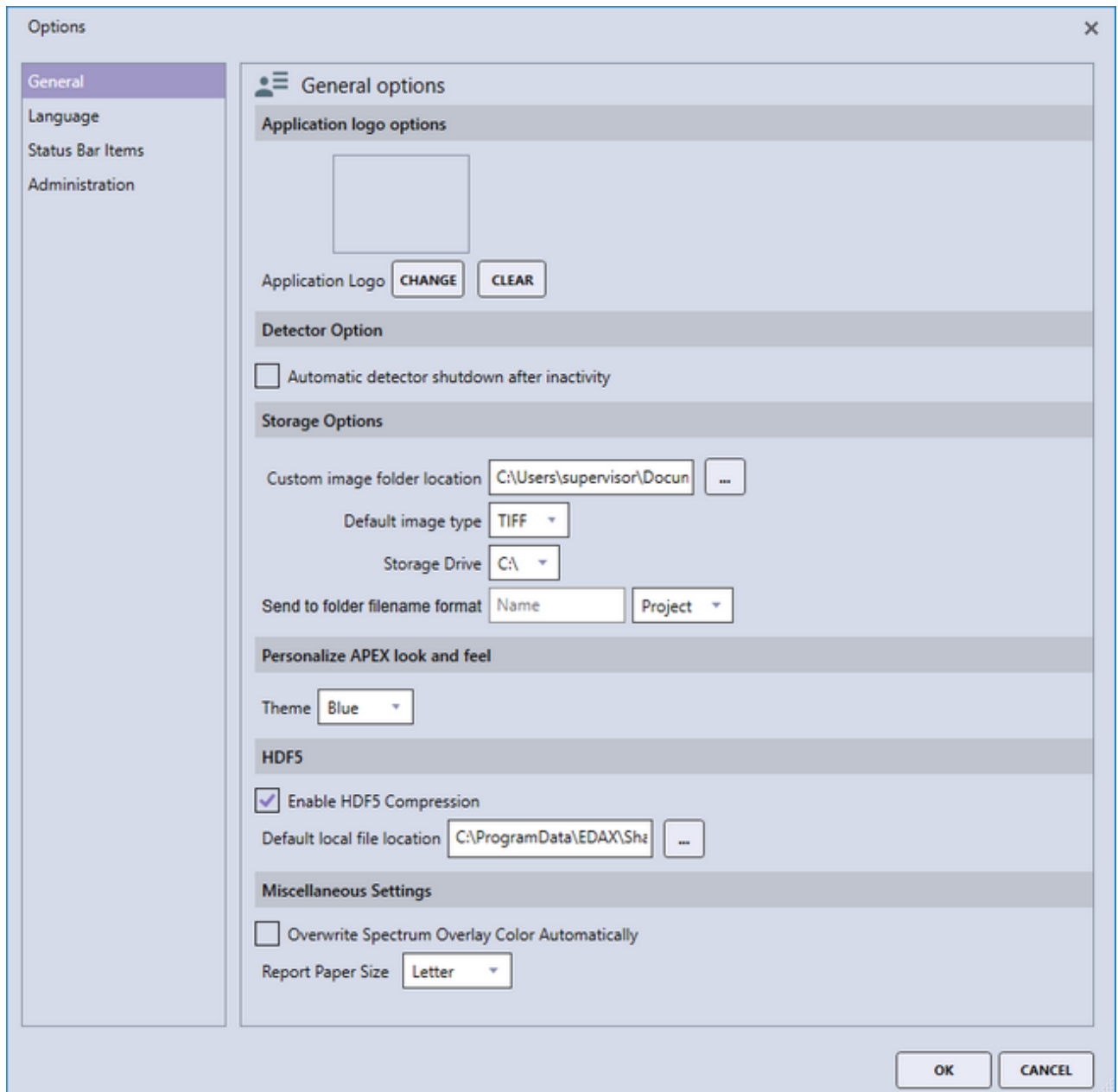
Options Tab

This tab allows users to customize the display and storage options to best meet their needs. The options are discussed in [User Profile Preferences](#).

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User Profile Preferences

Click on User Profile icon on the top right corner of the GUI, then click on Account and Options will pull up the User Profile Selections Window, pictured below.



(The User Profile Selection Window)

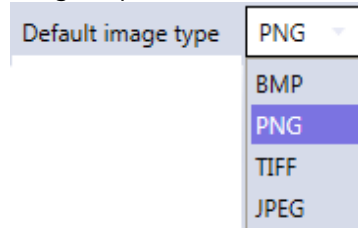
General Options

- **Application Logo>Change or Clear:** The Application Logo>Change icon allows the user to specify an image that will be used as the application logo. This logo will be displayed in the top right of the APEX™ window, and will appear on all reports. To upload an image, click Change and select a file. To remove the current image, click Clear.
- **Detector Options:** Automatic detector shutdown after inactivity. Enabling this option will shut off detector cooling after a period of non-use (Elect and Elite detectors only).
- **Storage Options:**

- **Image Folder and Image Type Selection:** This setting allows the user to define the folder to which images and graphics will be saved to when using the *Send to Folder* option. To select a folder, click on the ... on the right of the current folder path and select a new folder.



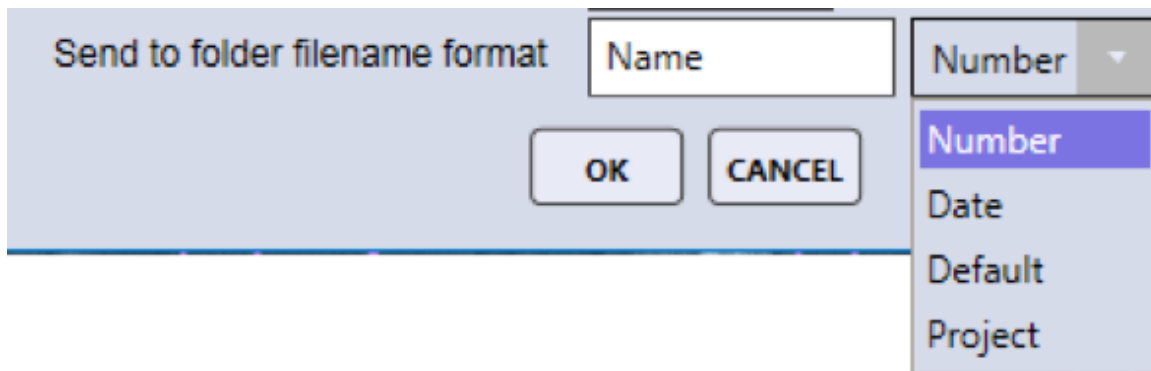
- **Default image type:** This drop-down selection allows the user to select from four different graphic file types to save images as: BMP, PNG, TIFF, or JPEG. These formats are defined in the Data File Listings topic.



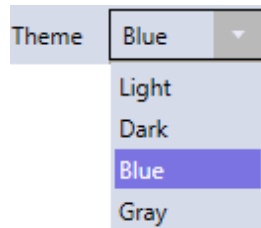
- **Storage Drive:** This selection is to define where the APEX™ raw data (*Spectrum, Linescan, and Maps*) are saved. Typically, this is the C drive but other internal hard drive locations can be used.

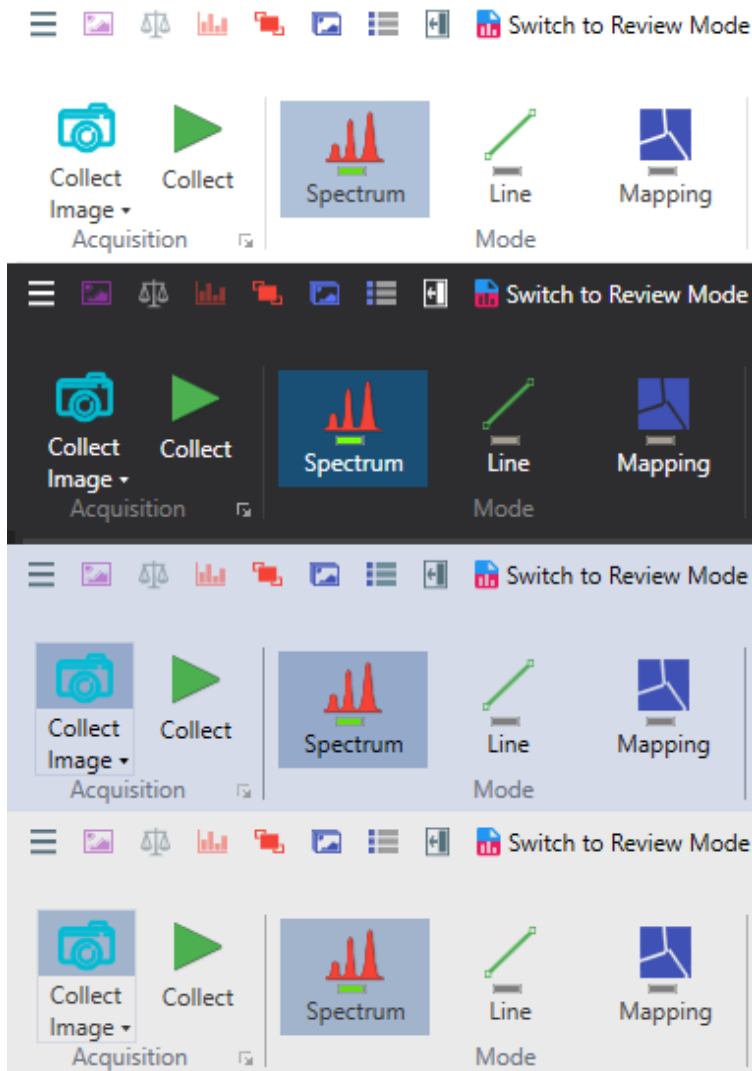


- **Send to Folder File name Format:** APEX™ allows for the precise naming of the files that are created via the *Send to Folder* method. The *Name* text field can be used to define a file name, followed by either a number, date, date-time stamp (default) or project, selected via the drop-down menu.



- **Personalize APEX look and feel:** The APEX™ application supports four different color themes for the entire software display. The use of themes is based on personal preference and APEX™ must be restarted in order for a new theme to take effect.

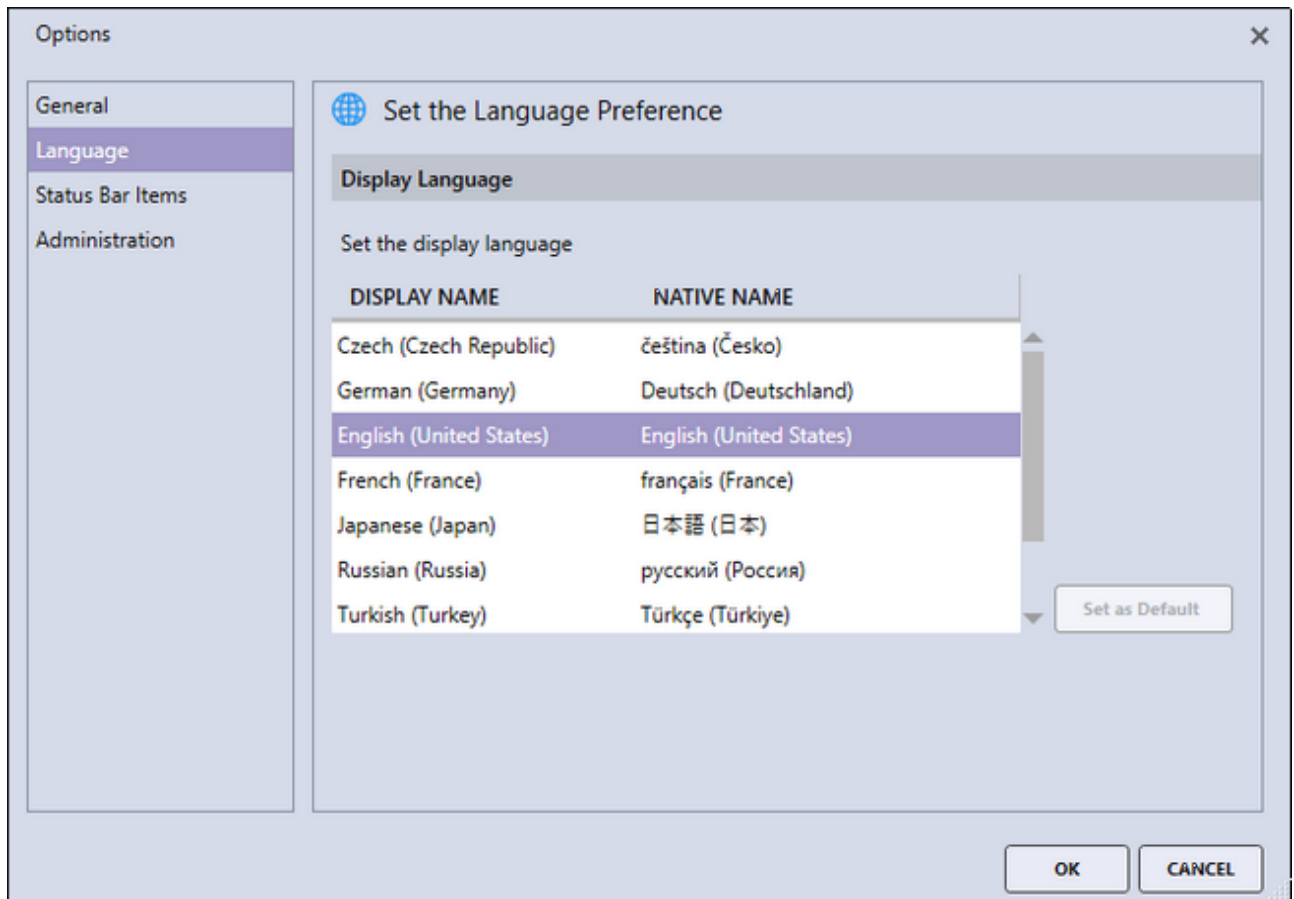




- HDF5
- Enable HDF5 Compression: This option will enable compression on HDF5 files for reduced file size. Some system slow down is to be expected.
- Default local file location: This setting allows the user to define the folder to which HDF5 project files will be saved to. To select a folder, click on the ... on the right of the current folder path and select a new folder.
- Miscellaneous Settings:
 - Overwrite Spectrum Overlay Color Automatically: Overwrites default spectrum overlay colors. See Spectrum View Color Settings.
 - Report Paper Size: Choice between A4 and letter for the reporting page size.

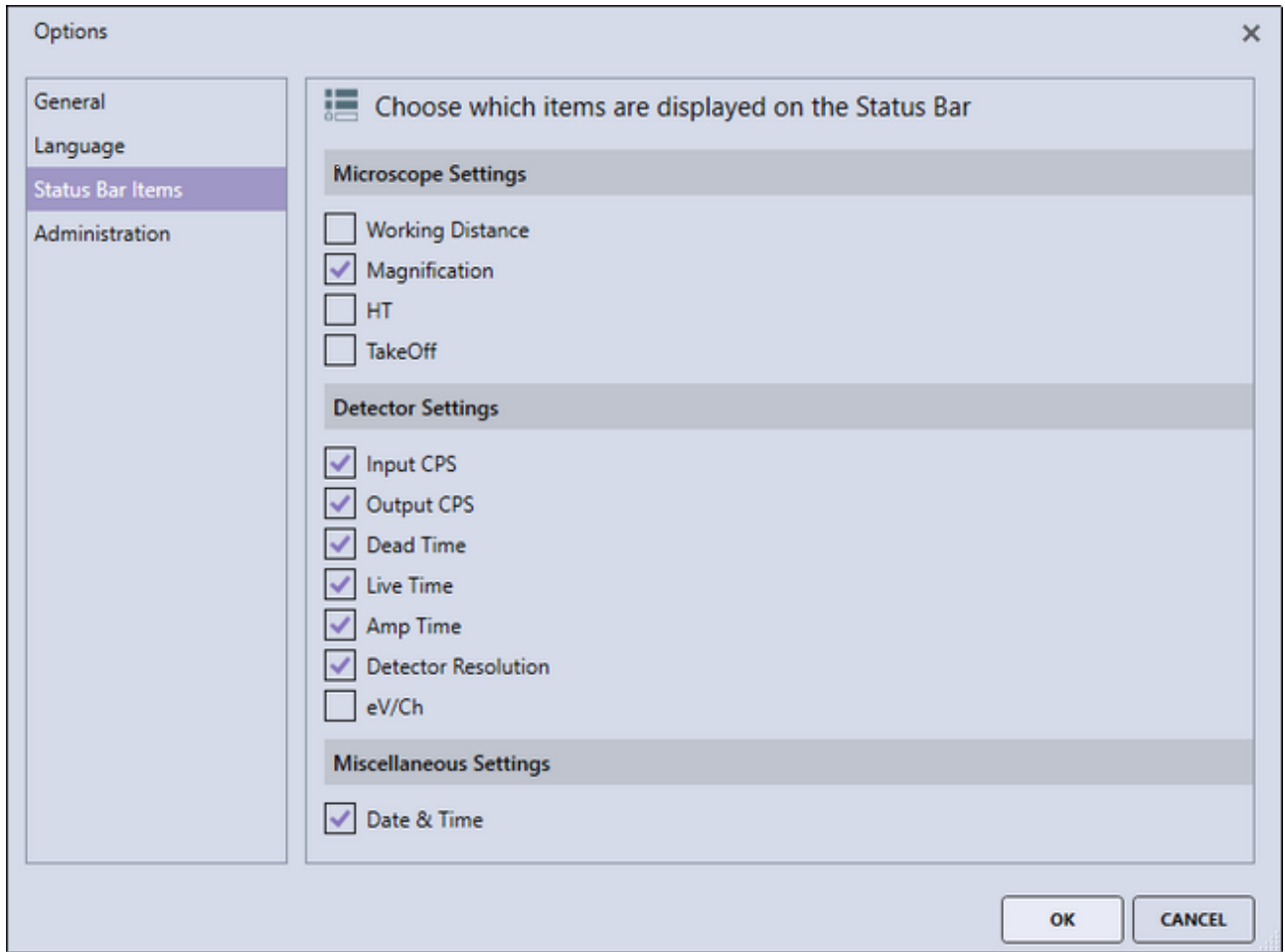
Language

There are eight language choices for APEX™: English, Chinese, Czech, French, German, Japanese, Russian, and Turkish. After setting a new language, restart the APEX™ software to see the new language take effect.



Status Bar Items

This menu allows the user to customize the parameters shown in the Status Bar on the bottom of the screen. To select a parameter, click the check-box next to it. To remove a parameter, deselect the check-box. More info can be viewed in the Status Bar section.

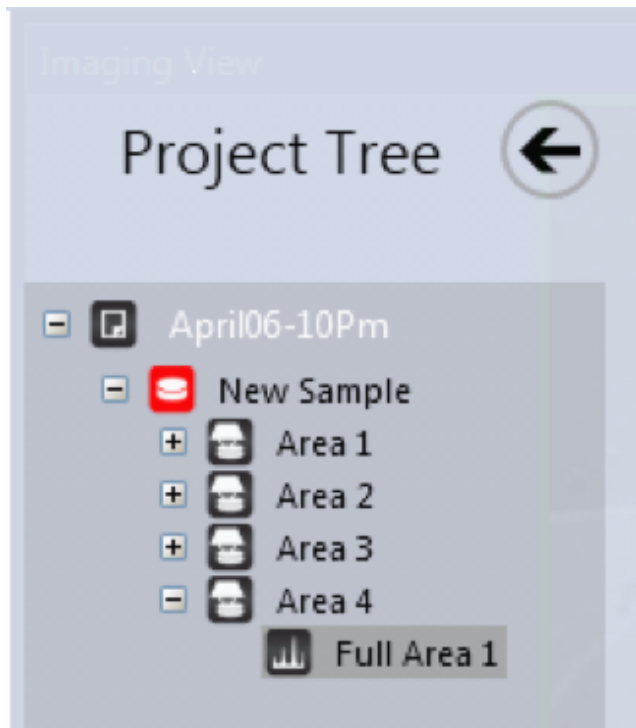


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The Project Tree

Project Tree Panel

Projects, samples, and data automatically appear in the project tree panel. It is an easy way to look through data and images. Each time a new sample is created, a new image is collected, and new spectra are collected, a new branch is created on the project tree. To open the project tree, use the project tree icon in the title bar. To close the project tree, click the project tree icon again or the back arrow next to the words Project Tree. Double click on the Spectrum node, such as Full Area 1, and it will be displayed. In live mode, double clicking on a data node will open it in review mode. Each node type has a different icon, being a spectrum, linescan, and a map. The tree is organized with the main node being the project, followed by the sample node, the image node, and the data node. Right clicking on a given project node gives a dialog box with the options Open Folder, Delete and Rename. Clicking the Open Folder will open a Windows Explorer window in the location of the data file while Delete will delete the active node and Rename will allow the user to edit the node name.



(The Project Tree Panel)

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Project Tree Function Icons

Directly below the project tree nodes are 3 function buttons:



(The Project Tree Function Icons)

The function buttons mirror the Rename, Delete and Open Folder options that can also be found by right clicking in the project tree.

When collecting spectral data, each type of area is named by the collection method used. Full Area is the total image area, Spot means the data was collected from a single electron beam position, Selected Area means a portion of the total image area is selected for collection, and Free Draw means a custom, hand drawn area was defined via the free draw function. The number at the end indicates the sequence number of the collection.

For example: if you collect three spot locations you would have EDS Spot 1, EDS Spot 2, and EDS Spot 3.

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Project, Sample, and Print Icons

In the bottom left corner of the project tree panel, there are three icons labeled project, sample (only shown in live mode), and print.



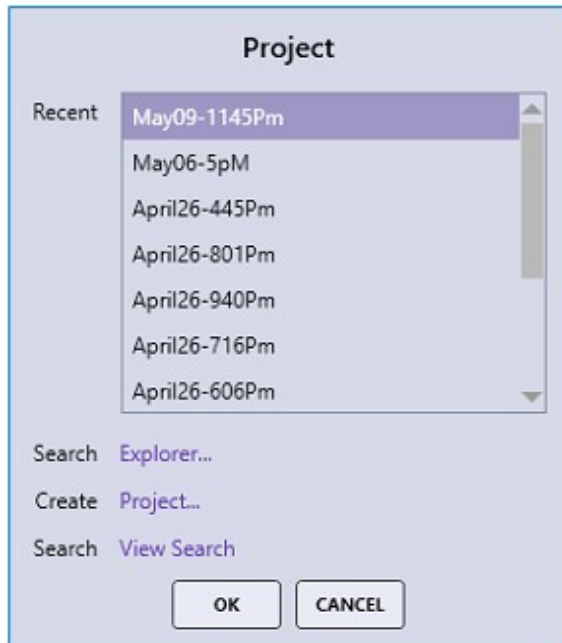
Note: These icons are only visible when the project tree panel is open

To view a more detailed description of the respective function of each icon, click on the icon you wish to view in the image above.

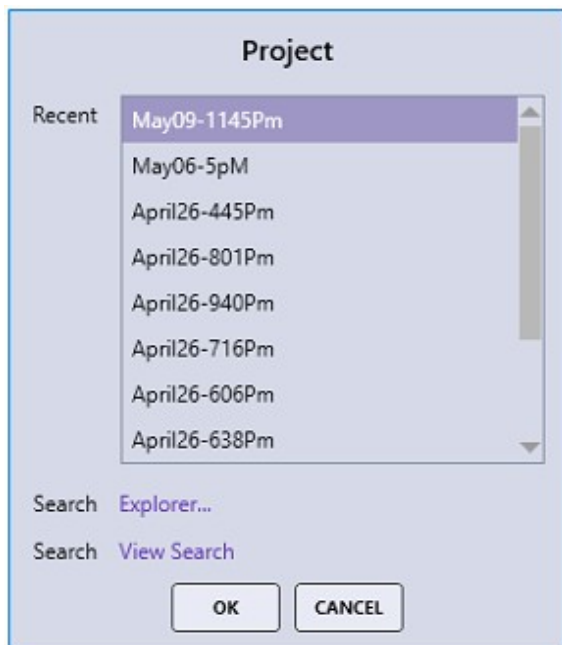
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The Project Icon

Clicking on the project button displaces the project selection window below. When in collection mode, the window on the left is displayed. When in review mode, the window on the right is displayed.



(The Project Icon Windows)



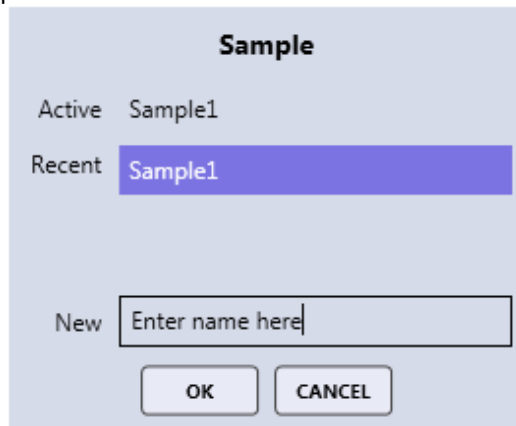
The project window shows the most recent projects followed by:

- Search Explorer: Opens Windows Explorer in the last used HDF5 file location.
- Create: Creates a new project.
- Search View Search: Opens a window with a list of recently opened project. The images from the projects are displayed to remind the user of the contents of the project. To review the selected project, click on the Open button.

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The Sample Icon

The sample icon displays the sample selection window. To open an existing sample, double click on the sample in the list. To create a new sample, click on the *New* text-box and enter a name for the new sample.



(The Sample Window)

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The Print Icon

The print icon outputs a screen capture of the entire APEX™ window to the printer. To print specific portions of the screen (i.e. the image, spectrum, or quant results) save the item to the custom folder and then open to print.

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Collection Modes

There are three main modes for collection in APEX™ EDS: spectrum, linescan, and X-ray map. These modes are used to achieve different types of data sets, depending on the nature of the user's work.



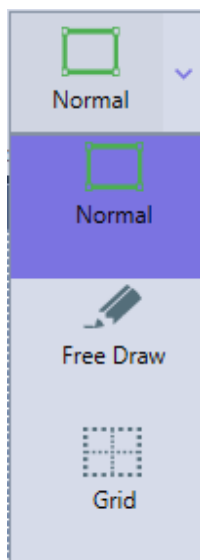
Spectrum

The spectrum mode collects a spectrum of the selected area for a period of time, set by the user. There are two options for spectrum collection: Survey and Normal.



(The Spectrum Mode Icons)

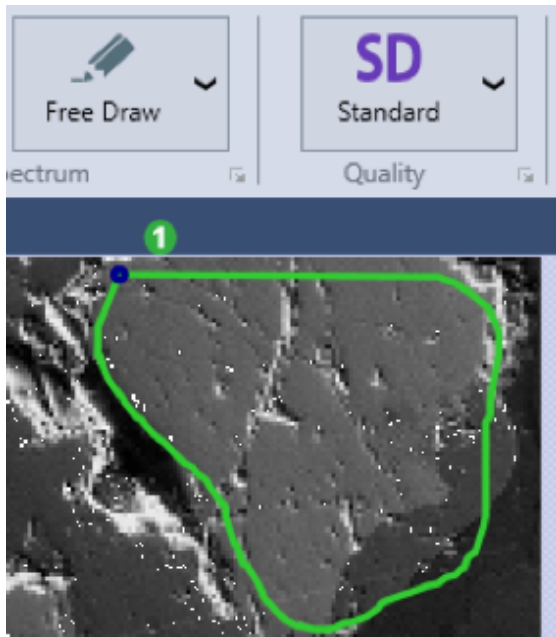
- When in Survey Mode a spectrum collection will start as soon as a point or area is selected in the SEM image. Selecting a new point or area will restart the acquisition, making it easy to click around in the image and identify features of interest. It is a good, quick way to get an overview of what materials are in a specimen, but the spectrum will not be saved after collection.
- The Normal Mode has three different settings: Normal, Free Draw, and Grid:



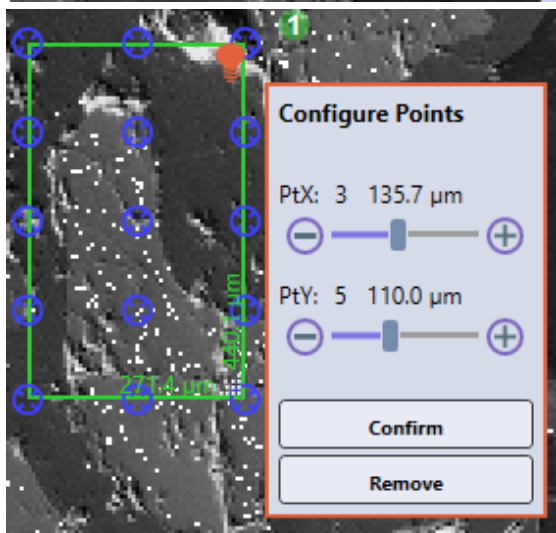
(The Spectrum Mode Drop-Down Menu)

1. *Normal*: Allows the user to define analysis locations individually.
2. *Free Draw*: The free draw mode allows the user to draw any shape onto the image area for analysis.
3. *Grid*: Allows the user to define a matrix of equidistant points for which the spectra will be collected sequentially.

Below are examples of both the Free Draw and Grid Collection Modes



(Free Draw)



(Grid)

Linescan

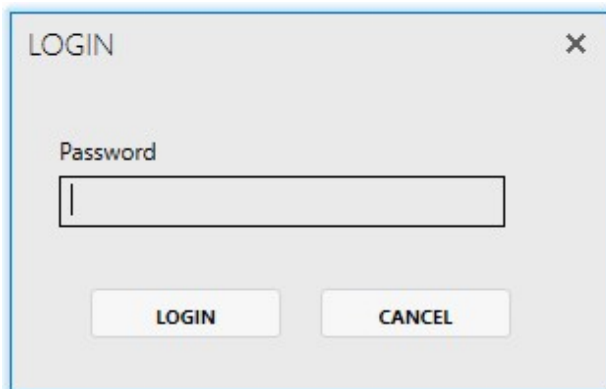
Linescan mode collects a spectrum across a line defined by the user. This mode is especially useful for determining compositional profiles or gradients within a sample.

X-Ray Map

The X-ray map mode collects spectra for each individual pixel over an area, creating a detailed, color-coded image of the specimen's composition. This process takes much longer than collecting a spectrum but provides very useful, in-depth data.

Multi-User Mode

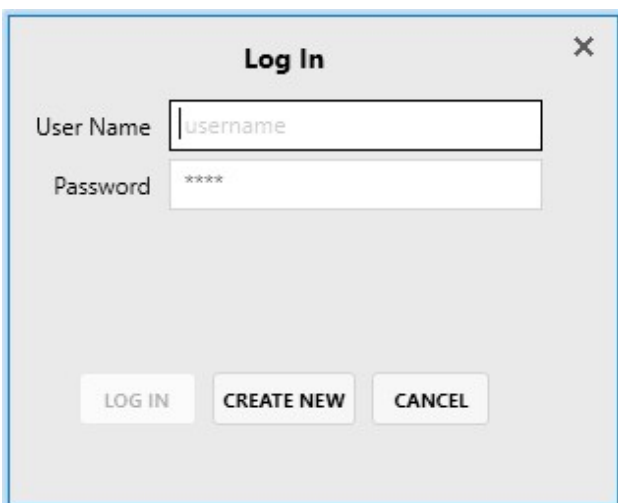
Note: Multi-user Mode is only available in APEX Advanced. To activate the multi-user mode for Apex, open up the user preferences dialog window by clicking on the user profile icon on the top right of the screen. The Activate Multi-user mode checkbox is disabled by default, click on the pencil icon to open up the password dialog box to enable this control. The password for this control is the default APEX Administrator password or administrator created password. After entering the correct password and pressing login, the checkbox will become enabled and this box can be checked to activate multi-user mode. Restart the software to apply multi-user mode. In the default multi-user mode, user account control takes place within the APEX software and can be managed by the administrator account. In this mode, a login dialog box will prompt for the user credentials when APEX starts. A second option is to use the Microsoft Windows authentication to give access to APEX. In this mode, APEX will automatically open/create a user profile corresponding to the active Microsoft Windows user.



A dialog box titled "LOGIN" with a close button (X) in the top right corner. It contains a "Password" label above a text input field. Below the input field are two buttons: "LOGIN" and "CANCEL".

Click the pencil button and enter the admin password to unlock

- Activate Multi-user mode 
- Use Windows Authentications



A dialog box titled "Log In" with a close button (X) in the top right corner. It contains two labels: "User Name" and "Password". The "User Name" label is above a text input field containing the text "username". The "Password" label is above a text input field containing "****". Below the input fields are three buttons: "LOG IN", "CREATE NEW", and "CANCEL".

Disabling Multi-user Mode

Disabling Multi-user mode while logged in with a normal user will require the administrator password or the administrator created password to disable the checked box. To enter the administrator password, click on the pencil icon and the password dialog box will appear. A password is not required to disable Multi-user mode whenever the Administrator is logged into Apex.

Administration

Users

USER NAME	FIRST NAME	LAST NAME	INFO
ApexData	EDAX	Applications	
Administrator	Administrator		
Factory	User	Apex	
Service	User	Apex	

Restrict New Users

CREATE USER

EDIT USER

DELETE USER

RESET PASSWORD

EDIT USER STAGE FUNCTIONALITY

Creating a New User

New user can be created in two places.

- Whenever Apex starts up in multi-user mode and the login screen is shown, there is a Create New button. This button can be disabled in Administrator user settings by enabling Restrict New Users, leaving the following option as the only way to create new users.

New User Account

User Name

Password

Retype Password

First Name

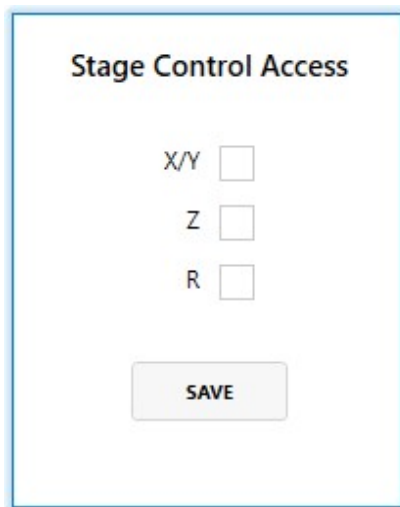
Last Name

CREATE CANCEL

- Administrator login can create new users in the User Profile Dialog under the User Account tab and click on the Create User button. This button is not visible to other users.

Users Tab

- Edit User: The administrator can edit user details for all users. User can edit their first and last name under the User Account tab in User Preferences window.
- Delete User: Delete a user profile from the APEX software.
- Reset Password: Select a profile from the user list and click to reset the user defined password. The user will be prompted to create a new password next time logging in to APEX.
- Edit User Stage Functionality: This allows the administrator to enable APEX controlled automatic stage motion of the various axis for a given user profile. This is required for Batch and Montage data collection.

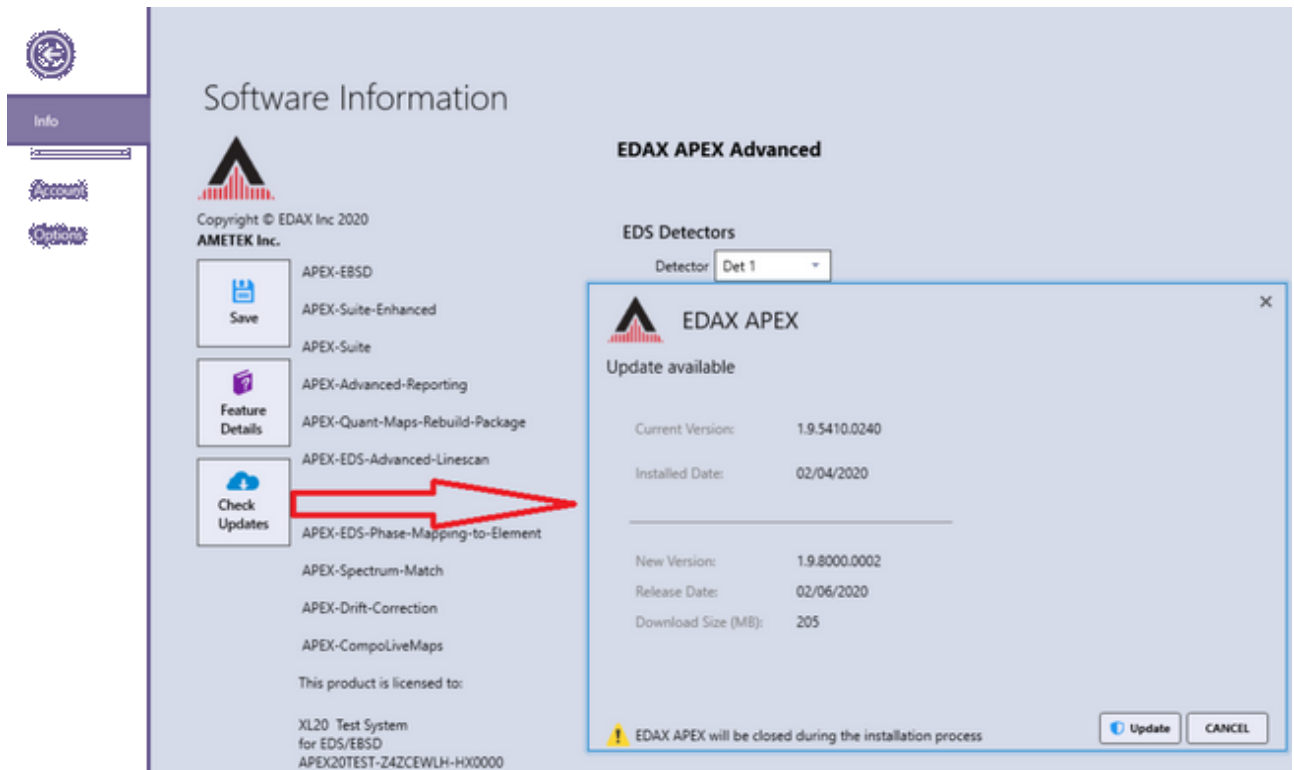


The image shows a dialog box titled "Stage Control Access". It contains three rows of text, each followed by a checkbox: "X/Y", "Z", and "R". Below these checkboxes is a "SAVE" button.

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Check for Updates

This feature requires a live internet connection, and the user must have pre-registered for this option. Click on the Check Updates icon will bring up the pop-up window shown below.



Click on the Update button to start the download process from EDAX, followed by the installation of the latest version available. You must reboot the workstation after performing this update. If you are not registered for automatic updates, you will need to contact EDAX Sales to register.

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Image and Data Collection

Image and Data Collection

In order to collect a spectrum, line scan, or map, an image must be collected first. There are many different settings to optimize image and data collection, depending on the nature of the work as well as the process used. The settings for image and data collection will now be outlined.

