



microCMA Installation and Operation Manual

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Table of Contents

microCMA Introduction	4
Analyzer Specifications.....	4
microCMA Control	5
Control Specifications	5
Micro CMA control Front and Rear Panel Diagrams	6
Safety Notices	7
Authorized Personnel	7
Safety Symbols	8
Procedural Warnings	8
Unpacking and inspecting the microCMA package	9
Installing the Analyzer.....	9
Perform a resistance check of the analyzer:.....	9
Install the analyzer onto your vacuum chamber	10
Installing the driver and CMapp software on your PC.....	11
Connecting the Controller Cables	12
Theory of Operation.....	13
Electron Gun Theory	13
AES analyzer theory	15
Operation of the microCMA electron gun	16
Operating the control with the analyzer	16
Emission Offset calibration	17
Initial Filament Current setting.....	21
Conditioning the electron gun and electron multiplier	22
Optimizing the Wehnelt Voltage using a picoammeter	23
Optimizing the Wehnelt Voltage without a Picoammeter	24
Setting the filament current limit	25
Setting the emission shutdown current limit	26

Setting the CMA to Target distance – the Elastic Peak..... 27

Calibrating the AES energy linearity 28

Survey and Multiplex data acquisition 32

 Surveys 32

 Multiplex 34

Data Massage..... 37

Software Updates 38

 Downloads 38

Replacement Parts 39

Contacting RBD Instruments Inc. 40

Limited Warranty 41

Product Service 42

microCMA Introduction

This manual provides information about the microCMA Package, which includes -

1. Cylindrical Mirror Analyzer
2. microCMA Controller, Preamplifier and cable assembly
3. Auger Electron Spectroscopy Handbook

The cylindrical mirror analyzer (CMA) is based on the classic second order focusing design and incorporates a 3kV coaxial electron gun, an extended dynamic range Channeltron electron multiplier and a mumetal shield.

The microCMA controller provides the beam, sweep, and multiplier voltages which are controlled via a USB interface. The CMapp (Cylindrical Mirror application) software provides for control of all aspects of the electron gun and analyzer except for the electron beam focus which is set manually. The controller indicates when the filament current and beam voltage are active, and whether the vacuum interlock is functioning. The main power to the electron gun and analyzer supplies is turned off automatically if the vacuum interlock is disabled or if the cable to the controller is unplugged.

The preamp is connected to the CMA and provides amplification of the detected Auger electron signal. A cable assembly connects the preamp to the controller where the amplified analog signal is converted to digital via a 16-bit A/D.

The analyzer fits on a 2.75" CF flange, which must have an ID of 1.50" or larger. The microCMA analyzer is UHV compatible and fully bake-able to 200° C.

Analyzer Specifications

Specification	Description
Analyzer Type	Single Pass CMA (Cylindrical Mirror Analyzer)
Analyzer Working Distance	3.8 mm
Energy Resolution	Fixed at 0.7 %
Signal-to-Noise	100 :1 on clean silver with 300nA 3kV
Electron Multiplier	Extended Dynamic Range Channeltron
Electron Gun	Coaxial 3 kV, non-imaging
Minimum Spot Size	150 μ m
Filament	Tungsten hairpin
Analyzer Mounting	70 mm (2.75") OD, 1.50" ID tube
Vacuum Integrity	UHV bakeable to 200 degrees C
Power Supply/Control	USB protocol, software controlled 120VAC or 220VAC

microCMA Control

The microCMA Control provides all the necessary voltages and currents required to operate the microCMA cylindrical mirror analyzer. The front panel focus control allows the electron beam size to be varied, and can be adjusted to optimize current density. All other electron gun and analyzer functions are software controlled.

Control Specifications

Specification	Description
Input Power	120 or 220VAC @ 47-63 Hz, Single Phase
Beam Voltage	100 V to 3 kV
Ripple-to-Noise	≤ 20 mV peak-to-peak
Focus Voltage	Variable, 70 to 90% of the Beam Voltage
Front Panel Controls	
» Main power	Manual (local), turns on main power to control
» Focus Voltage Control	1-turn potentiometer
Vacuum Interlock (on Back Panel); BNC-type connector	TTL High=OFF. This connector provides a TTL output that needs to be shorted or the control is disabled.
Emission Voltage	+5 V to +60 V, software adjustable and set as a percentage of min to max.
Filament Control	Software controlled. 0 to 2.8 amps DC maximum
Filament Current Limit	.93 amps typical, set in software
Filament Voltage	Nominally 8 V at .93 amps
Cooling	Convection and cooling fan
Dimensions	19" rack mount x 14" deep x 5.25" high

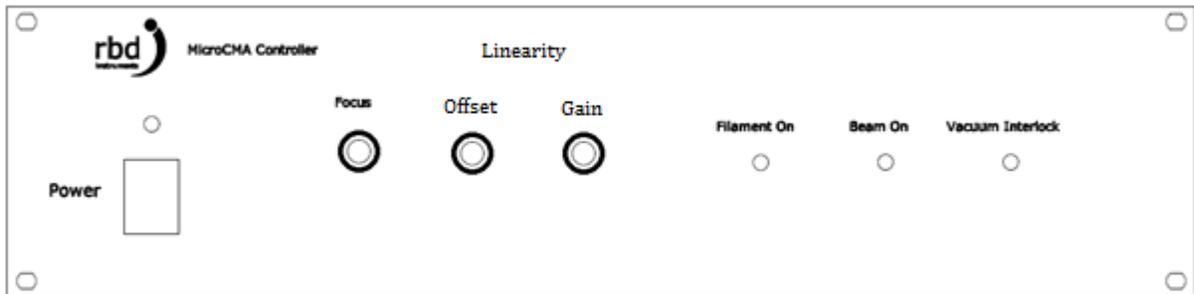
Micro CMA control Front and Rear Panel Diagrams

The following diagrams show the controls and connections, as applicable, on the front and back panels of the control.

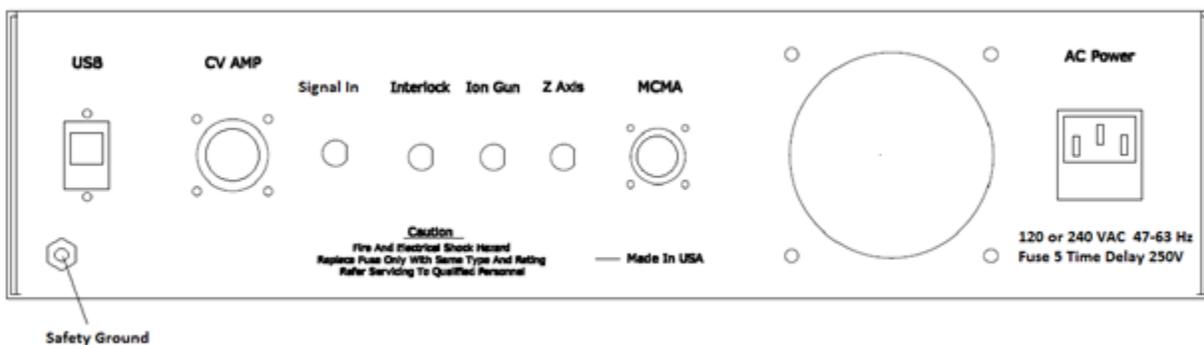
The user set voltages include the electron gun focus, the energy offset and energy gain.

LEDs on the front panel indicate the status of the filament, beam voltage, vacuum interlock and main power.

microCMA Control Front Panel



microCMA Control Rear Panel



Safety Notices

RBD Instruments Inc. (RBD) products are designed with consideration of the safety of those who come in contact with them. Towards this end, we have defined the skills and knowledge that operators and maintenance personnel must have to interact with our products.

Authorized Personnel

Operators and maintenance personnel require specific skills to interact with RBD's products.

Operators of RBD equipment are required to be familiar with the technical information and instructions provided in the included documentation. It is also expected that unless Operators have the skills and knowledge required by maintenance personnel, Operators will not attempt to repair or maintain the equipment without the assistance of someone who has such skill and knowledge and guidance by RBD technical personnel.

Qualified and skilled maintenance personnel will have the following knowledge and experience:

Training and experience with high voltage above 3 kV.

Familiarity with and understanding of the documentation included with the equipment.

Awareness, familiarity, and understanding of all safety notices and symbols that are included in the documentation and on the equipment.

Safety Symbols

To help you quickly recognize possible safety hazards, we have provided safety symbols below that are used elsewhere in this document as well as on the equipment itself, as applicable.

	<p>This symbol indicates hazardous voltages may be present that could cause death or serious personal injury. Service to be done by trained personnel only.</p>
	<p>This Caution symbol indicates that damage to equipment exists. Service to be done by trained personnel only.</p>
	<p>This symbol indicates that the equipment must be unplugged from its power source before any service or maintenance is performed on the equipment.</p>

Procedural Warnings

When a step in a procedure presents a potential hazard or danger, we have identified the hazard or danger using the following words:

Danger: When an imminent hazardous situation is not avoided, serious injury, or death could result.

Warning: When a potentially hazardous situation is not avoided, serious injury, or death could result.

Caution: When a potentially hazardous situation is not avoided, minor or moderate injury to personnel or damage to equipment could result.

Unpacking and inspecting the microCMA package

The contents of the microCMA shipping box include:

1. microCMA (in a vacuum shipping container)
2. microCMA controller
3. Z translator
4. 9103 USB Picoammeter (which includes a USB cable, a ground cable and USB thumb drive with software and driver).
5. Preamp cable.
6. Ground cable.
7. USB cable.
8. Vacuum Interlock cable.
9. Preamp bracket

Open the box and remove all contents. Carefully set the microCMA on a table and ensure that it can't move. The electrical feedthrough is ceramic and any mechanical shock could result in a vacuum leak.

If any of the contents appear to be damaged during transit, contact RBD Instruments immediately. Save all shipping packaging as those may be required for a shipping insurance claim.

