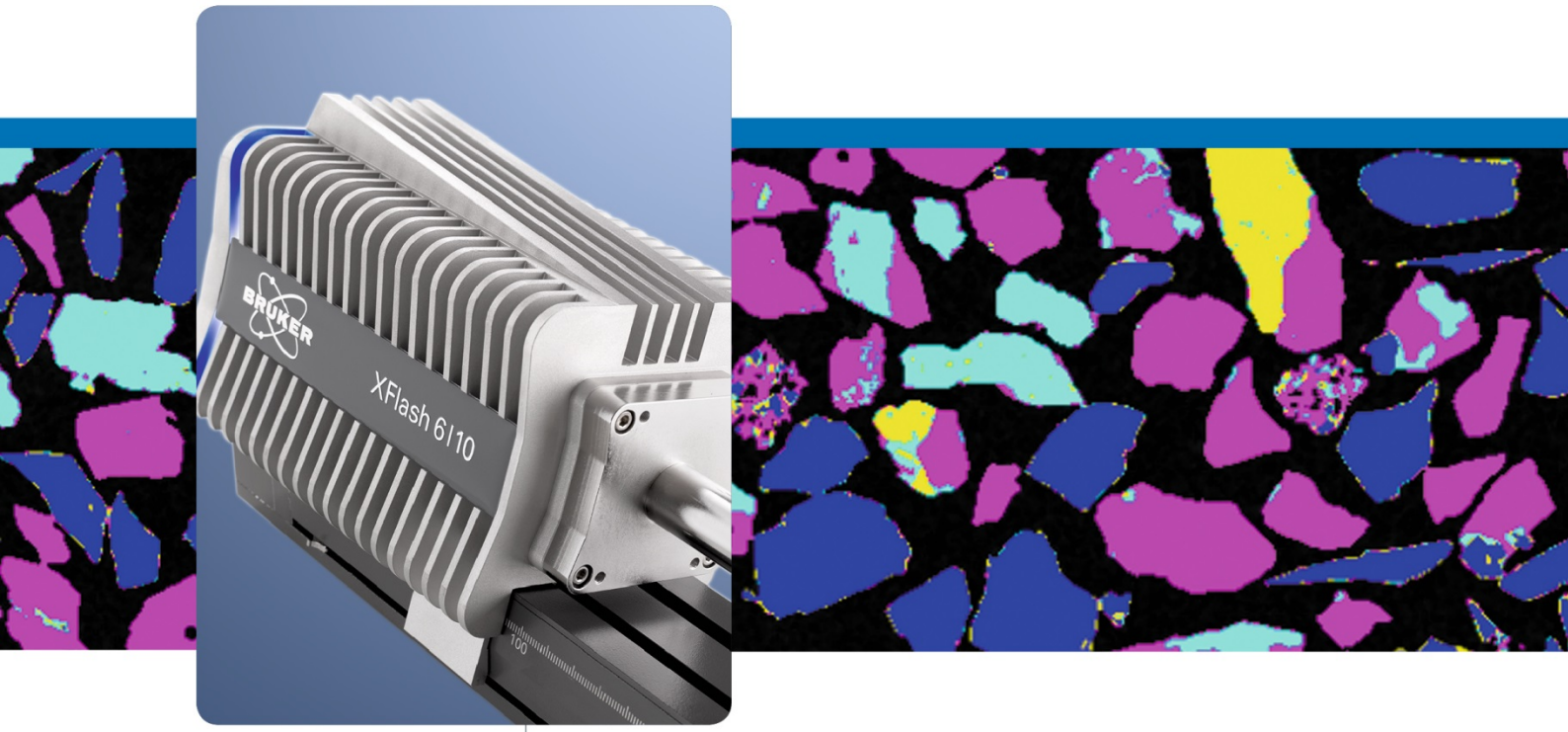


ESPRIT Feature

Determination of geometric and compositional data of particles

User Manual

EDS

Innovation with Integrity

Bruker Nano GmbH
Am Studio 2D
12489 Berlin

Tel. +49 (30) 670 990-0
Fax +49 (30) 670 990-30
E-mail support.BNA.EMEA@bruker.com
Internet www.bruker.com

We have checked the contents of this manual for agreement with the hardware and software described. Since deviations cannot be precluded entirely, we cannot guarantee full agreement. However, the data in this manual are reviewed regularly and any necessary corrections are included in subsequent editions. Suggestions for improvement are welcome.

Order no. DOC-M82-EXX040 V2

Contents

1 Introduction

Based on the speed and accuracy of the QUANTAX EDS system with its powerful and intuitive ESPRIT software, the Feature module brings new capabilities to the microanalysis package.

Feature is the ESPRIT module for particle analysis. It can be used to detect, measure and analyze any form of feature and to provide its chemical classification. ESPRIT Feature is fully integrated in the ESPRIT software package of the QUANTAX EDS System. This allows the analyst to use all of the required functions of ESPRIT without having to switch programs. ESPRIT´s Jobs function permits the preselection of all settings and methods for a fully automated feature and chemical classification run.

This user manual provides information about the two main operations of feature analysis, particle analysis and chemical classification.

2 ESPRIT Feature

To use the ESPRIT Feature module, start the ESPRIT software and select the Feature workspace by clicking the Feature icon (No. 1in Fig. 1).

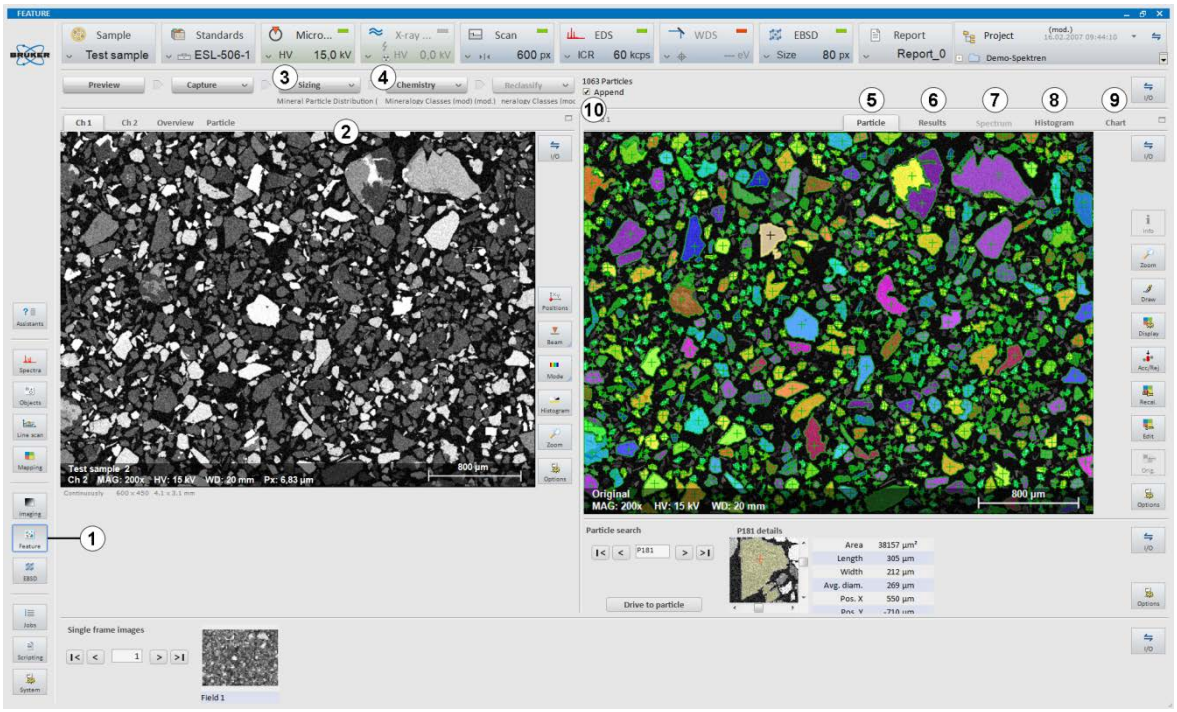


Fig. 1 ESPRIT's Feature workspace

An image can be placed into the image chart (No. 2 in Fig. 1) for processing via the IMPORT/EXPORT icon I/O or by drag and drop. This can be done from a file, from the current image acquisition or from the current project. Furthermore, it is possible to import a HyperMap database for analysis.

