Operating MANUAL

For XRF-2000 Series

MicroP

Rev. 5.12

December 26, 2012

IMPORTANT – PLEASE READ THIS FIRST!

PLEASE READ CAREFULLY THE OPERATION AND APPROPRIATE MAINTENANCE INSTRUCTIONS IN THIS MANUAL BEFORE ATTEMPTING TO OPERATE THE EQUIPMENT. NOTWITHSTANDING MICRO PIONEER'S LIMITED WARRANTY, MICRO PIONEER WILL NOT ASSUME ANY LIABILITY FOR INJURY, LOSS OR DAMAGE TO PERSONNEL, PROPERTY OR TO THE EQUIPMENT IF IT IS NOT CONNECTED OR OPERATED PROPERY.

SERVICE AND REPAIR OF THE SYSTEM SHOULD BE LIMITED TO QUALIFIED PERSONNEL ONLY. THE SYSTEM MUST BE DISCONNECTED FROM THE ELECTRICAL POWER SOURCE BEFORE SERVICING.

MICRO PIONEER RESERVES THE RIGHT TO MAKE CHANGES AND IMPROVEMENTS IF THE SYSTEM, AS WELL AS IN THE SPECIFICATIONS AND DESCRIPTIONS PROVIDED IN THIS MANUAL WITHOUT PRIOR NOTICE. FOR ADDITIONAL INFORMATION, PLEASE CONTACT:

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1. Introduction

1.1 System Purpose

XRF-2000 systems are designed to measure the thickness of multi coating elements or detect the elements in analyzed samples and determine their concentrations using X-Ray fluorescence (XRF).

The analysis performed by XRF-2000 series can by divided into three categories:

- Thickness measurement – measure the thickness of multilayer coating
- Qualitative analysis – Identification of the elements in a sample and inspection of the acquired spectra on a comparative basis.
- Quantitative analysis – Quantitative determination of the concentrations of the elements in a sample. This is performed after carrying out calibration procedures, using a pre-analyzed set of standards and empirical models, or via the fundamental parameters method.

The system software (XRayV5) runs under Windows XP, Vista or higher.

XRF-2000 Series

1.2 Principles of Operation

XRF-2000 Series systems utilize the phenomenon that when a sample is irradiated with x-ray radiation, the sample's atoms are excited. As the atoms return to their stable state, they emit x-ray photons (X-ray Fluorescence – XRF).
Each element has its distinct characteristic emission lines. The energy of these lines are documented in tables and stored in the computer's memory. A given sample's elements are identified by comparing the lines in the acquired spectrum to the corresponding element lines listed in the system's database.

The intensity (magnitude) of the element's lines in the acquired spectrum is related to its concentration or thickness. Increasing the concentration or thickness of an element result is an increase in the intensity of the fluorescent radiation characteristic of that element. By using empirical or theoretical physical models, the system can provide precise qualitative and quantitative analysis or thickness measurement.

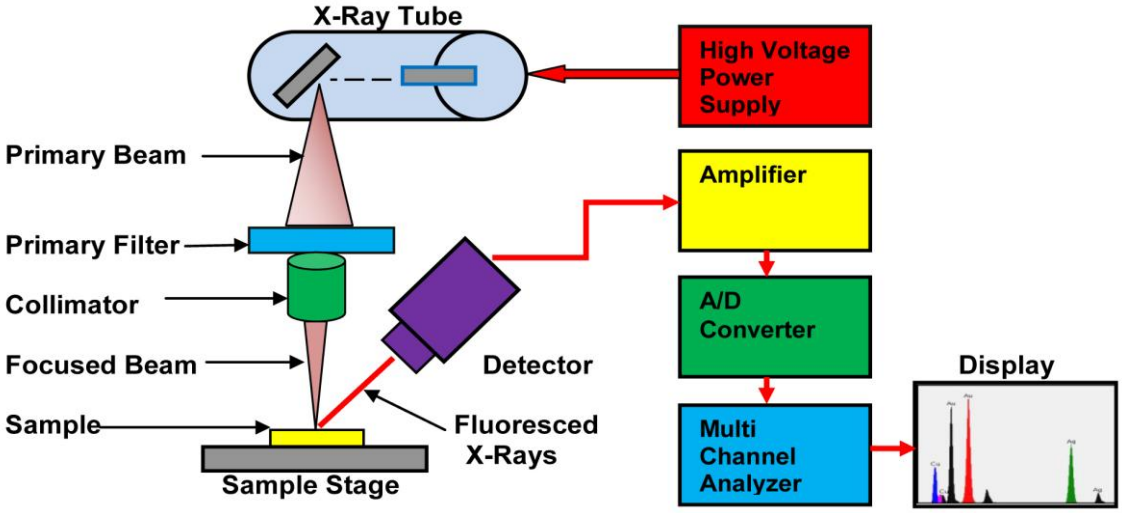
XRF-2000 Series systems employ a proportional counter or Si PIN diode detector to detect x-rays emitted from the sample. These detectors are capable of acquiring a spectrum containing many lines from many elements simultaneously. The counters or detectors convert the x-ray photons to proportional electric pulses. These signals are amplified and converted into a digital form by the Analog-to-Digital Converter (ADC). The data of the accumulated spectra are stored and displayed on the computer's monitor as a spectra histogram.

Besides characteristic lines, any observed spectrum also contains background signals, their characteristic dependent on many factors, especially excitation conditions. In order to reduce background and increase useful signal, X-ray high voltage and emission current can be varied, as well as utilizing changeable special filters. All these allow optimizing the spectrum of exciting X-ray beam for any given application.

ED-XRF analysis tools enjoy the following advantages:

- Broad concentration range from ppm (mg/Kg) levels up to 100%.
- Sensitivity to all the elements in the periodic table from Magnesium to Uranium.
- Fast response: Typical analysis time is usually under a few minutes.
- Simultaneous analysis of many elements.
- Non-destructive: The X-ray radiation does not leave any effects in the sample after analysis. Rare or precious samples are well as calibration standards can be tested an unlimited number of times without losing any of their authentic properties.
- Flexibility of sample form: The sample may be in solid, powder,

liquid or thin film form; or even be a few layers of elements plated on a thick base substrate. In most cases, samples are analyzed with minimal preparations.



1.3 TYPICAL SPECIFICATIONS

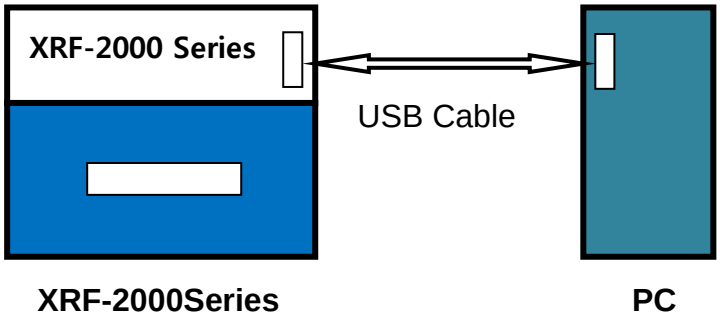
Input Power
115/220 VAC, 50/60Hz, 150W (maximum) Typically 220VAC 0.5A

Power Cable
The power cable will be supplied by the local MP representative to meet IEC 224 or IEC 245 standards.
The inner wire diameter should be at least 0.75mm.

Fuse
On the Main Power: 2A

Power On/Off Switch
Once the AC input cable is connected from the system to the wall, system power up and shut-down should be done using the On/Off switch on the front right side of the system.

Connect to PC
Only one connection by USB Cable



X-Ray System Specifications

Chamber	
Input Power	110/220 volts AC 50/60hz
Data Port	USB
Temperature Control	Automatic preamp and chamber temperature regulation
Focusing	Precision laser assisted
Sample Positioning	Laser-guided parts placement
Safety Circuitry	Automatic X-ray shut-off within 0.5 seconds, if chamber door opened during measurement
Multi-Channel Analyzer	
Channels	1024, 2048, 4096, 8192 channels
Pulse Processing	High speed using micro-processor
Temperature Control	Automatically regulated
X-Ray Source	
X-Ray Tube	Long life, tungsten target, miniature spot size
High Voltage	0-50kV, oil-cooled
Tube Current	0-1.0 mA
XRF Housing	Large oil-filled tank encloses both X-ray tube and high voltage
Collimators	
Type	Single fixed or multiple (automatic)
Single Fixed	0.1, 0.2, 0.3,0.4 0.1 x 0.3mm Other size (opion)
Multiple Automatic (5 Total)	0.1, 0.2, 0.3, 0.4, 0.05 x 0.3mm

Detection System	
Detector	Proportional counter Si PIN DIODE (150~260eV)
Filters	Motorized (Co, Ni Optional)
Primary Filters	Mo, Ta, Ti, Ni, Al (Optional) Total 7 Filters
X-Y-Z Stages	
Operating Type	Precision, high speed stepper motors with ramped acceleration and cushioned deceleration
Stage Positioning	Mouse or automatic controls "Point and Measure" 2-D and 3-D positioning
EZ Loading Stage	Automatic stage forward by opening/ closing door
Camera System	
Camera	Digital, CCD, color, high-resolution
Display Image	Monitor overlay video display
Reticle Image	Software generated target
X-Ray Beam	Collimator Size displayed by software
XRF Beam Alignment	X-ray beam and camera optics are auto aligned
Lighting	Long-life LED, adjustable
Dual Focus	
Normal	10-20mm fixed one point (Optional)
Dual	20-90mm fixed two point (Optional)

Calibrations	
Application	Single layer, multi-layer, alloy thickness and composition, plus solution analysis
Correction Functions	- Density correction - Drift correction by reference sample
Statistical Analysis	
Statistics	Mean, maximum, minimum, range, standard deviation
Charts and Graphs	X-bar and range chart, histograms
Report Printing	
Reports	Five (5) custom report formats
Previewing	Instant previewing of reports
Custom Heading	Company name and logo
Parts Images	Sample picture can be printed on report
Qualitative Element Analysis	
Method	ROI and peak distance method
Display	Color spectrum with element labeling
Magnification	Magnifies/highlights desired items
Stage Programs	
2-D	Regular distance parts and surface measurements
3-D	Topographical mapping of plating thickness
Random	Irregular distance parts measurement

Chamber Model Specifications

Type H

Type L

Type PCB

Model Name	Type H	Type L	Type PCB (slotted)
Chamber Dimensions	610W x 670D x 600H	610W x 670D x 490H	610W x 670D x 490H
Inside Chamber Dimensions	550W x 550D x 100H	550W x 550D x 30H	Infinity x 30H
X-Y-Z Stage Travel	210W x 180D x 110H	210W x 190D x 30H	210W x 170D x 30H
Maximum Sample Weight	5Kg	3Kg	3Kg

These specifications are subject to change without notice due to product improvements.

2. System Operation

2.1 Safety Considerations

- **Standard Procedures**

All standard safety procedures for operating electrical machinery should apply to spectrometers of this series.

Each system is intended to be operated only as indicated in its Operation Manual.

Maintenance work inside the machine should be performed only by authorized personnel.

- **Power Source**

This product is intended to operate from a power source that does not supply more than 230 volts RMS (in 220 volt version) or 120 volts RMS (in 115 volt version) between either supply conductors or between supply conductor and ground. A protective ground connection by way of the grounding conductor in the power cord is essential for safe operation.

- **Grounding the Product**

This product is grounded through the grounding conductor of the power cord. To avoid electrical shock, plug the power cord into a properly wired receptacle before connecting to the product input or output terminals. A protective ground connection by way of grounding conductor in the power cord is essential for safe operation.

- **Danger arising from loss of Ground**

Upon loss of the protective ground, all accessible conductive parts (including knobs and controls that may appear to be insulated) can render an electric shock.

- **Use the proper power cord**

Use only the power cord and connector specified for your product and valid in the country where the machine in installed. Make sure that both are in good condition and do not use extension cables.

- **Use the proper fuse**

To avoid fire hazard, use only a fuse of the correct type, voltage rating and current rating as specified.

2.2 Radiation Safety

XRF-2000 Series equipment is intrinsically safe from radiation hazards. Every machine is inspected prior to its delivery, ensuring that level of radiation anywhere around the sample chamber is not higher than the ambient radiation in the free environment. The instruments are equipped with safety magnetic switches to ensure that proper shielding is in place during x-ray operation, avoiding a possibility of exposure to radiation. Overriding safety features should not be done under any circumstances. These features have been installed for your safety.

Depending on the country, personnel operating X-ray instrumentation may have to be registered with the relevant health and radiation control authorities and may be required to wear dosimeters to monitor their exposure to radiation as well as to undergo annual medical examinations to safe guard their health. Local radiation control authorities may require that your instrument be registered with the relevant controlling bodies and that you carry out periodic radiation leak detection tests to ensure the ongoing safety in the utilization of the instrument.

You will need to check the relevant legislation and your compliance thereof with the correct controlling bodies in your country.

2.3 Site Preparation

- **INSTALLATION SITE**

The system site should be free of excessive mechanical vibrations and strong acoustical noise. Strong electrical fields such as those generated by arc welding instruments, induction furnaces, large electric power lines, etc., can interfere with signals from the X-ray Detector and decrease its resolution.

Please do not hesitate to consult the service agent if you suspect that such problems exist.

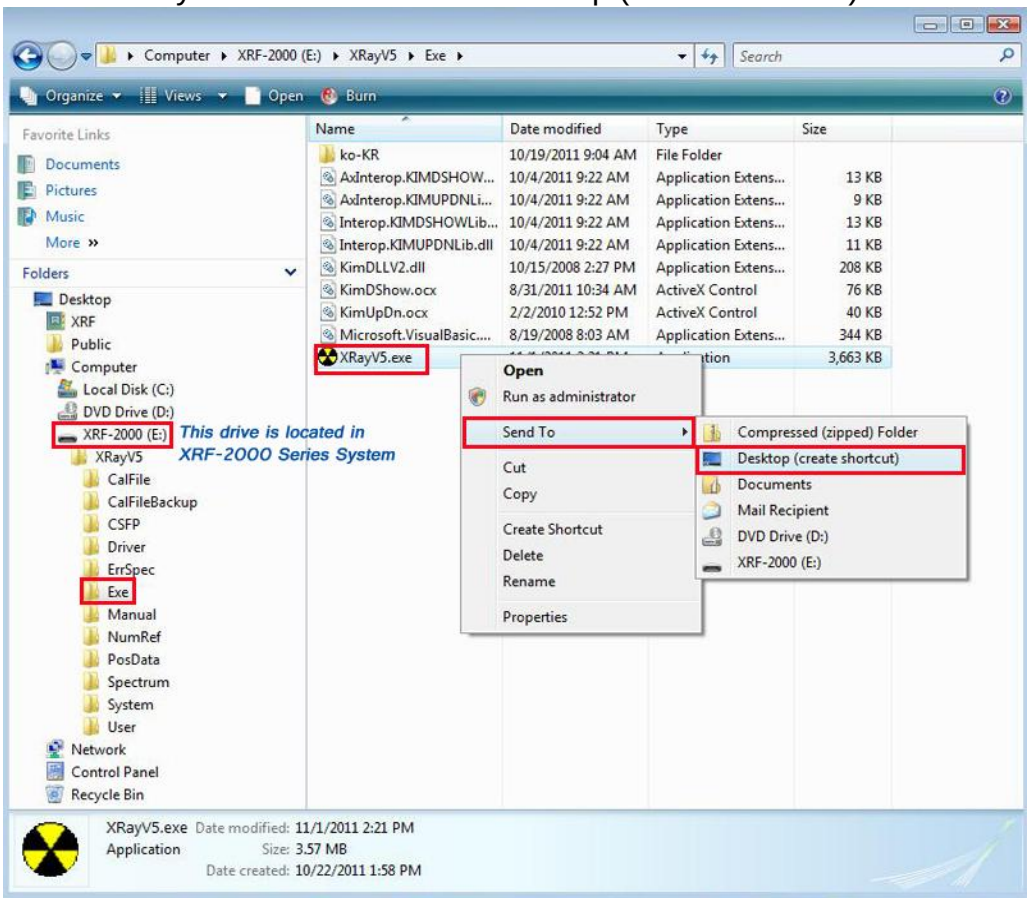
- **PHYSICAL ENVIRONMENT**

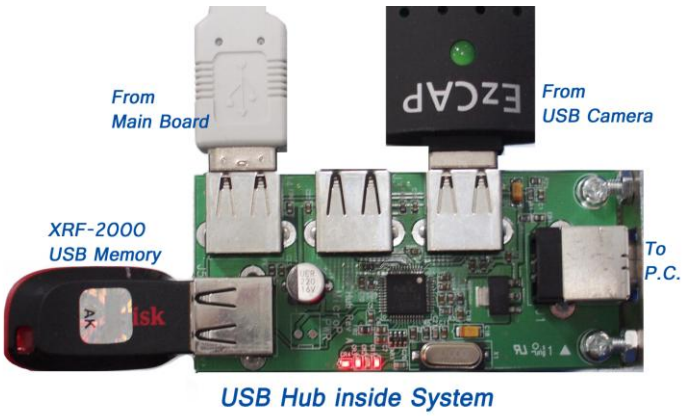
Keep the system and its vicinity clean and dust-free; circuit boards and components in the system and computer could fail due to an accumulation of conductive dust or from corrosion.

Avoid extreme temperatures or high humidity. The recommended operating temperature range is 20 - 25° C. Constant temperature assures the stability of system calibration.

2.4 Software Installation

Make sure your computer is correctly connected and then turn on the monitor and computer. XrayV5 is software of XRF-2000 series and updated periodically. You can download it from MicroP Co., Ltd. web site www.micropioneer.com.
The system has its own storage device as USB memory. When the system is connected to computer, USB memory will be your hard disk which is named XRF-2000.
XRayV5 includes many folders. Go to E:\XRayV5\Exe Folder and right click on XRayV5.exe and send to->desktop (Create shortcut).

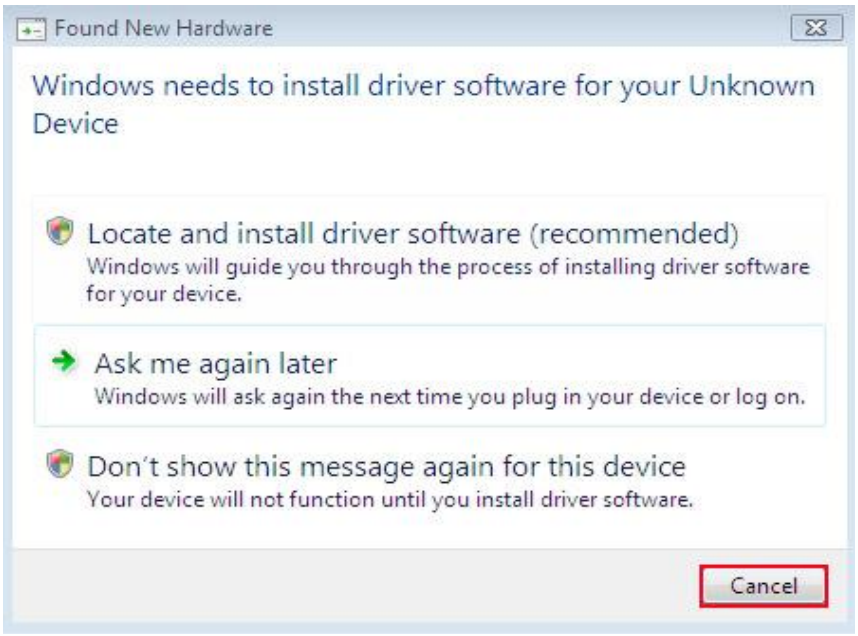




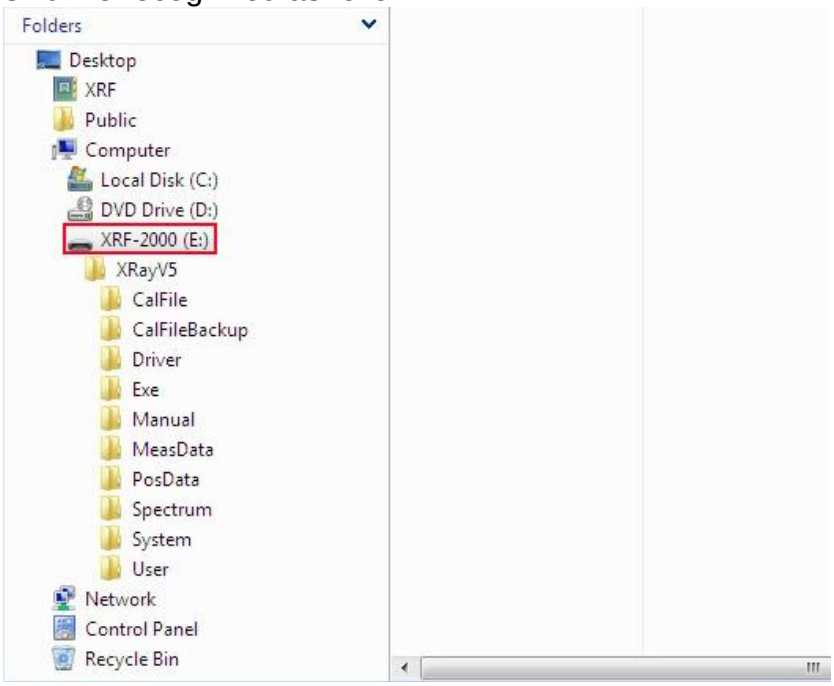
2.5 Drive Installation

2.5.1 Connect System to Computer

- System Power On and connect system to computer through the USB cable. Then “Found New Hardware window will be displayed as below.



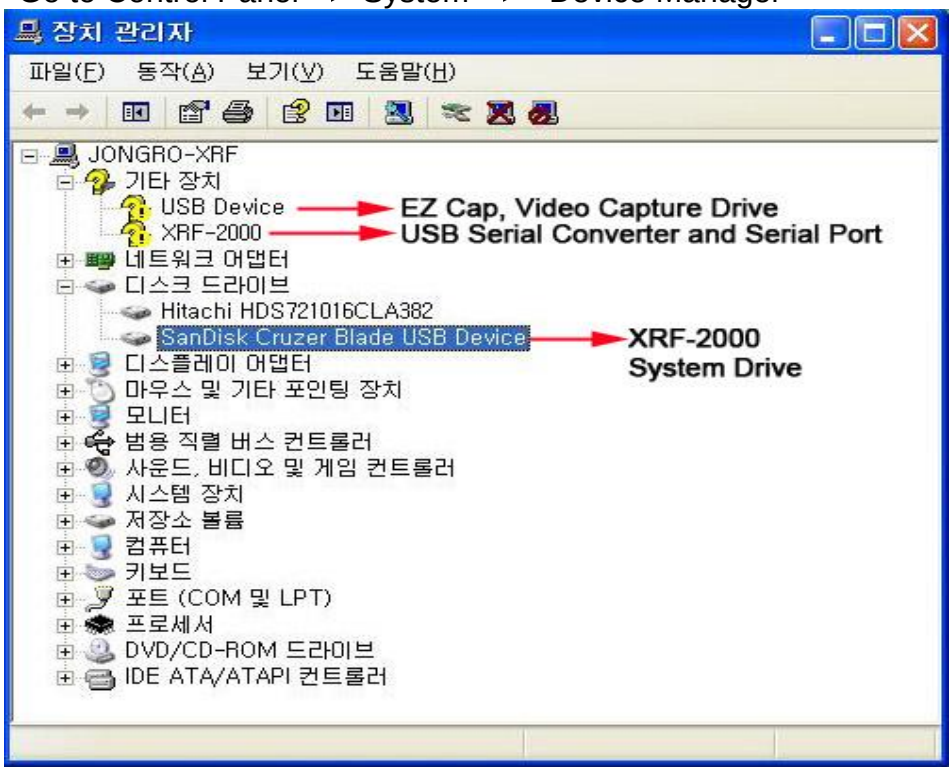
- Cancel all windows for driver installation and make sure if your system disk drive recognized as follow.



- If you see system disk drive as above, go next.(Drive name might be different depends on computer configuration).

2.5.2 Install Drivers

◆ Go to Control Panel → System → Device Manager

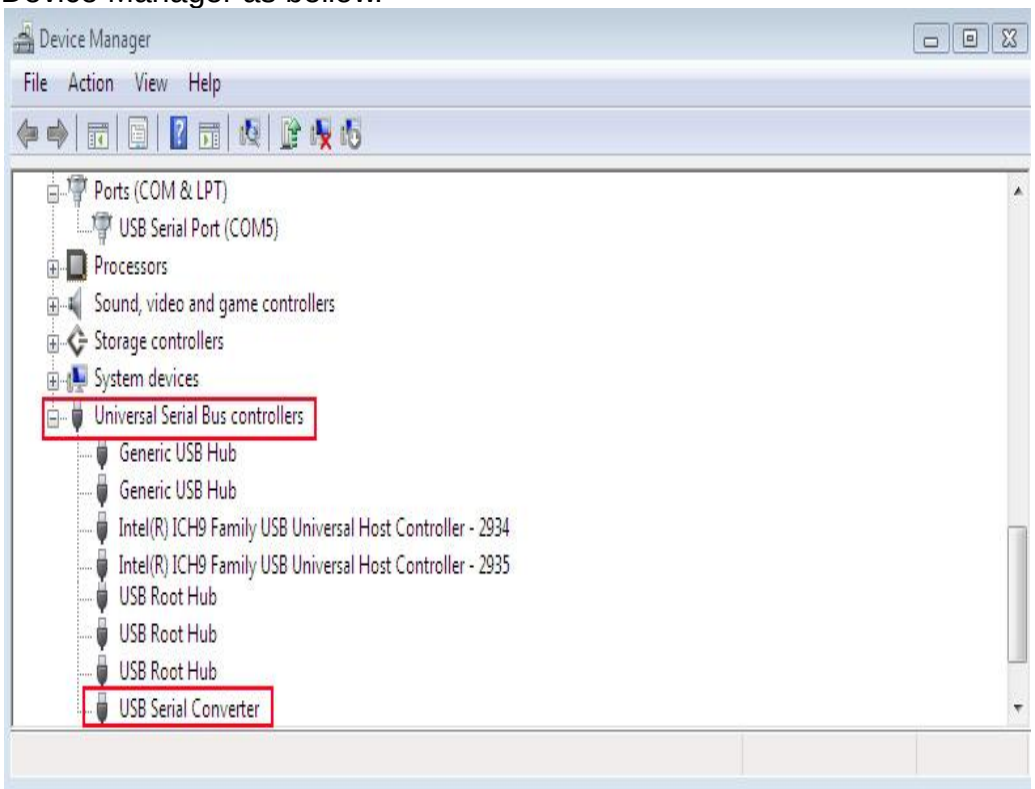


- ✓ There are two uninstalled drivers, USB device which is EZ Cap (Video Capture Card) and XRF-2000 which are USB serial converter and USB serial port.
- ✓ Disk drivers are automatically installed and nothing to do.

◆ Right Click on XRF-2000 and click “Update drive software”.
◆ Click Browse Icon and select E:\XRayV5\Driver\Serial directory as below;

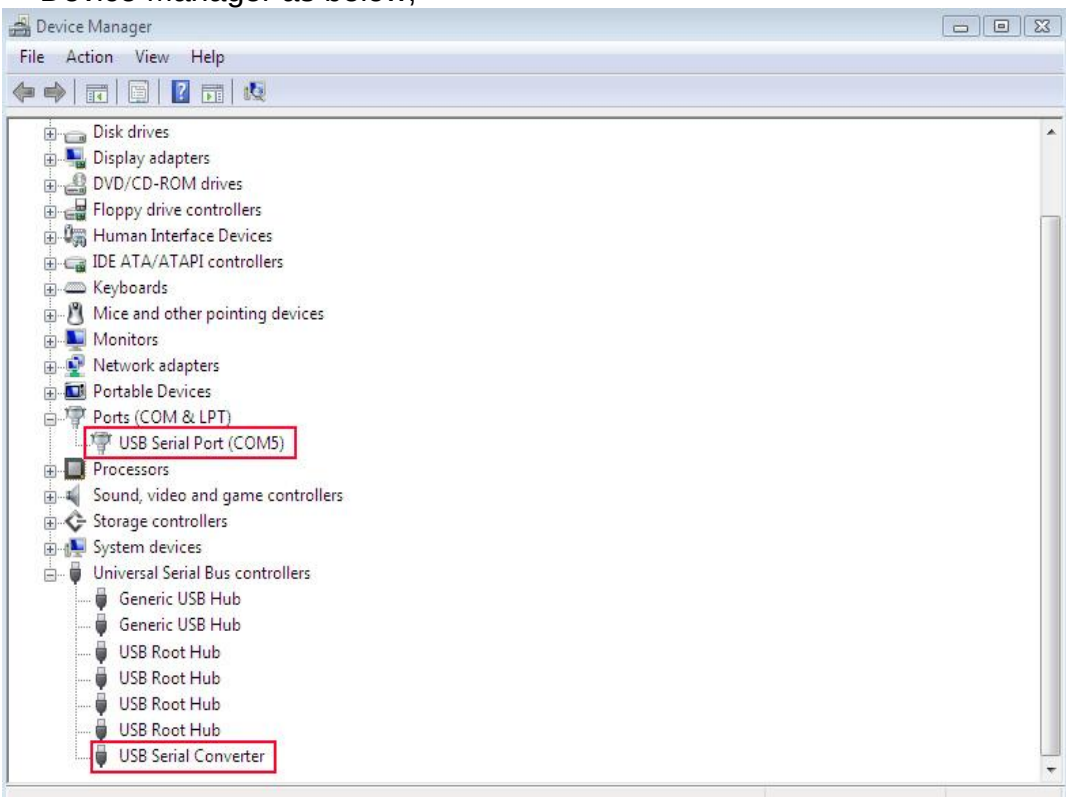
◆ Click Next will install the driver for USB serial converter.

◆ After installing the driver you can see the USB Serial Converter in Device Manager as bellow.

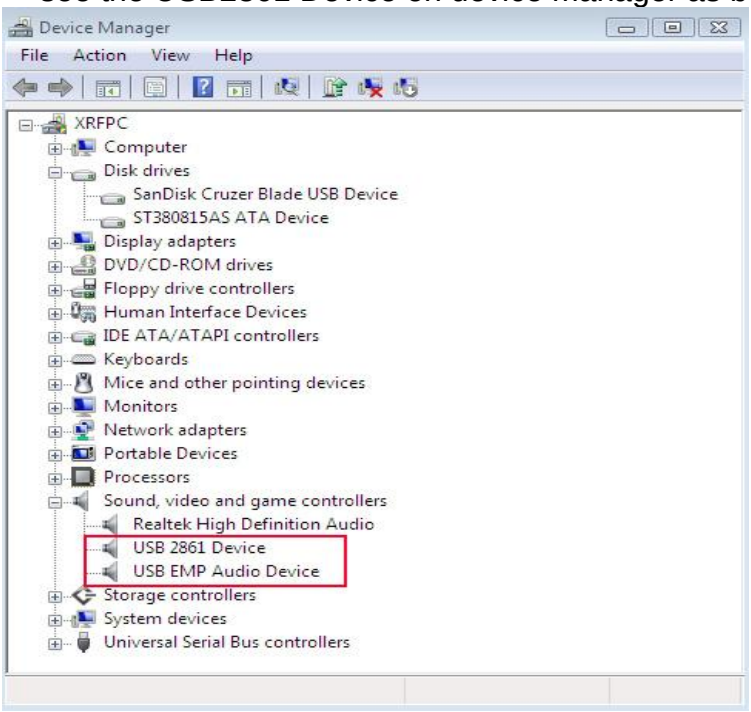


◆ Right Click again on XRF-2000 and “Update drive software”.
◆ Click Browse Icon and select E:\XRayV5\Driver\Serial directory.
◆ Click Next will install the driver for USB Serial Port.

- Finally you can see the USB Serial Converter and USB Serial Port in Device Manager as below;

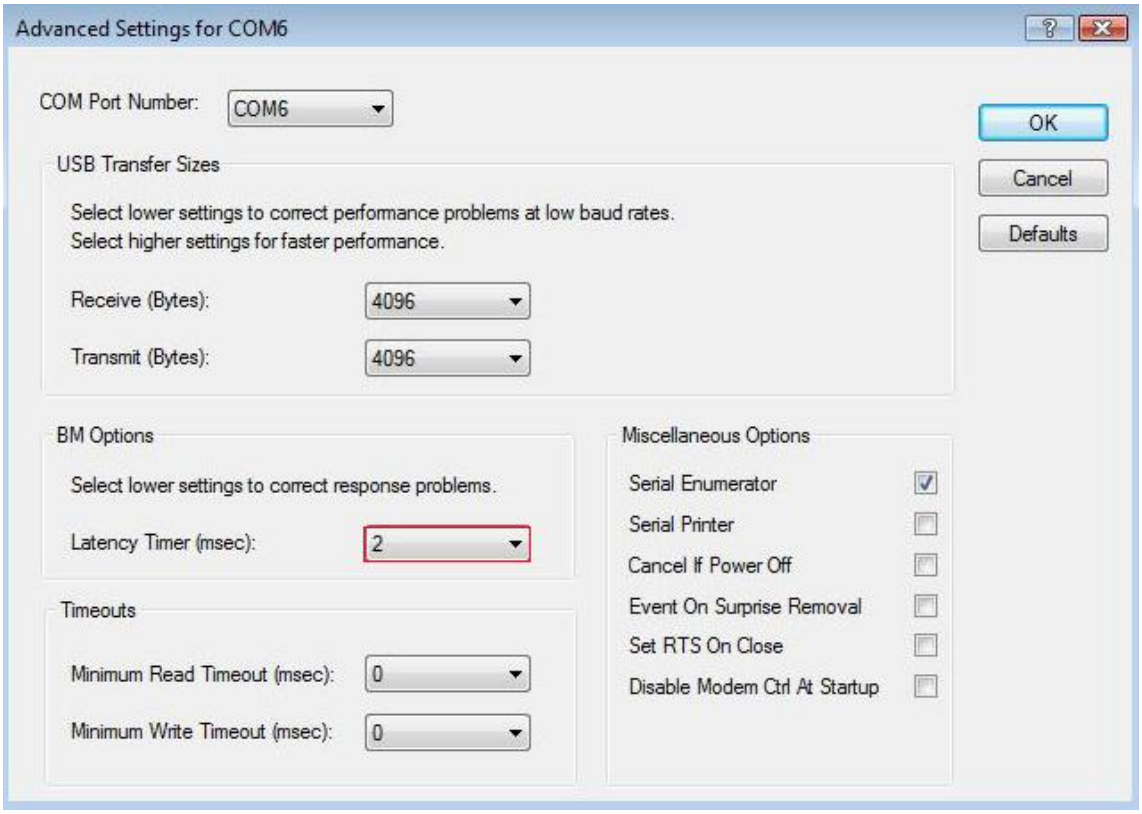


- Right Click on USB Device and “Update drive software”.
- Click Browse Icon and select E:\XRayV5\Driver\EzCap directory.
- Click Next will install the driver for EzCap capture card and you will see the USB2861 Device on device manager as below.



2.5.3 To Increase System Speed

- Quit the XRayV5 program.
- Go to Control panel -> System -> Device Manager -> Ports (COM & LTP) -> USB Serial Port -> Properties -> Port Settings -> Advanced and change Latency time to 2 as follows.



- Click OK and return to normal operation mode.
- Close Device manager.
- Execute XRayV5 program again.

