XRF analysis

10 Am241 smoke detector sources arranged in annular fashion around a steel ring end to end with lead collimator window.All filters removed from window.Scattering is an issue here.Detector-source-target arrangement can vary from annular,central or side arrangement.This topic is discussed in detail in Geo's Xrf manual. Recommended free software is Thermimo.

My setup is simple

Rap 47 detector to pick up low energies

Gs 2002 pro drivers

Essentially for qualitative analysis.Setup is crude with poor geometry.My setup is not good for picking up the different peak lines as its resolution is poor .Thanks to Thermimo xrf software I can do measurements in a satisfactory manner.Due to matrix effects, my setup falls short in doing detailed quantitative analysis.Commercial software like Ampteks can address this complexities.

Not ideal for studying alloys with close peaks like brass(Cu and Zinc) due to merging effects.Solder with with Pb and tin is ok to name a few.

X –RAY beam limiting leaded adjustable cone collimator used to house the ludlum collimator.The Ludlum collimator above sits inside the x-ray cone like a double shield.Not sure if it helps decreasing Bg radiation but it definitely protects me from radiation.

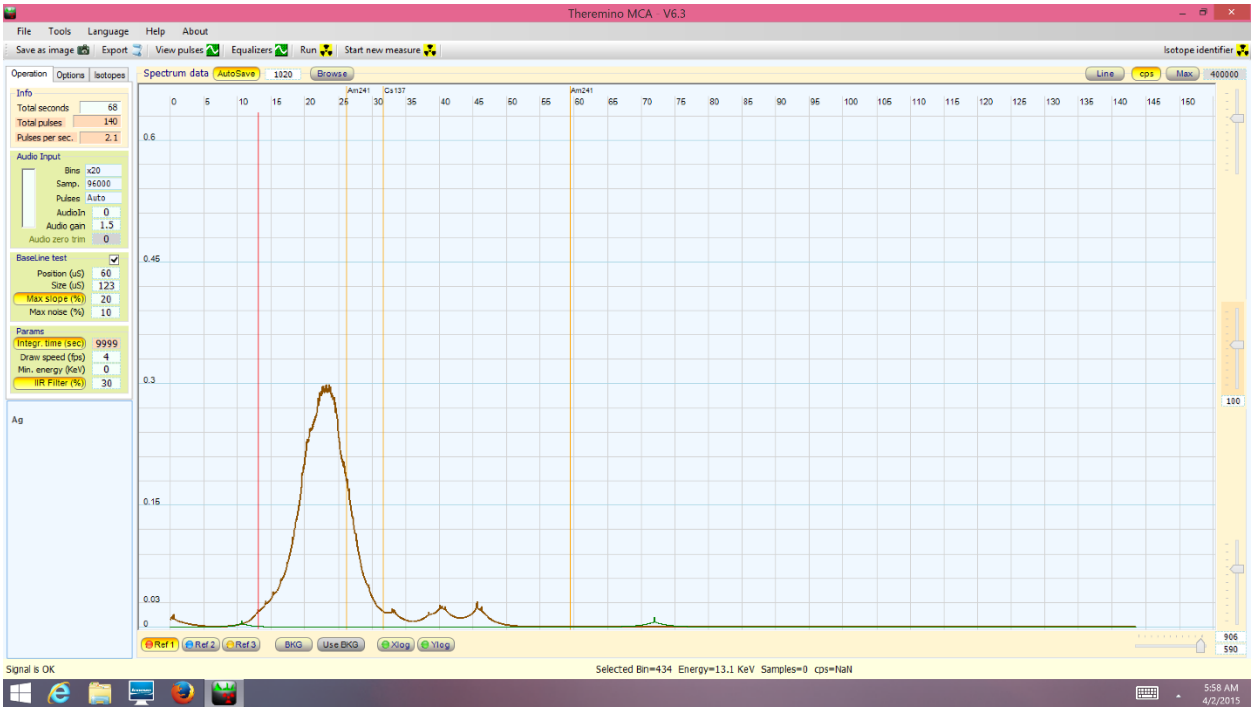
Picture showing my 10 Am sources with steel ring sticking out of the x-ray cone.Also notice the lead strip jutting out. I cut a strip of lead sheet and made it into ring and glued it within the steel ring.I put a lead ring in before but was not helping to reduce backscatter probably sunken. My experience states it has to protrude a little from the Am source base to work effectively.For adequate shielding against backscatter , the lead shield must be as close as possible to the Am sources.I guess it needs to protrude a bit because the Am sources are sitting on an elevated platform.This ring will minimize background scatter significantly.

I am using the cone in reverse manner as you can see.Perhaps someday I will find another use for it. X-ray photography is an option.My Am sources are mainly lying flat so it projects a perpendicular beam. Ideal for flat specimens measuring I inch square or more.Even thumb size irregular samples work for qualitative analysis in my experience.

Sample holder technique if your hands are tired.I have a pair of 0.5 mm thick lead gloves too but cumbersome to wear ..cannot even hold a forcep with it or pick up small specimens.

For calibration , I use another Am source in a lead shield.There may be issues with the first peak which differs depending on age of the smoke detector.As you may know the first peak consist of several gamma and xrf peaks which can be confusing in this setup. I use 29.37 kev Neptunium as my first peak.The second 59 kev peak remains constant. The default first peak in Thermimo is different.I learned this through trial and error.After initial calibration I fine tune my calibration with known metal xrf sources and move the Thermimo peaks a bit.After some experimenting one can get fairly accurate calibration. This subject of Am241 peaks is discussed in detail elsewhere in this forum.

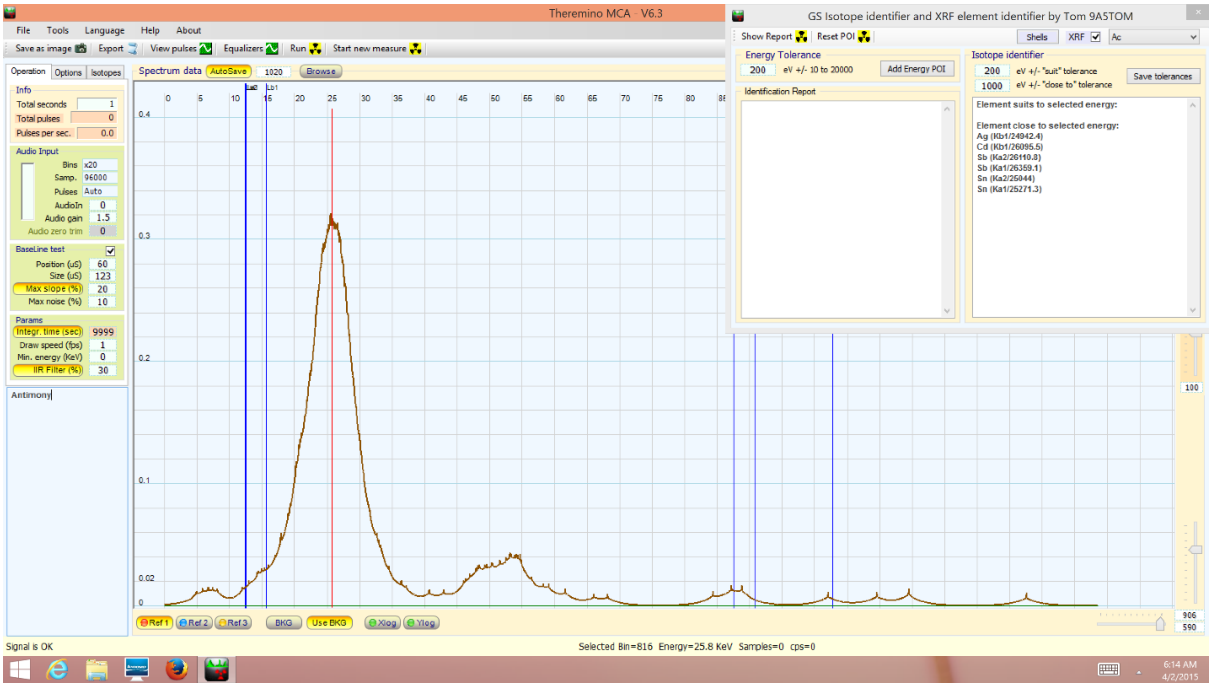
Silver



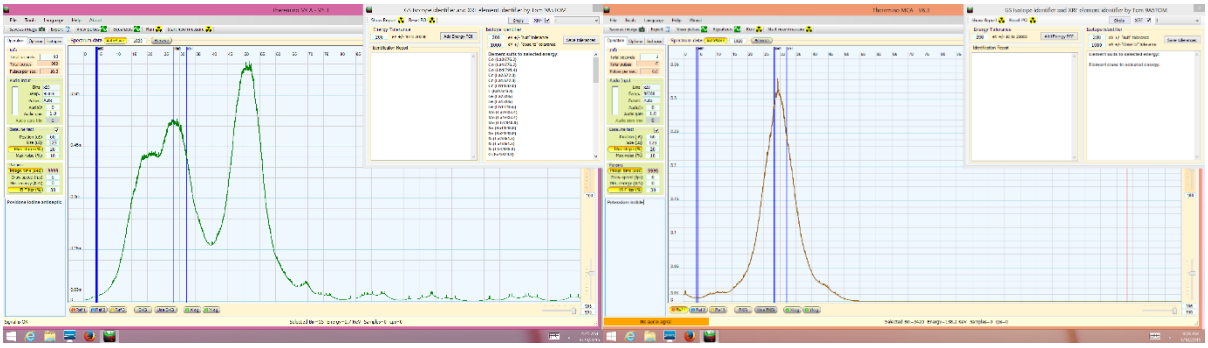
Small silver chain tightly packed .Notice the K peak without much scattering.I have easily auntheticated silverware bought from my overseas trips.

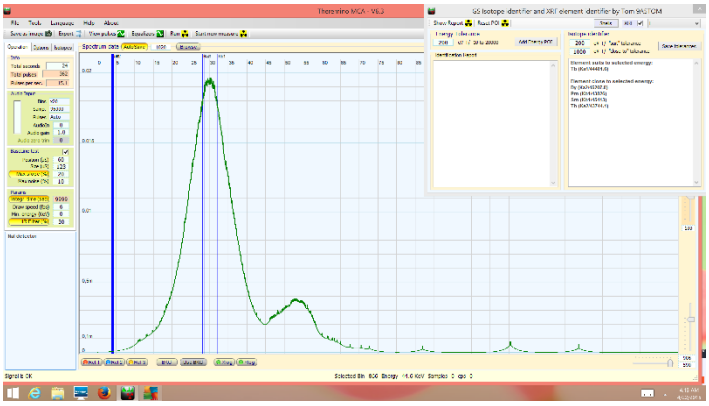
ANTIMONY

Antimony with different K peaks in the region.



IODINE



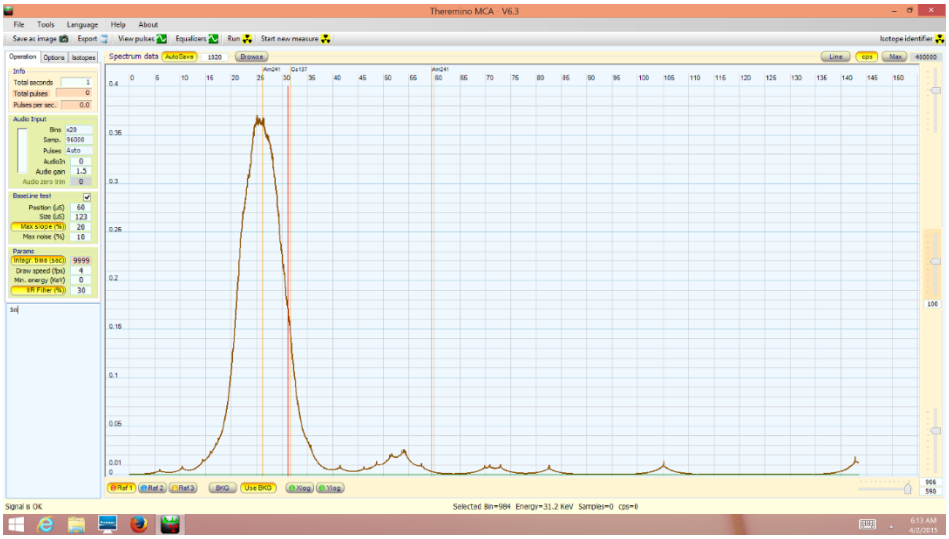


NaI detector(bottom pic) is an exellent source for iodine with small scatter on the right.Remember to put it the right way around.NaI shows backscatter due to the detector housing.