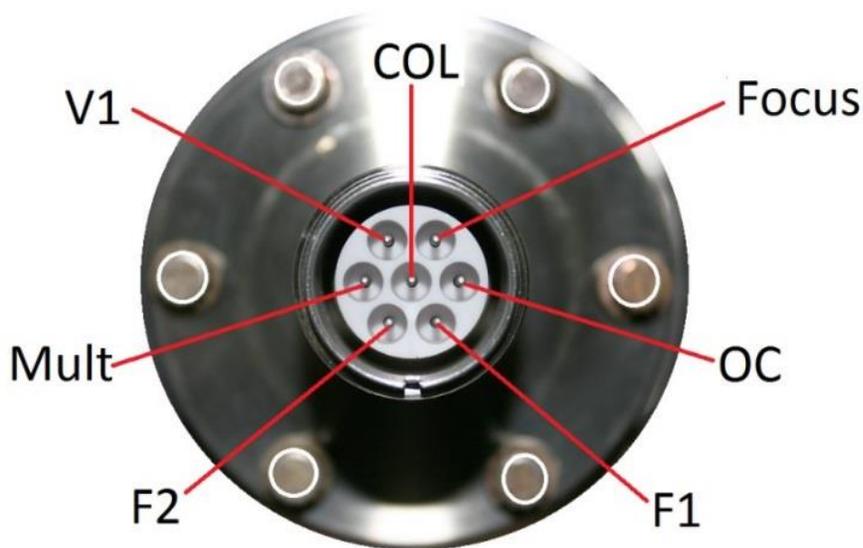
Installing the Analyzer

Perform a resistance check of the analyzer:

Test the resistances on the CMA (cylindrical mirror analyzer). This step ensures that all internal contacts in the CMA are correct.

- a. Using an ohm meter, measure the resistance of the pins on the microCMA analyzer. See the flange diagram below.
- b. The filament pins (F1 to F2) should show 1 ohm of resistance between them.
- c. The outer cylinder OC pin should have 3 Meg ohms (+/- 100 K ohms) with respect to the flange. (Note: Some CMAs have an OC resistance of 4 Meg ohms, depending on the specific conical and flat termination ceramic revision).
- d. The multiplier pin should have 10 to 12 Meg ohms to the flange.
- e. The multiplier to OC pins should have about 15 Meg ohms between them.
- f. All other pins should be open to each other and to the flange.

If the resistance check does not pass, contact RBD Instruments before installing the CMA into your vacuum chamber.



Install the analyzer onto your vacuum chamber

1. Install the CMA and Z translator onto your chamber. Note the orientation of the key on the microCMA electrical feedthrough and install the CMA in whichever position provides the least amount of stress on the preamp cable. Use the large ID 2.75" CF copper gaskets that were included with your microCMA package. You can also mount the preamp to the Z translator using the preamp L bracket.
2. Pump your chamber down and bake out the system for 10 to 12 hours @ 150 to 200C to remove water vapor from the microCMA analyzer surfaces.



CAUTION! The preamplifier and cable must always be removed from the CMA prior to bake out.



Make sure that the microCMA controller is OFF when disconnecting or installing the preamplifier cable.

It is very important that you bake the CMA after installation of the CMA in order to remove water vapor from the CMA internal surfaces, especially the electron gun section. AES is a UHV technique and so you will get better results if your chamber vacuum is in the low 10⁻⁹ Torr range or better.

Installing the driver and CMAApp software on your PC

The driver and CMAApp application are located at the bottom of the microCMA product page on the RBD Instruments website at www.rbdinstruments.com

Install Driver – The ACCESSIO usb interface card requires that the windows driver be installed. Copy the driver to your PC desktop and run the installation. Make sure that the microCMA controller is OFF and that the usb cable is not connected to the PC. Once the driver has been pre-installed Windows will load the driver automatically the first time the microCMA controller is found.

Install CMAApp – CMAApp is the microCMA control and data message software. Copy the file to the desktop and run the installer. CMAApp will automatically install itself.

Note that with Windows 10 you may need to disable the driver signature enforcement in order to load the software. Here is a link on how to do that -

<https://www.drivethelife.com/windows-drivers/how-to-disable-driver-signature-enforcement-on-windows-10-8-7-xp-vista.html>

Connecting the Controller Cables



CAUTION! The microCMA controller needs to be turned OFF when making cable connections to the controller and also when connecting the preamplifier to the CMA.

Connect preamplifier to CMA (after bake-out) Note the orientation of the key on the analyzer and make sure that the corresponding notch in the analyzer cable lines up with the key on the analyzer. The connector on the preamp is delicate, please be careful not to rotate the connector when installing it to the analyzer and make sure that the connector is firmly seated all the way down on the CMA feedthrough. The connector needs to be tight to ensure a proper electrical ground. On the controller end, make sure that the flat spot on the outside of the cable matches the flat spot on the controller MCMA connector.

Connect the CV amp cable and Signal In cable to the back of the controller.

The Safety ground cable is connected from the back of the controller to the vacuum chamber or power ground.

Connect the USB cable between the controller and a USB port on your PC.

The Vacuum Interlock cable is connected to an ion gauge set point relay. This ensures that current and voltage is not applied to the analyzer unless the chamber is under vacuum. The recommended set point value is 2×10^{-7} Torr.

The Vacuum Interlock BNC connector on the back of the microCMA control has a +4V TTL voltage on the center pin. **NOTE:** The Interlock connector on the back of the control must be connected to relay contacts only – no voltage should be applied to the Interlock cable.

When the set point relay in the ion gauge is closed, the +4V is pulled low and the Vacuum Interlock LED on the front panel will turn green to indicate that the vacuum level is safe to operate the microCMA controller and analyzer. Refer to the manual for your specific ion gauge control to determine how to wire the vacuum interlock cable to your ion gauge set point board.

If you do not have a vacuum interlock option on your ion gauge control you can short out the Vacuum Interlock with a BNC shorting cap.

The AC Power is plugged into your electronic rack 120 VAC or 220 VAC outlet. Make sure that you connect only the correct voltage to the AC power connector as indicated by a black mark on the back of the controller.

The Ion Gun and Z Axis connectors are for future use and have no connections at this time.

Theory of Operation

Electron Gun Theory

The 3kV coaxial electron gun is the heart of the microCMA. Understanding the electron gun theory is critical in order to properly operate the electron gun and to obtain repeatable and quantitative AES data.

The electron gun comprises five components -

The filament

The Wehnelt aperture

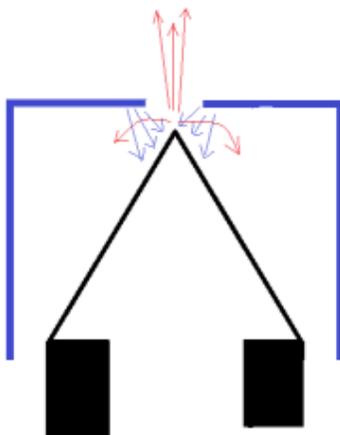
The Anode aperture

The Focus lens

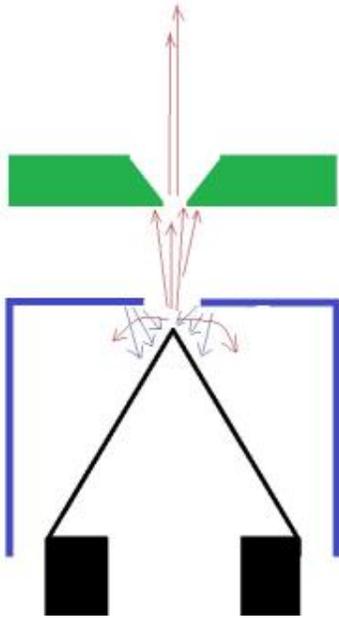
The Exit aperture

The filament is a tungsten hair pin type that emits electrons when the tip of the filament reaches 2550 degrees C. To heat the filament to this temperature a DC current of approximately 1.0 amps is applied between the two filament legs.

The Wehnelt aperture helps to shape the electron beam. By applying a slightly negative voltage to the Wehnelt aperture an electrostatic-field is formed around the filament tip which forces only electrons from the tip of the filament to be focused into the Anode aperture. The filament current and Wehnelt voltage together control the number of electrons that leave the filament tip (emission current). The filament and Wehnelt supplies both float on the beam voltage.

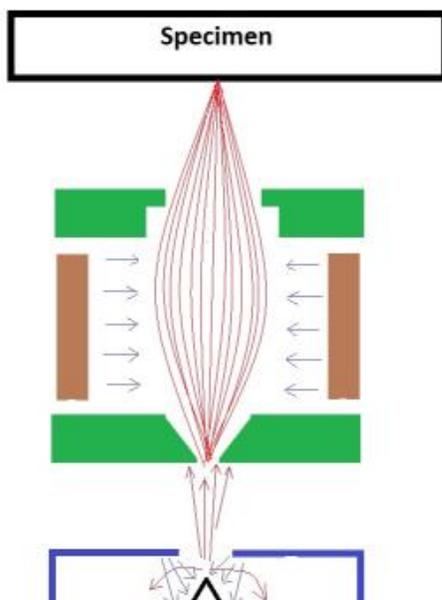


The Anode aperture is at ground potential and it attracts the emitted electrons to provide kinetic energy to the beam. The anode aperture also helps set the size and shape of the electron beam.



The Focus lens provides a negative voltage to the beam which enables the user to minimize the electron beam size at the optimal sample to end of CMA optics distance. A focused electron beam provides optimal signal to noise and energy resolution of the Auger Electron peaks.

Finally, the Exit aperture further shapes the electron beam and also acts a pre-analyzer energy filter. The combination of the anode aperture, focus lens, and exit aperture is functionally an Einzel lens.



