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Installation and User's Guide

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X-Strata920

Hitachi High-Tech Analytical Science

	• Before using the instrument, read the safety instructions and precautions carefully.
	• Be sure to observe the safety instructions in this manual and the WARNING/CAUTION labels on the instrument.
	• Keep this manual in a safe place nearby so it can be referred to whenever needed.

Preface

This handbook provides all the information necessary for the safe and proper installation and operation of the X-Strata920.

Customer support

Hitachi High-Tech Analytical Science has global customer support facilities that provide a coordinated response to customer's queries. All queries are recorded on our Support database and are dealt with as quickly as possible. If we are not able to answer the query immediately, we will contact you promptly.

To obtain technical support, please refer to the back page of this handbook, or contact your local Hitachi High-Tech Analytical Science representative.

Health and safety information

The X-Strata920 contains hazardous areas. Before working with the unit, all personnel must read and become thoroughly familiar with the information given in chapter 1.

In particular, you must read, understand and strictly observe all:

- Warning notices
- Caution notices
- Safety labels and markings on the equipment

For ease of reference and rapid response in an emergency, this handbook must be safely kept in close proximity to the X-Strata920.

Intended users

Intended users of the X-Strata920 include the person (or persons) with authority over the equipment, and the following persons who handle and work with the equipment:

- Operators – persons trained in the use of the X-Strata920 for the purposes for which the equipment is intended.
- Service engineers – persons trained in the installation, commissioning, maintenance, repair, testing and decommissioning of the X-Strata920, who operate any part of the system for the purpose of performing checks, tests, adjustments and/or repairs to the equipment.

Users of the X-Strata920 must have received adequate training on its safe and effective use before attempting to work with the equipment. Please contact your local Hitachi High-Tech Analytical Science representative for information on training requirements and training courses that are available.

Training requirements vary from country to country. Users must ensure that training is given in accordance with all applicable local laws and regulations.

If any user of the equipment has not been directly trained by a representative of Hitachi High-Tech Analytical Science, ensure that they understand the safety issues associated with the system, and that they consult relevant personnel for guidance when operating the system.

Intended use of the equipment

The X-Strata920 is an instrument for the non-destructive measurement of composition and coating thickness. It is capable of measuring the thickness of almost any coating – single layer, multi-layer, or alloy, on almost any substrate. The instrument can also determine solution concentration, alloy composition, assay, and materials analysis. The X-Strata920 is intended only for the purpose of analysing sample parts placed inside the analysis chamber.

The X-Strata920 is intended to be installed, used and operated only for the purpose for which the equipment was designed, and only in accordance with the instructions given in this manual. Nothing stated in this manual reduces the responsibilities of users to exercise sound judgement and best practice.

The installation, use and operation of the X-Strata920 are subject to laws in the jurisdictions in which the equipment is installed and in use. The equipment will be installed by a representative of Hitachi High-Tech Analytical Science, and must be used and operated only in such ways that do not conflict with said applicable laws and regulations.

Use of the X-Strata920 for purposes other than those intended and expressly stated by Hitachi High-Tech Analytical Science, as well as incorrect use or operation of the equipment, may relieve Hitachi High-Tech Analytical Science or its agent of the responsibility for any resultant non-compliance, damage or injury.

Compliance

The X-Strata920 complies in full with the requirements of Low Voltage Directive (LVD) 2006/95/EC and EMC Directive 2004/108/EC.

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Copies of the compliance documentation can be obtained on request.

Disclaimer

The information contained in this document is subject to change without notice.

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Acknowledgements

All tradenames and trademarks that appear in this manual are hereby acknowledged.

Acronyms, abbreviations and special terms

A Glossary of acronyms, abbreviations and special terms is given at the end of this manual.

Table of contents

1   Safety information

The X-Strata920 meets, or exceeds, all recognized industry standards and complies with agency requirements for safety and electromagnetic compatibility (EMC) compliance. A safety check is performed on each instrument at the factory, prior to shipment.

Proper use of the instrument is the responsibility of the user. Although operators are not required to wear monitoring devices, the use of such devices is left to the operator's discretion.

1.1   Pictograms and signal words

Important information in these operating instructions and on the instrument is marked with the following pictograms.

DANGER

... indicates a hazardous situation which, if not avoided, will result in death or serious injury.

WARNING

... indicates a hazardous situation which, if not avoided, could result in death or serious injury.

CAUTION

... indicates a hazardous situation which, if not avoided, could result in minor or moderate injury.

1.1.1   Hazard symbols

Danger!
This sign indicates an immediate risk of death or injury.

Danger!
Hazardous electric current!
This sign indicates hazardous electric current.

Warning!
Crush hazard!
This sign indicates hazardous situations with limb crush hazard.

Danger!
X-radiation hazard!
This sign indicates an X-radiation hazard.

Warning!
Laser radiation hazard!
This sign indicates a laser radiation hazard.

Warning!
Poisonous substances warning!
This sign indicates hazardous situations due to poisonous substances.

1.1.2 Symbols for personal protective equipment

Wear eye protection!

Wear protective gloves!

Wear face protection!

1.1.3 Notice and information symbol

NOTICE

NOTICE
... indicates important information (e.g. material damage), but does not indicate hazardous situations.

Information Tips and information are marked with the hand symbol with pointed index finger and the word "Information" in bold print.
The hazard information is described in detail in chapter 1.2.

1.2 Detailed hazard information

1.2.1 Servicing and use

All servicing to this equipment must be done by Hitachi High-Tech Analytical Science trained engineers. Use of controls, or adjustments of performance or procedures other than those specified herein, is not permitted.

If the equipment is used in a manner not specified by the manufacturer, the protection provided by the equipment might be impaired.

1.2.2 National regulations

There may be country/state specific regulations for the use of this equipment. Users are responsible for complying with all such regulations including, but not limited to, making any statutory notifications and arranging any servicing that is mandatory according to the regulations. Please contact your local Hitachi High-Tech Analytical Science representative for advice on applicable regulations.

1.2.3 Radiation safety

⚠ WARNING

X-radiation hazard!
Exposure to X-rays can cause severe injury. Obey the safety instructions in this manual to avoid exposure to X-rays.

The X-Strata920 contains a small X-ray tube housed in a shielded and interlocked radiation enclosure. A radiation warning light on the front of the instrument indicates when X-rays are being generated inside this enclosure. Failure of any of the interlocks to the enclosure immediately shuts off the X-ray power.

A full radiation safety assessment has been carried out by an independent Radiation Protection Advisor. The assessment included a survey of the radiation dose rates at the exterior surface of the instrument performed at maximum X-ray power (45 kV, 800 µA). The survey reported that, during normal operation, there are no accessible radiation dose rate levels above 1.0 µSv/hr (1.00 mrem/hr) at 100 mm from the unit. The unit can be operated as any other item of laboratory equipment – users do not need to wear personal radiation dosimeters (subject to local regulations).

To maintain this level of safety, any servicing required within the instrument must be done by Hitachi High-Tech Analytical Science trained service engineers.

1.2.4 Electrical safety

⚠ DANGER

Electric voltage!
The X-Strata920 contains hazardous voltages that can cause death, severe injury or burns.

- Ground the instrument with the three-wire grounding cord provided. Failure to do so may result in electrical shock.
- The X-Strata920 incorporates high and low voltage power supplies. It is not necessary to remove the covers during routine use.
- The instrument must never be operated with its outer case removed.
- Service work must only be done by Hitachi High-Tech Analytical Science trained service engineers.
- Prior to beginning maintenance or service work, always check that the electrical supply cord is disconnected from the mains supply.
- Disconnect the electrical power supply cord to the X-Strata920 before changing a fuse. Failure to do so may result in electrical shock.
- For continued protection against fire and electric shock, replace the fuses with the same type and rating of fuse only (T2A-250 V).

1.2.5 Laser

⚠ WARNING

Risk of injury due to laser radiation!
Exposure to laser radiation can cause severe eye damage or burns.

- Do not look directly into the beam produced by any class of laser.
- Do not view the beam through any optical instruments.

The X-Strata920 contains two low energy lasers for focusing the collimated X-ray beam on the sample and positioning the sample prior to insertion into the unit. Both lasers are embedded in the centre of the measuring chamber, pointed downwards towards the table.

The lasers are gallium arsenide type Class 2 laser products, rated at less than 1 milliwatt, and operate in a continuous mode.
For service and repair, the lasers must be treated as Class 2 laser products.
Under normal operating conditions, the lasers meet the requirements for Class 1 laser product to IEC/EN 60825-1 (2007).

The X-Strata920 lasers contain no user serviceable parts and must only be adjusted or replaced by qualified Hitachi High-Tech Analytical Science service engineers.

- Consult Hitachi High-Tech Analytical Science before replacing the laser.
- Any attempt to adjust or service the laser may result in exposure to radiation.

1.2.6 Toxic materials

WARNING

Risk of injury due to beryllium!
The windows of X-ray tubes and detectors contain beryllium, which is extremely toxic by inhalation and ingestion and a probable human carcinogen. It is a serious respiratory irritant and may be harmful if in contact with the skin.
- To avoid fatal or serious injury, always obey the precautions given below.

Under normal circumstances, X-ray and detector windows are not harmful. However, if they become damaged in any way, there is a potentially increased risk of contact with beryllium dust. Inhalation of beryllium dust is harmful.
If a window is damaged, always obey these precautions:

- In the event of actual or suspected damage to a beryllium window, IMMEDIATELY CONTACT Technical Support or your local Hitachi High-Tech Analytical Science representative for advice.
- Always avoid contact with the windows of the X-ray tube and detectors.
- Do not attempt to clean the beryllium windows after sample breakage or spillage.
- Contact Technical Support or your local Hitachi High-Tech Analytical Science representative for advice.
- Do not touch the window of an X-ray tube or detector.
- Avoid breathing dust or powder when in the vicinity of the X-ray tube or detector.
- If you suspect that an X-ray tube or detector is damaged, wear safety glasses, protective gloves, a face mask and a respirator when in the vicinity of the X-ray tube or detector.
- Ensure that the area is well ventilated.
- If you inhale, ingest or make skin contact with beryllium particles, seek immediate medical assistance.

1.2.7 Lifting and carrying

WARNING

Risk of injury when lifting the instrument!
The X-Strata920 weighs more than 60 kg.
- Lift and move the instrument with appropriate lifting equipment only.

NOTICE

For short-distance transport (e.g. within the same room), please observe the following information:
- In general, the instrument must be lifted and transported with greatest care.
- During transport, make sure the instrument is in horizontal position!
- Always lift the instrument from the bottom. Do not attempt to lift the instrument from the front panel or the rear cover.

2 Technical description

The X-Strata920 measuring system consists of:

- **Analysis chamber** – contains the X-ray tube and the measuring device.
- Computer – controls the measuring system and executes the control software. An IBM® compatible, Pentium® compatible personal computer (PC) is used.

| NOTICE | Adding hardware to the PC may cause conflicts with the X-Strata920 operation. Contact Hitachi High-Tech Analytical Science before installing any new hardware. Failure to do so will void the warranty on the **X-Strata920** system. |

- **Monitor** – displays measuring information and guides the user through the measuring functions. The display is a high-resolution VGA colour monitor.
- **Mouse** – provides a simple, efficient user interface pointer with the system.
- **Keyboard** – standard PC interface.
- **Printer (optional)** – provides a hard copy output of measuring and statistical data. Any printer that is compatible with the Microsoft® Windows® operating system installed on the PC can be used.
- **Software** – SmartLink FP (Microsoft® Windows® based system).

2.1 Theory of operation

The theory of X-ray fluorescence and the principle of operation are given in the annex in chapter 13.2.

2.2   Technical data

Tab. 2-1   Technical data

Parameter	Details
Element range	Phosphorous 15 to Uranium 92.
Layers and elements	5 layers (4 layers + base). Composition analysis of up to 25 elements simultaneously.
X-ray excitation	50 W (50 kV and 1 mA) micro-focused tungsten anode tube.
Detector	Xenon-filled proportional counter.
Secondary beam filters	Up to 3 filters for overlap corrections (vanadium, cobalt, and nickel).
Collimators	Up to 6 collimators. Various sizes from a selection of round, square and rectangular shapes.
Digital pulse processing	4096 CH digital multi-channel analyzer. Automatic signal processing including dead time correction and pulse pile up rejection.
Computer (equivalent or better)	Processor: Intel 2 Duo E7500 2.93 GHz. Memory: 500 Gb Hard disk, 2 Gb RAM. Operating system: Microsoft® Windows® 7.
Power supply	Voltage: 110 V to 230 V with frequency range of 50 Hz to 60 Hz. Current rating: 2 A.
Working environment	-10 °C (14 °F) to +40 °C (104 °F) and up to 98 % relative humidity, non-condensing.
Configuration options	Standard fixed base. Mini-well base. XY programmable base.
XY travel[a]	178 mm x 178 mm (7" x 7").
Z travel	43 mm (1.7").
Software languages	English, Chinese (traditional and simplified), French, German, Spanish, Japanese, Korean, Italian and Czech.
Weight	97 kg
Dimensions (W x L x H) Standard fixed base: Mini-well base: XY motorised base:	407 mm x 770 mm x 305 mm (16" x 30.3" x 12"). 407 mm x 770 mm x 400 mm (16" x 30.3" x 15.7"). 610 mm x 1037 mm x 375 mm (24" x 40.8" x 14.8").

a.   XY programmable base option only.

2.3   Methods of analysis

The X-Strata920 operating system software is equipped with two methods of analysing the measurement data. One is the *region of interest* (ROI) method and the other is the *fundamental parameters* (FP) method. These methods differ in the mathematical algorithms used in the software to analyze the raw measurement data and convert it into thickness, composition or concentration. The choice of method depends on the specific application.

2.4   Calibration

Before the X-Strata920 can be used to make measurements, it must be calibrated. Calibration is a means of correlating the readings of an instrument with certified standards. It requires you to specify parameters, take measurements on known standards, then save the associated spectrum and data in a calibration file. A calibration file must be set up for each type of coating, alloy or solution that you intend to measure. The SmartLink FP operating system provides the ROI and FP methods of analysis. You must decide which method to use when setting up a calibration. This decision is determined by the type of materials, the specific application and the desired objectives or goals. The calibration method must be selected when making an ROI calibration, or the chemical elements to be included must be selected when making an FP calibration. Then the parameters are defined and the required standards identified in the standards table are measured. See chapter 5 for more information.

Contact Hitachi High-Tech Analytical Science Technical Support for help in choosing the best method for your requirements.

2.4.1   Spectrum calibration

The spectrum calibration routine (shown as the **SpectCal** icon in the software), compensates for any change in instrument performance caused by a change in the X-ray tube/detector characteristics. This correction is automatically applied after the SpectCal sample has been measured.

The SpectCal sample is provided with the instrument and has two sections, marked on the SpectCal standard as Cu-Ag and Ag. To make measurements, click the **SpectCal** icon and follow the on-screen instructions given in the dialogue box that then opens. Firstly, the Cu-Ag portion of the sample is measured, then the Ag portion of the SpectCal sample is measured. If all results are satisfactory, a dialogue box opens at the end of the measurement sequence, showing successful measurement of the SpectCal sample For optimum performance, it is recommended that spectrum calibration is performed at least once each day – before performing calibrations or taking readings, especially if the X-Strata920 has been switched off. A spectrum calibration must be performed more often when using applications where the peaks of the coating and the base are very close together. Certain applications prompt you to perform a spectrum calibration before beginning a measurement session. See chapter 5.2 for more information.

2.4.2   Applications

Once calibrations have been performed, it is suggested that applications are created for each of the parts or processes that you want to measure. Using simple programming steps, XYZ patterns and XYZ programs can be created to simplify and automate measurements. A program, a calibration file and other parameters can be specified and saved as an application file that can then be used each time a part or process is to be measured.

Measurements and statistics are saved with each application. They can be viewed on the **Stats** tab and printed in a report. See chapter 6 for more information.

2.5   Measurements

If the database option is installed, measurements are made by using the *MEASURE PARTS* mode. Otherwise measurements are made by selecting one of the three available methods in the *MEASURE SAMPLES* mode.

When the database option is installed, SmartLink FP can be used to make measurements before the database is set up. From the **Taskbar** or the **Task** submenu, select **Measure Samples**. An application, a calibration or counts can be used to make measurements from the Measure Samples screen.

2.5.1   Datum points

A datum point is the reference location for the points of measurement defined in a pattern. It should be a readily identifiable feature of a part so that it can be found easily during the positioning process. The use of a datum point on a sample adjusts the pattern for the difference between the sample's location and the location at which the program was originally defined. Use of a second datum point compensates for differences in the rotational orientation of the sample. Defining a datum point in a program identifies the location for the pattern datum point on the sample to be measured.

Datum points allow freedom when placing samples in the chamber for measurement. If datum points were not used, the sample(s) would have to be placed in exactly the same location, with the same rotational orientation, as when the pattern was created.

Datum points in XYZ patterns

The datum point in an XYZ pattern is a single point to which the points of measure are referenced.

Datum points in XYZ programs

Datum points can be defined in any type of XYZ program. The recommended number of datum points depends upon how the program is to be used:

- No Datum
    - Use on samples that are symmetrical around both axes, OR
    - Use when the program will be used before the sample is moved, OR
    - Use when the samples are placed in a fixture that locates them in an exactly reproducible position on the table.
- One Datum Point
  Use on samples that are symmetrical around both axes, and when several samples are to be measured. One datum point allows alignment of the X-ray beam over the measurement areas when the positions of the sample to be measured and the original sample are different.
- Two Datum Points
  Use on asymmetrical samples. Two datum points allow alignment of the X-ray beam over the measurement areas when there is a difference between the position and rotational alignment of the sample to be measured, and the position and rotational alignment of the original sample.

2.6   Statistics

Readings that are taken with an application, or with a part number in the database option, are saved in data files. Statistics are calculated from the readings, along with X-bar charts, R charts and a histogram.

When using an application to make measurements, an option is available to display all the readings taken with the application or to display readings from the current measurement session only.

Readings can also be printed in a report. A default report can be specified when an application is set up, or a report can be created with the report generator to print the information.

When exiting an application, readings are saved automatically in a data file named after the application.

Readings taken with a calibration or in *COUNTS* mode cannot be saved.

Readings and statistics made with a part number are stored in a file in the optional database (see chapter 2.7.1).

2.7 Optional programs

2.7.1 Database

A database option is available for SmartLink FP. With this option, measurements, statistics and other operator-entered information can be stored in a relational database comprising records and fields. The database contains eight, user-defined data fields, a *part number* field, and a field for the date and time at which measurements were made. The database will be configured by the Hitachi High-Tech Analytical Science installation engineer as part of the installation.

The part number field is used to represent a category of information such as a specific part, a process, a customer, etc. and can be given an alias if required. Each part number consists of one or more applications.

Records are grouped in the database by each part number field. The data can be sorted, viewed or printed in different ways by using the query function. When a part number field is used in a query or search, all the data related to that part number appears in the query results. The other fields can also be used to specify additional search conditions and thus refine the query. The results of the query can be viewed on screen, or printed in a report format by using the SmartDocs report generator.

A default report can be selected and used to print the data. By selecting a part number from the database, you can automatically execute many applications and measure different coatings at programmed locations on the part. Readings can be tagged to mark events during the measurement session.

Before the database can be used, it must be set up with special software tools. When the database has been set up, part numbers can then be created from the existing applications.

To use the database in SmartLink FP, select a part number, enter information in any or all of the user-defined fields, then make measurements. All data is then stored in the database and is grouped by the part number field.

2.7.2 Report generator

The X-Strata920 report generator is an optional program that creates reports of measurements and statistical data made with SmartLink FP. The report generator is an option controlled by the **HASP** key. The reports use measurements and data selected from the SmartLink FP database, or from application files imported into the program. The reports can be printed.

You can select the data to display, and specify how and where it will appear on the report page. Reports can be given a unique appearance by using imported images, custom text fields, borders and background colours. Changes can be made rapidly by dragging and dropping objects to different locations on the page, and by re-sizing them. In addition to creating individual reports, templates can be made to simplify and speed up the creation of new reports. The reports can be used to meet ISO, QSO or FQA reporting requirements, or as a certification document for customers.

3   Installing the X-Strata920

Information   The X-Strata920 will be installed by a Hitachi High-Tech Analytical Science trained Installation Engineer. If it is necessary to re-install all or part of the equipment, contact your local Hitachi High-Tech Analytical Science representative for advice.

3.1   Location of the X-Strata920

Although the X-Strata920 is a laboratory quality precision instrument, the solid-state rugged design permits use in a production environment.

- Place the X-Strata920 on a rigid, level table of adequate size – a minimum of 3 feet to 6 feet (0.91 meters to 1.8 meters).
- Ensure there is sufficient room for the storage of inspected and waiting materials.
- The instrument also requires at least 6 inches (152 mm) of clearance around all sides to allow for proper ventilation and access to power cables and other interconnection cables.
- There must be unrestricted access for air egress from the fan at the rear of the instrument.
- The electrical power supply should be close to the instrument and accessible in normal operation. It is recommended that power conditioners are installed to provide maximum stability of the input voltage. Refer to chapter 2 for information on electrical and environmental requirements.

3.2 Connect the cables

3.2.1 X-Strata920 rear panel connections

Fig. 3-1 shows the rear of an X-Strata920 analysis chamber. Connect the cables as shown. Refer to tab. 3-1 for cable identification.

Fig. 3-1   Rear view of the X-Strata920

3.2.2 Computer rear panel connections

Fig. 3-2 shows a typical rear view of a computer. The identification letter corresponds to the marking on the cable.

Connections to the computer may change if the computer model is updated.
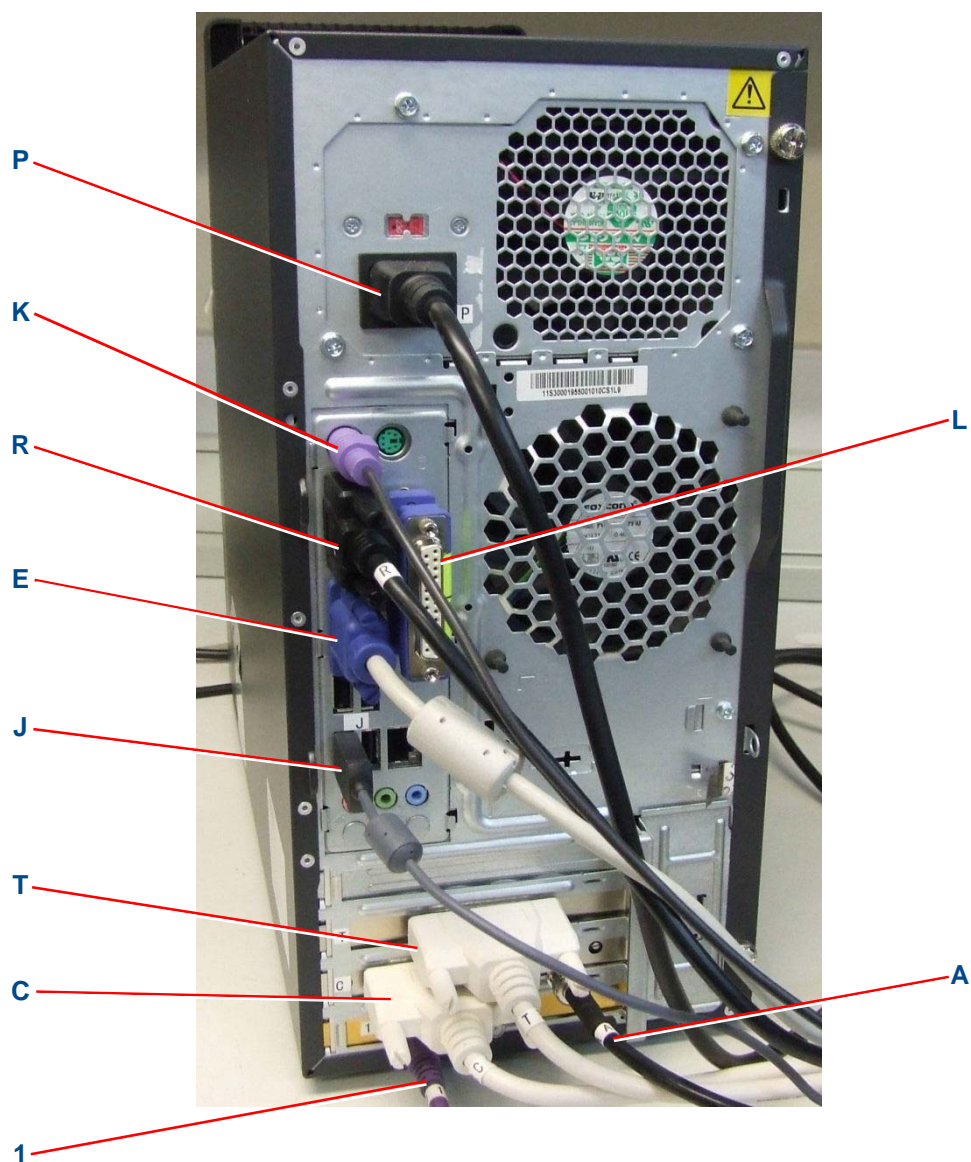
Fig. 3-2   Typical rear view of computer

Table 3-1   Computer and chamber cable identification

Computer connection	Chamber connection	Identification
A	B	BNC to BNC analogue signal coaxial cable.
C	D	25-pin male to female interface cable.
T	U	25-pin male to female interface cable.
1	I	In-line composite video connection via interface box H.
R	S	RS 232 serial cable (for X/Y table option).
	Q	Power connector at the chamber.

Table 3-2   Computer connector identification

Connector	Identification
K	Keyboard connector.
J	Mouse connector.
P	Power connector at the computer.
E	Monitor cable connection.
L	Optional printer cable connection.

3.3 Configure the software

3.3.1 Set up the database

On a new system, the database is unstructured and the fields are blank. Before the database option can be used with SmartLink FP, the system must be configured to your specifications. You must decide what information is to reside in each of the eight fields, and how they are to be named. The Hitachi High-Tech Analytical Science technical representative will set up the database as part of the installation process.

To prepare the database for use, a Hitachi High-Tech Analytical Science technical representative uses special software tools to modify the computer system registry with the data field names you have selected. When this has been done, these fields become a permanent part of the SmartLink FP operating system and cannot be changed.

It is not necessary to use all of the fields of the database, but future requirements should be considered before the database is set up and the registry is modified.

SmartLink FP can be used to take measurements before the database is set up. From the *MEASURE SAMPLES* mode an application, a calibration or Spectrum Counts can be used to make measurements.

3.3.2 Set up the print header

Information   This option is only available if the database option is NOT installed.

The fields in the print header can represent a specific category of information; such as work orders, customers, operators, or plating lines, etc. A thorough review of your present operation, requirements, and objectives must be completed before naming the fields.

Once the labels for the fields have been entered, they cannot be changed.

1. Click **Setup** in the main menu.
2. Click **Print Header** in the menu that appears.

4 Getting started

4.1 Front panel controls

X-rays ON warning lamp

Power ON lamp

START button

X-rays Enable/ Disable key switch

X-ray Shutter Open lamp

STOP button

Emergency stop button

Fig. 4-1 X-Strata920 front panel controls

4.1.1 Emergency stop button

A single push of the red emergency stop (**EStop**) button quickly shuts off electrical power to the equipment and places it in a shutdown condition. To operate:

1. Push in the **EStop** button on the front panel of the equipment.

To release the **EStop** button:

1. Twist the **EStop** button in either direction.

The button pops out to its original position. After releasing the **EStop** button, electrical power is not restored to the equipment until the green **Start** button is pressed.