Iodide salt(top right) in this case a teaspoon of Potassium iodide wrapped with soft white tape gives bright peaks without much scatter.

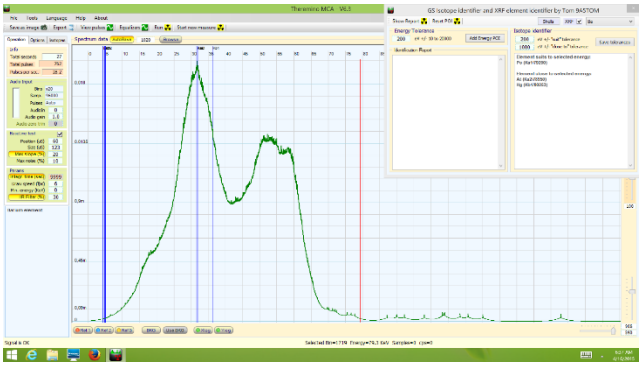
Povidone iodine (top left)antiseptic with scatter too due to its organic base.Pic above.

TIN



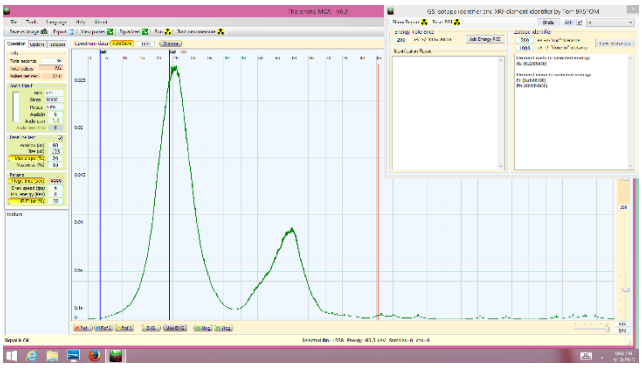
Pure tin showing K lines.

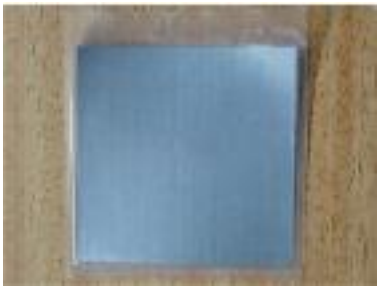
BARIUM



A pure barium sample immersed in oil.

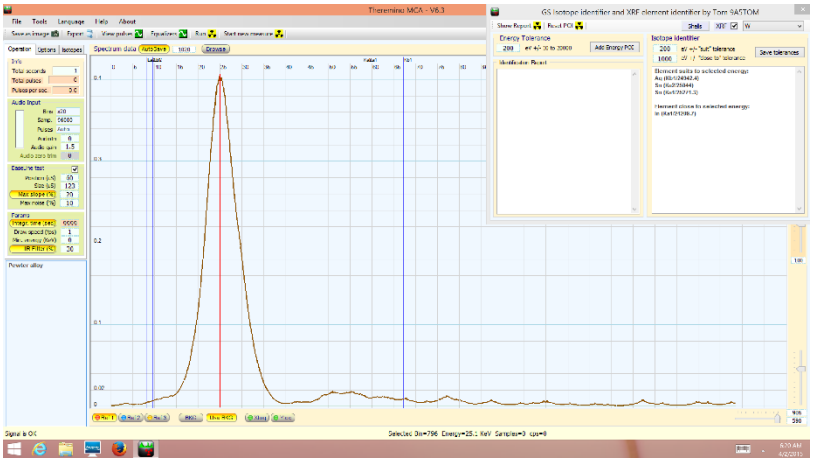
INDIUM





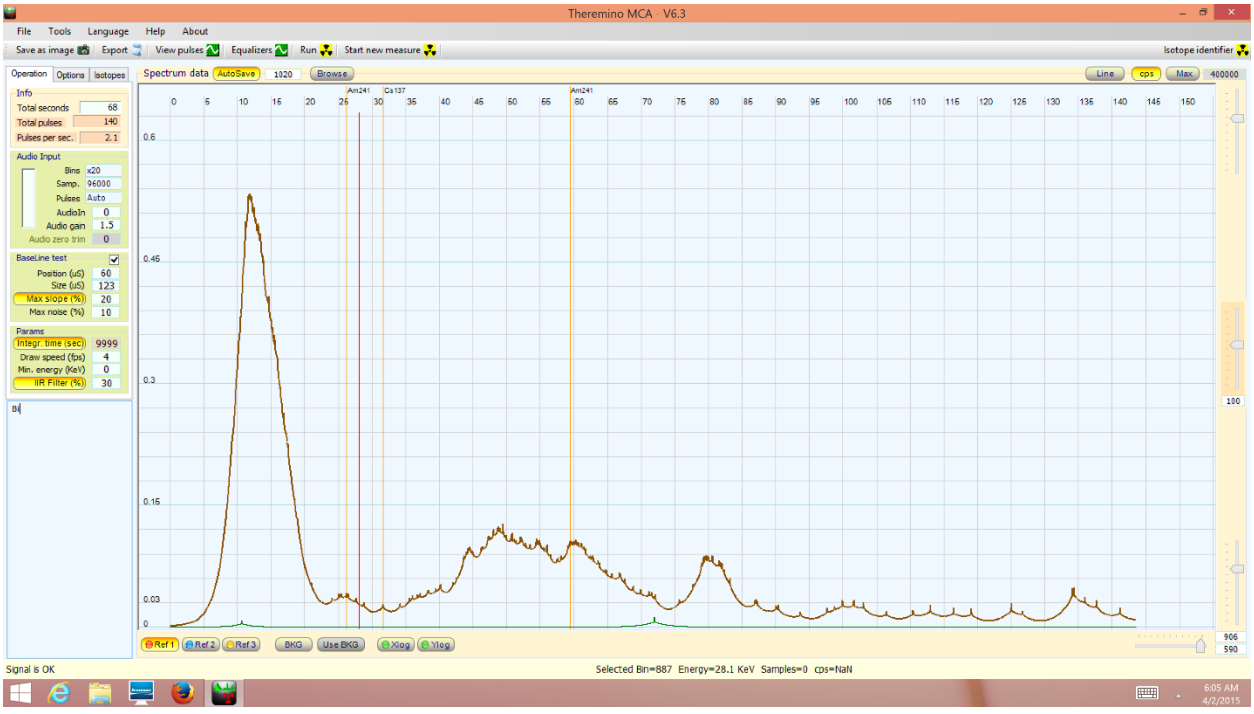
1 sq inch metal strip showing K peak with scatter

PEWTER



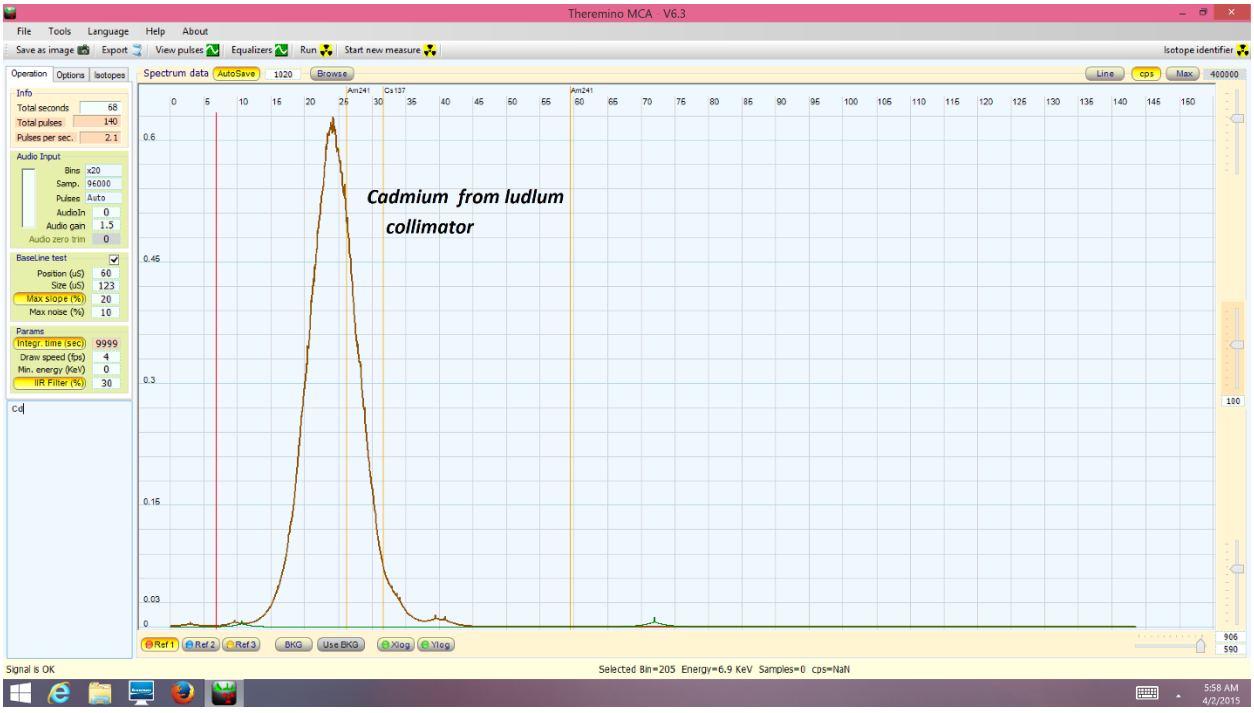
Alloy with mainly tin and other elements.Suggestive of tin.If I do the superimpose test which I left out,tin is most likely.Confirmation requires a sensitive detector to pick at least 2 peaks within tin line range.

BISMUTH



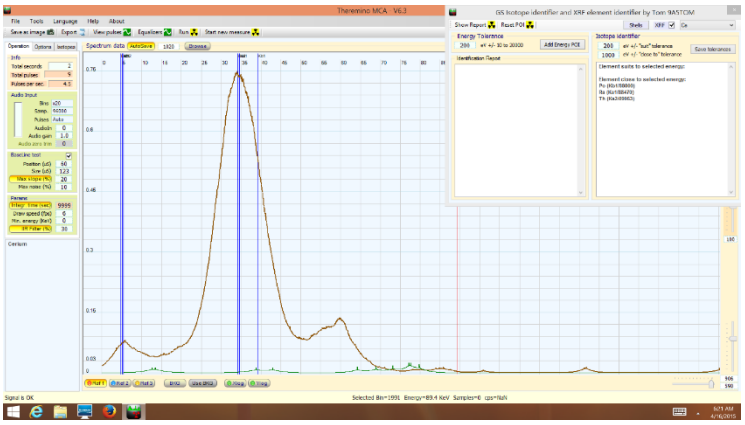
Pure bismuth metal showing L peak

cadmium



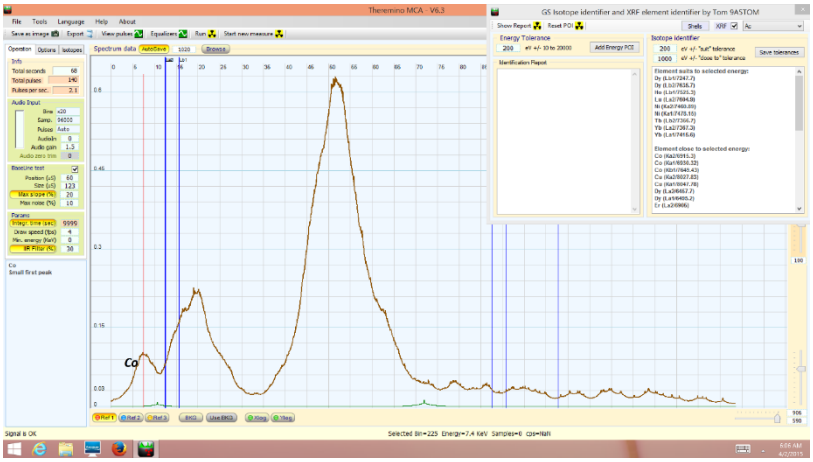
There is pic of cadmium provided in this file.Beware of cadmium toxicity.