In order to maximize the lifetime of the electron gun filament, provide an adequate signal to noise ratio, and also to minimize sample electron beam damage, it is recommended that the electron gun is operated with a target current of 300 nA. The ratio of emission current to target current is typically 10 to 1. Therefore, 3.00 μ A of emission current will correspond to approximately 300 nA of target current. This is useful to know for situations where it is not possible to measure the electron current (if the target is not electrically isolated from ground). In that case, you can use the emission current to estimate the target current. If your target is not grounded, then it is recommended to operate the electron gun using a Picoammeter with a +90V bias to get accurate and repeatable target currents.

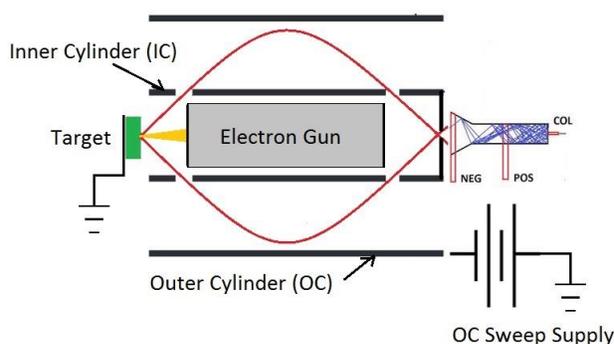
When not measuring target current the target should be grounded otherwise the low energy AES peaks will be shifted by 90 eV.

The optimal Wehnelt voltage % is slightly different for 2kV and 3kV beam energies. To accommodate for this effect, CMap provides a slope feature where the correct Wehnelt % can be set for 2kV and 3kV beam voltages. The slope will track automatically when the beam voltage is changed from 2kV to 3kV.

The sample to target distance (elastic peak) is set using a beam voltage of 2kV. AES data is acquired at 3kV.

To be able to safely operate the electron gun at 3kV it must first go through an outgas / conditioning process. CMap provides an automated Conditioning routine. Once conditioned the beam voltage can be changed quickly from 2kV to 3kV.

AES analyzer theory



Electrons are accelerated at energies of up to 3kV and focused on the target. Auger electrons enter the CMA at the second order focusing angle of 42.3 degrees. As the outer cylinder voltage is swept the corresponding electrons that have the correct energy pass through an aperture where they enter an electron multiplier and are amplified enough to be counted. The output of the electron multiplier is fed into a preamplifier and ultimately the signal is counted and displayed on the PC monitor as N/E counts vs kinetic energy.

Operation of the microCMA electron gun

Description:

The 3kV electron gun comprises a tungsten hairpin filament, a Wehnelt lens, an anode aperture and a focus lens. For optimal performance of the microCMA, the electron gun is operated in a low target current mode. The current draw of the beam voltage module is displayed as emission current. The ratio of emission current to target current is typically 10:1, so it is possible to estimate the target current in situations when it is not possible to measure the actual target current. However, for best repeatability measuring the target current with a +90V biased picoammeter is recommended.

The wehnelt voltage suppresses electrons coming off the filament in order to optimize the target current and the beam size. The optimal wehnelt voltage is slightly different for 2kV and 3kV and that slope can be calibrated in the software.

Once the filament operating current is determined the filament current limit is set to a value slightly higher than the normal operating current which prevents damage to the electron gun if the filament current is accidentally ramped up past the normal operating point.

To minimize heat from the electron gun and sample damage, a target current of 300nA (approximately 3.00 uA of emission current) is recommended.

Operating the control with the analyzer

Turn on the microCMA control. The green LED to the right of the ON/OFF switch should be illuminated.

The Vacuum Interlock LED should be green. The Filament ON and Beam ON LEDs should not be on.

Wait for 2 to three seconds for the USB control board that is inside the control to initialize.

On your PC, open the CMapp software.

If the microCMA controller is recognized, then CMapp will open with no error message.

If you get an error message that the microCMA controller was not found, then close CMapp and turn off the control.

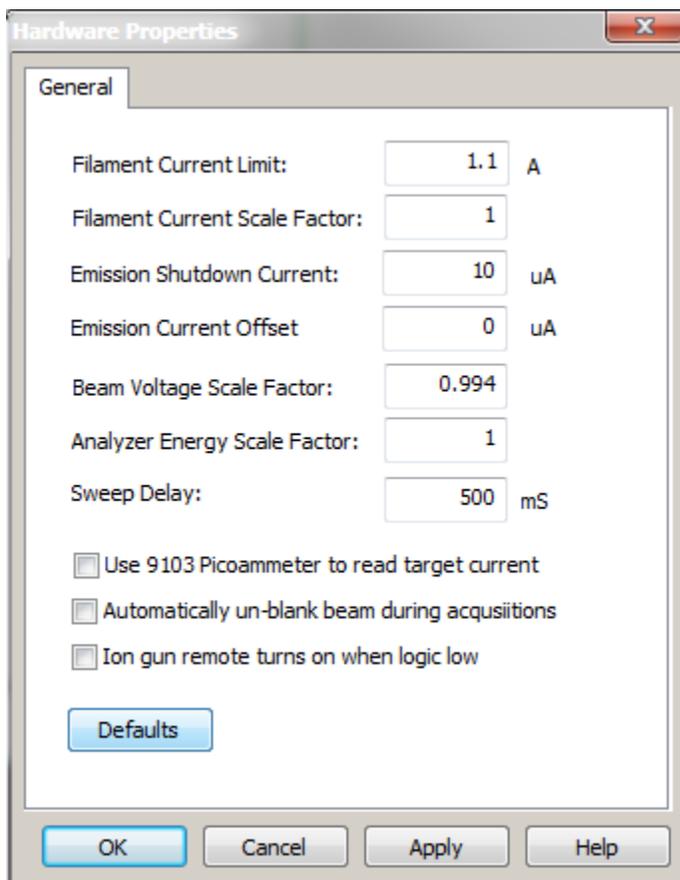
Repeat the process and this time wait a little bit longer after turning on the control before opening the CMapp software. Windows needs to find and recognize the microCMA's USB control board.

If installing a new microCMA package, you can import all the electron gun settings that were included on the USB thumb drive by selecting System – Import properties. The following procedures show how to calibrate all electron gun settings.

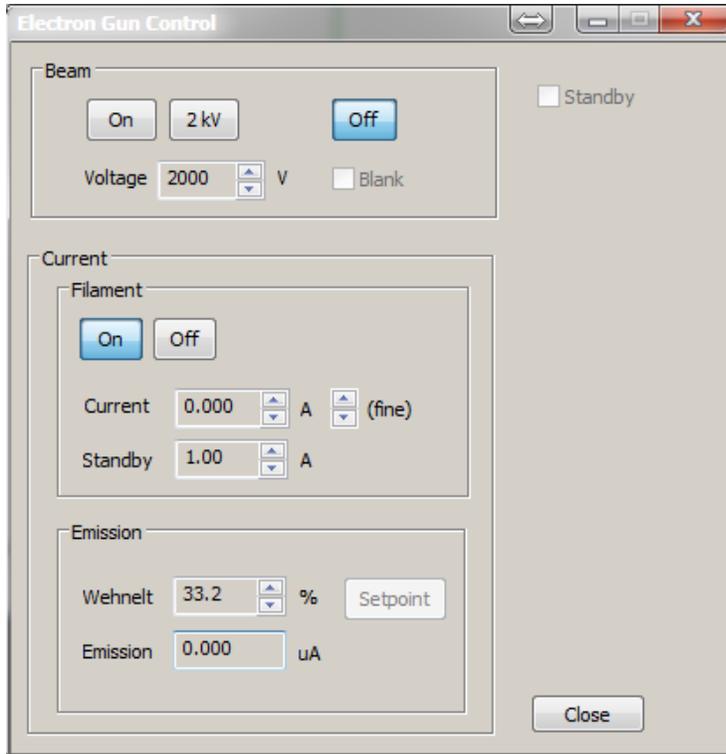
Emission Offset calibration

The current draw from the beam voltage module is displayed in the electron gun dialog box as the emission current. There is a small amount of leakage current in the beam voltage module and this procedure subtracts that leakage current out of the emission current value.

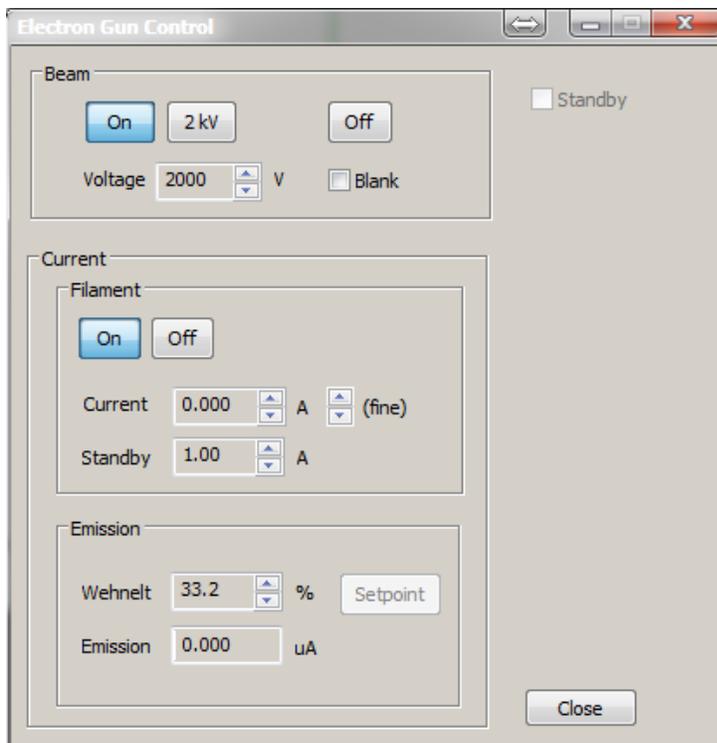
1. Turn on the microCMA controller.
2. Wait a few seconds for Windows to find the microCMA controller and then open CMapp
3. Open the Hardware Properties dialog box and set the Emission Current Offset to 0 μA .
Note that on older microCMA controllers that the emission current offset is in the range of 650 nA. On newer controllers the emission current offset is close to 0.



