

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

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Chapter 1

Introduction to APEX™

1.1 Launching APEX™

From the windows desktop double click on the APEX™ application icon to start the software (shown in figure 1.1).

Figure 1.1: The APEX™ Icon



The application splash screen will start and display the EDAX License information as shown in figure 1.1.

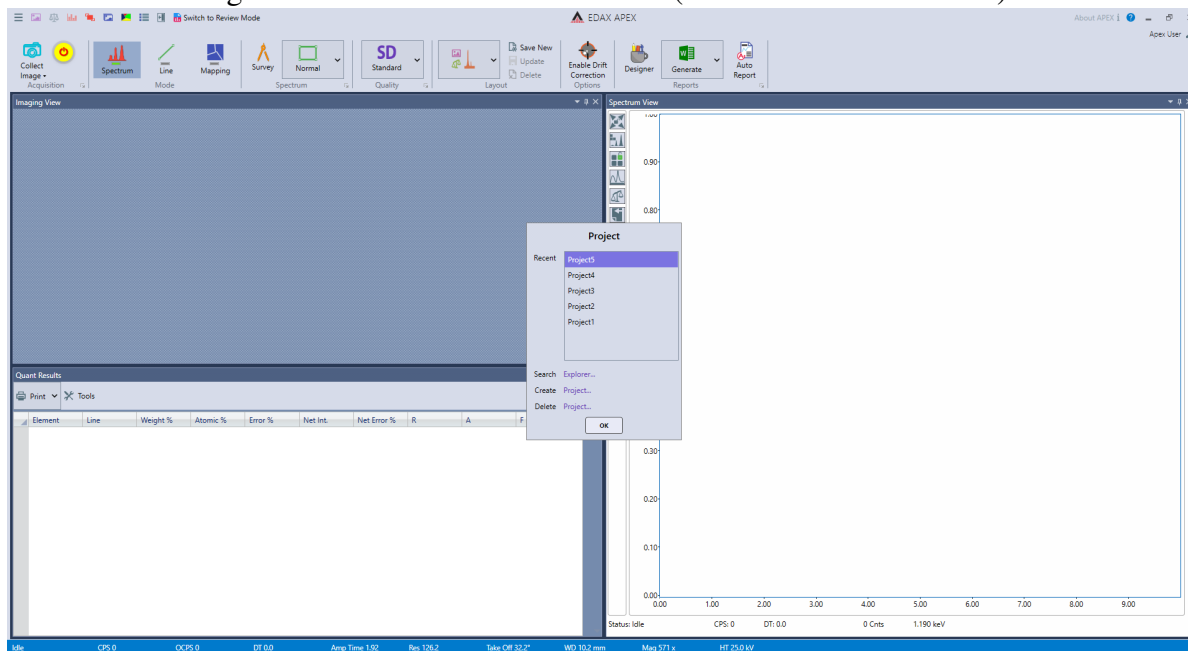
Figure 1.2: APEX™ Application Screen



When the application is ready the startup window shown in figure 1.3 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** The default name is "New Project," but any name can be entered as long as it does not contain the characters ~ \ ^ < > % @ * + \ / ? \$ " :. To proceed from the new project window click **OK**.

Figure 1.3: APEX™ Launch Screen (Live Collection Window)



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 **Cooling On** icon on the **Collection Toolbar** (see section 1.3 on page 5). For advanced detector cooling and slide control settings, refer to section 7.1 on page 87.

1.2 Layout Overview

The title of the window displays which mode APEX™ is in. It has two states: a live collection window and a review window. **EDAX APEX™** is the data collection window (figure 1.3), while **EDAX APEX™ Review** (figure 1.4) is where you can review all types of data and produce reports.

- One of the many powerful features of the APEX™ 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**.

Preset Layout Options

APEX 1.5 gives users the option of choosing from multiple layouts for each mode i.e. Spectrum, Line Scan or Mapping, see figure 1.5.

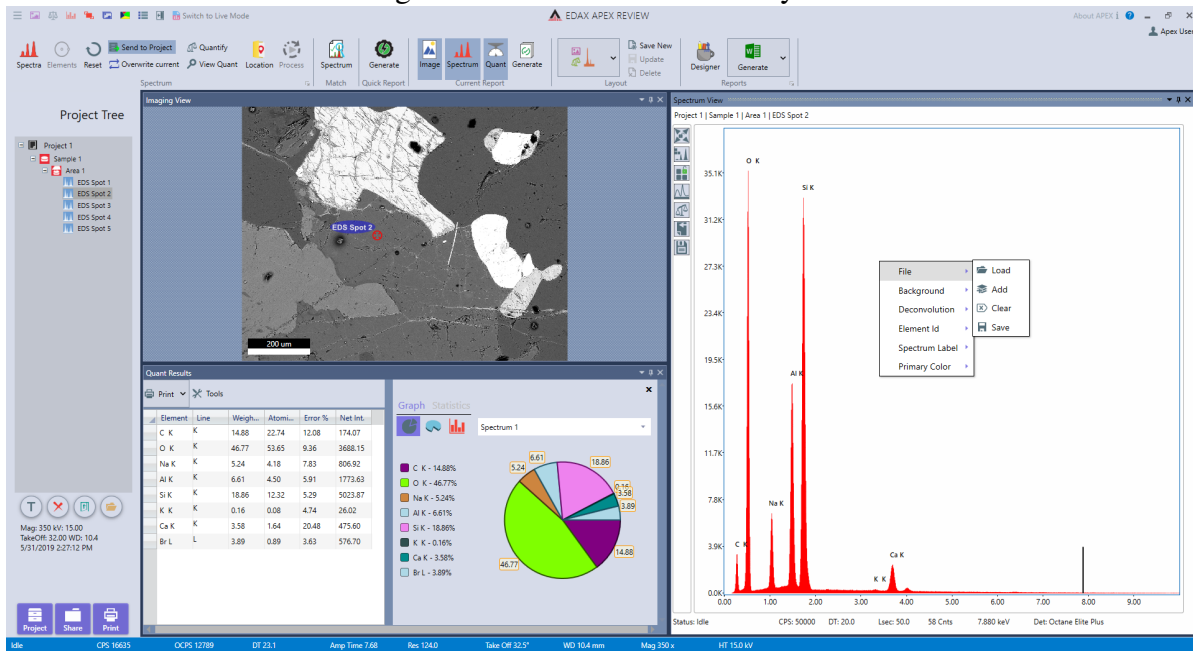
Preset Layouts Spectrum/Line Scan Mode:

- **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:

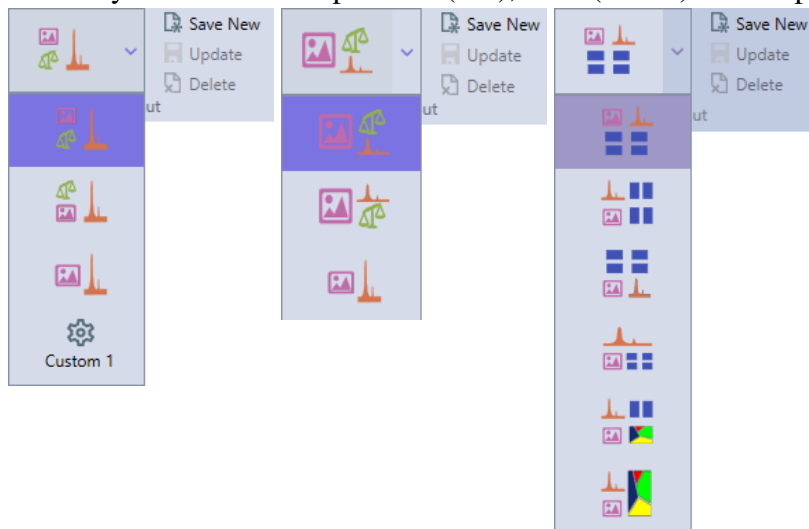
1.2. LAYOUT OVERVIEW

Figure 1.4: APEX™ Review Layout



- **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.

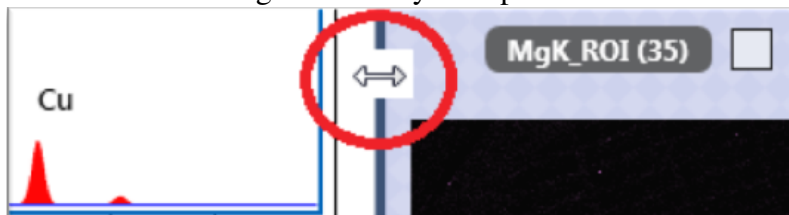
Figure 1.5: Expanded Layout Toolbar in Spectrum (left), Line (center) and Mapping mode (right)



To fine tune the layout of windows, move the mouse pointer over the splitter sections (see red circle in figure 1.6) 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.

Figure 1.6: Layout Options



Multiple Custom Layouts

APEX 1.5 allows a user to 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. Once the layout is saved it will be selected and a new **Custom Layout** Icon appears in the layout combo box (see Figure 1.5 left). The **Update** and **Delete** buttons become active when a custom layout is selected. You can see a thumbnail tooltip 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 layout combo box.

1.3 Icons

Title Bar Toolbar

The title bar toolbar shown in figure 1.7 allows the user to switch between live collection window and review window and to show or hide different view panels in order to easily view spectra, quant, and mapping results. As APEX™ can display live quant results while data is collecting, these icons are especially useful.

Figure 1.7: The Title Bar Toolbar



Description of the title bar icons:

Show/Hide the APEX™ Project Tree Panel



Show/Hide the Image Panel



Show/Hide the Quantification Panel



Show/Hide the MultiMap X-ray Panel



Show/Hide the Spectrum View Panel



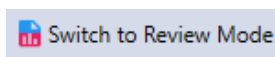
Show/Hide the Multifield Scan Table



Show/Hide the Advanced View Panel



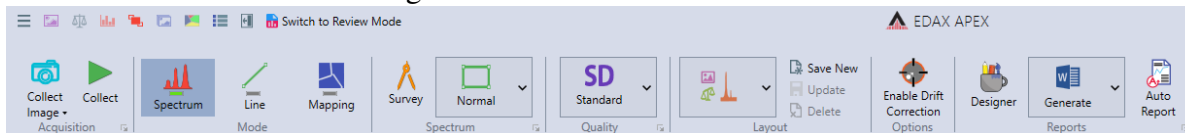
Switch from Collection to Review Mode



Collection Toolbar

Below the title bar toolbar is the collection toolbar (figure 1.8) which enables users to set up data collection. 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.

Figure 1.8: The Collection Toolbar



Main Status Bar and Spectrum Status Bar

The Main Status Bar is located at the bottom of the main user interface. The display of the status bar can be customized in **User Preferences** (see section 1.4). Available options are:

Description of the collection toolbar icons:

The Image Collection Icon



The Detector Cooling Icon



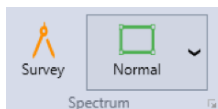
The Data Collection Start/ Stop Icon



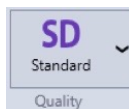
The Collection Mode Icons



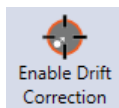
The Spectrum Mode Icons



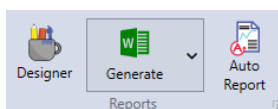
The Collection Quality Icon



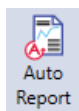
The Drift Correction Icon



The Report Generation Icons

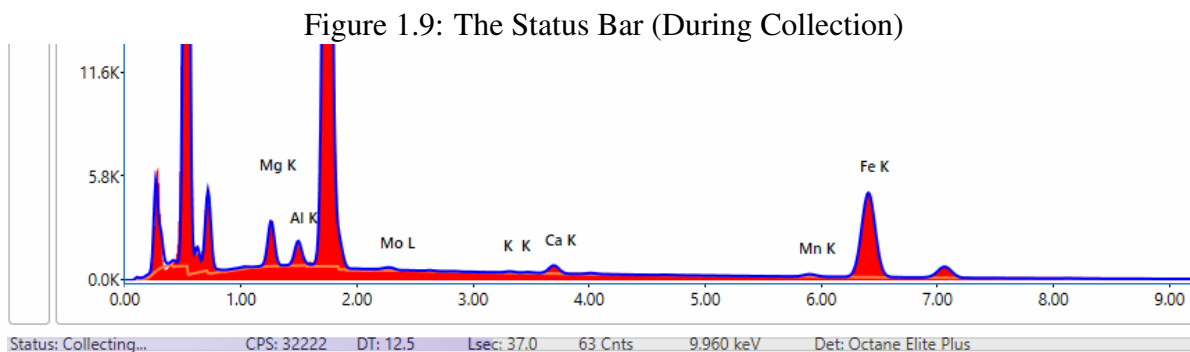


The Auto Report Icon



- **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.

The Spectrum Status Bar is located at the bottom of the Spectrum View window. 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 status bar.



- There are three possible status displayed: **Collecting**, **Idle**, and **Identifying Elements**. There is also a progress bar behind the text that shows the progression of spectrum collection. 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 collecting, **purple** when an image is collecting, and **red** if there is a network communication problem.

Collection Conditions:

- **CPS** : The EDS Detector input counts per second. After collection the average CPS is shown.
- **DT** : The Dead Time percentage (updated once per second). After collection the average DT is shown.
- **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.

1.4 User Profile Preferences

The user profile preferences allows users to customize the display and storage options to best meet their needs. To access the user profile menu, click the **User Profile Icon** in the top right on the screen as shown in figure 1.10. This will pull up the **User Preferences** tab, shown in figure 1.11. The **User Account** tab enables a user *First Name* and *Last Name* to be entered for the account (see Figure 1.12). This name will be used for reports. The **User Name** is automatically set to ApexData. For more information on data backup and handling settings, see section 6.2 on page 83.

Figure 1.10: The User Profile Icon

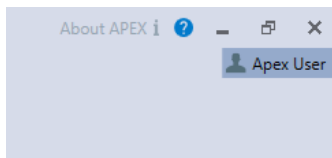


Figure 1.11: The User Profile Selection Window

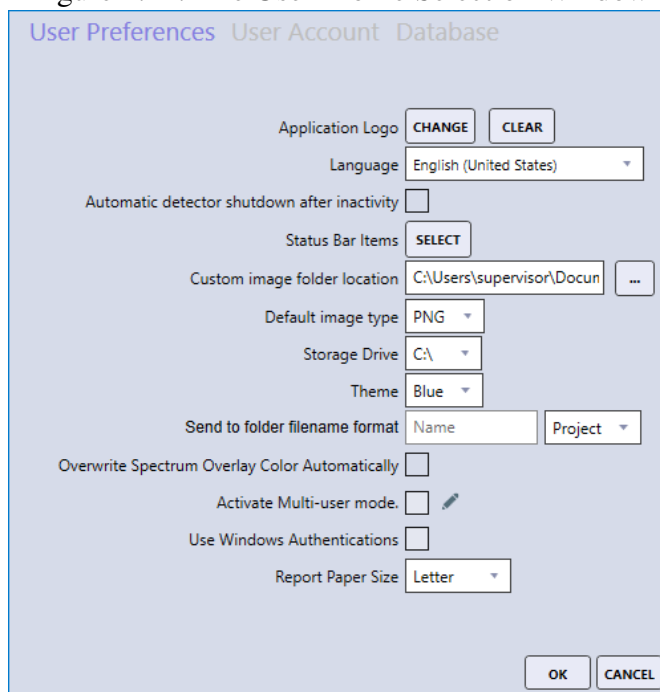
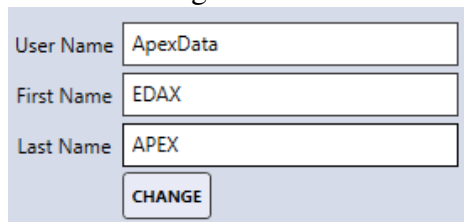


Figure 1.12: Change User Account Window



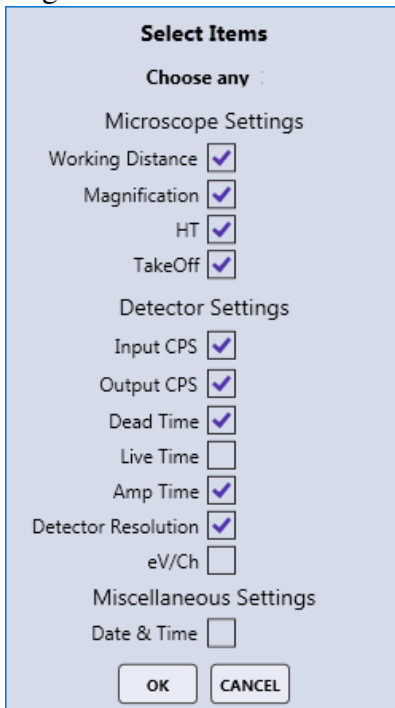
- **Application Logo→Change or Clear:** The Application Logo → Change icon allows the user to specify an image that will be used as the application logo. This logo will be displayed in the top right of the APEX™ window and will appear on all reports. To upload an image, click **Change** and select a file. To remove the current image, click **Clear**.
- **Language:** There are eight language choices for APEX™: English, Chinese, Czech, French, German, Japanese, Russian, and Turkish. Use the drop down menu to select a language as shown in figure 1.13.

Figure 1.13: Language Drop Down Menu



- **Automatic detector shutdown after inactivity:** Checking this box will shut down detector automatically after inactivity.
- **Status Bar Item Selection:** This icon allows the user to customize the parameters shown in the *Status Bar* on the bottom of the screen. Clicking the **Select** icon brings up a pop-up window in which parameters can be selected as shown in figure 1.14. To select a parameter, click the check-box next to it. To remove a parameter, deselect the check-box. For more about the status bar, see section 1.3 on page 5.
- **Custom Image Folder Location:** 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, shown in figure 1.15.
- **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 as shown in figure 1.15.
- **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, see figure 1.16.
- **Theme:** The APEX™ application supports four different color themes for the entire software display (see Figure 1.17). The use of themes is based on personal preference and APEX™ must be restarted in order for a new theme to take effect.
- **Send to Folder Filename 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 as shown in figure 1.18.
- **Overwrite Spectrum Overlay Color Automatically:** Overwrites default spectrum overlay colors. See section 3.2.4 on page 50 for more information.
- **Activate Multi-user Mode:** Enables/Disables multi-user mode. See section 1.7 on page 16 for more information.

Figure 1.14: Status Bar Items



A dialog box titled "Select Items" with a light blue background. It contains three sections of settings, each with a title and a list of items with checkboxes. The first section is "Microscope Settings" with items: Working Distance (checked), Magnification (checked), HT (checked), and TakeOff (checked). The second section is "Detector Settings" with items: Input CPS (checked), Output CPS (checked), Dead Time (checked), Live Time (unchecked), Amp Time (checked), Detector Resolution (checked), and eV/Ch (unchecked). The third section is "Miscellaneous Settings" with item: Date & Time (unchecked). At the bottom are "OK" and "CANCEL" buttons.

Select Items

Choose any :

Microscope Settings

Working Distance ☒

Magnification ☒

HT ☒

TakeOff ☒

Detector Settings

Input CPS ☒

Output CPS ☒

Dead Time ☒

Live Time ☐

Amp Time ☒

Detector Resolution ☒

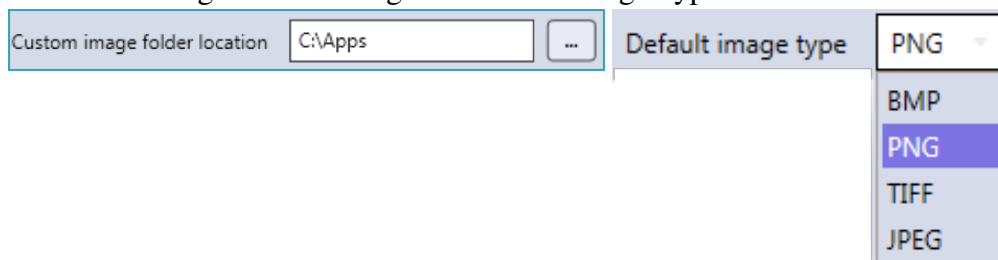
eV/Ch ☐

Miscellaneous Settings

Date & Time ☐

OK CANCEL

Figure 1.15: Image Folder and Image Type Selection



A dialog box for selecting image folder and type. It has two main sections. The first section is "Custom image folder location" with a text box containing "C:\Apps" and a browse button "...". The second section is "Default image type" with a dropdown menu. The dropdown is currently set to "PNG" and is open, showing a list of image formats: BMP, PNG (highlighted), TIFF, and JPEG.

Custom image folder location C:\Apps ...

Default image type PNG

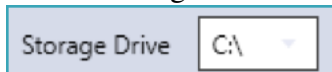
BMP

PNG

TIFF

JPEG

Figure 1.16: Storage Drive Selection



A dialog box for selecting a storage drive. It has a label "Storage Drive" and a dropdown menu. The dropdown is currently set to "C:\".

