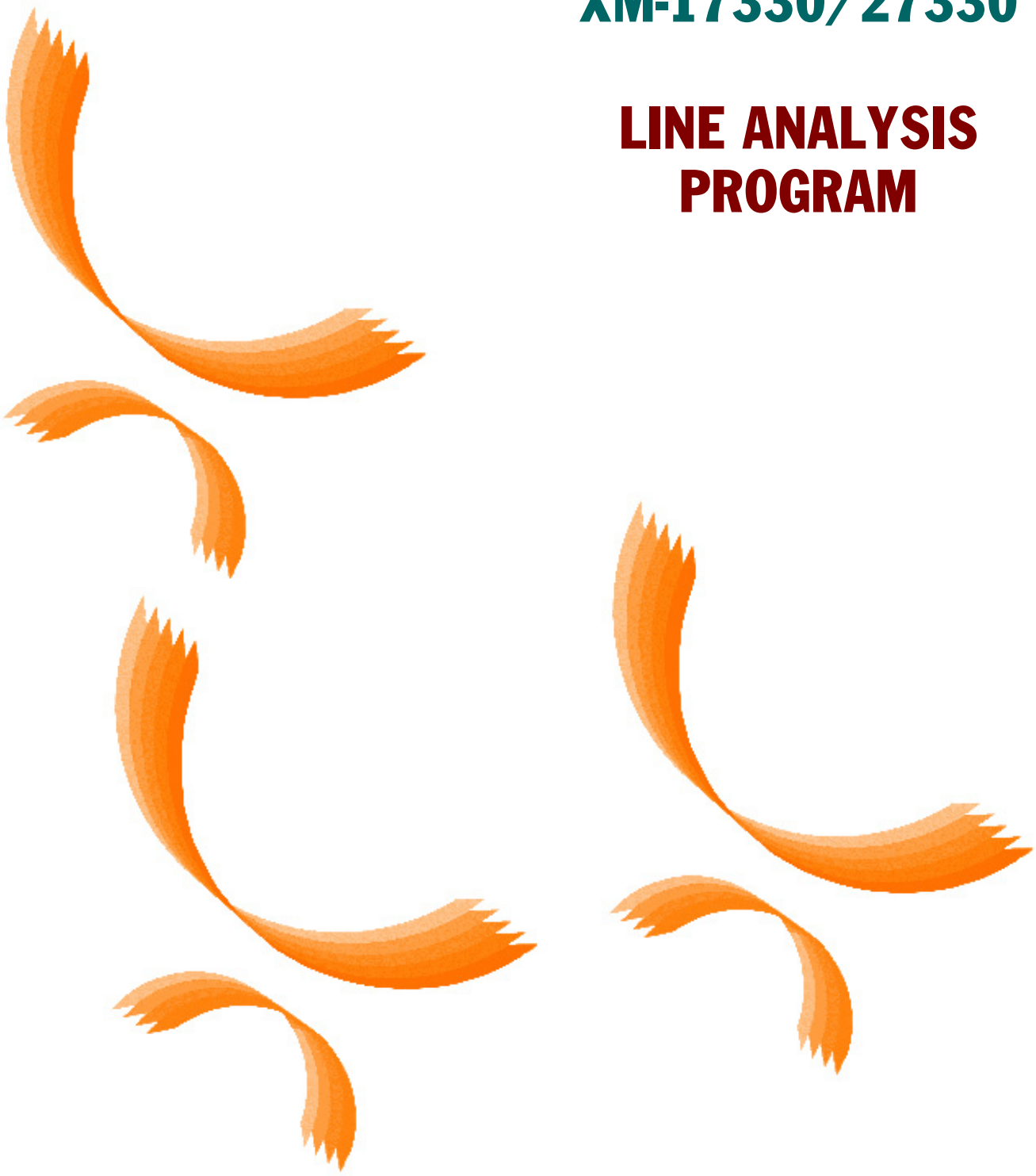
C

CONTENTS

XM-17330/27330

LINE ANALYSIS PROGRAM



IXM-17330/27330-1LN (608001)
APR2002-03210213
Printed in Japan

JEOL
Serving Advanced Technology

NOTATIONAL CONVENTIONS AND GLOSSARY

General notations

⚠ **WARNING :**	A potentially hazardous situation which, if not avoided, could result in death or serious injury.
⚠ **CAUTION :**	A potentially hazardous situation which, if not avoided, could result in minor injury or material damage. Material damage includes, but is not limited to, damage to related devices and facilities, and acquired data.
– CAUTION – :	Points where great care and attention is required when operating the device to avoid damage to the device itself.
✍ :	Additional points to be remembered regarding the operation.
☞ :	A reference to another section, chapter or manual.
1, **2**, **3** :	Numbers indicate a series of operations that achieve a task.
◆ :	A diamond indicates a single operation that achieves a task.
File:	The names of menus, or commands displayed on the screen, and those of buttons of the instrument, are denoted with **bold** letters.
File–Exit :	A command to be executed from a pulldown menu is denoted by linking the menu name and the command name with a dash (–). For example, **File–Exit** means to execute the **Exit** command by selecting it from the **File** menu.

Mouse operation

Mouse pointer:	An arrow-shaped mark displayed on the screen, which moves with the movement of the mouse. It is used to specify a menu item, command, parameter value, and other items. Its shape changes according to the situation.
Click:	To press and release the left mouse button.
Right-click:	To press and release the right mouse button.
Double-click:	To press and release the left mouse button twice quickly.
Drag:	To hold down the left mouse button while moving the mouse.

CONTENTS

1 GENERAL

This program executes line analysis by acquiring signals from wavelength dispersive X-ray spectrometers (WDS) or an energy dispersive X-ray spectrometer (EDS), while scanning either the sample stage or the electron beam.

Up to 30 spectra can be acquired in a single measurement. And up to eight of the spectra being acquired can be displayed on a monitor. Various functions are available for measured spectra, including processing such as zooming in or out, and operations such as smoothing.

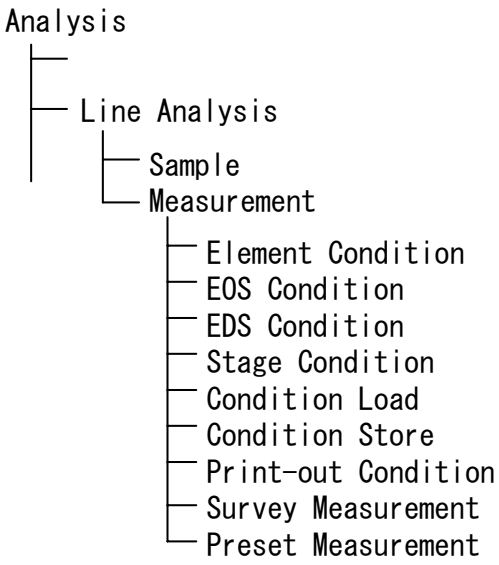
2 SPECIFICATIONS

Spectrum measurable:	Up to 30 spectra
Number of measurement points per spectrum:	10 to 10,000
Measurement step interval	
Line analysis by stage scan:	0.5 to 1,000 μm (down to 0.02 μm with micro step stage driver)
Line analysis by beam scan:	Automatically determined from magnification and the number of measurement points
X-ray counting time:	1 to 10,000 ms per step
Number of measurement preset points per sample:	1 to 10,000
Number of accumulations:	1 to 50
Realtime display during measurement:	Possible
Spectrum display functions:	Display of up to 8 spectra X-ray intensity display Mass concentration display Spectrum expansion and reduction
Selectable forms of spectrum display (Vector, Dot and Bar)	
	Spectrum and background color (selectable from 8 colors each) Multiple display areas
Spectrum calculations:	Dead-time correction Smoothing Background removal Arithmetic involving constants Arithmetic involving two spectra

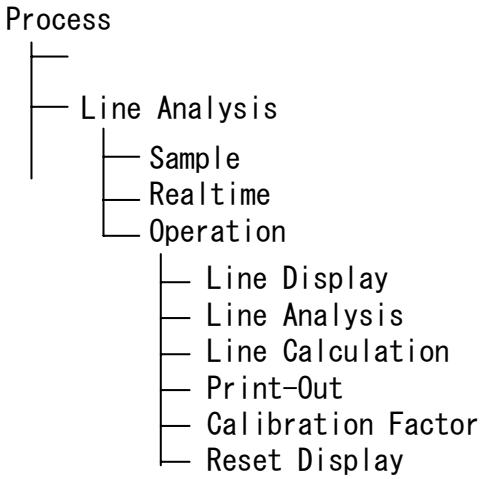
C

3 PROGRAM STRUCTURE

■ Measurement



■ Processing



4 OPERATION

This chapter describes the procedure for line analysis.

4.1 Preparation for Measurement

The following procedure opens the Line Analysis function window.

1. Open the EPMA Main Menu on the computer display and then click on the **Analysis** icon to display the **Analysis** menu.

☞ Refer to the instruction manual of the microanalyzer main unit to learn how to open the EPMA Main Menu.

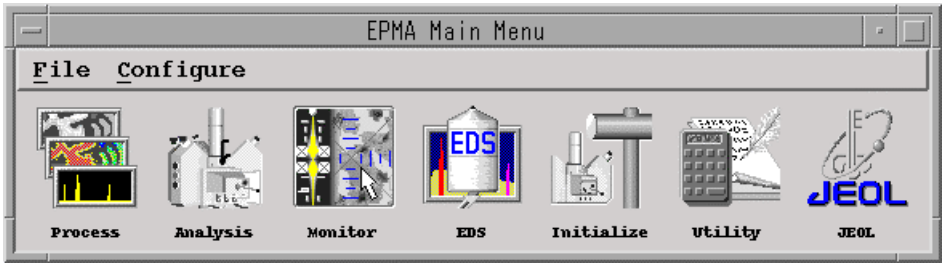


Fig. 1 EPMA Main Menu

2. Select **Line Analysis** from the **Analysis** menu.

The Line Analysis function window opens. Proceed to the following sections.

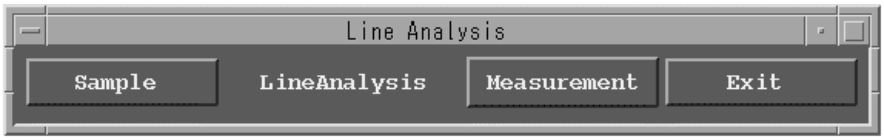


Fig. 2 Line Analysis function window

4.1.1 Setting group and sample names

◆ Select **Sample** from the Line Analysis function window.

The Select Sample window opens as shown in Fig. 3.

Using this window, you can select or record group and sample names. Specify group and sample names before setting measurement conditions.

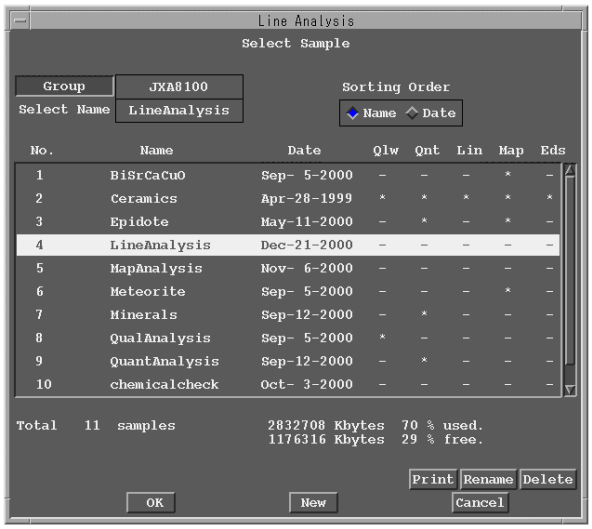


Fig. 3 Select Sample window

■ Recording, deleting, renaming, and printing sample names

To record a new sample name, click on the **New** button.

To select a presently recorded sample name, click on the line of the sample name; then it will be highlighted. You can delete, rename, or print a sample name by clicking on the corresponding button in the Select Sample window of Fig. 3.

Button	Function
New	After clicking on the **New** button, you can enter new sample names. The maximum length is 14 characters.
Print	Click on the **Print** button in the Select Sample window to print the list of sample names.
Rename	After clicking on the **Rename** button, you can enter new sample names.
Delete	To delete the sample names that have just been recorded, specify them in the window and click on the **Delete** button. To delete the sample names that have already been used for measurement, select **Utility–File Utility** from the EPMA Main Menu. If you use the **Delete** button to delete the sample names already used for measurement, all their corresponding data will be deleted.
OK	Clicking on this button finalizes the selection of the highlighted sample name, and closes the window.

Sorting sample names

You can sort sample names by clicking on the **Name** or **Date** button under **Sorting Order** in the Select Sample window of Fig. 3.

Button	Function
Name	Selecting **Name** for **Sorting Order** rearranges the sample names in alphabetical order.
Date	Selecting **Date** for **Sorting Order** rearranges the sample names in chronological order.

Recording, deleting, renaming, and printing group names

◆ Click on the **Group** button in the Select Sample window.

The Select Group window opens as shown in Fig. 4.

The operations for group names are the same as for sample names.

Fig. 4 Select Group window

4.2 Measurement

◆ Select **Measurement** from the Line Analysis function window.

The Measurement menu for Line Analysis opens as shown in Fig. 5.

You can execute the operations described below by selecting the items from the menu.