For feature analysis, there are two main operations that have a pre-defined process associated with them.

- Particle analysis, performed through the Sizing button (No. 3 in Fig. 1)
- Chemical classification, performed through the Chemistry button (No. 4 in Fig. 1).

Both operations need to be set up and adjusted depending on the sample and what results are to be expected. The latter performs the first one automatically in advance.

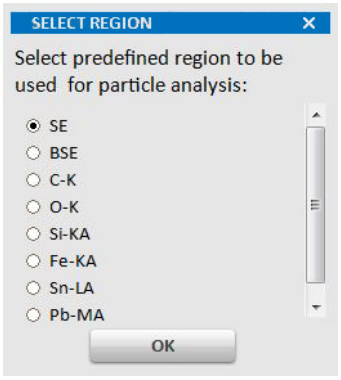


Fig. 2 Select region dialog

For feature analysis of a HyperMap (*.bcf file), the database needs first of all to be loaded into the Feature workspace via the I/O icon. Then the **SELECT REGION** dialog will be opened automatically (Fig. 2). The Hypermap can be loaded with the BSE image. Alternatively, an element can be selected to highlight a particluar chemical phase in the analysis. After pressing OK, the same procedure as for normal feature analysis can be applied, except for the spectra acquisiton, as this takes place by combining spectra in the HyperMap pixels of each particle.

2.1 Particle Tab

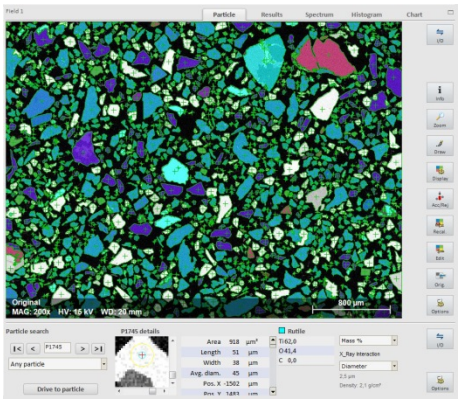


Fig. 3 Particle tab

The particle tab (No. 5 in Fig. 1) is the place where the particle image is dragged or opened, and the resultant image of the feature analysis is shown. If the particle tab is active, an analyzed particle can be selected either by clicking onto the particle in the list under the Result tab or by selecting a particle within the image. Both are highlighted simultaneously. There is a two-way link to the spectra list from here. If one or more particles are selected, the associated spectra are highlighted in the spectrum tab (and vice versa).

2.2 Results Tab

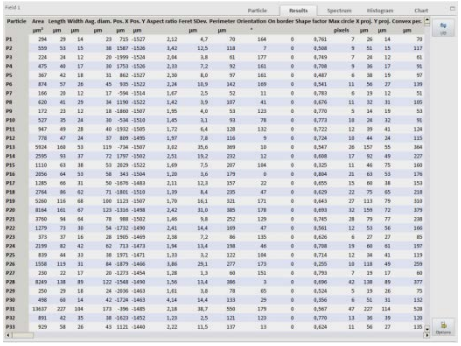


Fig. 4 Result tab

After Sizing, all detected particles will be listed with all morphological data (Area, length etc.) under the result tab.

2.3 Spectrum Tab

After a feature analysis has been performed, the spectrum tab (No. 7 in Fig. 1) shows the spectrum with the quantified results for each analyzed particle.

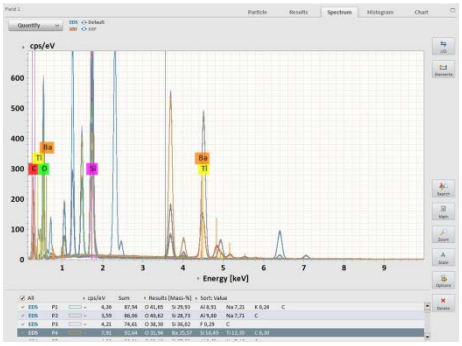


Fig. 5 Spectrum tab

Each spectrum can be separately viewed, exported, or dragged into a project. From there the spectrum can be dragged into the spectra dialog for manual quantification.

If the Append checkbox 

(No. 10 in Fig. 1) is ticked after a sizing or chemistry measurement, only that type of measurement (either sizing or chemistry) can be performed from that point onwards. However, the stage can be moved (manually) and the next measurement will be appended to the previous. Like this, a semi-automtatic particle analysis can be performed in the Feature mode. The saving of the particle list (*.pan) will save all fields that were performed with the Append box ticked.

2.4 Histogram Tab

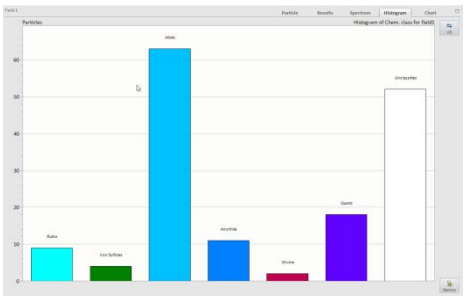


Fig. 6 Histogram tab

This is the tab (No. 8 in Fig. 1) where the histogram of the result of the binned particles (according to the selected feature, e.g. particle size/area or chemical class) is displayed. If one or more histogram bars are selected, the associated particles are highlighted in the particle list (under the result tab) and image (under the Particle tab).

2.5 Chart Tab

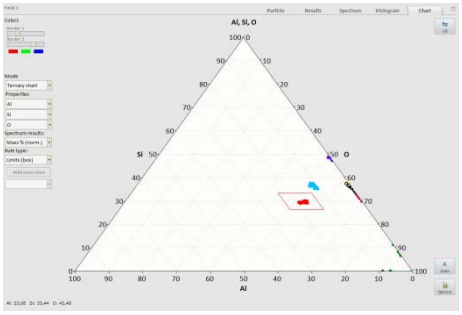
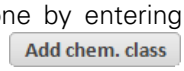


Fig. 7 Chart tab

After a feature analysis has been performed, the chart tab (No. 9 in Fig. 1) offers further options to plot diagrams (histograms, binary and ternary diagrams) with the collected geometrical and chemical data.

Using the mouse, the position of a plotted point can be determined. Furthermore, as with the Histogram tab, a range of plotted points/particles can be selected and highlighted.

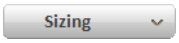
Furthermore, if the plotted points of a binary diagram are chemical in nature (e.g. Fe and S), then the selected clusters can be added as chemical class. This is done by entering a name (e.g. Chalcopyrite) below the 

button and pressing it. The data set will be reclassified with the new scheme.

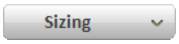
3 Feature Analysis

The feature analysis method encompasses steps such as image filtering, morphological filtering, binarization, minimum particle size (for noise and artefact exclusion), and physical property filtering (such as area, circumference, aspect ratio, elongation etc.). It also includes different options for how the results should be displayed.

3.1 Load a Preset Feature Analysis Method

To load a preset feature analysis method click on the downward-facing triangle at the 

button. Then click **Load...** to open the **LOAD FEATURE ANALYSIS FILTERS** dialog and select a method (Fig. 8).

Once the method is loaded the method name should be displayed below the 

button. Based on this method, particles will be chosen for Morphological and chemical analysis. However, this preset method has to be adjusted for the sample to be analyzed.