Storage Drive C:\

Figure 1.17: Theme Selection and Color Schemes

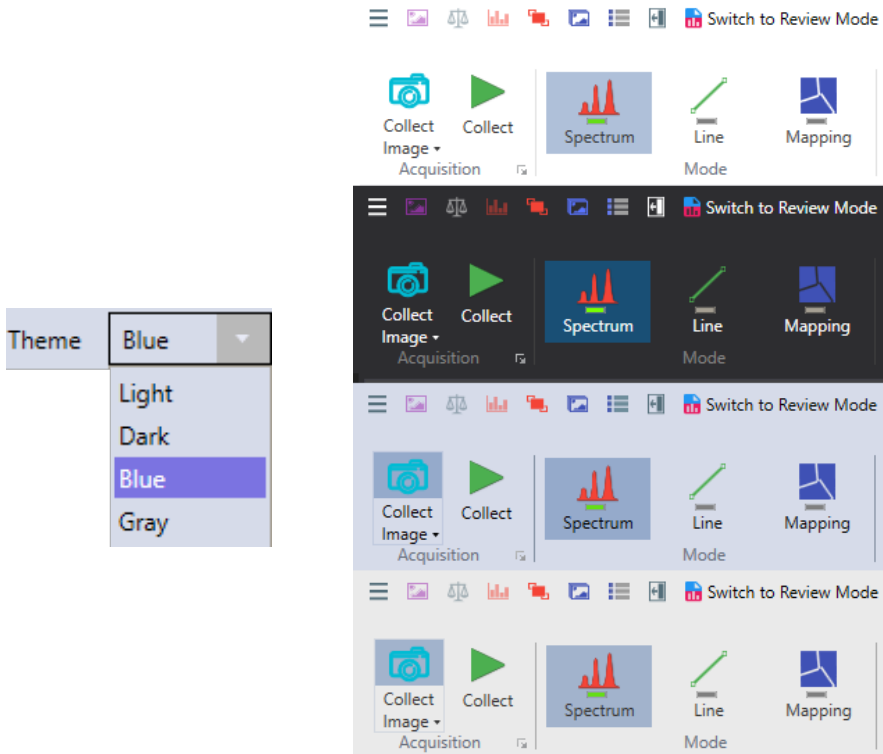
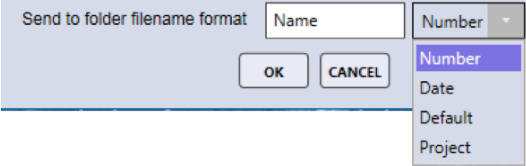


Figure 1.18: Send to Folder File name



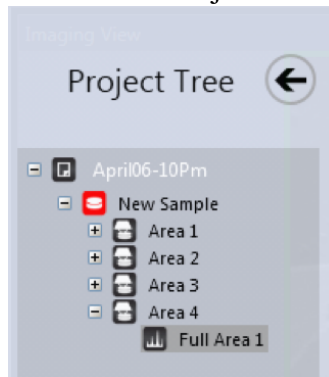
- **Use Windows Authentications:** With **Use Windows Authentications** checkbox checked, the login used for the Windows Operating system is tied to the APEX software. See Section 1.8 on page 20 for more information.
- **Report Paper Size:** Chooses between Letter and A4 for the report paper size.

1.5 Project Tree Panel

Projects, samples, and data automatically appear in the **project tree panel**, shown in figure 1.5. It is an easy way to look through data and images. Each time a new sample is created, a new image is collected, or 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 ← next to the words **Project Tree**. Double click on a Spectrum node, such as *Full Area 1*, and it will be displayed. 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 an **Open Folder** dialog box. Clicking **Open Folder** will open a Windows Explorer window in the location of the raw data.

Warning: *Do not rename, delete, or move the data using Windows Explorer as this can result in data loss. Use APEXTM data management options instead.*

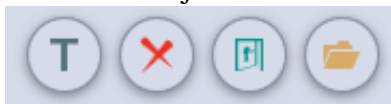
Figure 1.19: The Project Tree Panel



Project Tree Function Icons

Directly below the project tree nodes are 4 function buttons, see figure 1.5.

Figure 1.20: The Project Tree Function Icons



- Click on the **T** icon to rename a node on the project tree.
- Click on the **Garbage Bin** icon to remove a node on the project tree.
- Click on the **Blue Open door** icon to reload the data from the current node.
- Click on the **Folder** icon to view the contents of the *Custom Image* folder.

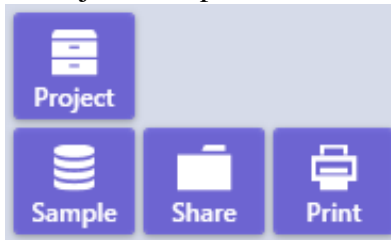
When collecting spectral data, each type of area is named by the collection method used. **Full Area** is the total image area, **Spot** means the beam was not rastered and data was collected single beam position, **Selected Area** means a portion of the total image area is selected for collection, and **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.

Project, Sample, Share, and Print Icons

In the bottom left corner of the project tree panel, there are four icons labeled: project, sample, share, and print, seen in figure 1.21. *For information on the share icon, see section 6.1 on page 79.*

Figure 1.21: Project, Sample, Share, and Print Icons

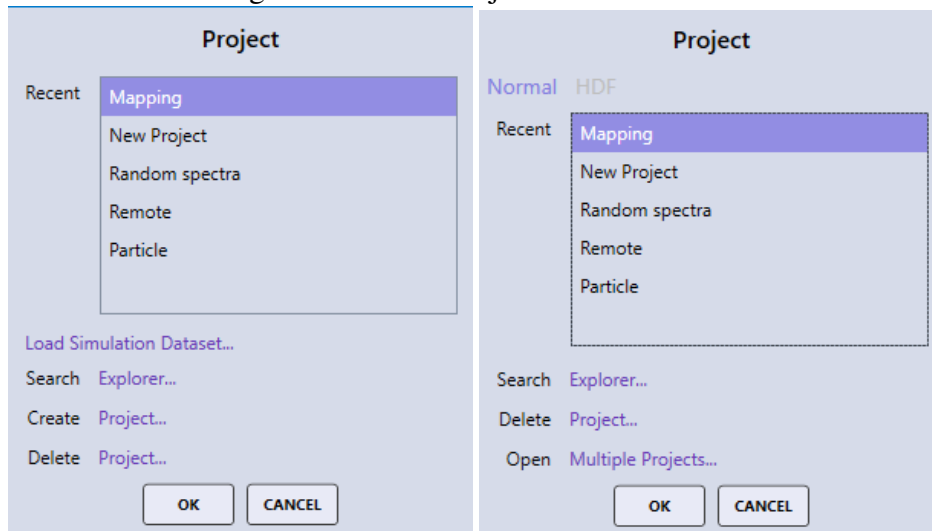


Note: *These icons are only visible when the project tree panel is open.*

The Project Icon:

Clicking on the project button displays the project selection window shown in figure 1.22. When in collection mode, the window on the left is displayed. When in review mode, the window on the right is displayed. In this mode, projects saved in HDF5 file format can be opened in the HDF tab, further details can be found in section 6.1 on page 81.

Figure 1.22: The Project Icon Windows

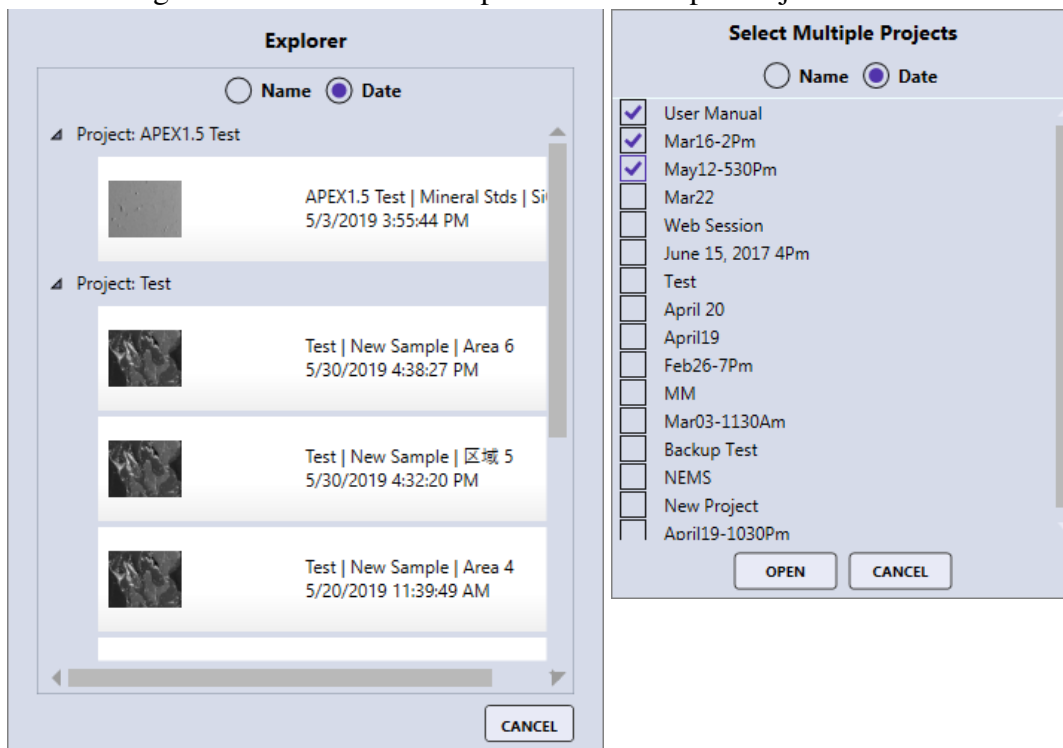


The project window shows the five most recent projects followed by:

- **Search:** Opens a window with the list of all projects on the system. The projects can be sorted by name or by last accessed date, to view the images associated with the data, click on the arrow by the project name.
- **Create:** Creates a new project.
- **Delete:** Opens a window where a saved project can be deleted. To review the selected project, click on the **Open** button. The images from the projects are displayed to remind the user of the contents of the project, shown in figure 1.23.
- **Open: Multiple Projects:** When in review mode multiple projects can be opened and loaded to the project tree, shown in figure 1.23.

When on working on a remote system the live side of the software will be running in simulation mode for educational purposes. To change the dataset associated with the simulation mode a **Load Simulation Dataset** option will show up in the live project window.

Figure 1.23: The EDAX Explorer and Multiple Project Windows



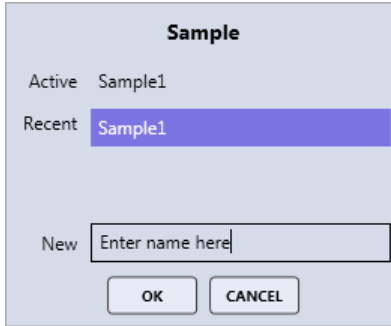
The Sample Icon:

The sample icon displays the sample selection window as shown in figure 1.24. 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 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.

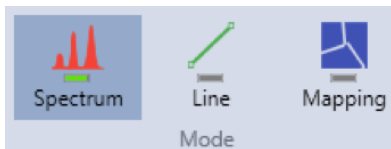
Figure 1.24: The Sample Window



1.6 Collection Modes

Figure 1.25 shows the three main modes for collection in APEX™: 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. Details of data collection are given in chapter 2.

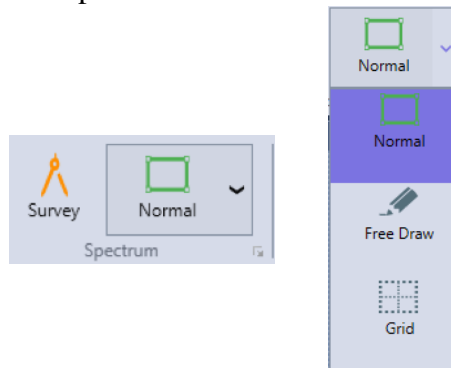
Figure 1.25: The Collection Mode Icons



Spectrum

The spectrum mode options are shown in figure 1.26. The spectrum mode collects a spectrum of the selected area or point(s) for a period of time, set by the user. There are two options for spectrum collection: **Survey** and **Normal**.

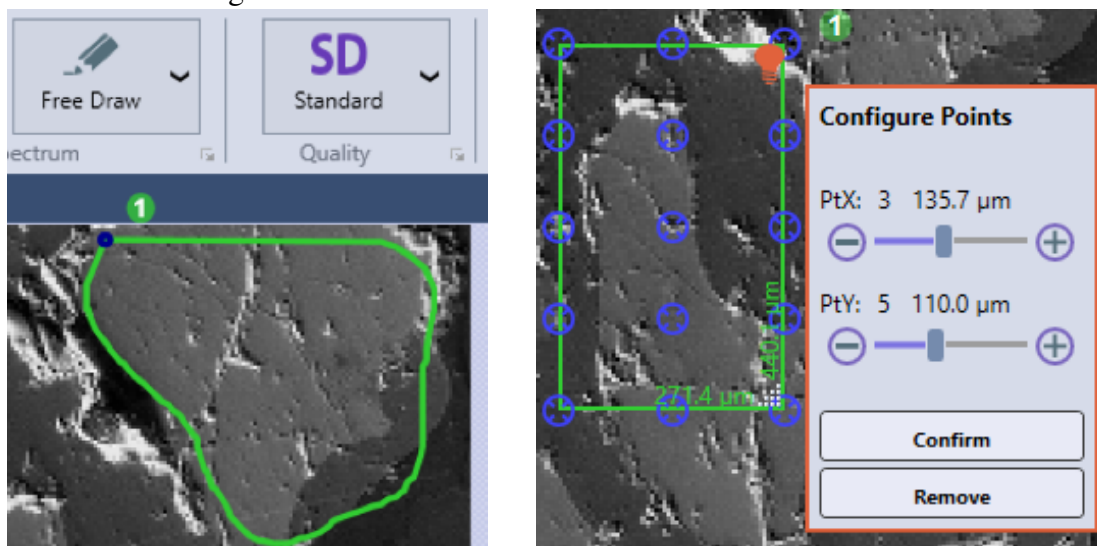
Figure 1.26: The Spectrum Mode Icons and Drop-down Menu



- When in **Survey Mode** a spectrum collection will start as soon as a point or area is selected in the SEM image. Selection 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, see figure 1.27:
 - **Normal**: Allows the user to define analysis locations individually.
 - **Free Draw**: The free draw mode allows to the user to draw any shape onto the image area for analysis.
 - **Grid**: Allows the user to define a matrix of equidistant points for which the spectra will be collected sequentially.

Figure 1.27: The Free Draw and Grid Collection Modes



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 the specimen.

X-Ray Map

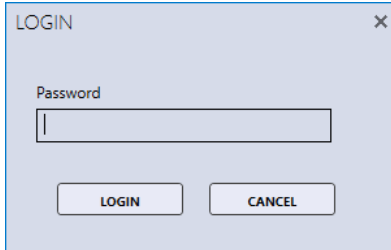
The X-ray map mode collects spectra for each individual pixel over an entire area, creating a detailed, color-coded image of the specimen's composition. This process takes much longer than collecting a spectrum but provides very useful, in-depth data.

1.7 Multi-user Mode

Note: Multi-user Mode is only available in APEX Advanced.

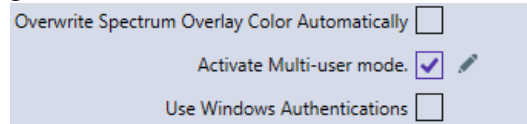
To activate the multi-user mode for Apex, open up the user preferences dialog window by clicking on the user profile icon on the top right of the screen (see section 1.4). The Activate Multi-user mode checkbox is disabled by default, click on the pencil icon to open up the password dialog box to enable this control (see Figure 1.28). 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 (see Figure 1.29). The next time APEX starts up, a login dialog box will prompt (see Figure 1.30).

Figure 1.28: Login Screen to Enable Multi-user



A login 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".

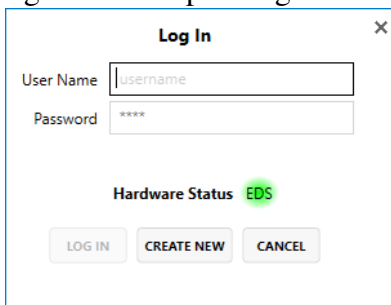
Figure 1.29: Checkbox to Activate Multi-user



A settings panel with three options, each with a checkbox and a pencil icon to its right:

- Overwrite Spectrum Overlay Color Automatically ☐
- Activate Multi-user mode. ☒
- Use Windows Authentications ☐

Figure 1.30: Apex Login Screen



An "Apex Login" dialog box with a close button (X) in the top right corner. It contains the following elements:

- Log In** (header)
- User Name:
- Password:
- Hardware Status: **EDS** (with a green highlight)
- Buttons: LOG IN, CREATE NEW, 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.

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 (see Figure 1.30), there is a **Create New** button. This button can be disabled in Administrator user settings leaving the following option as the only way to create new users.
- Administrator login can create new users in the **User Profile Dialog** under the **User Account** tab and click on the **Users** button (see Figure 1.31). This button is not visible to other users. After clicking the **Users** Button, a window will open with a list of Apex users, below the list is a **Create User** button (see Figure 1.32).

Both places will display the same control to create new user (see Figure 1.33).

Figure 1.31: User Account Tab

The screenshot shows a window titled 'User Preferences' with three tabs: 'User Preferences', 'User Account', and 'Database'. The 'User Account' tab is selected. It contains the following fields and buttons:

- User Name: Administrator
- First Name: Administrator
- Last Name: (empty)
- Buttons: CHANGE, CHANGE PASSWORD
- Accounts: USERS
- Buttons: OK, CANCEL

Editing a User

User can edit their first and last name under the **User Account** tab in **User Preferences** window. The administrator can also edit user details in the **User Account** tab (see Figure 1.34).

1.8 Administrator Feature

Resetting User Password

Resetting user password can only be done by an administrator. To reset a user's password, you need to select the user in the list and then click on **Reset Password** button (see Figure 1.32).

Figure 1.32: List of Users

The 'Users' dialog box is displayed within a window titled 'User Preferences User Account Database'. The dialog box contains a table with the following data:

USERNAME	NAME	INFO
Administrator	Administrator	
ApexData	User Apex	
Factory		
Service		
User1	User 1	

Below the table, there is a checkbox labeled 'Restrict New Users' which is currently unchecked. At the bottom of the dialog box, there are four buttons: 'CREATE USER', 'EDIT USER', 'DELETE USER', and 'RESET PASSWORD'. Below these buttons are 'OK' and 'CANCEL' buttons. The main window also has 'OK' and 'CANCEL' buttons at the bottom right.

Figure 1.33: New User Account Screen

The 'New User Account' dialog box is shown. It contains the following fields and buttons:

- User Name: [Text Input Field]
- Password: [Text Input Field]
- Retype Password: [Text Input Field]
- First Name: [Text Input Field]
- Last Name: [Text Input Field]
- Buttons: 'CREATE' and 'CANCEL'

Figure 1.34: User Account Screen for Non Admin

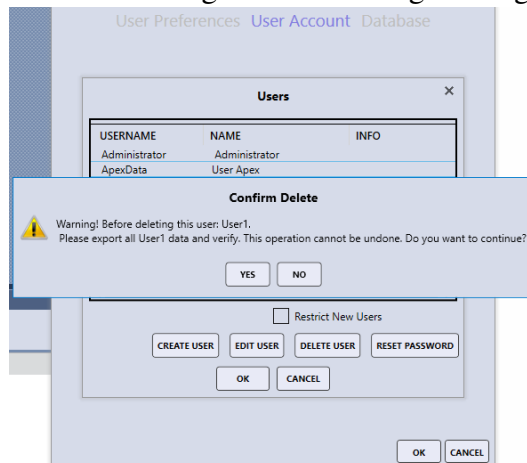
The 'User Account' screen is displayed within a window titled 'User Preferences User Account Database'. It contains the following fields and buttons:

- User Name: [Text Input Field] (Value: ApexData)
- First Name: [Text Input Field] (Value: Apex)
- Last Name: [Text Input Field] (Value: User)
- Buttons: 'CHANGE', 'OK', and 'CANCEL'

Deleting a User

Deleting user password can only be done by an administrator. To delete a user, you need to select the user in the list and click the Delete User button. A warning dialog box will appear (see figure 1.35).

Figure 1.35: Deleting a User Warning Message Box



Restricting Creating New Users

Restricting the creation of a new user can only be done by an administrator. Having **Restrict New Users** checkbox in Figure 1.32 checked restricts creating users whenever Apex starts up on the login screen.

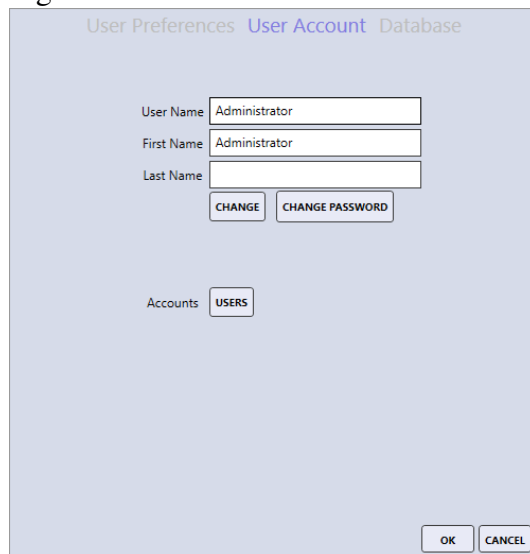
Changing Administrator Password

To change the administrator password, the administrator will need to log into Apex. Open the User Preferences window and select User Account tab (see Figure 1.31). To change Administrator password, click on **Change Password** button, this button is only visible to the Administrator. The Change Password Window will open after the **Change Password** button is clicked. The old password is required and the new password will be asked to enter twice (see Figure 1.37).