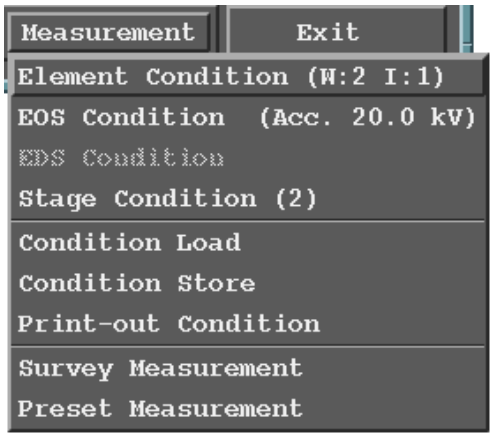


Fig. 5 Measurement menu for Line Analysis

4.2.1 Element Condition

◆ Select **Element Condition** from the Measurement menu for Line Analysis.

The Element Condition window opens as shown in Fig. 6. In this window you can record the elements that you want to measure and their measurement conditions for spectrometers and detectors of **WDS**, **EDS** (for JXA-8200), and **IMS**.

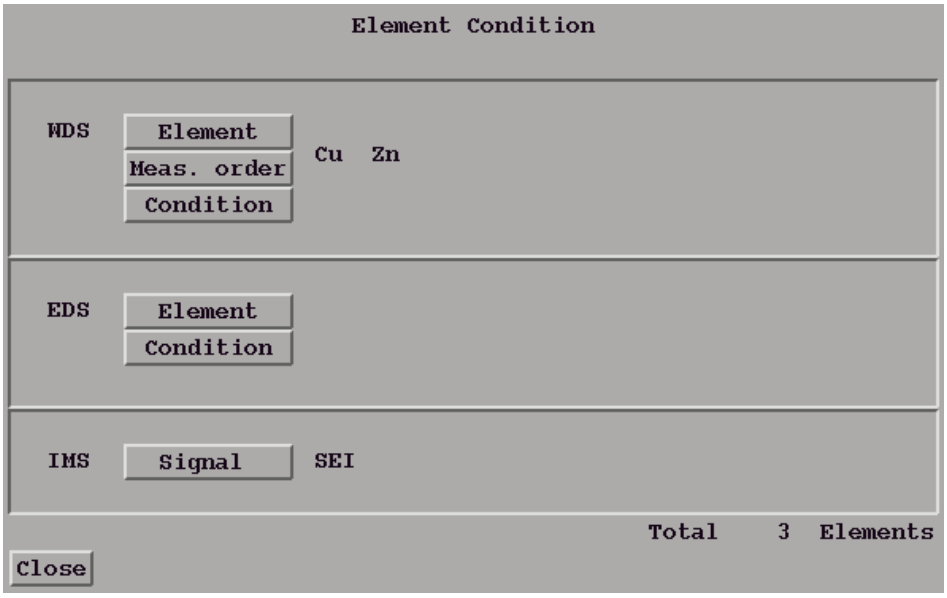


Fig. 6 Element Condition window

Recording and deleting elements to be measured

You can record up to 30 elements in total for **WDS**, **EDS** and **IMS**.

A single element may be recorded more than once. If, for example, the same element is recorded twice, the program treats it as two elements.

How to record elements

This example explains how to record a WDS element.

1. Select **WDS**–**Element** in the Element Condition window.
   The WDS Elements window opens as shown in Fig. 7.

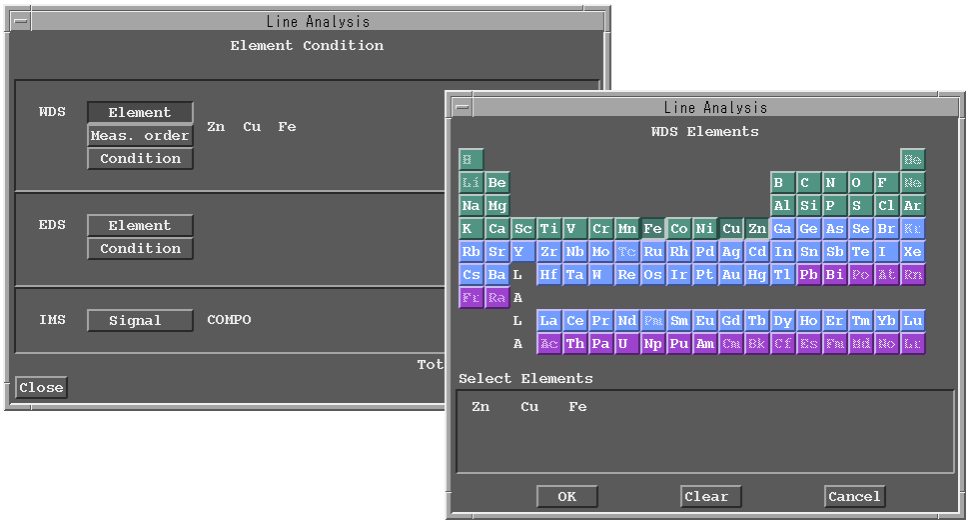


Fig. 7 WDS Elements window

2. Click on the element labels that you want to record in the WDS Elements window.
   The specified elements will be highlighted, and also shown in the Select Elements box.
3. Click on the **OK** button.

How to delete elements previously recorded

This example explains how to delete a WDS element.

1. Select **WDS**–**Element** in the Element Condition window.
   The WDS Elements window opens as shown in Fig. 7.
2. Click on the element labels that you want to delete in the WDS Elements window.
   The specified elements will be highlighted, and also shown in the Select Elements box.
3. Click on the **Clear** button.

Setting measurement order

You select a channel to use and the measurement order for each element. If you make the selection so that measurements are not concentrated in any one specific channel, you can shorten the total measurement time.

◆ Select **WDS–Meas. order** from the Element Condition window.
The Measurement order window opens.

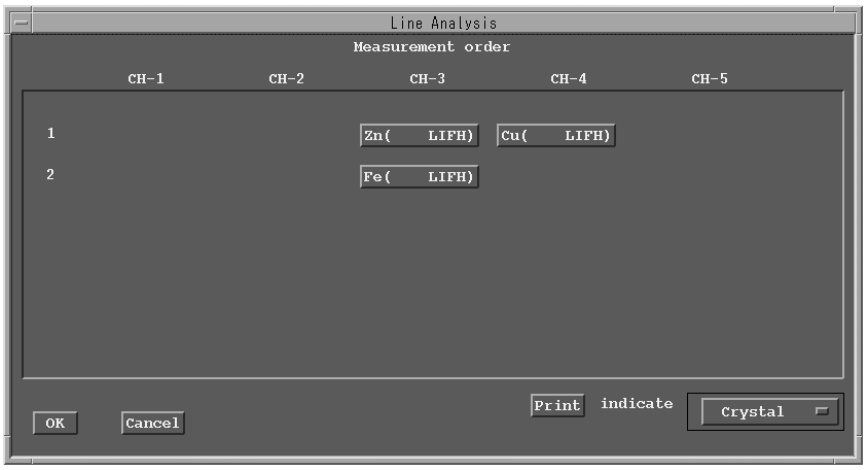


Fig. 8 Measurement order window

Drag an element label using the mouse to set the measurement order. Dragging up and down changes the measurement order and dragging left and right changes the channel number. If the measured X-rays are out of range of spectrometric analysis, the mouse cursor turns to an X and you cannot select the channel for analyzing the X-rays.

Ordinarily, element name and X-ray analyzing crystal name are displayed in the element label. By selecting **Peak Pos.** for **Indicate** in the Measurement order window, it is possible to display wavelength instead of the crystal name. Doing this allows you to arrange elements in wavelength order. However, since you cannot change X-rays and analyzing crystals in this window, change them using the WDS Element Condition window (described later) and set the measurement order there.

Setting measurement conditions for WDS elements

◆ Select **WDS–Condition** from the Element Condition window (refer to Fig. 6).

The WDS Element Condition window opens as shown in Fig. 9. Here you can change measurement conditions for WDS elements.

✍ The eight items from **Back (+) (mm)** to **Bac. Count** are used only for quantitative analysis and standard-sample analysis. They are not used for line analysis.

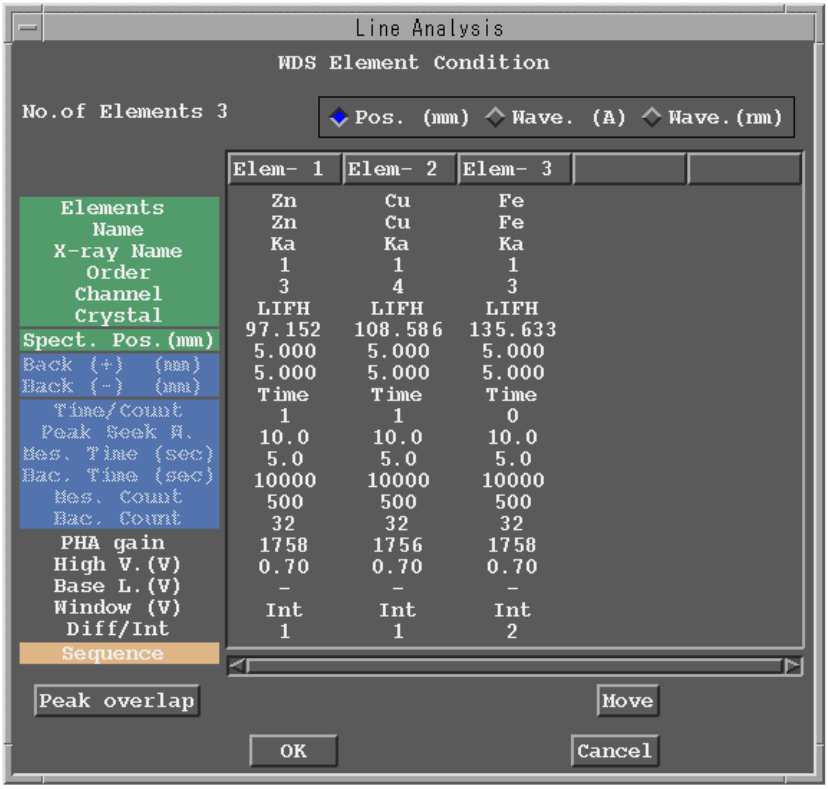


Fig. 9 WDS Element Condition window

Set the measurement conditions according to the procedure below.

1. Click on the **Elem-n** button for the conditions that you want to change.

The WDS Element Data Table window opens as shown in Fig. 10.

✍ The number "**n**" in **Elem-n** indicates the condition number such as 1, 2, 3,...

2. Click on the item you want to change, and then change its setting.

The highlighted **Select No.** in this table shows the WDS Element Condition of the selected **Elem-n**.

✍ Up to 20 measurement conditions can be created for each element. These conditions are used in common for quantitative analysis, map analysis and other analyses.

✍ To create a new **WDS Element Data Table**, use the **New** button.
To copy an existing table, use the **Copy** button.
To re-sequence conditions, use the **Exchange** button.
To erase conditions, use the **Delete** button.

✍ If you want to set the specified channel to the specified conditions, click on the **Set** button.

If you want to read the present instrument conditions into the **WDS Element Data Table** in the column whose **Select No.** is highlighted, click on the **Read** button.

3. Click on the **OK** button.

The WDS Element Data Table window disappears, and the conditions selected for **Select No.** will be read into the Element Condition window.

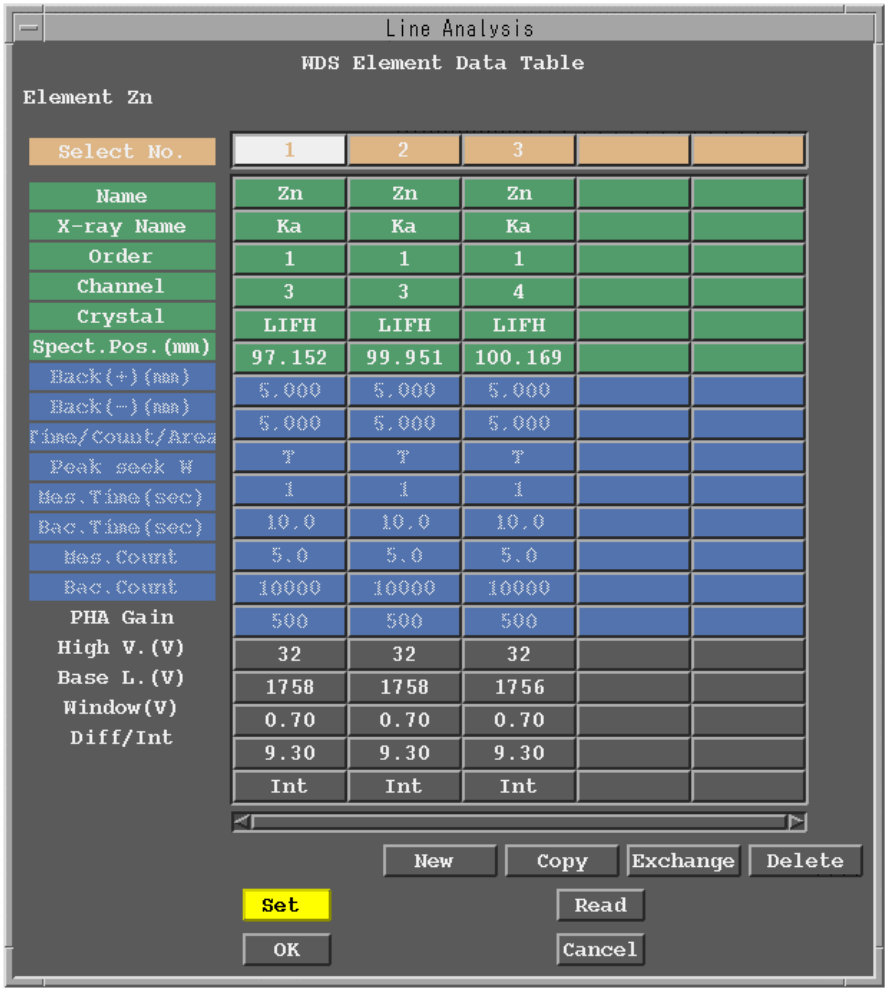


Fig. 10 WDS Element Data Table window

Setting measurement conditions for EDS elements

◆ Select **EDS–Condition** in the Element Condition window (refer to Fig. 6).