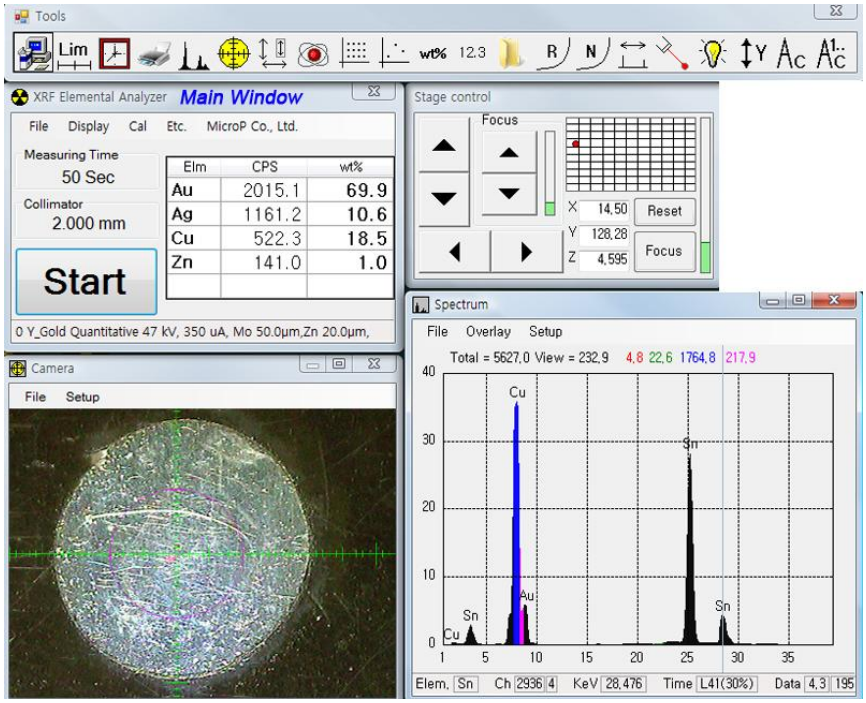
2.5 Running XRF-2000 software

① Turn on the XRF-2000 Series Machine.

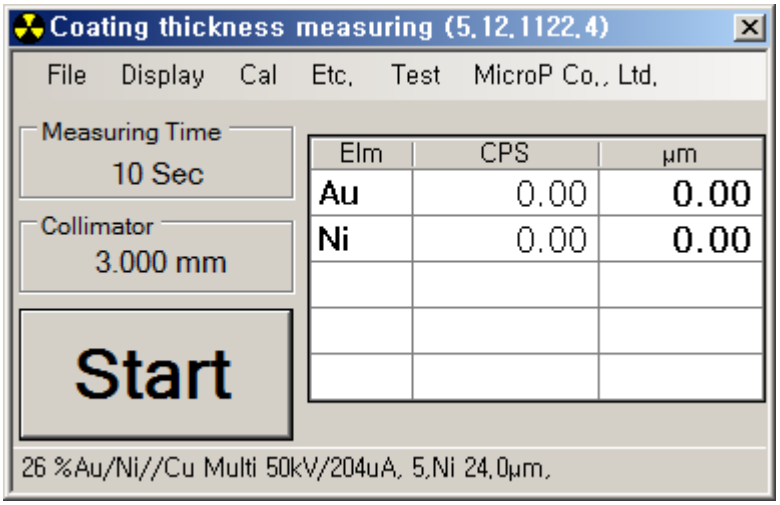
② Turn on the computer (if not already done) and click the XrayV5 icon on the desk top to active XrayV5.

③ Enter Password “t” and click on the opening message.

④ The main XRayV5 screen appears.

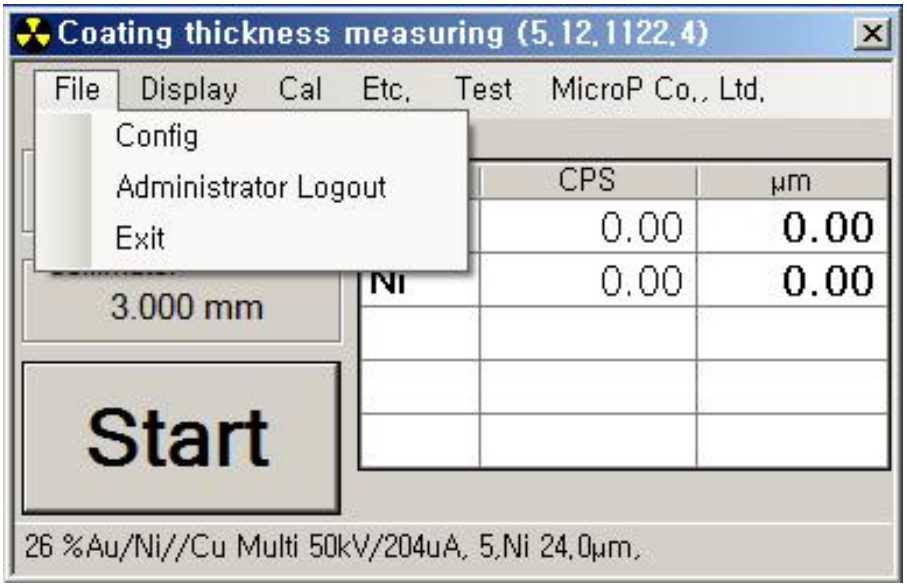


3. Main Window

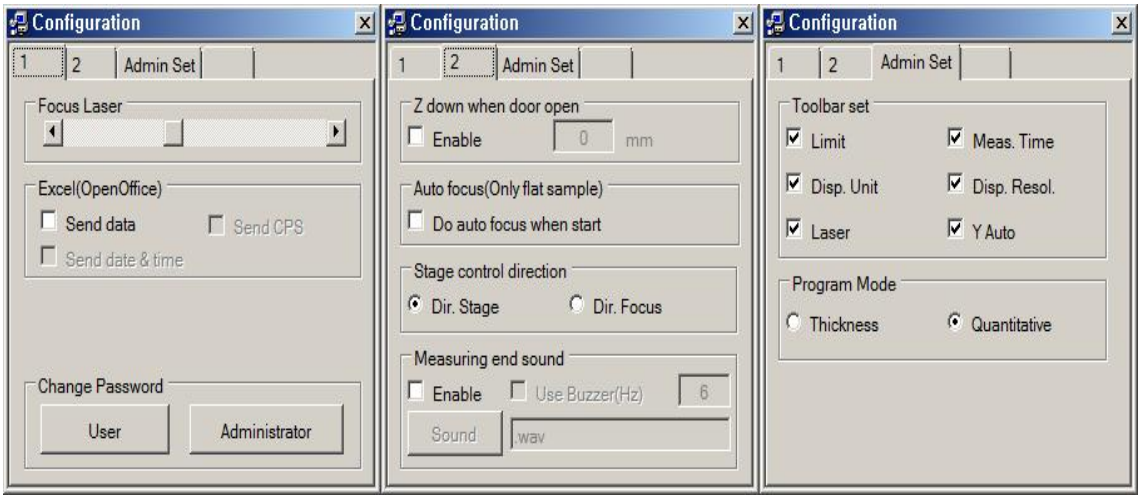


Indicate Measuring Time, Collimator Size, Start and Stop Button, CPS Information, Result of Thickness or Concentration and Measuring Mode. Start Button toggles start and stop to measure.

3.1 File Menu



3.1.1 Config window



Menu 1

- Focus Laser: Control brightness of laser on Camera Window.
- Excel (Open Office is available in public)
  - Send Data: ON/OFF data transfer to Excel. Excel file must be opened prior to data transfer.
  - Send Date & Time: ON/OFF date and time to Excel.
  - Send CPS: ON/OFF CPS to Excel
- Change Password

Change the operator and administrator password.
Administrator password can be changed when administrator is logged in.

Menu2

- Z down when door open: Enable Z axis down to specified distance when door is opened.
- Auto focus (Only flat Sample): Enable automatic focus prior to start measurement.
- Stage control direction: Dir. Stage moves stage same direction with stage control direction. Dir. Focus moves stage opposite direction with stage control direction.
- Measuring end sound: Specify music file (wav format) or internal buzzer to hear when measuring is finished.

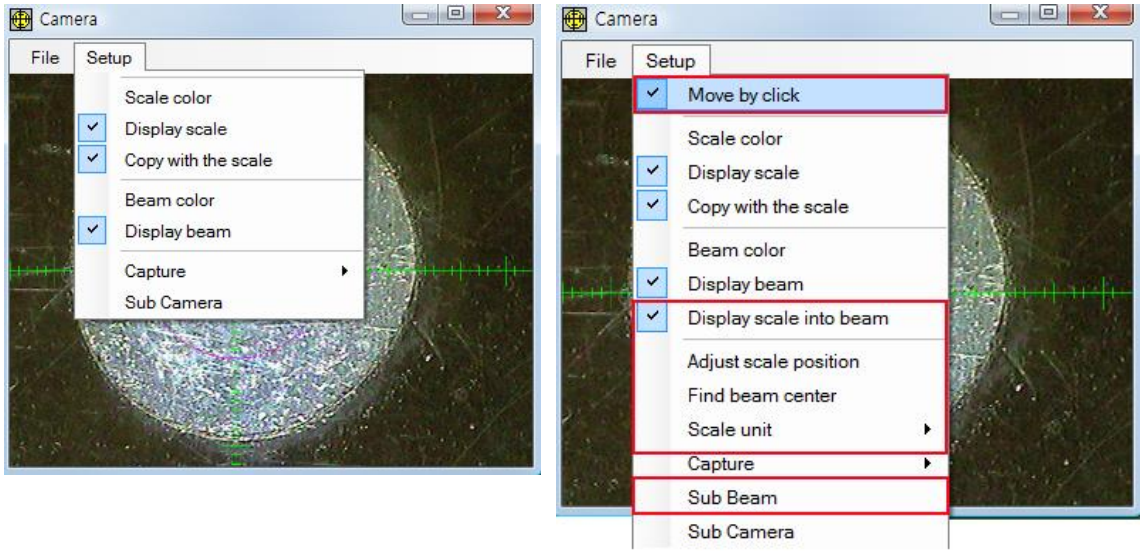
Admin Set

- Tool Bar Set: Set On/Off listed sub menu in Tool Bar. Default is checked all.
- Program Mode: Define system as Thickness Gauge or Elemental Analyzer, the system which has Dual Detector must be selected as Quantitative.

3.1.2 Administrator Login

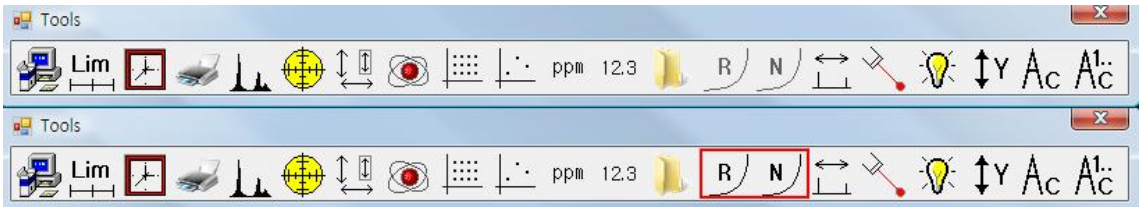
- Initial password is “t”.
  - ✓ Enable specific menu in administrator mode

- Camera display window



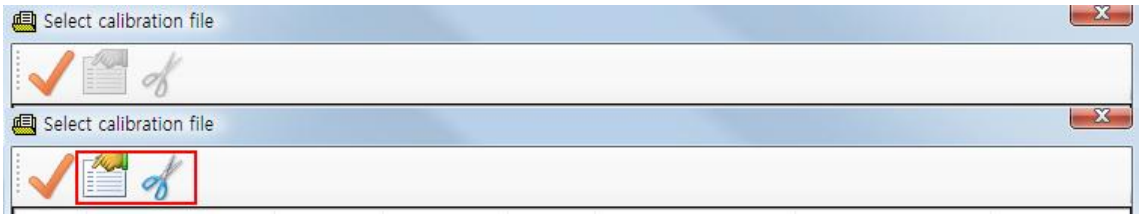
After administrator login, enabled menu on Camera Window shows in right side.

- Main window & Main toolbar :



Re Calibration, New Calibration, Measuring correction, Density correction menus are enabled when administrator Login.

- Select Cal File :

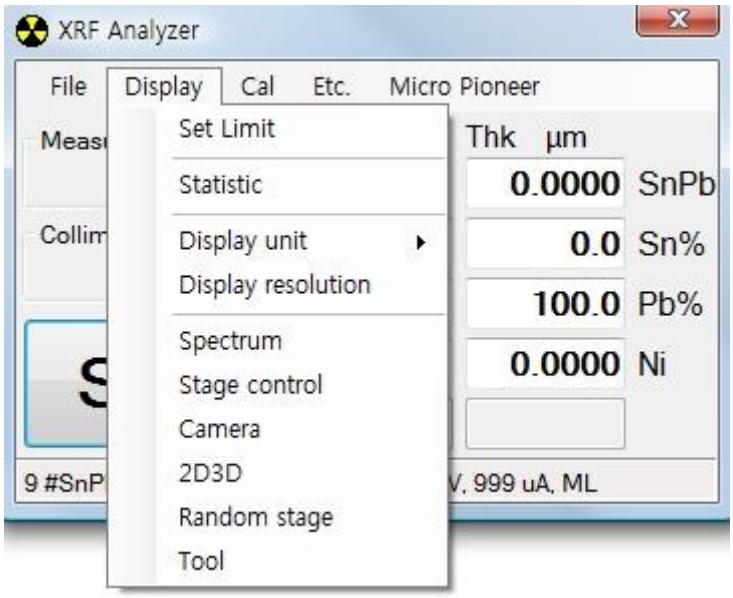


Delete Cal File and comment on Cal File are enabled when administrator is logged in.

3.1.3 Exit

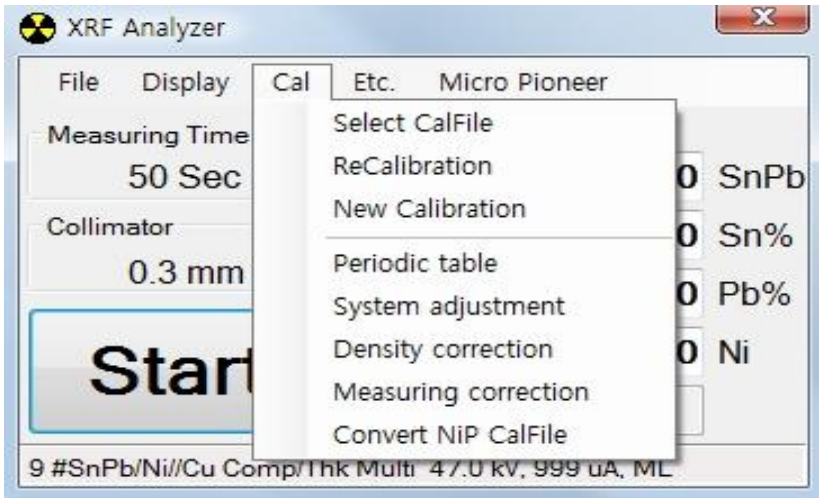
Quit the program

3.2 Display



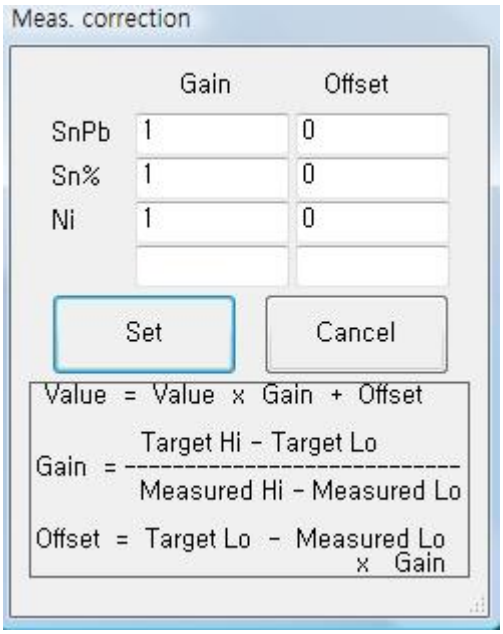
Toggle window on and off. Description of each window is described in Chapter 4.

3.3 Cal



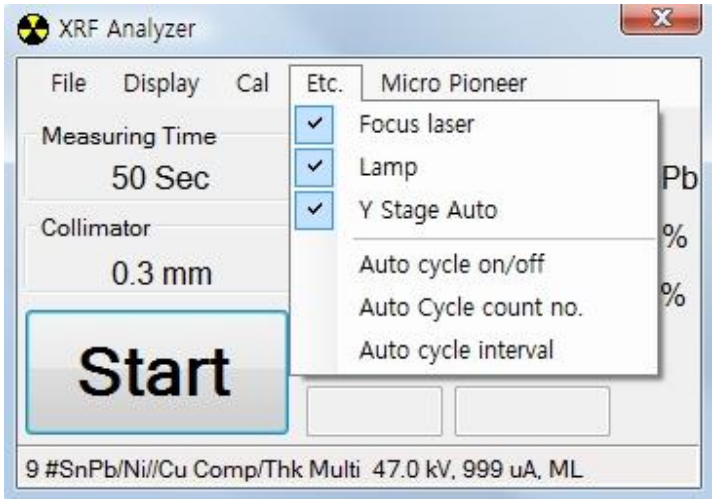
Description of function is described in Chapter 4 except following.

- Measuring Correction : Make user correction



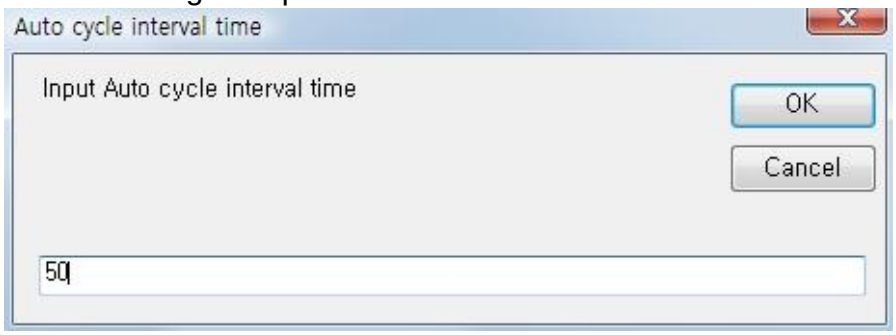
Gain=1 Offset=0 is default value which means measuring correction is not effected to result.

3.4 Etc



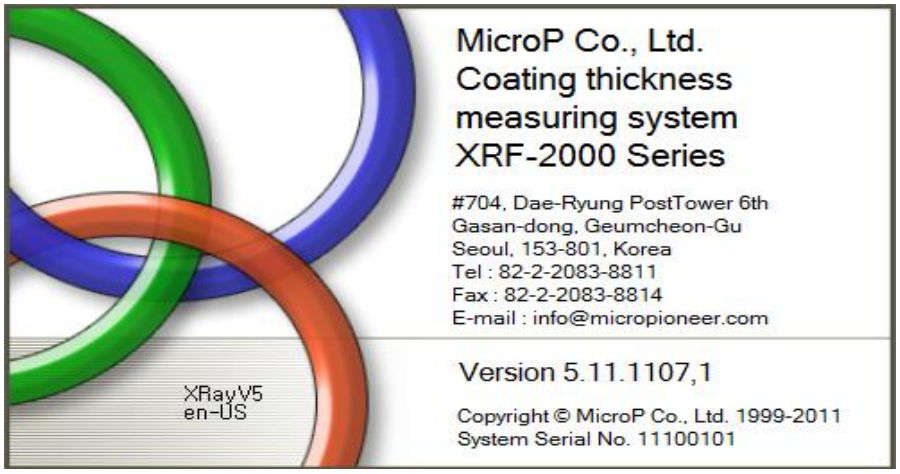
Description of function is described in Chapter 4 except the following.

- Auto cycle interval: Input Auto cycle interval time. The interval time is measuring time plus rest time.



3.5 MicroP Co., Ltd.

Display Micro Pioneer company information, Software version and System Serial No.



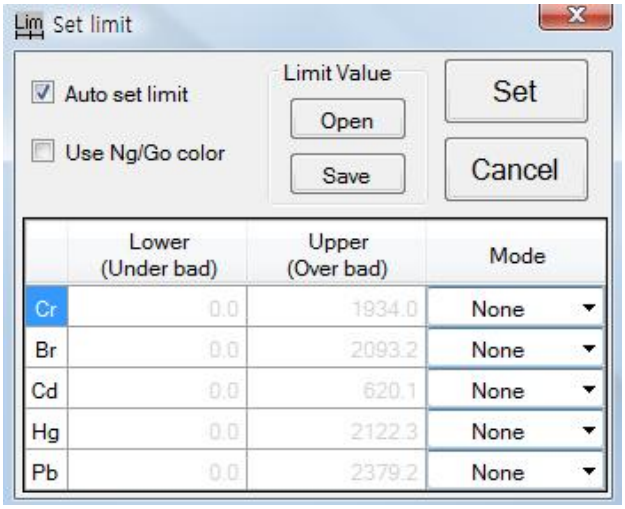
4. Main Toolbar

	Laser Focus, Send to Excel, Change Password, Program Mode
Lim	Set control limit of Result
	Set measuring time
	Display statistic window
	Display Spectrum windows
	Display Camera window
	Display Stage control window
	Display Periodic Table window
	Display 2D & 3D measuring window
	Display Random stage window
µm	Set measuring unit
12.3	Set Display decimal point
	Select calibration file
R	Re-Calibration of Cal file
N	New Calibration of Cal File
	Display System adjust window
	ON/OFF Focus Laser
	ON/OFF illumination lamp on camera window
Y	ON/OFF Y-Stage Push-Pull function. ON: when Door opened, Stage move to forward.
AC	ON/OFF Auto-Cycle function
A1.. C	Set number of Auto-Cycle count

4.1 System Configuration

Refer to chapter 3.1.1

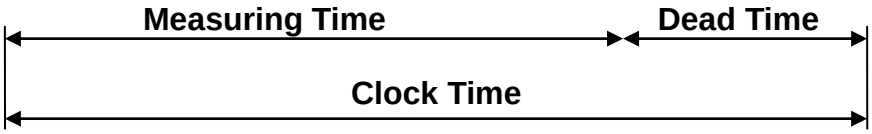
4.2 Set Limit



- ✓ Lower : Lower limit value for Low Mode
- ✓ Upper : Upper limit value for Up Mode
- ✓ Mode
  - ◆ Low : Measured data is bigger than 'Lower value' means good
  - ◆ UP : Measured data is lower than 'Upper value' means good
  - ◆ LowUp: Measured data is between 'Lower value' and 'Upper Value' means good.
- ✓ Auto Set Limit: Set the limit value automatically from measured data.
- ✓ Use Ng/Go Color: Display the data result as a color, Green means good, Red means no good.
- ✓ Open/Save: Open or Save the limit value file.
- ✓ Set: Apply limit value.
- ✓ Cancel: Cancel limit value.

4.3 Set Measuring Time

Sets the measuring time (the sample is exposed to X-rays). The figure below defines Clock Time vs. Measuring Time (also called "Live-time") and Dead Time.

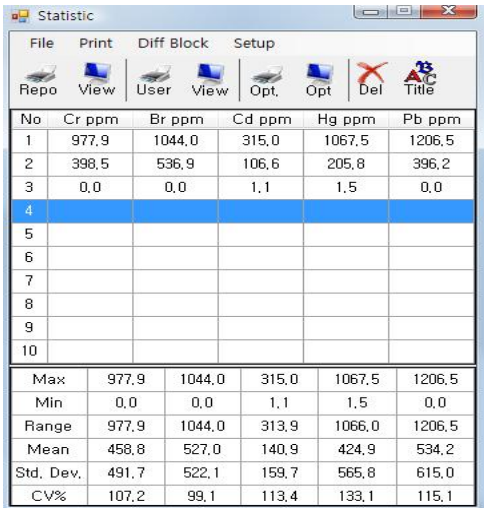


The Clock Time is corrected for the Dead Time, always meaning:

Clock Time≥ Preset Time

Enter measuring time and click OK or press enter key.

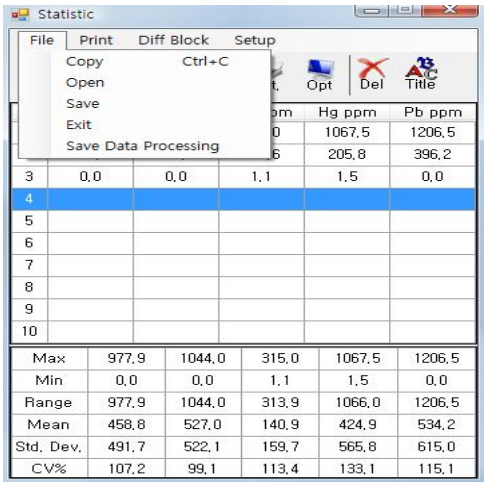
4.4 View Statistic Window



No	Cr ppm	Br ppm	Cd ppm	Hg ppm	Pb ppm
1	977,9	1044,0	315,0	1067,5	1206,5
2	398,5	536,9	106,6	205,8	396,2
3	0,0	0,0	1,1	1,5	0,0
4					
5					
6					
7					
8					
9					
10					
Max	977,9	1044,0	315,0	1067,5	1206,5
Min	0,0	0,0	1,1	1,5	0,0
Range	977,9	1044,0	313,9	1066,0	1206,5
Mean	458,8	527,0	140,9	424,9	534,2
Std. Dev.	491,7	522,1	159,7	565,8	615,0
CV%	107,2	99,1	113,4	133,1	115,1

Statistic Window displays thickness or concentration of samples and statistical information. Also provide a function of preview, print, user defined print form, adding comment and open/save file.

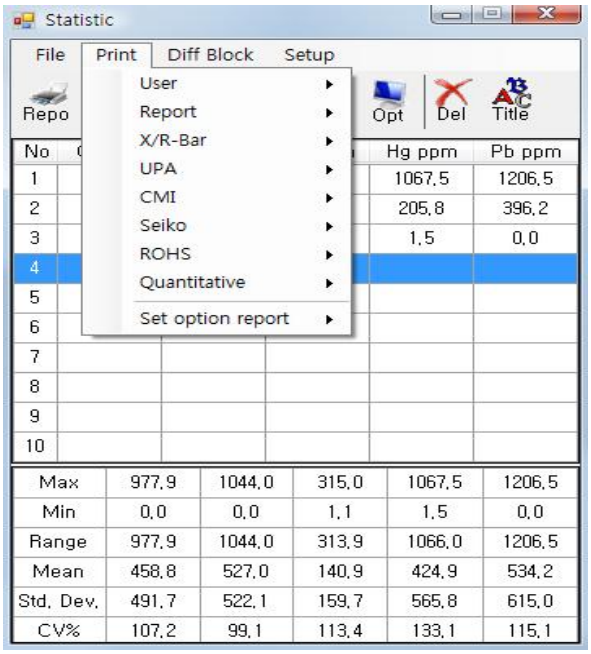
4.4.1 File Menu



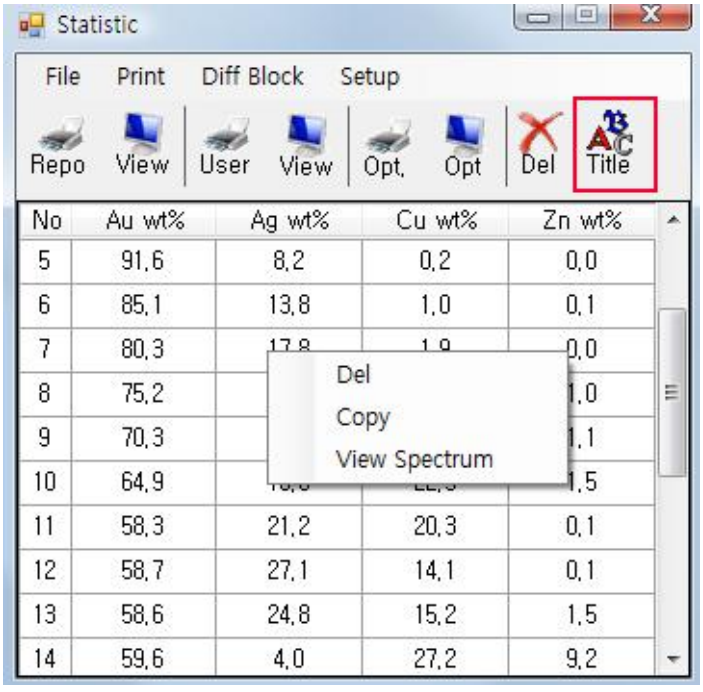
- Copy: Copy data to clip board as a text and to paste to notepad etc.
- Open: Open saved data file.
- Save: Save data file as default (*.sdt), old version(*.n001) and text(*.txt) format.
- Save Data Processing: Save data for bar code reader etc.

4.4.2 Print Menu

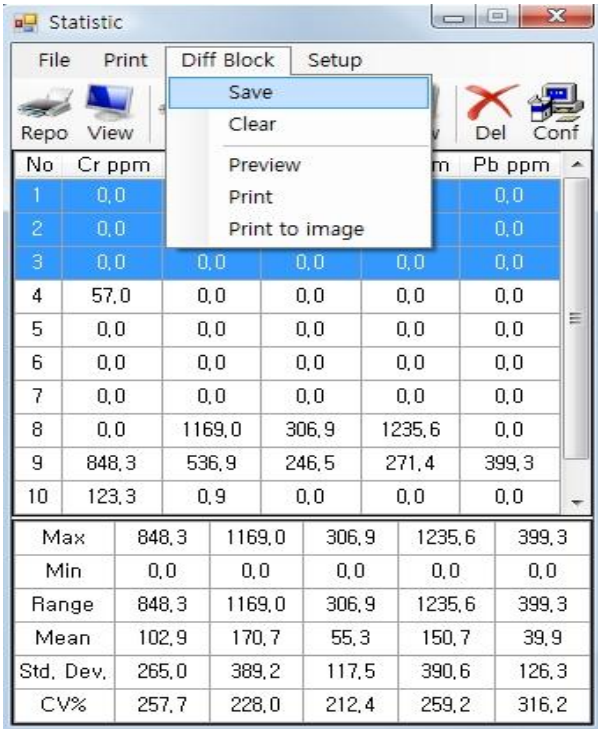
- Select a different type of print form such as UPA type, CMI type etc.
- Each menu has a preview mode, direct print mode and print to image mode.
- Set option report menu to fix the print form as one of the various.



Right Click to delete line by line or to copy whole data to move to Excel.
Click Title to edit Customer name, part No., etc.



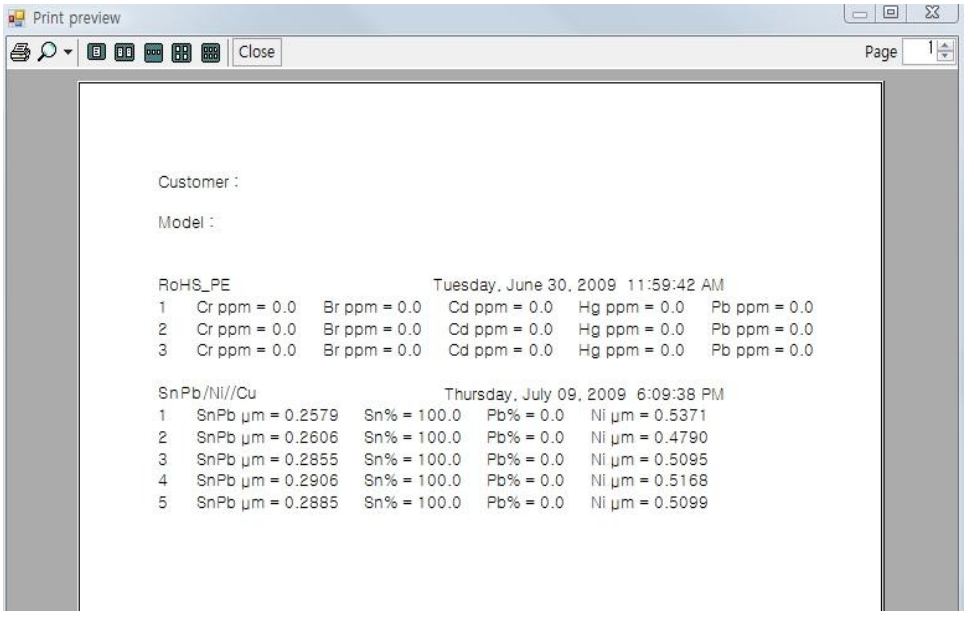
4.4.3 Diff Block Menu



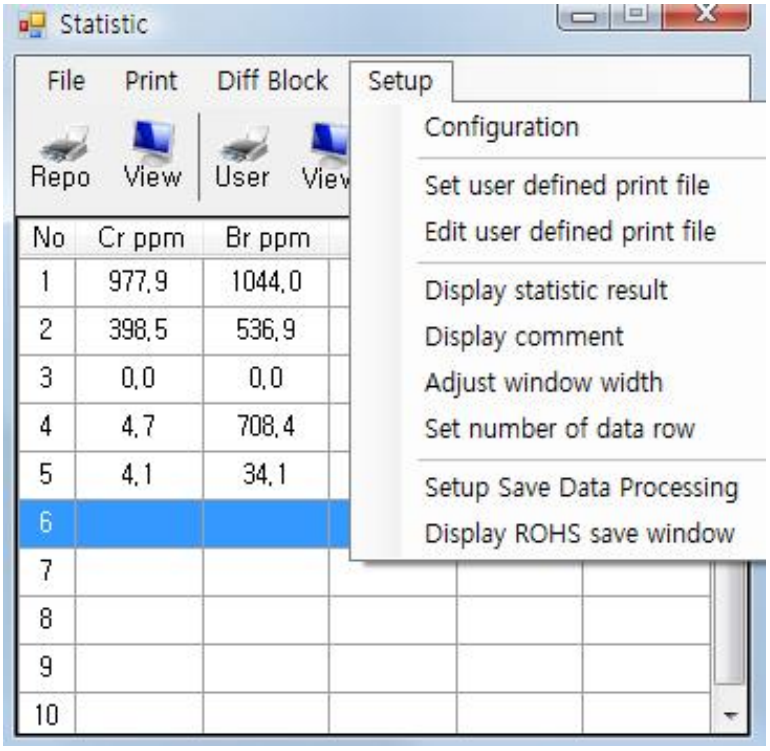
No	Cr ppm				Pb ppm
1	0.0				0.0
2	0.0				0.0
3	0.0	0.0	0.0	0.0	0.0
4	57.0	0.0	0.0	0.0	0.0
5	0.0	0.0	0.0	0.0	0.0
6	0.0	0.0	0.0	0.0	0.0
7	0.0	0.0	0.0	0.0	0.0
8	0.0	1169.0	306.9	1235.6	0.0
9	848.3	536.9	246.5	271.4	399.3
10	123.3	0.9	0.0	0.0	0.0

Max	848.3	1169.0	306.9	1235.6	399.3
Min	0.0	0.0	0.0	0.0	0.0
Range	848.3	1169.0	306.9	1235.6	399.3
Mean	102.9	170.7	55.3	150.7	39.9
Std. Dev.	265.0	389.2	117.5	390.6	126.3
CV%	257.7	228.0	212.4	259.2	316.2

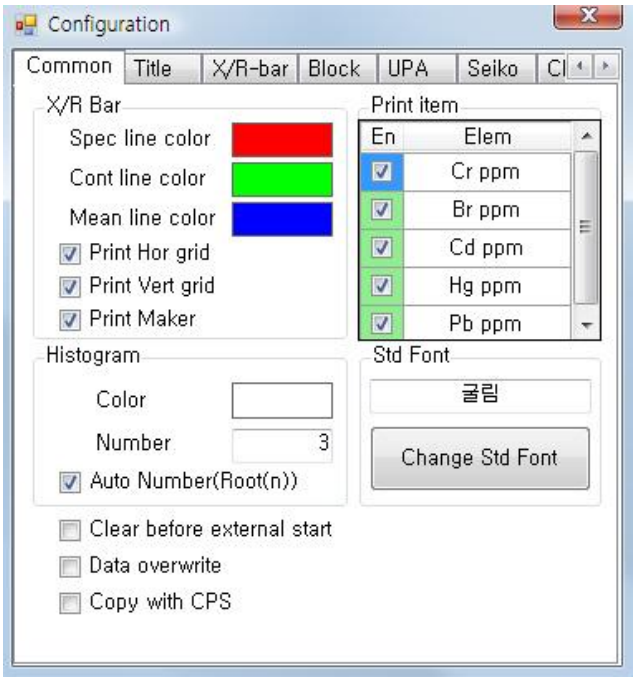
- This Menu allows printing different applications' results in same format on same paper.
- Select Cal file and analyze sample and drag result and Save, go another Cal file and analyze sample and drag result and Save.
- The results from different application are printed in same format.