NOTICE	**Loss of data and risk of damage**

Activation of the **EStop** button removes electrical power which could result in the loss of data.
- Only use the **EStop** button in emergencies and not as the primary power down method.
- Frequent use of the **EStop** button may reduce the life of the X-ray tube.

4.1.2 Switching X-rays ON

The SmartLink software is password protected. The correct password must be entered before the software will run, which then applies power to the X-ray tube and X-rays will be generated.

4.1.3 Switching X-rays OFF

Using the correct power-on and power-off procedures will prolong the life of the X-ray tube. The correct methods of switching X-rays off are:

1. Exit SmartLink software.
   A pop-up message opens, allowing you to confirm that you want to power off the X-ray tube.
2. To turn off power to the X-ray tube without exiting the SmartLink software:
   - Select Maintenance, Technician and click the Power Off button.

Information The availability of this option depends upon the password level in use.

4.1.4 X-ray enable/disable key switch

Power to the X-ray tube is disabled by turning the X-ray key switch to the **Disable** position.

Information The X-ray key switch should normally be used only to disable X-ray generation when X-rays have already been switched OFF by one of the methods in chapter 4.1.3.

NOTICE	**Risk of X-ray tube damage!**

The X-ray key switch should only be used for maintenance, or when shut down, and not as the primary means of switching X-rays off. Incorrect use of the X-ray key switch may reduce the life of the X-ray tube.

4.2 Start up and shut down the system

Follow the recommended power on and power off procedures to prolong the life of the X-ray tube.

4.2.1 Start the system

Switch the hardware units ON in this order:

1. X-Strata920:
   • Switch power ON at the rear panel of the X-Strata920 (see fig. 3-1).
   • Press the green (start) button on the front panel.
2. Computer.
3. Monitor.
4. Printer.

4.2.2 Shut down the system

Exit the program before switching the system OFF:
• Click **Exit** on the Menu bar, OR
• Click the **X** icon in the upper right of the display.

This switches OFF electrical power to the X-ray tube and shuts down the program.

Switch the hardware units OFF in this order:

1. Shut down the computer using the Windows shut down sequence.
2. Press the red (stop) button on the X-Strata920.
3. Switch off the monitor.
4. Switch off the printer.

4.3 Log on and off

4.3.1 Log on

The Log On dialogue box opens when:
- the SmartLink FP program is first started

OR

- the previous user has logged out.
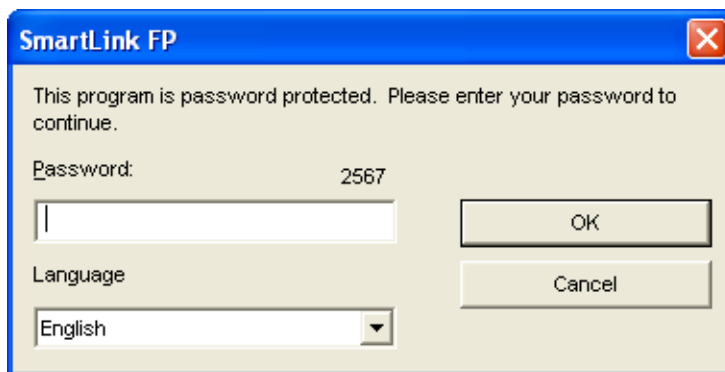
1. Enter your password, which appears as asterisks for security.
2. Click **OK**.

If you enter a valid password, SmartLink FP opens and access to the system is granted.

4.3.2 Lost password

If you have lost your password or SmartLink FP does not recognise a valid password:

1. Note the number displayed in the bottom, right of the Log On dialogue box.
2. Call Hitachi High-Tech Analytical Science Technical Support, who will provide you with a temporary password for use only once. Contact details are given in chapter 13.3.

☞ *Information* The four-digit number changes each time you start SmartLink FP or log off. Ensure that you report the current number to Hitachi High-Tech Analytical Science Technical Support.

3. Log on using the temporary password.
4. Enter a permanent password in the Password Maintenance program to allow future access to the system.

4.3.3 Log off

☞ *Information* To prevent unauthorised use of the X-ray system, you must log off when finished. Logging off clears all results from the measurement screen.

- Click **Log Off** in the Main menu.
  The SmartLink FP dialogue box opens so that the next user can log on. X-ray power remains ON until SmartLink FP is closed by clicking the **X** box at the top of the menu.

4.4 SmartLink Auto Lock

SmartLink Auto-Lock is a software feature whereby the user interface is locked from user inputs after a period of inactivity.

In this context, inactivity is defined as no user activity (mouse or keyboard) and no measurements taking place.

The software displays a log-in dialogue as soon as a period of inactivity longer than the time-out period is detected.
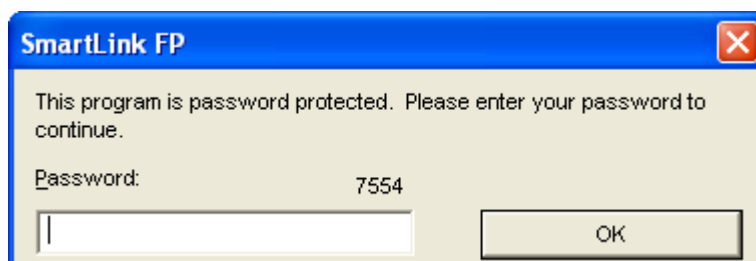
You can unlock the user interface by entering a password that has the same user access rights as the password that was used to log into SmartLink.

The software can also be unlocked by requesting a temporary password from Hitachi High-Tech Analytical Science Customer support. The temporary password is calculated from the 4-digit number displayed in the log-on dialogue (7554 in the image above).

Information Auto-lock does not clear results from the measurement screen.

4.4.1 SmartLink Auto Lock setup

The Auto-Lock feature can be customised by using the Auto-Lock tab in the Options dialogue box.
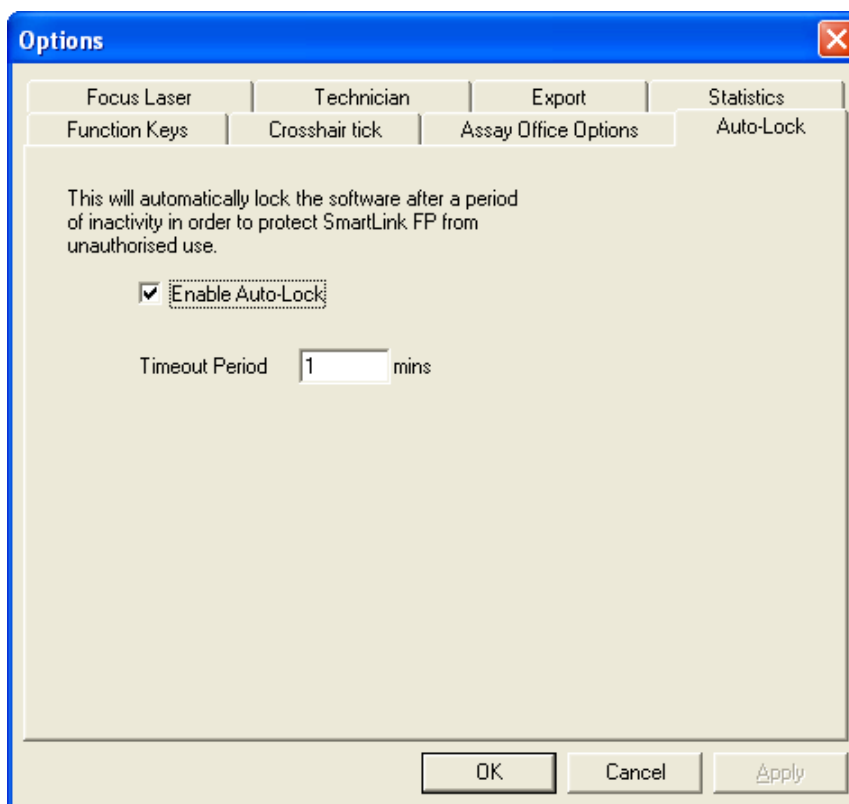
1. Tick the Enable Auto-Lock check box to enable the lock.
2. Adjust the time out period by entering a value (minutes) in the **Timeout Period** box. Only numbers of 1 or more are accepted. The default auto-lock time-out period is 15 minutes.
3. Clear the check box to disable the lock if it is not required.

4.5   Menus

Open menus on screen by clicking with the mouse or by using keyboard shortcuts.

Table 4-1   Keyboard shortcuts

Function	Keyboard Shortcut
Menus	To access a menu, press and hold the **<ALT>** key, then press the key that corresponds to the underscored letter of the menu you want to access.
Tabs	From a menu, move through the various tabs (Video, Parameters, Spectrum, Standards, etc.) by pressing the **<F5>** or **<F6>** key. The **<F5>** key moves to the left: the **<F6>** key moves to the right.
Standards Table (ROI calibration)	This shortcut applies when making or editing an ROI calibration. On the Standards tab, use the **<F7>** and **<F8>** keys to navigate the standards table. Press the <**F7>** key to move down the table. Press the **<F8>** key to move up the table. On the Spectrum tab, use the **<F7>** and **<F8>** keys to display the spectra for each of the items in the standards table (if they have been measured).

4.5.1 Main menu

The Main menu is located at the top of the screen and allows access to the features and options of the system.

Fig. 4-2   Return to main menu

Click a menu item to open a drop-down submenu which lists the tasks or features that can be selected. Not all menu items are shown, depending on the type of screen in use.

Table 4-2   Main menu items

Menu item	Description	Accessibility
File	Opens the **File** submenu from which file tasks such as **open**, **save**, or **print** can be performed.	This option is not accessible from the Spect Cal screen.
Spectrum	Opens the **Spectrum** submenu from which spectrum data can be saved, exported, or printed.	Only accessible from the Calibrate and Measure Samples screens.
Stats	Opens the **Statistics** submenu, which controls how the measurement statistics are displayed and saved.	Only displays from the Measure Samples screen. Menu items are accessible only when using an application to make measurements.
Task	Opens the **Task** submenu, which contains the same functions that can be accessed directly by clicking on the appropriate icons on the taskbar.	
Setup	Opens the **Setup** sub menu. Four operations can be performed: 1 Part numbers can be added or removed if the database option is installed. 2 Information can be added to the print header fields if the database option is not installed. 3 Custom units can be defined and edited. 4 The **Options** submenu for specifying global system variables can be accessed.	
Video	Opens the **Video** submenu. Two operations can be performed: 1 Characteristics of the video display can be adjusted. 2 The screen image of the part in the measuring chamber can be captured and saved.	
View	Used to open or close the Taskbar and Status Bar on the screen.	
Maintenance	For use by a technician, or using a high level password, to adjust operational characteristics of the X-ray system and to maintain the data files.	
Exit	Exits the program and switches off the power to the X-ray system.	
Logoff	Signs off the system after use, thus preventing unauthorized use of the X-ray system. A dialogue box opens for the next user to log in.	
Help	Accesses the help system.	

4.5.1.1 Setup menu

Access the Setup menu by clicking **Setup** on the Main Menu.

Table 4-3   Setup menu items

Menu item	Description
Database	Only accessible if the database option is installed. Used to access the Database Maintenance menu to set up new part numbers, and to modify, copy or delete existing part numbers.
Print Header	Only accessible if the database option is NOT installed. Used to name the labels for the eight data fields that can be used in a report.
Custom Unit	Used to define custom units of measurement to be added to the system. The standard units provided in the system are mil, micro-inch, millimetre, and micrometre. The custom units can be specified when setting up a calibration.
Options	Used to globally configure certain options of the system. From this menu the focus laser time, export configurations for the Surfer option, XY Table movement specifications, system coordinates, Z axis controls and disabling of statistics can be performed.

4.5.2   Menu bar

The menu bar below the Main menu contains icons that are used to directly access functions that appear on the **File** submenu. It also contains the **Print Preview** icon. Not all of the icons may be accessible, depending on the task selection made from the Main menu.
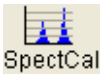
Table 4-4   Menu bar icons

Icon	Description
	New – click to open a new screen, e.g. in the Calibration Menu it opens a new calibration screen. This icon is not accessible from the Measure Samples or Measure Parts screens.
	Open – click to open an existing file such as an application, a program, or a calibration. This icon is not accessible from the Measure Samples or Measure Parts screens.
	Save – click to save information from the active screen. The program prompts for a file name and location when saving a new file. This icon is not accessible from the Measure Samples or Measure Parts screens.
	Print – click to print a report from an application. If the database option is installed, it can also print a report from the Measure Parts screen. The readings are printed in the default report format selected for the application or part number. This icon is only accessible from the Measure Samples or Measure Parts screens.
	Print Preview – click to display the default report for the selected application or part number, and the data specified in the query.

4.5.3 Taskbar

Many of the features in the **Task** submenu can also be accessed directly by clicking icons displayed on the taskbar beneath the Main menu.

Table 4-5   Taskbar icons

Icon	Description
SpectCal	**Spect Cal** – click to perform a spectrum calibration (see chapter 5.2).
Measure	**Measure** – click to make measurements of samples using an application, a calibration or counts.
Parts	**Parts** – click to measure parts using the database, or to maintain the database. This icon only appears when the database option is installed.
Assay	**Assay** – click to measure the gold content (in carat) when analysing gold samples in jewellery, coins, gold bars, etc. Assay is an optional function.
Cal FP	**Cal FP** – click to make a new calibration or modify an existing calibration using the FP method.
Cal	**Calibrate** – click to make a new calibration or modify an existing calibration using the ROI method.
Apps	**App**s – click to create a new application or modify an existing application.
Pattern	**Pattern** – click to make a new pattern or modify an existing pattern.
Program	**Program** – click to create a program or modify an existing program.

4.5.4 Status bar

The Status bar is located across the bottom of the screen and displays information about the X-ray system and the measuring sequence. Table 4-6 lists the items in the Status bar, from left to right.

Table 4-6   Status bar items

Item	Description
System status	This box displays the status of the system, which is normally *Ready*. It also describes the function of the menu or icon that the mouse pointer is resting on.
Parameter 1	This box displays an operating parameter of the X-ray tube. It is used by technicians for diagnostic purposes.
Parameter 2	This box displays another operating parameter of the X-ray tube. It is used by technicians for diagnostic purposes.
Collimator size	This box displays the size of the collimator that is selected for the measurement.
Filter	This box displays the filter that is selected, if any, for the measurement.
X-position	Displays the X position coordinate (R-value) of the crosshairs with reference to the current origin.
Y-position	Displays the Y position coordinate (Theta value) of the crosshairs with reference to the current origin.
Z-position	Displays the Z position coordinate with reference to the current origin.
Measuring system status	Displays the measuring system status. Normally **Idle**, but different messages appear during the measurement cycle, such as **Wait Power**, **Measuring** or **Shutter Timeout**.

4.5.5 Check boxes

Conventional Microsoft Windows check boxes occur extensively throughout SmartLink FP. For ease of explanation, this convention is used in this handbook:

- To tick a check box means to click in the box so that it contains a tick ☑ . When a box is ticked, its associated function is enabled.
- To clear a check box means to click in the box so that the tick is removed ☐ . When a box is cleared, its associated function is disabled or, if the check box has a toggle action, the alternative function is enabled.

5   Calibration

5.1   Calibrate screen
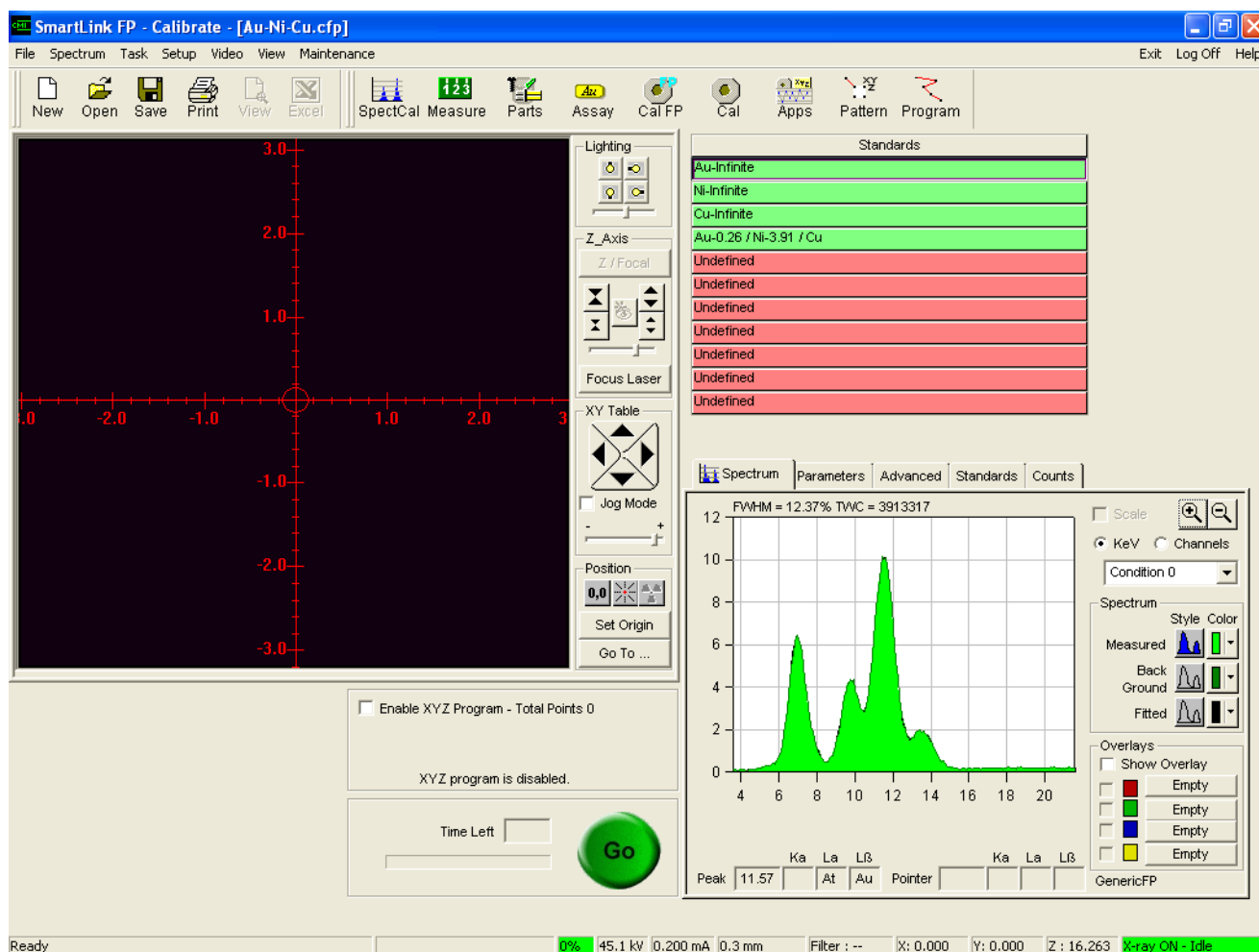
Fig. 5-1   Calibrate screen

The Calibrate screen has two main panels. The information in the bottom panel depends on the selected function tab (Spectrum, Parameters, Advanced, Standards, Counts). The top panel contains the standards table, which lists the standards required to complete the calibration and indicates, by colour, which standards have been measured.

5.1.1 FP calibration screens

5.1.1.1 Select Element menu
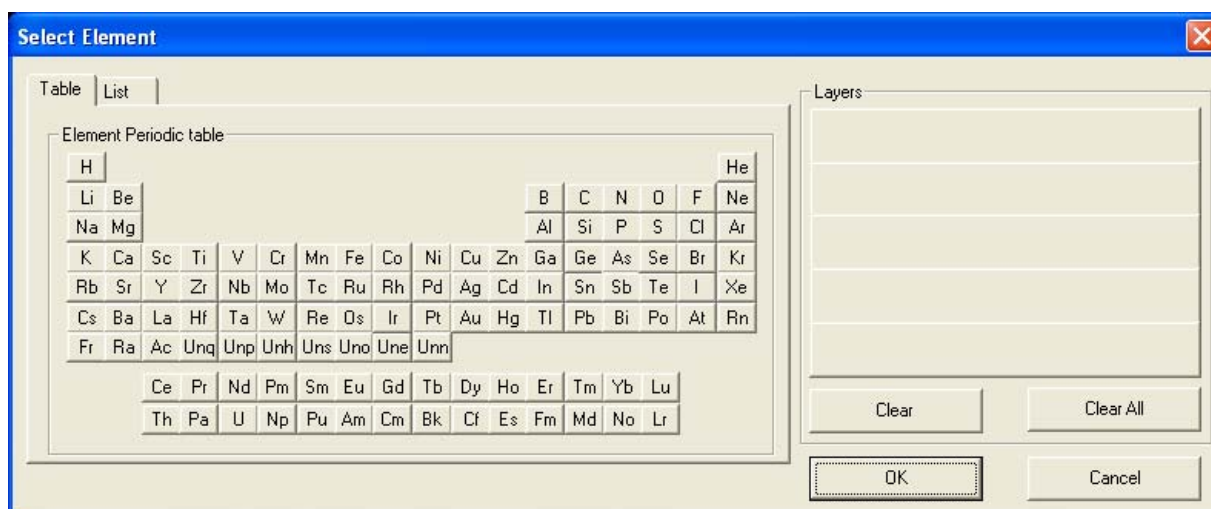
Fig. 5-2   Select Element menu

An FP calibration requires you to define the content(s) of each layer by selecting the chemical elements to be used in the calibration. This is done from the Select Element menu. Open the menu by clicking the **Calibrate FP** icon on the taskbar, then click the **New** icon on the menu bar.

The menu is divided into two panels. The left panel contains two tabs, either of which can be used to select an element and move it to the desired layer in the calibration. The right panel pictorially represents a cross-section of the calibration being set up. It displays five blank layers – the maximum number that can be measured.

Table tab   Displays all the available chemical elements as they are located in the Table of Elements. To select an element, click and drag it to the desired layer on the right panel of the menu.

List tab   Displays all the available elements in alphabetic order. Click and drag a desired element to the appropriate layer on the right panel of the menu.
Also displayed are four items of information about the element currently selected: element name, numeric location in the Table of Elements, atomic weight and type.

Layers   Represents a pictorial cross-section of the calibration to be made. Initially, five blank layers are displayed.
Starting at the top layer, select an element from the table or list and drag it to the desired layer.
If a layer consists of an alloy, drag all the elements of the alloy to the appropriate layer.

Clear   Highlight an element and click to remove the element from a layer.

Clear All   Click to remove all the selected elements from the layers.

OK   Click to accept the structure of the calibration and proceed to the Parameters tab.

Cancel   Click to exit the Select Element menu.

5.1.1.2 FP calibration – Spectrum tab
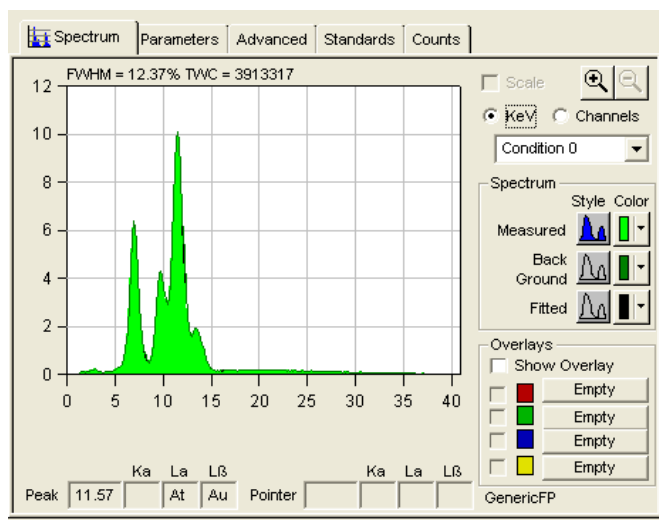
Fig. 5-3 Typical Spectrum tab for FP calibration

This screen opens for FP calibration. It is used to view the spectrum of the elements recorded in a calibration or a measurement. The screen can be used to compare the measured spectrum against spectra of known elements or standards that have been saved. The screen is accessed from the Measure and Calibrate screens.

Spectrum display
The centre of the display contains a spectrum of the sample being measured. The x-axis shows the location of the spectral information in keV or channels. The y-axis defines the counts per second (CPS) that were measured.

When a measurement is taken on a sample, a graphical representation of the data begins to appear on the display. The peaks represent the chemical elements contained in the sample. The horizontal location of a peak energy is specific to a given element.

Magnification and reduction icons
These icons are used to enlarge or reduce a portion of the spectrum for closer analysis. To zoom in,

1. Click and drag the mouse over the region of the spectrum to be enlarged.
2. Click the **Zoom In** icon.
3. To return to the original spectrum, click the **Zoom Out** icon.

FWHM
This value is computed by the software and is displayed at the top left of the graph. FWHM is the acronym for *full width half maximum* and refers to the width of the element spectrum at one half of the peak value. It is a measure of the resolving power of the system.

KeV or Channels
Select the units used to display the spectral data by clicking on the **KeV** or **Channels** button.

Spectrum The type of spectrum to display, and its colour, are selected from the controls in this area of the screen.

Table 5-1   *Controls on the FP calibration – Spectrum screen*

Component	Description
Color	These three buttons select the colour for each of the spectrum displays. Click the button to open a colour palette, then click the required colour.
Style	Select the type of spectrum to display by clicking one of these buttons: **Measured** – displays the measured spectrum. **Background** – displays a spectrum with corrections made by the SmartLink FP algorithms for the background present in the measurement. **Fitted** – displays a spectrum that the SmartLink FP algorithms have calculated from the measured and background-corrected spectrums.

Spectrum overlays Spectra from measurements can be saved in files. For comparison purposes, a previously saved spectrum can be overlaid on the current spectrum. Up to four saved spectra can be overlaid at one time.

Elements panel **Peak**

The **Peak** fields on the Spectrum screen contain information about the area where the highest number of counts occurred for the displayed spectrum.

- The left field contains the KeV/Channel where the highest number of counts occurred. The value of this entry depends on the selection of **KeV** or **Channels** as the display unit of measurement.
- The three right fields contain other elements that emit X-ray energies at the peak location. Elements with Ka, La or Lb emission lines that fall at the location of the peak reading are listed here.

Pointer

When the cursor is positioned inside the graph area, the **Pointer** fields on the Spectrum screen contain information about the **KeV/Channel** at the point where the cursor is located.

- The left field displays the **KeV/Channel** corresponding to where the cursor is located. The value of this entry depends on the selection of **KeV** or **Channels** as the display unit of measurement.
- Elements whose Ka, La or Lb emission lines fall at the location of the pointer are listed in the three boxes on the right.

Printing the spectrum Click the **Print** icon or the **Print** option in the Spectrum drop-down menu to print a copy of the displayed spectrum.

5.1.1.3 FP calibration – Parameters tab

Fig. 5-4   Parameters tab for FP calibration

Use this tab to specify the parameters to be used when making the FP calibration. Use the **Standards** tab to enter information about the thickness and % composition of each layer of the standards used in the calibration.

The **Parameters** tab for new calibrations displays the default settings of the system. The information can be left as shown or changed as required. The **Parameters** tab for existing calibrations displays the information that was entered and saved when the calibration was last made or modified.

The choice of parameters depends on the type of materials involved in the calibration and the application. Contact Hitachi High-Tech Analytical Science for assistance with these selections. Table 5-2 lists the functions for which parameters can be defined.