The WDS Element Condition window opens as shown in Fig. 11. Here you can change measurement conditions for EDS elements.

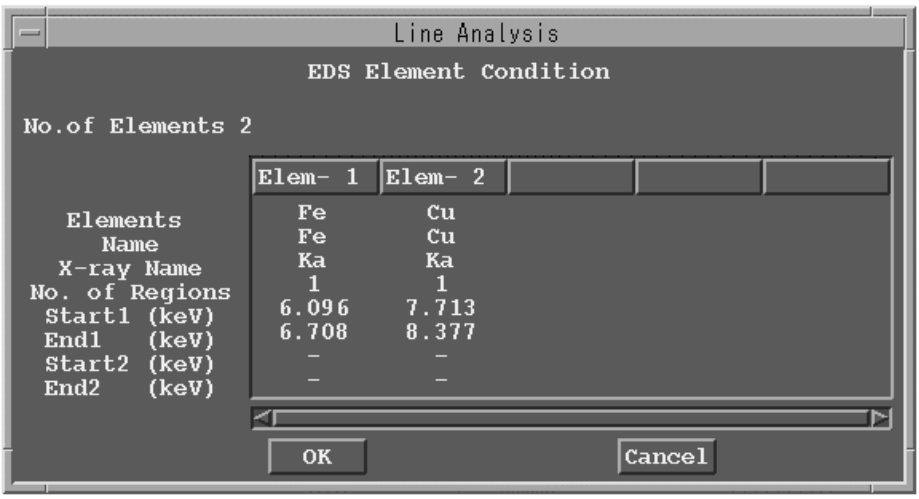


Fig. 11 EDS Element Condition window

EDS measurement sequences are automatically set for the elements in the order in which they are recorded, each for eight elements: the first eight elements are measured in the first sequence, the ninth to sixteenth elements in the second sequence, and so on.

Concerning a ROI (Region of Interest), which is an energy measurement range, you can determine it by specifying both **Start 1 (keV)** and **End 1 (keV)**, and then the default values for line analysis are automatically displayed as for map analysis in the EDS Element Data Table window.

When specifying EDS measurement conditions, note the following.

- If two characteristic X-ray peak positions are so close that their ROIs may overlap each other, first record the element in the Element Condition window of Fig. 6, then click on the **EDS–Condition** button to open the EDS Element Condition window of Fig. 11. Here, the program automatically calculates their ROIs so that they will not overlap and displays them. Then, click on the **Elem-n** button and the EDS Element Data Table window will appear. The displayed ROI values in this window may not be identical to those in the EDS Element Condition window, but this is not a problem.
- To change the ROI, directly type numbers in **Start 1 (keV)** and **End 1 (keV)** in the EDS Element Data Table window. Alternatively, display an EDS spectrum and set up a ROI on the spectrum, then click on the **Read** button in the EDS Element Data Table window. At this time, the **ROI** number in the EDS Element Data Table window must be the same as the **Element** number (**Elem-n**) shown in the EDS Element Condition window.

  If you want to restore the defaults after you have changed the values of **Start 1 (keV)** and **End 1 (keV)**, display an X-ray name listing by clicking on the **X-ray Name** button in the EDS Element Data Table window. Here, click on the X-ray

name of interest; then the default values will be displayed at **Start 1 (keV)** and **End 1 (keV)**.

- Usually, you set a ROI at one point for each element. However, you can set it at two points that are apart from each other (for example, Kα line and Lα line). To do so, set **No. of Regions** in the EDS Element Data Table window to **2** and enter values at **Start 2 (keV)** and **End 2 (keV)**. Then click on the **Set** button. The presently selected ROIs (shown at **Select No.**) will be set up in the EDS screen. Moreover, it is possible to record multiple sets of conditions for **Select No.** in the EDS Element Data Table window, and to use one of them by selecting it. The operation for this method is the same as that for the WDS measurement.

Setting measurement conditions for IMS signals

1. Select **IMS–Signal** in the Element Condition window (refer to Fig. 6).
The Image Signal window opens as shown in Fig. 12.

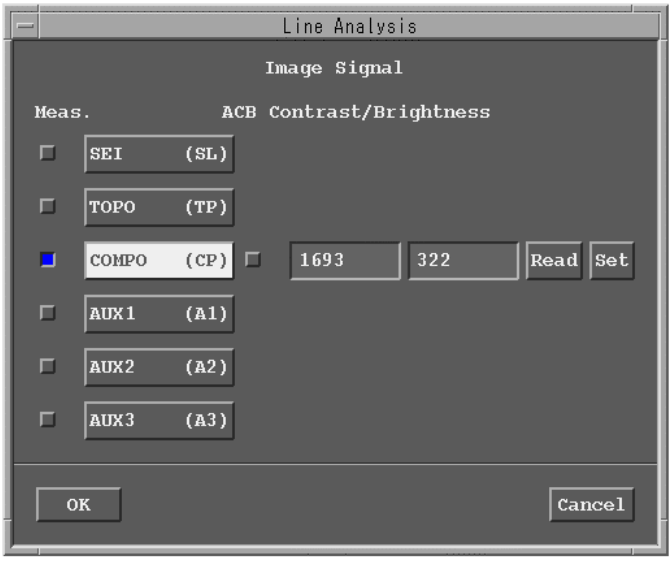


Fig. 12 Image Signal window

2. Click on the desired image signal measurement (**Meas.**) buttons.
The selected image signals will be measured. In the example of Fig. 12, **COMPO** is selected.

3. Then you can use the **Read** and **Set** buttons for **ACB Contrast/Brightness**.
If you select **ACB Contrast/Brightness** before Step 2, its setting will be executed before measurement after any image signal name button is selected.

If you specify multiple image signals, for example, the **SEI** and **TOPO** signals, then the data of the SEI signal will be acquired in the first sequence and the TOPO signal in the second sequence.

The signal shown under the dashed line in the Image Signal window (**COMPO** signal) is available if the optional Second ISD is installed. This selection permits you to acquire two types of image signal data in the first sequence.

4.2.2 EOS Condition

Using the EOS Condition window, you can set the conditions of the electron optical system (EOS). Clicking on the **Read** button reads the present EOS conditions and displays them on the EOS Condition window in which you can input and alter items such as Probe Scan. When **Scan Type–Beam** is selected, **Magnification**, **Probe Scan** and **Scan Mode** are controlled automatically.

◆ Select **Measurement–EOS Condition** in the Line Analysis function window.

The EOS Condition window opens as shown in Fig. 13.

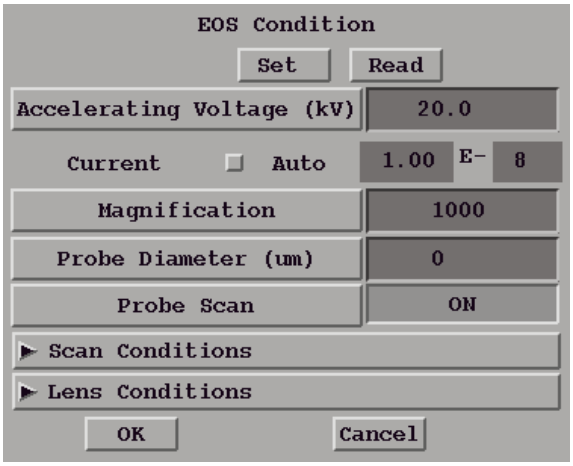


Fig. 13 EOS Condition window

The EOS Condition window has the following objects.

Object	Function
Set	Sets the EOS to the presently displayed measurement conditions.
Read	Reads the present EOS conditions, and displays them in the EOS Condition window.
Accelerating Voltage	Sets the accelerating voltage (in kV).
Current	Displays the beam current. Click on the **Auto** button to specify the current; the specified current will be set automatically before measuring, and the automatic current-setting mode will be applied.
Magnification	Sets the scan magnification for **Scan Type–Stage**. This function is in effect only when **Probe Scan** is **ON**. When you perform measurement at a very low magnification, the WDS elements will be out of the X-ray collecting conditions, and you cannot obtain good results.
Probe Diameter	Sets the probe diameter (in μm) for measurement. This function is in effect only when **Probe Scan** is **OFF**.
Probe Scan	Turns **Probe Scan** on or off for measurement.

Object	Function
Scan Conditions	Clicking on the arrowhead of this button opens a pop-up menu, in which you can set the four items below. You can set **Scan Mode**, **Scan Speed** and **Auto Focus** only when **Probe Scan** is **ON.** However, you can set **Stabilizer** even if **Probe Scan** is **OFF**.
Scan Mode	Specifies the scan mode for measurement. The choices are **Picture**, **Bup**, **Line**, **Spot** and **Area**.
Scan Speed	Selects the scan speed for measurement from S1 to S12. The larger the number is, the slower the speed is.
Auto Focus	Select automatic focusing (**Auto Focus**) or manual focusing (**Manual Focus**) before measurement.
Stabilizer	Specify whether to use the beam stabilizer (select from **CL & Tilt**, **CL**, and **Tilt**) or not (**Off**).
Lens Conditions	Clicking on the arrowhead of this button opens a pop-up menu for the following two items.
Condenser Lens	Sets the Condenser Lens to Coarse or Fine for measurement.
Object Lens	Sets the value of the Objective Lens for measurement.
OK	Finalizes the input EOS conditions, and closes the EOS Condition window.
Cancel	Cancels the input EOS conditions, and closes the EOS Condition window.

4.2.3 EDS Condition for JXA-8200

With the JXA-8200 Series EPMA, when you specify the EDS as the spectrometer, you need to set the measurement conditions for the EDS.

◆ Select **Measurement**–**EDS Condition** in the Line Analysis function window.
The EDS Condition window opens as shown in Fig. 14.

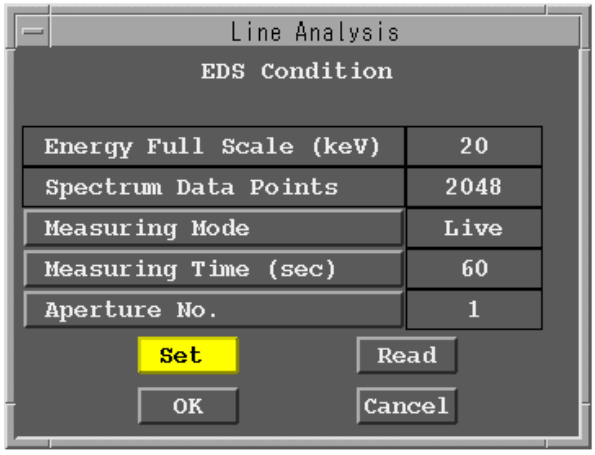


Fig. 14 EDS Condition window

The following items are for controlling the EDS detector.

Button	Function
Energy Full Scale	Is set to 20 kV.
Spectrum Data Points	Is set to 2 K channels.
Measuring Mode	Is not used for the Line Analysis.
Measuring Time	Is not used for the Line Analysis.
Aperture No.	Selects the aperture number from 0 to 5. The value 0 is for open. The larger the number, the smaller the aperture diameter. The value 6 is for closed, and so it cannot be used for measurement.

To select an aperture number, first set the beam current, and then select the appropriate aperture number so that the Dead Time becomes 20 to 30%, while actually collecting EDS spectra.

Clicking on the **Set** button sets the EDS to the EDS spectrum-collection conditions that are presently displayed in the EDS Condition window.

Clicking on the **Read** button reads the EDS spectrum collection conditions that are presently set and displays them in the EDS Condition window.
Note that you can use the **Set** and **Read** buttons only when the EDS Home Window is on the screen.

4.2.4 Stage Condition

Using the Stage Condition window, you can specify analysis areas before measurement. If the analysis areas have been recorded, they are shown when this window opens.

1. Select **Measurement–Stage Condition** in the Line Analysis function window.
The Stage Condition (Line) window opens as shown in Fig. 15.

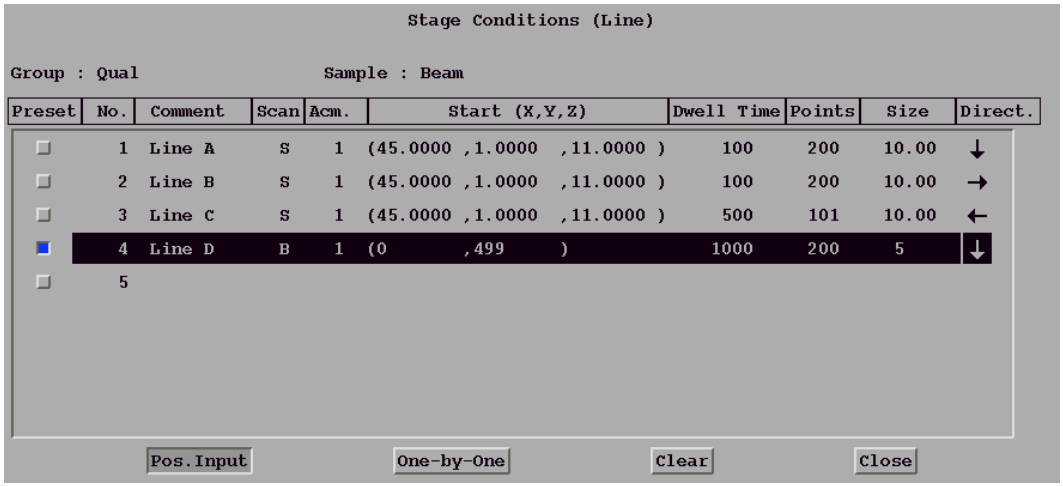


Fig. 15 Stage Conditions (Line) window

2. Click on any analysis position number in the Stage Conditions (Line) window.
The line for that position number will be highlighted.