4.4.4 Setup Menu



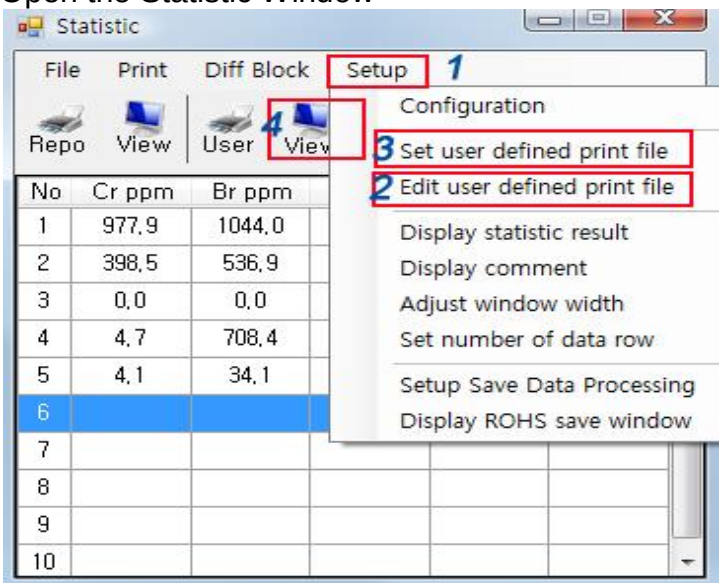
4.4.4.1 Configuration



All option for print form is able to define in configuration menu, such as customer name, company logo and others.

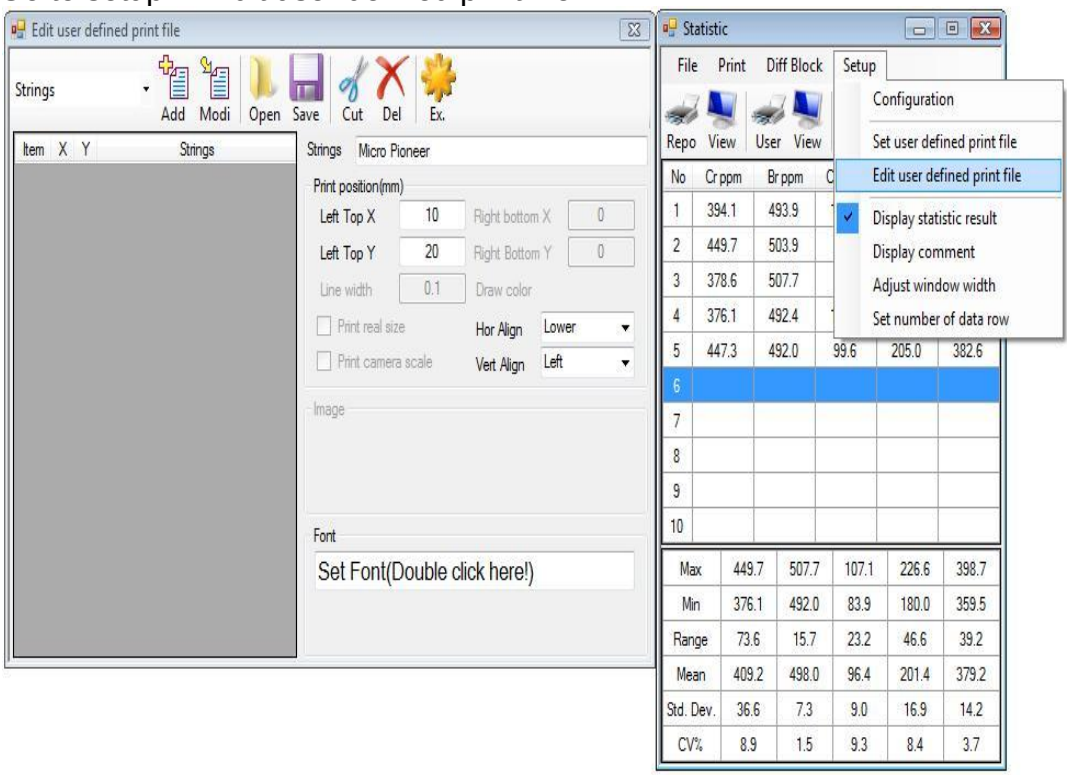
4.4.4.2 Edit User Defined Print File

1) Open the Statistic Window

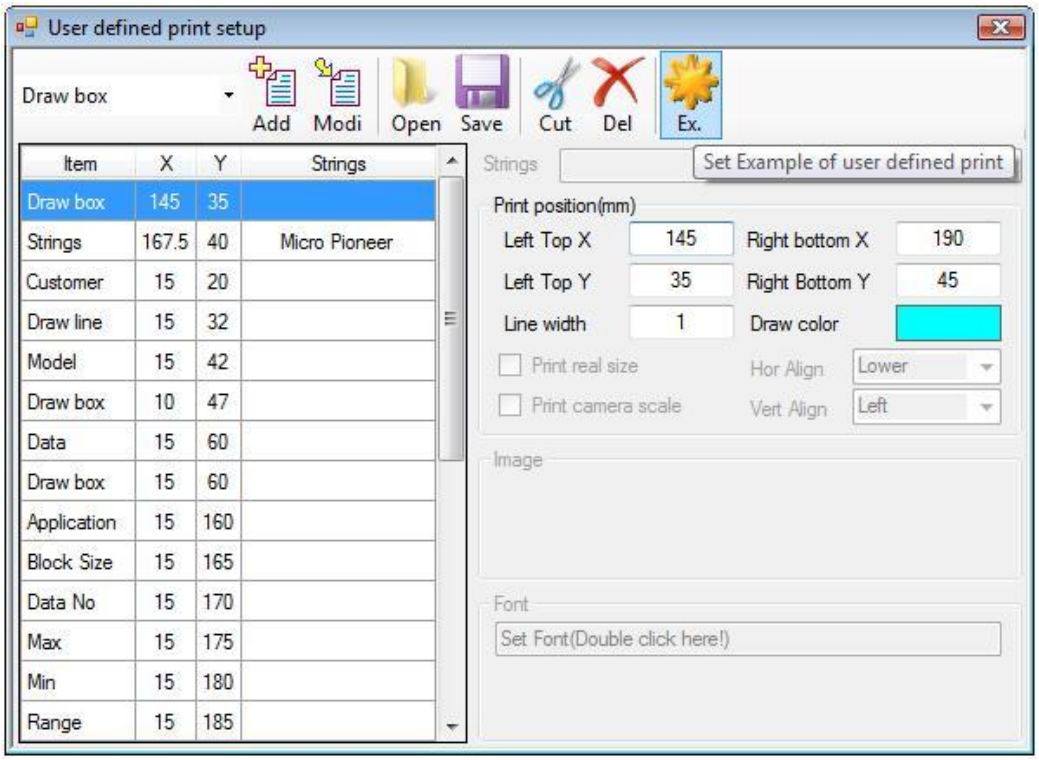


The sequence of creating the user defined print form is Setup -> Edit user defined print file -> Save edited user defined print file -> Set user defined print file -> View and repeat until the completion.

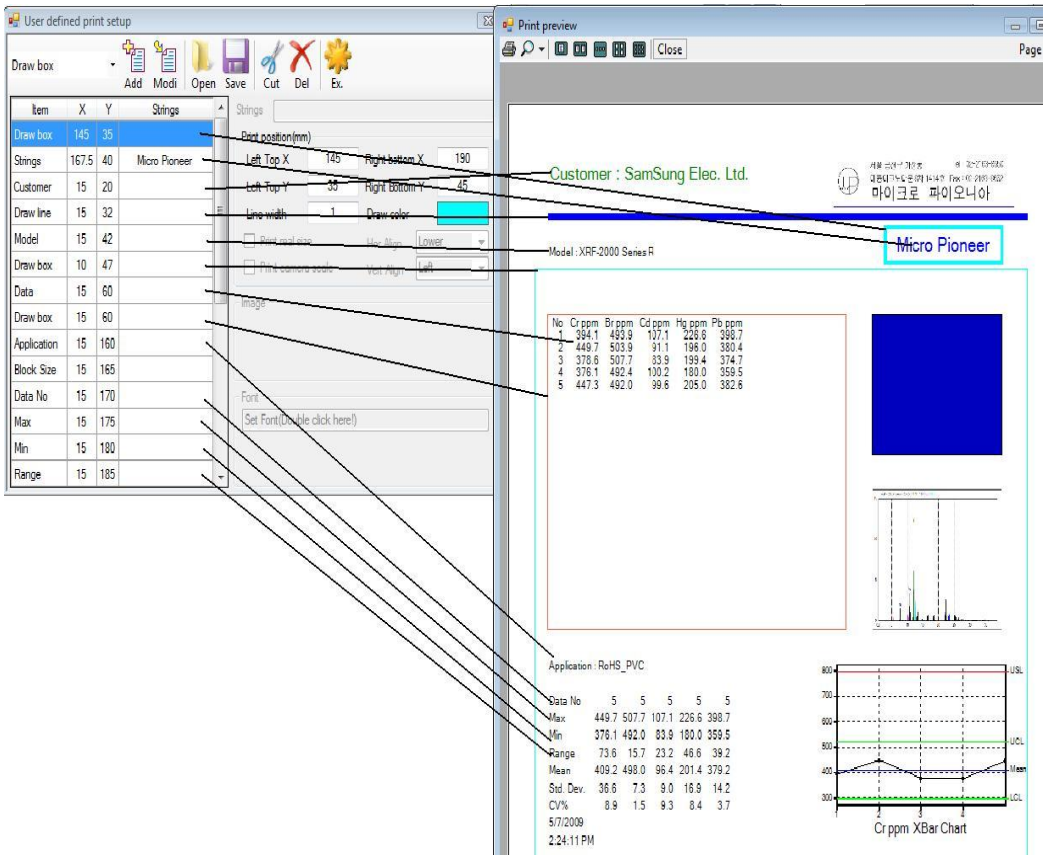
2) Edit user defined print file
Go to setup -> Edit user defined print file.

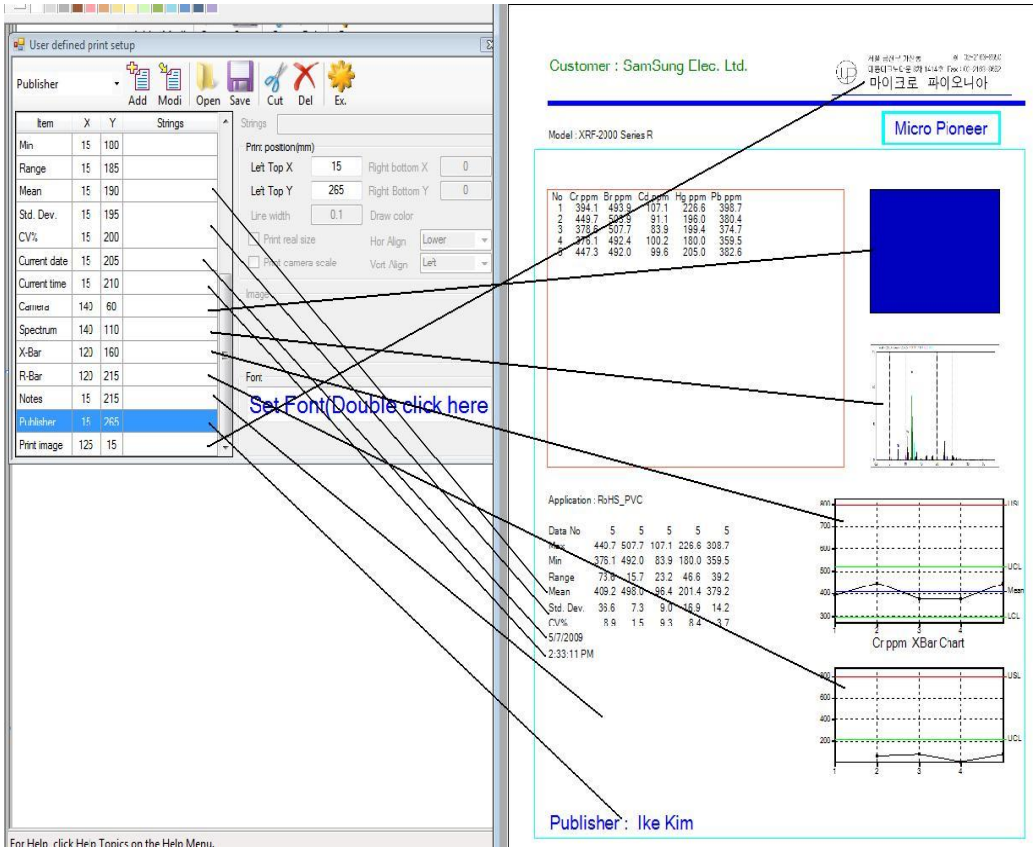


Then blank setup table will appear as above. Click Ex. Icon to open the standard print form.

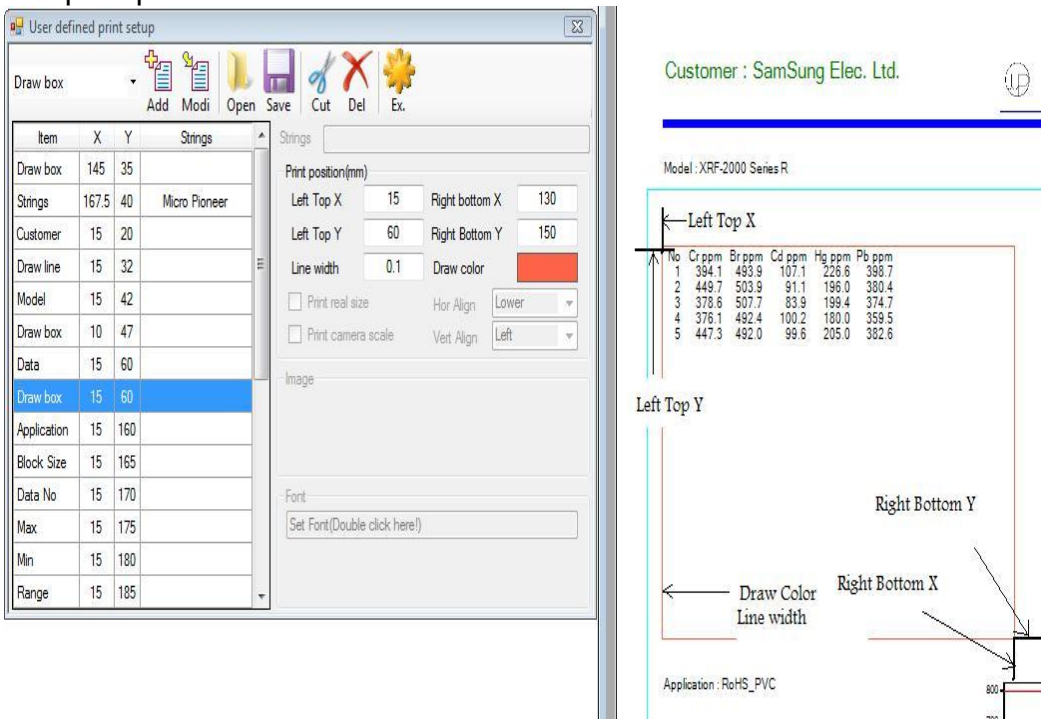


The relation between setup table and hard copy of the user defined print file is as follows.

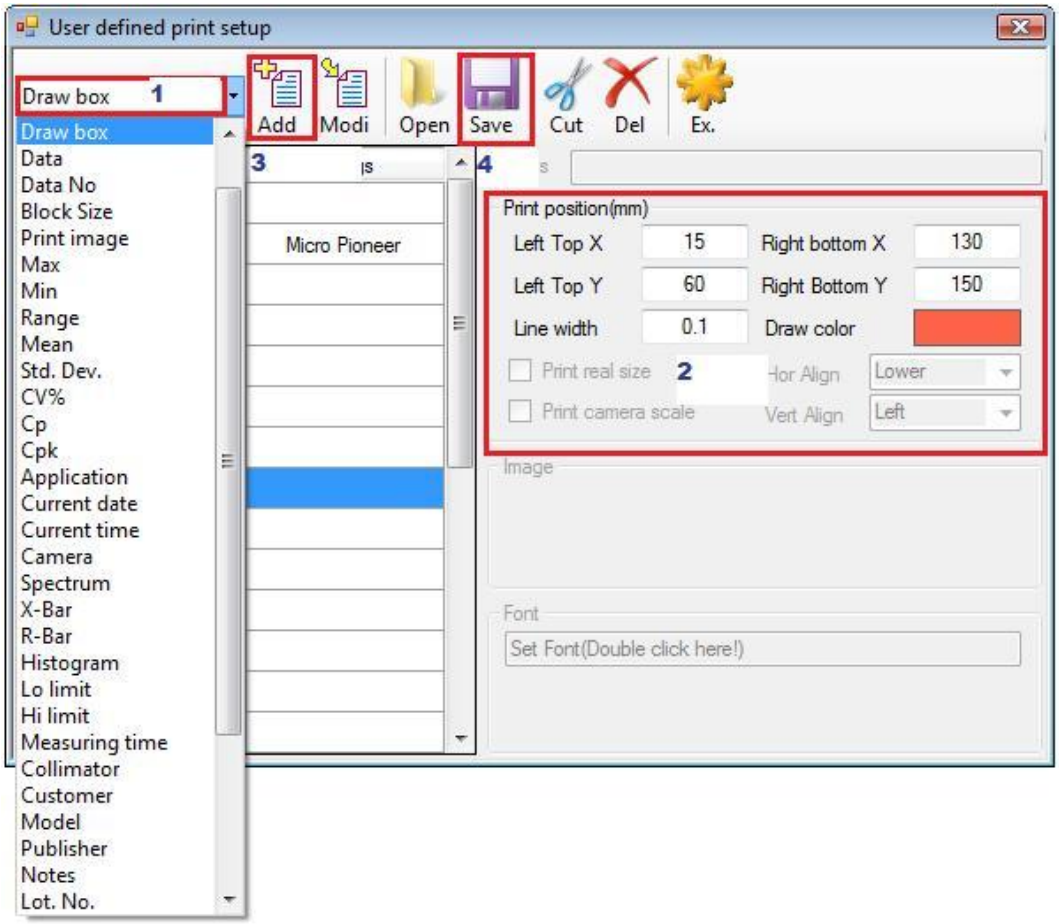




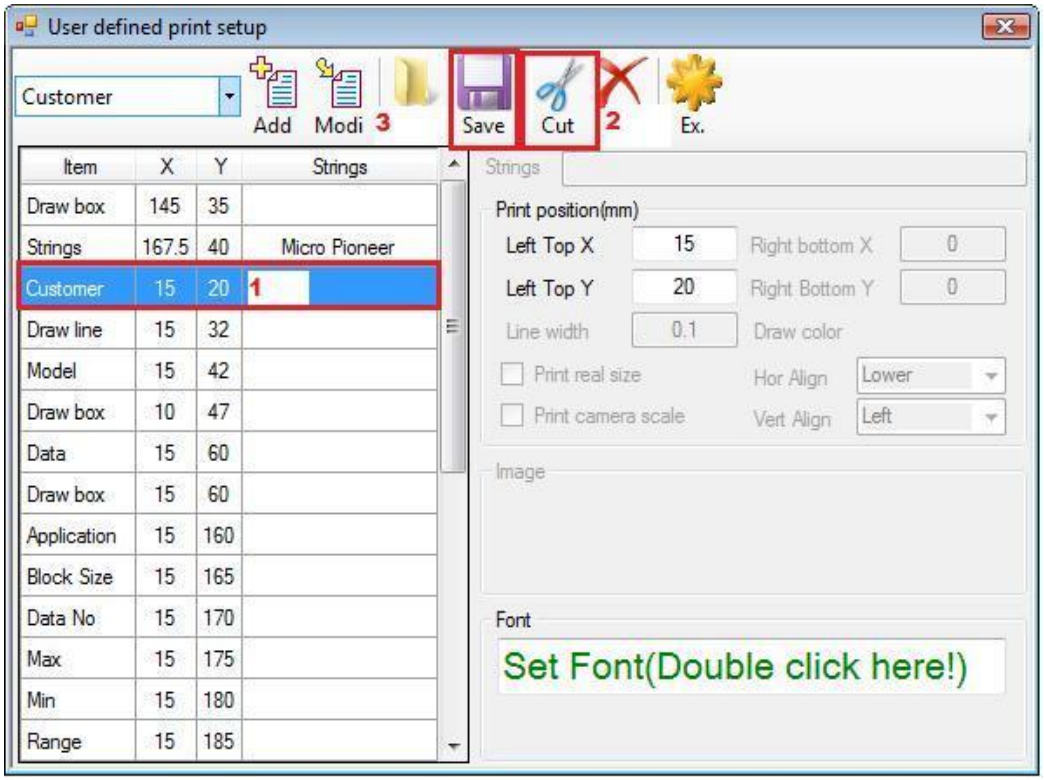
The print position of X and Y means as follows.



3) Add/Delete Item

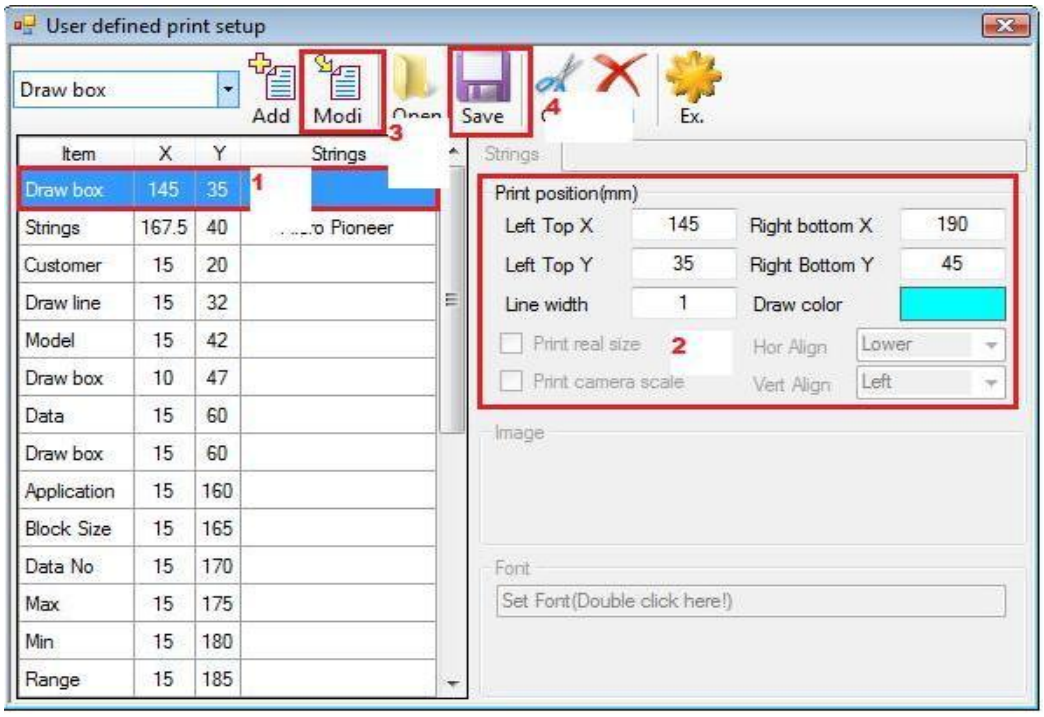


ADD -Select item to add, specify print position and click Add Icon then save to user defined print file(*.UDP).



Delete – Select item to delete and click Cut Icon then save to user defined print file(*.UDP).

4) Edit Item



Edit – Select item to edit and change the print option such as position, color, Font and line width etc. and click Modi Icon then save to user defined print file(*.UDP).

5) Sample of User Print Form

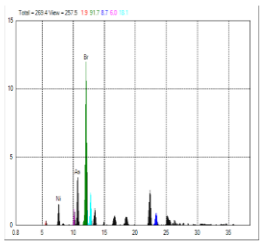
Customer : SamSung Elec. Ltd.

서울 금천구 가산동 Tel : 02-2163-8650
대륭테크노타운 8차 1414호 Fax : 02-2163-8652
마이크로 파이오니아

Model : XRF-2000 Series R

Micro Pioneer

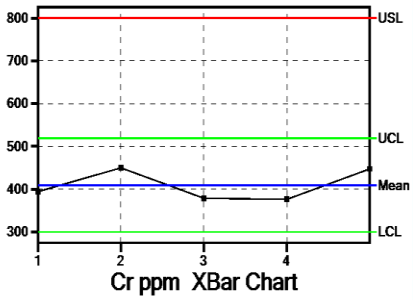
No	Cr ppm	Br ppm	Cd ppm	Hg ppm	Pb ppm
1	394.1	493.9	107.1	226.6	398.7
2	449.7	503.9	91.1	196.0	380.4
3	378.6	507.7	83.9	199.4	374.7
4	376.1	492.4	100.2	180.0	359.5
5	447.3	492.0	99.6	205.0	382.6



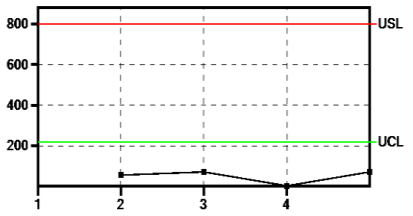
Application : RoHS_PVC

Data No	5	5	5	5	5
Max	449.7	507.7	107.1	226.6	398.7
Min	376.1	492.0	83.9	180.0	359.5
Range	73.6	15.7	23.2	46.6	39.2
Mean	409.2	498.0	96.4	201.4	379.2
Std. Dev.	36.6	7.3	9.0	16.9	14.2
CV%	8.9	1.5	9.3	8.4	3.7

5/7/2009
3:15:53 PM



Cr ppm XBar Chart



Publisher : Ike Kim

4.5  Spectrum window

4.5.1 Qualitative Analysis

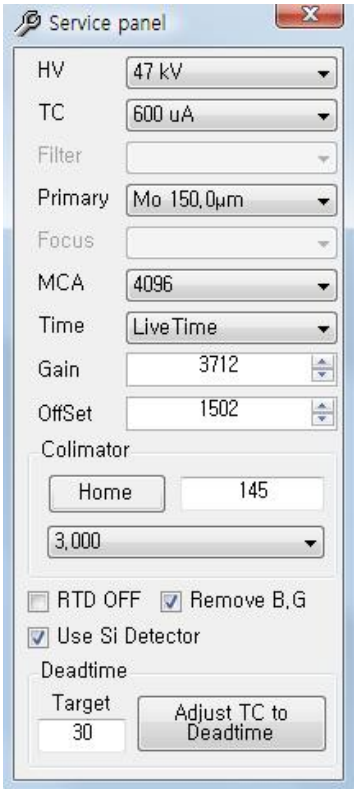
The objective of qualitative analysis is to identify the elemental component of unknown substances. The first step in qualitative analysis is spectra acquisition. Following spectra acquisition, the spectra must be manipulated and studied to best determine additional spectra acquisition and/or the qualitative answer desired. This covers guidelines for qualitative analysis including various spectral manipulations.

- **Setting acquisition parameters**

(High Voltage and Tube Current setting in CAL File)

Since the purpose of qualitative analysis is to identify the components in a sample, acquisition parameters should be selected to optimize the identification CAL File. This is done by maximizing the spectral range covered by the excitation-detection system as well as obtaining sufficient sensitivity to identify even trace amounts of the elements present in sample. This is accomplished by optimizing the X-Ray levels. Total CPS on Spectrum window is a good indication of this optimized level. Voltage (KV) and current (uA) settings, combined, should allow for Dead Time 30% in PIN Diode System, 5% in Proportional Counter system.

- **Guidelines to excitation parameter efficiencies**



Place cursor on Main window and click the Main window then press Alt+Ctrl+Shif simultaneously and hold these keys and type “pioneer” and Press Enter key. Then service menu will appear in spectrum window. Click Service menu on the Spectrum window.

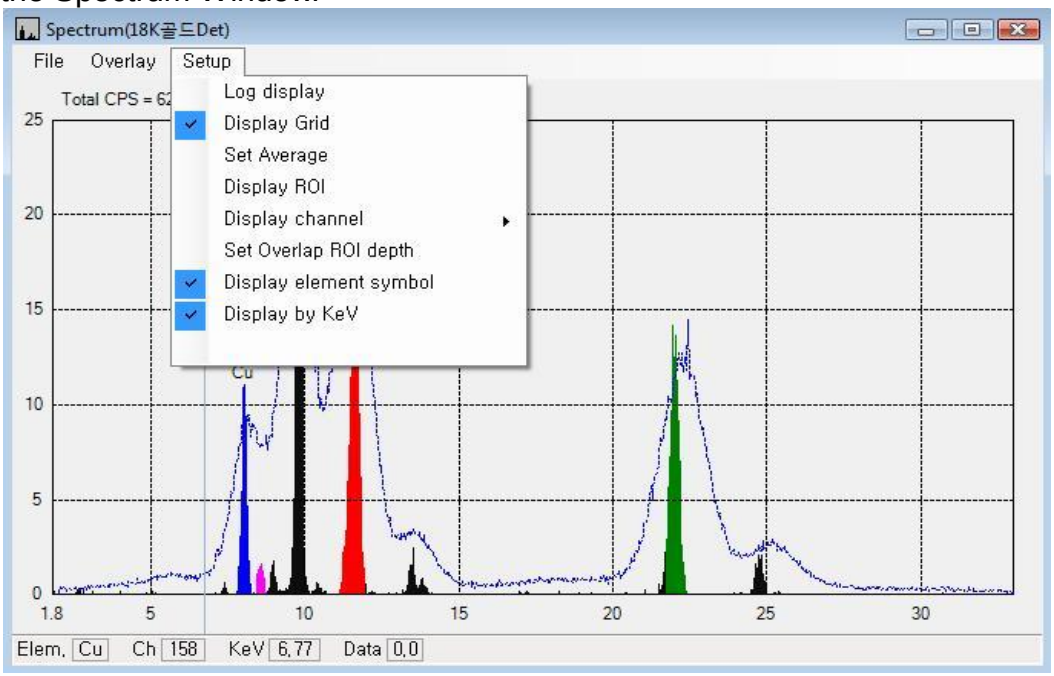
On the service menu try to get a good spectrum regarding application by changing all the parameters such as HV, TC, Primary Filter and collimator etc.

Clicking adjusting TC to Dead time button will optimize tube current for 30% of dead time(PIN Diode) , 5%(Proportional Counter).

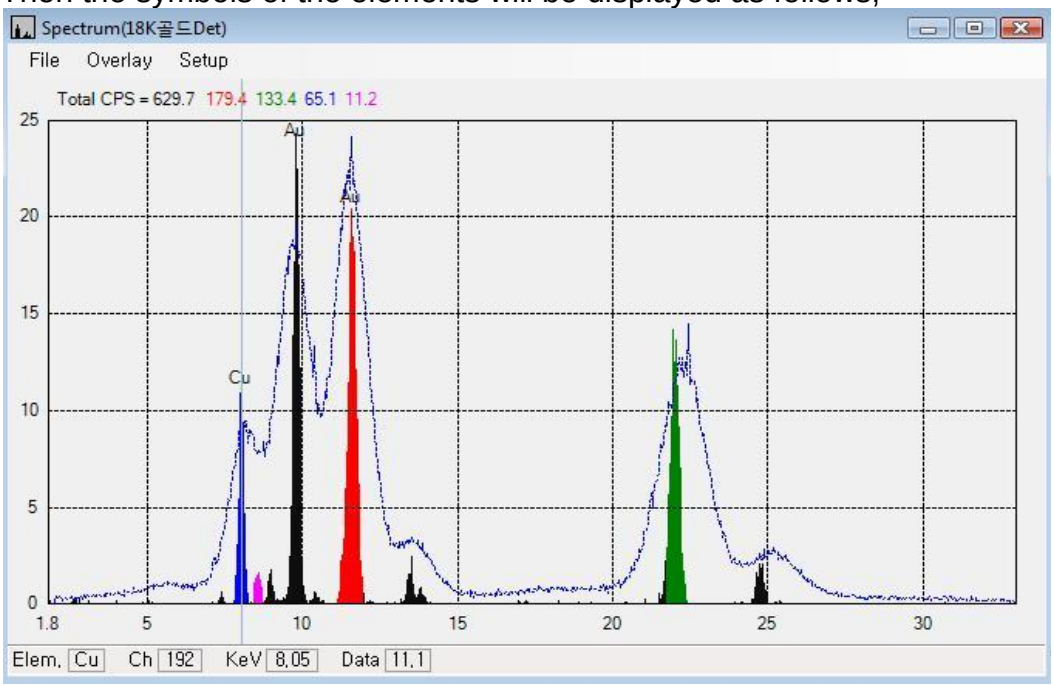
For more specific excitation conditions, the use of filters to modify the exciting radiation is recommended. Filters modify the exciting radiation and may selectively enhance the excitation of certain analytes within the sample.

4.5.2 Editing and Manipulating Spectra

Automatic identification of peaks can be performed after spectra have been acquired. Click the Setup pull-down menu. Click Display element symbol in the Spectrum Window.