Table 5-2   Controls on the FP calibration Parameters screen

Title	Description
Hardware Settings	On units equipped with the multi-collimator option, select the size of the collimator to be used for measuring the standards. Click the menu box arrow and select a collimator from the sizes offered in the drop-down menu. If required, specify the operating voltage and current of the X-ray tube.
Calibration Information	Enter descriptive information about the calibration in the field. The date of the latest modification made to the calibration is displayed.
Measurement Settings	Specify the reading time and the number of decimal places (precision) to be recorded. The calibration reading time specified should not be less than four times the value of the anticipated measure time, when the calibration is used to measure samples. Click on the menu box arrow to select the units of measure. If custom units have been defined, select them from the drop-down menu.

5.1.1.4 FP calibration – Advanced tab
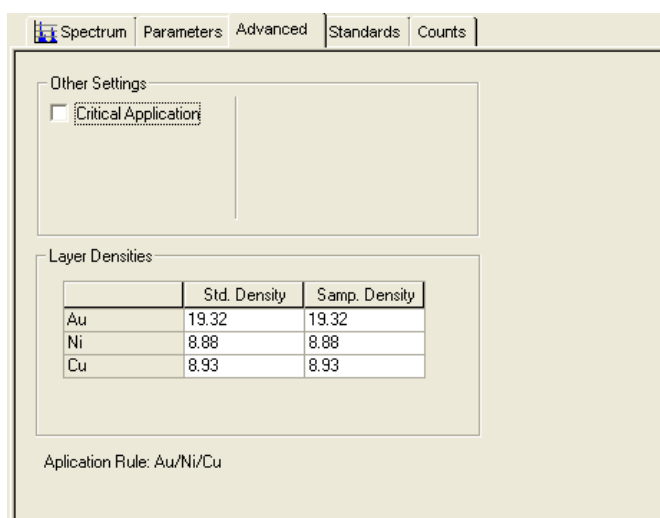
Fig. 5-5   Advanced tab for FP calibration

Table 5-3   Controls on the Advanced tab for FP calibration

Title	Description
Other Settings	This section is reserved for future developments.
Critical Application	Tick this box to designate this calibration as a critical application. Calibrations so designated suggest a spectrum calibration is performed whenever the calibration is selected for use in a measurement session, or whenever more than 30 minutes have elapsed since the last spectrum calibration.
Layer Densities	A table displays the standard density for each of the chemical elements specified in the calibration. Enter values in the **Sample Density** column for chemical elements whose density differs from the standard. The FP algorithms use this value to adjust the calculation of that element's thickness or concentration. The entered value is used for that element's density in all layers in the calibration.

5.1.1.5   FP calibration – Standards tab

Fig. 5-6   Standards tab for FP calibration

This screen contains a table that displays information about the required standards for the calibration. The table contains columns for thickness and percentage composition of each layer in the calibration. If a layer contains more than one chemical element, the percentage composition for each element and the thickness of the layer must be entered.

Information about optional standards to be measured and included in the calibration is added to the table from this screen.

1.   Click the first line in the table.
2.   Enter the thickness and/or composition information.
3.   Press the **<tab>** key to move to the next column.
4.   If information for another standard must be entered, go to the next line in the table.

5.1.1.6   FP calibration – Standards table

	Au Layer	Ni Layer
Standards	Thickness	Thickness
Au/Ni/Cu	0.26	3.91
Au/Ni/Cu	0.00	0.00
Au/Ni/Cu	0.00	0.00
Au/Ni/Cu	0.00	0.00
Au/Ni/Cu	0.00	0.00
Au/Ni/Cu	0.00	0.00
Au/Ni/Cu	0.00	0.00
Au/Ni/Cu	0.00	0.00

Fig. 5-7   Standards table on the FP Calibrate screen

The standards table displays in the right panel of the Calibrate screen. It lists all of the infinite standards to be measured for the defined calibration. Optional standards that have been entered from the standards tab also appear. The status of each standard is indicated by the colour as explained in table 5-4.

Table 5-4   Colours used in the standards table

Colour	Status of the Standard
Red	A required standard that is unmeasured.
Grey	An optional standard that is unmeasured.
Green	A required standard that has been measured during this session.
Blue	A required standard that has been measured in previous sessions, and the reading has been stored.
Yellow	An optional standard that has been measured, but whose readings will not be used to calculate results.

5.1.1.7 FP calibration – Counts tab

| Standards | Co | | | -- | |
	Au	Ni	Cu	Au	Ni
Au-Infinite	1.00000	0.00000	0.00000	1.00000	0.00000
Ni-Infinite	0.00000	1.00000	0.00000	0.00000	1.00000
Cu-Infinite	0.00000	0.00000	1.00000	0.00000	0.00000
Au-0.26 / Ni-3.91 / Cu	0.10044	0.39517	0.02800	0.11837	0.41989
Undefined	0.00000	0.00000	0.00000	0.00000	0.00000
Undefined	0.00000	0.00000	0.00000	0.00000	0.00000
Undefined	0.00000	0.00000	0.00000	0.00000	0.00000
Undefined	0.00000	0.00000	0.00000	0.00000	0.00000
Undefined	0.00000	0.00000	0.00000	0.00000	0.00000
Undefined	0.00000	0.00000	0.00000	0.00000	0.00000
Undefined	0.00000	0.00000	0.00000	0.00000	0.00000

Fig. 5-8   Counts tab for FP calibration

The Counts tab contains a table that displays the counts recorded for of each of the measured standards.
For an FP calibration, normalised values are shown.

5.1.2 ROI calibration

5.1.2.1 ROI calibration – Spectrum tab
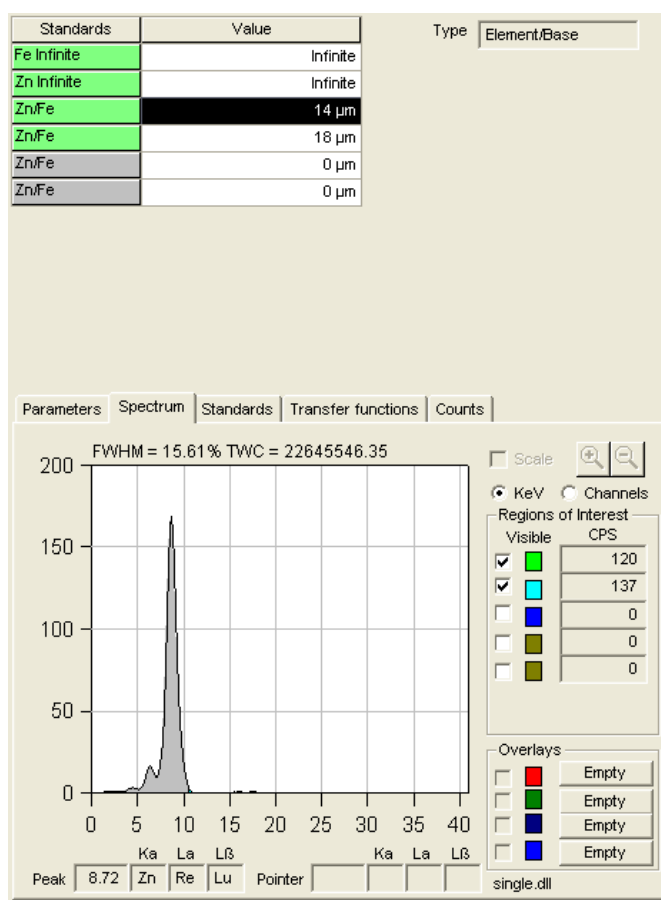

Fig. 5-9   Typical Spectrum tab for ROI calibration

This screen opens when an ROI calibration is run. It is used to view the spectrum of the chemical elements recorded in a calibration or a measurement. It can be used to compare the measured spectrum against spectra of known elements which have been saved. The screen is accessed from the Measure and Calibrate screens.

Spectrum graph	The graph shows a spectrum of the sample being measured. The x-axis shows the location of the spectral information in keV or channels. The y-axis shows the CPS that were measured.

When a measurement is taken on a sample, a graphical representation of the data begins to appear on the graph. The peaks represent the chemical elements contained in the sample. The horizontal location of a peak is specific to a given element. The background appears as a thin blanket of counts along the bottom portion of the graph. For nonmetals, or metals of low atomic number, the background appears as a wide peak across a large part of the spectrum. To expand a section of the spectrum, a portion of the curve may be selected and enlarged.

Magnification and reduction icons

These icons are used to enlarge or reduce a portion of the spectrum for closer analysis. To zoom in,

1. Click and drag the mouse over the region of the spectrum to be enlarged.
2. Click the **Zoom In** icon.
3. To return to the original spectrum, click the **Zoom Out** icon.

FWHM

This value is computed by the software and is displayed at the top left of the graph. FWHM is the acronym for *full width half maximum* and refers to the width of the element spectrum at one half of the peak value. It is a measure of the resolving power of the system.
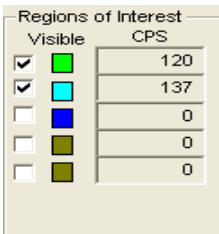
KeV or Channels

Select the units to display the spectral data in by clicking on the button adjacent to either **KeV** or **Channels**.

Regions of Interest panel

ROI are defined parts (regions) of the spectrum that can be highlighted in different colours so that they are easily distinguished. Up to five ROI can be selected at one time. Table 5-5 describes of the Region of Interest panel on the Spectrum screen.

Table 5-5   Controls on the Regions of Interest panel

Component	Description
	Visible – tick one of the five check boxes to display a defined portion (the region of interest) of the spectrum on the spectrum graph.
	The coloured box shows the colour for the selected region of interest (1 to 5).
	Click buttons 1 to 5 to specify the colour of the box and the energy range for the desired region of interest. Once an energy range has been defined, counts continue to be displayed, even though the tick has been removed from the **Visible** check box.
	CPS displays the total counts per second associated with the defined region of interest. If a reading is taken that is less than or greater than 1 second, the counts are converted to the equivalent of a 1 second reading.

Spectrum Overlays panel

Spectra from measurements can be saved in files. For comparison purposes, a previously saved spectrum can be overlaid on the current spectrum. Up to four saved spectra can be overlaid at one time.

Elements panel

Peak

The **Peak** fields contain information about the area where the highest number of counts occurred for the displayed spectrum.

- The left field shows the KeV/Channel where the highest number of counts occurred. The value of this entry depends on the selection of **KeV** or **Channels** as the display unit of measurement.
- The other three fields show other element(s) that emit X-ray energies at the peak location. Elements with Ka, La or Lb emission lines at the location of the peak reading are listed here.

Pointer

When the cursor is positioned inside the graph area, the **Pointer** fields contain information about the KeV/Channel where the cursor is currently located.

- The left field shows the KeV/channel corresponding to the location of the cursor. The value of this entry depends on the selection of **KeV** or **Channels** as the display unit of measurement.
- Elements whose Ka, La or Lb emission lines fall at the location of the pointer are listed in the three other fields.

Printing the spectrum

Click the **Print** icon or the **Print** option in the Spectrum drop-down menu to print a copy of the displayed spectrum.

5.1.2.2 ROI calibration – Parameters tab

Fig. 5-10   Parameters tab for ROI calibration

This tab specifies the parameters that will be used when making the calibration.

The Parameters tab for new calibrations displays the default settings of the system. The information can be changed if required.

The Parameters tab for existing calibrations displays the information that was entered and saved when the calibration was made.

The choice of parameters depends on the type of materials involved in the calibration and the application. Contact Hitachi High-Tech Analytical Science for assistance with these selections.

Parameters can be entered in the fields listed in table 5-6.

Table 5-6   Controls on the ROI calibration Parameters screen

Title	Description
Calibration	This field is blank when a new calibration file is being made. When you open an existing calibration file, the field shows the name of the file.
Last Modified	The date when the calibration file was last saved.
Collimator	Shows the collimator size. Units equipped with more than one collimator contain a list of available collimators. Choose the largest collimator size that best fits the area to be measured. The shape and size of the crosshairs on the **Video** tab reflect the collimator selected.
Units	Enter the unit of measure to be used for the thickness measurement of the calibration standards. Select the desired unit of measure from the list of available units. Custom units are also be displayed. It is suggested that you choose the same units as those of the standards to be used in the calibration.
Precision	Enter the number of decimal places to be included in the value of the reading. Enter an integer between 0 and 5. It is suggested that you use the same number of decimal places as those of the standards to be used in the calibration.
Reading Time	Enter the time used to take measurements of each calibration standard. The default value is 60 seconds for a 12 mil collimator. When using smaller collimators, increase the reading time. The value should be at least 4 times the anticipated period of time to be used when making measurements.
Use XYZ Pattern to Measure Standards	Tick this check box to use an existing XYZ pattern to automatically measure each of the standards in the calibration. This option is available for the XY table option only.
Description	Enter comments about the calibration in this field.
Cal Factor	This option is available only when making a composition calibration. The default value is one.
Element	Displays the chemical elements selected for the type of calibration.
ROI	Displays the default region of interest in KeV, where each listed element fluoresces. These values can be changed.
Filter / Numerical Filter	These fields show the recommended mechanical or numerical filtering for the application. Click **Filter Wizard** to change these parameters (see chapter 5.1.2.6).
X Time	Enter the multiple of the **Reading Time** to be used to measure the standards for that layer. The default value is one. Change this value to specify a different time for measuring each layer of coating.
Samp. Density	If the density of the sample is different to the **Std. Density**, enter the theoretical mass per unit volume of the samples being measured.
Std. Density	Displays the theoretical mass per unit volume of the standards being used in the calibration.
Critical check box	Enable this option when the application being calibrated has an element and a base whose spectral peaks are in close proximity. With this option selected, if the time elapsed since the last spectrum calibration is 30 minutes or more you are prompted to perform a spectrum calibration. The prompt only appears when performing a calibration in which the **Critical** feature has been enabled. The **Critical** feature is automatically enabled when the application requires a numerical filter.
Absorption check box	To enable this option, tick the adjacent check box. The absorption method analyzes the fluorescence absorbed by the coating. It is used when the coating is a non-metal such as a solder mask, a metal with an atomic number lower than 22, or when you want to define the region of interest to be that of the base material. The energies associated with non-metal coatings and elements that have atomic numbers lower than 22 are too low to be read by the detector. In the absorption method, the calibration records the counts from the region of interest of the base material, instead of the region of interest of the coating. With an absorption calibration, the calibration counts decrease as the thickness increases.

Table 5-6   Controls on the ROI calibration Parameters screen

Title	Description
Thin Coating check box	To enable this option, tick the adjacent check box. Only enable the **Thin Coating** option when measuring very thin coatings where an infinite coating standard is not available. This type of calibration produces a linear curve between the base and the known standard. It is not intended as a replacement for the normalized beta curve, when infinite standards are available. Consult Hitachi High-Tech Analytical Science if you have questions on your specific application. When this option is enabled, the infinite standard and all but one thickness/composition standard are removed from the **Standards Table**.
Ratio Method check box	To enable this option, tick the adjacent check box. The **Ratio Method** option is used when measuring samples of odd configurations on which the camera cannot be focused, or where the focus distance is unknown but you want to use the same calibration. This method allows measurements of plated samples in severely recessed areas, such as chassis and cans, without the need to visually view the test area. The ratio method can only be used for single layer applications and where no mechanical or numerical filters are used.
Br Correction	To enable this option, tick the adjacent check box. This selection appears when certain calibration types are selected where the presence of bromine may interfere with the readings. For example, bromine is found in printed circuit boards, A change is made to add a numerical filter to compensate for the bromine. Also a measurement of a bromine infinite sample is required in the **Standards Table**. When this option appears, the **Critical** option is automatically set.
3 Point Cal	This option appears when making a solution calibration. It is used to provide tracking over a large range of concentrations. When this option is selected, a third solution is added to the standards required for calibration. This provides a more accurate curve by using three points to calculate the transfer function rather than a linear extrapolation.

5.1.2.3 ROI calibration – Standards tab
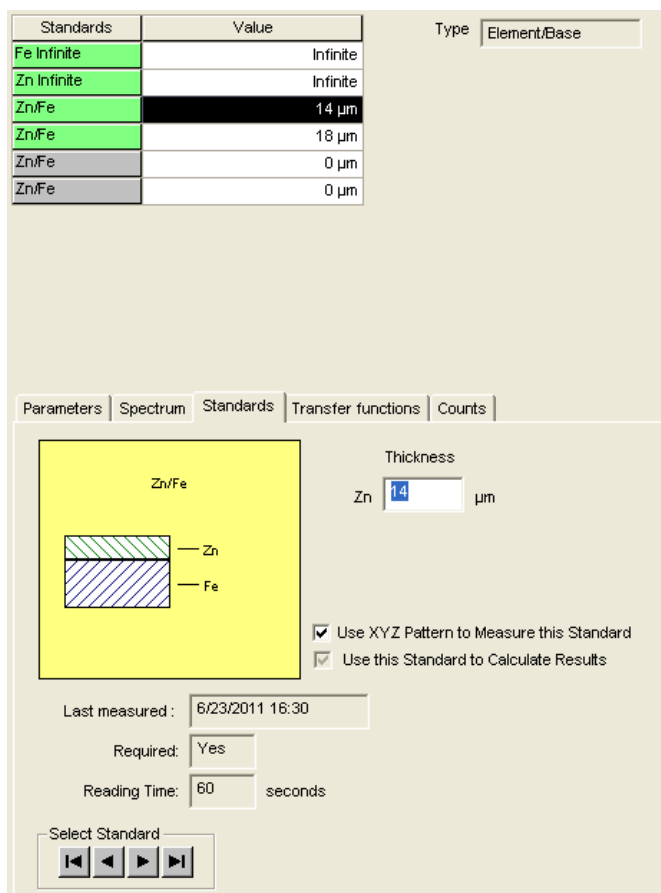
Fig. 5-11   Standards tab for ROI calibration

Click the Standards tab to open the Standards screen. It contains information about the standard highlighted in the Standards Table located to the right of the screen.

Table 5-7   Controls on the ROI calibration standards tab

Title	Description
Diagram	This is a cross-section diagram of the highlighted standard. The number of coating layers varies, depending upon the type of standard.
Thickness/ Composition/ Concentration Field	Enter a value for either the thickness, composition or concentration of the highlighted standard, depending on what type of calibration has been selected.
Use this Standard to Calculate Results	Select to include the measurement data from the highlighted optional standard in the calculation of the transfer function curve. A greyed tick appears in the check box when the highlight is on a required standard.
Last Measured	The date the selected standard was last measured.
Required	Displays *Yes* or *No*, depending whether the selected standard is required for this calibration.
Reading Time	The time used when the selected standard was measured. The time is set on the Parameters tab.
Select Standard Arrows	These arrows navigate through the items in the Standards Table. ⏮ Highlights the first item in the table. ◀ Moves up one line from the current position. ▶ Moves down one line from the current position. ⏭ Highlights the last item in the table.

To enter the thickness, composition or concentration values for a standard:

1. On the Standards Table, highlight the thickness/composition/concentration standard for which a value is to be entered. Infinite standards for chemical elements do not require an entry. Use the mouse to select a standard or use the **<F7>** and **<F8>** keys to navigate through the table entries.

2. Enter the value of the selected standard in the **thickness/composition/ concentration** box on the Standards Tab. The box is highlighted with a **0** displayed.

3. Highlight the next standard to be entered.

4. Repeat steps 1 and 2 for each standard required to complete the calibration. Standards that are required for the calibration and have not been measured are displayed with a red background.

Standards table for ROI calibration

This table lists the standards to be measured for the selected calibration, and the optional standards that can be used for each layer or composition. For most ROI calibrations, only two thickness standards of the same type are required. Up to four thickness standards of each layer or composition are allowed. The type of calibration that has been selected is shown in a display box above the Standards Table.

Table 5-8   Standards table columns

Column	Description
Standards	This column lists the required standards, and the optional standards that can be used. The status of each standard is indicated by the colour of the background displayed (see table 5-4).
Value	This column contains the thickness/composition/concentration of the standard, which has been entered from the Standards tab on the left side of the screen. Until values are entered from the Standards tab, these fields display values of 0. Infinite standards for elements do not require an entry, and display infinite as the value. Infinite standards for compositions require an entry for the known percentage of the materials, and display 0%.

5.1.2.4 ROI calibration – Transfer Functions tab
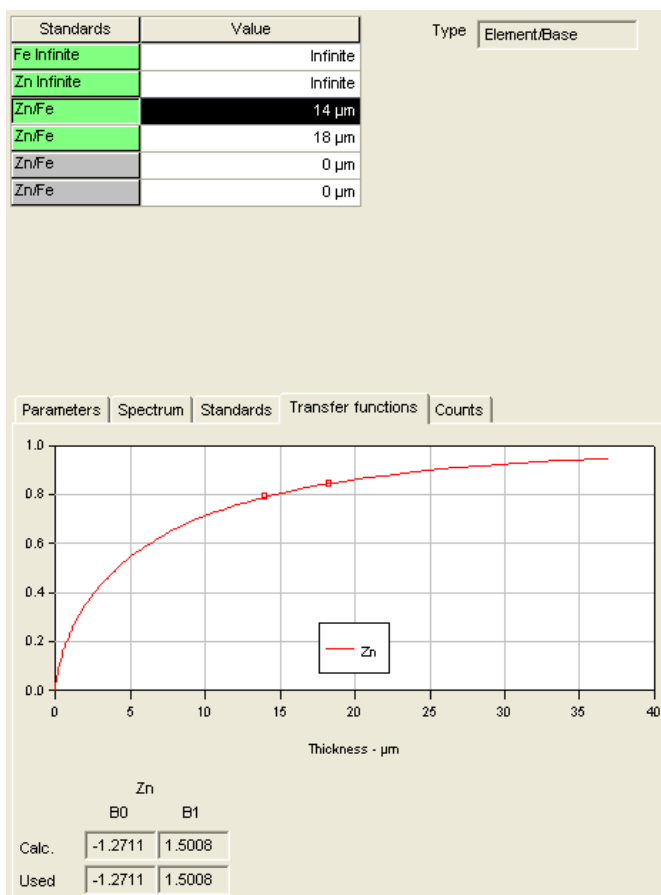
Fig. 5-12   ROI calibration – Transfer Functions tab

The Transfer Functions tab of the Calibration screen displays a graphical interpretation of the curve(s) produced in the calibration. Each coating in the calibration is represented by a curve that is identified in a legend. The X-axis of the graph represents the thicknesses of the standards in the designated units and the Y-axis represents the normalized counts.

The four boxes at the bottom of the tab contain information that can be accessed only by a high-level password and are used to evaluate parameters. The boxes are not used for making calibrations or taking measurements.

5.1.2.5 ROI calibration – Counts tab

For an ROI calibration, the actual counts are displayed, together with additional information: for example the ROI expressed in KeV is shown for each chemical element, and the type of filter(s) used is also shown.

Standards	Value
Fe Infinite	Infinite
Zn Infinite	Infinite
Zn/Fe	14 µm
Zn/Fe	18 µm
Zn/Fe	0 µm
Zn/Fe	0 µm

Type: Element/Base

Parameters | Spectrum | Standards | Transfer functions | **Counts**

		Zn	Fe
	Element	Zn	Fe
	Filter	--	--
	ROI-Low	7.7	5.5
Standards	ROI-High	9.9	7.5
Fe Infinite		246	14275
Zn Infinite		24974	581
Zn/Fe	14 µm	19821	2077
Zn/Fe	18 µm	21181	1385
Zn/Fe	0 µm	0	0
Zn/Fe	0 µm	0	0

Fig. 5-13   ROI calibration – Counts tab

5.1.2.6 Filter wizard

The filter wizard feature automatically determines the proper combination of mechanical and numerical filtering required for the selected calibration type. The wizard displays the results in the Parameters tab. You can use the filter wizard to modify the selections if desired:

1. Click the **Filter Wizard** button from the Parameters tab in *CALIBRATE* mode. The pop-up Filter Wizard window appears.
2. In the Step 1 window, identify all the chemical elements involved in the calibration. You can delete the elements specified, or add new ones to the calibration.
3. Click **Cancel** to leave the filter wizard without saving any of the changes.
4. Click **Next** to move to the next filter wizard screen.
5. The Step 2 window displays the selection of mechanical and numerical filters the filter wizard has specified for this calibration type.
   To change a setting, click the setting and enter the new information. Click **Use Defaults** to revert to the original filter wizard settings.
6. Click **Back** to go back to the Step 1 window.
7. Click **Finish** to leave the filter wizard and save the changes that have been made.

5.2   Spectrum calibration

The spectrum calibration routine (shown as the SpectCal icon in the software), compensates for any change in instrument performance caused by a change in the X-ray tube/detector characteristics. This correction is automatically applied after the SpectCal sample has been measured.

The SpectCal sample is provided with the instrument and has two sections, marked on the SpectCal standard as Cu-Ag and Ag. Measurement involves selection of the SpectCal icon on the screen. A message dialogue box then opens half way down the right side of the screen. It describes the steps required.

Conduct a spectrum calibration once each day before performing calibrations or taking readings, especially if the unit has been turned off. Spectrum calibrations should be done more frequently when using applications where the peaks of the coating and base are very close together. Certain applications prompt you to perform a spectrum calibration before beginning a measurement session.

5.2.1   Perform a spectrum calibration

There are two parts to the spectrum calibration procedure. Both parts must be performed to complete the calibration.

1.   Click **Spectrum Cal** on the taskbar. The Video screen is displayed.
2.   Position the Cu-Ag portion of the Spectrum Cal standard under the crosshairs.
3.   Focus the camera system.
4.   Click **GO**.
      The X-Strata920 begins a series of measurements. Instructions and the progress of the calibration are displayed in the Status window on the right of the screen.
      When the first portion of the calibration is completed, this message opens:
      Place the pure Ag under the collimator, focus, then click **GO**.
      The calibration is not complete.
5.   Position the Ag portion of the standard under the crosshairs.
6.   Focus the camera system.
7.   Click **GO**.

When finished, this message opens:

Spectrum calibration successful.

If an error message opens, the calibration has not completed successfully. The X-Strata920 may not be operating correctly. Contact technical support before using the instrument for measurements.

5.3 Calibration procedures

5.3.1 Overview of calibration

The calibration process is described below. The details vary slightly, depending on the specific calibration being made, but the process is the same. Two calibration methods are provided:

- FP calibration
  See chapter 5.3.2.
- **ROI calibration**
  See chapter 5.3.3.

1. Select **FP Calibration** or **ROI Calibration** from the Task menu, or click one of the **Calibrate** icons on the taskbar.
2. Click the **New** icon on the menu bar to open a new calibration screen.
3. If making an ROI calibration, select the type of calibration. If making an FP calibration, select the elements to be measured.
4. Specify the parameters for the calibration.
5. Enter the standards data.
6. Measure the required standards individually or use the auto-cal feature. Readings can be taken at one location on a standard, or averaged over an area by using a grid scan pattern.
7. Name and save the calibration file. SmartLink FP identifies the method used to make the calibration as FP or ROI when the file is saved.

5.3.2 Perform an FP calibration

To set up an FP calibration, you must specify the chemical elements in each layer in the coating of the sample to be measured, then enter information in the Parameters tab and the Standards tab. Measurements are then taken on the required standards and the results and the spectrum are saved in a calibration file. This calibration file can be used to measure standards to verify the readings, take measurements on samples with the same type of coatings as those used in the original calibration, and it can be specified when setting up an application file.
Measurements can be taken at a single point on each of the required calibration standards, or a grid scan pattern can be used to take an average measurement over a defined area.
The Auto-Cal feature can be used to specify the grid scan pattern to be used and to automatically measure the selected standards.
When measurements of the calibration standards have been taken, a spectrum graph of the material(s) is produced.