Cerium



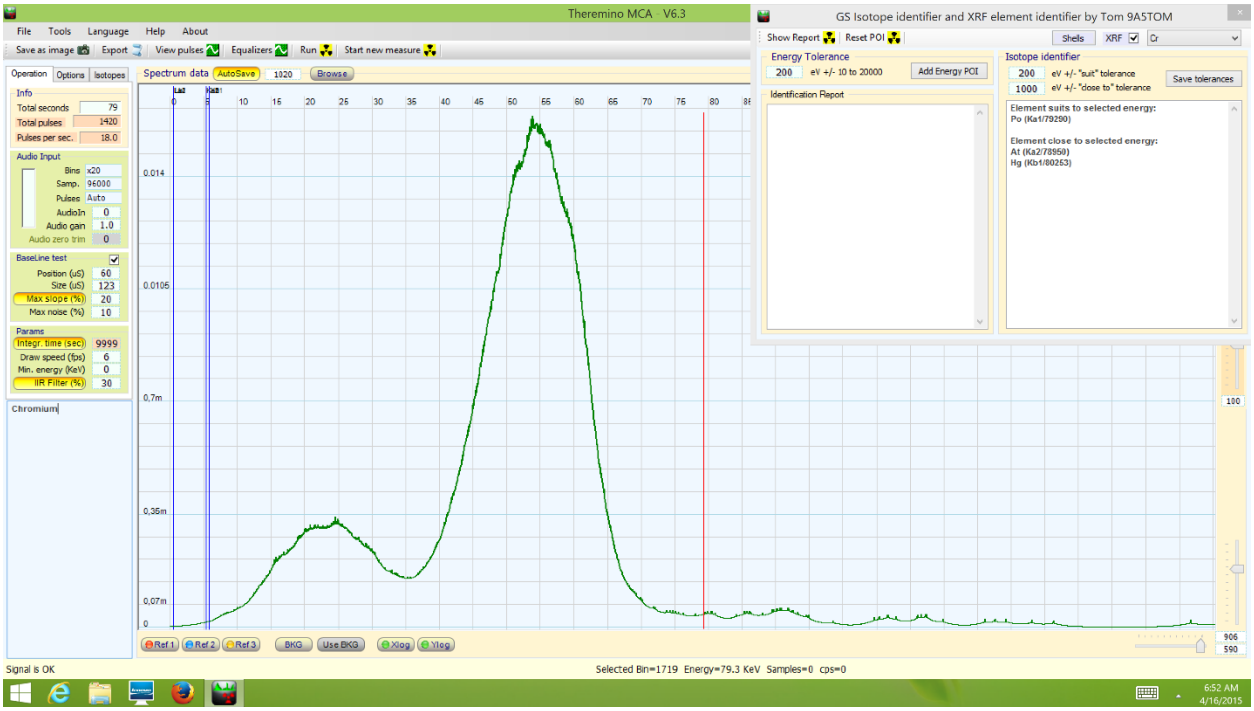
Cerium powder in pure form from China.Notice the K and possibly L peaks.Middle Z elements in the Periodic Table may give both K and L lines.

COBALT



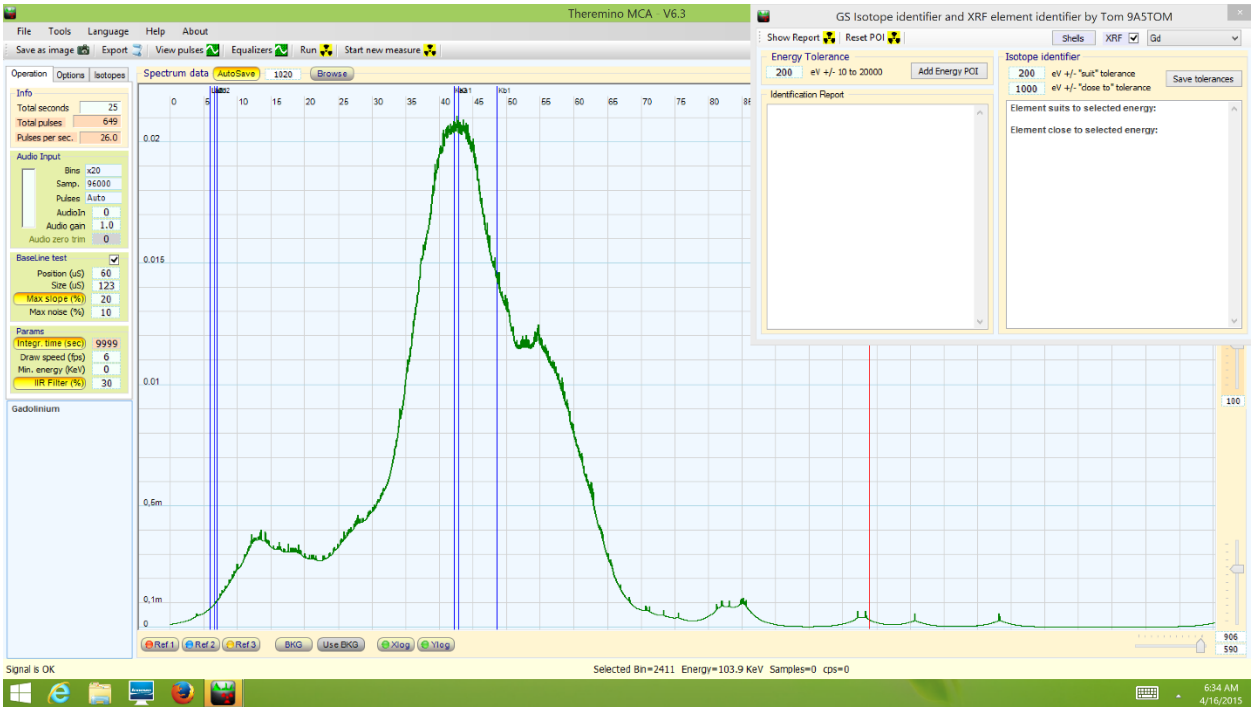
Pure electrolytic cobalt showing K peak.Low Z elements showing more gains in compton scattering unlike heavier metals.

CHROMIUM



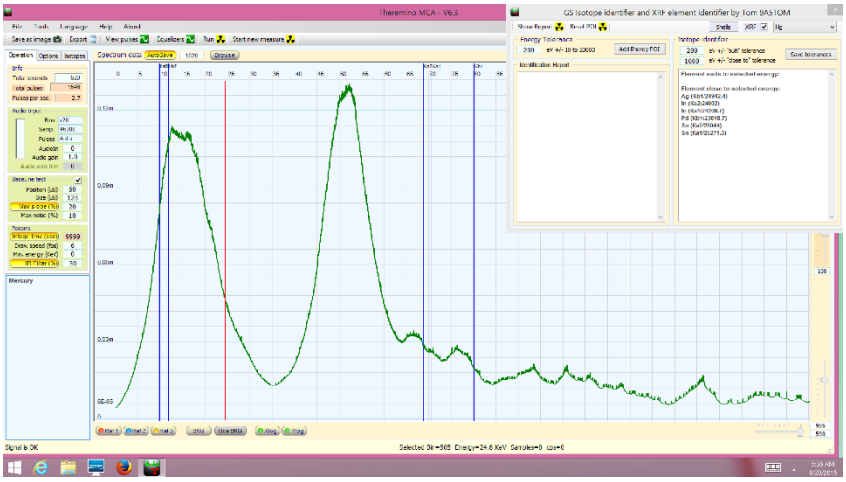
Pure chromium .. .. my detector not sensitive enough.Resolution improves with heavier element

GADOLINIUM



Pure Gadolinium showing K line . The lower peak is probably scatter.

MERCURY



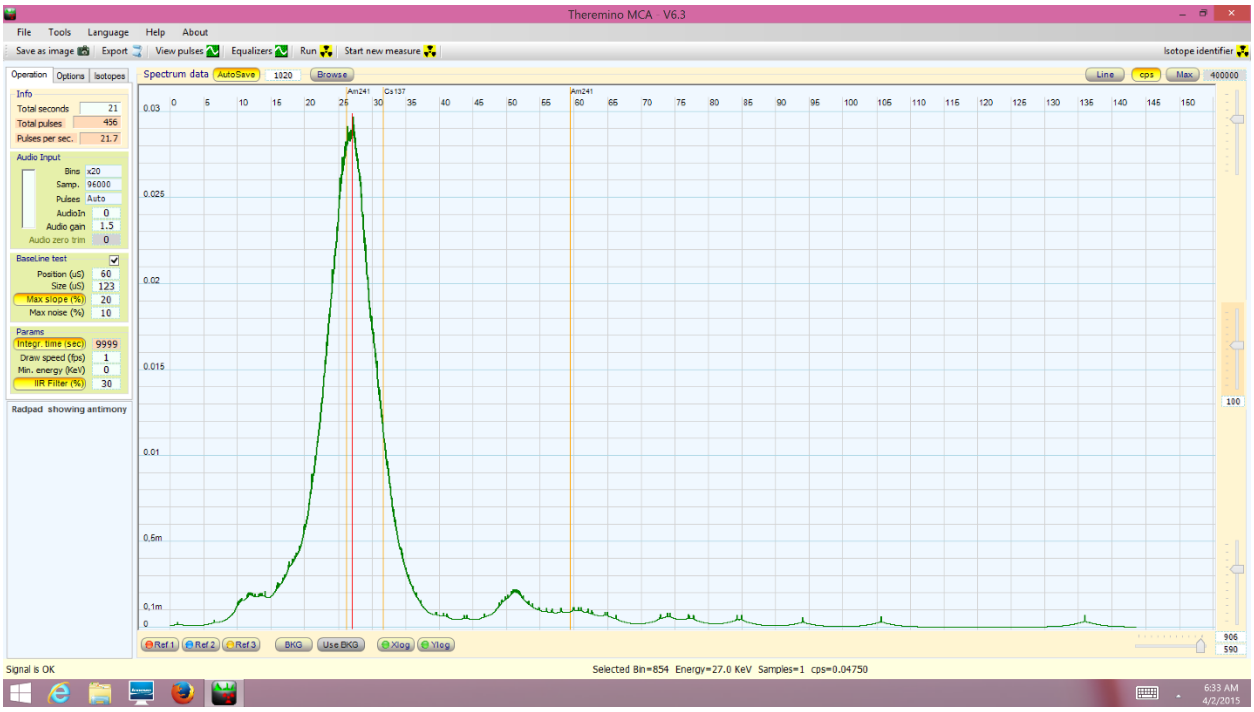
MERCURY

Mercury packed enabling more surface contact possible K line.

Radpad and cadmium sample I used.

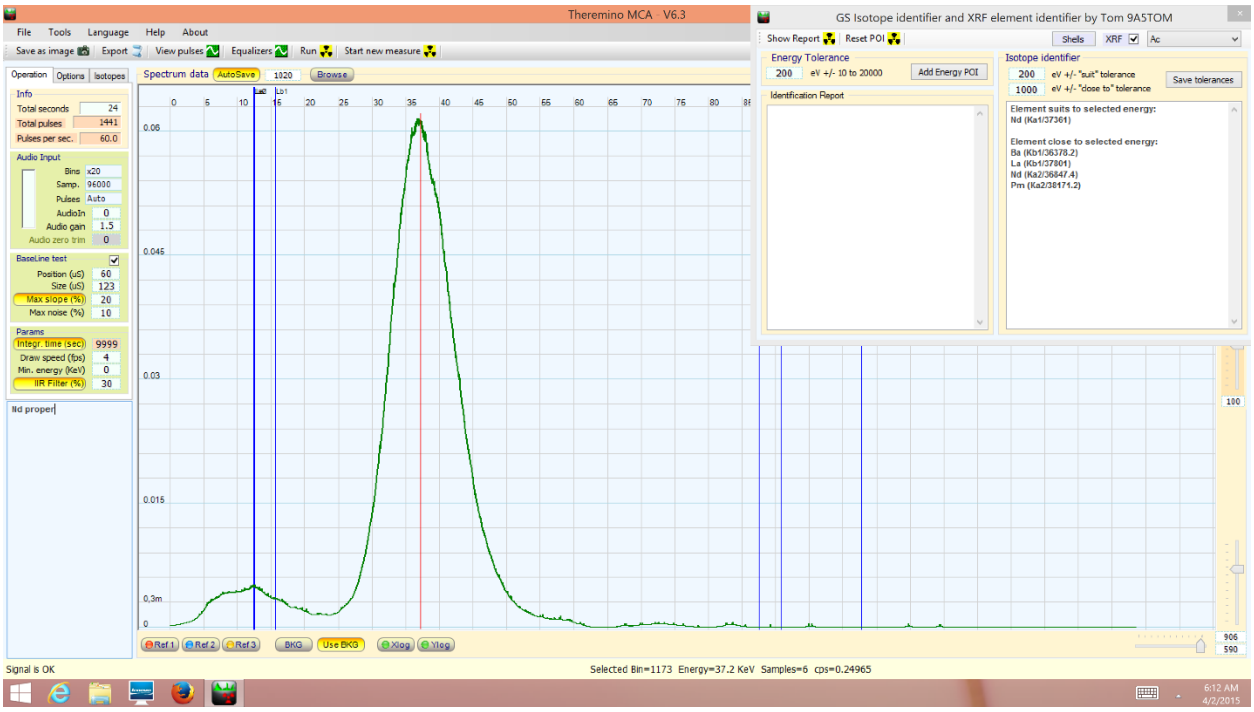
Radpad is lightweight metal polymer used doing fluoroscopy procedures to shield backscatter from patient to medical personel.