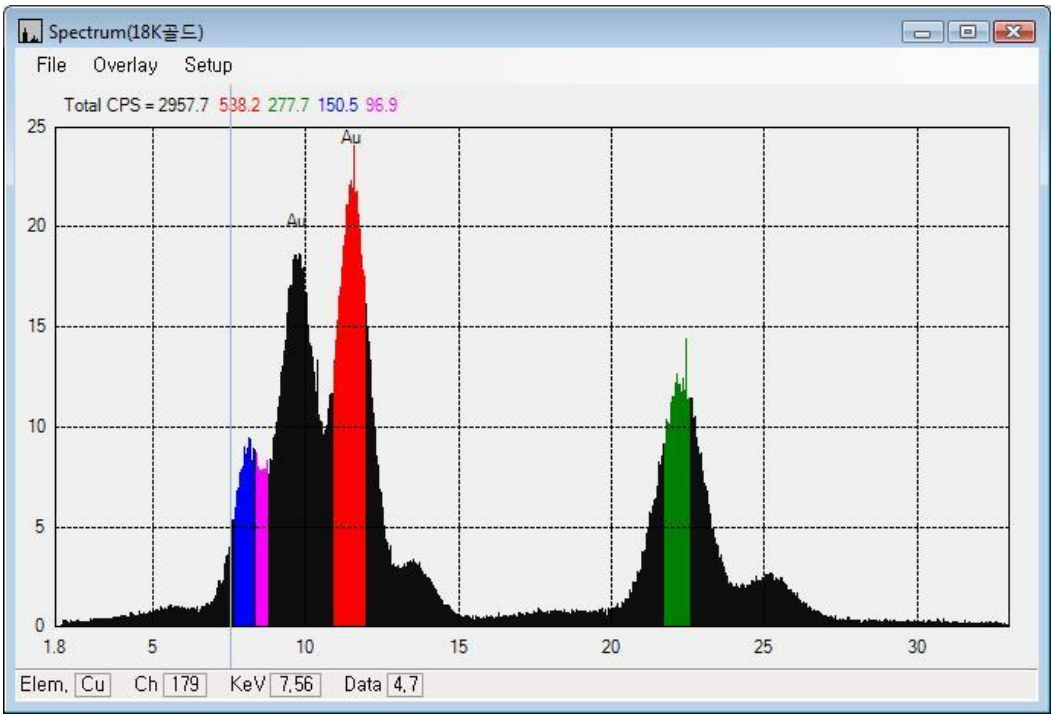


Then the symbols of the elements will be displayed as follows;

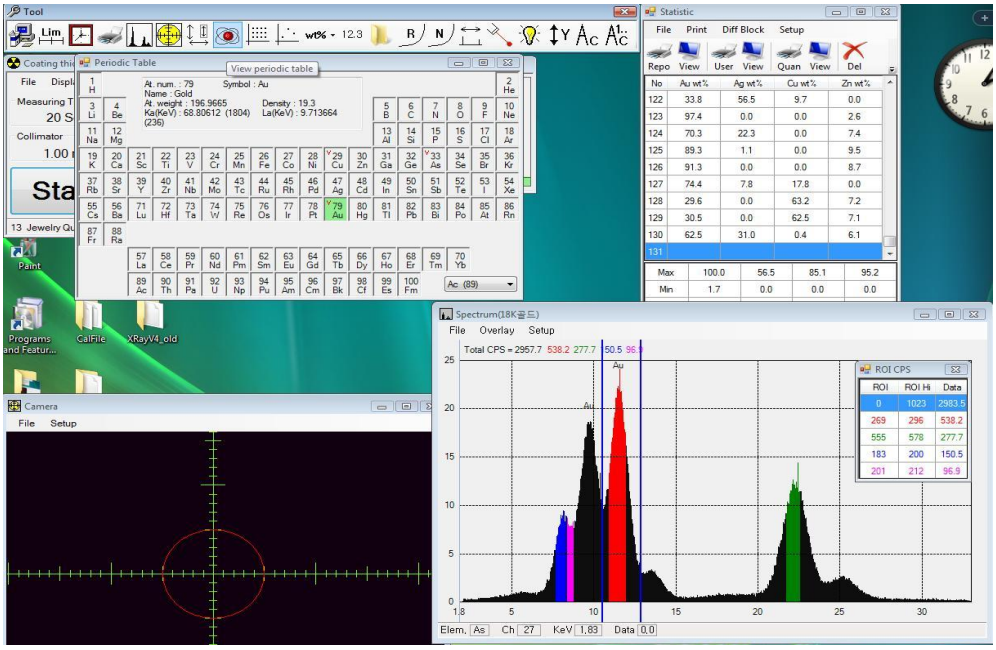


The overwrapped spectrum is acquired by proportional counter and main spectrum is acquired by Si PIN detector for 18K Gold alloy. These spectra show the different resolution for the same sample since resolution of counter is around 1,200eV and PIN detector is 149eV. If the peak is not identified automatically move cursor to center of the spectrum then the bottom of the

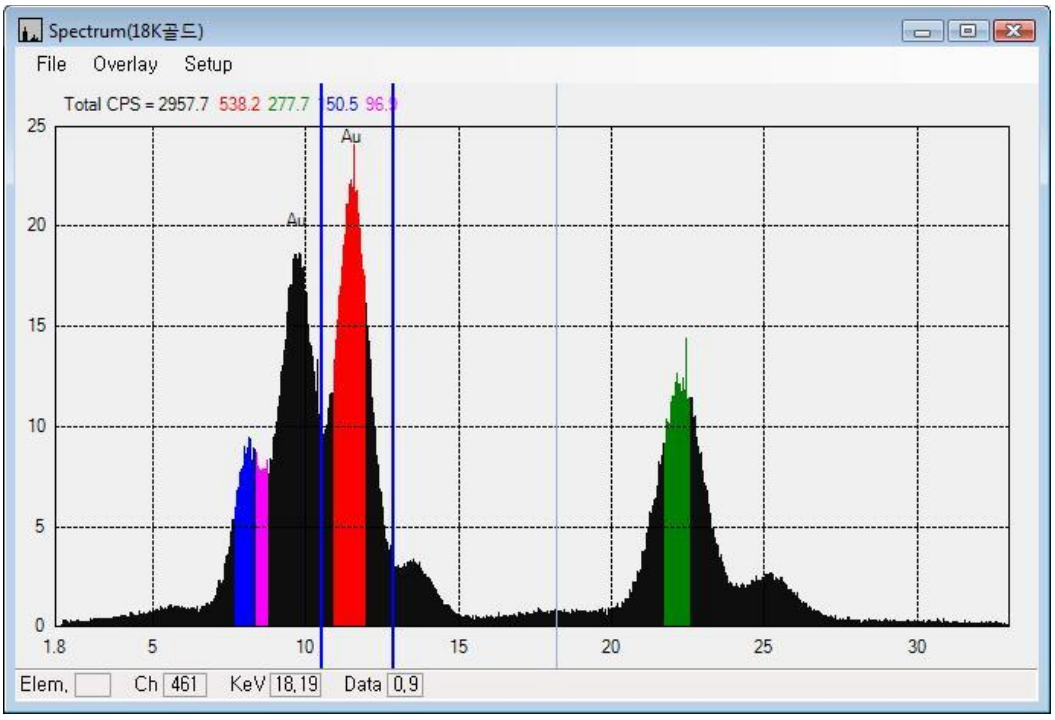
window display the possible element, channel, KeV and Data(CPS) as shown in above. The Green peak on right side is peak for Silver K-a(22.16KeV) but it is not identified automatically because the center of the sliver K-a moved to the left (called peak shift) as 21.96KeV. Therefore the right two peaks should be determined as K-a and K-b of the Silver by operator because there are no other possible elements regarding its energy of the X-Ray. Using the proportional counter, it will be looked like as follows;



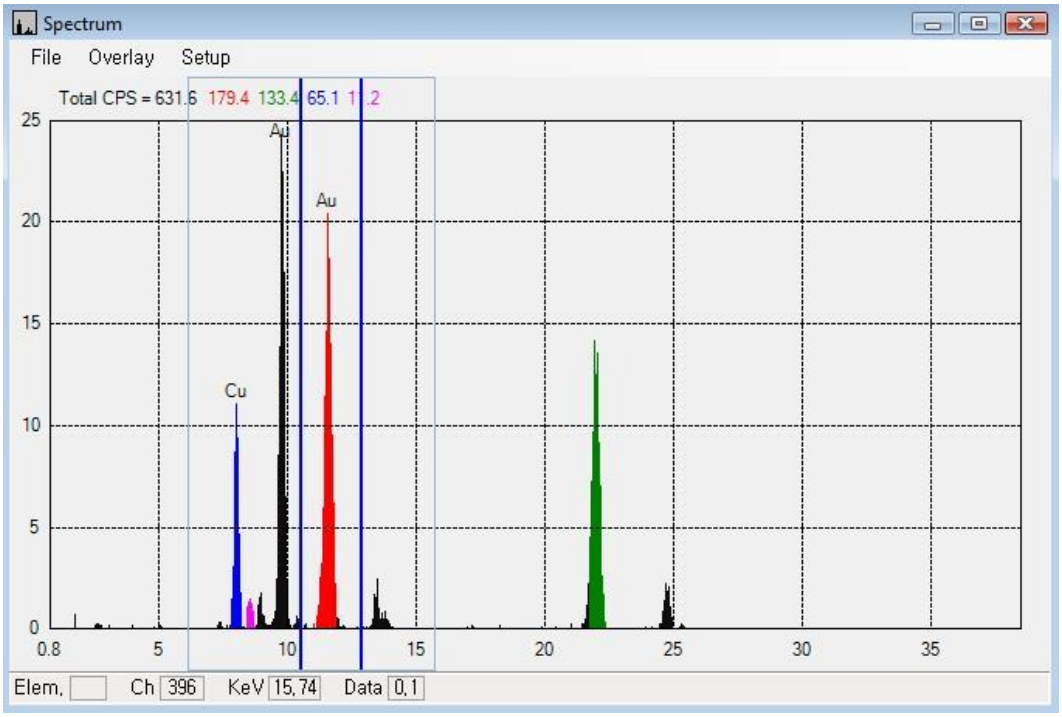
Because of wide resolution of the proportional counter, Cu and Zinc are overwrapped each other. Sometimes this is very confused to identify the peak. So if there is a peak in certain ROI (Region of Interest) it is possible to exist overwrapped peak by neighborhood elements. View periodic table menu on tool bar provides useful function to identify the spectra. Click View periodic table menu on tool bar.

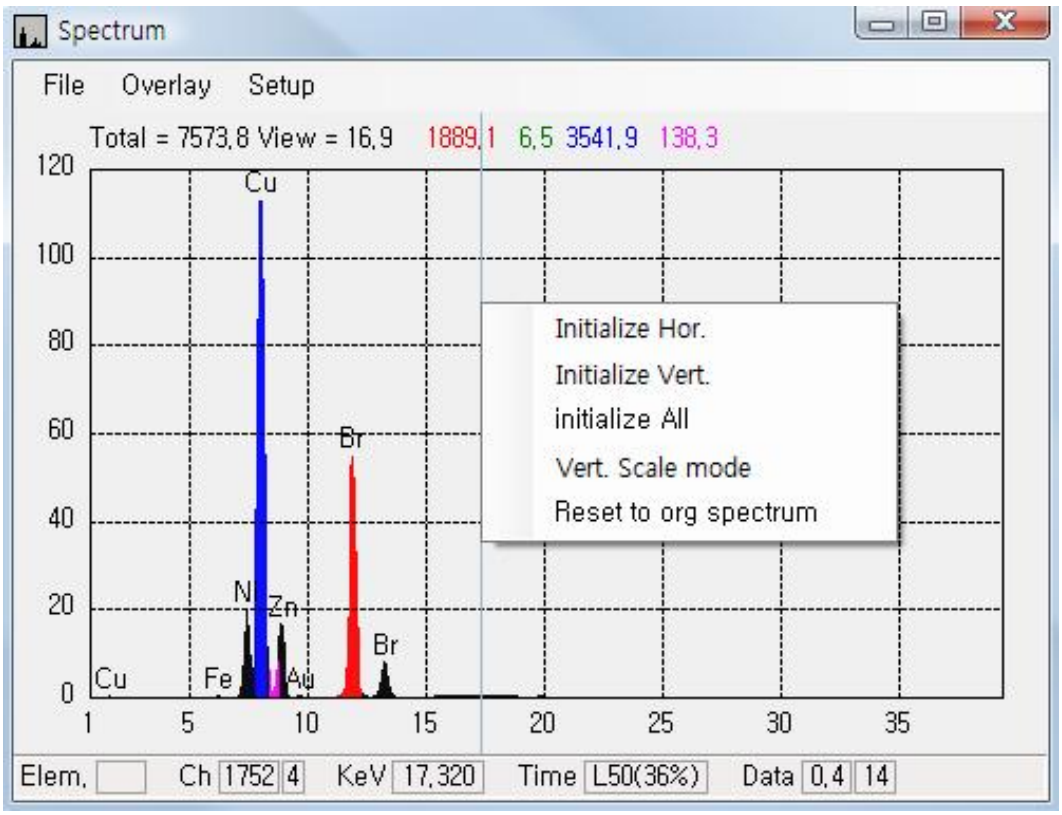


Clicking specific element shows its information such as Atomic number, Energy Value etc. and two vertical lines (blue lines) which is ROI low and ROI High are placed on the Spectrum window. Below is example of clicking Au.



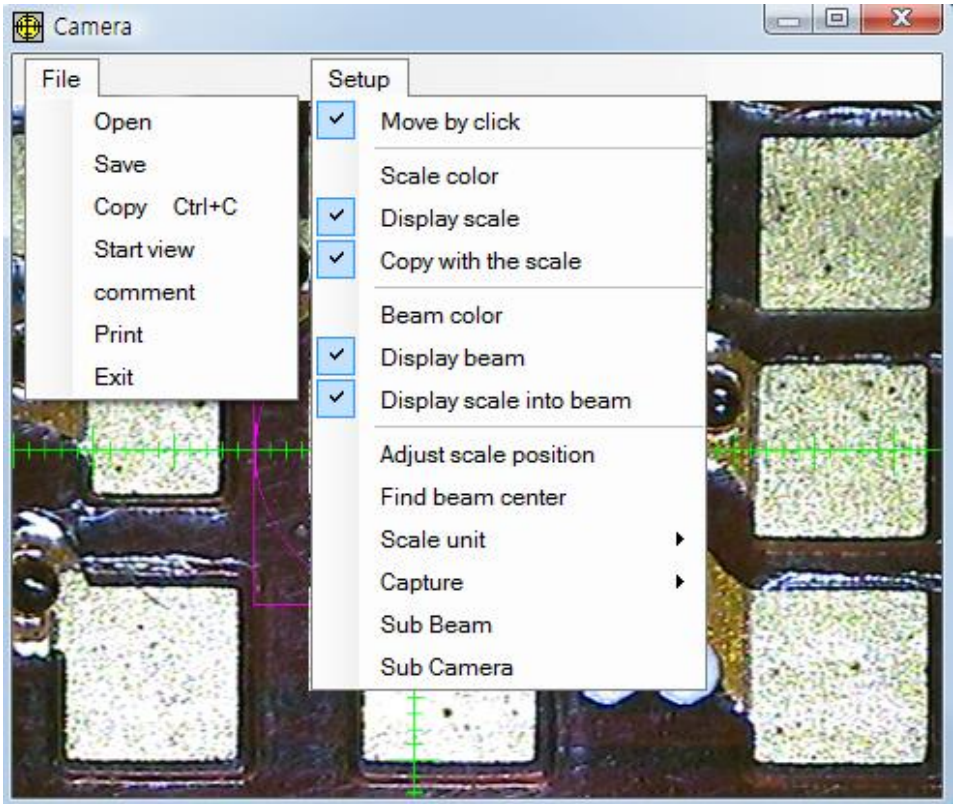
Drag to specific area can extend display area for details of the spectra.





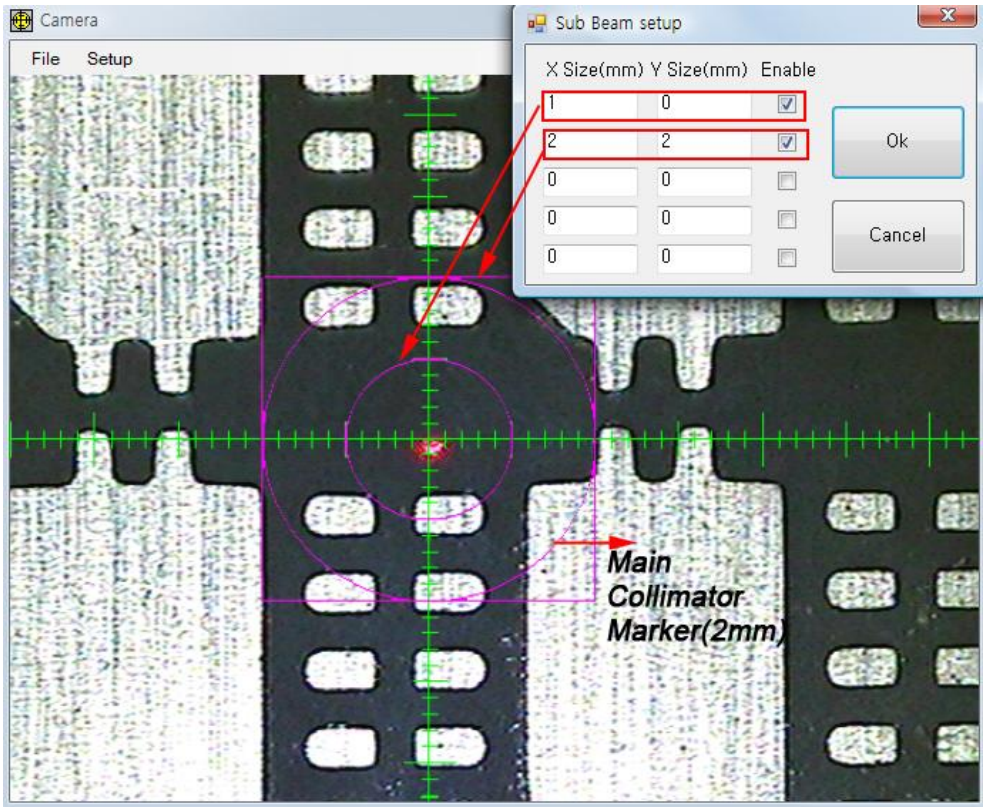
Click Right button shows menus to initialize, expend/reduce the vertical scale and reset to original spectrum.

4.6 Camera window



- ✓ Open/Save: Save sample image as bmp or jpg format.
- ✓ Copy: Copy sample image to clipboard.
- ✓ Start view: Start capturing sample image.
- ✓ Comment: Enter comment text to print.
- ✓ Print: Print sample image.
- ✓ Move by click
  - ◆ Double click where you want to move.
  - ◆ Left click to move XY axis, Right click for Z focus.
- ✓ Scale color: change scale color.
- ✓ Display scale: ON/OFF scale line.
- ✓ Copy with Scale: Copy to sample with scale to clipboard.
- ✓ Beam color: Modify Beam display color.
- ✓ Display beam : ON/OFF beam display
- ✓ Display scale into beam: ON/Off scale inside collimator circle.
- ✓ Adjust scale position: Adjust center of scale line manually.
- ✓ Find beam center: Automatically find the beam position.
- ✓ Scale Unit: Change scale unit in mm or mils.
- ✓ Capture: Select image source device (Capture Card).

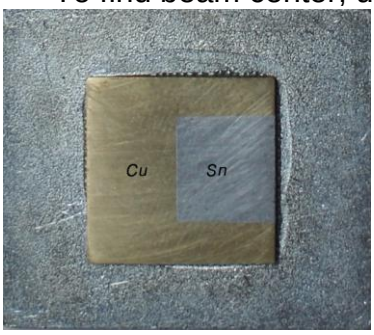
4.6.1 Sub Beam: Generate multi indicator



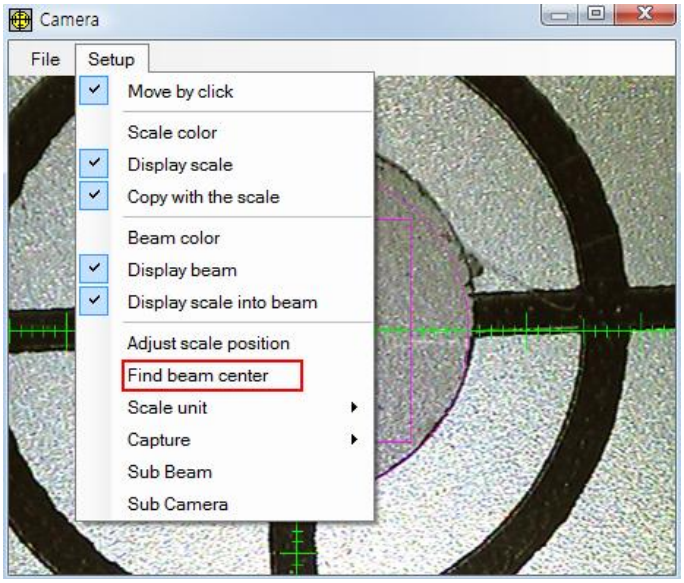
✓ To change the camera window size, hold and drag right side or corner of the camera window.

4.6.2 Find Beam Center

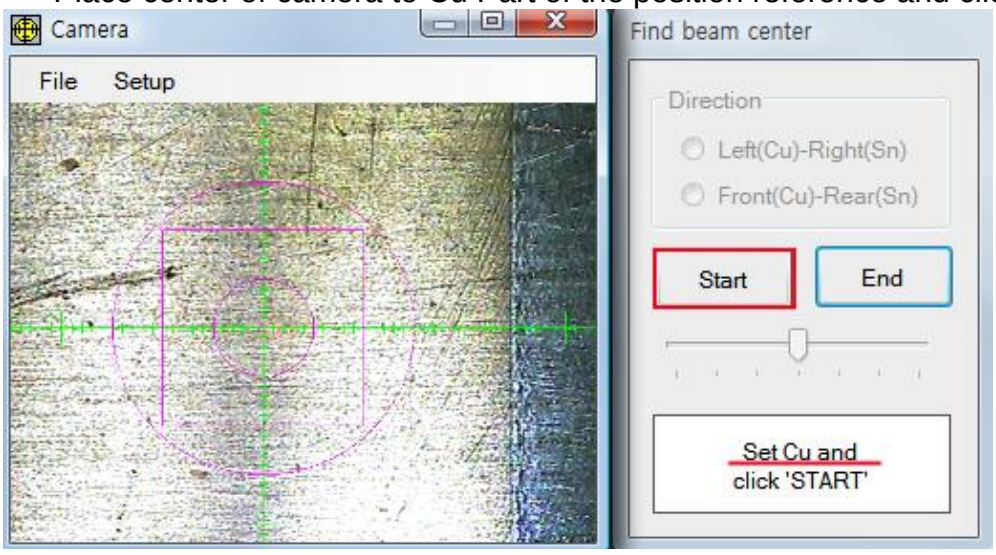
To find beam center, use below position reference.



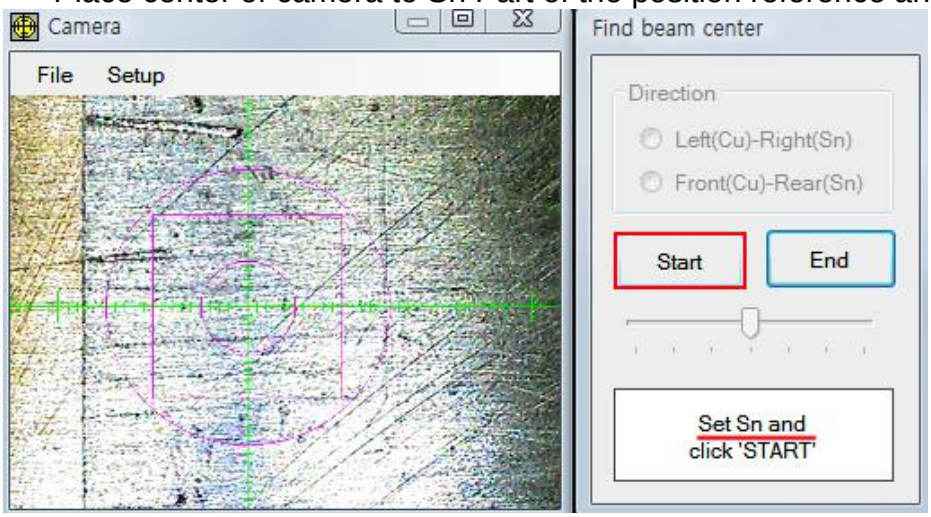
Click Find beam center on Camera Window.



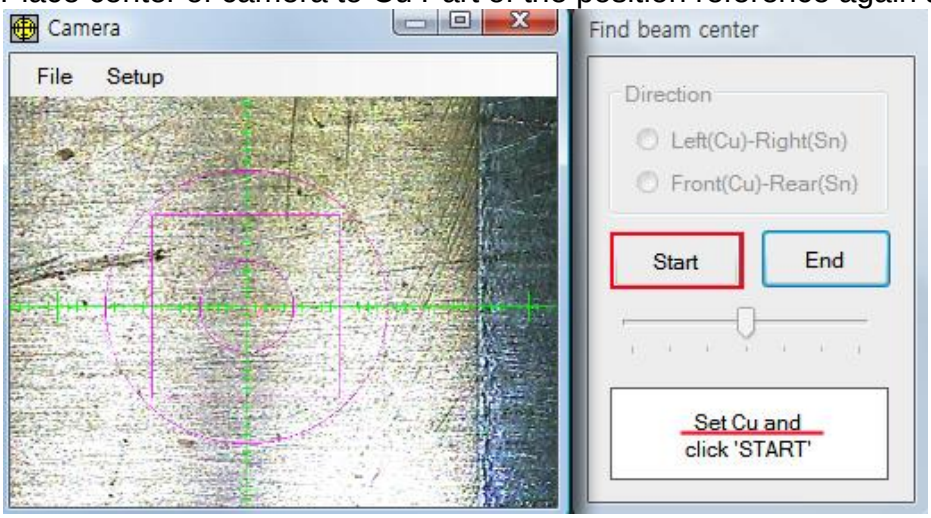
Place center of camera to Cu Part of the position reference and click Start.



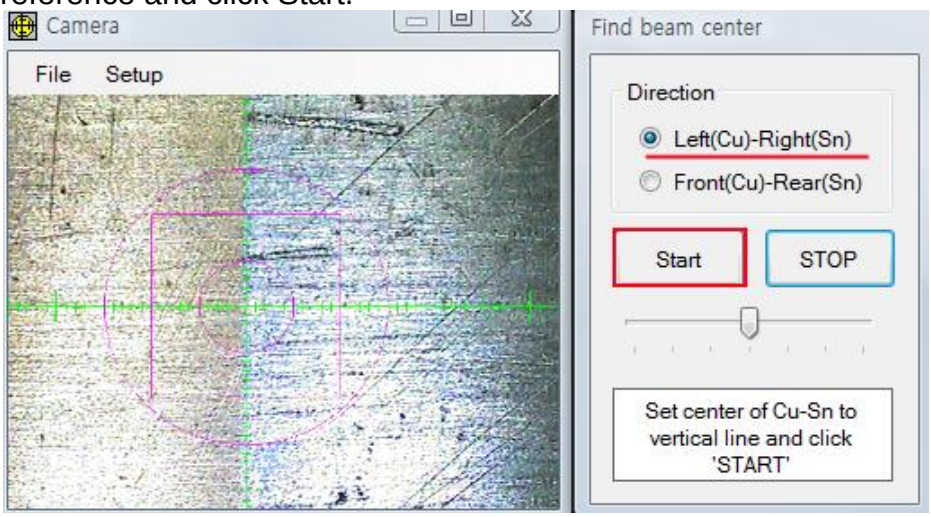
Place center of camera to Sn Part of the position reference and click Start.



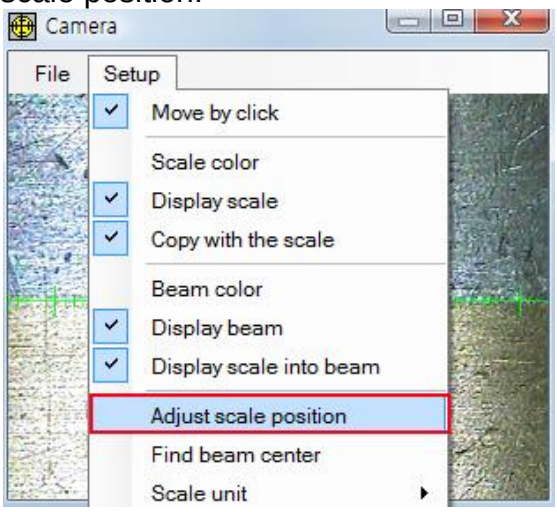
Place center of camera to Cu Part of the position reference again and click Start.



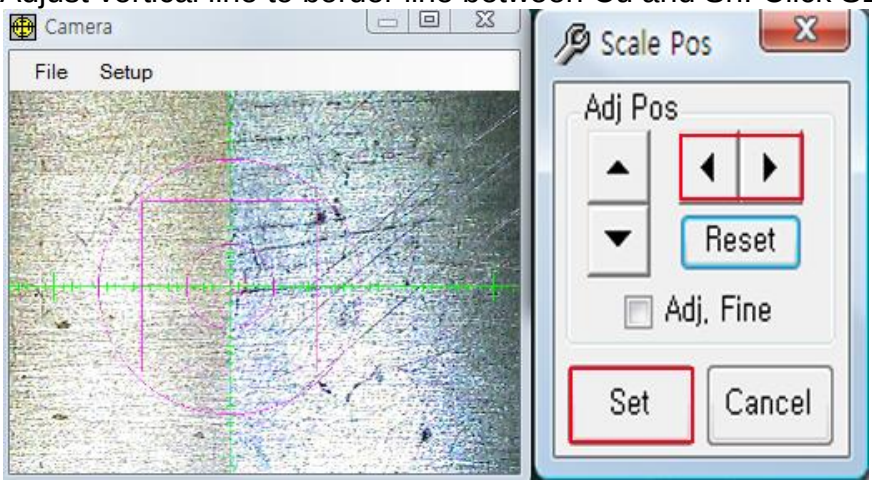
Place center of camera to border line between Cu and Sn of the position reference and click Start.



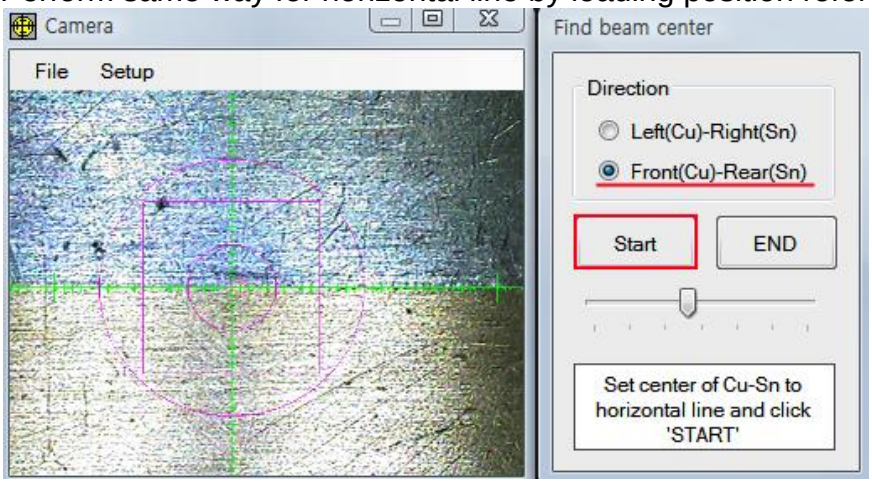
When system finish to find the center of beam, make sure the vertical line coincide with border line between Cu and Sn. If does not, Go setup -> Adjust scale position.



Adjust vertical line to border line between Cu and Sn. Click SET.



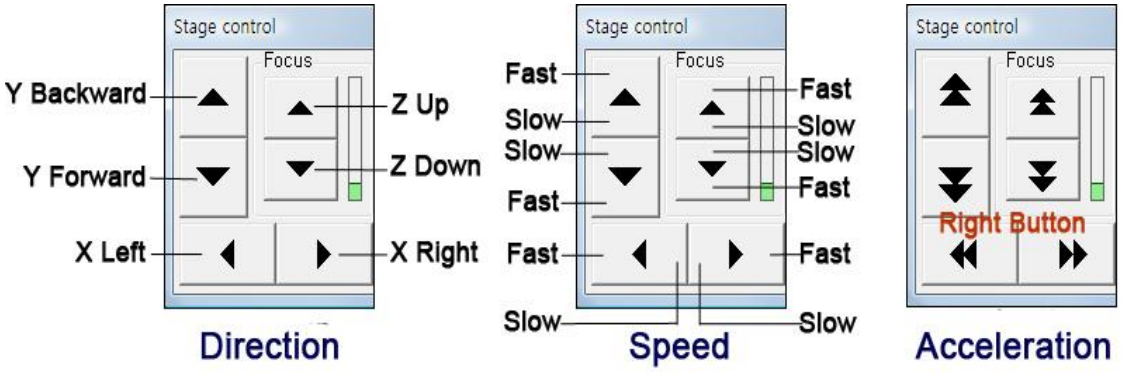
Perform same way for horizontal line by loading position reference as follows.

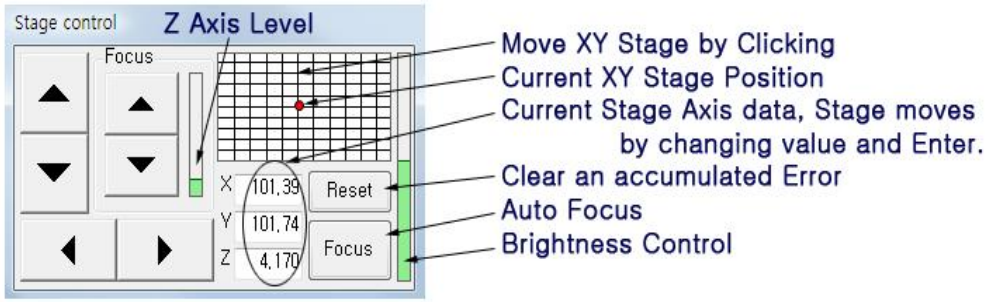


Click END to save and exit.

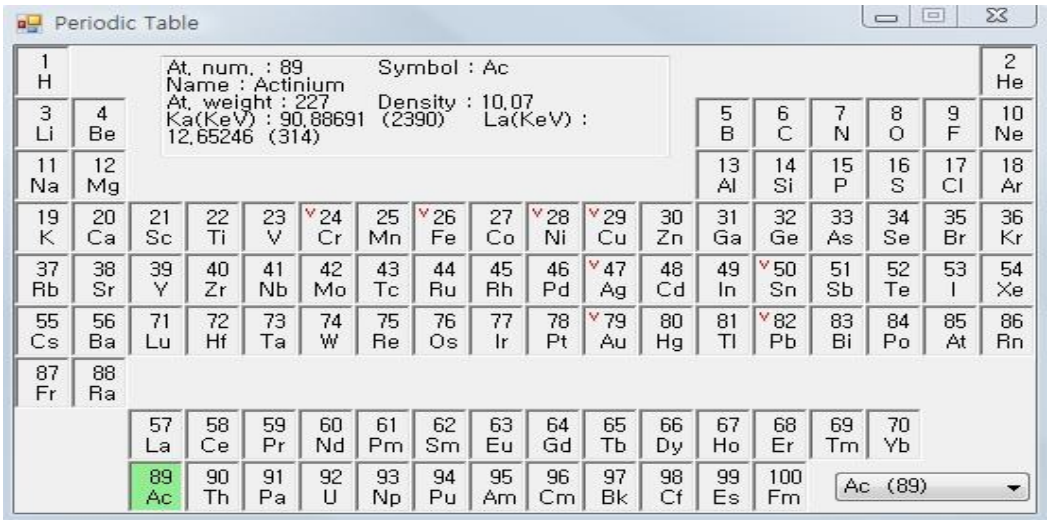
4.7 Stage Control Window

Moving speed will be changed by the mouse operation. Left button is slow speed control. The speed will be changed by the clicked position. The inner position is slow speed and outer position is fast speed. Right button is fast speed control by using acceleration and deceleration method.