3. Click on the **Pos. Input** button of the Stage Conditions (Line) window.

The Line Input/Analysis area Working window opens as shown in Fig. 16.

In this window, specify the analysis position for that point by entering data necessary for the items described on the following pages. Clicking on the arrowhead buttons ▲,▼ at the lower right corner of the Line Input window moves up or down by one the line of the analysis point number shown in Fig. 15.

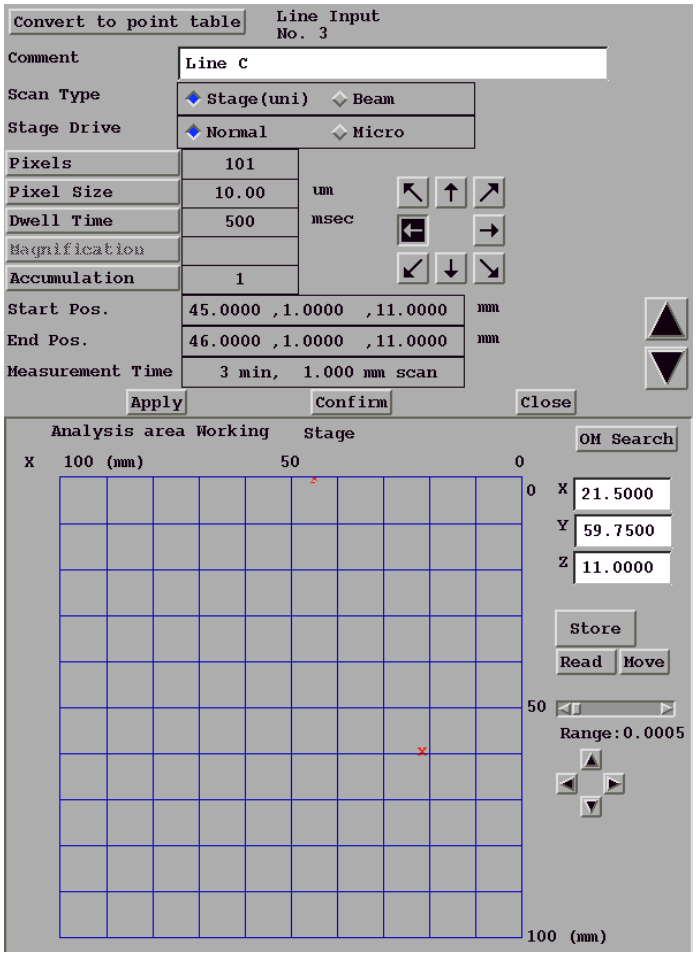


Fig. 16 Line Input/Analysis area Working window

4. Execute the following operations to set conditions.

■ Specifying analysis area in stage scan mode

When specifying an analysis area for stage-scan analysis, set **Scan Type** to **Stage (uni)** in the Line Input/Analysis area Working window of Fig. 16.

There are the following three methods to specify the analysis area.

- Specifying the start point and end point
- Specifying the start point and direction
- Specifying the center point and direction

These methods are separately described below.

Specifying the start point and end point

The start and end points can be set on the Analysis area Working display in the lower half of the window, using one of the following four methods:

- Enter the X, Y and Z positions of the stage by using the keyboard.
- Determine the stage position, using the Joystick Controller of the EPMA basic unit, and then click on the **Read** button.
- Click the mouse button on the desired position in the two-dimensional display area of the Analysis area Working display. Move the stage by clicking on the **Move** button, and then click on the **Read** button.
- Finely adjust the stage position by clicking on the four arrow buttons (▲, ▼, ◀, ▶) in the lower right of the window, and then click on the **Read** button.

  ✍ The distance the stage moves when you click on an arrow button is variable with the scroll bar above the arrow buttons.

1. To determine the start point of measurement, display the coordinate position in the X, Y and Z display boxes using one of the above methods and then click on the **Store** button.
   The Store menu appears.
2. Select **To Start** from the Store menu.
   The X, Y and Z coordinates of the start point will be entered in the **Start Pos.** display box.
3. Determine the end point of measurement as in Step 1 and click on the **Store** button.
   The Store menu appears.
4. Select **To End** from the Store menu.
   The X, Y and Z coordinates of the end point will be entered in the **End Pos.** display box.
5. Specify **Pixel Size** (measurement interval) in μm.

   ✍ The value at **Pixels** is automatically calculated upon specifying the number of measurement points.

Specifying the start point and direction

1. To determine the start point of measurement, display the coordinate position in the X, Y and Z display boxes using one of the above methods and then click on the **Store** button.
   The Store menu appears.
2. Select **To Start** from the Store menu.
   The X, Y and Z coordinates of the start point will be entered in the **Start Pos.** display box.
3. Determine the direction by clicking on one of the eight arrow buttons.

   ✍ Only eight directions are selectable, whereas any direction can be selected by specifying the start and end point.
4. Specify the values of **Pixel Size** and **Pixels**.
   The end point will be determined.

● Specifying the center point and direction

1. To determine the center point of measurement, display the coordinate position in the X, Y and Z display boxes using one of the above methods and then click on the **Store** button.
   The Store menu appears.
2. Select **To Center** from the Store menu.
   The X, Y and Z coordinates of the center point will be entered in the **Start Pos.** display box.
3. Determine the direction by clicking on one of the eight arrow buttons.
   ✍ Only eight directions are selectable, whereas any direction can be selected by specifying the start and end point.
4. Specify the values of **Pixel Size** and **Pixels**.
   The end point will be determined.

■ Setting Dwell Time and Accumulation

Enter **Dwell Time** in **msec**.

Enter the desired number of measurements in the **Accumulation** input box. The program will conduct measurement the number of times specified here and accumulate the results. The measurement time is displayed at **Measurement Time**.

■ Confirming analysis positions

After you have specified the measurement conditions, confirm and correct the analysis area, and finalize the specified conditions.

1. Click on the **Confirm** button to confirm the analysis positions.
   The stage moves to the start position (**Start Pos.**) and a position confirmation message appears.
2. Check the position and, if necessary, correct the Z-axis position using the Joystick Controller. Then press the **STORE** button.
   The stage moves to the end point (**End Pos.**).
3. Repeat checking and correcting the position in the same manner as Step 2, and press the **STORE** button again.
   ✍ If the Z-axis positions for the start and end points are different, the Z-axis positions between these two points are automatically corrected at measurement.
4. After making sure that the positions are correct, click on the **Apply** button to finalize the measurement conditions.
   These conditions will be displayed on the highlighted line in the Stage Condition window of Fig. 15.

If you want to specify other analysis areas in succession, click on the arrow buttons (▲, ▼) at the upper right of the window and change the analysis position number.

Specifying analysis area in beam scan mode

You can carry out line analysis measurement by scanning the electron beam without moving the stage.

1. Select **Beam** for **Scan Type** by clicking on the **Beam** button (see Fig. 17).
2. First move the stage using the Joystick Controller to determine the center of the scan, and then specify the analysis position for beam scan mode by selecting one of the eight analysis directions.
3. Set the beam analysis conditions in the same manner as in the stage scan mode.

The scan range depends on the magnification, and it can be as large as the size of the display screen.

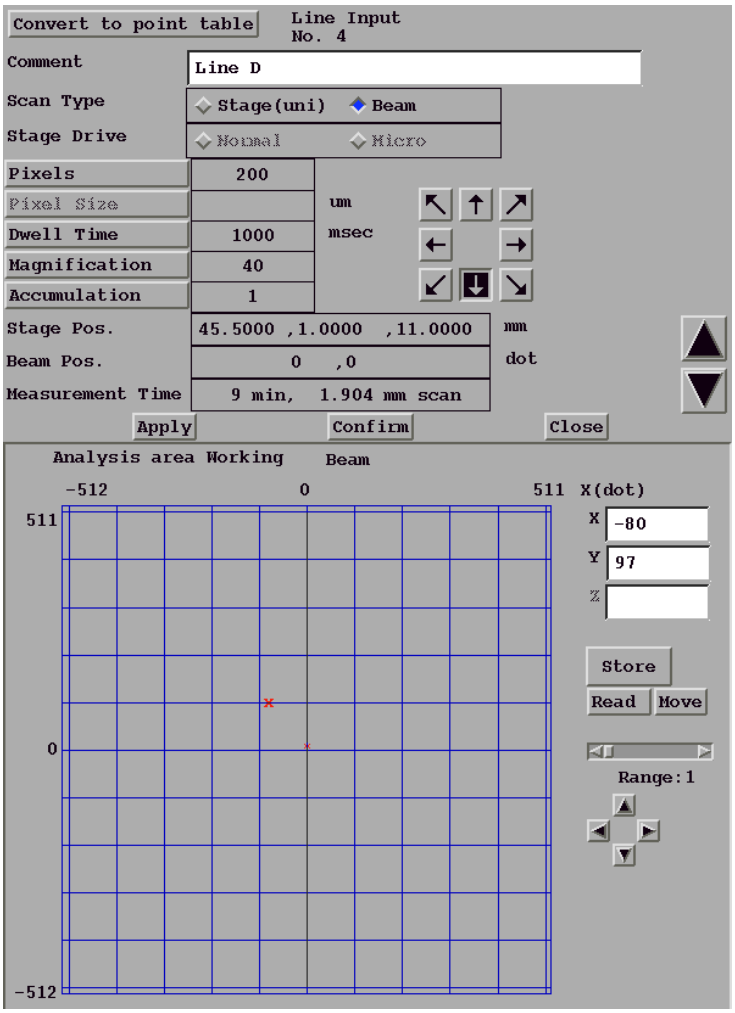


Fig. 17 Line Input/Analysis area Working (Beam) window

■ One-by-One Measurement

1. In the Stage Conditions (Line) window, click on the analysis position **No.** line you want to analyze.
   The analysis position line will be highlighted.
2. Click on the **One-by-One** button.
   The One-by-One Measurement window opens.
3. Here, check the measurement conditions, and if they are acceptable, click on the **Acquire** button.
   The program executes measurement on the analysis number in the highlighted line, as shown in Fig. 15.

4.2.5 Condition Load

Using **Condition Load**, you can load stored line analysis conditions such as **Element Condition**, **EOS Condition** and **EDS Condition**. It saves you time when setting spectrometer conditions.

1. Select **Measurement**–**Condition Load** in the Line Analysis function window.
   The Condition File Load window opens as shown in Fig. 18.

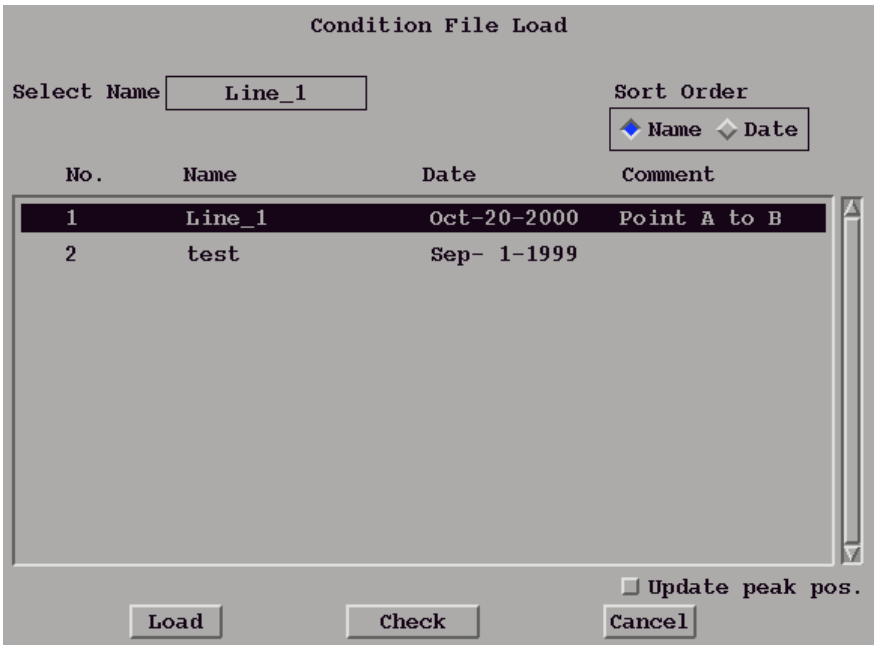


Fig. 18 Condition File Load window

2. Specify the desired number of analysis conditions and click on the **Load** button.
   The recorded measurement conditions will be loaded.
   If you click on the **Check** button before loading, the details of presently highlighted conditions will be displayed in the text window, and you can confirm them beforehand.

4.2.6 Condition Store

Using **Condition Store**, you can store in a file the line analysis conditions you have set. The items of conditions are **Element Condition**, **EOS Condition**, and **EDS Condition** (for JXA-8200).

1. Select **Measurement–Condition Store** in the Line Analysis function window.
The Condition File Store window opens as shown in Fig. 19.