Windows Authentication Mode

The administrator can enable windows authentication by going to the User Preferences window and checking the **Use Windows Authentication** checkbox. This feature works only when both **Activate Multi-user mode** and **Use Windows Authentication** are enabled (see Figure 1.38). With Windows Authentication checked, the login used for the Windows Operating system will be applied to the APEX software.

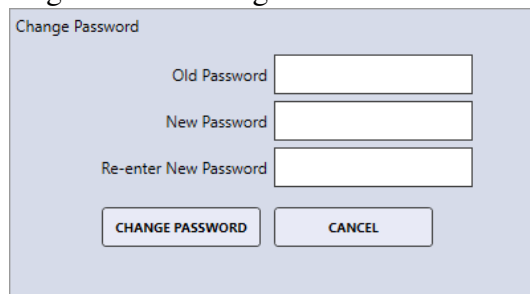
Figure 1.36: Administrator User Account



The dialog box has a title bar with three tabs: "User Preferences", "User Account" (selected), and "Database". The "User Account" tab contains the following fields and buttons:

- User Name:
- First Name:
- Last Name:
- Buttons:
- Accounts:
- Bottom right:

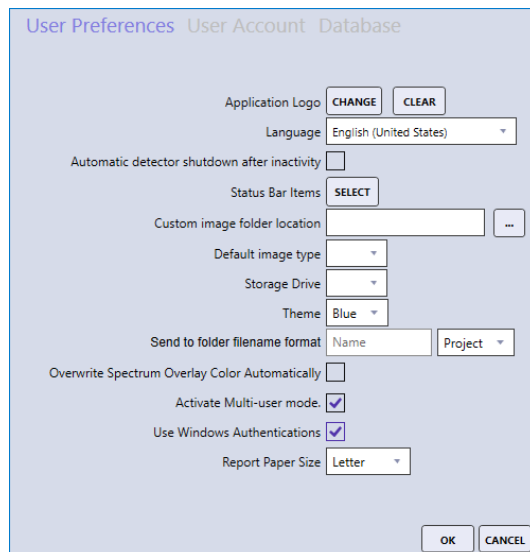
Figure 1.37: Change Password Window



The dialog box has a title bar with the text "Change Password". It contains the following fields and buttons:

- Old Password:
- New Password:
- Re-enter New Password:
- Buttons:

Figure 1.38: Windows Authentication Mode Enabled



The dialog box has a title bar with three tabs: "User Preferences" (selected), "User Account", and "Database". The "User Preferences" tab contains the following fields and buttons:

- Application Logo:
- Language:
- Automatic detector shutdown after inactivity: ☐
- Status Bar Items:
- Custom image folder location:
- Default image type:
- Storage Drive:
- Theme:
- Send to folder filename format:
- Overwrite Spectrum Overlay Color Automatically: ☐
- Activate Multi-user mode: ☒
- Use Windows Authentications: ☒
- Report Paper Size:
- Bottom right:

Chapter 2

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 are outlined below.

2.1 Image Collection

The camera icon on the image toolbar starts or stops image collection. While the image is collecting, the image icon turns **purple** (see figure 2.1) as well as the application status bar.

Figure 2.1: The Image Icon while idle (Left) and while collecting (Right)

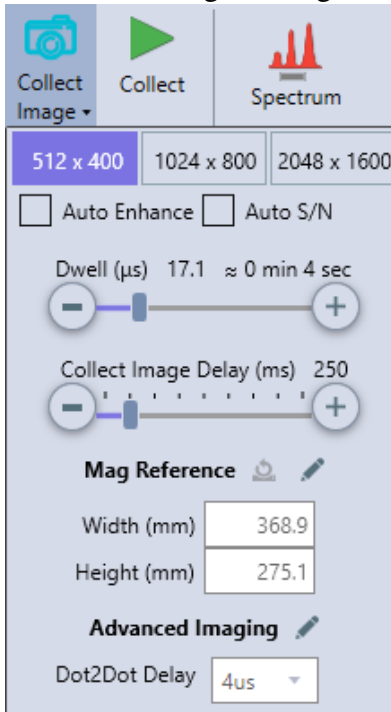


Clicking on the down arrow selection (on the image icon) will display the **Image Collection Parameters** pop up window, shown in figure 2.2. There are three sizes for image collection matrices: 512 x 400, 1024 x 800 and 2048 x 1600 pixels. The larger the values of the matrix, the higher resolution. 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 point) 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.

Figure 2.2: The Image Settings Window



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

Clicking the **Reset** button, to the right of **Mag Reference** will reset the 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**.

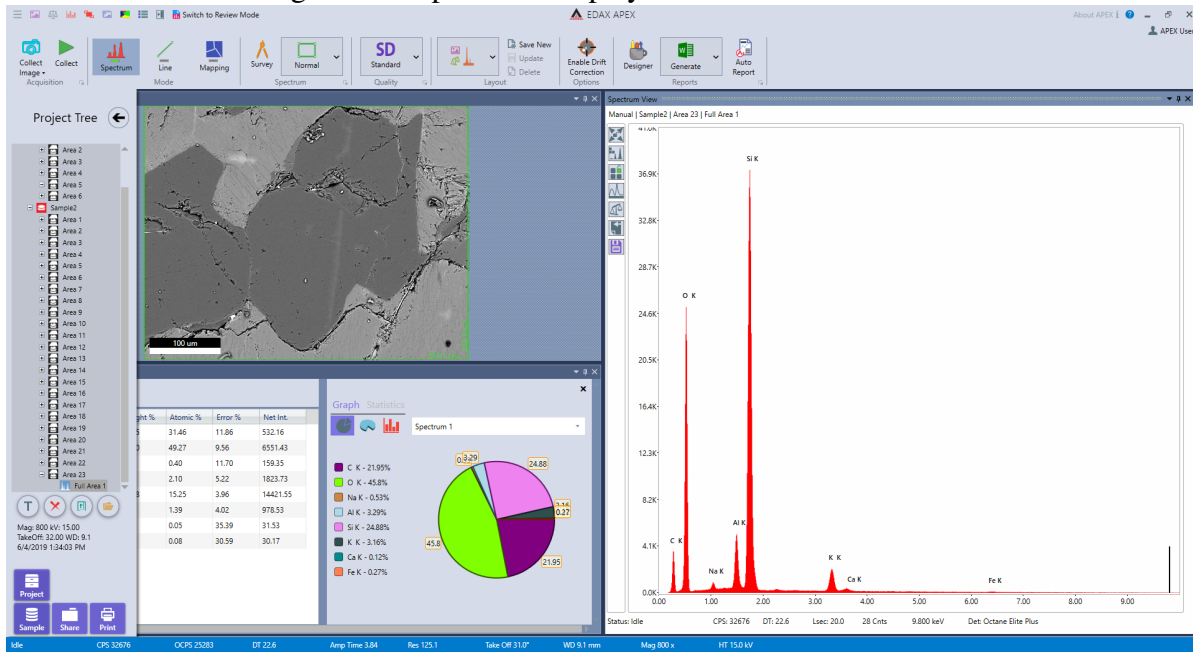
2.2 Spectrum Collection and Settings

The layout for spectrum collection is shown in figure 2.3. 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. If no areas are defined, a spectrum of the full area will be collected. 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 window. The name of

the spectrum will be shown in spectral view window, as well as the project tree, as soon as the collection starts. To modify the element list and change the spectrum settings, see section 3.2 on page 42.

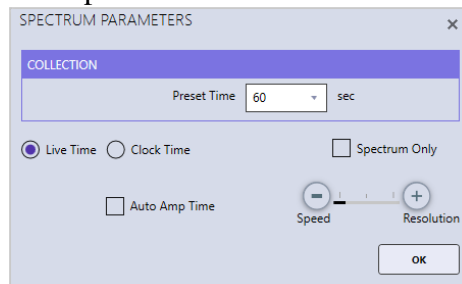
Figure 2.3: Spectrum Display Collection in APEX™



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 (shown in figure 2.4) in which the user can set the collection time and choose between **Live** and **Clock** time as well as amp time.

Figure 2.4: Spectrum Parameters → Manual Mode



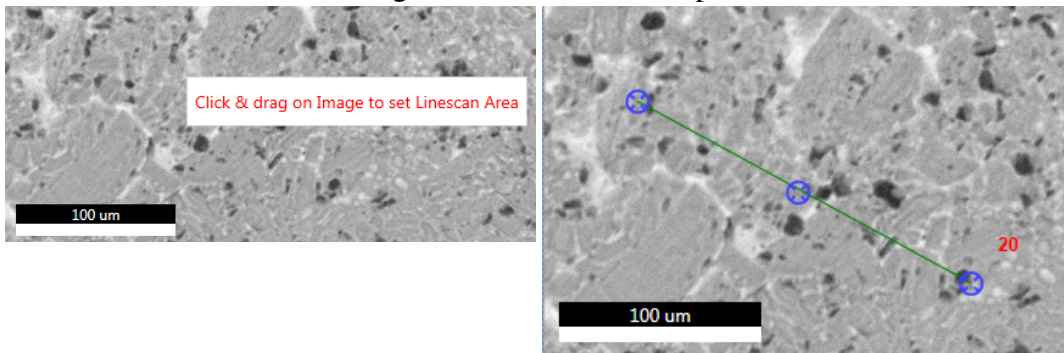
Clock time is the amount of time that data is collected, which does not account for dead time. Live time is the amount of time data is collecting plus processing time (dead time). In the automatic modes (Quick, SD, HD) there is a check-box for **Auto Amp Time** which automatically sets the amp time based 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 slide bar with Speed and Resolution. Drag the slide bar to set amp time, longer amp times will give lower throughput and higher dead time but better peak resolution. Slower amp times increase throughput and are well suited for high count rate applications.

2.3 Linescan Collection and Settings

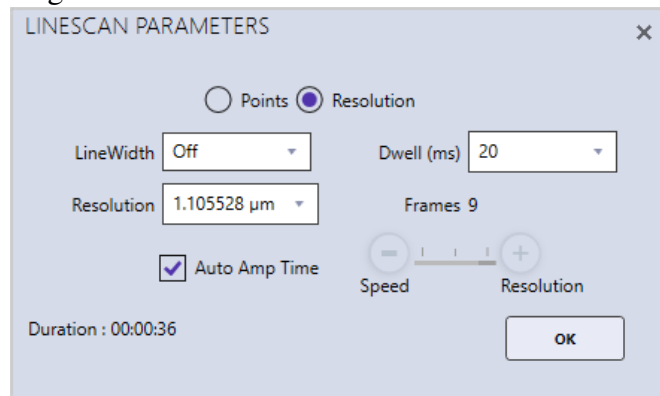
After collecting an image, click on the **Linescan Icon** to enter linescan mode. A message will pop up over the image area asking the user to draw a line on the image to define the linescan profile for collection, see figure 2.5. After drawing the line, the end points of the line can be dragged to change the length or direction 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.

Figure 2.5: Linescan Setup



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 1000 X-rays per point on average while the numbers for SD and HD are 10000 and 20000 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, shown in figure 2.6.

Figure 2.6: Linescan Parameters → Manual Mode



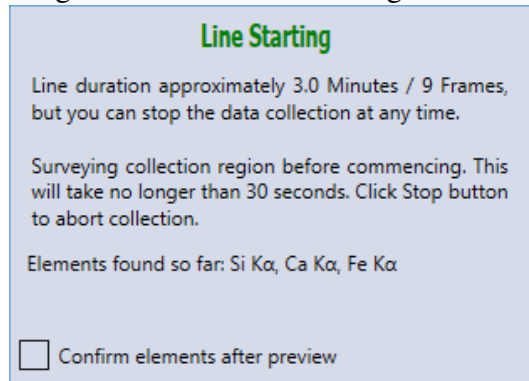
Linescans can be acquired in two possible stepping modes: Points or Resolution. In **Points** mode, the number of points over which data will be collected is manually entered by the user. Enter the number

of points and then click *Enter*. In **Resolution** mode, select a resolution value from the drop-down list or type in a number and the number of points used will be calculated automatically.

- **LineWidth:** To scan a line perpendicular to the linescan, instead of individual point locations, change the line width. This is useful for getting 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.
- **Points:** When using the *Points* radio button selection, number of points for line will be used.
- **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 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 slide bar with Speed and Resolution. Drag the slide bar to set amp time.
- **Duration:** The estimated time required to collect the linescan based on the given parameters.

Once the line is defined and the quality mode is selected, 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 (see Figure 2.7). 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. *Note: If the element list is locked, a spectrum preview will not be displayed.*

Figure 2.7: Linescan Starting Window



During collection, the linescan and spectral displays are shown in real-time, see figure 2.8. The element list can be modified and custom ROIs can be added in the same way as with mapping (described in section 2.4.1 on page 32). The overlaying elements on the line can be checked or unchecked during collection to enable/disable the display of the given element. All defined elements will be displayed above the image. At the end of the scan a line profile will be displayed. Right clicking on the linescan window will bring up options to apply smoothing to the linescan as well as changing the y-axis scaling.

The color of the linescan axis and element colors can be changed in the collection toolbar under options (see figure 2.9).

Figure 2.8: Linescan Profile

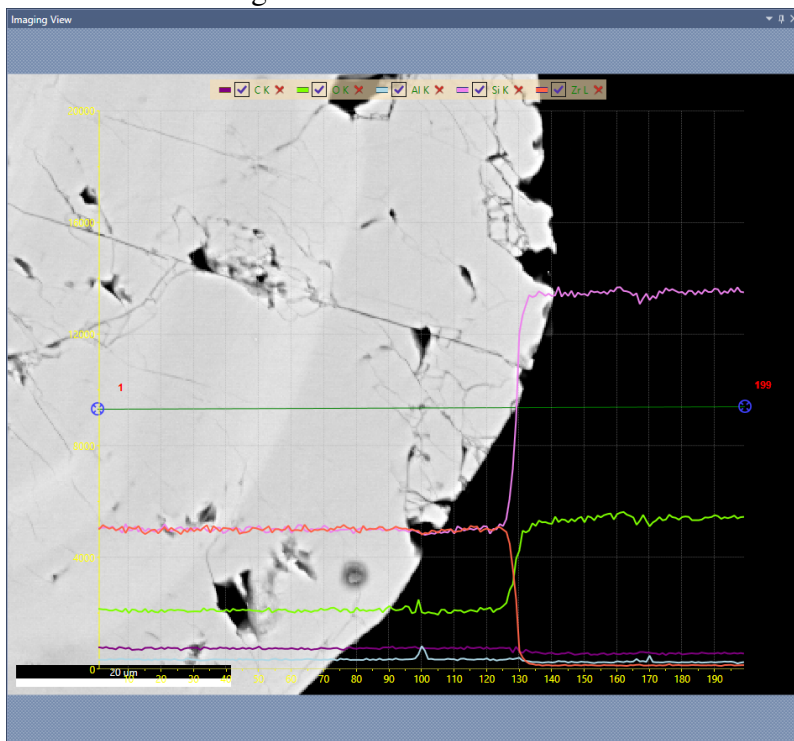
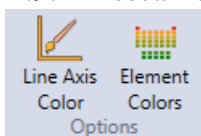
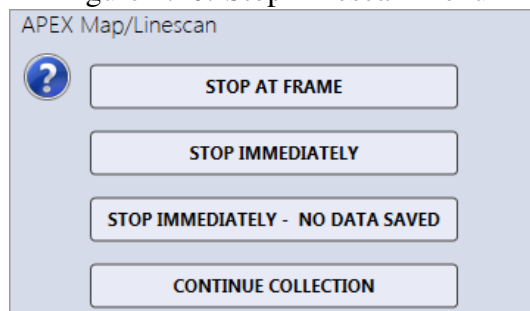


Figure 2.9: Linescan Options



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 pop-up box shown in figure 2.10 will appear.

Figure 2.10: Stop Linescan Menu



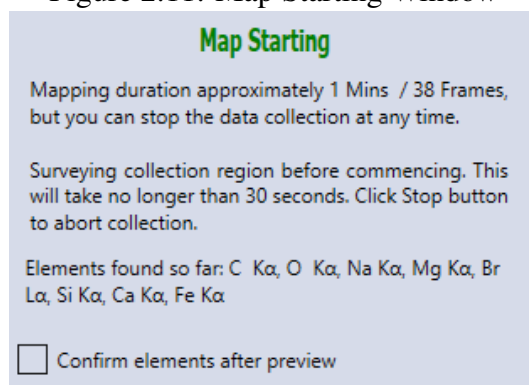
Stop Linescan Menu:

- **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.

2.4 X-Ray Map Collection and Settings

After collecting an image, click on the **Mapping Icon** to enter mapping mode. By default the entire image will be mapped, see page 32 for instruction on how to change the area. 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 in figure 2.11. 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.*

Figure 2.11: Map Starting Window



During the collection, the X-ray maps will be displayed in real-time, illustrated in figure 2.12. 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 on frame, the time remaining in the map collection, and a progress bar. A green line rastering the map, which shows the location of the beam, can be turned on and off by right clicking on the image window.

During collection it is possible to extract from a spot or an area by interacting with main Image View. The extracted spectrum is overlaid on the summary spectrum (see Figure 2.13). The summary and extracted spectra will be updated on periodic bases. To extract from another location, just click for spot and click-drag for area.

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 pop-up box shown in figure 2.14 will appear.

2.4. X-RAY MAP COLLECTION AND SETTINGS

Figure 2.12: Map Collection

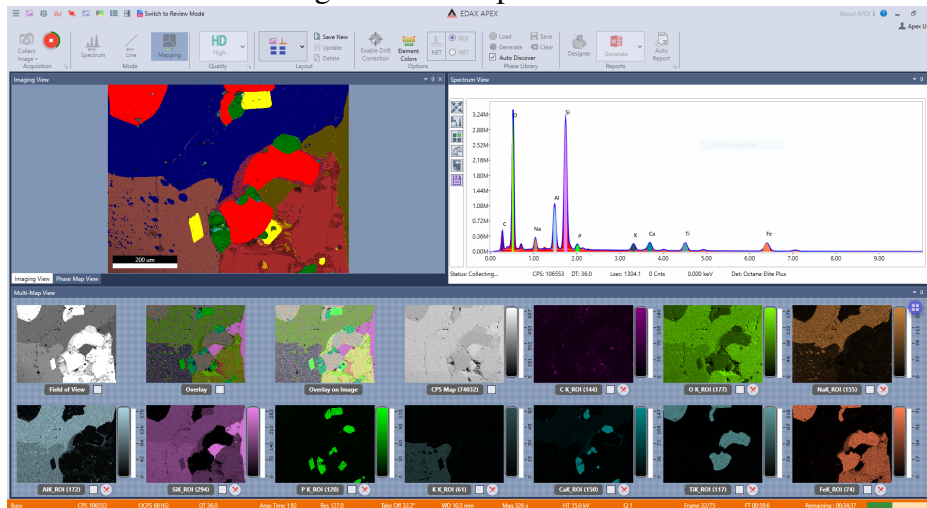


Figure 2.13: Extracting a Spectrum During Collection

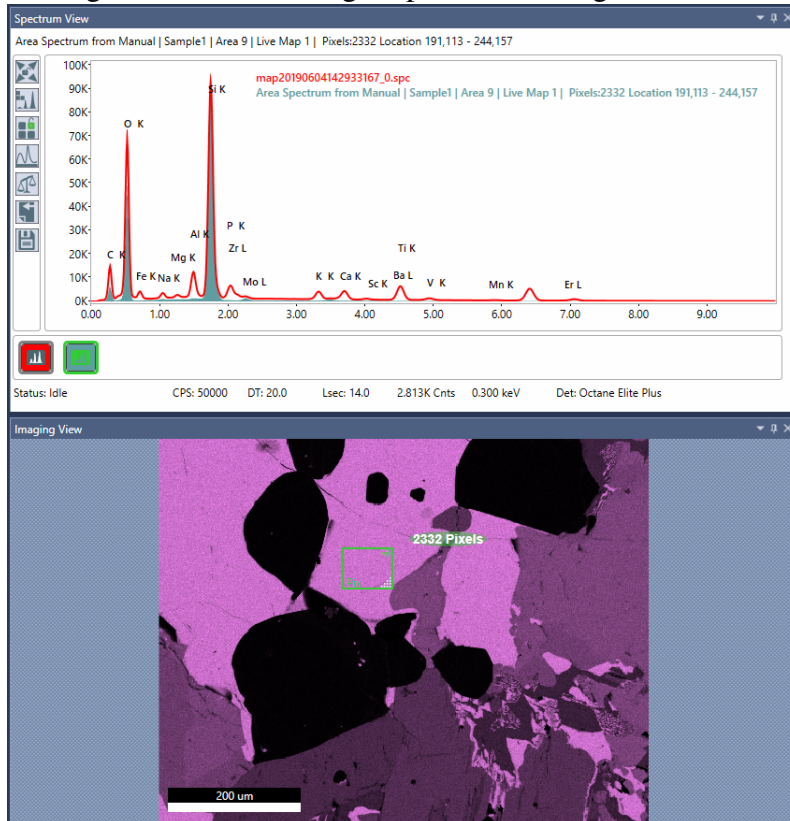
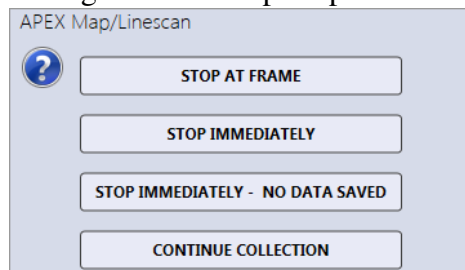


Figure 2.14: Stop Map Menu

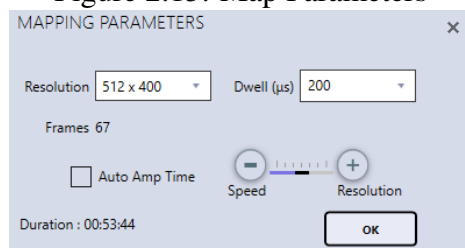


Stop Map Menu:

- **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 1000 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, shown in figure 2.15.