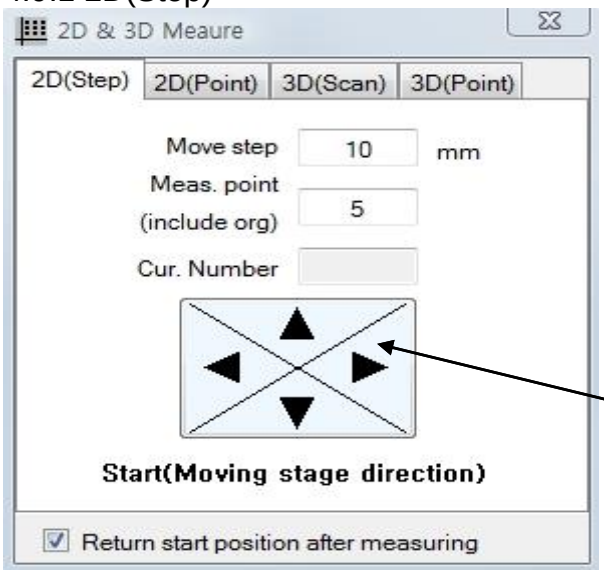


4.8 Periodic Table



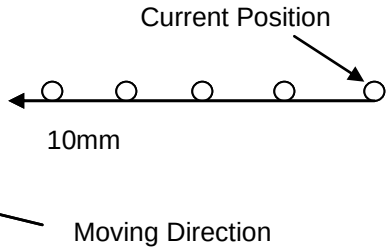
4.9 2D&3D Measure Window

4.9.1 2D(Step)

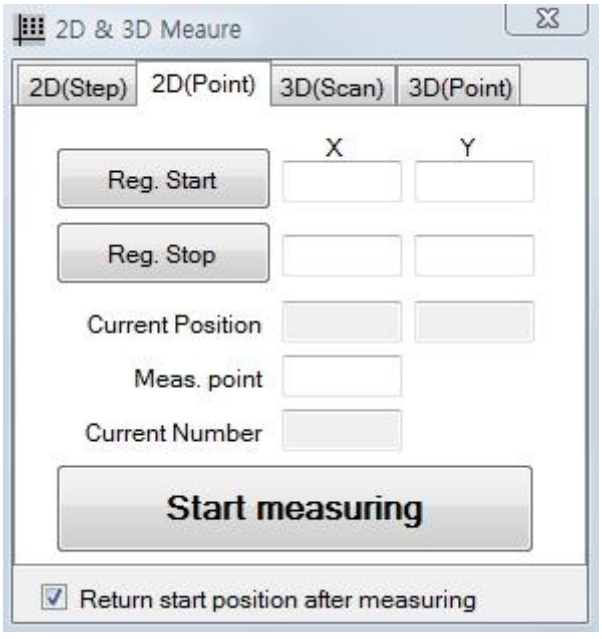


ex) 5 times analysis at intervals of 10mm from current position.

Clicking direction starts to measure.



4.9.2 2D(Point)

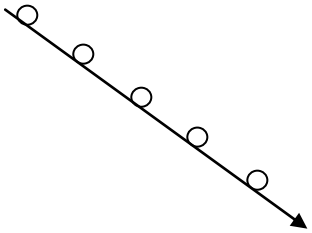


Move Sample to start position and Click Reg. Start Button.

Move Sample to end position and Click Reg. Stop Button

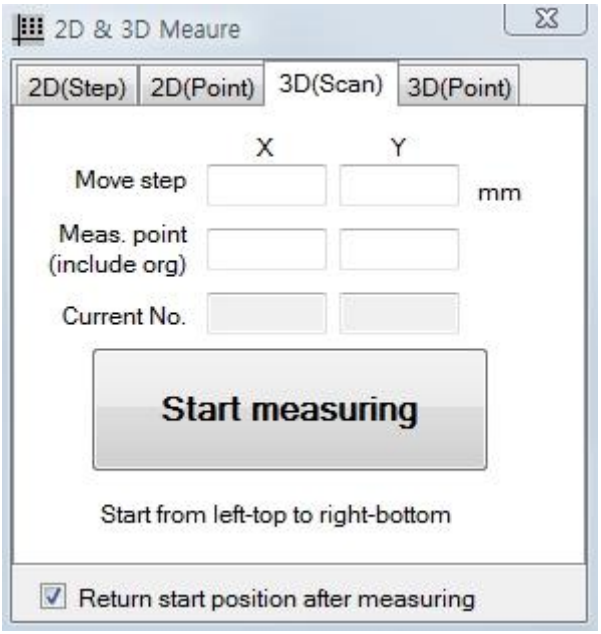
Enter Number of Analysis

Click Start measuring.

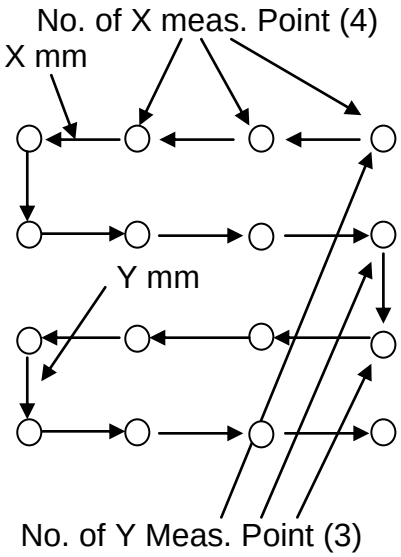


Moving distance = (Start - Stop) / (Meas. point - 1)

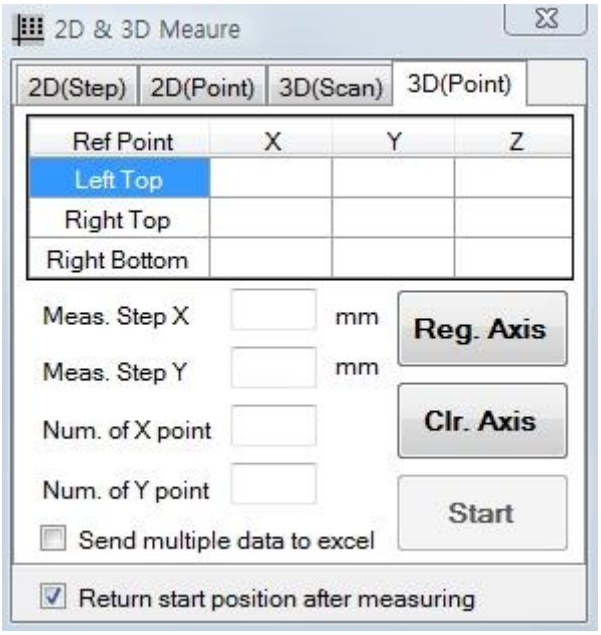
4.9.3 3D (Scan)

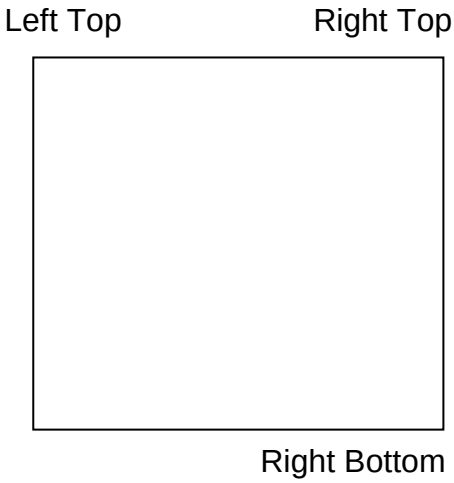


Ex)



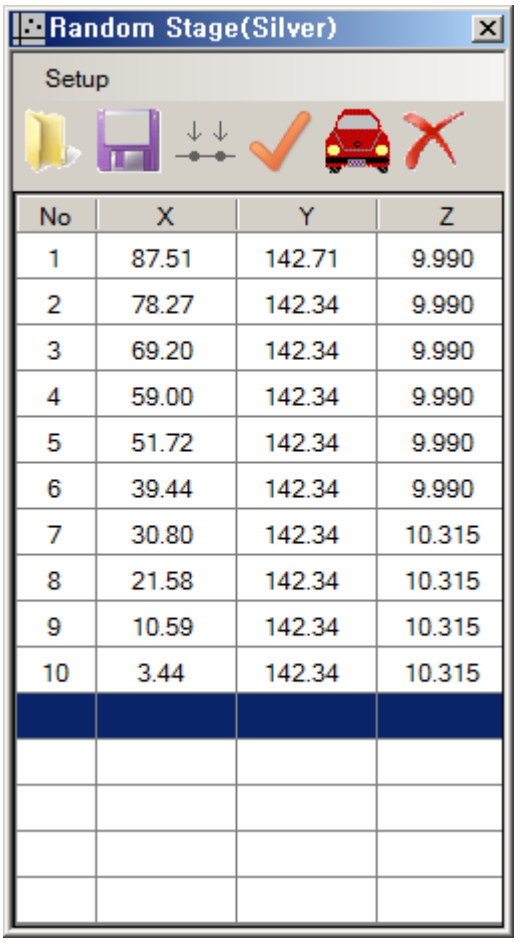
4.9.4 3D (Point)





- ✓ Place camera position and cursor to left top and click Reg. Axis Button.
- ✓ Place camera position and cursor to right top and click Reg. Axis Button.
- ✓ Place camera position and cursor to right bottom and click Reg. Axis Button.
- ✓ Enter No. of point for X, Y. Then moving distance for X and Y are calculated by system.
- ✓ Click Start button.

4.10 Random Stage

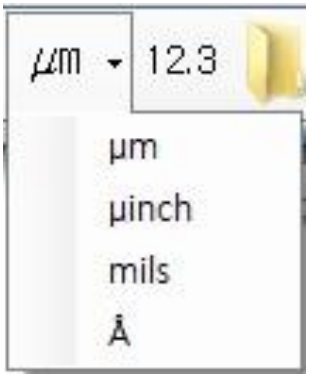


No	X	Y	Z
1	87.51	142.71	9.990
2	78.27	142.34	9.990
3	69.20	142.34	9.990
4	59.00	142.34	9.990
5	51.72	142.34	9.990
6	39.44	142.34	9.990
7	30.80	142.34	10.315
8	21.58	142.34	10.315
9	10.59	142.34	10.315
10	3.44	142.34	10.315

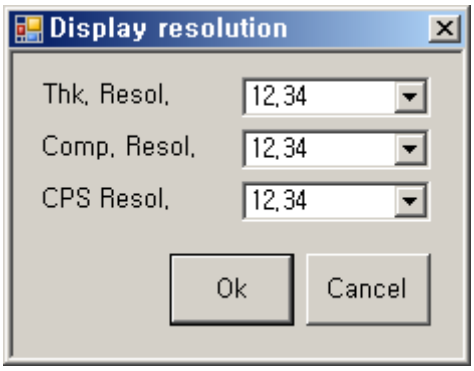
✓ Open/Save : Open/Save position data file.
✓ Set: Register the axis data. Space bar also works.
✓ Run: Start the measuring.
✓ Del: Clear all axis data.
✓ Ref: with saved position data, set ref.1 and 2 recalculate all other data.

Clicking right mouse button menu
✓ Del: delete the selected axis data.
✓ Move To axis: Move the stage to selected axis data.

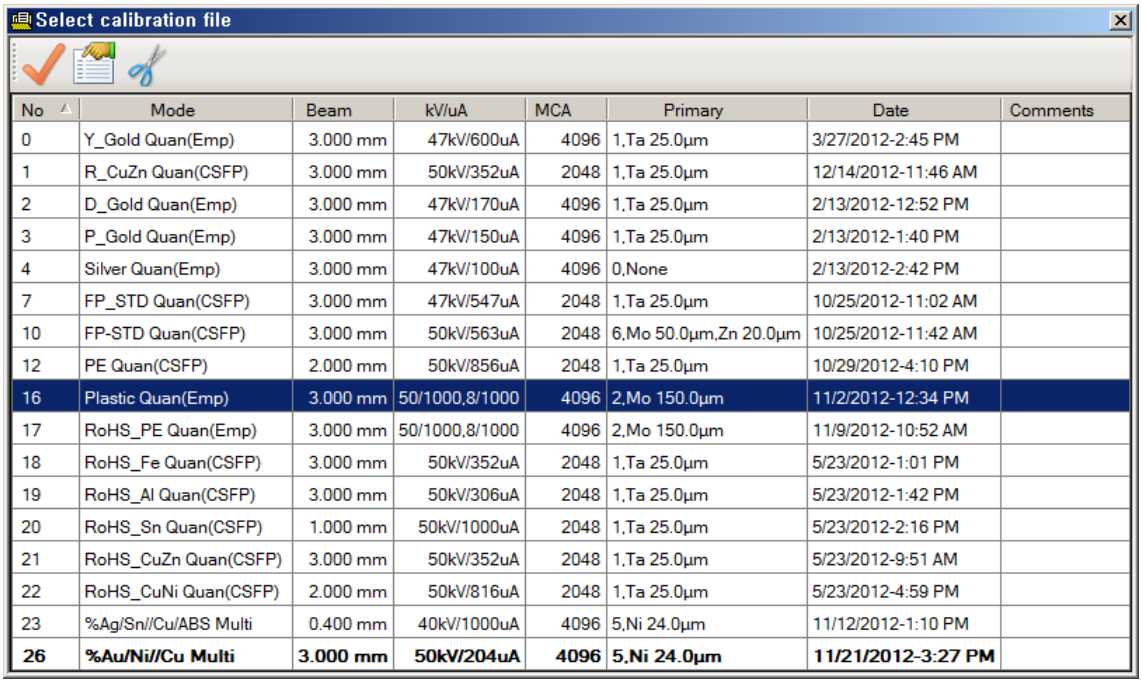
4.11 Set measuring Unit



4.12 12.3 Set Decimal Point



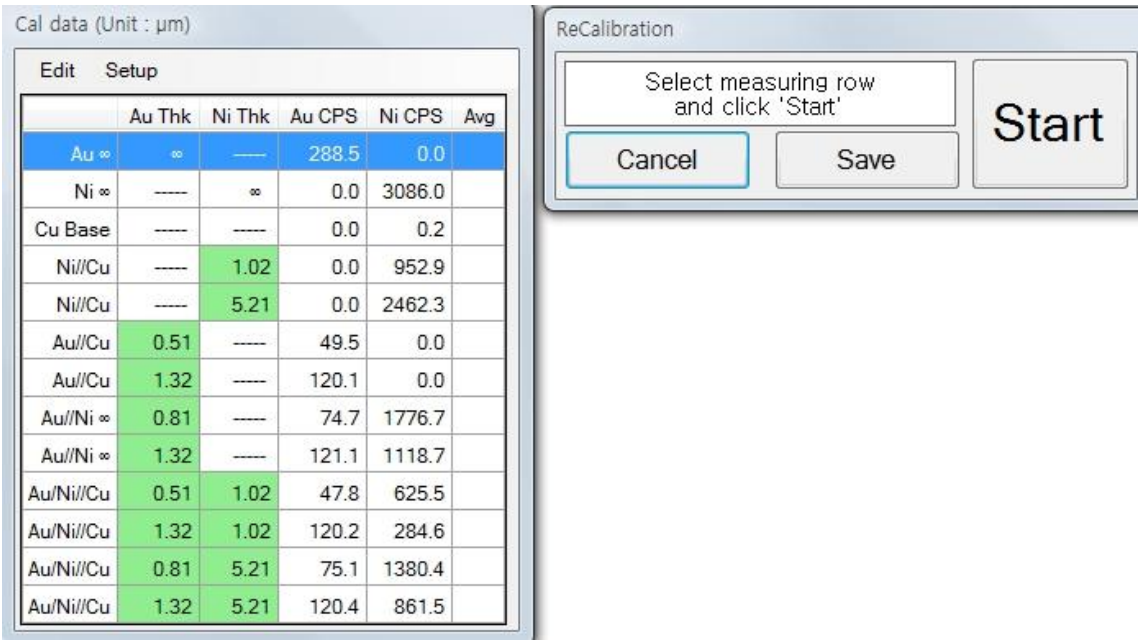
4.13 Cal File Select Window



No	Mode	Beam	kV/uA	MCA	Primary	Date	Comments
0	Y_Gold Quan(Emp)	3.000 mm	47kV/600uA	4096	1,Ta 25.0μm	3/27/2012-2:45 PM	
1	R_CuZn Quan(CSFP)	3.000 mm	50kV/352uA	2048	1,Ta 25.0μm	12/14/2012-11:46 AM	
2	D_Gold Quan(Emp)	3.000 mm	47kV/170uA	4096	1,Ta 25.0μm	2/13/2012-12:52 PM	
3	P_Gold Quan(Emp)	3.000 mm	47kV/150uA	4096	1,Ta 25.0μm	2/13/2012-1:40 PM	
4	Silver Quan(Emp)	3.000 mm	47kV/100uA	4096	0,None	2/13/2012-2:42 PM	
7	FP_STD Quan(CSFP)	3.000 mm	47kV/547uA	2048	1,Ta 25.0μm	10/25/2012-11:02 AM	
10	FP-STD Quan(CSFP)	3.000 mm	50kV/563uA	2048	6,Mo 50.0μm,Zn 20.0μm	10/25/2012-11:42 AM	
12	PE Quan(CSFP)	2.000 mm	50kV/856uA	2048	1,Ta 25.0μm	10/29/2012-4:10 PM	
16	Plastic Quan(Emp)	3.000 mm	50/1000,8/1000	4096	2,Mo 150.0μm	11/2/2012-12:34 PM	
17	RoHS_PE Quan(Emp)	3.000 mm	50/1000,8/1000	4096	2,Mo 150.0μm	11/9/2012-10:52 AM	
18	RoHS_Fe Quan(CSFP)	3.000 mm	50kV/352uA	2048	1,Ta 25.0μm	5/23/2012-1:01 PM	
19	RoHS_Al Quan(CSFP)	3.000 mm	50kV/306uA	2048	1,Ta 25.0μm	5/23/2012-1:42 PM	
20	RoHS_Sn Quan(CSFP)	1.000 mm	50kV/1000uA	2048	1,Ta 25.0μm	5/23/2012-2:16 PM	
21	RoHS_CuZn Quan(CSFP)	3.000 mm	50kV/352uA	2048	1,Ta 25.0μm	5/23/2012-9:51 AM	
22	RoHS_CuNi Quan(CSFP)	2.000 mm	50kV/816uA	2048	1,Ta 25.0μm	5/23/2012-4:59 PM	
23	%Ag/Sn//Cu/ABS Multi	0.400 mm	40kV/1000uA	4096	5,Ni 24.0μm	11/12/2012-1:10 PM	
26	**%Au/Ni//Cu Multi**	**3.000 mm**	**50kV/204uA**	**4096**	**5,Ni 24.0μm**	**11/21/2012-3:27 PM**	

- ✓ Set: Use the selected cal file.
- ✓ Edit comment: Edit the comment of selected cal file.
- ✓ Delete: Delete the selected cal file.

4.14 Recalibration Window



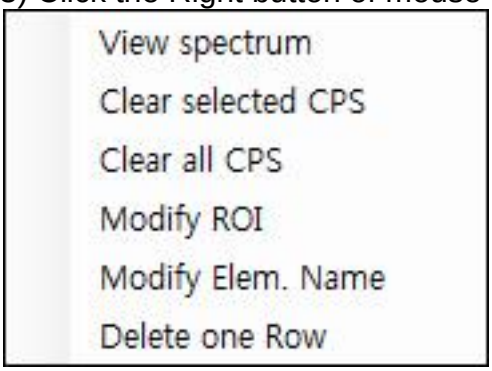
	Au Thk	Ni Thk	Au CPS	Ni CPS	Avg
Au ∞	∞	-----	288.5	0.0	
Ni ∞	-----	∞	0.0	3086.0	
Cu Base	-----	-----	0.0	0.2	
Ni//Cu	-----	1.02	0.0	952.9	
Ni//Cu	-----	5.21	0.0	2462.3	
Au//Cu	0.51	-----	49.5	0.0	
Au//Cu	1.32	-----	120.1	0.0	
Au//Ni ∞	0.81	-----	74.7	1776.7	
Au//Ni ∞	1.32	-----	121.1	1118.7	
Au/Ni//Cu	0.51	1.02	47.8	625.5	
Au/Ni//Cu	1.32	1.02	120.2	284.6	
Au/Ni//Cu	0.81	5.21	75.1	1380.4	
Au/Ni//Cu	1.32	5.21	120.4	861.5	

- Recalibration procedure.

1) Manual axis calibration.
- Set one calibration standard (ex: Au Inf.) on the stage.
- Adjust position and focus.
- Select desired (ex: Au Inf.) row on 'Calibration Data' window.
- Click 'START' button on Recalibration window.
- Click 'START' button again. Then average data will be used for calibration data.

2) Automatic axis calibration.
- Set all calibration standards on the stage.
- Adjust position and focus.
- Double click the desired (ex: Au Inf.) axis row then axis data will be registered.
- Register all of calibration standard axis data.
- Click the 'START' button.

3) Click the Right button of mouse will be display the pop-up menu.

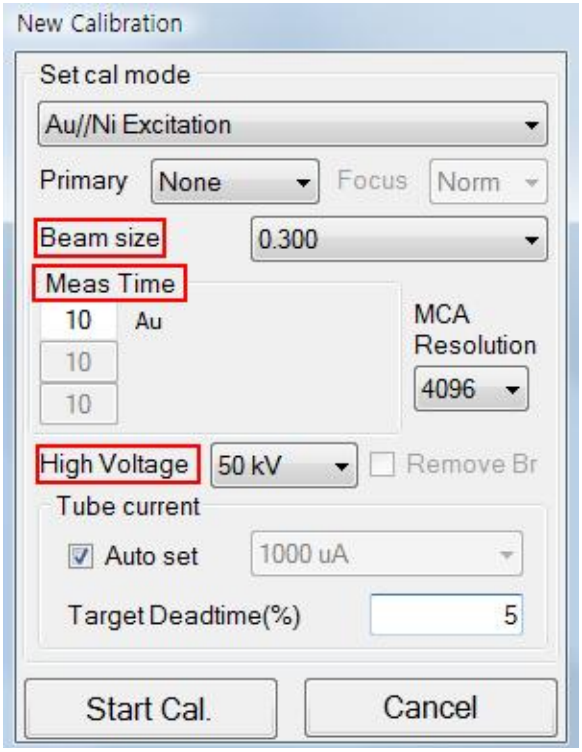


- ✓ View Spectrum: display standard's spectrum on spectrum window.\
- ✓ Clear selected CPS: Clear CPS for selected row data.
- ✓ Clear all CPS: Clear entire CPS in Cal data.
- ✓ Modify ROI: Change ROI value as eV.
- ✓ Modify Elem. Name: Change element name.
- ✓ Delete one Row: Remove selected standard.

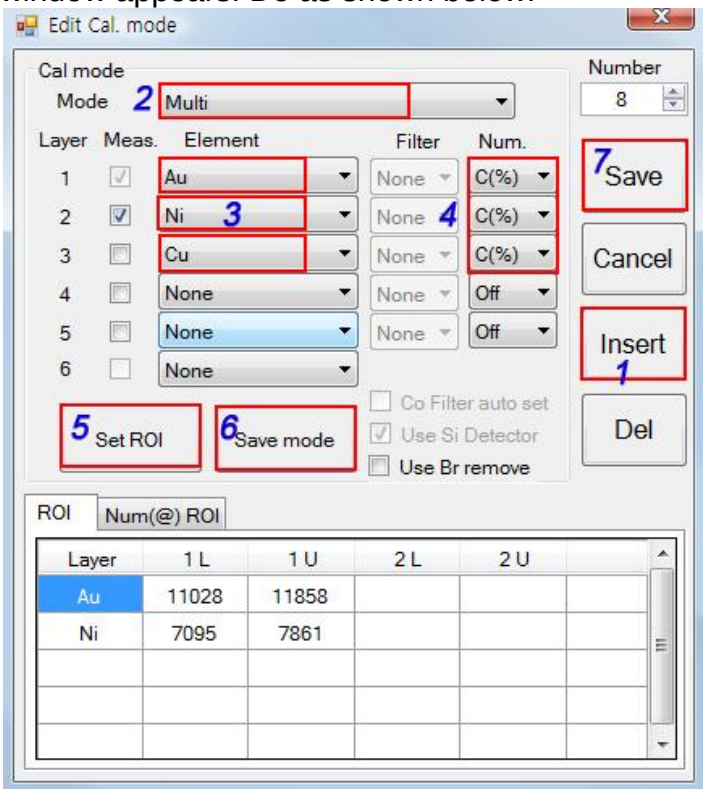
4.15  New Calibration

4.15.1 Thickness Calibration

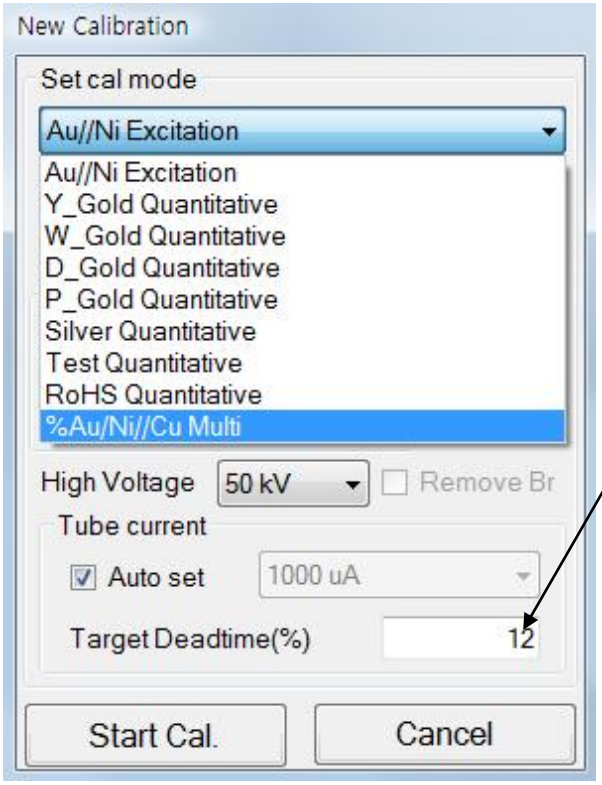
Click  icon for new calibration (ex:Au/Ni//Cu)



Double Click on Beam size, Meas Time and High Voltage, then Edit Cal. Mode window appears. Do as shown below.

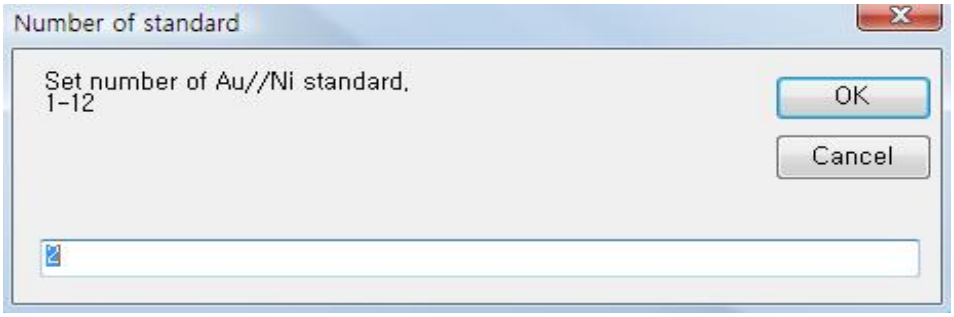


Select Cal. Mode which is just created.

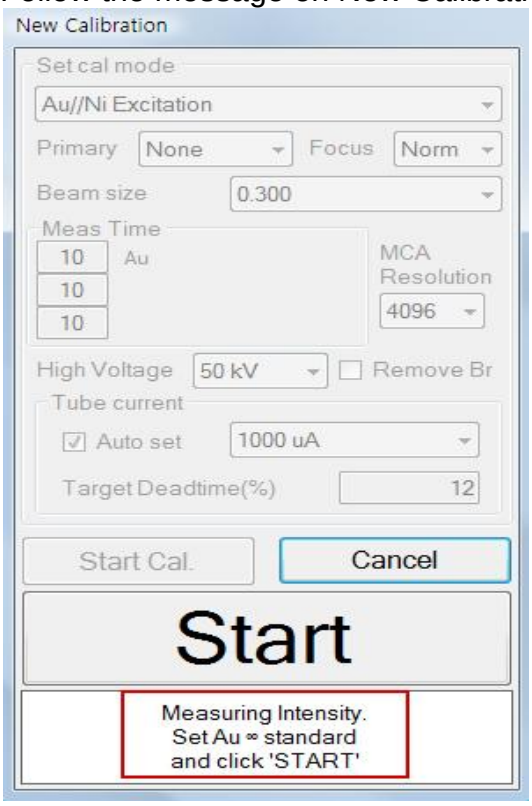


Target Dead time is 5% for Proportional Counter, 30% for PIN Diode detector.

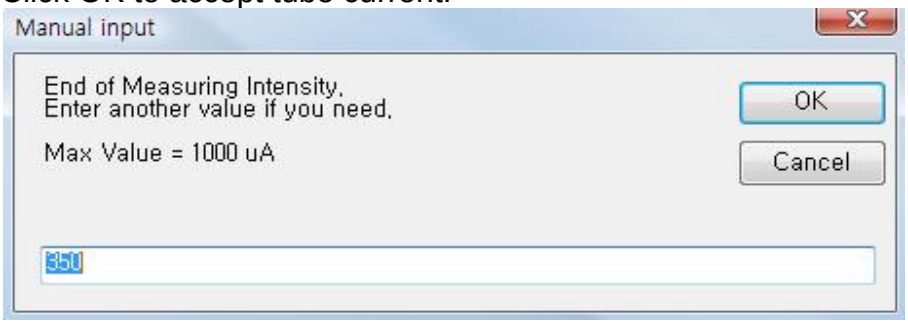
New calibration will use pre-defined cal mode. Click Start Cal. button, and enter number of standard foil.



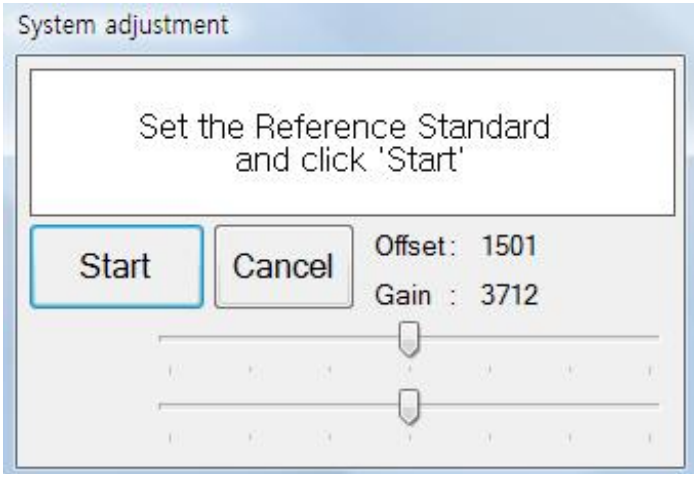
Follow the message on New Calibration Window.



Click OK to accept tube current.

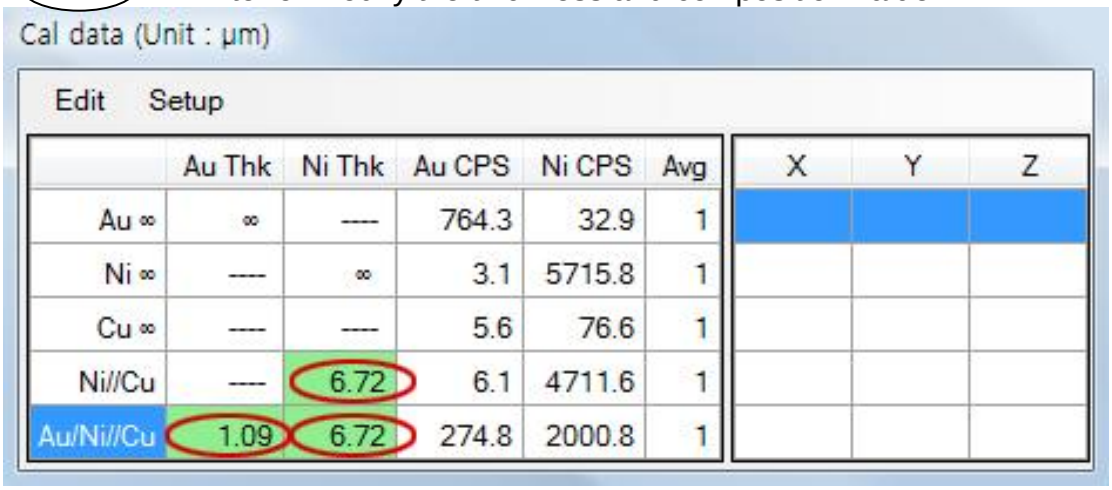


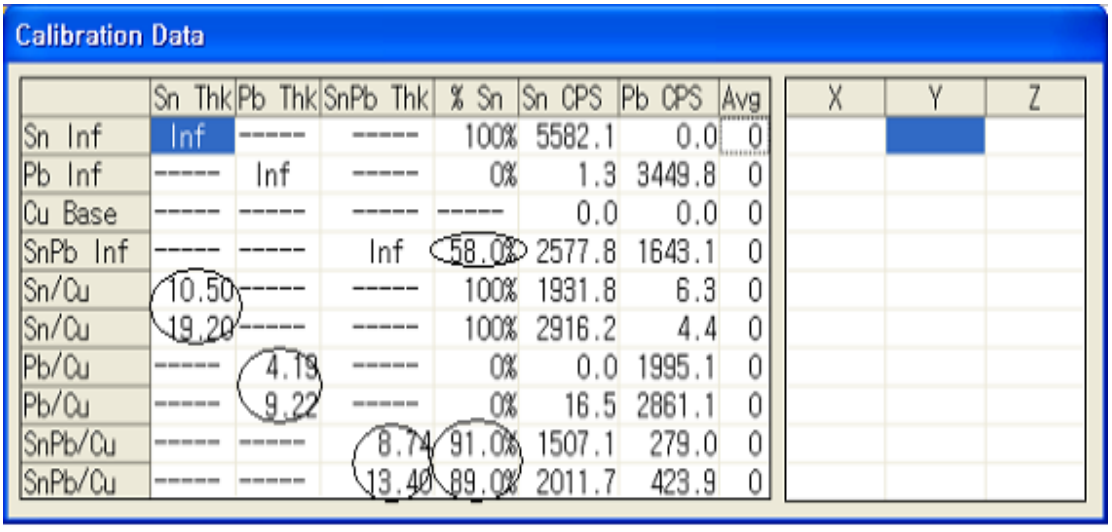
Load reference standard and click start.



Example of Calibration

: Enter or modify the thickness and composition value.