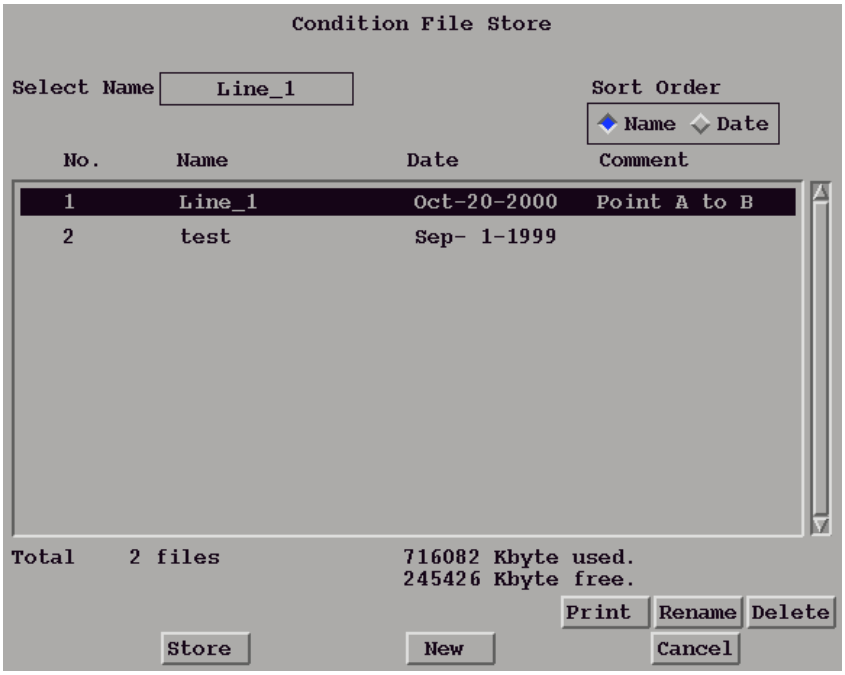


Fig. 19 Condition File Store window

2. Click on the **New** button in the Condition File Store window.
The Condition File Name window opens.

3. Enter the desired file name (up to 14 characters) and comment (up to 40 characters) in the Condition File Name window and click on the **OK** button.
The Condition File Name window disappears.

4. Click on the **Store** button in the Condition File Store window.
The analysis conditions will be stored.

4.2.7 Print-out Condition

1. Select **Measurement–Print-out Condition** in the Line Analysis function window.
   The Print-out Condition window opens as shown in Fig. 20.

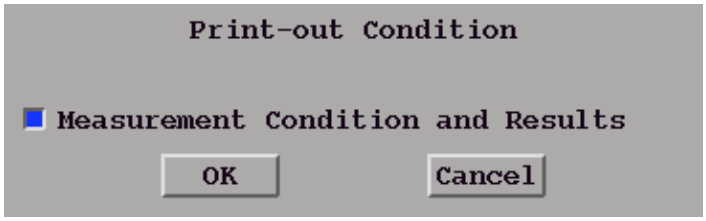


Fig. 20 Print-out Condition window

2. Click on the **Measurement Condition and Results** button in the Print-out Condition window.
3. Click on the **OK** button.
   The measurement conditions and results will be printed at the end of measurement.

4.2.8 Survey Measurement

The **Survey Measurement** mode is used to perform rough measurement prior to the main measurement. It has the advantage of reducing the time required to enter conditions.

1. Select **Measurement–Survey Measurement** in the Line Analysis function window.
   The Survey Measurement window opens.
2. Specify the condition items in the Survey Measurement window.
3. Click on the **Acquire** button in this window.
   Survey measurement will be performed at the present stage position under the present EOS conditions. The data that you obtain are always stored at the stage No. 99999 of the presently selected **Group Name** and **Sample Name**, being overwritten with every measurement.
4. If you wish to store the measurement results as your own in a file after **Survey Measurement**, click on the **Save Survey** button; then enter Position No. and Comment.

4.2.9 Preset Measurement

Using **Preset Measurement**, you can perform measurements in succession by using stored measurement conditions.

1. Select **Measurement–Preset Measurement** in the Line Analysis function window.

The Preset Measurement window opens as shown in Fig. 21.

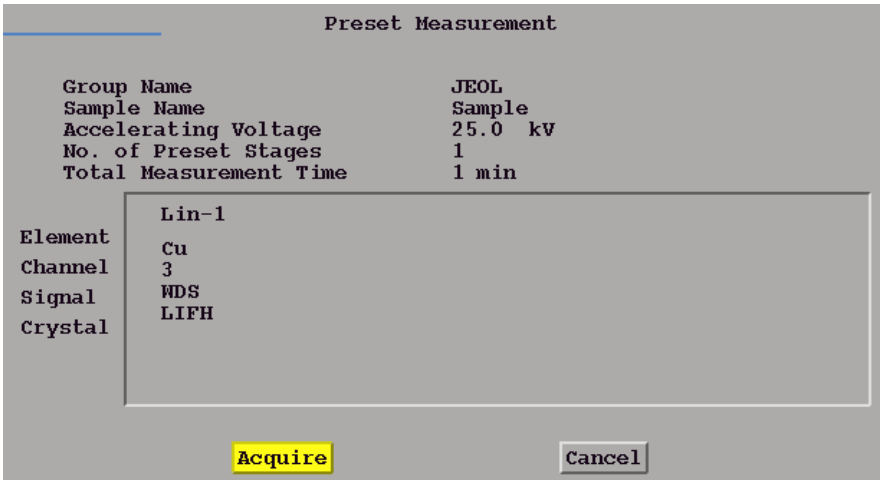


Fig. 21 Preset Measurement window

2. Click on the **Acquire** button in the Preset Measurement window.

The preset measurement conditions and the analysis positions in the list of the Stage Condition window whose **Preset** check boxes are turned on will be loaded. Then the measurement will be carried out in succession at the analysis positions, starting with the smallest number.

4.2.10 Measurement Control Window

During measurement, the Measurement Control Window in Fig. 22 will be displayed, showing the progress for the measurement being made. Clicking on the **Measurement Stop** button stops the measurement, and clicking on the **Accum. Stop** button stops the accumulation of measurements.

Fig. 22 Measurement-under-way window

4.3 Processing

The following sections describe how the measured data of line analysis is displayed and processed.

1. Click on the **Process** icon in the EPMA Main Menu.
   The Process menu opens.
2. Select **Line Analysis** from the Process menu.
   The Line Analysis function window (for processing) opens. Proceed to the following sections.

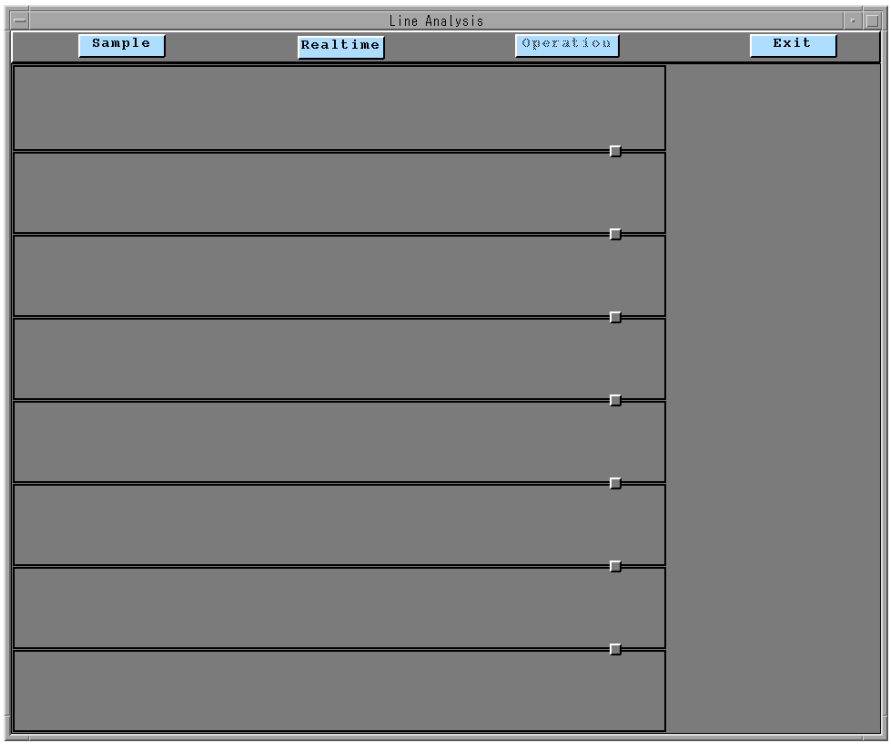


Fig. 23 Line Analysis function window (for processing)

4.3.1 Selecting group and sample names and displaying spectra

1. Click on the **Sample** button in the Function window shown in Fig. 23.
   The Sample window appears as shown in Fig. 24.
   Here, you can work on the **Sample**, **Stage Position**, and **X-Ray Spectra**, in this order.
2. Specify the sample name to be displayed and processed, the stage positions, and the measured characteristic X-rays, by positioning the cursor and clicking the mouse button.
   All the specified items will be highlighted.
3. Click on the **OK** button.
   The spectra will be displayed.

   If you specify only the sample name and stage positions without specifying the X-rays, as many spectra as specified in the Max Spectra box will be displayed automatically beginning with the top.

You can change the number of spectra to display by clicking on the **Max Spectra** button and then inputting the desired number of spectra. You can display up to eight spectra.

Details of buttons other than those explained above are as follows.

Button	Function
Group	To specify another group name, click on the **Group** button to open the Group window, and from the group names displayed, select the desired name.
Make Icon	Selecting this button makes a new icon in place of an icon made with **Show Icon**.
Show Icon	Selecting this button displays spectrum icons in the **X-Ray Spectra** column after measurement.
Max Spectra	This button indicates the number of spectral lines that can be displayed. This number, which is limited to a maximum of eight, can be changed in a window that opens when you click on the **Max Spectra** button.
Dummy	If you want to keep a vacant space next to the selected image, click on the **Dummy** button after selecting an image.
Selected List	Click on the **Selected List** button to open a separate window, which lists the file names for the specified spectra. This button may be used, for example, to check the presently selected spectra. Remember that clicking on a file name in the list cancels the selection of the file name.

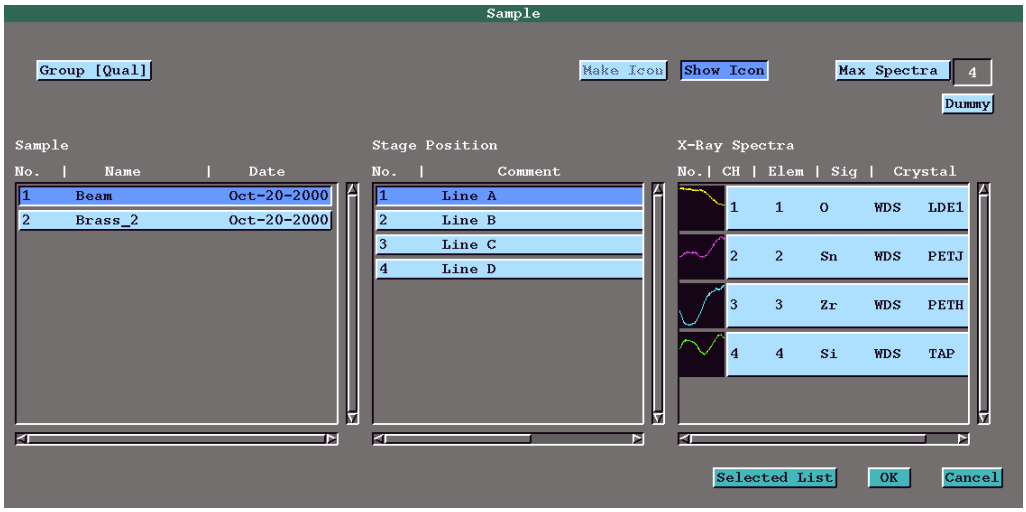


Fig. 24 Sample window

4.3.2 Operation

1. Display spectra using the procedure described in Sect. 4.3.1.
Spectra in the Line Analysis function window as well as the Spectra Specify window are displayed as shown in Fig. 25.

2. Click on the element you want to process in the Spectra Specify window.
If you click on the **All** button in the window, all the displayed images will be processed as specified.

3. Click on the **Operation** button in the Line Analysis function window.
The Operation menu appears. Select a processing item.

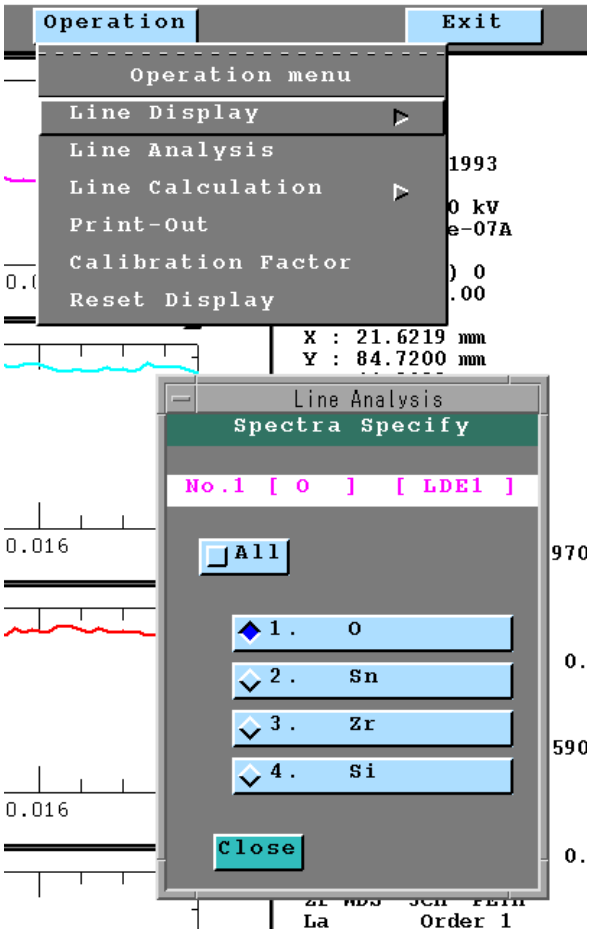


Fig. 25 Spectra Display, Operation menu and Spectra Specify window

Line Display

1. Select **Operation–Line Display** in the Line Analysis function window.
The Line Display menu opens as shown in Fig. 26.