Figure 2.15: Map Parameters



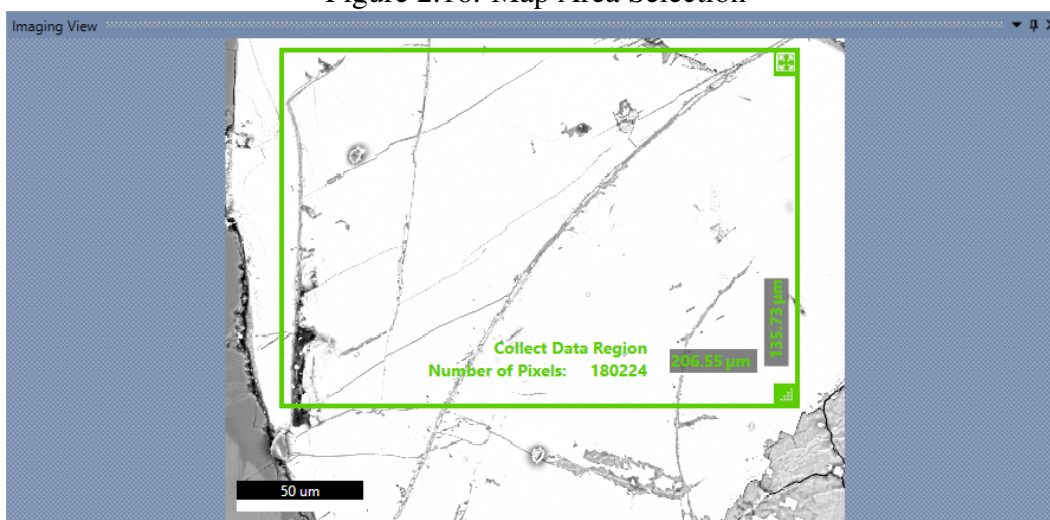
- **Resolution:** There are five different collection matrices that can be used for mapping: 64 x 50, 128 x 100, 256 x 200, 512 x 400, and 1024 x 800 pixels. Use the drop down menu to select a resolution value.
- **Dwell (µseconds):** The data collection time per pixel per frame. If the desired dwell 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 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 slide bar with Speed and Resolution. Drag the slide bar to set 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 in figure 2.16. To change the size of the box, drag the sizer 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.

Figure 2.16: Map Area Selection



Map Element Color Options:

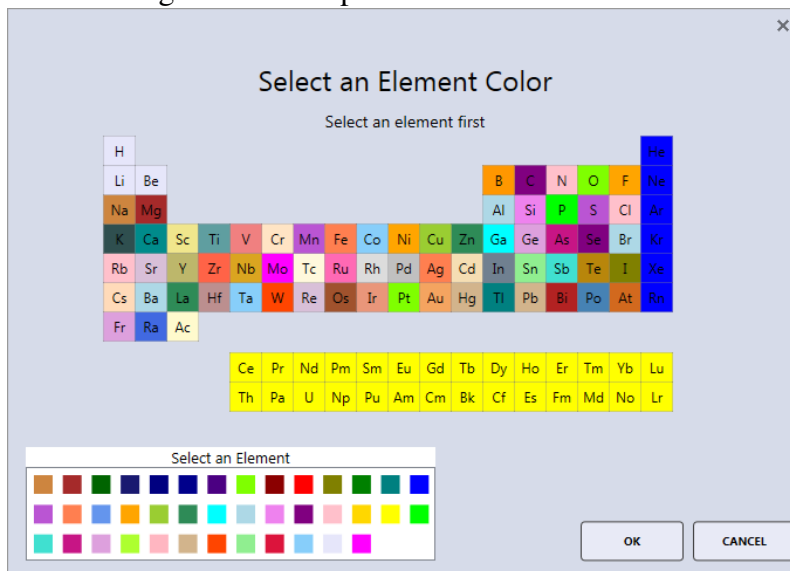
Before starting a map, during a map collection, or after mapping the color of the elements on the periodic table can be customized. Click the **Element Colors** icon in the toolbar and click on specific elements to change their color (see Figure 2.17). The colors set in this window will also be used for mapping elements when in review mode. *Note: This option is only available in live mode so the title of applications window should read EDAX APEX™.*

2.4.1 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 (described in section 3.2 on page 42) will bring up the option to display the energy ranges used for ROI maps (see Figure 2.18). The ROI regions are displayed with their associated element colors. 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 as shown in Figure 2.19. When elements or ROIs have been added or removed, a refresh icon will appear in the top right of the spectrum window (shown in Figure 2.20). Clicking the refresh icon will update the map display to reflect the spectrum window

Figure 2.17: Map Element Color Selection



elements and ROIs. Removing elements or ROIs can also be done by clicking on the trash can below the relevant map.

Figure 2.18: Display of map ROI energies

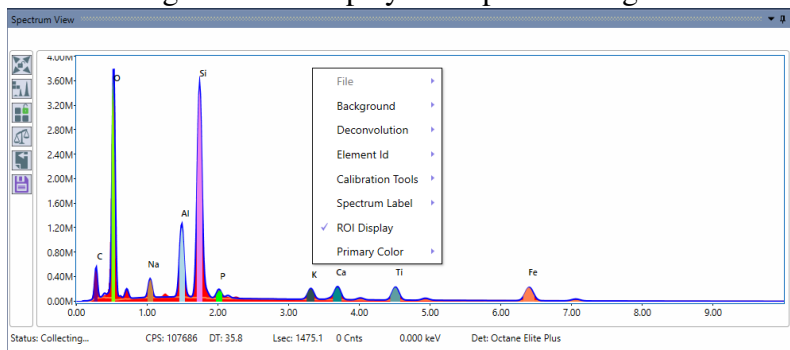
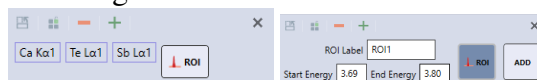


Figure 2.19: Add custom ROI



2.4.2 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 checkbox.

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 checkboxes to switch all maps between the two modes. Individual maps can be switched by clicking on the NET/ROI

Figure 2.20: Refresh map elements

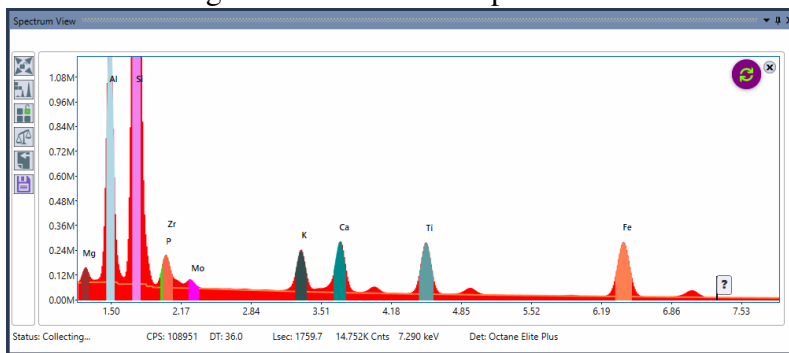
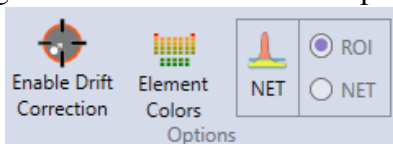
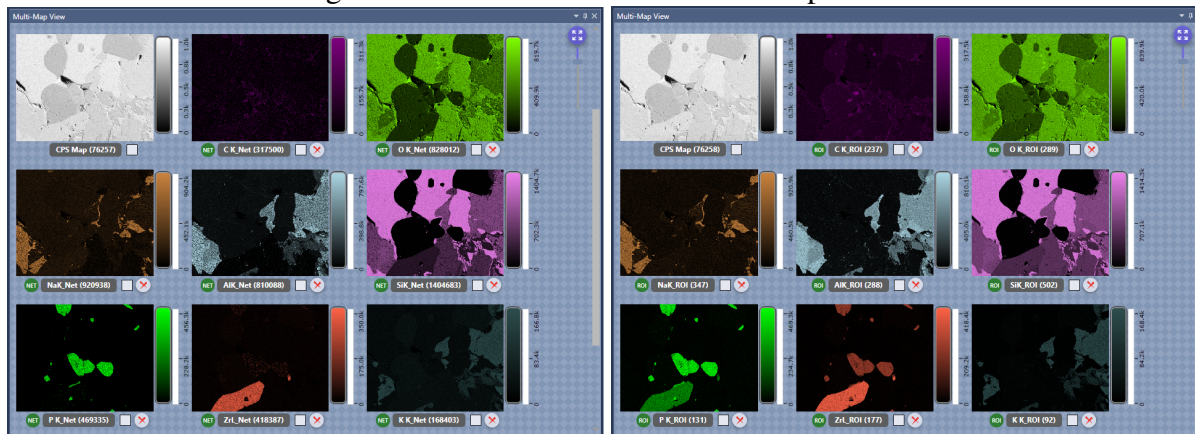


Figure 2.21: NET and ROI Map Icon



label beneath the map. In order to save a NET or ROI map for a specific element map, select the wanted map using the checkbox. Element maps created with the NET or ROI function on will be labeled accordingly (see figure 2.22).

Figure 2.22: NET and ROI Element Map Labels



2.4.3 Smart Phase Mapping

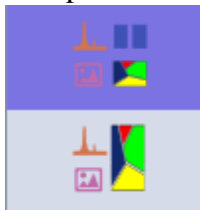
Note: Phase mapping is only available in APEX advanced.

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's 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 (see figure 2.23 or by clicking the phase icon

in the top left of the GUI. The threshold for the goodness of fit criteria before a new phase is created can be adjusted by the slider wheel to the left of the identified phases.

License key options **APEX EDS Phase Mapping to Element** and **APEX Suite Enhanced** are required for this feature. Default layout options specific for Phase Mapping are shown in the layout combo box (see Figure 2.23).

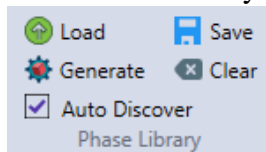
Figure 2.23: Default layout options available for Phase Mapping



Phase Library Toolbar Options

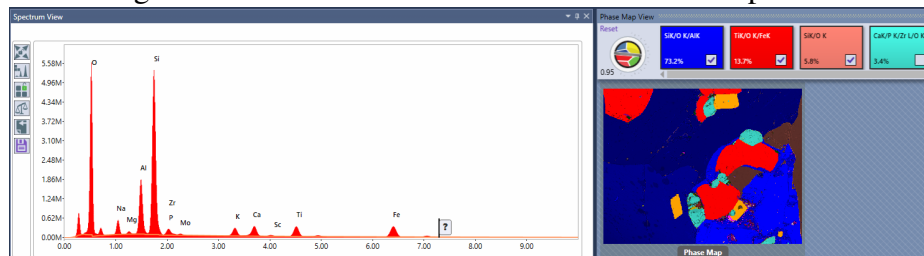
By default the phase routine will populate a library without any user interaction. It is possible to change this and customize the libraries by using the phase library toolbar options shown in figure 2.24. Selecting one or more phases will display them in the main map window, if none are selected all phases will be shown.

Figure 2.24: Phase Library Toolbar



- **Auto Discover:** This option will discover new phases based on current element list. If un-Checked (Locked), only the phases selected will be considered during mapping.
- **Load:** Load previously saved phase library file (*.pml). This is TEAM compatible.
- **Generate:** Generate a Phase based on Spectra loaded. The generated Phase is shown in Phase Map View (Grey). A color selection window will appear to select the color of the phase.

Figure 2.25: Generated Phase Shown in Phase Map View

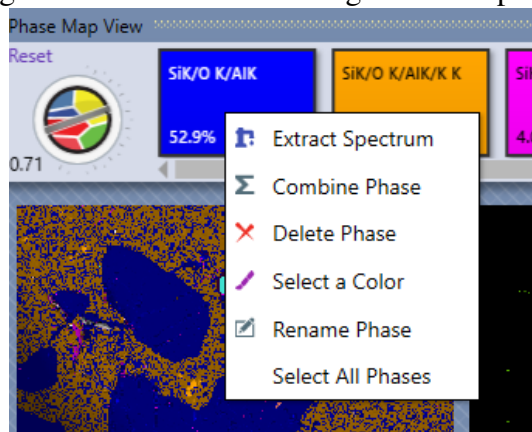


- **Save:** Save Selected Phases as Phase Library.
- **Clear:** Clear loaded Phase Library Phases from Phase Map View.

Phase Button Right-Click Options

Figure 2.26 shows the phase button right-click options.

Figure 2.26: Phase Button Right-Click Options

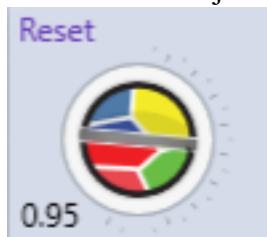


- **Extract Spectrum:** Extract selected Phase Spectra. The extracted spectra will be displayed in a Phase Spectra View window that shows up as a tabbed window in the Spectrum Display by default.
- **Combine Phase:** Combines 2 selected phases. During collection, any 2 phases can be combined.
- **Delete Phase:** Delete Phase.
- **Select a Color:** Select the color of the phase.
- **Rename Phase:** Rename phase to custom name.
- **Select All Phases:** Select all phases.

Tolerance Adjustment Knob

This knob is displayed in the top left corner of the **Phase Map View** window. It adjusts 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.

Figure 2.27: Tolerance Adjustment Knob

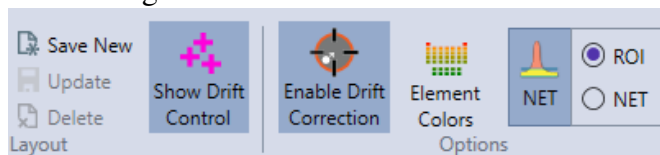


2.5 Drift Correction

Note: *Drift Correction is only available in APEX advanced.*

To turn on/ off **Drift Correction**, use the **enable drift correction** icon in the toolbar shown in figure 2.28. Once drift correction is turned on, the **Show Drift Control** icon can be used to show or hide the drift view panel.

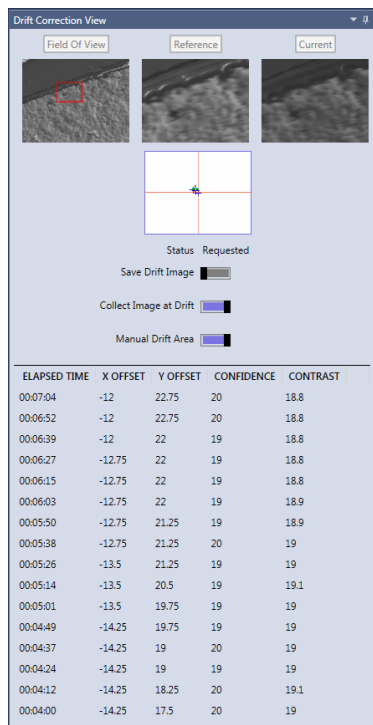
Figure 2.28: Drift Correction Icons



2.5.1 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 (see figure 2.29) as well as in the data table, via x, y offset coordinates and their corresponding time.

Figure 2.29: The Drift Correction View Window



There are three toggle buttons in the drift correction window to adjust the settings for drift control, simply click the button 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 as shown in figure 2.30. When this function is turned on, before data collection starts, the user must select a reference area on the image using the green box and click **select**.

2.6 Multifield Scan Table

To turn on/off the **Multifield Scan Table**, use the scan table icon in the title bar: it is the sixth icon from the left. Clicking the icon brings up the scan table window as shown in figure 2.31. Multiple areas,

Figure 2.30: Manual Drift Area



including area, point, and free draw spectra, as well as linescans, can be defined here and then collected as a batch.

Figure 2.31: Scan Table Window

Est. Duration: 128 sec					<input type="button" value="Import"/> <input type="button" value="Export"/> <input type="button" value="Delete All"/>		
ID	TYPE	SUB TYPE	TIME (SEC)	DWELL	UNIT	FRAMES	RESOLUTION
1	PointAnalysis	Spot	20	<input type="text" value="20"/>	L sec		<input type="text" value=""/>
2	PointAnalysis	Spot	20	<input type="text" value="20"/>	L sec		<input type="text" value=""/>
	LineScan	Line	68	<input type="text" value="0.02"/>	sec	17	<input type="text" value="0.65"/>
3	PointAnalysis	FreeDraw	20	<input type="text" value="20"/>	L sec		<input type="text" value=""/>

After each area is defined, it will automatically appear in the scan table window. The dwell time and resolution for each spectra 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 table window.

- **Import:** Reads 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.

Chapter 3

Data Analysis and Display

3.1 Quant View Window

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 the precision and accuracy of the quantitative analysis algorithm is highly dependent on sample preparation and conditions. Ideally the spectra should originate from a flat, homogenous, conductive bulk sample.

Numerics Only View:

The numerics only view displays the quant results in a table which can be customized by the user, see figure 3.1. 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, be aware that this does not imply that the quant results have two decimal points of precision.

Figure 3.1: Quant Results Window and Display Options

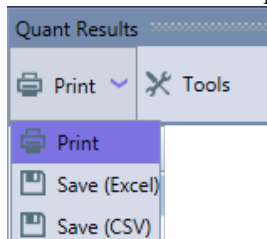
The screenshot shows the 'Quant Results' window. It contains a table with columns: Element, Line, Weight %, Net Int., and R. A context menu is open over the table, listing options with checkboxes: Weight %, Atomic %, Error %, Net Int., and RAF factors (all checked). Below these are 'Single Decimal Quant' and 'Auto-hide R zero values' (unchecked).

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

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, see figure 3.2. 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:** 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.

Figure 3.2: Print Menu Options

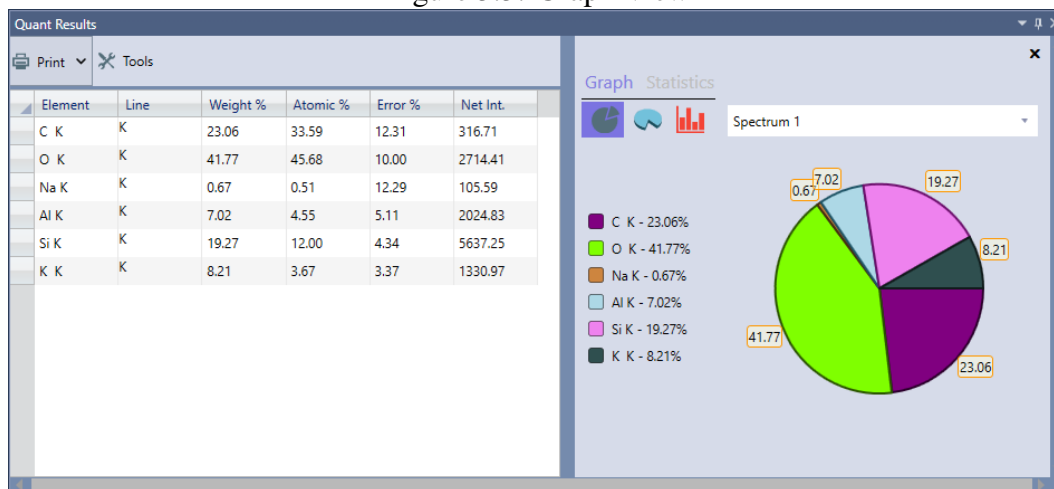


Note: These print options will only print the quant results, not the spectra or SEM image.

Graph View:

Clicking the **Tools Icon** will enable or disable the display of the weight percentage results in graphics form, see figure 3.3. 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.

Figure 3.3: Graph View



There are three graph display modes as illustrated in figure 3.4: **2D-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.

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, see figure 3.5. 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.

Click on the **Statistics** → **Options menu** to select one of the eight options (see figure 3.6), listed below.