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Image Collection

The camera icon on the image toolbar starts or stops image collection. While the image is collecting, the image icon turns purple as well as the application [status bar](#).



(idle)

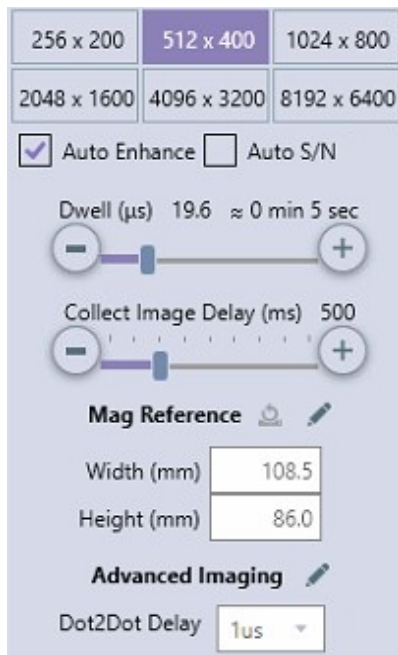


(image is collecting)

Clicking on the down arrow selection (on the image icon) will display the Image Collection Parameters pop up window, shown below. There are six sizes for image collection matrices: 256 x 200, 512 x 400, 1024 x 800, 2048 x 1600, 4096 x 3200 and 8192 x 6400 pixels. The larger the values of the matrix, the higher the resolution. The selected resolution will appear highlighted on the window.

The quality of the image can be adjusted further using the following settings:

- Auto Enhance: This option automatically adjusts the image brightness and contrast after the image is collected. It yields nicely contrasted images.
- Auto S/N: This option pre-scans the image area and automatically determines the Image Dwell Time number to acquire a low noise (High Quality) image.
- Dwell(us): The imaging dwell time (in microseconds per pixel) can be selected by the user. The larger the number, the longer the collection time, but this yields lower noise and therefore, better quality. Clicking or sliding the scroll bar shows the time per point and estimated frame time update. *Note: When using the Auto S/N feature, dwell time is selected automatically.*
- Collect Image Delay (ms): This setting is the delay time (in ms), set by the user, for the microscope to settle between the external control of the beam and image acquisition.
- Mag Reference: This option is an adjustment factor to fine tune the precision of the *EDAX Micron Marker* in APEX™ for any Electron Microscope. This option is password protected. The adjustment is done at initial installation and checked as part of a preventive maintenance visit.



(The Image Settings Window)

- *Width*: Adjust this value when using a specimen that has image features of a precisely known width.
- *Height*: Adjust this value when using a specimen that has image features of a precisely known height. Since EDAX Image aspect ratio is 1:28 to 1, this height value should be the (width value) / 1.28 to ensure square pixels.

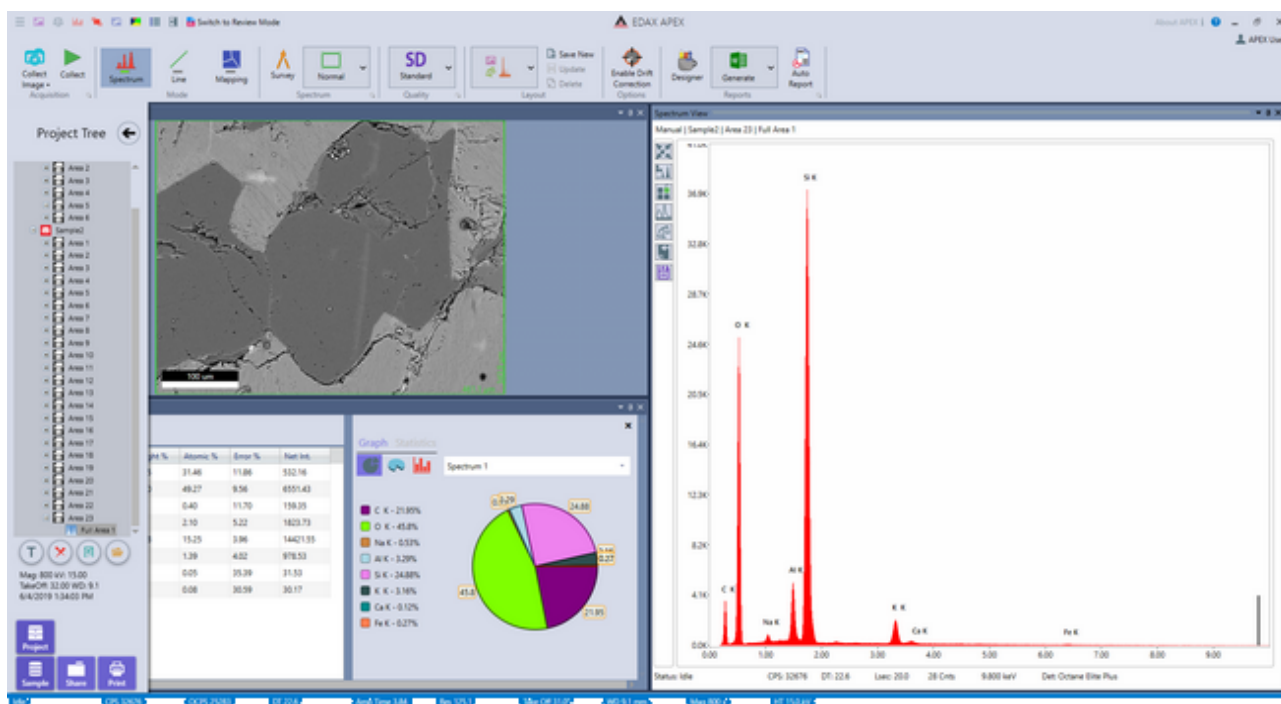
Clicking the Reset button to the right of Mag Reference will reset values to 128 (width) and 100 (height).

- Advanced Imaging: This option is password protected.
- Dot2Dot Delay: This is settling time (in μs) when moving the electron beam from one point to another.

Once the image has been collected, it will appear in the image window. As soon as data is collected, the image will automatically be saved to the [project tree](#). To save the image as an image file on the hard drive, right click on the image and then click Send to Folder. The image will be saved in the folder defined in the [User Preferences](#).

Spectrum Collection and Settings

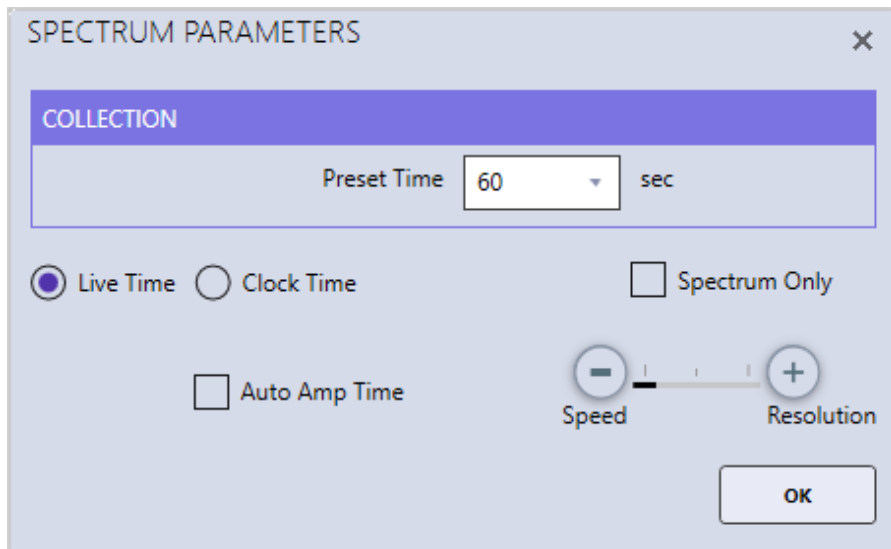
After collecting an image, click on the image area to define a spot, or area(s) over which the spectrum will be collected. If multiple areas are defined, the software will collect spectra at each of them sequentially. Click the Collect Icon to start the spectrum acquisition. The spectrum window will immediately start collecting a spectrum for the amount of time defined in Spectrum Parameters. During the collection, the elements will automatically be identified after a few seconds, and the quant results will be displayed in the quant view window. The name of the spectrum will be shown in the spectral view window as well as the [project tree](#) as soon as collection starts. The user can also modify the element list and change the [spectrum settings](#).



(Spectrum Display Collection in APEX™)

Spectrum Parameters:

The right-side drop-down menu, next to the Spectrum Quality Icon, allows the user to select one of the four quality modes for data collection: Quick, SD (standard definition) HD (high definition) and Manual. The collection parameters can be customized by the user for each collection mode. When in spectrum mode, the settings for each quality mode can be modified by clicking the arrow next to the word *Spectrum* on the bottom of the [collection toolbar](#). A pop-up window appears in which the user can set a collection time and choose between Live and Clock time.



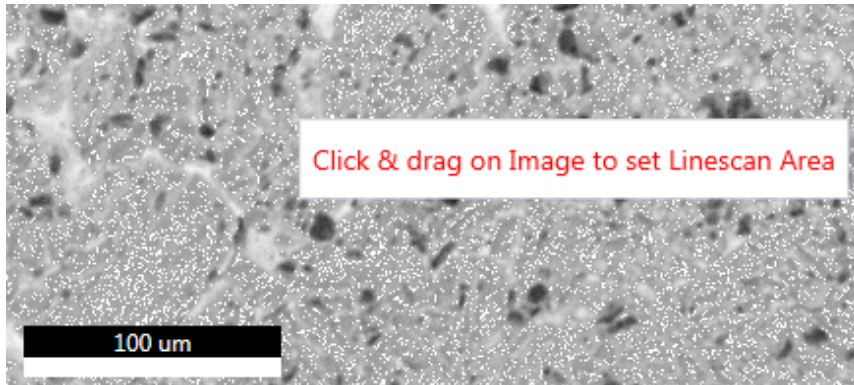
(Spectrum Parameters > Manual Mode)

Live time is the amount of time that data is collected plus processing time (dead time). Clock time is the amount of time data is not accounting for dead time. A 10 second acquisition with 50% dead time will take 20 seconds with live time but 10 seconds with clock time. In the automatic modes (Quick, SD, HD) there is a check-box for Auto Amp Time which automatically sets the amp time based on the input counts per second, in order to balance throughput and resolution. When the Manual quality icon is selected or when Auto Amp Time is deselected in the automatic modes, the pop-up window displays a slider bar with Speed and Resolution. Drag the slider bar or click the plus and minus symbols to adjust the amp time.

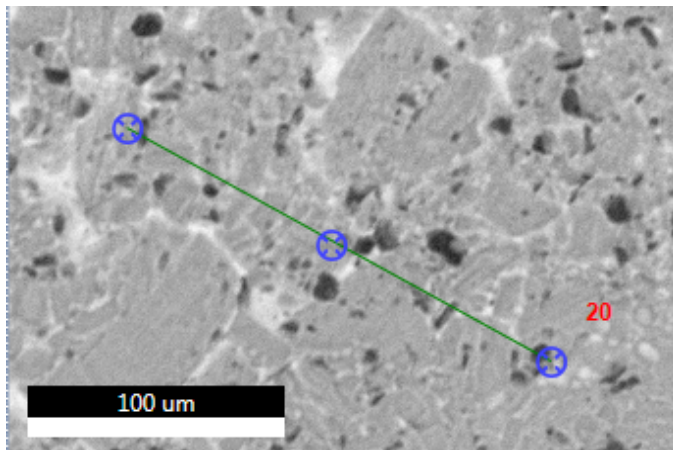
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Linescan Collection and Settings

Clicking on the Linescan Icon enters the linescan mode. A message will pop up over the image area asking the user to draw a line on the image to define the linescan profile for collection. After drawing the line, the end points of the line can be dragged to change the length of the line. To move the line, drag the blue circle in the middle of the line. To delete the line, move the cursor onto the line (outside of the blue circles) and a stop sign appears. Click the stop sign to delete the line.



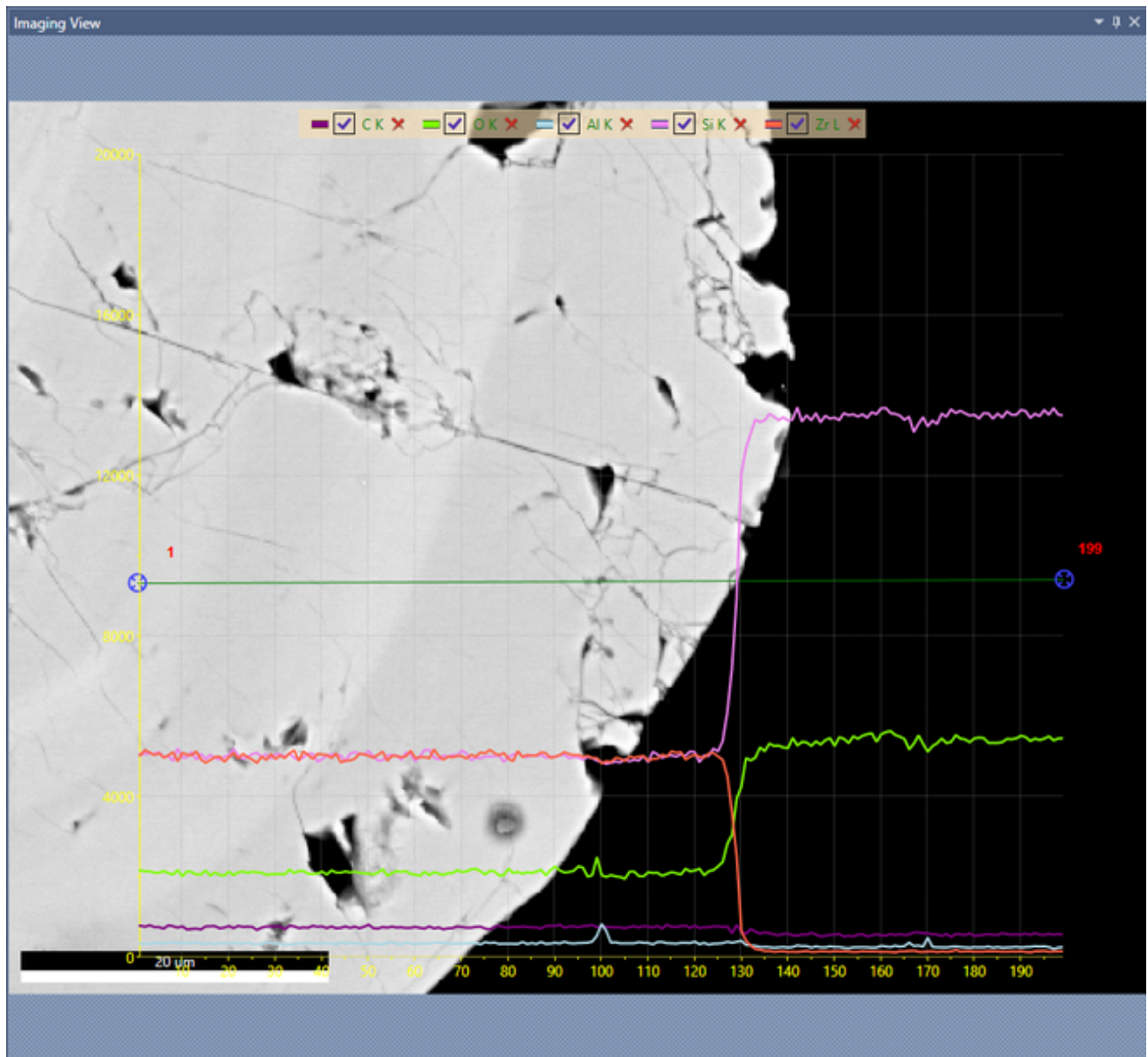
(Linescan Setup)



Once the line is defined, click the Collect Icon to start the linescan acquisition. The software will pre-scan the line selected and determine which elements are present, which will be shown in a pop-up box along with the estimated collection time. Clicking Confirm Elements in the pop-up box will immediately display the detected elements on the periodic table where the user can add and remove elements as desired. *Note: If the element list is locked, a spectrum preview will not be displayed.*

During collection, the linescan and spectral displays are shown in real-time. The element list can be modified and custom ROIs can be added in the same way as with mapping. This is discussed in detail later in the [X-ray map collection and settings](#). The overlaying elements on the line can be checked or unchecked during collection to enable/disable the display of the given element. Right clicking on the linescan display shows options to adjust Y-axis scaling and apply smoothing to the elemental curves. All defined elements will be displayed above the image. At the end of the scan a line profile will be displayed. To stop the linescan data collection, click the Stop icon next to the collect image icon. This can be done at any point during the collection and the following menu of options will appear.

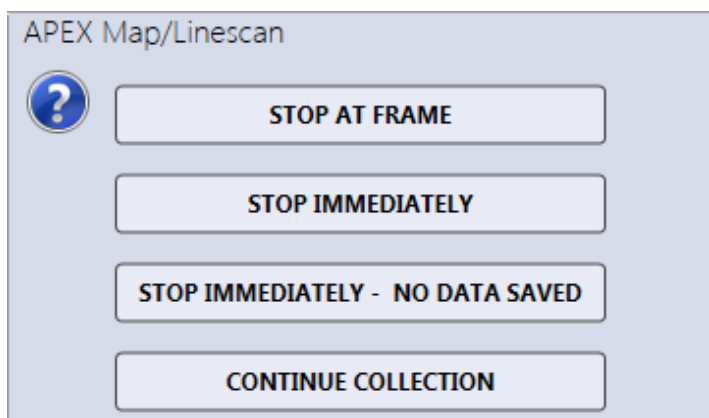
(Linescan Profile)



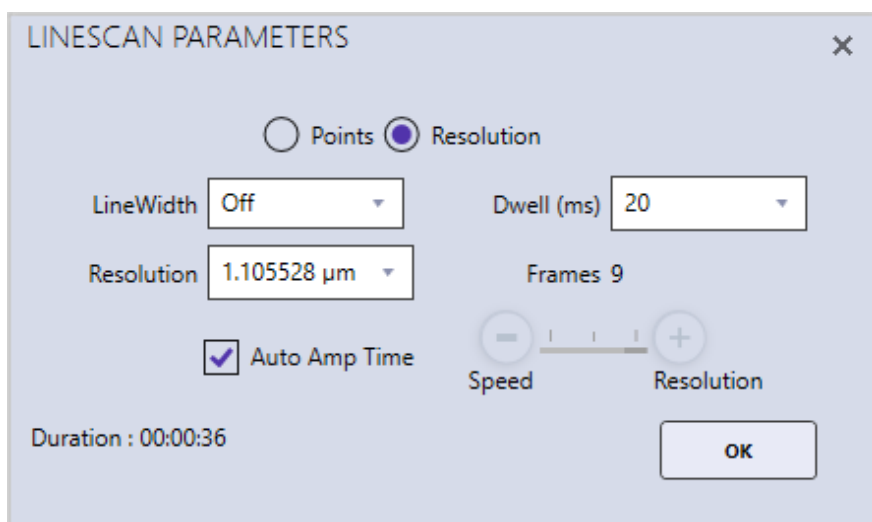
Stop Linescan Menu:

- Stop at Frame: Allows the collection of the current frame to complete, then stops.
- Stop Immediately: Immediate stop of the collection. The data is saved for reviewing. This means that the data collected will have dissimilar collection times before and after the point at which the collection was stopped.
- Stop Immediately: *No Data Saved*. Stops the collection. There will be no data saved.
- Continue Collection: Resumes the collection process. No loss of data will occur.

(Stop Linescan Menu)



The right-side drop-down menu, next to the Linescan Quality Icon, allows the user to select one of the four quality modes for data collection: Quick, SD, HD, and Manual. In quick mode the software will aim to acquire 1,000 X-rays per point on average while the numbers for SD and HD are 10,000 and 20,000 respectively. The collection parameters can be customized by the user for each collection mode. To set the linescan parameters, click the arrow next to the word *Linescan* on the bottom of the [collection toolbar](#) in linescan mode and a pop-up box will appear.



Linescans can be acquired in two possible stepping modes: Points or resolution. In Points mode, the number of points over which data will be collected is manually entered by the user. Enter the number of points and the click *Enter*. In Resolution mode, select a resolution value from the drop-down list or type in a number and number of points used will be calculated automatically.

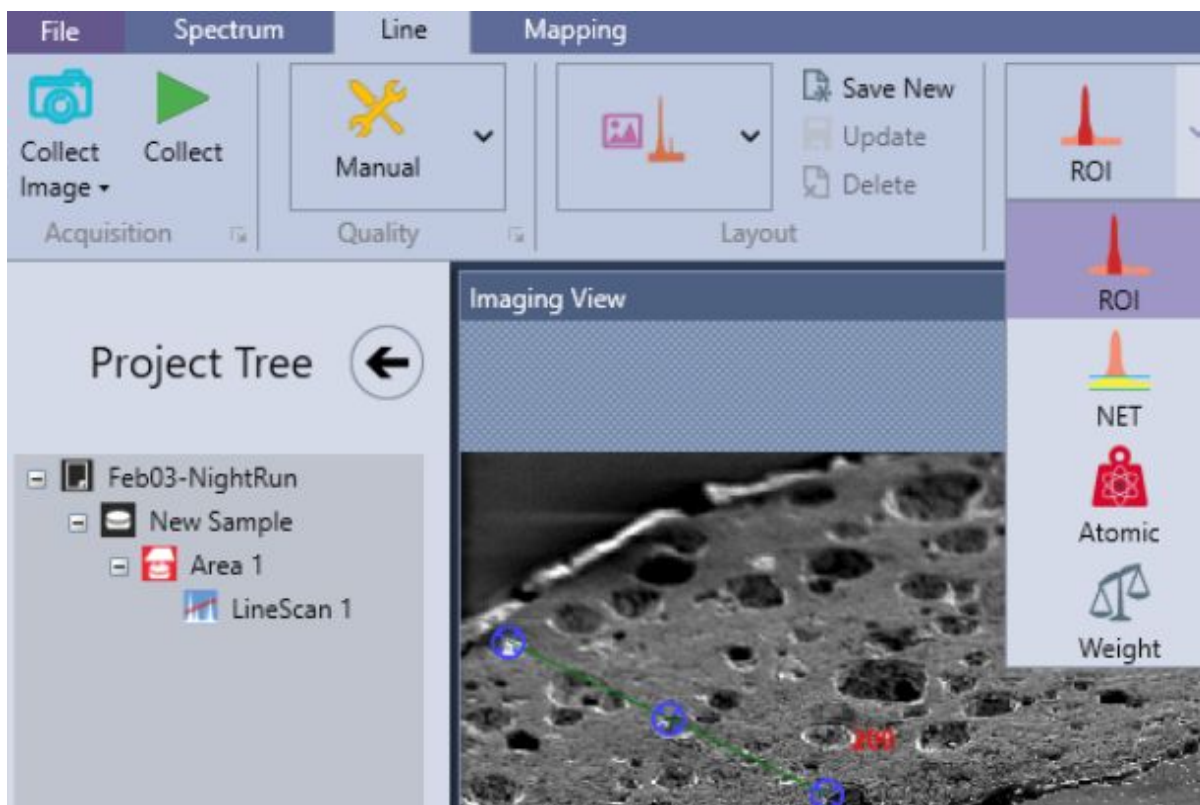
- **Line Width:** To scan a line perpendicular to the linescan instead of individual point locations, change the line width. This is useful for obtaining a more accurate intensity average for the elements. If the desired line width value is not in the drop-down list, type in the value and press enter.
- **Dwell (milliseconds):** The data collection time per point per frame. If the desired dwell time is not in the drop-down list, type in the value and press enter.
- **Resolution:** When using the *Resolution* radio button selection, this will select the distance between each point collected.
- **Frames:** The number of integrated frames that will be collected. In manual mode, the

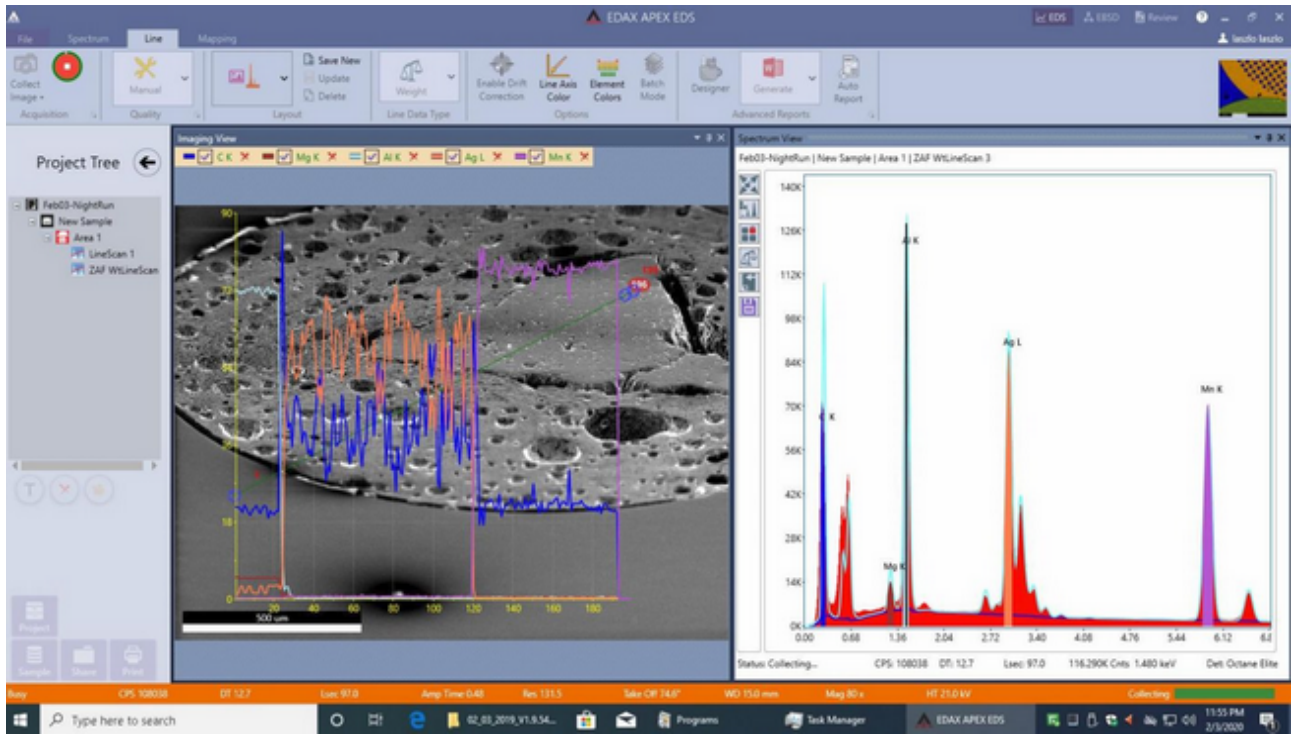
user can select the number of frames to collect. In the other three modes (Quick, SD, or HD), the software will automatically calculate the number of frames to acquire the pre-defined level of data quality. For High, the software will collect an average of 20,000 X-rays per point, for standard 5000 X-rays and for quick 1000 X-rays. If the desired frame number is not in the drop-down list, type in the value and press enter.

- **Amp Time Selection:** In the automatic quality modes (Quick, SD, HD) there is a checkbox for *Auto Amp Time* which automatically sets the amp time based on the input counts per second in order to balance throughput and resolution. When the Manual quality icon is selected or when Auto Amp Time is deselected in the automatic modes, the pop-up window displays a slider bar with Speed and Resolution. Drag the slider bar or click the plus and minus symbols to adjust the amp time.
- **Duration:** The estimated time required to collect the linescan based on the given parameters.

Live Quant For Linescan Collections

If the APEX license key has the LiveCompoMap option you can collect Live NET or AT/WT% Linescan data. The live display will show the quantitative or net intensity numbers directly and the data will be saved in the corresponding format. Alternatively the ROI linescan can be re-calculated in post collection. There is a slight time overhead per point ~ 100 milliseconds, it is recommended to use 200 msec dwell time or longer.



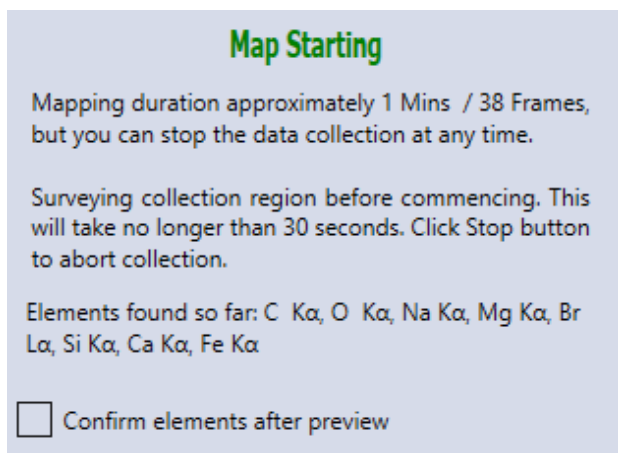


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X-Ray Map Collection and Settings

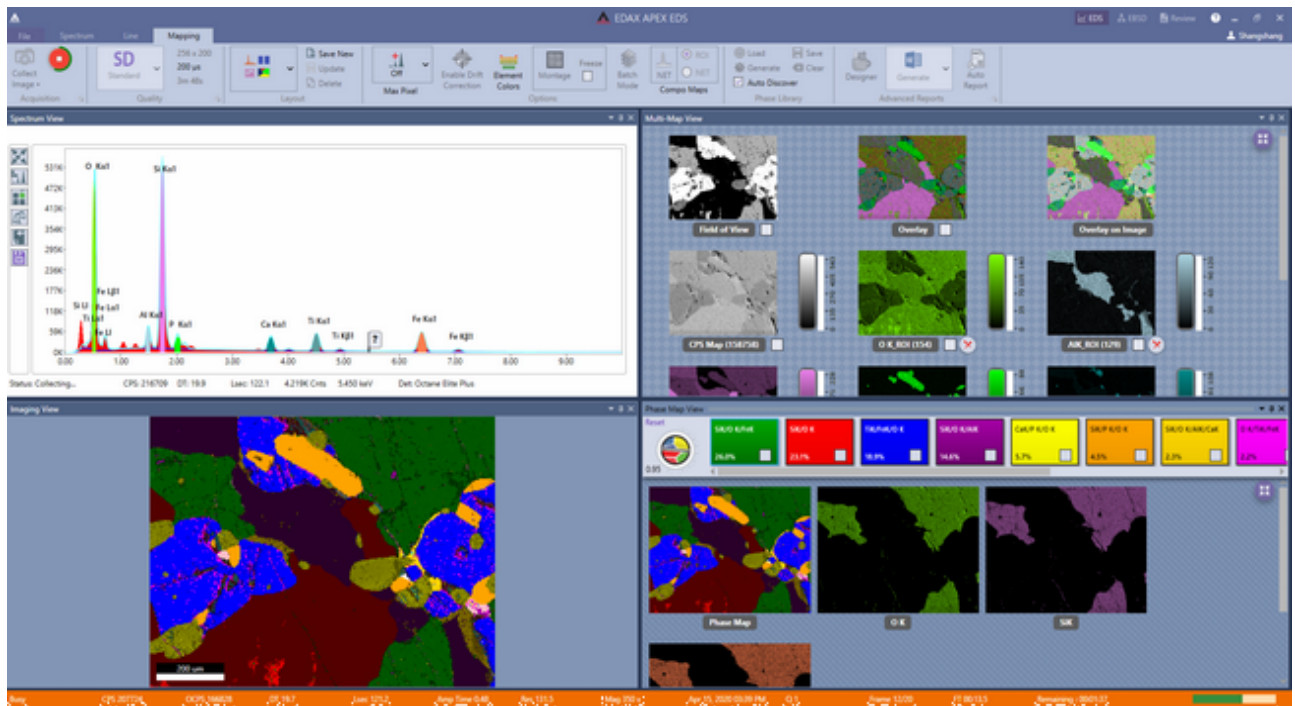
Map Collection and General Settings

After collecting an image, click on the Mapping Icon to enter mapping mode. By default the entire image will be mapped. You can also change the area, which is discussed below. Once the area is defined, click the Collect Icon to start the map acquisition. The software will pre-scan the area selected and determine which elements are present, which will be shown in a pop-up box along with the estimated collection time, shown below. Clicking Confirm Elements in the pop-up box will immediately display the detected elements on a periodic table where the user can add and remove elements as desired. Additionally, the red delete icon next to each element map can be used to remove an element. *Note: If the element list is locked, a spectrum preview will not be displayed.*



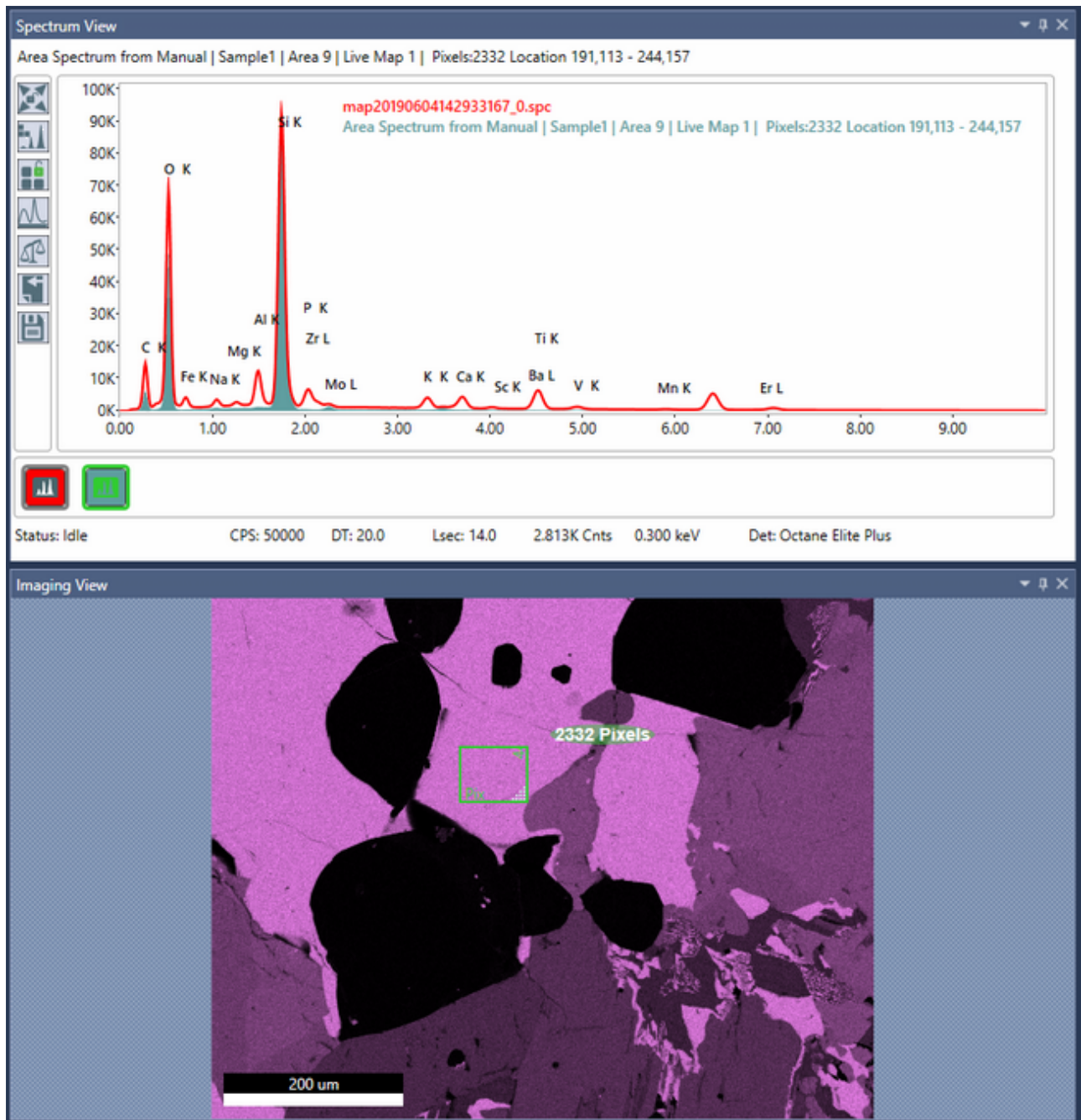
(Map Starting Window)

During the collection, the X-ray maps will be displayed in real-time, illustrated in the figure below. Clicking the arrow icon in the top right corner of the Multi-map window will toggle the display to show the default layout or the custom zoom layout. In the custom zoom layout the slider control beneath the arrow icon changes the amount of zoom. The status bar provides useful information about the collection, including: the frame number being collected, the time to collect a frame, the time remaining in the map collection, and a progress bar. A line showing the current frame progress can be turned on by right clicking the main map window and selecting Show Progress Line.



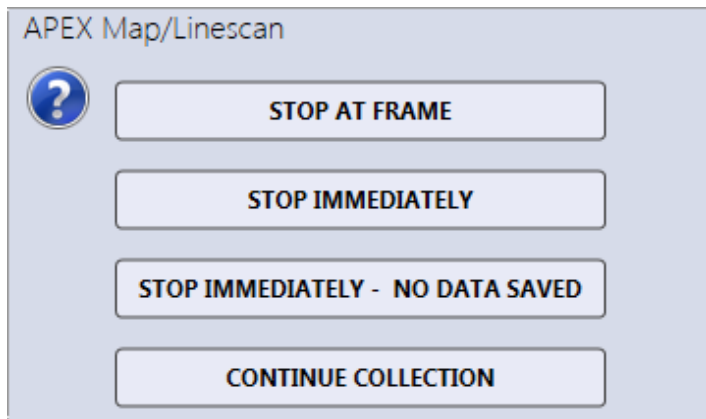
(Map Collection)

During collection it is possible to extract from a spot or an area by interacting with the Imaging View. The extracted spectrum is overlaid in the summary spectrum, shown below. The summary and extracted spectra will be updated on periodic basis. To extract from a location, just click for spot and click-drag for area.



(Extracting a Spectrum During Collection)

To stop the map data collection, click the Stop icon next to the collect image icon. This can be done at any point during the collection and the following menu of options will appear.