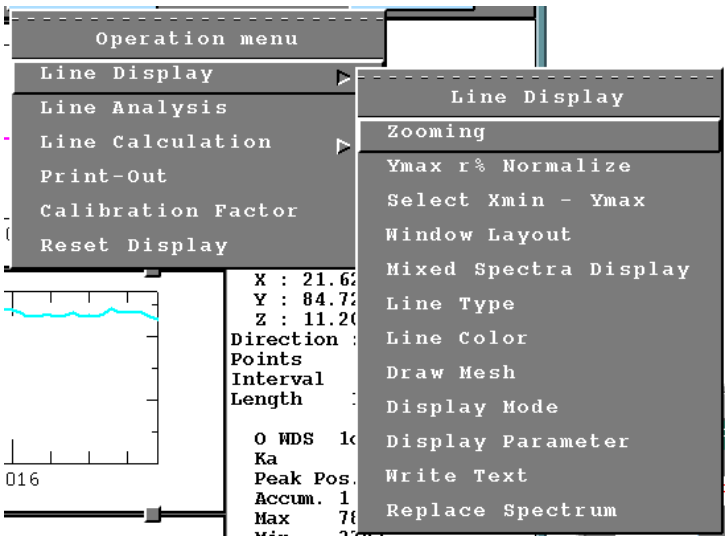


Fig. 26 Line Display menu

2. Select the desired processing item from the Line Display menu.

The twelve processing items are explained next.

Zooming

1. Select **Line Display–Zooming** from the Operation menu.
The Zooming window opens, and also at the same time the graph window showing the whole spectrum image opens separately as shown in Fig. 27.

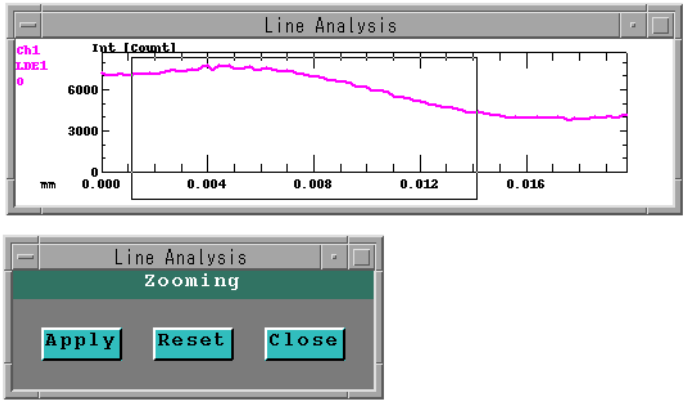


Fig. 27 Zooming window

2. Click on the button of the desired spectrum number in the Spectra Specify window (refer to Fig. 25).

To specify the spectrum to be processed, select a spectrum number as explained in this step, or click on any position on the spectrum that is being displayed.

3. Position the mouse cursor at the upper left corner of the part of the displayed spectrum that you want to zoom and drag the cursor in the diagonal direction.
   A rectangular frame is formed.
4. Once you have decided the size to be zoomed in on, release the mouse button, and then click on the **Apply** button.
   The part of the spectrum in the specified area is enlarged in the graph window.
   ✍ If you performed Step 3 in the graph window, you need not click on the **Apply** button.
5. To move the frame for enlargement, drag a point near the center of the frame to the desired position. If you want to change the size of the frame, drag the frame line.

✍ In these operations, the shape of the mouse cursor will change so that you can distinguish each operation.

- **Ymax r % Normalize**

You can redisplay the maximum intensity of a spectrum on display at the desired percentage of full scale by using this function.

1. Select **Line Display**–**Ymax r % Normalize** from the Operation menu.
   The Ymax r % Normalize window opens as shown in Fig. 28.

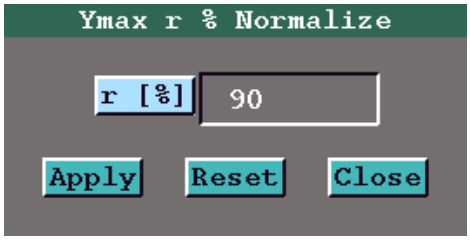


Fig. 28 Ymax r % Normalize window

2. Click on the button of the desired spectrum number in the Spectra Specify window (refer to Fig. 25).
3. Type the desired value in the **r [%]** input box of the Ymax r % Normalize window.

✍ In this step, you can obtain the same result by using the following alternative procedure.

   a. Click on the **r [%]** button in the Ymax r % Normalize window.
      The r window opens.
   b. Enter the desired percentage in the input box of the r window by clicking on the number buttons in the r window; then click on the **Set** button.
4. Click on the **Apply** button.
   The spectrum of maximum intensity will be displayed at the desired full-scale percentage.

Select Xmin – Ymax

You can set the horizontal (**Xmin – Xmax**) and vertical (**Ymin – Ymax**) scales for spectra to the desired values.
The procedure is the same as for the Ymax r % Normalize window.

1. Select **Line Display**–**Xmin – Ymax** from the Operation menu.
   The Select Xmin – Ymax window opens as shown in Fig. 29.

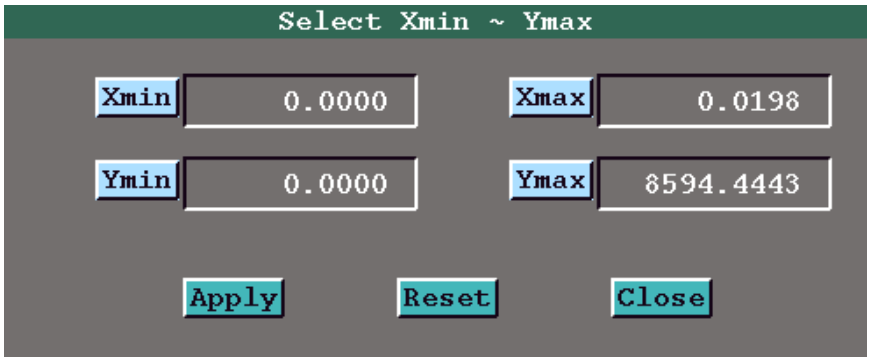


Fig. 29 Select Xmin–Ymax window

2. Type the desired values in the **Xmin**, **Xmax**, **Ymin**, **Ymax** input boxes of the Select Xmin–Ymax window.
3. Click on the **Apply** button.
   The desired spectrum will be displayed.

Window Layout

You can specify the layout of the Line display using this function.

- Select **Line Display**–**Window Layout** from the Operation menu.
  The Window Layout window opens.

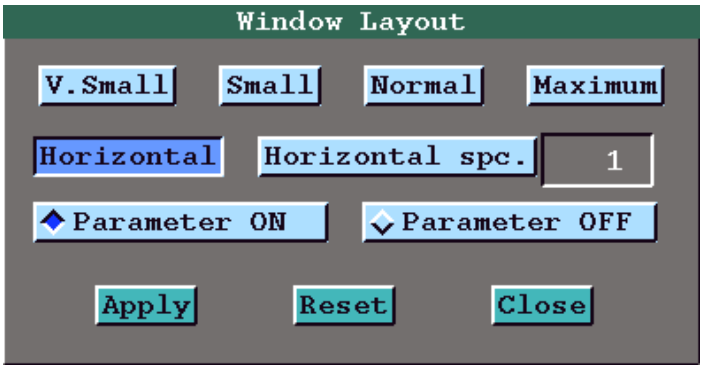


Fig. 30 Window Layout window

Button	Function
V. Small **Small** **Normal** **Maximum**	To change the window size, select the desired size by clicking on one of the four buttons. ☞ Alternatively you can change the size of the window by dragging the frame of spectrum display.
Horizontal	If **Horizontal** is off, sashes are displayed at the borders of displayed spectra that are vertically in a column. You can adjust the height of the spectrum window by dragging the sash buttons. If **Horizontal** is on, sashes are not displayed at the borders. You can specify the number of spectra to be shown horizontally by entering the number in the **Horizontal spc.** input box.
Horizontal spc.	You can specify to enter the number of spectra to be shown horizontally if **Horizontal** is on. If the number is one, spectra are displayed in one column. If the number is two, spectra are displayed in two columns.
Parameter ON	If you want to display parameters on the right side, select **Parameter ON**.
Parameter OFF	If you do not want to display parameters on the right side, select **Parameter OFF**.

● Mixed Spectra Display

You can display spectra individually on different parts of the display or all together in one area.

◆ Select **Line Display–Mixed Spectra Display** from the Operation menu.
The Mixed Spectra Display window opens as shown in Fig. 31.

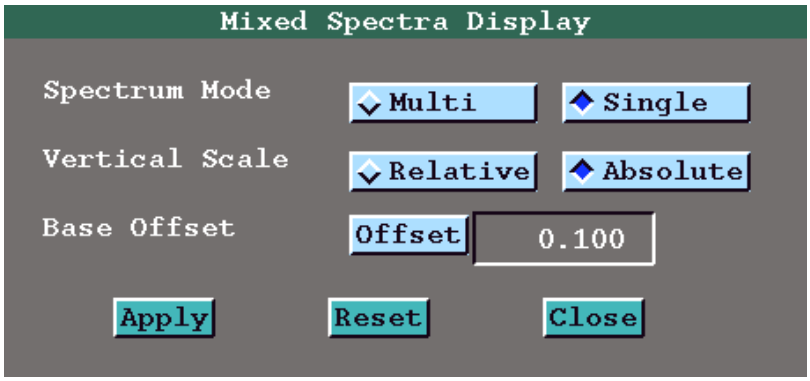


Fig. 31 Mixed Spectra Display window

If **Spectrum Mode** is Multi, multiple spectra are displayed in the respective areas.

If **Spectrum Mode** is **Single**, multiple spectra are displayed all together in one display area. In the **Single** mode, if you have selected **Relative** for **Vertical Scale**, the full-scale value of the vertical axis becomes 100; the relative intensity of each spectrum is shown with the maximum value of each spectrum taken as 100.

If you have selected **Absolute** for **Vertical Scale**, spectra will be shown with the maximum value of all spectra taken as 100.
Enter the base level interval of each spectrum to be displayed in the **Offset** input box of **Base Offset** (usually enter 0.0 to 1.0.). If the value of **Offset** is 0, the vertical axis scale

is displayed as a percentage. If you enter a number other than 0, the baseline moves as the offset in which the maximum value of each spectrum is taken as 1, and then the maximum and minimum values are displayed.

● Line Type

You can specify the style for displaying spectra.

◆ Select **Line Display**–**Line Type** from the Operation menu.
The Line Type window opens as shown in Fig. 32.

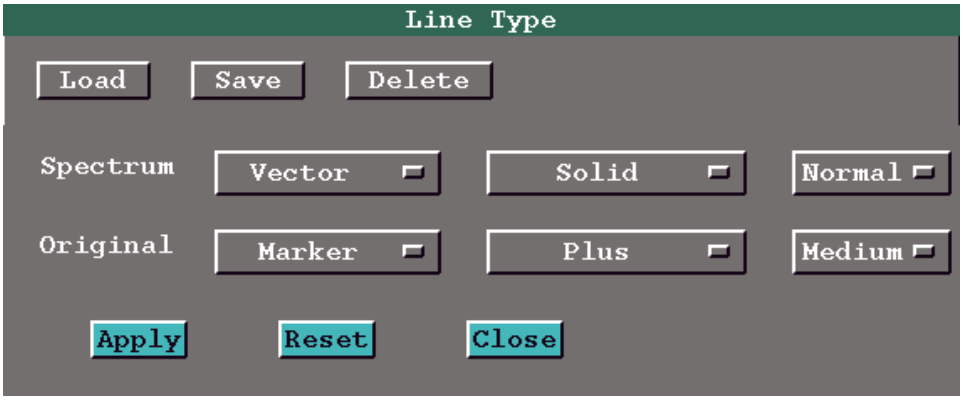


Fig. 32 Line Type window

To specify the style for displaying spectrum lines, select the desired items from the following list; then click on the **Apply** button to display the spectra in the specified style.

- Style for displaying the line
  Vector: Line
  Marker: Symbols
  Bar: Vertical bars
  Marker + Vector: Symbols and line
  Vector + Bar: Lines and vertical bars
- Line type for Vector
  Solid: Solid line
  Dash: Dashed line
  Dot: Dotted line
  Dash Dot: Dashed line with a dot
  Dash Dot Dot: Dashed line with two dots
  Long Dash: Long dashed line
- Thickness of the line
  Thin: Thin line
  Normal: Normal line
  Thick: Thick line

You can store, recall and delete using the **Load**, **Save** and **Delete** buttons.

Line Color

You can change the color of the displayed spectra, background and parameter area by using **Line Color**.

◆ Select **Line Display**– **Line Color** from the Operation menu.
The Line Color window opens as shown in Fig. 33.