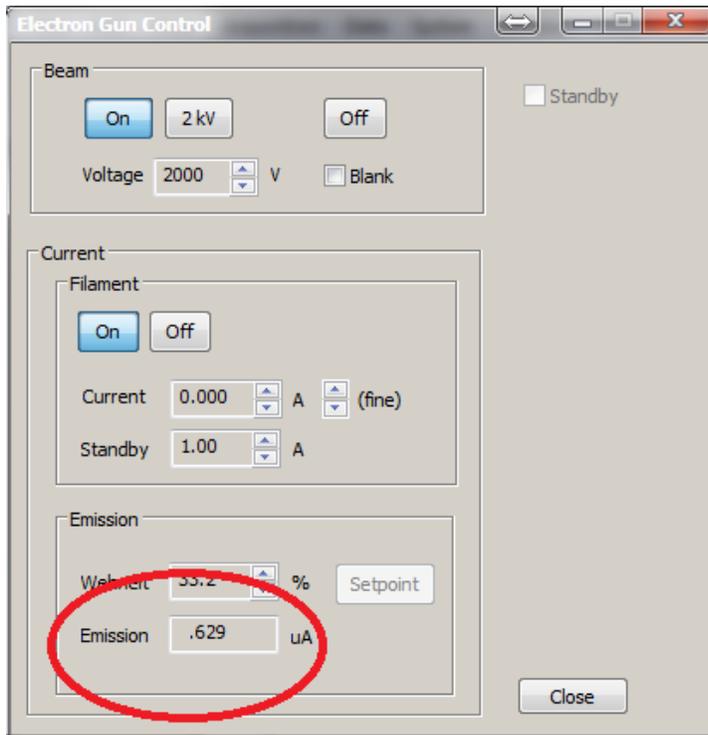
4. Close the Hardware Properties dialog box
5. Open the Electron Gun dialog box.
6. Turn on the filament current but keep it set to zero.



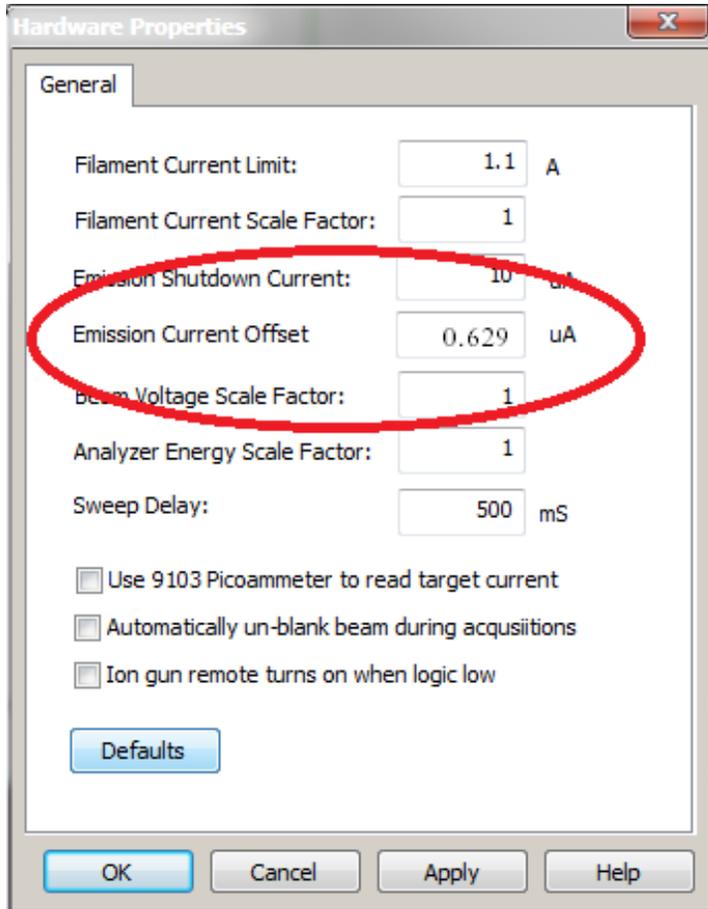
7. Press the 2 kV button to turn the Beam voltage on and set it to 2 KV.



8. The Emission current will indicate a value of 3 to 4 uA and will drift down and stabilize over the period of 5 to 10 seconds. Once it stabilizes note the reading.



9. Open the Hardware Properties dialog box and enter the Emission current value noted in step 7 above into the Emission Current Offset section.



10. Close the Hardware Properties dialog box and open the Electron Gun control dialog box.
11. Turn on the filament current but keep it at zero amps.
12. Turn on the beam voltage and set it to 2kV.
13. Verify that the emission current drifts down to approximately zero in 5 to 10 seconds.

Repeat the procedure if necessary.

Initial Filament Current setting

Before the electron gun can be conditioned, the initial filament Turn On current must be determined. That is the filament current where the filament is hot enough to start emitting electrons.

1. Turn on the beam voltage to 2.0 kV
2. Turn on the filament current and slowly increase the current to .8 amps.
3. Observe the ion gauge for indication of outgassing.
4. Measure the target current and very slowly increase the filament current until you have about 50nA of target current. Typically, that will be around .9 to .93 amps. Or, 1.15 amps on older microCMAs.
5. If you are not able to measure target current, monitor the emission current in the electron gun dialog box and increase the filament current until you have about 500nA of emission current.
6. Let the target/emission current stabilize.
7. Adjust the wehnelt % for the max current peak, but do not exceed 300 nA of target current. Once you find the peak press the setpoint button in the Emission dialog box.
8. Very slowly increase the filament current until you have 200 nA of target current or 600 nA of emission current. Note the value of the filament current. This is the initial filament turn on current.

Conditioning the electron gun and electron multiplier



CAUTION! Before running the Conditioning routine, the vacuum chamber should be baked out and the vacuum level should be in the low 10⁻⁹ Torr or better.

1. Position the CMA to about 2 CM from the targets
2. Open the **Conditioning** dialog box located under System – Conditioning.
3. Set the initial values to those shown in the dialog box below, but for the filament current use the previously determined Initial Filament Current value. Note that in order to set the filament current value in the Beam section that the Filament section check box needs to be unchecked.

The screenshot shows the 'Conditioning' dialog box with the following settings:

- Filament:** Starting: 0.000 A, Ending: 1.020 A, Time: 30 mins.
- Beam:** Starting: 0 V, Ending: 3000 V, Time: 120 mins. The 'Filament On' checkbox is checked, and the filament current value is set to 1.020 A.
- Multiplier:** Starting: 0 V, Ending: 1800 V, Time: 30 mins.

Additional controls include 'Start', 'Defaults', and 'Close' buttons, and a 'Status' field with a 'Time Remaining' indicator.

4. Press start and the filament will ramp up and then stay on while the beam voltage is ramped up. The filament and beam are off when the multiplier voltage is ramped up.
5. The first time that the microCMA is conditioned it is important to go slowly. The times that are shown in the initial conditioning values are the minimum recommended time values. If possible, a longer time for the filament, beam and multiplier will result in a more thorough outgassing and conditioning. For example, 60 minutes for the filament, 180 minutes for the beam and 45 minutes for the electron multiplier.

Optimizing the Wehnelt Voltage using a picoammeter

Note: The electron gun should be conditioned to 3kV before this procedure can be performed.

1. Position the microCMA to the nominal end of optics to sample distance (about 4mm)
2. Set the beam voltage to 2kV and turn it on (just press the 2kV button).
3. Turn on the filament current and slowly bring it up to .9 amps
4. Measure the target current and increase the filament current until you have 100 nA
5. Adjust the emission wehnelt % for maximum target current. The emission wehnelt % is typically 20 to 60%. If necessary, adjust the filament current up or down and set the target current to 300nA.
6. Let the filament stabilize for a few minutes and then readjust the filament current for 300nA.
7. Note that if you are unable to measure target current you will need to set it using the elastic peak. See setting the elastic peak.
8. Press the Setpoint button in the electron gun control dialog box. This sets the emission slope for 2kV.
9. Slowly increase the beam voltage to 3.0 kV
10. Adjust the emission wehnelt % for maximum target current, which should be very close to the value that was obtained at 2kV.
11. Press the Setpoint button in the electron gun control dialog box. This sets the emission slope for 3kV.

Once the slope is set you will be able to change the beam voltage from 2kV to 3kV and the target current will be unchanged.

Optimizing the Wehnelt Voltage without a Picoammeter

If your sample manipulator is always grounded, then you will not be able to measure target current. This procedure will explain how to determine the correct target current without the aid of a Picoammeter.

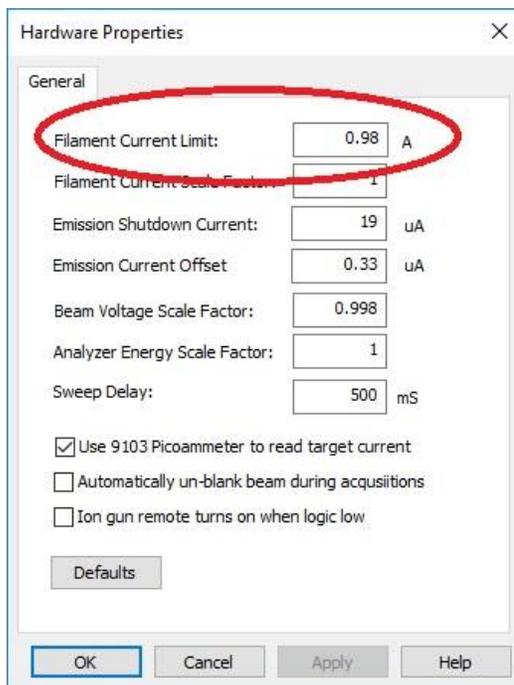
Note: The electron gun should be conditioned to 3kV before this procedure can be performed.