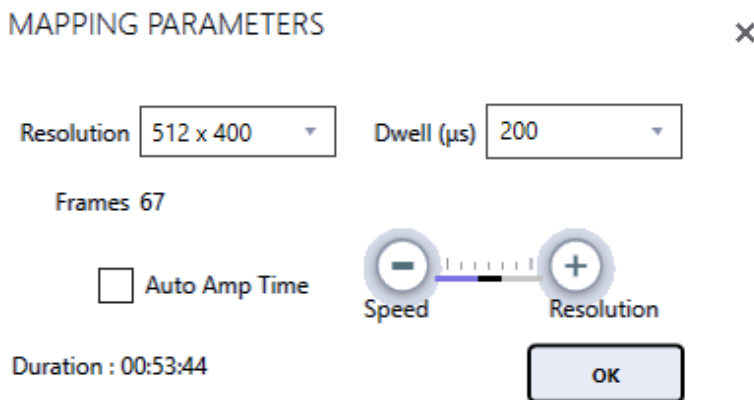


(Stop Map Menu)

Stop Map Menu:

- Stop at Frame: Allows the collection of the current frame to complete, then stops.
- Stop Immediately: Immediate stop of the collection. The data is saved for reviewing. This means that the data collected will have dissimilar collection times before and after the point at which the collection was stopped.
- Stop Immediately: *No Data Saved*. Stops the collection. There will be no data saved.
- Continue Collection: Resumes the collection process. No loss of data will occur.

The right-side drop-down menu next to the Map Quality Icon, allows the user to select one of the four quality modes for data collection: Quick, SD, HD, and Manual. In Quick mode the software will aim to acquire 300 X-rays per pixel on average while the numbers for SD and HD are 600 and 1,000 respectively. The collection parameters can be customized by the user for each collection mode. To set the map parameters, click the arrow next to the word *Mapping* on the bottom of the collection toolbar in mapping mode and a pop-up box will appear.



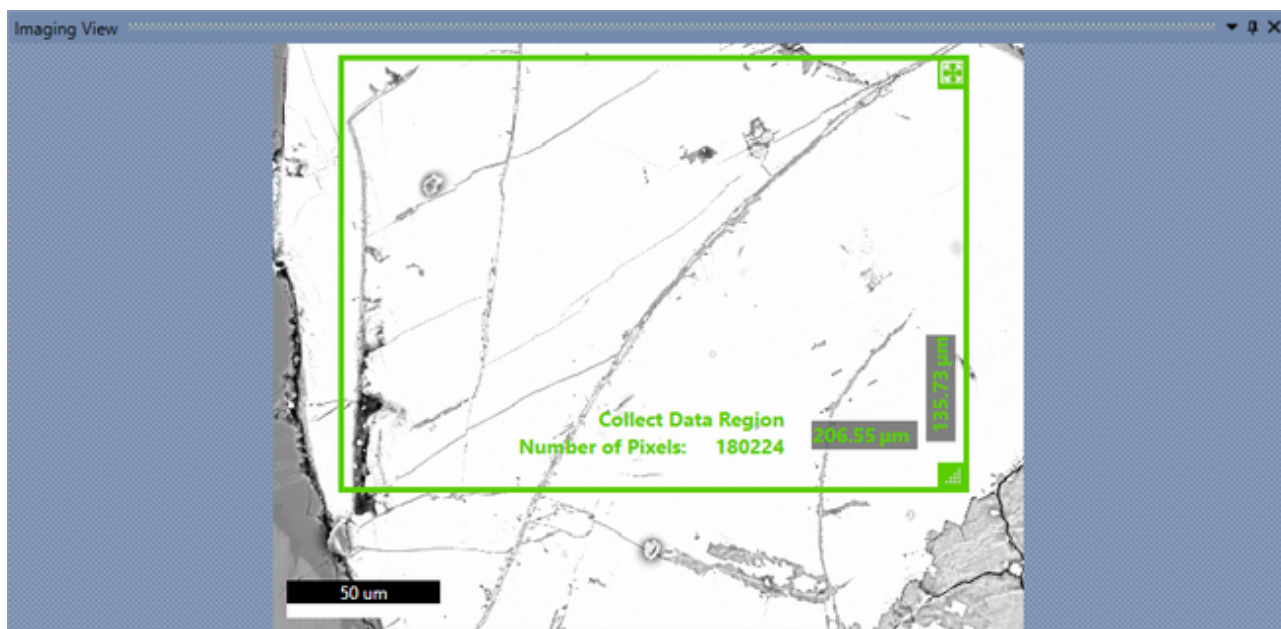
(Map Parameters)

- Resolution: There are five different collection matrices that can be used for mapping: 64 x 50, 128 x 100, 256 x 200, 512 x 400, and 1024 x 800 pixels. Use the drop down menu to select a resolution value.
- Dwell (µseconds): The data collection time per pixel per frame. If the desired dwell time is not in the drop-down list, type in the value and press enter.
- Frames: The number of integrated frames that will be collected. In manual mode, the user can select the number of frames to collect. In the other three modes (Quick, SD, or HD), the software will automatically calculate the number of frames to acquire the pre-defined level of data quality. If the desired frame number is not in the drop-down list, type in the value and press enter.

- **Amp Time Selection:** In the automatic quality modes (Quick, SD, HD) there is a checkbox for *Auto Amp Time* which automatically sets the amp time based on the input counts per second in order to balance throughput and resolution. When the Manual quality icon is selected or when Auto Amp Time is deselected in the automatic modes, the pop-up window displays a slider bar with Speed and Resolution. Drag the slider bar or click the plus and minus symbols to adjust the amp time.

Map Area Selection:

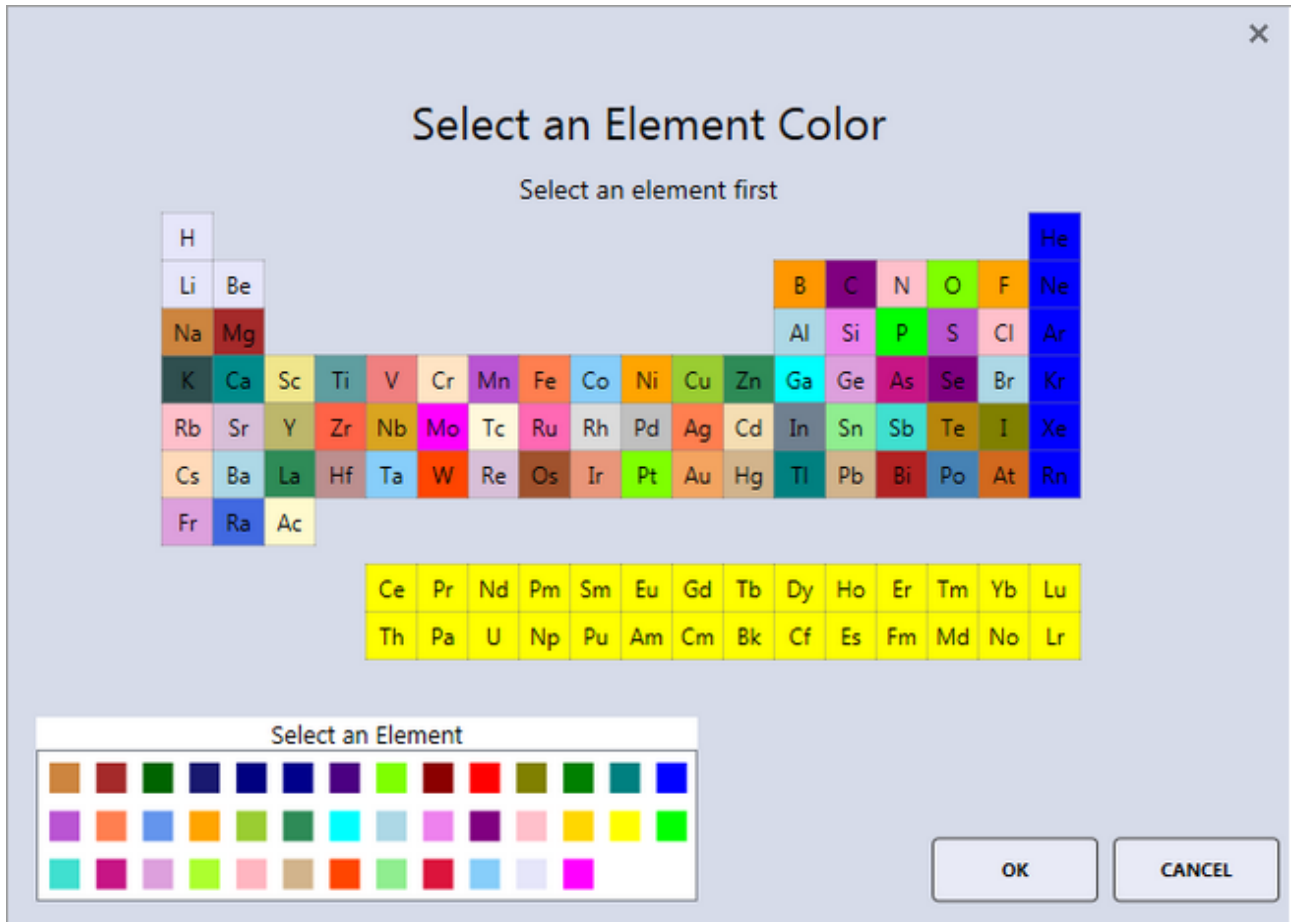
As a default, X-ray maps are collected from the entire image area. To collect a map from a portion of the image or to focus on one distinct feature, adjust the green box on the image view window as shown below. To change the size of the box, drag the size control in the bottom right corner of the box. To shift the location of the box, click the center of the box, hold the mouse button, and drag. The preset x-resolution value will be used for map, but the y-resolution value will automatically be re-calculated to preserve an image aspect ratio of 1:28 to 1. The number of mapping points will be displayed on the green box.



(Map Area Selection)

Map Element Color Options:

Before starting a map, during a map collection, or after mapping, the color of the elements on the periodic table can be customized. Click the Element Colors icon in the toolbar and click on specific elements to change their color. The colors set in this window will also be used for mapping elements when in review mode.



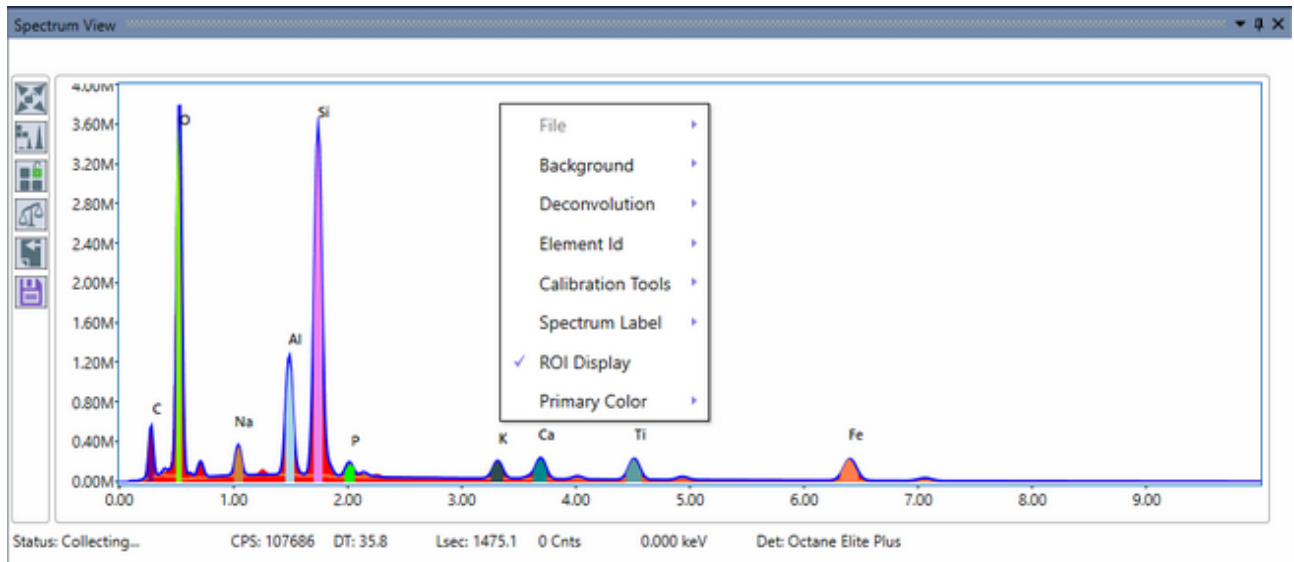
(Map Element Color Selection)

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ROI Display, Custom ROI and Changing Elements While Mapping

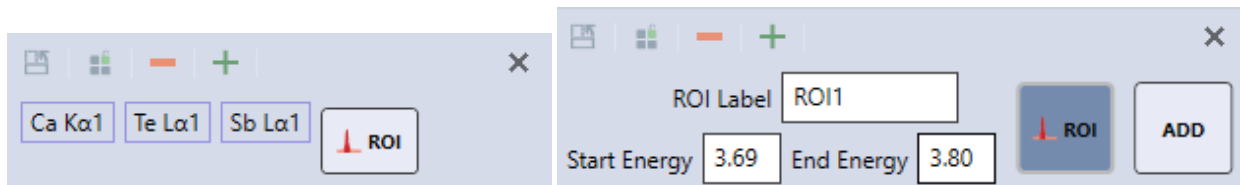
Note: Changing elements while mapping is only available in APEX advanced.

While maps are collecting, a right click in the [spectrum view window](#) will bring up the option to display the energy ranges used for ROI maps, shown below. The ROI regions are displayed with their associated element colors.



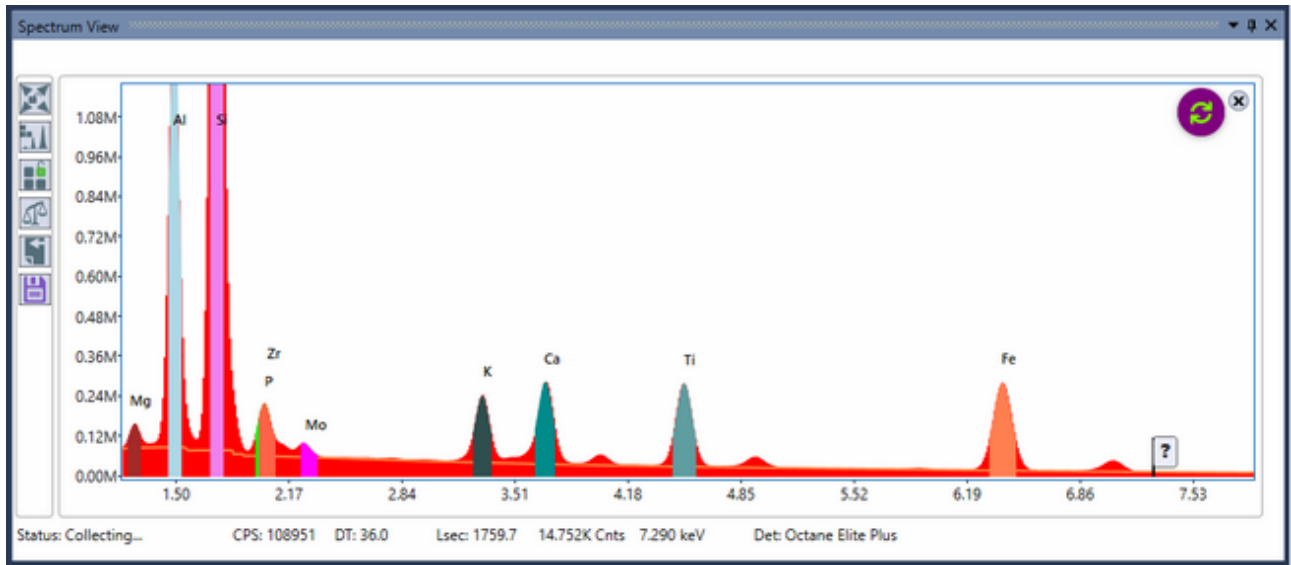
(Display of Map ROI energies)

When adding and removing elements in the spectrum window, an additional option for ROI will be displayed in map mode. This allows the user to create one or more custom energy ranges for mapping.



(Add Custom ROI)

When elements or ROIs have been added or removed, a refresh icon will appear in the top right of the spectrum window (shown below). Clicking the refresh icon will update the map display to reflect the spectrum window elements and ROIs. Removing elements or ROIs can also be done by clicking on the trash can below the relevant map.



(Refresh Map Elements)

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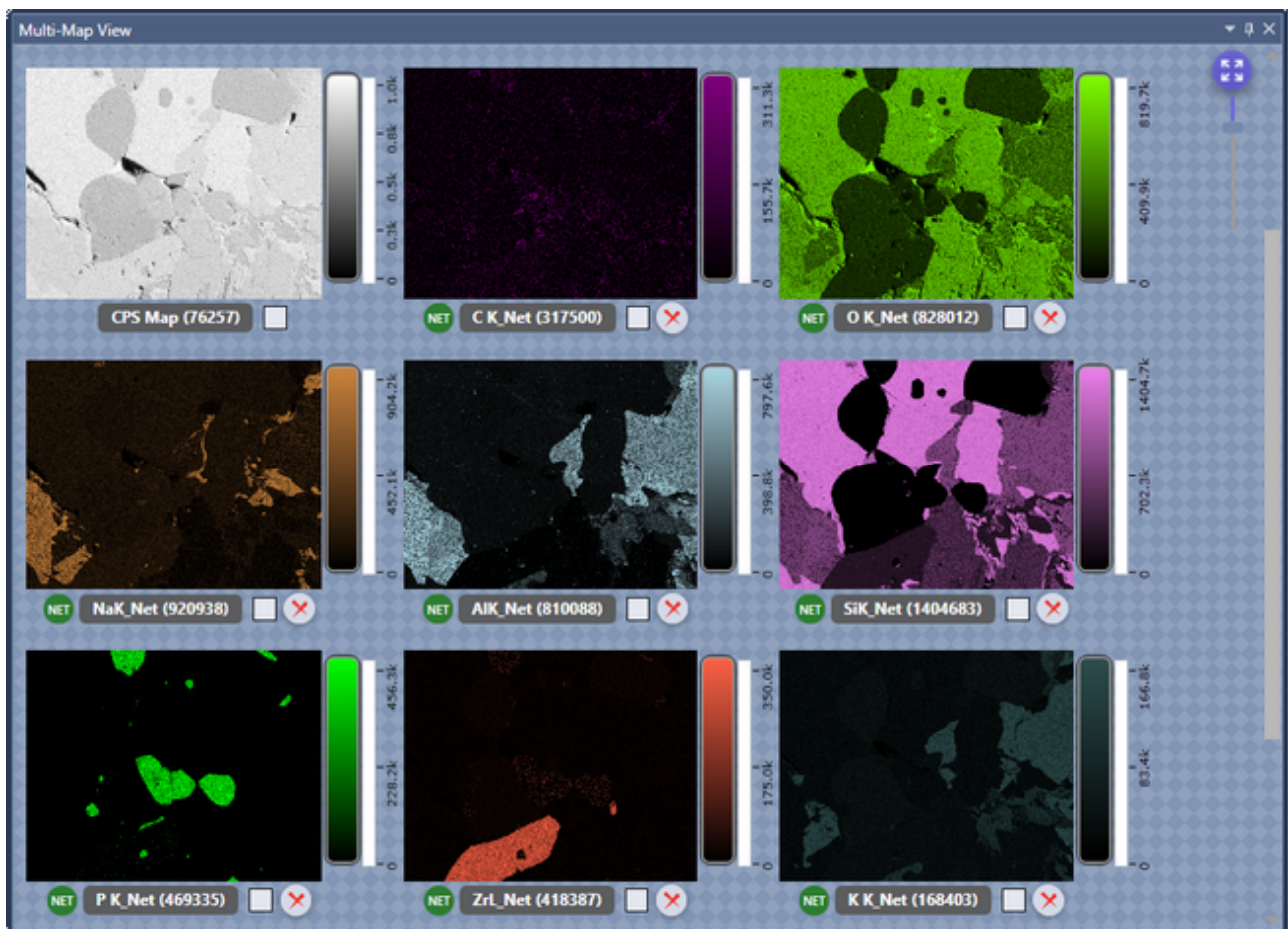
Live NET and ROI Map Options

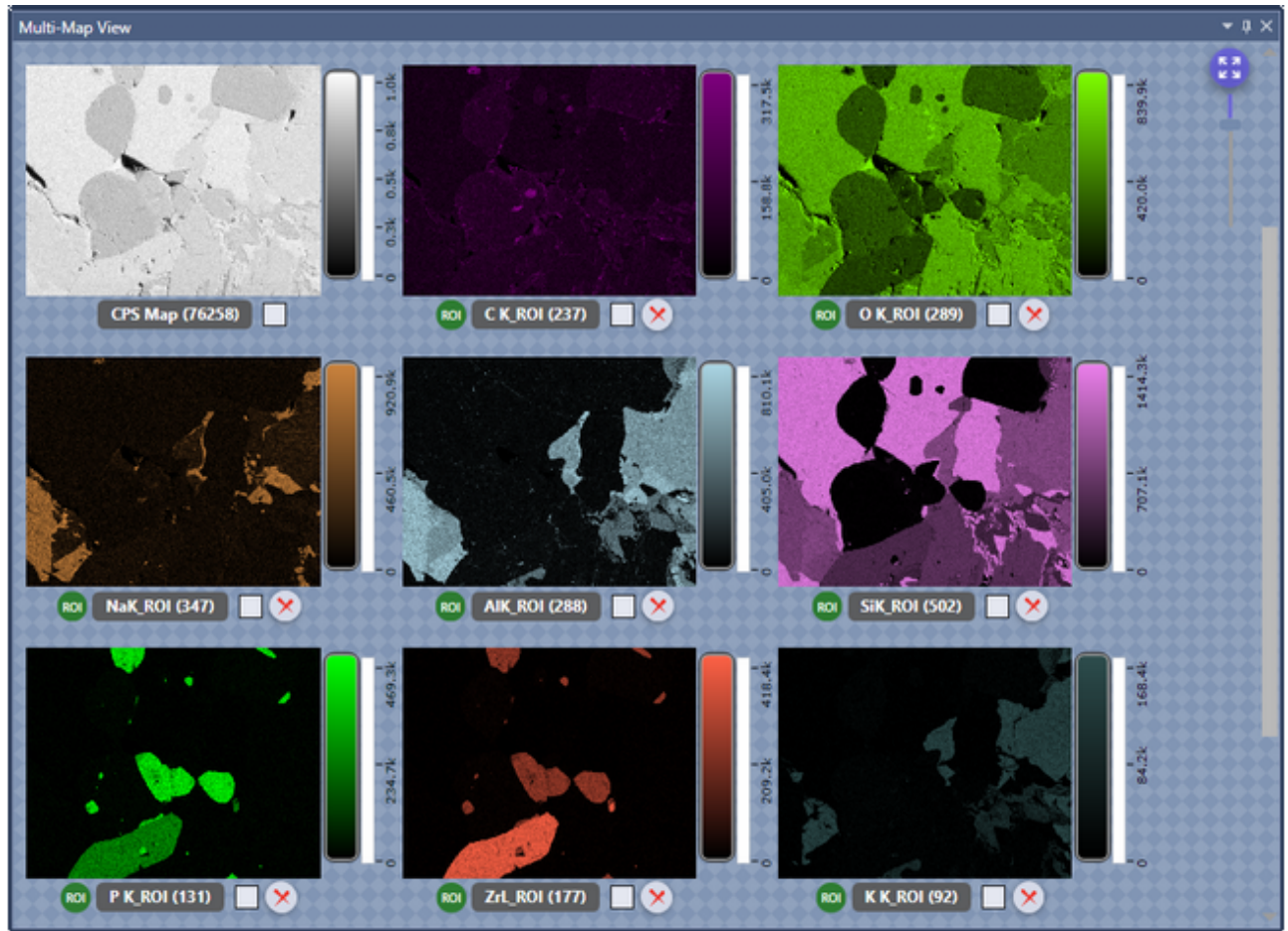
Note: Live Net maps/CompoMaps are only available in APEX advanced.

In Mapping Mode, the NET icon appears in the toolbar. If Net maps are desired, the option should be turned on before acquisition is started. When selected, the icon turns gray and allows the user to select NET or ROI map in real time, via the check box.



The NET function applies background correction and peak deconvolution to the data while the ROI function displays the map in scaled, raw counts. While data is being collected, use the check boxes to switch all maps between the two modes. Individual maps can be switched by clicking on the NET/ROI label beneath the map. In order to save a NET or ROI map for a specific element map, select the desired map using the check box. Element maps created with the NET or ROI function on will be labeled accordingly (see images below).





(Net and ROI Element Map Labels)

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Smart Phase Mapping

Note: Phase mapping is only available in APEX advanced.

The Phase Map routine will separate areas of the sample that have similar composition and color code them accordingly. To do this, the routine looks at ROI counts of the identified elements and applies a background subtraction. It then compares the count ratios of the peaks pixel by pixel and groups them by a chi-square goodness of fit. Note that there is a relatively high threshold for how big a peak needs to be in order to be taken into account, which means that trace and minor elements typically will not be added in the phase mapping element list. To display the phase maps, a GUI layout including phase maps have to be selected either by the default layout drop down or by clicking the Application Menu icon in the top left of the GUI and the clicking Phase Map View. The threshold for the goodness of fit criteria before a new phase is created can be adjusted by the Tolerance Adjustment Knob to the left of the identified phases.

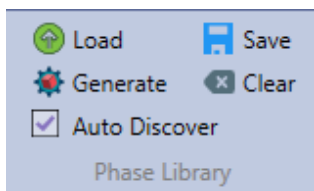


(Default Layout Options Available for Phase Mapping)

License key options APEX EDS Phase mapping to Element and APEX Suite Enhanced are required for this feature.

Phase Library Toolbar Options

By default the phase routine will populate a library without any user interaction. It is possible to change this and customize the libraries by using the phase library toolbar options shown below. Selecting one or more phases will display them in the main map window, if none are selected all phases will be shown.



(Phase Library Toolbar)

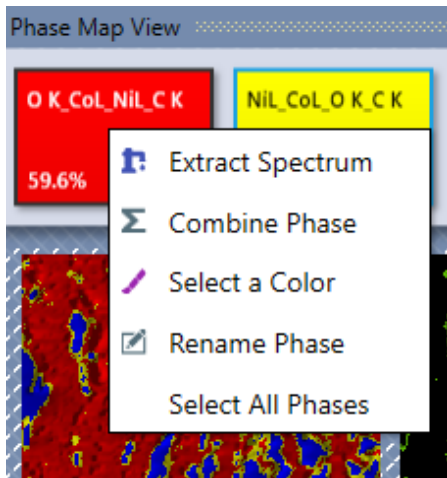
- **Auto Discover:** This option will discover new phases based on current element list. If unchecked (locked), only the phases selected will be considered during mapping.
- **Load:** Load previously saved phase library file (*.pml). This is EDAX TEAM compatible.
- **Generate:** Generate a Phase based on current active spectrum. The generated Phase is shown in Phase Map View (grey). A color selection window will appear to select the color of the phase.
- **Save:** Save Selected Phases as Phase Library.
- **Clear:** Clear loaded Phase Library Phases from Phase Map View.

Phase Button Right-Click Options

- **Extract Spectrum:** Extract selected Phase Spectra. The extracted spectra will be displayed in a Phase Spectra View window that shows up as a tabbed window in the Spectrum Display by default.
- **Combine Phase:** Combines 2 selected phases. During collection, any 2 phases can be

combined.

- Select a Color: Select the color of the phase.
- Rename Phase: Rename phase to custom name.
- Select All Phases: Select all phases.



(Phase Button Right-Click Options)

Tolerance Adjustment Knob

This knob is displayed in the top left corner of the Phase Map View window. It adjust how "different" the relative count ratios should be before a new phase is added. Turning the knob will adjust the tolerance between 0 and 2. Clicking Reset will reset the tolerance to the default value. This knob controls the number of phases identified, not how low counts the routine will take into account.



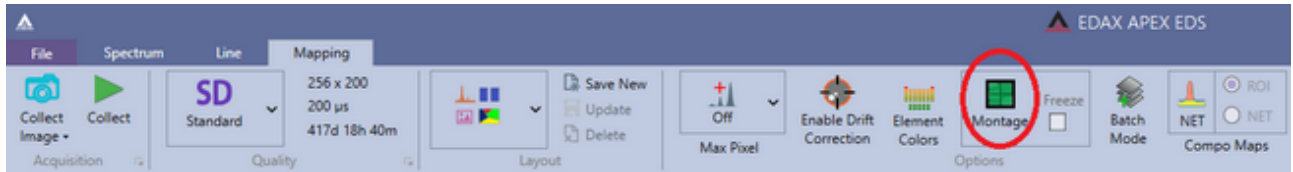
-0-

Montage Mapping

Note: License key options APEX Montage Mapping and APEX Suite Enhanced are required for this feature.

Montage Mapping Setup

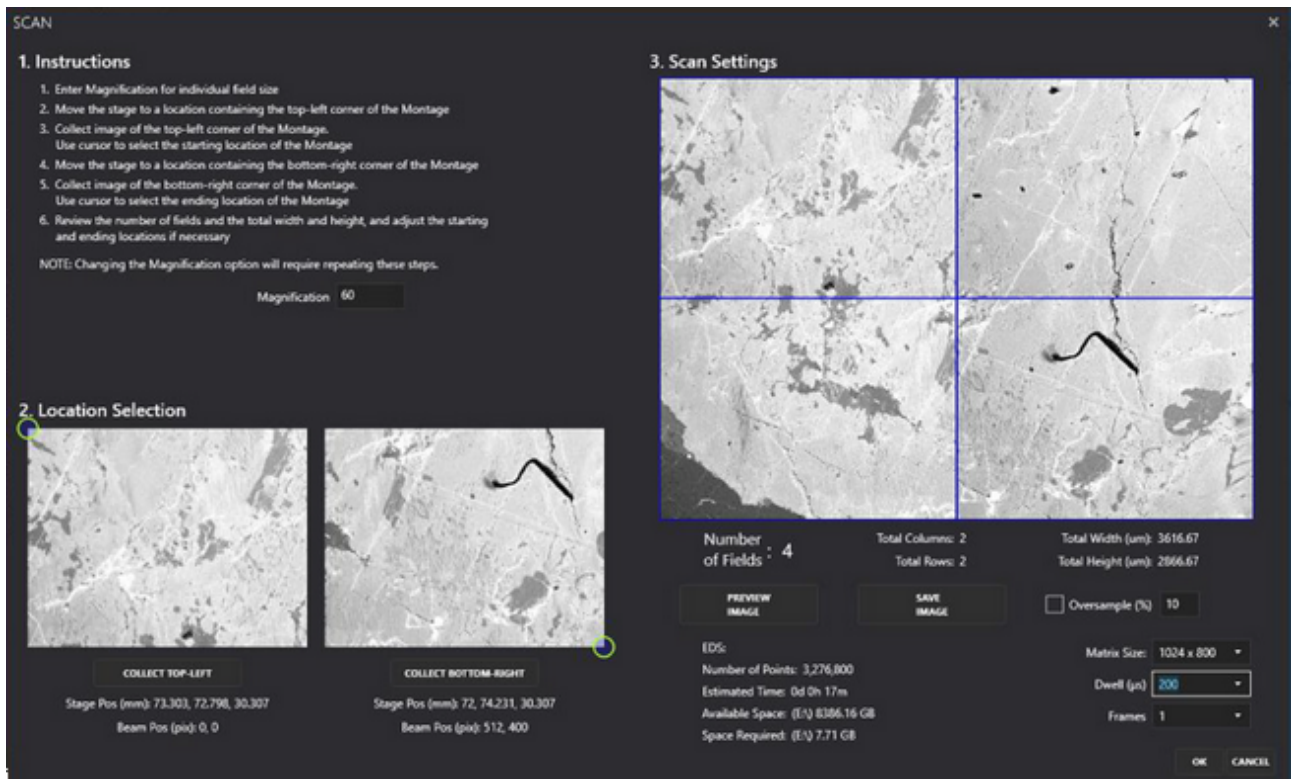
To start the setup – Select Montage toolbar button. When selected, the Montage mode is always active. To return to normal mapping mode de-select this button. Click Freeze to lock in Montage mode operation (setup parameters) – you can open/close the same Montage setup with this option.



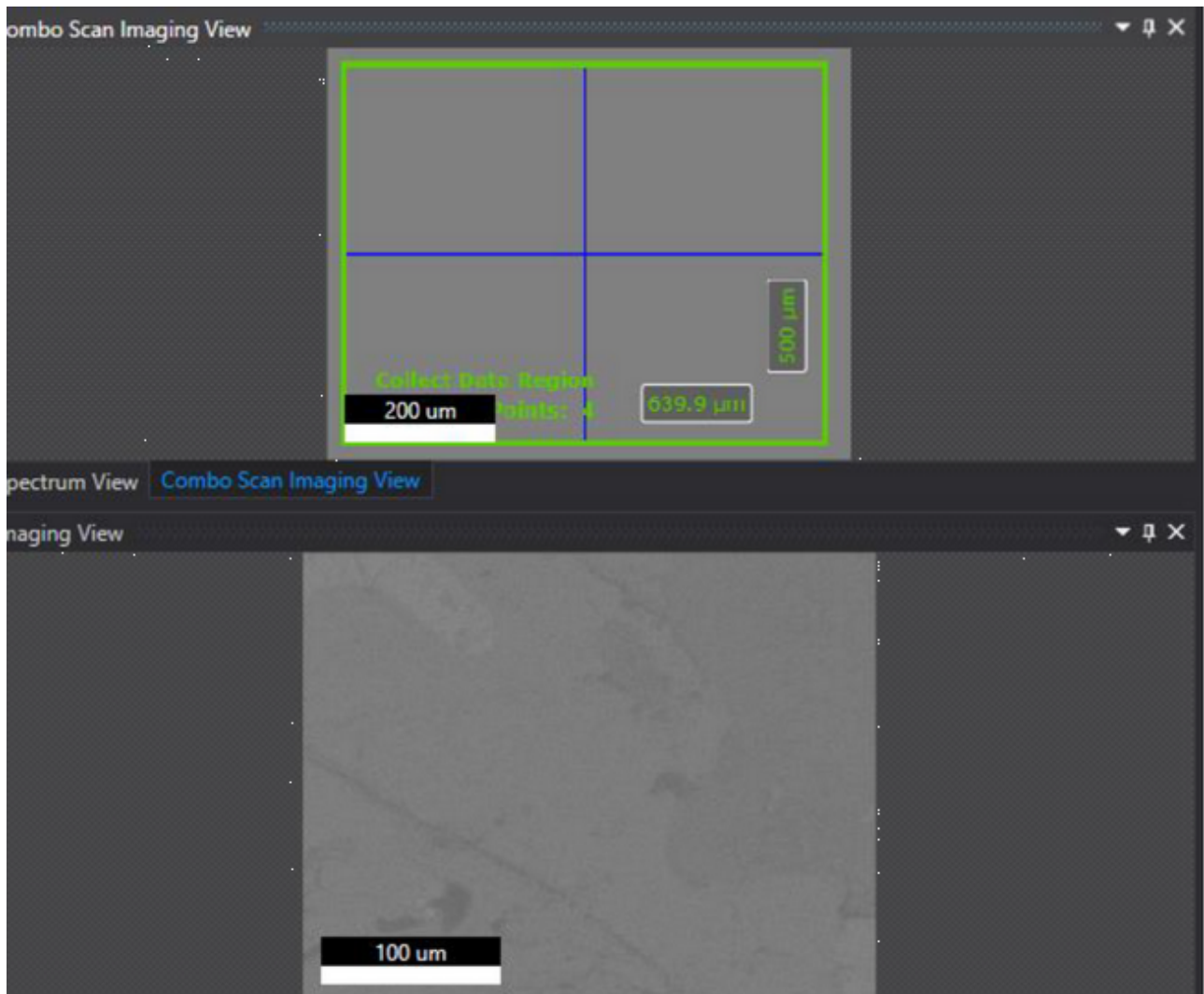
(Montage Toolbar Button)

Move to the Starting Stage position and click the Collect Top-Left button. When the image is collected, you can select the offset at top left for starting position of Montage.

Move to the Ending Stage position and click the Collect Bottom-Right button. When the image is collected, you can select the offset at Bottom right for ending position of Montage. This will automatically calculate the number of fields and be show them in a grid layout. Clicking the Preview Image button will go through the montage and collect an SEM image of each field. This can be useful for checking the alignment before the full run.



Select Matrix size, dwell time and frames and Click OK to complete the setup of the area. The Main display will now show the fields:



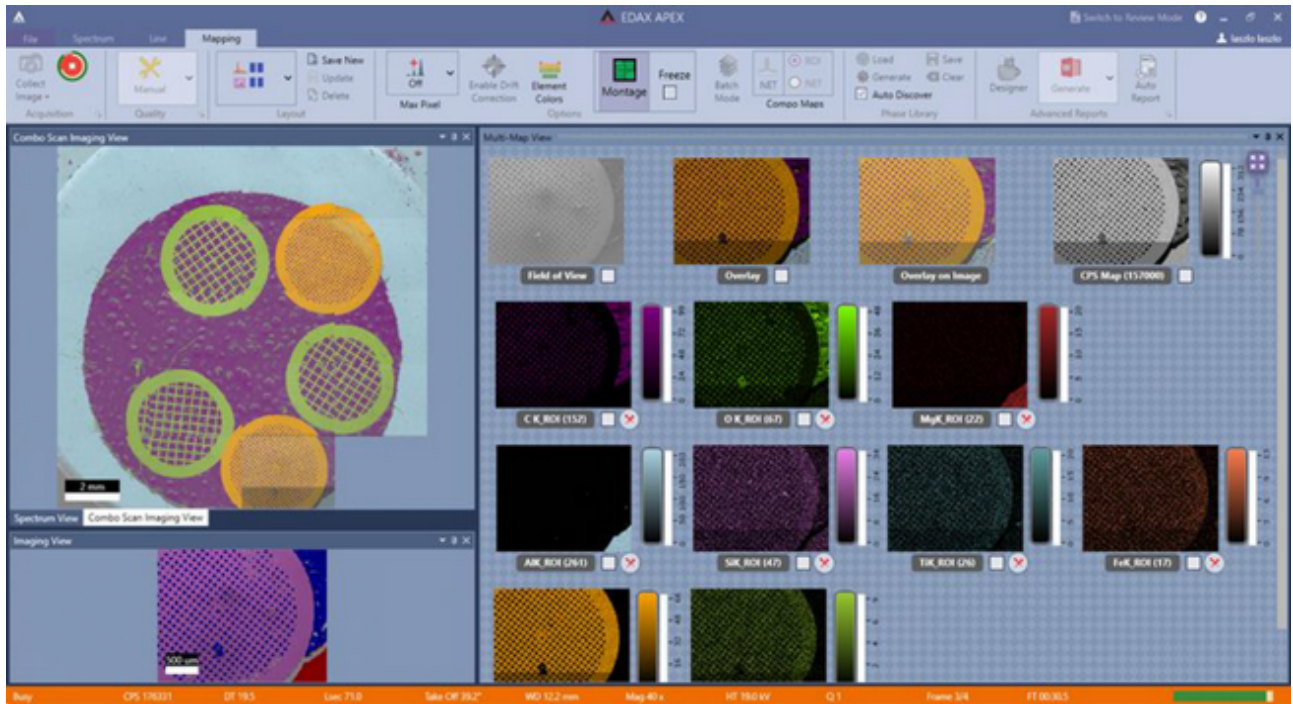
Ideally you should first collect a spectrum representative from the complete mapping area that is being mapped and then lock the element list.