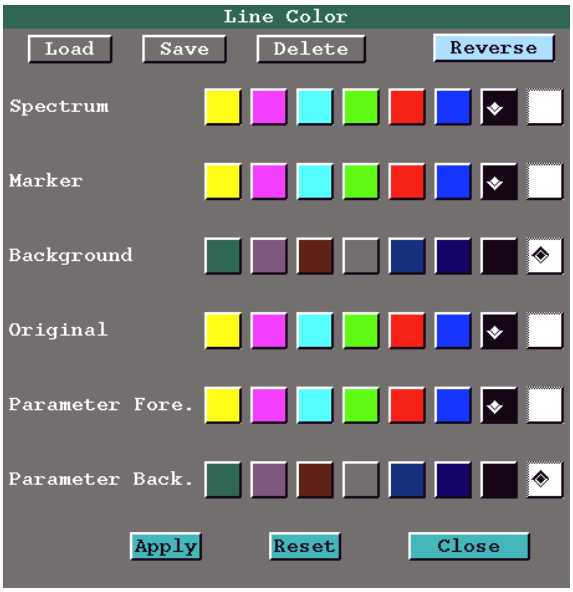


Fig. 33 Line Color window

To specify the colors for displaying spectra, background and parameter areas, select the desired items from the following list; then click on the **Apply** button to display the color as desired.

- Items that you can display in color

Spectrum:	Spectra
Marker:	Marker
Background:	Background
Original:	Original spectra prior to calculation
Parameter Fore.:	Parameter characters
Parameter Back.:	Parameter background

You can store, recall and delete by using the **Load**, **Save** and **Delete** buttons.

Draw Mesh

You can draw a grid as the background of spectra by using **Draw Mesh**.

◆ Select **Line Display–Draw Mesh** from the Operation menu.
The Draw Mesh window opens.

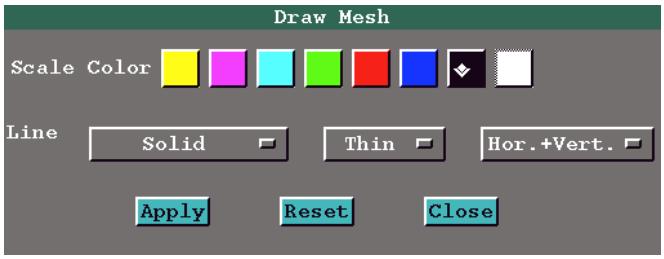


Fig. 34 Draw Mesh window

To specify **Scale Color** and **Line** for the grid, select the desired items from the following lists; then click on the **Apply** button to display the grid as desired.

- Line type
  Solid: Solid line
  Dash: Dashed line
  Dot: Dotted line
  Dash Dot: Dashed line with a dot
  Dash Dot Dot: Dashed line with two dots
- Thickness of the line
  Thin: Thin line
  Normal: Normal line
  Thick: Thick line
- Lines to draw
  Hor. + Vert.: Horizontal and vertical lines
  Horizontal: Horizontal lines
  Vertical: Vertical lines
  None: No lines

Display Mode

Using **Display Mode**, you can select whether to display spectra in terms of intensity or concentration.

◆ Select **Line Display–Display Mode** from the Operation menu.
The Display Mode window opens as shown in Fig. 35.

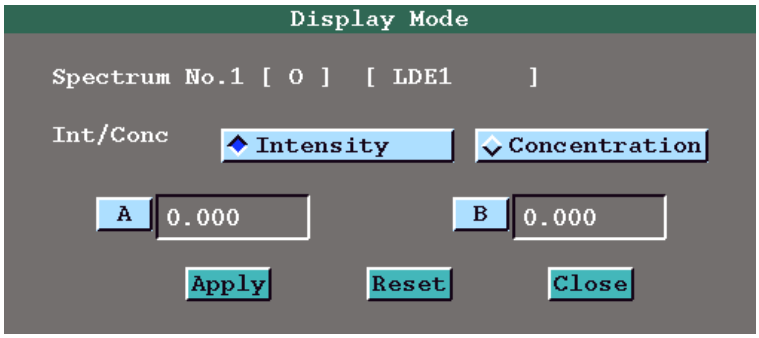


Fig. 35 Display Mode window

Here, by clicking on **Intensity** or **Concentration**, you can select whether to display spectra in terms of intensity or concentration. For the concentration mode, be sure to enter constants **A** and **B**.

The constants A and B are related as follows.

$$I = A \times C + B$$

where

I:	X-ray intensity
C:	Concentration
A:	X-ray intensity per 1% concentration, in counts/((μA) (msec) %)
B:	Background, in counts/((μA)(msec)) For image signals, the division by msec is not performed.

Display Parameter

You can specify which parameter item to display in the parameter-display area of the Line Analysis function window, by using **Display Parameter**.

1. Select **Line Display**–**Display Parameter** from the Operation menu.
The Display Parameter window opens as shown in Fig. 36.

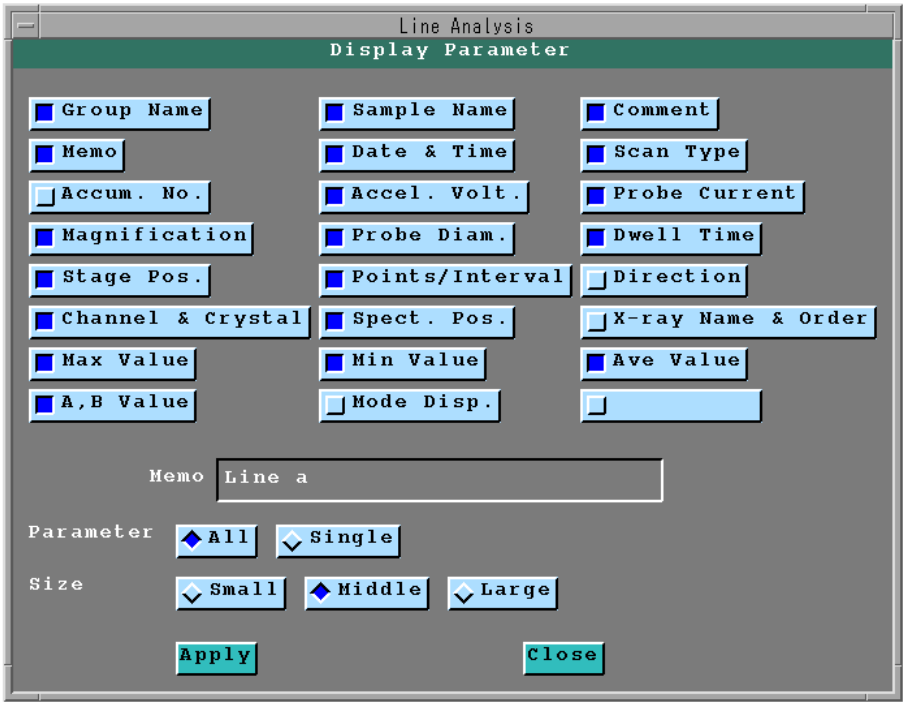


Fig. 36 Display Parameter window

2. Select the desired parameters; then click on the **OK** button.
The specified parameters are displayed in the parameter-display area of the Line Analysis function window.

- You can enter a character string in the **Memo** input box to be displayed as one of the parameters in the window.
- If you select **All**, the information of all the spectra is shown, while if you select **Single**, only the information of the specified spectrum is shown.
- To change the size of the displayed characters, select **Small**, **Middle** or **Large**.

Write Text

You can write text in the display area of spectra by using **Write Text**.

1. Select **Line Display**–**Write Text** from the Operation menu.

The Write Text window opens as shown in Fig. 37.

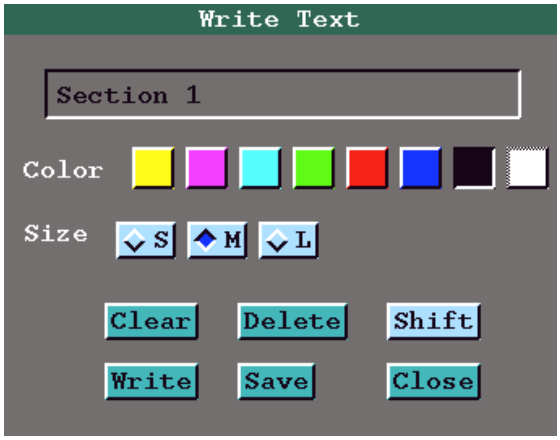


Fig. 37 Write Text window

2. Input the desired text in the input box of the Write Text window; then specify **Color** and **Size**, and click on the **Write** button.

The text is displayed on the selected spectrum of the Line Analysis function window.

Button	Function
Color	Selects the color of text.
Size	Selects the character size of text as **S**, **M** or **L**.
Clear	Clears the input box.
Shift	Adjusts the position of the input text when you drag it.
Delete	Deletes the text. Click on this button and then select the text that you want to delete from the list of texts.
Write	Writes text on the selected spectrum.
Save	Saves the texts that you have written on spectra. The texts will be displayed when you next open the spectra.

● Replace Spectrum

You can replace the spectra that are being displayed by using **Replace Spectrum**.

1. Select **Line Display**–**Replace Spectrum** from the Operation menu.
The Replace spectrum window opens.

Fig. 38 Replace spectrum window

2. Select the number of the spectrum to remove in the Spectra specify window (refer to Fig. 25).

3. Click on the **Apply** button in the Replace spectrum window.
The Sample window opens.
☞ Refer to Fig. 24 Sample window.

4. Select the spectrum to insert in place of the removed spectrum from the Sample window.

■ Line Analysis

Using **Line Analysis**, you can examine the intensity or concentration of the desired position on a spectrum.

1. Select **Operation**–**Line Analysis** in the Line Analysis function window.
The Line Analysis window opens as shown in Fig. 39.

In this window you can display the X-ray intensity of one point or the average X-ray intensity of three points, or the distance between two points in the horizontal direction on a spectrum.

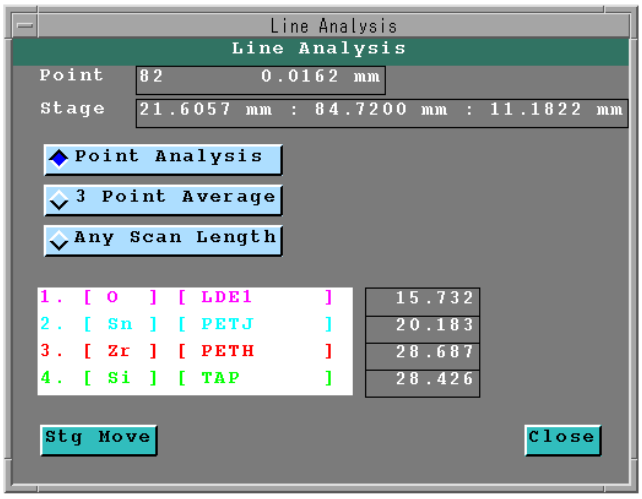


Fig. 39 Line Analysis window

2. Click on any position on a spectrum.

3. Select **Point Analysis**, **3 Point Average** or **Any Scan Length**.

Object	Function
Point	The display box shows the measurement position calculated from the data in the file corresponding to the spectrum presently being processed.
Stage	The display box shows the X, Y, and Z positions of the sample stage corresponding to the spectrum presently being processed.
Point Analysis	Selecting this button displays the X-ray intensity of one point on a spectrum.
3 Point Average	Selecting this button displays the average X-ray intensity of three points on a spectrum.
Any Scan Length	If you click on two points on a spectrum, the distance between the two points is displayed.
Stg Move	Clicking on this button moves the sample stage to the measurement position corresponding to the spectrum presently being processed.

■ Line Calculation

Using **Line Calculation**, you can carry out arithmetic operations on the spectrum.

1. Select **Operation–Line Calculation** in the Line Analysis function window.
The Line Calculation menu opens as shown in Fig. 40.

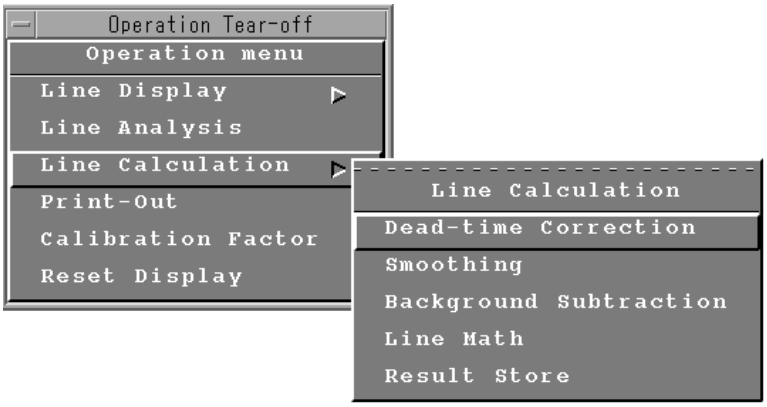


Fig. 40 Line Calculation menu

2. Select a process from the Line Calculation menu.

The five processes are explained next.

● Dead-time Correction

Using **Dead-time Correction**, you can correct raw X-ray intensity data. Data involving a high X-ray count rate (tens of thousands of counts per second) becomes more accurate through dead-time correction.

☞ For the formula for calculation, refer to the separate instruction manual of the Quantitative Analysis Program.

◆ Select **Line Calculation–Dead-time Correction** from the Operation menu.
The Dead-time Correction window opens as shown in Fig. 41.