1. Position the microCMA to the nominal end of optics to sample distance (about 4mm)
2. Set the beam voltage to 2kV and turn it on (just press the 2kV button).
3. Turn on the filament current and slowly bring it up to .9 amps
4. Open the multiplier settings dialog box and turn the Auto EMS box off (un-checked).
5. Set the multiplier voltage to 1000 V.
6. Acquire an elastic peak.
7. Adjust the filament current until you get about 30K counts on the elastics peak.
8. Adjust the emission wehnelt % for maximum elastic peak counts. The emission wehnelt % is typically 20 to 40%. If necessary, adjust the filament current up or down and set the counts to 30 to 40K, but less than 50K. If you get a flat top on the elastic peak, that means that the detector is saturated and you should reduce the filament current. Also, the emission current should never exceed 10uA.
9. Let the filament stabilize for a few minutes and then readjust the filament current for 30 to 40 K counts on the elastic peak.
10. Press the Setpoint button in the electron gun control Emission dialog box. This sets the emission slope for 2kV.
11. Slowly increase the beam voltage to 3.0 kV and set the wehnelt % for maximum counts in the elastic peak. Note that since the beam voltage is now 3kV you will not see an elastic peak. You will see a rising background and the counts will also be lower than with the 2kV elastic peak. That is normal. Just adjust the wehnelt % for the maximum counts.
12. Press the Setpoint button in the electron gun control dialog box. This sets the emission slope for 3kV.
13. Set the beam voltage to 2kV and recheck that the elastic peak maximum counts are still about 35 K. If not, adjust the filament current up or down slightly as needed.
14. Note the emission current value. Typically, this will be approximately 3 uA and that corresponds to 300nA of target current.
15. In the Multiplier properties dialog box, check the Auto EMS box. Also set the default voltage to 1300V.

When acquiring data use the emission current value determined in step 14.

Setting the filament current limit

1. Position the CMA to about 4mm from the target.
2. Turn on the electron gun and set the Beam voltage to 2kV and adjust the filament current for 300nA of target current (or 3 uA of emission current if you can't measure target current).
3. Let the target current stabilize for a minute or two.
4. Next, increase the filament current until you have 400nA of target current. (or 10 uA of emission current if you can't read target current).
5. Note the filament current value and the emission current value.
6. Set the filament current back down to where you have 300nA of target current (3uA emission typical but each filament is different).
7. Open the Hardware Properties dialog box and set the filament current limit to the value that you used to set the target current to 400 nA.



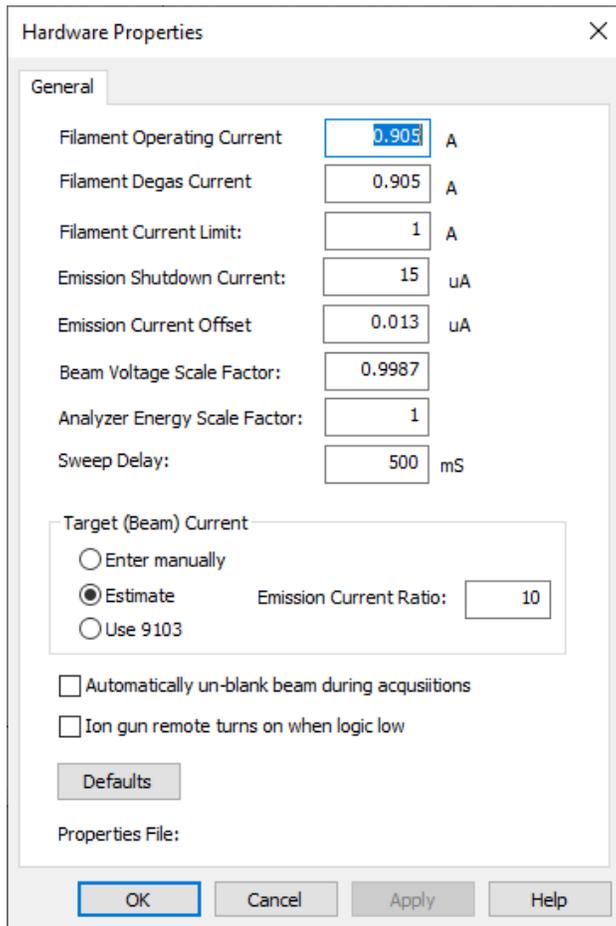
8. Save and close the Hardware Properties dialog box.
9. The filament current limit is now set.

In addition to the software set filament current limit, there is a factory set current limit of 1.3 amps, a backup Zener diode limit of 1.35 amps, and a filament current fuse. So, the filament has multiple levels of protection. But the ultimate filament protection is you! Keep the target current at 300nA and the filament will last for thousands of hours.

Setting the emission shutdown current limit

As an additional filament safety layer CMap monitors the emission current. If the emission current gets too high, CMap will turn off the beam voltage and filament current.

1. Open the Hardware Properties dialog box.
2. When you set the filament current limit in the previous step (setting the filament current limit) you noted the emission current value when you had 400 nA of target current.
3. Add 4 to 5 μA to the previously noted emission current value and enter it in the Emission Shutdown Current section as shown below.



If the emission current exceeds the shutdown value, the beam voltage and filament current will turn off.

To reset the emission shutdown, close the electron gun dialog box. When you re-open the electron gun dialog box all electron gun settings will be reinitiated.

Setting the CMA to Target distance – the Elastic Peak

The Elastic peak alignment is used to set the CMA to target distance.

Open the Acquisition – New Alignment dialog box.

If the Lower and Upper limits are not as shown below, press the 2kV Elastic Peak Settings button.

Alignment Settings

Energy

Lower Limit: 1950.00 eV

Upper Limit: 2050.00 eV

EV/Step: 1.00 eV

2 kV Elastic Peak Settings

Acquisition Time

Time/Step: 15.0 mS

Auto Set Beam to 2 kV

Auto Diff / Smooth After Acquisition

Edit Gun Settings...

Acquire

Apply

Cancel

Help

1. Set the beam voltage in the Electron gun dialog box to 2kV
2. Position the end of the CMA to about 4 mm from the target.
3. Acquire the alignment and move the CMA in or out as needed to position the top of the elastic peak is centered at 2kV.
4. Adjust the Focus knob on the controller for the sharpest peak.

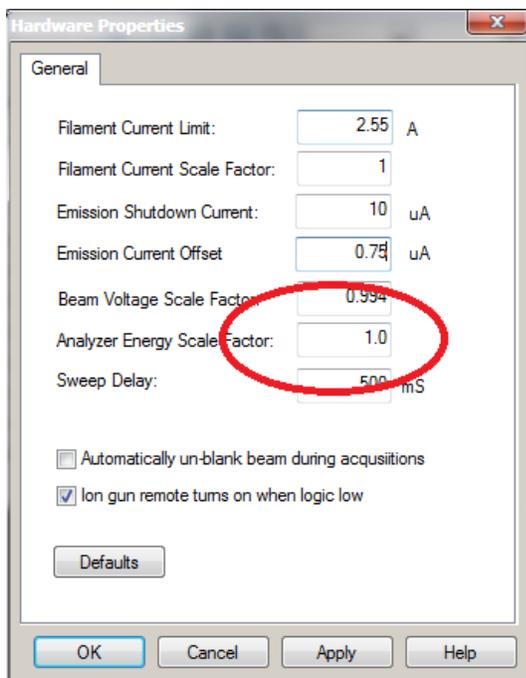
The CMA to sample distance is now set correctly. Each time you want to acquire a Survey or Multiplex you must first acquire a 2kV elastic peak alignment.

Calibrating the AES energy linearity

On the front panel of the microCMA controller there are two energy linearity adjustment potentiometers. The left hand potentiometer is the OFFSET adjustment and the right hand potentiometer is the GAIN adjustment.



To adjust the energy linearity, first, make sure that the Analyzer Scale factor is set to 1.0 in the Hardware Properties dialog box.



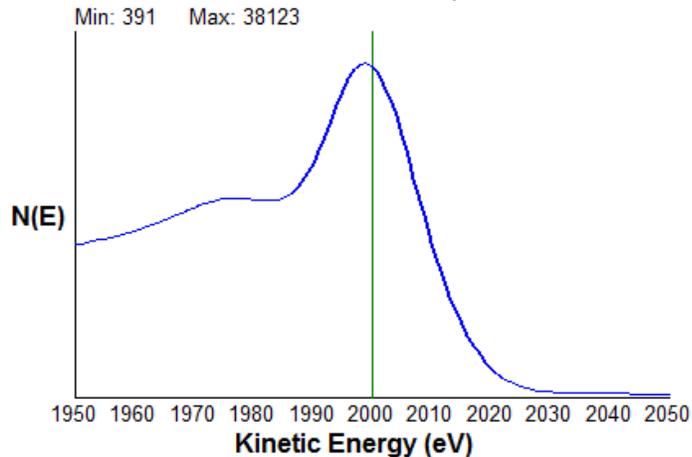
Insert a piece of a sample with both low and high energy peaks and sputter it clean. Copper, nickel or iron will work.

Set the CMA to sample distance to about 3.5mm.

Acquire an elastic peak alignment with the beam voltage at 2kV and a stable target current at 150 to 500na.

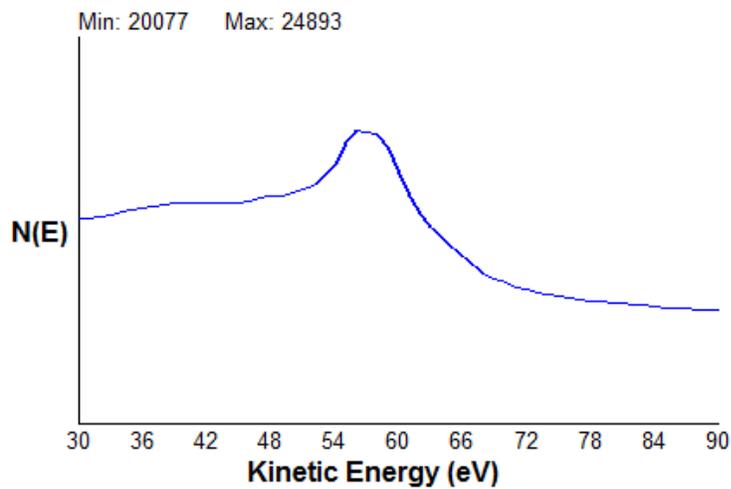
Adjust the focus for the sharpest elastic peak.