To start click the Collect button, the Montage Collection will begin after you click on YES.



If the Element List is locked, the Montage will begin, otherwise a preview spectrum is collected, and you can modify the element list as desired. Once the map starts you can still modify the element list only during the collection of the very first stage field.

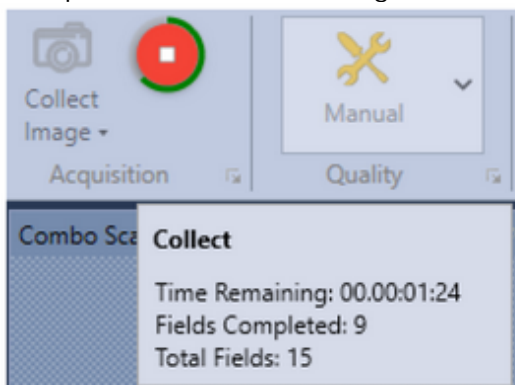
Imaging view and Multi-Map views will display the current fields collection of maps, and the Montage Imaging view will display all the map fields collected.



During the collection, you can click on each individual map to display it in the larger Montage Imaging view. You can see below the progress indicator; the green outside ring is the total Montage progress and the white inner ring is the progress for this one field.



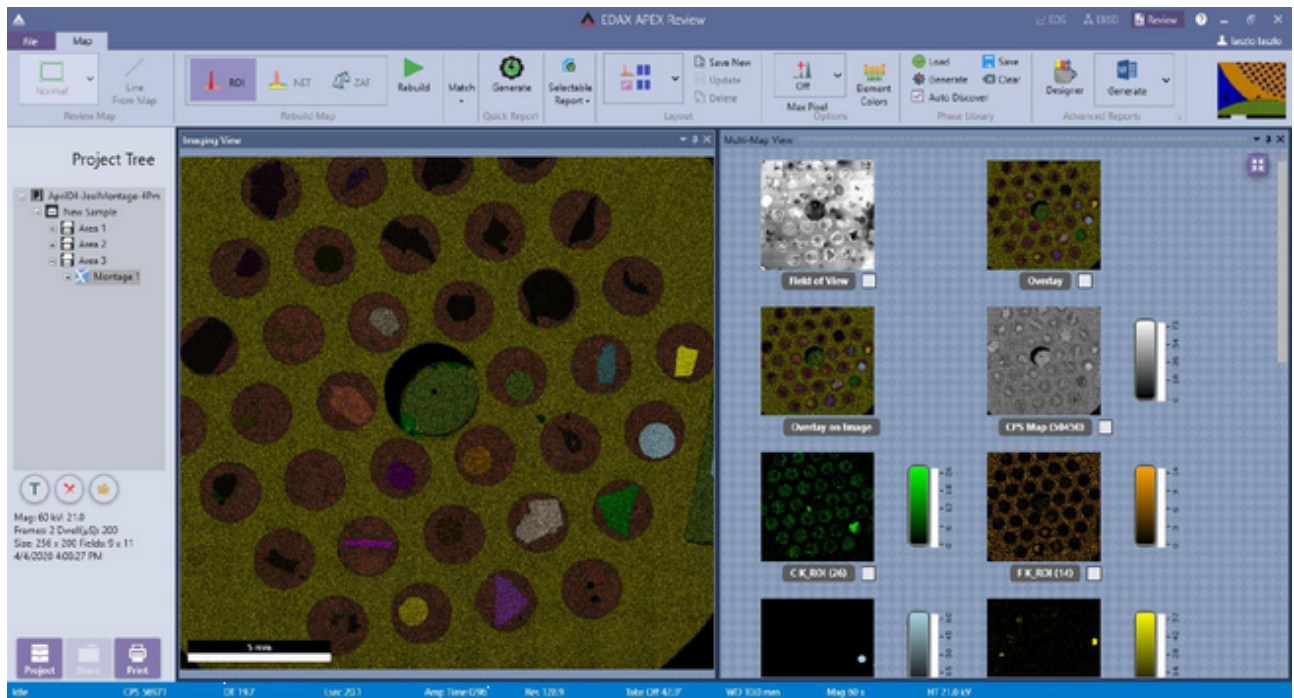
During an EDS Montage collection, you can hover over the collect/progress button and the following progress information displayed below. Also, the current frame # and stage field# are updated in the bottom right of the main status bar.



Montage Review

As seen below the EDS Montage data is displayed in the Review mode. The "Montage"

project node is the multi-field scan. You can also review each individual field by double clicking on that field # in the project tree.





High-Resolution Graphics output files are now supported via the “Send to Folder” function which outputs the full resolution of the collected data images in the file format (extension PNG, BMP, TIFF or JPG) you have selected. Very large maps with multiple element overlays can take several minutes to generate.



Note that Microsoft Paintbrush cannot display images that have an X or Y resolution which is greater than 10,000 Pixels.

Montage Fields Alignment

To check the Montage field width/height alignment, use the Preview Image button and see how close the adjacent fields match, often a copper grid is used for this test. To fine tune the fitting, you must adjust the Mag Reference Width/Height (mm) values, and then go back into Montage, recollect the 2 images & re-run the Preview Image to see how the changes you made improve the fit.

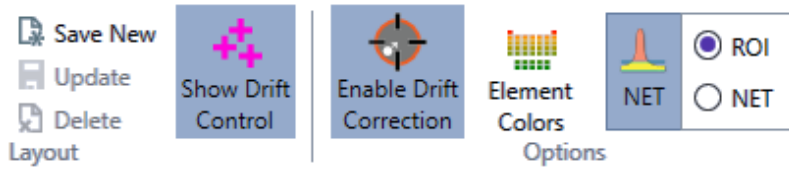
Mag Reference  	
Width (mm)	128.0
Height (mm)	100.0

The other aspect of the alignment is to check if there is any Y-Shift in the Stages X-Travel. If this is the case you will need to turn on and adjust the SEM Scan Rotation to compensate for the offset or calibrate the SEM.

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Drift Correction

To turn on/off Drift Correction, use the enable drift correction icon in the toolbar. Once drift correction is turned on, the *Show Drift Control* icon can be used to show or hide the drift view panel.



(Drift Correction Icons)

Drift Correction View Window

The drift correction view window appears on the right hand side of the screen, when enabled and in live mode. It shows the field of view, reference, and current images for the data set being collected. The location of the drifting sample is shown on the graph as well as in the data table, via x, y offset coordinates and their corresponding time.

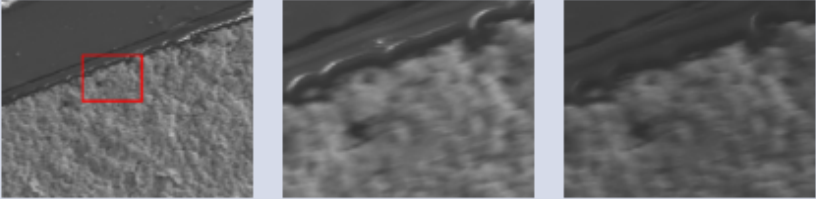
(The Drift Correction View Window)


Drift Correction View

Field Of View

Reference

Current





Status Requested

Save Drift Image

Collect Image at Drift

Manual Drift Area

ELAPSED TIME	X OFFSET	Y OFFSET	CONFIDENCE	CONTRAST
00:07:04	-12	22.75	20	18.8
00:06:52	-12	22.75	20	18.8
00:06:39	-12	22	19	18.8
00:06:27	-12.75	22	19	18.8
00:06:15	-12.75	22	19	18.8
00:06:03	-12.75	22	19	18.9
00:05:50	-12.75	21.25	19	18.9
00:05:38	-12.75	21.25	20	19
00:05:26	-13.5	21.25	19	19
00:05:14	-13.5	20.5	19	19.1
00:05:01	-13.5	19.75	19	19
00:04:49	-14.25	19.75	19	19
00:04:37	-14.25	19	20	19
00:04:24	-14.25	19	19	19
00:04:12	-14.25	18.25	20	19.1
00:04:00	-14.25	17.5	20	19

There are three switch bars in the drift correction window. To adjust the settings for drift control, simply click the bar to turn the function on/off. When the bar is purple, the function is on. Save Drift Image saves the reference image used for drift control. Collect Image at Drift collects and saves the "current image" each time it is adjusted due to drift. Manual

Drift Area enables the user to set the reference area for drift control. When this function is turned on, the user must select a reference area on the image using the green box and click select before data collection starts.



(Manual Drift Area)

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Scan List

To turn on/off the Scan List, use the scan list icon on the application menu. Clicking the icon brings up the scan list window.

Est. Duration: 128 sec				Import		Export		Delete All			
ID	TYPE	SUB TYPE	TIME (SEC)	DWELL	UNIT	FRAMES	RESOLUTION				
1	PointAnalysis	Spot	20	20	L sec						✗
2	PointAnalysis	Spot	20	20	L sec						✗
	LineScan	Line	68	0.02	sec	17	0.65				✗
3	PointAnalysis	FreeDraw	20	20	L sec						✗

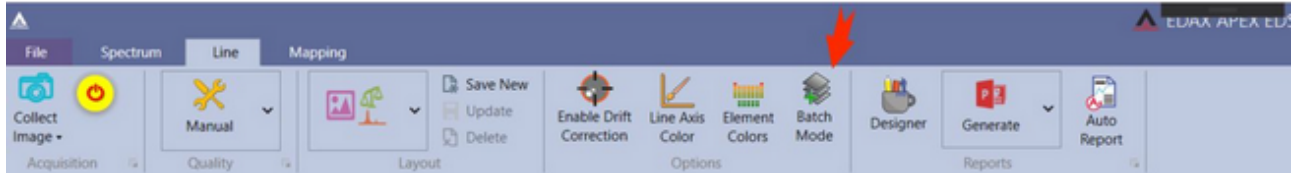
After each collection is defined, it will automatically appear in the scan list window. The dwell time and resolution can be entered manually in the Dwell and Resolution cells. An estimate for the total collection time is displayed in the top left corner of the scan list window.

- Import: Read from a previously stored scan table file. The file must be a *.Amt file.
- Export: Saves the table entries to a *.Amt file.
- Delete All: Erases all the entries in the table. Clicking the trash can next to a specific entry will delete just that entry.

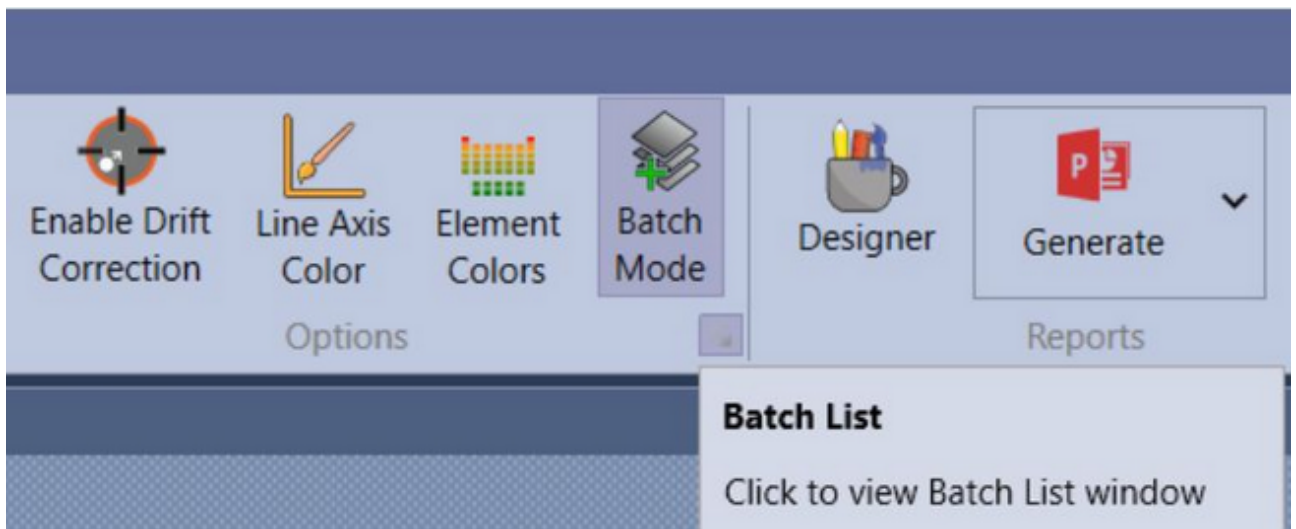
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Batch Mode

Batch Mode allows the collection of data in a batched process at different stage positions. To enable batch mode, click the Batch Mode button. This button is available in Spectrum, Line and Map mode.



When clicked an advanced mini button appears.



This button will bring up the Batch List window. This window will list all the items that are stored for batch collection. Individual items can be edited or deleted and the entire list can be imported/exported.


BATCH LIST

Est. Duration: 40 sec

Import Export Delete All

Type	Sub Type	Time (sec)	Dwell	Unit	Frames	Resolution	Stage	
LineScan	Line	20	0.05	sec	4	2.16	1 : (0.000, 0.000, 40.000)	✗
LineScan	Line	20	0.05	sec	4	1.77	1 : (0.000, 0.000, 40.000)	✗
Mapping	Map	96	200	µs	8	256x200	2 : (10.000, 10.000, 40.000)	✗
		Number of Points						
		256						

To begin adding items to the list, set the desired stage position. Collect an image then draw a line, map or draw a spectrum area. Move the stage again, collect a new image, then draw a line, map or a spectrum area. The items in the list will grow accordingly. The list is also available from the scan list.



Est. Duration: 60 sec

Import Export Delete All

Type	Sub Type	Time (sec)	Dwell	Unit	Frames	Resolution	Stage	
LineScan	Line	20	0.05	sec	4	2.16	1 : (0.000, 0.000, 40.000)	✗
LineScan	Line	20	0.05	sec	4	1.77	1 : (0.000, 0.000, 40.000)	✗
Mapping	Map	96	200	µs	8	256x200	2 : (10.000, 10.000, 40.000)	✗
PointAnalysis	Area	20	20	L sec			2 : (10.000, 10.000, 40.000)	✗

Idle CPS 9 OCPS 9 DT 0.0 Lsec 0.0 Amp Time 3.84 Take Off 30.0°

The [scan list](#) contains the same information as the batch list however the scan list is a slide out control and can not be moved. You can access the batch list from the scan list by clicking the button below:



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Data Analysis and Display

Quant View Window

Quant View Window Introduction

While data is collecting, the quant results will automatically appear and update in the quant window, designated by the user in layout settings. There are multiple options for viewing quant results including: numerics only, graphs, and statistics. Be aware that any accurate quantitative analysis requires the spectra to originate from a flat, homogenous bulk sample.

Numerics Only View

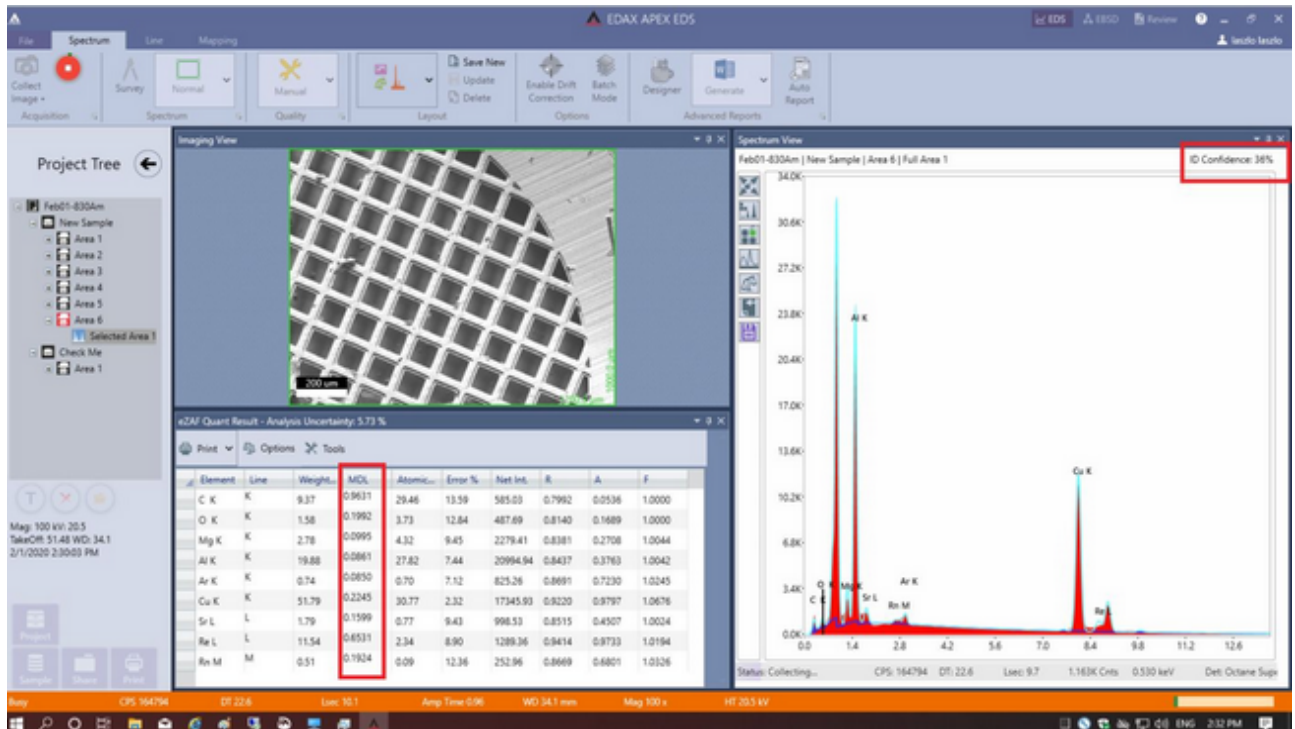
The numerics only view displays the quant results in a table which can be customized by the user. Right click on the Quant Results Window to turn on or off (via a check mark) the quant values that will be used for display and reports. The *Single Decimal Quant* option sets the weight and atomic percentages to just a single decimal point of accuracy. The default display setting is two decimal points, but be aware that this does not imply that the quant results have two decimal points of precision.

The screenshot shows the 'Quant Results' window with a table of element data and a context menu open. The table has columns for Element, Line, Weight %, Net Int., and R. The context menu includes options for Weight %, Atomic %, Error %, Net Int., RAF factors, Single Decimal Quant, and Auto-hide R zero values.

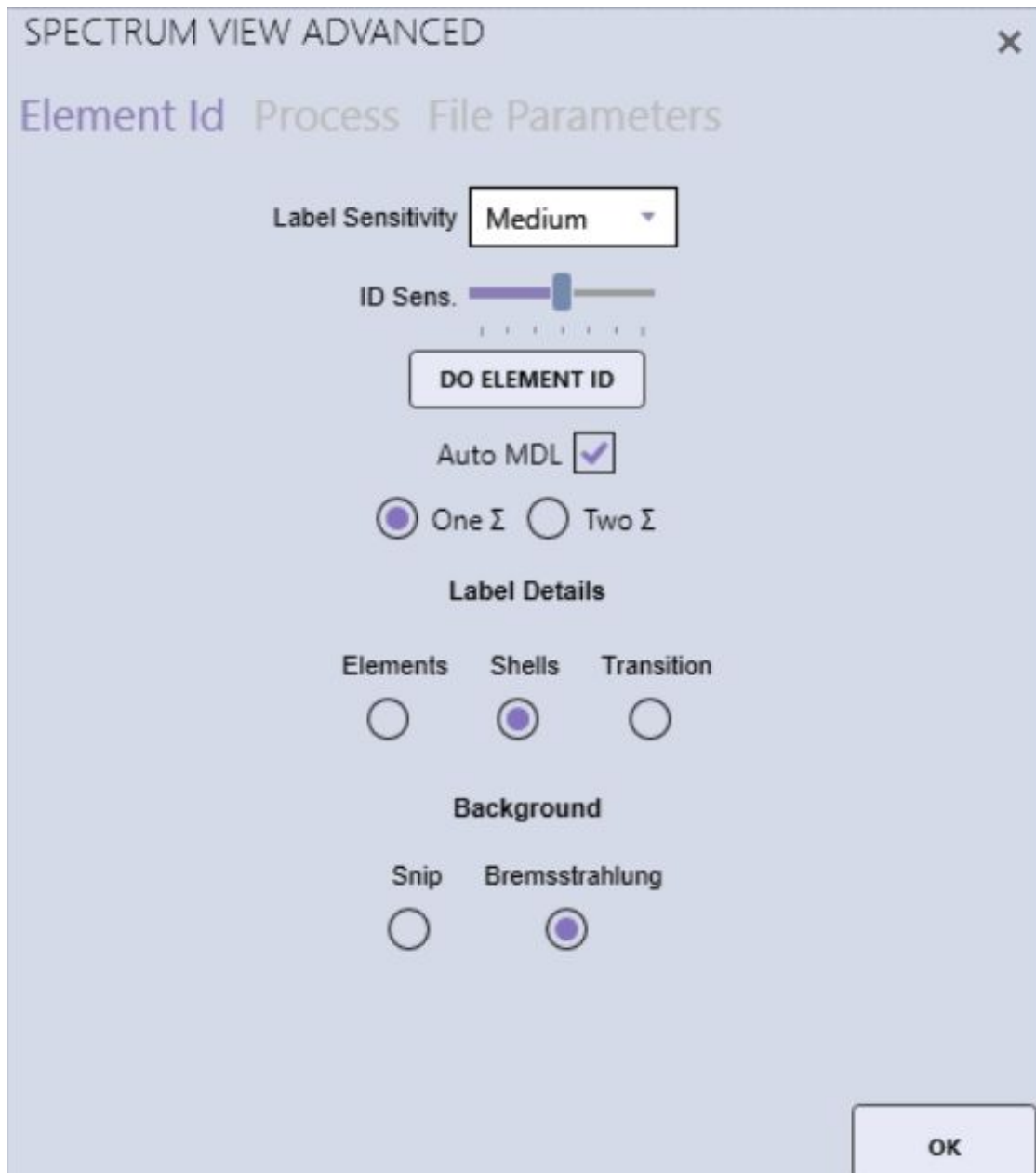
Element	Line	Weight %	Net Int.	R
K K	K	8.26	1331.09	0.9
Si K	K	19.39	5637.21	0.9
Al K	K	7.06	2024.76	0.9
O K	K	41.90	2713.40	0.9
Na K	K	0.67	105.60	0.9
C K	K	22.64	307.80	0.9
Ca K	K	0.08	10.89	0.9

(Quant Results Window and Display Options)

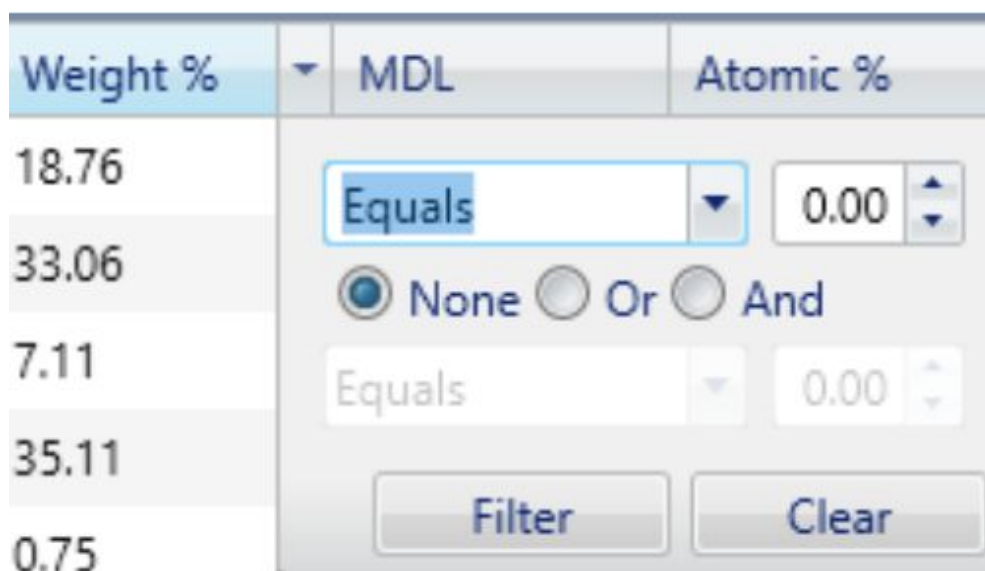
- ID Confidence: You can see in the top right corner of the spectral collection window; the ID Confidence % value is displayed during the collection.
- MDL : The Minimum Detectable Limit for each element. This is displayed on the Quant Window during the collection and in review mode.



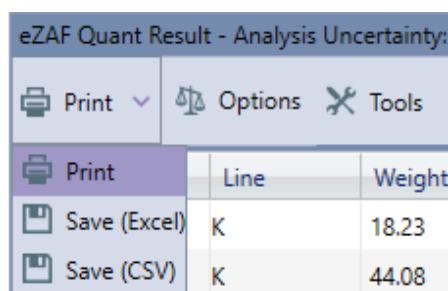
You can select the option Auto MDL on the [Spectrum View Advanced](#) panel, and then you can select the sensitivity as either One or Two Sigma. Elements that do not meet the defined sigma value are removed the quantitative display.



Most column selections on the Quant Table can apply a filtering option. You will see selecting the drop down list will pop up this option.



The quant window also has a Print Menu in the upper left corner that allows the user to print or save the results to file. To select a method, click the arrow to the right of the Print icon to view the drop-down menu and click on one of the following options.



(Print Menu Options)

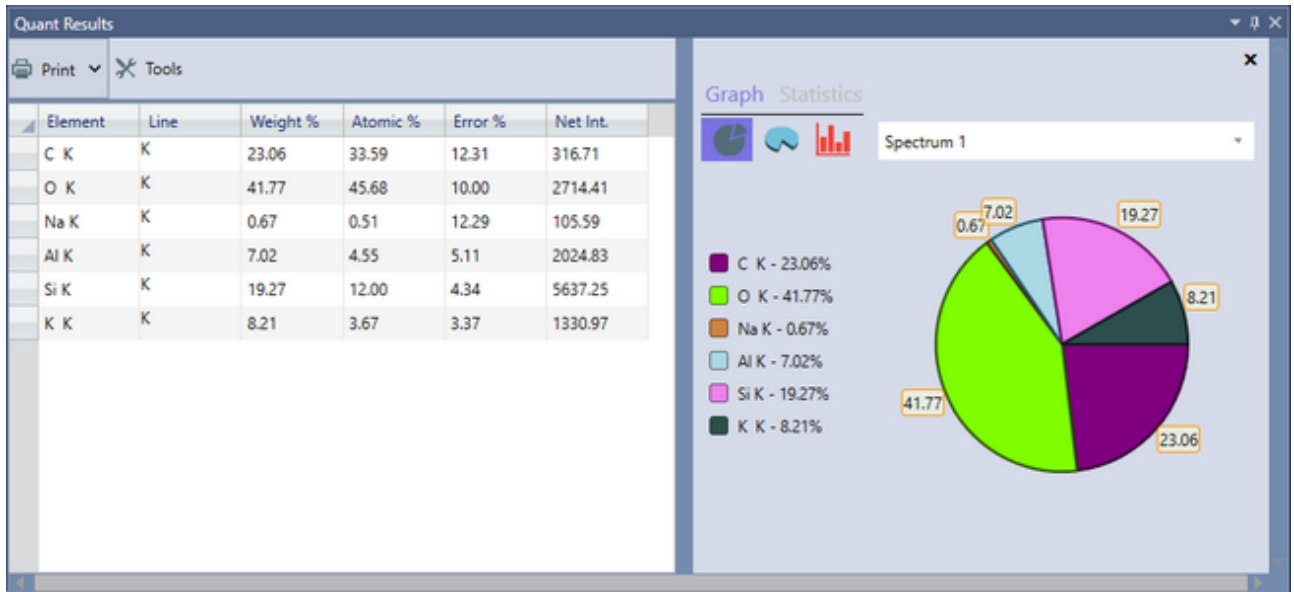
- Print: Outputs the quant results to the printer.
- Print > Save (EXCEL): Outputs the quant results to a Microsoft Excel XLSX file.
- Print > Save (CSV): Outputs the quant results to an ASCII CSV file.

Note: These print options will only print the quant results, not the spectra or SEM image.

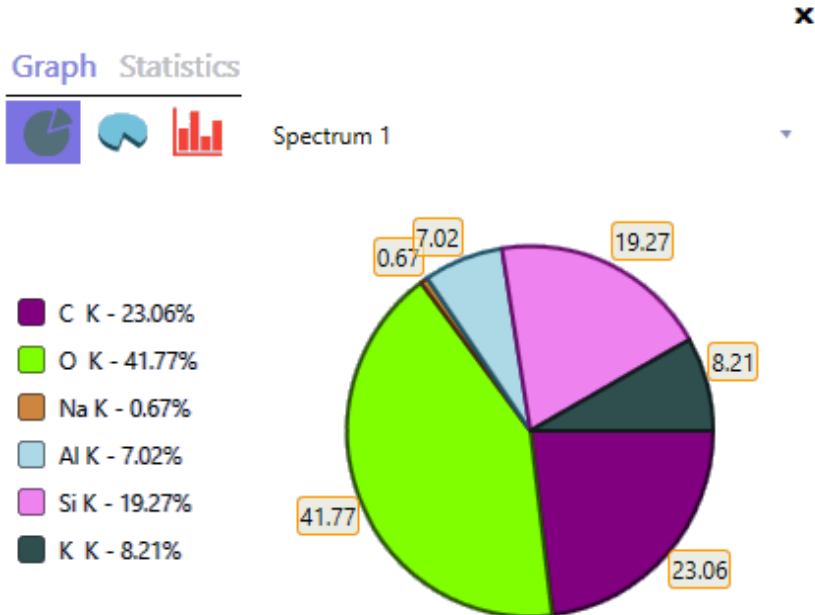
Graph View

Clicking the Tools icon will enable or disable the display of the weight percentage results in graphics form. In this mode, the quant numerical values are limited to four columns. To customize which results are displayed, right click on the quant results window.

There are three graph display modes: 1D-Pie, 3D-Pie, and Bar Graph. To select a mode, use the icons under the word *Graph*. When using the bar graph mode, there is a drop-down selection. When multiple spectra are loaded, the user can quickly switch between the quant graphs of each spectrum using the drop down menu above the graph.



(Graph View)

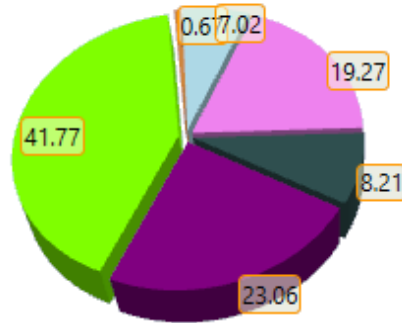


Graph Statistics



Spectrum 1

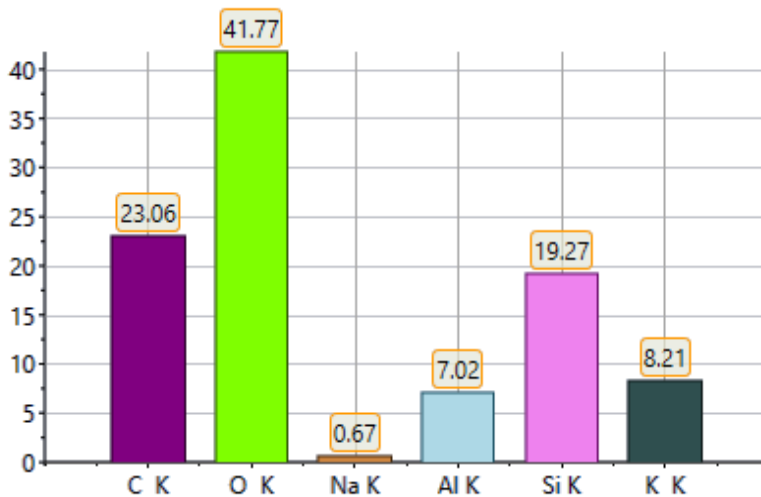
- C K - 23.06%
- O K - 41.77%
- Na K - 0.67%
- Al K - 7.02%
- Si K - 19.27%
- K K - 8.21%



Graph Statistics



Spectrum 1



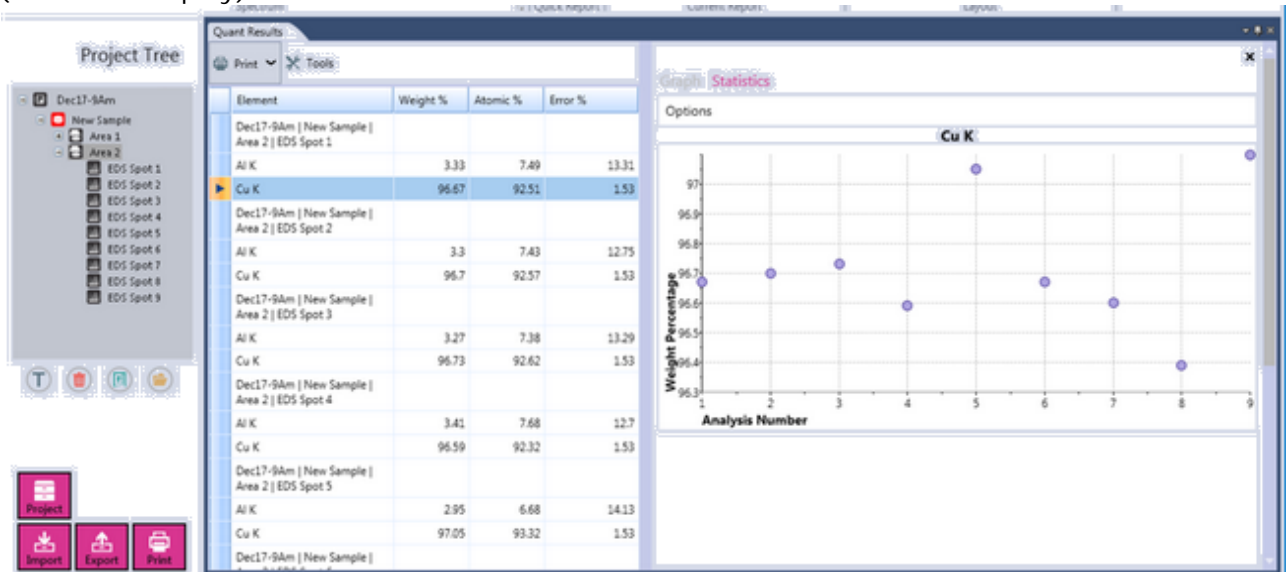
(1D-Pie, 3D-Pie, and Bar Graphs Options)

Statistics View:

The statistics option allows the user to view the data from multiple spectra simultaneously. First, select the spectra to be reviewed by dragging them from the project tree, into the same spectrum view window. Then, select the element to be examined by clicking on it in the quant results table. Next, click the Tools icon and select Statistics. The graph will show the weight percentage concentrations for the selected element, for all spectra in the series. This is

particularly useful for visualizing trends or checking for homogeneity. To change the element displayed, click on the element name in the quant table.

(Statistics Display)

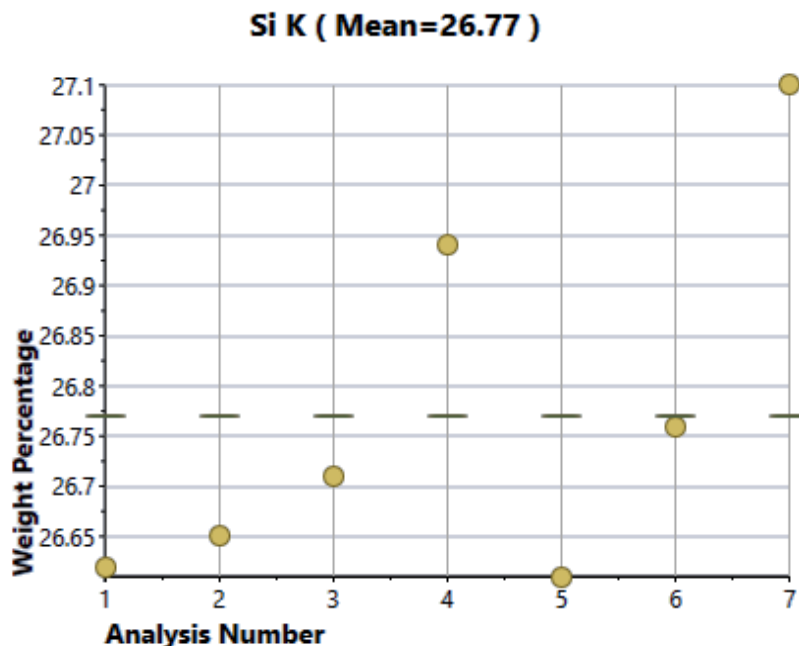


Click on the Statistics > Options Menu to select one of the eight options, listed below.

X

Graph Statistics

Options



(Statistics Options > Mean)

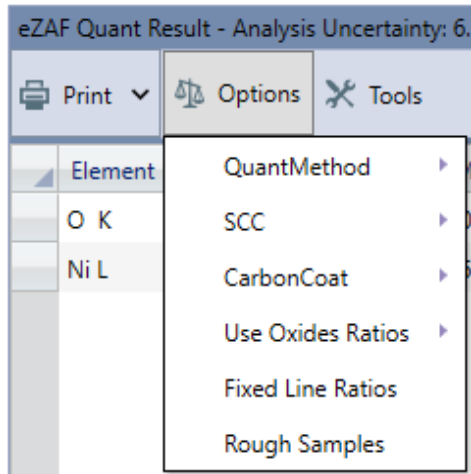
- Max: Draws a dashed line to mark the highest concentration in the series.
- Mean: Displays the mean value of the entire series.
- Median: Displays the median number in the sorted series.
- Min: Draws a dashed line to mark the lowest concentration in the series.
- N: Displays the weight percentage values for the series.

- Q1: Displays the first quartile.
- Q3: Displays the third quartile.
- Standard Deviation: Displays the standard deviation (σ) of the series.

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Advanced Quantitative Methods

Click on the Options button to bring up the Advanced Quantitative Methods drop down menu.



eZAF: APEX EDS uses the eZAF algorithm by default. eZAF is based on the net counts (background subtracted and peak deconvoluted) with atomic number, absorption and fluorescence corrections applied.