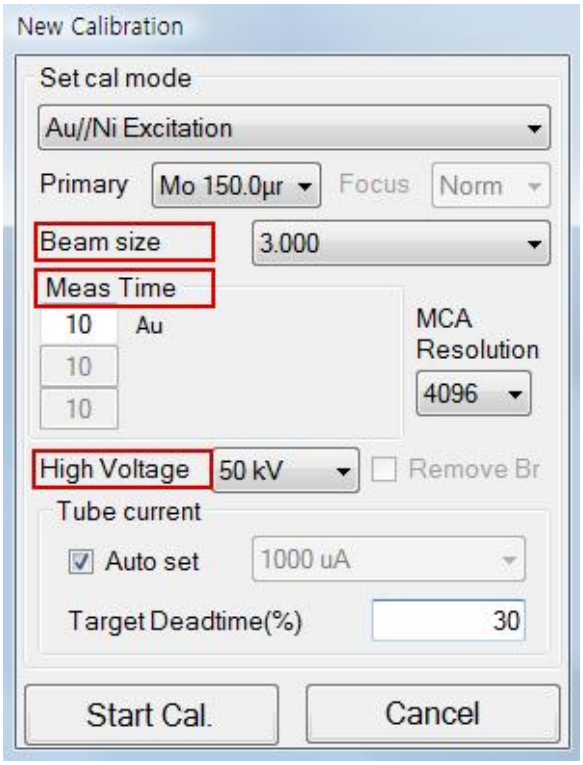




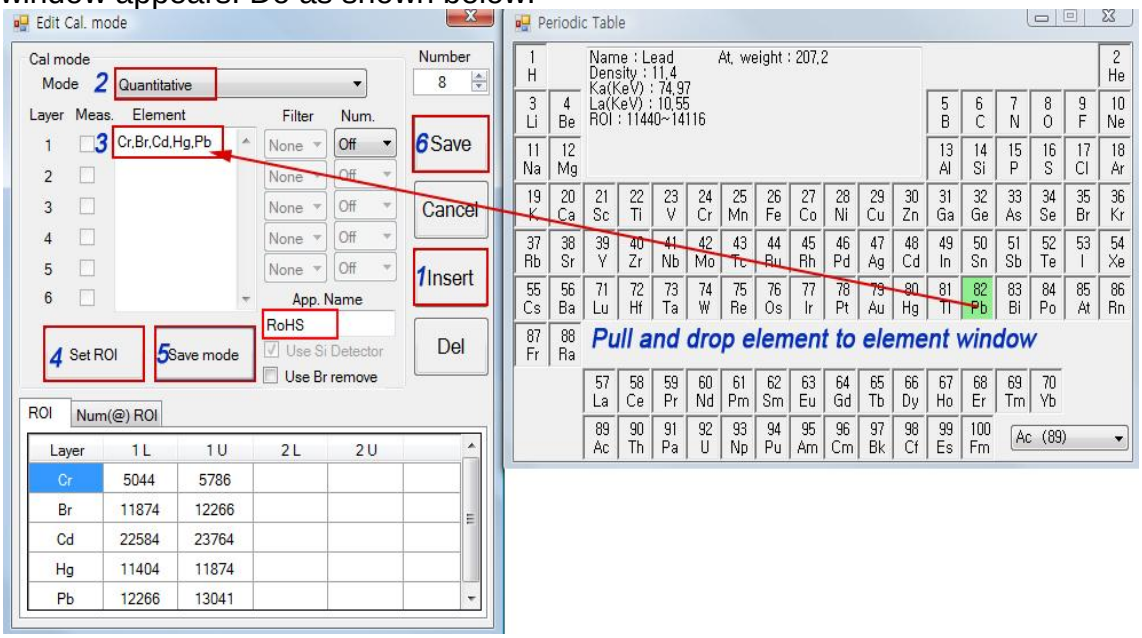
Save new calibration.

4.15..2 Quantitative Calibration

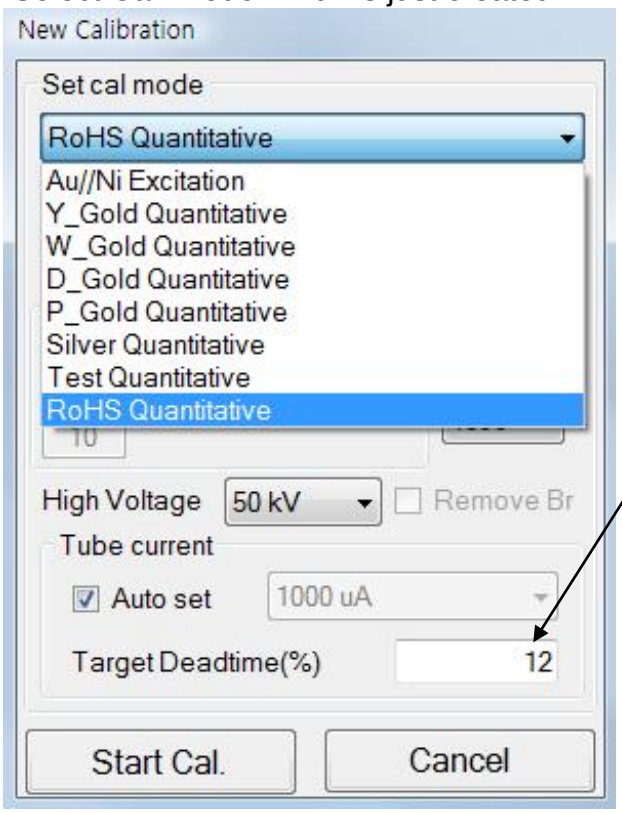
Click  icon for new calibration (ex: RoHs Plastic)



Double Click on Beam size, Meas Time and High Voltage, then Edit Cal. Mode window appears. Do as shown below.

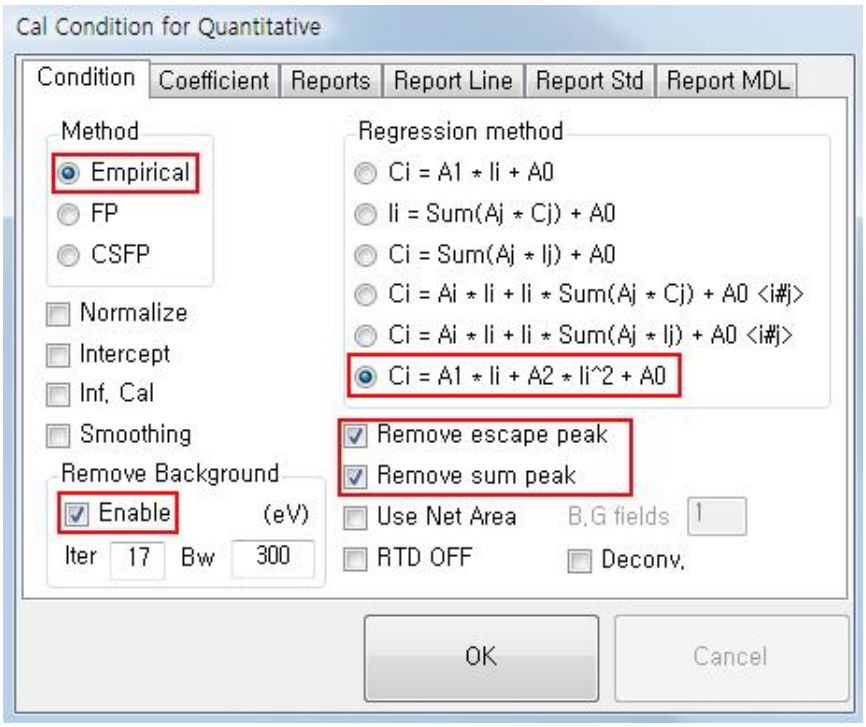


Select Cal. Mode which is just created.



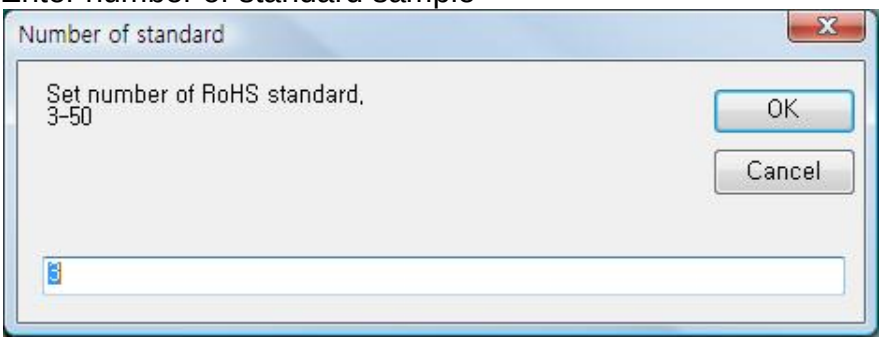
Target Dead time is 5% for Proportional Counter, 30% for PIN Diode detector.

Click Start Cal. And check as below.

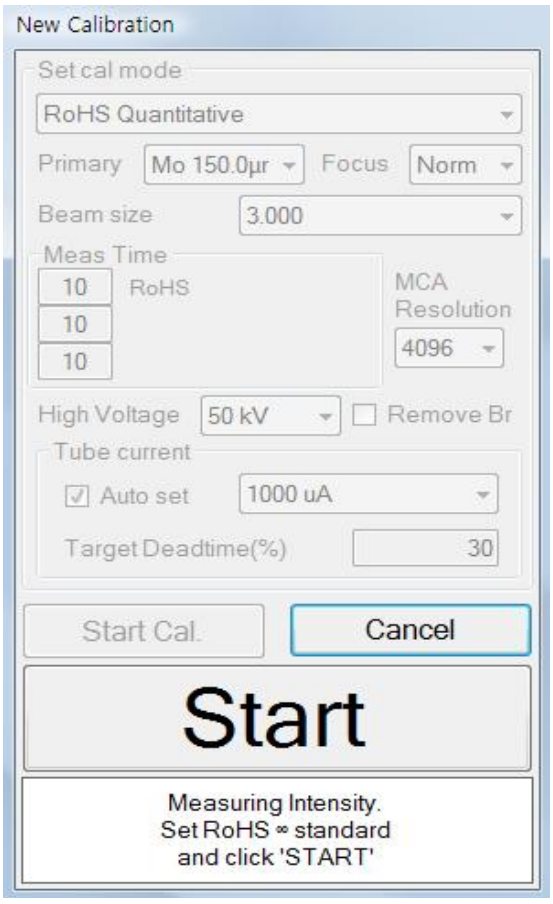


Click OK.

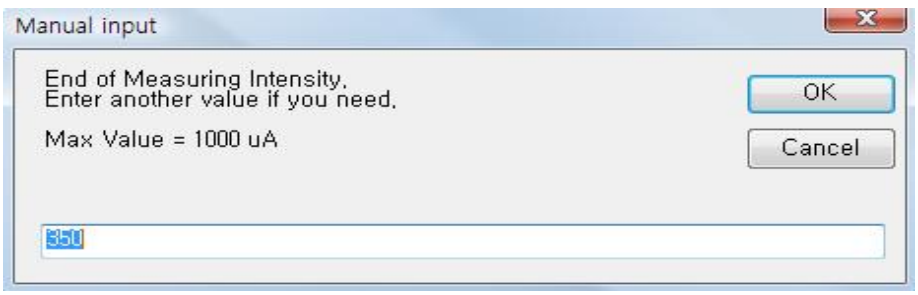
Enter number of standard sample



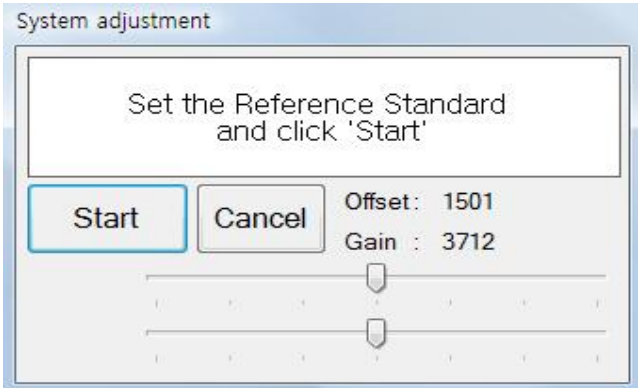
Using around middle concentration of standard, get tube current by clicking Start.



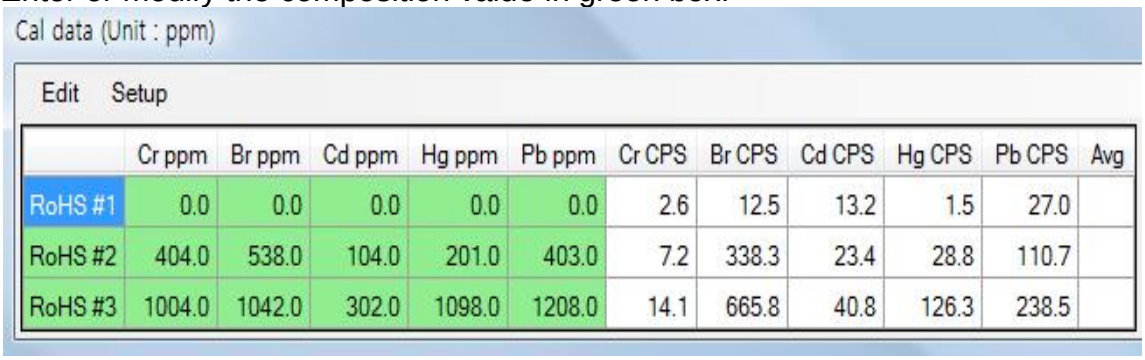
Click OK to accept tube current.



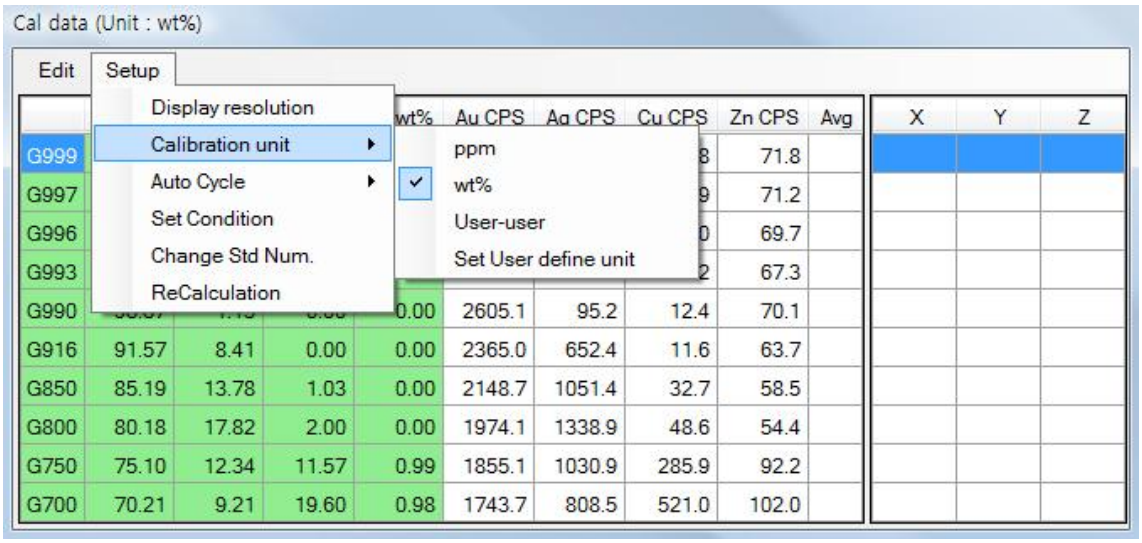
Load reference standard and click start.



Example of Calibration
Enter or modify the composition value in green box.



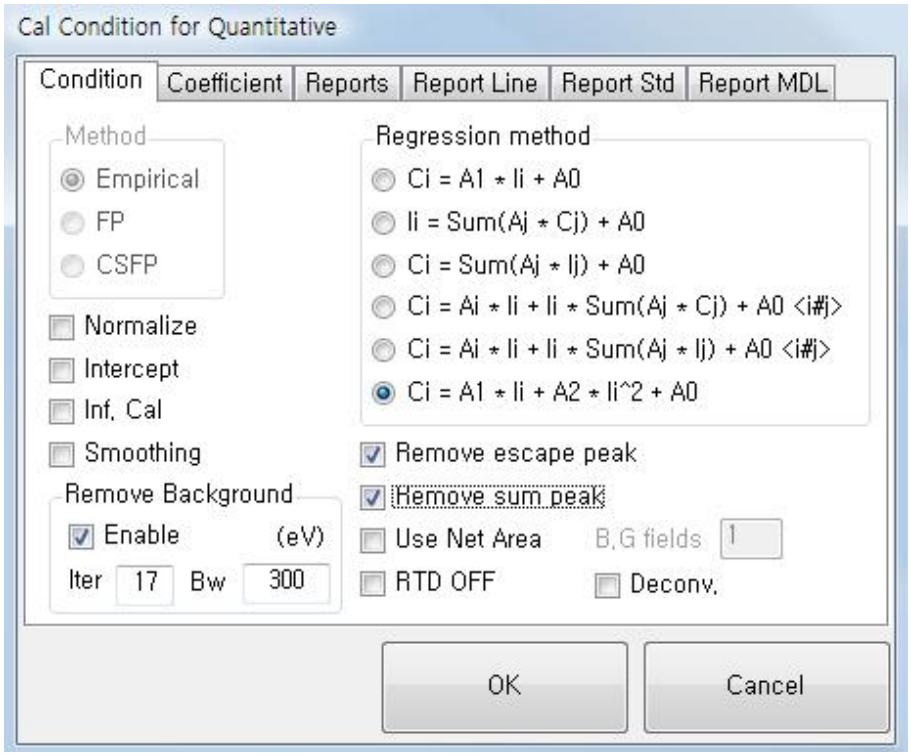
	Cr ppm	Br ppm	Cd ppm	Hg ppm	Pb ppm	Cr CPS	Br CPS	Cd CPS	Hg CPS	Pb CPS	Avg
RoHS #1	0.0	0.0	0.0	0.0	0.0	2.6	12.5	13.2	1.5	27.0	
RoHS #2	404.0	538.0	104.0	201.0	403.0	7.2	338.3	23.4	28.8	110.7	
RoHS #3	1004.0	1042.0	302.0	1098.0	1208.0	14.1	665.8	40.8	126.3	238.5	



				wt%	Au CPS	Ag CPS	Cu CPS	Zn CPS	Avg	X	Y	Z
G999								71.8				
G997								71.2				
G996								69.7				
G993								67.3				
G990				0.00	2605.1	95.2	12.4	70.1				
G916	91.57	8.41	0.00	0.00	2365.0	652.4	11.6	63.7				
G850	85.19	13.78	1.03	0.00	2148.7	1051.4	32.7	58.5				
G800	80.18	17.82	2.00	0.00	1974.1	1338.9	48.6	54.4				
G750	75.10	12.34	11.57	0.99	1855.1	1030.9	285.9	92.2				
G700	70.21	9.21	19.60	0.98	1743.7	808.5	521.0	102.0				

- ✓ Display Resolution: change decimal point of Thickness, Concentration and CPS.
- ✓ Calibration Unit: Select concentration unit or specify unit
- ✓ Auto Cycle: Set acquiring time and waiting time.
- ✓ Set Condition: Select calibration parameters.
- ✓ Change Std. Num.: Add or delete standard.
- ✓ Recalculation: Recalculate calibration curve.

After acquiring all standard, calibration curve must be reviewed and change calibration parameters to get a good result. Go to Setup -> Set condition in Cal data window.



- ✓ Method: Select Empirical or FP- The unknown sample spectrum is compared to that of standards and the spectrum most similar is used for estimating the unknown sample's composition. Empirical models are applied where the coefficient matrix {Aij} is determined by regression analysis using a set of standard samples with known composition.

- ✓ Normalize: Select if total concentration is 100%
- ✓ Remove Background: Select If peak of element is not stand alone.
- ✓ Regression Method: select one of 6 equations.

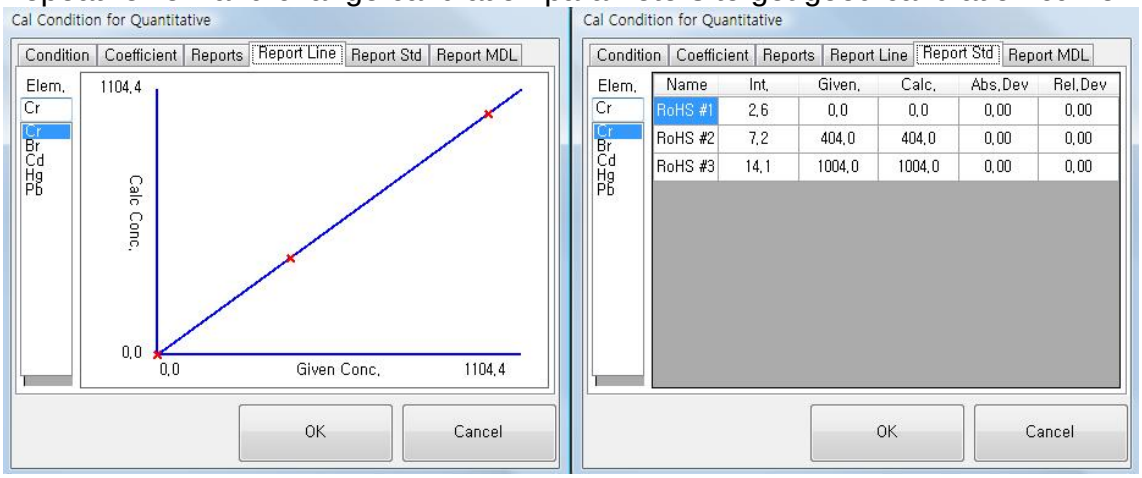
#1: Ci = Ai * Ii.+ Ao
#2: Ii = Sum (Aj*Cj)+ Ao
#3: Ci = Sum (Aij*Ij)+ Ao
#4: Ci = Ai*Ii + Ii*Sum (Aj*Cj)+ Ao(i#j)
#5: Ci = Ai*Ii + Ii*Sum (Aj*Ij)+ Ao (i#j)
#6: Ci = A_1Ii + A_2 Ii^2 +Ao

- ✓ Remove escape peak: Escape Peaks appearing as a result of the SiK radiation escaping from the Si detector, can be removed by enabling this selection.

- ✓ Remove sum peak: Sum, or pileup, peaks arise because two incoming x rays arrive at the pulse processor (amplifier) within a time frame that is less than the fast discriminator can detect the peak from the first event. This results in peaks that have energies with the sum of the two incoming x-ray events. For example, two incoming Fe-Kα photons (each with an energy of 6.4 keV), which pileup, would produce a count at 12.8 keV. This can be removed by enabling this selection.

- ✓ RTD OFF: RTD (Rise Time Discriminator) circuit has been implemented in the preamplifier. When RTD is active (RTD OFF is not checked), the shaped pulses are internally gated and only pulses corresponding to “good” X-ray events are allowed to be sent to the MCA for analysis. The RTD internal threshold is set to about 2 KeV. If energies less than 2 KeV are to be detected use RTD OFF function.

Repeat review and change calibration parameters to get good calibration curve.

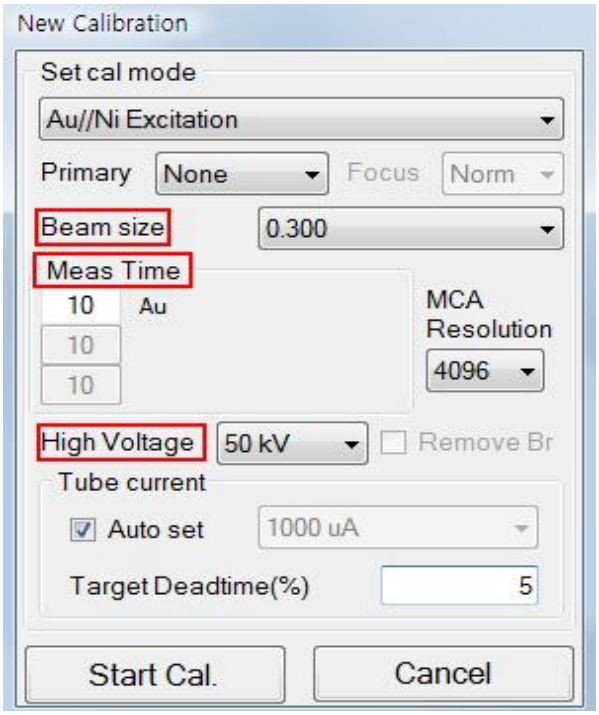


Regression Condition window

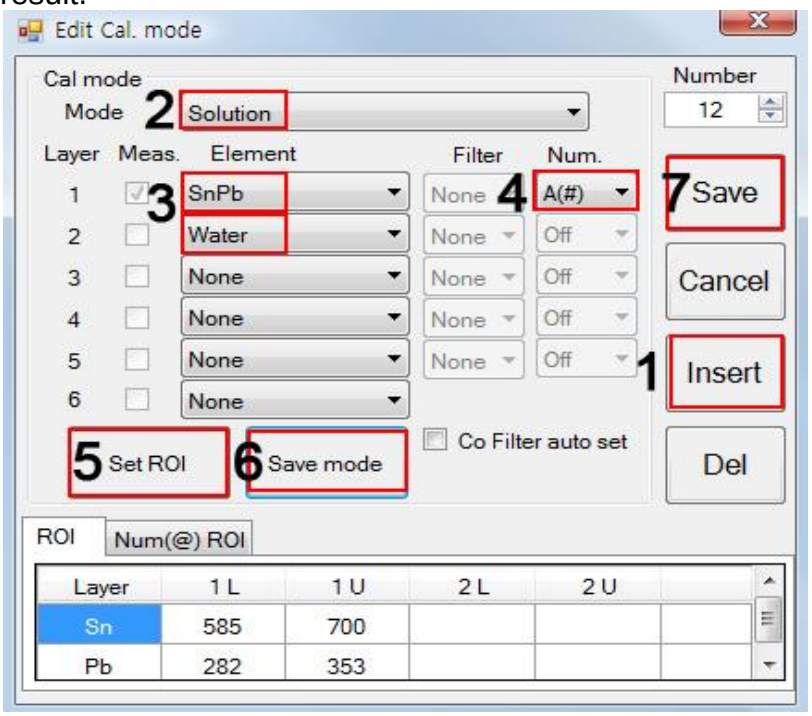
In addition to graphic displays of the results, a detailed numeric report of the analysis results is provided by the Cal Condition window. It includes the regression coefficients and indices, the given and calculated concentration of each standard, and the absolute and relative difference between the given and calculated concentrations. In Report Line tab, the horizontal coordinate represents the specified concentration of the standard as input in the Cal data window; the vertical coordinate represents the calculated concentration as calculated by the regression model.

4.15.3 Plating Bath Calibration

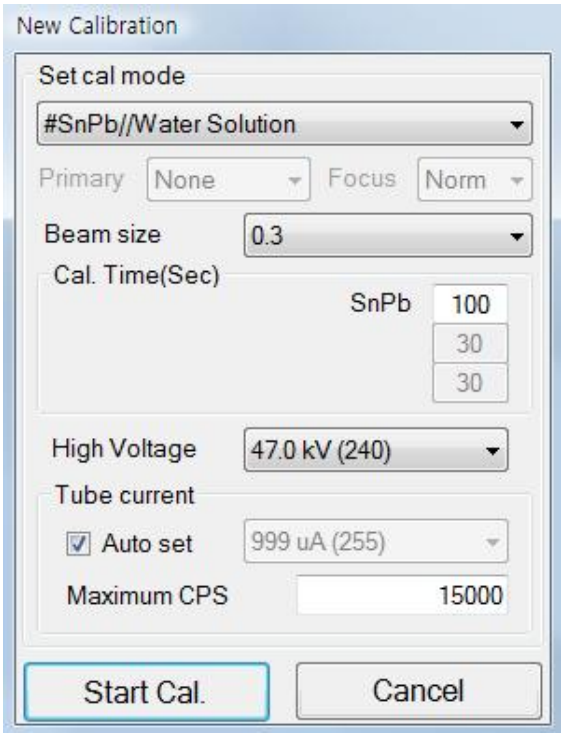
Click  icon for new calibration on the tool bar (ex: Sn-Pb content in plating bath)



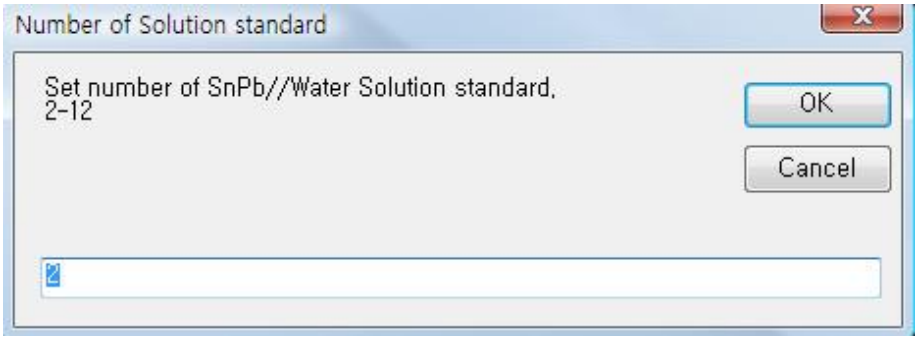
Double Click on Beam size, Meas Time and High Voltage, then Edit Cal. Mode window appears. Do as shown below. Try to change numerical filter to get better result.



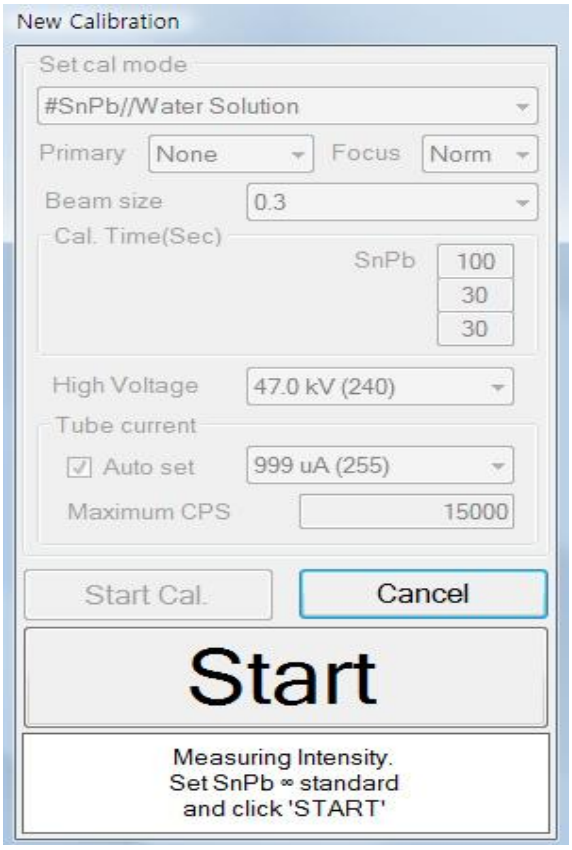
Select Cal. Mode which is just created. Select biggest collimator and set measuring time as 100 sec. High Voltage must be adjusted regarding measuring element.
Ex) ZnNi = 35KV, SnPb = 47KV



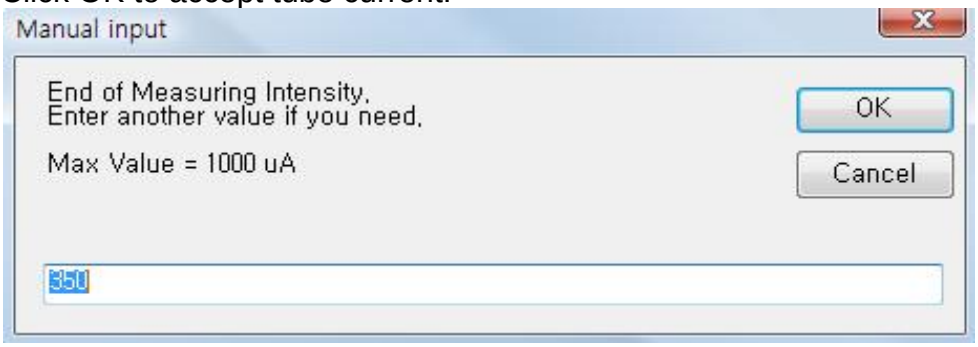
New calibration will use pre-defined cal mode. Click Start Cal. button, and enter number of solution standard.



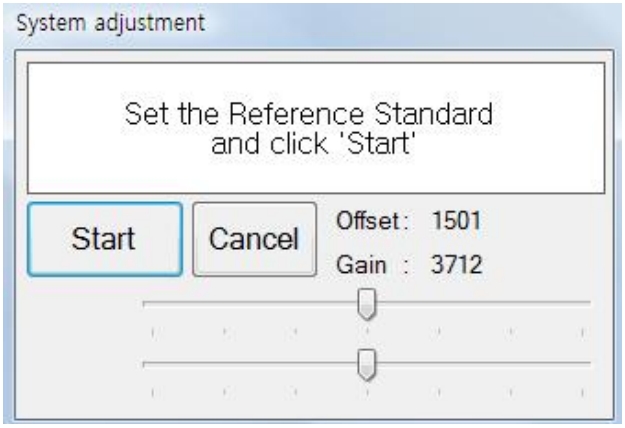
Follow the message on New Calibration Window.
Load SnPb infinity, Sn infinity, Pb infinity and general water in sample cup and click start step by step.



Click OK to accept tube current.

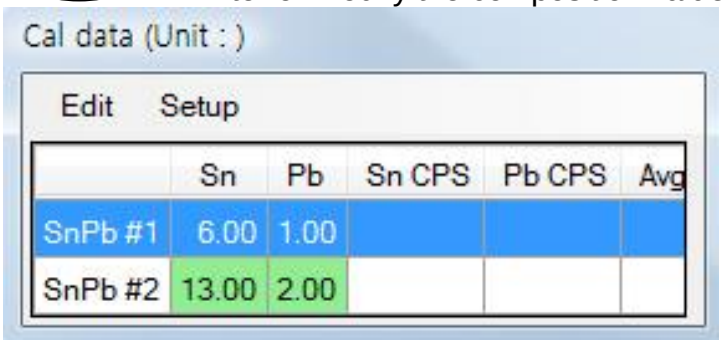


Load reference standard and click start.

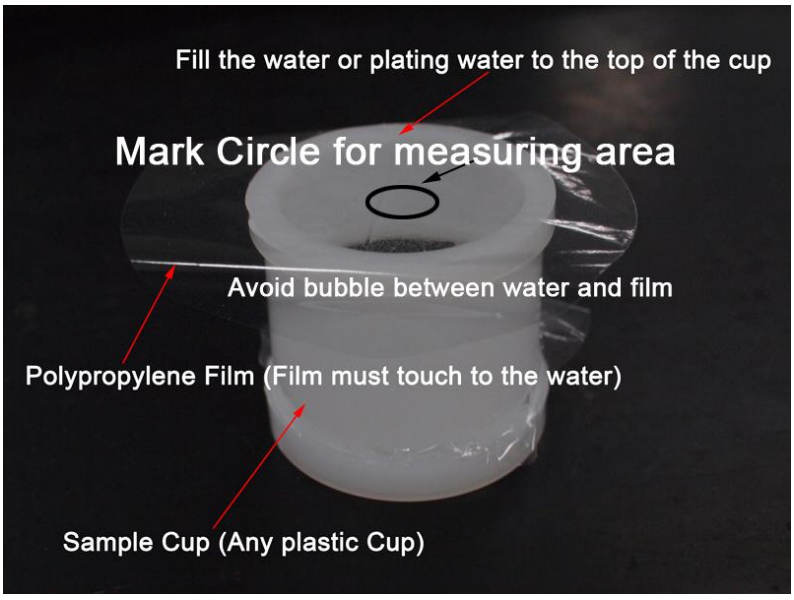


Example of Calibration

: Enter or modify the composition value.



Prepare Plating water standards as follows (Example). Plating water standards must be measured by AAS to verify its concentration.
SnPb #1 = Sn 6g/L+Pb 1g/L
SnPb #2 = Sn 13g/L+Pb 2g/L



Sample Cup preparation (Substitution)

4.16 System Adjustment Window

4.16.3 General

System Adjust is for positioning to the right energy location of the known peaks in KeV using Reference Standard which is contained Cu and Sn.