RADPAD



Radpad . Polymer being made of C.H,O and N do not produce xrf.Information about metal used in Radpad is scanty. There appears to be antimony here.Besides there was net literature stating antimony tungsten or bismuth barium??

Pure Neodynium powder

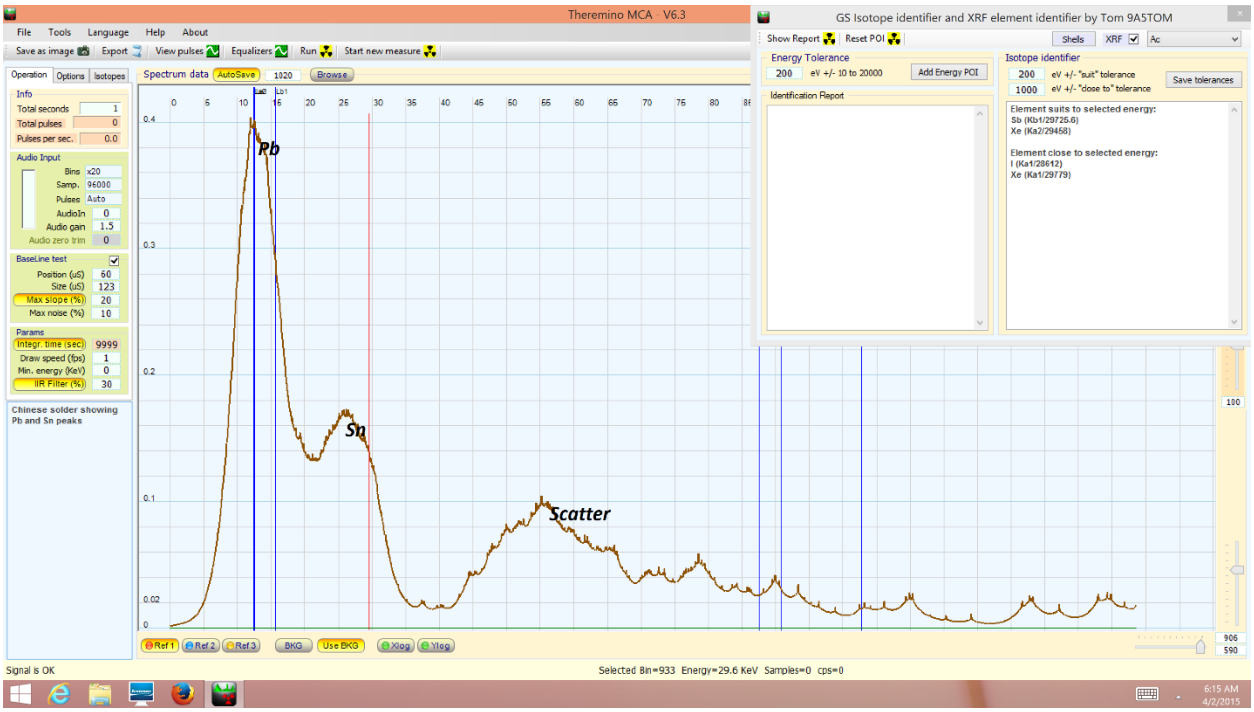


Nd powder showing K peak

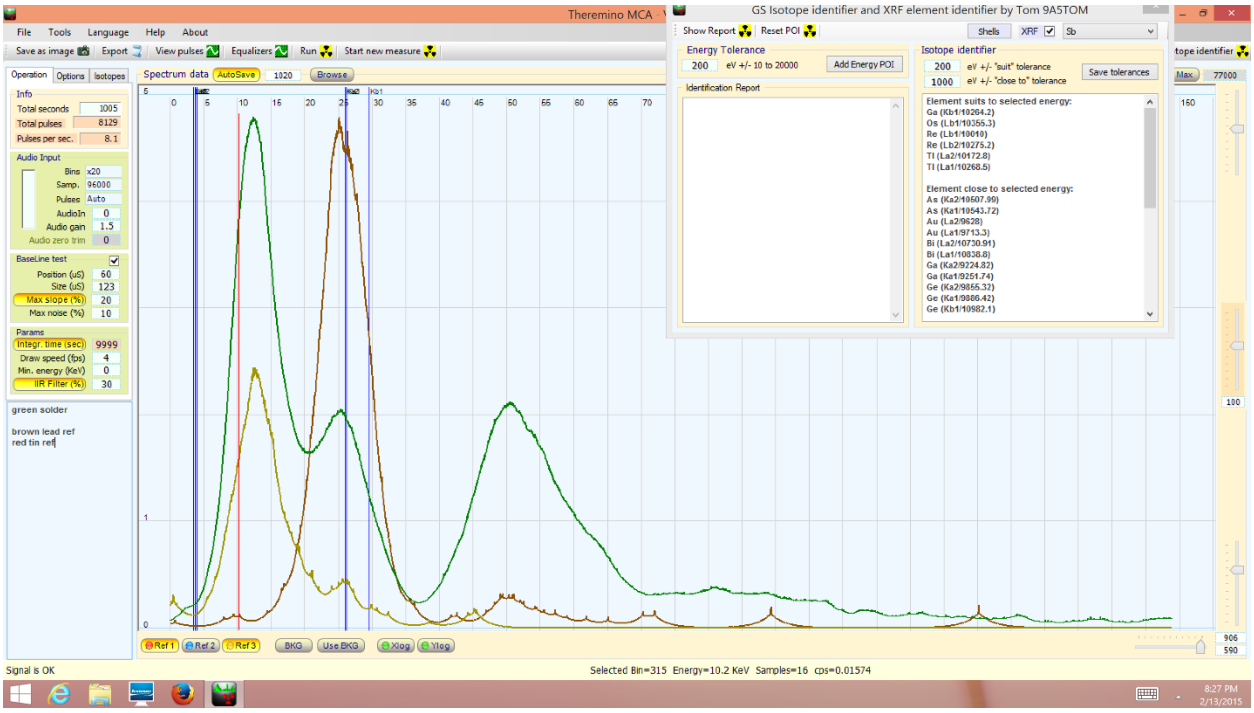
BNC ADAPTOR

Showing silver peak.This adaptor is coated with silver. Just goes to show xrf is “skin deep”

SOLDER


Theremino MCA V6.3
File Tools Language Help About
Save as image Export View pulses Equalizers Run Start new measure
Spectrum data AutoSave 1020 Browse
Pb
Sn
Scatter
Chinese solder showing Pb and Sn peaks
GS Isotope identifier and XRF element identifier by Tom 9A5TOM
Show Report Reset POI
Energy Tolerance
Add Energy POI
Identification Report
Isotope identifier
Save tolerances
Element suits to selected energy:
Sb (Kb1/29725.6)
Xe (Ka2/29458)
Element close to selected energy:
I (Ka1/28612)
Xe (Ka1/29779)
Signal is OK
Selected Bin=933 Energy=29.6 KeV Samples=0 cps=0

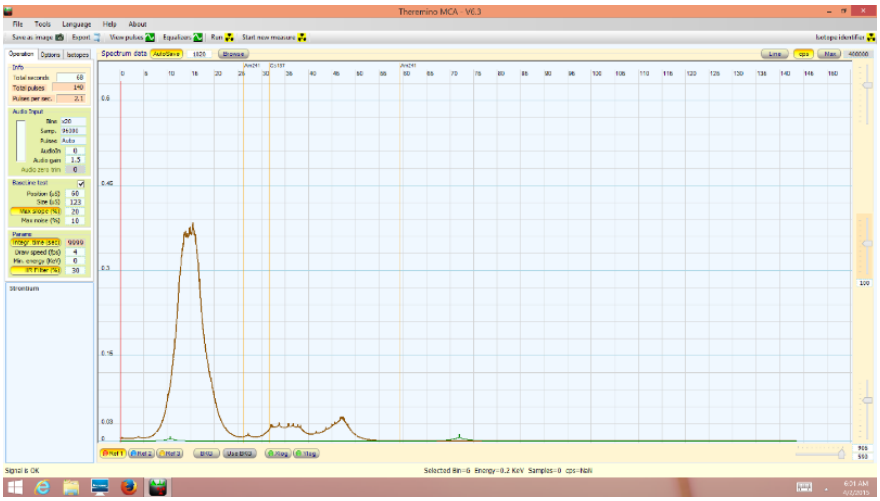
Chinese solder showing Pb and Sn. Supposedly 60:40 Sn/Pb but not here.Unable to assess concentration ratio.Need to do a series of test comparing known concentration ratio vs intensity and plotting a graph. Like a backdoor approach.Another approach is using least square fitting.



Three in one graph

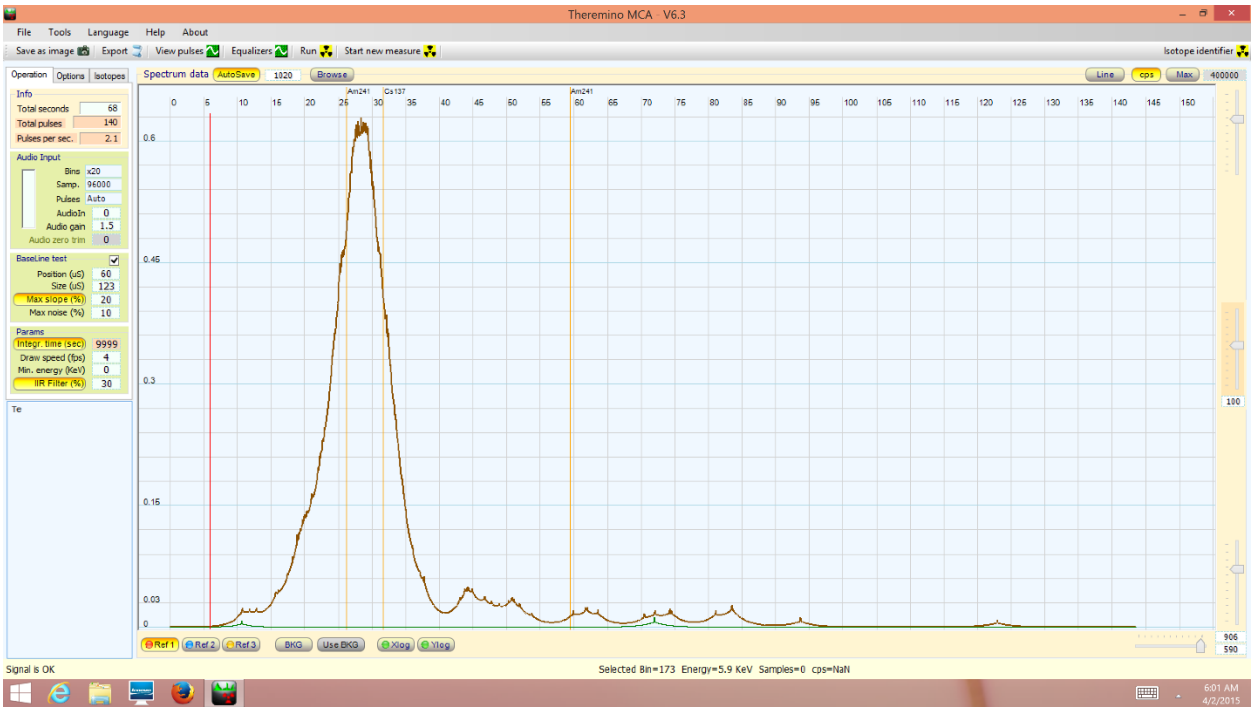
Sometimes due to resolution issues , I use this way to confirm my elements by superimposing the peaks