PeBaZAF : Peak to Background ZAF can be used alternatively to eZAF. It is often recommended for particles, rough surfaces and fractures as it is less sensitive to topography effects. Generally PeBaZAF requires better statistics/longer acquisition times to obtain good results and is not applied for elements below Na. PeBaZAF provides standard-less non-normalized results. Below there are 2 columns displayed for Wt% , the first column is non-normalized, and the second column (Weight%) is normalized to 100%

The screenshot shows the 'PeBaZAF Quant Result - Analysis Uncertainty: 31.46 %' window. The table below displays the quantitative results for various elements.

Element	Line	Wt %	Weight...	Atomic...	Error %	P/B Ratio	Net Int.	A
C K	K	75.29	44.39	65.15	15.40	0.0000	2051.92	1.0000
O K	K	4.19	2.47	2.72	16.13	0.0000	261.78	1.0000
Mg K	K	5.67	3.34	2.42	7.20	52.8946	1848.46	1.0471
Al K	K	72.68	42.85	27.99	6.08	821.0051	27715.61	1.0382
Cl K	K	0.27	0.16	0.08	18.25	4.3031	76.32	1.0302
Ar K	K	0.66	0.39	0.17	9.82	10.5617	196.92	1.0245
Cu K	K	5.14	3.03	0.84	4.95	93.1618	588.56	1.0021
Mo L	L	5.72	3.37	0.62	3.92	64.1135	811.38	1.0374
Total		169.62	100.00					

Carbon Coating Corrections:

Auto – Calculates the Carbon thickness during and at the end of the spectral collection.

Manual – Allows you to input a known Carbon Thickness coating value.

When you are in manual mode you can input a thickness value in nanometers.

Calculate – Calculates the carbon thickness from the spectrum displayed.



Standard-less Customized Coefficients (SCC)

Allows for the optimization of the eZAF standard-less quantification model. This is done by measuring a single element reference sample followed by samples of known composition for the elements that are to be optimized. Single element reference and known composition samples must be measured under identical conditions but multiple sets can be combined to span a larger set of elements. The use of a reference measurement also allows for non-normalized standard-less quantification.

Select an SCC

Recent

LOAD

SAVE AS

3kV

BN 3kV

_Sec

ZirconTest

FrankTest

FelixTest

Elements: Si, Ta, W

Create

User Profile Set as default in User Profile

UPDATE REFERENCE

DELETE

Beam Current (nA) Standard Current (nA) 1.000

KV 25 Standard kV 5.00

Ref. Value 692.7543

OK **CANCEL**

Standard Factor (SF) : If PeBaZAF selected, SCC will be replaced by SF. Standard Factors allows optimization of the PeBaZAF quantification model in a similar fashion as the SCC for eZAF model.

Use Oxides Ratios: If oxides ratios is enabled, oxygen will not be quantified based on counts in the oxygen peak. Instead, the oxygen concentration will be back-calculated based on the other elements in the sample, under the assumption that all elements are oxidized to stoichiometry. This option should only be used for fully oxidized samples.

Element Results: When enabled, all elements will be shown in weight percent with the oxygen weight percent based on stoichiometry as the last entry.

eZAF Quant Result - Analysis Uncertainty: 8.94 %						
Print		Options		Tools		
Element	Line	Weight %	MDL	Atomic %	Error %	Net Int.
Na K	K	2.9	0.08	2.6	8.9	1225.3
Al K	K	9.7	0.05	7.3	5.1	7290.7
Si K	K	26.1	0.05	18.9	4.5	19984.2
K K	K	8.9	0.08	4.6	3.5	3743.0
Oxygen	K	52.5		66.7	0.0	0.0

Oxide Results: When enabled, the individual elements will be shown with their corresponding stoichiometry and oxygen will be shown as 0 weight percent.

eZAF Oxides Quant Result - Analysis Uncertainty: 13.10 %						
Print		Options		Tools		
Element	Line	Weight %	MDL	Mole %	Error %	Net Int.
O	K	0.0	0.00	0.0	16.5	13869.7
Na 2O	K	4.2	0.08	4.6	8.7	1203.1
Al 2O3	K	20.4	0.05	13.8	5.0	7282.3
Si O2	K	63.2	0.05	72.6	4.5	19984.3
K 2O	K	12.2	0.09	8.9	3.6	3743.8

Set Oxide Ratios: The stoichiometry can be modified by selecting an element then selecting the appropriate oxide ratio.

✕

Oxides

Select an oxide ratio for an element(s)

H																			He
Li	Be										B	C*	N	O*	F				Ne
Na	Mg*										Al*	Si	P	S	Cl*				Ar*
K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu*	Zn	Ga	Ge	As	Se	Br			Kr
Rb	Sr	Y	Zr	Nb	Mo*	Tc	Ru	Rh	Pd	Ag	Cd	In	Sn	Sb	Te	I			Xe
Cs	Ba	La	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	Tl	Pb	Bi	Po	At			Rn
Fr	Ra	Ac																	
Ce					Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu		
Th					Pa	U	Np	Pu	Am	Cm	Bk	Cf	Es	Fm	Md	No	Lr		

Select an oxide ratio

Al	zO ₂ ▾	1.5	OK	CANCEL
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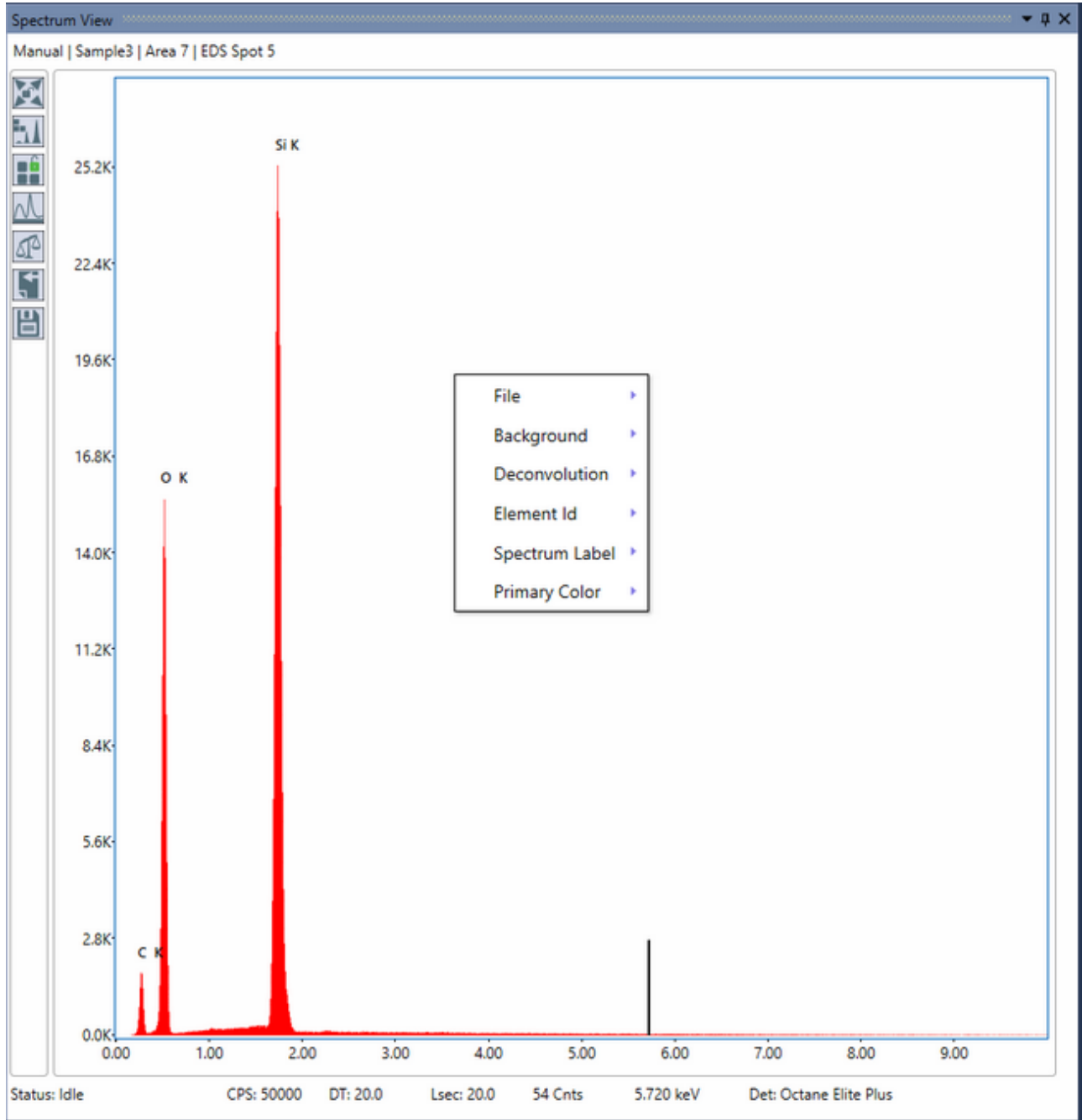
Fixed Line Ratios: The relative height of the individual contributions in a line series are allowed to vary to achieve the best fit and most precise quantification. Enabling fixed line ratios will lock the relative height to tabulated values for pure elements.

Rough Samples: Enabling rough samples will fit the background model in the low energy range to back-calculate the effective sample tilt. This will generally improve quantification on particles and rough samples.

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Spectrum View

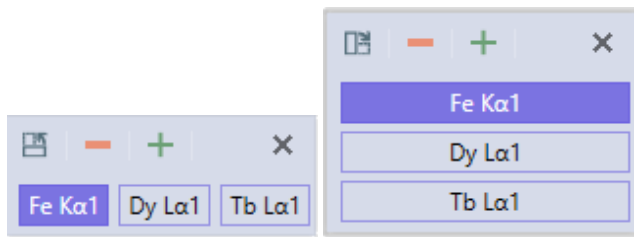
Peak ID



(Spectrum View Window)

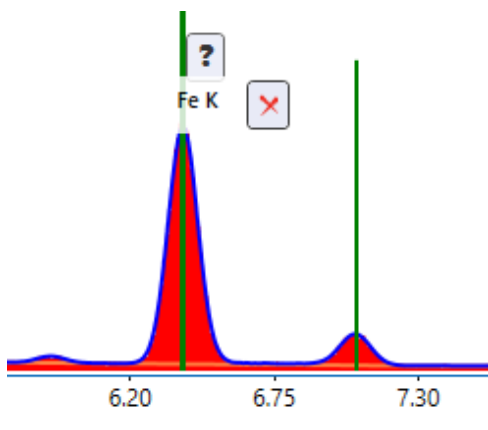
Peak ID:

During or after a spectrum is collected, the user can alter the Peak ID in order to identify trace elements and other elements of interest or to remove elements. To Add an elemental label, left click on the peak in the spectrum, hover the cursor over the question mark that appears, and a window containing the possible elements at that energy will be displayed. This Peak ID window can be dragged to different locations on the spectrum view window and will be displayed until manually closed using the X icon in the top right corner.



(Peak ID Window)

In the Peak ID window, click on the desired element to mark the peak with that elemental label and add it to the quant results. To label other peaks on the spectrum, use the + and - buttons to move up or down in energy, or click on a peak manually. To change the orientation of the Peak ID window, use the icon in the top left corner. To close the Peak ID window, use the X icon in the top right corner. Hovering the cursor over an existing elemental label will cause an X to appear next to the label. To Delete that element, click on the X.



(Peak ID > Remove Elements)

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Spectrum View Toolbars

The spectrum view window has two toolbars: the [vertical toolbar](#) and the [pop-up menu](#), which can be accessed by right clicking on the window.

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Vertical Toolbar

The vertical spectrum toolbar is located in the top left corner of the spectrum view window and has six options which are described in detail below. Hover over an icon on the image to view its name. A more detailed description of each icon's respective functions can be found below.

Spectrum Home



Reapply Expert ID



Modify Element List



Manual Background



Update Quantification Results



Send to...



Save Changes



Use Settings Saved With Spectra (review only)



- Spectrum Home: This Icon will *Home* the spectral display. There are two modes for the home icon: Auto and Manual. When the icon is in the Unlocked Position, it is in auto mode. Simply click the icon to reset the spectrum view and display the spectrum from 0 keV to 2/3 of the acceleration voltage. When the icon is in the Locked Position, it is in manual mode. Hovering over this button will display the Customize option. Click the customize button to display the customize pop-up window.



(unlocked)



customize

(locked)

Customize Home

Auto Manual

LOAD FROM SPECTRUM

Start KeV

End KeV

Fixed Vertical Scaling

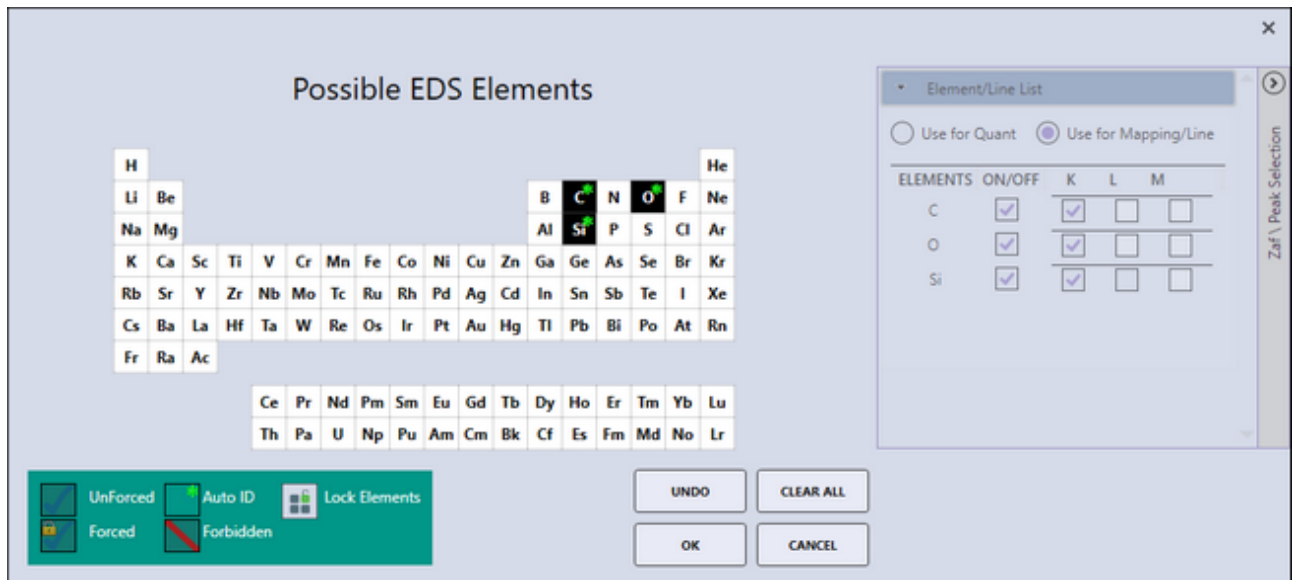
1

OK **CANCEL**

(Customize Pop-up Window)

This customize pop-up window can be used to adjust the spectrum display home position by setting the start and end KeV values on the bottom of the spectrum display to find regions of interest. The Fixed Vertical Scaling option is useful when investigating specific regions and when comparing overlaid spectra. In the bottom part of the customize pop-up window, the color coded spectrum number followed by the full scale counts for the spectrum can be seen. When fixed vertical scaling is applied a box appears where the scale of the counts axes can be changed. The overlaid spectra can now be scaled relative to the display axes by adjusting the full scale counts of the individual spectra.

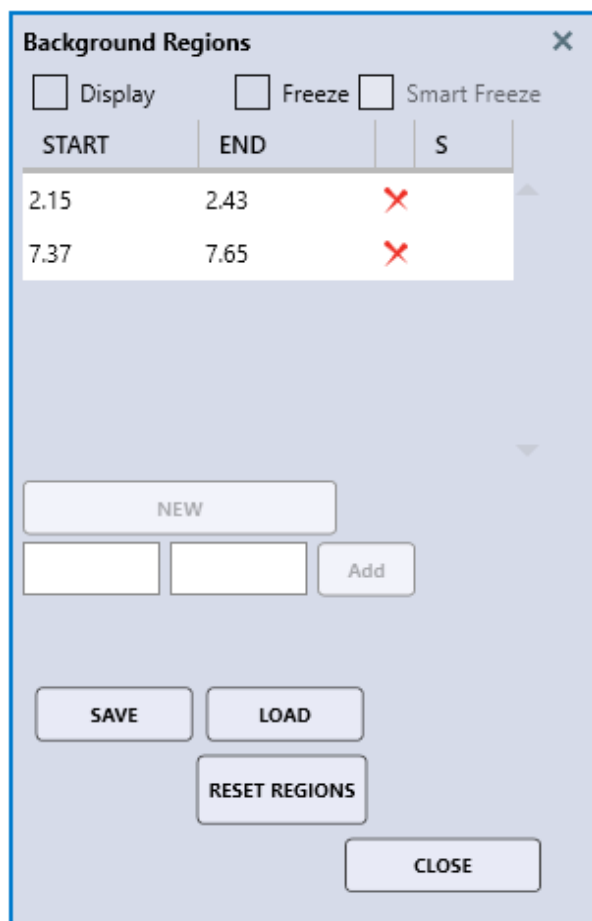
- **Re-Apply Element Identification:** Re-runs the automatic identification routine taking current model selections into account. If the reset pop-out is clicked, all models settings will be reset and element ID as well as background regions in Bremsstrahlung mode will be auto-set.
- **Modify element list:** Allows the user to modify the element list. Clicking the icon will bring up a pop-up window with the periodic table. The user can then select which elements will appear in the Peak ID of the spectrum and in the quant results. A * means that the element was found to be present by the automatic element identification routine, while a black box on a given element indicates that it is included in the model. Click an element to toggle it on or off.



(Periodic Table Window)

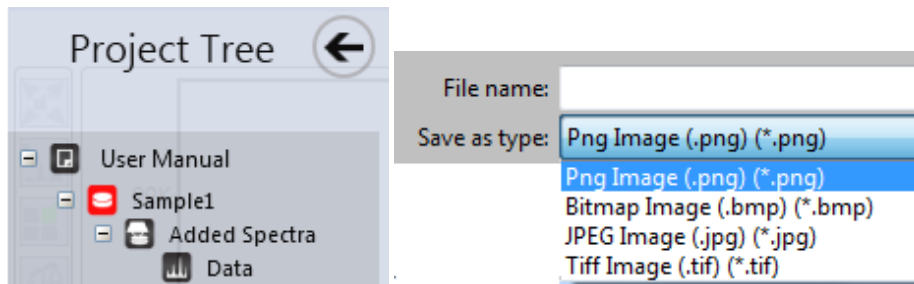
The symbol key in the bottom left corner of the pop-up window shows the different symbols that appear on the table and their meaning. Click on one of the symbols to activate it and then click on the element on which it should be applied. Setting an element to forbidden means that it will never show up in the identification whether it is present or not, if an element is set to forced it will always show up in the identification whether it is present or not, setting an element to unforced means that it is included in the model but can potentially be removed on subsequent applications of the automatic identification if it is not found to be present. This pop-up window also gives the user the option to lock or unlock the elements used for Peak ID. When the element list is unlocked, the symbol is green. When the element list is locked, the symbol is red. Clicking the on the back arrow on the right hand side of the window expands the ZAF control which enables the user to select the energy lines used to quantify and map each element.

- Manually Adjust Spectrum Background Region(s): Clicking this icon will display the Background Regions pop-up window, which allows the user to set, update, and remove background region(s). Note: Only available for the Bremsstrahlung background model.



To add new background region(s), the Display check box needs to be checked. One option is to select background region(s) in the spectrum directly. The other option is to input a start and end energy in the text boxes underneath the button and click the Add button. To add one more region, click the New button and repeat the previous step. To update background region(s), the user can either drag a background region in the spectrum to change its width or location, or highlight a background region in the list box and click the start/and/or end energy to adjust. A background region can be removed by clicking the "x" symbol next to the end energy in the list box. Clicking the Reset Regions button will reset the background to automatically adjusted. If the Freeze button is enabled, the current background regions will be applied to any spectrum loaded going forward. The Smart Freeze button will lock the background regions going forward but also check if a peak shows up in a background region and if so, disable the background region for that spectrum.

- Update Quantification Results: This icon displays the quant results in a pop-up window. In live mode the quant results are continuously updated, meaning this icon is only needed for certain layout options.
- Send to... This icon has three options for sending or saving the current files;
 - Send to Folder:* Send the following files to the folder defined in user preferences: SPC (Binary Spectrum File), MSA, CSV, *.BMP (or other image file depending on user preference settings).
 - Send to Project:* Saves the current spectrum into the project tree. It is copied into a node named Added Spectra.
 - Save As:* Same functionality as the *Send to Folder:* button except that the file output location can be selected in a pop-up window.



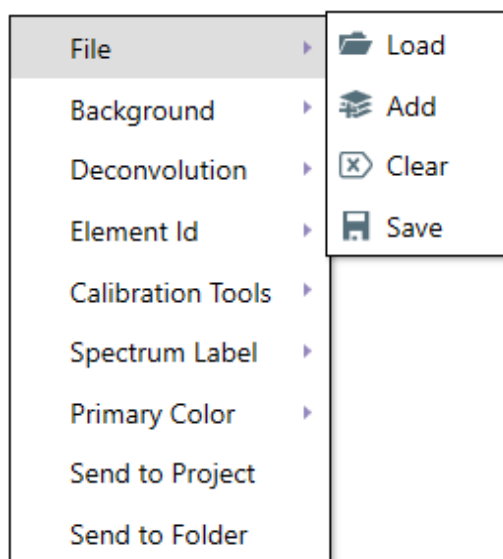
(Send to Project and Save As Options)

- Save Changes: Clicking here will cause any model changes made to the spectrum to be saved to the disk file. This button will turn pink when the spectral model has changed and is not yet saved to the disk file.
- Use Settings Saved with Spectra (review only): With this option enabled, all model settings saved with a spectrum will be applied when the spectrum is loaded. If disabled, the current review settings will be applied to the spectrum.

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Spectrum Pop-Up Menu

To display the pop-up menu, right click on the spectrum view window. There are nine items in the menu, all of which have their own options.



(Spectrum Pop-up Menu)

- File:
 - Load*: Read a store spectrum in .spc file format and display it
 - Add*: Add a spectrum to the display, usually for overlay purposes.
 - Clear*: Remove all spectra from the display.
 - Save*: Copy the current spectrum displayed to a disk file (*.spc).
- Background: A selection to turn on or off the background display. The background color can also be customized here.
- Deconvolution: A selection to turn on or off the deconvolution display. The deconvolution color can also be customized here.
- Element ID:
 - Show Element ID*: Turns the elemental labels on/off.
 - Show Sum Peaks*: Turns the Sum Peak labels on/off.
 - Show Esc Peaks*: Turns the Escape Peak labels on/off.
 - Limit to Quant Labels*: To reduce screen clutter, the user can select to label only the lines that will be used for quant, i.e. only one label will be displayed per element regardless of the number of X-ray lines.
 - Label Sensitivity*: Discussed in [Spectrum View Advanced Settings](#).
 - Label Details*: Discussed in [Spectrum View Advanced settings](#).
- Calibration Tools (live mode only): EDS spectrum [Calibration methods](#).
- Spectrum Labels:
 - Label Size*: Use this option to select from the six possible font sizes for elemental labels.
 - Label Border*: Switches on and off the bounding box around element labels.
- Primary Color: Use this option to set [spectrum primary color](#).

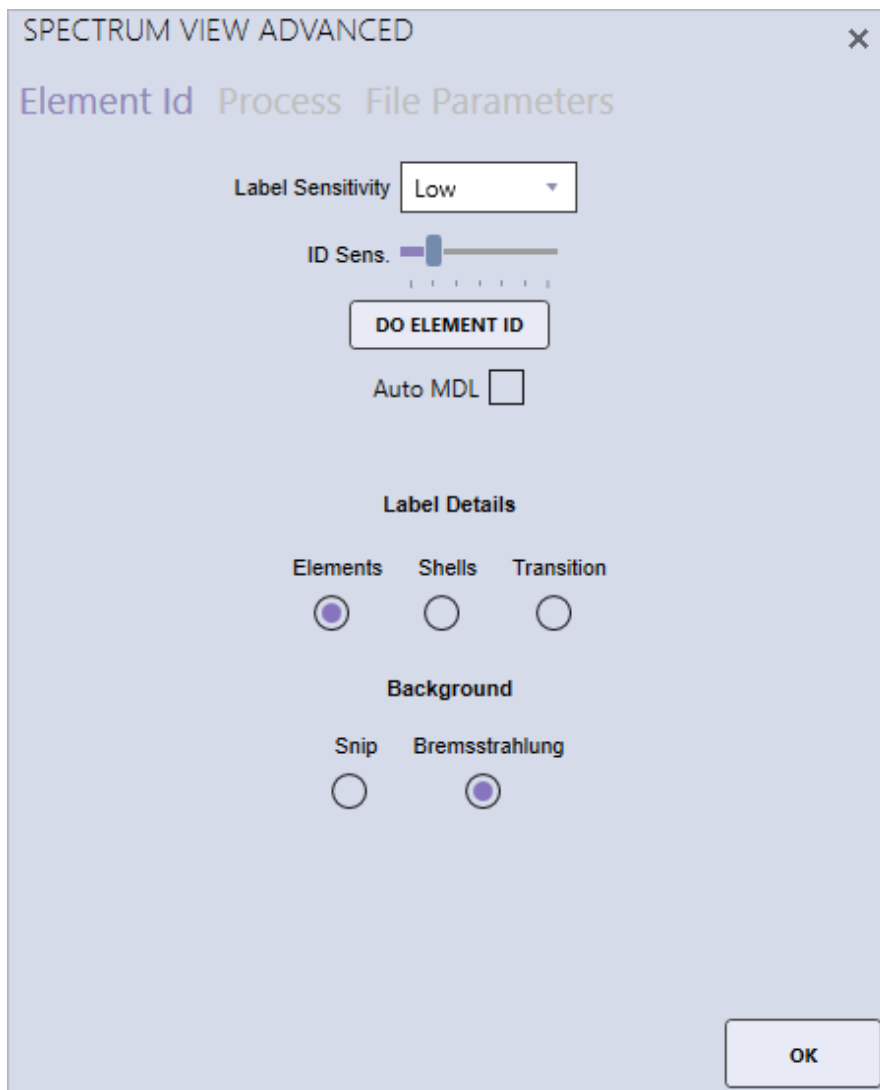
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Spectrum View Advanced Settings

To access the spectrum view advanced pop-up window, click on the arrow in the bottom right of the spectrum icon. There are three tabs in the advanced settings menu: Element Id, Process and File Parameters. The options and their settings are described below.

Element ID:

The element ID menu allows the user to change the preferences for the element labels and ID sensitivity that appear on the spectra. Be aware that the settings in live and review mode are de-coupled, meaning that one choice of background method and settings can be applied to the current acquisition while review data using other methods.



(Element ID Menu)

- **Label Sensitivity:** The drop down selects the number of labels to show. A setting of *Low* would only put labels on primary elements and lines, while *High* would label minor lines as well.
- **ID Sensitivity:** This selection controls the minimum peak size for an element to be included in an AutoID routine. A setting of 6 would include minor peaks and trace elements but potentially also identify noise peaks, while a setting of 1 would only identify primary peaks.
- **Do Element ID:** Performs an automatic Peak Identification on the spectrum currently

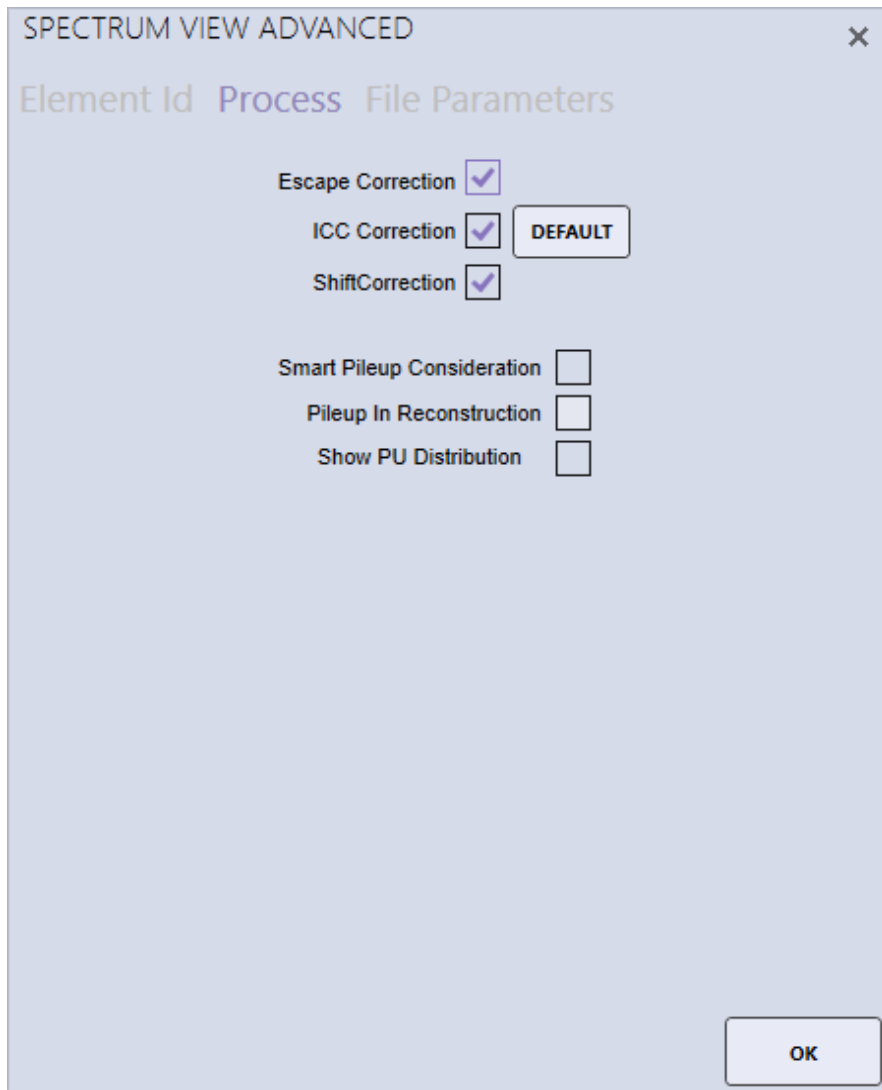
displayed. If the ID sensitivity has been changed, this will include new background region search.

- Auto MDL: Use auto minimum detectable limit. Discussed in [Quant View Window Introduction](#).
- Label Details:
 - Elements*: Displays only the element name in the element label.
 - Shells*: Displays the element name followed by the shell (K,L,M).
 - Transition*: Displays the element name, shell, and transition symbols.
- Background:
 - Snip: Applies a pure mathematical background approximation methods (Statistics-sensitive Non-linear Iterative Peak-clipping). For APEX Standard this is the only option.
 - Bremsstrahlung: Applies a full physical algorithm-based Bremsstrahlung calculation. Only available with APEX Advanced.

Process:

The process menu is used to enable or disable correction factors and pileup consideration. Escape peaks are caused by a Si X-ray being fluoresced by an incoming X-ray from the sample and consequently escaping the Si detector crystal. They will be seen as a small peak down-shifted by 1.74 keV relative to the X-ray that caused the fluorescence. Incomplete charge collection is a term used to describe when not all the electrons/charge for a given peak is collected/measured, which typically leads to a low energy tail. In the energy range below roughly 700 eV the incomplete charge collection leads to a peak shift which can be compensated by the shift correction.

At increased count rates it is common to see sum peaks and filling of the gap between two adjacent peaks. This is generally referred to as pileup which is caused by two X-rays hitting the detector almost simultaneously. The Smart Pileup Consideration is enabled by default and includes the pileup in the spectrum model. Be aware that in order for the pileup correction to work, the spectra should originate from homogenous regions.



- Escape Correction: Displays *Escape Peaks* on spectral display.
- ICC Correction: Applies *Incomplete Charge Collection Correction* method to the spectrum. Incomplete Charge Collection typically results in downshift and/or tailing or peaks. The correction is already included in the modeling, the option can be toggled to see the ICC effect on the acquired spectrum.
- Shift Correction: Applies low energy *Shift Correction* for light elements to the spectrum.
- Smart Pileup Consideration: Enables the calculation of pileup peaks based on spectrum and count rate.
- Pileup in Reconstruction: Includes the calculated pileup in the deconvolution overlay in the spectrum window.
- Show Pileup Distribution: When enabled the user can choose to see the pileup distribution (the number of counts that stem from pileup effects) as a yellow line in the spectrum window, or to see the corrected spectrum, where pileup has been subtracted.

File Parameters:

The File parameters menu displays the current parameters for the spectrum displayed. These values are automatically determined from the microscope and the preset settings. To make changes, type a new value into the parameter box and click Save. This will write the values displayed back to the actual spectrum file (*.spc).

SPECTRUM VIEW ADVANCED ×

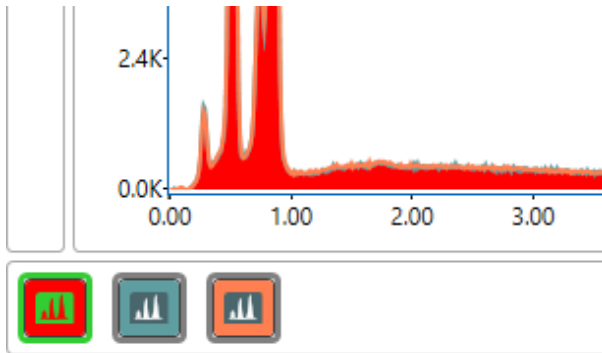
Element Id Process File Parameters

kV	<input type="text" value="15"/>	Intersection Distance	<input type="text" value="10"/>
WD	<input type="text" value="9.99"/>	Scale Setting	<input type="text" value="45"/>
Tilt	<input type="text" value="0"/>	Elevation Angle	<input type="text" value="32"/>
Beam Current	<input type="text" value="1"/>	Actual Elevation	<input type="text" value="31.99"/>
Resolution	<input type="text" value="124.34"/>	Azimuth Angle	<input type="text" value="29"/>
Geometry Base	<input type="text" value="1"/>	Geometry Factor	<input type="text" value="1"/>

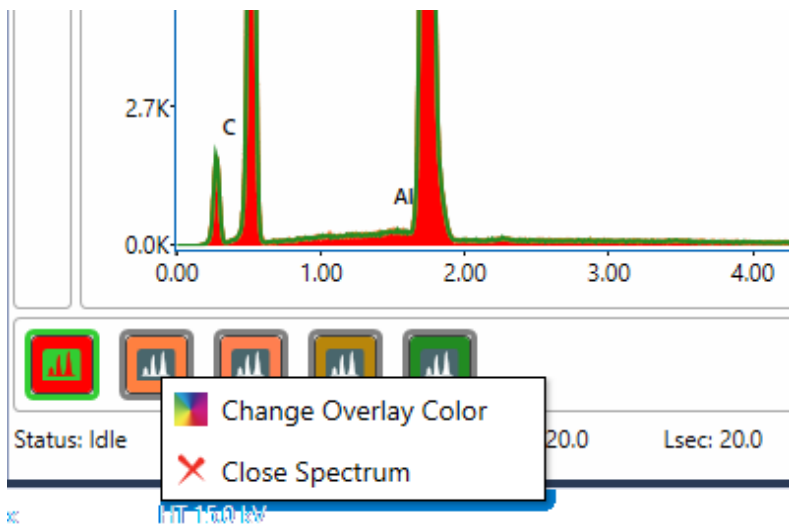
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Additional Spectra Overlay Methods

There are two additional methods for overlaying spectra. The first is to click on an area in the project tree that has multiple spectra under it. All of the spectra from the area will be overlain. The second method is to drag the desired spectra from the project tree to the spectrum display to create an overlay. The spectra that was dragged over first's elements will be displayed using spectral overlay mode. To toggle outline versus filled spectra, left click on the spectrum icons in the bottom of the main spectrum view.



To close a spectrum, right click on the toggle button and click Close Spectrum button.