Slightly adjust the Z axis to determine where the elastic peak provides the highest counts and the best shaped elastin peak. Readjust the focus knob for the best peak shape. Note that at this time the elastic maximum may not occur at 2000 eV.

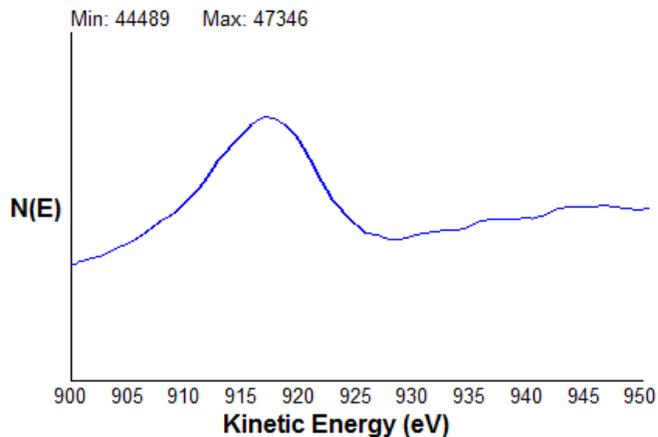


Next adjust the right hand Gain potentiometer knob on the microCMA control front panel so that the elastic peak comes in at 2000 eV. This is the focal point of the CMA and the *initial* linearity adjustment

Set the beam voltage to 3kV and set up and acquire an alignment from 30 to 90 eV but **DO NOT MOVE THE SAMPLE**. For this example, we are using copper which has a low energy peak of 60eV. Refer to the AES handbook for the low energy peak positions of other elements. Acquire the alignment and adjust the left hand Offset potentiometer on the front panel so that the low energy copper peak comes in at about 58 eV (60 to 61 eV differentiated).

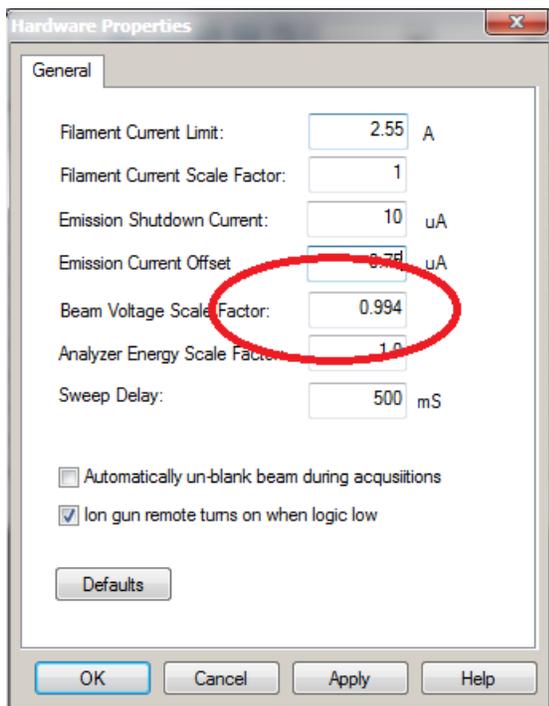


Next set up and acquire an alignment from 900 to 940 eV **BUT DO NOT MOVE THE SAMPLE**. If necessary, adjust the right-hand Gain potentiometer so that the high energy copper peak comes in at 917eV (920 eV differentiated). Refer to the AES handbook for the high energy peak positions of other elements



Repeat as necessary until both the low and high energy copper peaks are correct. When differentiated the low energy Cu peak should be 60eV and the high energy peak should be 920 eV.

Finally, set the beam voltage to 2kV and reacquire a 2kV elastic peak again but - **DO NOT MOVE THE SAMPLE**. If the elastic peak does not come in at 2kV then you will need to adjust the Beam voltage scale factor in the Hardware properties dialog box.



To adjust the Beam Voltage Scale Factor, make a small change to the starting value of 1.000 (.005) and say OK.

Reacquire the 2kV elastic peak to see how far the peak moved and then repeat the process until the elastic peak comes in at 2kV. Remember, **DO NOT MOVE THE SAMPLE** to get the peak to come in at 2kV, adjust the Beam Voltage Scale factor. With 2 small changes to the Beam Voltage Scale factor value, you will be able to calculate the correct value so that the elastic peak comes in at 2 kV.

Now that you have adjusted the offset, gain and beam voltage scale factor the analyzer is calibrated. From this point on when the sample is positioned so that the 2kV elastic peak is centered at 2 kV the sample is at the focal point of the CMA and the peaks will be at the correct energy.

You set the sample to target distance (elastic peak alignment) with the beam voltage at 2kV.

For survey and multiplex data, set the beam voltage to 3kV.

Survey and Multiplex data acquisition

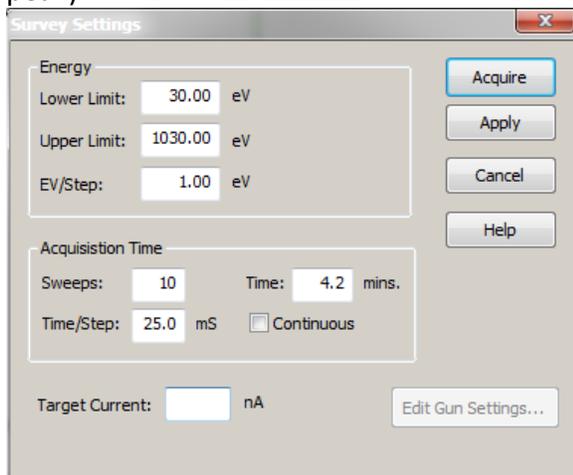
Surveys

Surveys are wide scans, typically with a range of 30 eV to 1030 eV. A rule of thumb for AES is that the beam voltage should be at least three times as high as the eV that you want to scan up to. Since the electron gun in the microCMA is limited to 3kV, then 1030 eV is the maximum limit of a scan. You can look at higher energy peaks in the range of 1400 to 1600 eV, but those peaks will be smaller and take more time to average the signal.

The lower limit of 30 eV is selected due to the large amount of low energy electrons below 30eV. If you scan from 0 to 1000eV then when you differentiate the data the scale will be skewed (the peaks of interest will be smaller).

To acquire a survey, select Acquisition – New survey (or the New Survey Icon).

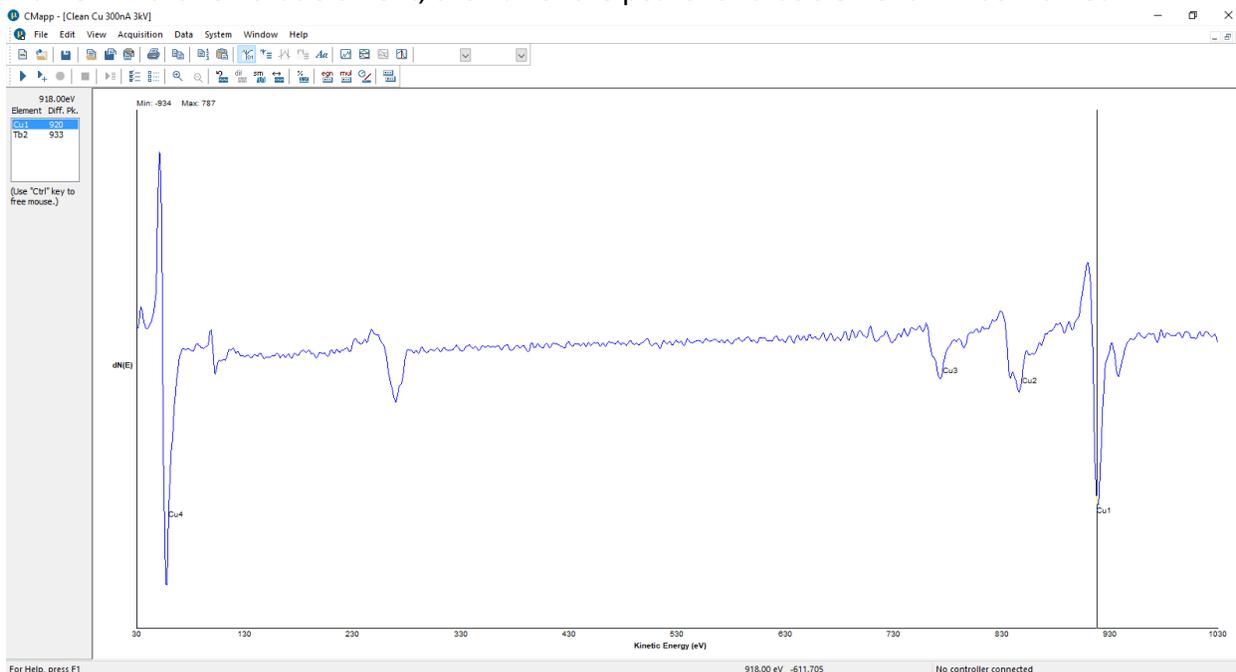
Select the parameters shown below. 25mS works well as a time per step, and 10 sweeps is typically enough total acquisition time for an adequate signal to noise ratio. Depending on what elements you are investigating you may need more than 10 sweeps. The AES sensitivity of elements varies from a range of Ag (which has a large peak) to As (which has a very small peak).