STRONTIUM



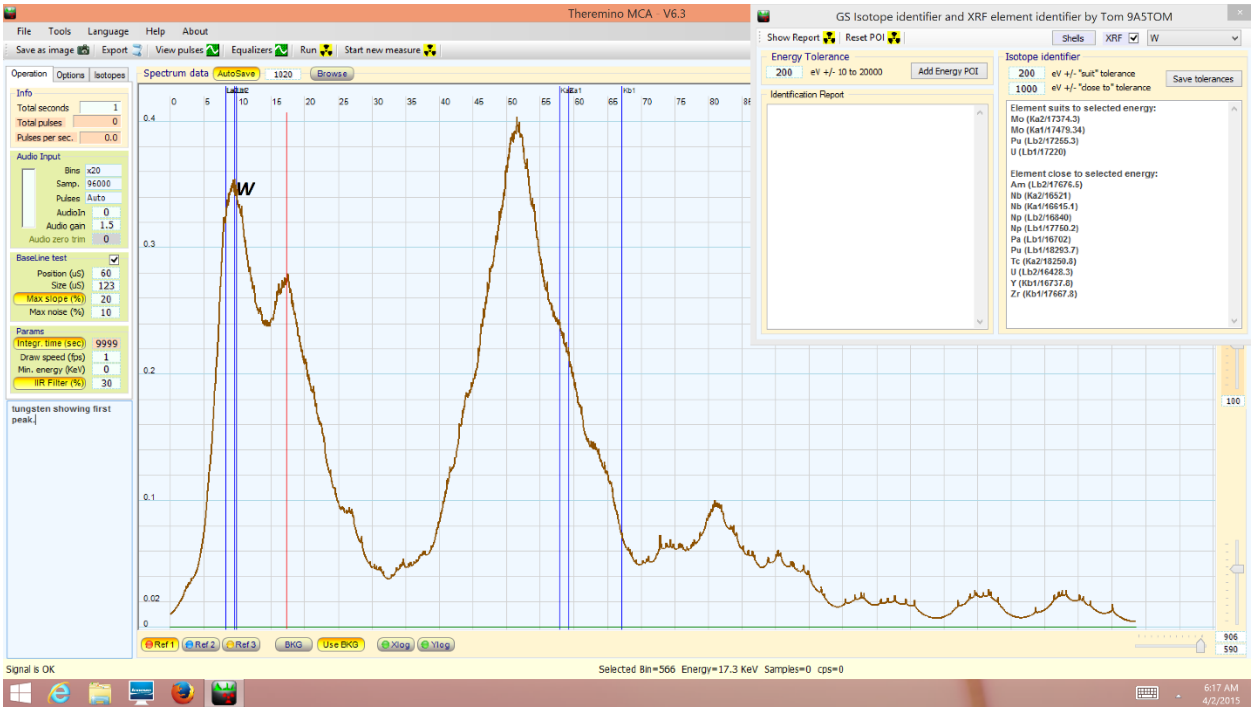
Strontium yellow powder

TELLURIUM



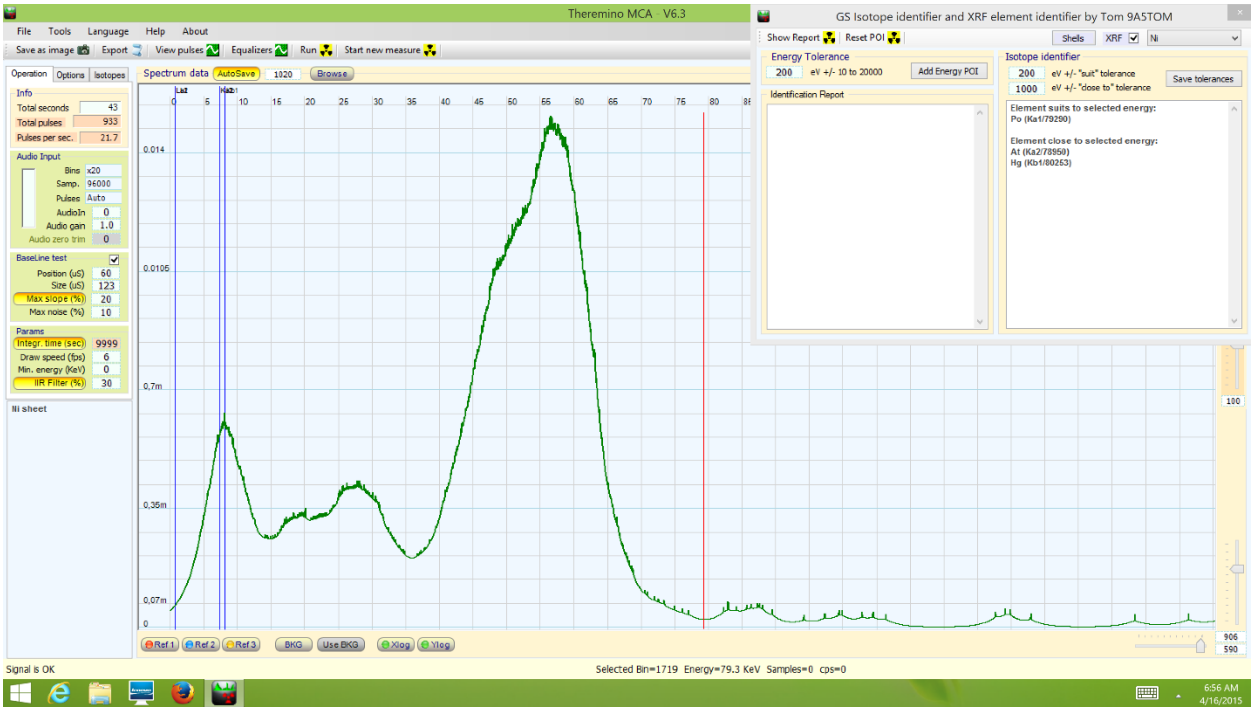
Rare earth tellurium

TUNGSTEN



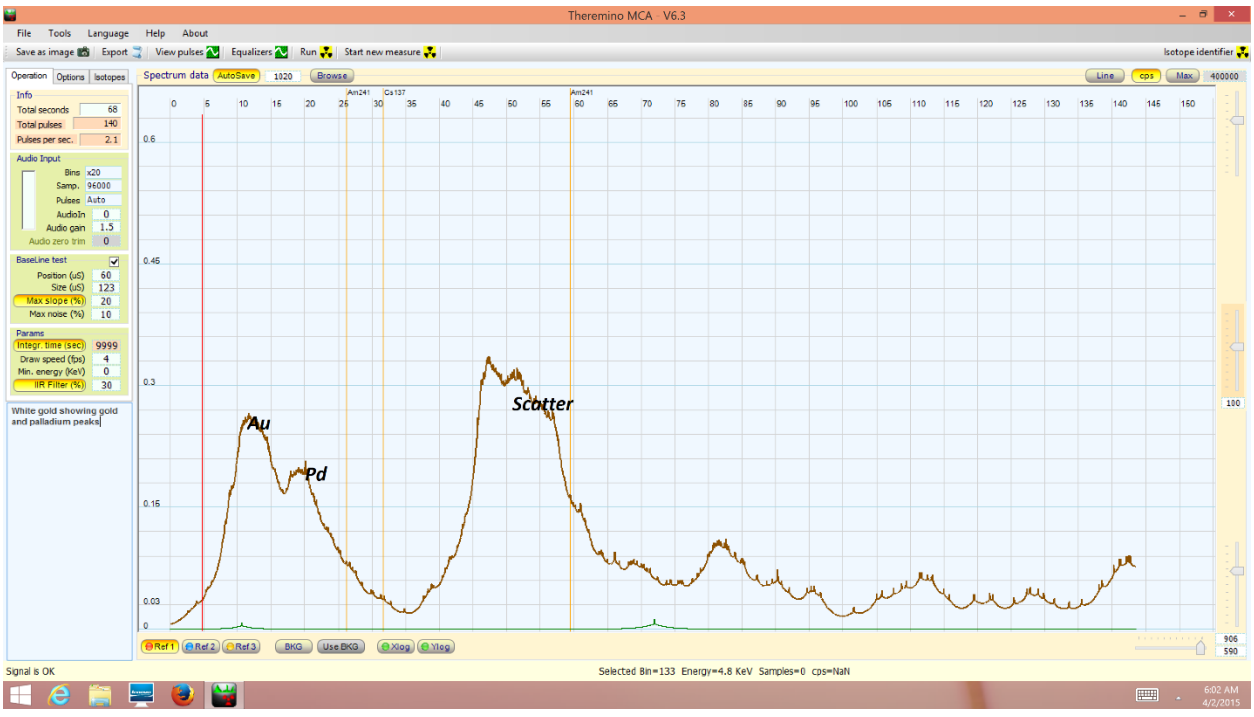
1 inch square tungsten metal showing L peak

NICKEL



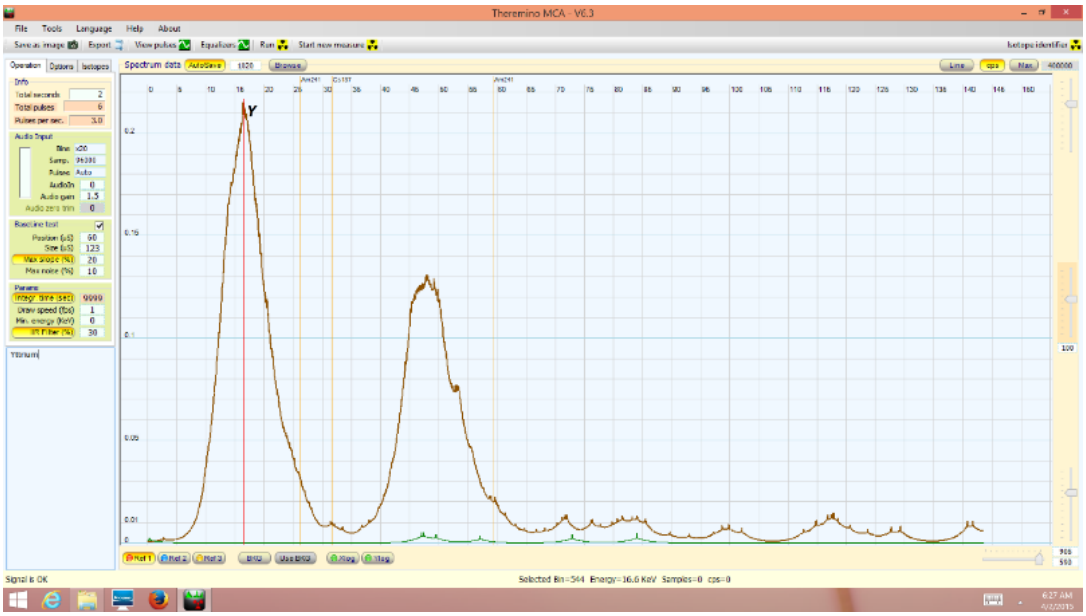
Nickel showing K peak and Compton scattering.

White gold .