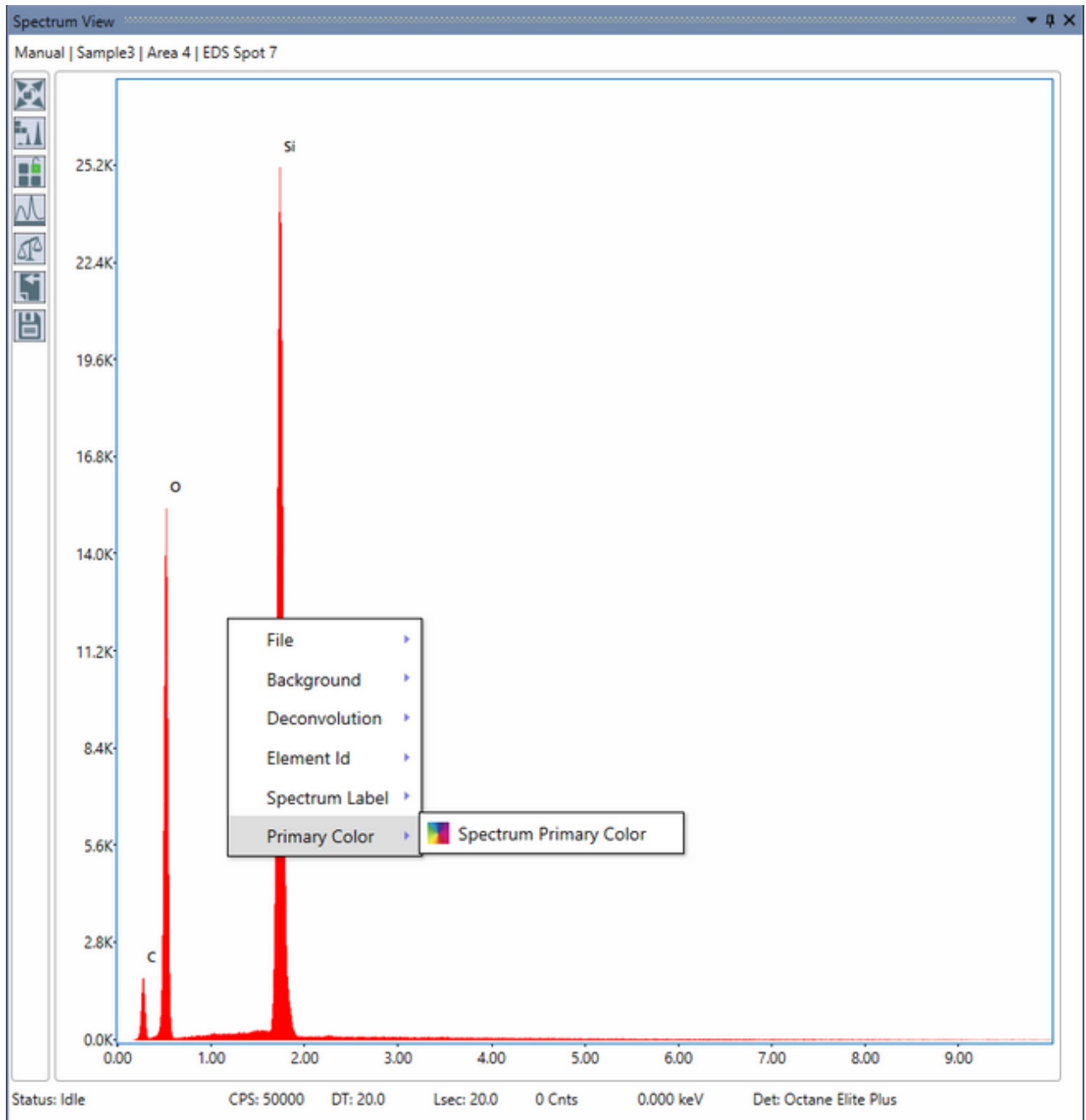


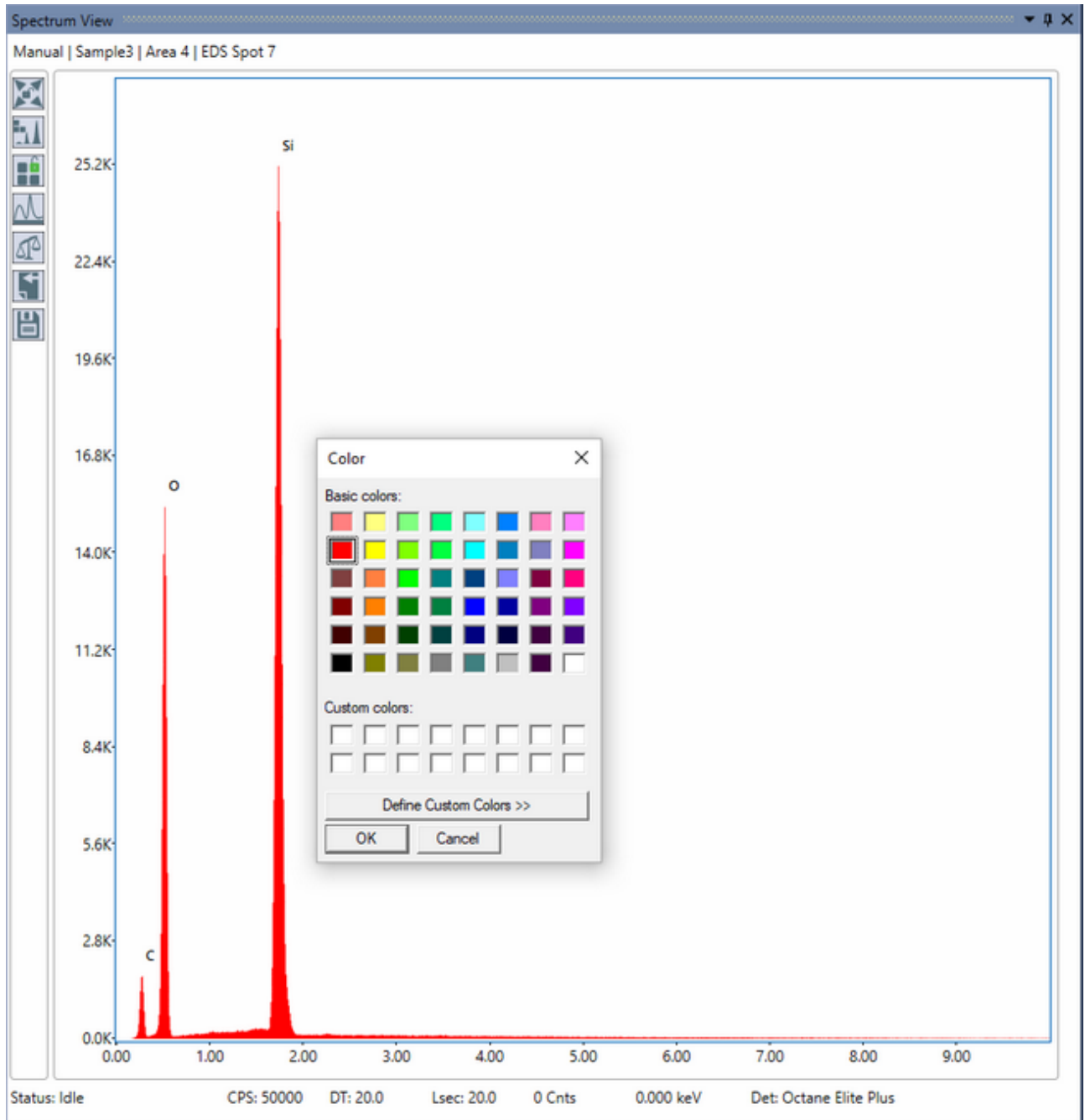
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Spectrum View Color Settings

Setting Spectrum Primary Color

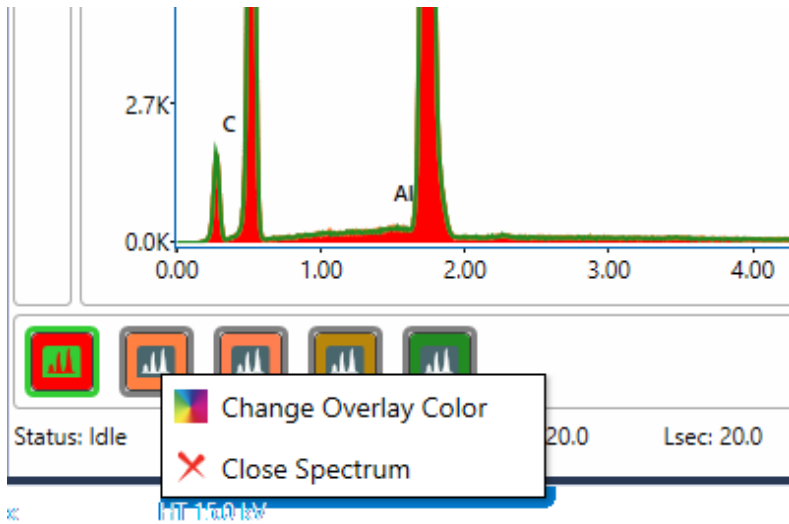
Click the Primary Color menu item and then Spectrum Primary Color. A color dialog box will appear with a list of colors that are defined for the system display. When more than 1 spectrum is loaded, this menu item is not visible.





Setting Spectrum Secondary Overlay Colors

To set the secondary colors for spectra, more than 1 spectrum needs to be open. Toggle buttons are located at the bottom left of the spectrum view window. The first toggle button will take the color from the primary spectrum color and cannot be changed here. The second one onwards will be able to change the colors by right clicking on the button to show menu item Change Overlay Color. Left click on the toggle button to change overlay color for the spectrum.

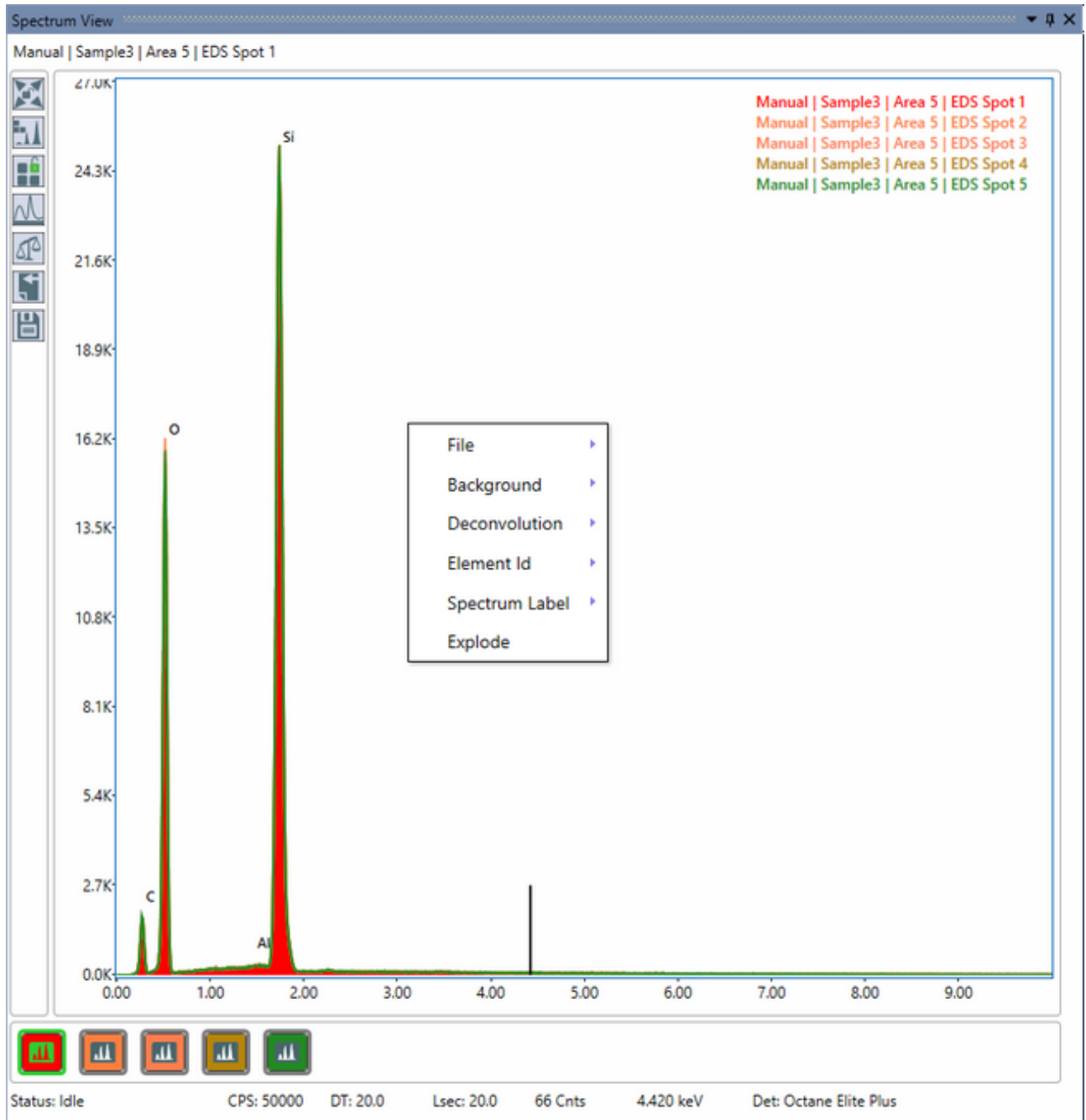


By default the new color selections are not saved and the software will revert to the default overlay colors. To change this behavior, go into the [User Profile Preferences](#) and check the box next to the label "Overwrite Spectrum Overlay Color Automatically".

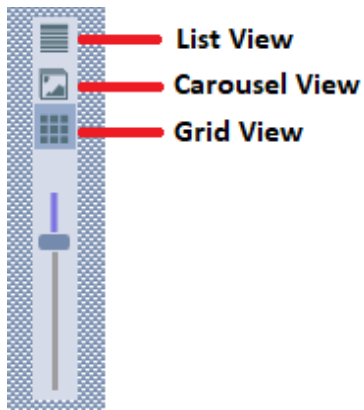
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Multi-Spectra View

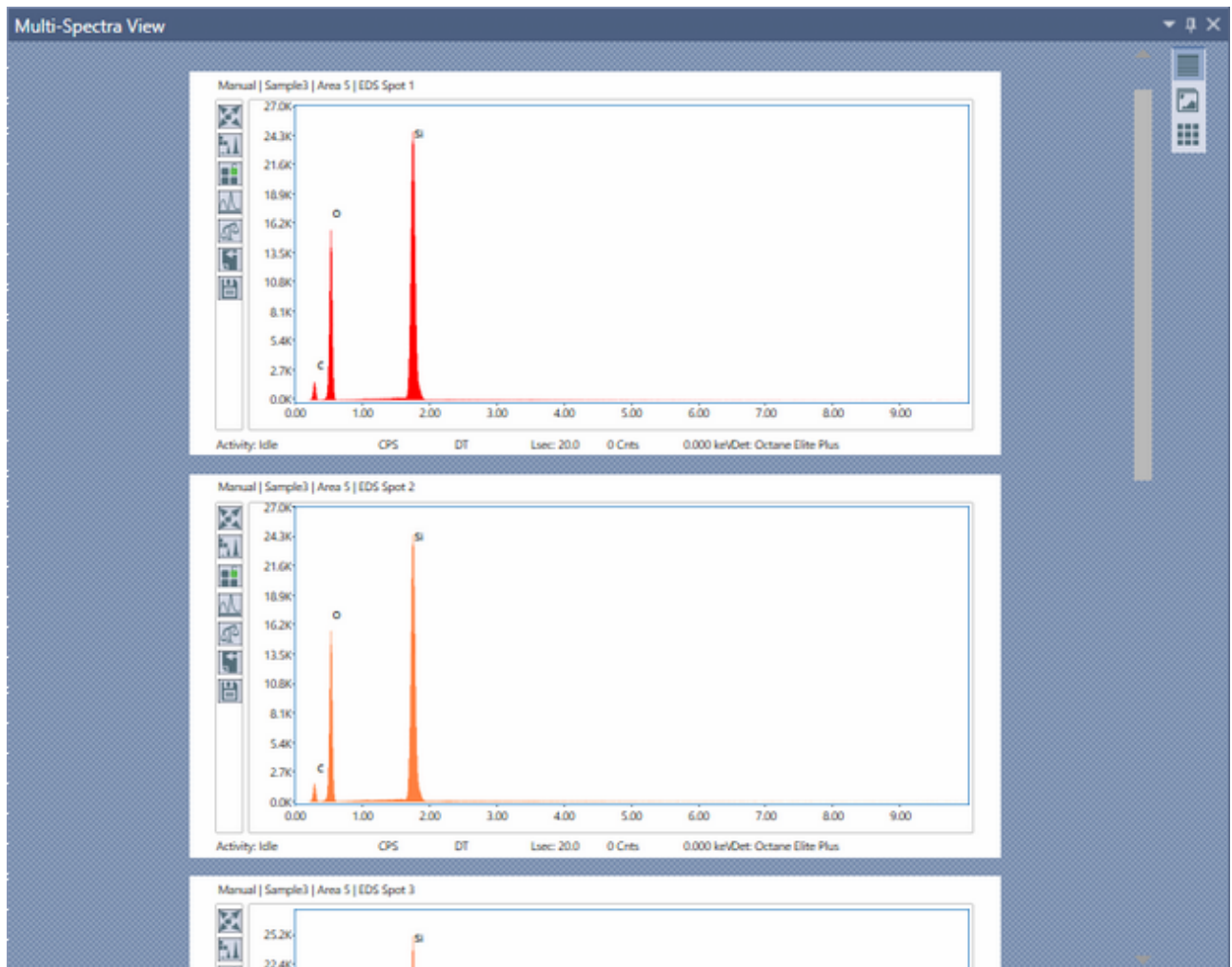
Whenever there is more than one spectra loaded, there is feature that can open each spectrum into a Multi-Spectra View. To use this feature, right click on the spectrum view window to open the context menu. Click the menu item Explode, this will open the Multi-Spectra View.



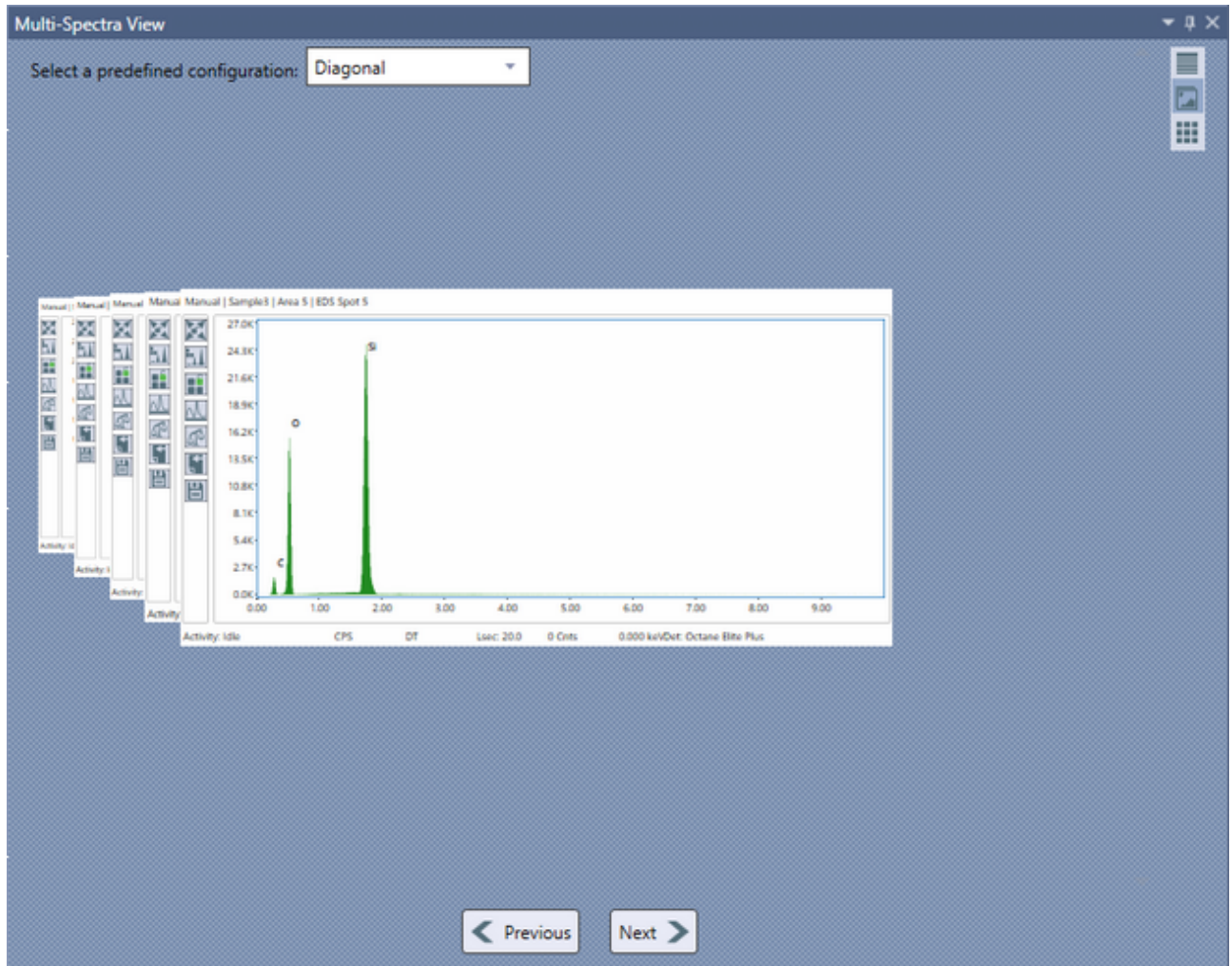
There are three view modes available on the Multi-Spectra view window.



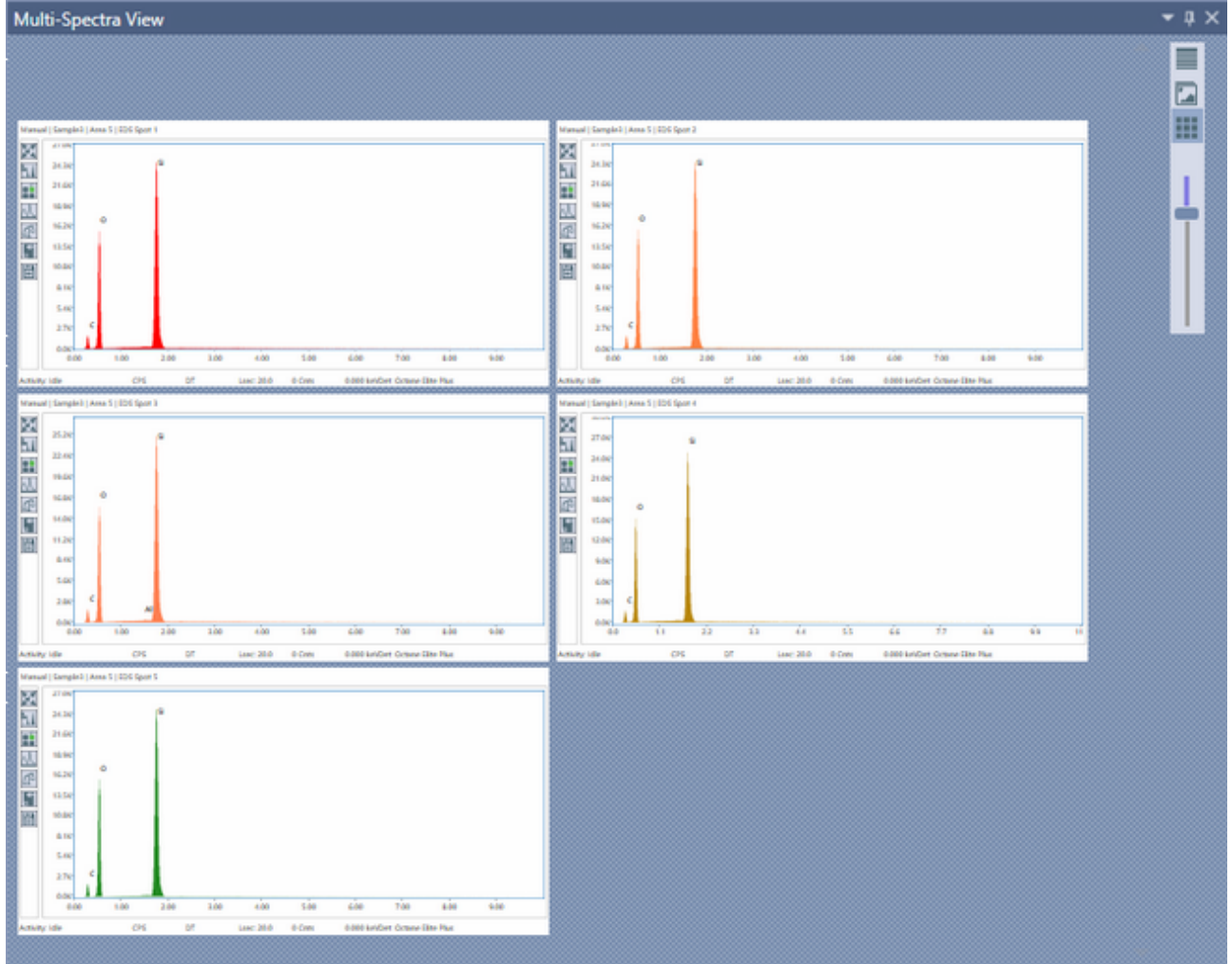
- List View: this view will display all spectra vertically.



- Carousel View: A carousel view provides scrolling animation to create the effect of a spectrum movement when scrolled. This view has four predefined configuration: Diagonal, Ellipse, Parabola, and Zigzag.



- Grid View: this view arranges each spectrum from left to right based on available space. There is a zoom control to resize each spectrum.



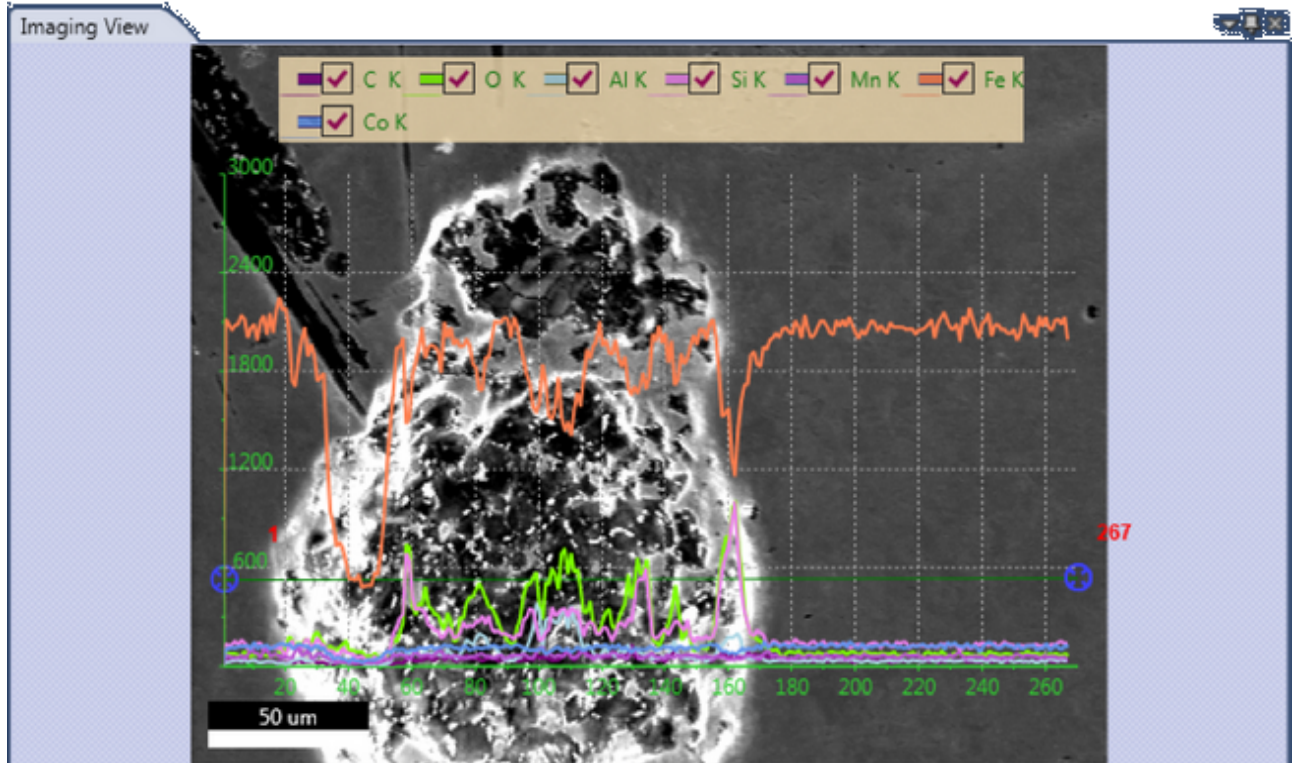
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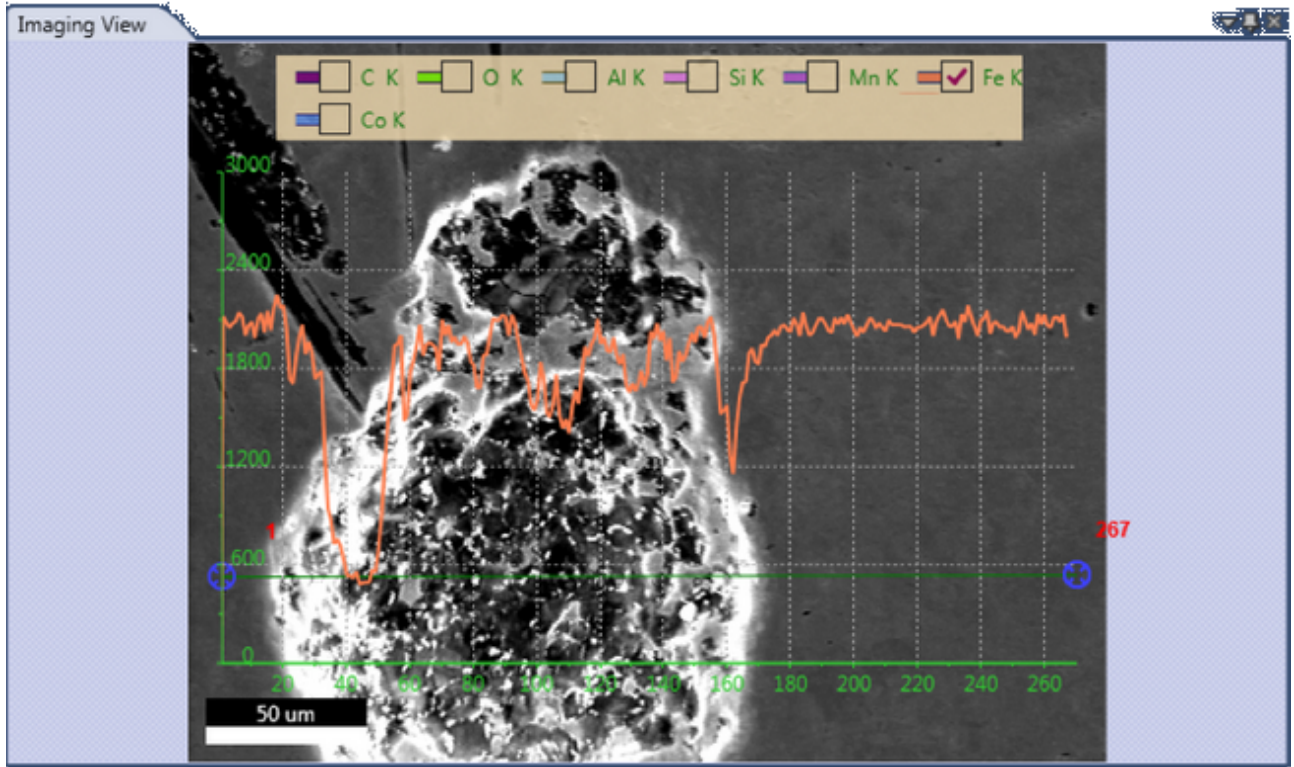
Linescan View-> Image Window

When in linescan mode, the spectral lines of each element appear in the image window, overlaid on the image. The user can check or uncheck the boxes on the top of the image to display the profiles of each element.

In the image below, all elements have been unchecked except the Fe K profile, therefore; only the Fe K is now displayed. To send the image to the folder defined in User Preferences, right click on the image and select Send to Folder.

(Linescan View)





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Multi-map View Window

When in mapping mode, the Multi-Map View window displays the different types of maps that the software compiles, as thumbnails in the same window. The name, data type (Field of View/SEM image, CPS map, region of interest (ROI), net intensity (NET), weight percentage (Wt%), or atomic percentage (At%)), and the maximum intensity of each map is displayed below the map. Maps are automatically collected in ROI mode or optionally NET but can be post processed in ROI, NET, Wt%, or At% mode. The status bar, on the bottom of the screen, displays the Frame: frame number currently being collected over the total number of frames, the frame time (FT): how long each frame takes to collect, the Remaining dialogue: the time remaining for map collection, and a Progress Bar: a visual representation of how much of the map is completed.

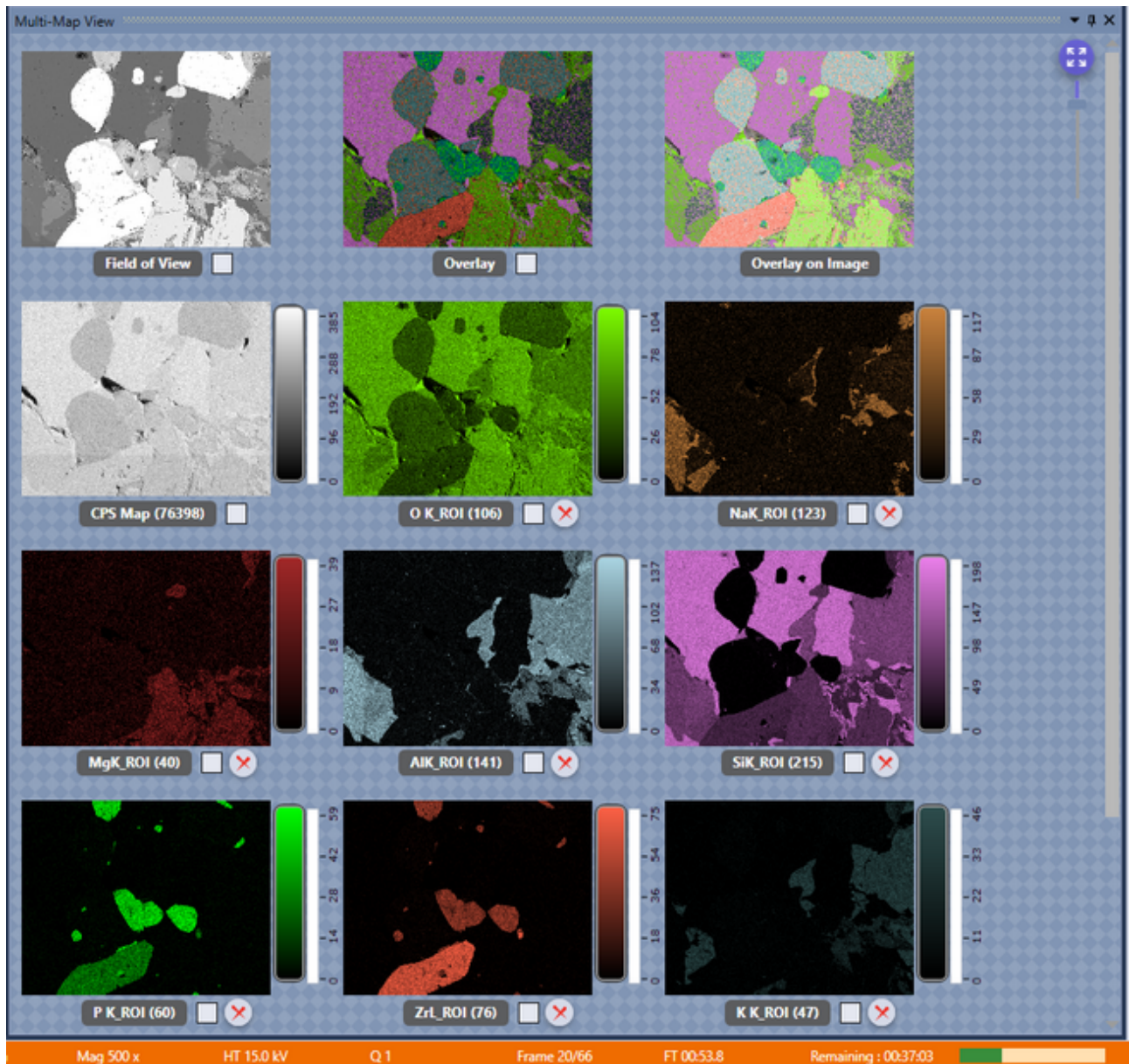


Image-Map Overlay

Clicking a specific map thumbnail will transfer that image to the main image view. Clicking on several maps will result in an overlay of the maps onto the large single image view. The maps with checked check boxes will be displayed. To add a map to the overlay, click the check box.

To remove a map from the overlay, uncheck the check box.

Overlay on Field of View and CPS map/CPS normalization

If the Field of View is selected along with one or more elemental maps, the elemental maps will be transparent to show the SEM image below. If the CPS map is selected along with one or more elemental maps, a CPS normalization will be applied to the elemental maps.

Zoom

Clicking the zoom arrow icon, located in the upper right side of the multi-map view window, turns on/off the Manual Zooming Function. When manual zoom is on, the scroll bar below the zoom icon can be used to set the amount of zoom applied to the thumbnail display. The amount of zoom also affects the number of maps displayed on the screen. When the scroll bar is all the way at the top, it is at the maximum zoom factor and only one map will be displayed. Depending on the amount of zoom applied, there is a vertical scale Intensity Bar to the right of each map showing its corresponding intensity scale.

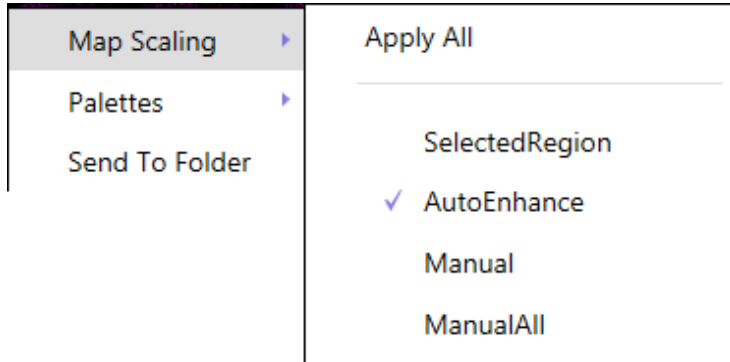
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Mapping Pop-Up Menu

To display the Mapping Pop-up Menu, right click on any of the maps. The menu has three main functions: Map Scaling, Palettes, and Send to Folder. The functions and their options are explained below.

Map Scaling

Map scaling enables the user to select a range of values, based on the collected intensities, for the map display.

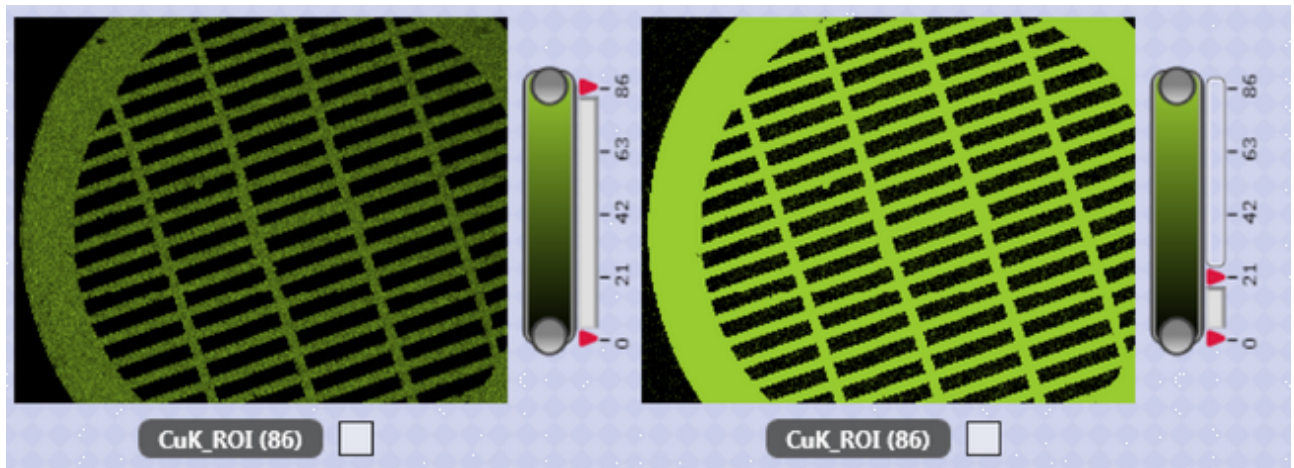


(Map Scaling Menu Options)

- Apply All: When checked, the intensity settings will be applied to all maps in the display.
- Selected Region: Allows the user to define a low and high threshold in the histogram to extract a spectrum from. See below for histogram details.
- Auto Enhance: Suppresses hot and cold pixels and enhances contrast by using 95% of the total histogram data for display. The intensity bar advanced options are not accessible in auto enhance mode. See below for intensity bar advanced options.
- Manual: Allows the user to manually adjust the intensity of one map.
- Manual All: Applies the manually set intensity value to all maps. This mode is the most useful for quantitative maps where all maps can be scaled to one value.