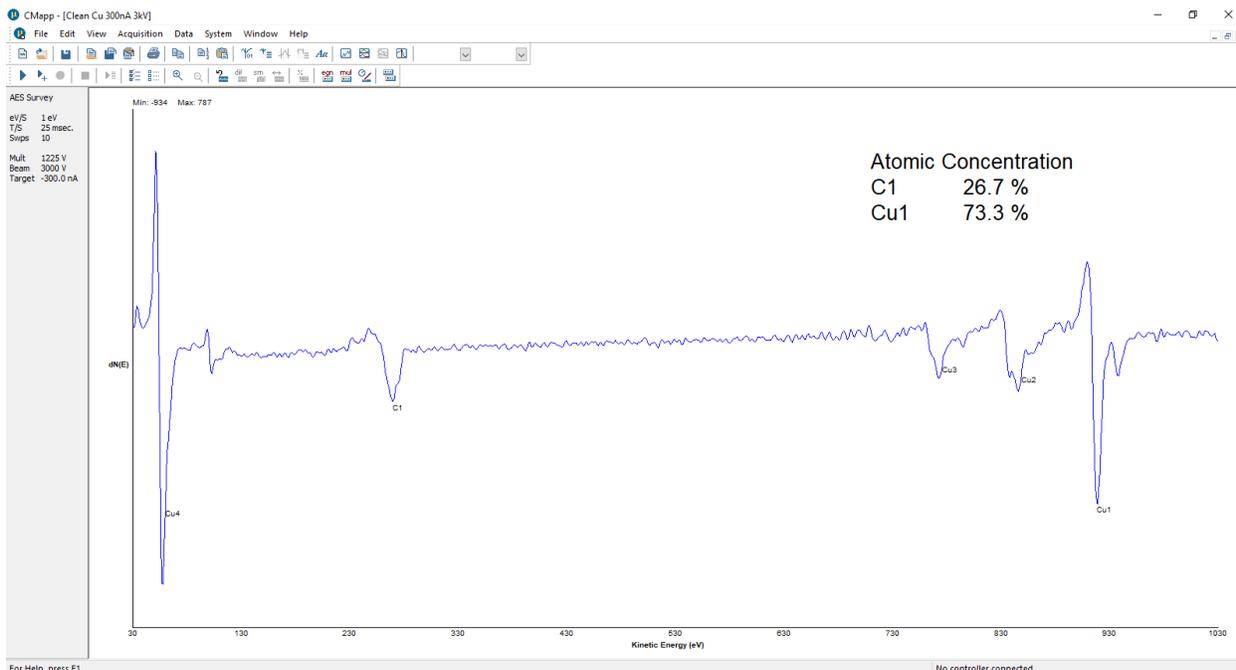
You can set the 9103 USB Picoammeter (in the System - Hardware Properties dialog box) to automatically measure the target current before the survey acquisition begins. If you do not have a 9103 you can manually enter the target current in the Survey Settings dialog box. Recording the target current is useful for comparing different samples as you want to use the same acquisition settings for both sample sets.

To acquire the survey, press the green Start Acquisition button on the task bar, or Acquisition – Start.

Once the survey is complete you can use Mark/Track to label peaks. When you click on the bottom of a peak the element list will open and CMap will select the closest peak to the marker. If click on that element, then all of the peaks for that element will be marked.



Once you have marked all the peaks of interest you can perform the Atomic Concentration calculation:



Multiplex

A multiplex is a series of narrow scans which is useful for two reasons –

1. All acquisition time is spent acquiring elements of interest
2. By taking more sweeps useful data can be obtained from small peaks or peaks buried in the noise.

To acquire a multiplex, select Acquisition – New Multiplex or the Multiplex icon.

The Multiplex dialog box will open.

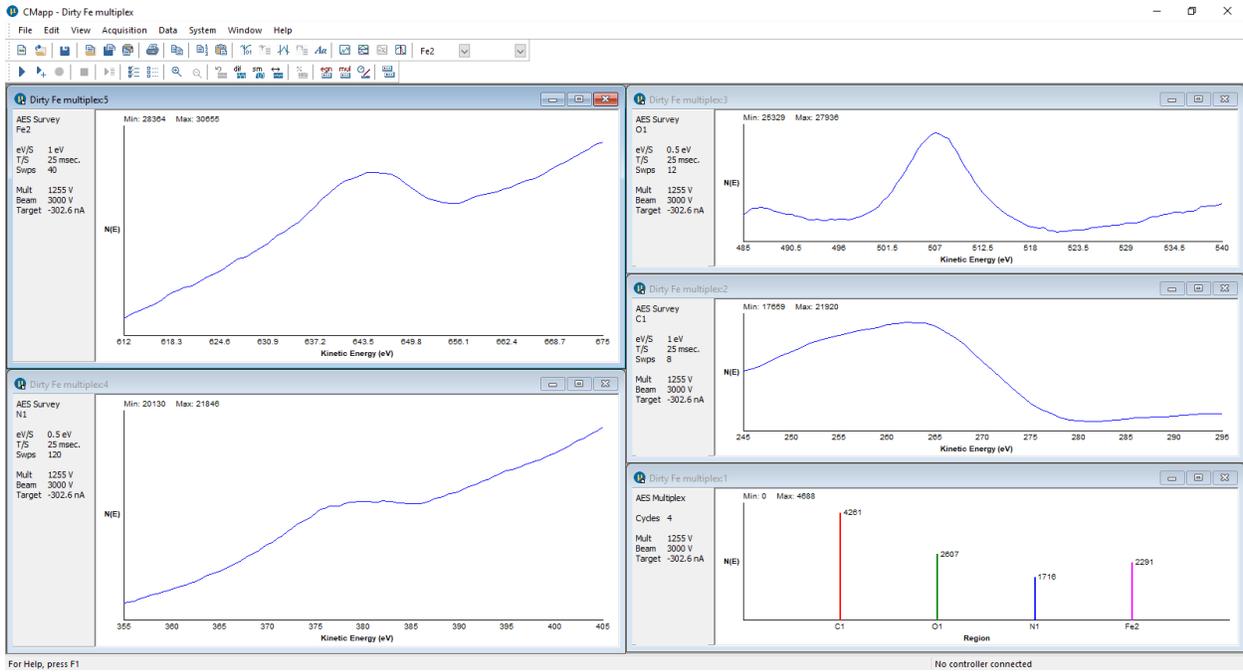
Click the Add button to add elements that you want to acquire.

When the select Element dialog box opens you can type the first two letters of any element or scroll up and down and click on the elements. All blue highlighted elements will be entered into the regions list.

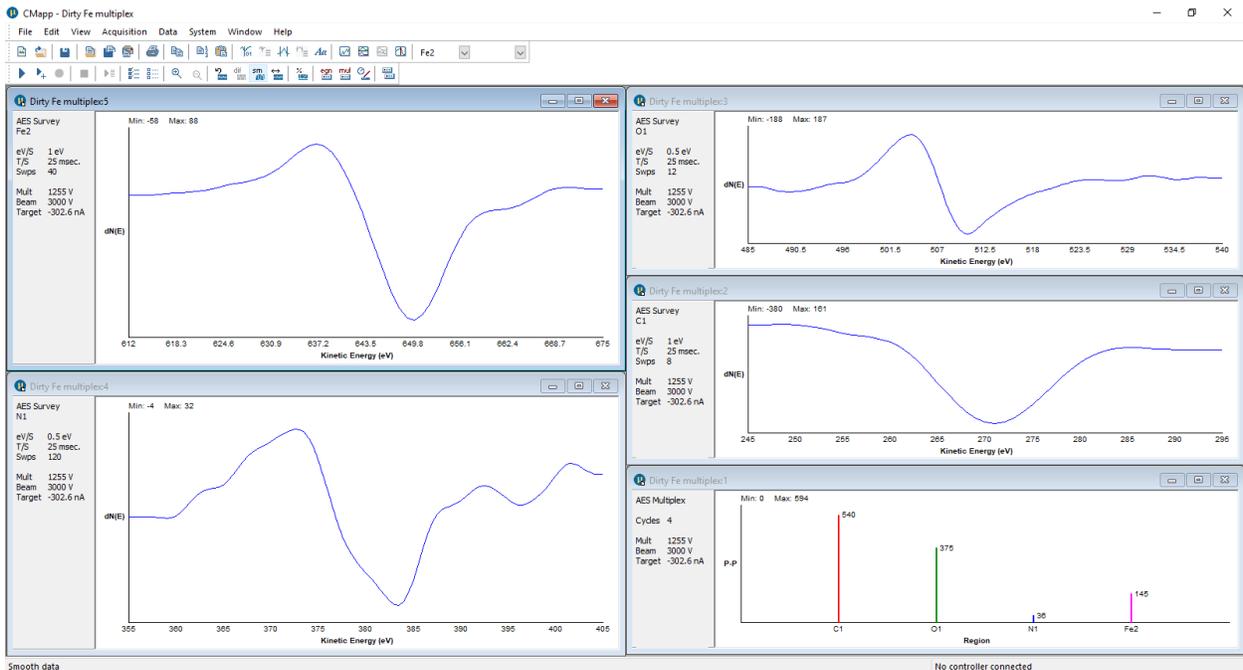
Determine the number of sweeps for each region. If you acquire a survey before you set up the multiplex, you can look at the peak heights on the survey as a reference. Use 1 or 2 sweeps for the largest peak, then use more sweeps on the smaller peaks. If a peak is $\frac{1}{2}$ the height of the largest peak, then take twice as many sweeps on that peak. If a peak is very small or buried in the noise, then take a lot more sweeps on that peak.

Select the desired number of cycles. A cycle is one complete set of surveys. For example, 1 sweep on Carbon, 2 sweeps on O2, 10 sweeps on Fe2 and 40 sweeps on Nitrogen.