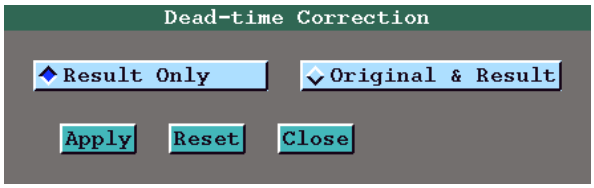


Fig. 41 Dead-time Correction window

- If you want to display only the results of the correction, click on the **Result Only** button.
- If you want to display the data obtained before and the results of the correction, click on the **Original & Result** button.

Note that data once subjected to dead-time correction will become meaningless if it undergoes the correction again.

● Smoothing

Using **Smoothing**, you can smooth spectra.

◆ Select **Line Calculation–Smoothing** from the Operation menu.
The Smoothing window opens as shown in Fig. 42.

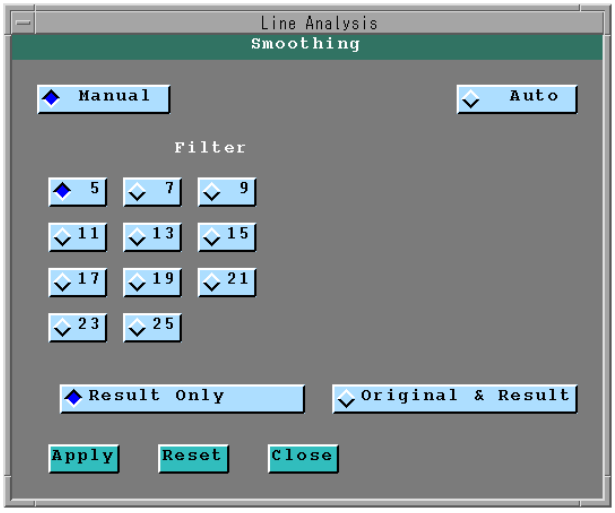


Fig. 42 Smoothing window

- If you click on the **Manual** button, the spectrum will be smoothed by the Savitzky-Golay method based on the specified numbers of points and filters.
- If you click on the **Auto** button, then the optimum number of filters is automatically selected, and the spectrum is smoothed.

Background Subtraction

The Background Subtraction function allows you to remove the background components from spectra.

1. Select **Line Calculation–Background Subtraction** from the Operation menu.
   The Background Subtraction window opens as shown in Fig. 43.

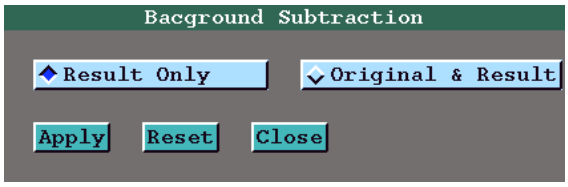


Fig. 43 Background Subtraction window

2. Click on several background positions of the presently selected spectrum.
3. Click on the **Apply** button.
   The background components are automatically removed through calculation, and the results will be displayed.

- If you specify one point, the background will be a line parallel to the horizontal axis.
- If you specify two points, the background will be a line between the two points.
- If you specify more than two points, the background will be a spline curve.

Line Math

Using **Line Math**, you can perform arithmetic operations involving a constant (**K**) on a single spectrum or addition, subtraction, multiplication, or division of two spectra.

1. Select **Line Calculation–Line Math** from the Operation menu.
   The Line Math window opens as shown in Fig. 44.

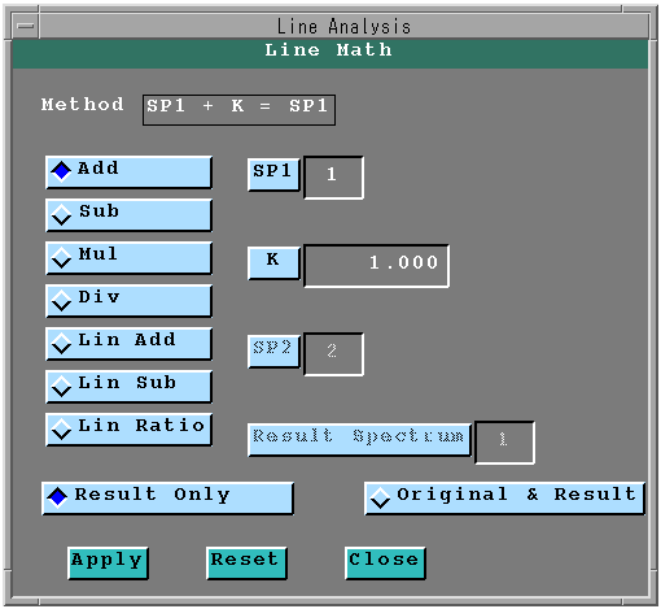


Fig. 44 Line Math window

2. Select the desired item from **Add** to **Lin Ratio** by clicking on it.

- Arithmetic operations involving a constant on a single spectrum
  Select **Add**, **Sub**, **Mul** or **Div** first, and then click on the **K** button. A numerical value input window opens. Specify the desired value.
  ✍ You can specify **K** also by typing the desired value in the **K** input box.
- Addition, subtraction, multiplication, or division of two spectra
  Select **Lin Add**, **Lin Sub**, or **Lin Ratio** first, and then click on the **SP1**, **SP2** and **Result Spectrum** buttons respectively. Each number selection input window opens. Specify the desired number.
  ✍ You can specify **SP1**, **SP2** and **Result Spectrum** also by typing the desired number in their input boxes.

3. Click on the **Apply** button.
The program executes the calculation and displays the resulting spectrum.

● Result Store

Using **Result Store**, you can store in a file the results of arithmetic operations and other data on the displayed spectrum.

1. Select **Line Calculation**–**Result Store** from the Operation menu.
The Result Store window opens as shown in Fig. 45.

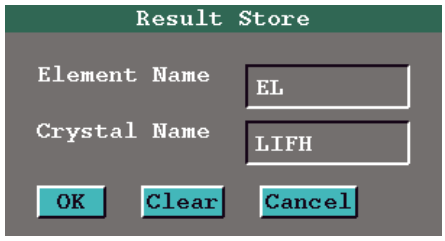


Fig. 45 Result Store window

2. Enter up to 2 characters in the **Element Name** input box and up to 8 characters in the **Crystal Name** input box.

3. Click on the **OK** button.
The spectrum specified in the Spectra Specify window will be stored in addition to the spectra presently stored in the file.

✍ How to delete a spectrum once stored

a. Select a spectrum that you want to delete in the Spectra Specify window.

b. Enter two slashes (//) in the **Element Name** input box and eight slashes (////////) in the **Crystal Name** input box of the Result Store window.

c. Click on the **OK** button.
The selected spectrum will be deleted.

■ Print-Out

Using **Print-Out**, you can print measurement conditions and results, and spectrum data.

1. Select **Operation**–**Print-Out** in the Line Analysis function window.
   The Print-Out window opens as shown in Fig. 46.

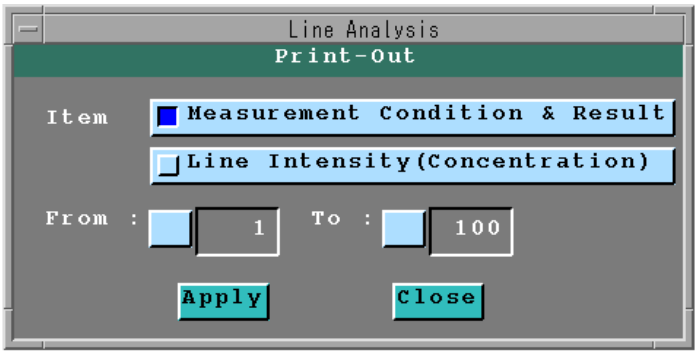


Fig. 46 Print-Out window

2. Click on the desired **Item** button(s).
3. If you want to specify the range of data numbers to print in the **From** and **To** input boxes, be sure to click on the **Line Intensity (Concentration)** button. Then specify the range.
4. Click on the **Apply** button.
   The Listing window appears. The numbers specified for printing are displayed in this window.
5. Click on the **Print** button in the Listing window.
   The output will be sent to the printer.

Calibration Factor

Here, you specify calibration factors A and B, which are used for converting spectral X-ray intensity to concentration.

1. Select **Operation–Calibration Factor** in the Line Analysis function window.
The Calibration Factor window opens as shown in Fig. 47.

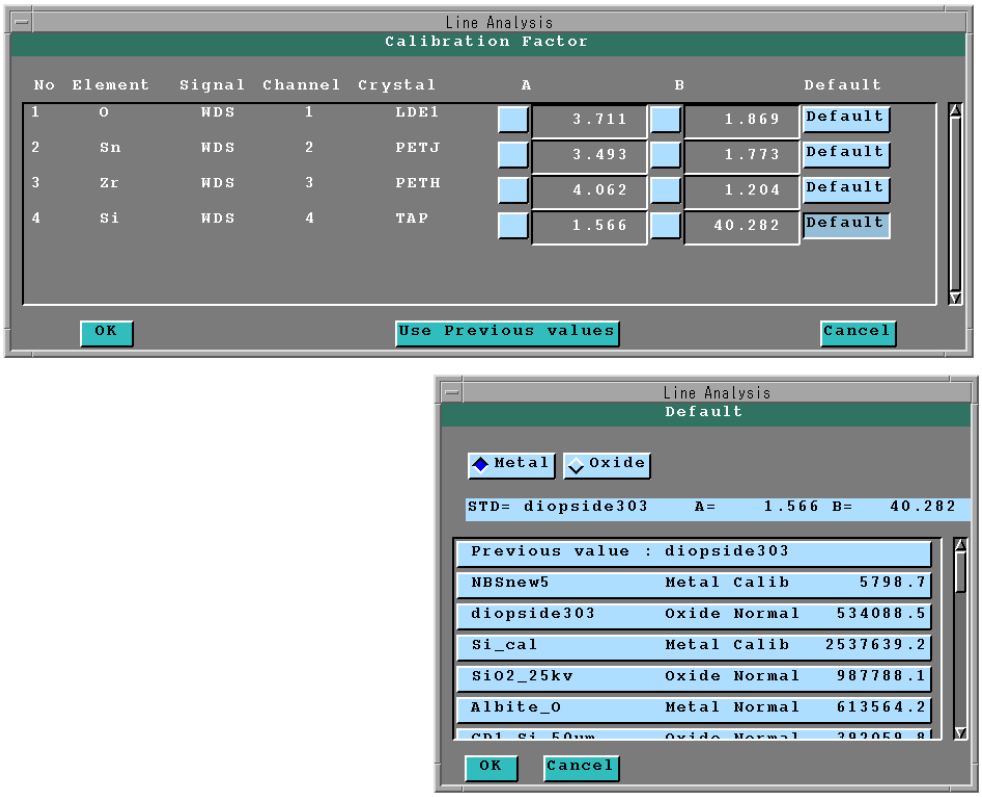


Fig. 47 Calibration Factor and Default windows

2. Click on the **A** or **B** button for each spectrum in the Calibration Factor window.
A numerical input window opens.

3. Enter an appropriate value in the **A** or **B** input box, using the numerical input window.

To see an appropriate value to enter, click on the **Default** button. Then the Default window opens as shown in Fig. 47.

If you select **Cal**–**STD** in this window, the A and B factors will be calculated based on the standard samples for Semi-Quantitative Analysis.

If the standard samples were measured previously, their data will be applied to the calculation of the A and B factors.

For a discussion of the A and B factors, see “Display Mode” in Sect. 4.3.2, “Operation” of this instruction manual.

Reset Display

Using **Reset Display**, you can restore a spectrum to the original state.

1. Select **Operation**–**Reset Display** in the Line Analysis function window.
   The Reset Display window opens as shown in Fig. 48.

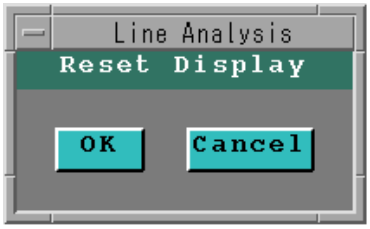


Fig. 48 Reset Display window

2. Click on the **OK** button.
   The processing that has been done to the data is undone.

4.4 Realtime Display

The Realtime Display function causes the monitor to display data being acquired during line analysis.

1. Click on the **Process** icon in the EPMA Main Menu.
The Process menu opens.

2. Select **Line Analysis** from the Process menu.
The Line Analysis function window (for processing) opens (refer to Fig. 23).

3. Click on the **Realtime** button.
The Realtime Control window opens as shown in Fig. 49.

Fig. 49 Realtime Control window

✍ There is no need to specify a sample name for realtime display by using the **Sample** button. If you perform normal processing of line analysis, you have to specify a group name and sample name by clicking on the **Sample** button in the window of Fig. 23.

4. To select a realtime display mode, click on the **Channel No. Order** button or **Spectrum No. Order** button.

Button	Function
Channel No. Order	Spectra will be displayed in the order of spectrometer channel number, starting at the top in the spectral display frame.
Spectrum No. Order	Spectra will be displayed in the order of spectral measurement date and time, starting at the top in the spectral display frame. If all the display areas are used, the displayed spectra will be replaced by the new ones from the top in the spectral display frame.

5. Specify the number of spectra to be displayed by clicking on the desired **Max Cell Spectra button** (**1** to **8**).

6. Click on the **Start** button.
Realtime display starts.

If you want to change the setting of **Drawing Mode** or **Max Cell Number**, stop the realtime display by clicking on the **Stop** button, and then change the settings.

Even during measurement, you can close the Realtime Display window by clicking on the **Close** button. Then, you carry out the tasks described in Sect. 4.3.2, “Operation.”