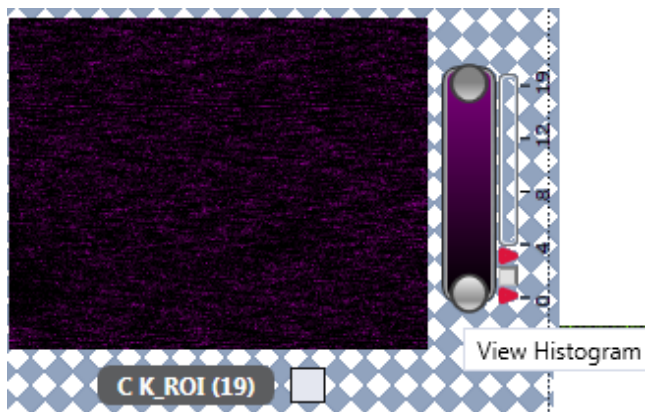
Intensity Bar Advanced

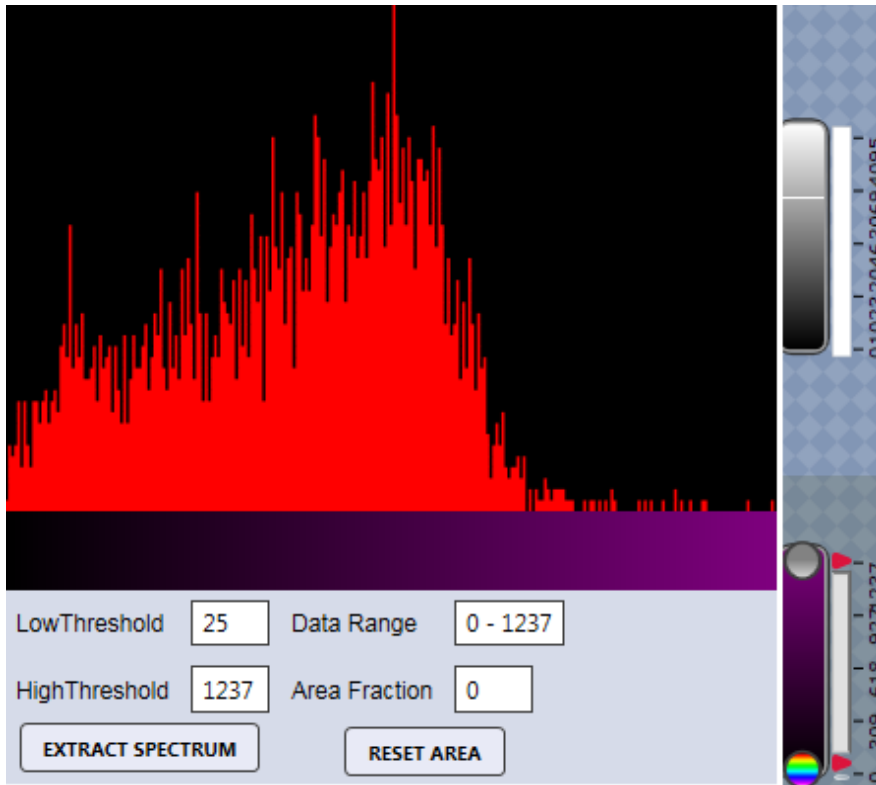
In modes other than *Auto Enhance Mode*, the vertical intensity bar changes to display more advanced features. There are two red arrow sliders and two gray round sliders to select other optional modes. The red sliders are used to adjust the contrast of the map. The contrast of the map below has been adjusted by lowering the upper red slider. The left map's upper slider is at a value of 86 counts while the right's is at 21 counts.



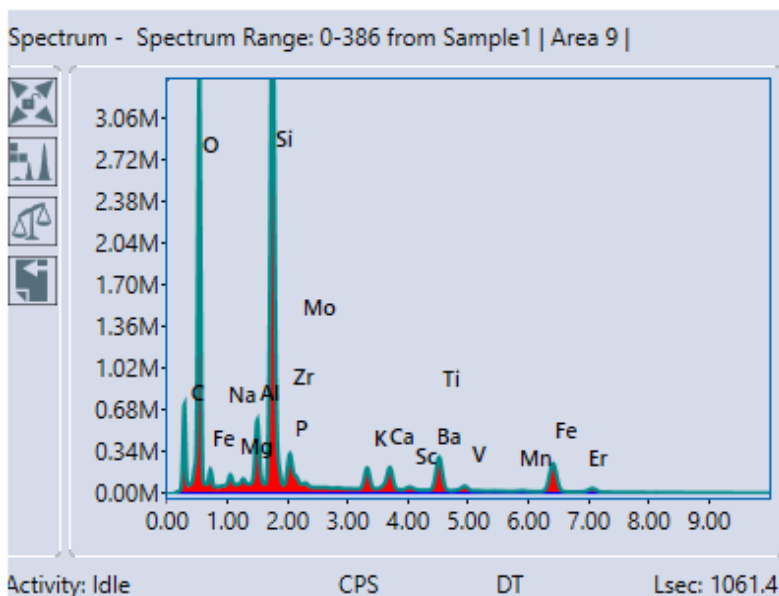
Histogram Settings

The histogram used for spectrum extraction is compiled by sorting map pixels based on their intensity. These intensities are then normalized and displayed as a histogram. Clicking the Bottom Gray Round Button will display the histogram of the map data. Clicking on the button again (which is now rainbow colored), will Close the histogram window.





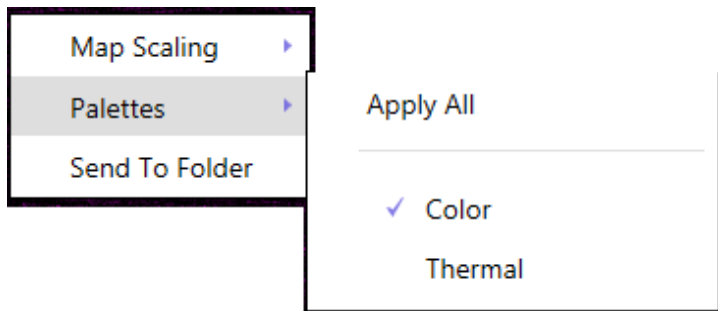
Below the histogram, the upper and lower threshold values for spectrum extracted can be entered. After entering a range of values, the data range and fraction of the total area selected will be displayed. To reset the threshold values, click Reset Area. Clicking the upper gray round button or Extract Spectrum will extract and display the map's Intensity Range Spectrum. The range of values is displayed in the title bar of the spectrum.



(Intensity Range Spectrum)

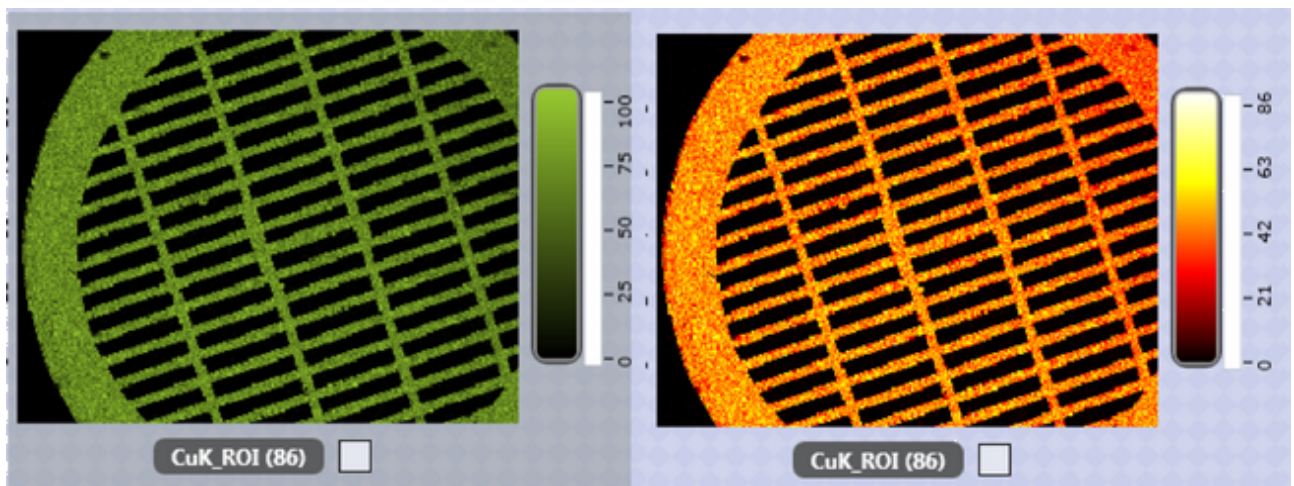
Palettes

The palette function allows the user to set the color palette to one of the two options. Color and Thermal.



(Map Scaling Menu Options)

- Apply All: When checked, the currently defined palette settings will be applied to all maps in the display. To define specific maps to the current palette, uncheck this option.
- Color: Displays maps using 256 shades of a single color.
- Thermal: Displays maps using a standard thermal palette with 256 shades between black and white



(Color Vs. Thermal Palette)

Send to Folder

The Send to Folder option sends the currently selected image or map to the folder specified in the user preferences window. The map is saved as an image and .csv file.

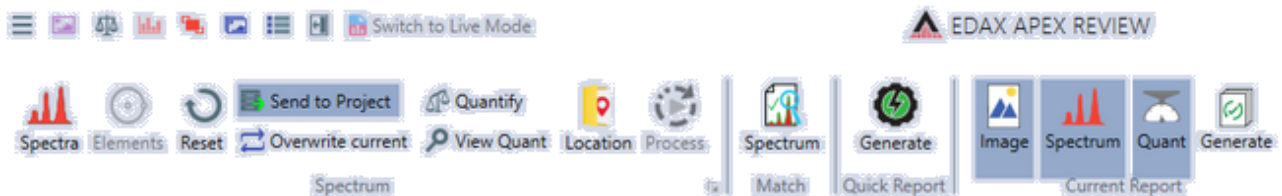
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Review Mode and Toolbars

Spectrum Review

Spectrum Auto Processing

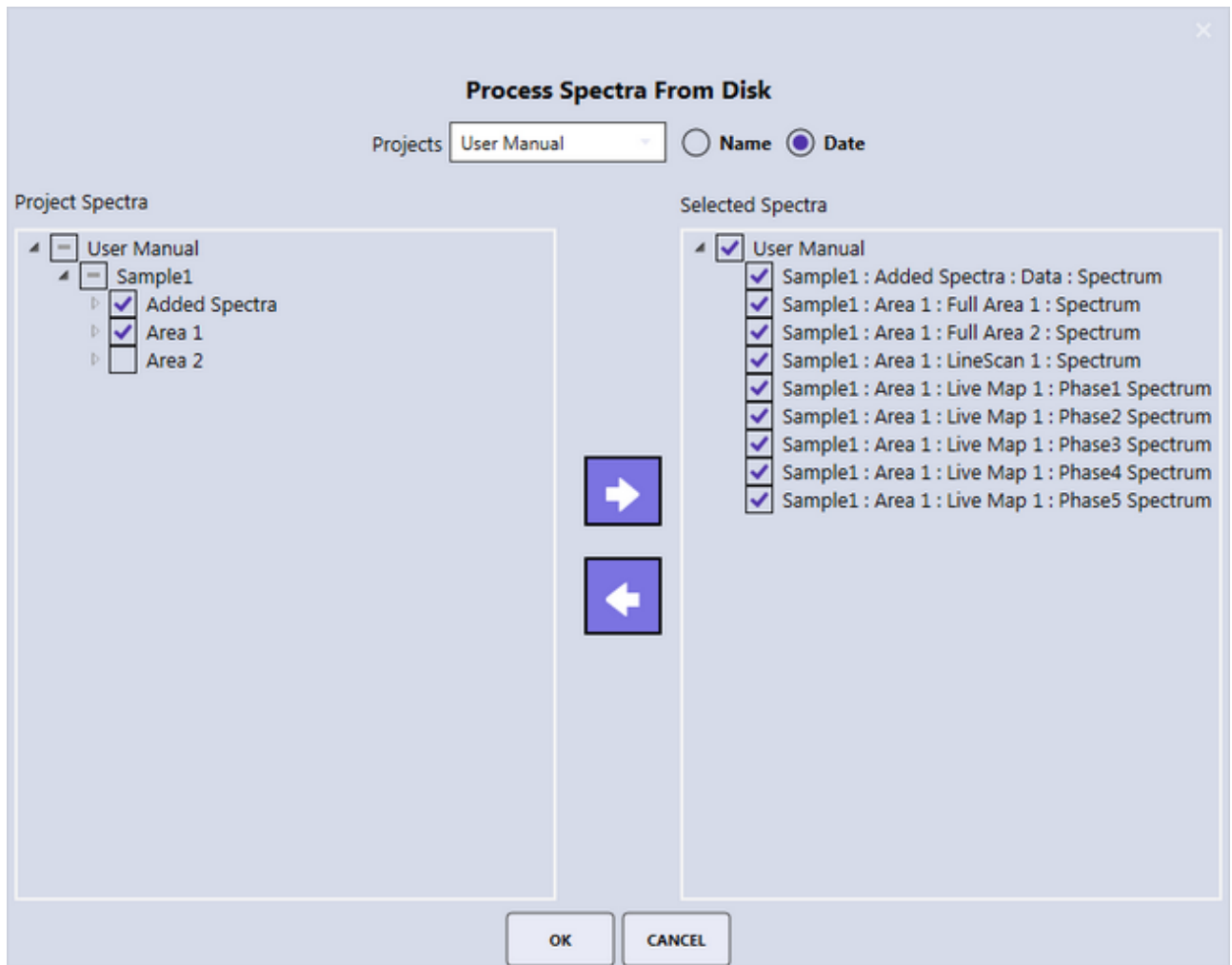
The first block of the spectrum review toolbar is for Auto Reprocessing multiple spectra. This is primarily used if a series of spectra need to be analyzed for an element that was omitted in the original run.



(Spectrum Review Toolbar)

- **Spectra:** This icon brings up a window in which the user can select which spectra will be processed.

Projects: Located at the top of the spectra processing window, this drop down menu allows the user to select which projects will be processed. The projects can be sorted by Name or Last Accessed Date. The window has two columns: Project Spectra and Selected Spectra. Use the arrows to copy the desired spectra to the right column. Only spectra with checked boxes will be copied. When all of the desired spectra appear in the Selected Spectra column, click OK.



(Spectra Processing Window)

- Elements: Use the elements icon to modify the original element list. A pop-up window is displayed which allows the user to add or remove elements from the quant results. Use the *add* and *remove* icons on the left side to control these functions. All elements with blue checks will appear in the quant results while all elements with red slashes will not.



Auto Process Elements

H																			He
Li	Be											B	C*	N	O*	F		Ne	
Na	Mg											Al*	Si*	P	S*	Cl		Ar	
K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni*	Cu	Zn	Ga*	Ge	As*	Se	Br		Kr	
Rb	Sr	Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd	In	Sn	Sb	Te	I		Xe	
Cs	Ba	La	Hf	Ta	W	Re	Os	Ir	Pt	Au*	Hg	Tl	Pb	Bi	Po	At		Rn	
Fr	Ra	Ac																	

Ce	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu
Th	Pa	U	Np	Pu	Am	Cm	Bk	Cf	Es	Fm	Md	No	Lr

RESET OK CANCEL

- Add Element
- Remove Element
- Edit Element
- Master Elements

(Elements Pop-Up Window)

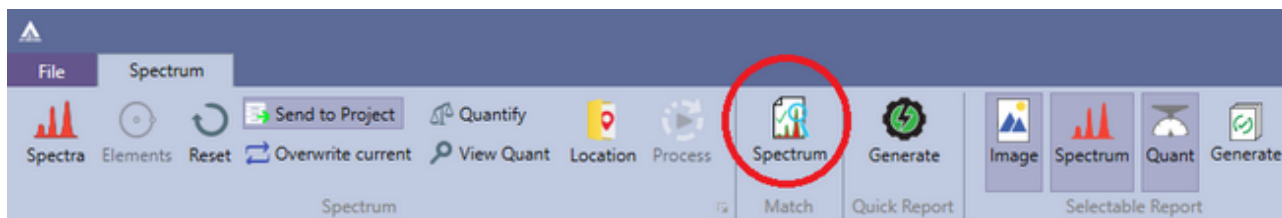
- Reset: Clears all changes made so far.
- Send to Project: Saves all processed spectra to the current project.
- Overwrite Current: Once the spectra are processed, use this icon to overwrite the original element list.
- Quantify Spectra: Reapplies quant to all selected spectra.
- View Quant: Outputs all quant results from the spectra to the quant window.
- Location: Defines a folder location where the summary XLS file will be stored.
- Process: Starts the spectral batch processing.

The arrow in the bottom of the spectrum portion of the toolbar brings up the [Spectrum Advanced View](#) window. The [generate icon](#) is used to create a report.

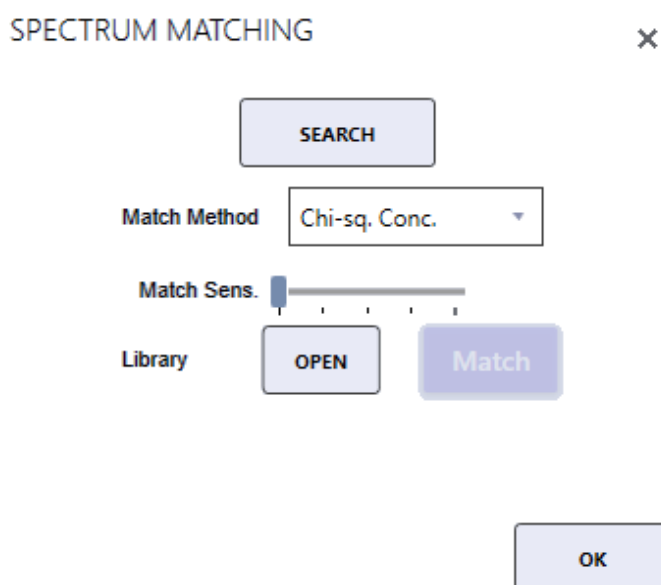
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Spectrum Matching

The spectrum matching routine allows rapid identification of unknowns by comparing them against a library of known spectra. To access Spectrum Matching, click on the Spectrum icon on the second block of the spectrum view toolbar.

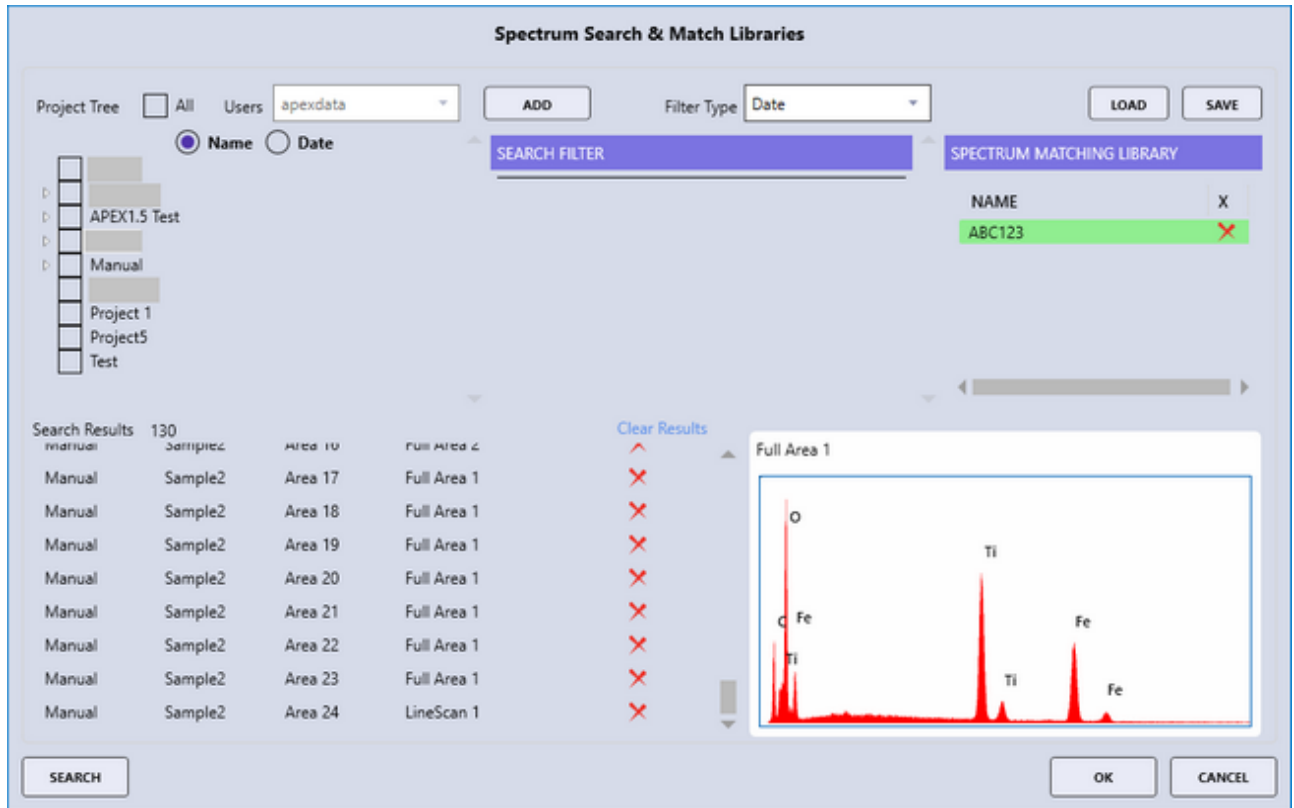


The Spectrum Matching menu pops up.



- Match Method: There are two types of matching possible, Chi-Squared fit on Concentration or on the Raw Spectral Channel Data. Use the drop-down menu to select a method.
- Match Sensitivity: The minimum fit threshold required to report a match to the unknown. Adjust the threshold by using the slider bar to set a percentage.
- Library > Open: Use this option to load a saved spectrum match library file. Click open and select a file from the local computer.
- Library > Match: Runs a spectrum matching search using the currently defined match library for the best possible matches against the currently displayed spectrum. The spectrum matches will be displayed in overlay on the spectrum display. The name of the currently loaded spectrum match library file will be displayed below the open/match icons.
- Search: Displays a setup window for defining, reviewing or modifying a match library file. To load an existing match library *double click* on the name in the spectrum matching library panel, or click on the name and then the Load button. To create a new library or modify an existing select the project(s) or project nodes that contain the desired match spectra and click the Search button at the bottom left of the window. This will populate

the search result list, where individual spectra can be selected to display them in the mini-spectrum view. Spectra can be removed from the list by clicking the delete button. Once the list is complete, the library can be saved by clicking on the Save button. If desired, a filter can be added to the search via the Add button above the search window. There are three filter types for searching: Date, Element, and Analysis conditions. After setting a new search filter, click Search.



(Spectrum Search Window)

- **Date:** Allows the user to filter search results based on the spectra date. The start and end date must be provided.
- **Element:** Allows the user to filter search results based on the elements in the spectra. See below for details.
- **Analysis Conditions:** Allows the user to filter search results based on the kV or name of the spectra.

When in Element mode, clicking the Add button brings up a pop-up window that allows the user to define which elements to filter search results based on by using the periodic table and input the elemental concentration or intensity min/max range.

ADD Filter Type **Element**

SEARCH FILTER

Anl Cond. **KV**
15

Date 5/5/2019
6/6/2019

Element Al,Si,Fe **Edit**

(Spectra Filter Window)

Select an Element

H																						He
Li	Be											B	C	N	O	F						Ne
Na	Mg											Al	Si	P	S	Cl						Ar
K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br						Kr
Rb	Sr	Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd	In	Sn	Sb	Te	I						Xe
Cs	Ba	La	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	Tl	Pb	Bi	Po	At						Rn
Fr	Ra	Ac																				

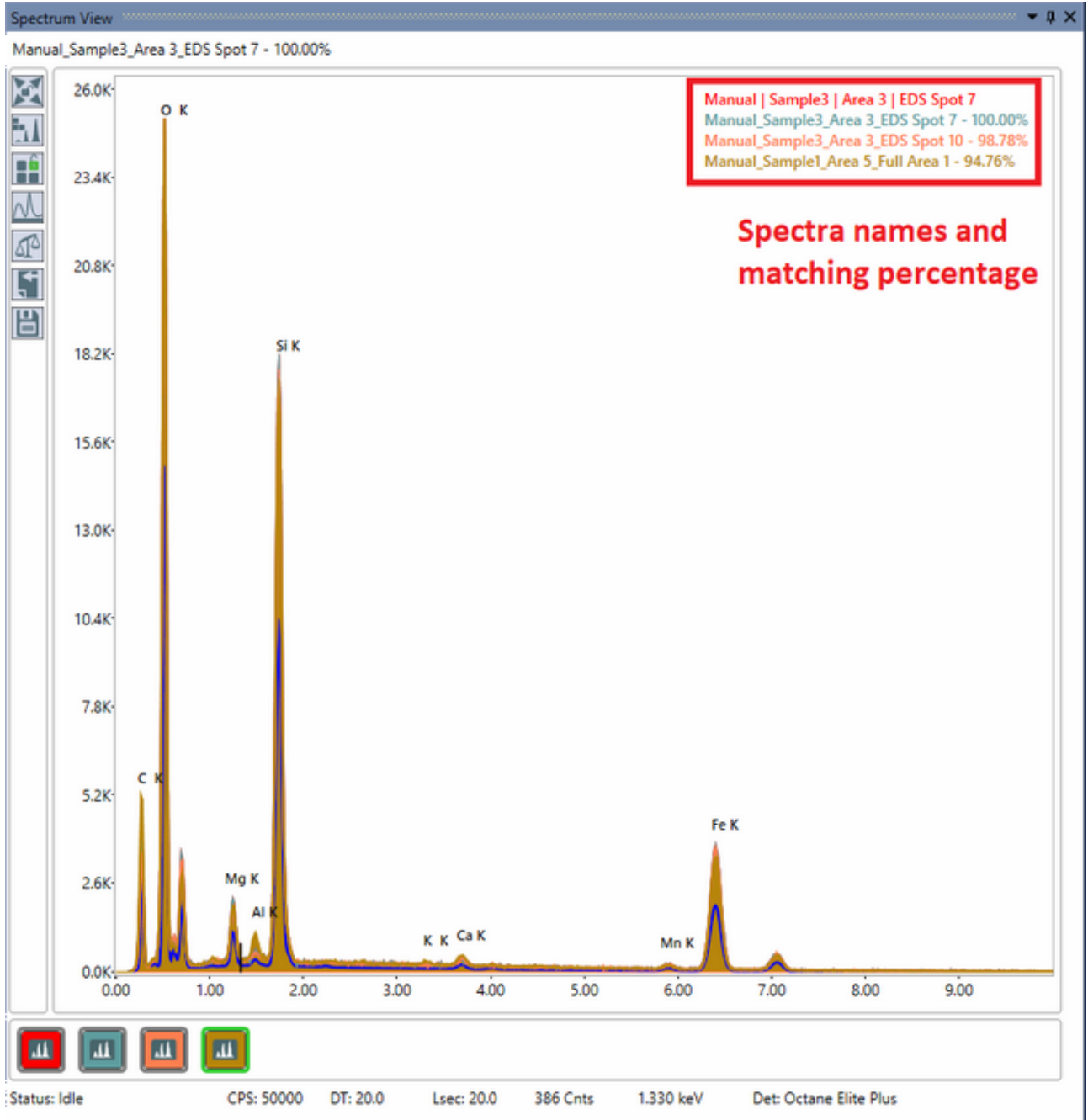
Ce	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu
Th	Pa	U	Np	Pu	Am	Cm	Bk	Cf	Es	Fm	Md	No	Lr

Wt% At% Net Inten.

Element	Min	Max
C	65	100
N	50	100
O	20	100
Al	5	100

(Element Search Pop-Up Window)

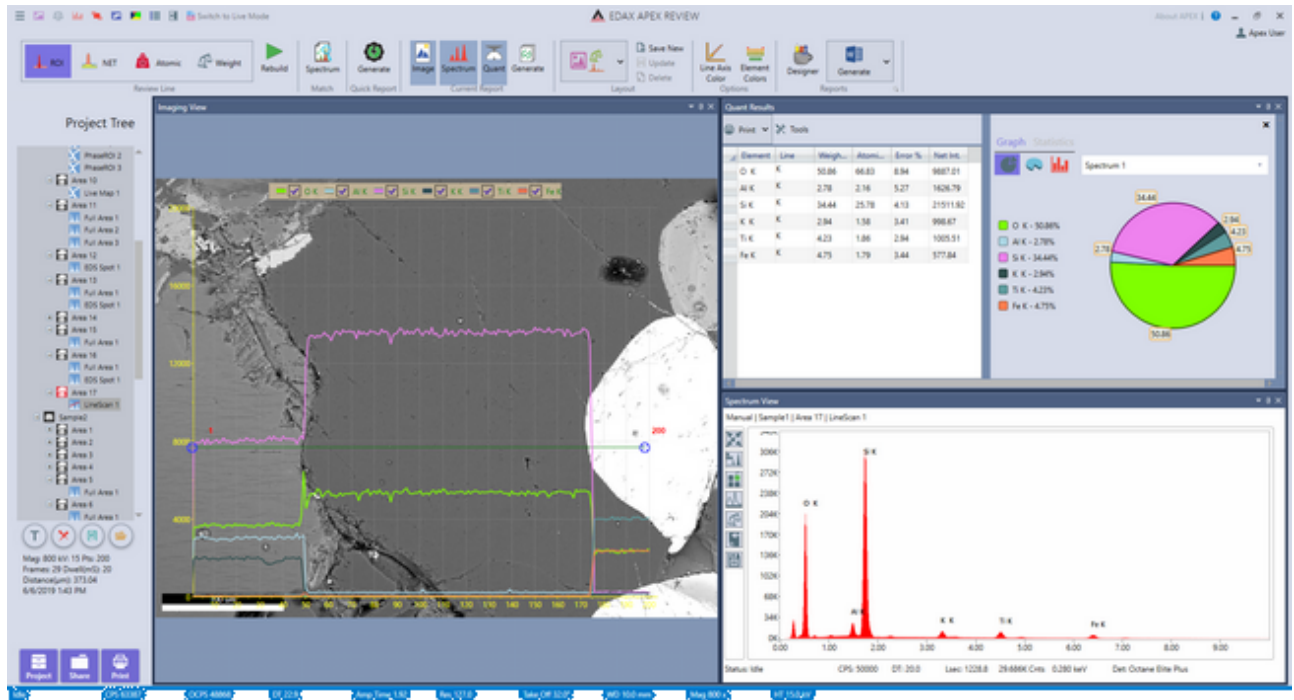
After the spectra have been selected and the preferences for spectrum matching have been set, click the Match button in the spectrum matching menu. The software will perform the matching process to the active spectrum that is currently displayed. The first three spectra from the match library file will be displayed overlaid the original spectrum. In the top right of the main spectrum window, the names of the matched spectra and their matched fit percentage, set by the match sensitivity option, are displayed.



(Spectrum Matching Overlay)

-O-

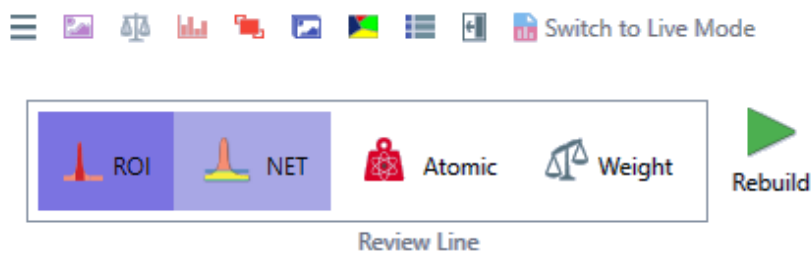
Linescan Review



(Linescan Rebuild Window)

Clicking on any point on the line in the imaging view will display the associated spectrum and quant results. To remove an element from the overlaid display in the imaging view, uncheck its corresponding check box. To add an element to the display, check its corresponding check box.

Linescan Review Toolbar:

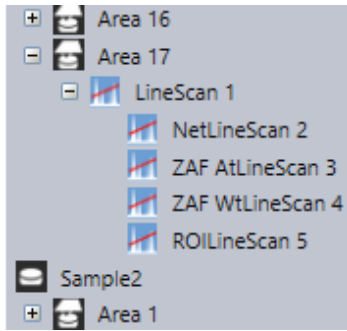


(Linescan Review Toolbar)

- ROI, NET, Atomic, Weight: These icons allow the user to select the wanted output data. Linescan data can only be acquired live in ROI mode but the rebuild options enables users to define NET, atomic %, and weight % linescans. Additionally, elements can be added or removed from the element list. To select a rebuild method, click one of the four icons.
- Rebuild: After selecting an icon, click the Rebuild icon. The periodic table will be displayed and elements can be added to or removed from the linescan rebuild. Click the OK icon to start the rebuild process. To stop the linescan rebuild process, click the Stop icon. The rebuild time will depend on the number of points and elements in the linescan.

In the project tree, each rebuild is placed under the original linescan's collection and is given

a sequence number. The rebuilds are also named according to the type of rebuild performed. NET, ZAF, Weight, ZAF Atomic, and ROI.

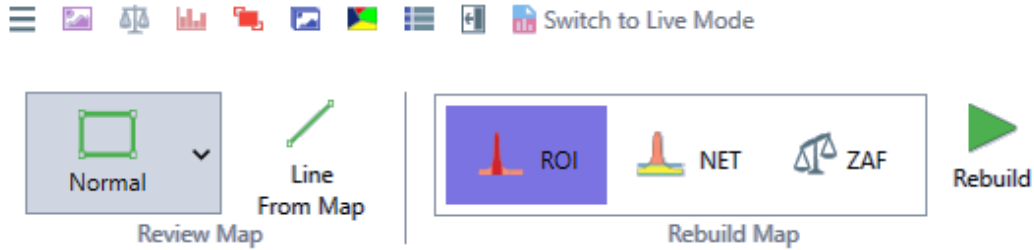


(Linescan Rebuild Project Tree)

-0-

Mapping Review

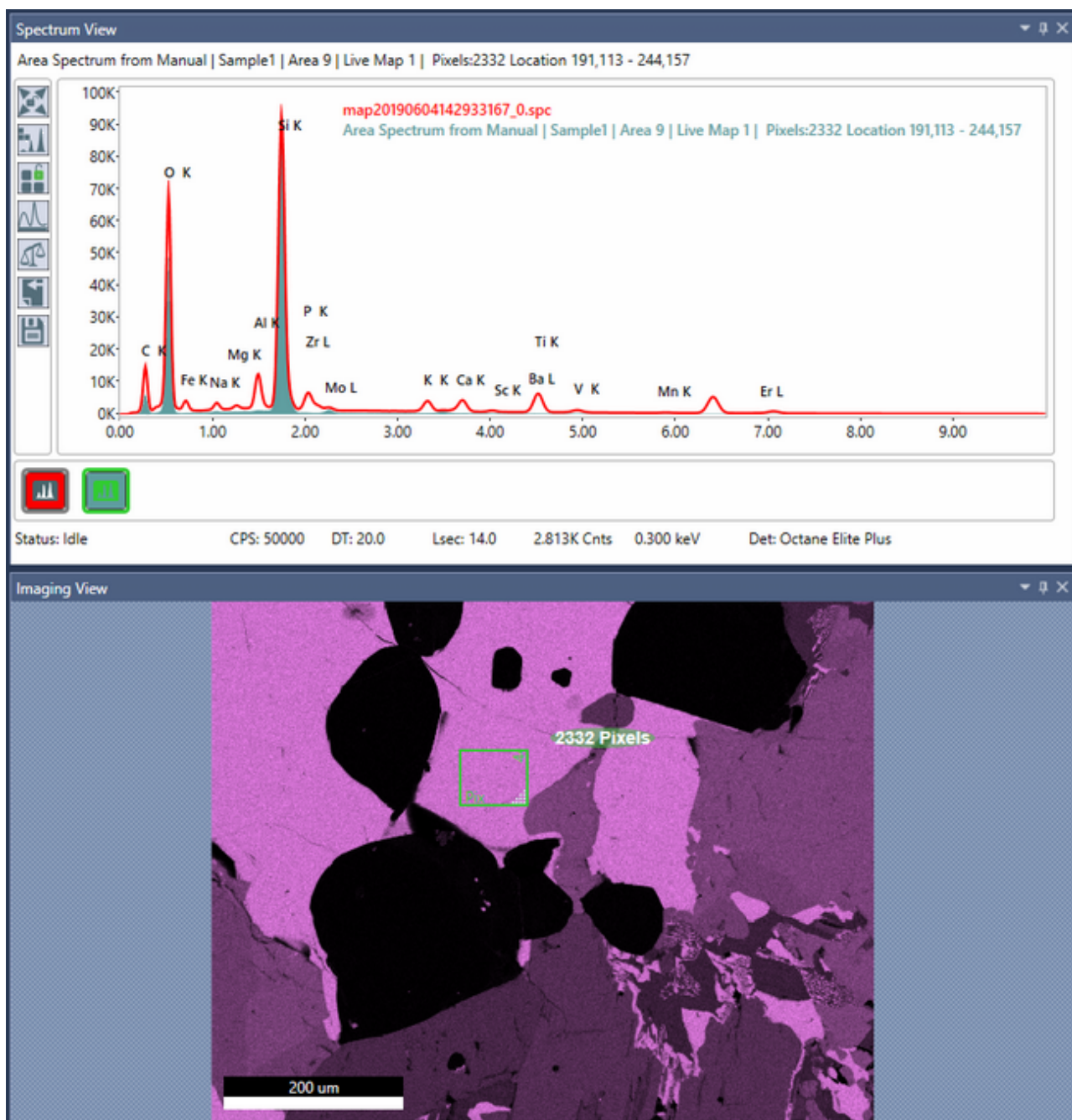
After collecting a map, there are two options in review mode: Review and Rebuild. Review mode enables users to select a portion of the existing map and extract the data from that selection. Rebuild mode reprocesses the map with the ROI, NET, or ZAF option.