3.1. QUANT VIEW WINDOW

Figure 3.4: 2D-Pie, 3D-Pie, and Bar Graphs Options

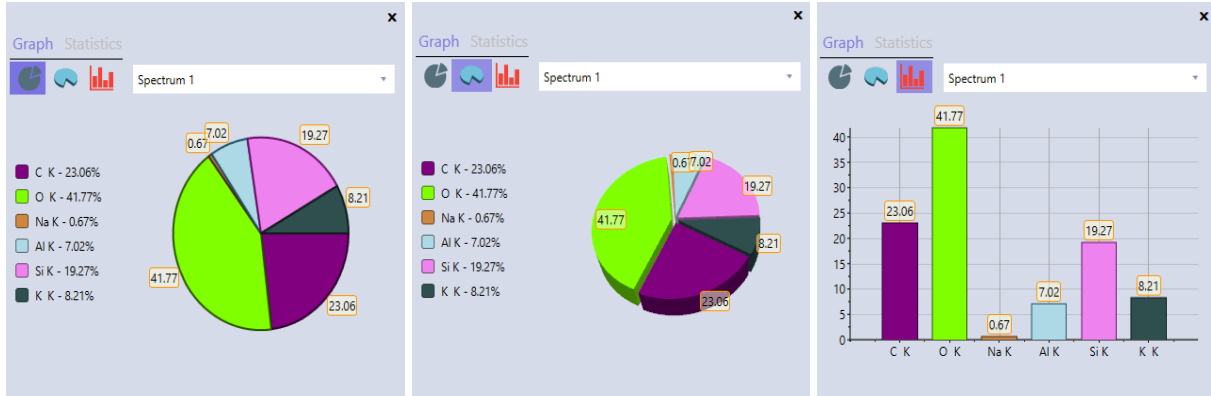


Figure 3.5: Statistics Display

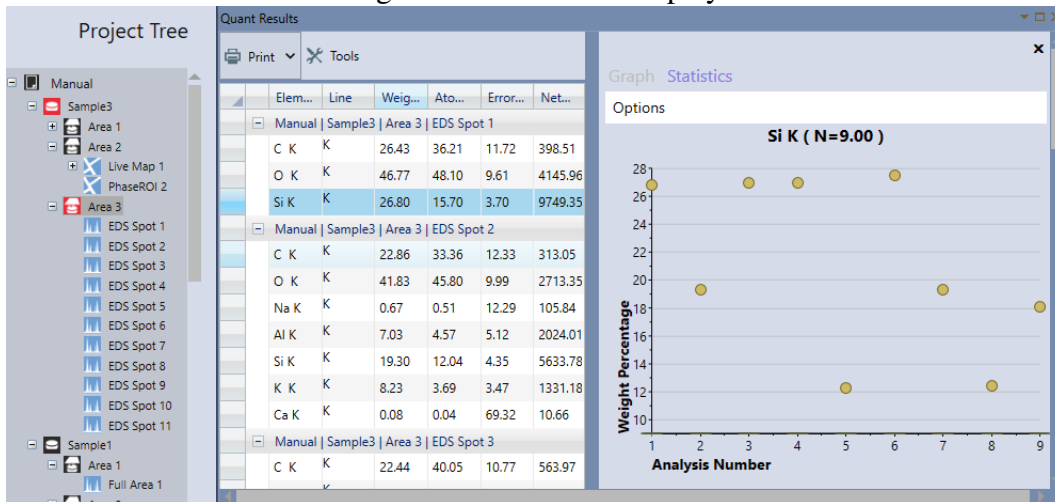
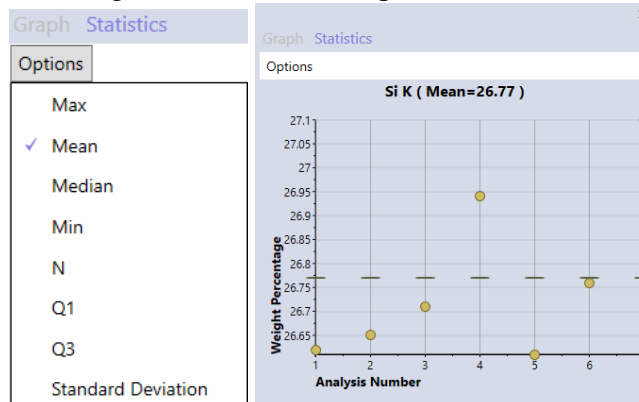


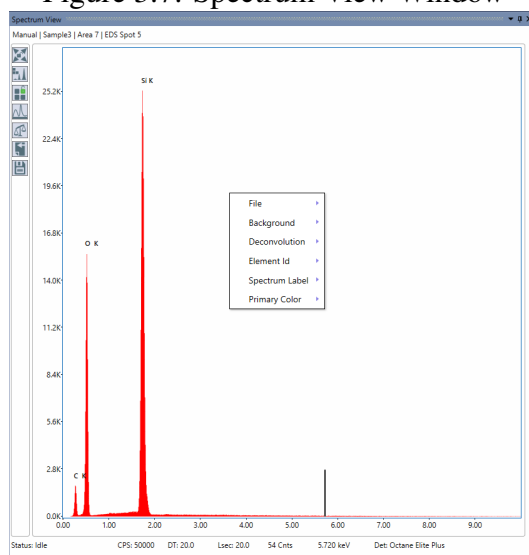
Figure 3.6: Statistics Options → Mean



- **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 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.

3.2 Spectrum View Window

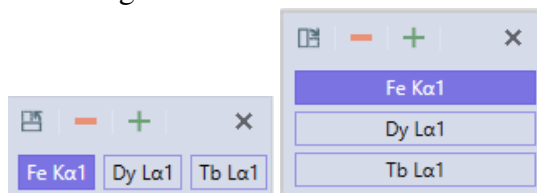
Figure 3.7: Spectrum View Window



Peak ID:

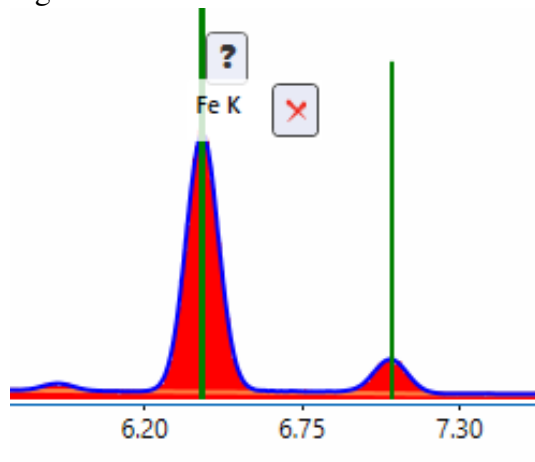
During or after a spectrum is being collected, the user can alter the Peak ID in order to identify trace elements and other elements of interest or to remove elements. To **Add** an elemental label, left click on the peak in the spectrum, hover the cursor over the question mark that appears, and a window containing the possible elements at that energy will be displayed, see figure 3.8. Note that the display will depend on the selection of element label sensitivity, see section 3.2.2. The 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.

Figure 3.8: Peak ID Window



In the Peak ID window, click on the wanted 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 on an existing elemental label will cause an **X** to appear next to the label. To **Delete** that element, click on the **X**, see figure 3.9.

Figure 3.9: Peak ID → Remove Elements



3.2.1 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.

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.

- 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 $\frac{2}{3}$ of the acceleration voltage. When the icon is in the **Locked Position**, it is in manual mode (see figure 3.10). Hovering over this button will display the **Customize** option. Click the customize button to display the customize pop-up window shown in figure 3.11.

Figure 3.10: Home Icon



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

Vertical Toolbar Options:

Spectrum Home

Reapply Expert ID

Modify Element List

Manual Background

Update Quantification Results

Send to...

Save Changes

Use Settings Saved With Spectra (review only)



Figure 3.11: Customize Pop-Up Window

Customize Home

☒ Auto
 ☐ Manual

LOAD FROM SPECTRUM

Start KeV 0

End KeV 10

☐ Fixed Vertical Scaling

1 5779

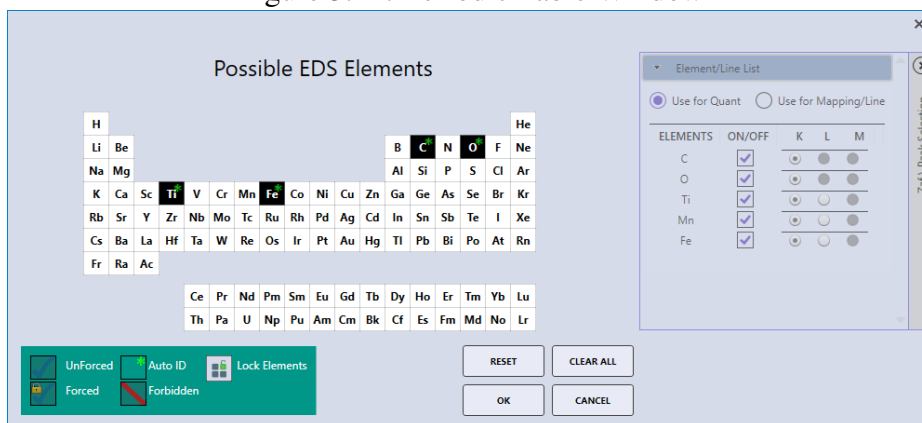
OK

CANCEL

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 model 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 this icon will bring up a pop-up window with the periodic table, see figure 3.12. 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 in on or off.

Figure 3.12: Periodic Table Window

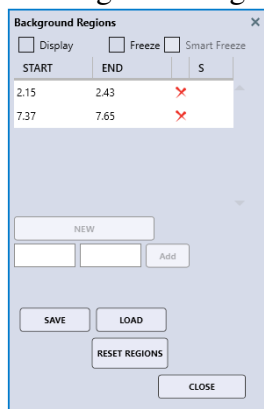


The symbol key in the bottom left corner of the pop-up window shows the different symbols that appear on the table and their meaning. Click on one of the symbols to active it and then click on the element on which is should be applied. Setting an element to forbidden means that it will never show up 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 right hand side of the window expands the ZAF list 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), see figure 3.13. To add new background region(s), the **Display** checkbox 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 listbox 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

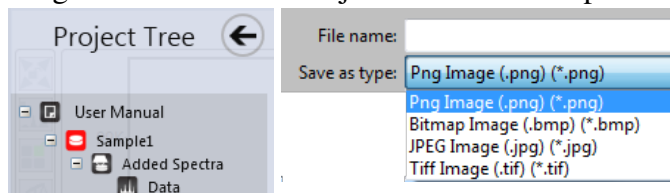
listbox. Clicking the **Reset Regions** button will reset the background to automatically adjusted. If the **Freeze** button is enabled, the current background regions will be applied to any spectrum loaded going forward. The **Smart Freeze** button will lock the background regions going forward but also check if a peak shows up in a background region and if so, disable the background region for that spectrum.

Figure 3.13: Background Regions Window



- **Update Quantification Results:** This icon updates 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:** Sends 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 setting).
 - **Send to Project:** Saves the current spectrum into the project tree. It is copied into a node named *Added Spectra* or under the map from which it was extracted.
 - **Save As:** Same functionality as the **Send to Folder** button except that the file output location can be selected in a pop-up window.

Figure 3.14: Send to Project and Save As Options

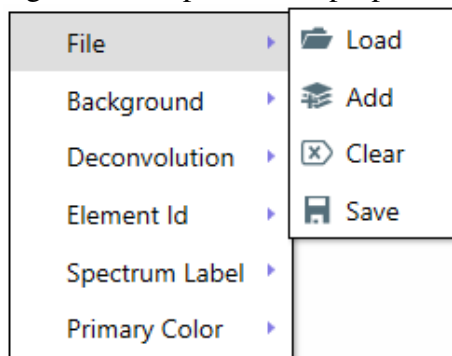


- **Save Changes:** Clicking here will cause any model changes made to the spectrum to be saved to the disk file. This button will turn pink when the spectral model has changed and is not yet saved to the disk file.

Spectrum Pop-Up Menu:

To display the pop-up menu, right click on the spectrum view window. There are six items in the menu as shown in figure 3.15, all of which have their own options.

Figure 3.15: Spectrum Pop-up Menu



- **File:**
 - **Load:** Read a stored 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 currently 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:** Selection for how many lines/labels to display for the detected elements. Selection is based on line height relative to the primary line.
 - **Label Type:** Display with element symbols only, element and shell, or element and shell with transition name.
- **Calibration Tools:** EDS Spectrum Calibration methods, only available in live mode. See section 7.3 on page 90 for more information on calibration.
- **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. See section 3.2.4 on page 50 for more information.

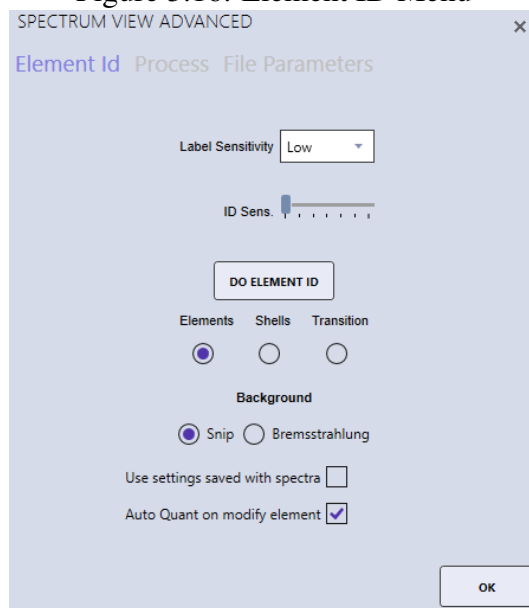
3.2.2 Spectrum View Advanced Settings

To access the spectrum view advanced pop-up window, click the arrow in the bottom right of the spectrum icon. There are four tabs in the advanced settings menu: element ID, file parameters, and process.

Element ID:

The element ID menu (shown in figure 3.16) 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.

Figure 3.16: Element ID Menu

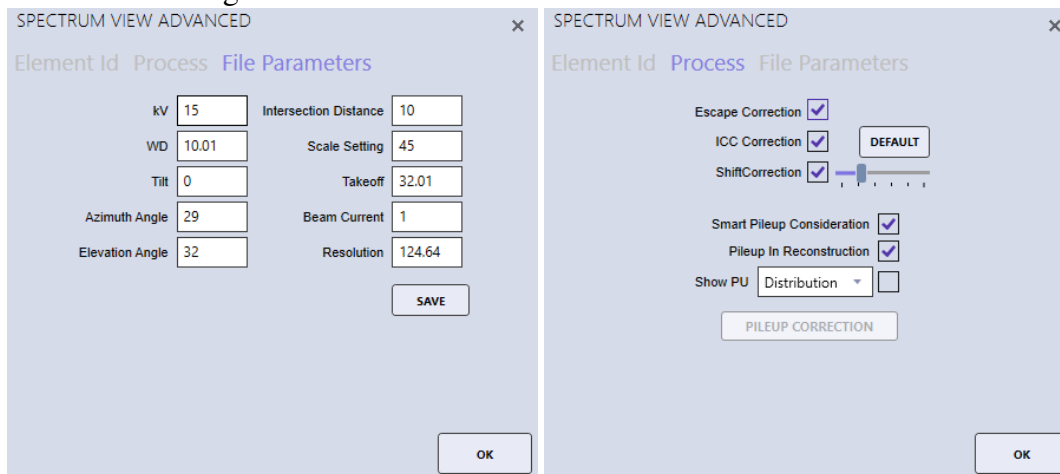


- **Label Sensitivity:** The drop down selects the number of labels to show. A setting of low would only put labels on primary elements and lines while high would label minor lines as well.
- **ID Sensitivity:** This selection controls the minimum peak size for an element to be included in an AutoID 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.
- **Label Display:**
 - *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 method (Statistics-sensitive Non-linear Iterative Peak-clipping).
 - **Bremsstrahlung:** Applies a full physical algorithm-based Bremsstrahlung calculation.
- **Use settings saved with spectra:** 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.
- **Auto Quant on modify element:** Enable this option to automatically run the quantification routine any time an element is added or removed from the element list.

File Parameters:

The file parameters menu displays the current parameters for the spectrum displayed, see figure 3.17 (left). 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).

Figure 3.17: File Parameters Menu and Process Menu

**Process:**

The process menu (see figure 3.17 right) 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 downshifted 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.
- **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:** 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.

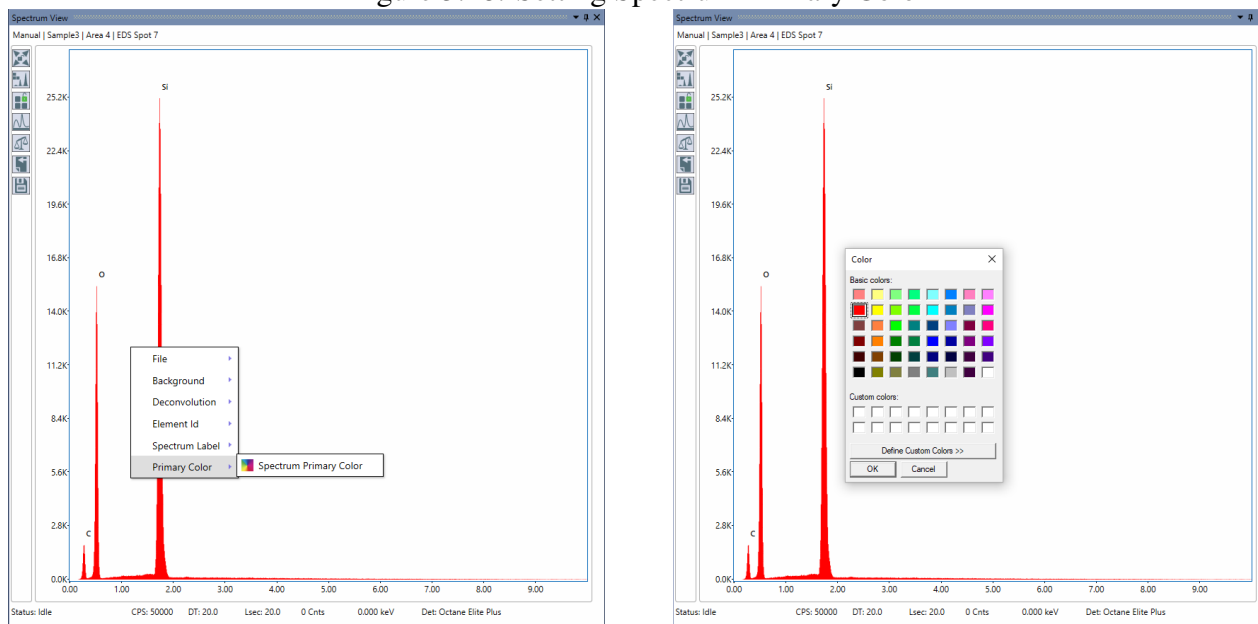
3.2.3 Additional Spectra Overlay Methods

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.

3.2.4 Spectrum View Color Settings

- Setting Spectrum Primary Color:** Clicks the **Primary Color** menu item and then **Spectrum Primary Color** (see Figure 3.18 Left). A color dialog box will appear with a list of colors that are defined for the system display (see Figure 3.18 Right). When more than 1 spectrum is loaded, this menu item is not visible.

Figure 3.18: Setting Spectrum Primary Color



- 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 (See Figure 3.20 Left). The second one onwards will be able to change the colors by right clicking on the button to show menu item "Change Overlay color". Right click on the toggle button to change overlay color for the spectrum (See Figure 3.20 Right). 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 Property window and check the box next to the label "Overwrite Spectrum Overlay Color Automatically" See Figure 3.19).
- Closing a Spectrum when Multi-spectra are Opened:** To close a spectrum, right click on the toggle button and click Close Spectrum button (See Figure 3.20 Right).

Figure 3.19: User Preference Window

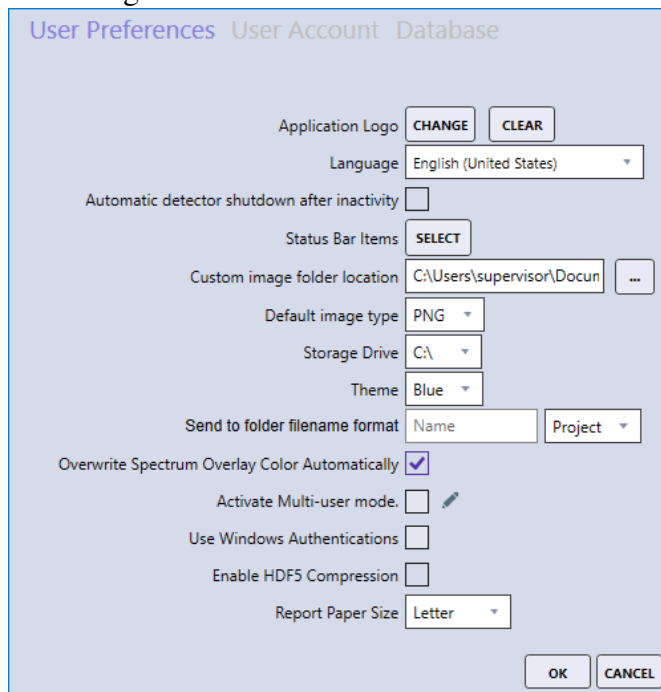
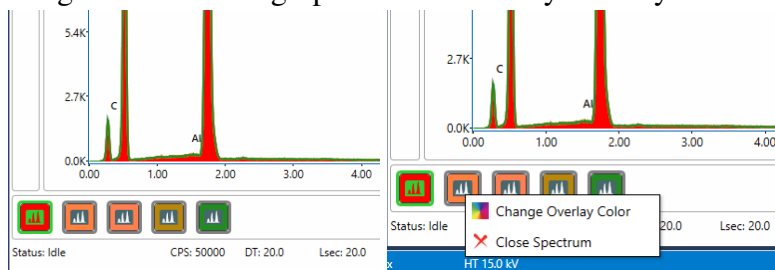


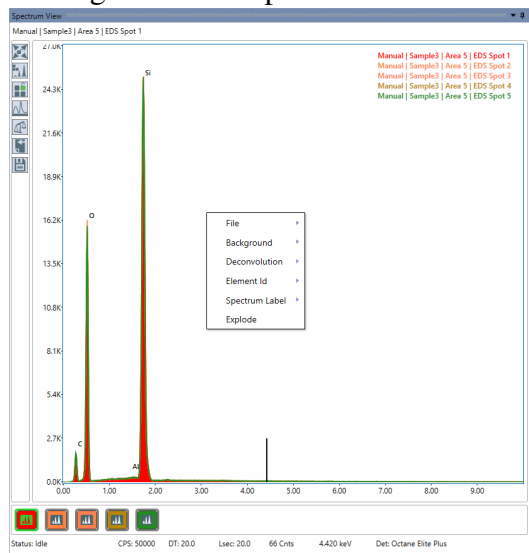
Figure 3.20: Setting Spectrum Secondary Overlay Colors



3.2.5 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. (See Figure 3.21)

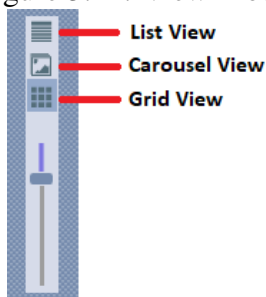
Figure 3.21: Explode Menu Item



There are three view modes available on the Multi-Spectra view window (see Figure 3.22).