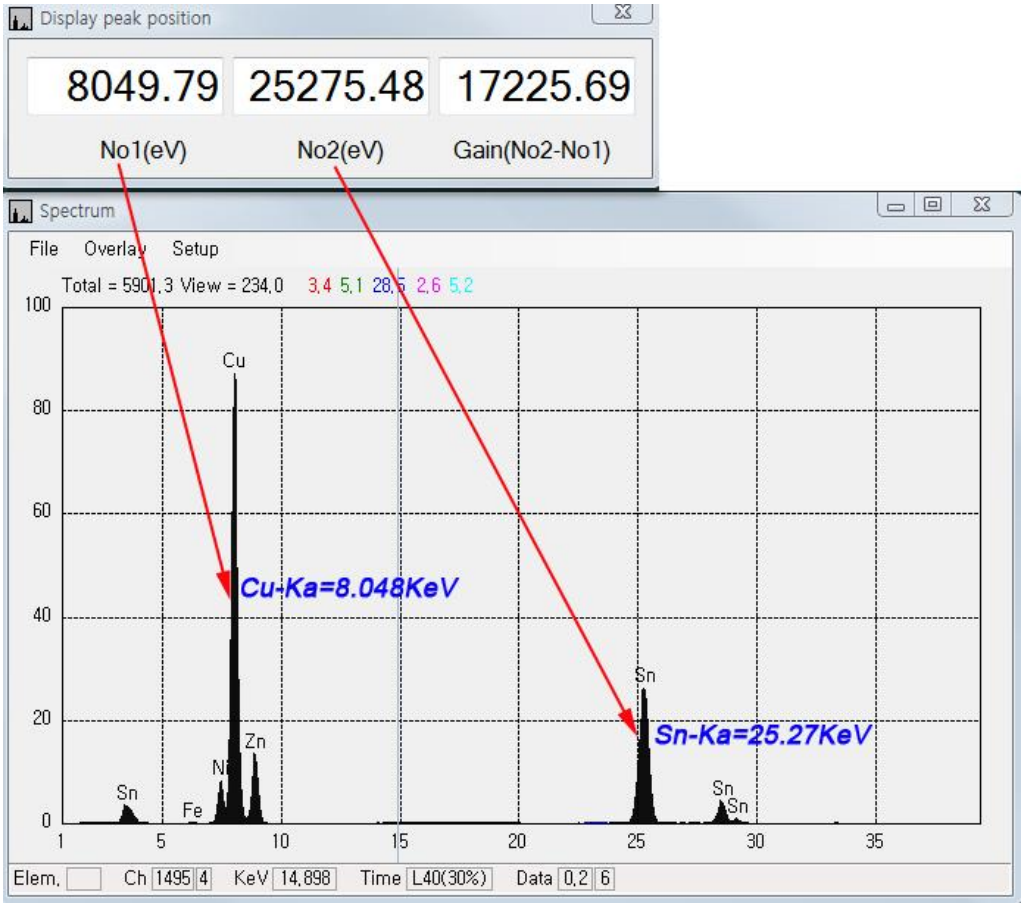
Load Reference standard on the stage and adjust XY & focus. Click 'START' button to adjust.

System will turn on X-Ray several times and adjust the value of the Offset and Gain automatically to find proper position for Cu and Sn peaks.

4.16.4 Concept of the system adjust

Reference Standard contains two elements, Cu and Sn. The energy of the Cu is 8.048Kev and Sn is 25.27 KeV.

A good example of the System Adjust likes the following figure.



To display Peak Information, place cursor on the Spectrum Screen then press Alt+P simultaneously.

4.17  Focus Laser

On/Off Focus Laser.

4.18  Lamp
On/Off Lamp for Camera.

4.19  Set Y Stage Auto Move
Analysis position moves to near door side when cover is opened and moves to analysis position automatically when cover is closed.

4.20  Auto Cycle Measurement
Enable statistical Measurement.

4.21  Auto Cycle Number
Enter Number of Analysis for Auto Cycle Measurement.

5. **How to Measure**

5.1 Loading Sample

- Open the door. The stage will move forward when 'Push Pull' () function is ON.
- Load sample at laser beam position on the stage.
- Close the door. The stage will move backward.
- Adjust the sample by using stage control window.

5.2 Adjust Focus

- Adjust Focus laser to vertical scale line.

5.3 Select Cal File and Click Start Button.

6. Maintenance

Following these maintenance steps will insure normal and reliable operation of the system. This maintenance is intended to be performed by the operator.

1) Fan Filters
Once a month clean the cabinet fan filter.

2) Sample Chamber
The stage might have a problem if the chamber is not clean, especially if volatile liquid or porous materials contaminate it. In a dirty chamber, there always exists the risk that some particles or liquid will accumulate on the surface of the thin Be window.

3) Si PIN Detector
The detector window is made of Beryllium foil, only 12.5 microns thick. Beryllium is a very corrosive element: water and many other liquids and particles can interact with it and generate pinholes within a short period. The result is loss of the vacuum in the detector cryostat.

4) Follow the maintenance instructions in the computer's manual to assure its proper operation.

7. Troubleshooting

This sub-section offers assistance in correctly diagnosing and possibly correcting common problems. Emphasis has been put on problems that arise from incorrect operation or settings, or other difficulties that can easily be corrected by simple means. In general, only trained service personnel must solve hardware problems.

Warning:

Do not attempt to repair the system on your own. Consult your service agent before trying to repair any hardware failures.

An accurate description of the problem is essential for the effective assistance from the service department. When dealing with a problem related to operation or analysis results, the most effective initial step is to relate the problem to one of the following main categories:

1. Hardware or software
2. Method and/or data associated with problem
3. Operator/Operation

Any connection between the problem and an action preceding it or an environmental cause may help in the identification of the problem's source.

A further aid is to define the problem nature by the following criteria:

1. **Is the problem always the same?**
2. **Does the problem appear at regular intervals or random intervals?**

The correct answers to many of the questions suggested above may not be an easy task, although the solution to many may be very simple.

The XRF-2000 constantly monitor the major signals and component operations in the system. Many problems, usually hardware and operation-related are

- **No System Response**

When the system has no response massage,

1. The USB communication cable on the computer side is not connected or the connector is bad.
2. Turn off the system and turn it on after 5 second.
3. Check Power on Lamp on the main switch. If power on lamp is not illuminate, check the main fuse on rear side of system.

- **Peaks Not in the Correct Position**

The proper way to verify energy calibration is to perform system adjustment as described in Chapter 4.16. Common reasons for peak shifts are:

- Cabinet heat-up due to dust in the filter or faulty fans.
- Big environment temperature change

- **No X-rays**

X-rays generation is off in the following reasons:

- Sample chamber cover open, or not fully closed.
- Acquisition is completed.

X-ray Tube Related Problems

High Voltage breakdowns are identified by sudden changes in the HV and tube current readings on monitoring in the software.

- **X-ray Tube Oil**

Routinely check for oil leakage from the x-ray tube housing and inside chamber. If a leak is noted, discontinue operation immediately and contact your service engineer.

Warning:

The insulating oil is processed in the factory to attain high dielectric strength. Please consult with the service agent before attempting to add or replace the oil.

Appendix

A. X-RAY FLUORESCENCE (XRF)

When a primary x-ray excitation source from an x-ray tube or a radioactive source strikes a sample, the x-ray can either be absorbed by the atom or scattered through the material. The process in which an x-ray is absorbed by the atom by transferring all of its energy to an innermost electron is called the “photoelectric effect.” During this process, if the primary x-ray had sufficient energy, electrons are ejected from the inner shells, creating vacancies. These vacancies present an unstable condition for the atom.

As the atom returns to its stable condition, electrons from the outer shells are transferred to the inner shells and in the process giving off a characteristic x-ray whose energy is the difference between the two binding energies of the corresponding shells. The emitted x-rays produced from this process are called “X-ray Fluorescence,” or XRF. The process of detecting and analyzing the emitted x-rays is called “X-ray Fluorescence Analysis.” In most cases the innermost K and L shells are involved in XRF detection.
A typical x-ray spectrum from an irradiated sample will display multiple peaks of different intensities.

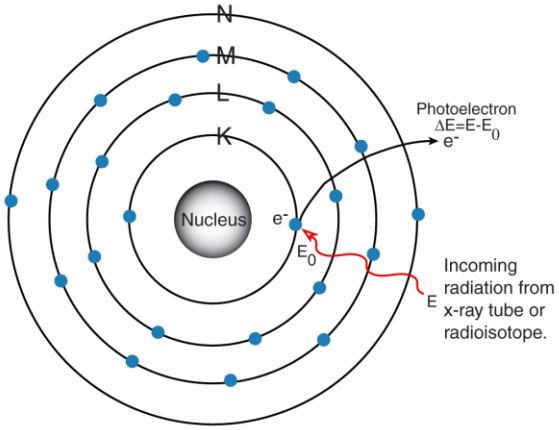
The characteristic x-rays are labeled as K, L, M or N to denote the shells they originated from.
Another designation alpha (α), beta (β) or gamma (γ) is made to mark the x-rays that originated from the transitions of electrons from higher shells. Hence, a Kα x-ray is produced from a transition of an electron from the L to the K shell, and a Kβ x-ray is produced from a transition of an electron from the M to a K shell, etc. Since within the shells there are multiple orbits of higher and lower binding energy electrons, a further designation is made as α1, α2 or β1, β2, etc. to denote transitions of electrons from these orbits into the same lower shell.

The XRF method is widely used to measure the elemental composition of materials. Since this method is fast and non-destructive to the sample, it is the method of choice for field applications and industrial production for control of materials. Depending on the application, XRF can be produced by using not only x-rays but also other primary excitation sources like alpha particles, protons or high energy electron beams.

Sometimes, as the atom returns to its stable condition, instead of emitting a characteristic x-ray it transfers the excitation energy directly to one of the outer electrons, causing it to be ejected from the atom. The ejected electron is called an “Auger” electron. This process is a competing process to the XRF. Auger electrons are more probable in the low Z elements than in the high Z elements.

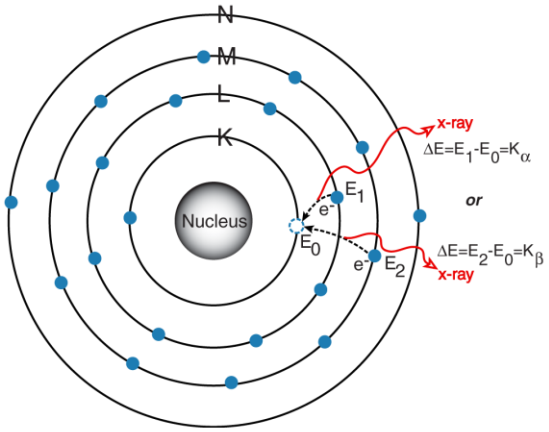
The X-Ray Fluorescence Process

Example: Titanium Atom (Ti = 22)



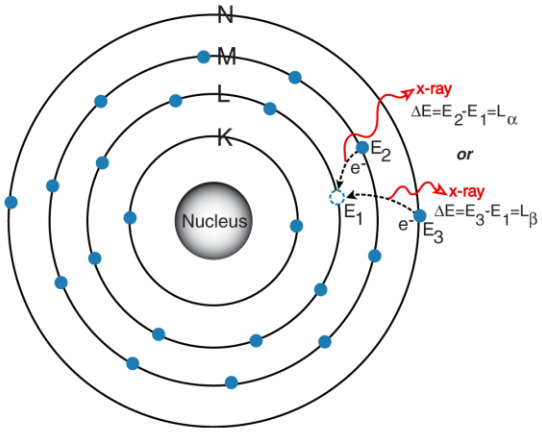
1) An electron in the K shell is ejected from the atom by an external primary excitation x-ray, creating a vacancy.

The K Lines

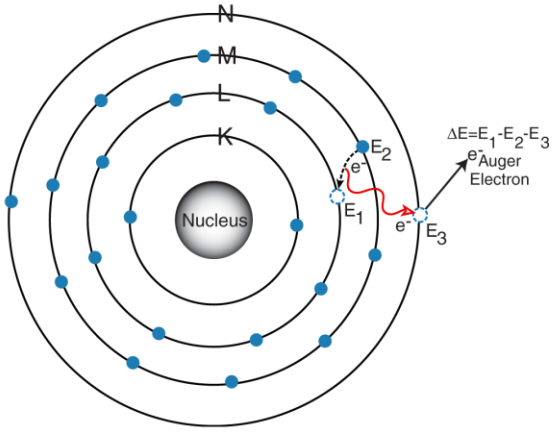


2) An electron from the L or M shell "jumps in" to fill the vacancy. In the process, it emits a characteristic x-ray unique to this element and in turn, produces a vacancy in the L or M shell.

The L Lines



3) When a vacancy is created in the L shell by either the primary excitation x-ray or by the previous event, an electron from the M or N shell "jumps in" to occupy the vacancy. In this process, it emits a characteristic x-ray unique to this element and in turn, produces a vacancy in the M or N shell.



"Auger" Electron

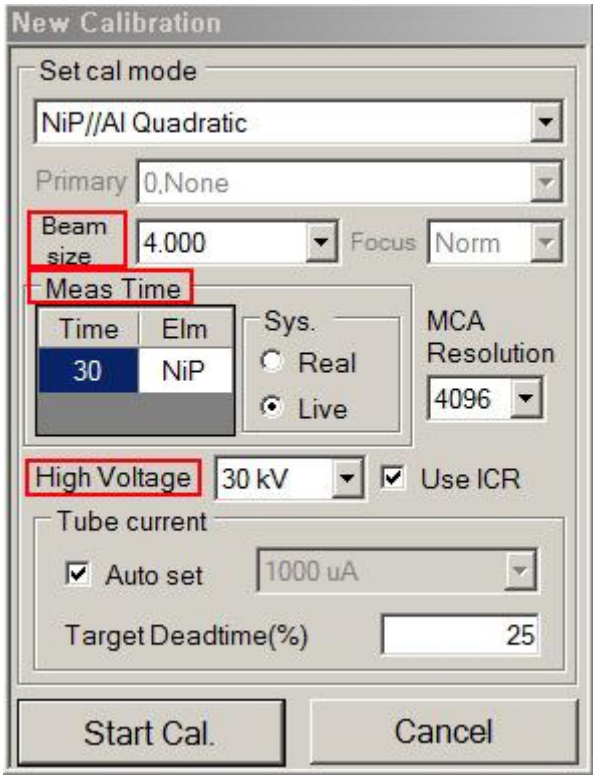
The excitation energy from the inner atom is transferred to one of the outer electrons causing it to be ejected from the atom.

Appendix B

New Calibration for Disk (V5 Version)

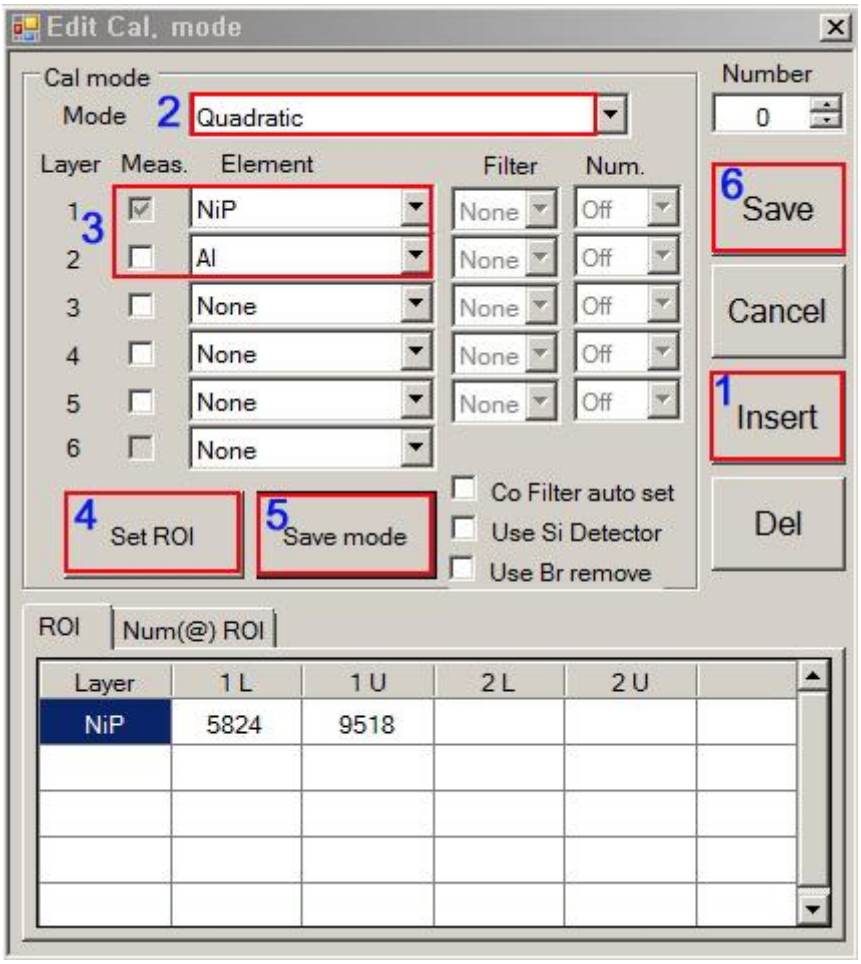
Thickness Calibration (ex: NiP//Al)

1. On Main Window, Go File → Administrator Login → “t” → Enter.
2. Click  icon for new calibration on tools Bar and set as shown below.



- ✓ Select cal mode: Select application. If not exist, Double Click on Beam size, Meas Time and High Voltage and perform step 3.
- ✓ Beam size: Select collimator size.
- ✓ Time: Set measuring Time.
- ✓ Sys: Select Live for live time regarding Dead Time.
- ✓ MCA: Select MCA channel.
- ✓ High Voltage: Set Tube high voltage for element to be analyzed. (ex-30KV for NiP)
- ✓ Use ICR: Check for background ROI.
- ✓ Tube Current: Check Auto set to get optimized TC at target Dead time.
  Target Dead time: Set 25%

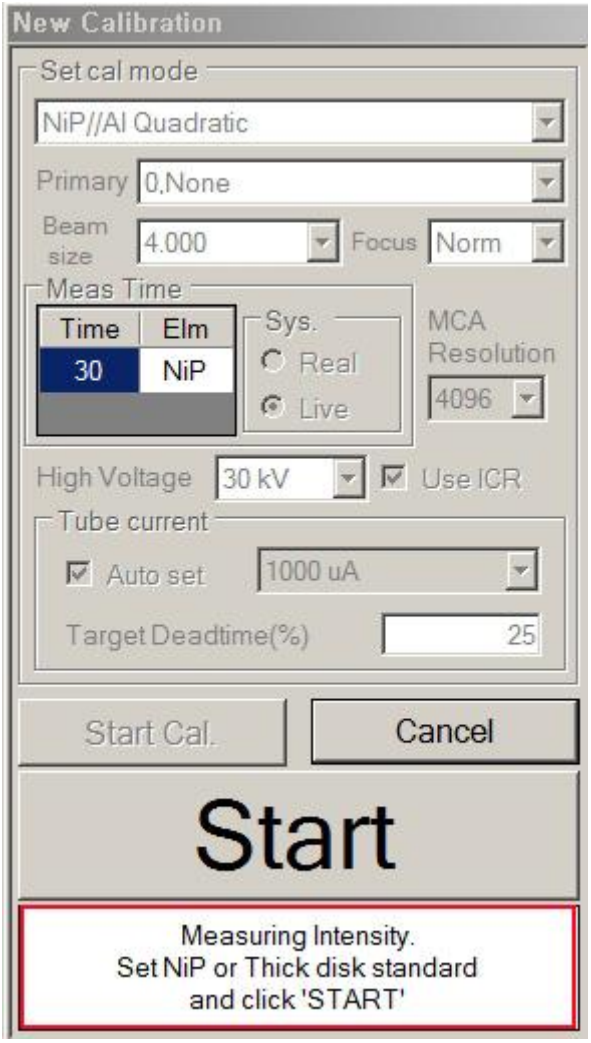
3. To create cal mode, double Click on Beam size, Meas Time and High Voltage in the new Calibration Window, then Edit Cal. Mode window appears. Set as shown below.



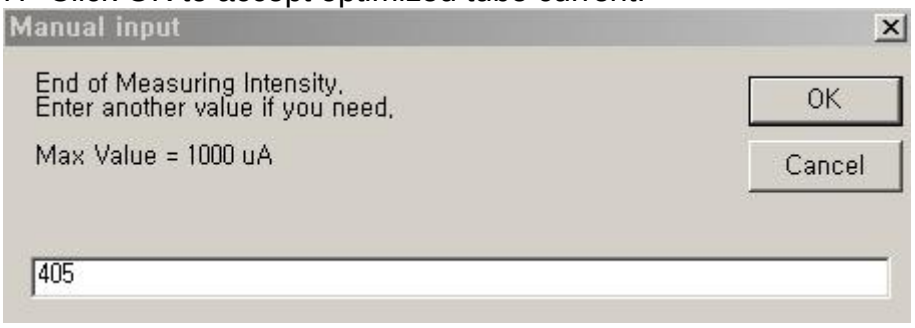
4. Click  Button in the new Calibration Window to proceed.

5. Enter number of standard foil.

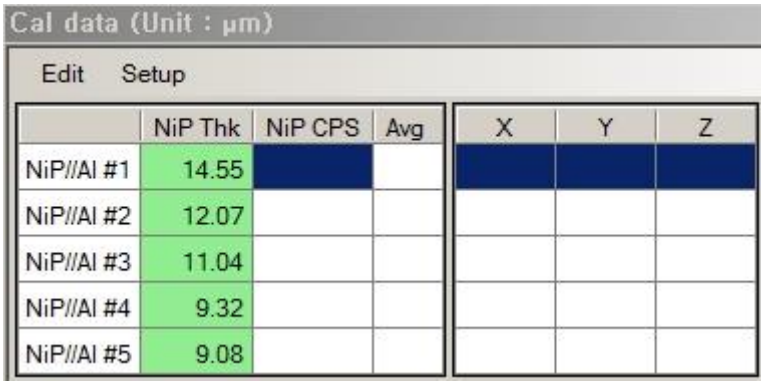
6. Follow the message in the New Calibration Window to get optimized Tube Current.

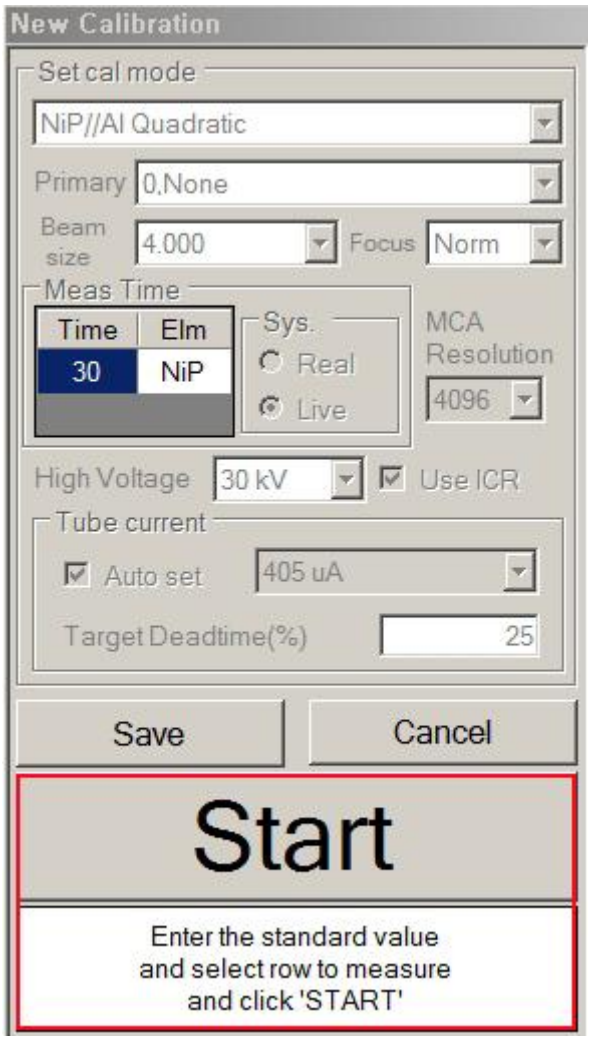


7. Click OK to accept optimized tube current.



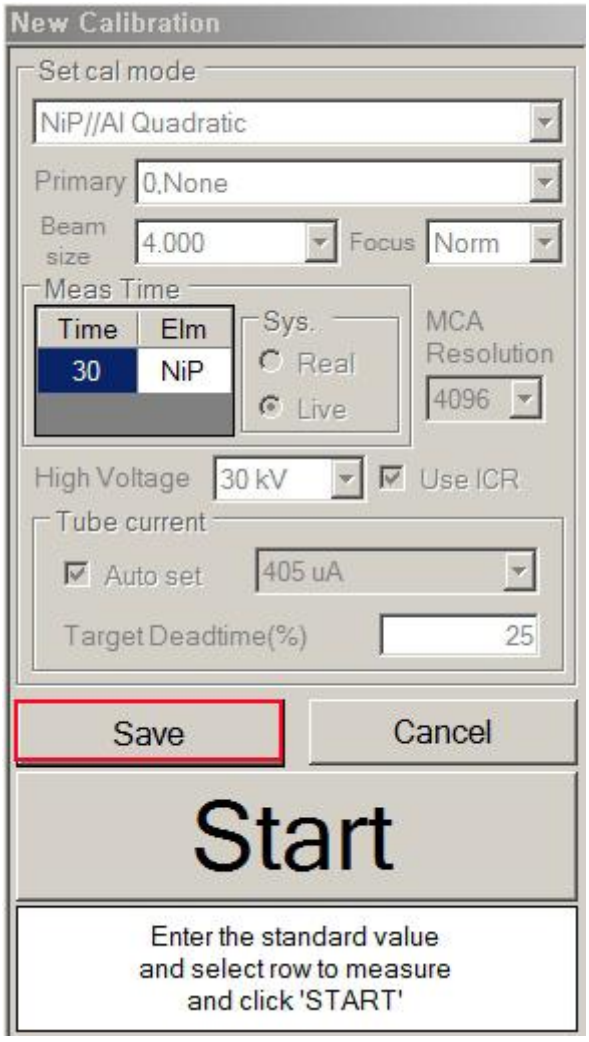
8. Enter thickness value for each standard and load standard into chamber and click Start button in the new Calibration Window.





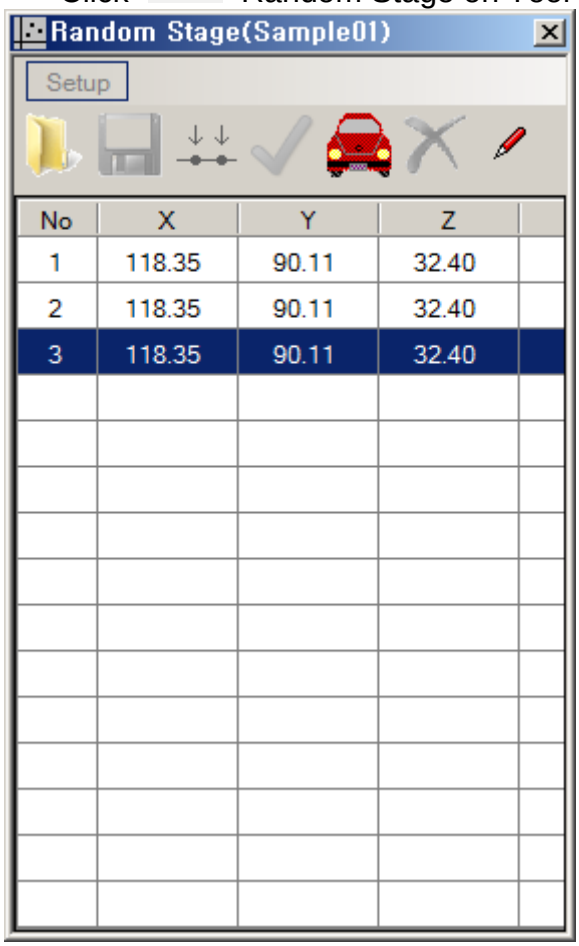
✓ Example of Calibration

9. Click Save button to save new calibration File.

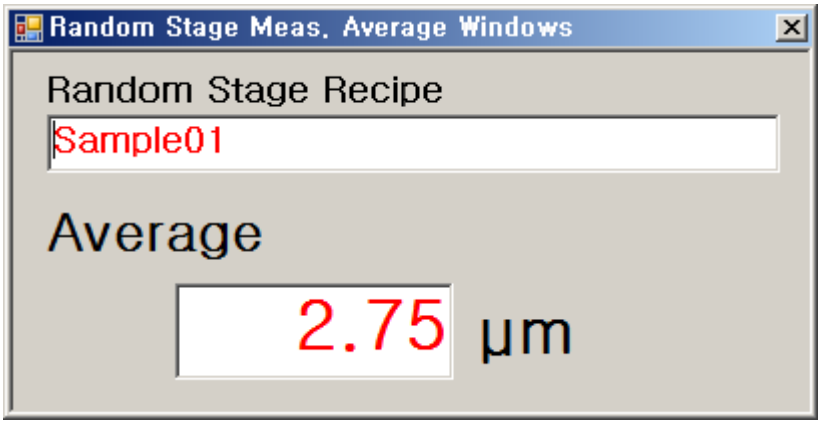


10. Using Random Stage Recipe

✓ Click  Random Stage on Tool Bar.



✓ Open position Data file.
✓ Click Pencil Icon.
✓ Click Car Icon to run.

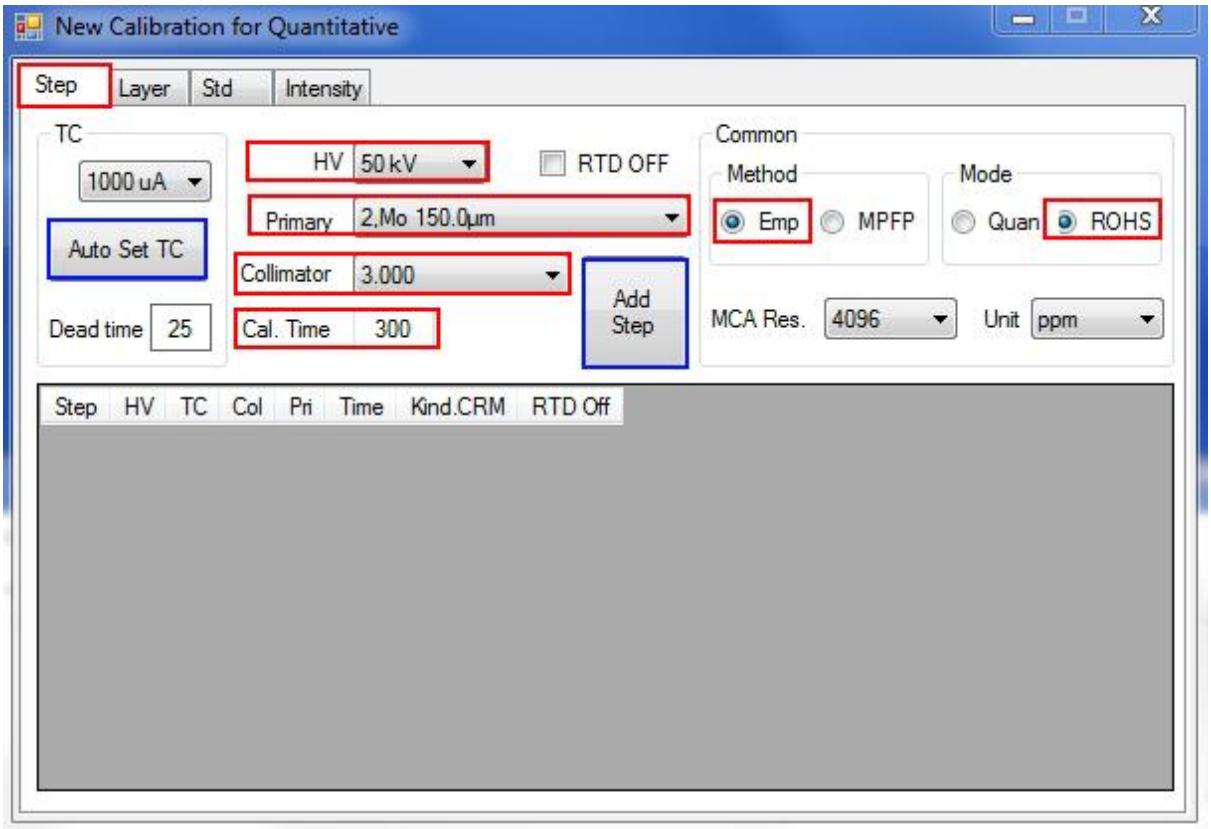


Appendix C

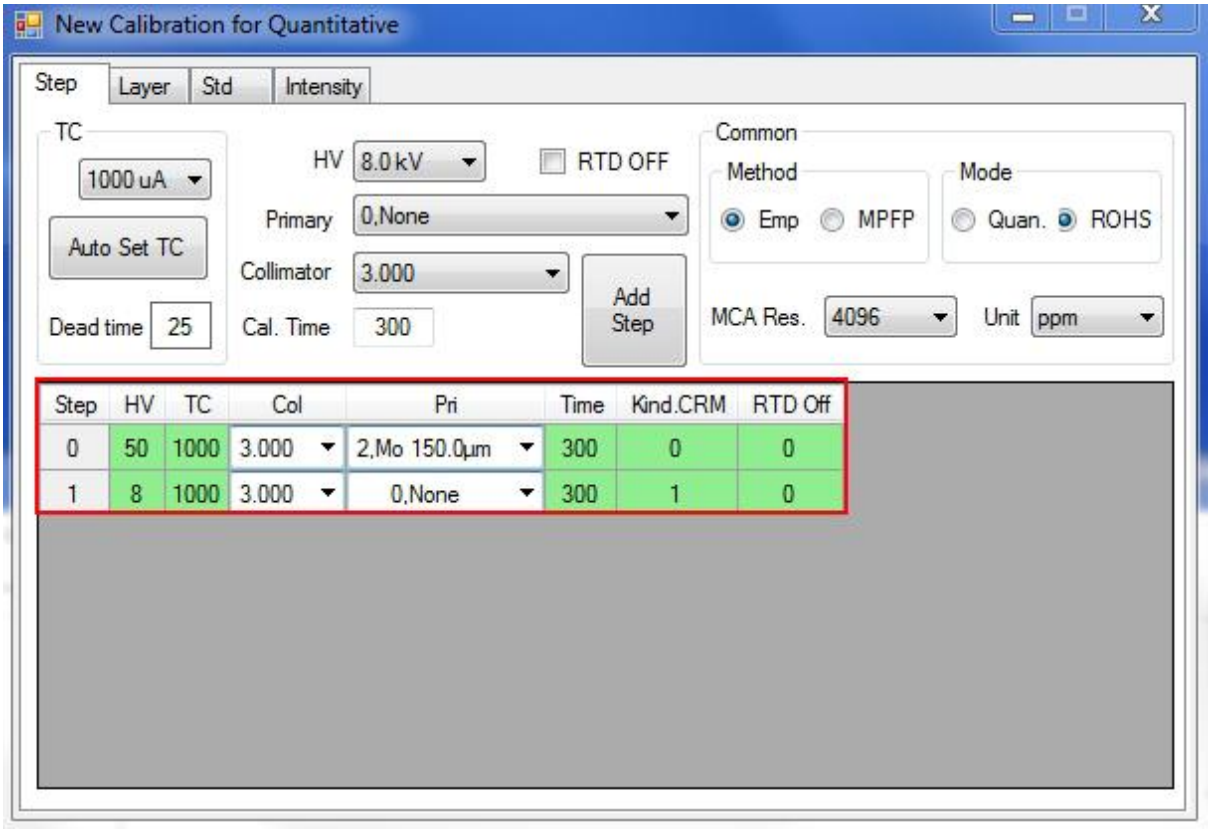
New Calibration for RoHS_Plastic

1. Step
   - Go File -> Administrator Login -> “t” -> O.K.
   - Click  icon for new calibration (ex: RoHs Plastic)

   - Set acquisition parameters as shown below.