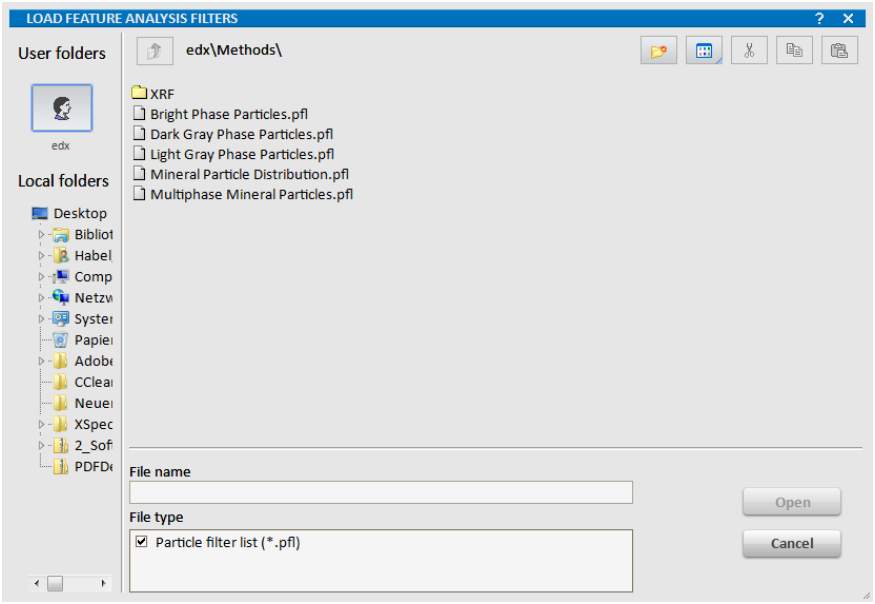


Fig. 8 List of available preset feature analysis methods

3.2 Create or Edit a Feature Analysis Method

Every preset feature analysis method has to be adjusted for the sample to be analyzed.

At first capture a BSE image of your particle sample by clicking the Capture button. Then drag this image to the Particle tab on the right side of the workspace.

To set up or to edit a feature analysis method, click on the downward-facing triangle at the Sizing button and click **Edit...**. Alternatively, click directly on the method name below the Sizing button. The **CONFIGURATION OF PARTICLE DETECTION** dialog (Fig. 9) opens where all steps (icons) on top from left to right have to be performed.

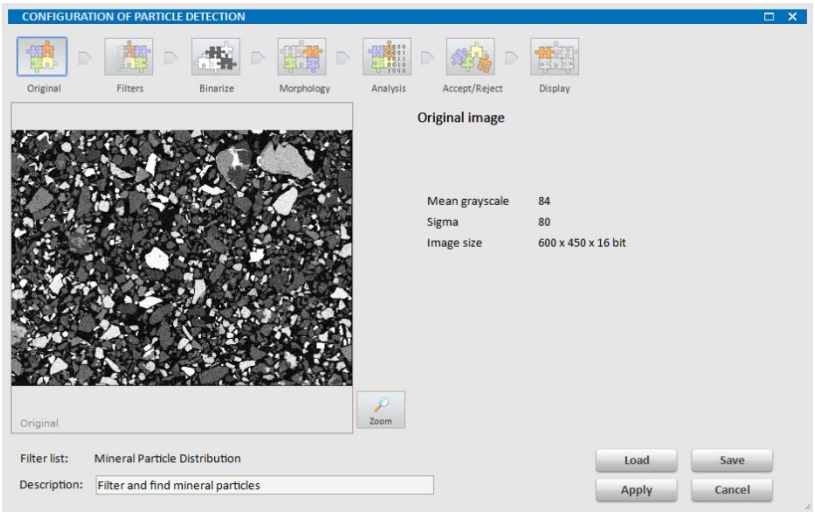


Fig. 9 Configuration of particle detection dialog

Using the Apply button all changes can be applied at any time to edit a loaded preset method.

Using the Save button the edited/ created chemical classification method can be saved.

3.2.1 Original Image

At the first step (**Original**), the image displayed will be the captured image which currently occupies the workspace (see Fig. 9). The dialog window can be resized, and will by default resize the image to fit. By pressing the magnifying glass 

, the image will be resized to its actual size.

If it has not been done already, an existing method can be loaded using the 

button.

3.2.2 Selecting Pre-binarization Filters

Change to the second step **Filters**.

A list with the selected filter(s) is displayed on the right hand side (see Fig. 10). If the option **Active** is ticked, the shown filters will actually perform their function during the procedure. The active option **Manual** indicates that the execution of the method will halt for this filter and allow readjustment (hence becoming a semi-automatic method). The column **runs** displays the number of times the filter will be run over the image. The column **Filter** shows the actual filter name.

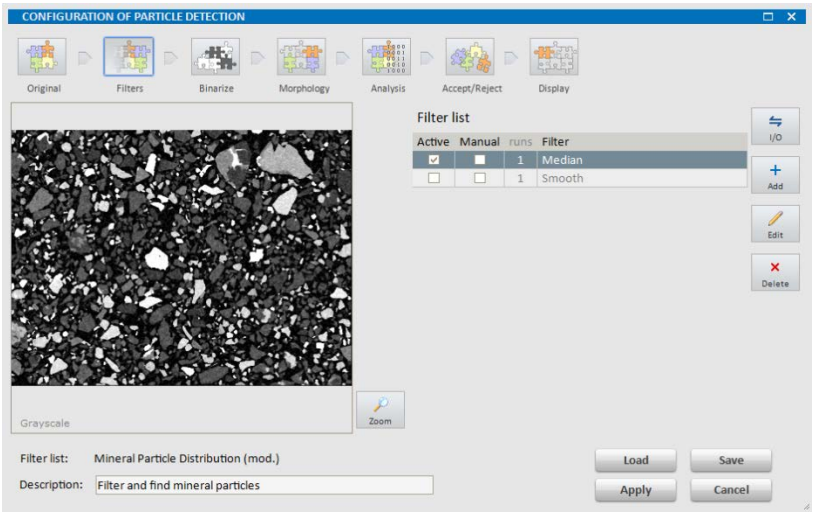


Fig. 10 Configuration of particle detection dialog – Step Filters

To add a filter, press the 

button. This opens the **SELECT FILTER** dialog (Fig. 11), giving the name for possible filters.

Pre-binarization filter list:

Uneven. This function performs a shading correction to equalize the shading gradient due to non-uniform sample illumination across the field of view.

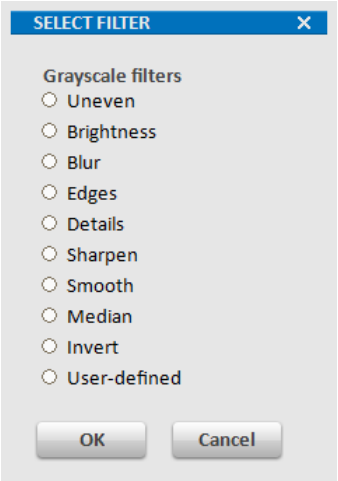


Fig. 11 Select filter dialog for pre-binarization filters

Brightness. This function adjusts the brightness of the image.

Blur – Filter. Image noise and detail levels can be reduced. The visual effect of this technique is a smooth blur resembling that of viewing the image through a translucent screen.

Edge – Filter. This filter enhances edges between light and dark features in the image. It amplifies edges by giving them a strong contrast, and reduces contrast of regions that have no edges.

Detail – Filter. This filter enhances detail in the image and gives details, structure or features a greater contrast. It has a sharpening effect on the image.

Sharpen – Filter. Bevels are emphasized, the image looks more focused than the primary image. Inevitably the image noise increases.

Smooth – Filter. Noisy images can be improved. The intensity of the filter can be adjusted by the slide control.

Median – Filter. This filter enhances and softens images, reducing speckle and salt and pepper noise. The size of the median region can be adjusted with upper slider (blur and dilation effect), while the rank is adjusted with the lower slider (reducing or increasing overall brightness).

Invert – Filter. This function inverts the grayscale image.