1. Select **Calibrate FP** from the Task menu or click **Cal FP** on the taskbar.
   The Calibrate screen opens.
2. Click the **New** icon on the menu bar to open a new calibration screen.
   The Select Elements menu opens.
3. Click and drag a chemical element from the Table tab or the List tab to the top layer of the five layers shown. The calibration must be defined by starting with the top layer.
4. If a layer consists of an alloy, drag each of the chemical elements that comprise the alloy to that layer.

5. When finished, review the contents of each layer and compare it to the desired calibration.
6. If the layers on the screen are correct, click **OK**, to accept the layer definition and proceed to the Parameters tab.
7. If the layers on the screen are incorrect, click **Clear** to remove selected chemical elements, or **Clear All** to remove all the chemical elements.
8. Click the Parameters tab (see chapter 5.1.1.3).
9. Review the default information that is displayed, and make any changes that are required.
10. Click the Standards tab.
11. Enter the values of all of the standards that are required to complete the calibration.
12. Click the Video tab,
13. To perform an automatic calibration, see chapter 5.3.5.
14. To perform a manual calibration, see chapter 5.3.2.1.

5.3.2.1 Perform a manual FP calibration

1. Highlight the standard to be measured on the Standards Table.
2. Position the standard under the crosshairs.
3. Focus the camera system.
4. Click **GO**.
5. Repeat steps 1 to 4 until all the standards have been measured.
6. Name and save the calibration file.
7. When the readings have been taken, click the Spectrum tab to review the spectrum graph of the chemical element(s) that have been measured.

5.3.3 ROI calibrations

To set up a new calibration, select a calibration type that is representative of the application to be measured, then enter the required information in the Standards Table and the Parameters tab.

Measurements are taken on the required standards and the results and the spectrum are saved in a calibration file. The calibration file can be used to measure standards to verify the readings, take measurements on samples of the same type of coatings as those used in the original calibration, and it can be specified when setting up an application file.

Measurements can be taken at a single point on each of the required calibration standards, or a grid scan pattern can be used to take an average measurement over a defined area.

The Auto-Cal feature can be used to automatically measure the selected standards. If desired, it can also be used to specify a grid scan pattern for the measurement. When measurements of the calibration standards have been taken, a transfer function curve and a spectrum graph of the material(s) are produced.

5.3.3.1 ROI calibration types

There are five different types of calibration that can be made by using the ROI method:

- **Binary Alloy/Base**
  Used to measure the thickness and composition of a binary alloy layer over a base material (e.g. SnPb/Cu).
- **Element/Base**
  Used to measure a single layer of a chemical element over a base material (e.g. Au/Ni, Ni/Fe).
- **Element/Binary Alloy Thk/Base**
  Used to measure a dual layer coating over a base material, where the top layer is a chemical element and the second layer is a binary alloy.
- **Element/Element/Base**
  Used to measure a dual layer coating over a base material, where both of the coatings are chemical elements.
- **Solution**
  This type of calibration is used to measure the concentration of metal ions in a plating solution. It is an option licensed by the **HASP** key.

5.3.3.2 Perform an ROI calibration

1. Select **Calibrate** from the Main menu or click **Calibrate** on the toolbar.
   The Calibrate screen opens.
2. Click the **New** icon on the menu bar.
   The New dialogue box opens.
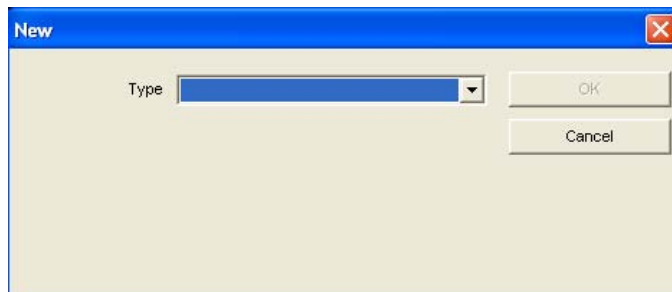
3. Click the arrow of the **Type** box to open the list of calibration types that are available.
4. Select the calibration type that matches the application to be measured. Fields are displayed in the dialogue box for each layer involved in the calibration.
5. Use the arrows to the right of each field to open lists of available chemical elements.
6. From each list, select the chemical element for the indicated layer (Coating, Top, Middle, Base, etc.).
7. Click **OK** to accept the entered parameters.
8. Click the Parameters tab.
9. Review the default information on the Parameters tab and make changes as necessary.
10. When you have made all the changes to the Parameters tab, click the Standards tab.
11. Enter the values of all of the standards that are required to complete the calibration.
12. When you have entered the values of the standards, click the Video tab.
13. To perform an automatic calibration, see chapter 5.3.5.
14. To perform a manual calibration, see chapter 5.3.3.3.

5.3.3.3 Perform a manual ROI calibration

1. Highlight the standard to be measured on the Standards Table.
2. Position the standard under the crosshairs.
3. Focus the camera system.
4. Click **GO** to start the measurement.
5. When the measurement is complete, the Standards Table automatically highlights the next non-measured standard.
6. Check that the correct standard is highlighted.
7. Repeat steps 2 to 4 until all the required standards have been measured.
8. Name and save the calibration file.
9. When the readings have been taken, click the Spectrum tab to review the spectrum graph of the element(s) that have been measured.
10. Click the Transfer Function tab to access the transfer function curve(s).

5.3.4   Use a grid pattern to measure calibration standards

Most calibrations are performed by taking a single reading in the centre of the calibration standard and equating the thickness of the standard to the counts read at the point of measure. If desired, measurements on the standards can be obtained by using a grid scan pattern to average readings over a defined area.

1. Select the type of calibration from the Task submenu, or click on one of the **Calibrate icons** on the taskbar.
    The Calibration screen opens.
2. Click the **New** icon on the menu bar.
3. If an ROI calibration is to be made, make selections from the **New** drop-down menu. If an FP calibration is to be made, choose from the **Select Elements** drop-down menu.
4. Click **OK**.
5. Click the Parameters tab.
6. Enter the parameter information as desired.
7. Click the Standards tab and enter the standards information.
8. Tick the **Enable XYZ Pattern** check box to enable the grid feature.
9. Locate the crosshairs at the point on the standard that is to be used as the corner of the scan pattern.
10. Click the **Add Point** icon. This becomes the datum point for the grid scan pattern selected.
11. Click the **Add Pattern** icon. The Select XYZ Pattern Window, containing all of the XYZ patterns that have been made, is displayed.
12. Select the desired grid scan pattern from the list. *Grid scan* is the only type of pattern that can be used.
13. Click **Open**.
14. Tick the check box to verify the pattern location. The unit moves through the pattern.
15. If desired, click **Delete** to remove the pattern and start again.
16. Click **GO**.
17. Repeat steps 9 to 16 on each standard requiring the pattern measurement.
    The Auto-Cal feature can be used instead of using a grid scan pattern individually on each standard. A quick program can be set up that will use a grid scan pattern to measure all the required standards at the locations selected.
18. Name and save the calibration file.
19. After the readings have been taken, the spectrum graph of the element(s) measured can be reviewed by clicking the Spectrum tab.
20. For an ROI calibration, access the transfer function curve(s) by clicking the **Transfer Function** tab.

5.3.5　Perform an automatic calibration (Auto-Cal)

The Auto-Cal feature allows you to define a point on each standard where a reading will be taken, store the points, then read all the designated standards automatically. Most calibrations are performed by taking a single reading in the centre of the calibration standard and equating the thickness of the standard to the counts read at the point of measure. If desired, measurements on the standards can be made by using a grid scan pattern to average readings over a defined area (see chapter 5.3.4).

1. Select the type of calibration from the Task submenu or click on one of the **Calibrate icons** on the taskbar. The Calibration screen opens.
2. Click the **New** icon on the menu bar.
3. Make selections from the **New** drop-down menu if an ROI calibration is to be made, or from the **Select Elements** drop-down menu if an FP calibration is to be made.
4. Click **OK**.
5. Click the Parameters tab.
6. Enter the parameter information as desired.
7. Click on the Standards tab and enter the standards information.
8. Tick the **Enable XYZ Pattern** check box to enable the grid feature.
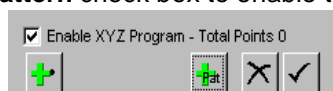
A menu opens.
9. Place the crosshairs at the point on the first standard where a measurement is to be made.
10. Focus the camera system.
11. Click **+**.
     The **Total Points** value beside **Enable XYZ Program** indicates 1.
12. If required, click **+Pat** to select a grid pattern to measure the standards.
     The Select XYZ Pattern Window opens. It contains all the patterns that have been created.
13. Select the desired grid scan pattern from the list.
14. Click **Open**. The grid scan is the only type of pattern that can be used.
     The selected grid scan pattern will be used to measure all standards selected in the Auto-Cal program.
15. Move to the next standard to be measured.
16. Place the mouse crosshairs at the point to be measured.
17. Focus the camera system.
18. Click **+**. The **Total Points** value is now 2.
19. Repeat steps 15 to 18 until all the required standards have been selected.
20. To preview the program, click the tick and verify the location of the points stored in the Auto-Cal program.
21. To delete a point, click the cross.
22. Click GO to start the measurement process.

6 Setup application

6.1 Setup Application screens

6.1.1 Setup Application – Parameters tab

Fig. 6-1   Parameters tab for Setup Application
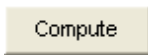
From the **Parameters** tab you can:

- Select the calibration to be used.
- Define the measurement parameters.
- Specify an XYZ program.

When an FP calibration is chosen, the **Known Values** table opens below the **XYZ Programming** panel. Depending on the type of application, values for thickness, composition or concentration can be entered for each layer. If values are entered for a layer, those values are used and readings are not taken for that layer.
The screen contains the features given in table 6-1.

Table 6-1   Controls on the Setup Application Parameters tab

Element	Description
Measurement Parameters panel	
Compute	Click to display a list of the calibration files. Select the calibration to be used and click **Open**.
Measurement Time	The length of the measurement. The value entered is transferred to the measure screen upon selection of the application file. This value should not be less than 25 % of the calibration time. This parameter can also be changed from the measure screen. If a grid scan pattern is to be used in this application; the measurement time is overwritten by the scan time that is selected during programming.
Select	Click to display the Compute Measurement Time menu. Enter values for the standard deviation and target thickness, and select an element. Click **Compute** to calculate the optimum measurement time for the values entered.
Units	The units of measurement in which the readings will be displayed. The units selected can be different from those used in the calibration. If the selected calibration uses custom units, these are also displayed and can be selected. Click the arrow key and select the units from the drop-down menu.
Precision	The number of decimal places that will be displayed in the readings. To change this value, highlight this field and enter a new value between 0 and 4.
Critical	Enables the *Critical* feature, which prompts you to perform a spectrum calibration if more than 30 minutes has elapsed since the last calibration. The feature is automatically enabled when the application requires a numerical filter.
XY Search	Toggles the *XY Search* feature on or off. If **XY Search** is enabled, the **Search Wizard** menu appears. Enter the desired data for the search criteria. This feature can also be enabled from the Measure screen.
XYZ Programming panel	
Enable XYZ Program	To select a program to be used with the application, tick the check box. The **Select** button and the display box open.
Compute	Click to display a list of existing XYZ program files. Select the required file from the list and click **Open**.

6.1.2   Setup Application – Print Options tab

Fig. 6-2   Setup Application Print Options tab

This tab appears when using an application to make measurements.

When the database option is *not* installed, the field labels are defined and entered in the **Print Header** menu, which is accessed from the **Setup** menu.

When the database option is installed, the field labels are copied over from the names given to the fields when the database is setup.

The fields can be used to represent categories of information, which can be selected to print in a report.

Use the Print Options tab to:

- Select a report that you want to print from an application or change the previously selected default report.
- Select when the report is to be printed.
- Select what readings are to be printed.
- Enter data into one or more of the print header data fields. The fields can be selected to print in the report.

The screen contains the following information:

Table 6-2   Controls on the Setup Application Print Options tab

Item	Description
Default Information	Enter the information that you want to appear when the header fields are printed in a report. Information can be entered in any or all of the eight fields.
Print When	Click the button beside the required report printing option. The options are: 1 **On Demand** – print only when required, by clicking **Print** on the toolbar. 2 **When Session Finished or Demand** – print automatically when exiting the measurement application.
Print What	Click the button beside the required option. The options are: 1 **All Readings** – prints all readings in the application file. 2 **Only Current Session** – only prints readings taken during the current measurement session (i.e. before exiting the measurement application). 3 **Select a Range of Readings** – prints a range of readings that is defined from the drop-down **Header Information** menu when printing the report.
Default Report Template	Click **Select Report** to display a menu of the standard reports available in the report generator. Limited changes can be made to these reports such as text changes in the report title block, moving any of the fields or tables to different locations, adding charts or tables, and adding the header data fields. The changes are saved after the report is printed, but no further modifications can be made to the report once it has been saved. The report can be used again to print different data, but changes in the report format or layout cannot be made. Click the report you want to specify as the default for the application, then click **Open**. Click the **Print** icon from an application. The specified measurements/statistics taken with the application and the header field information are then printed in the report.

6.1.3 Setup Application – Stats tab

Fig. 6-3   Setup Application Stats tab

This tab is used to specify a group size for the statistics and to set measurement limits for the application. The group size can also be changed in the **Statistics Parameters** menu, which is accessed from the **Stats** menu. When limits are used, the **Cpk** parameter is added to the statistics summary.

Table 6-3   Controls on the Setup Application Stats tab

The group size is specified globally for the application and applies to all layers.	
Group Size	This field indicates the number of consecutive measurements, taken with this application file, that will be grouped together as one point in the X-bar and R charts. To change the group size, highlight the field and enter the desired value. When the group size is set to a number greater than one, an average of each group is printed after the last reading for that group.
The following features are specified individually for each layer of the application:	
Enable	To enable limits for a layer, tick the check box. When enabled, the readings from this layer are included in, and saved with, the statistics. The readings always display whether the limits are enabled or not.
Limits	To enable limits for a layer, tick the check box. If a reading is outside the set limits, it is identified. The **Cpk** parameter appears in the statistics when limits are used.
Low Limit	Enter the value you want to define for the lower limit. If a measurement exceeds a defined *Low Limit*, the reading is displayed on the screen in red preceded by a downward arrow, indicating that the reading is too low. The reading is also marked with an asterisk (*) in the **Readings** folder of the **Stats** tab.
High Limit	Enter the value you want to define for the high limit. If a measurement exceeds a defined *High Limit*, the reading is displayed on the screen in blue preceded by an upward arrow, indicating that the reading is too high. The reading is also marked with an asterisk (*) in the **Readings** folder of the **Stats** tab.
Corr Slope	This value can be applied after calibration to make a statistical correction to the gradient of the calibration data. The default value is 1.0.
Corr Of	This value can be applied after calibration to make a statistical correction to the offset of the calibration data. The default value is 0.0.

6.1.4 Setup application – Excel reporting

The Excel Export function allows you to export analysis results into a Microsoft® Excel® spreadsheet. For ease of use and flexibility, pre-defined and customisable templates can be selected, depending on customer requirements.

6.1.4.1 Excel reporting setup

The Excel Export function must be setup in the Setup Applications menu.
To create or select an application:

1. Go to the Excel Export tab.
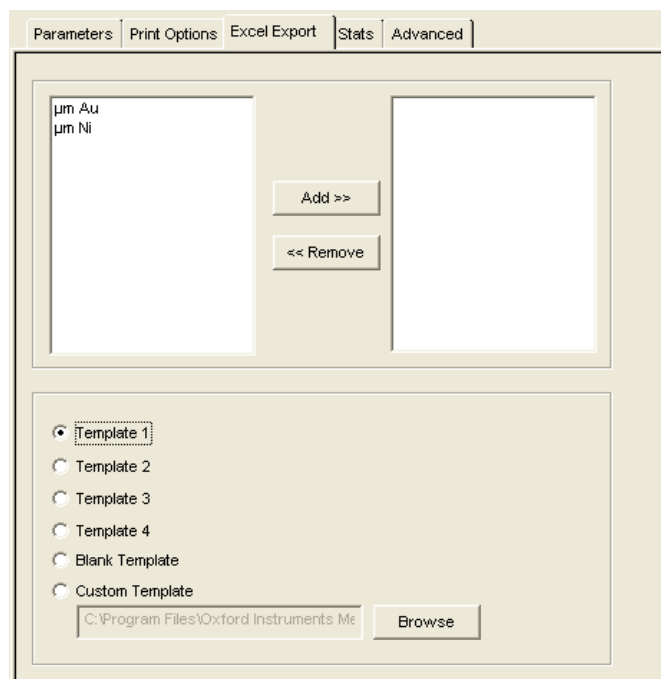
The elements measured in the application are listed.

2. Highlight the first element you want to export, then click **Add >>** to select it for the Excel Export.
3. Repeat step 2 for each chosen element.
4. When all chosen elements have been added, select the template you want to use for the Excel report.
5. Click **Browse** to select a user-defined template, if available.

6. Save the application.
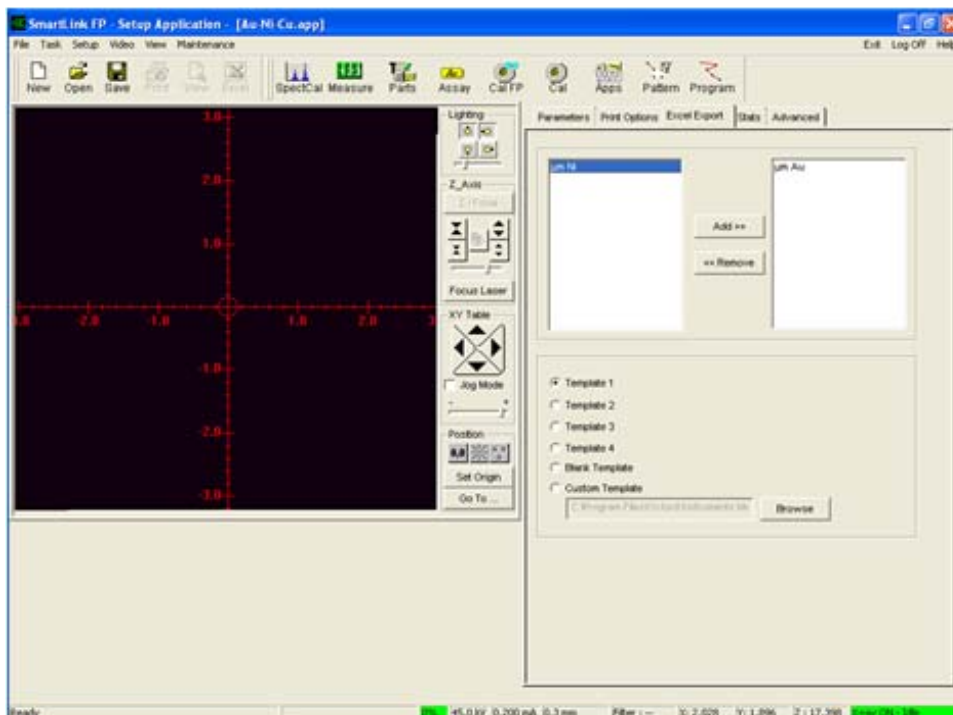
7. When the Excel Export function is setup, select the application in the Measure screen.
   The Excel icon opens in the row of icons at the top of the screen.
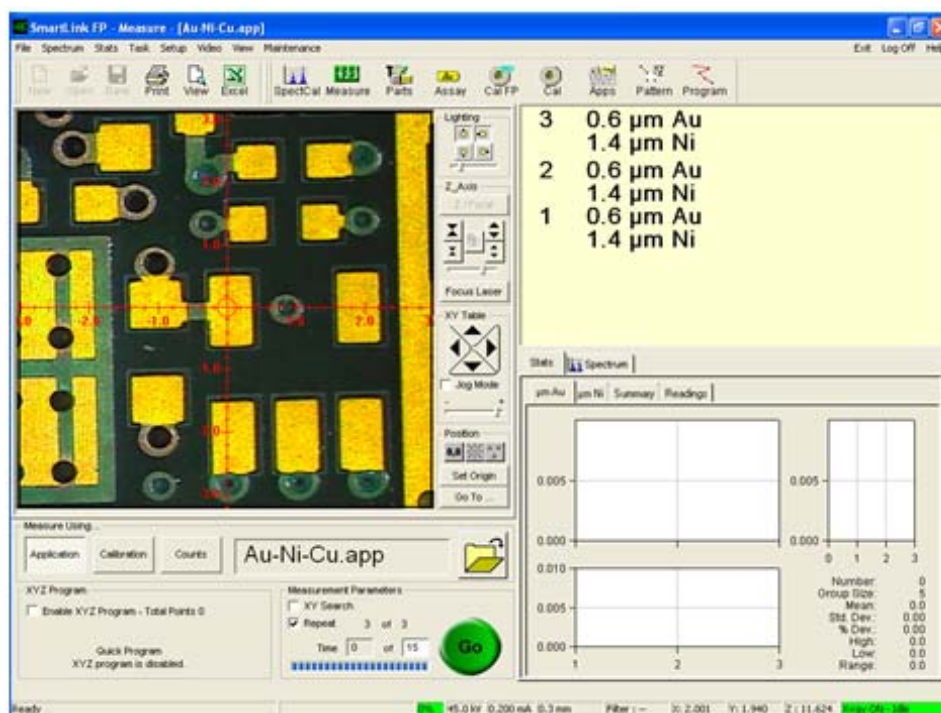
8. When analyses are completed, click the Excel icon to export all results into the report template.
   The report opens automatically.

9. Rename and save the Excel results file in a location of your choice.
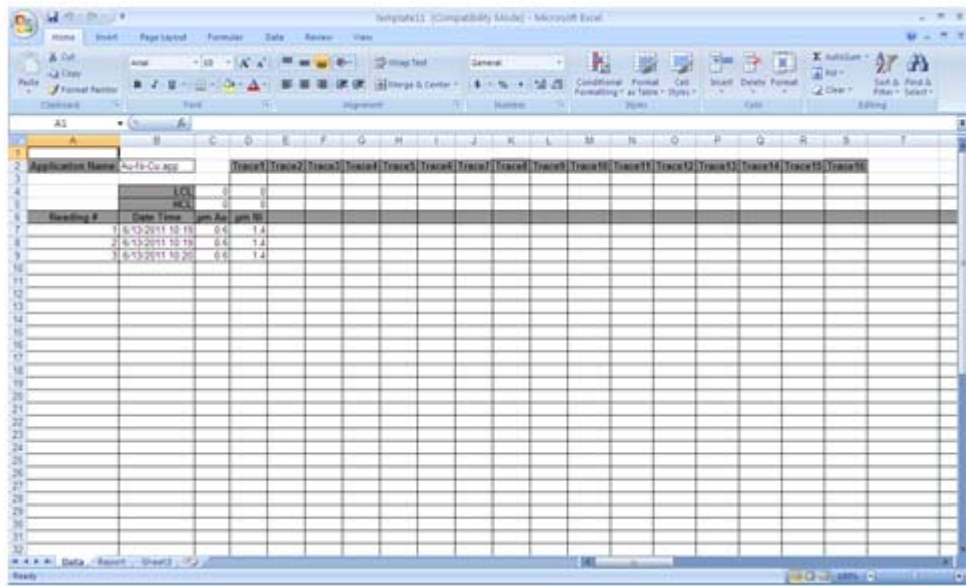
6.1.5 Setup Application – Base Correction tab
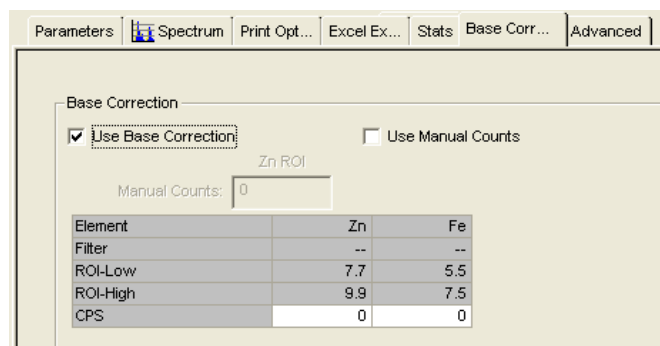
Fig. 6-4   Setup Application Base Correction tab

The **Base Correction** tab only displays in applications that specify an ROI calibration. A base correction is used to adjust for the difference between the base material of the sample to be measured and the base material used in the calibration standards. The adjustment can be from the counts measured on the sample material, or the adjustment in counts can be manually entered.

6.1.6 Setup Application – Advanced tab
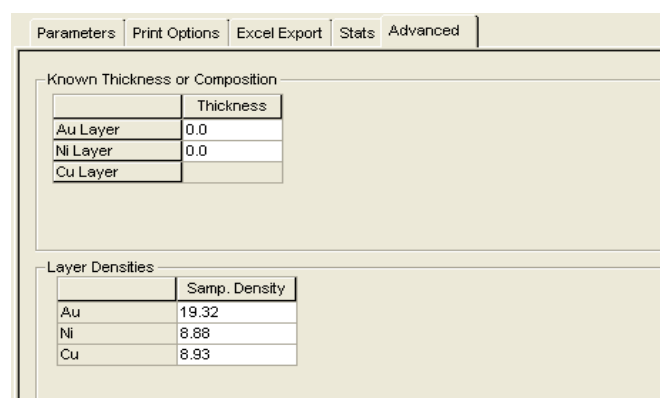
Fig. 6-5   Setup Application – Advanced tab

If a layer thickness, composition or density is known and constant, this information can be defined in the **Advanced** tab. This optimises calculations and corrections, especially if the metal layers on the calibration standards and unknown samples have different densities.

6.1.7 Pattern screens

6.1.7.1 XYZ Pattern tab

This tab appears in the Calibrate screen if the **Use XYZ Pattern to Measure Standards** check box on the Parameters tab is ticked. It displays a diagram of the grid scan pattern to be used to measure the standards in the calibration. This tab is similar to the Map tab used to define XYZ Patterns and XYZ Programs.

Table 6-4   Symbols used on the XYZ Pattern tab diagram

Symbol	Description
Red diamond	This diamond indicates the position of the datum point, and is located at X and Y coordinates of 0.0, 0.0.
Black diamond	These diamonds indicate the upper left and lower right corners of the area to be scanned.
Grey shading	A grey shaded area represents the area covered by a grid scan.

Table 6-5   Controls used on the XYZ Pattern tab

Control	Description
Next	Click this button to move the outline to the point of measure in the pattern.
Previous	Click this button to move the outline to the previous point of measure in the pattern.
Point	This field indicates the number of the point of measure currently being displayed.
X, Y, Z	These fields show the X, Y and Z coordinates of the point of measurement currently being displayed.

6.1.7.2 Map tab

When an XYZ pattern or XYZ program has been entered or selected, the Map tab displays a diagram indicating the locations of the programmed points. Click on the Map tab to view the diagram.

Table 6-6   Symbols on the Map tab diagram

Symbol	Description
Red diamond	This diamond indicates the position of the datum point, and is located at X and Y coordinates of 0.0, 0.0.
Black diamond	These diamonds indicate positions of defined points of measure. These diamonds appear for random, line, and grid programs.
Grey shading	A grey shaded area represents the area covered by a grid scan.
Dotted outline around a dot or pattern	This indicates the point or pattern currently being displayed.