- **List View:** this view will display all spectra vertically (see Figure 3.23).
- **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 (see Figure 3.24).
- **Grid View:** this view arranges each spectrum from left to right based on available space. There is a zoom control to resize each spectrum (see Figure 3.25).

Figure 3.22: View Modes



3.3 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, see figure 3.26.

Figure 3.23: List View

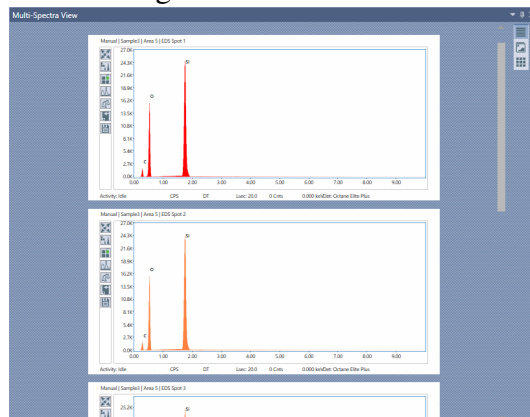


Figure 3.24: Carousel View

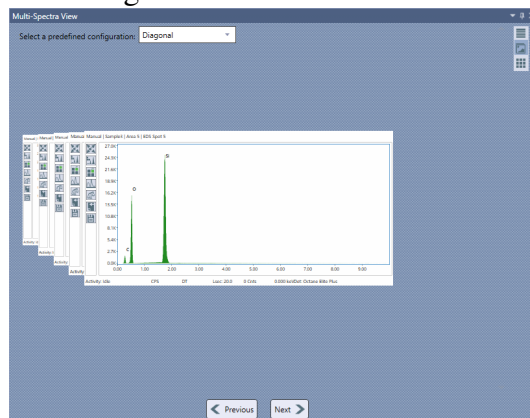


Figure 3.25: Grid View

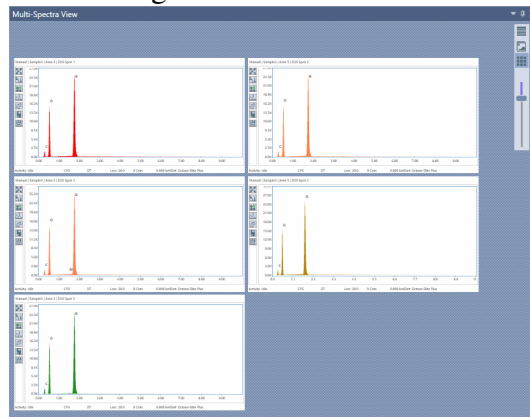
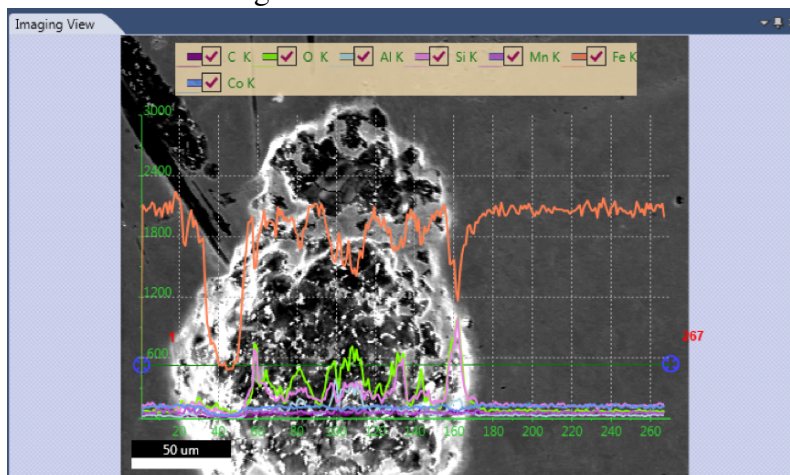
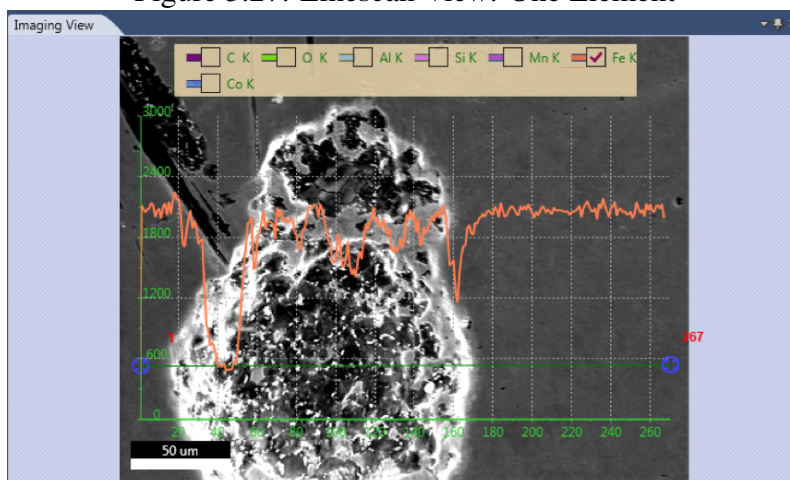


Figure 3.26: Linescan View



In figure 3.27, 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**.

Figure 3.27: Linescan View: One Element



3.4 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**: the time remaining for map collection, and a **Progress Bar**: a visual representation of how much of the map is completed.

Figure 3.28: Multi-Map Window

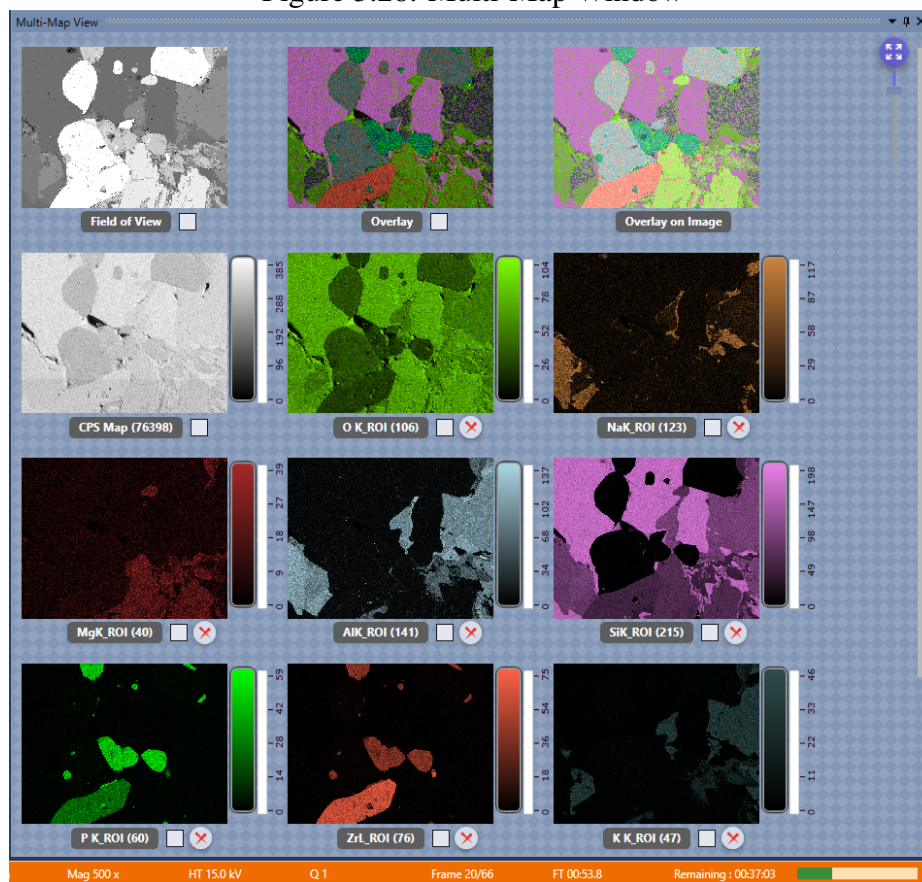


Image-Map Overlay:

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.

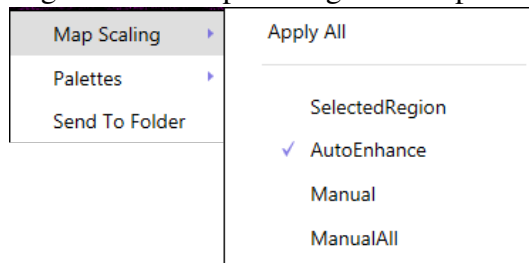
3.5 Mapping Pop-Up Menu:

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.

Figure 3.29: Map Scaling Menu Options



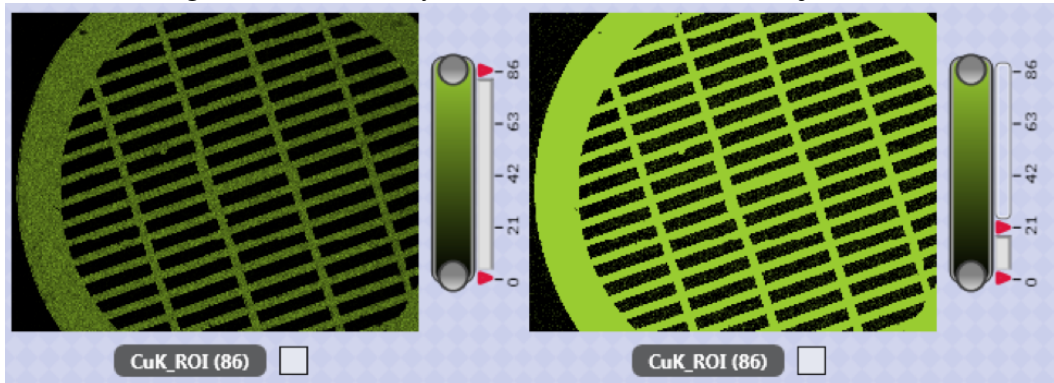
- **Apply All:** When checked, the intensity settings will be applied to all maps in the display.
- **Selected Region:** Allows the user to define a low and high threshold in the histogram to extract a spectrum from. See below for histogram details.

- **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 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 **grey** round sliders to select other optional modes. The **red** sliders are used to adjust the contrast of the map. The contrast of the map in figure 3.30 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.

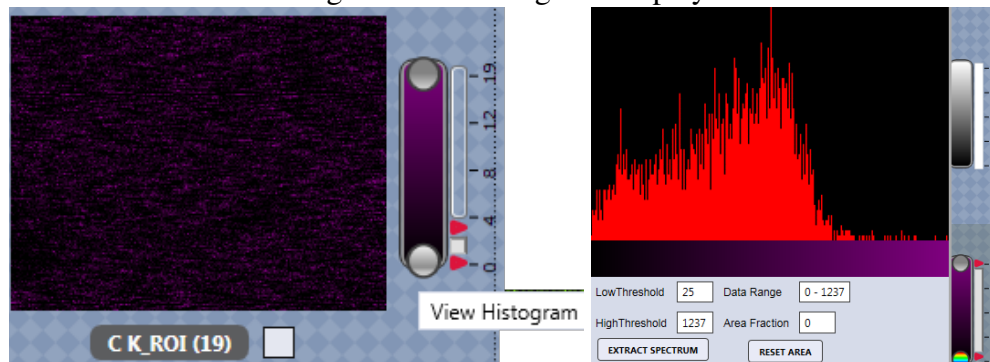
Figure 3.30: Intensity Bar Advanced: Contrast Adjustment



Histogram Settings:

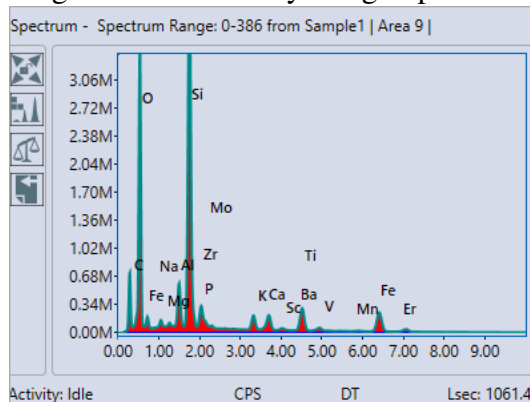
The histogram used for spectrum extraction is compiled by sorting map pixels based on their intensity. These intensities are then normalized and displayed as a histogram as shown in figure 3.31. Clicking the **Bottom Grey Round Button** will display the histogram of the map data. Clicking on the button again (which is now rainbow colored), will **Close** the histogram window.

Figure 3.31: Histogram Display



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** as shown in figure 3.32. The range of values is displayed in the title bar of the spectrum.

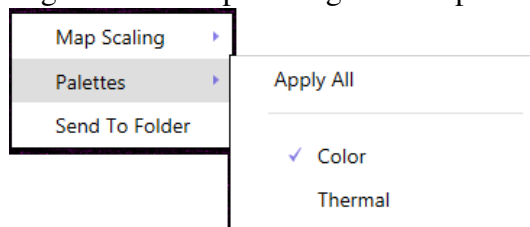
Figure 3.32: Intensity Range Spectrum



Palettes:

The palette function (see figure 3.33) allows the user to set the color palette to one of the two options: **Color** and **Thermal**.

Figure 3.33: Map Scaling Menu Options

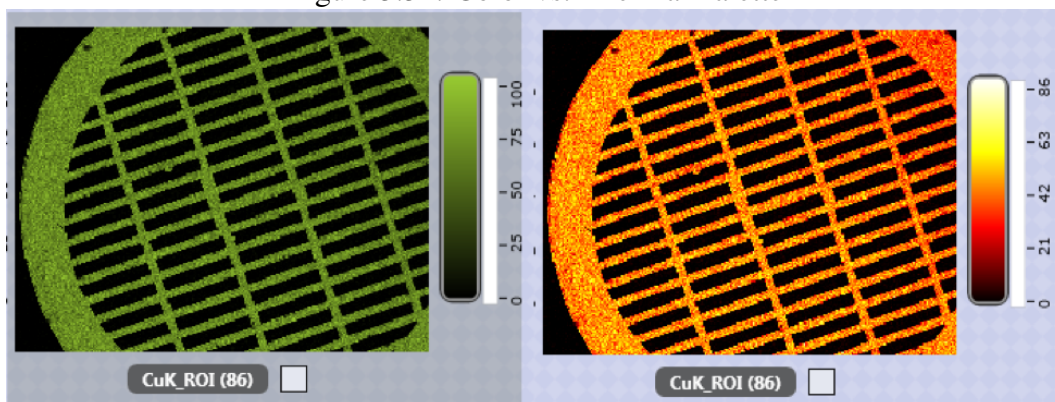


- **Apply All:** When checked, the currently defined palette settings will be applied to all maps in the display. To define specific maps to the current palette, uncheck this option.
- **Color:** Displays maps using 256 shades of a single color.
- **Thermal:** Displays maps using a standard thermal palette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

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.

Figure 3.34: Color vs. Thermal Palette



Chapter 4

Review Mode and Toolbars

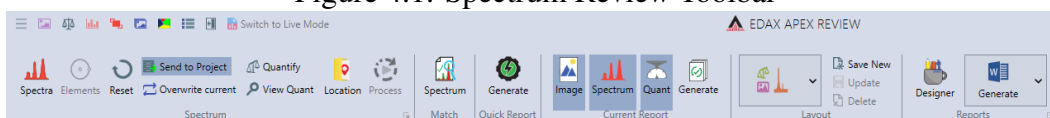
After data has been collected using one of the three collection modes, it can be reviewed and revised in review mode. To enter review mode, click the **Switch to Review Mode** icon in the title bar toolbar or double click on a relevant entry in the project panel.

4.1 Spectrum Review

The Spectrum Review toolbar is shown in figure 4.1. The segments are as follows:

- **Spectrum/Batch processing**
- **Spectrum Match**
- **Quick Report**
- **Current Report**
- **Layout**
- **Custom report**

Figure 4.1: Spectrum Review Toolbar



The **generate** icons are used to create a report. See section 5 on page 71 for more on reporting. Layout options are similar between live and review mode as described in section 1.2 on page 2.

4.1.1 Batch processing

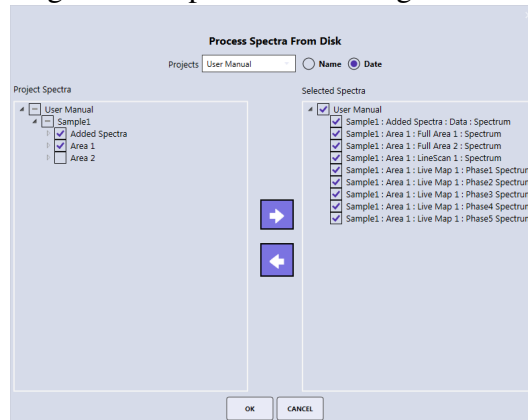
The first block of the spectrum review toolbar is for **Auto Reprocessing** multiple spectra. This is primarily used if a series of spectra need to be analyzed for an element that was omitted in the original run or to change background modeling options.

- **Spectra:** This icon brings up a window in which the user can select which spectra will be processed, see figure 4.2.

4.1. SPECTRUM REVIEW

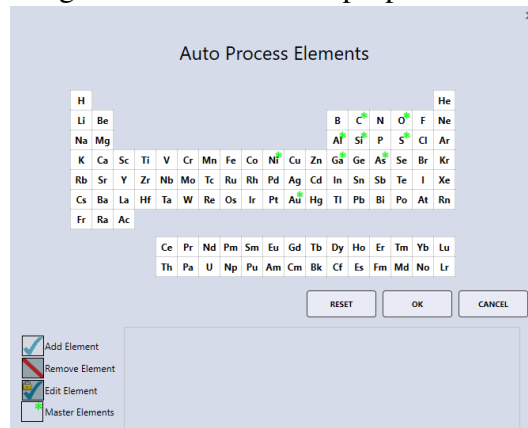
- **Projects:** Located at the top of the spectra processing window, this drop down menu allows the user to select which projects will be processed. The projects can be sorted by **Name** or **Last Accessed Date**. The window has two columns: **Project Spectra** and **Selected Spectra**. Use the arrows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

Figure 4.2: Spectra Processing Window



- **Elements:** Use the elements icon to modify the original element list, see figure 4.3. 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.

Figure 4.3: Elements Pop-up Window

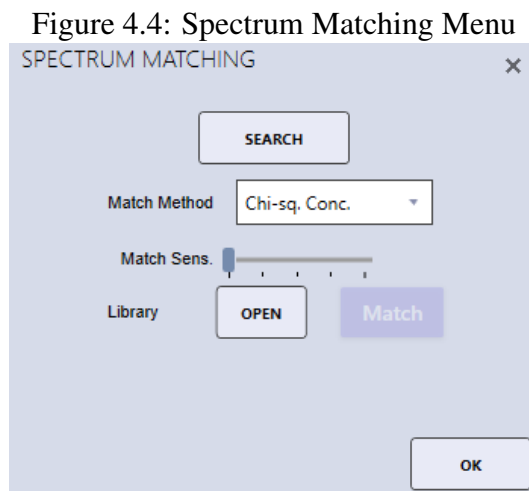


- **Reset:** Clears all changes made so far.
- **Send to Project:** Saves all processed spectra to the current project.
- **Overwrite Current:** Once the spectra are processed, use this icon to overwrite the original spectrum modeling settings.
- **Quantify Spectra:** Reapplies quant to all selected 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. See section 3.2.2 on page 47 for more information.

4.1.2 Spectrum Matching (Optional for APEX standard)

The spectrum matching routine (see figure 4.4) allows rapid identification of unknowns by comparing them against a library of known spectra.



- **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. Adjusted 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 as shown in figure 4.5. 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 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. As shown in figure 4.6 there are three filter types for searching: **Date**, **Element**, and **Analysis conditions**. After setting a new search filter, click **Search**.
- **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.