User-defined. Convolution filter with user-defined convolution kernel

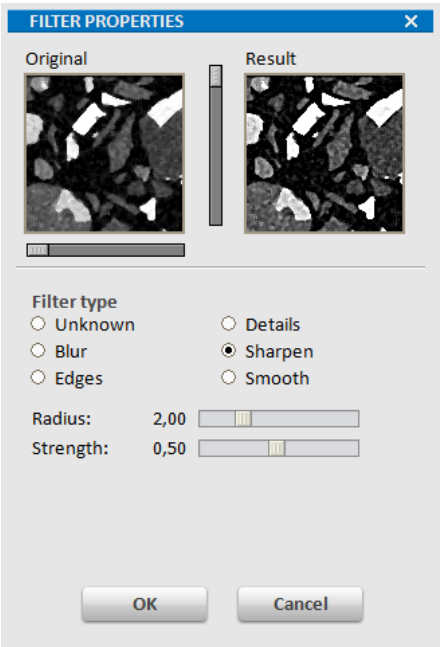


Fig. 12 Filter properties dialog

After selecting a filter in the **SELECT FILTER** dialog (Fig. 11), the **FILTER PROPERTIES** dialog (Fig. 12) will open, allowing for adjust the configuration of the filter. It shows the original image and the effect of the filter. Changes can be performed via slider control to the size and effect of the filter interaction and function.

To delete a filter, select the filter and press the 

button.

To edit the properties of a filter, select the filter in the list and press the  button. This will open the **FILTER PROPERTIES** dialog (Fig. 12), where the filter properties can be edited.

Note: The more filters are added, the more details will be lost from the original image.

3.2.3 Binarization of the image

Select the third step **Binarize** (Fig. 13).

The binarization can be performed in two ways: single phase or multi phase (multiple colours, one for each phase). The binarization highlights image sections that fall within a certain grayscale range. The positions of the thresholds can be set by SHIFT + mouse click + dragging the vertical line in the histogram. Alternatively, the values in the columns **From** and **To** in the phase list table below can be changed manually. The upper value is fixed at the maximum. The histogram height is scalabe by using the mouse on the left hand side of the histogram area and dragging up or down.

If the **Display background** option is ticked, the lowest (darkest) grayscale phase is selected as background and will be shown.

For the **Automatic mode**, there are three methods: **Slope**, **Otsu** and **Mean**. These determine how the phases are calculated. The number next to the automatic mode is the sensitivity. This changes the number of phases that are found with the algorithm.

If the **Manual mode** is selected, phases can be added and adjusted in the binarization diagram using the "SHIFT" key and the left mouse button. When highlighting a phase with the left mouse click, phases can be deleted with the "Delete" key.

The **Center only** tickbox allows the histogram in the centre of the image to be used for calculation of phases (in case of shading effects near the edge).

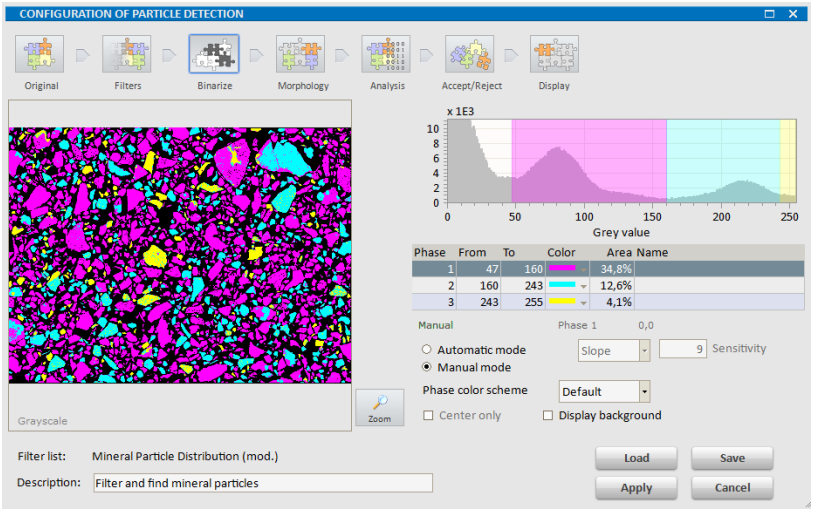


Fig. 13 Configuration of particle detection dialog – Step Binarize

3.2.4 Morphology (Post-Binarization) Filter

Change to the next step **Morphology**. A list with the selected filter(s) is displayed on the right hand side (see Fig. 14).

As with the pre-binarization filters, the list of selected filters can be configured, but this time with post-binarization morphological filters. These filters perform operations to clean up the masked image, separate particles and close holes. This is necessary to measure the particles properly.

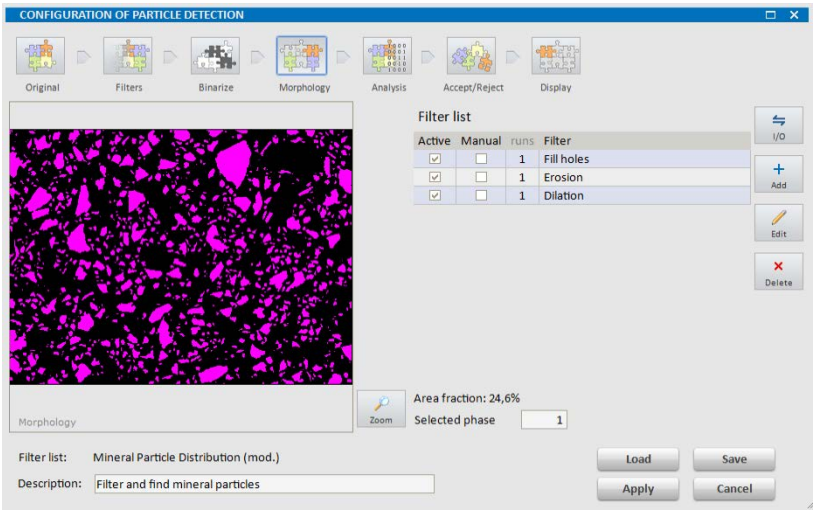


Fig. 14 Configuration of particle detection dialog – Step Morphology

To add a morphology filter to the list, press the Add button. This opens the **SELECT FILTER** dialog (Fig. 15).

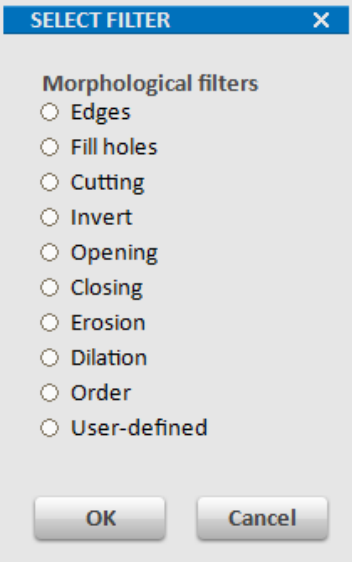


Fig. 15 Select filter dialog for morphological filters

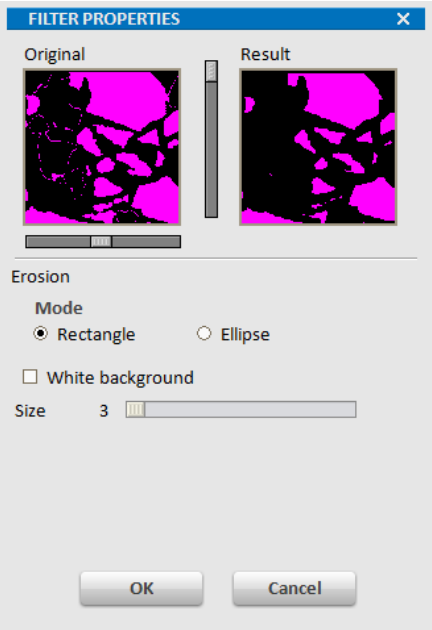


Fig. 16 Filter properties dialog for morphological filters

Post-binarization filter list:

Edges. This filter creates outlines (dark lines) at edges, and colors the flat areas white.