Table 6-7   Controls on the Map tab

Control	Description
🔍+	This icon appears only on the Map tab of an XYZ program. Click the icon to show a diagram of the numbered dots that correspond to an XYZ Pattern. A green dot indicates the datum point of the pattern.
🔍-	This icon appears only on the Map tab of an XYZ program. Click the icon to show an overview of the entire program area. The pattern displayed is indicated by a dotted outline. A green line connects the datum point to the first point of measure. Grey lines connect the points in the order of entry. The green datum points are numbered in the order of entry.
Next	Click this button to move the outline to the next consecutive point/pattern of measure.
Previous	Click this button to move the outline to the previous point/pattern of measure.
Point	This field indicates the number of the point/pattern of measure currently being outlined.
X, Y, Z	These fields display the X, Y and Z coordinates of the point of measure currently being displayed, or the coordinates of the datum of the pattern being displayed.

7 Programming

Programming provides a method to automatically perform measurements on a sample, or a group of samples, using defined patterns. Several samples can be placed in the chamber and an application can be selected. In one step, SmartLink FP will:

- Repeat the pattern over each of the samples.
- Display and save the measurement data.
- Print a report, if one has been selected.

The basic programming steps are:

1. Create an XYZ pattern (random, linear, grid or grid scan), and save it in a file (see chapter 7.1).
2. Create a program that specifies locations at which the designated pattern is to be run (see chapter 7.1.2).
3. Create an application which specifies a program, a calibration, a report type and details of how the measurements will be taken and displayed (see chapter 7).

7.1 Create an XYZ pattern file

An XYZ pattern defines the number of points of measurement and their location, referenced to a datum point. When an XYZ pattern is made and saved, it can be used in XYZ programs and directly from the *CALIBRATE* mode.
Four types of patterns are available:

- **Random pattern**
  Used when you want to measure points in random locations across the sample(s).
- **Linear pattern**
  Used to take N measurements in a straight line between the defined first and last points.
- **Grid pattern**
  Used to take N discreet measurements in a grid configuration of A columns and B rows.
- **Grid scan pattern**
  Used to take one continuous measurement that produces an average reading over the defined grid area.

7.1.1   Set up a random pattern

1. Select **Setup** from the Main menu.
2. Select **XYZ Pattern** from the pull-down menu or click the **Pattern** icon on the toolbar.
3. Select **Random** from the **Type** drop-down list.
4. Place the representative sample in the measurement chamber.
5. Focus the camera on the sample.
6. If the X-Strata920 is fitted with more than one collimator, select the collimator size to be used in setting up the pattern, based on the physical characteristics of the sample. The collimator size used when taking measurements will be that referenced in the calibration file selected for the measurement.
7. Select a spot on the sample that can be easily located. This will be designated as the datum point.
8. Move the XY Table so that the crosshairs are over the datum point.

Define Datum

9. Click **Define Datum**.
10. Move the XY Table to align the crosshairs over the first point to measure.
11. Focus the camera system.

Add Point

12. Click the **Add Point** icon. The value in the **Number of Points** box increases by 1.
13. Move the XY Table to align the crosshairs over the next point to measure.
14. Repeat steps 10 to 12 for each additional point to be measured.

Save As...

15. When finished, click **Save As...** and name and save the pattern.

7.1.1.1 Set up a linear pattern

When measurements are taken, the distance between the first and last points is divided into N-1 equal spaces, computed as the total distance divided by the number of points. The first measurement is taken on point number 1. The second measurement is taken at the computed distance from the first point, in a straight line between the two input points. This continues until the last measurement is taken on the second input point.

1. Select **Setup** from the Main menu.
2. Select **XYZ Pattern** from the pull-down menu or click the **Pattern** icon on the toolbar.
3. Select **Linear** from the **Type** drop-down list.
4. Place the representative sample in the measurement chamber.
5. Focus the camera on the sample.
6. If the X-Strata920 is fitted with more than one collimator, select the collimator size to be used in setting up the pattern, based on the physical characteristics of the sample. The collimator size used when taking measurements will be that referenced in the calibration file selected for the measurement.
7. Select a spot on the sample that can be easily located. This will be designated as the datum point.
8. Move the XY Table so that the crosshairs are over the datum point.
9. Click **Define Datum**.
10. Move the XY Table to align the crosshairs over the first point to measure.
11. Focus the camera system.
12. Click **Add Point**.
13. Move the XY Table to align the crosshairs over the last point to measure.
14. Focus the camera system.
15. Click **Add Point**.
    The **Add Line** window opens.
16. Enter the number of points you want to measure in the linear pattern.
17. Click **OK**.
18. Click **Save As...** and name and save the pattern.

7.1.1.2   Set up a grid pattern

The size of the grid is determined by defining the first measurement point as one corner of the grid and the last measurement point as the diagonally opposite corner. The grid size is then divided into A equally spaced columns and B equally spaced rows. A and B are specified in a drop-down menu that opens after the second point is defined.
The first measurement is taken on point number 1 at a corner of the grid. The XY Table then moves horizontally to the next point in the row, where the second measurement is taken. When all measurements on the first row are complete, the XY Table moves down to the next row, until all points have been measured.

1. Select **Setup** from the Main menu.
2. Select **XYZ Pattern** from the pull-down menu or click the **Pattern** icon on the toolbar.
3. Select **Grid** from the **Type** drop-down list.
4. Place the representative sample in the measurement chamber.
5. Focus the camera on the sample.
6. If the X-Strata920 is fitted with more than one collimator, select the collimator size to be used in setting up the pattern, based on the physical characteristics of the sample. The collimator size used when taking measurements will be that referenced in the calibration file selected for the measurement.
7. Select a spot on the sample that can be easily located. This will be designated as the datum point.
8. Move the XY Table so that the crosshairs are over the datum point.
9. Click **Define Datum**.
10. Move the XY Table to align the crosshairs over the first point to measure.
11. Focus the camera system.
12. Click **Add Point**.
13. Move the XY Table to align the crosshairs over the last point to measure.
14. Focus the camera system.
15. Click **Add Point**.
    The **Add Grid** window appears.
16. Enter the number of points you want to measure in the X (A columns) and Y (B rows) directions.
17. Click **OK**.
18. Click **Save As...** and name and save the pattern.

7.1.1.3   Set up a grid scan pattern

The size of the grid is determined by defining the first measurement point as one corner of the grid and the last measurement point as the diagonally opposite corner.
When measuring using a grid scan, the XY Table moves under the collimator, thus scanning the defined area. The direction and time of the scan can be specified in a drop-down menu that opens after the second point is defined. The displayed reading is the average thickness of the scanned area.

1.   Select **Setup** from the Main menu.
2.   Select **XYZ Pattern** from the pull-down menu or click the **Pattern** icon on the toolbar.
3.   Select **Grid Scan** from the **Type** drop-down list.
4.   Place the representative sample in the measurement chamber.
5.   Focus the camera on the sample.
6.   If the X-Strata920 is fitted with more than one collimator, select the collimator size to be used in setting up the pattern, based on the physical characteristics of the sample. The collimator size used when taking measurements will be that referenced in the calibration file selected for the measurement.
7.   Select a spot on the sample that can be easily located. This will be designated as the datum point.
8.   Move the XY Table so that the crosshairs are over the datum point.
9.   Click **Define Datum**.
10. Move the XY Table to align the crosshairs over the first point to measure.
11. Focus the camera system.
12. Click **Add Point**.
13. Move the XY Table to align the crosshairs over the last point to measure.
14. Focus the camera system.
15. Click **Add Point**.
     The **Add Grid Scan** dialogue box opens. It shows the minimum and maximum grid scan time values that can be entered.
16. Enter the time to be taken for the complete scan measurement.
17. Enter the **Scan Direction**.
18. Click **OK**.
19. Click **Save As...** and name and save the pattern.

Define Datum

Add Point

Add Point

Save As...

7.1.2 Create an XYZ program file

An XYZ program defines the number of times, and the locations, where an XYZ pattern is to be used. This allows you to repeat a pattern at defined locations on a single sample or a group of samples. Once an XYZ program is made and saved, it can be used in applications.

Three types of program configuration are available:

- **Random program**
  Used when the samples or areas to be measured are symmetrical about both axes and have no distinguishing characteristics to use as a reference. Therefore the measurements can be made in a random fashion.

- **Linear program**
  Used when the samples, or areas of interest on a sample, are located in a straight line and are equally spaced.

- **Grid program**
  Allows measurement of a large number of samples, or taking measurements of an area of a sample in a defined grid pattern.

Select a program configuration to match the geometry of an individual sample, or the arrangement of multiple samples in the chamber.

7.1.2.1　Set up a random program

1. Select **Setup** from the Main menu.
2. Select **XYZ Program** from the pull-down menu or click the **Program** icon on the toolbar.
3. Place the sample, or group of samples, in the measurement chamber.
4. Focus the camera on the sample.
5. If the X-Strata920 is fitted with more than one collimator, select the collimator size to be used in setting up the pattern, based on the physical characteristics of the sample. The collimator size used when taking measurements will be that referenced in the calibration file selected for the measurement.
6. Decide if a datum point is to be used. In the **Datum Point** box, select **None**, **One** or **Two** datum points.
7. If you select **None**, go to step 13.
8. Select a spot on the sample that can be easily located. This will be designated as the datum point.
9. Move the XY Table so that the crosshairs are over the first datum point.
10. Click the **Define Datum 1** button.
11. If **Two** datum points have been selected, move the XY Table so that the crosshairs are over the second datum point.
12. Click the **Define Datum 2** button.
13. Click **Select Pattern...**.
14. Select a pattern from the list of patterns displayed.
15. Move the XY Table to view the first sample or area, and select a point where it is desired to take measurements.
16. Align the crosshairs over this point.
17. Focus the camera system.
18. Click **Add Point**.
    The value in the **Number of Points** box increases by 1. This point has been designated as the pattern datum point for the first sample or area.
19. Repeat steps 15 to 18 until the desired number of pattern datum points has been selected.
20. When finished, click **Save As...** and name and save the program.

7.1.2.2 Set up a linear program

1. Select **Setup** from the Main menu.
2. Select **XYZ Program** from the pull-down menu or click the **Program** icon on the toolbar.
3. Place the sample, or group of samples, in the measurement chamber.
   Locate the samples or areas so that they are in a straight line, equally spaced, and with the pattern datum point of each sample at the same rotational orientation.
4. Focus the camera on the sample.
5. If the X-Strata920 is fitted with more than one collimator, select the collimator size to be used in setting up the pattern, based on the physical characteristics of the sample. The collimator size used when taking measurements will be that referenced in the calibration file selected for the measurement.
6. Decide if a datum point is to be used. In the **Datum Point** box, select **None**, **One** or **Two** datum points.
7. If you select **None**, go to step 13.
8. Select a spot on the sample that can be easily located. This will be designated as the datum point.
9. Move the XY Table so that the crosshairs are over the first datum point.
10. Click the **Define Datum 1** button.
11. If **Two** datum points have been selected, move the XY Table so that the crosshairs are over the second datum point.
12. Click the **Define Datum 2** button.

Select Pattern ...

13. Click **Select Pattern...**.
14. Select a pattern from the list of patterns displayed.
15. Move the XY Table to view the first sample or area and select the point where you want to take measurements.
16. Align the crosshairs over this point.
17. Focus the camera system.

Add Point

18. Click **Add Point**.
    The value in the **Number of Points** box increases by 1. This point has been designated as the pattern datum point for the first sample or area.
19. Move the XY Table to view the last sample or area and select the point where you want to take measurements.
20. Align the crosshairs over this point.
21. Focus the camera system.
22. Click the **Add Line** button. This point is the pattern datum point of the last point in the line.
23. In the Add Line window, enter the number of samples or areas in the line.
24. Click **OK**.

Save As...

25. Click **Save As...** and name and save the program.

7.1.2.3 Set up a grid program

1.   Select **Setup** from the Main menu.
2.   Select **XYZ Program** from the pull-down menu or click the **Program** icon on the toolbar.
3.   Place the sample, or group of samples, in the measurement chamber.
     Locate the samples in a grid pattern consisting of at least 2 across and 2 down. The rows and columns must be full, equally spaced, at right angles to each other, and the pattern datum point of each sample must be at the same rotational orientation.
4.   Focus the camera on the sample.
5.   If the X-Strata920 is fitted with more than one collimator, select the collimator size to be used in setting up the pattern, based on the physical characteristics of the sample. The collimator size used when taking measurements will be that referenced in the calibration file selected for the measurement.
6.   Decide if a datum point is to be used. In the **Datum Point** box, select **None**, **One** or **Two** datum points.
7.   If you select **None**, go to step 13.
8.   Select a spot on the sample that can be easily located. This will be designated as the datum point.
9.   Move the XY Table so that the crosshairs are over the first datum point.
10. Click the **Define Datum** button.
11. If **Two** datum points have been selected, move the XY Table so that the crosshairs are over the second datum point.
12. Click the **Define Datum 2** button.

Select Pattern ... 13. Click **Select Pattern...**.

14. Select a pattern from the list of patterns displayed.
15. Move the XY Table to view the first sample or area and select the point where you want to take measurements. This sample or area must be at a corner of the grid.
16. Align the crosshairs over this point.
17. Focus the camera system.

Add Point 18. Click **Add Point**.

The value in the **Number of Points** box increases by 1. This point has been designated as the pattern datum point for the first sample or area.
19. Move the XY Table to view the last sample or area and select the point where you want to take measurements.
20. Align the crosshairs over this point.
21. Focus the camera system.
22. Click the **Add Grid** button. This point is the pattern datum point of the last point in the line.
23. In the Add Grid window, enter the appropriate number of samples or areas in the X (columns) and Y (rows) boxes.
24. Click **OK**.

Save As... 25. Click **Save As...** and name and save the program.

7.1.2.4   Verify a pattern or program

Open

1.   Click the **Pattern** or **Program** icon on the toolbar.
2.   Click **Open** and select the pattern or program file you want to verify.
3.   Click the Map tab and view the locations of the defined points of measurement.
4.   Click the Video tab,
5.   Move the XY Table to align the crosshairs over the datum point.

Adjust Datum
6.   Click **Adjust Datum**.

Preview All Points
7.   Click **Preview All Points**. The XY Table moves through the defined pattern or program.

7.1.2.5   Modify a pattern or program

Open

1.   Click the **Pattern** or **Program** icon on the toolbar.
2.   Click **Open** and select the pattern or program file to be modified.
3.   Move the XY Table to align the crosshairs over the datum point.

Adjust Datum
4.   Click **Adjust Datum**.
5.   Use the arrow buttons to move to the point to be modified. The number of the point selected appears in the current box.
     •   Click ▐◀ to move to the first point.
     •   Click ▶ to advance to the next point.
     •   Click ◀ to return to the previous point.
     •   Click ▶▌ to move to the last point.
6.   Move the XY Table so that the new location is under the crosshairs.

Replace
7.   Click **Replace**, then click **YES** on the pop-up menu that opens.
8.   Repeat steps 5 to 7 for each point to be modified.

Save As...
9.   Click **Save As...** and select the file opened in step 2 or save the pattern or program with a new name.

8   Applications

An application is one of the methods that can be selected to make measurements.
An application file consists of:

•   A calibration.
•   The parameters to be used in taking measurements.
•   An XYZ program.
•   An optional default report to be used for print information.

The Quick XYZ Program feature can be used if no XYZ program has been selected.
Measurements and statistical data are saved in a data file associated with the
application.
Applications are also selected when defining a part number in the database option.

8.1   Create an application

1.   Click the **Apps** icon on the taskbar.
2.   Click the **New** icon.
3.   Click **Select** on the Parameters tab.
4.   Choose the required calibration from the drop-down menu.
5.   Enter the appropriate information for the application in the Parameters tab
      (see chapter 6.1.1).
6.   If desired, select a program to use with this application, or create a quick program.
7.   Enter the desired information in the header data fields on the Print Options tab
      (see chapter 6.1.1).
8.   If required, select a default report from the Print Options tab.
9.   If required, enter information in the Stats tab (see chapter 6.1.3).
10.   When an ROI calibration is selected and a base correction is required, enter the
      information on the Base Correction tab (see chapter 6.1.5).
11.   Name and save the file.

8.2 Perform a base correction

To perform a base correction, open an existing application or create a new application and specify an ROI calibration.

1. For a new application, from the Parameters tab select the calibration to be used.
2. Click the Base Correction tab.
3. Tick the **Use Base Correction** check box.
   This enables the base correction. A base correction count table, the Video tab and the Spectrum tab open.
4. To manually input the correction count:
   - Enable the **Use Manual Counts** box.
   - Enter the value in the **Manual Counts** window.

Information If a manual count has been entered, it overrides the measured value only if the Use Base Correction check box is selected.

5. To measure the sample base material for the correction:
   - Click the Video tab.
   - Align the sample of the new base material under the crosshair.
   - Click **GO** to measure the sample.
   - When the measurement is complete, name and save the file.

9 Database

9.1 Database screens

The database screens are only available if the database option has been purchased.

9.1.1 Database maintenance menu

This drop-down menu is accessed from the Main Menu by clicking on **Setup** and then **Database**. It is used to:

- Verify the integrity of the database.
- Add new part numbers.
- Modify existing part numbers.
- Delete selected readings from the database.

Table 9-1   Database maintenance menu

Button	Description
Verify Database	Click this button to verify the integrity of the database. If an application specified in a part number is deleted, the part number cannot be used to make measurements. Clicking this button locates the part number and delete the records and part numbers from the database.
Part Number Program	Click this button to access the **Select Part Number** menu. Use this menu to add a new part number, modify an existing part number, copy a part number or delete a part number.
Remove Readings	Click this button to access the **Delete Readings** menu. Use this menu to delete selected readings.

9.1.2 Part number program menu

This menu is used to:

- Add a new part number (record) to the database.
- Modify or copy existing part numbers.
- Delete part numbers.

Table 9-2   Buttons in the part number menu

Button	Description
(Add)	To add a new part number to the database, enter the name or designation for the part number in the window box and click **OK**.
Modify	Click **Modify** and then click on the arrow in the window box. The existing part numbers are displayed in a drop-down window. Select a part number and click **OK**. A warning displays, indicating only certain features may be modified. Click **OK** and the SLP database wizard displays the modify menus.
Copy	Click **Modify** and then click on the arrow in the window box. The existing part numbers are displayed in a drop-down window. Select the part number to be copied and click **OK**. The **Copy** drop-down menu displays and prompts you to enter a new part number in the window. Enter the new number and click **OK**.
Delete	Click **Modify** and then click on the arrow in the window box. The existing part numbers are displayed in a drop-down window. Select a part number and click **OK**. A warning displays, asking if you want to proceed. If so, click the **Yes** box and then click **OK**. The part number and all of its records are removed from the database.

9.1.3 "Remove Readings" menu

This menu is accessed from the **Remove readings** button on the **Database Maintenance** menu. It allows you to specify search criteria for selecting readings, and then to remove selected readings from the database. The data fields shown in the screen below are examples only. The actual fields depend on how your database was setup.

Fig. 9-1   "Remove Readings" menu

Table 9-3   Fields and functions on the delete readings menu

Item	Description
Part Number	Tick the **Part Number** check box use the arrow key to select a part number from the drop-down list.
Date Range	There are two date selection fields. Use one field to select readings based on a specific day, month & year, or both fields to select a range of readings between two dates. Each field has 5 operators to define the date. Choose from less than (**<**), less than or equal to (**<=**), equal to (**=**), greater than (**>**), greater than or equal to (**>=**).
Preview	Displays all the readings that match the search criteria in the display window.
Clear List	Clears all the readings in the display window. This key **DOES NOT** remove any readings from the database.
Delete	Deletes the selected reading(s) from the database. Click **YES** to confirm that you want to remove the readings from the database.
Cancel	Returns to the previous menu.
Display Window	A scrollable window that displays the readings that match the search criteria. The part number, the point of measure (POM), the characteristic measured, the measurement value and the date are displayed. The total number of readings displayed is shown below the window.

9.2   Database operation

This section applies only if the database option is enabled. To use the database, part numbers (or another name if one has been assigned) must be created for each item for which that data is to be collected.

A part number consists of:

- One or more applications.
- Optional text information about the measurements being made.
- An optional picture of the part being measured.
- An optional default report for printing the data.

The steps below are the same for setting up any part number. The SmartLink FP database wizard guides you through the steps and prompts for the required information.

1. From the Setup menu, select **Setup Parts**. The Database Maintenance menu opens.
2. Click the **Part Number Program** button.
3. Enter the new part number in the Select Part Number drop-down menu.
4. Click **OK**.
5. From the Select Applications menu, select the applications to be included in this part number.
6. Click **Next**.
7. From the Group Applications menu, select those applications with common datum point(s) that you want to group. This is an optional step, but grouping applications reduces the number of datum points to be adjusted.
8. Click **Next**.
9. From the Part Description & Image drop-down menu, perform any of the following actions as required:
   a. Enter text describing the measurements to be made.
   b. Enter additional information.
   c. Include a picture, a screen capture or a drawing of the part to be measured.
   d. Select a default report that can be printed from the report generator.
10. Click **Next**.
11. In the Information Summary menu, review the information you have entered.
12. Click **OK** to enter the part number into the database, or click **Back** to make changes or additions to the part number.

9.2.1 Database – Select Applications screen
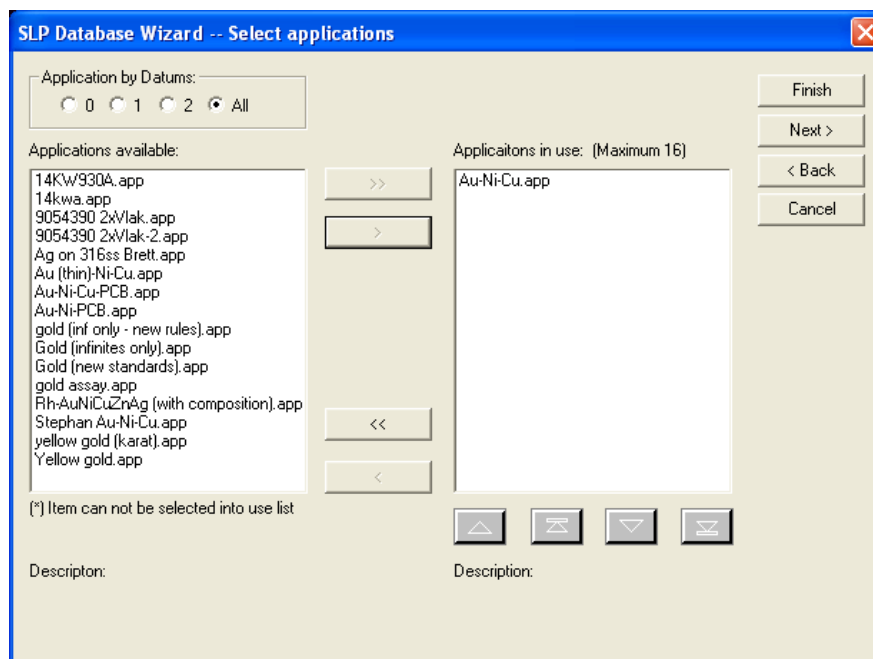
Fig. 9-2   Database – Select Applications screen

This screen opens after a part number has been designated to be entered into the database. Select the applications that are to be attached to this part number. Only those applications with the same number of datum points can be used in a part number.

Table 9-4   Controls on the Database Select applications screen

Feature	Description
Application by Datums	Select the number of datum points desired. Those applications with the selected number of datums are listed in the left window. For example if **2** is selected, only those applications with 2 datum points are listed.
Applications available	Displays the applications that are available for selection. An application preceded by an asterisk (*) cannot be used. Select an application and then click on the single right arrow key in the centre of the windows to move the selection to the right window. Click on the single left arrow key to remove the selection from the right window. The double arrow keys move all of the available applications.
Applications in use	Displays the applicatons that have been selected for the part number being created. A maximum of sixteen (16) applications can be used in each part number.
Move application buttons	$\boxed{>}$ Move a selected application to the right panel. $\boxed{<}$ Move a selected application to the left panel. $\boxed{>>}$ Move all applications to the right panel. $\boxed{<<}$ Move all applications to the left panel.
Navigation buttons	Below the right window, there are four arrow keys that can be used to navigate through the selected applications: $\boxed{\triangle}$ Move up the application list. $\boxed{\triangledown}$ Move down the application list. $\boxed{\unicode{x23A4}}$ Go to the first item in the application list. $\boxed{\unicode{x23A5}}$ Go to the last item in the application list.

Table 9-4   Controls on the Database Select applications screen

Feature	Description
Function buttons	The four function buttons are used after the application selection process is completed:
	FINISH – Enters the existing information into the database without proceeding through the rest of the steps.
	NEXT> – Moves to the next screen in the enter part number process.
	<BACK – Moves to the previous screen.
	CANCEL – Exits the enter part number process.
Description	A description and datum information appear below each window, depending on which application is selected. These are for the use of technicians when troubleshooting the database.

9.2.2   Database Group Applications screen
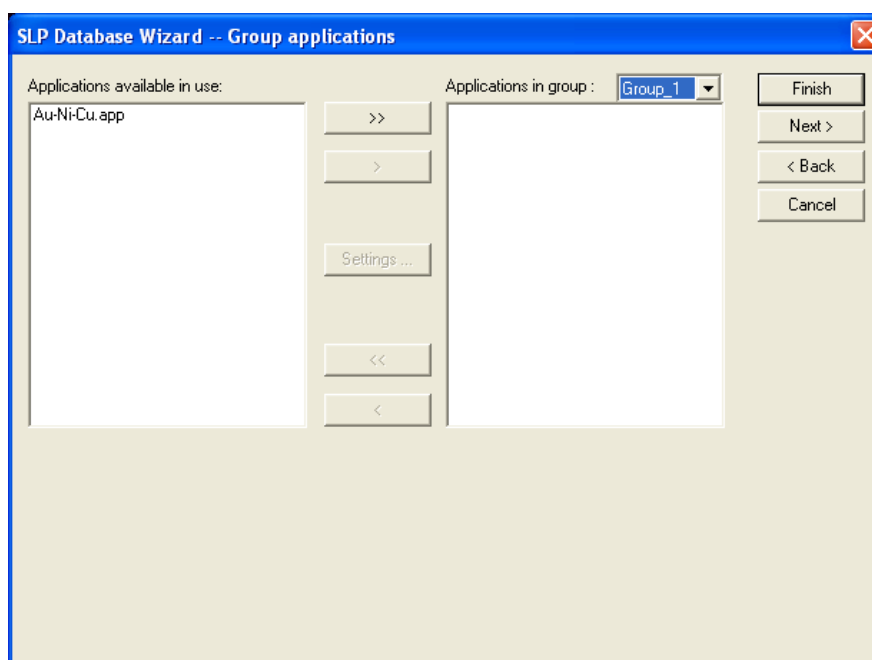
Fig. 9-3   Database Group Applications screen

This screen opens after you have selected applications that are to be used with a part number. Use this screen to group those applications that have common datums. Grouping applications reduces the time to adjust datums when the part number is used to make measurements. For example, if all the applications used in a part number have a common datum and are placed in a group, then there is only one datum to adjust when using the part number to make measurements.