(Mapping Review Toolbar)

- Review Map: Extracts the spectrum from spot or rectangular area selected by the user.

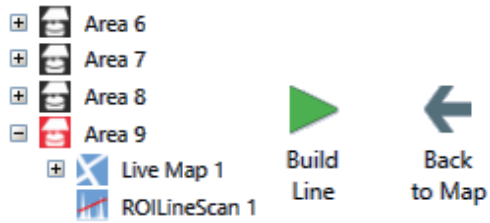
Normal: Enables the user to select an rectangular area for extraction. Click the Normal icon and select an area on the image view. The number of pixels selected is displayed on the image and the spectra. The spectral display will automatically update each time the area is redefined.



(Mapping Review > Normal Mode)

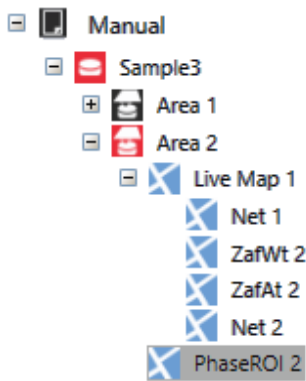
Free Draw. Enables the user to select an area, via drawing, for extraction. Click the Free Draw icon and select an area on the image view. If a point location is defined, left click and drag on the X/Y values next to the point to move to a new spot. The spectral display will automatically update each time the area is redefined.

Line from Map. This option extracts a line profile from the collected X-ray map. Click the Line From Map icon and then draw a line on the map to see a profile. The current element list will be displayed on the image view. Click OK to start the linescan generation. After the linescan is created, it will appear on the project tree below the map data with a sequence number. Each linescan will also be labeled according to the type of extraction: ROI, NET, or ZAF. To build another linescan, use the Back To Map icon to return to the mapping display.



(Line from Map Project Tree and Back to Map Icon)

Rebuild Map: Maps can be rebuilt into three types of data: ROI, NET, or ZAF. The ROI maps display is in scaled raw counts, the NET maps display in background subtracted counts per second, and the ZAF (quant) maps from a scale of 0-100 weight% or atomic%. In the project tree, each map rebuild is assigned sequence number named by the type of rebuild. In the ROI and NET modes, a single output data set will be created, but rebuilding using ZAF mode creates NET, ZAF Atomic %, and ZAF Weight % datasets.



(Map Rebuild Project Tree)

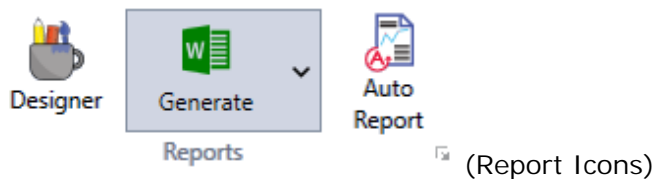
Rebuild: Use this icon to start the rebuilding process. The rebuild list of elements will appear on the screen for selection at the start of the process.

-0-

Reporting and Printing

Report Generation: Live Mode

APEX™ allows users to easily create reports in Microsoft Word or PowerPoint, while still in live mode. The report icons in the top right corner of the collection toolbar, enable the user to generate a report using pre-existing templates or design a template. To use a pre-existing template, select one of the options from the drop down menu. A preview of the report will be displayed as the mouse is hovered over each option. Clicking the Report Icon will start report generation and orange dots will appear under the icon while the report is loading.



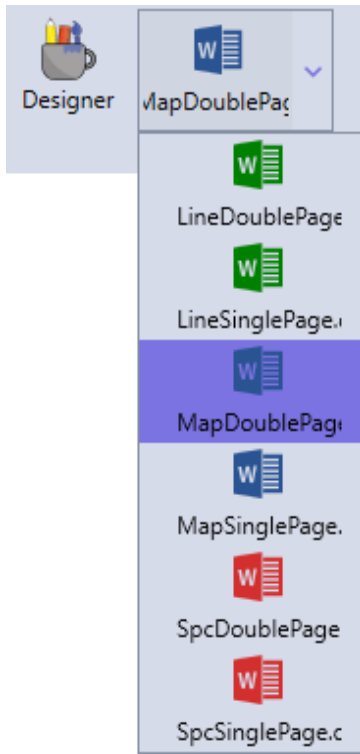
Report Designer

To create a report template for future use, click the Designer icon on the [collection toolbar](#). This will open a blank template that can be customized.

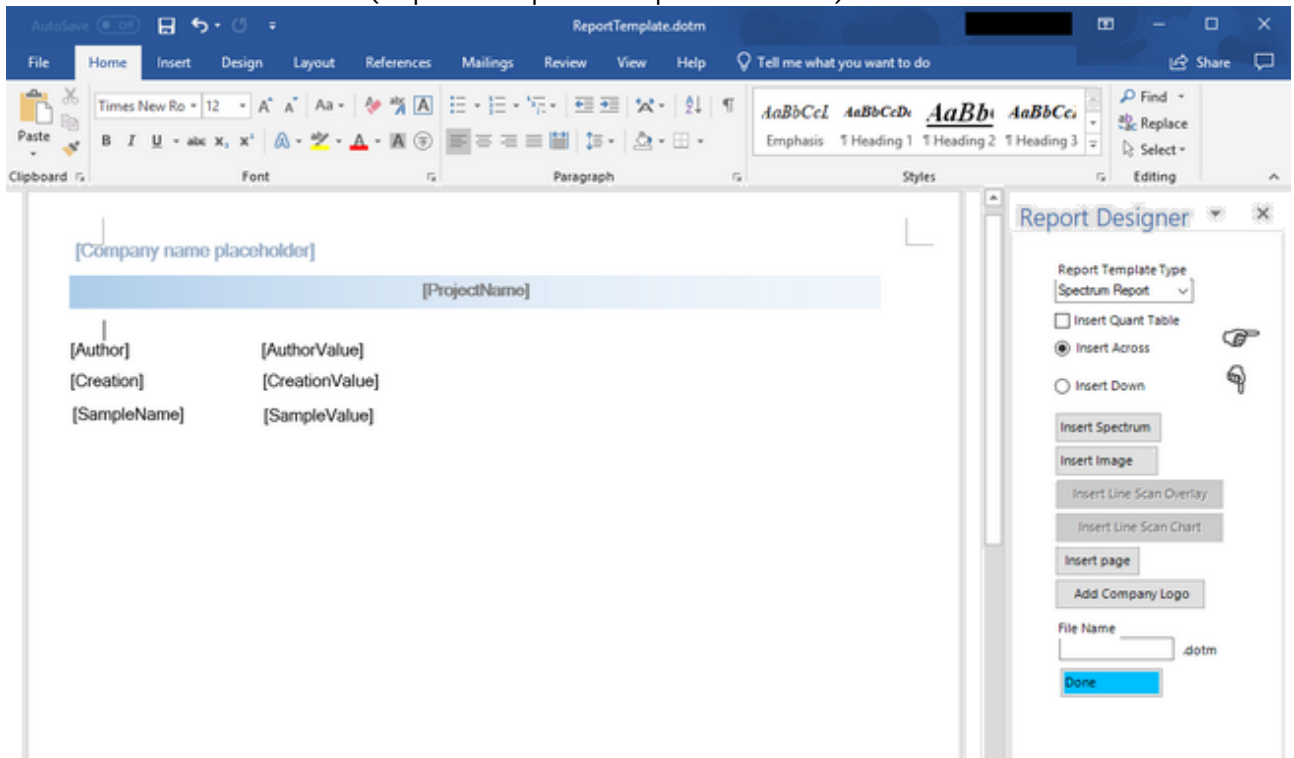
On the right side of the screen, select a report type from the drop down menu and then select *Insert Across* or *Insert Down* to specify the layout of the report. Use the Insert Spectrum and Insert Image icons to add wanted features to the report. Currently the template only supports one spectrum and one image per page. Extra pages and a company logo can also be added to the template using the corresponding icons. To save the template, enter a file name in the box and click the blue Done icon. This template will now appear in the Report Template Menu for future use

Report Properties Window

To access the Report Properties Window, click the arrow icon next to the word Reports in the collection toolbar. This window enables the user to customize the font and formatting of reports. To select a font type, color, and size for reports, use the drop down menus next to these options. The energy (keV) of the spectrum on the report can also be customized by entering a value in the box. Use the check boxes to enable or disable Fixed Auto Scaling.



(Report Template Drop Down Menu)



ReportTemplate.dotm - Word

File Home Insert Design Layout References Mailings Review View Help Tell me what you want to do

Clipboard Font Paragraph Styles Editing

Times New Roman 12 A⁺ A⁻ Aa -

B I U abc x₁ x² -

Emphasis Heading 1 Heading 2 Heading 3 Heading 4

Find Replace Select

Report Designer

Report Template Type: Spectrum Report

Insert Quant Table

Insert Across

Insert Down

Insert Spectrum

Insert Image

Insert Line Scan Overlay

Insert Line Scan Chart

Insert page

Add Company Logo

File Name: .dotm

Done

[Company name placeholder]

[ProjectName]

[Author] [AuthorValue]

[Creation] [CreationValue]

[SampleName] [SampleValue]

Jan28-9Pm | New Sample | Area 5 | EDS Spot 1

KV:21 Mag:50 Takeoff: 40.56 Live Time : 20 Amp Time(us) : 0.96 Resolution:(eV) : 128.8
Det : Octane Elect Super

Area 1

Page 1 of 1 0 words 100%

REPORT PROPERTIES



Font: Arial
Font color: Black

Report Format: Microsoft Word
Font size: 10

Company Name on Report Header: EDAX APEX

Start KeV: 0
End KeV: 0
 Fixed Vertical Scaling
 Use Customized Home View
 WYSIWYG Spc Mode

Default Spectrum Report Template: SpcDoublePage.dotm
Default Line Scan Report Template: LineDoublePage.dotm
Default Mapping Report Template: MapDoublePage.dotm

Single Image Image per Spectrum

Show Overlay

Show Phase Spectra

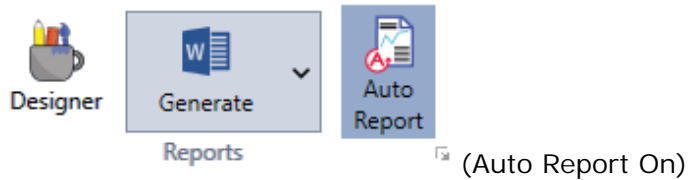
OK CANCEL

(Report Properties Window)

-0-

Auto Report

Clicking the Auto Report icon will enable Auto Report and change the icon color (shown below) When Auto Report is enabled the report engine will generate a report as soon as data collection finishes. Since the report engine works independently, data collection and review can continue while the report is being generated.



The report template for auto reporting, for each collection mode, can be specified using the drop down menu. *Note: The auto report function will not generate a report if a template is not specified.* The number of images included in the report as well as the option to display map overlay can also be customized using this menu.

-0-

Spectrum or Linescan Report: Review Mode

To generate a report, not using Microsoft Word or PowerPoint, the software must be in Review Mode. To enter review mode, click the Switch to Review Mode icon on the [title toolbar](#). Review mode can also be accessed by double clicking on a project tree node. This will load that specific data-set in review mode.



There are two options for creating reports: Quick Report and Selectable Report. The quick report mode creates multiple page reports with all data while the selectable report mode offers a selection of which data to include. To create a report, click one of the two Generate icon located in the Quick Report Area, on the left, or the *Selectable Report Area*, on the right. Clicking the Image, Spectrum, and Quant icons will add or remove them from the report. When an item is selected, it is highlighted grey and will appear in the report. When in *Linescan Mode*, checking or un-checking the element check boxes displayed on the image overlay will add (checked) or remove (unchecked) elements from the report. Clicking the Generate icon will open the report in the Report Viewer. From there, the report can be saved as a number of different formats, such as: PDF, XPS, PowerPoint, Excel, and HTML. To access the save options in report viewer, simply click on the Save icon and a drop-down menu will appear. The report can also be sent directly to an Outlook email account via the Email option. The display of the report can be adjusted using the Zoom function in the bottom right of the report viewer.

(Report Viewer Windows)

Report-Viewer

Print Open Save

Parameters Thumbnails Find Editor

One Page Two Pages Multiple Pages Page Width Full Screen

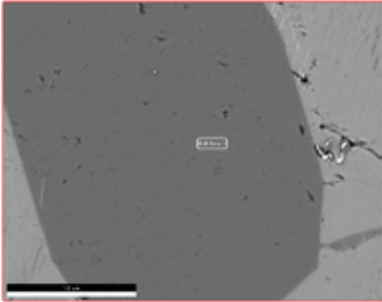
Document File... Adobe PDF File... Microsoft XPS File... Microsoft PowerPoint File... HTML File... Microsoft Excel File... OpenDocument Calc File... Text File... Rich Text File... Microsoft Word File... OpenDocument Writer File... Data File... Image File...

EDAX APEX

Manual

Author: Apex User
 Creation: 6/4/2019 11:45:18 AM
 Sample Name: Sample2

Area 5

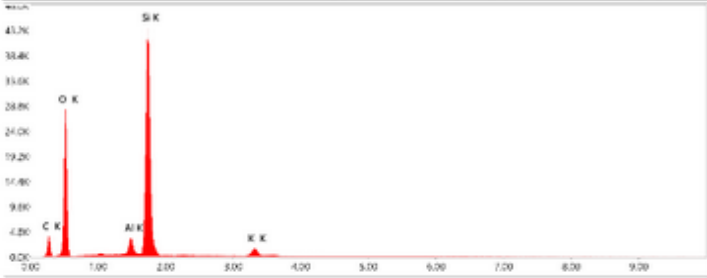


Smart Quant Results

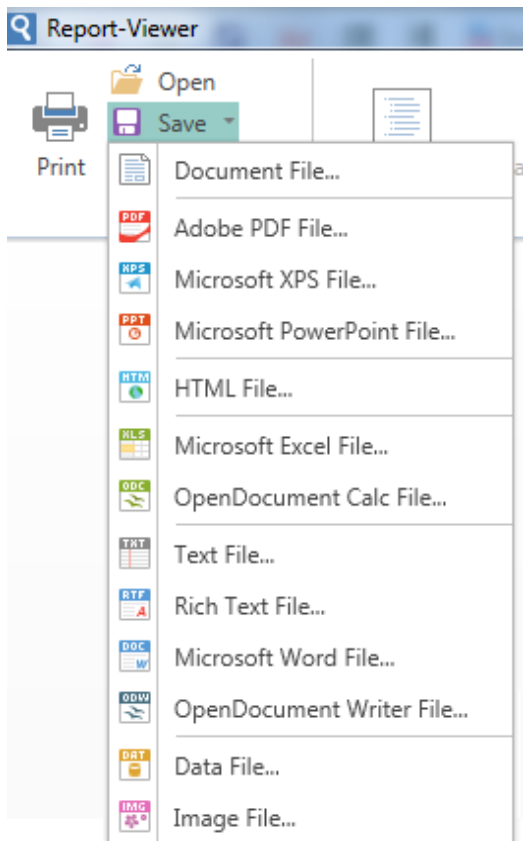
Element	Weight %	Atomic %	Error %
C K	23.05	32.57	11.74
O K	46.56	49.38	9.52
Al K	2.03	1.31	5.42
Si K	26.16	15.8	3.82
K K	2.16	0.94	4.39

Full Area 1

15 kV Mag: 2500 Takeoff: 32 Live Time(s): 20 Amp Time(μs): 7.68 Resolution(eV): 124



Det: Oxford Elite Plus



(Report Viewer Save Options)

Multiple Spectra Report:

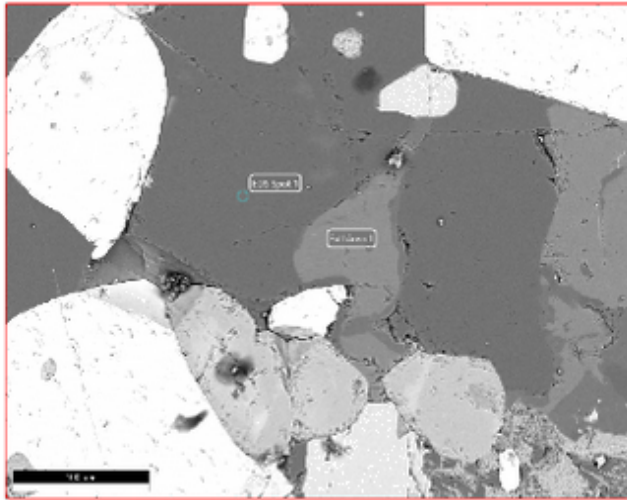
Double click on an area or sample in the project tree to display all of the spectra under that node. The wanted spectra can also be dragged and dropped in the display window to show multiple spectra. Once the spectra are displayed, to generate a report with one spectrum per page, click Quick Report > Generate. To generate a report with all the spectra overlaid on one display, click Current Report > Generate. In current report mode, use the spectra, quant results, and image icons to display/hide items from the report.

EDAX APEX

Manual

Author: Apex User
 Creation: 6/6/2019 11:32:43 AM
 Sample Name: Sample1

Area 16

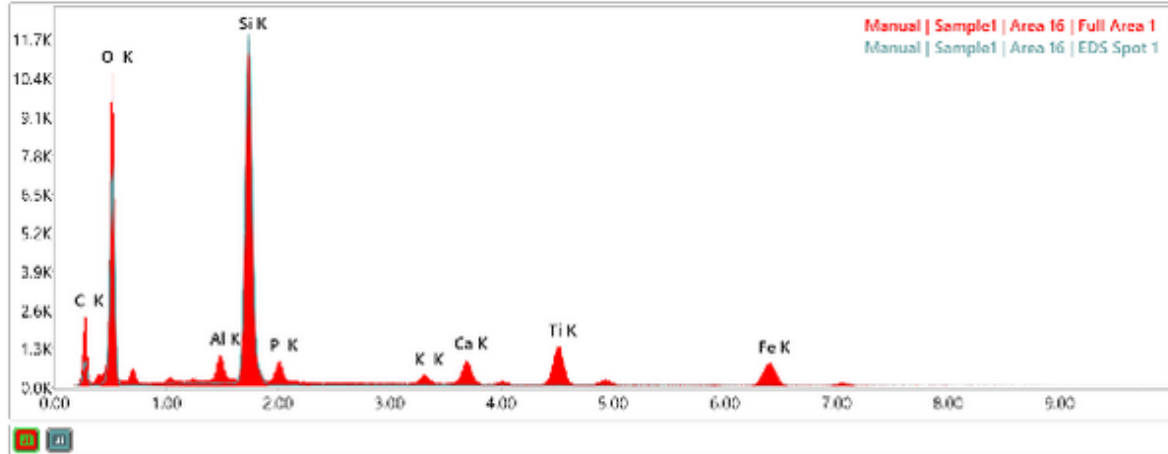


Smart Quant Results

Element	Weight %	Atomic %	Error %
Manual Sample1 Area 16 Full Area 1			
C K	22.52	34.54	12.11
O K	40.71	46.88	10.06
Al K	1.2	0.82	7.51
Si K	14.86	9.75	4.52
P K	1.22	0.73	8.83
K K	0.84	0.4	11.13
Ca K	2.89	1.33	4.95
Ti K	6.56	2.52	3.75
Fe K	9.2	3.04	4.38
Manual Sample1 Area 16 EDS Spot 1			
C K	26.3	36.05	11.96
O K	46.86	48.22	9.6
Si K	26.84	15.73	3.7

Spectrum Overlay

KV: 15 Mag: 800 Takeoff: 32 Live Time(s): 20 Amp Time(μs): 7.68 Resolution:(eV) 124.6



Det: Octane Elite Plus

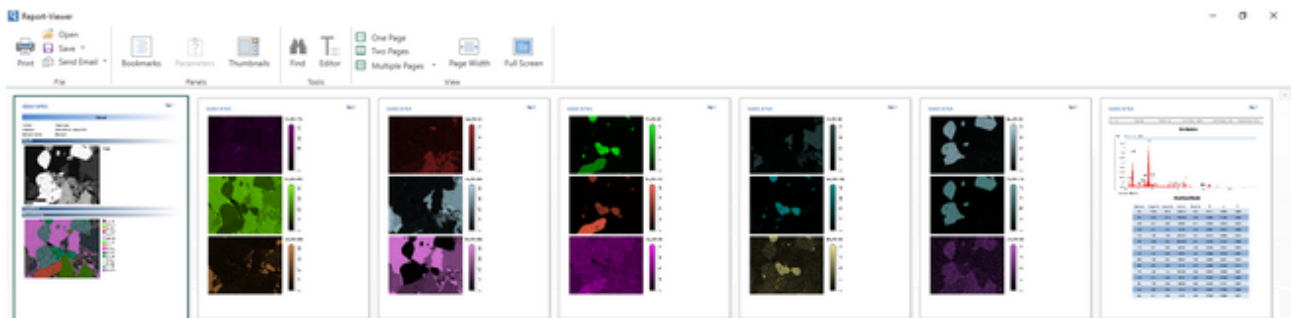
(Current Report Display)

-0-

X-Ray Map Report: Review Mode

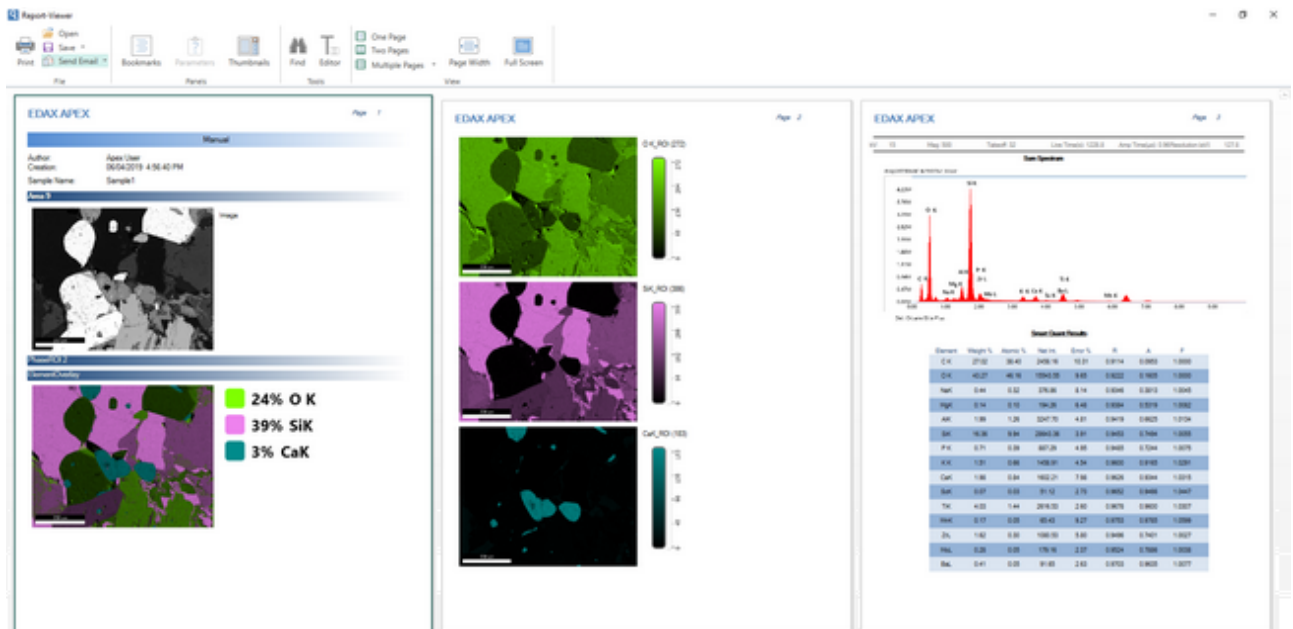
When in mapping review mode, use the Quick Report or Selectable Report option to create a report. Use the check-boxes next to each element map to select (checked) or remove (unchecked) maps from the report.

- Quick Report: When quick report is selected, all of the collected maps (except the CPS map) will be sent to the report.
- Selectable Report: When selectable report is selected, only the maps selected (via their check boxes) will be sent to the report. Use the spectrum icon to add (highlighted) or remove (not highlighted) the Sum Spectrum from the report.



(X-Ray Map Quick Report)

(X-Ray Map Current Report)



-0-

Print Results

There are multiple options for printing data and images collected in APEX™. Items sent to the printer can also be saved as PDF files for easy access and sharing.

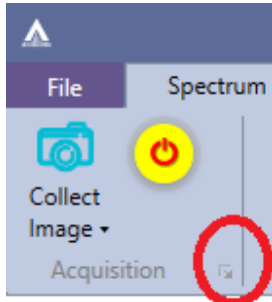
- **Print Image:** To print an image, use the *Send to Folder* option on the image view. Then, open the saved image the folder and print the image.
- **Print Spectrum:** To print a spectrum, use the *Send to Folder* option on the spectrum view. Then, open the file to print.
- **Print Quant:** To print quant results, use the *Print Icon* in the quant menu. Click the icon and then select a printing method.
- **Print Screen:** To print the entire APEX™ screen, use the [print icon](#) in the bottom left corner of the project tree.
- **Print Report:** To print a report, [generate a report](#) in report viewer. Then, click the *Print Icon* in the top left of the screen.

-0-

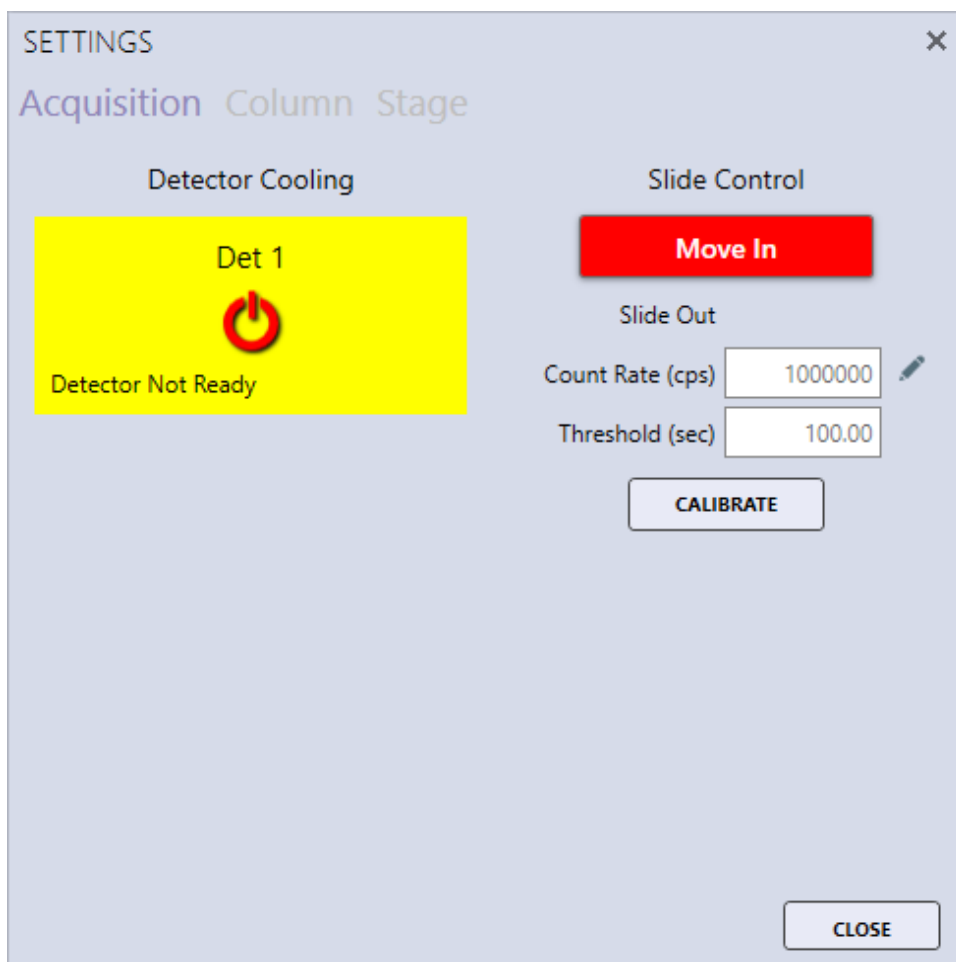
Advanced Settings

Detector Cooling and Slide Control

To access the Detector Cooling and Slide Control Settings, click the arrow in the Acquisition field of the live mode.



A pop-up window will be displayed showing the Detector Cooling and Slide Control options. This window displays the detector status and can be used to turn cooling on or off for Elect and Elite detectors as well as inserting and retracting Elite detectors.



Moving the Slide

To move the slide, click the Move In button shown below.

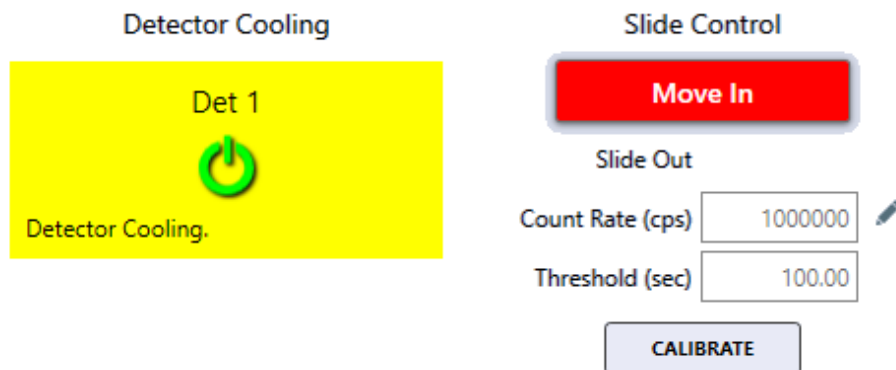
SETTINGS

✕

Acquisition Column Stage

Detector Cooling

Slide Control



Det 1

Detector Cooling.

Move In

Slide Out

Count Rate (cps) 1000000

Threshold (sec) 100.00

CALIBRATE

Once the slide is in, the button label changes to Move Out and the color turns to green. The slide status will state Slide In. To move the slide out, click the Move Out button.

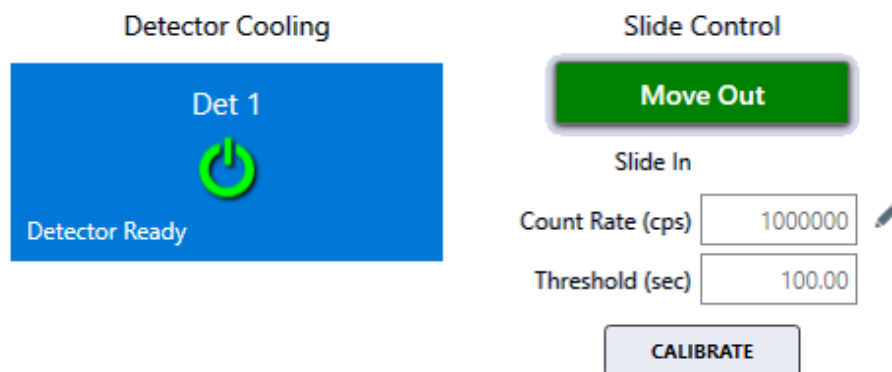
SETTINGS

✕

Acquisition Column Stage

Detector Cooling

Slide Control



Det 1

Detector Ready

Move Out

Slide In

Count Rate (cps) 1000000

Threshold (sec) 100.00

CALIBRATE

Count Rate and Threshold

The Count Rate and Threshold settings are used to automatically retract the detector to avoid very high X-ray counts for an extended period of time. When the CPS exceeds the Count Rate for longer than the number of seconds given by the threshold value, the detector will automatically retract to the out position.

Calibrating the Slide

To calibrate the slide, click the Calibration button. The button will be disabled until the calibration is complete. Slide calibration automatically determines the slides analyze and retract positions.

-0-

Microscope Column and Stage Control

The EDAX Column and Stage control options are only available for certain microscopes and must be installed and configured. To access the Column and Stage Control Settings, click the arrow below the [collect icon](#) in the Acquisition field of the live mode. The second tab on the pop-up window will display the Column/Stage control options. This window is a floating window which enables users to make adjustments while collecting an image and see those changes immediately.

SETTINGS

✕

Acquisition **Column** Stage

AUTO FUNCTIONS

AUTO FOCUS STI

FINE FOCUS

Auto Beam-OFF

AUTO BC

COARSE FOCUS

HT On/Off

BRIGHTNESS

40.92

%

HT

25.0

kV

CONTRAST

56.57

%

MAGNIFICATION

800

BEAM BLANK

0

WD

10.12

mm

SPOTSIZE

12

SPECIMEN CRT

1

nA

COARSE FOCUS

FINE FOCUS

READ STATUS

CLOSE

(Column Control)

To switch on or off the Microscope High Tension, slide the HT On/Off slider control. To turn off the high tension after a lengthy analysis, use the Auto Beam-OFF check box before starting the analysis. This function is typically used for X-ray maps, linescans, or multipoint spectral analysis.

Click the third tab on the pop-up window will show the stage control options. Use the X and Y boxes to specify a stage location. Click Set XY to move the stage to that location. Click Read Positions to update the X and Y values after the stage has been moved via the controls on the microscope.

SETTINGS



Acquisition Column Stage

X: Y: R: Z: T:

SET XY

READ POSITIONS

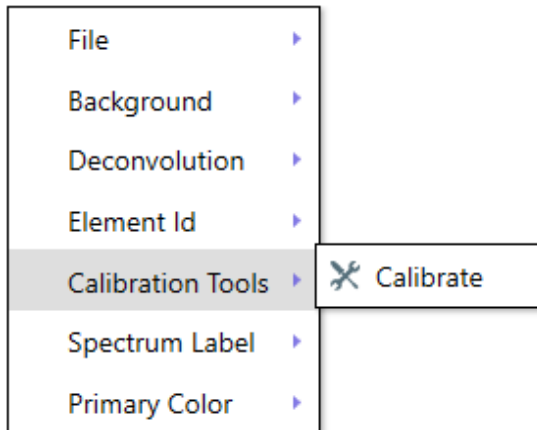
CLOSE

Note: If the stage and column control options are not available, this window can still be used to set the magnification and KV to match the SEM conditions prior to the analysis.

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Spectral Calibration

It is recommended that the spectral calibration is verified periodically. When the spectrum deconvolution does not match the collection spectra, the software should be calibrated. Typically this is done using an Aluminum and Copper specimen. Load this type of sample into the SEM and adjust the beam current for roughly 15,000 CPS. The high tension should be set to above 25 kV and the SEM field of view should be adjusted so the Al K and Cu K peaks are of roughly equal height in the spectrum view. Right click on the spectrum view window and select Calibration Tools from the options menu. Then click Calibrate.



(Calibration Menu)

APEX™ will immediately collect a spectrum for a short period of time. If an Aluminum and Copper specimen is being used, the target energies are preset in the software and the calibration can be started using the Calibrate button. If a different specimen is being used for the calibration, the two target energies must be entered manually, in keV, in the Peak 1 and Peak 2 boxes before clicking the Calibrate button. It is recommended the energies be large, non-overlapping peaks several keV apart in energy and above 1 keV.

Clicking the Calibrate button will start the spectrum acquisition and when the two peak energies are within specification, the calibration is complete. During the calibration, the window tile will display that calibration is in progress. The window can be moved around by clicking on the tile and dragging. The Delta values are the difference (in keV) between the target and measured peak energies. Click the Stop button to abort the calibration process at any time. Calibration may take a few iterations to complete, but when Peak 1 is within 1 eV and Peak 2 is within 1.5 eV of the target values, the calibration should complete. If the calibration does not complete in several minutes, click Stop. The calibration routine should be run for all amp times.

	Target	Delta
Peak 1	1.486	0.0000
Peak 2	8.04	0.0000

Calibrate All

Resolution:

Fine Gain:

Zero:

When the calibration is complete, Calibration Successful will be displayed at the top of the calibration window. Use the View Log button to display the previous calibrations performed on this system. The log file of calibrations can be found at C:\ProgramData\EDAX\Dpp4Calibration.xml. The log file contains the date and time of the calibration, the amp time and eV/channel used, the fine gain, the zero, the input CPS, the peak energies, the dead time, the detector number, the detector resolution at Mn K α , and the detector temperature.

Calibration Successful ✕

	Target	Delta
Peak 1	1.486	0.0010
Peak 2	8.04	0.0009

Calibrate All

Resolution

Fine Gain

Zero

DATE & TIME	AMPTV	EVC
5/2/2019 9:14:00 AM	3.84	10
5/2/2019 9:13:35 AM	1.92	10
5/2/2019 9:13:19 AM	0.96	10
5/2/2019 9:13:02 AM	0.48	10
5/2/2019 9:12:21 AM	0.24	10
4/4/2019 6:18:12 PM	0.48	10
4/4/2019 5:59:43 PM	7.68	10
3/21/2019 6:56:21 PM	3.84	10

-0-

APEX Tutorial Slide

Click the Tutorial Slide button in the [Application Menu](#) to display this option. It contains useful How-To videos with voice-over, explaining some APEX processes and workflows. The Play, Pause, Stop, and Full Size View options are located below each video.

-0-

Index

- A -

Additional Spectra Overlay Methods 94
Advanced Quantitative Methods 76
APEX Tutorial Slide 142
Application Menu 9
Auto Report 128

- B -

Batch Mode 65

- C -

Check for Updates 33
Collection Modes 28
Collection Toolbar 11

- D -

Detector Cooling and Slide Control 135
Drift Correction 61

- F -

File Menu 14

- I -

Image and Data Collection 34
Image Collection 35

- L -

Launching APEX 4
Layout Overview 6
Linescan Collection and Settings 39
Linescan Review 119
Linescan View-> Image Window 102
Live NET and ROI Map Options 52

- M -

Map Collection and General Settings 44
Mapping Pop-Up Menu 106

Mapping Review 121
Microscope Column and Stage Control 137
Montage Mapping 56
Multi-map View Window 104
Multi-Spectra View 98
Multi-User Mode 30

- O -

Other Project Tree Icons

- P -

Peak ID 81
Print Results 134
Project Tree Function Icons 22
Project Tree Panel 21

- Q -

Quant View Window Introduction 68

- R -

Report Generation: Live Mode 124
ROI Display, Custom ROI and Changing Elements While Mapping 50

- S -

Scan List 64
Smart Phase Mapping 54
Spectral Calibration 139
Spectrum Auto Processing 111
Spectrum Collection and Settings 37
Spectrum Matching 114
Spectrum or Linescan Report: Review Mode 129
Spectrum Pop-Up Menu 89
spectrum primary color 89
Spectrum View Advanced Settings 90
Spectrum View Color Settings 95
Spectrum View Toolbars 83
Status Bars 13

- T -

The Print Icon 27
The Project Icon 24
The Sample Icon 26

- U -

User Profile Preferences 16

- V -

Vertical Toolbar 84

- X -

X-Ray Map Report: Review Mode 133

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