Fill holes. This algorithm fills or closes black areas within a body.

Cutting. This algorithm cuts particles by calculating closest points of inflexion and performing a watershed operation. It attempts to separate touching particles.

Invert. This function inverts the binary image.

Opening. The open operation performs a dilation followed by an erosion operation.

Closing. The close operation performs erosion followed by dilation.

Erosion. The erode operation returns the minimum value of the surrounding pixels, having an erosion effect on white particles on a black background.

Dilation. The dilate operation returns the maximum value of the surrounding pixels, having a dilation effect on white particles on a black background.

Order. This filter enhances and softens images, reducing speckle and salt and pepper noise. The size of the median region can be adjusted with upper slider (blur and dilation effect), while the rank is adjusted with the lower slider (reducing or increasing overall brightness).

User-defined. Convolution filter with user defined convolution kernel

After selecting a filter in the **SELECT FILTER** dialog (Fig. 15), the **FILTER PROPERTIES** dialog (Fig. 16) is opened, allowing for adjust the configuration of the filter. Changes can be performed via slider control to the size and effect of the filter interaction and function.

To delete a filter, select it and press the Delete button. To edit the properties of a filter, select the filter in the list and press the Edit button.

3.3 Analysis

In this step, the first set of exclusions is selected. Several radio buttons allow decisions about the border particles. A white background can be set by activating the corresponding tick box (Fig. 17). Additionally, the minimum particle size in pixels can be entered and the resulting area will be displayed in µm² then. The number of particles found with the chosen criteria is also displayed.

Once the radio buttons and tick boxes have been activated/ deactivated, the selected and accepted particles will be displayed individually colored.

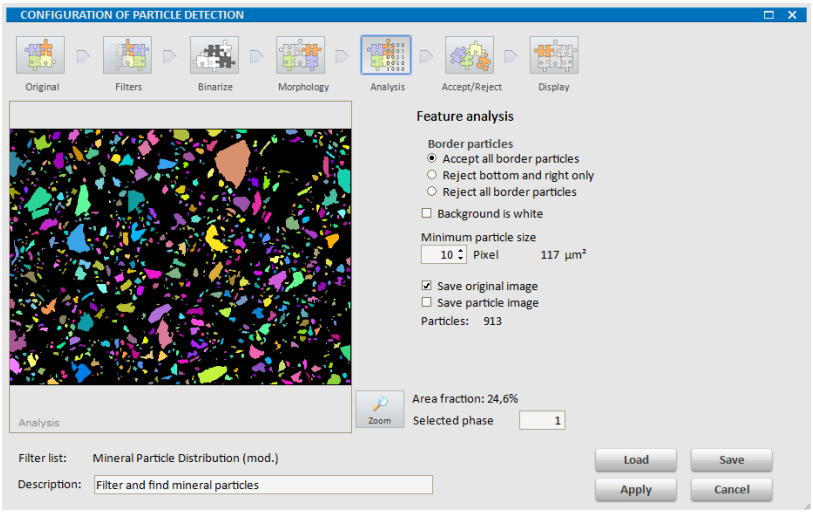


Fig. 17 Configuration of particle detection dialog – Step Analysis

3.4 Accept/Reject

In this step, a number of particle property filters can be included. These filters will accept particles according to their properties within set ranges, and reject the rest. As with the pre- and post-binarization filters, the property filters can be added, changed or deleted with the icons Add, Edit and Delete (Fig. 18).

Ticking the **Keep rejected particles** checkbox will include the particles in the display (in gray color), but will exclude them from particle analysis and chemical classification.

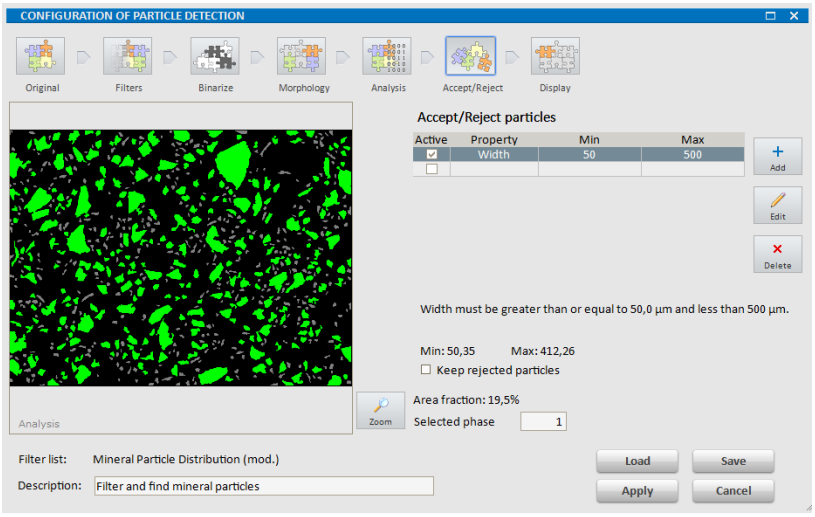


Fig. 18 Configuration of particle detection dialog – Step Accept/Reject

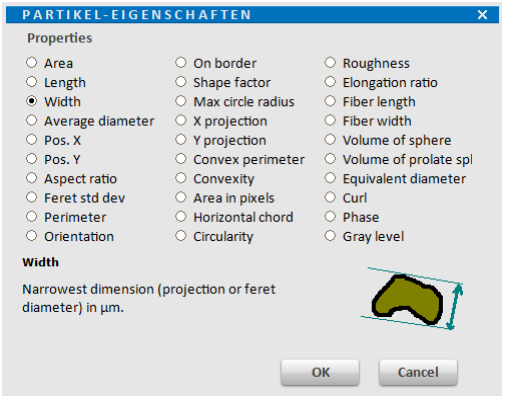


Fig. 19 Particle properties dialog

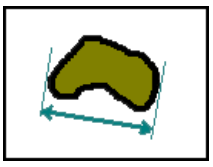
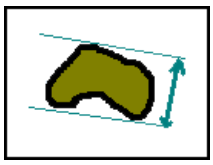
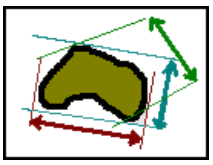
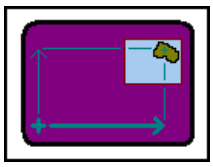
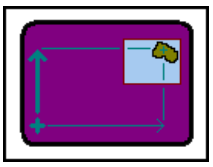
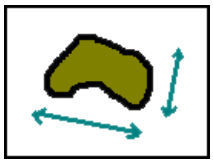
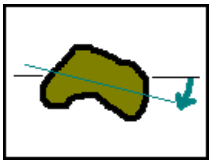
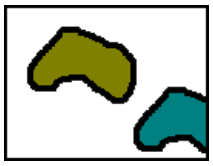
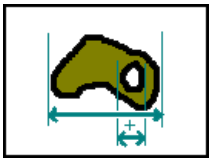
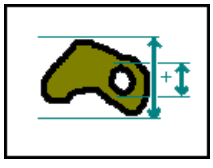
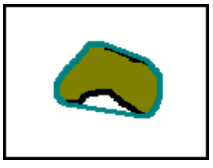
To select specific particle property filters open the the **PARTICLE PROPERTIES** dialog with the 

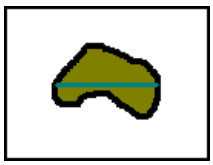
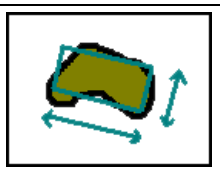
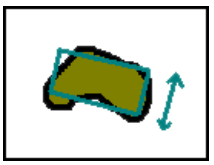
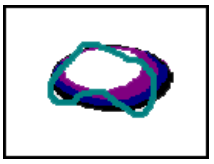
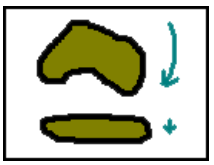
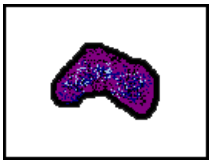
icon (Fig. 19).