Table 9-5   Controls on the Database Group applications screen

Feature	Description
Group window	Displays the current group. Click the down-arrow key to select another group. A maximum of sixteen (16) groups can be established.
Applications available in use	Displays all the applications that have been selected for use in the part number. Click on an application to highlight it, and then click an arrow key to move it to the right (in group) window.
Applications in group	Displays the applications that have been selected for the group being created.
Move group buttons	> Move a selected group to the right panel. < Move a selected group to the left panel. >> Move all groups to the right panel. << Move all groups to the left panel.
Settings	Click this button to access the Settings menu. Use this menu to change an application's limits, for this part number only.
Function buttons	The four function buttons are used after the application have been selected:
	FINISH – Enters the existing information into the database without proceeding through the rest of the steps.
	NEXT> – Moves to the next screen in the enter part number process.
	<BACK – Moves to the previous screen.
	CANCEL – Exits the enter part number process.

9.2.2.1   Database Settings screen
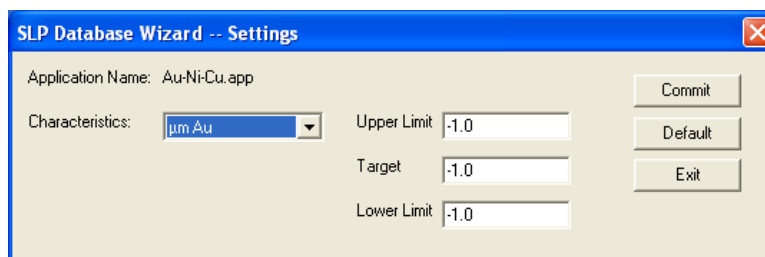
Fig. 9-4   Database Settings screen

To access this screen from the Group Application menu, highlight an application and click the **Settings** button. This screen is used to assign new limit and target values for each characteristic of an application. The new values do not replace the values in the application but are applied to this part number only.

Table 9-6   Controls on the Database Setting screen

Item	Description
Application Name	Displays the name of the application selected in the Group Application menu.
Characteristics	Click the arrow key and select the measurement characteristic whose limits are to be changed from the drop-down list.
Limit Windows	Place the cursor in each window and enter new values for the **Upper Limit**, the **Lower Limit** and the **Target**. The default values from the application are displayed.
Function keys	**Commit** – Adds the new limits to the part number record in the database.
	Default – Returns the part number limits to the default values contained in the application.
	Exit – Returns to the Group Application menu.

9.2.3 Part description menu

This menu appears after the applications have been grouped. From this menu descriptive text and an image can be added. This information appears when the part number is selected for making measurements. A default report can also be assigned so that readings and other data can be printed directly from SmartLink FP.

Table 9-7   Controls on the Part Description menu

Feature	Description
Description and instructions	Enter descriptive text in this field. Examples are information about the part being measured, the procedure for making the measurements, or fixtures or tools to be used.
Report	Click the **Report** button to assign a default report to this part. When making measurements from SmartLink FP, click the **Print** icon to print the information in the default report format.
Image	An image can be added to the part description to aid in identifying the part. Click the **Image** button and add any bitmap image file, such as a screen capture, scanned pictures, or CAD files.
Function keys	The three function buttons are used after the applications have been grouped.
	Finish – Proceeds to the last step.
	<BACK – Moves to the previous screen.
	CANCEL – Exits the enter part number process.

9.2.4 Information summary menu

This is the last step in the process of adding a part number to the database. The menu displays after the Part Description menu has been completed. This menu allows you to review all the information and images that have been attached to the part number record.

Table 9-8   Controls on the Information Summary menu

Feature	Description
Specifications window	The scrollable window allows you to review the specifications of the part number before it is added to the database. The window displays each application, its limits and target value, the individual points of measurement, and how the applications are grouped.
Image window	Displays the image that was saved for the part number.
Function keys	The three function keys are used after you have reviewed the part information.
	OK – Adds the part number to the database.
	<BACK – Moves to the previous screen.
	CANCEL – Exits the enter part number process.

10 Measurements

10.1 Measure screen

Video panel

View panel
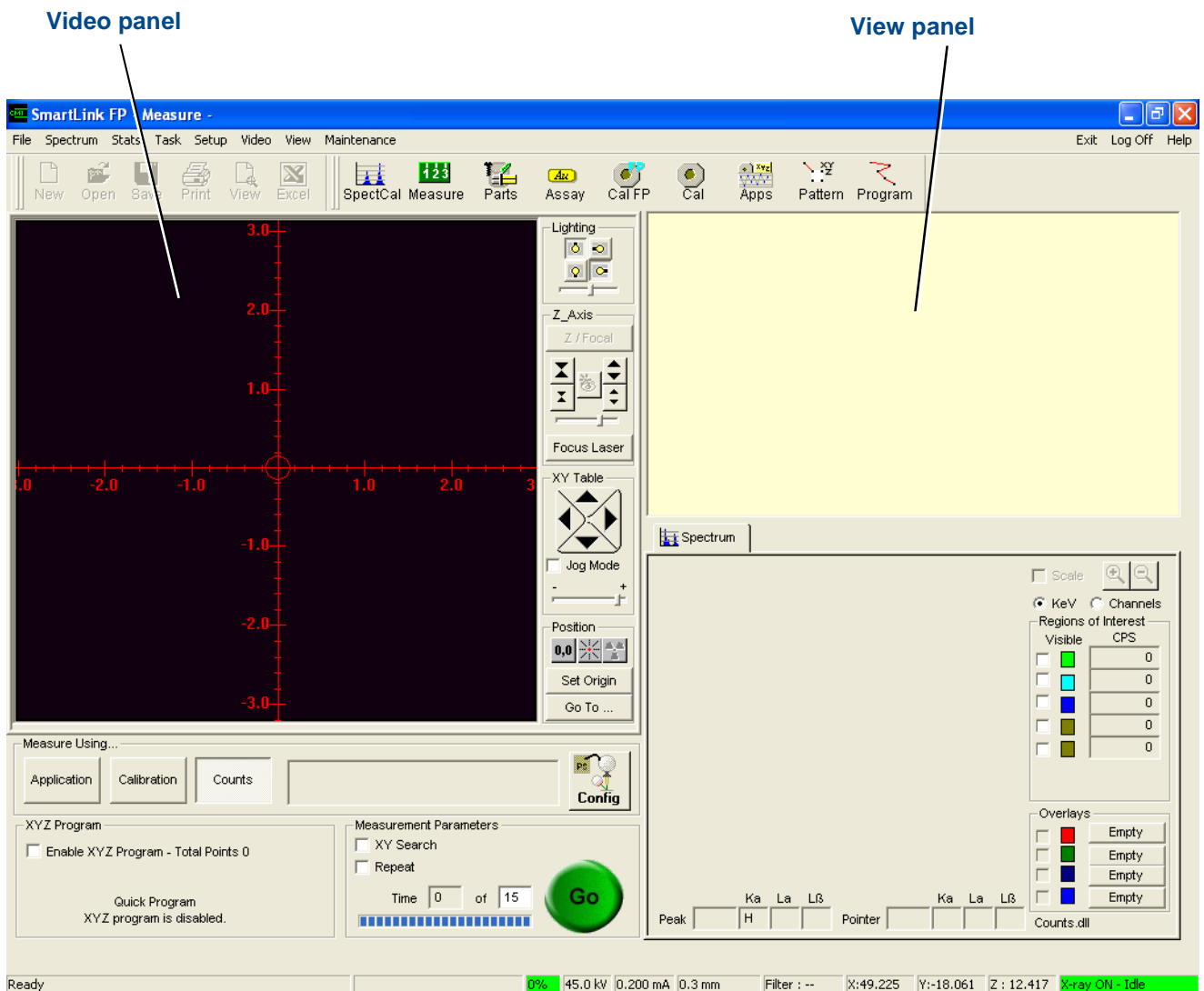
Fig. 10-1   Measure screen

All measurements are made from the Measure screen using the method that has been selected.
Open the Measure screen by clicking the **Measure** icon on the taskbar.

☞ *Information*   The **Parts** icon is available only when the database option is installed.

10.1.1 View panel

The measurements are shown in the View panel in the upper right part of the screen, and on the **Stats** tab. The format of the display in the View panel is determined by the selection made in a **Show Details** pop-menu, and by any limits that have been defined.

10.1.1.1 Show Details

This menu selects how the measurement readings are displayed in the view window:

1. Right-click the mouse anywhere in the View panel to open the **Show Details** drop-down menu.
2. Click the menu to change the display. You can choose to display the measurement data only, or the measurement data with additional details.

Measuring Thickness – When the **Show Details** drop-down menu is ticked, the thickness, units of measure and the type of material display in the view window. When the tick is not visible, only the thickness and the type of material display.
Measuring Counts – When the **Show Details** option is enabled, the counts per second for each material in the sample is shown, along with the tolerance. When the **Show Details** option is disabled, only the counts per second display.

10.1.2 Video panel

Click the Video tab from the Measure, Calibrate, Setup, or Spectrum Cal screens to view the sample in the measurement chamber.
Use the Video panel to:

• Position the sample.
• Focus the camera system.

The left portion of the video panel displays an image of the sample in the chamber. The centre portion contains controls for the lighting, table movement, and camera system positioning. The right portion of the video screen contains features and information that depend on the mode currently in use.

10.1.2.1 Lighting controls (colour camera models only)

The four **Lighting** icons adjust the lighting inside the X-ray chamber. Each icon is labelled with a light bulb symbol in a different orientation, each of which controls one of the four lights inside the chamber. Click one of the icons to toggle its associated light between *full on*, *dim on* and *off*. Try different combinations of the controls until the lighting is acceptable.
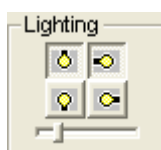
10.1.2.2 Z-Axis controls

The **Z-Axis** controls on the Video panel control vertical movement of the camera system to focus the X-ray beam on to the sample.

Table 10-1 Z-Axis controls

Icon	Description
	Quickly moves the camera system closer to the table.
	Slowly moves the camera system closer to the table.
	Quickly moves the camera system further from the table.
	Slowly moves the camera system further from the table.

10.1.2.3 Focus Laser controls (XY programmable base option only)

The **Focus Laser** feature provides a laser beam that allows you to position the sample at the correct location for measurement. The sample is positioned correctly when the laser beam is focussed on the sample.
To use the **Focus Laser** feature:

1. Click **Focus Laser**:
   a. The vertical crosshair is removed.
   b. The lights inside the chamber dim.
   c. A flashing laser beam appears.
   d. The **Intensity** slide bar becomes active (see chapter 10.1.2.4).
2. Check that the flashing beam is positioned on the horizontal axis of the display. If it is not, adjust the focus automatically or manually:

Automatic focus

    a. Align the centre of the mouse cursor crosshair over the centre of the flashing laser beam.
    b. Click the left button of the mouse. The Z-axis automatically moves until the flashing laser beam is positioned over the horizontal axis. The sample is now in focus. The chamber lights illuminate, the vertical crosshair reappears and the **Intensity** slide bar becomes inactive.

Manual focus

    a. Use the appropriate Z-axis directional arrows to position the flashing laser light over the horizontal crosshair.
    b. Click the **Focus Laser** button to exit focus mode.

10.1.2.4 Intensity slide bar

This control is active only when **Focus Laser** is enabled. It controls the intensity of the flashing laser light. The greater the intensity, the slower the beam appears to flash.
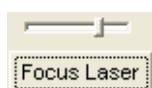
10.1.2.5 XY Table controls

The XY Table controls on the Video panel allow you to position the sample under the X-ray beam by using these methods:

- **Direct movement** – Place the mouse crosshairs at the required position and click. The XY Table automatically moves to the crosshair position.
- **Manual XY move** – Ensure that the **Jog Mode** check box is cleared. Then click and hold one of the four direction arrows (see table 10-2). The XY Table moves until the mouse button is released. Use the **Slow-Fast** slide bar to control the speed of movement.
- **Jog** – Tick the **Jog Mode** check box. Then click one of the four direction arrows. The XY Table moves a set distance for each click.

Table 10-2 XY Table icons

Icon	Description
▲	Moves the XY Table so that the back of the sample is under the crosshair.
▼	Moves the XY Table so that the front of the sample is under the crosshair.
▶	Moves the XY Table so that the right side of the sample is under the crosshair.
◀	Moves the XY Table so that the left side of the sample is under the crosshair.

10.1.2.6 Position controls

The Position controls on the Video panel allow you to move the X, Y and Z axes to an exact set of coordinates relative to the current origin.

Table 10-3 Position icons

Icon	Description
0,0	This button moves the XY Table to the position that has been designated as the origin, i.e. The location where the X,Y (R, Θ) and Z coordinates are 0.000.
(laser)	The laser button moves the XY Table to the front of the chamber, with the door in the opened or closed position.
(radiation)	The radiation button moves the XY Table so that it is centred under the X-ray beam.
Set Origin	This button sets the current X, Y and Z-axis positions to values of 0.00 units. Future values of coordinates will be displayed relative to this position.
Go To ...	Displays a window that allows entry of new coordinates, relative to the current origin. The unit of measure of the coordinates is specified when the unit is created.

10.1.2.7 Measure Using controls

Click a button in this panel to choose whether measurements will be taken using an **Application**, a **Calibration**, or **Counts**.

XYZ Program

Use the **Enable XYZ Program** check box to enable or disable the Quick XYZ Program. This option allows you to create a random, linear, grid or grid scan pattern that is used only for the current measurement session (see chapter 10.1.10).

Measurement parameters

The Measurement Parameters panel of the Measure screen contains information about how readings will be taken. When an application or calibration is selected, the parameters that were specified when setting up the file are transferred to the Measure screen. If **Counts** is selected, these fields are filled with default values. The transferred values and the default values can be changed.

Time

Change the time to be used for the measurement by entering a new value. If the displayed value is changed, it must not be less than 25% of the calibration time specified in the selected calibration. If a new time that is less than 25 % of the calibration time is entered, a warning message opens. This field displays a default value of 30 seconds when **Counts** is selected.

XY Search

The **XY Search** feature allows you to program the X-Strata920 to take readings on very small samples (e.g. traces on a printed circuit board), where alignment of the sample is difficult. When measuring using the **XY Search** feature, a series of short measurements is taken across the width of the sample. The table then returns to the position where the reading matches the selected criteria and takes the measurement using the normal time setting.

If an application which specifies this feature has been selected, a tick indicates that it is already enabled. To enable the feature, tick the **XY Search** check box to open the Search Wizard. Enter the search parameters to be used when the measurement is taken.

The available parameters are:

Search direction

The search can be made along the X-axis, the Y-axis, or in both directions.

Search options

Table 10-4 XY search options

Option	Description
Search Distance	This is the distance between the first and last search points. In a search of both axes, the distance searched on both axes is the same.
# Steps	The number of short readings taken in the selected direction. The default is 5 steps. Available choices from the pull-down list are 3, 5, 7, 9, and 11 steps.
Total Distance	The total distance of the search. A default value of 0.1 is displayed. Enter the required value for the sample being measured.
Time per Search Reading	The time of each reading during the search. The default is 2 seconds. Highlight this field and enter the desired time.
Approximate Total Time	The number of seconds needed to complete the selected instructions. The software calculates this value.

Energy Range

This part of the menu indicates the criteria that the X-Strata920 will look for during the search. The final measurement is taken where the search measurement meets the criteria selected in this section. Click the arrow key next to the box and select the chemical element to search for, or enter values for the keV range. Choose to search for maximum counts or minimum counts by clicking the adjacent box.

Repeat

The **Repeat** feature allows you to take multiple readings on a sample without having to repeatedly click the **GO** button:

If an XYZ program and the **Repeat** feature are activated while measuring with an application, the X-Strata920 executes the XYZ program the number of times designated in the Measurement Parameters panel.

10.1.3   Spectrum tab

The Spectrum tab opens when the Measure, Calibrate, or Spectrum Cal screens are displayed. This screen displays a spectrum of the chemical element(s) in the sample being measured. A spectrum display is a graphical presentation of the number of counts recorded during a measurement and the energy level (in KeV or Bins) at which they were recorded.

If the Spectrum tab is viewed in a calibration, you can display the spectrum of each standard in the Standards Table by clicking on it with the mouse. When the Spectrum tab is viewed from a Measure screen, it displays the composite spectrum of the elements in the sample being measured.

The spectrum screen has a different appearance when making an ROI measurement and when making an FP measurement. The spectrum is composed of either the regions of interest defined in the ROI calibration or the Measured, Background and Fitted spectrums of an FP calibration. The controls at the right side of the screen select both the location and colour of the regions of interest or the three spectrums from an FP measurement.

10.1.4   Stats tab

The **Stats** tab provides a convenient means of viewing the readings made with the instrument. It also displays readings as:
*   Statistics
*   An X-bar and R chart
*   A histogram

The **Stats** tab can display readings and statistics made with any of the measurement methods.

Readings and statistics can also be printed:
*   To print the **Stats** tab, click the **PRINT** command in the **Stats** Menu.
*   To print the information in a user-designed report format, along with text, graphical information and images, use the Report Generator.

The Stats tab is displayed from the Measure screen.

Statistics displayed when using an application are either taken from the current session or from all of the measurements made with the application, depending on the selection made in the Stats menu.

Statistics displayed when using a part number include all of the readings made and accepted with the part number. The statistics from readings made with a calibration or in counts mode are not saved, and the displayed statistics are from the current measurement session.

10.1.4.1 Stats tab from Measure Parts

When using Measure Parts to take readings, the **Characteristic** tab is replaced with a selection box from which a point of measure in the part number is selected. The charts, statistical summary and readings of the point of measure selected display on two additional tabs.

10.1.4.2 Statistic Parameters menu from Measure Parts
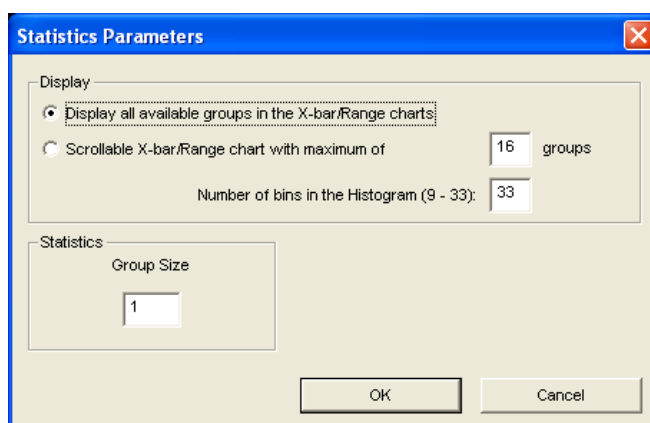
Fig. 10-2   Statistics Parameters menu

This drop-down menu appears in the Measure Parts screen, when the **Parameters** option is clicked from the Stats menu. If an application has been selected, the group size that was entered in the Stats tab in the Setup Application screen is displayed. If a calibration is selected, the default values are displayed.

Display

Select the desired option by clicking on its adjacent button.

- **Display Groups**
  Choose to display all the available groups or the scrollable X-bar chart option. To change the number of groups displayed, highlight this field and enter a number between 10 and 2000. If the number of readings taken exceeds the value entered, the system selects the scrollable chart option.

- **Scrollable Chart**
  The scrollable chart option displays the number of groups shown in the box. Arrow keys are provided to scroll through the displayed groups. Enter a value for the number of groups to scroll through. The default value is 16.

- **Histogram**:
  To change the number of bins used to plot the histogram, highlight this field and enter a number between 9 and 33.

Group size

To change the number of consecutive measurements included in a group, highlight this field and enter the desired value. When the group size is set to a number other than one, an average of each group is printed after the last reading for that group.

OK/Cancel

When finished, click **OK** to record the changes made, or click **Cancel** to exit the menu without saving any changes.

10.1.4.3 Stats tab from Measure Samples

When using Measure Samples to take readings, the Stats tab contains three additional tabs, which display specific types of information:

Characteristics tab

The Characteristics tabs are the first set of tabs in the Stats tab. Each tab displays:
- X-bar and R charts
- A histogram
- A summary of the statistics for a specific characteristic (layer) of the sample being measured.

The number of tabs, their labels and the information displayed, depends on the method of measurement. If measurements are being taken with an application or a calibration, each tab displays the coating material and the units, or the % coating for a composition. If the counts mode is used, each tab displays the number of counts in the defined region of interest.

Summary tab

The Summary tab displays the statistical summary of the individual measurement statistics, for the characteristic selected in the first tab. Values are displayed for the number of readings, group size, mean, standard deviation, percent deviation, high and low readings, and the range.

When using an application to make measurements, the statistics displayed are for the current measuring session or for all of the measurements taken, depending on the selection made in the Stats menu.

Readings tab

The Readings tab lists the individual readings, for the characteristic selected in the first tab and the date and time they were made.

When the group size is set to a number greater than one, an average of each group is printed after the last reading for that group.

When limits are enabled, readings that exceed a limit are marked with an asterisk (*).

A **Delete** key at the bottom of the screen allows individual readings to be deleted:

1. Click on the reading number to select a single reading to be deleted.
2. To delete more than one reading, press and hold the **<Ctrl>** key on the keyboard, and click on the number of each reading to be deleted.
3. Click **Delete**.

10.1.5   Load and unload samples

⚠ **WARNING**

X-radiation hazard!

Exposure to X-rays can cause severe injury. Obey the safety instructions in this manual to avoid exposure to X-rays.

Place the sample to be analysed in the X-Strata920 through the front access door.

*   Electrical interlocks attached to the chamber door do not permit the X-ray shutter to open if the chamber door is open or if an electrical interlock has failed.

10.1.6   Measurement methods

Two modes are provided for taking measurements:

*   **Measure Parts (Database)** – a part number entered in the database is selected. Measurements are then made as defined in the part number. Refer to the database option for details.
*   **Measure Samples** – measurements may be taken using an application file, a calibration file, or counts per minute (see chapter 10.1.8).

☞ *Information*   The Measure Parts mode is accessible only when the database option is installed.

10.1.7   Position the sample

To take a measurement on a sample, it must first be positioned underneath the crosshairs displayed on the Video screen. The X-rays emitted by the collimator are directed at the crosshair intersection. Depending on the collimator selected, the shape of the point of intersection on the Video screen is a square, a rectangle or a circle. This shape represents the size of the X-ray beam when it reaches the sample. Since the entire beam must fit on the sample being measured, this shape also represents the minimum sample size that can be measured with the selected collimator.

Units fitted with automatic XY or Z positioning have features that help you to align the sample under the crosshairs. These features are described below.

Units with manual XY or Z positioning require you to manually align the sample under the crosshairs.

10.1.7.1 Sample positioning laser (XY units only)

⚠ WARNING

Risk of injury due to laser radiation!
Exposure to laser radiation can cause severe eye damage or burns.
- Do not look directly into the beam produced by any class of laser.
- Do not view the beam through any optical instruments.

When the door is open, a red dot of laser light is visible on the XY Table.

1. Place the sample so that the red dot is on the area to be measured.
2. Close the door and check that the sample is aligned under the crosshairs on the Video screen.
3. If necessary, adjust the position of the sample from the Video screen.

10.1.7.2 Position the Z-axis

The camera system moves along the Z-axis when focusing on a sample. Focus every time a measurement is made, so that the camera system is the same distance from the sample. This ensures that the same quantity of X-ray radiation reaches the sample for every reading.

When placing tall samples in the chamber:

1. Move the Z-axis fully down to prevent the sample from colliding with the X-ray components when the door is closed.
2. With the door open, place the tall sample on the table and move the Z-axis upwards to increase the distance between the elevator and the table.
3. When the distance between the elevator and the table is greater than the height of the sample, close the door.
4. Position the sample under the crosshairs from the Video screen.

10.1.7.3 Position the X-Y-axis

The X and Y positions of the sample can be adjusted in several ways.

Manual XY Move mode

Use Manual XY Move mode to move the XY Table continually in a selected direction. Click on a directional arrow key and hold down the left mouse button to move the table. Release the mouse button to stop the movement. The speed of XY Table movement is controlled by the slide bar that appears when *JOG* mode is disabled.

1. Clear the **Jog Mode** check box on the Measure screen.
2. Click one of the four arrow buttons to position the sample.
3. Use the **Slow - Fast** slide bar to control the speed of the table movement:
   a. Place the cursor on the slide bar, click the left mouse button to grab the slide bar, then drag slide bar to the desired position between **Slow** and **Fast**.
      OR
   b. Place the cursor on the slide bar track and click the left mouse button. The slide bar will move towards the cursor.

Point and Click (XY units only)

1. On the Measure screen, place the mouse pointer on the point of the sample to be measured.
2. Click the left mouse button. The table automatically moves to that point.

Simulated Joy Stick mode (XY units only)

1. Press and hold the right mouse button. The mouse pointer changes to a joystick symbol.
2. Move the mouse pointer in the desired direction. This moves the table.
3. Release the right mouse button to stop the table movement.

Jog mode

1. Tick the **Jog Mode** toggle box on the Measure screen. The **Slow/Fast** slide bar disappears. A box opens, allowing you to enter a movement increment.
2. Enter the desired distance for the table movement.
3. Click one of the four arrow buttons to position the sample. Each click of an arrow button moves the table by the specified distance.

Go to

1. Click **Go To ...**.
2. Enter the desired coordinate(s) in the **Go To XYZ (or RQZ)-Position** window which opens. The coordinates are relative to the current origin.
3. Click **OK** to accept the entered values.
   The table moves to the selected location.

10.1.8   Make a measurement using measure sample

Use the following general procedure when making measurements.

1. Place the sample in the chamber.
2. Position the sample under the crosshairs.
3. Focus the video display.
4. Click the relevant button in the **Measure Using** panel to select the required measurement method (see chapter 10.1.8.1).
5. If **Application** or **Calibration** is selected, click the **Open Folder** icon at the right of the display box and select the application file or calibration file you want to use. The selected file name appears in the display box. Measurements are taken using the parameters defined in the selected application or calibration file. When measurements are taken, the information displayed consists of the thickness or composition and the material. Two thicknesses are displayed for measurements of dual layer coatings.
6. If **Counts** is selected, click the **Settings** icon to the right of the display box. The Measurement Parameters drop-down menu opens.
7. Select the filter, collimator size, X-ray current and X-ray voltage. When measurements are taken, the counts per minute obtained for each material in the sample is displayed.

10.1.8.1 Measure sample options

The following methods can be used to measure samples:

Application
- Used to make thickness/composition measurements of samples with an application file.
- Uses the calibration specified in the application file.
- Allows measurements to be taken using the XYZ program specified in the application file, or a Quick XYZ Program if no XYZ program is specified.
- Can print the statistics in a report format selected from the Print Options tab.
- Statistics can be saved from an individual measurement session and from all of the readings taken with the application.

Calibration
- Used to check a calibration by measuring a standard.
- Can be used to make thickness or composition measurements with a calibration file.
- A Quick XYZ Program can be entered and used to make a measurement.
- Does not permit the use of XYZ programs.
- Statistics can only be printed in the format displayed on the Stats tab.
- Statistics cannot be saved.

Counts
- Used for material analysis by obtaining measurements, in counts per minute, from a sample.
- Allows you to select the collimator size, filter, and X-ray settings to be used for the measurement.
- A Quick XYZ Program can be entered and used to make a measurement.
- Does not permit the use of XYZ programs.
- Statistics can only be printed in the format displayed on the Stats tab.
- Statistics cannot be saved.

10.1.8.2 Make a measurement using a part number

To use the database to make measurements, part numbers have to be set up and entered into the database (see chapter 9).