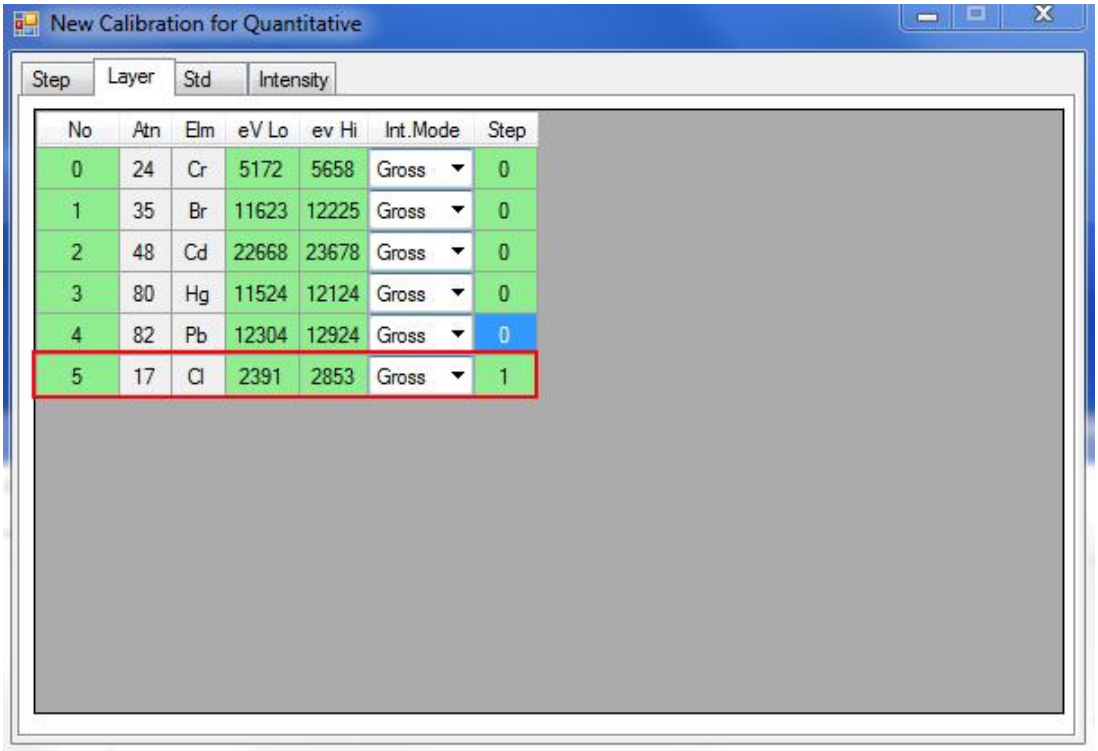


- Load middle range concentration of standard samples.
- Click Auto set TC button, then system will show you optimized TC value.
- Click Add Step button.
- If you have another standard samples such as Cl (Halogen Free) which means multi-acquisition parameters, repeat again using different acquisition parameters.
- The final settings are as follows for multi-acquisition parameters.

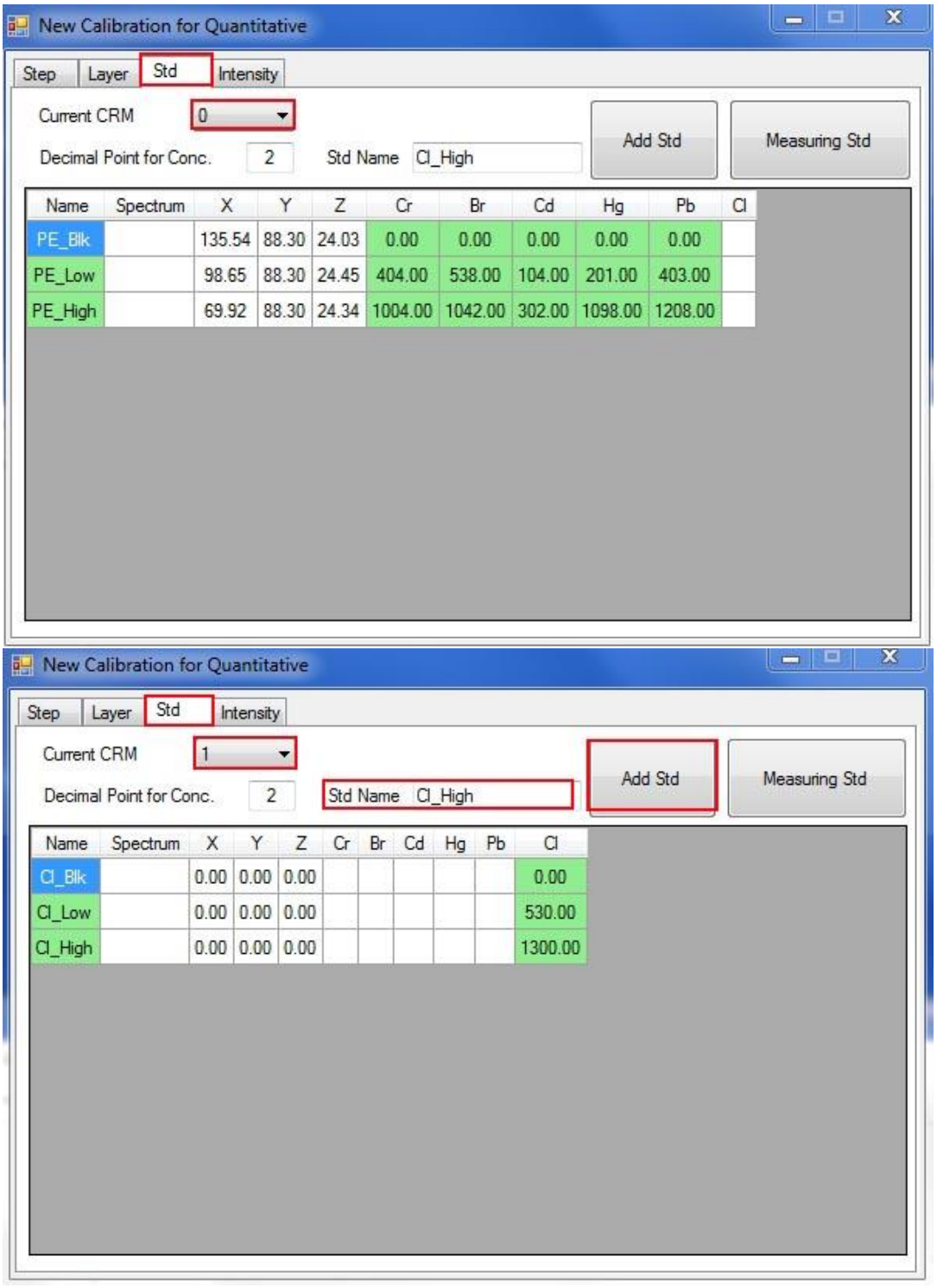


2. Layer

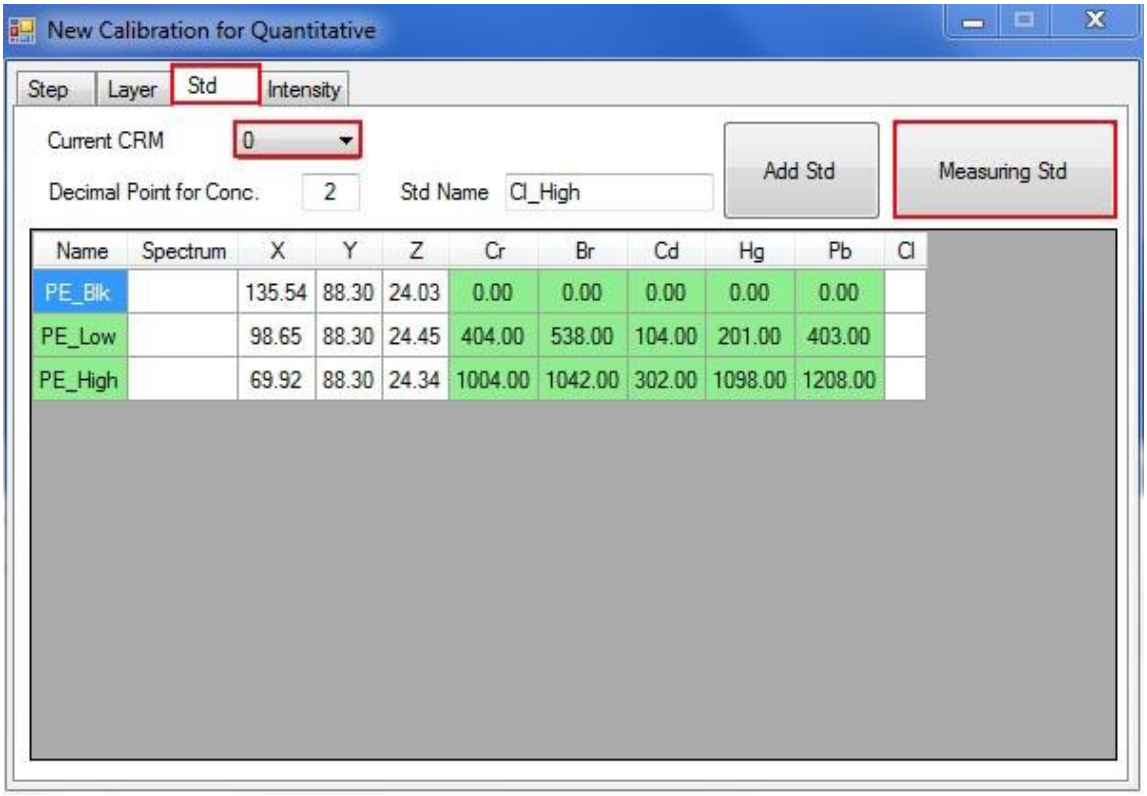
- Click periodic table on tool bar and drag element to be analyzed into layer window. The final settings are as shown bellow.



3. Std
   - Enter Standard Name for Layer 0 and Layer 1 as below.

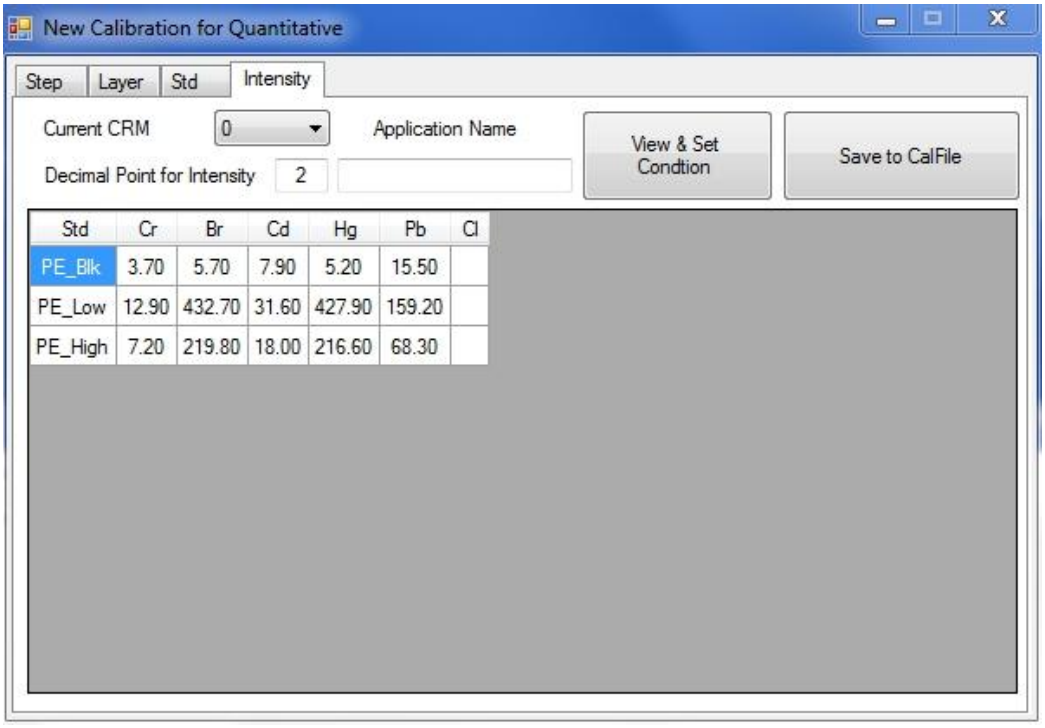


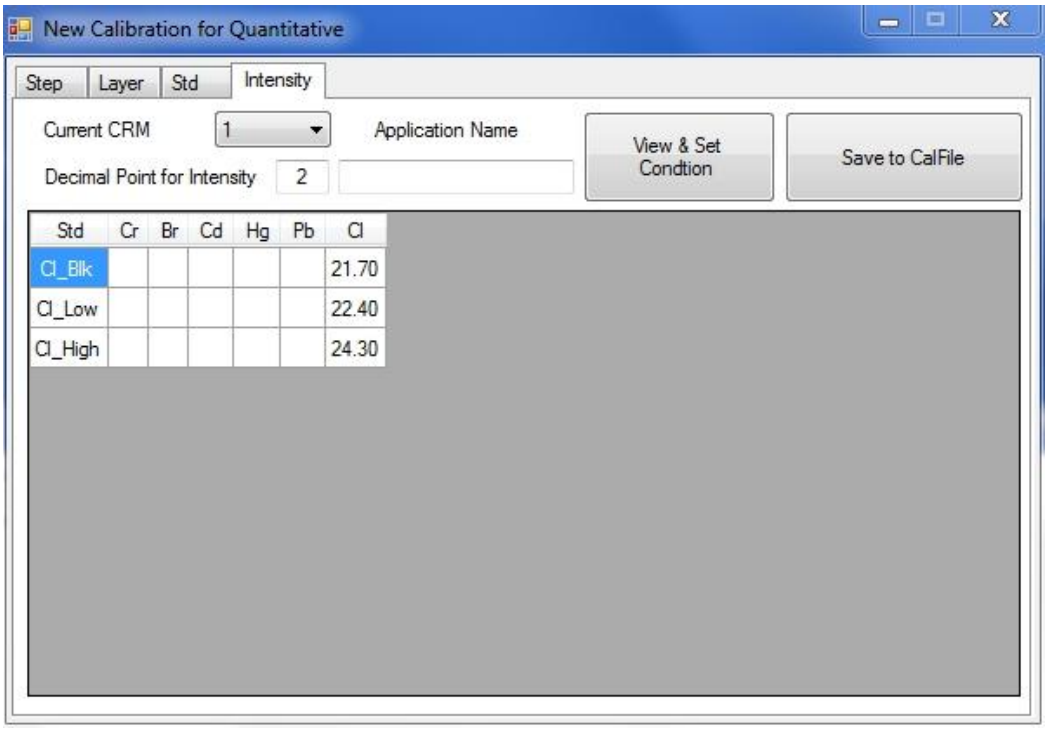
   - Click one of standard name and load standard sample in chamber the click Measuring Std.



- Repeat measuring for layer 1 as layer 0.

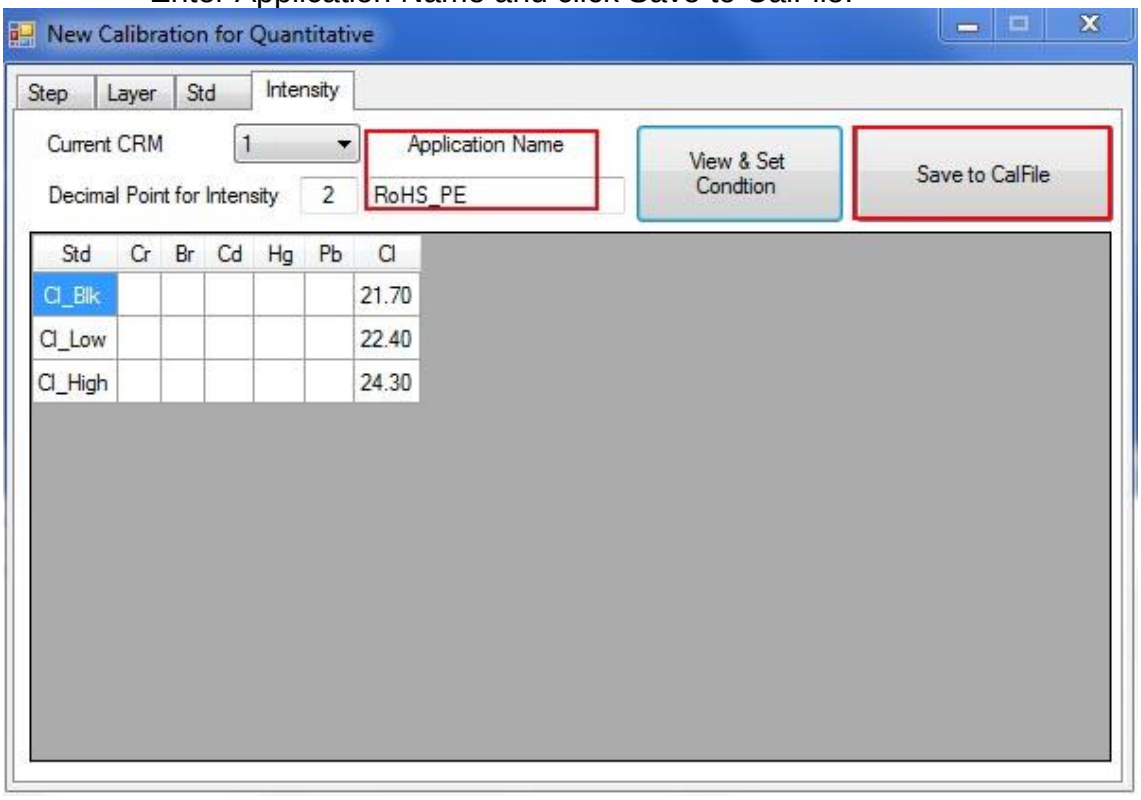
4. Intensity
   Finally check intensity for each layer as follows.





5. Save CAL File

- Enter Application Name and click Save to CalFile.



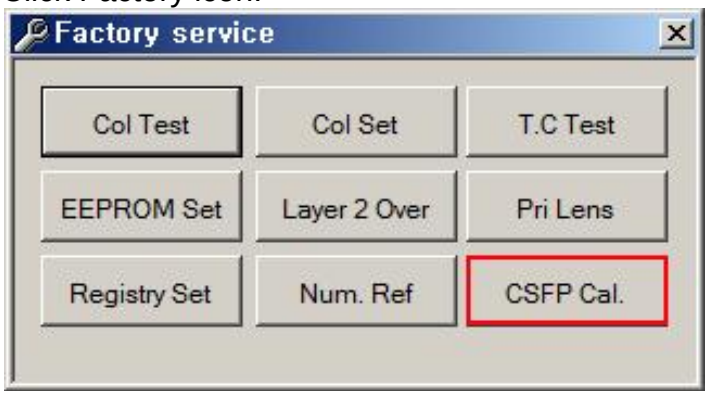
D. Calibration for CSFP

This procedure is for unsatisfied FP result or new FP calibration.

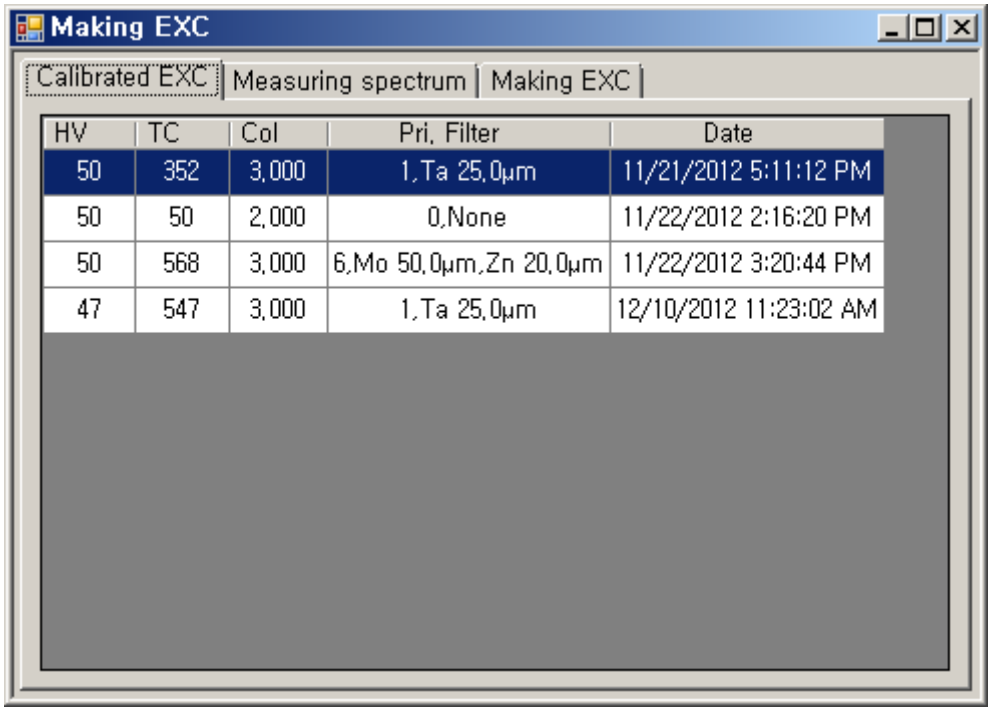
1. Login and get Factory service
   - ✓ On main window, go File -> Administrator Login -> “t” -> O.K.
   - ✓ Place cursor on Main window and click the Main window then press Alt+Ctrl+Shif simultaneously and hold these keys and type “pioneerok”. Then factory menu will appear on tool bar.

   - ✓ Perform System Adjustment (Refer to step 4.16 in Operating manual).

2. Click Factory icon.

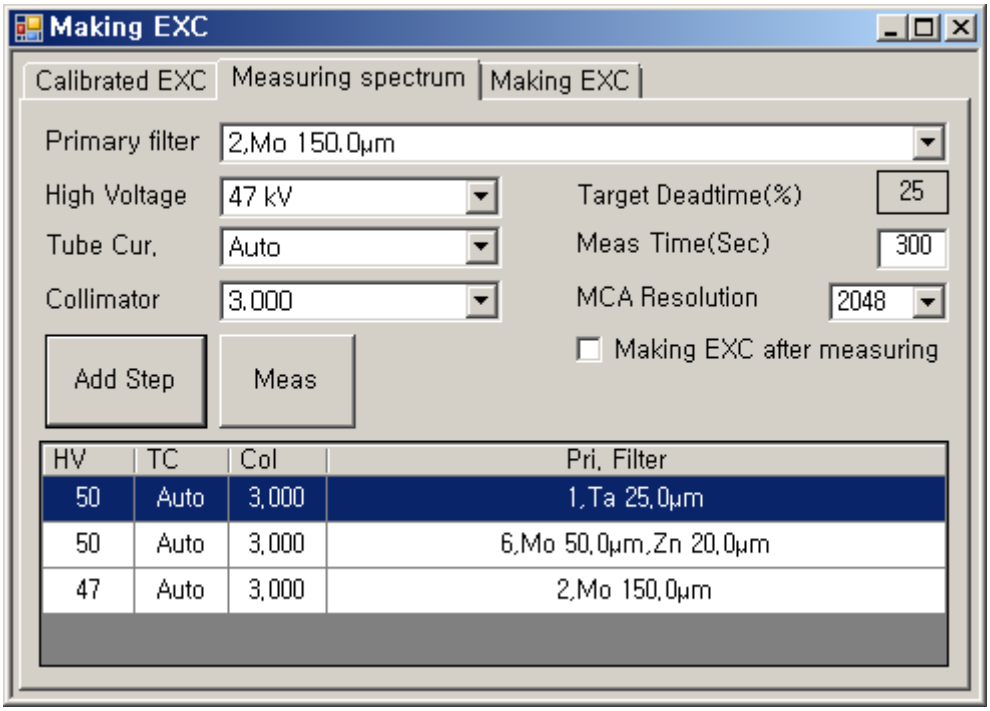


3. Click CSFP Cal.



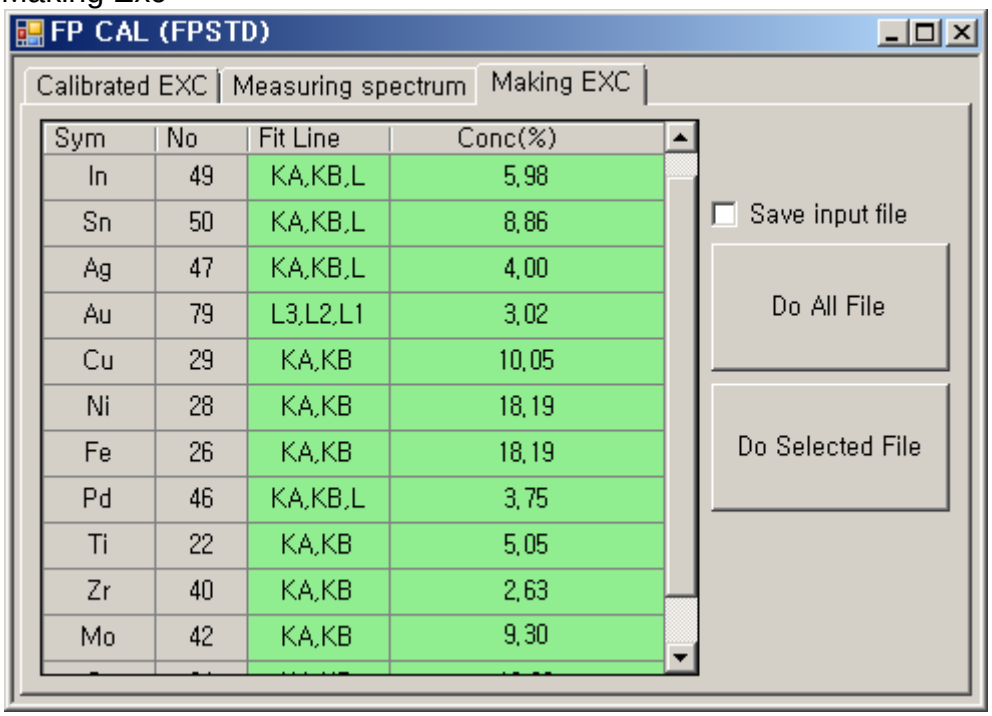
A. Calibrated EXC
Calibrated conditions are listed which are various combination with High Voltage, Tube Current, Collimator and Primary Filter. If you are first time to use FP, you will see blank. In case of unsatisfied FP result, delete all existing lines by clicking right mouse and delete, after that build up all combination of acquisition parameters again in next step.

B. Measuring spectrum
- ✧ Load FP Standard provided by MicroP Co., Ltd in to sample chamber.

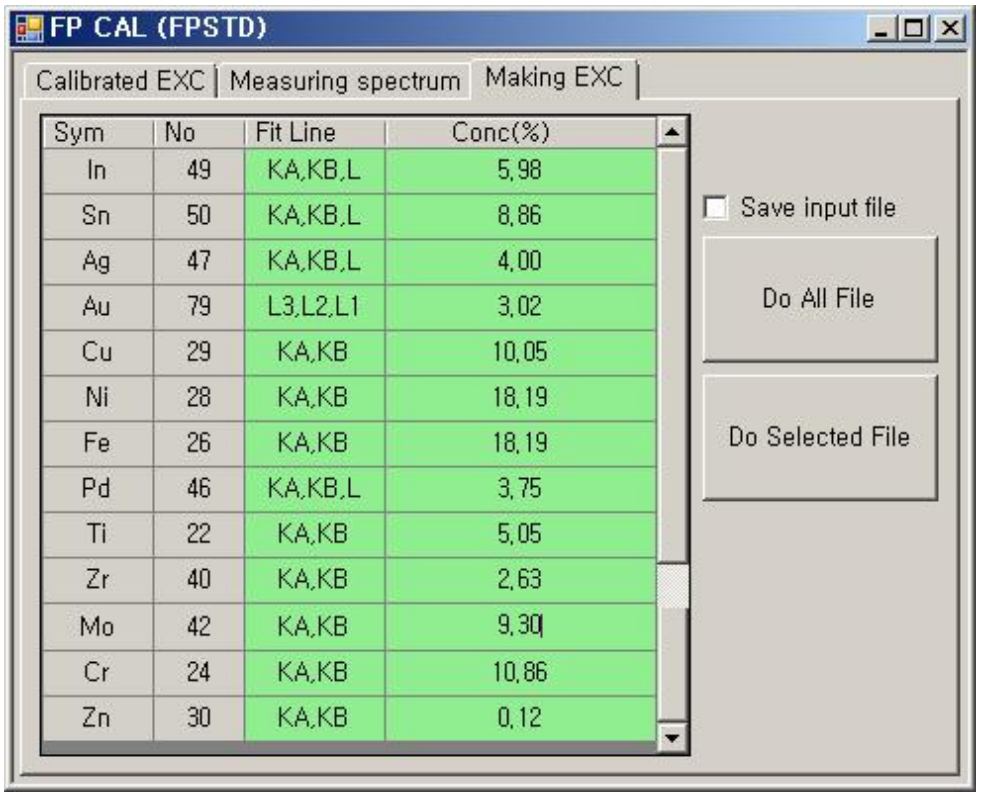


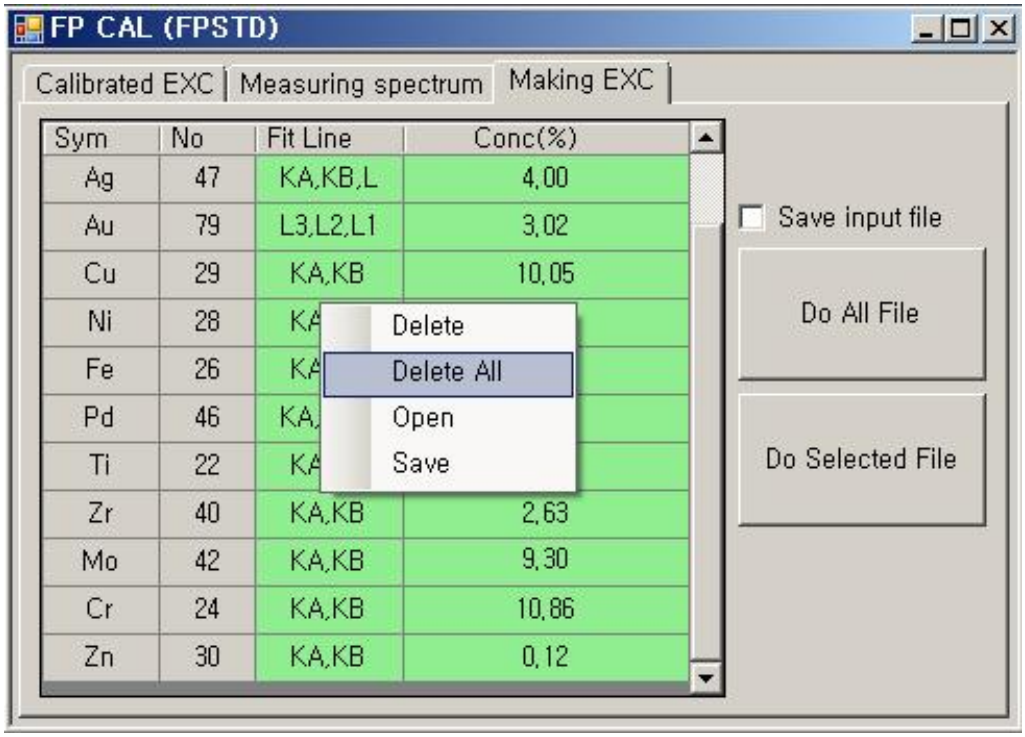
- ✓ Add Step: Select acquisition parameter (PF, HV, TC, Col) and click Add Step.
- ✓ Target Dead Time is optimized as 25%
- ✓ Meas Time is optimized as 300 sec.
- ✓ MCA resolution is optimized as 2048 channel. More channels will take more time to calculate FP parameters and total measuring time.
- ✓ Making EXC after measuring: Currently not in use.
- ✓ Meas: After set all acquisition parameters to be used in your system or additional need then click Meas. System will adjust TC to get 25% D.time and acquire spectrum step by step and save it.

4. Making Exc

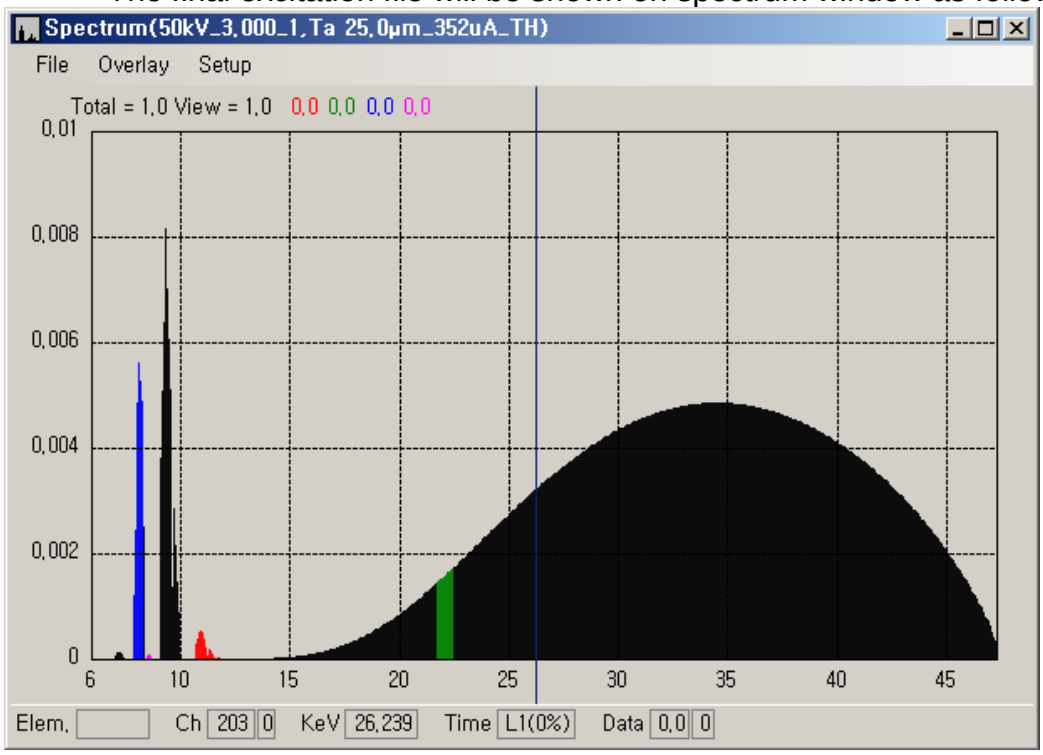


- ✓ Click Periodic table and drag and drop elements into making EXC window.
- ✓ Enter Fit Line and Concentration. The FP standard composition is as follow.





- ✓ This table can be deleted line by line or all and saved or opened by right click of mouse.
- ✓ Click Do All file to create excitation files for all spectrum or click Do Selected File for specific spectrum.
- ✓ The final excitation file will be shown on spectrum window as follow.



- ✓ Close all FP calibration windows.