A description of the selected filter and its acceptance criteria is shown in the **PARTICLE PROPERTIES** dialog.

Section 3.5 gives an overview of all available filters.

3.5 Particle Property Filter List

Sketch	Name/Description		Sketch	Name/Description
	Area: Area in square microns			Length: Longest dimension (projection or feret diameter) in microns
	Width: Narrowest dimension (projection or ferret diameter) in microns			Average diameter: Average of all particle's ferret diameter in microns
	Pos. X: The X coordinate of the center of the largest inscribed circle within the particle, in microns, relative to the stage origin.			Pos. Y: The Y coordinate of the center of the largest inscribed circle within the particle, in microns, relative to the stage origin.
	Aspect ratio: A dimensionless ratio of length to width; 1 for a round particle, >1 for an elongated particle			Feret standard deviation: Variation of the particle's ferret diameters in microns.
	Perimeter: Length of the perimeter in microns			Orientation: Angle of orientation of long axis; 0 to 180 degrees, or -1 if not available
	On border: 1 if the particle touches the image border, 0 if it is fully within the image.			Shape factor: Shape or form factor, a dimensionless measure of roundness; near 1 for round particles, <1 for irregular particles
	Max circle radius: Radius in pixels of the maximum inscribed circle			X projection: Length of projection of particle onto the X-axis, plus length of projection of internal holes, in microns.
	Y projection: Height of projection of particle onto the Y-axis, plus length of projection of internal holes, in microns.			Convex perimeter: Convex perimeter in microns, shortened by cutting across indentations

Sketch	Name/Description		Sketch	Name/Description
	Convexity: Convexity, a measure of boundary indentations; 1 for smooth particles, <1 if indentations are present			Area in Pixels: Area as a pixel count
	Horizontal chord: Longest horizontal chord in microns.			Circularity: A dimensionless measure of circularity; near 1 for round particles, >1 for irregular particles
	Roughness: A dimensionless measure of boundary irregularity; near 1 for smooth particles, >1 for rough particles			Elongation ratio: A dimensionless ratio of fiber width to length; 1 for a round particle, <1 for an elongated particle, 0 if unavailable
	Fiber length: Fiber length in microns, if the particle can be treated as a fiber.			Fiber width: Fiber width in microns, if the particle can be treated as a fiber.
	Volume of sphere: Volume of the particle in cubic microns, assuming the particle can be treated as a sphere.			Volume of prolate sphere: Volume of the particle in cubic microns, treated as a prolate sphere (grain of rice shape).
	Equivalent diameter: Equivalent diameter in microns, assuming a circular particle.			Curl: A dimensionless measure of curl or crookedness; 1 for a straight particle, <1 for a curled particle.
	Phase: Phase in the segment image for multi-phase analysis.			Gray level: The average grayscale level across the entire particle.

3.6 Display

In this step, the display of the particle properties list, the coloring of the particles and the transparency of the feature analysis mask can be defined. The set-up of the histogram as subsequent result display and the bins or ranges can also be performed.

By ticking the check box **Particle properties All,** the corresponding variable of each particle will be displayed in the particle list (Fig. 20).

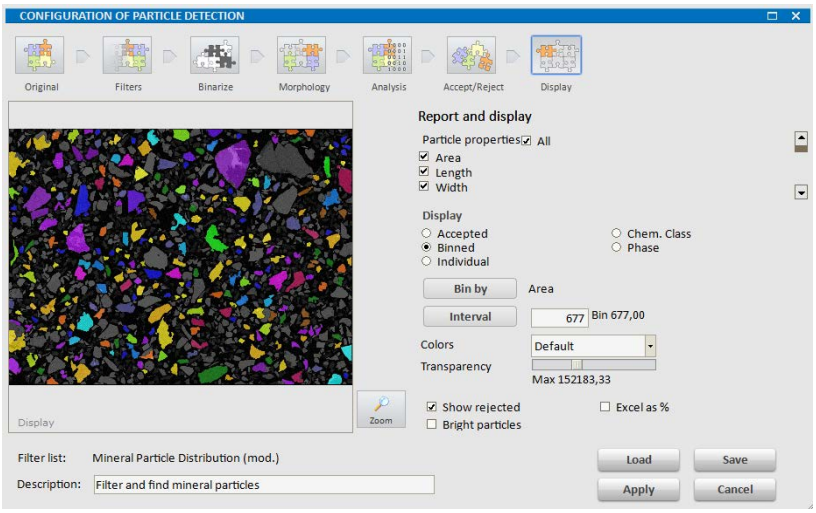


Fig. 20 Configuration of particle detection dialog – Step Display

The display panel allows the user to select how the particles in the display are colored.

1. Selecting the **Accepted** radio button displays the accepted particles in bright blue, and the rejected in gray.

2. Selecting **Binned** will color the particle according to the bin parameters.This is explained below.

3. Selecting the **Individual** radio button will color each particle in a different color (up to a certain number of colors and will start again); this coloring in process is random.

4. Selecting **Chem Class** will color the particles according to the chemical classification. If the particles do not fit into a ceratin chemical class, they will be colored gray.

5. Selecting **Phase** will color the particles according to multi-phase color segmentation.

The Bin by button allows the particles to be "binned" or put in to buckets according to a selectable property (see Fig. 19). The particles are sorted into ranges defined in the re-bin field which determines the size or width of the bin.

The **Colors** of the binning can also be set to a number of possible schemes, ranging from **Default** to **Stoplight** and **Earth**. This effect can only be seen in the binning color mode.

In the slider next to **Transparency** the transparency of the feature mask can be adjusted.

By ticking the **Show Rejected** checkbox all the rejected particles will be shown in gray. However, these particles will not be chemically analyzed.

By ticking the **Bright Particles** checkbox the particles will be colored in a brighter (solid) color.

Note that the feature analysis method can be saved or loaded at any time using the Save button and the Load button in the **CONFIGURATION OF PARTICLE DETECTION** dialog.

Using the Apply button all changes/current settings can be applied at any time to edit a loaded preset method.

4 Chemical Classification

The chemical classification method encompasses the settings for the spectrum acquisition, where the spectrum shall be acquired from, which quantification method to use and the classification settings for each class including if it is a hit class, its color designation, weight percent (un-normalized), and comparison between elements.

4.1 Load a Chem Class Method

A pre-saved classification method can be loaded by clicking on the downward-facing triangle at the Chemistry button. Then click **Load...** to open the **LOAD CHEMICAL CLASSIFICATION** dialog and select a method (Fig. 21).

Once the method is loaded the method name should be displayed below the Chemistry button. This is the method that will be used for a chemical classification measurement.