White gold chain showing gold and palladium peak

YTTRIUM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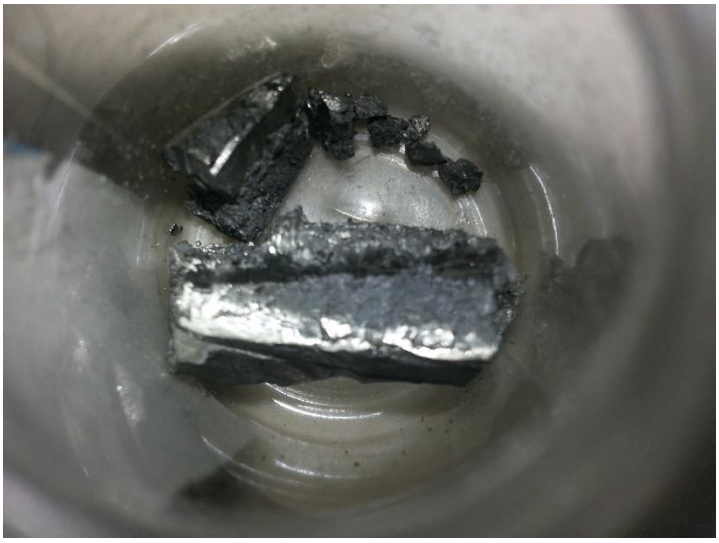
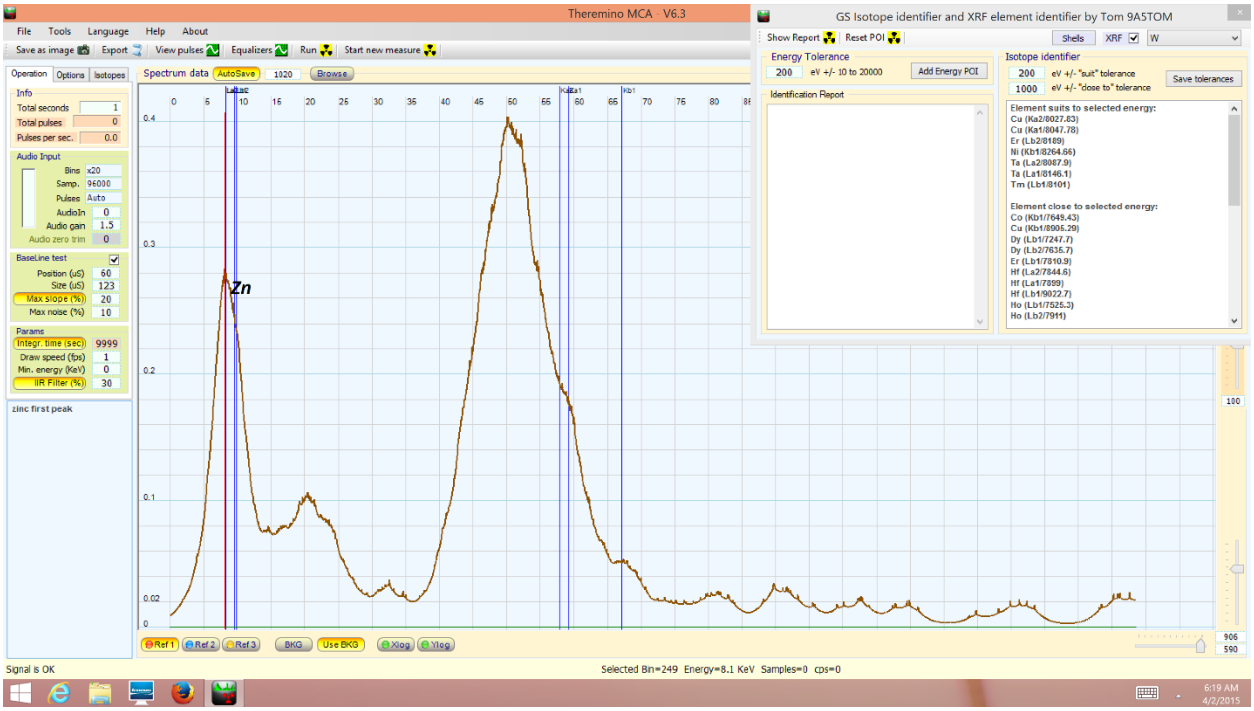
File Tools Language Help About
Spectrum data
Y
Signal is OK
Selected Bin=544 Energy=16.0 KeV Samples=0 cps=0



YTTERBIUM

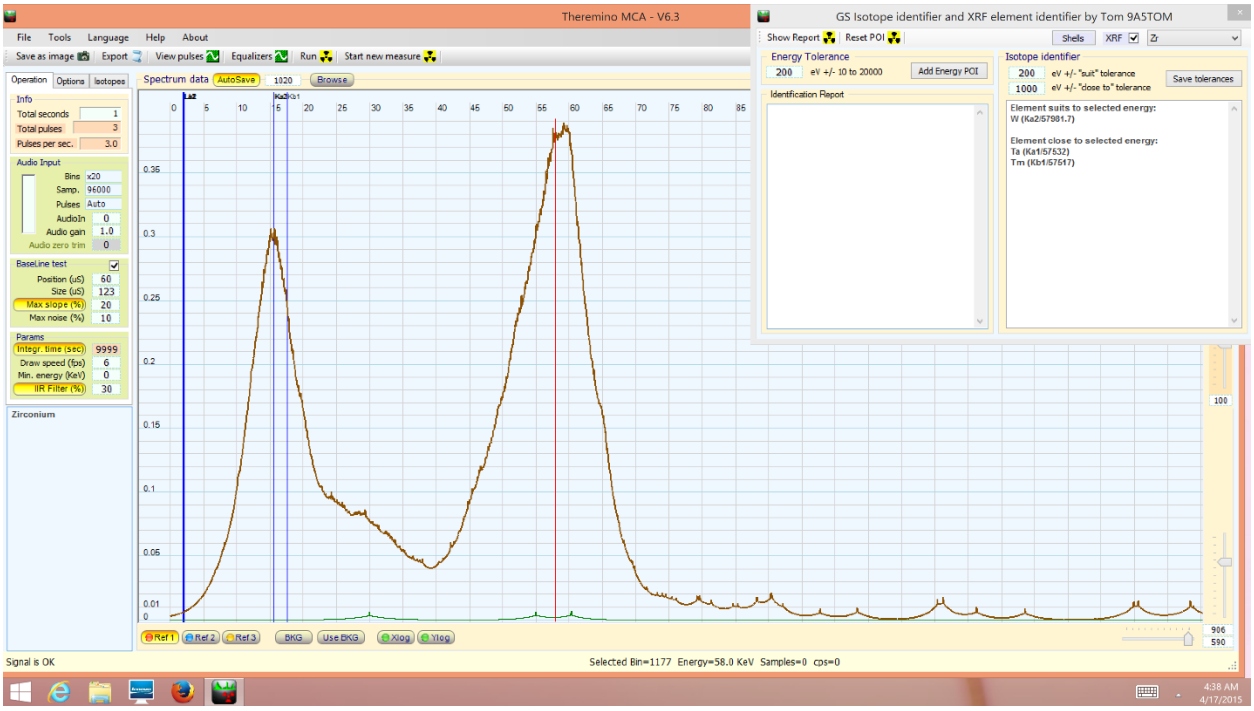
Yb showing K peak.Am 59 kev energy is sufficient to fluoresce Yb 51 kev energy.Sometimes confused between ytterbium and yttrium.Even their symbols are similar.

ZINC



Zinc showing K peak and scatter from low Z elements.

ZIRCONIUM



Zirconium metal.Not a kitchen knife.The right peak is scatter.

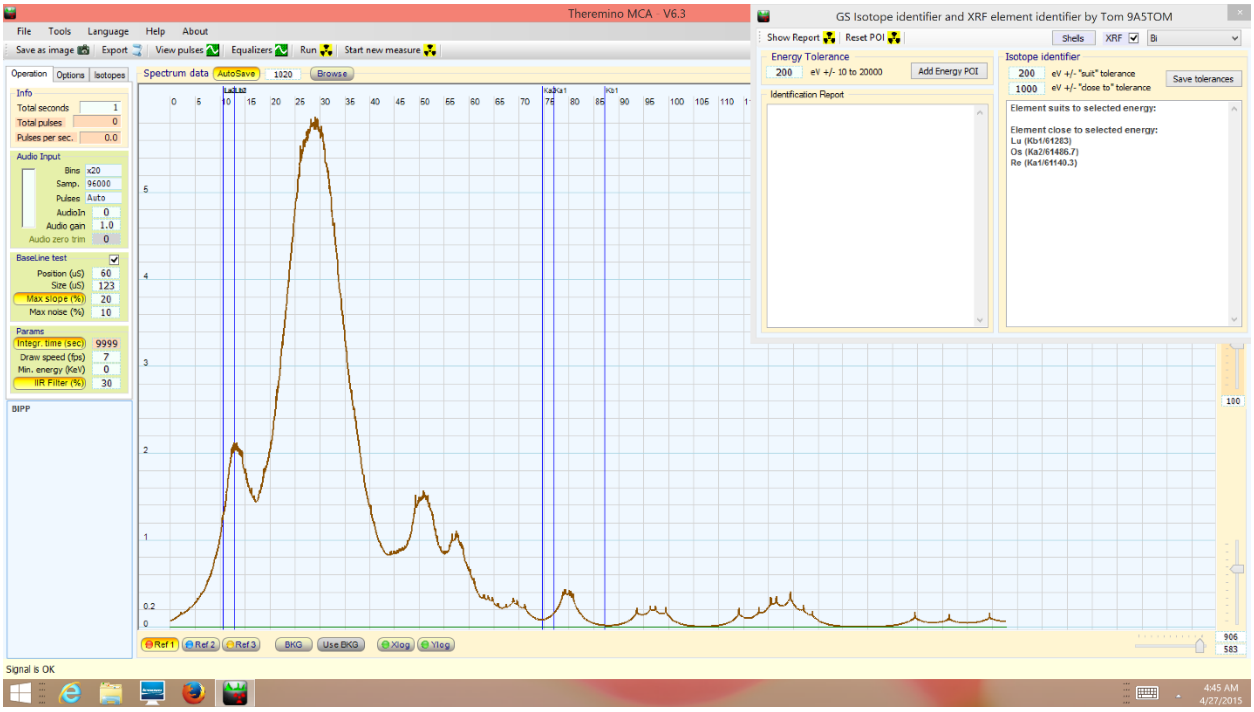
BIPP

Bismuth iodine paraffin paste. Used medically for nasal packing after soaking a long ribbon gauze with it

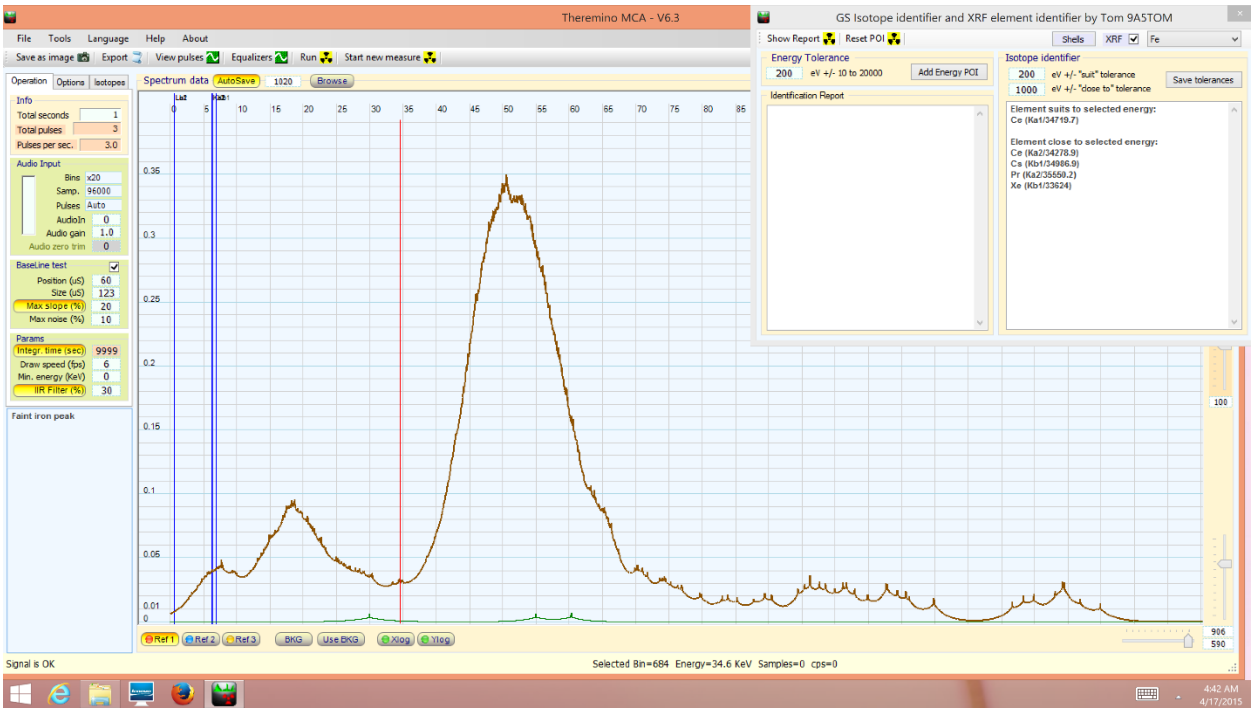
See Xrf pic .

BIPP

Showing Iodine peak and scatter on the right.There is a small shoulder peak on the left which corresponds to Bi L lines



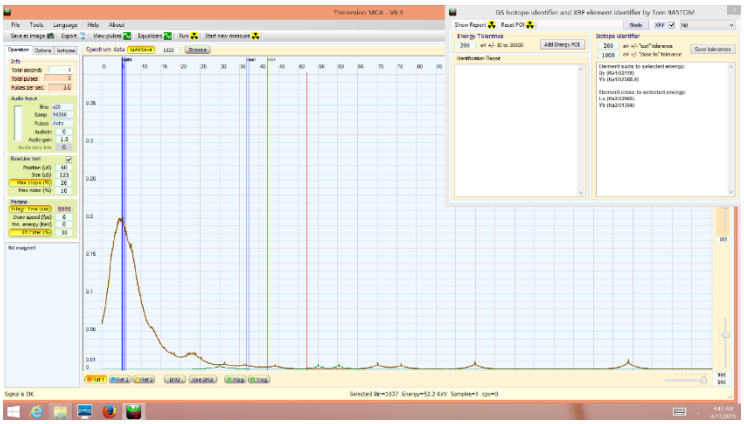
Iron



Small piece of rusting iron. Barely discernible peak.