1. Select the part number to be used and enter appropriate information into the data fields (see chapter 10.1.8.3).
2. If the part number references an XYZ program, adjust the datum point(s) (see chapter 10.1.8.4).
3. Click **GO** to take the measurements.
4. Review the measurement values and accept or reject them (see chapter 10.1.8.5).

10.1.8.3 Select a part number for a measurement

Use this menu to select a part number from the database to make measurements with. Information relating to the measurement can also be added to the data fields.

1. Select **Measure Parts** from the Task menu, or click the **Measure Parts** icon on the taskbar.
   The Measure Parts screen opens in the right half of the display.

Select Part Number

2. Click **Select Part Number**.
   The Part Information dialogue box opens. The information that appears in the part number and data fields defaults to the data from the last measurement taken. The dialogue box shown below is typical. Your own display will contain the data field names that were assigned when the database was set up.
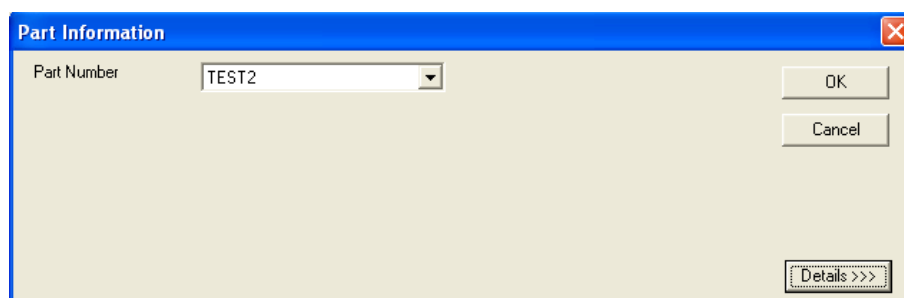
3. Select the part number for which you want to take measurements.
4. Review the data fields and enter any appropriate information appropriate for this measurement into the data fields. You do not need to enter information into all the fields, but unused fields must be blank. You can enter new information, or click the arrow and select from the previous entries displayed in a drop-down box.

☞ *Information*   If you exit Measure Parts mode without taking measurements and then return, you must re-enter all the new information into the data fields. The program defaults to the information from the last measurement taken.

5. Click **OK** to accept the information.
6. Click **Details** to display more of the Part Information menu.
   The scrollable descriptive text window, the summary information about the part number and an image open, if this information was added in the Part Description menu when the part number was created.

10.1.8.4 Adjust datum points

After a part number has been selected and information entered into the data fields, the Program Settings tab screen opens. This screen lists the applications used in the part number by groups. Each group has a common datum point(s). Example screens are shown below. The contents of the screens depend on the specific part numbers you have created. Before measurements can be taken, change the datum(s) in the applications used by the selected part number to the part in the X-ray chamber.

Parts that use datum points

If datum points are used, the applications display in red as shown below. Before measurements can be taken, each group of datum(s) must be adjusted to the location on the part that corresponds to the location to which the datum in the program is referenced.

If all the datum(s) are in one group, only one adjustment is required. If there are two datums per group, then each datum in the group must be adjusted. When the datums in each group have been adjusted, all the applications display in green as shown below. The **GO** button also becomes accessible.
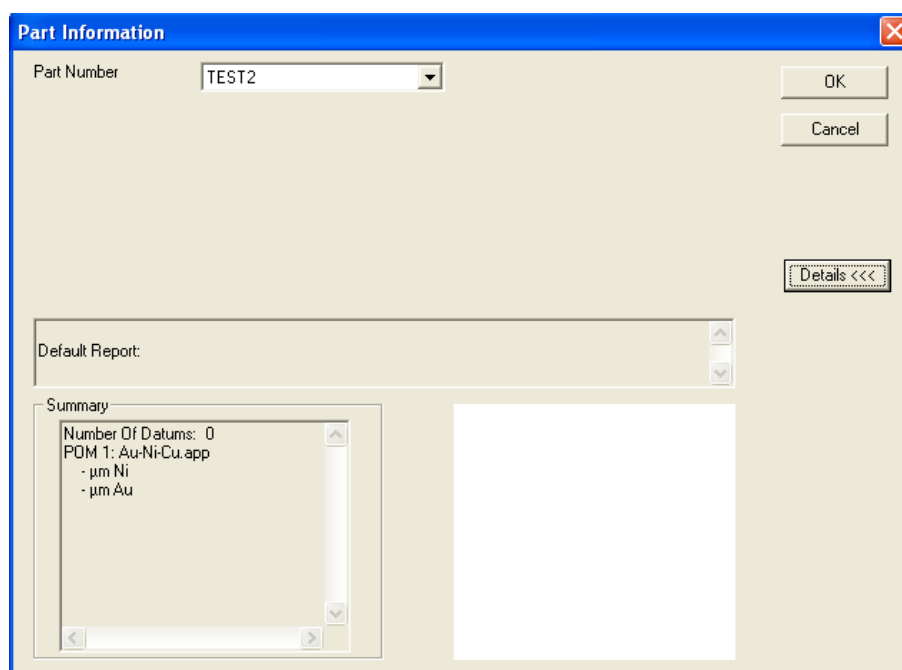
1. From the video screen, position the crosshairs at the location on the part that you want to use for the first datum.
2. Click **Adjust Datum 1**.
   If there is one datum for the group, the button is labelled **Adjust Datum**. The software highlights the next group of applications.

   If there are two datums for the group, the table moves to the second program datum point.
3. Adjust the crosshair position on the part to the required location.
4. Click **Adjust Datum 2**.
   The colour of this group of applications changes to green. The next group of applications is highlighted.

Select Part Number

5. Repeat steps 1 to 4 until all of the datums have been adjusted.
   The number of points to be measured for the part number is displayed at the bottom of the screen, below the **Select Part Number** button.

6. Click the **4** button to verify the programs.

7. Click **GO** to begin taking measurements.

Parts without datum points

If the selected part number has no datums, the applications display in yellow.

1. Position the crosshairs at the location on the part that measurements are to be taken.

2. Click **GO** to begin taking measurements.

10.1.8.5 Review measurements data

When the software has finished taking the measurements specified in the part number, the Accept Readings screen shown below opens. Readings are listed sequentially, and any out-of-limit readings are identified. Readings can also be tagged to mark this group of readings or to identify an event that occurred during the measurement.
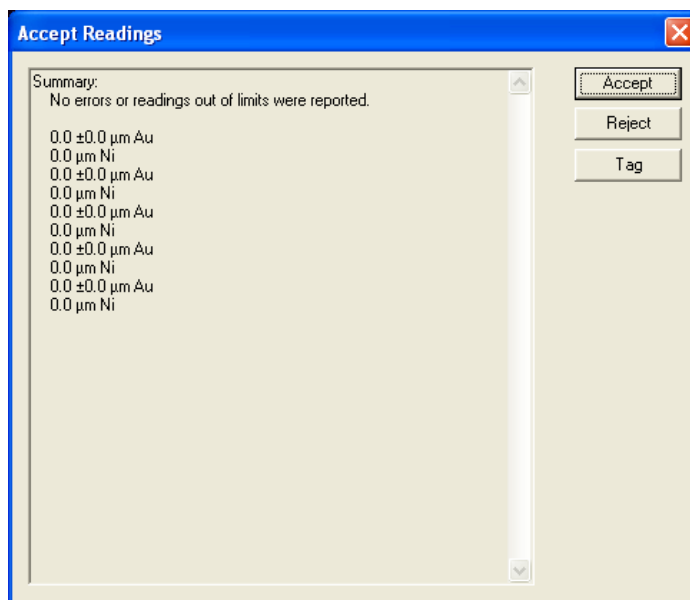
1. Click **Accept** to add these readings to the database.
2. Click **Reject** to reject all of the readings.
3. Click **Tag** to access the drop-down Tag menu (See chapter 10.1.8.6).

10.1.8.6 Tag a measurement

Tags are markers that are added to a measurement record in the database. Each tag is identified by a single letter. They can be used to note an event that occurred during the measurement or add information to the record in the database. The tags are displayed on the Stats tab, and when the data is printed in a report.
The Tag menu is accessed from the Accept Readings menu that opens after the measurements specified in the part number have been taken.
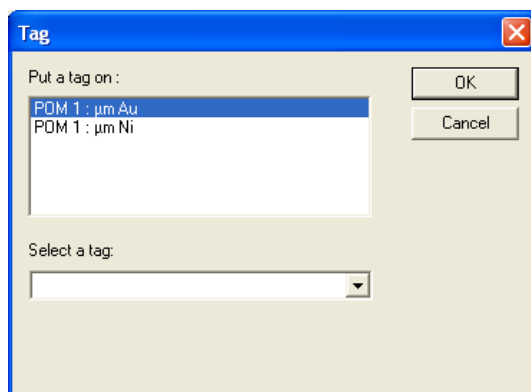
To add an existing tag:

1. Click the arrow in the Select a Tag window to display the list of existing tags.
2. Select one of the tags.
3. Left-click the mouse to add the tag to the window.
4. Select one of the points of measure displayed in the Put a Tag On window.
5. Click **OK**.

To add a new tag:

1. Place the cursor in the window.
2. Enter a letter followed immediately by a (-) hyphen.
3. Type text to describe what the tag represents.
4. Select a point of measure.
5. Click **OK**.

☞ *Information*   Make you use a new letter when adding a new tag. If you use an existing letter, a warning opens indicating that you are changing a tag that is attached to previous readings. If you ignore this warning and click OK, an asterisk (*) and the phrase *Tag has been changed* is placed next to the data that formerly used this tag.

10.1.8.7 Use the repeat feature

The repeat feature allows you to take multiple readings on a sample without repeatedly clicking the **GO** button.

To enable the repeat feature:

1. Tick the **Repeat** check box. The Repeat Measurements window opens.
2. Enter the desired configuration in the displayed fields:
   a. **Number of Readings** – type the number of readings to be taken.
   b. **Time Between Readings** – type the length of time, in seconds, to wait between readings.
3. Click **GO** once.
   The unit will take the designated number of readings.

10.1.9 Perform an XY search

1. Align the crosshair at the centre of the sample.
2. Focus the camera system.
3. Select the **XY Search** box on the Measure screen.
4. Take the measurement in the normal manner.
   A series of short measurements in the X direction, the Y direction, or in an XY grid formation will begin, based on the configuration of the Search Wizard.
   When all the readings are taken, the table returns to the position that matches the selected criteria. A measurement, using the normal length of time, begins at this point.

10.1.10 Quick XYZ program

The Quick XYZ Program feature is available when selecting an application that does not specify a program, a calibration or *COUNTS* mode for a measurement. This option allows you to create a random, linear, grid or grid scan pattern that is used only in the current measurement session.

To set up a Quick XYZ Program:

1. Tick the **Enable XYZ Program** check box.
   The Quick Program menu opens.
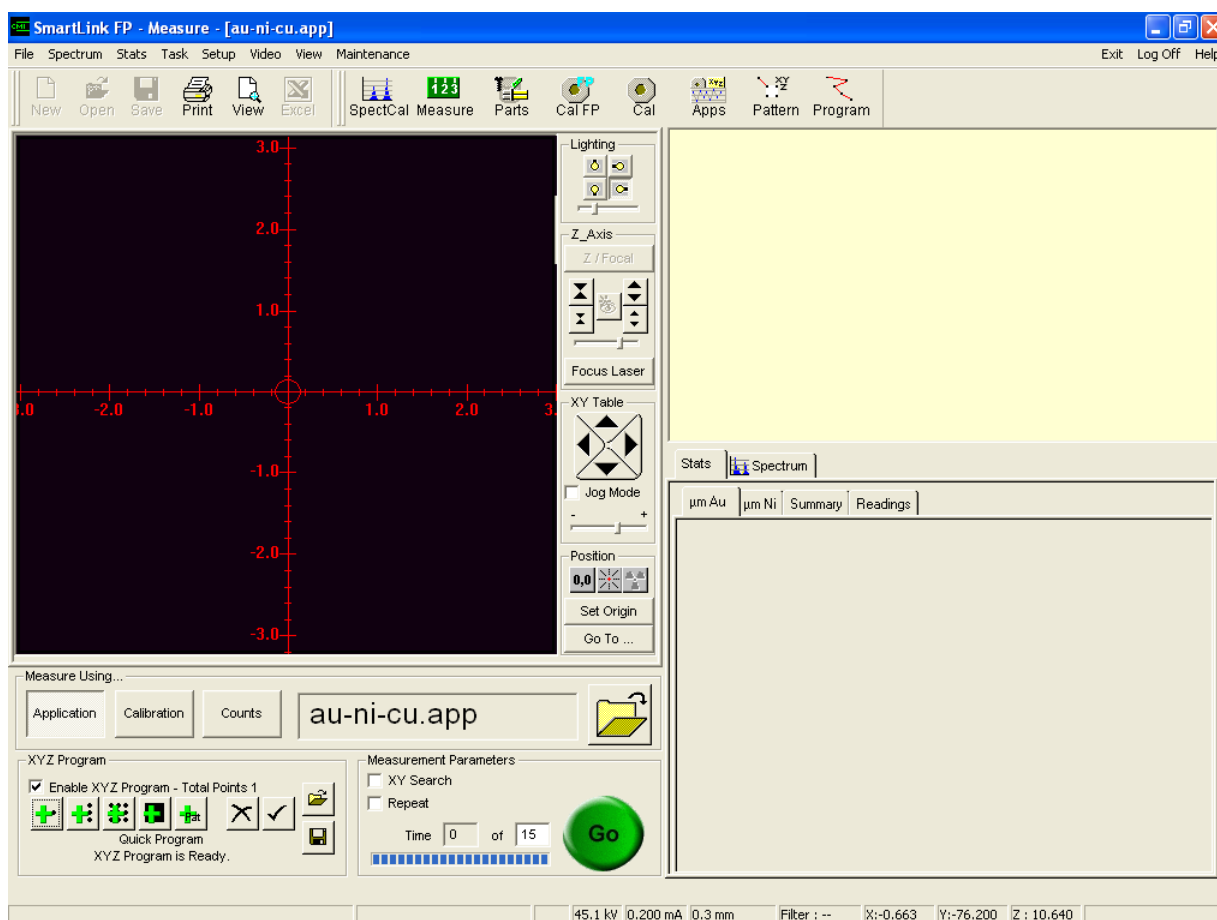
Fig. 10-3   Quick Program menu

2. Move to the first point to be measured and click the **Add Point** button.
3. Use the other buttons described below to set up the rest of the program.
   a. Click **Add Point** to add a point to the program. The coordinates of the new point are the location of the crosshairs.
   b. Click **Add Line** to add a line after one point has been defined. Use the drop-down menu to specify the number of points in the line.
   c. Click **Add Corner** to add a corner to the grid after one point has already been defined. Use the drop-down menu to specify the number of points on the X and the Y axis.
   d. Click **Add grid scan area corner** to add a corner of the grid scan area, after one point has already been defined. Use the drop-down menu to specify the time and direction of the scan.
   e. Click the cross to delete the last point that was added.
   f. Click the tick to preview the program without taking measurements.
4. Click **GO** to start the measurement routine.

10.1.11   View a spectrum

The Spectrum tab appears when the unit is the Measure, Calibrate and Spectrum Cal screens.

10.1.11.1 Enlarge the spectrum

Detailed observation can be made of narrow portions of the spectrum by enlarging the desired portion. Each KeV/Channel becomes wider so that small changes can be observed.

1.   Use the mouse to point to the left or right edge of the desired region.
2.   Click the left mouse button and drag the mouse across the part of the spectrum that is to be magnified. Diagonal lines highlight the defined region.
3.   Click **Zoom In**.
     The selected portion expands across the width of the graph.
     The height of graph remains the same as the original spectrum.
4.   If required, repeat steps 1 through 3 on the magnified spectrum to enlarge the spectrum further.
5.   To view the entire spectrum again, click **Zoom Out**.

10.1.11.2 Define regions of interest on a spectrum

To select a region of interest:

1.   Tick the box to the left of one of the five numbered buttons in the **Regions of Interest** panel of the Spectrum screen.
     The Define ROI window opens.
2.   To change the colour of the highlighted region of interest:
     a.   Click **Specify Color ...**. A conventional Windows colour palette opens.
     b.   Choose a basic colour or define a custom colour using the conventional Windows procedure.
     c.   Click **OK**.
3.   You can define the region of interest in two ways:
     a.   If the region of interest is associated with a known chemical element, click the drop-down list and select the element from the list.
     b.   If the region of interest is not associated with a known chemical element, enter the upper and lower limits of the energy range (in KeV) in the fields provided.
4.   Click **OK** to accept.

10.1.11.3 Save a spectrum

1. Take a measurement on the sample to be used to produce the spectrum.
2. Click **Save As** in the Spectrum menu.
3. In the File Name window, enter the name by which to reference the spectrum. Saved spectra are automatically given an extension of **.sp**.
4. Click **Save**.

10.1.11.4 Produce spectrum overlays

1. Save the spectrum to be used as an overlay (see chapter 10.1.11.3).
2. Take a measurement on the new sample.
3. Click one of the **Empty** buttons in the **Spectrum Overlays** section of the Spectrum screen.
4. Select the name of the saved spectrum to be used as the overlay from those displayed in the window.
5. Click **Open**.
   A line in the colour of the box adjacent to the selected **Empty** button appears on the graph.
6. To remove an overlay, clear the check box adjacent to the **Empty** button.

10.2 Print measurement results

10.2.1 Print from an application (Measure Samples)

1. If you want to review a report before printing, click the **View** icon.
2. Click the **Print** icon after measurements have been completed.
   The Header Information drop-down menu opens.
3. Review the information in the header data fields and make any changes or additions desired.
4. If the **Select a Range of Readings** option is selected in the Print Options tab (setup in applications), enter the range of measurements to be printed in the report. Select measurements by the reading number, which is displayed along with the readings in the Stats tab.
5. Click **Continue**.
   If a default report is specified in the application, the Report Generator opens in the background and prints the default report.
   If no default report has been specified in the Print Options tab, the Report Generator opens so that a report can be selected.
6. Click the **Open Folder** icon.
7. Select the report to be printed.
8. Click **Open**.
9. The Report Generator prints the data from the application in the selected report.

10.2.2 Print from the database (Measure Parts)

1. Click the **View** icon if you want to review the report before printing.
2. Click the **Print** icon after measurements have been completed.
   If a report was selected when the part number was set up in the database, SmartLink FP opens the Report Generator in background, executes the query, and prints the data in the format of that report. The data used in the report is selected from the search criteria defined in the query that was saved with the report.
   If no report was selected when the part number was set up, the Print Report drop-down menu opens.
3. Choose the report you want to use to print the data and click **OK**.
   The select report selected starts printing. The data for the report is selected by the search criteria of the query that was saved with the report.

Refer to Report Generator help for details on setting up reports and defining a query to select the data you want to print.

10.3   Setting measurement options

10.3.1   Custom units

This option is used to create a new unit of measure. Two types of custom units can be created – one for a constant and one for a density correction. A base unit of measurement is first selected. Values are then entered into an equation that computes the custom unit.

Custom units must be created before they can be selected when setting up a calibration. Custom units can be specified when setting up an application by selecting a calibration that uses the custom unit.

Information   Custom composition units cannot be created.

10.3.1.1   Create a custom unit

Click **Custom Unit** from the Setup menu.
- The Custom Unit Wizard guides you through the process.

10.3.1.2   Delete a custom unit

1. Select **Custom Unit** from the Setup menu.
2. In the **Custom Units Wizard – Step 1** window, select the application type that contains the custom unit to be deleted.
3. Click **Next**.
4. In the **Custom Units Wizard – Step 2** window, click **Next**.
5. In the **Custom Units Wizard – Step 3** window, click the custom unit to be deleted from the list in the Delete Existing Custom Units section.
6. Click **Delete**.
7. Repeat steps 5 and 6 to delete as many items as required.
8. Click **Finish**.

11   Other functions

11.1   Video menu

The Video menu provides functions used to configure features of the video display.

Zoom

Click this option to enlarge the image on the display. This feature helps you to align the collimator on small samples.

Save Image

This selection can be used to save the image on the display as a bitmap. After this option is selected, enter a *file name* for the image in the drop-down **Save Video Image** menu. Then click **Save**.

Crosshair colour

This displays a chart of basic colours from which colour of the crosshairs on the video display can be chosen. To change the colour of the crosshairs, click the desired colour in the chart and then click **OK**.

ReSync

This option resets the video image. Click this option if you are experiencing problems with the video image.

Config Video

This drop-down menu allows adjustment of the video display parameters. Adjust the slider controls to obtain the desired quality of video image.

Fig. 11-1   ATI Video Configuration menu

11.2 Stats menu

The Stats menu is accessed from the Main menu, when in the Measure Samples screen. It is not accessible from Measure Parts or other screens.

Readings taken with an application are automatically saved in a data file upon exiting the application. Readings from a measurement session can be saved in a separate file by using the **Save** option in the menu, and entering a name for the session file. Readings taken with a calibration or in COUNTS mode cannot be saved.

Statistics are calculated from the readings along with X-bar and R charts, and a histogram. Readings, statistics, X-bar and R charts, and histograms are displayed on the Stats tab and can be printed in reports.

The following operations can be performed by clicking on the appropriate item in the menu.

Table 11-1 Stats menu features

Item	Description
Current Stats Only	When a tick appears in front of this item, only the readings and statistics from the current measurement session are displayed. To see all the readings and statistics taken with an application, clear the menu item. Readings taken with a calibration and in COUNTS mode are not saved, so only the current session information is displayed.
New Session	Click this item to begin a new measurement session. If a calibration or the COUNTS mode is used, the statistics from the current session are cleared.
Save	Only readings and statistics made with an application can be saved from this menu. Readings and statistics made with a part number are saved in the database. Readings made with a calibration or in COUNTS mode are not saved. Readings are automatically saved in a data file when exiting an application. The file is named after the application. This menu can be used to save session statistics in a separate file. 1. Click **Save**. A dialogue box opens which displays the layer(s) that has/have been measured. 2. Select a layer or tick the **All** check box to select all layers. Then click **OK**. 3. The **Save As** drop-down menu opens. 4. Enter a name for the file and click **Save**.[a]
Print	Click this item to print the information as it is displayed on the Readings tab, or the Characteristics tab(s). A Print dialogue box opens. Select a characteristic or readings and click **OK**. Use the report generator to print the information in a report format.
Parameters	Click this item to display the drop-down Statistics Parameters menu. Use this menu to set the group size and specify viewing information for the readings.
Clear	Click this item to delete the statistics and readings. If **Current Stats Only** is selected, then only the readings and statistics from the current measurement session are deleted. If Current Stats Only is *NOT* selected, then all of the readings and statistics made with the application are deleted.

a. Data can be saved as comma separated values (.csv file), which can then be opened in Microsoft Excel.

11.3   Setup Options menu

The Setup Options menu allows you to globally configure various features of the system. Click **Setup** from the Main Menu bar and then on **Options** in the drop-down menu, to display the six tabs of the Setup Options menu. Each tab identifies a folder that contains information or features. The features can be enabled or disabled. A feature is enabled (ON) when the check box is ticked.

11.3.1   Focus Laser tab

Auto Focus Time   This feature controls the length of time between when the focus laser is adjusted, and when the display reverts to the Video screen. Enter the time, in seconds, as required.

11.3.2   Technician tab

This tab contains information used by the technician when troubleshooting the system. You cannot change the displayed values.

11.3.2.1   Measurement Limit

This field displays the default **Max Normalized** value. This is the point on the calibration curve beyond which the readings display an *Over Range* warning or the maximum normalized value, whichever has been selected on the Statistics tab. The default value of 0.95 indicates that readings that are greater than 95 % of the total range for the application are considered to be too thick. Readings above this range may not be as accurate as those within the range and can produce a higher standard deviation.

11.3.2.2   X-Ray Factors

- **Gain Factors**
  The gain factors are values used in troubleshooting the system.
- **Ag Counts**
  Displays the counts measured when the first spectrum calibration was performed on this unit. The counts are automatically monitored by the SmartLink software. If the counts measured during subsequent spectrum calibrations vary beyond the specifications, a warning and error message open. The X-Strata920 must be serviced before additional measurements can be made, as any new readings may be erroneous.
- **Flux Factor**
  Displays the current flux factor, which is determined by the spectrum calibrations.

11.3.3   Export tab

Allows you to enable the serial export of data files.

Serial Options   When enabled, this option allows readings to be exported to the serial port every time they are taken. It also allows you to specify the format for exporting the data.
To export data, tick the **Enable Serial Output** check box. To automatically place a date and time stamp on the readings, tick the **Enable Date/Time** check box.
The data can be exported in one of four formats:

1. The number of counts, the element, the thickness, the standard deviation.
2. The thickness only.
3. The number of counts and the thickness.
4. The number of counts, the element, the thickness, the standard deviation and the application used to take measurements.

11.3.4   XY Table tab

This contains three options for moving the XY Table.

11.3.4.1 Disable XY Table when door is opened

• When this option is **On**, the XY Table does not move out when the door is opened.
• When this option is **Off**, the XY Table moves out when the door is opened. When the door is closed, the table moves back to its original position.

11.3.4.2 Reset XY when door is opened

When this option is **On**, the XY Table moves out when the door is opened. When the door is closed, the table moves back to the centre position.
When this option is **Off**, the XY Table does not move when the door is opened.

11.3.4.3 Coordinate System

Select the type of coordinate system to be used to define the table position. The default selection is Cartesian coordinates. When polar coordinates are selected, the default 0 degrees position can also be selected.
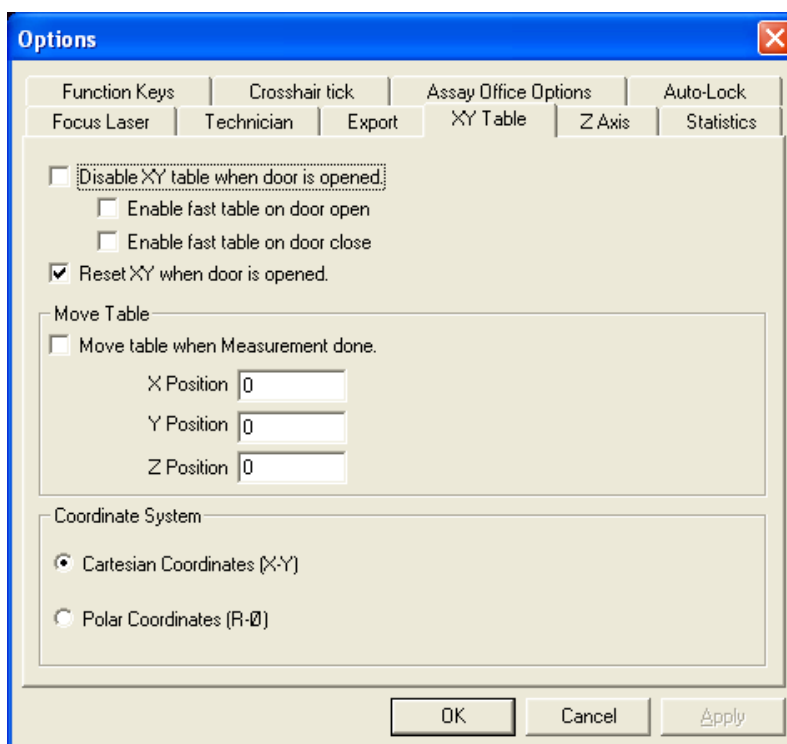
Fig. 11-2   Coordinate system option screen

11.3.5 Z Axis tab

This folder contains two options concerning the movement of the Z-axis.