Figure 4.5: Spectrum Search Window

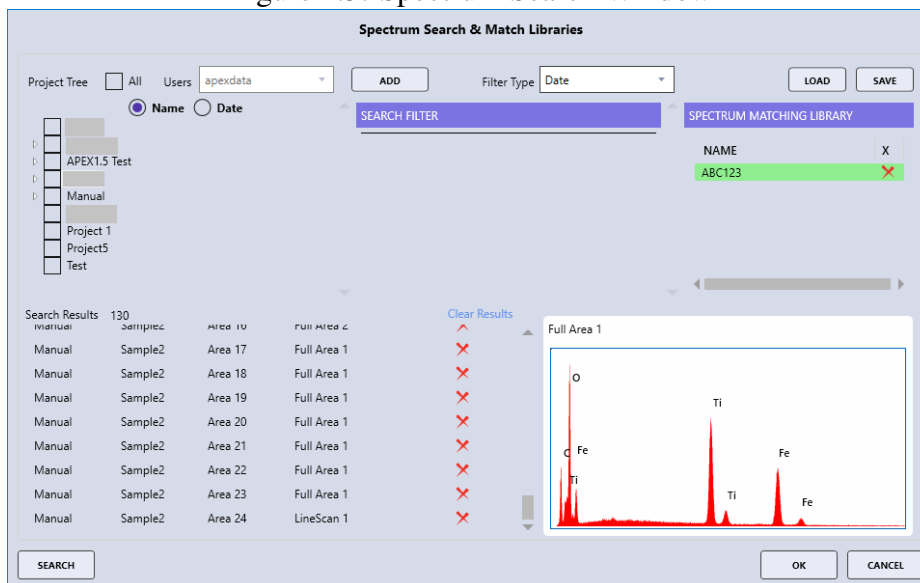
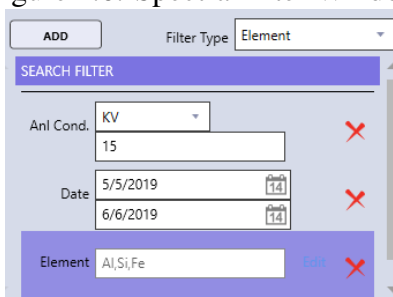


Figure 4.6: Spectra Filter Window



4.1. SPECTRUM REVIEW

- **Analysis Conditions:** Allows the user to filter search results based on the kV or name of the spectra.

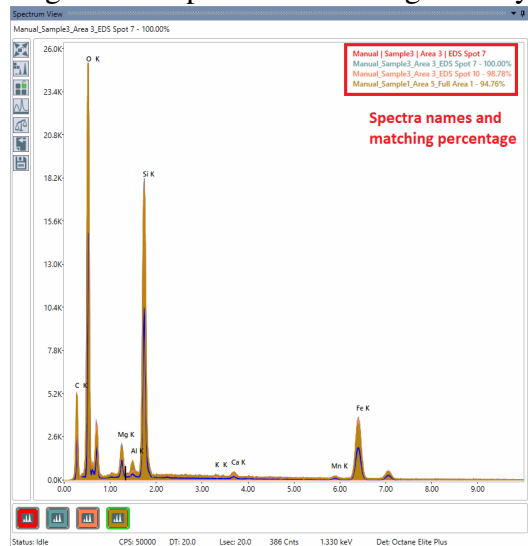
When in **Element** mode, clicking the **Add** button brings up a pop-up window shown in figure 4.7 that allows the user to define which elements to filter search results based on by using the periodic table and input the elemental concentration or intensity min/max range.

Figure 4.7: Element Search Pop-Up Window

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

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, see figure 4.8. 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.

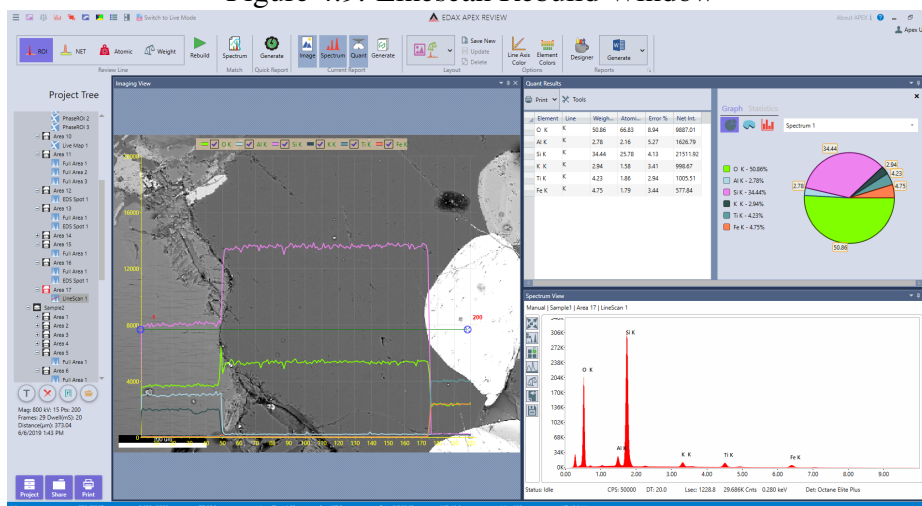
Figure 4.8: Spectrum Matching Overlay



4.2 Linescan Review

When loading a linescan dataset, the layout will automatically switch to the linescan review mode as shown in figure 4.9.

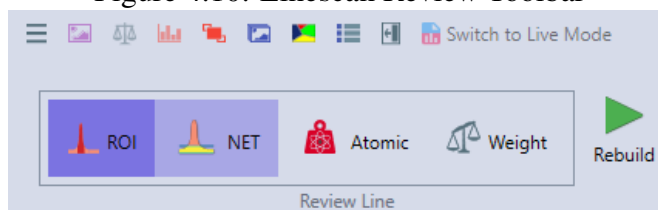
Figure 4.9: Linescan Rebuild Window



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:

Figure 4.10: Linescan Review Toolbar



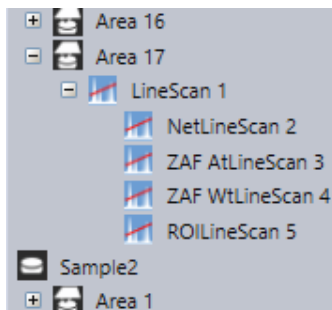
- ROI, NET, Atomic, Weight:** These icons allow the user to select the desired output data of a linescan rebuild. Linescan data can only be acquired live in ROI mode but the rebuild options enables users to define NET, atomic %, and weight % linescans. Additionally, elements can be added or removed from the element list. To select a rebuild method, click one of the four icons.

Note: Atomic and Weight rebuild is optional for APEX standard.

- 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.

Figure 4.11: Linescan Rebuild Project Tree

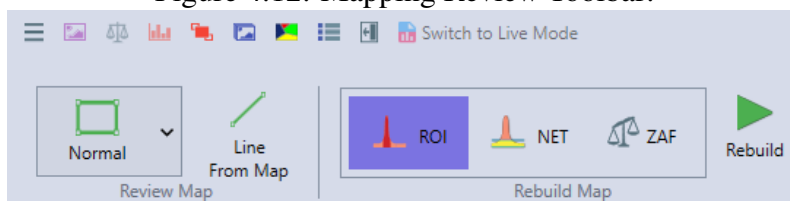


4.3 Mapping Review

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.

Note: Atomic and Weight rebuild is optional for APEX standard.

Figure 4.12: Mapping Review Toolbar:



- Review Map:** Extracts the spectrum from spot or rectangular area selected by the user. It is possible to move the point or area around and see the spectrum update continuously. For area, left click inside the area and drag, for point, left click on the coordinate point label and drag.
 - 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.
 - 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 the 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.
- 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,

Figure 4.13: Mapping Review→ Normal Mode:

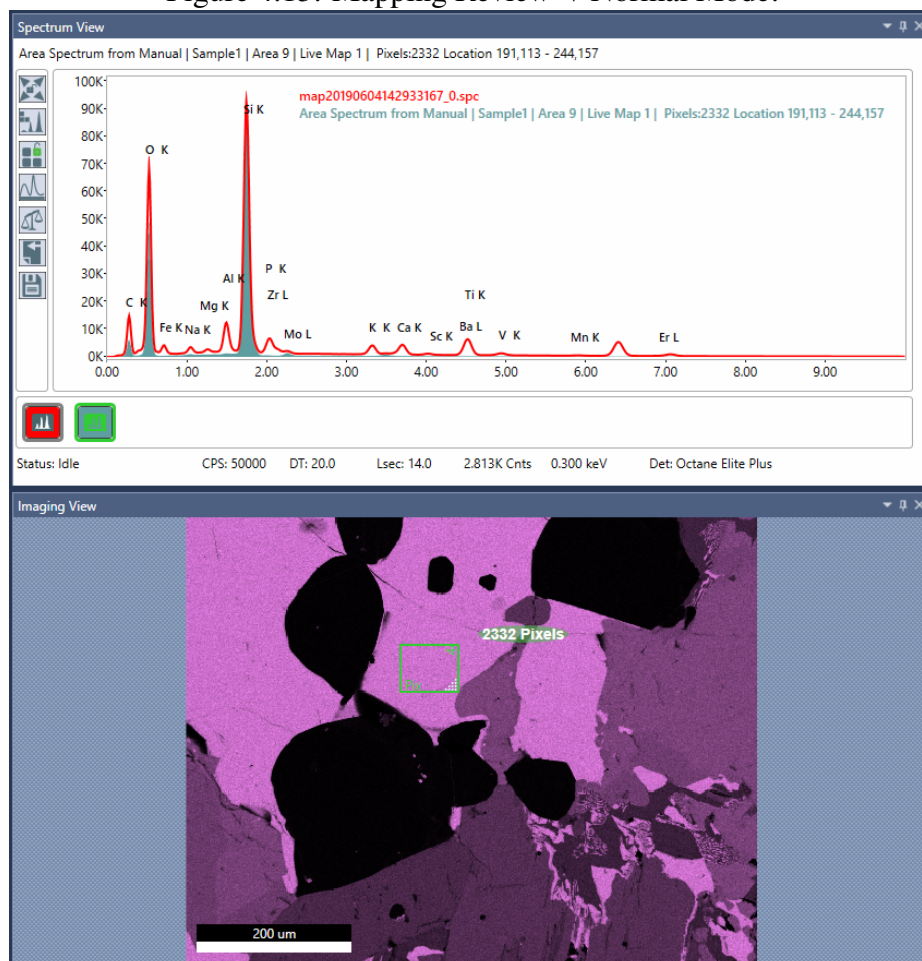
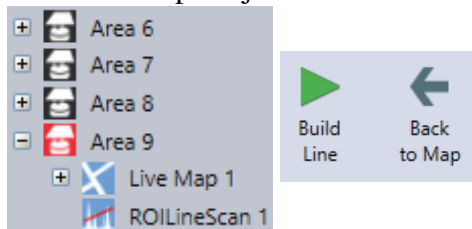
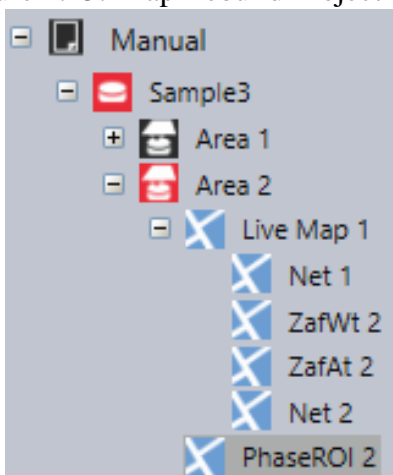


Figure 4.14: Line from Map Project Tree and Back to Map Icon:



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.

Figure 4.15: 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.

Chapter 5

Reporting and Printing

5.1 Report Generation: Live Mode

Note: *Live report generation and custom templates are optional for APEX Standard.*

APEX™ allows users to easily create reports in Microsoft Word or PowerPoint, while in still live mode. The report icons, in the top right corner of the collection toolbar (see figure 5.1), enable the user to generate a report using pre-existing template or design a template. To use a pre-existing template, select one of the options from the drop down menu (shown in Figure 5.2). A preview of the report will be displayed as the mouse is hovered over each option. When using the Word/Powerpoint advanced reporting option, it is possible to append multiple reports by keeping the Word/Powerpoint document open and clicking the **Generate** for each desired data-set to be added to the report.

Figure 5.1: Report Icons: Live Mode, Report Generating

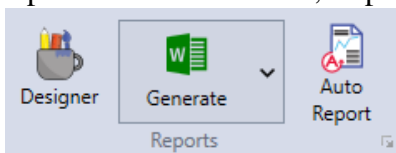
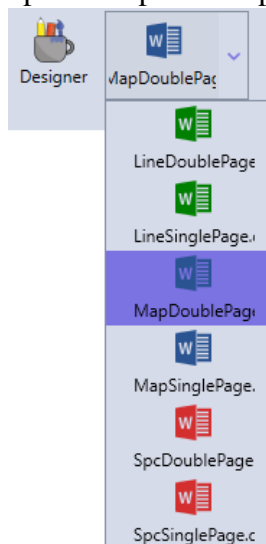


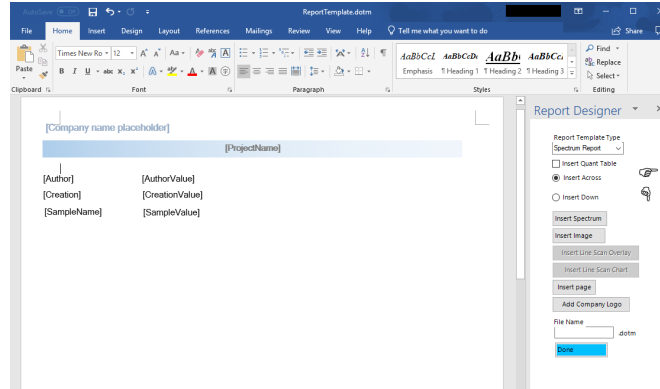
Figure 5.2: Report Template Drop Down Menu



Report Designer

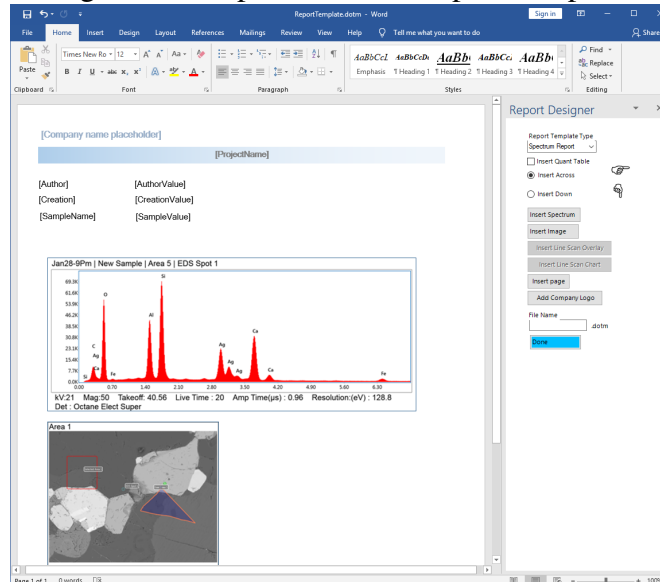
To create a report template for future use, click the **Designer** icon on the collection toolbar. This will open a blank template that can be customized (shown in Figure 5.3).

Figure 5.3: Blank Word Report Template



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 (shown in Figure 5.4). 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. Company name on report header can be changed in the **Report Properties** window described in section 5.1 on page 73. 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.

Figure 5.4: Populated Word Report Template

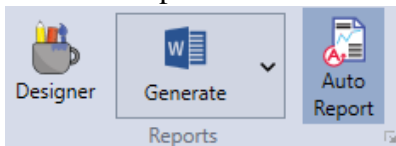


Auto Report

Clicking the **Auto Report** icon will enable Auto Report and change the icon color (shown in Figure 5.5). When Auto Report is enabled, the report engine will generate a report as soon as data collection finishes

(orange dots will appear under the **Generate** icon while the report is loading). New data collection will be added to the report automatically as long as **Auto Report** is turned on. Since the report engine works independently, data collection and review can continue while the report is being generated.

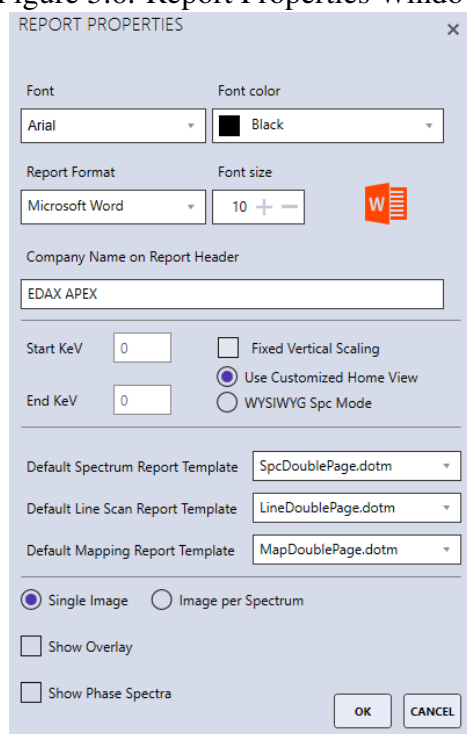
Figure 5.5: Word Report Icons: Auto Report On



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.

Report Properties Window

Figure 5.6: Report Properties Window

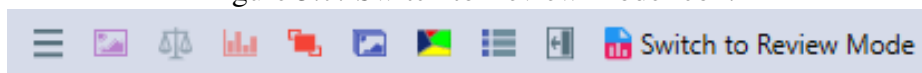


To access the Report Properties Window, click the arrow icon next to the word **Reports** in the collection toolbar. This window enables the user to customize the font and formatting of reports (shown in Figure 5.6). To select a font type, color, and size for reports, use the drop down menus next to these options. To change the company name on report header, type in the company name in the box. Use the checkboxes to enable or disable **Fixed Vertical Scaling**. Start and End KeV values are loaded from the Customized Home View on the Spectrum view and are read only values. When **Use Customized Home View** radio button is selected, the spectrum on the report will have the corresponding start and end KeV values.

WYSIWYG Spc Mode will generate the spectrum on the report the same as on the screen.

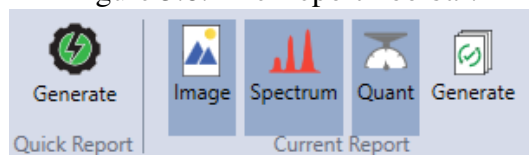
5.2 Spectrum or Linescan Report: Review Mode

Figure 5.7: Switch to Review Mode Icon:



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 (shown in Figure 5.7). Review mode can also be accessed by double clicking on a project tree node. This will load that specific data-set in review mode.

Figure 5.8: The Report Toolbar:



There are two options for creating reports: **Quick Report** and **Current Report**. The quick report mode creates multiple page reports with all data while the current report mode offers a selection of which data to include. To create a report, click one of the two **Generate** icons located in the *Quick Report Area*, on the left, or the *Current Report Area*, on the right (shown in Figure 5.8). Clicking the **Image**, **Spectrum**, and **Quant** icons will add or remove them from the current report. When an item is selected, it is highlighted grey and will appear in the report. When in **Linescan Mode**, checking or unchecking 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** (shown in Figure 5.9). 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 (shown in Figure 5.10). The report can also be sent directly through 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.

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 **spectrum**, **quant**, and **image** icons to display/hide items from the report.