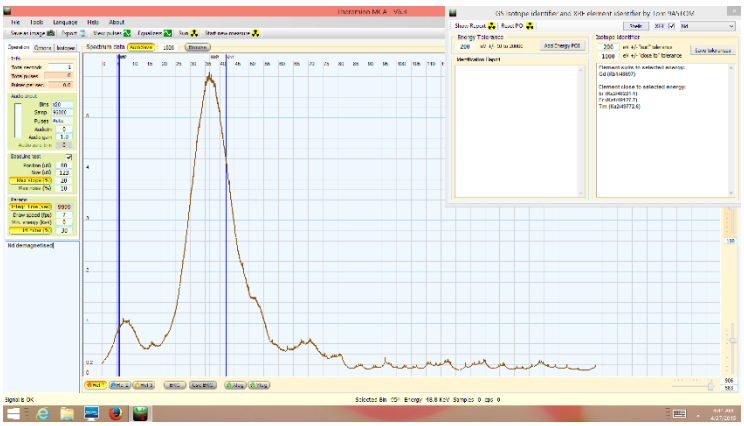
Nd magnet

Not demagnetized



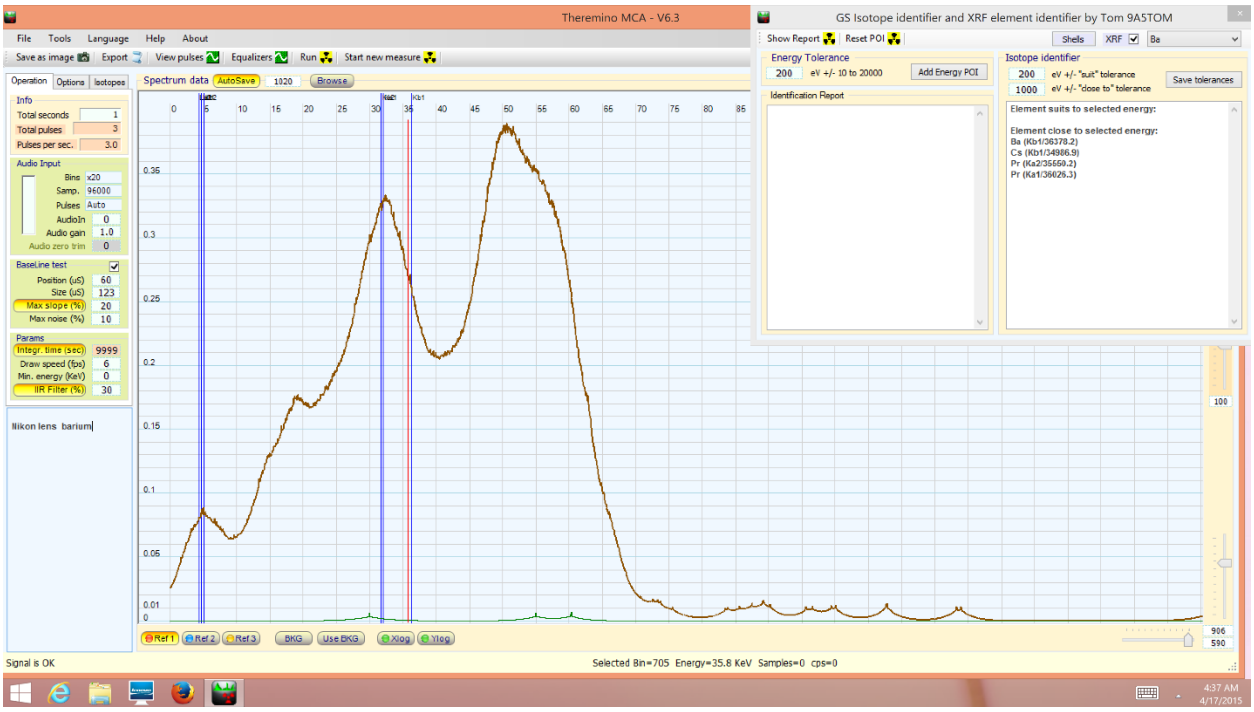
Nd magnet ..not demagnetized. Showing confusing results. Pure Nd does show pic like this .Magnets disturbs electronics and deviate electron flow through PMT tubes. It is best to demagnetize and deplate it first or get a native one.Kindly see Xrf for Nd pure in another section here.

Demagnetized



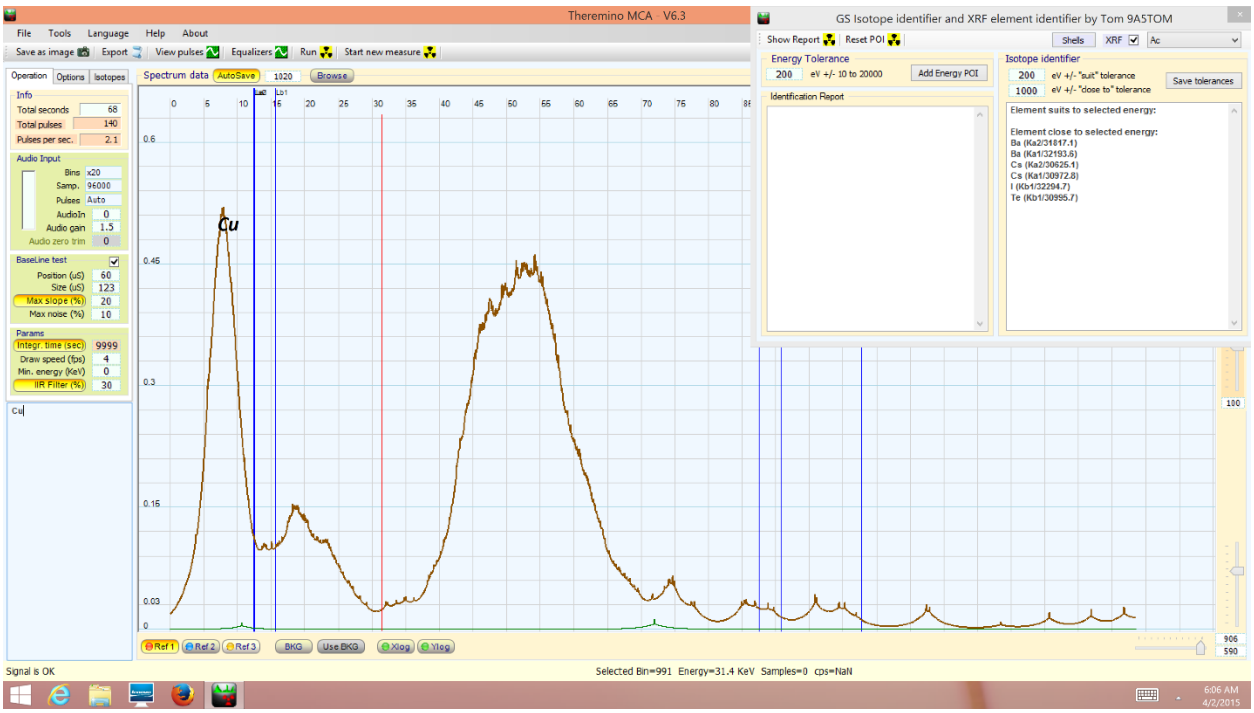
After heating over candle fire for 5 minutes showing Nd lines.

NIKON LENS



Barium peaks are seen here.Barium is added to improve refractive index.