11.3.5.1 Disable Z Axis protection

The Z-axis protection feature prevents the sample moving too close to the camera system, which could cause damage to the detector. When Z-axis protection is enabled, a sensor detects when the sample approaches the camera system and automatically moves the sample away.

- When this option is **On**, Z-axis protection is enabled.
- When this option is **Off**, the Z-axis protection is enabled.

11.3.5.2 Home Z Axis when door is opened

- When this option is **On**, the Z-axis moves to the home position each time the door is opened.
- When this option is **Off**, the Z-axis does not move when the door is opened.

11.3.6 Statistics tab

11.3.6.1 Disable Statistics

To disable the statistics feature of the software, tick the check box. The program must be shut down and restarted for the change to take effect. When the statistics feature is disabled, the **Stats** tab does not display in *MEASURE* mode and the reading statistics are not saved.

11.3.6.2 Out of Range Readings

To enable this feature, tick the check box. This allows an out-of-range reading to be displayed as the maximum normalized value, which has a default setting of 95 % of the measurement limit for the application. If the feature is disabled, an *Over Range* warning opens if the last reading is out-of-range.

12 Maintenance

NOTICE | There are no user replaceable fuses or parts in the X-Strata920. Internal service of the X-Strata920 must be done by Hitachi High-Tech Analytical Science technicians only.

12.1 Maintenance menu

The Maintenance menu is opened from the Main menu. It allows you to:
- Reset certain features of the X-ray that may have changed due to outside influences.
- Maintain the various data files.

The Maintenance menu is intended for use by Hitachi High-Tech Analytical Science technicians or persons trained by Hitachi High-Tech Analytical Science in the installation, operation, service and maintenance of the X-Strata920. The Maintenance menu can be only be accessed by users who have a high level password.

12.1.1 File maintenance

Allows you to list the various data files that have been created and delete any that are not needed.

1. To display the existing files, click one of these list buttons:
   - Applications
   - Programs
   - Spectrums
   - Stats
   - Calibrations
   - Patterns
   - Surfer Files
   - Bitmaps
2. From the displayed list, select the file(s) to be deleted.
3. Click **Delete** at the bottom of the screen.
4. Click **Exit** to return to the Main menu.

12.1.2 Technician

This option opens the **Tech Controls** menu. The menu is used by Hitachi High-Tech Analytical Science technicians for diagnostics purposes.

12.1.3   Crosshair alignment (XY units only)

The crosshair alignment feature allows you to align the collimator so that the X-rays are directed to the spot represented by the crosshairs on the screen. This alignment is critical when measuring small samples or when exact positioning is required
(see chapter 12.2.1)
A crosshair alignment standard is required to perform this alignment.
The standard can be purchased from Hitachi High-Tech Analytical Science.

12.1.4   Magnification

This feature is used to adjust the magnification of the camera video image relative to the actual dimensions of objects shown in the Video window. Magnification is set at the factory before the unit ships.

12.1.5   Laser offset (XY units only)

The laser offset feature is used to adjust the positioning of the image so that the sample is positioned under the crosshairs when aligned with the focus laser.

12.1.6   Usage log

This feature displays the time and password used for every log-in to the instrument. If an invalid password is used, the entry is marked with a red diamond and the invalid password is recorded.
To delete entries from the usage log:

1.   Click **Usage Log** on the Maintenance menu. The Usage Log menu opens.
2.   Click the green or red diamond to the left of the entry to be deleted.
3.   Click **Delete**.
4.   To delete all the records, click **Delete All**.
5.   Click **Exit** to leave the Usage Log menu.

12.1.7   Other features

There are three additional features that are greyed out and can only be accessed with a special password. They are diagnostic aids for use by Hitachi High-Tech Analytical Science technicians.

12.2 Mechanical adjustments

12.2.1 Perform a crosshair alignment

1. Select the **Crosshair Alignment** option from the Maintenance menu.
   Instructions for this procedure appear in the upper right corner of the screen.
2. Obtain a crosshair alignment standard.
3. Place the alignment standard in the chamber so that the copper part of the standard is to the left and the tin part is to the right.
4. Close the door to move the standard under the collimator.
5. Manually position the standard so that the line separating the elements is parallel to the vertical crosshair.
6. Align the cursor over the line separating the elements.
7. Click the left mouse button.
8. Click **GO**.
   The unit begins to automatically align the crosshair. If the unit is equipped with more than one collimator, the smallest collimator is aligned first. The program monitors the intensity of the peaks produced by each element during the process. The XY Table moves back and forth until the collimator is aligned.
9. When the unit has finished aligning each of the collimators, open the door.
10. Re-position the standard so that the copper part of the standard is at the top and the tin part is at the bottom of the display.
11. Close the door to move the standard under the collimator.
12. Manually position the standard until the line separating the copper and tin is parallel to the horizontal crosshair.
13. Align the cursor over the line separating the elements.
14. Click the left mouse button.
15. Click **GO**.
    When the process is complete, the message *Collimator Alignment Complete* opens.

12.2.2 Perform a laser offset adjustment

To perform this procedure, obtain a sample with a dot or a small circle that can be seen on the video screen. A Hitachi High-Tech Analytical Science logo on a standard can also be used for this procedure. Instructions are shown in the upper right corner of the screen throughout this procedure.

1. Select the **Laser Offset** option from the Maintenance menu.
2. Click the **Start** button.
3. Open the door.
4. Align the positioning laser to the chosen spot.
5. Close the door.
6. The reference point is displayed on the screen.
7. Click the reference point.
   The table moves the reference point to the centre of the crosshairs. The offset coordinates are displayed.
8. Click **OK** to accept these coordinates.

12.3 Electrical items

12.3.1 Cooling fans

Ensure that the cooling fans are kept clear of obstructions.
The X-Strata920 has cooling fans:
- at the rear of the X-ray chamber;
- on the power supply in the computer.

12.3.2 Monitors

To prevent screen damage, switch monitors off when they are not in use. If a long program or series of readings is being run, switching the monitor off does not affect the measurement process.

12.3.3 Fuse replacement

The *Power Entry Module* fuses on the back of the chamber can be replaced by a person other than a Hitachi High-Tech Analytical Science technician. Replace fuses only with the correct type and rating, which are T2A - 250V fuses.

12.3.4 Power supply disconnection

After shutting down the instrument (see chapter 4.2.2), the primary method of disconnecting the electrical power supply is to remove the plug from the power supply socket. The power socket should be close to the equipment and accessible in normal operation.

12.4 Annual service

X-Strata920 units have an annual re-calibration cycle. Contact Hitachi High-Tech Analytical Science to arrange annual calibration and preventative maintenance.

13   Annex

This chapter contains
- glossary
- information on the theory of X-ray fluorescence
- the service addresses

13.1 Glossary

13.1.1 Special terms

Application File
An application is one of the methods that can be used to make measurements. An application consists of a calibration, the parameters to be used in taking measurements, an XYZ program and optionally the type of report to print. These characteristics are saved in a file. The Quick XYZ Program feature can be used if no XYZ program has been selected. Measurement and statistical data are also saved in the file. Applications are specified in the database option when setting up part numbers.

Bare Standard
A type of standard used in making a calibration. It consists of the base material, without any coatings.

Bins
Also referred to as *channels* (see below).

Calibration
A procedure for correlating readings from a specific instrument with a known, certified standard. Calibrations can be made using the FP method or the ROI method.

Calibration File
A calibration consists of readings taken on standards and spectrum data, which are stored in a file. It is used to calibrate the system for a specific type of measurement or application, and to generate the curve fitting function and a spectrum. It can be selected as one of the methods used to make measurements. It can be used to take measurements on similar types of samples, to read-back known standards to verify the accuracy of the calibration or it can be specified for use in an application. The Quick XYZ Program feature can be used with a calibration. Measurement data and statistics cannot be saved.

Channels
When *channels* is selected as the unit of measure for the display, the energy of the spectrum is divided into 4096 segments called channels. The spectrum display is then converted from KeV to the corresponding channel or bin number. The X-axis of the graph, the regions of interest, the peak and the pointer information will all be displayed in channel numbers.

Counts Only
One of the methods that can be used to take measurements. It is useful for performing a material analysis of the sample. When a measurement is made, the counts and the location in KeV of the counts are displayed. A Quick XYZ program can be created to take the measurement and a collimator and filter can be selected. Measurement data, other than the spectrum, cannot be saved.

Counts Per Second
Counts per second is defined as the number of photons emitted from the sample being measured and detected in a one second time interval.

Current Stats
Statistics generated during the current measurement session. Also referred to as *session stats*.

Database
The database program (Measure Parts) is an option for SmartLink FP that can be used to make and store measurements in a relational database, along with user entered information. A relational database consists of information stored in records and fields. Fields identify a specific category or type of information. Records are grouped in the database by each part number field and contain all of the measurements and data that relate to that specific part number.

Datum Point	A datum point is the reference location, or coordinates, for the points of measurement defined in a pattern or a program. It should be a readily identifiable feature of a part so that it can be found easily during the positioning process.
Fundamental Parameters (FP)	A technique for mathematically analyzing the raw X-ray measurement data to determine spectral information, coating thickness, alloy composition, or solution concentration. The algorithms are contained in the SmartLink FP operating system software. The algorithms are determined by the type of calibration that is selected.
Infinite Standard (Infinites)	A type of standard used to make a calibration. It consists of a sample of either a pure element, an alloy composition sample, or the solvent for a solution. The sample behaves like an infinitely thick sample.
KeV	When KeV is selected as the unit of measurement for the display, the spectrum, the x-axis of the graph, the regions of interest, the peak, and the pointer information are all displayed in units of keV. The system defaults to units of keV.
Method of Measurement	Measurements may be taken using either the *MEASURE SAMPLES* mode or the *MEASURE PARTS* mode (if the database option is installed). The measure samples mode uses one of three methods. Select either an application or a calibration for measurement, or select to measure using counts only. Follow the procedure for the method selected. The measure parts (database) option allows you to take measurements as defined in the part numbers that have been setup in the database.
Part number	*Part Number* is the name of the field in the database that is used to group information. Use *Part Number* to identify a specific part, a process, a customer, or any other category that you want to group information under.
Password Maintenance Program	Passwords are controlled through password maintenance, which is a separate program accessed independently from SmartLink FP.
Pattern Datum Point	A selected reference point on a sample or area, which becomes the datum point for the XYZ pattern that is to be performed.
Region of Interest (ROI)	A technique for mathematically analyzing the raw X-ray measurement data to determine spectral information, coating thickness, alloy composition, or solution concentration. The algorithms are contained in the SmartLink FP operating system software. The algorithms are determined by the type of calibration that is selected.
Report Generator	*Report Generator* is an optional program that creates custom reports, which are used to print measurement data made with SmartLink FP. Readings and statistical information from an application file or from the database can be selected and printed. Graphical information and screen captures can also be included in the reports.
Session Stats	Statistics generated during the current measurement session. Also referred to as current stats.
Standards	Standards are samples of the base materials, coatings, alloys, or solutions where the values of the thickness, compositions, or concentrations are certified in accordance with procedures of the National Institute of Standards and Technology.

Thickness/ Composition/ Concentration Standard	A type of standard used in making a calibration. It consists of either a coating of a known thickness, an alloy of a known composition, or a solution of a known concentration.
XYZ Pattern	A file consisting of a collection of coordinates referenced to a datum point or origin that locate points where measurements will be made. Patterns can be random, linear, grid or grid scan arrangements.
XYZ Program	A file consisting of one or more XYZ patterns referenced to a program datum point(s) that can be specified in an application and used to make measurements. Programs can be random, linear or grid arrangements.

13.1.2   Acronyms

Table 13-1 Acronyms

Acronym	Meaning
BEC	background equivalent concentration
CPS	counts per second
csv	comma separated values
EDXRF	energy dispersive X-ray fluorescence
EC	European Community
EMC	electromagnetic compatibility
FP	fundamental parameters
FWHM	full width half maximum
ISO	International Organisation for Standardisation
KeV	kilo electron volt
LVD	Low Voltage Directive
PC	personal computer
POM	point of measurement
ROI	region of interest
VGA	video graphics array
XRF	X-ray fluorescence

13.2   Theory of X-ray fluorescence

13.2.1   Introduction to XRF analysis

X-rays, which form a part of the electromagnetic spectrum (see fig. 13-1), are generated when atoms of elements are struck by particles such as electrons, or by other higher-energy radiation.The process of primary X-ray emission, which takes place inside an X-ray tube, can be considered simply as the production of characteristic X-ray wavelengths of the tube anode element when it is bombarded by a beam of high-energy electrons.
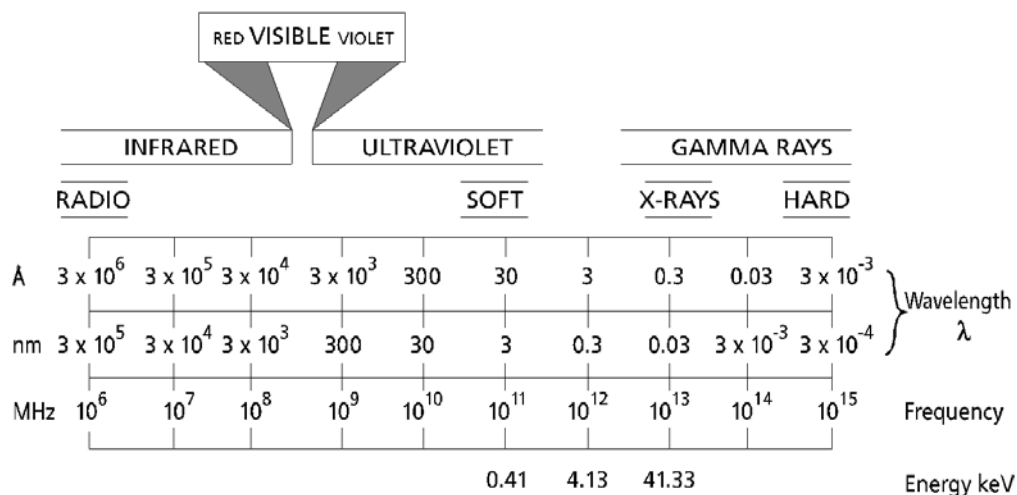

Fig. 13-1   Part of the electromagnetic radiation spectrum

☞ *Information* Although the X-ray region can be defined by its frequency in MHz, it is more convenient to use wavelengths specified in angstrom units ($1\text{Å} = 10^{-10}$ m) or the SI unit nanometres (1 nm $= 10^{9}$ m).

Characteristic X-rays are often also expressed in terms of energy in units of kilo electron volts (keV), which is inversely proportional to wavelength. This means that the energy of the X-ray emission lines in keV increases with increasing atomic number. The relationship between energy and wavelength is as follows:

$$E(keV) = \frac{12.4}{wavelength(\text{Å})}$$

As the atomic number of an element increases, the energy of its most sensitive characteristic emission spectral line (*the K line*), increases. Low atomic number elements are often known as *light* elements and their X-ray radiations are significantly absorbed by air. Conversely, high atomic number elements are known as *heavy* elements.

It is important to recognise that each element has a number of characteristic lines, and that these occur as the result of internal electron transitions within the atom. The lines occur as the result of the excess energy liberated when electrons from higher energy levels *fall down* to take the place of K, L and M electrons which have been ejected by the exciting radiation (see fig. 13-2).
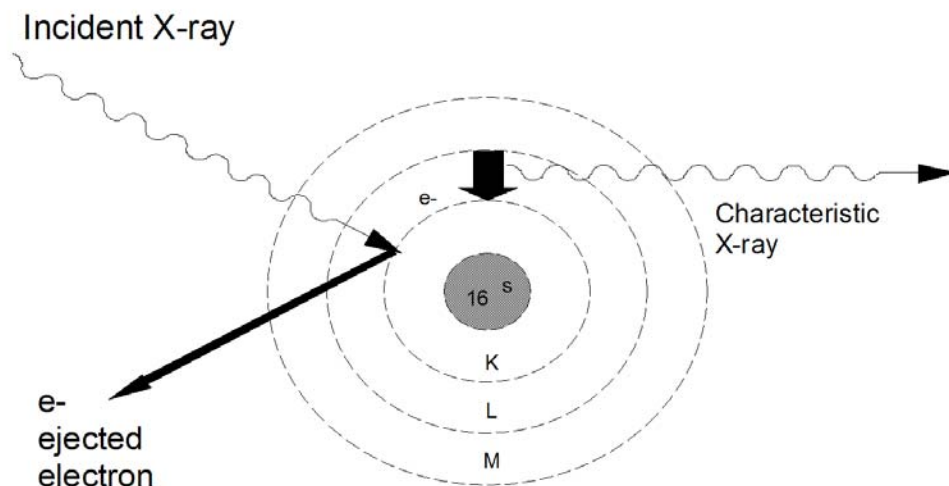

Fig. 13-2   Illustration of internal electron transitions within the sulfur atom

These discrete energy differences give rise to characteristic element lines. These are discussed below and shown in fig. 13-3. When X-rays are used as a source of radiation to excite other elements, the process is known as X-ray fluorescence (XRF).
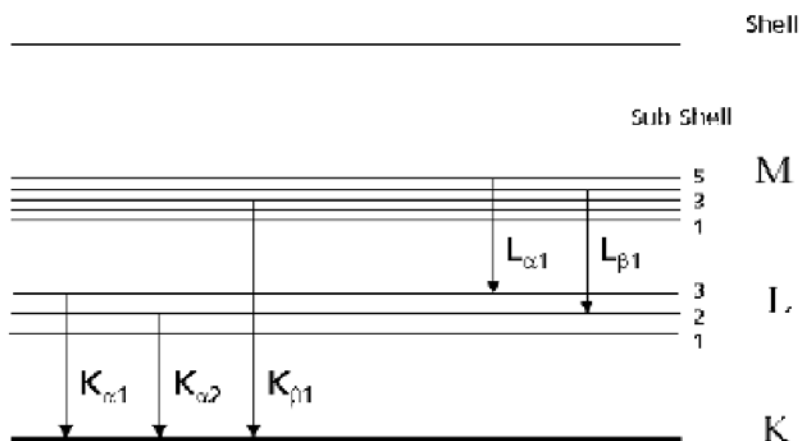

Fig. 13-3   Fluorescence of sulfur atom

Fig. 13-3 represents the electron energy levels about the nucleus of a sulfur atom for the K, L and M shells. Each transition results in the emission of an X-ray photon, its energy being equal to the difference between the two energy levels involved.
The emitted K lines have a higher energy than the emitted L lines or the emitted M lines. Wherever possible, XRF analysis uses the K lines because they are the most sensitive.

13.2.2 Selective excitation and primary beam filtration in EDXRF

Energy dispersive XRF (EDXRF) spectrometers have detectors that see the X-rays of all energies simultaneously. This advantage must be used carefully to ensure a maximum count rate that the detector will accept.

In the EDXRF spectrometer therefore, it is important to reduce the percentage of the spectrum taken up by background counts, and this is achieved by selective excitation and primary beam filtration. In practice, this means that the excitation voltage used for a particular range of elements is the voltage that effectively excites the highest energy line and no more. This avoids producing large amounts of continuum background higher in energy than the element with the highest energy that is to be analysed under these conditions. In addition, placing a filter between the X-ray tube and the sample will modify the position of the peak energy available for excitation.

Information   Metal samples and coatings do not produce a high spectral background, therefore the use of primary filters is not required.

13.2.3 Absorption of X-rays

Knowledge of the nature of X-ray absorption is fundamental to the understanding of almost all events in X-ray analysis. Two basic facts must be understood:

1. X-rays are absorbed according to Beer's law:

$$I_x = I_o e^{-\mu \rho x}$$

where

Ix = the intensity transmitted through a thickness x
Io = the initial incident intensity
μ = the mass absorption coefficient
r = the density
x = the thickness of the absorber

2. The value of the mass absorption coefficient changes with wavelength, and a plot of the variation between absorption and wavelength shows maxima followed by a sharp drop – the absorption edge. Fig. 13-4 shows this effect.

Absorption edges occur at each critical excitation wavelength (5.0185 Å), i.e. at the critical excitation energy (2.4700 keV) of sulfur.
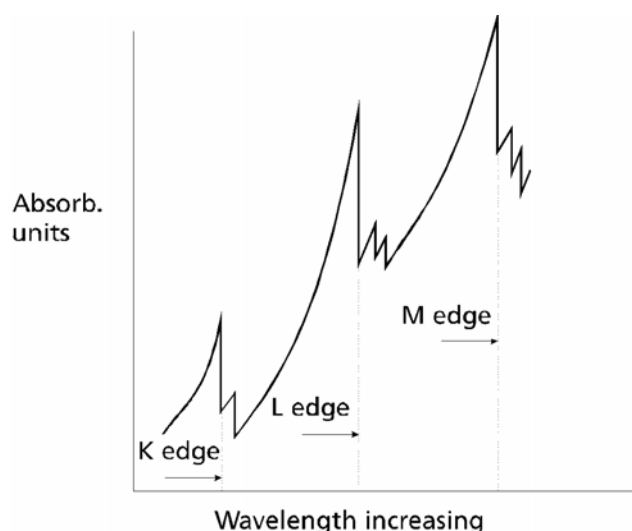

Fig. 13-4   Diagrammatic representation of absorption edges

Elements of higher atomic numbers are normally known as heavy elements and, because they have many electrons, they have a series of absorption edges – K, L, M, etc. The higher the atomic number, the higher the energy of the K spectral lines. Conversely, elements of a low atomic number are known as light elements and have K spectral lines of low energy.

From a study of a set of mass absorption tables, it is clear that the magnitude of the mass absorption coefficient at the energy being studied plays a principal role. This is the basis of inter-element (matrix) correction procedures, which are needed in the analysis of multi-element materials. The make-up of the material or the matrix determines how much of the excited characteristic radiation escapes from the sample: this is measured and related by calibration to the concentration of the element.

These inter-elements effects are automatically corrected for in the SmartLink FP software.
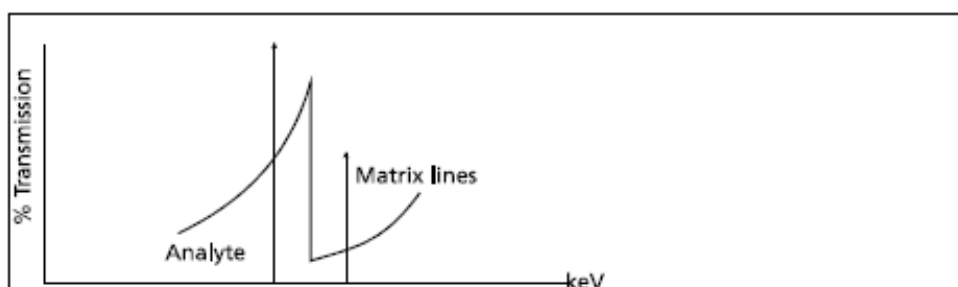
13.2.4　Single filter method

Fig. 13-5　Conditions supporting the single filter method

A single filter may be employed where the line of the element to be measured (analyte) is lower in energy than the element(s) to be discriminated against, and where the absorption edge of the filter lies to the high energy side of the analyte line. This is represented in fig. 13-5.

The use of a single filter mounted in front of the detector, known as a secondary filter, plays a very important role. Filters may be programmed to selectively absorb elements of higher energy (normally those of a higher atomic number).

These filters work particularly well in the transition elements region (Ti to Zn). For example Cu and Zn peaks, which overlap if no secondary filter is used, can be resolved in the spectrum when using a cobalt secondary filter.

13.2.5   Precision

The term *precision* is used to describe the repeatability of the instrument, which is normally quoted as the standard deviation.
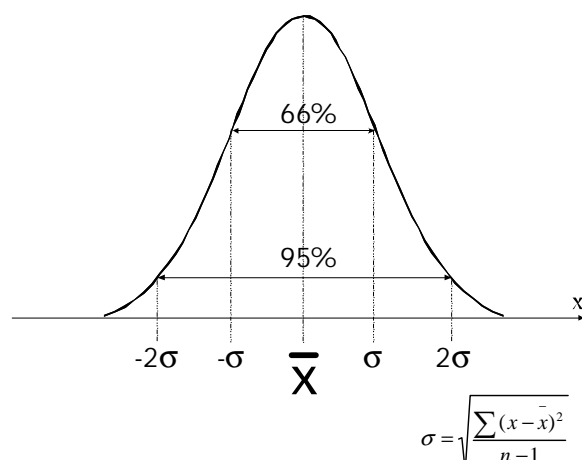

Fig. 13-6   Typical normal distribution

Fig. 13-6 shows a typical Gaussian distribution, which can be used for any measured value where random events are involved. From this it can be seen that the deviation from the mean value (above and below) for approximately 66 % of all the measured values is a value which is called sigma (s). Twice this standard deviation value either side of the mean accounts for 95 % of all the measured values, and three times this value either side of the mean takes in 99.97 % of all measured values.

These break-points are frequently used to describe various levels of confidence. That is to say, there is a 1 in 20 chance in getting a result with a deviation more than twice the one sigma (s) value above or below the mean.

With X-ray analysis, the measurements comprise a series of numbers accumulated by counting photons of a particular energy entering a detector. This counting process obeys a normal distribution and one standard deviation (1 s) is equal to the square root of the total number of photons counted:

$$1\sigma = \sqrt{\text{total number of photons counted}}$$

and

total number of photons counted = (C + BEC) * QT

where:

C = concentration
BEC = background equivalent concentration
Q = sensitivity (counts per second per concentration unit)
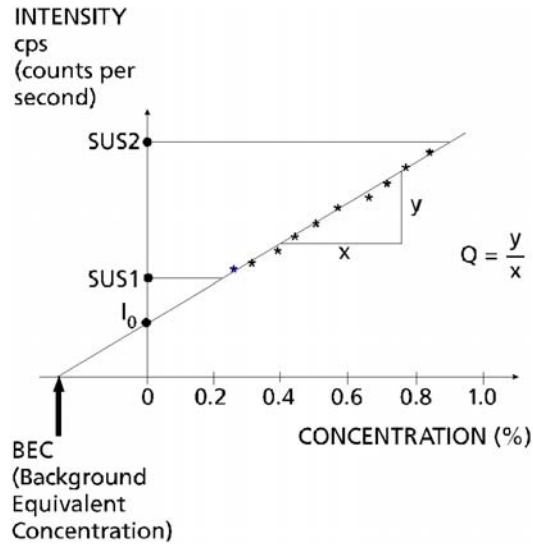T = counting/analysis time (in seconds)

Fig. 13-7   Concentration vs intensity

In fig. 13-7:

$$1\sigma = \sqrt{(C + BEC)*QT} \text{ counts}$$

however:
QT counts = 1 %
so that:

$$1\sigma = \frac{\sqrt{(C + BEC)*QT}}{QT}\% = \frac{\sqrt{(C - A_o)A_1}}{T}$$

$$1\sigma = \sqrt{\frac{(C + BEC)}{QT}}\%$$

Information   A0 is negative.

From this it is seen that:

$$\sigma \text{ at zero } = \sqrt{\frac{BEC}{QT}}\% = \sqrt{\frac{-A_o \times A_1}{T}}$$

Three times this value is known as the limit of detection (LOD).

It should be remembered that precision and time are intimately related. For example, if the requirement is to improve the value for sigma at a particular concentration level by a factor of two, then the counting time must be increased by a factor of four. That is to say, the time must increase by the square of the improvement required.

13.3   Service

If you need any help handling this product, please contact your service partner of Hitachi High-Tech Analytical Science or call us at the Service Centre:

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