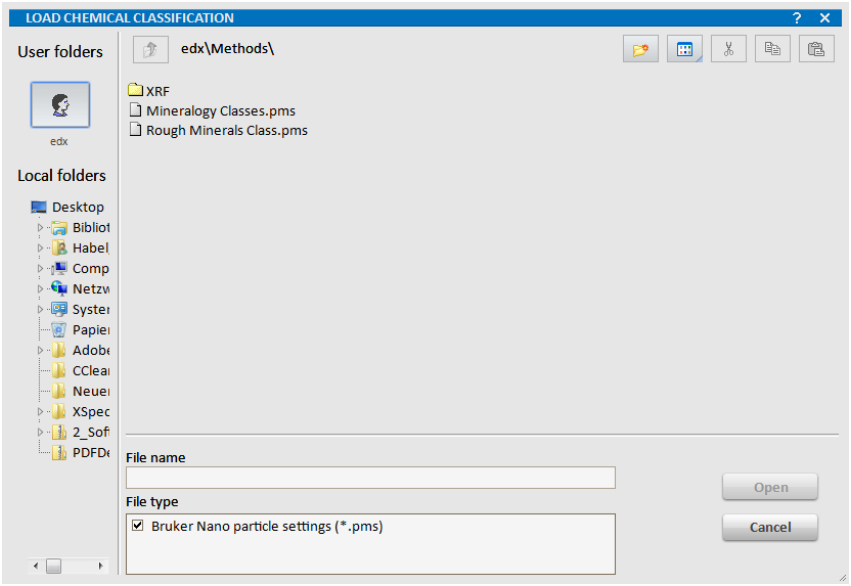


Fig. 21 List of available preset chemical classification methods

4.2 Create or Edit a Chem Class Method

To create or edit a chem class method, click on the downward-facing triangle at the Chemistry button and click **Edit…**. Alternatively, click directly on the method name below the Chemistry button. This opens the **EDIT CHEMICAL CLASSIFICATION** dialog (Fig. 22).

If it has not been done already, an existing method can be loaded using the Load button as well as a description of the method can also be added in the **Description** field.

Using the Apply button all changes can be applied to edit a loaded preset method.

Using the Save button the edited/ created chemical classification method can be saved.

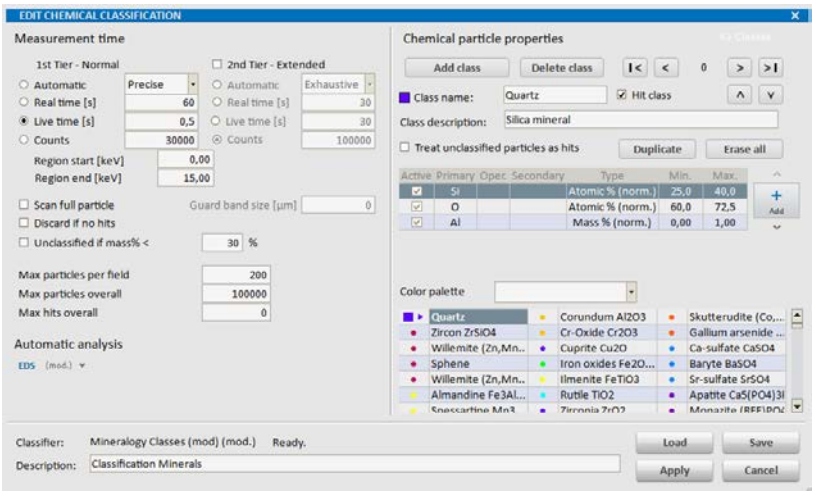


Fig. 22 Edit chemical classification dialog

4.3 Chemical Class Properties

The chemical particle properties are shown in the right side of the **EDIT CHEMICAL CLASSIFICATION** dialog.

To create a chemical class, click Add class, which will create either the first class (class 0), if no classes are present or the last class, if classes are already present.

The current class number is shown inbetween the forward > >I and backward buttons I< < and next to the Delete class button. Above this the number of classes in this chemical class file is displayed. Each class can be given a name, a description and a color. The color can be assigned by clicking on the color next to **Class name**.

Below the **Class Description** field the Duplicate button allows a class to be duplicated.

Above the **Class Description** field are the priority buttons ^ v for the position or ranking of the classes. This ranking will give the importance of a class, as a particle may fall into more classes than only one. The priority of a class will determine which class a particle will become, if it can fit into more than one class. The other classes it falls into will also be retained.

On the left of the priority buttons the **Hit class** option checkbox is placed. A hit class is a chemical classification that is of interest, whereas a non-hit class may not be of importance. This can be set by a tick into the **Hit class** checkbox. The color of the class is shown left of the class name. This will be the color of the particles after chemical classification (if the option **Chem. class** is selected in the **Display** dialog of the feature analysis method, see Fig. 20).

Treat unclassified particles as hits is the option to make unclassified particles as hits. This will ensure that a particle falling outside of the classification is part of the hit list, and is brought to the operator's attention.

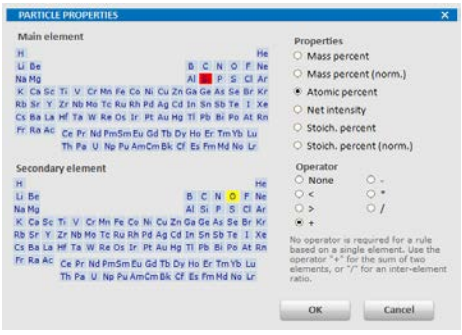


Fig. 23 Class rules dialog

Class rules are the rules that determine a classification. For a class to be useful, at least one rule needs to exist.

Click on + Add to add a new rule. This opens the **PARTICLE PROPERTIES** dialog. It can be as simple as a single element with a mass percent between 0 and 100%, or can have an operator to compare to another element (Fig. 23).

All rules are given in the list in the middle of the **Chemical particle properties** panel (Fig. 22). Rules

can be added (Add), changed (Change) or deleted (Delete) to get to desired filtering of elements until a class performs as desired.

4.4 Measurement Time Settings

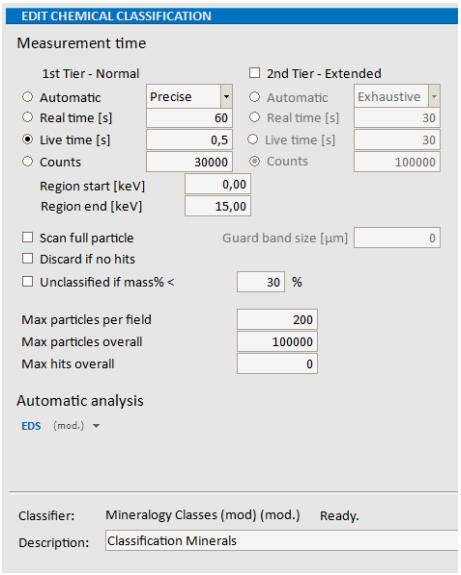


Fig. 24 Measurement time panel as part of the EDIT CHEMICAL CLASSIFICATION dialog

The **Measurement time** panel (Fig. 24) is shown in the left side of the **EDIT CHEMICAL CLASSIFICATION** dialog.

If all features found by the binarization should be measured with same spectral statistics, leave the **2nd Tier-Extended** tickbox unselected. Then the spectrum measurement settings under **1st Tier – Normal** apply.

It is possible to perform a "survey" measurement of the found particles and perform an additional measurement of certain particles with better spectrum statistics (**2nd Tier – Extended**). In this case check the **2nd Tier – Extended** tickbox and specify the spectrum measurement settings below.

A second measurement of an identified particle will be performed, if the found particle based on its quantification is classified as **Hit class**. This function can be activated before performing the measurement by ticking the **Hit class** checkbox in the **EDIT CHEMICAL CLASSIFICATION** dialog.

4.5 Quantitative Analysis Settings

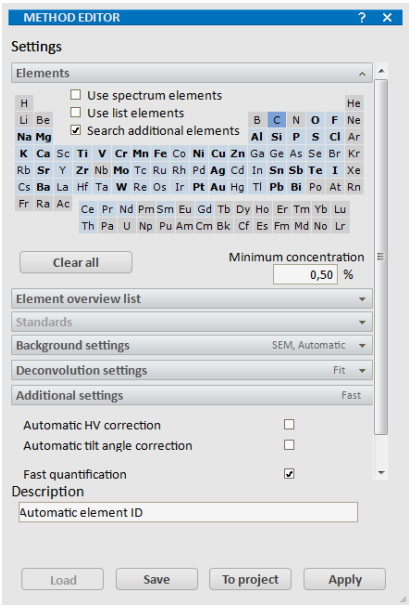


Fig. 25 Fast quantification option in the Method Editor

The method for quantification is set in the **Automatic analysis** panel of the **EDIT CHEMICAL CLASSIFICATION** dialog (Fig. 24).