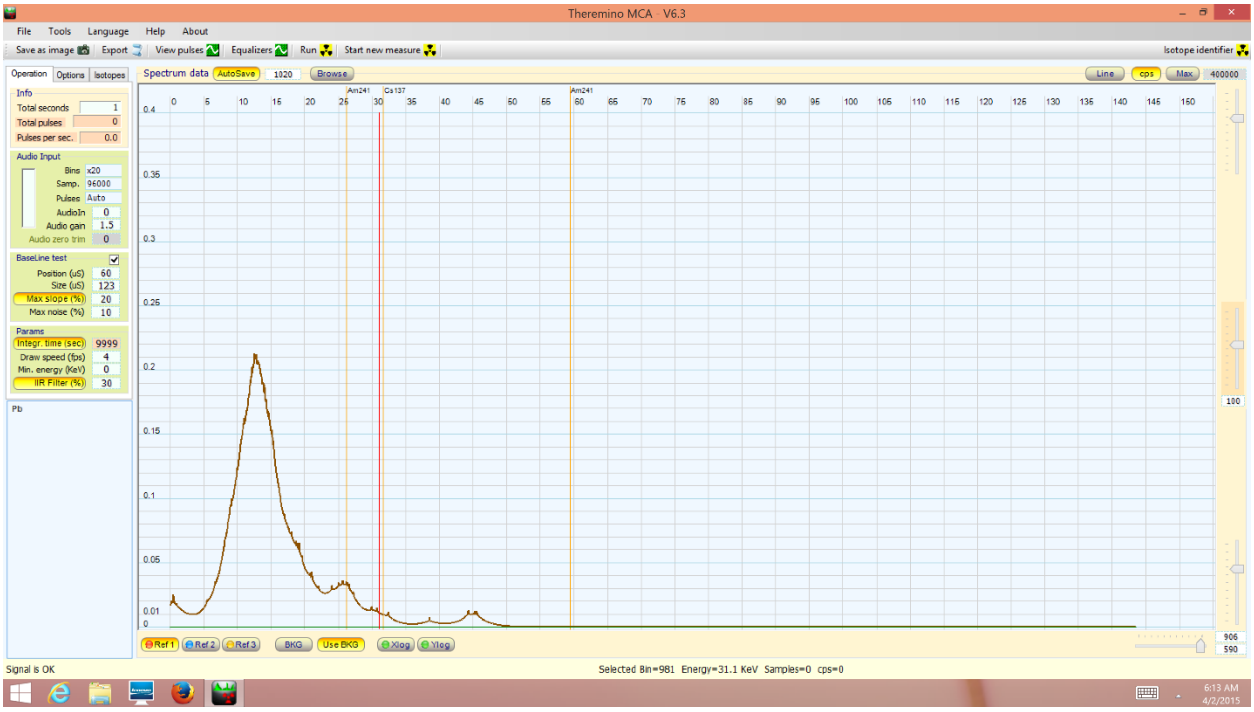
Copper



Copper K peak well seen with scatter on the right

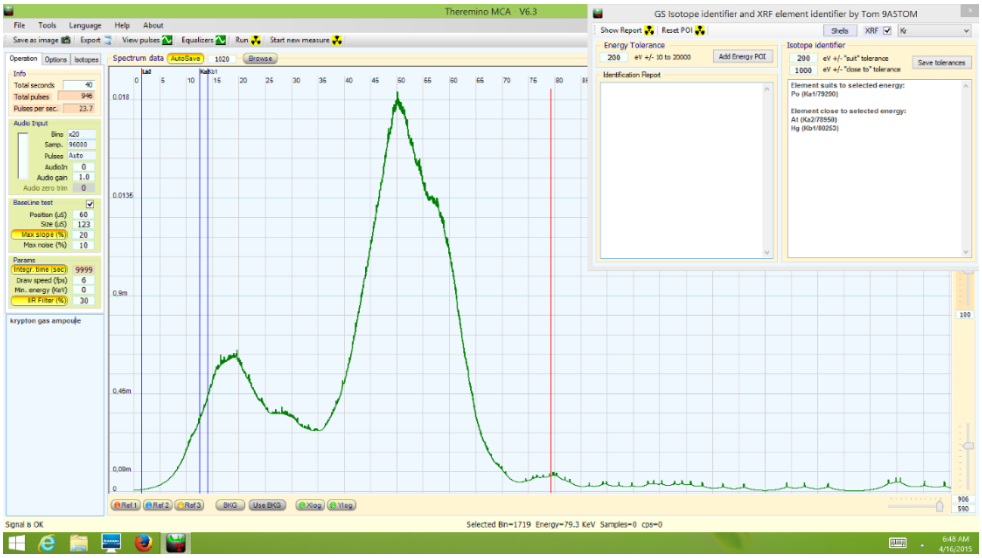
LEAD

My heavy lead gloves



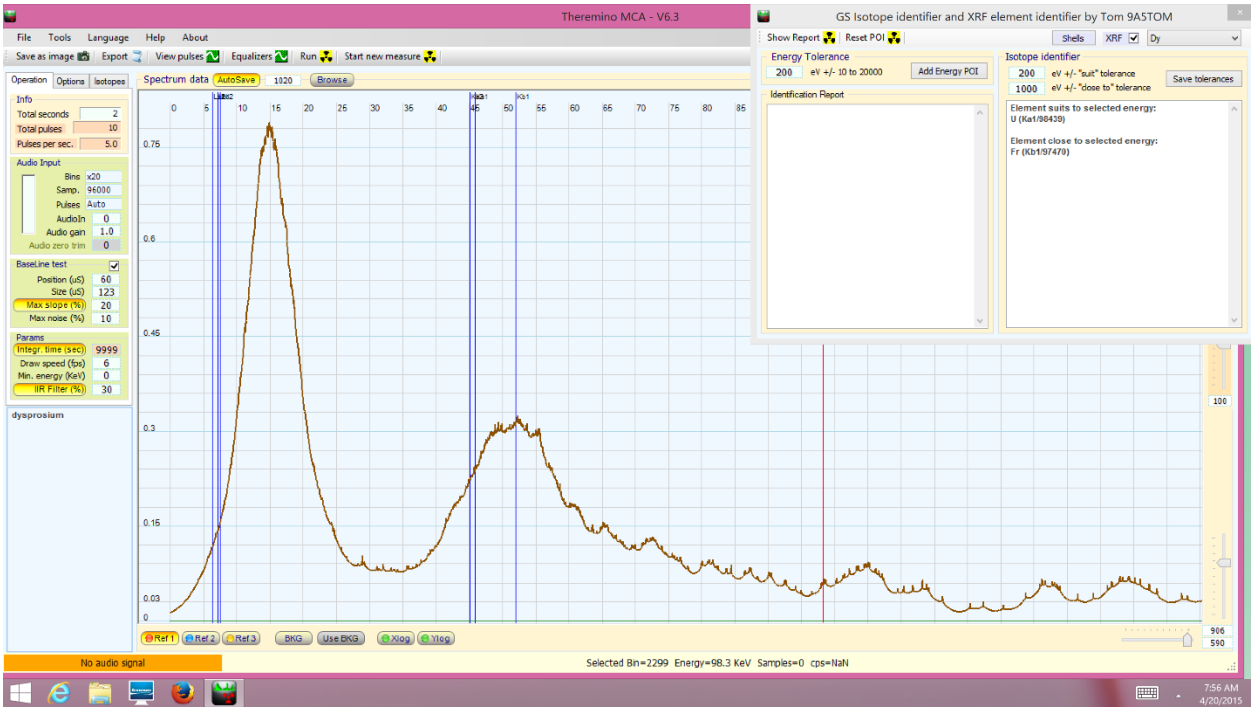
Pb L peak seen clearly.

Krypton

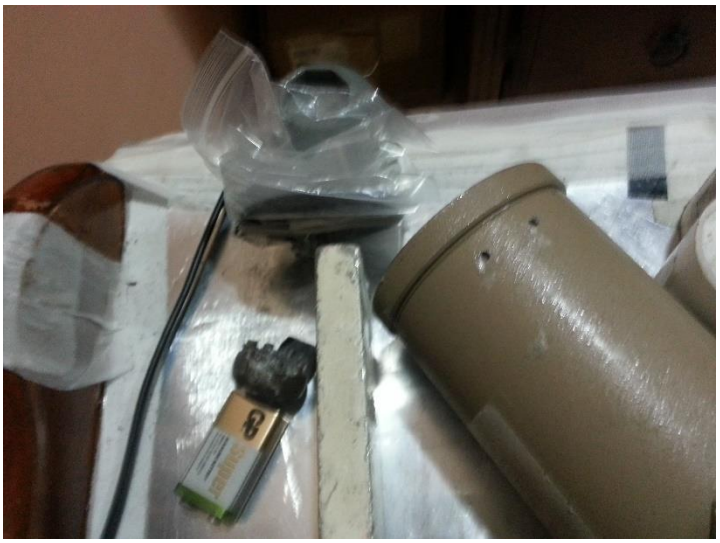


Krypton in plastic ampoule only showing plastic scattering.I guess xrf supports solids and liquids but not gases here.I need to work on this one .

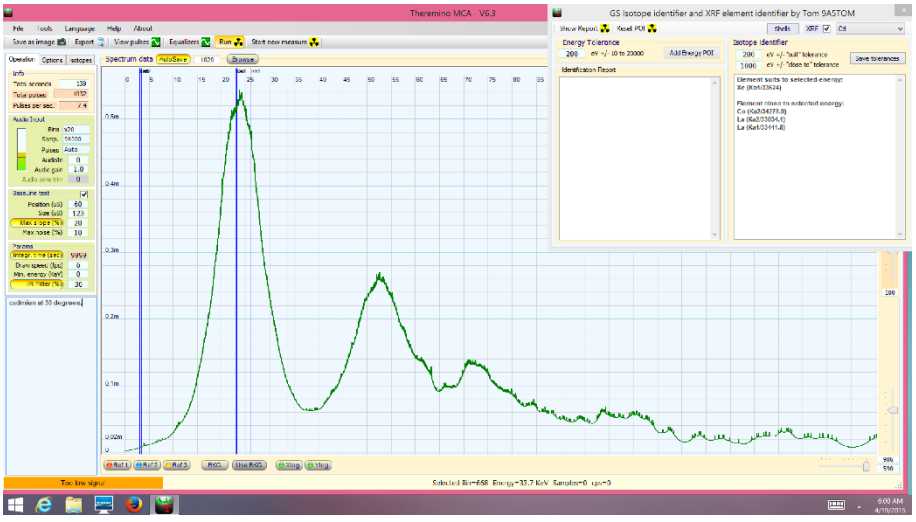
Dysprosium



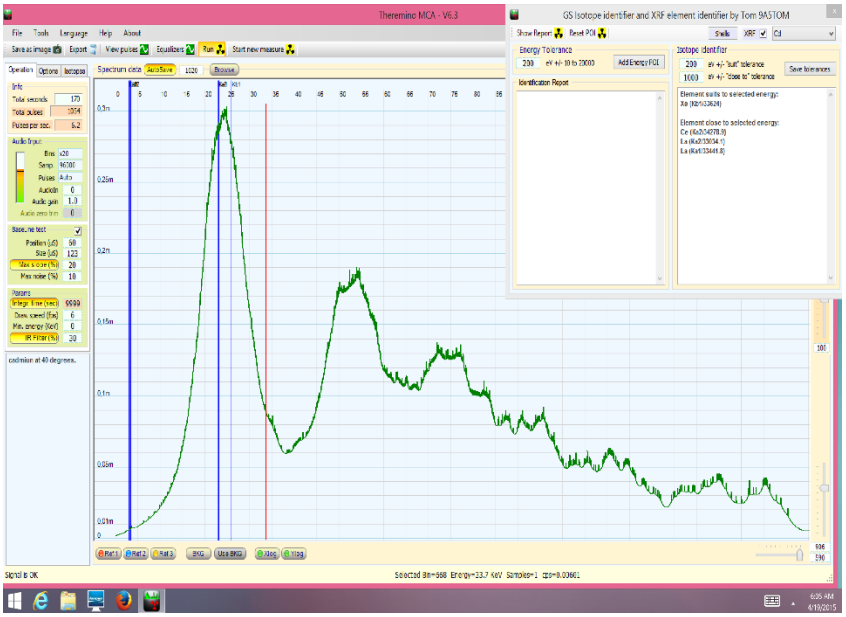
Small sample about 1 cm size.Due to tiny size and my flat source arrangement was difficult to get this spectrum.Not conclusive.



Experimenting with side setup.Americium source ,target and detector in an angle.The americium source on the left is separated from the detector by a lead block.This is to prevent backscatter from source.The target source is cadmium covered with plastic.The Am source is being supported by a battery.Similarly done with cerium and tin.

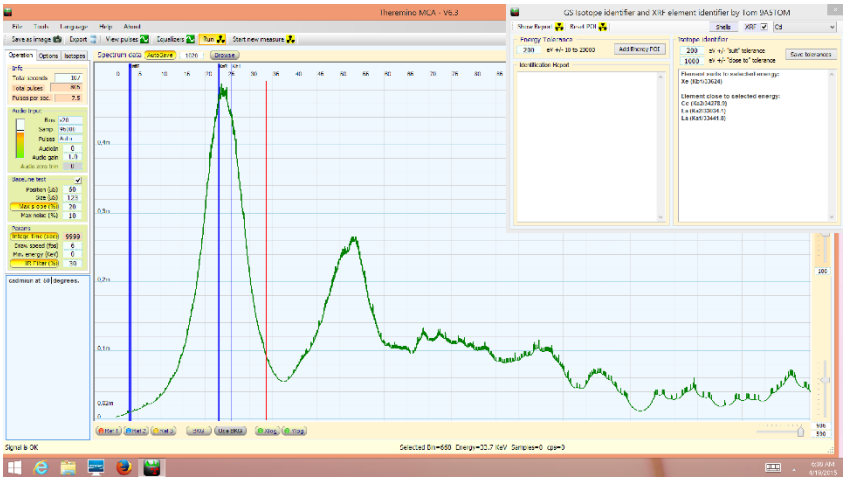


Cadmium at 30 degrees



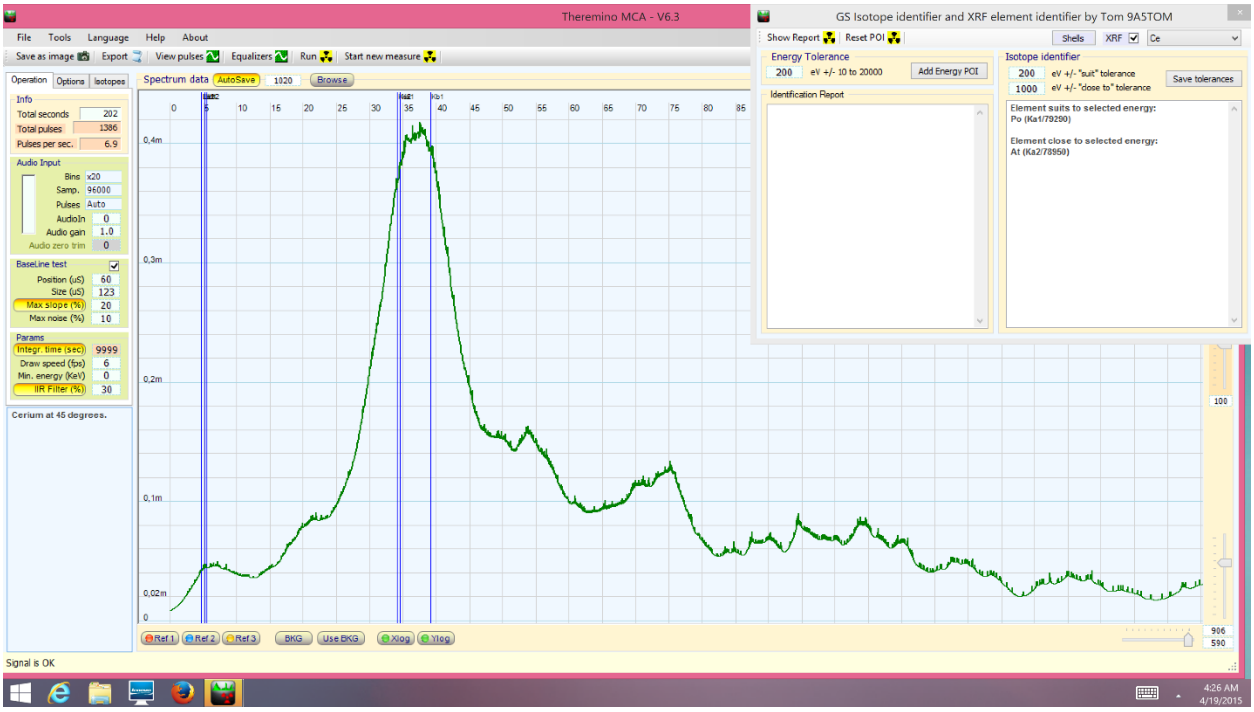
Cd at 40 degrees

Cd at 50 degrees



A tricky setup but if done properly can eliminate scatter significantly.But Compton Scattering is here to stay .By varying the angle at which the detector is placed ,the amount of Compton scatter changes,as seen from the Cd graphs.

Tin at 45 degrees



Cerium at 45 degrees

POINTS TO REMEMBER

ORGANIC ELEMENTS (H,C,N,O) DO NOT GIVE XRF PEAKS

LOW Z ELEMENTS ONLY GIVE K LINES

HIGH Z ELEMENTS ONLY GIVE L LINES

MIDDLE Z ELEMENTS MAY GIVE BOTH K AND L LINES

THANKS TO GEO FOR HIS FEEDBACK

Thank you Thermimo team for this wonderful software.

TARAY

sukhjez@yahoo.com