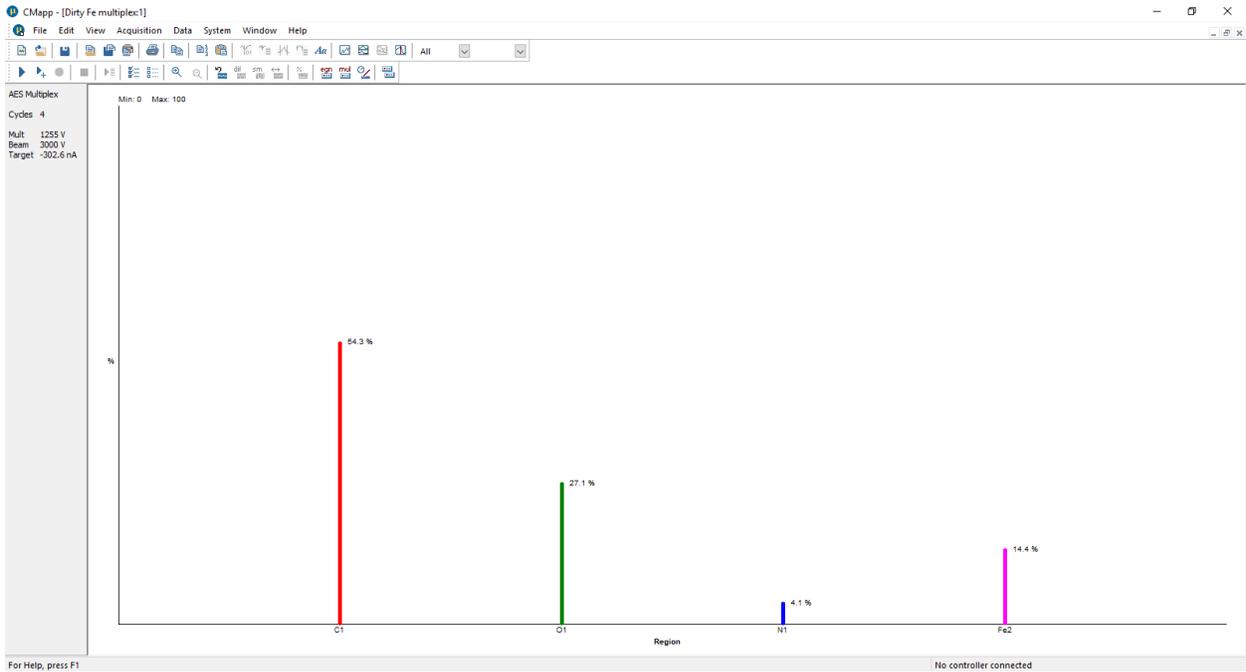
Acquire the multiplex by pressing the green Acquire arrow. Once the acquisition starts, Select Window – Display all regions. A separate display window will open for each region as well as the Multiplex summary window.



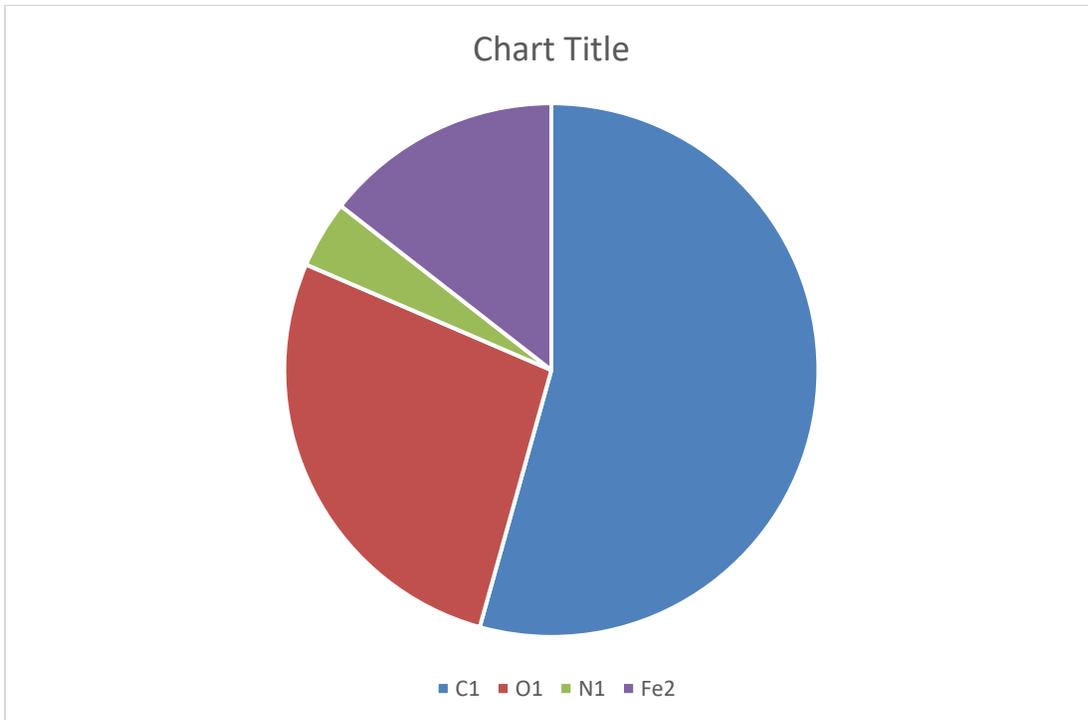
Once the data has been acquired you can smooth and differentiate:



Then once the data has been differentiated you can calculate the Atomic Concentration:



And copy / paste the ASCII data into Excel or you favorite data massage software:



Data Massage

Smooth – Savitzky-Golay algorithm

Differentiate - Savitzky-Golay convolution

Zoom – Click the left mouse button and drag a box, when you release it will zoom in. Restore zooms back out

Mark/Track – Cursor that also marks the peaks used in the Atomic Concentration calculation

Atomic Concentration – Provides a ratios of a single element to the sum of the other elements selected. Uses the sensitivity factors in the element table for the calculation. Data must first be differentiated before the AC% can be calculated.

Select endpoints – Allows for more accurate AC% of multiplex data. Selecting endpoints is useful for separating peaks from different elements that are close together (such as Chromium and Oxygen).

Software Updates

CMapp software updates will be available periodically on the microCMA downloads page at our website - <https://www.rbdinstruments.com/products/microcma.html>
RBD Instruments will also notify customers when updates are available.

Downloads

Download Windows drivers and the CMapp application for the microCMA below.

[microCMA Drivers](#)

Unplug the microCMA USB interface before downloading, then plug back in for updates to take effect.

[microCMA CMapp Application.](#)

Uninstall any previous versions of CMapp before installing the latest version.

Operation Videos

For the most up to date operation information please watch the videos at the links below –

microCMA Operation and Training Videos ([Playlist](#))

[In regions such as China without access to YouTube, the training videos can also be found here.](#)

If you cannot open the links above, please go to the microCMA product page on our website at

www.rbdinstruments.com

Replacement Parts

The following microCMA analyzer parts are available for field replacement by the user:

Replacement part	Part Number	Description
Electron gun stack	MCMA-EGSTKPR	Pre-aligned electron gun filament with Wehnelt, anode and focus elements.
Maintenance tool kit	MCMA-INSKITPR	Kit that includes all of the tools necessary to work on a microCMA analyzer.
Electron Multiplier	MCMA-5901-EDR	Extended dynamic range electron multiplier
IC Grid	MCMA-MD-25	Pre-welded IC grid



Electron Gun Stack

Contacting RBD Instruments Inc.

When contacting RBD Instruments Inc. please visit our website at www.rbdinstruments.com and create a support ticket by clicking on the Portal Register button in the upper right hand corner.

Once you have registered you can access your tickets by clicking on the Portal Login button. We will respond as quickly as possible, typically within 24 hours.

Our ship to and mailing address is:

RBD Instruments Inc.
2437 N.E. Twin Knolls Drive
Bend, OR 97701
USA

Phone- 541 330 0723



Limited Warranty

RBD Instruments, Inc. (referred to as “Company”) warrants that the product(s) discussed in this document will perform substantially in accordance with the accompanying written materials, and will be free from defects in materials and workmanship for the period of one year from receipt by buyer. In the event applicable law imposes any implied warranties, the implied warranty period is limited to 90 days from the date of receipt. Some jurisdictions do not allow such limitations on duration of an implied warranty, so the above limitation may not apply to the buyer. Other than as described here, there are no other expressed or implied warranties.

Customer Remedies

The Company’s and its suppliers’ entire liability and Customer’s exclusive remedy shall be the repair or replacement of the product that does not meet this Limited Warranty. This Limited Warranty is void if failure of the product has resulted from accident, abuse, modification, or misapplication of the product(s). Any replacement product will be warranted for the remainder of the original warranty period or 90 days, whichever is longer.

No Other Warranties

To the maximum extent permitted by applicable law, the Company and its suppliers disclaim all other warranties, either express or implied, including, but not limited to implied warranties of merchantability and fitness for a particular purpose. This limited warranty gives customer specific legal rights. Customer may have other rights depending on the jurisdiction.

No Liability for Damages

To the maximum extent permitted by applicable law, in no event shall the Company or its suppliers be liable for any damages whatsoever (including without limitation, special, incidental, consequential, or indirect damages for personal injury, loss of business profits, business interruption, loss of business information, or any other pecuniary loss) arising out of the use of or inability to use this product, even if the Company has been advised of the possibility of such damages. In any case, the Company’s and its suppliers’ entire liability under any provision of this agreement shall be limited to the amount actually paid by the buyer.

In addition, this warranty does not cover loss, damage, or defects that result from transportation to buyer, improper care by buyer, buyer-supplied software or other components, unauthorized changes, use, or misuse (including, but not limited to, use outside of the specified environmental conditions).

Product Service

Any claims of product failure of performance must be reported to Company within 30 days of product's receipt by buyer.

The Company recognizes that expendable items may not function for the full year covered by this Limited Warranty. Expendable items, such as filaments, grids, special ceramics, and electron multipliers are therefore excluded from the Limited Warranty for the specific product of which they are a part. However, each of these expendable items will have its own warranty and will be replaced or repaired in accordance with its warranty.

Buyers who purchased the product through one of the Company's international sales representatives should contact their sales representative to make arrangements for return, repair, or replacement.