It will also contribute to the chemical classification results. The method should be an automatic method for quickest analysis. An interactive method would be extremely slow and require a large amount of interaction per frame.

Via the gray triangle next to the quantification method name the METHOD EDITOR can be opened, where the **Fast quantification** checkbox is located in the Addional settings subsection. Activating this option enables a fast quantification method which takes a few short-cuts to save time at the cost of quantification accuracy.

5 Automatic Particle Analysis

Automation of the feature analysis and chemical classification can be performed at a number of desired points or over an area or line using Jobs. For this it is required that the StageControl and Jobs option is also present. The automation is performed by setting up a feature analysis job, and selecting a previously defined feature analysis and chemical classification method. This then allows the measurement of the sample and finally the creation of the particle list and result summary.

There are two ways to create a Feature Job. One way is to use the IMPORT/EXPORT icon  in the top right corner of the Feature workspace – using **Add to job** allows all settings to be saved into the job list at the current position.

Alternatively a job can be created from scratch. For details please refer to the Jobs User Manual.

6 Measurement Review

For a complete online or offline analysis of the measurement, the particle data can be opened from from IMPORT-EXPORT menu in the feature workspace.

For offline review, the particles can be completely reclassified with or without quantification as all the spectra are saved together with the particle list. All particles and their morphological data are also included. The review functionality under **Particle Search** can be used online or offline, with exception of driving live back to fields and features.

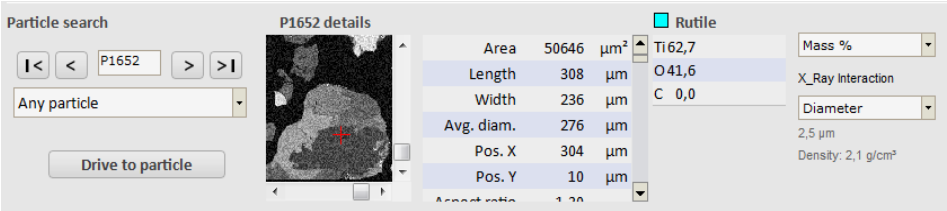


Fig. 26 Offline review

Once the data is loaded, the particles can be reviewed in offline mode, until a particle of interest is found. If the particle has to be driven back to, it is important that the particle is selected in the **Particle Search**. In online mode the Drive to particle button can be pressed, which will drive the stage to that particle.

During this review, the particle image and list will be updated under the **Particle** tab (see section 2.1) and the current particle highlighted. Simultaneously, the spectrum and quantified results for each will also be selected under the **Spectrum** tab (see section 2.3).

The **Histogram** and **Chart** tabs (see section 2.4 and 2.5) will display either the current field or the statistics of all fields, depending on the selection under the Options button.

The **Particle Search** submenu is a useful tool not only to drive back to particles and view frames and particles offline, but also to perform targeted searches and reclassification of particles.

For example, all unclassified particles can be reviewed by selecting the categorie **Unclassified** from the drop-down list under the Particle Search submenu. Alternatively, a particle of a chemical type can be isolated by using the drop down list.

The classified particles can be reclassified with a different chemical classification method. Simply load a new method by clicking the on the Reclassify button and click the Reclassify button. Alternatively, change the current method by clicking directly on the method name, adjust the method class rules. Afterwards click the Reclassify button.

If the new or changed chemical classification method has a different or edited quantification method, the tickbox **New Quant** must be checked. To do so open the drop-down menu by clicking the on the Reclassify button. It will take longer as it will need to re-quantify all spectra before re-classifying the particles.

7 Quick Measurement Workflow

To perform a measurement, follow the steps below.

	Step	Explanation/ Hints
1	Capture a BSE image of your particle sample.	
2	Drag the image into the **Particle** tab on the right side of the workspace.	*See section 2.1.*
3	Click on the Sizing button to set up or edit a feature analysis method and click **Edit…**.	*Alternatively, click directly on the method name below the Sizing button.*
4	After editing, click the Sizing button.	*All desired particles will be detected and analyzed for morphological parameters. The morphological parameters are listed under the **Result** tab and the **Chart** tab.*
5	After sizing is completed, click on the Chemistry button to load or edit an existing method for chemical classification and click **Edit…**.	*Alternatively, click directly on the method name below the Chemistry button.*
6	To analyze the sample, click the Chemistry button.	*All particles will be analyzed and quantified. When the chemical classification is completed, all particle spectra are listed under the **Spectrum** tab. All particles are grouped in particle classes under the **Histogram** tab and can be plotted in the **Chart** tab.*
7	Review the measurement under **Particle search**.	*See chapter 6.* *The review functionality can be used online or offline, with exception of driving the SEM stage back to fields or particles. Unclassified particles can be reviewed by selecting **Unclassified** in the drop down list in the **Particle search**. Alternatively, a particle of a certain chemical type can be isolated.*
8	To reclassify particles with a different chemical classification method, load a new method or edit the current method and click the Reclassify button.	*If the new or modified chemical classification method has a different or edited quantification method, **New Quantification** must be ticked under the Options submenu. Before the particles can be re-classified, all spectra need to be re-quantified.*

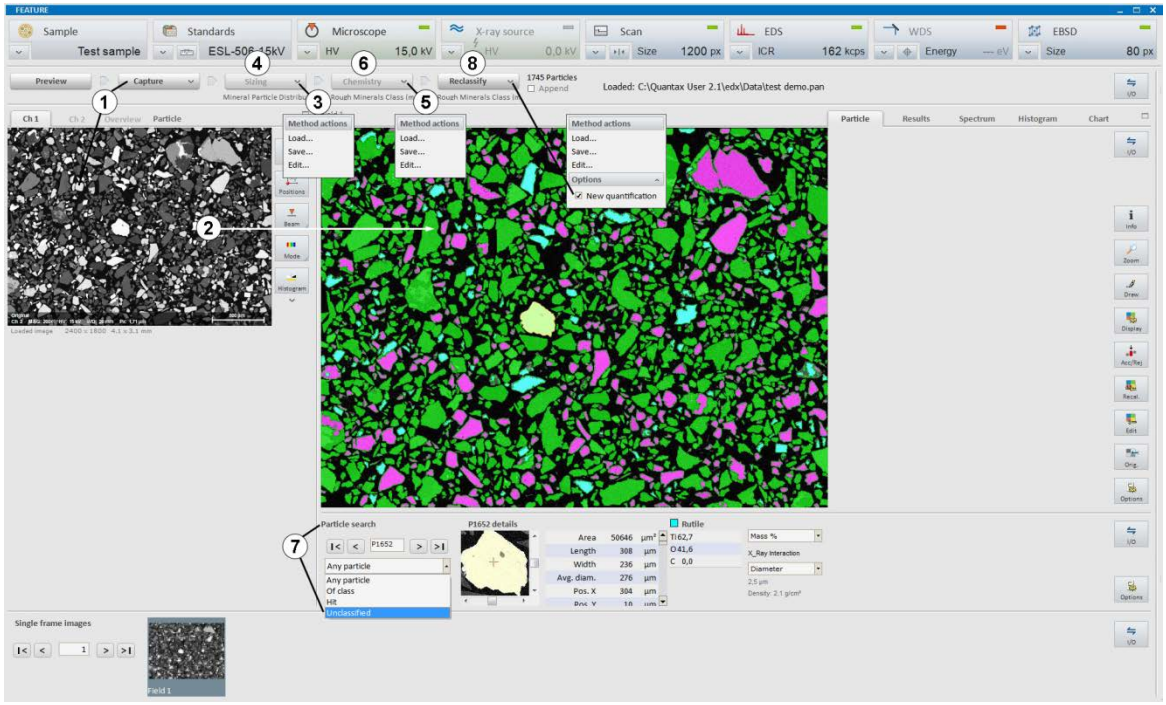


Fig. 27 Quick measurement workflow

Index