Figure 5.9: Report Viewer Windows:

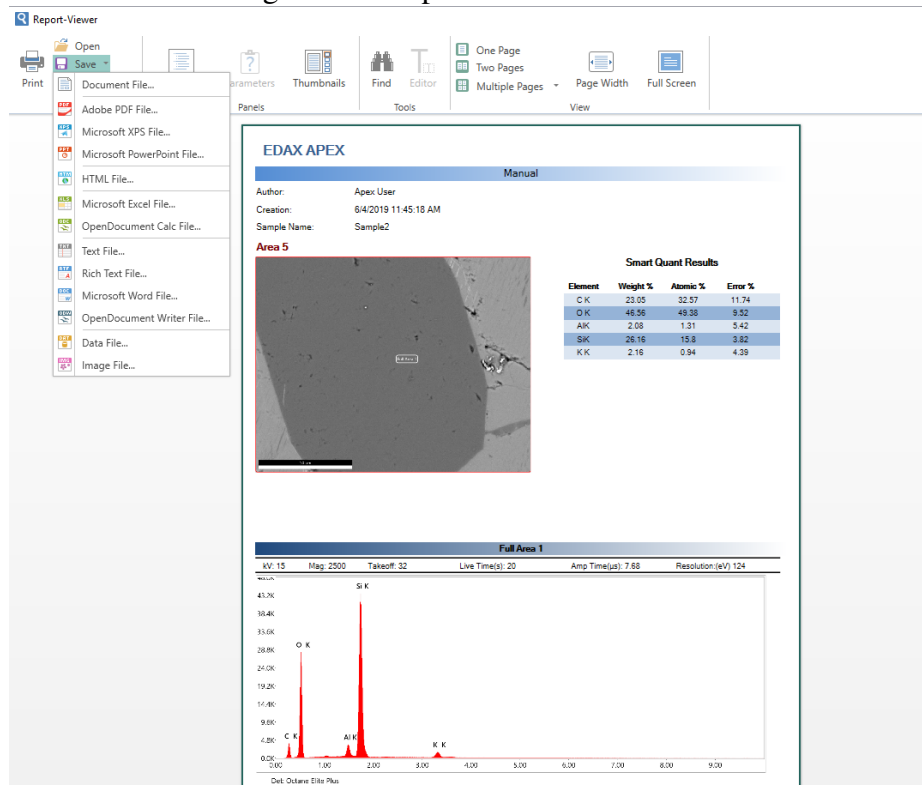


Figure 5.10: Report Viewer Save Options:

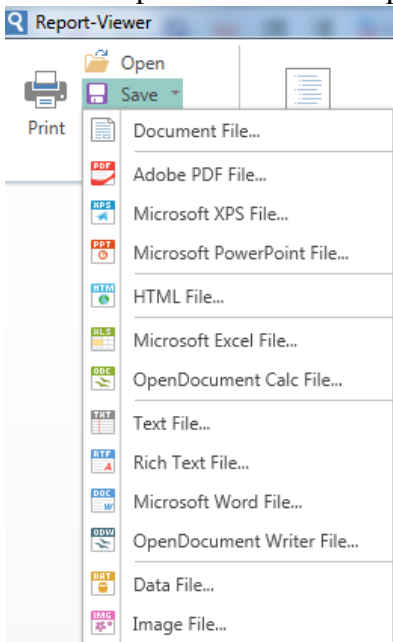
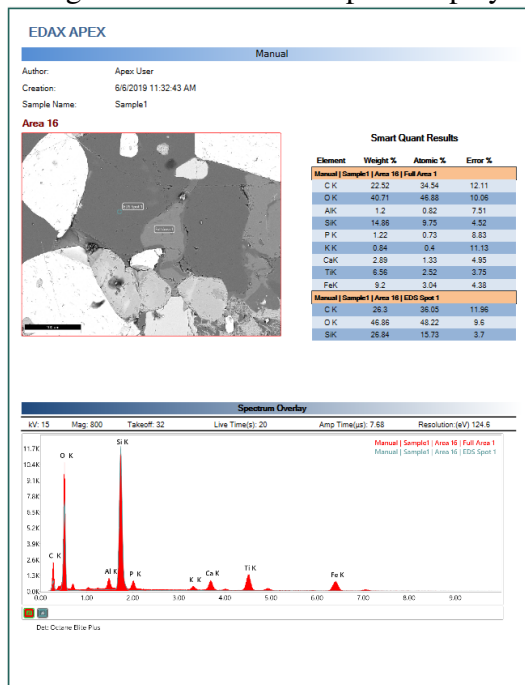


Figure 5.11: Current Report Display

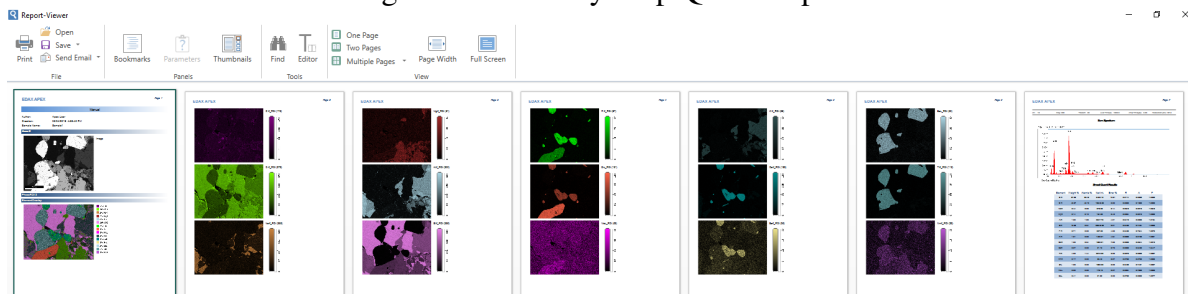


5.3 X-Ray Map Report: Review Mode

When in mapping review mode, use the **Quick Report** or **Current 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.

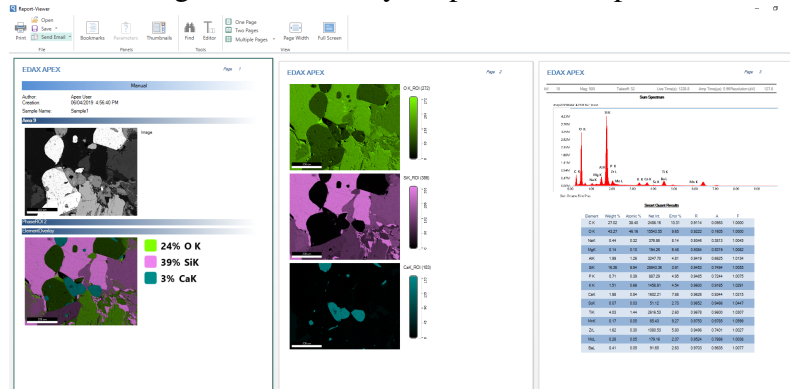
- Quick Report:** When quick report is selected, all of the collected maps (except the CPS map) will be sent to the report (shown in Figure 5.12).

Figure 5.12: X-Ray Map Quick Report



- Current Report:** When current report is selected, only the maps selected (via their check boxes) will be sent to the report (shown in Figure 5.13). Use the spectrum icon to add (highlighted) or remove (not highlighted) the **Sum Spectrum** from the report.

Figure 5.13: X-Ray Map Current Report



5.4 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.

Chapter 6

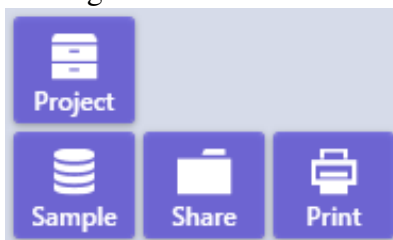
Data Handling and Backup

6.1 Import, Export, and Merge Data

In bottom left corner below the project tree menu, next to the project, sample, and print icons, is the **Share** icon, see figure 6.1. Clicking the share icon displays a window (shown in Figure 6.2) that prompts the user with four options: Export, HDF, Import, and Merge.

Note: In live mode, clicking the share icon brings up the export window. In review mode, the export, HDF, import, and merge options are available as well.

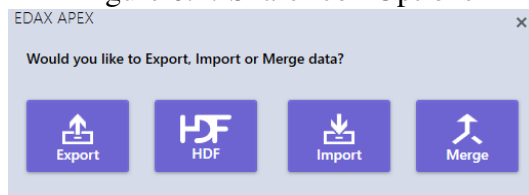
Figure 6.1: Share Icon



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

Overview of Share Icon Options:

Figure 6.2: Share Icon Options



- **Export:** Backs up ALL the selected projects.
- **HDF:** Creates a self-contained HDF5 file for each selected project.
- **Import:** Temporarily displays data that was exported (usually from some other workstation), but does **not** save the actual data to the database.
- **Merge:** Imports the data from a different workstation system, and this data becomes part of the local database. Once data is merged, it is permanently saved on the workstation.

Export Icon:

Clicking the **Export** button will display the window shown in figure 6.3. Using the check-boxes, select the project(s) to be backed up. In the top right-hand corner of the pop-up window, there are three boxes which enable batch selection of projects.

Figure 6.3: Export Pop-up Window



- **First box: Collapse ALL** → All Project nodes are collapsed.
- **Second box: Check ALL** → All Project nodes are checked (enabled for backup).
- **Third box: Un-Check ALL** → All Project nodes are un-checked. As a default, this is how the window is first displayed.

Next, click the **OK** button and choose a destination folder for data backup and click **Select Folder**. If the selected backup folder already exists the message shown in figure 6.4 will be displayed. Click **Yes** to overwrite and start the backup process. While the backup is running, a progress window will be displayed on the screen as shown in figure 6.5. Click the **Stop** button to stop the backup process.

Figure 6.4: “Overwrite Existing Backup File” Message

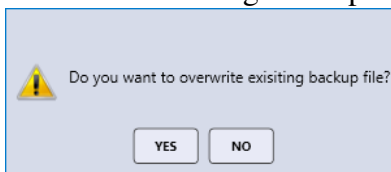
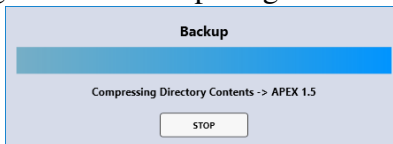


Figure 6.5: Backup Progress Window



Each project is saved as a *Zip* file with some support files as shown in figure 6.6. The database entries are in the *.BAK file, the raw APEX data is in the *.ZIP file, and the a name listing of all the backed up files is in the *.XML file. For information on **Auto Backup Settings**, see section 6.2 on page 83.

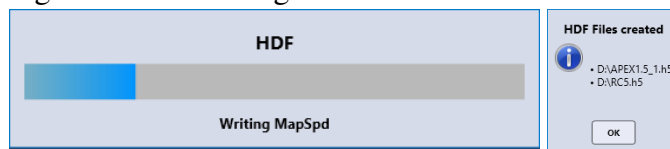
Figure 6.6: Backup File Names

Name	Date modified	Type	Size
APEX 1.5.zip	6/5/2019 2:17 PM	Compressed (zipp...	11,866 KB
backupinfo.inf	6/5/2019 2:17 PM	Setup Information	1 KB
backupInfo.xml	6/5/2019 2:17 PM	XML Document	2 KB
EdaxAcquisitionX.BAK	6/5/2019 2:17 PM	BAK File	6,752 KB

HDF Icon:

This function will create a self-contained HDF5 file for each selected project. It is a self-contained full project file so the user can work on the single file and everything is saved back to the file. Clicking the **HDF** icon will display the same window as clicking the **Export** icon and follow the same work flow for backup. While the HDF5 files are being created, a progress window will be displayed on the screen. Once the task is complete, a notification with file paths will pop up, see figure 6.7

Figure 6.7: HDF Progress and Notification Windows



The HDF5 files can be opened in the project selection window in **Review Mode**.

Import Icon:

The Import function does not permanently import data that was backed up elsewhere. This function only allows for the temporary review of APEX™ data: **the data will not be saved on the current workstation**. However, any changes to the project will be saved back to the zip file and will be shown if the project is imported at a later point. To select a *.BAK file to temporarily review, click on the project file and the progress bar will appear while the project is being restored. When it is finished, a notification will pop up, click **OK**. Next, the EDAX data will be loaded into the project and another progress window will appear, see figure 6.8.

Now, the project tree is outlined with blue dashes: this is an indication that the data is only in a **temporary review mode**. Clicking the **Detach** icon, on the bottom of the screen, in the center, will remove the current data and switch back to selecting a project that is saved on the local computer, see figure 6.9.

Figure 6.8: Import Progress Windows

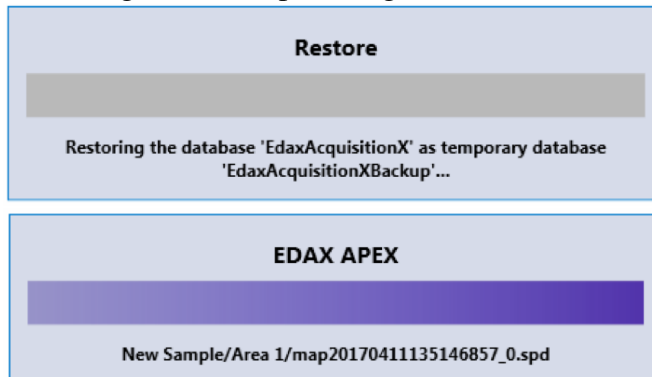
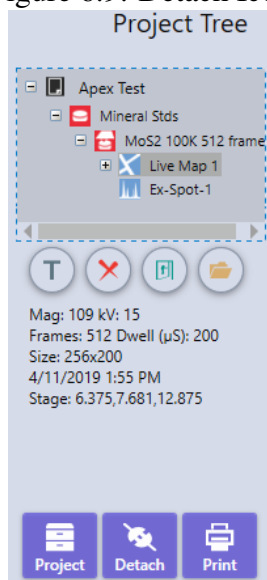


Figure 6.9: Detach Icon



Merge Icon:

To **permanently import data** that was backed up (via the Export icon), from another live EDAX system, click the **Merge** button. Select the wanted *.BAK file and the project will be merged back to the local database, becoming a permanent part of the local APEX™ Database. A progress box will appear while the project is merging, shown in Figure 6.10. After the project has been merged, it can be found using the **Project Explorer**.

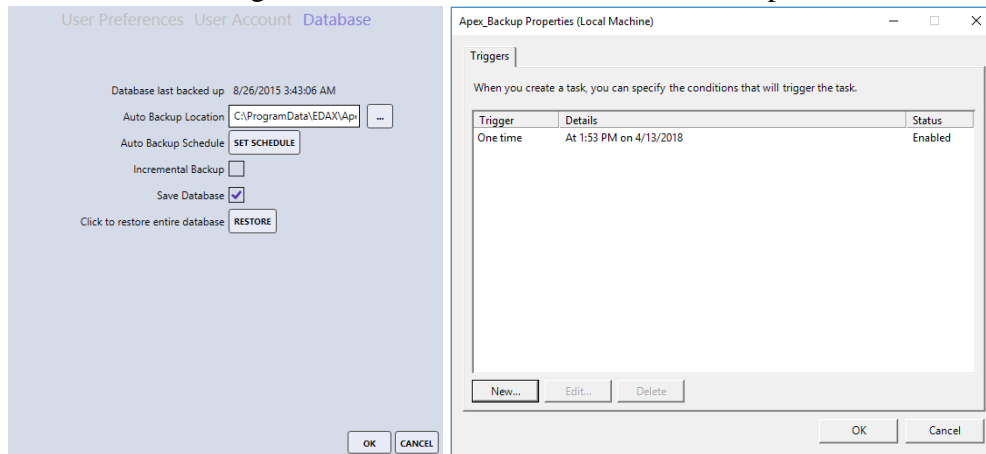
Figure 6.10: Merge Progress Window



6.2 Automated Data and Database Backup

To provide the easiest, most reliable, powerful data and database backup capabilities available from Microsoft, the Windows Scheduling function has been added to the APEX™ software. In the user preferences menu under **Database** (see figure 6.2), use the **Auto Backup Location** option to select a place to backup data. Use the ... button to select an existing location or create a new one. Network and removable drives can be used for data backup.

Figure 6.11: User Preferences Auto Backup



Use the **Auto Backup Schedule**→**Set Schedule** button to select the trigger for when data backup(s) will take place (shown in Figure 6.2). Checking the **Incremental Backup** box will only backup items that were not previously backed up. This process is very fast and efficient because only the new data will be backed up. If there was no previous backup data in the defined folder, a full data backup will be executed. The **Save Database** option includes a copy of the sql database along with the data backup. This option is enabled by default and recommended so that the system can be rolled back in the event of database corruption, only disable it if the backup size is an issue.

Clicking the set schedule button brings up a window that displays the current settings for backups that are defined to take place. Use the **New...**, **Edit...**, or **Delete** buttons to fine tune the backup schedule.

Figure 6.13: Login Window

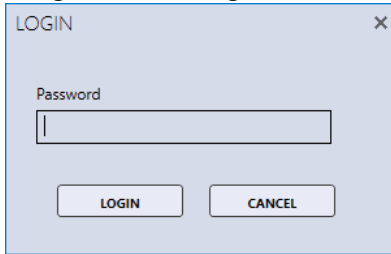
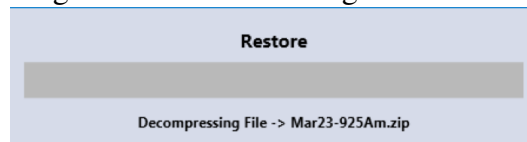


Figure 6.14: Restore Progress Window



Chapter 7

Advanced Settings

7.1 Detector Cooling and Slide Control

To access the **Detector Cooling and Slide Control Settings**, click the arrow in the **Acquisition** field of the live view (circled in red in Figure 7.1). A pop-up window will be displayed showing the Detector Cooling and Slide Control options (see Figure 7.2). 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.

Figure 7.1: Acquisition Settings Function Arrow Circled

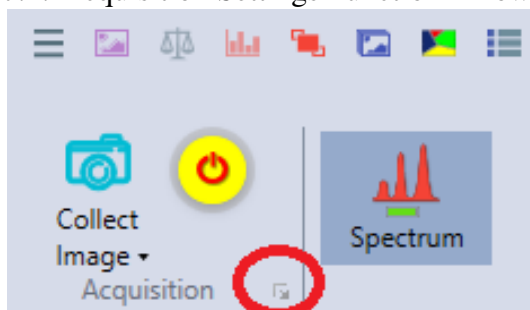
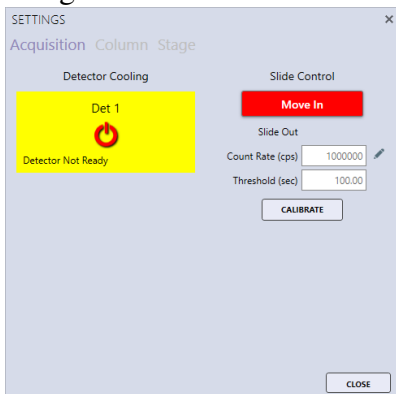


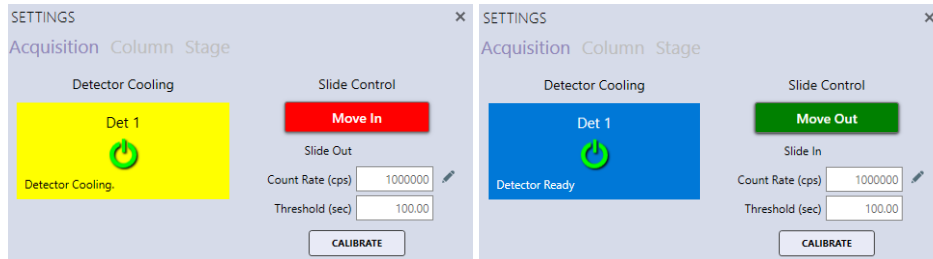
Figure 7.2: Acquisition Settings Window with Detector Cooling and Slide Control



Moving the Slide

To move the slide click the **Move in** button (see Figure 7.3 Left). Once the slide is in, the button label changes to **Move Out** and the color turns green. The slide status will state **Slide In** (see Figure 7.3 Right). To move the slide out, click the **Move Out** button.

Figure 7.3: Acquisition Settings Window with Slide in the In and Out Positions



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 Calibrate button. The button will be disabled until the calibration is complete. Slide calibration automatically determines the slides analyze and retract positions.

7.2 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 view. A pop-up window will be displayed showing the Column/ Stage control options, see figure 7.5. This window is a floating window which enables users to make adjustments while collecting an image and see those changes immediately.

Figure 7.4: Acquisition field



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.

Figure 7.5: Column Control

SETTINGS ×

Acquisition Column Stage

AUTO FUNCTIONS

AUTO FOCUS STI FINE FOCUS ☐ Auto Beam-OFF

AUTO BC COARSE FOCUS

HT On/Off ☒

HT 25.0 kV BRIGHTNESS 40.92 %

MAGNIFICATION 800 CONTRAST 56.57 %

WD 10.12 mm BEAM BLANK 0

SPECIMEN CRT 1 nA SPOTSIZE 12

COARSE FOCUS FINE FOCUS

READ STATUS

CLOSE

Figure 7.6: Stage Control

SETTINGS ×

Acquisition Column Stage

X: 0.000 Z: 0.000

Y: 0.000 T: 0.000

R: 0.000

SET XY

READ POSITIONS

CLOSE

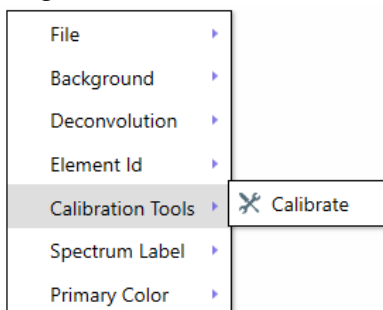
Click **Stage** to show the stage control options as shown in figure 7.6. Use the **X** and **Y** boxes to specify a stage location. Click **Set XY** to move the stage to that location. Click **Read Positions** to update the X and Y values after the stage has been moved via the controls on the microscope.

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.

7.3 Spectral Calibration

It is recommended that the spectral calibration is verified periodically. When the spectrum deconvolution does not match the collection spectra, the detector 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**.

Figure 7.7: 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 title will display that calibration is in progress. The window can be moved around by clicking on the title 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.

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.

Figure 7.8: Calibration Collection and Complete Windows

Collecting Preview

	Target	Delta
Peak 1	1.486	0.0000
Peak 2	8.04	0.0000

☐ Calibrate All

Calibrate View Log

Resolution: 124.007

Fine Gain: 0

Zero: 0

Calibration Successful

	Target	Delta
Peak 1	1.486	0.0010
Peak 2	8.04	0.0009

☒ Calibrate All

Calibrate View Log

Resolution: 124.64

Fine Gain: 0.8964

Zero: 1.399

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

7.4 APEX™Tutorials Panel

Click the **Show/Hide the Tutorials Panel** icon in the title toolbar to display the tutorials panel (see page 5 for a description of the title toolbar). 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.

